City of Sebastian

Stormwater Master Plan Update

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City of Sebastian

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B Central Indian River Lagoon Basin Management Action Plan

C Indian River Lagoon National Estuary Program Comprehensive Conservation and Management Plan

D Integrated Pest Management Plan

E United States Department of Agriculture / Natural Resources Conservation Service Soil Survey Report

F NOAA National Geodetic Survey Coordinate Conversion and Transformation Tool

G NOAA Atlas 14 Precipitation Frequency Data

H Inspection & Maintenance Standard Operating Procedures

I Capital Improvement Plan Detailed Cost Estimates

J Stormwater Asset GIS Database

K Stormwater Network Summary Tables

Acronyms and Abbreviations

ac	Acres
AST	Above-ground Storage Tank (Petroleum)
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CCMP	Comprehensive Conservation and Management Plan
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan
CIRL	Central Indian River Lagoon
(the) City	City of Sebastian
CMMS	Computerized Maintenance Management System
COD	Chemical Oxygen Demand
CoR	County Road
CR	Citizen Request
CWA	Clean Water Act
DEM	Division of Emergency Management
DO	Dissolved Oxygen
ECFTX	East Central Florida Transient Expanded Model
EOS	Extent of Service
ERU	Equivalent Residential Unit
F.A.C. or FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
F.S.	Florida Statutes
ft	Foot
FWRA	Florida Watershed Restoration Act
GDC	General Development Corporation
GI	Green Infrastructure

GIS	Geographic Information System
GISB	Grate Inlet Skimmer Box™
GMSL	Global Mean Sea Level
H&H	Hydrologic and Hydraulic
HAB	Harmful Algal Bloom
HMGP	Hazard Mitigation Grant Program
HSG	Hydrologic Soil Groups
HTF	High Tide Flooding
ICPR	Interconnected Channel and Pond Routing (model)
IPC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IRFWCD	Indian River Farms Water Control District
IRL	Indian River Lagoon
IRLCCMP	Indian River Lagoon Comprehensive Conservation and Management Plan
IRLNEP	Indian River Lagoon National Estuary Program
kg	Kilogram
km	Kilometer
LA	Load Allocation
lbs	Pounds
LDC	Land Development Code
LDR	City of Sebastian Land Development Regulation
LET	Load Estimation Tool
LOS	Level of Service
m	Meter
MCM	Minimum Control Measures
mgd	Million Gallons Per Day
mg/L	Milligrams Per Liter
MHHW	Mean Higher High Water
MS4	Municipal Separate Storm Sewer System
mt	Metric Tons
N/A	Not Applicable

NAVD88	North American Vertical Datum of 1988
NCAT	National Geodetic Survey Coordinate Conversion and Transformation Tool
NEP	National Estuary Program
NGVD	National Geodetic Vertical Datum
NIRL	North Indian River Lagoon
NOAA	National Oceanic and Atmospheric Administration
NOD	Nitrogenous Oxygen Demand
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
OSTDS	Onsite Sewage Treatment and Disposal System
PE	Professional Engineer
PLSM	Pollutant Load Screening Model
PUD	Planned Unit Development
R&R	Renewal and Replacement
RSL	Relative Sea Level
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SIRL	South Indian River Lagoon
SMPU	Stormwater Master Plan Update
SOP	Standard Operating Procedure
SR	State Road
SRID	Sebastian River Improvement District
SRWCD	Sebastian River Water Control District
SU	Stormwater Utility
SWIL	Spatial Watershed Iterative Loading
SWIM	Surface Water Improvement Management
SWMP	Stormwater Management Program
SWMS	Stormwater Management System
SWPPP	Stormwater Pollution Prevention Plan

TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WBID	Waterbody Identification (number)
WCD	Water Control District
WLA	Waste Load Allocation
WMD	Water Management District
WSL	Water Surface Level
WWTF	Wastewater Treatment Facility
yr	Year

1 Introduction

This Stormwater Master Plan Update (SMPU) has been prepared in accordance with the City of Sebastian's (City) Comprehensive Plan Policy No. 4.1.4.2 and the Stormwater Master Plan Agreement (RFQ 20-05) between the City and Arcadis U.S., Inc., executed on October 15, 2020. This update represents a substantial revision of the 2018 Stormwater Master Plan Update that was completed by CWT Engineering, LLC in August 2018. This SMPU was prepared in accordance with the scope of services to leverage existing data and resources, include a Capital Improvements Plan (CIP) that will meet City needs, be practical and feasible to implement, and provide steps needed to apply for federal and state funding for the CIP projects.

1.1 Background

The City of Sebastian is located in the northern section of Indian River County at the confluence of the St. Sebastian River and the Indian River, approximately 95 miles southeast of Orlando and 12 miles north of the City of Vero Beach. Sebastian is the largest city in Indian River County, lying along nearly 9 miles of the lower eastern and southern banks of the St. Sebastian River and occupying 8,600 acres of the approximately 100,000 acres comprising the Sebastian River Watershed. Like many cities in Florida, Sebastian's economy is heavily reliant on tourism, and it is very close to many natural and scenic areas like the Indian River Lagoon, Pelican Island National Wildlife Refuge, Sebastian Inlet State Park, and St. Sebastian River Preserve State Park. Accordingly, maintaining the quality of the natural environment and providing high quality municipal services to its residents and visitors is of paramount importance.

The first settlements in Sebastian date back to the early 1880s. First known as Newhaven, Sebastian was founded in 1882 and named St. Sebastian. Later, "St." was removed from the name of the town, but not from the river. Sebastian was incorporated as a city in 1923 and consisted of and handful of residential and commercial structures on the east side of the coastal ridge, on the banks of the Indian River Lagoon.

In the late 1950s, a significant development of the City occurred when General Development Corporation (GDC) designed and constructed the street and drainage infrastructure to support development of approximately 15,000 single-family home sites. Most of these home sites were developed by the late 1990s. Subsequent development within the City and annexations during the last few decades have further expanded the urban area, increasing the population, expanding the City's stormwater system, and increasing both the quantity and pollutant load of stormwater discharges to the St. Sebastian River and the Indian River Lagoon.

Water quality degradation in the St. Sebastian River Watershed and the Indian River Lagoon has been an issue for many years and has worsened as development within the City of Sebastian and surrounding areas has progressed. The St. Sebastian River is a major tributary of the Indian River Lagoon, and agricultural lands west of Sebastian account for a major portion of the watershed runoff and contribute significantly to the stormwater discharge volume and pollutant loading to the St. Sebastian River. The St. Sebastian River has been identified as a priority waterbody in need of water quality rehabilitation and protection by the Indian River Lagoon National Estuary Program and the Indian River Lagoon Surface Water Improvement Management (SWIM) Program.

The St. Johns River Water Management District (SJRWMD) and the South Florida Water Management District (SFWMD) previously identified several drainage concerns for the St. Sebastian River watershed. The principal concern involves the volume of stormwater (fresh water) discharged to the river and its dilution effects on the salinity within the receiving waters. Excessive freshwater drainage into the Indian River Lagoon may result in species shifts that could have significant effects on its fragile ecosystem. In addition, increased suspended matter and excessive loading of pollutants and nutrients associated with stormwater runoff may further degrade water quality.

Much of the City's existing storm drainage system was designed at a time when the quantity, not quality, of discharged stormwater was the primary design consideration. The majority of the City's stormwater runoff is collected by a system of roadside swales, culverts, ditches and canals and discharges to the St. Sebastian River, which ultimately flows into the Indian River Lagoon. Much of the stormwater collection infrastructure was constructed by GDC during the early phases of the City's development in the 1950's and was not designed to provide the stormwater conveyance capacity, storage volume, or water quality treatment in accordance with the current City ordinance (No. O-13-11) and the stormwater requirements in Chapter 62-330, Environmental Resource Permitting, of the Florida Administrative Code (FAC).

In the past, the City of Sebastian has prepared several Stormwater Management Plans to address the quantity and quality impacts of the City's stormwater on the St. Sebastian River and has been diligently working on many projects and improvements to its stormwater system that were included in those plans. The City's primary objective has been to initiate implementation of Best Management Practices (BMPs) and increase wet detention areas to reduce the pollutant loading and freshwater discharge to the St. Sebastian River and the Indian River Lagoon.

The City has also taken steps in the last few years to reduce stormwater pollutant loading into the Indian River Lagoon by installing Nutrient Separating Baffle Boxes with filters to reduce the amount of nitrogen and phosphorus discharging through the existing drainage outfalls.

In 2020, the population of the City of Sebastian recorded by the U.S. Census Bureau was 25,054. The City is presently experiencing a high population growth rate, greater than other areas in the watershed. This rapid growth is expected to continue for the foreseeable future, which will place additional stresses on the City's stormwater system and make optimizing the management and performance of the City's stormwater infrastructure even more important.

1.2 Previous Studies

The City's Stormwater Master Plan efforts began in 1996 when the consulting firm Craven Thompson & Associates developed a stormwater drainage model and prepared a Stormwater Master Plan. The consulting firm CDM, Inc. was retained by the City in 2004 to update the plan and develop a new model using the Interconnected Channel and Pond Routing (ICPR) software developed by Streamline Technologies, Inc. to identify needed drainage improvements. In 2010, Neel-Schaffer, Inc. was retained to update the plan and model using the latest version of the ICPR program and verify drainage improvements with changes in FEMA topographic data files. The 2013 model used new topographic maps to help improvement terrain modeling. In 2017, the City retained CWT Engineering, LLC, to update the plan and model, which resulted in the production of the most recent Stormwater Master Plan Update dated August 31, 2018. This Stormwater Master Plan Update builds on the previous Master Plans and is also aligned with the City's Coastal Resiliency Plan developed in 2019 by Kimley Horn, the Consolidated Plan, 2019 – 2024, prepared by Guardian CRM Inc., and the Infrastructure and Coastal Conservation Elements of the City's 2040 Comprehensive Plan (adopted in June 2021).

1.3 Extent-of-Service and Level-of-Service

Arcadis reviewed available documentation and discussed with City staff the Extent of Service (EOS) and Level of Service (LOS) provided by the City's stormwater system. Currently, the EOS of the City's system covers most of the area within the City boundaries, except for a few developments that have separate stormwater systems not connected to the City's system. The LOS is used to determine the performance of the stormwater management system compared to the objectives and standards established by the City.

As for the LOS, the City's 2040 Comprehensive Plan (Infrastructure Element) includes the following objectives and policies:

- Ensure adequate stormwater drainage to protect against flood conditions and prevent degradation of surface water and groundwater quality (Objective 4-1.4)
- Provide updates to the City's Stormwater Management Master Plan in order to address deficiencies and meet stormwater needs for future growth (Policy 4-1.4.2)
- Ensure that drainage system components are monitored, inspected, and maintained pursuant to best management practices (Policy 4-1.4.9)

The first objective above sets a qualitative LOS for both flood conditions and water quality, while the second policy establishes a requirement for the City to pursue updates of the Stormwater Master Plan on a regular basis. The third policy establish a requirement for the City to maintain the drainage system. In addition, the City's adopted standard (Policy 4-1.1.2: LOS Standards) for determining the drainage capacity for a development is that "*Post development runoff shall not exceed the pre-development runoff rate for a 25-year, 24-hour storm event. Stormwater treatment and disposal facilities shall be designed to meet the design and performance standards established in Chapter 17-25,* [Florida Administrative Code] *FAC, with treatment of the runoff from the first one inch of runoff on the site to meet the water quality requirements of Chapter 17-302, FAC*".

This adopted LOS standard applies to the calculated peak rate of runoff for new development, but does not address the available drainage capacity of the downstream systems or the effects of larger storm events, both of which contribute to flooding conditions. Further, this standard incorporates by reference Chapter 17 of the FAC, which has been replaced with updated stormwater system design requirements as Chapter 62-330, FAC, which also incorporates by reference updated water quality standards set forth in Chapters 62-4, 62-302, 62-520, and 62-550, FAC. These references should be updated in the City Policy mentioned above.

Section 54-3-12.10 of the City's Land Development Code (LDC) includes a LOS requirement for new local roads regarding flood conditions, which provides a good reference point for a LOS analysis for the Master Plan. The sections below detail how the target LOS was determined to address both flooding protection and water quality.

1.3.1 Flooding

In order to establish an appropriate LOS for flooding**,** Arcadis reviewed LOS information from a variety of sources, which are summarized in Table 1 below.

Table 1-1. Level of Service from Available Sources

Source	Recommended Level of Service
City of Sebastian Land Development Code (LDC) Sec. 54-3-12.10.	g. Flood routing analysis for all new local road facilities shall show that the water elevation shall at no time during the design storm duration exceed an elevation that would: 1. Permit floodwater encroachment outside existing drainage easements or right-of-way for a three-year/24-hour duration storm. 2. Place more than 20% of the front yard or rear yard area below floodwater elevation any time during a ten-year/24-hour duration storm. 3. Exceed two inches above the lowest elevation on the centerline profile of the roadway for a 25-year/24-hour duration storm. 4. Exceed the finished-floor elevation of any structure for a 100-year/three-day duration storm for projects located in a flood hazard area.
City of Sebastian *2018 Stormwater Master Plan*	Flooding conditions defined as: • Top of road elevations were exceeded for the 25-year/24-hour or 100-year/24-hour storm event; or • Top of channel bank elevations were exceeded for the 25-year/24-hour or 100-year/24-hour storm event.
City of Sebastian *2040 Comprehensive Plan* *(Policy 4-1.1.2: LOS Standards)*	Post development runoff shall not exceed the pre-development runoff rate for a 25-year, 24-hour storm event. Stormwater treatment and disposal facilities shall be designed to meet the design and performance standards established in Chapter 17-25, FAC, with treatment of the runoff from the first one inch of runoff on the site to meet the water quality requirements of Chapter 17-302, FAC.
Florida Dept of Transportation *Drainage Design Guide*	• Roadside or median ditches or swales, including bypass and interceptor ditches: 10-year/24-hour storm event • Outfall ditches & canals: 25-year/24-hour storm event • Habitable structures: 100-year/24-hour storm event
St. John's River Water Management District (SJRWMD) *Permit Information Manual (2018)*[1]	(a) The post-development peak discharge rate must not exceed the pre-development peak rate of discharge for the mean annual 24-hour storm for systems serving both of the following: (1) New construction area greater than 50% impervious (excluding waterbodies) (b) Projects for the construction of new developments that exceed the thresholds in paragraphs 62-330.020(2)(b) or (c), F.A.(b) The post-development peak rate of discharge must not exceed the pre-development peak rate of discharge for the 25-year frequency, 24-hour duration storm for all areas of the District except: (1) For those systems which discharge directly into the St. Johns River north of Lake George, the man-made portions of the Intracoastal Waterway, the Intracoastal Waterway north of the Matanzas Inlet, or the Atlantic Ocean. Where separate basin criteria have been adopted (see section 13.0 of this Volume). Projects located in areas for which separate basin

[1] Permit Information Manual. St. John's River Water Management District, 1 June 2018.

Table 1-1. Level of Service from Available Sources

Source	Recommended Level of Service
	criteria have been developed must meet the flood protection design standards specified by the basin criteri©
	(c) The post-development volume of direct runoff must not exceed the pre-development volume of direct runoff for the 25-year frequency, 96-hour duration storm for systems discharging to landlocked lakes which are adjacent to properties of more than one ownership. These systems shall not cause an increase in the total pre-development flood stage. This can be accomplished through retention with percolation or, if the soil conditions are not sufficient for percolation, then through detention for a duration sufficient to mitigate adverse impacts on flood stages.
	(d) Systems which are within areas for which separate basin criteria have been adopted pursuant to Chapter 40C-41, F.A.C., must meet the applicable volume and rate requirements found in section 13.0 of this Volume.

The following is an excerpt from the Florida Department of Transportation (FDOT) Drainage Design Guide (2022):[2]

> *Roadside or median ditches or swales, including bypass and interceptor ditches, usually are designed to convey a 10-year frequency storm without damage; outfall ditches or canals should convey a 25-year frequency storm without damage. However, because the risks and drainage requirements for each project are unique, site-specific factors may warrant the use of an atypical design frequency. Regardless of the frequency selected, you should always consider the potential for flooding that exceeds standard criteria. Predevelopment stages for all frequencies up to and including the 100-year event must not be exceeded unless flood rights are obtained or the flow is contained within the ditch.*

Since the majority of the City's stormwater infrastructure is directly associated with roads, the City's desired LOS for protection against flooding was set to be similar to the FDOT LOS, while also incorporating, at a minimum, the City's LOS requirements as stated in the LDC.

1.3.2 Water Quality

Protection of surface water and natural resources, such as the Indian River Lagoon, is critically important to the City and its residents.

The City LDC has an adopted LOS in Section 54-3-9.7 for drainage facilities. The City's 2018 Master Plan update and the 2040 Comprehensive Plan did not contain a Water Quality LOS. Arcadis reviewed applicable Florida water quality requirements for stormwater design standards, Total Maximum Daily Loads (TMDLs) (Florida Department of Environmental Protection [FDEP 2009 and 2013], and the Indian River Lagoon Basin: Central Indian River Lagoon Basin Management Action Plan (FDEP 2021) summarized in Table 1-2. The Municipal Separate Storm Sewer System (MS4) TMDL waste load allocations are the same percent Total Nitrogen (TN) and Total Phosphorus (TP) reductions required for the load allocation (LA) assigned to the nonpoint sources in the river segments.

[2] Drainage Design guide. State of Florida Department of Transportation, Office of Design, Drainage Section, January 2022.

Table 1-2. Water Quality Requirements

Source	Requirements
City of Sebastian *Comprehensive Plan 2040*	No numerical standards related to water quality
Florida Water Quality Standards	Chapter 62-302, FAC (Attachment 2)
St. John's River Water Management District (SJRWMD) *ERP Applicant's Handbook – Vol II*	Chapter 62-302, FAC
TMDL Report: Nutrient and Dissolved Oxygen TMDLs for the Indian River Lagoon and Banana River Lagoon (FDEP 2009)[1]	South Central Indian River Lagoon (WBID[2] 5003D) & Indian River above Sebastian Outlet (WBID[2] 2963A) (Class II) Total Nitrogen Load Allocation Target 577,183 (lbs/yr) Total Phosphorus Load Allocation Target 109,055 (lbs/yr)
TMDL Report: Dissolved Oxygen and Nutrient TMDLs for Eight Tributary Segments of the Indian River Lagoon (FDEP 2013)	South Prong St. Sebastian River Estuary Segment (WBID 3129B1) (Class III) Total Nitrogen – Use Central IRL Target Total Phosphorus – Use Central IRL Target BOD – TMDL 1411 (lbs/day) South Prong St. Sebastian River Freshwater Segment (WBID 3129B2) Class III Total Nitrogen – Use Central IRL Target Total Phosphorus – Use Central IRL Target BOD – TMDL 1411 (lbs/day)
Central Indian River Lagoon Basin Management Action Plan (FDEP 2021)	Central Indian River Lagoon Project Zone SEB (for the City of Sebastian) Total Nitrogen Allowable Load Allocation – 7,906 lbs/yr Total Phosphorus Allowable Load Allocation – 2,885 lbs/yr

Notes:
1 Excludes Atmospheric Deposition
WBID – Water Body Identification used for TMDL

1.3.3 LOS Summary

Considering the City's current stormwater infrastructure and its condition, as well as the budget constraints, the Stormwater Master Plan Update uses the following practical and achievable LOS goals for both protection against flooding and compliance with water quality requirements:

- For roadside swales and their associated culverts: convey a 10-year, 24-hour storm event (7.24 inches of rainfall) with peak water surface at or below the edge of pavement.
- For backyard ditches and side yard swales and their associated culverts: convey a 25-year, 24-hour storm event (9.17 inches of rainfall) without damage to habitable structures. For roadways, do not exceed two inches above the lowest elevation on the centerline profile of the roadway for a 25-year, 24-hour duration storm.

- For canals: convey a 100-year, 72-hour storm event (14.9 inches of rainfall) without damage to habitable structures.
- For all stormwater discharges, maintain compliance with established TMDL limits and the Florida Water Quality Standards in Chapter 62-302, FAC.
- These LOS were agreed by the City and used to guide the evaluation of alternatives and CIP projects.

1.4 Regulatory and Intergovernmental Framework

The City of Sebastian, located in Indian River County, falls under the jurisdiction of many Federal, State, and local government agencies with respect to stormwater management. This section provides an overview of these various agencies and their role in the regulation of the City's stormwater program and its stormwater management system (SWMS). The City's goals and objectives regarding runoff water quality and volume reduction are based on the regulatory requirements set forth by the US Environmental Protection Agency's (USEPA's) Clean Water Act and its provisions, the Federal Emergency Management Agency (FEMA) National Flood Insurance Program and its regulations, the Florida Department of Environmental Protection (FDEP), the St. John's River Water Management District (SJRWMD), the Sebastian River Water Control District (SRWCD), and other regulatory agencies. A brief discussion of these agencies and their role in the regulation of the City's SWMS are in the sections that follow.

1.4.1 Agencies Having Jurisdiction

1.4.1.1 United States Environmental Protection Agency (USEPA)

The USEPA reviews dredge and fill permit applications under the United States Army Corps of Engineers (USACE) permitting authority. Both agencies monitor and permit fill activity along the Indian River Lagoon (IRL), where flood prone wetlands provide floodwater storage. Under authority of the Water Quality Act of 1987 (a.k.a Clean Water Act [CWA]) and its amendments, the USEPA delegated the authority for issuing National Pollutant Discharge Elimination System (NPDES) permits for point source discharges to the Florida Department of Environmental Protection (FDEP). Regulated point source discharges include Municipal Separate Storm Sewer Systems (MS4s), construction activities, and industrial activities.

Besides creating the NPDES program, the CWA established the National Estuary Program (NEP). Under that program, the Indian River Lagoon was identified as being an estuary of national significance threatened by pollution, overuse, and development. In 1991, the USEPA initiated the Indian River Lagoon National Estuary Program (IRLNEP). The IRLNEP was charged with developing a Comprehensive Conservation and Management Plan to ensure preservation of the IRL's fragile ecosystem. Final adoption of the Indian River Lagoon Comprehensive Conservation and Management Plan (IRLCCMP) was completed in 1996. The four program goals adopted in the IRLCCMP are as follows:[3]

- To attain and maintain water and sediment of sufficient quality to support a healthy estuarine system.
- To attain and maintain a functioning healthy ecosystem which supports endangered and threatened species, fisheries, commerce, and recreation.

[3] Indian River Lagoon Comprehensive Conservation and Management Plan Update 2008, Indian River Lagoon National Estuary Program (2008).

- To achieve heightened public awareness and coordination of interagency management of the Indian River Lagoon ecosystem; and
- To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore, and enhance the Indian River Lagoon system.

1.4.1.2 Federal Emergency Management Agency (FEMA)

FEMA regulates flood plain management in Indian River County and prepared county wide Flood Insurance Rate Maps. FEMA's regulations for the National Flood Insurance Program (NFIP) are implemented by the City and the County. As a participating community in the NFIP, the City of Sebastian must comply with FEMA requirements.

1.4.1.3 State of Florida Department of Environmental Protection (FDEP)

The FDEP, under the authority of FAC Chapter 62-3, reviews and permits stormwater discharge into waters of the State to ensure that state water quality standards are not exceeded. In 1986, permit authority was delegated to the St. Johns River Water Management District.

Additionally, in 1969 two (2) aquatic preserves were established in Indian River County. Aquatic Preserve #7 extends from Malabar in Brevard County to the northern City limits of Vero Beach. Aquatic Preserve A-9 extends from the southern City limits of Vero Beach to the Ft. Pierce Inlet in St. Lucie County. In 1975, the Florida Aquatic Preserve Act delegated the responsibility of managing those aquatic preserves to the Florida Department of Natural Resources (now FDEP).

1.4.1.4 St. Johns River Water Management District (SJRWMD)

The SJRWMD, under the authority of 40C-4, Florida Administrative Code, regulates the management and storage of surface waters within the St. Johns River Basin. The SJRWMD encompasses an area of over 12,400 square miles. Within its boundaries are the St. Johns River Basin, the Nassau River Basin, the Florida portion of the St. Mary's River Basin, and several coastal drainage basins, including a majority of the Indian River Lagoon. Indian River County, which has within its boundaries the upper basin or headwaters of the St. Johns River, is one of 18 counties that are under the jurisdiction of the SJRWMD.

Adopted in 1987, the Surface Water Improvement Management (SWIM) Act directed the SJRWMD to develop a SWIM Plan for the IRL. The scope of the IRL SWIM Plan is like that of the IRLCCMP. Due to the mutual similarities of those two programs, the IRLNEP was integrated with the IRL SWIM program upon adoption of the IRLCCMP.

1.4.1.5 Florida Department of Transportation (FDOT)

Under the authority of Florida Statutes Chapter 335.02, the FDOT owns and maintains numerous facilities which provide drainage for major arterial roads within Indian River County. The U.S. Highway 1 corridor, for example, is drained by many outfall ditches and canals. Those canals have defined drainage basins east of the Atlantic Coastal Sand Ridge. The FDOT permits connections to stormwater management facilities within FDOT rights-of-way.

While stormwater management facilities within the city limits of Sebastian are under the jurisdiction of the City, except for CR 512 (Fellsmere Road), small areas of the unincorporated county, between CR 512 and the southern limits of the City, drains north to the Elkcam Waterway. Sections of the St. Sebastian River-South Prong are under the jurisdiction of the City, the Sebastian River Improvement District (SRID), Indian River County, and the State of Florida.

1.4.1.6 Local Government - Indian River County

Indian River County has primary stormwater jurisdiction over major outfalls within the following areas:

- Unincorporated areas not included within the limits of Special FS Chapter 298 Drainage Districts, State of Florida road rights-of-way, private undeveloped land where no development has occurred, and property owned by the State of Florida or the Indian River County School District.
- Incorporated areas within county road rights-of-way.
- Secondary drainage facilities (minor swales and facilities leading to outfalls) which are maintained by the County and located within dedicated easements or rights-of-way in the unincorporated area. While County Ordinance 82-28 established the County's authority to regulate stormwater management practices, that authority was incorporated into the Flood Protection and Stormwater Management chapter of the County's land development regulations that was adopted by LDR Chapter 930. The Indian River County Public Works Department is charged with administering LDR Chapter 930.

1.4.1.7 F.S. 298 Special Drainage Districts

Water Control Districts have the authority to construct and maintain primary drainage facilities within their statutory boundaries. At the present time, there are five active drainage districts within Indian River County. These are: the Indian River Farms Water Control District (IRFWCD), the Sebastian River Improvement District (SRID), the Fellsmere Water Control District (FWCD), the St. Johns Improvement District, and the Delta Farms Water Control District.

1.4.1.8 Incorporated Municipalities

Incorporated municipalities have home rule powers to construct and maintain stormwater management facilities within their city owned easements, rights-of-way, and property. The incorporated municipalities within Indian River County include the City of Vero Beach, the City of Sebastian, the Town of Indian River Shores, the City of Fellsmere, and the Town of Orchid.

1.4.1.9 Private Systems

Privately owned agricultural operations in the County and developments within and outside the City own and maintain private stormwater management facilities. Although such facilities may not discharge directly to the City's SWMS, in many cases they discharge to the same receiving waters and may affect downstream water quantity and quality. The City only has jurisdiction over the private systems within its municipal boundaries.

1.4.2 City of Sebastian Goals and Regulatory Requirements

1.4.2.1 City Goal

The City's goal is to operate and maintain its stormwater system in full compliance with the Federal Clean Water Act and all applicable requirements of Federal, State and local agencies, providing the highest level of service possible to the City's residents and businesses, while effectively managing the quality and quantity of stormwater discharges to protect the sensitive natural environment and waterways in the area.

1.4.2.2 NPDES MS4 Permit Requirements

The City is covered under NPDES Permit No. FLR04E124 - Generic Permit to Discharge Stormwater from Phase II Municipal Separate Storm Sewer Systems (MS4), which expires on March 1, 2025. The permit is issued under

Section 403.0885, Florida Statutes (F.S.), and implemented through applicable provisions of Chapters 62-4, 62-620, 62-621, and 62-624, Florida Administrative Code (F.A.C.). Coverage under the generic permit constitutes authorization to discharge stormwater from Phase II Municipal Separate Storm Sewer Systems (MS4s) to surface waters of the State pursuant to the Department of Environmental Protection's (Department) federally approved National Pollutant Discharge Elimination System (NPDES) stormwater program consistent with Section 402(p)(6) of the Federal Clean Water Act. The generic permit is adopted and incorporated by reference at paragraph 62-621.300(7)(a), F.A.C. Under the generic permit, the operators of regulated Phase II MS4s must develop a Stormwater Management Program (SWMP) that includes best management practices (BMPs) with measurable goals and a schedule for implementation to meet the following six minimum control measures:

- **Public Education and Outreach** – Implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on waterbodies and the steps that the public can take to reduce pollutants in stormwater runoff.
- **Public Participation/Involvement** – Implement a public participation/involvement program that complies with state and local public notice requirements.
- **Illicit Discharge Detection and Elimination** – Subsection 62-624.200(2), F.A.C., defines an illicit discharge as "…any discharge to an MS4 that is not composed entirely of stormwater…," except discharges under an NPDES permit, or those listed in rule that do not cause a violation of water quality standards. Illicit discharges can include septic/sanitary sewer discharge, car wash wastewater, laundry wastewater, the improper disposal of auto and household toxics, and spills from roadway accidents.
    - Develop, if not already completed, a storm sewer system map showing the location of all outfalls, and the names and location of all surface waters of the state that receive discharges from those outfalls.
    - To the extent allowable under state or local law, effectively prohibit, through ordinance or other regulatory mechanism, non-stormwater discharges into the storm sewer system and implement appropriate enforcement procedures and actions.
    - Develop and implement a plan to detect and address non-stormwater discharges, including illegal dumping, to the storm sewer system.
    - Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper waste disposal.
- **Construction Site Stormwater Runoff Control**
    - Implement a regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to reduce pollutants in any stormwater runoff to the Phase II MS4 from construction activity that results in a land disturbance greater than or equal to an acre. Construction activity disturbing less than one acre must also be included if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more.
    - Develop and implement requirements for construction site operators to implement appropriate erosion and sediment control BMPs.
    - Implement requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.
    - Develop and implement procedures for site plan review that incorporate the consideration of potential water quality impacts.
    - Develop and implement procedures for receiving and considering information submitted by the public.

- Develop and implement procedures for site inspection and the enforcement of control measures.

- **Postconstruction Stormwater Management** – Implement and enforce a program to address the discharges of postconstruction stormwater runoff from areas with new development and redevelopment. (Note: In Florida, Environmental Resource Permits issued by water management districts typically serve as a Qualifying Alternative Program for purposes of this minimum control measure.)
- **Pollution Prevention/Good Housekeeping** – Implement an operations and maintenance (O&M) program that has the ultimate goal of preventing or reducing pollutant runoff from MS4 operator activities, such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, stormwater system maintenance, and staff training in pollution prevention.

1.4.2.2.1 Required Minimum Control Measures

Appendix A of the "Notice of Intent to Use Generic Permit for Discharge of Stormwater from Phase II Municipal Separate Storm Sewer Systems [FDEP Form 62-621.300(7)(b)] serves as written documentation of the required stormwater management program, further described in Part V of the generic permit. Appendix A includes a list of best management practices (BMPs) to be implemented by the City, as well as proposed measurable goals for each of the required elements under the six minimum control measures (MCM), set forth in Part V.B of the generic permit. A copy of the City's current NPDES MS4 permit and Appendix A of the permit is included as Appendix A of this Master Plan Update.

1.4.2.3 Adopted Total Maximum Daily Load (TMDL) Requirements

FDEP defines a TMDL as a "scientific determination of the maximum amount of a given pollutant that a surface water can absorb and still meet the water quality standards that protect human health and aquatic life." The Indian River Lagoon (IRL) TMDLs are targeted towards seagrass regrowth at water depths where seagrass historically grew in the lagoon. The seagrass coverage in the IRL has decreased over the years because of the degradation of water quality conditions.

Chapter 62-304.520, FAC contains the IRL TMDLs, which are divided into several areas of the IRL. The TMDLs for the Central and southern South Indian River are 278,273 lbs/year of TN and 53,599 lbs/year of TP, which represent a 56% reduction of TN and a 48% reduction of TP based on the year 2000 land use.[4]

1.4.2.4 Central Indian River Lagoon Basin Management Action Plan for Adopted TMDLs

A Basin Management Action Plan (BMAP) is a comprehensive plan for water quality restoration by reducing pollutant loading through current and future projects and activities. BMAPs contain a variety of physical and regulatory tools, such as permit limits on wastewater facilities, urban and agricultural best management practices

[4] Central Indian River Lagoon Basin Management Action Plan, FDEP, 2021.

(BMPs), and conservation programs designed to achieve pollutant reductions established by a TMDL. BMAPs are developed with and depend on local stakeholders for successful implementation, and are legally enforceable.

The Central Indian River Lagoon (CIRL) BMAP was first adopted in February 2013 and addresses adopted TMDLs for certain tributaries to the CIRL, including the South Prong of the St. Sebastian River. The CIRL BMAP is divided into four Project Zones as shown in Figure 1-1. A copy of the current approved Central Indian River Lagoon BMAP dated February 2021 is included in Appendix B.

The City of Sebastian is located in Project Zone SEB, which covers more than 117,881 acres of the CIRL BMAP. Urban land use makes up the largest portion of the project zone with 22.5 % of the area, followed by agriculture with 21.0 %. Stakeholders in Project Zone SEB are agricultural producers, Brevard County, City of Fellsmere, City of Palm Bay, City of Sebastian, FDOT District 4 and District 5, Fellsmere WCD, Indian River County, Sebastian River Improvement District, Town of Grant-Valkaria, Town of Orchid, and Vero Lakes WCD.

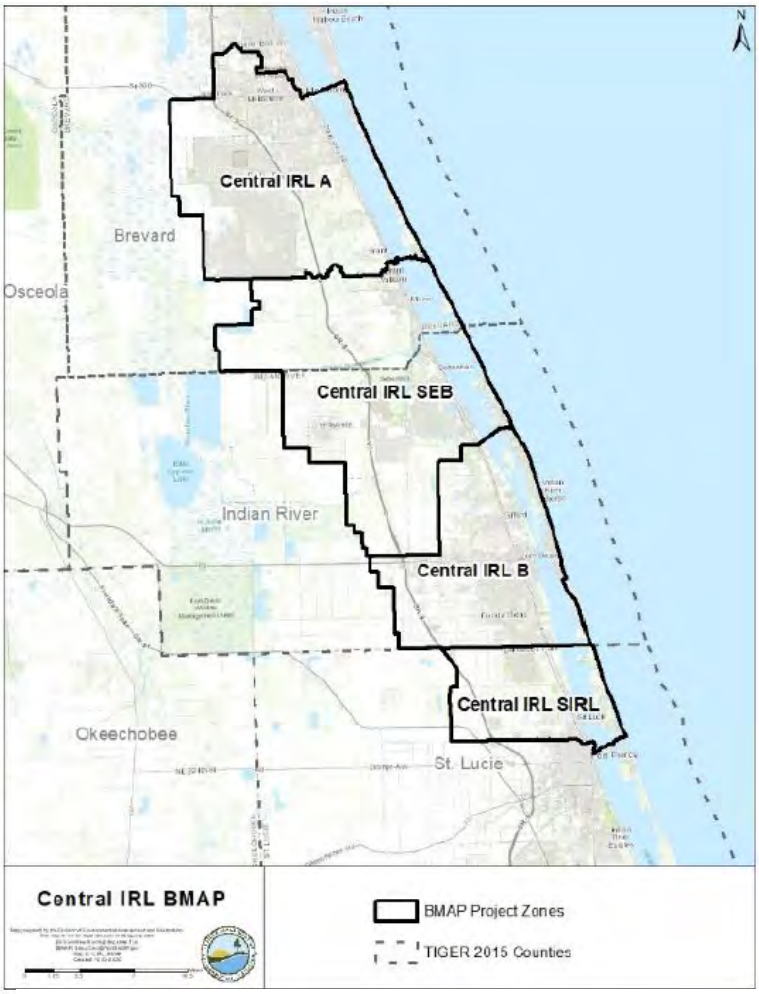

Figure 1-1. Central Indian River Lagoon BMAP Project Zones

Management actions provided by stakeholders, including projects, programs, and activities that may reduce nutrient loads to the CIRL, are included in the BMAP and have to meet several criteria to be considered eligible for credit.

The projects and activities in the CIRL BMAP are critical to the goal of recovering seagrass in the IRL, and their level of completion are tracked to show stakeholder efforts and progress towards the total required milestone reductions. FDEP conducts an assessment of progress towards the BMAP milestones every five years, and plan revisions are made as appropriate. FDEP has established milestones for the years 2025, 2030, and 2035 as follows:

5-year milestone in 2025: 35 % or 320,614 lbs/yr of TN and 77,290 lbs/yr of TP.

10-year milestone in 2030: 70 % or 641,228 lbs/yr of TN and 154,580 lbs/yr of TP.

15-year milestone in 2035: 100 % or 916,040 lbs/yr of TN and 220,828 lbs/yr of TP.

Under the 2021 CIRL BMAP, the City of Sebastian has the following TMDL allocations:

- Total Nitrogen (TN) = 28,624 lbs/year (adjusted for natural per acre load)
- Total Phosphorus (TP) = 2,885 lbs/year

The Florida Watershed Restoration Act (FWRA) includes an adaptive management process for BMAPs that continues until the TMDLs are met by incrementally reducing loadings through the implementation of projects and programs.

As mentioned previously, the City of Sebastian is a designated Phase II MS4 and is regulated by the Florida NPDES Stormwater Program. The City is identified as a contributor in the BMAP, and in accordance with Part X.B of the NPDES MS4 Permit No. FLR04E124 and Section 403.067, F.S., must comply with the adopted provisions of the Central Indian River Lagoon BMAP that specify activities to be undertaken by the City. If a BMAP is in development and scheduled to be adopted within two years by FDEP and watershed stakeholders, the City must continue to participate in the BMAP process and comply with the adopted provisions of the BMAP that specify activities to be undertaken by the City during the permit cycle.

Phase I and Phase II MS4s are required to implement stormwater management programs (SWMPs) to reduce pollutants to the maximum extent practicable and address applicable TMDL allocations. Both Phase I and Phase II MS4 permits include provisions for the modification of SWMP activities, at the time of permit renewal, for consistency with the assumptions and requirements of the adopted BMAP.

The CIRL BMAP is a broad, basin-wide approach to reduce the primary sources of human-caused nutrient loading throughout the CIRL Subbasin. The primary sources included in the CIRL BMAP are agricultural runoff, septic systems, urban stormwater, and wastewater. The sources that are applicable to the City are the last three and are briefly discussed in the sections below.

Septic Systems - Florida Department of Health (FDOH) data indicates there are 78,363 known and likely septic systems located throughout the CIRL Subbasin. Each local government within the CIRL is required to develop an onsite sewage treatment and disposal system (OSTDS) remediation plan to be adopted as part of the BMAP no later than July 1, 2025.

The OSTDS remediation plan requires entities to identify and address the following:

- Cost-effective and financially feasible projects necessary to achieve the nutrient load reductions required for OSTDS (e.g., sewering, advanced septic system retrofits, prohibiting the installation of new conventional septic systems).
- An inventory of OSTDS based on the best information available.
- OSTDS that would be eliminated through connection to existing or future central domestic wastewater infrastructure in the jurisdiction or domestic wastewater service area of the local government.
- OSTDS that would be replaced with or upgraded to enhanced nutrient-reducing systems.
- Cost of improvements and sources of funding.

The CIRL BMAP requires stakeholders to submit projects describing how septic loads are addressed as part of BMAP reporting and estimate the load reductions associated with each project.

The City of Sebastian has included Policy 4-1.2.3 regarding septic-to-sewer conversion in the 2040 Comprehensive Plan but has not yet filed an OSTDS remediation plan.

Urban Stormwater – Urban runoff is a significant source of nutrient loading to the CIRL but is already regulated under NPDES permits. MS4 permittees within the CIRL are required to develop and implement a stormwater management program. As mentioned in section 1.4.2.2.1, Appendix A of the City's NPDES MS4 permit serves as written documentation of its required stormwater management program. The FDEP and water management districts periodically update the stormwater design and operation requirements in Environmental Resource Permit rules to improve nutrient reduction in stormwater systems.

Wastewater – The USEPA has delegated authorization to FDEP to issue permits for discharges to surface waters under the NPDES Program. FDEP also issues permits for facilities and activities to discharge wastewater to surface waters and groundwaters of the state in accordance with state statutes and rules. These wastewater permits establish specific effluent limitations and other requirements based on the location, type of facility or activity, and type of industrial or domestic wastewaters discharged from a point source.

The CIRL BMAP dated February 2021 indicated that as of September 2020, there were 41 individually permitted wastewater facilities or activities in the CIRL Subbasin. All new or existing wastewater facilities that dispose of or discharge effluent in the BMAP area are subject to the BMAP provisions, regardless of whether the facility is listed in the BMAP.

As mentioned previously, the City is presently experiencing a high population growth rate, which is expected to continue for the foreseeable future. Therefore, adequate treatment capacity of domestic wastewater is essential. Domestic wastewater is treated through either wastewater treatment facilities (WWTFs) or OSTDS (septic systems). In the City, the majority of domestic wastewater is treated through septic systems.

Reducing the City's reliance on septic systems and moving towards a more conventional sanitary sewer collection system and wastewater treatment facilities also has its challenges. Current Florida law requires all existing and new domestic wastewater facilities discharging to surface waters of the state within or connected to the IRL to meet advanced waste treatment requirements no later than July 1, 2025 and must meet the stringent nutrient wastewater limitations set forth in the CIRL BMAP.

1.4.2.5 Indian River Lagoon Comprehensive Conservation and Management Plan

This section contains a brief summary of the Draft Indian River Lagoon National Estuary Program (IRLNEP) 2030 Comprehensive Conservation and Management Plan (CCMP), a copy of which is included in Appendix C.

The National Estuary Program (NEP) is a Federal non-regulatory program authorized by Section 320 of the Clean Water Act and administered by the USEPA. Each estuary in the NEP was designated by the U.S. Congress as an "Estuary of National Significance", and the Indian River Lagoon received its designation in 1990. Today, 28 estuaries in the U.S. and Puerto Rico have been designated as estuaries of national significance.

The 28 NEPs create long-term Comprehensive Conservation and Management Plans (CCMPs) that contain actions to address challenges and priorities related to water quality and living resources. Each NEP is governed by a Management Conference that is typically comprised of Federal, State, and local agencies and municipalities that provide funding, technical resources and policy guidance. NEPs create and implement CCMP action plans to meet the objectives of the Clean Water Act and to restore and maintain the ecological integrity of estuaries of national significance.

The first Indian River Lagoon National Estuary Program (IRLNEP) Management Conference was convened in 1991 and adopted its original CCMP in 1996. The SJRWMD served as the host agency for the IRLNEP from 1991 to 2015 and oversaw the implementation efforts of the original CCMP and its most recent update in 2008. However, the scope and direction of the IRLNEP CCMP was fundamentally altered following an unprecedented pico-cyanobacterial bloom in 2011 and damaging freshwater releases from Lake Okeechobee to the southern IRL. These events caused concerns for the future of the IRL among regulators, scientists, and the public.

As a result, the IRLNEP Management Conference structure was reorganized and a new host agency for the IRLNEP, the IRL Council, was created by interlocal agreement as an independent special district of the State of Florida. In accordance with the interlocal agreement, as amended, the FDEP, SJRWMD, SFWMD, Volusia County, Brevard County, St. Lucie County, Martin County, and the Indian River County Lagoon Coalition (representing three cities in Indian River County (Vero Beach, Sebastian, and Fellsmere) serve as the Board of

Directors of the IRL Council and as the policy board of the IRLNEP. The first operational fiscal year of the IRL Council began on October 1, 2015. Together, the IRL Council and its Management Board and advisory and oversight committees represent the IRLNEP Management Conference.

The reorganization of the IRLNEP resulted in increased financial support for IRL restoration to $2,100,000 annually of mixed federal, state, and local funding for IRL restoration projects.

The draft 2030 IRLNEP CCMP adopted the following goals:

1. To attain and maintain water and sediment of sufficient quality to support a healthy estuarine lagoon ecosystem;
2. To attain and maintain a functioning, healthy ecosystem which supports endangered and threatened species, fisheries, commerce, and recreation;
3. To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem; and
4. To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore, and enhance the IRL.

In addition, the CCMP identified 32 Vital Signs for IRL health, and for each of them, specific indicators were identified and will be measured to assess the condition of the Vital Sign and document how that condition changes through time. The selection and monitoring of these indicators is a complex process, and some may be reconsidered, modified, or replaced as new information becomes available.

For each Vital Sign, the following information is provided:

- Goals: The specific goals that will be achieved by implementing the actions for the Vital Sign.
- Issue Summary: Description of the issues facing the IRL system for the Vital Sign, using the best available information.
- Strategies: Approaches that should be implemented to achieve the goals for the Vital Sign.
- Action Plan Outputs (Deliverables): Specific deliverables including the responsible and partner entities, estimated costs, potential funding sources, and the IRLNEP role in delivering the output.
- Outcomes: Short-, medium-, and long-term outcomes expected from implementation of the outputs.
- Challenges to Success: Potential challenges to achieving the goals of the Vital Sign.
- Citations: Literature referenced in the above items for each Vital Sign.

In support of the CCMP revision, the IRLNEP proposed a list of projects that will improve wastewater infrastructure, reduce reliance on conventional septic systems, retain and treat stormwater, rehabilitate habitats, and enhance planning for resilient communities.

1.4.2.6 Integrated Pest Management Plan

The City of Sebastian, in an effort to best manage pests within the stormwater system, adopted the Integrated Pest Management (IPM) Plan as its aquatic vegetation maintenance control program. The Plan uses the following definition of Integrated Pest Management: “To promote the most sustainable pest management methods, based on planning and prevention, which aim to minimize risks to human and environmental health through the limited use of pesticides, while also remaining economically feasible.” A copy of the IPM is located in Appendix D.

The goals of the IPM Plan are:

- Protect environmental resources by reducing the amount of pollutants entering surface and ground water and minimizing effects on native plants, animals, and habitats
- Ensure effective economic pest management within the City's stormwater conveyance system, while minimizing health risks to the public, City staff, and the environment.
- Promote the transparency of the City's pest management activities.
- Increase public awareness of IPM methods and benefits.

Noxious aquatic vegetation is the only "pest" addressed in the plan. While there are species of fish, shellfish and insects present within the stormwater system, which are classified as "invasive," none besides the mosquito have achieved populations which require management. Mosquito Control is handled by the Indian River County Mosquito Control District and is exempt from the City's IPM Plan. The plan does not apply to any stormwater features located within any planned unit development (PUD), as these subdivisions have permits with the SJRWMD with requirements to maintain their own stormwater system. Also not covered by the IPM plan is the City's cemetery, parks, or other properties, as these assets are managed collectively by the City's Leisure Services Department and are addressed in a separate "Parks and Properties IPM Plan," which was adopted by City Council on October 14th, 2020.

The City's IPM Coordinator handles reporting to regulatory agencies, which credit the adoption of the IPM Plan as a Best Management Practice (BMP). Other goals for the IPM Plan include the following:

- Incorporate the IPM Plan into the Florida Department of Environmental Protections (FDEP)'s National Pollutant Discharge and Elimination System (NPDES) Phase II, MS4 Permit Cycle 4, Year 2 Annual Report (September 2022) and the Cycle 5 Notice of Intent (NOI) (September 2024) as a new BMP for Element 6: Pollution Prevention/ Good Housekeeping.
- Add as new project and update through the statewide Basin Management Action Plan (BMAP) annual report on water quality projects.
- Add as recent activity and provide updates to the Indian River Lagoon Council for the Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) annual report on lagoon-related accomplishments.

1.4.2.7 City Ordinances Related to the NPDES MS4 Permit SWMP

Illicit Discharge Ordinance

In accordance with SWMP Element 1a, BMP No. 4, the City enacted Article VI: Urban Stormwater Quality Management and Discharge Control, which prohibits non-stormwater discharges into the MS4 system and implements inspection, reporting, and enforcement procedures.

Surface Water Management Ordinance

SWMP Element 1a, BMP No. 4 is addressed by Article XII, which requires that any land development, which disturbs the soil, implement an erosion and sediment control plan. Such sites are subject to frequent inspections. Chapter 1, Article I and II provides for the general administration of violation and enforcement procedures for non-compliance with the Land Development Code. The Surface Water Management Ordinance requires that all construction site operators control discarded materials and provide a sanitary waste facility. Waste management on each site is inspected as part of the scheduled "Erosion Control" inspections.

Erosion and Sediment Control on Construction Sites

Article XVIII Sec.54-4-18.4 requires that sites greater than an acre, submit a SWPPP (Stormwater Pollution Prevention Plan) as part of their site plans that meets all City Land Development Ordinances, as well as apply for an NOI with the FDEP. The Stormwater Pollution Prevention Plan (SWPPP), or Erosion and Sediment Control Plan will be reviewed for BMPs as they relate to the proposed construction.

Site Plan Review

Article XVII outlines the site plan review procedures. Site plans are thoroughly reviewed by a committee of staff to ensure no adverse effects on water quality or environmentally sensitive areas.

1.5 Project Goals

The specific goals for this Stormwater Master Plan Update project are to:

- Develop a programmatic approach to address the current significant and costly backlog of stormwater capital improvement and system rehabilitation projects, while also anticipating future needs.
- Provide a systematic and defensible process for preparation of a 10-yr CIP Program and prioritization of capital projects, including establishment of strategic goals.
- Establish 10-year CIP with budget requirements.
- Identify specific federal and state sources for funding (grants, general funds or other funding mechanisms) and include the steps and process to pursue grants and meet reporting requirements for eligible CIP projects.
- Leverage digital tools for Geographic Information System (GIS) mapping of major stormwater assets and rehabilitation assessments.
- Develop a hydrologic and hydraulic (H&H) model to identify specific capital projects and support grant funding applications.
- Incorporate a multi-objective framework for the Master Plan organized by watershed that considers conveyance issues, flooding problems, maintenance needs, and water quality requirements and is integrated with local mitigation strategies and floodplain management requirements.

2 Existing Conditions

2.1 Geology and Soils

According to the Natural Resources Conservation Service (NRCS) Soils Report (1987),[5] a copy of which is included as Appendix E, Indian River County is in the coastal lowlands of the Atlantic Coastal Plain physiographic province, which are the remnants of ancient marine terraces. As shown in Figure 2-1, the county includes four distinct physiographic subdivisions, the Atlantic Coastal Ridge, the Eastern Valley, the Ten Mile Ridge, and the Osceola Plain.

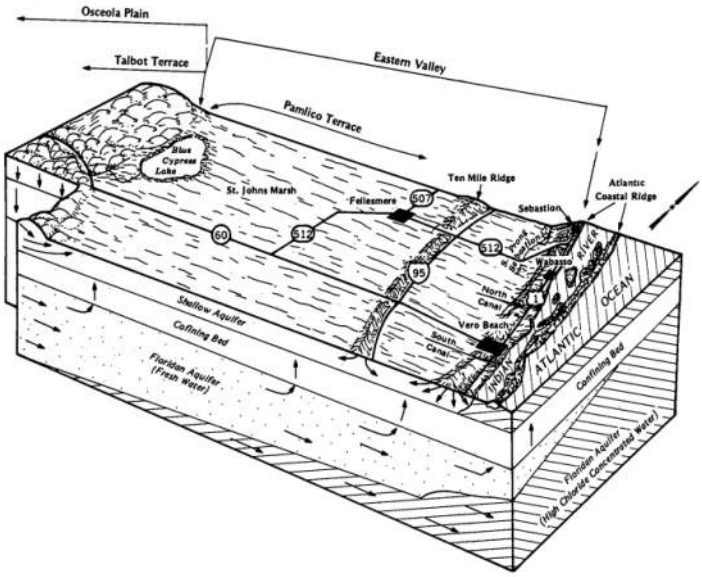

Figure 2-1. Geology and Physiographic Features of Indian River County (from NRCS)

The City of Sebastian is located in northeastern Indian River County, between the Indian River Lagoon and the South Prong of the St. Sebastian River. The easternmost portion of the City along the Indian River Lagoon lies within the Atlantic Coastal Ridge, where the soils are flat to gently sloping, sandy, and well drained. The majority of the City area lies west of the Atlantic Coastal Ridge, in the Eastern Valley, where the soils are predominately nearly level and wet. The topography of the City is very flat, with average grades of approximately 0.1 percent.

A shallow aquifer underlies all of the county and extends to a depth of approximately 150 feet below ground surface, where it is underlain by the Hawthorne Formation. The Hawthorne Formation acts as a confining layer and prevents the upward movement of water from the Floridan Aquifer, but also prevents the downward movement of water from the shallow aquifer, which results in high groundwater elevations and reduced percolation rates in the surficial soils. This is consistent with previous reports and observations from consultants and City staff, which indicated that the soils are virtually impermeable over most of the City and open channels have low infiltration rates and long recovery times.

Geologic and hydrogeologic information was obtained from the Soil Survey of Indian River County, published in 1987 by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). Geospatial soils data was obtained via the NRCS Web Soil Survey and the download noted that the data was Version 19 dated June 8, 2020. The Soil Survey classifies soils into four distinct Hydrologic Soil Groups (HSG), A-D, depending on their infiltration and runoff characteristics. HSG "A" soils, typically sands, have the lowest runoff potential while HSG "D" soils like clays and wetland soils have the highest. Soils with two HSG groups (i.e., A/D) indicate that a confining layer or high water table affects the infiltration rate that a given soil group would normally exhibit.

[5] Soil Survey of Indian River County, Florida. United States Department of Agricultural, Soil conservation Service. January 1987

The types, extents, drainage class and HSG of the soils within the City of Sebastian are shown below in Table 2-1. The soils within the City of Sebastian grouped based on drainage class are provided in Table 2-2. The majority of the City soils are poorly drained.

Table 2-1. City of Sebastian USDA/NRCS Soil Types

Soil Type	% of Drainage Area	Drainage Class	Hydrologic Soil Group
Chobee loamy fine sand, frequently ponded, 0 to 1% slopes	0.30	Very poorly drained	C/D
EauGallie fine sand	23.81	Poorly drained	A/D
Immokalee fine sand	18.04	Poorly drained	B/D
Myakka-Myakka, wet, fine sands, 0 to 2% slopes	12.22	Poorly drained	A/D
Oldsmar fine sand	9.33	Poorly drained	A/D
Pepper sand	0.90	Poorly drained	D
Riviera fine sand, 0 to 2% slopes	1.91	Poorly drained	A/D
St. Lucie sand, 0 to 8% slopes	1.34	Excessively drained	A
Archbold sand, 0 to 5% slopes	3.34	Moderately well drained	A
Wabasso-Wabasso, wet, fine sand, 0 to 2% slopes	0.28	Poorly drained	B/D
Pineda-Pineda, wet, fine sand, 0 to 2% slopes	1.33	Poorly drained	A/D
Quartzipsamments, 0 to 5% slopes	0.43	Somewhat poorly drained	A
Pomello sand, 0 to 5% slopes	5.98	Somewhat poorly drained	A
Arents, 0 to 5% slopes	2.77	Somewhat poorly drained	A
Floridana sand, frequently ponded, 0 to 2% slopes	0.06	Very poorly drained	C/D
Immokalee-Urban land complex	0.20	Poorly drained	A/D
Astatula sand, 0 to 5% slopes	6.96	Excessively drained	A
Satellite fine sand, 0 to 2% slopes	0.46	Somewhat poorly drained	A
Malabar fine sand	1.25	Poorly drained	A/D
Myakka fine sand, frequently ponded, 0 to 1% slopes	2.60	Very poorly drained	A/D
Holopaw fine sand, 0 to 2% slopes	1.57	Poorly drained	A/D
Electra sand, 0 to 5% slopes	0.08	Somewhat poorly drained	A
Pompano fine sand, 0 to 2% slopes	0.07	Poorly drained	A/D
Riviera fine sand, frequently ponded, 0 to 1% slopes	0.35	Very poorly drained	A/D
Lokosee fine sand	0.41	Poorly drained	A/D

Notes: Four percent of the City of Sebastian drainage area is covered in water and not included in the soil type table.

Table 2-2. City of Sebastian Soil Drainage Classes

	Sum of % of Drainage Area
Excessively drained	8.3
Moderately well drained	3.3
Poorly drained	71.3
Somewhat poorly drained	9.7
Very poorly drained	3.3

As shown in the data above, the high groundwater table effectively limits the infiltration capacity of the soils, which is consistent with the local geological conditions described previously. These conditions, combined with the

relatively flat topography, make drainage very challenging and restrict the types of BMPs that can be employed in the SWMS, especially those that improve water quality.

2.2 Environmental

Stormwater runoff from the City of Sebastian drains either directly to the Indian River Lagoon (for areas east of the Atlantic Coastal Ridge) or to the South Prong of the St. Sebastian River (via multiple outfalls) which ultimately discharges to the Indian River Lagoon. The Indian River Lagoon is a 156-mile-long estuary along Florida's east coast with impaired portions directly adjacent to lands in Volusia, Brevard, Indian River, and St. Lucie counties.

The Clean Water Act requires that the surface waters of each state be classified according to designated uses, such as drinking water, aquatic life, recreation, and agriculture. Florida has six classes, based on the degree of protection required. Currently, most surface waters in Florida, including many of those in the Central Indian River Lagoon (CIRL), are categorized as Class III waters, meaning they must be suitable for recreation and must support fish consumption and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

In 2009, the FDEP adopted revisions to the Verified List of Impaired Waters for the CIRL that identified several estuarine segments as impaired for dissolved oxygen (DO) due to low DO concentrations and nutrients due to an imbalance in flora and fauna because of decreases in seagrass distribution.

The FDEP reported that intense and extensive algal blooms in the IRL began in 2011 and have returned periodically. Harmful algal blooms (HABs) cause shading that stresses seagrass in the IRL, adverse effects on wildlife, and in some cases, detrimental effects on human health.[6]

2.3 Drainage System Characteristics

The City of Sebastian uses a combination of traditional stormwater infrastructure and Green Infrastructure (GI) to collect and convey stormwater runoff. The City's stormwater management system (SWMS) consists of the following:

- More than 360 miles of grassed swales and ditches (i.e., Roadside swales, Front Yard swales, Side Yard ditches, Back Yard ditches, etc.
- 1,293 culverts, totaling more than 126,000 linear feet of pipe, and other drainage structures
- 30 retention and detention ponds
- 9 nutrient separating baffle boxes
- 8.4 miles of canals that discharge at seven locations to the South Prong of the St. Sebastian River.

The SWMS has two primary purposes – (1) to drain surface water to prevent flooding within habitable structures and on roadways, and (2) to reduce pollutant loading to the City's canals, the South Prong of the St. Sebastian River, and ultimately the Indian River Lagoon (IRL). In order to satisfy both of these seemingly conflicting purposes, the SWMS must carefully balance the quantity of flows needed for proper drainage and the quality of the drained water to prevent excessive pollutant loading to receiving waters. GI components such as canals, wet detention and retention ponds are used to add capacity to the existing storm sewer system and increase removal of pollutants while creating additional green space benefits for the community.

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6 *Central Indian River Lagoon Basin Management Action Plan, February 2021.*

2.3.1 Previous Completed Improvements

The City has completed several important capital improvement projects in the SWMS since 2006, which are shown in Table 2-3, and have had positive effects on the quantity and quality of the stormwater discharged. Some of the listed projects were not previously identified on a SWMP update but were added separately by the City.

Table 2-3. CIP Projects Completed Since 2006

Project Name	Year Completed	SJRWMD Permit No.
Davis Street Drainage/Baffle Box	2006	98724-1
Periwinkle Detention Pond	2008	103638-1 & FDEP Permit
George Street Drainage	2009	18714-4
Collier Canal Dredging/Seawall	2009	104663-2 & FDEP Permit (Section 319 Grant Funds)
Potomac Street Baffle Box	2009	119623-1 & FDEP Permit
Schumann Park Imp./Drainage	2009	40952-2
Barber Sport Complex Drainage	2010	40775-4
City Stormwater Park Update	2012	No Permit
Quarter Round Review	2013	No Permit
Stormwater Master Plan Update	2013	No Permit
Coolidge Street Baffle Box	2014	135385-1
Presidential Street Drainage	2014	130339-1 (FDEP TMDL Grant Funds)
Water Monitoring/Testing	2014-2017	No Permit
Seawall Investigations	2014-2016	No Permit
Northern Area Ditch Cleaning	2015	No Permit
FDEP MS4 NPDES Update	2016	MS4 Permit
Tulip Detention Pond	2016	134274-1 & ACOE Permit FDEP TMDL/Section 319 Funds)
Working Waterfront Baffle Box	2016	145977-1 & FDEP Permit SJRWMD Grant and TMDL Grant)
Oyster Bag Pilot Project	2016	142124-1 & ACOE Permit
CavCorp Parking Drainage	2016	142058-2
Jefferson Street Drainage Repair	2017	FDOT US-1 R/W Permit

2.3.2 Previously Identified Drainage issues

After reviewing the previous studies and discussions with City staff, the following issues related to the City's stormwater management system have been identified.

2.3.2.1 Topography

The topography of the City is very flat, and the slopes of the conveyance structures (i.e., swales, ditches, culverts etc.) are in many cases too shallow for proper flow velocities, which limits their capacity. If stormwater runoff enters the conveyance structure at a greater rate than the flow capacity allows, the structure will rapidly fill up and flood over its banks onto adjacent areas.

In an experimental effort to improve the water conveyance in swales with shallow slopes, the City initiated the Quarter Rounds program in 2006, which used plastic pipes cut into quarters and installed along the bottom of the

swale. The plastic pipe is a lower friction coefficient than grass, and field testing showed it did improve the velocity. After installations were completed, the City found that homeowners were not adequately maintaining the swale bottoms, so the City hired contractors at a cost of approximately $250,000 per year to clean swales equipped with quarter round pipe. Maintenance costs continued to increase and the City ultimately determined the program was not cost effective, so it was cancelled by the City Council in 2017.

2.3.2.2 Surface Water Elevations (Tailwater Controls)

The overall system is, for the most part, a tailwater controlled system. The conveyance paths end at a waterbody (i.e., canal, St. Sebastian River, etc.), and if the water elevation within that downstream waterbody increases then a tailwater control occurs, decreasing the drainage flow and causing upstream water elevations to increase. It may not be possible or practical to solve all drainage problems within the City's system without reductions in tailwater elevations.

Drainage issues related to tailwater controls will be further exacerbated by the future effects of climate change and projected increases in sea level elevations in certain parts of the City. This issue is explained in more detail in Section 5 – Sea Level Rise Assessment.

2.3.2.3 Groundwater Elevations

Groundwater elevations throughout most of the City are between 0-1 foot below the ground surface, which significantly reduces or prevents the infiltration of stormwater from the swales, ditches, ponds, and canals and makes water quality treatment efforts extremely challenging.

2.3.2.4 Geology and Soils

The soils and underlying geology in the Sebastian area create many challenges for the management of stormwater as mentioned in Section 2.1. One of the most difficult challenges is the high groundwater conditions and corresponding low infiltration rates in swales, combined with very shallow grades. This results in standing water in many swales throughout the City after storm events. During system evaluations the addition of concrete linings in swales was considered to improve the drainage velocities and flows, but such modifications would be costly, would add substantial impervious area, and would increase runoff volumes that would likely overload downstream drainage areas and not be acceptable to regulators. For these reasons, they were not selected as a CIP project.

2.3.2.5 Inadequate Stormwater Infrastructure

Many of the localized flooding and other drainage issues identified in previous studies and observed in the City are the result of specific deficiencies in the stormwater management system. These deficiencies were further studied, and corrective measures were recommended to the City in the form of Capital Improvement Program (CIP) projects. Several of the identified CIP projects have been completed, but many others have not been addressed, presumably because of a lack of funding. The updated CIP project inventory, including project descriptions, current status, and estimated costs are included in Section 7 - Alternatives Development and CIP Prioritization.

2.3.2.6 Operations and Maintenance Difficulties

Maintenance of Open Channels - The presence of heavy vegetation reduces the flow velocity within an open channel (i.e., grassed swale, etc.), which in turn reduces its flow capacity.

- Front Yard Swale – Per City Code Section 54-2-7.15(d), it is the continuous responsibility of any owner of a lot to maintain such swales, ditches, and pipes on the site to maintain the proper flow of surface water. Maintenance issues with front yard swales and driveway culverts are widespread and have been a historical problem area in the management of the SWMS. The City has historically used code

enforcement to correct non-compliance issues, but only when reported by residents or noticed by City staff during other work activities. As noted above the inspection and maintenance of the swale is the responsibility of the homeowner therefore the City does not currently conduct regular inspections of the front yard swales.

In addition, the City mows the front yard swale of vacant lots to maintain adequate drainage, as the lot owners historically have been unresponsive. On vacant lot parcels that have "Quarter Round" installed, the City crews must hand clean the Front Yard swale to prevent damage to the PVC, which is labor-intensive and costly to the City.

- Side Yard and Back Yard Ditches – previous issues related to the side yard and back yard ditches included overgrown vegetation and unstable side slopes. The City began mowing these ditches through a contract vendor several years ago on a quarterly basis, which has improved the vegetation issue. However, the costs have increased rapidly and are a significant burden on the Stormwater Department's finances. Also, as the elevations required for building foundations and septic tank mounds have increased over the years, the slope of the side yard ditches also increased, rendering many of them unstable and subject to rapid erosion.
- Aquatic Weed Control – the City currently contracts for spraying aquatic weeds with herbicides to control them within the canals and minimize the discharge of live aquatic weeds downstream. This is costly to the City but must be regularly performed to effectively control aquatic weeds within the City's canals.
- Canal dredging – Sediment buildup and shoaling was observed in the City's canals, indicating the need for dredging to restore canal storage and conveyance capacity. City staff reported that the City has not performed maintenance dredging on the canals since they were constructed, except for the Collier Canal North, which was dredged during the 2009 bulkhead reconstruction project.
- Canal bulkheads – There are currently 756 bulkheads along the banks of the City's canals. The City of Sebastian owns and maintains approximately 20 seawalls within the City ROW along the banks of the City's canals. The remainder of the 756 bulkheads are privately owned and maintained. The bulkheads are constructed of several different materials, and more than 200 are structurally failing. For more information on the condition of the bulkheads, see Section 3.3.3.1.

Maintenance of Retention/Detention Ponds

- The City's SWMS includes 19 retention ponds and 11 detention ponds. The Stormwater Department maintains one (Schumann Dr.), all others are maintained by the Parks Department. Sediment buildup may have reduced the capacity of the ponds, they are not on a regular dredging schedule.

2.3.2.7 Environmental Concerns

As mentioned before, the St. Johns River Water Management District (SJRWMD) and South Florida Water Management District (SFWMD) previously identified several drainage concerns for the St. Sebastian River watershed. The principal concerns involve the seagrass coverage in the IRL and the volume of stormwater (fresh water) discharged to the river and its dilution effects on the salinity within the receiving waters. Excessive freshwater drainage into the Indian River Lagoon may result in species shifts that could have significant effects on its fragile ecosystem. In addition, increased suspended matter and excessive loading of pollutants and nutrients associated with stormwater runoff may further degrade water quality.

3 Data and Methodology

3.1 Meetings with the City and Available Data

A kickoff meeting was conducted with the City to introduce the Arcadis project team and review the City's drainage system, historical problems, recent projects, management issues, and identify data available for the master planning effort. The City had extensive hard copy files of previous master plans and previous project documentation, but there were no previous model files of the stormwater system. In addition, the only topographic information available was the Florida Division of Emergency Management (FDEM) Coastal Program 2007 Light Detection and Ranging (LiDAR) elevation data of Indian River County in vertical datum NAVD88.

After reviewing available documentation and several discussions with City staff, it was determined that a new GIS map of the major components of the City's stormwater system would be needed for the hydraulic and hydrologic modeling effort and to satisfy MS4 permit requirements. In order to make the GIS map as accurate as possible, Arcadis reviewed and digitized more than 280 as-built drawings, permits, sketches, and other documentation of the drainage features within the City's stormwater system. A field crew was mobilized and spent more than three weeks in the City locating, identifying, measuring, and surveying elevations for more than 4,400 stormwater drainage components to populate the GIS map.

3.2 Stormwater System GIS Map Development

The stormwater system GIS Map was developed to provide a geospatial database of the City of Sebastian stormwater system incorporating the best available information. The City provided several stormwater-related GIS layers and record drawings as noted in section 3.1. The database incorporated available City of Sebastian information such as CAD drawings, GIS layers including the ditches feature class and Weirs Dams feature class and georeferenced PDFs including "2015 – Ditch Location Map.pdf" and Plan view figures from the 2018 City of Sebastian Stormwater Master Plan. The GIS database and subsequent H&H modeling was completed in vertical Datum NAVD 88. Information collected from record drawings, PDF's, etc. in vertical datum NGVD 29 were converted to NAVD 88 by subtracting 1.463ft based on the NOAA National Geodetic Survey Coordinate Conversion and Transformation Tool (NCAT), see Appendix F for conversion documentation.

The information provided by the City of Sebastian was utilized as a starting point. The team utilized aerial imagery, surface topography, and Google Street View to identify stormwater assets not provided in the City of Sebastian data. Through desktop analysis, approximately 2,381 nodes and 1,875 pipes, culverts and open channels were identified. 75% of stormwater assets were missing critical parameters such as pipe size, invert elevation and rim elevation. Therefore, an ArcGIS online map was created for the survey crew to take measurements via Collector or Field Maps application while in the field.

Two shapefiles were created to represent the stormwater system: a point layer for stormwater structures and a polyline layer for closed pipes and open channels. Additional spot elevations were collected in areas with documented historic flooding. Private driveway culverts and cross pipes were also included in the geodatabase where drawings were available; however, these assets were not included in the modeling work, which focused on infrastructure owned by the City of Sebastian.

Due to survey time limitations, a priority ranking from 1 to 6 was assigned to all nodes and conduits. The highest priority for survey, Rank 1, was given if there was missing information necessary for the H&H modeling work such as conduit type, pipe material, pipe size, invert elevations, rim elevations and blockage conditions. Rank 2 was assigned to ditches that are adjacent to high priority Rank 1 nodes and conduits, and were missing cross-section

dimensions, invert elevations and vegetation conditions. Rank 3 was assigned to nodes and conduits which had at least one critical attribute identified from information provided by the City of Sebastian. Ranks 4-6 were low priority nodes and conduits that were not in critical locations for the H&H model development but were identified as part of the stormwater system.

Of the 2,381 nodes and 1,875 conduits identified for the field survey activities 2,170 nodes and 1,539 conduits were inspected. ~~Of the 2,381 nodes and 1,875 conduits identified for the field survey activities 2,360 nodes and 1,854 conduits were inspected.~~

Arcadis developed a stormwater system asset geospatial database in ArcGIS with the best available information from the desktop analysis, field inspections and survey and the H&H stormwater model development. The database is provided in Appendix J Stormwater Asset GIS Database.

3.3 Infrastructure Asset Survey and Assessment

3.3.1 Asset Assessment Goals, Criteria and Methodology

Arcadis reviewed available stormwater system information as mentioned in Section 1, 3.1, and 3.2. A GIS based inventory of stormwater assets was first developed using desktop analysis followed by a site visit stormwater inspection and field survey.

The infrastructure asset assessment included inspections of over 4,500 stormwater assets including:

- 756 bulkheads,
- 2,170 nodes which include culvert inlets/outlets, outfalls, baffle boxes, curb inlets, yard inlets, and manholes, and
- 1,539 conduits which include pipes, canals, and ditches.

In addition, 111 point elevations were taken at low points that were in flood hazard areas. The complete GIS database also includes inlets and conduits that were provided by the City or located in as-built drawings. The total asset inventory developed for field inspections and survey is comprised of 756 bulkheads, 2,381 inlets/nodes, 1,875 conduits (canals, ditches, etc.), and 27 outfalls for a total of 5,039 features.

3.3.2 Inspection Methodology

The inspections were performed using a Trimble R2 GNSS receiver and a mobile based application that allowed the inspectors to update the inventory of the stormwater conveyance system by taking elevations, dimension measurements, taking note of the material/size, uploading pictures of the asset, and writing down any comments specific to the asset to include condition assessments. The Trimble units were tested with Keynet VRS correction and the ESRI Field Maps App to verify the vertical and horizontal accuracy. The vertical accuracy was documented as +/- 0.2ft and the horizontal accuracy was documented +/-0.1ft. Previously unknown or undocumented assets which were discovered during the inspections were recorded and located with GPS coordinates.

3.3.3 SWMS Components

3.3.3.1 Canals

The City's Stormwater Management System (SWMS) includes approximately eight miles of canals, which have bulkheads on both sides for most of their length. The canals themselves showed varying amounts of vegetation and shoaling, and generally appeared to be in need of vegetation removal and maintenance dredging to reset their flow areas to their original design configurations. The bulkheads along the canal banks are constructed of a variety of materials, primarily concrete or steel sheet piling. The canals themselves are within the City's drainage easement and are maintained by the City, but the majority of the bulkheads are privately owned and maintained.

Figure 3-1. Bulkhead Toe Failure

As indicated above, a total of 756 bulkheads were inspected and about 85% were generally found to be structurally sound, but many of those showed signs of deterioration (i.e., cracks along the bulkhead face, concrete cap, etc.) and need maintenance. At the time of the inspections, 108 bulkheads had structurally failed and need to be replaced immediately, especially in the Schumann Lake area. An example of the observed bulkhead failures is shown in Figure 3-1, a bulkhead toe failure that occurred over multiple properties.

The bulkheads that were constructed of metal were consistently in better condition with fewer cases of failure, but that is likely because they are newer than the concrete bulkheads. Many of the properties with bulkheads also have moderate to high amounts of vegetation growing around and on top of the structures, which blocked the view for inspections and, if left unchecked, could cause future failures due to erosion and uplift from tree roots. For these reasons, no trees, shrubs or other vegetation with substantial root systems should be present within 20 feet of a bulkhead structure.

3.3.3.2 Green Infrastructure

The City's SWMS relies primarily on Green Infrastructure, a network of interconnected roadside swales, side yard swales, and backyard ditches, for conveyance of stormwater to canals and outfall points. Due to the sheer number of swales and ditches, our inspections were limited to the major flow paths for use in H&H model development. The thousands of roadside swale sections, though not specifically included in our inspections, were observed throughout the City during the field work and generally appeared to be in good condition, with some exceptions. However, the large number of roadside swale sections and their connecting driveway culverts in series create a collection system with a high probability for operational difficulties. A detailed inspection and hydraulic analysis of the roadside swale systems throughout the City should be performed in the future.

The GIS infrastructure database developed to facilitate the field inspections and survey activities described in Section 3.3.1 included 473 line features representing roadside swales, side yard swales, and backyard ditches. For each asset, the inspection data and a photo documenting its condition at the time of inspection was entered into the GIS database. Per City code, the private property owners are the responsible party for maintenance of swales and ditches. The City completes limited ditch regrading in association with road repaving projects. Approximately 60% of these swales and ditches were either in good condition or had evidence of being recently

cleared and regraded by the City. Approximately 40% of them had moderate to high amounts of vegetation that could potentially impede the stormwater drainage. A map of the drainage conditions observed during the inspections is shown in Figure 3-2.

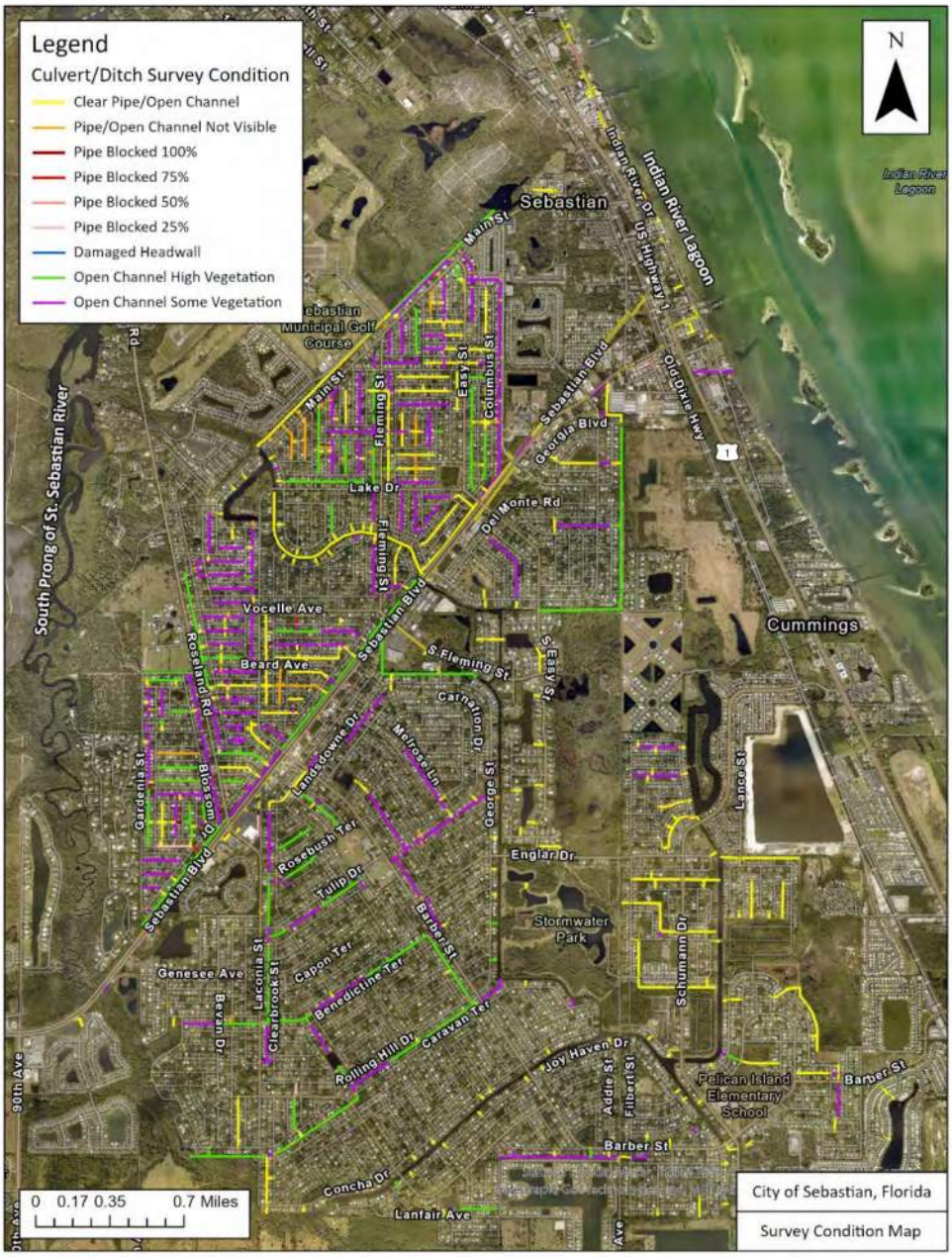

Figure 3-2. Observed Drainage Conditions

Note: The stormwater survey was focused on City-owned stormwater infrastructure. Private stormwater infrastructure including driveway culverts were not included in the surveying effort.

3.3.3.3 Conveyance Structures

The remainder of the stormwater inspections consisted of assessing the physical and operation condition of the conveyance structures, such as culvert inlets/outlets, outfalls, baffle boxes, curb inlets, yard inlets, manholes, and pipes. Except as noted, all accessible structures identified during the desktop analysis discussed in Section 3.2 were inspected and surveyed. Elevations were taken at the rim and invert(s) of these stormwater structures, when accessible. For pipes, additional field measurements were taken to document the pipe diameter and length, and the pipe material was noted. For each asset, the inspection data and a photo documenting its condition at the time of inspection was entered into the GIS database.

Note that the thousands of driveway culverts in the SWMS were not included in these inspections, as they are part of the residential roadside swale network and not specifically included in the hydraulic model due to a lack of survey and physical data. Note that the thousands of driveway culverts in the SWMS were not included in these inspections, as they are part of the residential roadside swale network and not specifically included in the hydraulic model due to a lack of survey and physical data. However, as mentioned in the previous section, the large number of roadside swale sections and their connecting driveway culverts in series create a collection system with a high probability for operational difficulties. A detailed inspection and hydraulic analysis of the roadside swale systems throughout the City should be performed in the future.

In all, 2,165 nodes were included in the GIS map for these conveyance structures. In all, 2,381 node features and 1,440 line features were included in the GIS map for these conveyance structures. Their condition was determined based on the amount of sediment inside the asset, whether the asset was blocked due to vegetation, or if the asset was damaged or collapsed. In most cases these assets were in good condition, with little or no sediment blocking the flow. However, there were a few locations in which sediment and vegetation blocked enough of the structure to prevent water from flowing at their intended levels.

The GIS infrastructure database developed to facilitate the field inspections and survey activities described in Section 3.3.1 included 473 line features representing roadside swales, side yard swales, and backyard ditches.

3.4 Hydrologic and Hydraulic Modeling

3.4.1 H&H Model Goals and Limitations

A dynamic 1D Hydrologic and Hydraulic (H&H) computer model of the City of Sebastian stormwater network was developed to evaluate the system performance in response to various conditions. The H&H model also supported capital improvement project development, permitting, grant funding applications and stormwater system performance evaluations.

3.4.2 Software Selection

Arcadis worked with the City of Sebastian to select a modeling software for the stormwater analysis that met the needs of the City. Arcadis completed a technical review of the existing City of Sebastian modeling approach and the capabilities of standard software programs and commonly applied modeling approaches. The existing City of Sebastian stormwater model files created in modeling software Interconnected Pond Routing model (ICPR) version 3 developed by Streamline Technologies Inc. were not available for review and therefore Arcadis reviewed the model documentation provided in the *Master Stormwater Management Plan Report, 2004*[7] and the

[7] CDM Smith. *Master Stormwater Management Plan*. City of Sebastian, Florida. February 2004.

Stormwater Management Plan Update, 2018[8]. Based on discussions with the City of Sebastian the top priorities when selecting the modeling software were low cost, wide software usage, model accessibility, and suitability for use on stormwater planning projects. The Team reviewed stormwater modeling software ICPR version 4, PCSWMM provided by Computational Hydraulics Int., and InfoWorks ICM by Innovyze. The software selected with input from the City of Sebastian for the hydrologic and hydraulic evaluation was PCSWMM which uses the EPA's public domain Stormwater Management Model (SWMM) engine. A summary of the PCSWMM software attributes is provided below:

- Relatively low cost
- High accessibility – PCSWMM model files can be accessed using the publicly available EPA SWMM5 software.
- Flexibility across projects - PCSWMM model network can be exported to GIS for easy data management and review in support of ancillary City of Sebastian objectives.
- Support and Software Usage - PCSWMM software and EPA SWMM5 is used throughout the US and has an extensive user group and online community.
- Suitability – PCSWMM is a dynamic hydrologic and hydraulic model software developed to support stormwater management.

The City of Sebastian is interested in 2D stormwater modeling capabilities. 2D modeling is helpful when evaluating surface flooding extents and complex overland flow paths associated with various design storm events. Arcadis recommended InfoWorks ICM as the software of choice for 2D modeling. PCSWMM software has a recommended maximum 2D area of 500 acres which would not support a system-wide 2D model of the City of Sebastian (7,243 ac). The City of Sebastian selected PCSWMM over InfoWorks ICM based on software costs and accessibility which are higher priorities to the City compared to 2D modeling capabilities. Utilizing the PCSWMM software the City of Sebastian will have the ability to create individual 2D models for areas of concern within the stormwater network with a total 2D surface areas less than 500 acres as necessary.

3.4.3 Model Extents and Level of Detail

The model extents were developed based on discussions with the City of Sebastian and are provided in Figure 3-3. The modeled network is focused on the pipes, culverts, and open channels owned by the City of Sebastian. In some locations roadside swales were included in the model extents in order to maintain system connectivity between City owned infrastructure. The model includes 2,210 conduits (pipes, culverts, open channels, swales, canals, etc.), 2,150 junctions (culvert inlets/outlets, catch basins, manholes, open channel confluence points, etc.), and 46 storage nodes (detention basins, ponds, GI features, etc.). There are an additional 57 storage nodes in the model that track and store runoff from Planned Unit Development (PUD) areas where stormwater runoff is managed onsite and disconnected from areas without stormwater infrastructure that are not tributary to the City of Sebastian stormwater network.

[8] CWT Engineering, LLC. Stormwater *Management Master Plan update*. City of Sebastian, Florida. August 2018.

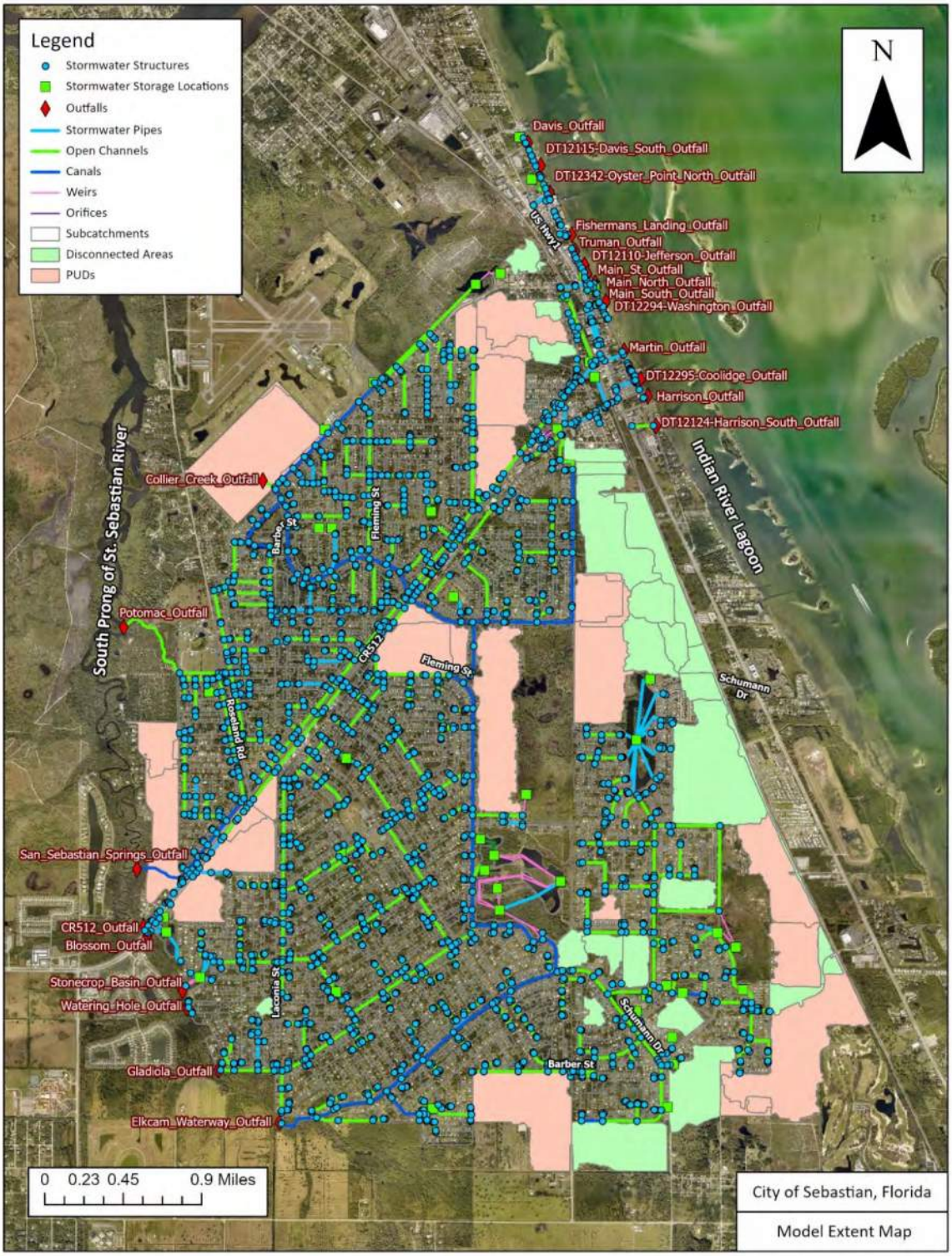

Figure 3-3. Hydrologic and Hydraulic Modeling Extents

There are a total of 27 outfall locations in the City of Sebastian, the locations are described in Table 3-1. Fourteen of the outfalls drain to the Indian River Lagoon, the outfalls are managed by the FDOT and the City of Sebastian as described in Table 3-1. Thirteen of the outfalls drain to the South Prong of the St. Sebastian River, the outfalls are managed by the City of Sebastian, Indian River County, and a private entity as described in Table 3-1. Two of the outfalls drain to Collier Creek which is tributary to the South Prong of the St. Sebastian River, the outfalls are managed by the City of Sebastian. There are 23 outfall locations included in the H&H model, as shown in Figure 3-3. The modeled outfalls are not a direct match to the outfalls documented in Table 3-1. The model includes a single outfall along Collier Creek labeled Collier Creek Outfall located 375ft downstream of the Hardee Dam and receives flow from the Twin Ditches Outfall and Hardee Outfall. Also, the model includes a single outfall along the Elkcam Waterway labeled Elkcam Waterway Outfall located 1,500ft downstream of the Elkcam Dam and includes flow from the Elkcam outfall, Laconia outfall and Lanfair outfall. Finally, the Sunport outfall is not included in the H&H model due to a lack of available information.

Table 3-1. Outfall Locations

Outfall Name	Responsible Party	Tributary Waterbody
Davis Outfall	City of Sebastian	Indian River Lagoon
DT12110-Jefferson Outfall	FDOT	Indian River Lagoon
DT12115-Davis South Outfall	FDOT	Indian River Lagoon
DT12124-Harrison South Outfall	FDOT	Indian River Lagoon
DT12294-Washington Outfall	FDOT	Indian River Lagoon
DT12295-Coolidge Outfall	City of Sebastian	Indian River Lagoon
DT12342-Oyster Point North Outfall	FDOT	Indian River Lagoon
Fisherman's Landing Outfall	City of Sebastian	Indian River Lagoon
Harrison Outfall	City of Sebastian	Indian River Lagoon
Main North Outfall	City of Sebastian	Indian River Lagoon
Main South Outfall	City of Sebastian	Indian River Lagoon
Main St Outfall	City of Sebastian	Indian River Lagoon
Martin Outfall	City of Sebastian	Indian River Lagoon
Truman Outfall	City of Sebastian	Indian River Lagoon
Hardee Dam Outfall	City of Sebastian	Collier Creek
Twin Ditches Outfall	City of Sebastian	Collier Creek
Blossom Outfall	City of Sebastian	South Prong of the St. Sebastian River
CR512 Outfall	Indian River County	South Prong of the St. Sebastian River
Elkcam Outfall	City of Sebastian	South Prong of the St. Sebastian River
Gladiola Outfall	City of Sebastian	South Prong of the St. Sebastian River
Laconia Outfall	City of Sebastian	South Prong of the St. Sebastian River
Lanfair Outfall	City of Sebastian	South Prong of the St. Sebastian River
Potomac Outfall	Indian River County / City of Sebastian	South Prong of the St. Sebastian River
San Sebastian Springs Outfall	Private	South Prong of the St. Sebastian River
Stonecrop Basin Outfall	City of Sebastian	South Prong of the St. Sebastian River

Table 3-1. Outfall Locations

Outfall Name	Responsible Party	Tributary Waterbody
Sunport Outfall	City of Sebastian	South Prong of the St. Sebastian River
Watering Hole Outfall	City of Sebastian	South Prong of the St. Sebastian River

Note 1: The Potomac Outfall is owned by Indian River County. The City of Sebastian has historically maintained the outfall and placed a Baffle Box at this location in coordination with Indian River County.

3.4.4 Hydraulic Parameters

The 1D hydraulic stormwater network was developed from limited GIS data provided by the City of Sebastian, digitized record drawings, field investigations, survey data and photos. The network includes closed pipe and open channel stormwater conveyance and is represented in the model with a collection of nodes and links. As discussed in Section *3.2 Stormwater System GIS Map Development* a desktop analysis was completed to create the City of Sebastian existing stormwater network geospatial database which included a review of available GIS data and record drawings, aerial imagery and Google Street View to identify open channels and pipes not included in the GIS data and record drawings. 75% of the stormwater assets identified during the desktop analysis were missing hydraulic attributes (pipe diameter, open channel geometry, invert elevations, rim elevations, pipe material, and open channel vegetation). Pipe and open channel attributes were collected by survey crews in 2022, as documented in Section 3.2. Open channel cross-section geometry and channel slope was based on surveyed cross-sections and channel elevations supplemented with surface topography. The Florida Division of Emergency Management (FDEM) Coastal Program 2007 Light Detection and Ranging (LiDAR) elevation data of Indian River County with a vertical accuracy of +/- 4 inches was used for the analysis and is in vertical datum NAVD88. An average open channel geometry is assigned to the length of the modeled open channel sections.

As part of the hydraulic data quality review the surveyed invert elevations were compared against the LiDAR topography and adjacent invert elevations documented in record drawings. The hand-held GPS unit has a documented vertical accuracy of +/-0.2ft. A limited number of surveyed invert elevations were found to have a larger range of accuracy than expected, approximately +/-1.5ft. The hand-held GPS unit used for survey data collection can result in less accurate data if satellite connectivity issues occur. Locations with inaccuracies in the surveyed elevations were determined based on the following criteria: negatively sloped pipes and open channels, invert elevations that exceeded the ground surface elevations derived from LiDAR or survey data. Locations with the invert elevation inaccuracies or missing invert elevations were either estimated based on the LiDAR topography or interpolated based upstream and downstream invert elevations while assuming constant slope. The invert elevation adjustments were focused on the larger pipes and open channels that were significant to stormwater conveyance. Due to limited existing system information and the flat nature of the City of Sebastian topography flow directions of the pipes and open channels were determined by reviewing invert elevations and pipe sizes under the assumption that smaller pipes flow to larger pipes.

The team reviewed the stormwater network following the surveying effort and identified gaps in the system connectivity; pipes, roadside ditches, and open channels not included in the hydraulic network developed through desktop analyses from available information. The roadside swales are not maintained by the City of Sebastian but were included as necessary to connect the City of Sebastian culverts, open channels, etc. in the stormwater model. For the assets not included or inaccessible during the surveying effort, hydraulic attributes were assumed based on topography, Google Street View, and upstream and downstream stormwater infrastructure. The open

channels with missing cross-section geometry were grouped into 6 categories according to vegetation condition and size of the channel according to 2007 LiDAR data and recent aerial imagery provided by Indian River County dated June 2021. Roadside ditches were grouped as one category assuming they have similar cross-section geometry. The average cross-section geometry was calculated for each category and was applied to each open channel and roadside ditch lacking cross-section geometry. Cross-section geometry for the large open channels was developed individually based on the 2007 LiDAR elevation data.

The Manning's, n, roughness coefficients for pipes and culverts were adjusted according to material type as noted in the record drawings and field survey. Open channel Manning's, n, roughness coefficients used in PCSWMM were based on existing conditions documented in field surveyed vegetation, site photographs, aerial imagery, and Manning's, n, roughness coefficients for channels[9]. Table 3-2 summarizes the Manning's, n, roughness coefficients used in the PCSWMM modeled pipes and open channels. In locations where detailed information regarding pipe material or open channel conditions was unavailable a default Manning's, n, roughness coefficient of 0.015 and 0.035 was assigned for pipes and open channels respectively.

Table 3-2. Manning's, n, Roughness Coefficients

Pipe Material / Open Channel Condition	Manning's Roughness Coefficient
Reinforced Concrete Pipe - Default	**0.015**
Polyvinyl Chloride and Cured In Place Pipe Lining	0.01
Concrete	0.015
Corrugated Metal/Aluminum Pipe	0.02
HDPE	0.012
Excavated Channel - Earth, straight, and uniform with short grass, few weeds	0.027
Clean, straight, full stage, no rifts, or deep pools, with some stones and weeds (Default or Clear)	**0.035**
Channels not maintained, weeds and brush uncut, clean bottom, brush on sides (Some vegetation)	0.05
Channels not maintained, weeds and brush uncut, dense weeds, high as flow depth (High vegetation)	0.08

Pipe blockages documented in the field survey efforts, Section 3.2 and 3.3, were not included in the existing conditions model. The H&H model assumes that pipe blockages have been addressed through regular O&M activities. This condition allows for identification of undersized infrastructure and supports the identification of CIP projects. System maintenance to remove sedimentation and pipe blockages is critical to the operation of the stormwater system as sedimentation and blockages negatively impact the conveyance capacity of the existing stormwater infrastructure and can increase the severity and frequency of surface flooding within the City.

The stormwater storage structures including detention basins and ponds were represented in the model as storage nodes. The storage nodes are assigned a stage-storage curve based on available record drawings or LiDAR topography. Specialty hydraulic features including weirs and orifices were included in the model to represent outlet control structures at the canals, outfalls, detention basins, etc. The Stormwater Park pump station is included in the

[9] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill.

PCSWMM model but based on discussions with the City of Sebastian staff the pump is not operated during wet-weather events and is therefore the pump station is turned off in the design storm simulations.

3.4.4.1 Outfall Boundary Conditions

There are 23 outfall locations included in the H&H model, as shown in Figure 3-3. Fourteen of the outfalls drain to the Indian River Lagoon and the remaining nine outfalls drain to the South Prong of the St. Sebastian River. The boundary conditions of the outfalls in the Indian River Lagoon are based on the mean sea level elevation data collected at the Trident Pier Station at Port Canaveral (Station No. 8721604) which is the closest National Oceanic and Atmospheric Administration (NOAA) Tide Station to the City of Sebastian. According to Figure 5-1 in Section 5 – Sea Level Rise Assessment, data collected at this station from 1994 to 2022 show the maximum of mean sea level elevation is 2.15ft NAVD 88 (1.2 MSL ft). The fixed stage water surface elevation of 2.15 ft was assigned to the 14 Indian River Lagoon outfalls for the 10-year, 25-year, and 100-year design storm events. The Indian River Lagoon boundary condition set to the maximum mean sea level allows for review of the capacity of the stormwater conveyance system. There are additional risks to stormwater infrastructure draining to the Indian River Lagoon which are present during periods of elevated water levels such as King Tides, Hurricanes, etc. The outfalls tributary to the South Prong of the St. Sebastian River were assigned a fixed stage elevation based on the FEMA Flood Insurance Study (FIS) for Indian River County, Florida[10] and incorporated areas revised on December 4, 2012. The FIS provides still water elevations by transect for 10-, 50-, 100-, 500-year recurrence intervals for use in floodplain management. The 25-year storm event at each transect was interpolated from the provided recurrence interval floodplain data. The location of each City of Sebastian outfall to the South Prong of the St. Sebastian River in relation to the FIS transects along the stream centerline was used to interpolate the water surface elevations for the 10-, 25-, and 100-year recurrence interval events. The boundary conditions at each outfall location are summarized in Table 3-2.

Table 3-3. Outfall Boundary Conditions

Outfall Name	10-year Water Surface Elevation, ft	25-year Water Surface Elevation, ft	100-year Water Surface Elevation, ft	Invert Elevation, ft
Blossom Outfall	6.27	7.37	8.94	8.54
Collier Creek Outfall[2]	12.30	13.12	14.20	5
CR512 Outfall[3]	6.34	7.43	9.00	0
Davis Outfall	2.15	2.15	2.15	-1
DT12110-Jefferson Outfall	2.15	2.15	2.15	-2.1
DT12115-Davis South Outfall	2.15	2.15	2.15	-1
DT12124-Harrison South Outfall	2.15	2.15	2.15	-3.8
DT12294-Washington Outfall	2.15	2.15	2.15	0.46
DT12295-Coolidge Outfall	2.15	2.15	2.15	-1.5
DT12342-Oyster Point North Outfall	2.15	2.15	2.15	-1.42
Elkcam Waterway Outfall[5]	7.97	8.91	10.47	5.54
Fisherman's Landing Outfall	2.15	2.15	2.15	-1
Gladiola Outfall	6.90	7.94	9.67	-1

[10] Federal Emergency Management Agency, Flood Insurance Study Indian River County, Florida and Incorporated Areas, 4 December 2012.

Table 3-3. Outfall Boundary Conditions

Outfall Name	10-year Water Surface Elevation, ft	25-year Water Surface Elevation, ft	100-year Water Surface Elevation, ft	Invert Elevation, ft
Harrison Outfall	2.15	2.15	2.15	-1
Main North Outfall	2.15	2.15	2.15	-1.46
Main South Outfall	2.15	2.15	2.15	2.54
Main St Outfall	2.15	2.15	2.15	3.94
Martin Outfall	2.15	2.15	2.15	-2
Potomac Outfall	1.98	3.13	4.85	7.56
San Sebastian Springs Outfall	5.26	6.38	8.00	6.15
Stonecrop Basin Outfall	6.60	7.67	9.32	0.54
Truman Outfall	2.15	2.15	2.15	0
Watering Hole Outfall	6.72	7.77	9.46	8.1

Note 1: Elevations are provided in vertical datum NAVD88
Note 2: The modeled Collier Creek outfall is located 375ft downstream of the Hardee Dam and includes flow from the Twin Ditches outfall and Hardee outfall
Note 3: The CoR512 outfall included in the H&H model is not owned by the City but receives flow from City property along CoR512. The outfall is located South of CoR512 and drains to the South Prong of the St. Sebastian River.
Note 4: The Sunport outfall is not included in the H&H model due to a lack of available information.
Note 5: The modeled Elkham Waterway outfall is located 1,500ft downstream of the Elkham Dam and includes flow from the Elkham outfall, Laconia outfall and Lanfair outfall

3.4.5 Hydrologic Parameters

Hydrologic parameters for the area tributary to the stormwater collection system were developed to define the PCSWMM calculations which convert rainfall into stormwater runoff and infiltration.

3.4.5.1 Subcatchment Delineation

Site topography, storm sewer inlet locations, site survey and visual inspections were used to delineate drainage areas throughout the system. The total modeled drainage area is 7,243 acres and was split into 1,898 subcatchments (see Figure 3-3). The City provided a map of locations and boundaries of Planned Unit Development (PUD) areas where stormwater runoff is managed onsite and these areas were delineated as individual subcatchments. Additionally, areas not identified as PUD's without stormwater infrastructure that were not tributary to the City of Sebastian stormwater network were delineated as individual subcatchments and are noted as a "Disconnected area" in Figure 3-3. There are 28 PUD subcatchments and 29 disconnected area subcatchments with a total acreage of 1,087 ac and 734 ac respectively.

The calculated subcatchment hydrologic parameters developed for the stormwater model are listed below.

- Subcatchment Parameters
  - Area
  - Average Flow Path Length
  - Average Subcatchment Slope

- Impervious Area
- Infiltration Parameters

Subcatchment parameters affect stormwater runoff volume and peak flow rates. Site topography is based on Florida Division of Emergency Management (FDEM) Coastal Program 2007 Light Detection and Ranging (LiDAR) elevation data of Indian River County with a vertical accuracy of +/- 4 inches. The LiDAR data along with the stormwater inlet locations identified through the review of record drawings, survey activities, and publicly available aerial/street-view imagery were used to calculate the subcatchment area in Arc Geographic Information System (ArcGIS). The subcatchment flow path length is defined by the distance runoff travels within a subcatchment to reach the outlet. The flow paths were developed in ArcGIS for each subcatchment based on the existing topography. The slope for each subcatchment is determined based on the average slope of the subcatchment and was calculated based on the existing topography.

The subcatchment impervious area was calculated in ArcGIS based on geospatial information regarding building footprints and roadway extents. The building footprint information was developed from the Indian River County building footprint shp file and was reviewed and updated. The *IRC_Building_Footprints_poly* file was compared against recent aerial imagery provided by Indian River County dated June 2021 and buildings identified as missing in the building footprint file were added and buildings that were not present in the aerial imagery were removed. The updated *IRC_Building_Footprints_poly* file is provided for reference in Appendix J Stormwater Asset GIS Database. When calculating the percentage of impervious area within the subcatchments the building impervious areas were increased by 25% to account for driveways. The roadway impervious area shp file was developed using a buffer of the street centerline file provided by the City of Sebastian. The existing system percent impervious is approximately 20%.

The modified Green-Ampt Infiltration method was selected for modeling the infiltration of rainfall into the pervious surfaces within the drainage area. Infiltration parameters are based on physical soil attributes and include the initial moisture deficit of the soil, soil hydraulic conductivity (infiltration rate), and the suction head at the wetting front. The stormwater infiltration within the City of Sebastian functions differently East versus West of the coastal divide. Detailed City of Sebastian soils information is provided in Section 2.1 - Geology and Soils. West of the coastal divide the groundwater is noted as within 1ft of the ground surface and there is a documented hardpan layer, both of which limit the infiltration potential. East of the coastal divide infiltration functions based on the physical characteristics of the soils. Two different approaches were used to develop infiltration parameters for the varied hydrogeology East and West of the coastal divide in the City of Sebastian.

East of the coastal divide the subcatchment Green-Ampt infiltration parameters were developed from a composite of the soils documented in the NRCS Web Soil Survey. The documented soil types were assigned Green-Ampt parameters based on the relative soil texture, as referenced from *Rawls (1983)*[11], the NRCS provided soil hydraulic conductivity ranges and the most hydraulically restrictive layer within each soil type. The Green-Ampt parameters for the various soil types are provided in Table 3-3.

[11] Rawls, W.J. et al. 1983. J. Hyd. Engr., 109:1316.

Table 3-4. Green-Ampt Parameters assigned City of Sebastian USDA/NRCS Soil Types

Soil Type	Hydrologic Soil Group	Hydraulic conductivity, in/hr	Suction head, in	Initial deficit (fraction)
Chobee loamy fine sand, frequently ponded, 0 to 1 percent slopes	C/D	0.06	8.66	0.262
EauGallie fine sand	A/D	0.06	8.66	0.262
Immokalee fine sand	B/D	2.49	6.49	0.378
Myakka-Myakka, wet, fine sands, 0 to 2 percent slopes	A/D	2.49	6.49	0.378
Oldsmar fine sand	A/D	0.06	8.66	0.262
Pepper sand	D	0.43	4.33	0.368
Riviera fine sand, 0 to 2 percent slopes	A/D	2.49	6.49	0.378
St. Lucie sand, 0 to 8 percent slopes	A	4.74	1.93	0.413
Archbold sand, 0 to 5 percent slopes	A	4.74	1.93	0.413
Wabasso-Wabasso, wet, fine sand, 0 to 2 percent slopes	B/D	2.49	6.49	0.378
Pineda-Pineda, wet, fine sand, 0 to 2 percent slopes	A/D	2.49	6.49	0.378
Quartzipsamments, 0 to 5 percent slopes	A	4.74	1.93	0.413
Pomello sand, 0 to 5 percent slopes	A	4.74	1.93	0.413
Arents, 0 to 5 percent slopes	A	4.74	1.93	0.413
Floridana sand, frequently ponded, 0 to 2 percent slopes	C/D	0.06	8.66	0.262
Immokalee-Urban land complex	A/D	4.74	1.93	0.413
Astatula sand, 0 to 5 percent slopes	A	4.74	1.93	0.413
Satellite fine sand, 0 to 2 percent slopes	A	4.74	1.93	0.413
Malabar fine sand	A/D	0.43	4.33	0.368
Myakka fine sand, frequently ponded, 0 to 1 percent slopes	A/D	2.49	6.49	0.378
Holopaw fine sand, 0 to 2 percent slopes	A/D	2.49	6.49	0.378
Electra sand, 0 to 5 percent slopes	A	0.43	4.33	0.368
Pompano fine sand, 0 to 2 percent slopes	A/D	4.74	1.93	0.413
Riviera fine sand, frequently ponded, 0 to 1 percent slopes	A/D	0.43	4.33	0.368
Lokosee fine sand	A/D	0.06	8.66	0.262

West of the coastal divide the infiltration is affected by additional factors that limit the potential for infiltration. The high water table and hardpan layer are reflected in the hydrologic soil groups (HSG) assigned by NRCS, 78% of the soils within the drainage area are hydrologic soil group D or two HSG groups (i.e., A/D, C/D) which indicate that a confining layer or high water table when present affects the infiltration rate that a given soil group would normally exhibit and the soil acts like HSG D. Additionally, the East Central Florida Transient Expanded Model (ECFTX) groundwater model recharge rates are less than 0.005in/hr in the City of Sebastian which confirms the limited infiltration potential. Therefore, the PCSWMM stormwater model Green-Ampt parameters West of the coastal divide were set to the most restrictive soil type documented in the City, a Sandy Clay Loam, which are provided in Table 3-4. For reference the hydraulic conductivity assigned to the area west of the coastal divide is reflective of the infiltration rate that would be achieved using the Curve Number method in this area.

Table 3-5. Green-Ampt Parameters assigned to Subcatchments West of the Coastal Divide

Soil Type	Hydraulic Conductivity, in/hr	Suction Head, in	Initial Deficit (fraction)
Sandy Clay Loam	0.06	8.66	0.262

Once the variable parameters were generated for each subcatchment, general hydrology parameters for all subcatchments were applied and are listed in Table 3-5.

Table 3-6. Subcatchment Hydrology Parameters

Subcatchment Parameter	Value
Overland Roughness (Manning's N) - Impervious	0.03
Overland Roughness (Manning's N) - Pervious	0.25
Depression Storage - Impervious	0.075 in
Depression Storage - Pervious	0.75 in
Percent Impervious with Zero Depression Storage	25%
Subarea Routing	Pervious
Percent Routed	75%

3.4.5.2 Rainfall

The existing City of Sebastian stormwater network performance was evaluated for the 10yr-24hr, 25yr-24hr, and the 100yr-24hr design storm events. The NOAA Atlas 14 Precipitation Frequency Data[12] was used to develop design rainfall depths for these design events and is included in Appendix G. The design event rainfall depths are provided in Table 3-6. The design rainfall depths were distributed over the 24-hour duration using the NRCS Type II FL Modified Distribution with a 30-minute interval. The NRCS Type II FL Modified Distribution is one of the recommended design storm distributions in the St. Johns River Water Management District Permit Information Manual and was selected because it was derived to more accurately simulate hydrographs for the State of Florida compared to the standard NRCS Type II rainfall distribution.

Table 3-7. Design Storm Rainfall Depths and Distributions

Design Storm Event Time (hr)	NRCS Type II FL Modified Rainfall Ratio *(SJRWMD Table 35.1-1)*	Cumulative Rainfall Depth (in)		
		10yr-24hr Design Storm	25yr-24hr Design Storm	100yr-24hr Design Storm
0:00	0.000	0.000	0.000	0.000
0:30	0.006	0.043	0.055	0.074
1:00	0.012	0.087	0.110	0.149

[12] Point Precipitation Frequency Estimates, National Oceanic and Atmospheric Administration Atlas 14, Volume 9, Version 2. Accessed 28 February 2022.

Table 3-7. Design Storm Rainfall Depths and Distributions

Design Storm Event Time (hr)	NRCS Type II FL Modified Rainfall Ratio *(SJRWMD Table 35.1-1)*	Cumulative Rainfall Depth (in)		
		10yr-24hr Design Storm	25yr-24hr Design Storm	100yr-24hr Design Storm
1:30	0.019	0.138	0.174	0.236
2:00	0.025	0.181	0.229	0.310
2:30	0.032	0.232	0.293	0.397
3:00	0.039	0.282	0.358	0.484
3:30	0.047	0.340	0.431	0.583
4:00	0.054	0.391	0.495	0.670
4:30	0.062	0.449	0.569	0.769
5:00	0.071	0.514	0.651	0.880
5:30	0.080	0.579	0.734	0.992
6:00	0.089	0.644	0.816	1.104
6:30	0.099	0.717	0.908	1.228
7:00	0.110	0.796	1.009	1.364
7:30	0.122	0.883	1.119	1.513
8:00	0.134	0.970	1.229	1.662
8:30	0.148	1.072	1.357	1.835
9:00	0.164	1.187	1.504	2.034
9:30	0.181	1.310	1.660	2.244
10:00	0.201	1.455	1.843	2.492
10:30	0.226	1.636	2.072	2.802
11:00	0.258	1.868	2.366	3.199
11:30	0.308	2.230	2.824	3.819
12:00	0.607	4.395	5.566	7.527
12:30	0.719	5.206	6.593	8.916
13:00	0.757	5.481	6.942	9.387
13:30	0.785	5.683	7.198	9.734
14:00	0.807	5.843	7.400	10.007
14:30	0.826	5.980	7.574	10.242
15:00	0.842	6.096	7.721	10.441
15:30	0.857	6.205	7.859	10.627
16:00	0.870	6.299	7.978	10.788
16:30	0.882	6.386	8.088	10.937
17:00	0.893	6.465	8.189	11.073
17:30	0.904	6.545	8.290	11.210
18:00	0.913	6.610	8.372	11.321
18:30	0.923	6.683	8.464	11.445

Table 3-7. Design Storm Rainfall Depths and Distributions

Design Storm Event Time (hr)	NRCS Type II FL Modified Rainfall Ratio *(SJRWMD Table 35.1-1)*	Cumulative Rainfall Depth (in)		
		10yr-24hr Design Storm	25yr-24hr Design Storm	100yr-24hr Design Storm
19:00	0.931	6.740	8.537	11.544
19:30	0.940	6.806	8.620	11.656
20:00	0.948	6.864	8.693	11.755
20:30	0.955	6.914	8.757	11.842
21:00	0.962	6.965	8.822	11.929
21:30	0.969	7.016	8.886	12.016
22:00	0.976	7.066	8.950	12.102
22:30	0.983	7.117	9.014	12.189
23:00	0.989	7.160	9.069	12.264
23:30	0.995	7.204	9.124	12.338
24:00	1.000	7.240	9.170	12.400

3.4.6 H&H Model Validation

The H&H model was validated to historical flooding locations documented by the City of Sebastian. Locations of historic flooding and the relative flooding depth were provided geospatially and were focused on roadway areas. Hydrologic and hydraulic parameters were adjusted in the model to match observed flooding. Additionally modeled peak flows throughout the stormwater network were compared to the flows provided in the 2004 Master Management Plan developed by CDM Smith. The PCSWMM model simulated higher flows on average compared to the 2004 ICPR model. This is likely due to the additional detail in the PCSWMM model and the fact the 2004 ICPR model was a skeleton model which only included the main conveyance network, approximately 80 culvert crossings and 204 subcatchments. The PCSWMM model is a planning level tool and provides a dynamic representation of the stormwater network performance based on the best available hydrologic and hydraulic input data. The model focuses on the main conveyance network and does not include all pipes and open channels within the model extents. A potential future improvement to the H&H model is the addition of stormwater overflow from the PUD areas into the City of Sebastian Stormwater network. The PUD areas are disconnected from the City of Sebastian stormwater network but can overflow into the network during extreme wet weather events. The addition of the PUD flows can improve the accuracy of the modeled system conditions.

3.4.7 H&H Model Limitations

The model is a planning level representation of the City of Sebastian stormwater network and is based on the information available at the time of development. The model focuses on the main conveyance network and does not include all pipes and open channels within the model extents. The H&H model is a living model and as improvements are made to the system and additional information is collected, including new survey data and field investigations, the model will require updates to reflect the current conditions. Application of the model for future evaluations and design projects should include review of the project area to assess any model improvement needed to reflect the condition under analysis, comparison of modeled flows and/or heads with the most recent monitoring data available, and review of available survey data of the stormwater conveyance network.

3.5 Existing Conditions Design Storm Analysis Results

The validated 1D Hydrologic and Hydraulic stormwater model was used to identify locations and volumes of simulated surface flooding and review hydraulic gradelines for design wet weather events. According to the simulated existing conditions H&H model 1073, 1424, and 1738 locations experience flooding for more than two hours for the 10yr-24hr, 25yr-24hr, and 100yr-24hr design storm events respectively. The conveyance capacity of the existing stormwater infrastructure as calculated with Manning's Equation was used to identify pipes and open channel that are capacity limited for the design storms The surface flooding locations, relative flooding volumes, and capacity limited pipes/open channels simulated in the existing conditions model for the 10yr-24hr, 25yr-24hr, and 100yr-24hr design storm events are shown in Figures 3-4, 3-5, and 3-6. Modeled pipes and open channels identified as capacity limited for the design storm events in the plan view figures are provided in the Appendix K Stormwater Network Summary Tables. The current City of Sebastian Stormwater conveyance network experiences surface flooding during frequent wet-weather events which is represented in the model. The H&H model is a 1D model and the surface flooding is modeled with an assumed surface flooding area of 500 sf at each node; manhole, catch basin, culvert inlet/outlet, etc. The H&H stormwater modeling results identify areas with limited conveyance capacity and supported the development of capital improvement projects which reduce surface flooding within network. 2D modeling of the stormwater network including the surface topography in relation to the stormwater network will affect the simulated flooding locations and flooding extents compared to the 1D modeling results.

The existing conditions design storm results assume that drainage through Collier Creek is consistent with the conditions included in the 2012 FEMA Flood Insurance Study and that the Hardee Dam is able to discharge into the Collier Creek. The stormwater drainage through the Hardy Dam is a critical outfall in the City of Sebastian stormwater network. The loss of drainage and flood control capabilities through Collier Creek would have serious impacts on the flooding frequency and extent within the City of Sebastian.

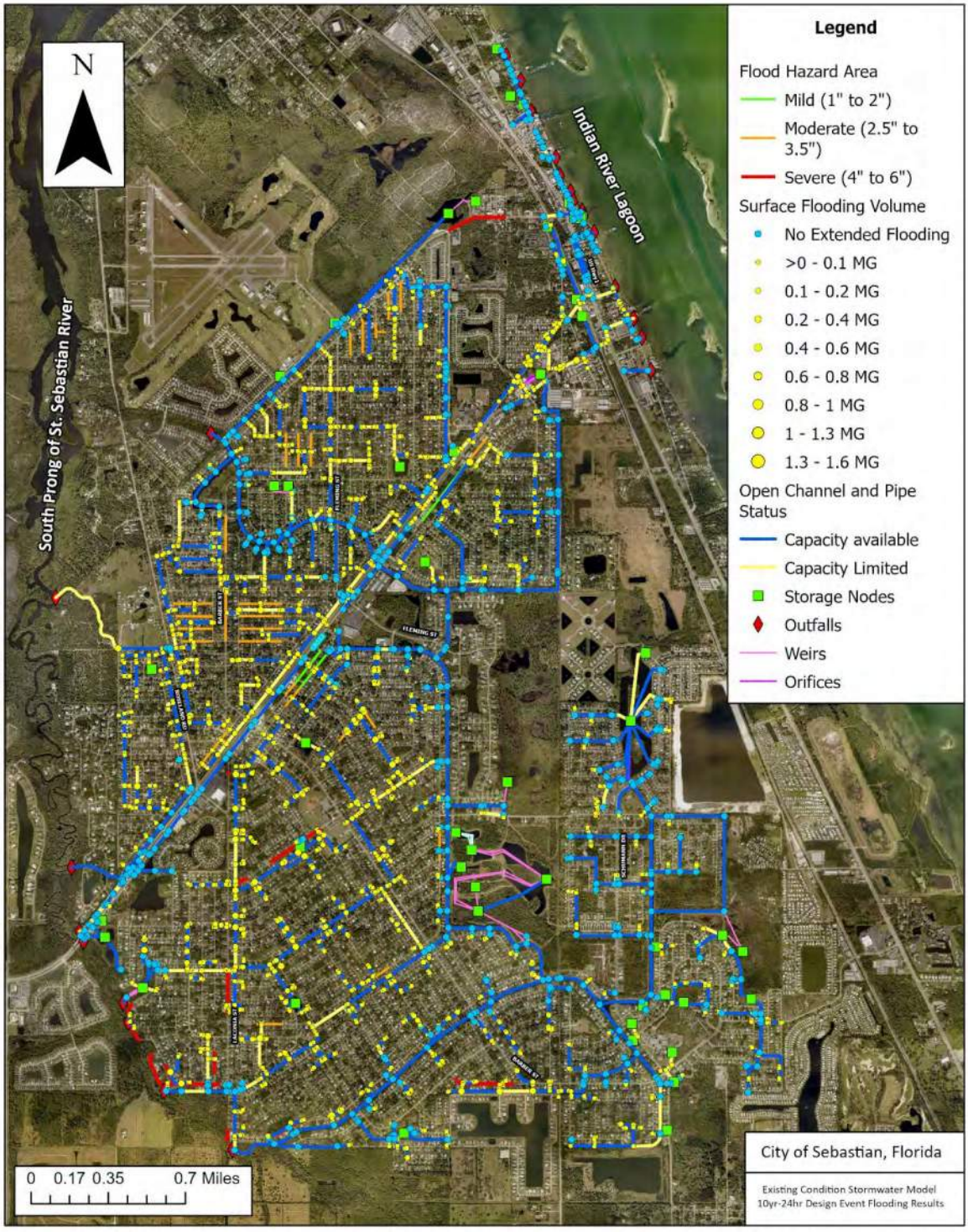

Figure 3-4. Surface Flooding Locations & Volumes, 10yr-24hr Design Storm

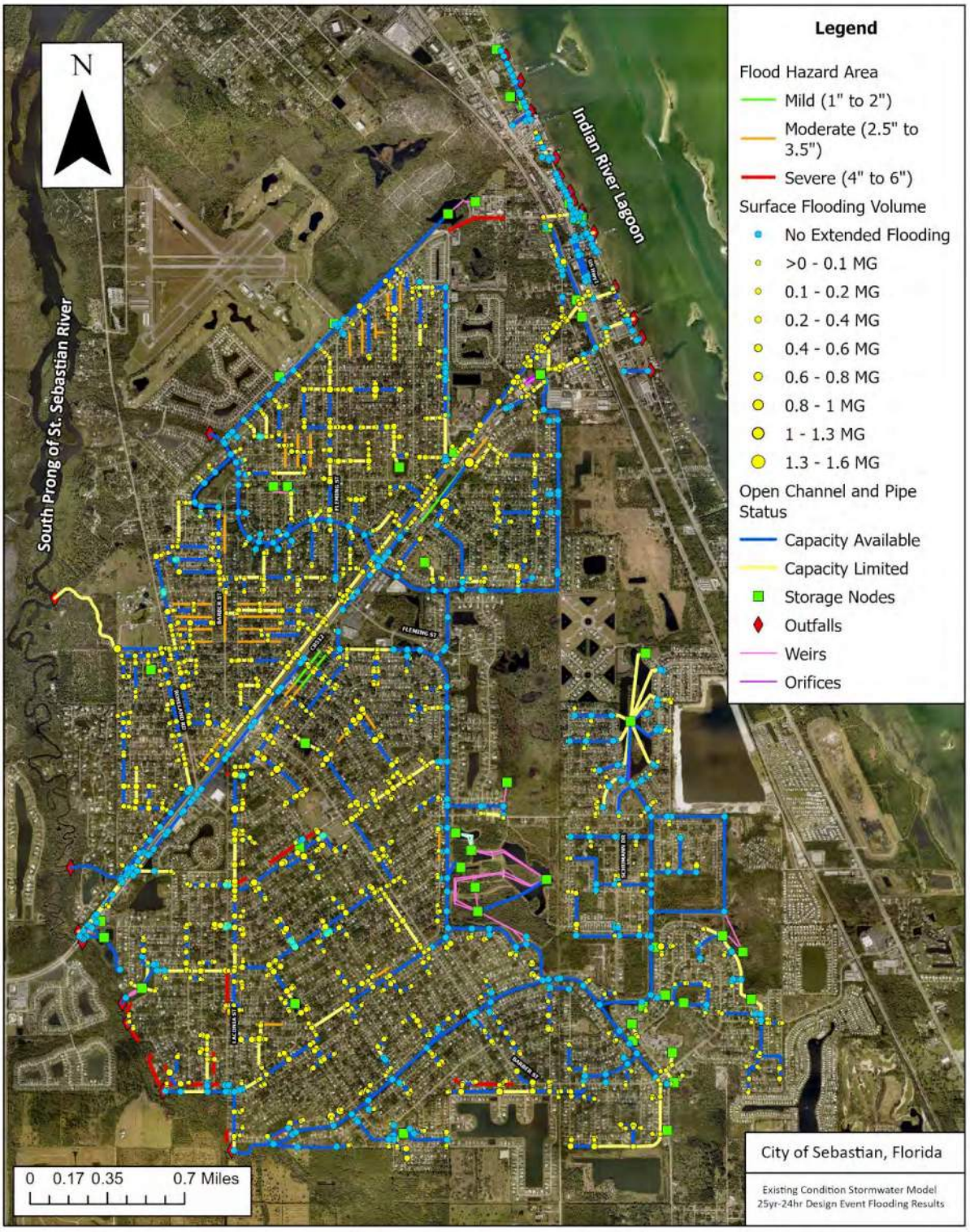

Figure 3-5. Surface Flooding Locations & Volumes, 25yr-24hr Design Storm

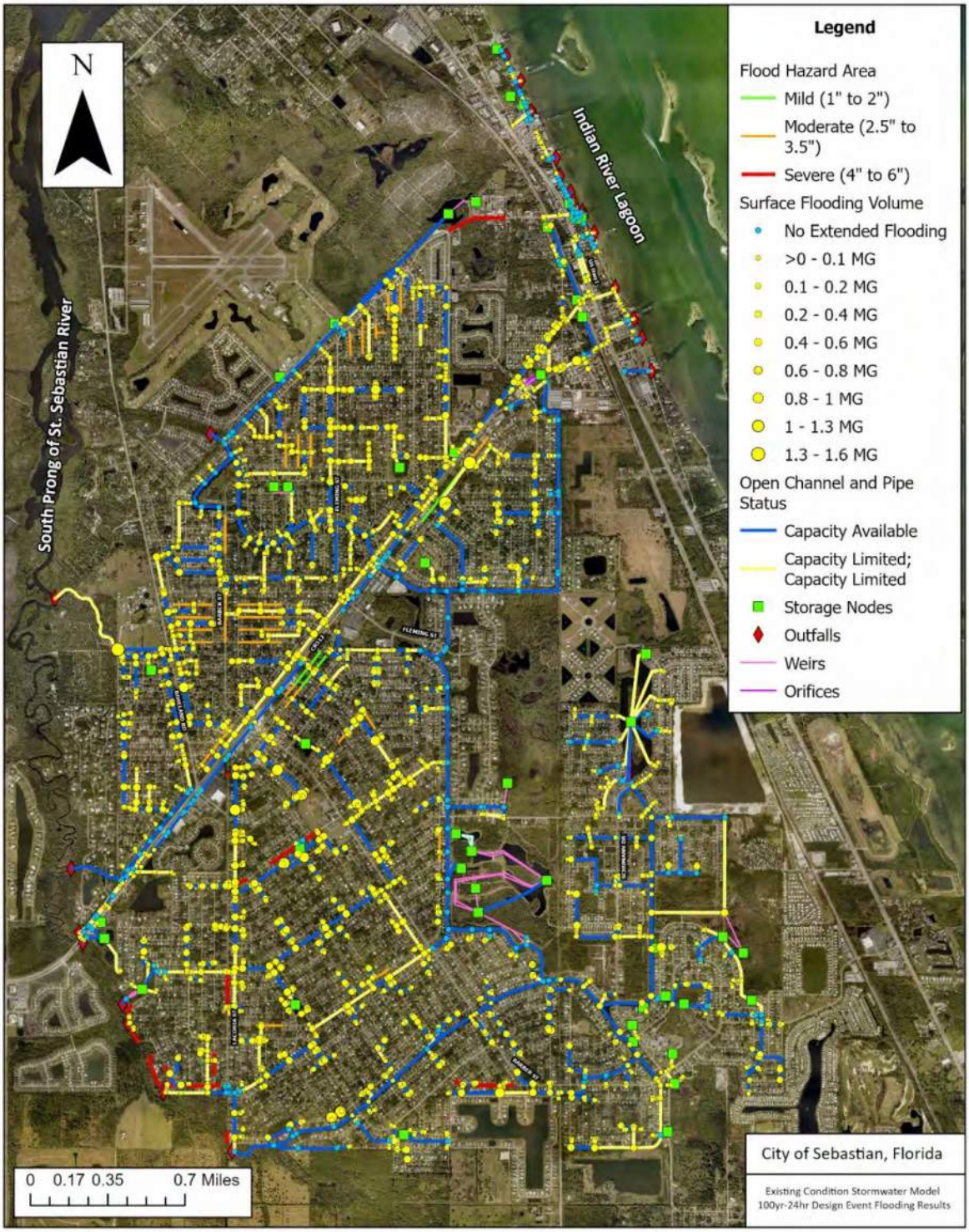

Figure 3-6. Surface Flooding Locations & Volumes, 100yr-24hr Design Storm

4 Water Quality Assessment

4.1 Effects of Urban Stormwater Runoff

Stormwater runoff from urbanized areas often has negative effects on downstream waterways and receiving waters. The extent and type of such effects vary, but they are often significant relative to other sources of pollution and environmental degradation. Urban stormwater runoff has both physical and chemical effects that impact water quality, water quantity, habitat and biological resources, public health, and the aesthetic appearance of urban waterways.

Adverse effects on receiving waters associated with stormwater discharges fall into one of the three following general classes:

- Short-term water quality effects during and after storm events. Such changes include temporary increases in the concentration of one or more pollutants, toxics or bacteria levels.
- Long-term water quality effects. These are cumulative effects associated with repeated stormwater discharges from many sources.
- Physical effects on the receiving waterbody. Examples include erosion, scour, deposition, plant and aquatic species changes, and other effects associated with increased frequency and volume of runoff that alters aquatic habitat.

A further discussion of these effects follows.

4.1.1 Water Quality Effects

Water quality effects pertain to changes in water chemistry and can significantly reduce the capacity of a waterbody to support life or to maintain its existing ecosystem diversity. The introduction of pollutants into a given waterbody is the most common means by which water quality is degraded, and the extent of degradation depends on the type(s) and concentrations of the pollutants.

Pollutants associated with urban runoff potentially harmful to receiving waters fall into the categories listed below:

- Solids
- Oxygen-demanding substances
- Nitrogen and phosphorus
- Pathogens
- Petroleum hydrocarbons (oils and greases)
- Metals
- Synthetic organics (pesticides, herbicides, etc.)

These pollutants degrade water quality in receiving waters near urban areas, and often contribute to the impairment of use and exceedances of criteria included in State water quality standards. The quantity of these pollutants per unit area delivered to receiving waters tends to increase with the degree of development in urban areas. As shown in Table 4-1 below, contaminants enter stormwater from a variety of sources in the urban landscape.

Table 4-1. Contaminant Sources

Contaminant Type	Contributing Sources
Sediment and Floatables	Roof systems, streets, lawns, driveways, roads, construction activities, atmospheric deposition, drainage channel erosion
Pesticides and Herbicides	Residential lawns and gardens, roadsides, utility right-of-ways, commercial and industrial landscaped areas, soil wash-off, etc.
Organic Materials	Roads, residential lawns and gardens, commercial landscaping, animal wastes
Metals	Automobiles, bridges, atmospheric deposition, industrial areas, soil erosion, corroding metal surfaces, combustion processes
Oil and Grease/Hydrocarbons	Roads, driveways, parking lots, vehicle maintenance areas, gas stations, illicit dumping to storm drains
Bacteria and Viruses	Lawns, roads, leaky sanitary sewer lines, sanitary sewer cross-connections, animal waste, septic systems
Nitrogen and Phosphorus	Lawn fertilizers, atmospheric deposition, automobile exhaust, soil erosion, animal waste, detergents

The concentrations of pollutants found in urban runoff are directly related to the level of development within the watershed. This relationship is shown in Table 4-2, a compilation of typical pollutant loadings from different urban land uses[13].

Table 4-2. Typical Pollutant Loadings from Urban Runoff by Land Use (lbs./acre-year)

Land Use	TSS	TP	TKN	NH_3-N	NO2+NO3-N	BOD	COD	Pb	Zn	Cu
Commercial	1000	1.5	6.7	1.9	3.1	62	420	2.7	2.1	0.40
Parking Lot	400	0.7	5.1	2.0	2.9	47	270	0.8	0.8	0.04
High Density Residential	420	1.0	4.2	0.8	2.0	27	170	0.8	0.7	0.03
Medium Density Residential	190	0.5	2.5	0.5	1.4	13	72	0.2	0.2	0.14
Low Density Residential	10	0.04	0.03	0.02	0.1	NA	NA	0.01	0.04	0.01
Freeway	880	0.9	7.9	1.5	4.2	NA	NA	4.5	2.1	0.37
Industrial	860	1.3	3.8	0.2	1.3	NA	NA	2.4	7.3	0.5
Park	3	0.03	1.5	NA	0.3	NA	2	0	NA	NA
Construction	6000	80	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
NA: Not Available - insufficient data to characterize loadings.

Other water quality parameters are not necessarily related to pollutants but are also very important to the overall health of aquatic ecosystems. These include such parameters as pH, temperature, dissolved oxygen, and salinity.

[13] Homer et al., 1994 in Protocol for Developing Nutrient TMDLs (USEPA 1999)

4.1.1.1 Short-Term Water Quality Effects

The short-term effects of pollutants on receiving waters vary widely, ranging from minor changes in temperature or salinity to complete loss of species or habitat, in the case of a major oil spill or other serious contamination event. In most cases, these changes usually only last for a few days or weeks following a storm event. However, repeated introduction of pollutants can lead to long-term effects, which are much more difficult to address.

4.1.1.2 Long-Term Water Quality Effects

Long-term water quality effects are those resulting from either large-scale contamination events or repeated introductions of smaller pollutant loadings over time. In either case, significant amounts of pollutants are introduced into a receiving water. Depending on the type of pollutant, they may bioaccumulate in aquatic plant and animal species, be deposited into sediments, reduce dissolved oxygen levels, or provide food for aquatic weed species. These effects can last for many years, can seriously impair the health and use of a waterbody, and are difficult to correct.

4.1.2 Physical Effects

While water quality effects are not usually observed by the general public, the physical effects of stormwater runoff are more visible. Stream channel and channel bank erosion provide direct evidence of water velocity impacts caused by urban stormwater. The volume of urban stormwater runoff increases directly with the amount of impervious area and the level of development within a watershed. As development continues, urban streams are often forced to accommodate larger volumes of stormwater runoff that recur on a more frequent basis. This leads to overloading the stream capacity and results in channel instability. The change in watershed hydrology associated with urban development also causes channel widening and scour, and the introduction of larger amounts of sediment and pollutants to urban streams.

Visible impacts include eroded and exposed stream banks, channel slope failures, fallen trees, sedimentation, and recognizably turbid or murky conditions. The increased frequency of flooding in urban areas also poses a threat to public safety and property. Both water quality and water quantity impacts associated with urban stormwater negatively affect aquatic and riparian (shore edges or similar) habitat in urban streams. Rapid salinity changes, higher levels of pollutants, increased flow velocities and erosion, alteration of riparian corridors, and sedimentation associated with stormwater runoff can all negatively impact the integrity of aquatic ecosystems. These impacts include the degradation and loss of aquatic habitat, and reduction in the numbers and diversity of wildlife species.

Public health effects are for the most part related to bacteria and disease-causing organisms carried by urban stormwater runoff into waters used for water supplies, fishing and recreation. Water supplies can potentially be contaminated by urban runoff, posing a public health threat. People coming in contact with contaminated water at beaches and other recreational sites can become seriously ill. Beach closures caused by urban runoff have a negative impact on the quality of life and can impede economic development as well. Similarly, the bacterial contamination of shellfish beds poses a public health threat to consumers, and shellfish bed closures negatively impact the fishing industry and local economies.

Debris and litter floating in urban waterways and deposited on stream banks and beaches are aesthetic impacts that are particularly noticeable to the general public. Stormwater is a major source of floatables that include paper and plastic bags and packaging materials, bottles, cans, and wood. The presence of floatables and other debris in receiving waters during and following storm events reduces visual attractiveness of the waters and detracts from

their recreational value. Nuisance algal conditions including surface scum and odor problems can also be attributed to urban stormwater in many instances.

Stormwater runoff from urban areas can contain significant concentrations of harmful pollutants that can contribute to adverse water quality impacts in receiving streams. Effects can include such things as beach closures, shellfish bed closures, limits on fishing and limits on recreational contact in waters that receive stormwater discharges.

4.2 Best Management Practices

BMPs are techniques, approaches, or designs that promote sound use and protection of natural resources to meet program goals and levels of service (LOS). BMPs are also required for permitting of both new development and retrofit of existing systems. The BMPs discussed in this section offer the most potential for application in the City. Since this SWMP deals primarily with existing systems in urbanized areas, emphasis was placed on BMPs that are better suited for that situation. Where possible, BMP descriptions and design information were taken from the latest version of the SJRWMD Permit Information Manual, dated June 1, 2018.

The use of a specific BMP depends on the site conditions and objectives such as water quality protection, flood control, or volume control. In many cases, there are multiple goals or needs for a given project. Therefore, multiple BMPs can be used in sequence to develop a “treatment train”. The treatment train concept is intended to maximize the use of available site conditions from the point of runoff generation to the receiving water discharge in order to maximize water quantity (flood control), water quality (pollutant load reduction), and wetlands benefits.

4.2.1 Best Management Practices (BMPs) Considerations

This section presents descriptions of various BMPs that are either currently in use or should be considered for use in the City SWMS. There are many BMPs available beyond those presented here, but the list was limited to only those BMPs that the City is already using or those for which the City can receive significant pollutant reduction credit under the CIRL BMAP if implemented. The BMPs are grouped as non-structural (regulation or ordinances) and structural (constructed facilities).

4.2.1.1 Non-structural Source Controls

- Land use planning
- Public information programs
- Stormwater management ordinance requirements
- Fertilizer application controls
- Pesticide and herbicide use controls
- Solid waste management
- Directly Connected Impervious Area (DCIA) minimization
- Erosion and sediment control on construction sites

4.2.1.1.1 Land Use Planning

Land use planning and management presents an important opportunity to reduce/minimize pollutants in stormwater runoff and control flooding by using a comprehensive planning process to integrate City goals into the development

and redevelopment process. Management measures may include modification or restrictions of certain land use activities and modification of existing City land development codes, perhaps even more restrictive than SJRWMD requirements. Land development codes to include larger storage volumes, stormwater harvesting, or other requirements for new developments or redevelopments can, in time, have significant positive effects on the City's SWMS. Greater restrictions may be warranted where development can affect impaired, threatened, or significant water bodies such as the IRL. Because increased pollutant loadings and flooding correspond to increase in impervious cover, land use planning and local land development codes can become effective control measures.

4.2.1.1.2 Public Information Program

A public information participation plan provides the City with a strategy for informing its employees, the public, and businesses about the importance of protecting stormwater from improperly used, stored, and disposed pollutants. Many people do not realize that yard debris or trash thrown into ditches today will worsen tomorrow's flooding and pollute surface waters. Municipal employees must be trained, especially those that work in departments not directly related to stormwater but whose actions affect stormwater. Residents must become aware that a variety of hazardous products are used in the home and that their improper use and disposal can pollute stormwater. Likewise, improper disposal of oils, antifreeze, paints, and solvents can end up in streams and lakes, poisoning fish and wildlife. If care is taken by individuals to properly dispose of yard debris, trash and hazardous materials, many problems can be reduced in magnitude or avoided. Increased public awareness also facilitates public scrutiny of industrial and municipal activities and will likely increase public reporting of incidents. Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, must be informed of ways to reduce their potential to pollute Stormwater. A key element of this program is public awareness of the benefits of roadside swales. These BMPs cost- effectively provide both water quantity and water quality benefits. The perception by many citizens is that shallow ponding (four to six inches) for one or two days after storms during the wet season is a problem. In reality, this shallow ponding and infiltration is the onsite storage that saves money by reducing pipe sizes and cost-effectively providing water quality treatment.

4.2.1.1.3 Fertilizer Application Control

Fertilizer application control is a voluntary control mechanism by citizens who use fertilizer as part of their landscaping activities. Fertilizer application controls are implemented through a public information program by making the public aware of the principals of environmental landscape maintenance and the problems associated with overuse of fertilizers. Overuse of fertilizers will cause excessive runoff of nutrients to surface waters thereby wasting money for the homeowner and potentially degrading the receiving water body. This is especially true during heavy rainfall periods that produce yard and neighborhood flooding. Information programs should also be extended to professional fertilizer users.

The City has implemented fertilizer application controls through its Integrated Pest Management (IPM) program, as well as its fertilizer ordinance. See Section 1.4.2.6 for more information. However, further education and enforcement of these items are necessary.

4.2.1.1.4 Pesticide Use Control

Pesticide use control is also a voluntary control by citizens who use pesticides as a part of their housekeeping and lawn maintenance activities. Some pesticides are priority pollutants (e.g., Endrin, Lindane, and Silvex), which can be toxic. Overuse of these chemicals can cause excessive runoff to surface waters and entry into the food chain. Many professional applicators of pesticides are using approved pesticides in a safe and proper manner. An information program on pesticide use will help to reduce the amount of pesticides entering the stormwater system.

The City has implemented pesticide use controls through its Integrated Pest Management (IPM) program, as well as its fertilizer ordinance. See Section 1.4.2.6 for more information.

4.2.1.1.5 Solid Waste Management

In some instances, problems can arise from trash and other debris flowing into and obstructing open channels, culverts, and storm sewers. It is recommended that the public be informed of the adverse impacts of littering and poor solid waste management. This can also include pet droppings and illegal dumping into storm drains, wooded areas, and ditches. Pet droppings can be a source of coliform bacteria and pathogens.

4.2.1.1.6 DCIA Minimization

Another non-structural BMP option would be for the City to minimize the amount of Directly Connected Impervious Area (DCIA) on a site and promote the use of green buffer zones around paved areas for infiltration. For example, roof runoff from structures can be directed to green buffer zones or shallow swales around houses. Requiring retrofitting of roof drainage systems for all existing and new construction would likely be difficult, but changing City building codes to require roof discharge to green areas for all new construction or significant repairs/alterations could be easier to accomplish. In addition, parking lots and driveways can be graded to landscaped/grassed areas or swales, reducing direct runoff to the storm drainage system.

4.2.1.1.7 Erosion and Sediment Control on Construction Sites

Erosion and sediment control on construction sites provides for the protection of receiving waters from sediment loads. Proper control during construction can be accomplished with gravel filter weirs, sediment fences, and temporary berms or swales. The City has implemented erosion and sediment controls through City Ordinance No. 54-3-11.2 an ordinance requiring erosion and sediment control on construction sites.

4.2.1.2 Structural Stormwater Controls

- Retention systems
- Dry detention systems
- Underdrain systems
- Wet detention systems
- Wetland Systems
- Exfiltration trenches
- Grassed swales and channels
- Water quality inlets and baffle boxes
- Skimmers
- Dams
- Aeration Systems

4.2.1.2.1 Retention Systems

The SJRWMD defines a retention system as a storage area designed to store a defined quantity of runoff, allowing it to percolate through permeable soils into the shallow ground water aquifer. Soil permeability and water

table conditions must be such that the retention system can percolate the desired runoff volume within a specified time following a storm event. After drawdown has been completed, the basin does not hold any water, thus the system is normally "dry." Unlike detention basins, the treatment volume for retention systems is not discharged to surface waters. Examples of retention systems include:

- Man-made or natural depressional areas where the floor is graded as flat as possible and turf is established to promote infiltration and stabilize the basin slopes (see Figure 4-1)
- Shallow landscaped areas designed to store stormwater
- Vegetated swales with swale blocks or raised inlets
- Pervious concrete with continuous curb

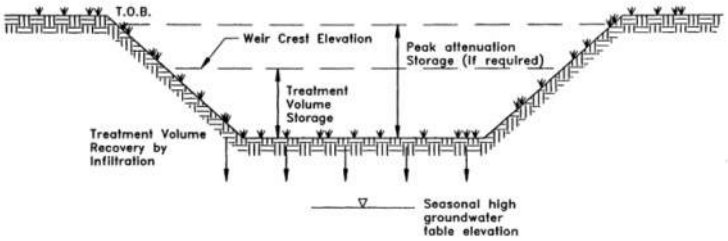

Figure 4-1. Typical Retention Pond Design (from SJRWMD)

Stormwater retention works best where soils are highly permeable and the seasonal high water table is situated well below the soil surface (at least 2 to 3 feet below pond bottom). The geology, soils, and groundwater conditions in the City of Sebastian are generally not well suited for the use of retention systems. However, retention systems may be suitable for use at individual urban redevelopment or retrofit sites within the watershed. The application of retention systems should be considered on a case-by-case basis within the study area where soils and water table conditions are suitable. The City currently uses several retention systems in the SWMS.

Potential Benefits of a Retention System

- Mimics the natural water balance of a site by promoting groundwater recharge close to the point of runoff generation.
- Can provide offline or on-line treatment for environmentally sensitive waters (e.g., Class II)
- Reduces peak rate and volume of flood discharge by retaining water onsite.
- Can be used as sediment traps during the construction phase of a project.
- Are reasonably cost-effective in comparison with other BMPs for both construction and maintenance costs (where soils are favorable).
- Effectively reduce pollutant loadings to receiving waters.

Potential Limitations of a Retention Basin

- Require well-drained soils to function properly.
- Unsuitable soils limit drawdown capacity, thereby reducing pollutant removal and flood control capacity.
- Soluble pollutants can be conveyed into groundwater.
- Possible nuisances such as odors, mosquitoes, and nuisance vegetation can occur if not designed, constructed, or maintained properly.

4.2.1.2.2 Dry Detention Systems

Dry detention systems are normally dry storage areas which are designed to store a defined quantity of runoff and slowly release the collected runoff through an outlet structure to adjacent surface waters. After drawdown of the stored runoff is completed, the storage basin does not hold any water, thus the system is normally "dry." A schematic of a typical dry detention system is presented in Figure 4-2.

Dry detention basins are similar to retention systems in that the basins are normally dry. However, the main difference between the two systems is that retention systems are designed to percolate the stored runoff into the ground while dry detention systems are designed to discharge the runoff through an outlet structure to adjacent surface waters.

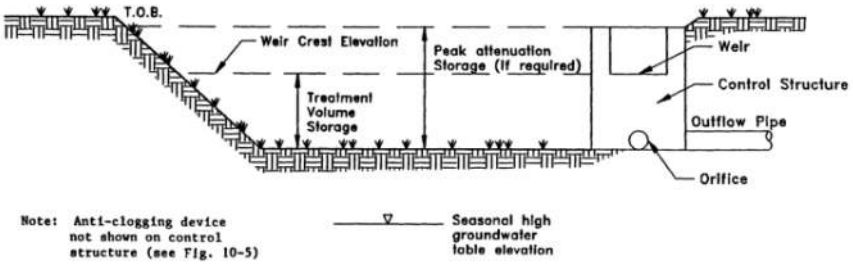

Figure 4-2. Typical Dry Detention Basin Design (from SJRWMD)

Sedimentation is the primary pollutant removal process which occurs in dry detention systems. Unfortunately, only pollutants which are primarily in particulate form are removed by sedimentation. Therefore, the pollutant removal efficiency of dry detention systems is not as great as systems such as retention and wet detention which remove both dissolved and particulate pollutants. Because of the limited pollutant removal efficiency of dry detention, this BMP must only be utilized where no other BMP is technically feasible. For example, use of dry detention must be restricted to the following situations:

(a) Where high ground water table or soil conditions limit the feasibility of other BMPs such as retention, and

(b) Small drainage basins (less than 5 acres). For larger projects (greater than 5 acres) other BMPs like wet detention shall be utilized instead of dry detention.

There are several design and performance criteria which must be met in order for a dry detention system to meet the District's requirements, including off-line detention volume, recovery time, outlet structure design, basin bottom and control elevations, length-to-width ratio, and maintenance requirements. Note that SJRWMD currently only permits off-line dry detention basins, which limits their application in some cases.

Potential Benefits of a Dry Detention Pond

- Reduction of downstream flooding problems by attenuating the peak rate of flow.
- Some removal of pollutant loadings to receiving bodies of water for suspended pollutants.
- Reduction in cost for downstream conveyance facilities.
- Creation of fill that may be used on site or sold (pond sediment removal).
- Low frequency of failure as compared with filtration systems.

Potential Limitations of a Dry Detention Pond

- Does not remove dissolved pollutants (nutrients) unless a permanent pool is included.
- Potential safety hazards if not designed and constructed properly.
- No permanent pool to store sediment inflow.

- Occasional nuisance problems such as debris and mosquitoes.
- Regular maintenance is required to prevent nuisance plant species from emerging and to remove accumulated sediments.
- Must be off-line.

4.2.1.2.3 Underdrain Systems

Stormwater underdrain systems consist of a dry basin underlain with perforated drainage pipe which collects and conveys stormwater following percolation from the basin through suitable soil. Underdrain systems are generally used where high water table conditions dictate that recovery of the stormwater treatment volume cannot be achieved by natural percolation (i.e., retention systems) and suitable outfall conditions exist to convey flows from the underdrain system to receiving waters.

A cross section of a typical underdrain system is shown in Figure 4-2. Underdrain systems are intended to control both the water table elevation over the entire area of the treatment basin and provide for the drawdown of the treatment volume. Underdrains are utilized where the soil permeability is adequate to recover the treatment volume since the on-site soils overlay the perforated drainage pipes.

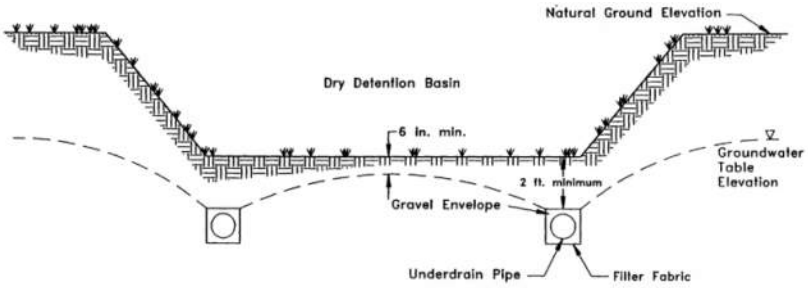

Figure 4-3. Typical Underdrain System Design (from SJRWMD)

There are several design and performance criteria which must be met in order for an underdrain system to meet SJRWMD requirements, including the following:

- The system should be designed to provide for the drawdown of the appropriate treatment volume within 72 hours following a storm event. The treatment volume is recovered by percolation through the soil with subsequent transport through the underdrain pipes.
- The system should only contain standing water within 72 hours of a storm event. The pipe system configuration (e.g., pipe size, depth, pipe spacing, and pipe inflow capacity) of the underdrain system must be designed to achieve the recovery time requirement.
- The underdrain system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions.

4.2.1.2.4 Wet Detention Systems

Wet detention systems are permanently wet ponds which are designed to slowly release collected stormwater runoff through an outlet structure. A schematic of a typical wet detention system is shown in Figure 4-4.

There are several components in a wet detention system which must be properly designed to achieve the required level of stormwater treatment. A description of each design feature and its importance to the treatment process is presented below.

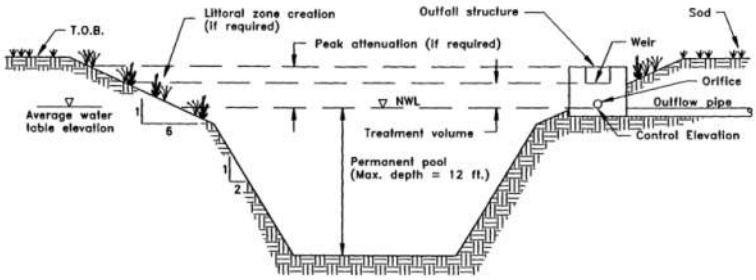

Figure 4-4. Typical Wet Detention System Design (from SJRWMD)

A wet detention system includes a permanent pool of water, a shallow littoral zone with aquatic plants, and the capacity to provide detention for an extended time necessary for the treatment of a required volume of runoff. In wet detention ponds, pollutant removal occurs primarily within the permanent pool during the period of time between storm events. They are typically sized to provide at least a two-week hydraulic residence time during the wet season. The primary mechanism for the removal of a particulate forms of pollutants in wet detention ponds is sedimentation. Wet detention systems can also achieve substantial reductions in soluble nutrients due to biological and physical/chemical processes within the permanent pool such as uptake of nutrients by algae and rooted aquatic plants, adsorption of nutrients and heavy metals onto bottom sediments, and biological oxidation of organic materials.

Wet detention systems are usually more visually appealing than dry ponds, particularly if there is desirable wetland vegetation around the perimeter of the permanent pool. When properly designed and constructed, wet detention ponds are actually considered as property value amenities in many areas. Also, wet detention ponds offer the advantage that sediment and debris accumulate within the permanent pool. Since this accumulation is out-of-sight and well below the pond outlet, wet detention ponds tend to require less frequent clean outs to maintain an attractive appearance and prevent clogging. Sediment forebay areas (or sumps) are recommended whenever possible.

The City has several wet detention systems in use, but due to the land area needed for these systems they may not be suitable for future systems as undeveloped area is very limited within the City's boundaries.

Potential Benefits of a Wet Detention System

- Reduction of downstream flooding problems by attenuating the peak rate of flow.
- Reduction in pollutant loadings to receiving waters for dissolved and suspended pollutants.
- Reduction in cost for downstream conveyance facilities.
- Creation of local wildlife habitat.
- More aesthetically pleasing than dry detention/retention systems.
- Low frequency of failure.
- Can be used in areas with high water tables and less permeable soils.
- Pollutant removal can be optimized with pretreatment such as retention swales.

Potential Limitations of a Wet Detention Pond

- Land area needed to meet dimensional requirements.
- Potential safety hazards if not designed and constructed properly (gradual slide slopes are desirable).

- Occasional nuisance problems such as odors, algae, debris, and mosquitoes.
- Regular maintenance of the littoral zone is required to control nuisance plant species.
- Recurring need for sediment removal from the permanent pool or sediment forebay.

4.2.1.2.5 Wetland Systems

Wetland systems incorporate either a natural or man-made wetlands area as part of a comprehensive stormwater management system in combination with other best management practices to provide treatment of runoff. The City's Stormwater Park was designed with a wetland system to improve nutrient removal and effluent quality. For these systems, the SJRWMD must ensure that a proposed wetlands stormwater management system is compatible with the existing ecological characteristics of the wetlands proposed to be utilized for stormwater treatment.

The only wetlands which may be considered for use to provide stormwater treatment are those which are:

(a) Isolated wetlands; and

(b) Those which would be isolated wetlands, but for a hydrologic connection to other wetlands or surface waters via another watercourse that was excavated through uplands.

The District must also ensure that water quality standards will not be violated by discharges from wetlands stormwater management system. To achieve these goals, specific performance criteria are set by the SJRWMD for systems which incorporate wetlands for stormwater treatment, including the required treatment volume, recovery time, maintenance of wetland hydroperiod, and others.

The design features of the system should maximize residence time of the stormwater within the wetland to enhance the opportunity for the stormwater to come into contact with the wetland sediment, vegetation, and micro-organisms (Livingston 1989).

Potential Benefits of a Wetland System:

- Reduction in pollutant loadings to receiving waters for dissolved and suspended pollutants.
- High-quality wildlife habitat
- Aesthetically pleasing

Potential Limitations of a Wetland System:

- Higher maintenance effort and cost – control of invasive species, periodic sediment removal, pump systems and control structure maintenance

4.2.1.2.6 Exfiltration Trenches

An exfiltration trench is a subsurface system consisting of a conduit such as perforated pipe surrounded by natural or artificial aggregate which temporarily stores and infiltrates stormwater runoff (Figure 4-5). Stormwater passes through the perforated pipe and infiltrates through the trench walls and bottom into the shallow groundwater aquifer. The perforated pipe increases the storage available in the trench and helps promote infiltration by making delivery of the runoff more effective and evenly distributed over the length of the system. Generally, exfiltration trench systems are utilized where space is limited and/or land costs are high (i.e., downtown urban areas).

Soil permeability and water table conditions must be such that the trench system can percolate the required stormwater runoff treatment volume within a specified time following a storm event. The trench system is returned to a normally "dry" condition when drawdown of the treatment volume is completed. Like retention basins, the treatment volume in exfiltration trench systems is not discharged to surface waters. Thus, exfiltration is considered a type of retention system.

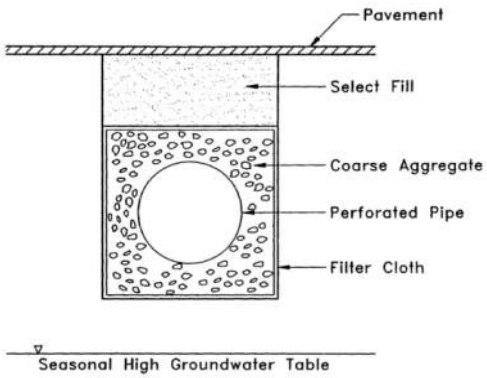

Figure 4-5. Typical Exfiltration Trench Design (from SJRWMD)

The operational life of an exfiltration trench is believed to be short (possibly 5 to 10 years) for most exfiltration systems. Sediment accumulation and clogging by fines can reduce the life of an exfiltration trench. Total replacement of the trench may be the only possible means of restoring the treatment capacity and recovery of the system. Periodic replacement of the trench should be considered routine operational maintenance when selecting this management practice.

The City has a few exfiltration trench systems within its SWMS, but only on the east side of the Coastal Ridge, where the groundwater conditions are suitable. Due to the high groundwater conditions throughout most of the City and short operational life of these BMPs, they do not appear to be cost-effective and the City should consider other options.

Potential Benefits of an Exfiltration Trench

- They mimic the natural groundwater recharge capabilities of the site.
- Can fit into space-constrained areas of a development site, including under pavement.
- Can provide offline treatment for environmentally sensitive waters (e.g., Class I, Class II, or OFW).
- Can be used to retrofit already developed sites where space is limited

Potential Limitations of an Exfiltration Trench

- Require highly permeable soils to function properly.
- Highly susceptible to sediment and fines loading.
- Have relative short life spans before replacement or extensive restoration/maintenance of systems is required.
- Often more costly than other treatment alternatives, especially when operation and maintenance costs are considered.

4.2.1.2.7 Grassed Swales and Channels

According to the SJRWMD, swales are a man-made or natural system shaped or graded to required dimensions and designed for the conveyance and rapid infiltration of stormwater runoff. Swales are designed to infiltrate a defined quantity of runoff through the permeable soils of the swale floor and side slopes into the shallow ground water aquifer (Figure 4-6).

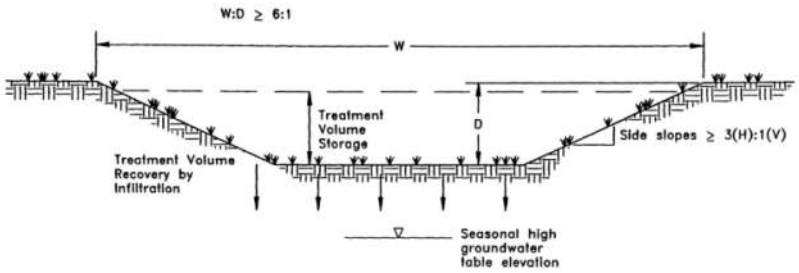

Figure 4-6. Typical Swale Design (from SJRWMD)

Turf is established to promote infiltration and stabilize the side slopes. Soil permeability and water table conditions must be such that the swale can percolate the desired runoff volume from the 3-year, 1-hour storm event. The swale holds water only during and immediately after a storm event, thus the system is normally "dry." Unlike retention basins, swales are "open" conveyance systems. This means there are no physical barriers such as berms or check-dams to impound the runoff in the swale prior to discharge to the receiving water.

Swales are normally used for conveyance systems to transport runoff offsite or to a stormwater facility. They are best suited for sites with soils of moderate-to-high infiltration capacity (usually Hydrologic Groups A or B). Grassed swales and ditches are widely used throughout the City of Sebastian's SWMS, but only really serve as a conveyance structure in most areas because their infiltration capacity is greatly limited due to the high groundwater conditions.

Potential Benefits of Shallow Grassed Swales

- Usually less expensive than installing curb and gutters, and usually less expensive than other water quality treatment controls.
- Hardly noticeable if shallow swales (0.5 to 1.0 ft. maximum depth) are designed and constructed with gradual slopes (3:1 to 6:1).
- Can provide off-line treatment for environmentally sensitive waters (e.g., Class I, Class II, or OFW).
- Can reduce peak rates of discharge by storing, detaining, or attenuating flows.
- Can be used in space-constrained areas such as along lot lines, rear of lots, and along roads.
- Can be used as water quality treatment or pretreatment with other BMPs in a treatment train.

Potential limitations of Shallow Grassed Swales

- Due to the long growing season in Florida, grassed swales are maintenance intensive and incur significant recurring costs for mowing and sediment removal.
- Effective only as a conveyance system in unsuitable soils.
- Possible nuisances such as odors, mosquitoes, or nuisance plant species can occur if not designed, constructed, or maintained properly.
- Aesthetically unpleasing if improperly designed and constructed (deep with steep side slopes-looks like a ditch).
- May not be suitable or may require geotextile matting in areas that serve as vehicle parking areas.

4.2.1.2.8 Inlet Filters

Inlet filters are simple BMPs that are designed to fit under the grate in a storm inlet structure and capture and separate solids (i.e., soil, road grit, grass clippings, etc.) and certain pollutants, such as hydrocarbons, from stormwater runoff as it flows into a storm inlet structure. They help reduce the deposition of solids in conveyance pipes and improve water quality within the SWMS. Inlet filters can fit a variety of inlet structures and are readily available. One example of an inlet filter is shown in Figure 4-7 at right and is presented in the section below.

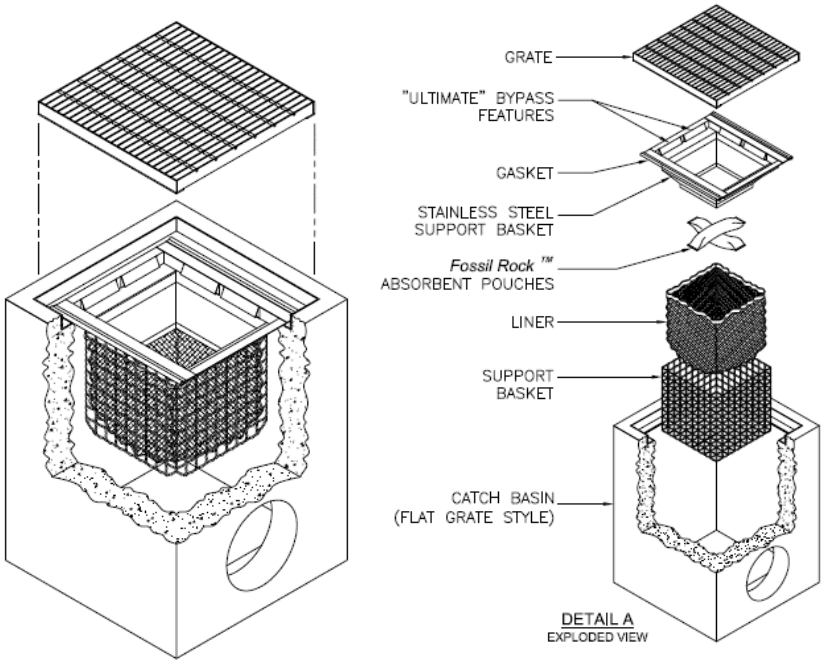

Figure 4-7. Flogard™ Inlet Filter and Exploded View

The Flogard™ Inlet Filter manufactured by Oldcastle Infrastructure is a specialized inlet filter used specifically for grated catch basins. The unit is made of stainless steel for long service life and durability. During a storm event, all incoming stormwater and solid material fall into the liner, which retains solid particles and causes pollutants to come in contact with absorbent material. Treated stormwater passes into the catch basin system, and the filter dries after each storm event. Collected debris is suspended and stored in a dry state above static water level until removed during service. According to the manufacturer, servicing only takes a few minutes and can be completed by simply lifting out the filter and dumping it into a container. No vactor truck is required, but recurring labor time and costs should be considered. The purchase price of a Flogard unit for a standard FDOT Type C inlet is approximately $1,500.00.

Benefits:

- Will not impede inlet water flow
- Captures debris and sediment
- Bypass openings prevent clogging
- Minimal space requirements
- Quick service times at an average of 15 minutes or less.

Potential Limitations:

- High initial cost due to number of inlets (approximately 320 in City's SWMS) but can be acquired a few at a time to reduce the capital costs.

- Require consistent, regular maintenance cleaning. Units should be cleaned approximately every four weeks but maintenance scheduled should be adjusted depending on storm frequency and observed loading rates.

4.2.1.2.9 Baffle Boxes

Baffle boxes are typically installed near or at the storm sewer outfall. They typically consist of a rectangular concrete box divided into three chambers where floatables, sediment, grit, and oil are separated from stormwater runoff as it passes through the chambers before exiting through an outlet to the storm drain system. The first chamber is designed for sediment trapping, and the second chamber is designed for oil separation. Each chamber contains a permanent pool and is accessible through manhole covers. The City currently has eight baffle boxes in its SWMS.

A baffle box is a good choice for a water quality control device in areas where the other more traditional measures discussed previously may not be applicable due to various constraints. The design of a baffle box is identical to a primary clarifier with the addition of a skimmer for floatables. Target pollutant sizes are fine sands and larger size particles. There are limited percent pollutant removal data on these devices, but the sediment and debris removed can be quantified when the boxed is cleaned.

Maintenance requirements vary by device and application, but generally require a minimum of cleaning the chambers at least twice a year to remove pollutants. The City currently cleans its baffle boxes on a quarterly basis. Frequent maintenance is essential for the effective removal of pollutants using these systems. The cleaning process from these devices includes pumping out the contents of each chamber into a tank truck. If the entire contents are pumped out as a slurry, they are then transferred to a sewage treatment system. If the runoff is separated from the sediments by onsite siphoning, the sediments can be trucked to a landfill for final disposal. These maintenance operations can be costly.

4.2.1.2.10 Aeration Systems

The canals and ponds within the SWMS are shallow and warm, with very little water movement. Stormwater runoff during storm events washes pollutants like nitrogen and phosphorus into the water, and their concentrations increase, resulting in algal blooms, increasing BOD, reducing dissolved oxygen content, and many other issues. The City has a few surface aerators in the canals, but they have a low oxygen transfer efficiency and do not have much effect on overall water quality. Diffused aeration systems are much more effective at introducing oxygen to water, which increases oxidation reactions and can significantly reduce the concentrations of phosphorus, ammonia, BOD and COD, and promotes beneficial bacteria. Properly designed and constructed diffused aeration systems could significantly improve water quality and are economical to operate and maintain.

However, aeration systems are not currently eligible for BMAP nutrient reduction credit and should only be considered by the City if implementation is done in coordination with regulatory agencies and BMAP revisions that will result in City nutrient reduction credits. A pilot study using an aeration system in a canal segment might be a potential segway to regulatory acceptance for these systems, which have had demonstrated success improving water quality in canals and ponds in Florida.

4.3 State Water Quality Standards

State water quality standards are established by FDEP and are set forth in chapters 62-4, 62-302, 62-520 and 62-550, F.A.C. Surface and ground water discharges from stormwater management systems, works, and other projects may not cause or contribute to a violation of state water quality standards.

4.3.1 Surface Water Quality Standards

State water quality standards for surface waters are contained in chapters 62-4 and 62-302, F.A.C. The standards apply at the point of mixing of discharge from the system with waters of the State. All surface waters of the State have been classified according to designated uses as shown in Table 4-3. Water quality classifications are arranged in order of the degree of protection required, with Class I water having generally the most stringent water quality criteria and Class V the least. However, Class I, II, and III surface waters share water quality criteria established to protect fish consumption, recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife.

Table 4-3. Florida Surface Water Classifications

Surface Water Class	Description
CLASS I	Potable Water Supplies
CLASS I-Treated	Treated Potable Water Supplies
CLASS II	Shellfish Propagation or Harvesting
CLASS III	Fish Consumption; Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
CLASS III-Limited	Fish Consumption; Recreation or Limited Recreation; and/or Propagation and Maintenance of a Limited Population of Fish and Wildlife
CLASS IV	Agricultural Water Supplies
CLASS V	Navigation, Utility and Industrial Use

The IRL and the South Prong of the St. Sebastian River are classified as Class II surface waters. Chapter 62-302.300(13), F.A.C. states that "…*excessive nutrients (total nitrogen and total phosphorus) constitute one of the most severe water quality problems facing the State. It shall be the Department's policy to limit the introduction of man-induced nutrients into waters of the State. Particular consideration shall be given to the protection from further nutrient enrichment of waters which are presently high in nutrient concentrations or sensitive to further nutrient concentrations and sensitive to further nutrient loadings*…" In addition to nutrient loadings of total nitrogen and total phosphorus, dissolved oxygen levels play a critical role in the overall health of surface waters. A brief discussion of the importance of these parameters on water quality is in the sections that follow.

4.3.2 Nutrient Loadings (Nitrogen and Phosphorus)

According to the EPA, nutrient pollution is one of America's most widespread, costly and challenging environmental problems, and is caused by excess nitrogen and phosphorus in the air and water. Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. Nitrogen is also the most abundant element in the atmosphere. Nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water.

However, when too much nitrogen and phosphorus enter the environment, the air and water can become polluted. The primary sources of nitrogen and phosphorus from human activities include urban and agricultural runoff, wastewater treatment facilities, and septic systems. Septic systems are a particular concern in the City of Sebastian, as more than 90% of the residences are equipped with them. According to the EPA, when a septic system is improperly managed, elevated nitrogen and phosphorus levels can be released into local water bodies or ground water. An estimated 10 to 20 percent of septic systems fail at some point in their operational lifetimes. The sheer number of septic systems within the City and their typical failure rates make them a significant potential source of

nitrogen and phosphorus loading on the City's SWMS. However, this issue cannot be quickly or easily solved, because the City does not have sufficient wastewater treatment facility capacity or the sewer collection infrastructure necessary for a centralized sanitary sewer system. The City has a septic-to-sewer conversion program, but to date only a few of the existing septic systems have been eliminated.

Excessive nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms and they can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish. Some algal blooms are harmful to humans because they produce elevated toxins and bacterial growth that can make people sick if they come into contact with polluted water, consume tainted fish or shellfish, or drink contaminated water.

Federal regulations related to nutrient pollution are expected to get more stringent, which will drive State regulations. In a memo dated April 5, 2022, EPA's Office of Water indicated plans to accelerate progress in controlling nutrient pollution in the nation's waters by scaling up existing, foundational approaches and more broadly deploying new data assessments, tools, financing approaches, and implementation strategies.

4.3.3 Dissolved Oxygen

The amount of dissolved oxygen (DO) an aquatic organism needs depends upon species, water temperature, and other factors such as the life stage of an organism. Oxygen demand is a measure of the oxygen used by microorganisms to decompose organic matter, and is expressed either as biochemical oxygen demand (BOD), chemical oxygen demand (COD), or nitrogenous oxygen demand (NOD).

- Biochemical oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per liter of sample during 5 days of incubation at 20°C.
- Chemical oxygen demand (COD) is a measure of the amount of oxygen that can be consumed by reactions in a measured solution. It is commonly expressed in mass of oxygen consumed over volume of solution and expressed in milligrams per liter (mg/L).
- Nitrogenous oxygen demand (NOD) is a quantitative measure of the amount of dissolved oxygen required for the biological oxidation of nitrogenous material, for example, nitrogen in ammonia, and organic nitrogen in wastewater.

Waters that have adequate DO under natural conditions but that are impaired for DO typically have one or more anthropogenic sources of organic matter that create an oxygen demand. For urban stormwater, examples of organic matter sources include leaves and other yard wastes, pet and animal wastes, fertilizer, sediment containing organic matter (e.g. topsoil), and hydrocarbons (e.g. oil). A median value for BOD in stormwater runoff in urban settings is about 8 mg/L, while a median value for COD is about 22 mg/L.

According to the FDEP's TMDL report, multiple environmental factors control DO concentrations in the IRL. Theoretically, the DO concentration in a given waterbody can be influenced by temperature, salinity, flow, water depth, photosynthesis, respiration, sediment oxygen demand (SOD), the oxidation of organic carbon or inorganic reductants, and low DO ground water input. Typically, low DO concentrations were observed in the lagoon during the summer months (May to September). Occasional DO concentrations lower than 5.0 mg/L were also observed in other months, but with a much lower frequency. While temperature is an important factor responsible for changes in DO, saturation DO concentrations under the typical summer water temperature (28^0 C) and salinity

(above 3 percent) should still be higher than 6.0 mg/L, as long as no other chemical and biochemical processes are involved (Clescerl et al. 1999). Therefore, DO concentrations lower than 4.0 mg/L in the IRL most likely result from factors other than temperature and salinity.

Florida's Surface Water Quality Standards require that the DO concentration for Class II and III marine waters "*shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained*".

4.4 Total Maximum Daily Load (TMDL) Requirements

As mentioned previously, the FDEP defines a TMDL as a "scientific determination of the maximum amount of a given pollutant that a surface water can absorb and still meet the water quality standards that protect human health and aquatic life." The Indian River Lagoon (IRL) TMDLs are targeted towards seagrass regrowth at water depths where seagrass historically grew in the lagoon. The seagrass coverage in the IRL has decreased over the years because of the degradation of water quality conditions.

Chapter 62-304.520, FAC contains the IRL TMDLs, which are divided into several areas of the IRL. The TMDLs for the Central and southern South Indian River are 278,273 lbs/year of TN and 53,599 lbs/year of TP, which represent a 56% reduction of TN and a 48% reduction of TP based on the year 2000 land use.

As mentioned previously, the Central Indian River Lagoon (CIRL) BMAP addresses adopted TMDLs for certain tributaries to the CIRL, including the South Prong of the St. Sebastian River. Management actions provided by stakeholders, including projects, programs, and activities that may reduce nutrient loads to the CIRL, are included in the BMAP and have to meet several criteria to be considered eligible for credit.

The projects and activities in the CIRL BMAP are critical to the goal of recovering seagrass in the IRL, and their level of completion are tracked to show stakeholder efforts and progress towards the total required milestone reductions. FDEP conducts an assessment of progress towards the BMAP milestones every five years, and plan revisions are made as appropriate. FDEP has established milestones for the years 2025, 2030, and 2035 as follows:

- 5-year milestone in 2025: 35 % or 320,614 lbs/yr of TN and 77,290 lbs/yr of TP.
- 10-year milestone in 2030: 70 % or 641,228 lbs/yr of TN and 154,580 lbs/yr of TP.
- 15-year milestone in 2035: 100 % or 916,040 lbs/yr of TN and 220,828 lbs/yr of TP.

4.5 Water Quality Model Evaluation

4.5.1 Water Quality Model – SWIL

The original BMAP nutrient loads were estimated using the Pollutant Load Screening Model (PLSM) and represented year 2000 loading in most of the IRL Watershed. SJRWMD developed the seagrass depth limits based on historical aerial photographs of the IRL from 1943 through 2001. FDEP used the PLSM and the seagrass depth limits to develop the IRL TMDLs that were adopted by rule.

After the TMDLs were adopted, several MS4 permittees within the IRL Watershed expressed interest in creating a new watershed model to improve upon the PLSM, which resulted in the development of the Spatial Watershed Iterative Loading (SWIL) Model. The SWIL model was proposed to FDEP as an alternative to the PLSM to calculate allocations for the IRL BMAPs and was selected for use. The sections below provide a brief summary of the SWIL modeling and the processes used to update the TMDLs. For more detailed information, please refer to the Indian River Lagoon Basin Central Indian River Lagoon BMAP (FDEP, 2021).

As mentioned previously, the TMDLs for the IRL (in Rule 62.304.520, F.A.C.) include a 56% reduction of TN and a 48% reduction of TP from their starting loads. The TMDL allocations were calculated in two steps, first by using the SWIL Model to establish the total TN and TP load, by project zone. To accomplish this, rainfall inputs from a representative period were used to simulate a wide range of rainfall patterns and amounts over a multi-year period. The SWIL outputs were used to generate a GIS-based Load Estimation Tool (LET) that included annual average loads from the watershed. The LET was then used to calculate updated TN and TP baseloads from all existing project treatment areas in the BMAP. To account for stakeholder credits for the various project types, the August 2020 FDEP BMP Efficiencies Guidance document was used to determine the appropriate credit calculations.

The second step in determining the TMDL allocations was to apply the respective TMDL percent reduction for TN or TP to the starting load, which resulted in the TN or TP reduction value. The TN and TP allocations were then calculated by subtracting the TN or TP reduction value from the TN or TP starting load. Additional adjustments were made to account for TN and TP loads from natural land areas.

Once the total required reductions for each project zone were determined, the percentage of each stakeholder's anthropogenic load relative to the total anthropogenic load for the project zone was calculated to determine their loading contribution, and the percentage of the project zone's required reduction was applied to stakeholders accordingly.

4.5.2 Water Quality Conclusions/Recommendations

The Indian River Lagoon TMDLs were determined by the SWIL model and are included in Chapter 62-304.520, FAC and divided into several areas of the IRL. The CIRL BMAP was developed to specifically address how the total required nutrient reductions would be achieved by the stakeholders in the four CIRL project zones by 2035. To date, the overall progress for TN and TP reductions over all four CIRL BMAP project zones relative to the established milestones appears to be on track. Figures 4-8 and 4-9 show the latest results for Project Zone SEB, which includes the City of Sebastian, where the FDEP reported a 23% reduction of TN load and a reduction of 51% of TP load allocated to Project Zone SEB from stakeholder projects completed through July 31, 2020.

Under the CIRL BMAP, the City of Sebastian's allowable loadings were established as shown in Table 4-4. To accomplish this, the City proposed several management actions (projects) that were included in the BMAP. To date, 16 projects have been completed by the City or are currently underway, resulting in load reduction credits of 5,223 lbs./year of TN (15.7% of required reduction) and 620 lbs./year of TP (10.3% of required reduction).

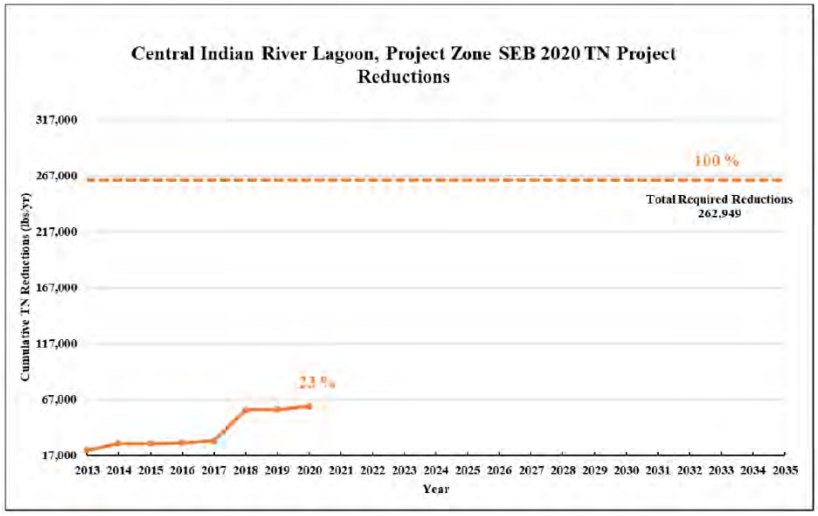

Figure 4-8. CIRL Project Zone SEB - TN Reductions Progress (2020)

While the City's performance appears to be lower than the overall progress reported for CIRL Project Zone SEB, it should be noted that the City has not yet received reduction credits for seven completed projects, including the Stormwater Park. That single project may account for a significant part of the City's required reduction goals.

The FDEP conducts an annual review of BMAP implementation efforts, and during that review project-specific information may be revised and updated, resulting in changes to the estimated reductions for those projects. The revisions may increase or decrease estimated reductions, and FDEP will work with stakeholders to address revisions as they are identified. In addition, there are several CIP projects eligible for reduction credits included in this master plan that may be proposed by the City as management actions in future updates of the CIRL BMAP.

Figure 4-9. CIRL Project Zone SEB - TP Reductions Progress (2020)

Table 4-4. City of Sebastian TN and TP Required Reductions and Allowable Loadings

Parameter	Starting Load (lbs./year)	Anthropogenic % in CIRL BMAP	Required Reduction (lbs./year)	Required Reduction (%)	Allowable Load (lbs./year)
Total Nitrogen (TN)	61,820	3.86	33,196	53.7	28,264
Total Phosphorus (TP)	8.901	3.84	6,015	67.6	2,886

The City of Sebastian appears to be meeting the allowable loads for TN and TP established in the CIRL BMAP. However, as additional development occurs, additional projects will be needed to ensure ongoing compliance with BMAP requirements.

Some possible projects that could be considered for the BMAP include the following:

- Additional dry detention areas
- Dredging of sediment from existing retention/detention ponds
- Reduction of canal water surface elevation to reduce peak discharge
- Blossom Ditch Drainage Improvements (CIP Project 24) – addition of a Baffle Box to the existing outfall to improve water quality.

5 Sea Level Rise Assessment

Global mean sea level (GMSL) rise results from a combination of warming ocean waters and the addition of water mass (i.e., glacial melt) into the ocean, and is a direct effect of warming climate trends. Increases in GMSL elevations are indicative of changing climate conditions, but it is the sea level rise at the local and regional level as measured by tide gauges and satellites that is most important for coastal communities such as the City of Sebastian. It is important to note that sea levels change locally for a variety of reasons and has not been and will not be uniform in time or location.

5.1 State Climate Change Efforts

The State of Florida was an early adopter of climate change and sea level rise legislation, starting with the Renewable Energy Technologies and Energy Efficiency Act in 2006. A major component of the Act was the creation of the new Florida Energy Commission, whose first report was required to include recommended steps and a schedule for the development of a state climate action plan.

Since then, climate change legislative activity has continued, with additional bills directed at utilities emissions, energy standards, automobile efficiency and emissions, green buildings, efficient land use patterns, energy conservation, greenhouse gas emissions in planning, and a bill providing for the Florida Building Commission to make recommendations on energy efficiency.

The State of Florida has focused its resources primarily on the disaster planning and recovery aspects of climate change rather than policy development. Several state agencies have worked on various climate change efforts, including the following:

- The Florida Fish and Wildlife Conservation Commission is doing a significant amount of data collection and monitoring related to habitat and species impacts.
- The Department of Economic Opportunity has been doing extensive work on sea level rise, including pilot planning efforts in several communities. Its approach has been to also provide technical assistance for local governments and to offer review and comment on compliance with legislation passed in 2015 related to addressing “Peril of Flood” issues in comprehensive plans. The Department of Economic Opportunity has also created numerous guides and compilations of resources for local governments that want to start addressing sea level rise in their policy framework.
- The Florida Department of Environmental Protection has primarily been limited to work related to climate change impacts on coral reefs.

In 2011, HB 7207 became law and significantly changed the state’s growth management policy, which is contained in Chapter 163, Florida Statutes (F.S.). The law contained many controversial changes, including a fundamental reorganization of the Florida Department of Community Affairs into a new Florida Department of Economic Opportunity; a shift that retained some planning and growth management functions but clearly focusing more on the state’s economic development policy. In addition, the law reduced state oversight of local planning decisions and actions, concentrating more on resources and issues with statewide significance. Relative to climate change, the law eliminated many of the energy efficiency and greenhouse gas reduction provisions from Chapter 163, F.S.

The 2011 law did not prohibit longer timeframes for planning, but the minimum required planning horizons in Florida’s comprehensive planning law (5 and 10 years) remain too short to effectively include consideration of climate change and sea level rise impacts, even when taking into account infrastructure or development with

usable life spans of many decades. The changes to comprehensive planning law in 2011 do not prevent Florida's local governments from engaging in proactive efforts to increase their resilience to coastal hazards (i.e., erosion, storms, and sea level rise), but they allowed for a more discretionary function than a prescriptive one.

The Florida Legislature in 2020 approved Senate Bill 178, and the rules to implement the bill were finalized in 2021 by the FDEP. Considered one of Florida government's first acknowledgments of rising seas and their complications, the law requires the sea-level impact project (SLIP) study to be done for all government structures built in the coastal building zone using state funds. The statute defines the building zone as most of the beach areas in Florida: the land from the high-water line to an area 1,500 feet landward of the coastal construction control line. Government-built structures in the coastal building zone must now undergo an assessment of the potential damage over the next 50 years from higher seas, flooding, storm surges and wave action.

5.2 Available Reports and SLR Projections

The most recent report available regarding sea level rise projections is from the U.S. Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force (the "Task Force") titled *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines* (the "Report"). The Report was published in February 2022 by the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA) and is an update to the 2017 Task Force report. The Report states that the set of global mean sea level rise scenarios from the 2017 report are updated and downscaled with output directly from the United Nations Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, through the efforts of the NASA Sea Level Change Team; updates include adjustments to the temporal trajectories and exceedance probabilities of these scenarios based upon end-of-century global temperatures.

The primary findings of the Report were as follows:

- Multiple lines of evidence provide increased confidence, regardless of the emissions pathway, in a narrower range of projected global, national, and regional sea level rise at 2050 than previously reported.
- Relative sea level along the contiguous U.S. coastline is expected to rise on average as much over the next 30 years (0.25–0.30 m over 2020–2050) as it has over the last 100 years (1920–2020).
- By 2050, the expected relative sea level (RSL) will cause tide and storm surge heights to increase and will lead to a shift in U.S. coastal flood regimes, with major and moderate high tide flood events occurring as frequently as moderate and minor high tide flood events occur today. Without additional risk-reduction measures, U.S. coastal infrastructure, communities, and ecosystems will face significant consequences.
    - Minor/disruptive high tide flooding (HTF; about 0.55 m above mean higher high water [MHHW]4) is projected to increase from a U.S average frequency of about 3 events/year in 2020 to >10 events/ year5 by 2050.
    - Moderate/typically damaging HTF (about 0.85 m above MHHW) is projected to increase from a U.S. average frequency of 0.3 events/year in 2020 to about 4 events/year in 2050.
    - Major/often destructive HTF (about 1.20 m above MHHW) is projected to increase from a U.S. average frequency of 0.04 events/year in 2020 to 0.2 events/year by 2050.
    - Across all severities (minor, moderate, major), HTF along the U.S. East and Gulf Coasts will largely continue to occur at or above the national average frequency.
- Higher global temperatures increase the chances of higher sea level by the end of the century and beyond. The scenario projections of relative sea level along the contiguous U.S. coastline are about 0.6–

2.2 m in 2100 and 0.8–3.9 m in 2150 (relative to sea level in 2000); these ranges are driven by uncertainty in future emissions pathways and the response of the underlying physical processes.

- Monitoring the sources of ongoing sea level rise and the processes driving changes in sea level is critical for assessing scenario divergence and tracking the trajectory of observed sea level rise, particularly during the time period when future emissions pathways lead to increased ranges in projected sea level rise.

The mean sea level elevation continues to rise with similar degree of fluctuation trends as illustrated in data collected from the National Oceanic and Atmospheric Administration (NOAA) Tide Stations. The NOAA Tide Station closest to the City of Sebastian is the Trident Pier Station at Port Canaveral (Station No. 8721604). As shown in Figure 5-1 below, data collected at this station from 1994 to 2022 show the mean sea level elevation increasing at a rate of approximately 0.5 feet (0.15 m) between 2020 and 2050 and the maximum sea level elevations increasing at a rate of approximately 0.6 feet (0.18 m) over the same period. These rates appear to be generally consistent with the lower range of the 0.25 – 0.30 m increase projected in the Report.

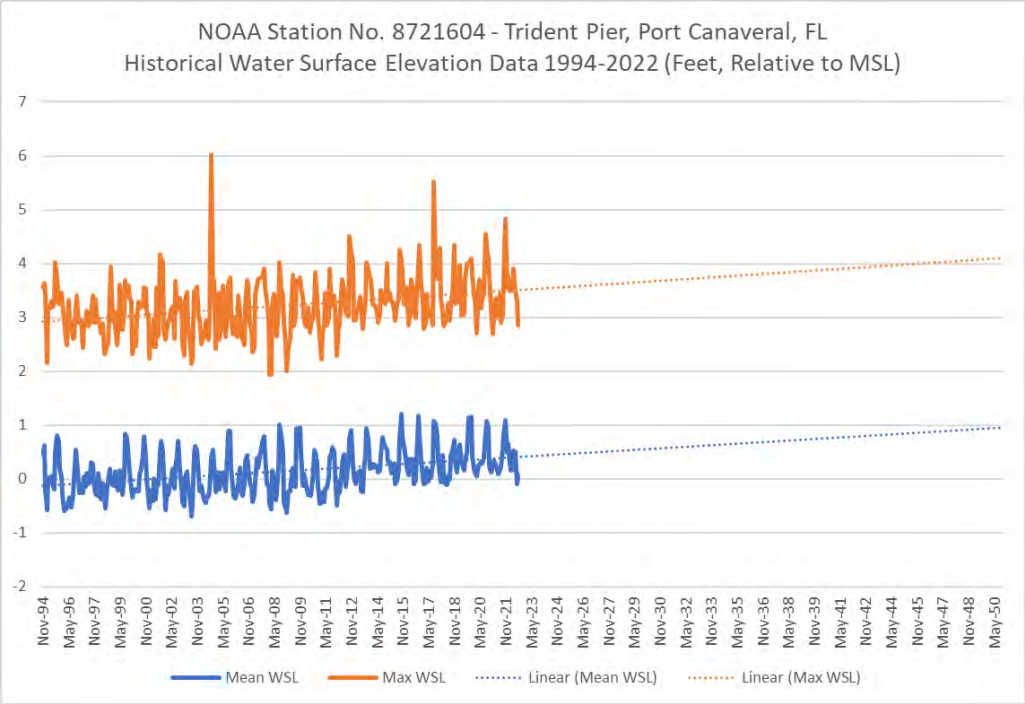

Figure 5-1. NOAA Tide Station No. 8721604 Historical Data

An increase in the sea level rise will not result in noticeable changes to the normal standing water elevations adjacent to existing roads and buildings. However, the changes in the performance of the City's SWMS during large and peak storm frequency events will be more noticeable. Stormwater conveyance systems rely on gravity to move the stormwater through open channels and drainage pipes. As the sea level increases at the outlet end of a drainage system, stormwater flow rates through that drainage system will be reduced, which will result in elevated flooding over longer durations.

The FEMA Flood Insurance Study (FIS) water surface elevations along the South Prong of the St. Sebastian River resulting from the 10-year, 25-year, and 100-year storm events were used as a boundary condition in the 10-year, 25-year, and 100-year stormwater models respectively and act as the controlling tailwater condition for the City drainage areas studied in this stormwater master plan update. The 10-year stormwater surface elevation

is higher than the projected 2050 sea level rise elevation and results in a conservative analysis of existing and proposed drainage system improvements. The City can continue to use this 10-year storm event tailwater elevation in replacing existing structures and in designing new storm systems.

The King Tide elevation was extracted from the Maximum Sea Level data recorded at the Trident Pier Station at Port Canaveral (Station No. 8721604) from 1994 to 2022. King Tides were assumed to be the two highest maximum sea level elevations recorded each year, generally occurring during the fourth quarter. Based on that assumption, the average King Tide elevation was calculated at 3.90 feet and the maximum elevation was 6.02 feet relative to Mean WSL. Therefore, the worst case tailwater condition for the City's SWMS through 2050 would be an increase in Mean WSL of 0.5 feet (approximately -0.46 feet NAVD88), with an additional 6.02 feet to account for a maximum King Tide event, or approximately elevation 5.56 feet NAVD88.

5.3 Expected Effects

Based on the data available, the estimated increase in mean sea levels alone through 2050 are not expected to have a significant effect on the performance of the City's SWMS. Figures 5-2, 5-3, and 5-4 below were taken from the NOAA Sea Level Rise Viewer and show the current conditions and the areas affected by one foot and two feet of seal level rise, respectively. However, in the unlikely event that a storm event were to occur during the peak of a maximum estimated king tide similar to Hurricane Nicole in November 2022, the resulting tailwater elevation may temporarily reduce or stop flow from some City outfalls (i.e., Stonecrop weir, etc.), resulting in localized flooding conditions upstream. City outfalls along the Indian River Lagoon may experience some surcharging prior to tide valve actuation and discharge flows would decrease due to the increase in tailwater elevations.

Other effects of sea level rise to the City may include the following:

- Increased shoreline erosion
- Habitat damage/destruction
- Habitat loss/migration
- Changes to plant and animal communities

There are many publications available discussing the sea level rise issue with suggested options for mitigation. The City should partner with Indian River County, SJRWMD, FDEP, and other agencies to craft joint policies that will address the economic needs of the City while mitigating the anticipated effects of rising sea levels. The following general mitigation policies should be considered:

- **Shoreline Protection.** Develop and enhance policies to protect and strengthen exposed shorelines along the Indian River Lagoon. These policies should focus on minimizing erosion and proper maintenance of infrastructure in the coastal and urban waterfront environments. These measures should also consider coastal setback zones.
- **Outfall Modifications.** The Stonecrop weir and other outfalls may need to be modified to maintain maximum allowable discharge flows with increased tailwater elevations. This effort must be balanced with the overall goals of reducing the quantity of discharged stormwater and improving its quality.

At this moment, there are no federal or state rules addressing sea level rise. This provides an opportunity for the City to develop policies and ordinances that make sense for their citizens. There are many publications available that can provide meaningful information to the City and its residents to aid in the difficult process of adapting to sea level rise. These include the following:

- City of Sebastian 2022 Stormwater Master Plan Update
- City of Sebastian 2040 Comprehensive Plan
- City of Sebastian Coastal Resiliency Plan
- Others

It is recommended that the City begins planning and having open discussions with residents and businesses on the issue of sea level rise so that policies and ordinances can be thoroughly considered by all stakeholders. Fortunately, sea level rise is generally not expected to have significant effects on the City's stormwater infrastructure, and SWMS components in affected areas can be modified to mitigate sea level rise. However, such modifications may require substantial costs, which may be a limiting factor for the City.

Figure 5-2. Current Conditions – NOAA Sea Level Rise Viewer

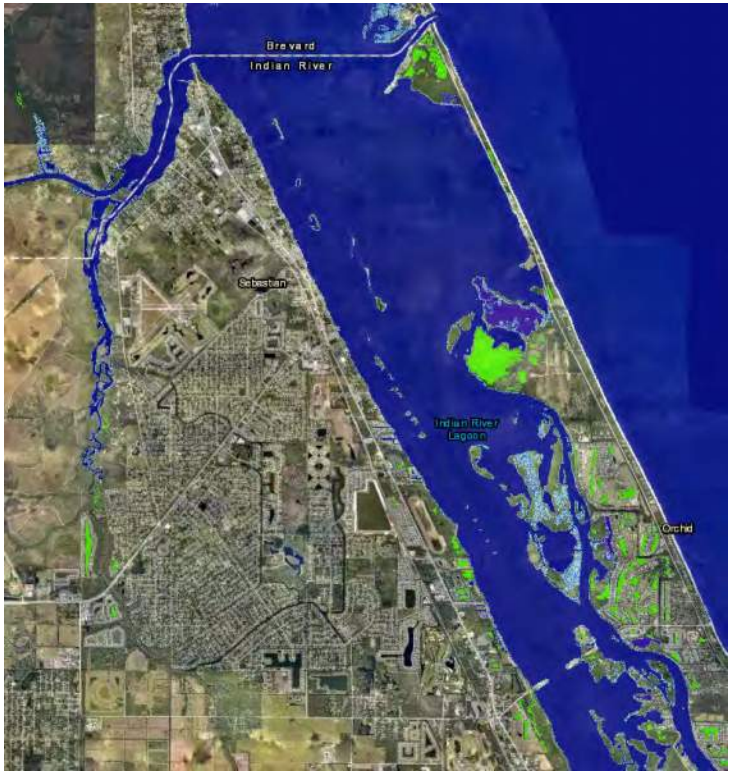

Figure 5-3. One Foot Sea Level Rise – NOAA Sea Level Rise Viewer

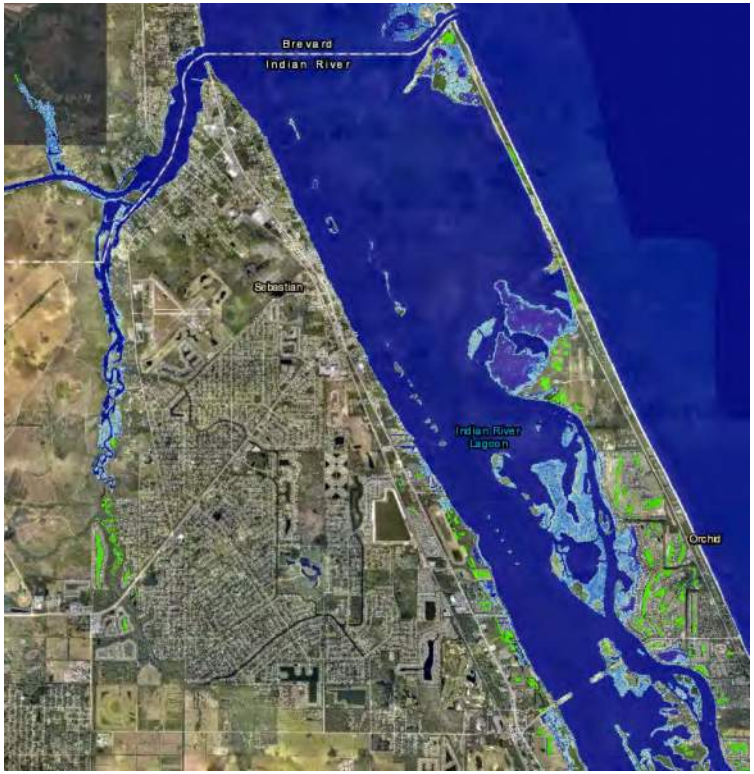

Figure 5-4. Two Foot Sea Level Rise – NOAA Sea Level Rise Viewer

6 Operations and Maintenance

6.1 O&M Program Requirements

Any operation and maintenance (O&M) program for any purpose needs to be well defined, given proper management authority, and be properly funded to provide sufficient staffing and equipment. Because the City's SWMS relies heavily on open channels to capture and convey stormwater, significant O&M activities are required to ensure proper functionality. The flow capacity of open channels depends primarily on the cross section and bottom slope, and is affected by sedimentation, erosion, and vegetation. Accordingly, the primary focus of the Proposed O&M Plan, presented in Section 6.4 below, is directed at the maintenance of open channels. Currently, the City requires residents to mow and maintain the grades of roadside swales, swales in drainage easements, and stabilize the banks of waterways (i.e., bulkheads) on their property. The City's Stormwater Division maintains over 100 miles of side and rear drainage ditches and approximately 9.1 miles of canals and waterways. The Division also manages the water retention at the stormwater park, airport drainage system, and maintains eight nutrient baffle boxes.

The O&M Plan for the City's stormwater system needs to include the following activities to make the system function properly and operate at peak performance and efficiency:

- Mowing of detention/retention ponds, swales, and ditches
- Regular visual inspections of all SWMS components
- Coordination of the mowing and maintenance of right-of-way swales (aka front yard swales) and associated driveway culverts
- Removal of sediment and debris from inlets, conveyance pipes, culverts, outfall structures, Nutrient Separating Baffle Boxes, and other drainage structures
- Removal of sediment and aquatic weed control in retention/detention ponds
- Removal of sediment and regrading of side yard and back yard ditches
- Effecting minor repairs
- Coordination of canal side slope maintenance, aquatic weed control and periodic removal of sediment
- Coordination with SJRWMD for maintenance of drainage paths outside City boundaries

Stormwater Management facilities including conveyance and attenuation provide the means of removing stormwater from streets, parking areas, public parks, public and private areas subject to stormwater runoff. The Stormwater Management facilities not only address environmental water quality controls, erosion abatement and drainage, but are integral to public safety. Improper maintenance of a stormwater systems affects surrounding property and infrastructure.

When developing a budget for O&M, the costs associated with renewal and replacement (R&R) of failing infrastructure should also be considered. Using typical unit cost, the ratio of number of structures to be maintained per year, and assuming a return period of 30 to 50 years, allows an estimate of the amount of city-wide stormwater infrastructure that may require R&R in an orderly and periodic cycle. Periodic R&R retrofit will minimize the spending with future CIP projects and effectively reduce the problems associated with, or caused by, poor drainage in other structures.

6.2 Relevant City Ordinances and Codes

Code of Ordinances - Article V - Ordinance No. O-0-16

This ordinance, adopted on Sept. 26, 2001, enacted Article V of the City's Land Development regulations and is codified under Chapter 102 of the City Code. The ordinance created and established in the City, in accordance with Section 403.0893, F.S. a stormwater management utility entitled the Sebastian Stormwater Utility (SU). This SU was given the responsibility for the City's stormwater management, and has all powers necessary for the exercise of its responsibility for the drainage from all properties within the City, including, but not limited to, the following:

1. Preparation of plans for improvements and betterments to the stormwater management system.
2. Construction of improvements and betterments to the stormwater management system.
3. Promulgation of regulations for the use of the stormwater management system, including provisions for enforcement of such regulations.
4. Review and approval of all new development permits within the city for compliance with stormwater management regulations included in present city ordinances or ordinances later adopted.
5. Performance of routine maintenance and minor improvement to the stormwater management system.
6. Establishment of charges for connection and use of the stormwater management system.
7. Evaluation of water quality concerns for discharges to the stormwater management system.
8. Performance of all normal utility functions to include construction, operation, and maintenance of the city's stormwater management system, including, but not limited to, the hiring of staff, the selection of special consultants, the entering into contracts for services and construction of facilities, and the handling of purchase, lease, sale or other rights to property for the stormwater management system.
9. Issuance of revenue bonds or other debt instruments for the purpose of performing those duties as described herein.
10. Imposition of a stormwater fee. The stormwater fee is applied to all property within the city unless otherwise exempted, for services and facilities provided by the stormwater management system. The fee amount is a flat fee of one Equivalent Residential Unit (ERU) per month, but the ERU calculation depends on the classification of the property. Exempt property is not subject to a stormwater fee. The fee for one equivalent residential unit (ERU) is $10.00 for each month. The City Council may establish a different rate for any fiscal period following the 2018-2019 fiscal year.
11. Establishing procedures for the collection of SU fees.
12. Establishing a Sebastian Stormwater Utility Fund for the deposit of all fees collected. The stormwater utility fund shall be used exclusively to provide funding for the stormwater management program.
13. The city manager may promulgate reasonable regulations concerning the operation of the Sebastian Stormwater Utility, with said regulations subject to modification or nullification by resolution of the city council.

Code of Ordinances - Section 54-2-7.15(d)

Paragraphs (2) and (3) of this Code section establish that the property owner is responsible for the maintenance of all drainage features on a property, including front yard swales, driveway culverts, side yard swales, and back yard ditches to maintain the proper flow of surface water.

Code of Ordinances - Article VI - Urban Stormwater Quality Management and Discharge Control

Ordinance No. O-13-11 established Article VI, which is intended to ensure the health, safety, and general welfare of citizens, and protect and enhance the water quality of watercourses and water bodies in a manner pursuant to and consistent with the Federal Clean Water Act (33 U.S.C. § 1251 et seq.) by reducing pollutants in stormwater discharges to the maximum extent practicable and by prohibiting non-stormwater discharges to the storm drain system.

One important requirement in this Article relative to the O&M of the canals within the City's stormwater system is Section 102-145. - Watercourse protection, which makes owners of properties along the banks of watercourses responsible for maintaining existing privately owned structures within or adjacent to a watercourse and maintaining and stabilizing that portion of the watercourse that is within their property lines in order to protect against erosion and degradation of the watercourse originating or contributed from their property.

Code of Ordinances – Article XII – Surface Water Management

Article XII (Code Section 54-3-12) establishes the minimum standards for surface water management and flood protection set forth in this article shall be applicable to all new construction, development or redevelopment requiring updated code compliance. This section gives the Stormwater Department review and approval authority over development permits.

The sections that follow provide a summary of the City's current O&M practices and a proposed O&M program based on current and planned future funding levels to improve the level of O&M activity and the overall performance of the City's SWMS.

6.3 Existing Operations and Maintenance Program

6.3.1 Stormwater Management Organization

The size and complexity of the City's stormwater infrastructure and its many requirements and goals highlight the critical importance of proper planning and efficient use of resources for its successful operation. On Sept. 26, 2001, the City adopted Ordinance No. O-0-16, which created and established a stormwater management utility called the Sebastian Stormwater Utility (SU). The SU was given the responsibility for the City's stormwater management and has all powers necessary for the exercise of its responsibility for the drainage from all properties within the City. The City of Sebastian has placed the responsibility for the management of the SU with the Stormwater Department. Funding for the Stormwater Department's administration, O&M costs and capital budgets is generated primarily from Stormwater Utility Fee revenues, with additional revenues from the Discretionary Tax and other sources. A detailed description of the Department's funding is included in Section 8 – Funding Plan and Grant Management.

6.3.2 Current Resources

The Stormwater Department currently has a staff of ten, as shown in Table 6-1 below. City staff work an average of 249 days per year, eight hours per day.

Table 6-1. Stormwater Department Staffing

Position	Count*
Clerical Support – Citizen Request Line (Part Time)	0.5
Stormwater Superintendent	1
Stormwater Utility Inspector (Part Time)	0.5
Maintenance III	3
Maintenance II	1
Maintenance I	4
TOTAL	**10.0**

**Count is for Full Time Equivalent (FTE) staff*

The Stormwater Department currently maintains a fleet of 24 vehicles and heavy equipment, as shown in Table 6-2 below. The fleet represents a capital value of approximately $3 million, and fleet items are replaced based on expected operational life.

Table 6-2. O&M Equipment Summary

Vehicle/Equipment	Age (Years)	Expected Life (Years)
601 - 2016 CHEVROLET 2500 4WD	6	7
603 - 2015 FORD F250 4WD	7	7
604 - 2018 FREIGHTLINER DUMPTRUCK	4	10
605 - 2018 FREIGHTLINER DUMPTRUCK	4	10
606 - 2005 CHEVROLET 3500 UTILITY TRUCK	17	7
607 - 2007 STERLING BRUSH TRUCK	15	10
608 - 2015 FORD F550 DUMP TRUCK	7	7
614 - 2006 CHEVROLET SILVERADO 4WD	16	7
616 - 2001 CHEVROLET 1500	21	7
620 - 2016 INT. VAC-TRUCK	6	10
632 - 2013 CHEVROLET 3500	9	7
633 - 2019 FORD F 150 TRUCK 4WD	3	7
649 - 2022 FREIGHTLINER SEMI TRACTOR	<1	10
677 - 2014 FORD F350	8	7
621 - 2014 BOBCAT EXCAVATOR E42	8	10
622 - 2020 311 CAT EXCAVATOR	2	10
642 - 2020 KUBOTA TRACTOR	2	10
643 - FRT LOADER MOUNTED TO SW 642	NA	NA
678 - 2014 JOHN DEERE 410K BACKHOE	8	10
686 - 2013 CAT M313D EXCAVATOR	9	10
690 - 2015 JOHN DEERE 825I GATOR	7	7
691 - 2016 JOHN DEERE TRACTOR 6130	6	10
692 - 2016 DIAMOND BOOM MOWER/DITCHER	6	10
636 - 2021 FELLING 70 TON GOOSENECK TRLR	1	10

6.3.3 Operational Responsibilities and Maintenance Activities

The City's Stormwater Department currently operates and maintains the stormwater infrastructure through a combination of direct maintenance by Department staff, coordination with other City Departments, and City contractors to maintain City-owned drainage components, and through coordination with the SJRWMD, businesses and residents to maintain privately-owned components. Current operational responsibilities, descriptions of maintenance activities conducted within the SWMS, and status notes are shown in Table 6-3.

The SWMS is currently divided into six management zones, as shown in Figure 6-1 below. In each zone, maintenance responsibility has been established for the many SWMS components (i.e., roadside swales, side swales, backyard ditches, culverts, baffle boxes, etc.) present. Due to limitations of funding and resources, the management of the SWMS is generally reactive, with inspections and maintenance performed on an as-needed basis or when responding to Citizen Requests (CRs).

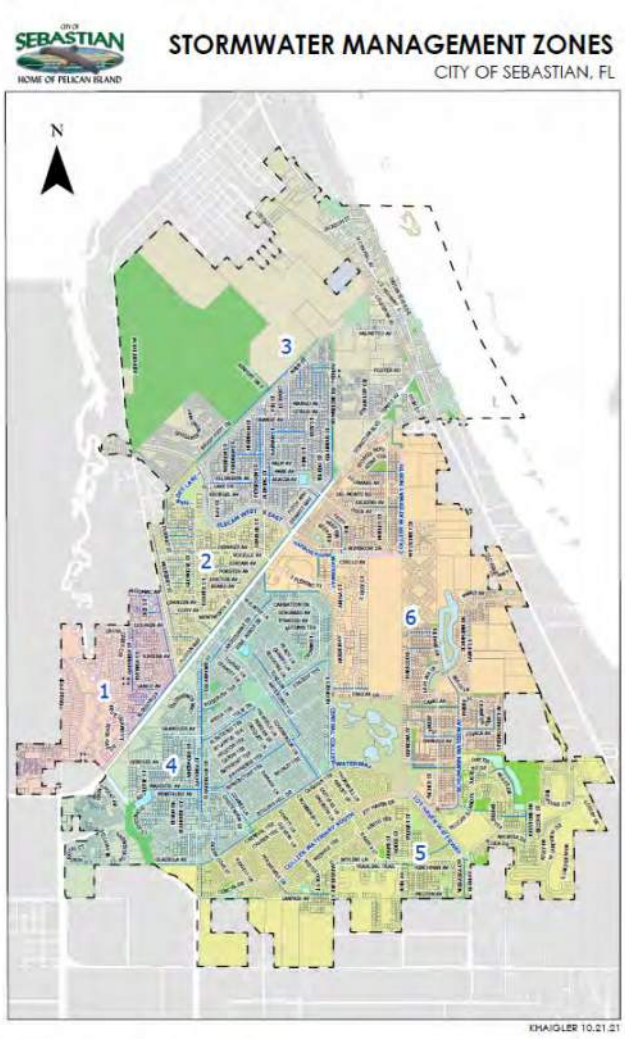

Figure 6-1. City of Sebastian Stormwater Management Zones

Table 6-3. Current Operational Responsibilities and Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsibility	Maintenance Frequency	Maintenance Activities and Notes
1	Front Yard Swale and Driveway Culvert	Routine Visual Inspection and Maintenance	Property Owner	As Needed	There are approximately 14,000 of these components in the SWMS. Maintenance issues with front yard swales and driveway culverts are widespread and have been a historical problem for the City.
2	Front Yard Swale and Driveway Culvert	Citizen Request Response	City	As Needed or in response to CR	The City currently receives many citizen requests (CR) per month related to front yard swales, which are currently processed through Code Enforcement procedures.
3	Front Yard Swale	Quarter Round Cleaning	City	As Needed or in response to CR	Approximately 3,505 front yard swales are equipped with the "Quarter Round" system previously installed by the City. The City cleans approximately 500 of these systems each year in conjunction with roadway repairs or CRs, which is a labor-intensive and costly activity.
4	Inlet Structure	Visual Inspection	City	Once before hurricane season, and before and after large storm events, about 10x/year total.	
5	Inlet Structure (and associated conveyance pipe	Routine Inspection and Maintenance	City	As Needed or in response to CR	The City has approximately 320 inlet structures, City staff reported that on average one inlet structure and the surrounding components can be cleaned per day.
6	Road Crossing Culvert	Routine Inspection and Maintenance	City	As Needed or in response to CR	The SWMS has approximately 1,300 road crossing culverts. Inspections and maintenance are performed in conjunction with a Citizen Request. Approximately 50 are inspected and cleaned each year.

Table 6-3. Current Operational Responsibilities and Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsibility	Maintenance Frequency	Maintenance Activities and Notes
7	Baffle Box	Routine Inspection and Maintenance	City	Quarterly	City has 9 of these, each takes approximately four hours to clean.
8	Side Yard Ditch	Mowing	City	Quarterly	City has a 10-foot easement area, mowed by City contractor.
9	Back Yard Ditch	Mowing	City	Quarterly	The City has a 20-foot drainage ROW from the back property line of each parcel abutting a back yard ditch for maintenance access. Back yard ditches are maintained by the City's contract mowing vendor.
10	Back Yard & Side Yard Ditch	Mowing Inspection	City	Quarterly	Verification of the City's contract mowing vendor's work, takes approximately one hour per month.
11	Driveway Culvert	Repair During Road Repaving	City	As Needed	The City removes and replaces a section of the driveway and the driveway culvert in conjunction with road paving. Approximately 30 are replaced per year.
12	Retention and Detention Ponds	Visual Inspection	City	Quarterly	The City has 30 ponds that are inspected each quarter.
13	Retention and Detention Ponds	Inspection and Maintenance	City & Private	Monthly	The SW Dept mows the Schumann Dr. retention pond, Parks Dept mows others. Private owners maintain private ponds.
14	Stormwater Park	Pump Operation	City	As Needed	SW Dept staff manually turn on the stormwater pumps for 1-2 hours per day if canal water levels are high enough.
15	Stormwater Park	Mowing	City	Monthly	SW Dept mows the Stormwater Park once per month. Parks Dept also mows it once per month.
16	Stormwater Park	Mowing	City	Annual	City contractor mows once per year, at the option of the City.
17	Public Works Compound	Mowing	City	Monthly	SW Dept mows once per month. Parks Dept also mows it once per month.

Table 6-3. Current Operational Responsibilities and Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsibility	Maintenance Frequency	Maintenance Activities and Notes
18	Dams and Weirs	Inspection and Maintenance	City	As Needed	The SWMS has two dams (Concha and Hardee) controlling discharge from the canals and one weir (Stonecrop) regulating discharge from the SWMS. Inspections and maintenance are performed on an as-needed basis.
19	Canals	Inspection and Maintenance	City	Visual Inspection every 6 months, maintenance dredging every 10 years	The City has a drainage easement over the canals and performed maintenance dredging in the Collier Canal North area in 2006. No other maintenance dredging has been performed. Significant sediment loading and shoaling in some areas was observed during field inspections. Aquatic weed control is performed by a City contractor in accordance with the City's IPM Plan.
20	Canal Side Slopes		City & Private	Visual Inspection every 6 months, maintenance as needed.	There are 756 bulkheads along the banks of City's canals. 20 are within the City ROW and City owned and maintained. Bulkheads located outside the drainage easement on private property are not maintained by the City. Physical inspections were performed in 2022 and many of the bulkheads were in fair or poor condition. More than 200 are structurally failing and in need of immediate replacement.
21	Offsite Drainage Areas		Private	5 Years	This includes drainage paths from the City's system that are privately owned and the City does not have a drainage easement. Maintenance of these areas in enforced by the SJRWMD via ERP permit requirements for the private developments.
22	Hurricane Preparation	Securing Buildings,	City	As Needed	

Table 6-3. Current Operational Responsibilities and Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsibility	Maintenance Frequency	Maintenance Activities and Notes
		Moving Equipment, Etc.			
23	Pre- and Post-Storm Inspection	System-Wide Visual Inspection	City	10x/Year	Before and after hurricanes and large storm events
24	Hurricane Recovery	Debris Cleanup	City	As Needed	Approximately 2 weeks after hurricane
25	Sidewalk Repair	Assist Public Works	City	As Needed	

6.3.4 Problem Areas

There are many problem areas affecting the operation, maintenance, and performance of the City's SWMS, including, but not limited to, the following:

- Physical Challenges
  - Topography - as discussed previously in Section 2, the majority of the City consists of very flat topography, with typical grades of 0.1%.
  - Geology – soils, confining layers
  - Groundwater – high surficial aquifer levels, low infiltration rates
- Environmental Challenges
  - Climate Change – more intense rainfall events in recent years, higher king tides, sea level rise
  - St. Sebastian River Watershed drainage patterns and offsite pollution loading
  - Water Quality issues
    - Low Dissolved Oxygen concentrations
    - High BOD/COD concentrations
    - Aquatic Weed Growth
    - Septic system dependence, lack of WWTP capacity.
- Regulatory Challenges
  - TMDL load reduction requirements for TN and TP
  - NPDES MS4 permit documentation
  - Development standards/permit reviews
  - No legal control over offsite discharge areas – dependent on SJRWMD
  - Issues related to City codes and operations (i.e., City maintenance of side and back yard ditches)

- Engineering and Construction Deficiencies
  - SWMS fundamental design deficiencies – roadside swales in residential areas apparently designed for 1-year, 3-hour storm event.
  - Current Drainage Issues
    - Localized flooding as discussed in Section 3.7.
    - Undersized culverts in many drainage paths
    - Negatively sloped pipes and culverts (negatively sloped stormwater pipes included in the H&H model are provided in the Appendix K Stormwater Network Summary Tables for reference).
    - Apparent incorrect culvert and control structure installations
- Funding Issues
  - SW Dept revenue. staffing and equipment needs
  - Capital Projects – several capital projects identified during previous master planning efforts have not been completed by the City, apparently due to funding limitations.
- Maintenance Issues
  - Front Yard Swales and Driveway Culverts
    - The City does not currently conduct routine inspections of the front yard swales and driveway culverts, only performing them after a CR is filed. If found deficient, the City goes through Code Enforcement procedures to address the deficiency with the property owner. If not corrected, the City can impose punitive fines until the deficiency is corrected. This current method of management consumes personnel time from several City departments and has not resulted in consistent or timely restoration of the drainage components. The City is currently evaluating options to improve compliance.
  - Side Yard Swales and Back Yard Ditches – regrading needs, raised foundation pads, septic fields, etc.
  - Inlet and Pipe Systems – cleaning frequencies, efforts, etc.
  - Culverts – inspection and cleaning frequencies
  - Canals
    - Capacity – Water elevations, dredging needs
    - Maintenance of canal banks – ownership/responsibility for existing bulkheads

6.3.5 O&M Plan Development

Based on information gathered, discussions with City staff, and our experience with municipal stormwater systems, we have developed a proposed Operations and Maintenance Plan for the Stormwater Department. As part of that effort, an operations model was developed to estimate the labor, equipment, and materials needed to operate and maintain the City's SWMS based on the proposed maintenance activities. The model includes staffing and equipment resources, and 22 maintenance activities. Estimated costs and resources needed for each activity were reviewed with City staff to ensure they are as accurate as possible. Based on the inputs provided, the model projects both the staffing levels and equipment needs of the Stormwater Department for the proposed O&M Plan that is detailed in the next section.

6.4 Proposed Operation and Maintenance Plan

This section provides a detailed Operations and Maintenance Plan (Plan) for the City of Sebastian's stormwater infrastructure, and is organized into seven sections and a series of appendices as follows:

Section	How to Use
Section 6.4.1 – Purpose and Goals	Statement of the purpose of the Plan and an overview of the City's goals and objectives from regulatory, environmental, and practical operations perspectives.
Section 6.4.2 – Stormwater Management Organization	Overview of the City's organizational structure, operational responsibilities and funding mechanisms for management of the SWMS.
Section 6.4.3 – Asset Management	Scope and workflow for an asset management system.
Section 6.4.4 – Standard Inspection and Maintenance Protocols	Standard inspection and maintenance protocols, tasks, frequencies, equipment, and materials. Detailed Standard Operating Procedures (SOPs) for common maintenance tasks are included in Appendix H.
Section 6.4.5 - O&M Forms, Logs, and Reporting	Contains the forms and reports necessary to implement asset management strategy. This chapter also includes protocols for data tracking, notifications, and reporting.
Section 6.4.6 – O&M Maintenance Scheduling	Documents the frequencies for inspection and maintenance tasks for several types of BMPs (Best Management Practices) and describes the scheduling for maintenance, both routine and otherwise. This chapter also outlines an adaptive management approach for evaluating and modifying maintenance schedules based on field observations. Where noted, management options are provided for the City's consideration.
Section 6.4.7 – Personnel, Equipment, and Budget Requirements	Budget estimates for the inspection and maintenance of the City's portfolio of BMPs. Budgets include requirements and costs for staffing, equipment, labor, and materials.

6.4.1 Purpose and Goals

This Plan has been developed for the City of Sebastian's consideration for the operation and maintenance of the City's stormwater infrastructure moving forward. The Plan has been carefully designed to fit within the City's budget, address existing problem areas, and provide a reasonable and workable regime for inspection, maintenance, data management, and reporting as well as staffing and budget allocations necessary to operate and maintain the City's SWMS successfully, sustainably, and comply with applicable Federal, State, and local permits and regulations. The Plan is meant to formalize operations and maintenance protocols for the SWMS and is intended for use primarily by the City's Stormwater Department staff tasked with operating the SWMS, but also incorporates support from other City Departments and funding sources. The Plan also serves as a reference for City officials, other City agencies and partners, the development community, and interested members of the public.

The City has many important goals for the operation and management of its stormwater infrastructure, including the following:

- Maintain compliance with all applicable Federal, State, and local permits and regulations.
- Meet all applicable policy goals in the City's Comprehensive Plan.
- Make the stormwater system more resilient and improve performance during larger storm events.

- Improve drainage and reduce recovery times.
- Improve the quality of discharged water, which can improve the water quality of receiving waters and help protect the environment.
- Maintain stormwater fees as low as possible and reduce economic burdens on the City's residents.
- Adjust City codes to complement and support stormwater management goals.
- Improve public education and outreach programs related to stormwater management.

As mentioned previously, the City's SWMS is a complex system of conventional drainage structures, green infrastructure, and a multitude of processes (e.g., pretreatment, conveyance, vegetation control, erosion, dredging, sediment removal, etc.) functioning in a dynamic urban environment that experiences approximately 58 inches of rain per year and occasional intense storm events. These factors place significant stresses on SWMS components, and the performance demands and maintenance requirements on the SWMS are high. Consequently, maintaining the SWMS presents many challenges and must be carefully planned and efficiently executed.

The operation and maintenance of the City's SWMS is further complicated by the fact that a significant portion of the City's roadside swales, critical components of the SWMS conveyance system, are maintained by individual residents. The large number of open channels and other SWMS components that are maintenance-intensive and the limited resources of the City require a carefully planned and executed operations and maintenance program. To that end, this O&M Plan was created to improve the SWMS performance, make the best use of the City's current resources, and provide the City with real options for continued improvement of the management of the City's stormwater infrastructure.

The Plan establishes protocols to ensure the proper function and long-term sustainability of the SWMS. Using an adaptive management approach, the Plan outlines inspection-driven protocols and recurring maintenance tasks, as well as data collection processes and format needed to continually evaluate the costs and needs of the program.

In addition, the Plan defines tasks, processes, equipment, staffing, and budgets, and includes Standard Operating Procedures (SOPs) that can be used by staff to communicate and implement its protocols. Due to the scale and complexity of the SWMS and the need for prompt response to issues, managing the flow of information between the Stormwater Department's field and office staff is essential. The Stormwater Department does not currently have an established asset management system. However, other City departments (i.e. Building Dept) use an asset management program for work order management and record keeping, and the City is considering expanding that program licensing to include the SWMS assets and Stormwater Department records. The Plan establishes forms that can be used in the field (for data collection) and in the office (for reporting, budgeting, and planning) via a software platform that is consistent with other City agencies. This approach allows the City to use data that is continuously collected through the O&M program to inform future decision-making with respect to maintenance strategies and target its investments to optimize performance.

It is important to note that this O&M Plan is not part of the City's NPDES MS4 permit. The standard inspection and maintenance protocols included in this Plan are only recommendations, and deviations from the Plan procedures do not necessarily constitute a violation of the City's NPDES MS4 permit.

6.4.2 Stormwater Management Organization

6.4.2.1 Organizational Structure

As mentioned previously, the City created the Sebastian Stormwater Utility (SU) and gave it the responsibility for the City's stormwater management, with all powers necessary for the exercise of its responsibility for the drainage

from all properties within the City. The City of Sebastian has placed the responsibility for the management of the SU with the Stormwater Department. Funding for the Stormwater Department's administration, O&M costs and capital budgets is generated primarily from Stormwater Utility Fee revenues, with additional revenues from the Discretionary Sales Tax and other sources. The management and funding structure for the SWMS appears very well planned, efficiently organized and with the necessary authority to meet the operational and maintenance challenges. This Plan does not propose any changes to the SU or Stormwater Department organizational structure. However, funding is a significant issue affecting the Stormwater Department, and a detailed analysis and other information related to funding levels necessary for the proper operation and management of the SWMS is included in Section 8 – Funding Plan and Grant Management.

6.4.2.2 Operational Responsibilities

The Stormwater Department is responsible for the maintenance of the SWMS, and currently is assisted by other City departments. There are no proposed changes to the operational responsibilities of the City with respect to SWMS maintenance. Note that the funding analysis in Section 8 assumes that activities currently conducted by other City departments will continue to do so. If the Stormwater Department were to assume all stormwater maintenance activities, the funding analysis would need to be revised accordingly.

6.4.3 Asset Management

6.4.3.1 Scope of Maintenance Asset Management

To ensure a robust, efficient, and cost-effective O&M Plan, various asset data must be stored, collected, and updated as the maintenance of BMPs takes place. During the development of the GIS map for the City's stormwater system, more than 8,500 SWMS assets were identified, located, and applicable data (i.e., asset type, materials of construction, dimensions, invert elevations, etc.) were compiled in the GIS database. This database of assets, including their respective features and any associated inspection and maintenance events, will play a crucial role in determining the life-cycle performance of each individual asset. These assets represent the major conveyance systems within the City's SWMS, but many more may be added in the future as the City's SWMS management efforts expand as the City continues to grow. Due to the sheer number of SWMS assets and the significant amount of data associated with them, a Computerized Maintenance Management System (CMMS) is needed to establish a system of regularly scheduled inspections and maintenance data updates.

The Stormwater Department does not currently have a CMMS but is evaluating available software systems and costs. Due to funding and staffing limitations many inspection and maintenance tasks are scheduled and performed on an as-needed basis, and documentation retrieval processes need improvement. As an interim measure, an MS-Excel based CMMS system is being developed based on the data collected for the GIS map. Proper use and organization of a CMMS will be essential in assuring that information is organized and utilized during the continued growth of the program.

6.4.3.2 Computerized Maintenance Management System (CMMS) Protocols

All inspection and maintenance tasks being performed will be recorded within the CMMS, along with attribute data updates from field surveys or reconstruction/modification of any assets. Inspections and maintenance activities will be scheduled based on preset intervals depending on the asset type and priority level. At the beginning of each workday City staff will generate reports from the CMMS for inspection and maintenance crews for planning daily work schedules. The CMMS report will show all scheduled activities, along with a cross reference to SOP forms that contain the appropriate data for each activity. During mobilization, the crew will review all assigned activities and

SOPs to assess if any specialized equipment or materials will be required. By performing this review, the crew will increase their preparedness and reduce the number of surprises they experience during the workday.

Completion of SOP forms should occur onsite during or immediately following completion of the inspection or maintenance work. By abiding by this practice, the crew can use the SOP form as a checklist to confirm that all requested maintenance tasks were performed and documented. Upon completion of work for the day, the crew will review the CMMS report and all SOP forms for activities that were completed and turn in the completed forms. The data from the forms will then be input into the CMMS system. Non-completed work will be carried out the next day. Significant discrepancies between work completed and work scheduled should be communicated to the City Engineer so that scheduling delays do not compound.

6.4.4 Standard Inspection and Maintenance Protocols

Guidance for standard inspection and maintenance protocols are detailed in this section. Recommended tasks, frequencies, equipment, materials, and other applicable protocols based on SWMS asset type are defined here.

6.4.4.1 Overview of Inspection and Maintenance Protocols

For inspection and maintenance tasks to be carried out efficiently and consistently, protocols have been developed for the most commonly occurring tasks. This section includes a detailed description of those tasks, and the required tools and equipment needed to conduct each of them. This section does not include all potential maintenance protocols. If the need to enact a maintenance protocol not detailed within this chapter arises, proper communication of the task goals and procedures will be required. SOPs have been developed for the most common tasks and are included in Appendix H.

6.4.4.2 List of BMP Asset Categories and Technologies

Detailed descriptions of BMP assets were discussed in Section 4.2. Brief descriptions of each type of BMP asset categories within the City are provided below in Table 6-4. Maintenance protocols for individual assets are typically prescribed based on the asset category.

Table 6-4. BMP Asset Categories

Category	Description
Non-Structural BMPs	These are regulatory or system-wide BMPs that focus on preserving open space, protecting natural systems, and incorporating existing landscape features into a site plan to manage stormwater at its source. Examples of non-structural (not fixed or specific to one location) BMPs include land use planning and public information programs.
Structural BMPs	These are constructed BMPs that help to prevent pollutants in stormwater runoff from leaving a property, entering storm drains, and impacting local waterways. There are thousands of structural BMPs across the City's stormwater system, and include such assets as weirs, dams, catch basins, baffle boxes, and culverts.
Canals	Stormwater assets classified as "canals" include the entire interconnected system of large open channel waterways that run through the City. Altogether, the City maintains over 9 miles of canals, including the Elkcam Waterway, Collier Waterway, Schumann Lake, Hardee Lake, Harbor Pt. Waterway, and Joy Haven Waterway.
Ponds	There are 30 stormwater ponds throughout the City. These include all the ponds located within City parks, as well as the interconnected ponds of the Stormwater Park, and the multiple ponds of the Day Drive Retention Area. Ponds can be retention or detention ponds, and may be part of a larger treatment train with wetland areas or canal systems.
Ditches and Swales	The majority of the stormwater conveyance system is an expansive network of ditches and swales running through back yard, side yard, and along roadways. Control of vegetation and sediment buildup within these BMPs is a constant maintenance task.
Dry Retention	Dry retention areas are located throughout the City and they are areas of lower elevation, which only hold water during periods of heavy rainfall. They are designed to overflow excess water into nearby water features through catch basins and pipes. Keeping dry retention areas vegetated is important to prevent compaction and increasing water infiltration. Too much vegetation can decrease the storage capacity and block the flow of stormwater towards other features.

6.4.4.3 Inspection Protocols for SWMS Assets

It is essential that inspections be conducted consistently and communication between inspectors and other team members be upheld. Inspections can be classified as one of five types: Visual Inspection, Routine Inspection, Post Storm Inspection, Compliance Evaluation Inspection, and State Regulatory Agency Inspection. These types of inspections are explained in Table 6-5.

Table 6-5. Inspection Types

Inspection Type	Description	Applicable BMPs
Visual Inspection	Visual inspection to verify physical and operational condition using a portable camera or vehicle-mounted GPS-enabled digital video camera. Photos and camera footage reviewed by Stormwater Department staff to determine compliance status. Non-compliance issues will be documented and processed according to current City code enforcement procedures.	Grassed swales, culverts, structures.

Table 6-5. Inspection Types

Inspection Type	Description	Applicable BMPs
Routine Inspection	Visual inspections and maintenance of stormwater management devices shall be conducted on a regular basis to discover conditions that could cause drainage issues resulting in localized flooding or discharges of potential pollutants to surface waters, and to ensure that appropriate stormwater control measures are in place (housekeeping, BMPs, structural controls, etc.). City staff will inspect SWMS components, document all inspections on appropriate forms, and track results of inspections to ensure that appropriate actions are taken. Inspection records will note all observations (color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious pollution indicators), including SWMS component ID, inspection date/time, inspector name, problems found, and steps to correct any problems, including who has been notified.	All BMP Types.
Post Storm (Supplemental) Inspection	City staff will conduct a visual post-rain inspection within 24 hours of a rain event of one inch or greater. The purpose of the inspection is to identify areas of standing water or other drainage issues due to the storm.	All BMP Types.
Compliance Evaluation Inspection	Annual inspection led by City Engineer to review documentation of training performed, inspections completed, maintenance activities performed, CMMS data completeness, and annual outfall evaluation for unauthorized discharges. This inspection will also confirm that all records required to be maintained as a condition of the NPDES MS4 Permit are being correctly completed, recorded, and are available for inspection.	All BMP Types.
State Regulatory Agency Inspection	FDEP representative may enter during normal business hours, or when stormwater discharges are occurring, to review all records maintained as a condition of the NPDES MS4 Permit; Inspect the facility, equipment, practices, or operations related to the Permit; or Monitor stormwater to ensure compliance with this Permit. A City representative will always escort the FDEP representative during the inspection. If at any time the FDEP representative takes photographs, the City representative will take a photograph as well.	All BMP Types.

6.4.4.4 Inspection Frequencies and Protocols

Inspection frequency is dependent on BMP ownership, maturation level, and inspection type as described in the following subsections. As sites mature, required inspection frequencies may be reduced per the adaptive management plan.

BMPs within Public ROW or Drainage Easements

BMPs located within the public right-of-way are typically subjected to a significant amount of stormwater loading, resulting in the need for continued inspection and maintenance to assure its function. Routine inspections of these SWMS components are typically recommended to be conducted monthly regardless of BMP type. However, the City considers the front yard swales and driveway culverts privately-owned BMPs and do not currently conduct regular inspections of them. This results in a significant portion of the drainage infrastructure within the City being highly susceptible to failure due to lack of maintenance, which has been a documented historical problem. The City is evaluating options for improving code compliance related to these BMPs, and in conjunction with that compliance effort, and because of the critical nature of these BMPs, it is recommended that the City implement a minimal visual inspection program for them. Due to the seasonal rain patterns and the City's limitations of funding and resources, these inspections are recommended twice per year, in May before the rainy season begins and in November after it ends. Additional inspections would also be made upon a resident complaint.

For public BMPs within public right-of-way or drainage easements, routine inspections and maintenance will be performed as shown in Table 6-6 below.

Private BMPs

Privately owned BMPs not in a public right-of-way generally experience less disturbance than their publicly owned counterparts. For this reason, expected inspection and maintenance frequencies are lower by comparison. Routine inspections are typically recommended to be conducted seasonally at a minimum, but the City only inspects privately-owned BMPs if there is a permit enforcement issue. However, ensuring that privately-owned BMPs are properly operated and maintained is very important, as they typically discharge into the City's SWMS. For this reason, it is recommended that the City establish a program for certification of all privately-owned stormwater systems. Such a program may include:

- A certification fee, additional revenue to the City's Stormwater Department to offset processing costs.
- An annual inspection report by a Florida-licensed professional engineer and accompanying digital time-stamped photographs.
- A certification form, signed and sealed by a Florida-licensed professional engineer documenting that the system is properly maintained and operating as designed and permitted.
- The City has a certification program in its existing Stormwater Fee Credit program for private systems exceeding SJRWMD standards, which could easily be incorporated.

Post-Storm Inspections

A post storm inspection is recommended to be done after a storm greater or equal to one inch of precipitation.

Other Inspections

Site Compliance Evaluation and State Regulatory Agency inspections are performed as needed.

Routine Maintenance Activities for SWMS Assets

Table 6-3 in Section 6.3.3 described the current SWMS maintenance activities, who is responsible for them and how often they are performed. This information was compared to published sources (i.e., USEPA, etc.), industry standards, and our experience with Florida stormwater systems to determine the appropriate activities, schedule, and resources needed to effectively maintain the City's SWMS and, where possible, to address identified problem areas.

The City's Stormwater Department is conducting most of the maintenance activities needed for the SWMS and appears to be doing a good job with the resources they have available. Unfortunately, the City's SWMS is very

challenging to operate and maintain, and the funding, staffing, and equipment resources will have to increase from current levels in order to properly maintain the system, document maintenance activities, and shift from a reactive to a proactive style of management. Addressing the many challenges presented has been a long and complex process; Arcadis has expended much time and effort carefully analyzing and modeling the SWMS, the Stormwater Department operations, funding sources, capital projects, reviewing hundreds of previous reports, plans, and documents, and conducting many meetings and discussions with City staff to generate the proposed Plan.

The Plan provides a roadmap to a more proactive method of managing the SWMS now, while also planning for additional resources in the future to improve operations and maintenance and optimize its performance. The routine maintenance activities included in the Plan are included in Table 6-6 below and represent the minimum maintenance activities that should be performed to keep the SWMS in proper physical and operational condition. The table presents the activity, a brief description, the responsible entity (RE), recommended frequency, and notes. SOPs with more detailed procedures that are intended for use by City staff during these maintenance activities are included in Appendix G.

In accordance with the City's IPM Plan, all City employees who, within the scope of their duties, direct maintenance activities on the stormwater system will be trained in the City's IPM Policies. A certification course on Green Business Best Management Practices will be provided through partnership with the University of Florida Indian River County Extension Office as needed. Stormwater and Public Works staff also receive certification training on Sediment and Erosion Control. The training sessions are coordinated by the Human Resources Director, who will track employees' attendance and ensure that City field staff holds an active certification. Licensed Applicators. At this time, City staff will not be applying any herbicides on the surface of, or within ten feet of aquatic areas. All aquatic herbicide applications will be performed by a State licensed contractor.

Where planned management methods need to change from existing ones and to address identified problem areas, management options are provided for the City's consideration.

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Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
1	Clerical Support	Support Staff	City	NA	Included in 2023 SW Dept. budget. Additional SW Dept staff to increase administrative and documentation effort, especially CMMS data management.
2	Front Yard Swale and Driveway Culvert	Drive-By Visual Inspection	City	Semiannual	The City does not currently conduct routine inspections of the front yard swales and driveway culverts. This inspection would be a simple drive-by visual inspection with a GPS-enabled camera to allow City staff to identify problem areas and begin the correction process early. Would be done in May and November, before and after hurricane season.
3	Front Yard Swale and Driveway Culvert and Citizen Request Response	Routine Visual Inspection and Maintenance	Property Owner	As Needed or by CR	Maintenance issues with front yard swales and driveway culverts are widespread and have been a historical problem area in the management of the SWMS. The current management method has not resulted in the correction of drainage issues quickly or consistently. Resident compliance with City codes associated with the maintenance of the front yard swales is a difficult issue, and one common to municipal stormwater systems. The level and methods of compliance enforcement is a policy decision for the City to make. The City is currently evaluating potential policy changes to improve code compliance. No official changes have yet been adopted, therefore, this report assumes no change from current practices. The SW Dept spends an estimated $51,000 per year on labor addressing CRs, about 24 hours of staff time per week.
4	Front Yard Swale	Quarter Round Cleaning	City		As a pilot program several years ago, the City installed “quarter round” (PVC pipe quarters) in the bottom of approximately 3,505 roadside swales in many areas to improve the drainage characteristics of the swales. The program was discontinued in 2019, but the quarter round sections were not removed. The City continues to perform regular cleaning (weedeating, edging and removal of all debris) of the installed quarter rounds on approximately 490 lots. This activity costs the City an estimated $132,000 per year, is very labor intensive, and is of marginal value to the operation of the SWMS. Consider removing the Quarter Round systems during future activities to reduce maintenance costs.

Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
5	Inlet Structure	Visual Inspection	City	10/year	No change
6	Inlet Structure and Conveyance Piping	Routine Inspection and Maintenance	City	Annual	Increase frequency to annual - current frequency is As Needed or in response to CR. Inlet structures and associated conveyance piping should be cleaned annually in Florida. There are approximately 320 inlets in the SWMS, City staff reported that typically only one can be cleaned per day. Increasing the maintenance frequency should reduce the average sediment loadings in these structures and increase the cleaning rate and work efficiency.
7	Road Crossing Culvert	Visual Inspection	City	Annual	Increase frequency to annual - visual inspection to identify and prioritize culverts for routine maintenance.
8	Road Crossing Culvert	Routine Inspection and Maintenance	City	20% per year	Change maintenance frequency so all culverts are cleaned every 5 years. The SWMS has approximately 1,300 road crossing culverts. The City currently cleans about 50 per year, this would increase to about 260 per year.
9	Road Crossing Culvert	Slip Lining	City	As Needed	City contractor performs sliplining of existing culverts rather than the City replacing them to minimize cost and disturbance. About $60k per year budgeted.
10	Baffle Box	Routine Inspection and Maintenance	City	Quarterly	No change proposed. City has 8 of these, each takes approximately four hours to clean.
11	Side Yard Ditch	Mowing	City	Quarterly	No change proposed. City has a 10’ easement area, mowed by City contractor. See Section 9.2 for discussion of adjustment of City codes.
12	Side Yard Ditch	Sediment Removal and Regrading	City	10% per year	Grassed swales and open channels should be on a 10-year regrading schedule.
13	Back Yard Ditch	Mowing	City	Quarterly	No change proposed. The City has a 20-foot drainage ROW from the back property line of each parcel abutting a back yard ditch for maintenance access. Back yard ditches are maintained by the City’s contract mowing vendor.

Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
14	Back Yard Ditch	Sediment Removal and Regrading	City	10% per year	Approximately 1,400 LF/day currently. Grassed swales and open channels should be on a 10-year regrading schedule.
15	Back Yard & Side Yard Ditch	Visual and Mowing Inspection	City	Quarterly	Expand existing inspection to be a visual inspection with documentation of back yard and side yard ditch conditions and verification of the City's contract mowing vendor's work.
16	Driveway Culvert	Repair During Road Repaving	City	As Needed	The City removes and replaces a section of the driveway and the driveway culvert in conjunction with road paving. Approximately 30 per year.
17	Retention and Detention Ponds	Visual Inspection	City	Quarterly	The City has 30 ponds that are inspected each quarter.
18	Retention and Detention Ponds	Inspection and Maintenance	City & Private	Monthly	No change proposed. The SW Dept mows the Schumann Dr. retention pond, Parks Dept mows others. Private owners maintain private ponds.
19	Stormwater Park	Pump Operation	City	Automatic	Optimize pump controls and operation to minimize SW Dept labor for this activity. Consider adding a smaller pump (perhaps solar powered) that will circulate a constant flow of water through the Stormwater Park and a shift to automatic control of the existing large pumps. The automatic control of the existing large pumps would need to be reviewed and optimized to operate only during large wet weather events based on the water levels in the Collier Central Waterway. Additional monthly electrical costs are not included in cost estimates for this item.
20	Stormwater Park	Mowing	City	Monthly	SW Dept mows the Stormwater Park once per month. Parks Dept also mows it once per month.
21	Stormwater Park	Mowing	City	Annual	City contractor mows once per year, as requested by the City.
22	Public Works Compound	Mowing	City	Monthly	SW Dept mows once per month. Parks Dept also mows it once per month.

Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
23	Dams and Weirs	Inspection and Maintenance	City	Semiannual	Change frequency to semiannual. The SWMS has two dams (Concha and Hardee) controlling discharge from the canals and one weir (Stonecrop) regulating discharge from the SWMS.
24	Canals	Inspection and Maintenance	City	Semiannual	The City has a 100' drainage ROW over the canals and performed maintenance dredging in the Collier Canal area in 2006. No other maintenance dredging has been performed. Significant sediment loading and shoaling in some areas was observed during field inspections. Aquatic weed control is performed by a City contractor in accordance with the City's IPM Plan.
25	Canal Side Slopes	Visual Inspection	City	Semiannual	Conduct semiannual visual inspections (in May and November) of canal banks and only those bulkheads that the City maintains to identify erosion or structural damage that needs to be addressed. Approximately 35% of parcels abutting canals have no seawall or other slope protection. There are 756 bulkheads along the banks of City's canals. 20 are within the City ROW and City owned and maintained. Bulkheads located outside the drainage easement on private property are not maintained by the City. Physical inspections were performed in 2022 and many of the bulkheads were in fair or poor condition. More than 200 are structurally failing and in need of immediate replacement.
26	Offsite Drainage Areas	Visual Inspections and Coordination with SJRWMD	City/SJRWMD and Private	Semiannual	Change to SW Dept staff conducting semiannual inspections of offsite drainage areas (in May and November) and document conditions of drainage paths from the City's system that are privately owned and the City does not have a drainage easement. Lack of maintenance in offsite drainage paths reduces discharge capacity from the City's system, resulting in elevated water surface elevations and localized flooding conditions during larger storm events. Maintenance of these areas in enforced by the SJRWMD via ERP permit requirements for the private developments. Coordinate with SJRWMD staff as needed to enforce maintenance requirements.

Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
27	Hurricane Preparation	Securing Buildings, Moving Equipment, Etc.	City	As Needed	No change proposed.
28	Post-Storm Inspection	System-Wide Visual Inspection	City	10x/Year	No change proposed. Inspection occurs only after hurricanes and large storm events.
29	Hurricane Recovery	Debris Cleanup	City	As Needed	No change proposed. Approximately 2 weeks after hurricane
30	Sidewalk Repair	Assist Public Works	City	As Needed	This activity is not related to the SWMS and does not appear to be a good use of very limited SW Dept. staff labor and should be removed. One option would be for the City to have an on-call contract for sidewalk repair/replacement rather than using City labor.
31	Side Yard and Back Yard Ditch	Plan Review	City	As Needed	Side slopes for septic system mounds and house foundations are sometimes extending into side yard swales. For developed properties, evaluate side slopes and shift swale within easement area if possible to restore original swale cross section and flow capacity. Obtain additional easement area, if necessary. For new construction, strictly enforce City Codes and deny all construction permits where septic mound or foundation pad side slopes interfere with side yard swale side slopes or longitudinal grades.

Table 6-6. Routine SWMS Maintenance Activities

Activity No.	Activity or SWMS Component	Description	Responsible Entity	Frequency	Maintenance Activities and Notes
32	Private stormwater systems discharging into City SWMS	Private System Certification Program	City & Property Owner	Annual	The City performs no maintenance or inspections of private systems. As part of the existing Stormwater Fee credit program the City has a certification program to ensure private systems are maintained, but it only applies to private systems that exceed SJRWMD design standards. Private systems that do not exceed SJRWMD design standards do not provide inspection or maintenance information to the City. This makes them susceptible to failure if not properly maintained and could also adversely affect the City's SWMS. Consider establishing a certification program (an expansion of the existing program) requiring all owners of private systems to submit a certification form signed and sealed by a Florida PE or Architect stating that its system is being properly maintained and operated, along with date stamped digital photographs. The City can charge a fee for the certification to generate additional revenue and the program would effectively leverage private entities to perform required maintenance and provide visual inspection information that can be entered into the City's CMMS system.

6.4.4.5 Non-Routine and Corrective Maintenance Protocols for SWMS Assets

Inspectors and maintenance crews should remain vigilant in diagnosing maintenance deficiencies and SWMS needs. If these types of items are identified, the inspector must make a judgement call to determine the proper course of action. If at any time the inspector is unsure of how to classify an identified issue not outlined within the O&M Plan, the City Engineer should be contacted for direction. These issues can be classified as either a non-routine maintenance task or corrective maintenance depending on their severity and the amount of work and coordination required to perform the task.

6.4.4.5.1 Non-Routine Tasks

Non-routine tasks are items that are not explicitly defined in the previous section but can be carried out during routine maintenance events without requiring specialized labor or equipment. Sufficient lead time should be provided to the maintenance crew to allow for proper preparation and procurement of materials. As with any maintenance activity, all work should be properly documented so that the attribute data in the CMMS is updated correctly and accurately.

6.4.4.5.2 Corrective Maintenance Actions

Corrective maintenance is defined as maintenance tasks that require significant effort or specialized labor or equipment to address. All members of the maintenance team, or even community members, can identify potential corrective maintenance tasks, whether through notes in work orders, or direct communication with City staff. Inspection work orders contain issue identification built into the work order. This is done to encourage inspectors to think about what types of issues may result in corrective maintenance action.

Regardless of its source, once issues that require corrective maintenance are identified, they will be elevated to the City Engineer who will decide how to address the issue. Corrective maintenance varies widely in cost and complexity. Less intensive corrective maintenance may require minor coordination between maintenance crews and other members of the maintenance team. More involved corrective maintenance may need to be added to the City's Capital Improvement Program. A well-defined project scope, schedule and estimated cost should be determined by the City Engineer as part of the corrective maintenance planning process.

Examples of corrective maintenance may include, but are not limited to, structural damage to SWMP components, grading issues, major reconstruction or repair work, or design issues affecting performance that are not correctable through routine maintenance. It is important that recurring issues are reported to the City Engineer rather than repeatedly deferred to corrective maintenance. Recurring issues may be indicative of other issues that cannot be fixed through corrective maintenance and may require a more thorough analysis.

Prioritizing Corrective Maintenance

Upon identifying a corrective maintenance need, the project priority should be discussed and decided upon by the City Engineer. Issues that without corrective maintenance pose a safety hazard or create a condition that prohibits the proper function of the SWMS should be prioritized over aesthetic or preventative tasks. The amount of time required to address corrective maintenance issues ranges from a few days to months depending on the severity, complexity, and priority of the issue. In certain more complex emergency cases, temporary resolutions should be presented as a stop-gap measure to address public safety or functional issues while a more permanent resolution is determined.

Priority ranking uses a simple calculation to weight the importance of a proposed corrective maintenance action based on multiple criteria. For each criteria, a weight (%) and importance score (1-5) is selected and a weighted ranking is calculated to determine its priority. For example, if a 40 foot long, 15-inch diameter culvert collapsed

and was backing up water into a grassed swale becoming a nuisance for 20 houses, the priority ranking calculation might be as follows:

Criteria	Weight (%)	Importance (1-5)	Weighted Score (A x B)	Notes/Examples
Public Safety/ Damage Hazard	30	3	0.3	1= No Hazard 5= Localized road flooding creating hazardous driving conditions
Area Affected	20	2	0.4	1= <10 properties 5= >100 properties
Correction Scope	20	3	0.6	1= Simple 5= Requires Engineering
Correction Cost	20	3	0.6	1= <$5,000 5= >$1M
Correction Schedule	10	3	0.3	1= <30 days to correct 5= >180 days to correct
Totals	**100**	**Priority Score**	**2.2**	

The priority ranking score can be interpreted as follows:

- Score of 1 = No impact - not a significant issue.
- Score of 2 = Minimal impact – issue easily addressed.
- Score of 3 = Moderate impact - causes some issues but can be addressed.
- Score of 4 = High impact – safety hazard and/or potential damage, difficult to address
- Score of 5 = Catastrophic impact – significant safety hazard and/or property damage.

For the example above, a priority ranking score of 2.2 would be Minimal Impact, issue easily addressed. Typical responses based on the priority ranking are presented below.

Priority Ranking	Response
1-1.99	Issue should be addressed during the next Routine Inspection.
2-2.99	Issue should be addressed before the next rainfall event.
3-3.99	Issue should be addressed as soon as possible before the next rainfall event.
4-5.00	Safety/Damage Issue - Immediate Repair or Action is required.

6.4.4.6 Recommended Maintenance Frequency Based on Service Level

Recommended maintenance frequency represents a balance between providing enough maintenance to encourage proper functioning of SWMS components and available funding. This plan provides an adaptive approach to maintenance frequency, focusing expenditures based on those SWMS components that have the largest performance effects on the City's system. The inspection and maintenance frequencies presented in this

Plan should be regularly reviewed and changed to fit current system priorities and funding levels. Recommended frequencies for specific maintenance tasks are presented in Table 6-6.

6.4.4.7 Preventative Functional Maintenance

During inspections and maintenance activities, City employees are expected to not only determine what issues are currently affecting a SWMS component, but also to look for and report signs of future issues. By identifying these issues early, the City Engineer can plan and execute preventative measures to prevent functional issues or reduce the cost required to remedy them. Depending on the severity and type of issues identified, preventative functional maintenance tasks may be included in future routine maintenance work orders as notes or may result in the creation of a corrective maintenance work order.

6.4.4.8 Aesthetic Maintenance

The City of Sebastian is a tourist destination, and as such proper aesthetic maintenance of SWMS components is one of the primary goals of the O&M Plan. By maintaining the proper aesthetics, the surrounding community will be more likely to have a positive perception of the SWMS and the City as a whole. Overgrown vegetation, defaced surfaces, and damaged components should be reported as aesthetic issues and handled by maintenance staff. Work orders specific to addressing aesthetic concerns, outside of the recurring schedule may be generated by the City at any time or upon receiving community feedback. However, the priority for addressing aesthetic issues must be carefully considered due to Stormwater Department staff availability and funding limitations.

6.4.5 O&M Forms, Logs, and Reporting

This section explains the template inspection forms, maintenance forms, and reports necessary to implement the asset management strategy. This section also includes protocols for data tracking, notifications, coordination with other agencies, and reporting safety hazards.

6.4.5.1 Requirements for Tracking and Reporting Inspections and Maintenance

The City is required to provide a semiannual report for the preceding six-month period to FDEP on January 30 and July 30 of each year. This report is required to include the status of any construction or compliance measures, completion of milestones, and problems encountered (or anticipated) - along with implemented (or proposed) solutions. The report also must include the status of permit applications, O&M information, and additional reports provided to other state agencies. Most of these items are beyond the scope of the Plan and are not discussed in detail in this document. This section focuses on reporting requirements related to proper O&M of built SWMS assets, typical problems encountered, and potential solutions.

Section 6.3.4 describes corrective maintenance as maintenance tasks that require significant effort or specialized labor or equipment to address. The status of corrective maintenance projects will be provided as part of the City's Semi-annual Report. For the purposes of reporting, corrective maintenance will be placed into one of three categories:

- Need for corrective maintenance identified,
- Corrective maintenance solution proposed, and
- Corrective action taken.

Reporting will include the status of the project and, depending on that status, a brief written summary of the observed issue and any recommended or performed corrections. Once a resolution has been reached and documented in CMMS further reporting related to the issue will not be provided unless the issue resurfaces.

6.4.5.2 Overview of Inspection and Maintenance Reporting, Data Management, and Forms

Maintenance Reporting and Data Management

Most data used to support the performance of O&M tasks is collected through a CMMS. The use of a CMMS system allows all pertinent O&M data to be stored within a single centralized repository. As mentioned previously, the City does not currently have a CMMS but is evaluating available software systems and costs. As an interim measure, an MS-Excel based CMMS system is being developed based on the data collected for the GIS map.

The interim CMMS will generate a daily work order report, which will show a list of all SWMS activities that are due for completion based on the established schedule. The CMMS will limit the number of activities assigned on the daily work order report to what can be reasonably accomplished in a normal workday by available maintenance personnel. In addition, the CMMS will have the capability to generate an emergency work order for a single activity independent of schedule or priority.

The work order report fields will be specifically designed to provide field crews with a concise listing of work needed, with all necessary information (i.e., SWMS component type, location, and cross-referenced SOPs). The work order reports and associated SOP forms can then be combined into a daily work order package, which will then be turned in at the end of each workday and the data entered into the CMMS.

Inspection and Maintenance SOP Forms

Standard forms for inspection of SWMS assets and routine and corrective maintenance SOPs for each asset type are included in Appendix G. The SOPs contain inspection details, checklists, and background information about the asset necessary to perform and document the work. The last page of each SOP is a Record of Service Form that contains the data fields that the City field crews will complete during an activity.

6.4.5.3 Notifications

The City Engineer or designated City staff member will provide the Stormwater Superintendent with the Work Order Report (along with applicable SOPs), who will in turn notify work crews and individual team members about upcoming maintenance and inspection activities. Work orders for inspections are generated based on recurrence intervals dictated by the adaptive management status of the asset, which can be easily changed as needed in the CMMS. Work orders for maintenance can be generated based on the result of routine inspections or minimum recurrence intervals as noted in the adaptive management plan.

Work Order Reports are not only used to assign work to crews as discussed above. Completed reports and SOP documentation will be provided to the City Engineer daily for input into the CMMS and to summarize work completed during the previous workday and flag any issues identified by the inspection and maintenance crews.

6.4.5.4 Coordination with Other Agencies

Coordination with other agencies such as the FDEP, SJRWMD, and others is critical to the success of the O&M program. Encouraging lasting relationships between agencies will create a sense of community and stewardship centered around the BMP assets. The City can champion this stewardship by remaining responsive to requests set forth by other agencies and community members and through the implementation of a proactive O&M program.

Throughout the life of the program, opportunities for partnership with other agencies may arise to accomplish program goals. As part of these partnerships, a memorandum of understanding between all associated agencies should be developed detailing the O&M responsibilities of each party.

6.4.5.5 Reporting Safety Hazards

Safety of workers and the public is a key element of the program. Promoting a safe environment is the duty of everyone – from City maintenance crews to individual community members. If a safety issue related to a SWMS asset is observed by an inspector or maintenance crew, it should be reported immediately to the City Engineer. The reporting person or crew should remain on site while the issue is resolved so long as there is no immediate danger. Identification of safety issues by inspection and maintenance personnel should not be limited to SWMS assets. If unsafe site conditions are identified or public safety issues are observed related to other City assets, they should be reported to the City Engineer or designated City staff member.

Safety issues with a SWMS asset reported by community members should be communicated to the City Engineer or designated City staff member. Once identified, the City Engineer should create emergency inspection or maintenance work orders or take other measures as appropriate.

6.4.5.6 Completion of Standard Inspection and Maintenance Forms

The final step required for any work activity is the completion of the hard copy SOP data collection form. The SOP form is then turned in to the City Engineer or designated City staff member so the CMMS database can be updated. When the CMMS asset data is updated with the completion date on the SOP form, then the activity is considered complete and will not appear on subsequent CMMS pending activity reports. Completed SOP forms are considered data points for the purpose of reporting and are to be kept on file with the City for a minimum of three years in accordance with USEPA recordkeeping requirements and City document storage policy.

6.4.6 O&M Schedules

Recurring maintenance frequencies for inspection and maintenance tasks for several types of BMPs, as well as workflows for inspection-driven maintenance activities are documented in this section. This chapter also outlines an adaptive management approach for evaluating and modifying maintenance schedules based on field observations. On occasion, sites will require maintenance outside of the recurring schedule. This need is facilitated by a site requiring emergency, corrective, or reactive maintenance.

6.4.6.1 Scheduling Routine Inspection and Maintenance

Keeping a well-organized schedule will allow the City to assure that their SWMS assets are maintained frequently and that crew members maintain a consistent workload. The schedule consists of two major elements, which are explained in detail below.

6.4.6.2 Recurring Schedule

The recurring schedule encompasses all routine inspection and maintenance tasks. Upon establishing a recurring schedule, assets will be visited in the same order over a set time interval. The recurrence interval for maintenance activities varies depending on both the activity and the asset type. Therefore, the CMMS will be set up to allow for up to four recurring maintenance activities to be schedule for each asset. The specific routine tasks that are carried out during each recurring activity will be defined by the activity and its associated SOP form.

6.4.6.3 Adjustments to Recurring Schedule and Adaptive Management

The activity types and recurrence intervals for each asset are established when the asset is added into the CMMS database. Tasks performed during these scheduled activities are based on asset-specific requirements, which are detailed in the SOPs. Both the frequency of routine visits and what tasks are performed during these visits can be changed based on operational experience, staff or funding limitations, or other reasons, which can result in

adjustments to the recurring schedule and possibly the SOP. However, such schedule adjustments cannot result in a recurrence interval that is below required minimum inspection or maintenance intervals for the asset type.

6.4.6.4 Scheduling Inspection-Driven Maintenance

Depending on the extent of the work, inspection-driven maintenance can occasionally be incorporated into a previously scheduled routine event without disrupting the remaining recurring schedule. Such additional inspection-driven work performed can be easily documented in the SOP forms and the CMMS activity notes. Certain inspection-driven events may include work that will require immediate action, additional time spent on site, or the use of specialized materials or equipment. In these cases, an additional event will be required and will be scheduled by the City Engineer.

6.4.6.5 Weather and Other Conflicts

If weather conditions do not allow for work or other conflicts arise resulting in the inability to perform work, the recurring schedule will need to be adjusted accordingly. If weather conditions do not allow for work or other conflicts arise resulting in the inability to perform work, the maintenance activity schedule will need to be adjusted accordingly. Cancellation of work for the day for whatever circumstance will be at the discretion of the City Engineer. Typically, if the delay is only a day or two the schedule can be shifted, and all work can still be completed within the month. However, if there are significant delays, the City Engineer may want to consider cancelling the lowest priority work orders to allow the crew to catch up to the original schedule.

6.4.6.6 Unscheduled Maintenance

Unscheduled maintenance is typically classified as either emergency maintenance or corrective maintenance. Both types of maintenance are outside of the recurring maintenance schedule, but the CMMS allows for unscheduled activities to be initiated by individual work orders and recorded when completed without affecting the recurring activities schedule. Since emergency maintenance often occurs as the result of an unsafe condition or a malfunctioning SWMS component, some recurring scheduled activities may need to be delayed to accommodate the higher priority emergency work, if sufficient float in the daily work schedule is not available. Corrective maintenance, which is often not as high of a priority as emergency maintenance, can be scheduled at the end of the month between recurring schedule cycles. The individual work orders for these activities will simply remain open until the activity is completed and recorded in the CMMS. In this way, the City can accrue a backlog of corrective maintenance work orders which can be performed during the dry season, or when workload permits.

6.4.6.7 Inspection Follow-up Protocols

Inspections sometimes result in the identification of additional maintenance tasks to be performed during upcoming routine maintenance events. Any additional work needed for an asset in an upcoming scheduled activity can be added as a note on the particular asset record in the CMMS asset database. Individual work orders will include such notes and other specific instructions relating to these identified issues or maintenance tasks. It is crucial that CMMS administration and inspection/maintenance personnel are in communication with each other consistently. This applies to verbal communication, communication written within work orders, and communication about schedule.

6.4.6.8 Documenting and Reporting Problems

One of the primary goals of inspectors is to identify issues with the BMPs they are inspecting and suggest potential solutions to these issues. When an inspector identifies an issue, they should first consider the safety implications of the issue both in terms of completing the inspection as well as others who may be interacting with

the BMP once the inspector is offsite. If a safety issue is identified, the inspector should immediately report it to the City Engineer. Safety issues should always be noted as high priority on a work order to allow for the rapid resolution of the issue and minimization of the safety risk. Inspectors should use the work order documentation as a tool for disseminating information to the rest of the Stormwater Department. Inspectors should not overly rely on work order documentation as their only line of communication, especially for issues that may pose safety risks, result in major repairs, or require specialized tools. Inspectors should strive to make sure issues they are identifying are being resolved in the most effective and efficient way.

Any inspector notes on a maintenance activity for a particular asset will be inherited by the upcoming maintenance work order for that asset. On the asset SOP documentation, the inspector can request a new individual work order be created for corrective or emergency maintenance. If either of these options are selected, the inspector should notify the City Engineer that an individual work order for a follow-up activity is needed. If for any reason the inspector is unsure if a new work order should be generated, the City Engineer should be contacted.

6.4.6.9 Initiating Corrective Maintenance

Corrective maintenance is initiated through the issuance of an individual work order in CMMS. A work order will be generated upon identification of the need for corrective maintenance; however, it will remain unassigned to a crew until additional details are provided and it is manually assigned. The City Engineer and Stormwater Superintendent should discuss the corrective maintenance request and define a plan for completing the work. Certain corrective maintenance tasks that do not require additional coordination may be assigned immediately by the Stormwater Superintendent. Other types of corrective maintenance actions may require additional visits to the site or consultation with design engineers or other experts. Once a plan has been defined, the work order can then be assigned, and the work completed with the necessary oversight. It is not common for some larger corrective maintenance tasks to take several maintenance cycles to plan for and mobilize, making it especially important for the inspector to identify and communicate the issue quickly and effectively.

6.4.6.10 Adding New Assets to the Schedule

As the City's SWMS grows, new assets will be entered into the maintenance program, and will therefore need to be added to the CMMS asset database and the recurring activity schedule established. New assets should be added to the CMMS asset database as soon as possible after they are installed or accepted for maintenance by the City, and then it will begin appearing on the Work Order Report as soon as it is due for a maintenance activity. During future schedule cycles, the City Engineer may adjust asset maintenance schedules to accommodate new assets most effectively. Periodically reordering the asset maintenance schedules may result in an increase in program efficiency.

6.4.6.11 Scheduling Capital Replacements

As SWMS assets near the end of their design life or system issues develop beyond the scope of corrective maintenance, these systems will be identified as needing replacement or major reconstruction and will be added to the Capital Improvement Program (CIP). CIP projects associated with end of design life will be scheduled as part of a long-term asset replacement plan by the City Engineer based on system life cycles and scheduled accordingly to minimize system downtime. As assets are replaced or reconstructed, their attribute data in the CMMS asset database will be updated, which will in turn be used to update the City's SWMS GIS database.

6.4.7 Personnel, Equipment, and Budget Needs

This section includes budget estimates for the inspection and maintenance of the City's current portfolio of SWMS assets. Budgets include staffing requirements (for operations as well as management), and a breakdown of equipment, labor, and materials costs.

6.4.7.1 O&M Cost Model

An MS Excel spreadsheet model was developed to estimate the total annual cost (i.e., labor, equipment, fuel, materials, etc.) of each activity required to maintain the City's SWMS and the number of employees needed at each grade for proper staffing. Based on discussions with City staff, 22 SWMS maintenance activities were identified with the typical labor and equipment used to perform each activity. Hourly cost rates for personnel, actual cost rates for materials, and hourly costs for equipment operation was calculated to provide an annual per activity cost. The model also compared the total available staffing hours to calculated annual totals to determine minimum staffing levels to complete the proposed annual activities.

6.4.7.2 Personnel and Equipment Requirements

Based on the O&M Cost Model calculations, the minimum labor effort required by City personnel (not including City administrative personnel) to maintain the current portfolio of BMPs in the SWMS is estimated at 36,778 hours. A summary of the labor hours by position is provided in Table 6-7 below. A breakdown of the equipment needs for the current portfolio of BMPs is provided in Table 6-8.

Table 6-7. O&M Cost Model Staffing Summary

Labor Positions	No. FTE on SWD Staff	No. FTE on RD Staff	Total Current Staff	Total Available Hours	Total Planned Hours	Difference	FTE Staff Adjustments	Total Planned Staff
Stormwater Superintendent	1		1	1,992	1,853	139	0.0	1.00
Asst. Superintendent		0	0	0	0	0	0.0	0.00
Stormwater Utility Inspector	0.25		0.25	498	179	319	0.0	0.25
Maintenance III	3	0	3	5,976	10,727	-4,751	3.0	6.00
Maintenance II	1	0	1	1,992	9,660	-7,668	4.0	5.00
Maintenance I	4	0	4	7,968	13,363	-5,395	3.0	7.00
Clerical Support P/T	0.5		0.5	996	996	0	0.0	0.50
TOTALS	**10**	**0**	**10**	**19,422**	**36,778**	**-17,356**	**10.0**	**19.75**

Table 6-8. O&M Equipment Summary

Activity	Estimated Cost Per Hour	Annual Usage Hours	Annual Cost
601 - 2016 CHEVROLET 2500 4WD	$2.68	210	$563.18
603 - 2015 FORD F250 4WD	$2.58	1,424	$3,675.09
604 - 2018 FREIGHTLINER DUMPTRUCK	$12.51	330	$4,127.07
605 - 2018 FREIGHTLINER DUMPTRUCK	$12.95	1,992	$25,790.00
606 - 2005 CHEVROLET 3500 UTILITY TRUCK	$2.49	996	$2,483.69
607 - 2007 STERLING BRUSH TRUCK	$13.83	996	$13,775.00
608 - 2015 FORD F550 DUMP TRUCK	$2.88	1,513	$4,358.58
614 - 2006 CHEVROLET SILVERADO 4WD	$2.44	1,494	$3,641.06
616 - 2001 CHEVROLET 1500	$1.87	843	$1,572.81
620 - 2016 INT. VAC-TRUCK	$12.62	2,637	$33,276.90
632 - 2013 CHEVROLET 3500	$2.67	1,248	$3,337.21
633 - 2019 FORD F 150 TRUCK 4WD	$1.92	960	$1,838.93
649 - 2022 FREIGHTLINER SEMI TRACTOR	$12.22	2,088	$25,523.49
677 - 2014 FORD F350	$2.36	360	$850.30
621 - 2014 BOBCAT EXCAVATOR E42	$21.81	330	$7,196.36
622 - 2020 311 CAT EXCAVATOR	$42.74	1,992	$85,146.28
642 - 2020 KUBOTA TRACTOR	$21.29	960	$20,435.64
643 - FRT LOADER MOUNTED TO SW 642	$10.00	0	$0.00
678 - 2014 JOHN DEERE 410K BACKHOE	$12.03	4,592	$55,238.49
686 - 2013 CAT M313D EXCAVATOR	$41.92	1,297	$54,367.65
690 - 2015 JOHN DEERE 825I GATOR	$8.01	0	$0.00
691 - 2016 JOHN DEERE TRACTOR 6130	$14.81	0	$0.00
692 - 2016 DIAMOND BOOM MOWER/DITCHER	$35.00	960	$33,600.00
636 - 2021 FELLING 70 TON GOOSENECK TRLR	$2.23	2,418	$5,391.86
	TOTALS	**29,640**	**$386,189.62**

6.4.7.3 Budget Requirements

Total budget requirements for the first full year of maintenance activities under the plan is estimated to be $2.2 million, with the total Stormwater Department budget projected to be $2.97 million. A summary of the budgeting requirements for maintenance activities is provided in Table 6-9. All budgetary estimates are based on the current portfolio of SWMP assets within the City. As more assets enter the program, additional budget and resources will need to be allocated accordingly.

Table 6-9. O&M Annual Budget Summary

BMP/SWMS Activity	Activity	Labor Hours	Estimated Annual Cost	Summary
Clerical Support	Office Support	996	$17,499.72	Annually, this work is estimated to generate 0.5 FTE positions.
Residential Road ROW Swale & Driveway Culvert	Drive-By Visual Inspection	105	$4,577.14	Annually, this visual inspection is estimated to generate 0.05 FTE positions. It is assumed that each of the 14,000 SWMS components is inspected twice per year and that an inspection crew working a full day can inspect about 2,400 per day on average using GPS-enabled vehicle-mounted cameras.
Residential Road ROW Swale & Driveway Culvert	Drive-By Visual Inspection Review and Citizen Request Response	1,248	$54,402.55	Annually, this activity is estimated to generate 0.63 FTE positions. It is assumed that the work will be reviewing visual inspections (approximately 32 hours per year) and responding to citizen complaints, approximately 24 hours per week.
Residential Road ROW Swale	Quarter Round Cleaning	8,342	140,562.82	This activity is estimated to generate 4.19 FTE positions annually. 30 of these activities are assumed to be completed each year. Estimate assumes a crew of four, and most of the work is required to be performed by hand.
Inlet Structure	Visual Inspection	165	$7,165.83	This activity is estimated to generate 0.08 FTE positions annually.
Inlet Structure	Routine Inspection w/ Cleaning	7,097	182,393.59	This activity is estimated to generate 3.56 FTE positions annually. Estimate assumes eight hours per cleaning, labor time may be significantly reduced if cleaning frequency is increased to once per year.
Road Crossing Culvert	Visual Inspection	129	$2,555.87	This activity is estimated to generate 0.06 FTE positions annually.
Road Crossing Culvert	Routine Cleaning	1,909	$61,042.79	This activity is estimated to generate 0.96 FTE positions annually.
Baffle Box	Routine Inspection w/ Cleaning	984	$19,782.01	This activity is estimated to generate 0.49 FTE positions annually. City has 8 baffle boxes, each is inspected and cleaned quarterly and each takes a crew of four approximately 4 hours to complete.
Side Yard Ditch	Mowing Verification Inspection	120	$5,177.38	This activity is estimated to generate 0.06 FTE positions annually.
Side Yard Ditch	Remove Sediment, Regrade 10' Width	1,408	$47,577.68	This activity is estimated to generate 0.71 FTE positions annually. Estimate assumes 10-year recurrence interval.
Back Yard Ditch	Mowing Verification Inspection	120	$5,177.38	This activity is estimated to generate 0.06 FTE positions annually.

Table 6-9. O&M Annual Budget Summary

BMP/SWMS Activity	Activity	Labor Hours	Estimated Annual Cost	Summary
Back Yard Ditch	Remove Sediment, Regrade 30' Width	9,338	386,702.95	This activity is estimated to generate 4.69 FTE positions annually. Estimate assumes 10-year recurrence interval.
Driveway Culvert Repair	Repair During Road Repaving	651	$75,794.52	This activity is estimated to generate 0.33 FTE positions annually. This work is only performed in conjunction with roadway repaving.
Retention/Detention Pond	Routine Visual Inspection	143	$3,202.58	This activity is estimated to generate 0.07 FTE positions annually.
Stormwater Park	Mowing - Assist Parks Dept	2,418	$90,365.31	This activity is estimated to generate 1.21 FTE positions annually.
Public Works Compound	Mowing - Assist Parks Dept	402	$13,163.89	This activity is estimated to generate 0.20 FTE positions annually.
Retention Pond	Mowing – Schumann Dr.	646	$18,390.69	
Hurricane Preparation	Securing Buildings, Moving Equipment, Etc.	34	$7,286.61	
Post-Storm Inspection	Visual Inspection	95	$4,100.99	
Hurricane Recovery	Debris Cleanup	322	$11,854.29	
Sidewalk Repair	Assist PW Staff	106	$8,612.13	
Contractor Activities	Mowing, Aquatic Weed Treatment, Equipment Leases, Etc.		$1,032,500.00	
	TOTALS	**36,778**	**$2,199,888.70**	

Note: The Residential Road ROW Swale and Driveway Culvert drive-by visual inspections would require the purchase of additional equipment.

7 Alternatives Development and CIP Prioritization

7.1 Previously Identified CIP Projects

Many Capital Improvement Program projects were identified in previous Master Plan updates and the full scope and budget estimates for the projects were sometimes unclear. Some of the projects are currently included in the City's Capital Improvement Program for the Stormwater Fund, and for those the scope and status of the projects were reviewed with City staff and evaluated against current modeling results to determine if they should continue to be included in the CIP program. Table 7-1 shows the previously identified projects that were eliminated from the CIP program or replaced with a new or modified project scope.

Table 7-1. Previously Identified CIP Projects Eliminated or Replaced

CIP Project Name	Description	Estimated Cost	Notes
Elkcam, George, Schumann Seawall Repair/Replace	Repair and/or Replace Seawalls in the Elkcam Canal, George Lake, Schumann Lake	$16,000,000	Identified in 2018 SWMP, no description. Not shown in current CIP - it appears this project was replaced with the project below.
Major Canal Improvements	This is to address major improvements to the canals. Sizable amounts are being programmed for each year so that portions of the work can be initiated.	$2,500,000	Current CIP shows $500k/year from FY 21-25, funded by Discretionary Sales Tax. Replaced with CIP Project Nos. 4-10.
Schumann Pipe Lining	Slip lining from Schumann Lake to Elkcam	$200,000	Identified in 2018 SWMP, Completed in 2019-2020 FY.
Pelican Island Place Drainage	Drainage improvements including driveways, swales, road crossing replacements and repaving. Drainage repairs were completed in order to extend the longevity of the road repaving work.	$475,000	Identified in 2018 SWMP, Completed in 2019-2020 FY.
Stonecrop Drainage Ditch	Due to erosion of the side slopes, this ditch is difficult to maintain and needs to be improved. The system drains the entire central section of the City and therefore is critical to maintain flow and avoid flooding. The project has been redesigned for open conveyance, versus piping, which substantially reduces the estimated costs. A FEMA Hazard Mitigation Grant is being pursued to provide 75% of the expected costs. Stormwater Funds of $215,000 are being allocated for the grant matching amount.	$860,000	Identified in 2013 SWMP (Bevan & Laconia culverts) @ $1M. Shown in current CIP at $860k FY20. Project removed from CIP list because it is currently being bid by the City. The project is a replacement of the Laconia culvert only with a 12x3' CON/SPAN bridge, with reduction of channel cross section and concrete armoring from Laconia to Stonecrop for stability.
Blossom Ditch Pipe	No description	$1,000,000	Identified in 2004 SWMP as 100LF of 48" RCP @$43k. Identified in 2013 SWMP @$1M, no description. Replaced with CIP Project No. 27.

Table 7-1. Previously Identified CIP Projects Eliminated or Replaced

CIP Project Name	Description	Estimated Cost	Notes
Empress Canal Piping	No description	$250,000	Identified in 2018 SWMP, Developer of adjacent property has agreed to install a CON/SPAN bridge with the construction of the development. Therefore, the repair was removed from the City's CIP plan.
Landsdowne Box Culvert	No description	$178,000	Shown as twin 36” culverts in 2013 MP @ $100k. Identified in 2018 SWMP, no description. Project removed because modeling showed it would not result in significant improvement.
Rosebush Box Culvert	No description	$242,000	Identified in 2013 SWMP as Rosebush Terrace Pipe (2-48” RCP @ $100k). Identified in 2018 SWMP, no description. Project removed because modeling showed it would not result in significant improvement.
Tulip Box Culvert	This is a pinch point on a main ditch. The existing road crossing pipes are undersized due to minimal road coverage over the pipes and need to be replaced. It is recommended that the replacement be accomplished with a CON/SPAN open flow design to enhance conveyance.	$232,000	Identified in 2013 SWMP as 42”x72” box culvert @$100k. Identified in 2018 SWMP, no description @$232k. $232,000 shown in FY22 CIP. Replaced with CIP Project No. 15.
Albatross Box Culvert	No description	$178,000	Identified in 2018 SWMP, no description. Not in current CIP. Replaced with CIP Project No. 16.
Bayfront Box Culvert	This is a main ditch pinch point and it needs to be replaced with a CON/SPAN open flow design. This will prevent the existing pipe to become plugged with debris, which causes the existing ditch to overflow into residential properties	$178,000	Identified in 2018 SWMP, no description @$178k. $178,000 shown in FY23 CIP. Replaced with CIP Project No. 17.
Benedictine Ditch Piping	No description	$1,515,000	Identified in 2018 SWMP, no description. Not in current CIP. Replaced with CIP Project No. 18.
Bryant/Friar Court Retention Pond	No description	$315,000	Identified in 2018 SWMP, no description. Not in current CIP. Replaced with CIP Project No. 19.
Oyster Point Drainage Box	Installation of catch basin in front of the FDOT outfall	$100,000	Identified in 2018 SWMP, Project completed.
Hardee Dam Retrofit Gates	No description	$150,000	Identified in 2018 SWMP, no description. Not in current CIP. Replaced with CIP Project No. 20.
Potomac Ditch Piping	No description	$393,000	Identified in 2013 SWMP, as Potomac Ave Lateral Pipe @$200k. Completed in 2016-2017 FY.
Potomac Baffle Retrofit for Filter	No description	$60,000	Identified in 2018 SWMP, no description. City removed project from CIP list. Existing Baffle

Table 7-1. Previously Identified CIP Projects Eliminated or Replaced

CIP Project Name	Description	Estimated Cost	Notes
			Box is functioning well and mostly in dry conditions.
Davis Street Baffle Retrofit for Filter	No description	$60,000	Identified in 2018 SWMP, no description. Not in current CIP. Deleted per City staff. The site is currently utilizing a generation 1 Baffle Box.
Rosebush Retention Basin	New Stormwater Pond	$315,000	Identified in 2018 SWMP. Replaced with CIP Project No. 22.
Indian River Drive Drainage Improvements	Realign Mulligan Pipe, Baffle Box at Southern Outfall, Baffle Box at Jackson Outfall/clear outfall area	$1,000,000	Identified in 2013 SWMP, no description. Not in current CIP. Replaced with CIP Project No. 23.

7.2 Current and Proposed CIP Projects

The following is an updated list of proposed CIP projects identified through the modeling work in this Master Plan, those included in prior Master Plan updates and those identified through discussions with City staff. The goal is to produce a 10-year CIP program with the most feasible schedule and strategy to fund those improvement projects with the highest priority and the greatest benefits to the City. The H&H Model was used to evaluate various CIP projects and develop initial recommendations to address drainage issues and reduce surface flooding for the 25yr-24hr design storm event. See Section 3.7 for a detailed explanation of H&H modeling results. The CIP projects were evaluated based on surface flooding reduction, open channel flooding reduction, and cost effectiveness. Design and implementation of the CIP projects should include a review of available survey data, system conditions, and constructability.

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$878,500	Shown in current CIP, $309,000 from FY21 to 25
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$119,000	Shown in current CIP, $595,000 from FY21 to 25
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$600,000	Shown in current CIP, $60,000/year
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and	$10,987,265	Future CIP, beyond 10-year planning horizon

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
		sod approximately 211,000 SF of side slope area.		
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$27,130,362	Future CIP, beyond 10-year planning horizon
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of of approximately 5,700 LF of existing seawalls and disposal of transite bulkhead panels, installation of approximately 5,770 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$21,585,297	Future CIP, beyond 10-year planning horizon
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transite bulkhead panels, installation of approximately 12,200 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF	$39,156,096	Future CIP, beyond 10-year planning horizon

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
		of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.		
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transite bulkhead panels, installation of approximately 5,300 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$13,195,257	Future CIP, beyond 10-year planning horizon
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transite bulkhead panels, installation of approximately 7,400 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$23,774,172	Future CIP, beyond 10-year planning horizon
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheetpile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$51,091,662	Future CIP, beyond 10-year planning horizon
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and	$571,182	Identified in 2018 SWMP, no

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
		Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.		description @$278k. Shown at $300k in FY24 CIP
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$1,570,614	Current CIP shows $240,000 FY21 CIP
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$365,199	Current CIP shows $250k FY25
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$200,000	
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area increased to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 16 and 17 are completed (culverts downstream of Tulip culvert)	$239,230	
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area increased to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 17 is completed (culvert downstream of Albatross culvert)	$174,375	
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area increased to 28 SF) which is similar to the proposed Laconia St CON/SPAN 12ft x 3ft bridge (30SF). This project would also	$824,663	

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
		include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.		
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St crossing South of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$636,163	
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area.	$282,512	
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. Per City staff, the concrete is still in ok condition, stoplogs need replacement.	$25,000	
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area.	$779,055	
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area.	$837,040	
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$73,309	
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting	$1,684,839	

Table 7-2. Current and Proposed CIP Projects

CIP Project No.	CIP Project Name	Description	Estimated Cost	Notes
		pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add 12'x24' NSBB to outfall for quality.		
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$755,939	
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$50,000	
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the retention area, at elevations 7.38ft and 7.62ft, two 60inch culverts. The compound weir dimensions are summarized below: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. The weir elevations prevent free discharge from the Stonecrop Ditch. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$100,000	
		Total Estimated Cost	**$197,686,732**	

7.2.1 Cost Estimate Criteria

A detailed cost estimate was prepared for each proposed CIP project, including a project location map, quantity takeoffs, contingency allowances, and notes referencing calculation assumptions and cost sources. Copies of the estimates are included in Appendix I.

7.3 CIP Prioritization Process/Tool

The method for prioritization of maintenance issues was presented in Section 6. CIP prioritization follows a similar methodology but is more detailed and results in a more thorough triple bottom line (TBL) type cost-benefit analysis that considers economic, social and environmental effects. Upon identifying a CIP need, the project priority should be determined by the City Engineer. Issues that without capital improvement pose a safety hazard or create a condition that prohibits the proper function of the SWMS should be prioritized over aesthetic or preventative projects. The amount of time required to address CIP projects ranges from a few weeks to months or even years depending on the severity, complexity, and priority of the project. In certain more complex emergency

cases, temporary resolutions should be presented as a stop-gap measure to address public safety or functional issues while a more permanent resolution is determined.

The CIP Priority scoring uses a simple calculation to weight the importance of a proposed project based on economic, social and environmental criteria. For each of those three criteria, a criticality score and project effectiveness score is determined through a series of scored queries and an overall percentage of total category score is calculated to determine its priority. CIP projects having the highest overall percentages are the highest priority projects. In the CIP Priority calculation, the score weighting was as shown in Figure 7-1.

Criteria	Criticality	Effectiveness
Economic	0.28	0.32
Social	0.30	0.32
Environmental	0.42	0.36
TOTAL	1.00	1.00

Figure 7-1. CIP Priority Criteria Weighting

Once the proposed CIP projects shown in Table 7-2 were identified, scoped, and cost estimates were prepared, a CIP Priority scorecard was prepared for each of them to determine their overall priority ranking. An example of a project scorecard is shown in Figure 7-2. A summary of the final priority scoring is shown in Figure 7-3, and a graph of the final Criticality vs. Effectiveness scoring is shown in Figure 7-4.

City of Sebastian Capital Improvement Project Benefit Cost Analysis Scoring Template

Project No: 13 **Description:** Concha Dam Repair

	Criticality of Issue for LOS			Project Effectiveness			PROJECT SCORE	
Criteria	**Score**	**Description**	**Context**	**Score**	**Description**	**Context**	**Criticality of Issue for LOS**	**Project Effectiveness**
ECONOMIC								
Project Cost				0	> $10,000,000	What is the cost (to the City) of the proposed project?		
				2	$5,000,000 - $10,000,000			
				4	$3,000,000 - $5,000,000			
				6	$1,000,000 - $3,000,000			
				8	$500,000 - $1,000,000			
				10	$100,000 - $500,000			10
				12	< $100,000			
Economic Impacts	0	Very Low	What are the economic impacts (future flooding damages, etc.) if the flooding or the asset condition is not addressed?	0	Very Low	What is the potential benefit of the proposed project to increased opportunities for economic development or community enhancements?	0	0
	4	Low		2	Low			
	8	Medium		4	Medium			
	10	High		6	High			
	12	Very High		8	Very High			
Condition of Existing Infrastructure Private	0	Excellent	What is the condition of existing prviate infrastructure assets in the project area?	0	No	Will the proposed project fix the private asset conditions in the project area?	0	0
	1	Good		1	Limited			
	2	Fair		2	Partially			
	3	Poor		3	Mostly			
	4	Very Poor		4	Completely			
Condition of Existing Infrastructure Public	0	Excellent	What is the condition of existing public infrastructure assets in the project area?	0	No	Will the proposed project fix the public asset conditions in the project area?		
	4	Good		2	Limited			
	8	Fair		4	Partially			
	10	Poor		6	Mostly		10	
	12	Very Poor		8	Completely			8
Economic Subtotal	***28***			***32***			***10***	***18***
SOCIAL								
Safety	0	No potential for injury / loss of life	What is the current impact on safety from flooding/assett condition in the project area for the intended level of service?	0	No	Will the proposed project minimize the impact on safety in the project area for the intended level of service?		
	2	Limited potential for injury		2	Limited		2	2
	4	Some potential for injury / loss of life		4	Partially			
	6	Reasonable potential for injury		6	Mostly			
	8	Great potential for injury / loss of life		8	Yes			
Number of Properties Impacted	0	None	How many properties are currently impacted by flooding/asset condition in the project area for the intended Level of Service?	0	None	How many properties will have postively benefited from the project for the intended Level of Service?		
	1	1 to 5		1	1 to 5			
	2	6 to 10		2	6 to 10			
	3	11 to 15		3	11 to 15			
	4	Greater than 15		4	Greater than 15		4	4
Traffic Flow on Public Streets	0	No potential impact	How is traffic affected by flooding/asset condition in the project area?	0	No	Will the proposed project positively affect traffic and flooding conditions in the project area?	0	0
	2	Secondary System / Alternatives Exist		2	Partially			
	4	Primary System / No Alternative		4	Yes/NA			
High Hazard Road Crossings in Project Area	0	No road crossing	Are there any high hazard road crossings in the project area?	0	No	Will the project postively affect the roadway crossings in the project area?	0	0
	2	Yes, one or more crossings		4	Yes/NA			
Proximity to Critical Facilities (hospitals, police, fire station, etc.)	0	> 2 miles	How close to the project area are facilities that provide health, safety or emergency response?	0			0	
	4	< 2 miles		0				
	8	Located within project area		0				
Degree of Flooding (Public)	0	1% (100-year) Storm	At what design storm frequency does flooding (>6") typically occur within the project area?	8	1% (100-year) Storm	To what level (design storm) has the project fixed the flooding problem?		
	2	4% (25-year) Storm		4	4% (25-year) Storm			
	4	10% (10-year) Storm		0	10% (10-year) Storm		4	0
Property Damage (Private)	0	None	What is the worst case facility flooding for the intended LOS?	0	Livable / occupied space	What level of facility flooding is predicted following project implementation?	0	
	1	Landscape / yard flooding		1	Crawl space / basement / mechanical			
	2	Garage / shed / driveway		2	Garage / shed / driveway			
	3	Crawl space / basement / mechanical		3	Landscape / yard flooding			
	4	Livable / occupied space		4	None			4
Social Subtotal	***30***			***32***			***10***	***10***
ENVIRONMENTAL								
Erosion	0	None	What effect will the project have on reducing erosion issues within the SWMS?	0	None/NA	How has the project postively affected the environment?		
	1	Limited		2	Limited			1
	2	Moderate		4	Moderate		2	
	3	Significant		6	Significant			
Water Quantity Reduction	0	None	What effect will the project have on reducing the quantity of stormwater discharged to receiving waterbodies?	0	None/NA	How has the project postively affected the environment?		
	4	Limited		2	Limited			
	8	Moderate		4	Moderate			
	12	Significant		6	Significant		12	6
Water Quality Improvement	0	None	What effect will the project have on improving the quality of stormwater discharged to receiving waterbodies?	0	None/NA	How has the project postively affected the environment? How much CIRL BMAP TN and TP reduction credit will the project be eligible for?		
	4	Limited		2	Limited			
	8	Moderate		4	Moderate			
	12	Significant		6	Significant		12	6
Habitat Improvement	0	None	What effect will the project have on improving the habitat of receiving waterbodies?	0	None/NA	How has the project postively affected the environment?		
	2	Limited		2	Limited			
	4	Moderate		4	Moderate			
	6	Significant		6	Significant		6	6
Public Health	0	None	What effect will the project have on improving public health parameters in receiving waterbodies?	0	None/NA	How has the project postively affected the environment?		
	1	Limited		2	Limited			
	2	Moderate		4	Moderate			
	3	Significant		6	Significant		3	6
Aesthetic Effects	0	None	What effect will the project have on improving the aesthatics of the SWMS and receiving waterbodies?	0	None/NA	How has the project postively affected the environment?		
	2	Limited		2	Limited			
	4	Moderate		4	Moderate		4	4
	6	Significant		6	Significant			
Environmental Subtotal	***42***			***36***			***39***	***29***
TOTAL	**100**			**100**			**59**	**57**
						% of Total Category Score	**59%**	**57%**

Figure 7-2. CIP Prioritization Project Scorecard

CIP Project No.	Description	Criticality of Issue for LOS Scores				Project Effectiveness Scores				TOTAL SCORE	Normalized Score
		Economic	Social	Environ.	Total	Economic	Social	Environ.	Total		
4	Harbor Point Waterway and Collier Waterway North Improvements	18	11	11	41	2	11	5	18	59	-0.96
5	Central Collier Waterway Improvements - North Section	18	11	12	41	2	11	5	18	59	-0.96
6	Central Collier Waterway Improvements - South Section	18	11	12	41	2	11	5	18	59	-0.96
7	Schumann Waterway Improvements	18	11	12	41	2	11	5	18	59	-0.96
8	Schumann Lake Improvements	18	11	12	41	2	11	5	18	59	-0.96
9	Joy Haven Waterway Improvements	18	11	12	41	2	11	5	18	59	-0.96
10	Collier Waterway South Improvements	18	11	12	41	2	11	5	18	59	-0.96
11	Ocean Cove Drainage Repair	14	20	16	50	16	23	12	51	101	0.57
12	Day Drive Retention Area Restoration	16	17	16	49	16	18	14	48	97	0.43
13	Concha Dam Repair	10	10	39	59	18	10	29	57	116	1.12
15	Stonecrop Ditch - Tulip Culvert Replacement	16	15	4	35	20	17	6	43	78	-0.27
16	Stonecrop Ditch - Albatross Culvert Replacement	16	15	4	35	20	17	6	43	78	-0.27
17	Stonecrop Ditch - Bayfront Culvert Replacement	16	15	4	35	20	17	6	43	78	-0.27
18	Benedictine Area Culvert Improvements	16	15	4	35	20	17	6	43	78	-0.27
19	Bryant/Friar Court Retention Pond	16	13	36	65	20	27	26	73	138	1.93
20	Hardy Dam Retrofit Gates	24	17	31	72	22	27	18	67	139	1.96
21	Surrey Terrace Retention Basin	0	11	19	30	8	17	16	41	71	-0.52
22	Newhall Terrace Retention Basin	0	11	19	30	8	17	16	41	71	-0.52
23	Coolidge Outfall Improvements	16	15	19	50	20	17	16	53	103	0.65
24	Blossom Ditch Drainage Improvements	18	15	19	52	12	21	20	53	105	0.72
25	Drainage Improvements at Hazel and Lloyd St	18	18	21	57	20	21	18	59	116	1.12
26	Stormwater Park Operation	4	2	16	22	16	4	14	34	56	-1.07
27	Stonecrop Retention Area	20	14	23	57	26	21	20	67	124	1.42
MAXIMUM SCORE		28	30	42	100	32	32	36	100	200	-

Figure 7-3. CIP Prioritization Scoring Summary

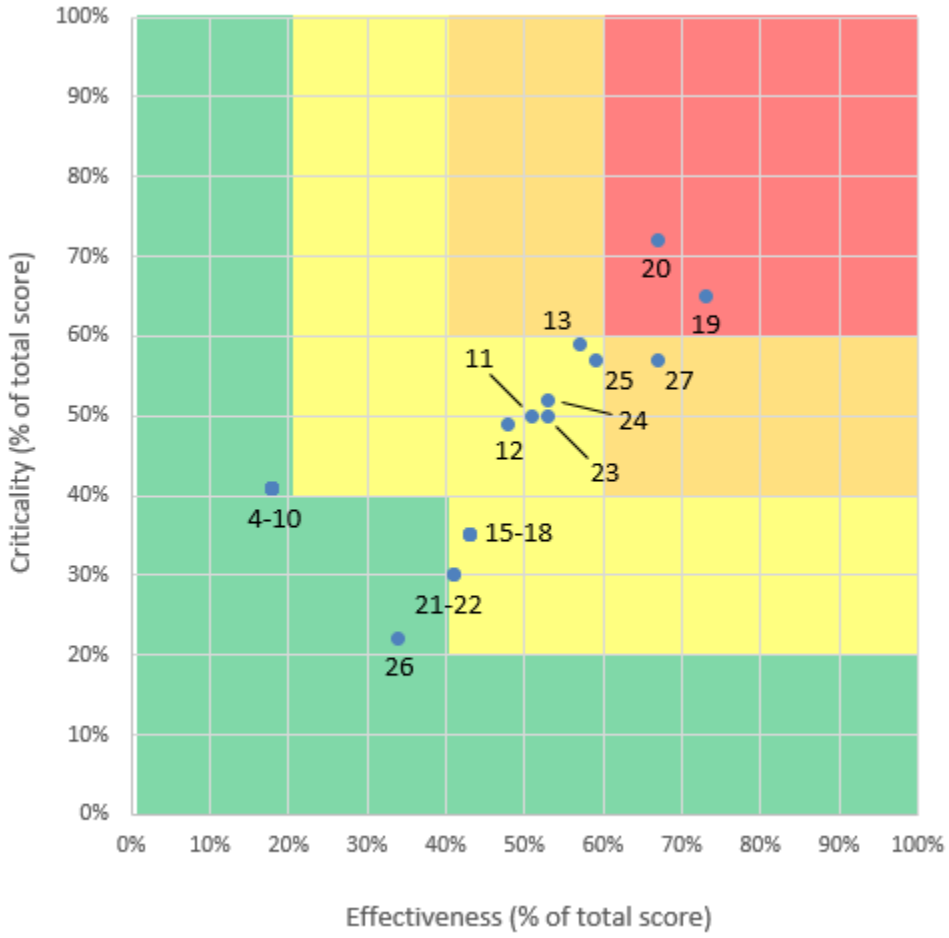


Figure 7-4. CIP Prioritization Scoring – Criticality vs. Effectiveness

7.4 Recommended and Prioritized Improvements

Projects with high costs and low priority scores were shown in the 10-year CIP plan as “Future”, and the CIP planning emphasis was directed towards lower cost, higher priority projects. A copy of the proposed CIP Plan from 2023-2033 including more than $9 million in capital projects is included in Appendix I. A detailed discussion of the funding plan for the CIP projects and the ongoing operations and maintenance of the City’s SWMS in included in the next Section.

8 Funding Plan and Grant Management

8.1 City Stormwater Department Revenue Sufficiency Analysis

8.1.1 Overview

As part of this Master Plan Update, Arcadis prepared a Revenue Sufficiency Analysis and forecast for the City of Sebastian's (City) Stormwater Department (Department) for the period FY2022 through FY2031. The Department's fiscal year runs from October 1st to September 30th. The purpose of this section is to present the Revenue Sufficiency Analysis and forecast, including the projection of revenues and expenses. Arcadis developed the projected CIP project needs for FY2022 through FY2031 based on modeling results and previously identified issues, and it is assumed that all funding for capital projects during the forecast period will come from the City's Discretionary Sales Tax (DST) Fund or another means of outside financing (grants, etc.). Relevant assumptions related to the development of the Revenue Sufficiency Analysis and associated forecast are also included throughout this section.

The financial forecast represents an estimate of the probable results of operations and reflects the Department's judgment as to the most likely set of conditions and course of action based upon present circumstances. Arcadis worked closely with the City and Department to obtain the information necessary to prepare the Revenue Sufficiency Analysis, and various financial and system information was provided to support the development of the analysis.

8.1.2 General Methodology

The Revenue Sufficiency Analysis is a determination of the annual revenue from rates which, combined with other sources of funds, will provide sufficient funds to meet the fiscal requirements of the system. The Revenue Sufficiency Analysis does not include a determination of the actual rates and charges of the system but provides a forecast of the total system rate revenue needs as well as increases in rate revenue, if any, that are projected for each year of the forecast.

The process employed in the Revenue Sufficiency Analysis results in the identification of revenue requirements of the system, such as operating expenses, capital expenses (minor and major, transfers out and the maintenance of both restricted and unrestricted reserves at appropriate levels. These revenue requirements are then compared to the total sources of funds during each year of the forecast period to determine the adequacy of projected revenues to meet requirements. To the extent that the existing revenue stream is not forecasted to be sufficient to meet the annual revenue requirements of the system, a series of rate revenue increases are calculated to provide revenue sufficient to meet those needs. The overall goal of the Revenue Sufficiency Analysis is to determine the revenue necessary over the forecast period to:

1. Meet the operating and capital revenue requirements of the stormwater system, including funding of the CIP

14. Build up a working capital reserve level of 4-months of operating expenses

The CIP, including the timing of projects and estimated costs, was developed by Arcadis to fit within the funding limits defined by City staff; thus, the CIP and revenue enhancements were fully integrated into the Revenue Sufficiency Analysis.

8.1.3 Data Used in the Analysis

This section of the report provides a summary of data used in the analysis as well as general assumptions made as part of the forecast. Where available, the analysis uses data sources from City planning documents such as the Comprehensive Annual Fiscal Report (Annual Report), Department projected operating results for FY2022, and the CIP.

8.1.3.1 Data Items

Key data items reviewed, discussed with the Department, and incorporated into the Revenue Sufficiency Analysis include the following:

- Financial management goals of the Stormwater Utility
- The beginning fund balance from the FY2022 Budget Book has been used as the beginning balance available in FY2022 (year 1 of the analysis).
- Sources of Funds from FY2022 projected operating results and the FY2023 Proposed Budget in the 2022/2023 Annual Budget
- Uses of Funds from FY2022 projected operating results and the FY2023 Proposed Budget in the 2022/2023 Annual Budget
- Capital Improvement Plan
- Arcadis' O&M modeling tool
- General assumptions related to:
  - Customer growth
  - Cost escalation factors

A discussion of the use of each of the above data items is presented below.

8.1.3.2 Working Capital Reserves and Balances

To better understand what funds the Stormwater Utility had on hand to start the forecast period, a detailed review of Stormwater's Working Capital Reserves and other cash balances associated with the FY2022 Budget Book was conducted. These data sources represent funds available at the end of FY2021, and therefore at the beginning of FY2022.

8.1.3.3 Sources of Funds from FY2022-2023 Draft Stormwater Budget

The City provided the FY2022-2023 Draft Stormwater Budget. From this document line-item revenue detail is obtained and serves as the basis for projecting financial performance in FY2022. In addition, line-item projected revenues for FY2023 through FY2031 are developed using the FY2022 projected revenues, provided by the City, as the basis.

8.1.3.4 Uses of Funds from FY2022-2023 Proposed Stormwater Budget

The City provided FY2022 projected expenses and the FY2023 Proposed Budget, and associated line-item expense detail, as the basis for the projection of financial performance for the forecast period. In addition, line-item projected expenses for FY2024 through FY2031 were developed using cost escalation factors for each line-

item. Cost escalation factors were reviewed by staff and were used to project line-item costs beyond the 2023 projections. For details on specific cost escalation factors see section 1.3.7.

8.1.3.5 Capital Improvements Plan (CIP)

The Department provided Arcadis with a forecast of annual funding (cash expenditure) requirements associated with the CIP for the FY2022 through FY2031 forecast period. Annual funding and cash expenditure provided in the CIP differs from “appropriated expenditure” in that the financial forecast considers the amount of actual costs projected to be expended in each year (whether paid for with cash or debt).

8.1.3.6 Arcadis O&M Model

City staff did not have an estimate of the total labor and equipment costs incurred by SWMS maintenance activities, nor an estimate of the total time necessary to complete them. Therefore, Arcadis developed an MS-Excel O&M model that calculates the full labor and equipment cost per hour and applies those costs to each activity based on labor crew size and composition and equipment used, details of which were provided by City staff. Costs for maintenance activities performed by City contractors are also included in the total cost calculations. The model then generates a breakdown of total costs and full-time equivalent labor required for each maintenance activity on an annual basis. The model also generates a side-by-side comparison of budget costs relative to existing budget costs to show deviations.

New Full Time Employee (FTE) Positions and Associated Benefits

The O&M model prepared by Arcadis estimates that the Department has a need of approximately twenty FTEs versus the fourteen FTEs currently budgeted. To incorporate these six additional FTEs into the forecast, Arcadis has assumed an additional two FTEs per year for three years starting in FY2024. Not inclusive of additional costs associated with cost escalation assumptions, the addition of six FTEs is expected to add $179,988 per year of costs by FY2026 (approximately $60,000 per year between FY2024 and FY2026).

Additionally, Arcadis has incorporated the associated increase in costs for employee benefits as a result of the six additional FTEs using the same methodology as described in the previous paragraph. The addition of six FTEs is expected to add $110,310 per year of benefits costs by FY2026 (approximately $37,000 per year between FY2024 and FY2026).

Other Contractual services

The O&M model prepared by Arcadis assumes that the Contract Mowing Services cost will be $87,000 beginning in FY2024 (an increase of $78,380 from what was budgeted in FY2023) as a result of additional routine pond cleaning and Stormwater Park pump maintenance. New contracts are expected to be negotiated after every three-year period in the forecast, with each new contract incorporating a 10% increase in costs at the start of the contract and an additional 3% increase in the final year of the contract (based on the structure of the City’s current contracts allowing an adjustment for inflation of up to 3% in the final year of its current contracts). FY2024, FY2027, and FY 2030 are the new contract years incorporated during the forecast period, with the total cost increasing to $111,681 by FY2031.

Contracted Mowing Services

The O&M model prepared by Arcadis assumes that the Contract Mowing Services cost will be $853,000 in the final contract year of FY2024 (an increase of $231,158 from what was budgeted in FY2023) as a result of optional mowing services that may be requested by the City. New contracts are expected to be negotiated after every three-year period in the forecast, with each new contract incorporating a 10% increase in costs at the start of the contract and an additional 3% increase in the final year of the contract (based on the structure of the City’s current

contracts allowing an adjustment for inflation of up to 3% in the final year of its current contracts). FY2025, FY2028, and FY 2031 are the new contract years incorporated during the forecast period, with the total cost increasing to $1,205,191 by FY2031.

Operating equipment

The O&M model prepared by Arcadis assumes an increase in need of operating equipment associated with maintenance activities due to increased maintenance frequencies for some activities and the resulting projected operational hours of equipment. Not inclusive of additional costs associated with cost escalation assumptions, the need for additional operating equipment associated with the planned maintenance activities is expected to add $224,502 per year of costs by FY2026 (spread across three years at approximately $75,000 per year between FY2024 and FY2026).

Sod/Cement/Culvert Pipes

The O&M model prepared by Arcadis assumes that these costs will be reduced by a combined total of $52,267 per year starting in FY2024 due to reductions in material usage projected by the O&M model based on discussions with City staff.

8.1.3.7 General Assumptions

To develop the financial and rate projections, certain assumptions were made regarding elements of the Revenue Sufficiency Analysis. A summary of those assumptions is presented below.

Growth

Based on discussion with the Department and reviewing the City's Comprehensive Plan, it was determined that 1.5% annual growth in the utility customer base would be projected during the forecast period.

Cost Escalation Factors

Based on discussion with the Department, the following annual cost escalation factors were applied starting in FY2024:

- General Inflation - 3.11% (5-year Average using the CPI-U Index)
- Labor and Benefits – 3.00% (all personnel related costs)
- Utilities - 5.00% (water/sewer, electric, trash pickup/hauling)

CIP

All capital projects and capital outlay (vehicles, equipment, etc.) during the forecast period assume full funding via the DST Fund or an alternative third-party funding source. No capital in the financial model is currently being funded from operating revenues or fund balance/cash reserves.

8.1.4 Financial Management and Goals of the Stormwater Utility

8.1.4.1 Minimum Working Capital Reserves in the Operating Fund

In order to maintain an appropriate level of liquidity, utilities typically establish some form of working capital target. This target typically ranges from an amount equal to 3 to 12 months of operating expense, depending on the unique operating/financial characteristics of the utility.

While maintaining sufficient levels of unrestricted reserves, or working capital, is critical to maintaining financial flexibility, it is also an important factor used by rating agencies to determine creditworthiness of utilities. While no singular criterion determines a utility's credit rating, liquidity is one of several important factors.

Utilities that keep too much cash on hand, while borrowing at the same time, can be viewed as building excessive cash reserves and paying interest expense in lieu of spending existing cash. However, the buildup of cash reserves beyond the 3 to 12-month level does not necessarily indicate excessive reserves so long as there is a plan to spend those funds in the near future on capital projects in lieu of additional borrowing.

The analysis presented herein considers a goal of an unrestricted working capital reserve amount greater than, or equal to, 4-months of operating expenses by FY2026.

8.1.5 Results of the Baseline Stormwater Revenue Sufficiency Analysis

After a thorough review of the above-mentioned data elements, and working through several alternative financial plans, Arcadis developed a plan which provides for the continued financial strength of the stormwater utility. The resulting financial plan is presented and described in the following sections, and reflects the analysis and assumptions noted above. Should there be any change to the data or assumption used, this plan would need to be updated accordingly.

8.1.5.1 Summary Pro Forma and Revenue Increases Required

The revenue requirements and financial goals of the Department during the forecast period identified the need for additional revenue. The annual adjustments required during the forecast period are as follows:

- October 1, 2023: 41.00% revenue increase. If applied to the Stormwater Fee, the monthly fee would increase approximately $4.10 per customer, from $10.00 to $14.10.
- October 1, 2024 (and annually thereafter): 3.00% revenue increase

Table 8-1 presents a summary stormwater pro forma financial forecast, including necessary revenue increases to 1) meet stormwater revenue requirements and 2) establish unrestricted cash reserves at targeted levels.

Table 8-1. Summary Pro Forma

Line No.	Description	Fiscal Year Ending September 30th FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FY2029	FY2030	FY2031
	Revenues										
1	Rate Revenues	$ 1,955,905	$ 1,985,244	$ 2,015,022	$ 2,883,799	$ 3,014,868	$ 3,151,893	$ 3,295,147	$ 3,444,911	$ 3,601,483	$ 3,765,170
2	Rate Revenues from Increase	-	-	826,159	86,514	90,446	94,557	98,854	103,347	108,044	112,955
3	Miscellaneous Revenue	37,880	37,588	37,588	37,588	37,588	37,588	37,588	37,588	37,588	37,588
4	Transfers In	-	-	-	-	-	-	-	-	-	-
5	Interest Income	-	-	-	-	-	-	-	-	-	-
6	**Total Revenues**	$ 1,993,785	$ 2,022,832	$ 2,878,769	$ 3,007,901	$ 3,142,902	$ 3,284,038	$ 3,431,589	$ 3,585,847	$ 3,747,115	$ 3,915,713
	Revenue Requirements										
7	Operating Expenses	$ 1,742,340	$ 2,149,474	$ 2,631,935	$ 2,940,732	$ 3,173,613	$ 3,276,444	$ 3,440,871	$ 3,513,636	$ 3,627,656	$ 3,811,388
8	Non-Operating Expenses	-	-	-	-	-	-	-	-	-	-
9	Transfers Out	-	-	-	-	-	-	-	-	-	-
10	Minor Capital Expense	-	-	-	-	-	-	-	-	-	-
	Debt Service										
11	Existing Debt Service	-	-	-	-	-	-	-	-	-	-
12	New-Revenue Bond	-	-	-	-	-	-	-	-	-	-
13	New-General Obligation Bond	-	-	-	-	-	-	-	-	-	-
14	New-State Revolving Loan Fund	-	-	-	-	-	-	-	-	-	-
15	**Total Debt Service**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
16	Capital Projects Funded with Cash	-	-	-	-	-	-	-	-	-	-
17	**Total Revenue Requirements**	$ 1,742,340	$ 2,149,474	$ 2,631,935	$ 2,940,732	$ 3,173,613	$ 3,276,444	$ 3,440,871	$ 3,513,636	$ 3,627,656	$ 3,811,388
18	**Revenues Over (Under) Expenses**	$ 251,445	$ (126,642)	$ 246,834	$ 67,169	$ (30,711)	$ 7,594	$ (9,281)	$ 72,211	$ 119,460	$ 104,325
19	**Beginning Balance**	$ 718,980	$ 970,425	$ 843,783	$ 1,090,617	$ 1,157,786	$ 1,127,076	$ 1,134,670	$ 1,125,389	$ 1,197,600	$ 1,317,060
20	**Revenues Over (Under) Expenses**	251,445	(126,642)	246,834	67,169	(30,711)	7,594	(9,281)	72,211	119,460	104,325
21	**Ending Balance**	$ 970,425	$ 843,783	$ 1,090,617	$ 1,157,786	$ 1,127,076	$ 1,134,670	$ 1,125,389	$ 1,197,600	$ 1,317,060	$ 1,421,385

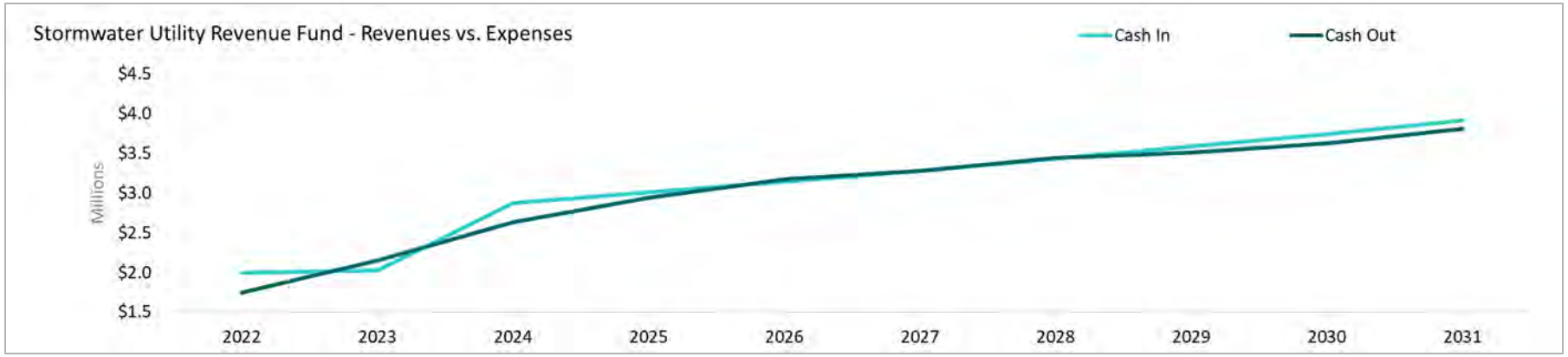


Figure 8-1. Revenues vs. Expenses (including annual revenue increases)

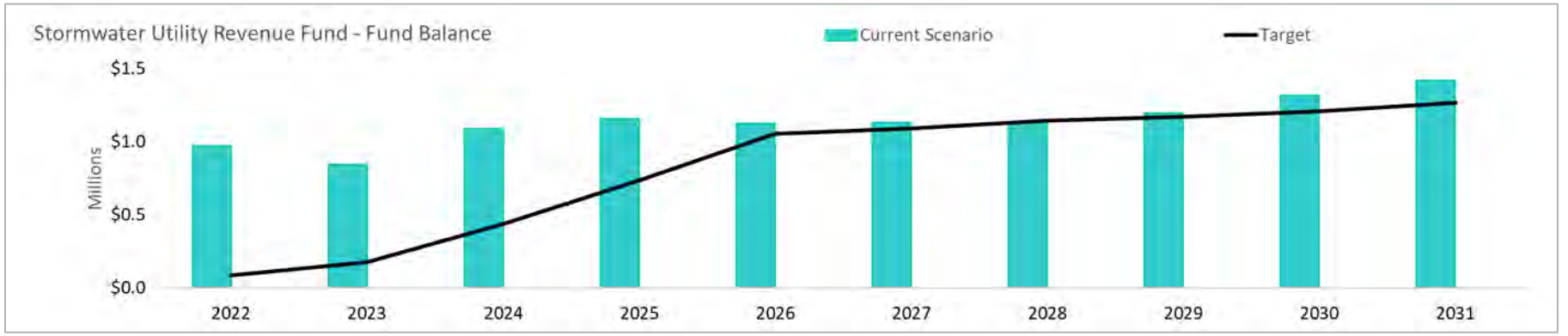


Figure 8-2. Stormwater Utility Revenue Fund – Fund Balance (including annual revenue increases)

8.2 Grant Funding Overview

Identifying the appropriate funding sources is essential for determining the types of financial assistance available. Revenue from the stormwater utility can be used to cover the local matching requirements for potential grants.

This section provides information on key agencies administering grant and loan programs, as well as a summary of how these programs best align with the CIP projects and long-term goals of the City. External funding sources are ideal opportunities to supplement capital budgets. The resources include federal and state grants, low- or no-interest loans, and special financing available for Water Infrastructure and Mitigation programs. While most of the programs identified in this section are managed by state agencies, both state and federal agencies administer grant and loan programs. Although some programs may be similar, each funding agency has its own eligibility criteria to determine which potential applicants can and cannot participate in the program.

Most state and federal funding opportunities are published on an annual basis through congressional and state appropriations, as well as after a major disaster declaration. State and federal agencies commonly replace or revise existing programs to incorporate innovative design and new regulatory requirements into eligibility qualifications. Changes in funding allocation, program criteria, and eligibility will be reflected in the most current issue of the publication, NOFO, or NOFA. It is important to note that the criteria established in prior year's announcements may not be applicable for the current year and these changes may impact the project scope. The City of Sebastian is encouraged to monitor new programs and opportunities and sign up for agency newsletters and/or Listservs to receive notifications directly.

Finally, due to unforeseen and unprecedented global events including the COVID-19 pandemic as well as the subsequent aftermath, the federal government has passed legislation to increase funding and expand programmatic criteria to help state and local governments adequately respond to and address many of the challenges and setbacks resulting from these events. Note, federal assistance to support infrastructure projects is considerable. With the authorization of the Bipartisan Infrastructure Law (BIL), existing federal programs have or will receive an infusion of funding that will allow agencies to expand their eligibility criteria. The increased allocation for various federal programs also allows agencies to evaluate a broader range of projects and provide greater level of assistance. In addition, BIL funds are available to eligible applicants potentially at a greater federal share for projects that can demonstrate benefits to eligible disadvantaged communities. The sources outlined below include the expanded guidance (as applicable) for existing federal programs.

8.2.1 Federal Funding Opportunities

8.2.1.1 Florida Department of Environmental Protection State Revolving Fund

Program Summary: Funded through the EPA, Florida's State Revolving Fund (SRF) is made up of three programs:

1. **Clean Water State Revolving Fund:** The Clean Water State Revolving Fund (CWSRF) program provides low-interest loans to local governments to plan, design, and build or upgrade wastewater, stormwater, and nonpoint source pollution prevention projects. CWSRF loan terms include a 20-year repayment and low-interest rates. Financing rates vary based on a variety of factors. Projects funded/awarded through the Bipartisan Infrastructure Law (BIL) are eligible to receive funds in the form of a grant, principal forgiveness loan, or low-interest loan. Eligible projects include Sea walls; Levees/dikes/berms; installation of flood attenuation; diversion, retention infrastructure within or beyond the footprint of a treatment works that protects the treatment works including floodwater

channels/culverts; green infrastructure; and natural systems capable of mitigating a storm surge (e.g., barrier beach and dune systems, tidal wetlands, and living shorelines).

2. **Drinking Water State Revolving Fund:** The Drinking Water State Revolving Fund (DWSRF) program provides low-interest loans to local governments and private utilities to plan, design, and build or upgrade drinking water systems. Discounted assistance (e.g., very low interest rates, grants, etc.) for disadvantaged communities is available. Interest rates on loans are below market rates and vary based on the economic wherewithal of the community.
3. **State Revolving Fund Management:** The SRF Management Program supports the Drinking Water SRF and Clean Water SRF programs by writing loan agreements, reviewing financials, approving procurement, processing disbursements and managing billing.

Eligibility: Local governments (city and county) and special districts are eligible to apply for and receive loan funds. For drinking water projects, private utilities are also eligible. Under the Bipartisan Infrastructure Law, grant funds may be awarded to applicants for project that benefit disadvantaged communities equitably from investments in water infrastructure. The BIL requires that (at minimum 49-percent of) CWSRF General Supplemental Funding must be provided as grants and forgivable loans to applicants that meet the state's affordability criteria or certain project types.

Submission Requirements: Applying for SRF funding (CWSRF and DWSRF) requires the submission of a Request for Inclusion form, which can be submitted any time during the year. The information in the form is used to establish a project's eligibility for funding, including any principal forgiveness, and priority score which is then used for placement on the funding list ("priority list"). Projects are funded, in order of their priority score or until funds are exhausted. Once the project is included on the funding list, the process for applying for the loan may begin.

Eligible Activities:

- Publicly owned wastewater collection and treatment facilities
- Publicly owned stormwater Best Management Practices
- Living shorelines
- Upgrades, Repair, Replacement, or Installation and Construction
- Infrastructure projects that make water systems more resilient to all threats

8.2.1.2 Water Infrastructure Finance and Innovation Act

Program Summary: The WIFIA Program is a federal credit program administered by the EPA for eligible water and wastewater infrastructure projects. The WIFIA program offers loans with low, fixed interest rates, and a length of up to 35 years. WIFIA loans can be combined with private equity, revenue bonds, corporate debt, grants, and SRF loans. The EPA is permitted to provide credit assistance in the form of secured (direct) loans or loan guarantees. The maximum amount of WIFIA credit assistance to a project is 49% of eligible project costs in almost all instances (total federal assistance may not exceed 80% of a project's eligible costs). The minimum project amount for large communities is $20 million, and the minimum project amount for small communities (population of 25,000 or less) is $5 million.

Eligibility: Borrowers may include local, state, tribal, and federal government entities, partnerships and joint ventures, and corporations and trusts.

Submission Requirements: For a projects to be considered during the availability period, EPA must receive a Letter of Intent (LOI) via SharePoint. **LOI submission can begin on September 6, 2022**.

Eligible Activities: The WIFIA program can fund projects that are eligible for the CWSRF (notwithstanding the public ownership clause) and projects that are eligible for the DWSRF that support the following activities (but not limited to):

- Brackish or seawater desalination, aquifer recharge, alternative water supply, and water recycling projects
- Acquisition of property (if it is integral to the project or will mitigate the environmental impact of a project)
- A combination of projects secured by a common security pledge or submitted under one application by an SRF program

Eligible development and implementation activities include:

- Development phase activities, including planning, preliminary engineering, design, environmental review, revenue forecasting, and other pre-construction activities
- Construction, reconstruction, rehabilitation, and replacement activities
- Acquisition of real property or an interest in real property, environmental mitigation, construction contingencies, and acquisition of equipment
- Capitalized interest necessary to meet market requirements, reasonably required reserve funds, capital issuance expenses, and other carrying costs during construction

8.2.1.3 Florida Department of Environmental Protection Nonpoint Source Funds

Program Summary: Funded through EPA, the Nonpoint Source program supports projects that reduce pollution from nonpoint sources, with a focus on impaired water bodies and goals identified in Total Maximum Daily Loads and restoration plans. Under this program, applicants can request funding through the following grant opportunities:

Federal Clean Water Act Section 319(h) Grants: Federal funds to address nonpoint source pollution. Approximately $6 million is awarded annually to the department by the Environmental Protection Agency (EPA) through section 319(h) of the Clean Water Act. The grant stipulates that a minimum of 50% (~$3 million) of the state's grant funds must go towards projects that implement adopted EPA-approved nine element Watershed Based Plans (WBPs), e.g., Basin Management Action Plans (BMAPs) or Reasonable Assurance Plans (RA Plans). The remaining 50% or less of the funding is not limited to projects that implement the BMAPs but are mostly used by the state administratively to run the grant program, therefore these funds are more limited for project use.

State Water-quality Assistance Grants (SWAG): Funds allocated by the state legislature to implement best management practices to reduce pollutant loads to have urban stormwater discharges meet water quality standards. Approximately $5 million is appropriated annually to the department through the Florida legislature for our State Water-quality Assistance Grant (SWAG). Projects must be shovel ready capital improvement construction projects treating impaired waters.

Eligibility: All local government including county and municipal governments, special districts, water management districts, other state agencies, public universities/colleges, and national estuary programs located in Florida are eligible to apply for funding. Federal-funded projects (319h Grants) generally require a minimum 40% non-federal match (Section 319(h) funding should generally not exceed 60% of the total eligible project cost). CWSRF loan funds can be the match.

Submission Requirements: Applications for submission to Florida DEP may be submitted any time. Submissions are reviewed in the fall and spring or as needed. Applications with higher local matches are more competitive.

Eligible Activities: eligible activities include but are not limited to:

- Projects that reduce nonpoint source pollution in priority watersheds including demonstration and evaluation of Best Management Practices
- Stormwater treatment
- Stormwater Infrastructure
- Measures to manage, reduce, treat, or recapture stormwater or subsurface drainage water
- Groundwater protection
- Hydrologic restoration

8.2.1.4 Florida Department of Environmental Protection Coastal Management Program

Program Summary: The Florida Coastal Management Program (FCMP) and its activities are funded annually by the National Oceanic Atmospheric Administration (NOAA). Each year, the FCMP makes a portion of NOAA funds available as pass-through grants for projects and activities that protect and manage natural & cultural resources and improve waterfront communities along Florida's coast. The FCMP awards grants through two competitive programs:

Coastal Partnership Initiation (CPI) Grant: Coastal Partnership Initiative (CPI) Grants CPI grants provide funds ranging from $10,000 to $60,000 for innovative local coastal management projects that inspire community action and promote the protection & management of coastal resources in the following three areas:

- Resilient Communities: projects that prepare for and respond to effects of climate change, natural hazard events and disasters.
- Coastal Resources Stewardship: projects that promote local stewardship and appreciation of fragile coastal resources.
- Access to Coastal Resources: projects that revitalize, renew, and promote local interest in their waterfront districts.

Eligibility: Funding for the CPI program is available for local projects specifically for state agencies & water management districts. Eligible applicants include local governments within the 35 coastal counties required to include a coastal element in the local comprehensive plan. Public colleges, universities, regional planning councils, non-profit groups and national estuary programs may also apply as long as an eligible local government agrees to participate as a project partner.

Submission Requirements: Each year in August or September, the FCMP publishes a Notice of Availability of Funds in the Florida Administrative Register to solicit proposals from eligible local government, education, and non-profit entities.

Eligible Activities: CPI funds are available to support habitat restoration, parks, waterfronts, public access facilities, environmental education and coastal planning.

State Agency and Water Management District Grant Program: The FCMP provides federal NOAA funds for state agencies and water management districts for projects related to coastal resource protection. Projects must contribute to the protection, management and enhancement of Florida's coastal resources.

Eligibility: Projects must be completed within a 12-month period. Project proposals should be between $15,000 and $74,000, with anticipated start dates in July 2022.

Submission Requirements: FY23 application cycle information currently not available. The FY 2022-23 grant application cycle closed on Nov. 30, 2021.

Eligible Activities: Eligibility activities include but are not limited to: Construction, Land Acquisition, Planning, Design and Coordination Activities, Habitat Restoration, Invasive exotic plant removal and habitat restoration.

8.2.1.5 Florida Division of Emergency Management Building Resilient Infrastructure and Communities Grant Program

Program Summary: The FEMA BRIC program is an annual recurring program administered by the FDEM that provides funding to eligible entities to reduce natural hazard risks and future losses caused by acute events and chronic stressors, driven by climate change, which are either observed or expected. For FY 2022, the priorities for the program are to incentivize natural hazard risk reduction activities that mitigate risk to public infrastructure and disadvantaged communities; incorporate nature-based solutions including those designed to reduce carbon emissions; enhance climate resilience and adaptation; and increase funding to applicants that facilitate the adoption and enforcement of the latest published editions of building codes. BRIC projects are eligible under separate program categories including:

State/Territory Competition: The Capability-and-Capacity-Building program provides financial assistance for activities that will enhance the knowledge, skills, expertise of the current workforce to expand or improve the administration of mitigation assistance. The maximum allocation for a state or territory under this category is $2,000,000, covering all activities/projects.

National Competition: Mitigation Projects grant funds are available to support cost-effective projects designed to increase resilience and public safety; reduce injuries and loss of life; and reduce damage and destruction to property, critical services, facilities, and infrastructure (including natural systems) from a multitude of natural hazards and the effects of climate change. Applicants may submit an unlimited number of project applications each valued up to $50,000,000. All National Competition projects must meet the rigorous quantitative and qualitative criteria and capture one or more of the following:

- Is an infrastructure project
- Incorporates of nature-based solutions for hazard mitigation
- Has mandatory state-wide building code adoption requirement
- Has Building Code Effectiveness Grading Schedule (BCEGS) Rating of 1 to 5
- Is generated from a previous FEMA HMA Project Scoping award or any other federal grant award, or the subapplicant is a past recipient of BRIC non-financial Direct Technical Assistance
- Has a non-federal cost share of at least 30% or, for Economically Disadvantaged Rural Communities a non-federal cost share of at least 12%
- Any community with a Centers for Disease Control and Prevention Social Vulnerability Index (CDC SVI) of 0.60 to 0.79, designated as an Economically Disadvantaged Rural Community, or any community with a CDC SVI of 0.80 or higher.

Eligibility: State, local and tribal entities are eligible to apply for funding. Mitigation projects must comply with federal environmental and historic property (EHP) regulations, laws, and executive orders, as applicable, and

must align with the State Mitigation Plan and Local or Tribal Mitigation Plan. Subapplicants are required have a FEMA-approved Local or Tribal Hazard Mitigation Plan by the application deadline and at the time of obligation of grant funds for mitigation projects (with the exception of mitigation planning). Mitigation activities are required to demonstrate cost-effectiveness. Applicants applying for mitigation projects must provide a BCA or other documentation that validates cost-effectiveness.

Submission Requirement: FY23 application cycle information currently not available. FY22 application cycle closed. Deadline to submit subapplication to the state was November 14, 2022 by 5:00 P.M. The Notice of Interest was due to FDEM no later than September 20, 2022 for the FY22-23 application period. Cost Share/Local Match requirement is a minimum of 25% non-federal sources for the local match portion and federal funding is available for up to 75% of eligible costs. Small, impoverished communities are eligible for cost share up to 90% federal/10% non-federal.

Eligible Activities: BRIC activities include but are not limited to the following:

- Building codes activities (State/Territory Competition C&CB)
- Partnerships, project scoping (State/Territory Competition C&CB)
- Hazard mitigation planning and planning related activities, and other activities (State/Territory Competition C&CB)
- Non-critical Structure Elevation (National Competition Mitigation Projects)
- Dry Floodproofing (National Competition Mitigation Projects)
- Mitigation Reconstruction (National Competition Mitigation Projects)

8.2.1.6 Florida Division of Emergency Management Flood Mitigation Assistance Program

Program Summary: The FEMA FMA program is administered by the FDEM and provides funding to eligible entities including local governments–cities, townships, counties, special district governments, state agencies, and federally recognized tribes. FMA funding is available annually regardless of whether a disaster has occurred in the previous year. FMA funds are available to support projects that either reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP. Eligible project types include:

Individual Flood Mitigation Projects: Grant funds can support projects that will 1) mitigate flood damage to at least 50% of structures that meet the definition of a severe repetitive loss (SRL) property, 2) mitigate flood damage to at least 50% of structures that meet the definition of a repetitive loss (RL) property, or 3) mitigate flood damage to at least 50% of structures that meet the definition of an SRL property. Project must also demonstrate:

- **Substantial Damage**: Structures that were determined Substantial Damage by the community within five (5) years of the submission deadline.
- **CDC Social Vulnerability Index (SVI)**: CDC Social Vulnerability Index (SVI) and NFIP Properties: Projects that benefit area(s) with average SVI score of greater than or equal to 0.6 (greater or equal to 0.8 maximum scoring).

Severe Repetitive Loss (SRL)/Repetitive Loss (RL) Property

Localized Flood Risk Reduction Project: All Localized Flood Risk Reduction projects must demonstrate that the proposed project benefits NFIP insured properties. Projects are eligible to receive up to $50 million of federal share. All Localized Flood Risk Reduction subapplications submitted for funding must demonstrate or incorporate the following:

- NFIP policy that is active as of the FMA application start date and is verified within the benefitting area of the project.
- CDC Social Vulnerability Index (SVI): CDC Social Vulnerability Index (SVI) and NFIP Properties: Projects that benefit area(s) with average SVI score of greater than or equal to 0.6 (greater or equal to 0.8 maximum scoring).
- Consideration for Climate Change and Other Future Conditions
- Incorporation of Nature-Based Solutions
- Severe Repetitive Loss (SRL) and Repetitive Loss (RL) Properties
- National Violation Tracker (NVT): Communities in good standing in the NFIP
- Community Rating System (CRS) Participation: Community floodplain-management activities that exceed the minimum National Flood Insurance Program standards.
- Cooperating Technical Assistance Partners Program (CTP) Participation
- FEMA Generated Projects or Other Federal Grant Award: Application generated from a previous federal grant award.
- Capability and Capacity Building (C&CB): C&CB activities should result in a resource, strategy, or tangible mitigation product that will reduce or eliminate risk and damage from future flooding, increase resilience, and promote a culture of preparedness, and projects must demonstrate that it will reduce flood claims against the NFIP based on the following (but not limited to):
- CDC Social Vulnerability Index (SVI) and NFIP Properties: Projects that benefit area(s) with average SVI score of greater than or equal to 0.6 (greater or equal to 0.8 maximum scoring)
- National Violation Tracker (NVT): Communities in good standing in the NFIP
- Community Rating System (CRS) Participation: community floodplain management activities that exceed the minimum National Flood Insurance Program standards.

Eligibility: State Agencies, Federally-Recognized Tribes, Local governments, and Federally-recognized Native American Tribal Governments are eligible to submit a subapplication. Owners of structures, residential or non-residential, that have been previously flooded must consult with their local or Native American Tribal government about submitting an application on their behalf for grant funds. All subapplicants must be participating in the NFIP, and not be withdrawn, on probation, or suspended. Structures identified in the subapplication must have an NFIP policy in effect at the application start date and must maintain it through completion of the mitigation activity and for the life of the structure. Community Flood Mitigation Projects are only eligible for 75% of the federal cost share. FEMA may contribute 100% of the federal cost share for Individual Mitigation Projects that include SRL properties and up to 90% of the federal cost share for RL properties. Mitigation projects must comply with federal EHP regulations, laws, and executive orders, as applicable. The EHP review process must be completed before funds are released to carry out the proposed project. Mitigation activities are required to demonstrate cost-effectiveness. Applicants applying for mitigation projects must provide a BCA or other documentation that validates cost-effectiveness. Subapplicants must have a FEMA-approved Local or Tribal Hazard Mitigation Plan by the application deadline and at the time of obligation of grant funds for mitigation projects (with the exception of mitigation planning). Project scoping, community flood mitigation projects, individual flood mitigation projects, and technical assistance applications must be consistent with the goals and objectives identified in the current FEMA-approved State or Tribal

(Standard or Enhanced) Mitigation Plan, and the local mitigation plan for the jurisdiction in which the project is located. The FMA program will prioritize assistance that benefits disadvantaged communities.

Submission Requirements: FY23 application cycle information currently not available. FY22 application cycle closed. Deadline to submit subapplication to the state was November 14, 2022 by 5:00 P.M. The Notice of Interest was due to FDEM no later than September 20, 2022 for the FY22-23 application period.

Eligible Activities: FMA activities include but are not limited to the following:

- Localized flood control (Local Flood Risk Reduction)
- Floodwater storage and diversion (Local Flood Risk Reduction)
- Floodplain and stream restoration (Local Flood Risk Reduction)
- Stormwater management (Local Flood Risk Reduction)
- Wetland restoration/creation (Local Flood Risk Reduction)

8.2.1.7 Florida Division of Emergency Management Hazard Mitigation Grant Program

Program Summary: The FEMA HMGP is administered by the FDEM and provides funding to eligible entities including state, local, tribal, and territory governments to support rebuilding efforts that reduce or mitigate future disaster-related losses. Grant funding through the HMGP is only made available following a presidentially declared disaster. HMGP funds are available for a broad range of uses, and projects do not have to align with a specific disaster (i.e., if a flood declaration is issued, an applicant can submit a project for tornado protection). Eligible project types and activities include:

- Flood Control and Drainage Improvement projects to reduce potential flood damage
- Utility Mitigation

Eligibility: The process of selecting eligible mitigation projects to be submitted for funding consideration has been delegated to each county's Local Mitigation Strategy Working Group (LMSWG) Grant-funded projects must comply with federal EHP regulations, laws, and executive orders, as applicable. The EHP review process must be completed before funds are released to carry out the proposed project. Mitigation activities are required to demonstrate cost-effectiveness. Applicants applying for mitigation projects must provide a BCA or other documentation that validates cost-effectiveness. Applicants also must have a FEMA-approved Local or Tribal Hazard Mitigation Plan by the application deadline and at the time of obligation of grant funds for project, project scoping, and technical assistance subapplications. Federal funding is available for up to 75% of eligible costs and the remaining 25% of eligible costs must be derived from non-federal sources (local match).

Submission Requirements: The grant application cycle for all HMGP disaster declarations are closed.

Eligible Activities:

- Retrofitting of existing buildings to make them less susceptible to damage from a variety of natural hazards.
- Development and adoption of hazard mitigation plans, which are required for state, local, tribal, and territorial governments to receive funding for hazard mitigation projects.
- Aquifer storage and recovery, floodplain and stream restoration, flood diversion and storage, or green infrastructure methods to reduce the impacts of flood and drought.
- Utility and infrastructure retrofits to reduce risk of failure caused by natural hazards

- Acquisition of hazard-prone property to remove people and structures from harm's way.
- Slope stabilization projects to reduce risk to people and structures

8.2.1.8 Florida Department of Economic Opportunity CDBG-DR

Program Summary: The Community Development Block Grant Disaster Recovery (CDBG-DR) program provides funding after Presidentially Declared Disaster for projects that focus on long-term recovery efforts. Grants may fund Disaster Relief, Long Term-Recovery, Restoration of Infrastructure, Housing, and Economic Revitalization. Funds may also be used to address an unmet need that arose from a previous disaster. Eligible projects include (but not limited to):

- Infrastructure: Replacement, relocation, or repair of damaged public facilities except for buildings for the general conduct of government.
- Planning and Capacity Building: Studies, analysis, data gathering, preparation of plans, and identification of actions to implement plans.
- Preparedness and Mitigation: Rebuilding activities, preparedness and mitigation measures.

Eligibility: Funds are awarded to state and local governments which become grantees. Those who receive grant money include state agencies, non-profit organizations, economic development agencies, citizens and businesses. All projects supported by HUD CDBG assistance must meet one of the CDBG's three National Objectives: benefiting low-and-moderate income (LMI) persons, addressing a severe and recently arising urgent community welfare or health need, and preventing or eliminating slum and blighting conditions. Cost share not required.

Submission Requirements: Following future disasters, subapplicants should consult with FDEO for program deadlines and submission guidance. Variable (disaster-dependent)

Eligible Activities:

- Construction
- Acquisition
- Preconstruction (design, engineering, planning)
- Rehabilitation/reconstruction
- Road and Bridge Repair – Water & Wastewater Facilities
- Job training and workforce development
- Loans and grants to businesses
- Improvements to commercial/rental districts

8.2.1.9 Florida Department of Economic Opportunity CDBG-MIT

Program Summary: The Community Development Block Grant Mitigation (CDBG-MIT) program provides assistance to areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate long-term disaster risks, reduce future loss, and protect community services that benefit human health and safety or economic security. Programs include:

- General Planning Support Program (GPS): support high-quality mitigation planning that will build a foundation for continuous coordination and data-driven outcomes.

- Critical Facility Hardening Program (CFHP): critical facilities are defined as the buildings/structures that serve a public safety purpose for local communities.
- General Infrastructure Program (GIP): funding to units of general local government to, upgrade water, sewer, solid waste, communications, energy, transportation, health and medical and other public infrastructure projects.

Eligibility: Local government including educational institutions, state agencies, and non-profits are eligible to apply. Projects must be in conformance with the State Mitigation Plan and Local or Tribal Mitigation Plan, beneficially impact HUD or state designated Most Impacted and Distressed (MID) areas, be cost-effective, and meet one of the CDBG's three National: benefiting low-and-moderate income (LMI) persons, addressing a severe and recently arising urgent community welfare or health need; or preventing or eliminating slum and blighting conditions. Cost Share not required.

Submission Requirement: Following future disasters, subapplicants should consult with FDEO for program deadlines and submission guidance. Application deadline for Round II is closed, however there is a future round - Round III (note: General Infrastructure Program (GIP) for Hurricane Michael closed on June 24, 2022). Round III will commence in 2022 with $150 million in funding, plus all remaining unobligated funds being available for allocation.

Eligible Activities: eligible activities include but are not limited to:

- Dry and wet proofing (CFHP)
- Energy resiliency Participant outreach (CFHP)
- Construction (GIP)
- Rehabilitation or construction of stormwater management systems (GIP)
- Improvements to drainage facilities GIP
- Modernization and resiliency planning (GPS)
- Comprehensive, capital improvement, and community development mitigation planning (GPS)
- Floodplain and wetland management plans (GPS)
- Upgrading mapping, data and other capabilities to better understand evolving disaster risks (GPS)
- Planning and public service activities necessary to reduce flood insurance premiums in the National Flood Insurance Program's (NFIP) voluntary Community Rating System incentive program (GPS)

8.2.1.10 Florida Department of Economic Opportunity Small Cities CDBG Program

Program Summary: The Florida Department of Economic Opportunity (DEO) administers the Small Cities CDBG Program. This competitive grant program awards funds to local governments in small urban and rural areas. The program provides an opportunity for communities to obtain funds for projects that they cannot otherwise afford. CDBG funds can also provide administrative support for local governments that may not have the staffing resources necessary to administer their projects. Examples of CDBG-funded projects include (but not limited to:

- Water and Sewer Improvements
- Drainage and Stormwater Improvements

Eligibility: Activity must meet at least one of the following National Objectives: benefiting to Low-and Moderate-Income Persons, eliminating of Slum and Blight, and addressing an Urgent Need. The condition must have

occurred within 18 months of application. Local governments applicants must demonstrate an inability to finance the activity on its own and that other funding is not available.

Submission Requirements: FY23 application cycle information currently not available FY22 application cycle closed (June 6, 2022 and closes July 21, 2022).

Eligible Activities: eligible activities include but are not limited to:

- Construction
- Rehabilitation or construction of stormwater management systems
- Improvements to drainage facilities
- Modernization and resiliency planning
- Capital improvements

8.2.1.11 EDA Public Works and Economic Adjustment Assistance Program

Program Summary: Public Works program provides funding to build, design, or engineer critical infrastructure and facilities that will help implement regional development strategies and advance economic development goals. Under the American Rescue Plan, the Economic Development Administration (EDA) allocated $3B in supplemental funding to assist communities nationwide. Funding includes support for economic development assistance to support long-term community economic recovery planning and project implementation, redevelopment and resilience. Projects must be aligned with a current CEDS (Comprehensive Economic Development Strategy) or equivalent EDA-accepted regional economic development strategy and clearly lead to the creation or retention of long-term high-quality jobs. Funds may be used for a wide variety of infrastructure projects including water and sewer system improvements. The goal of the program is to support projects that: lead to the creation and retention of jobs and increased private investment, advance innovation, enhance the manufacturing capacities of regions, provide workforce development opportunities, and grow ecosystems that attract foreign direct investment.

Eligibility: State, county, tribal, city and township, and special district governments, Institutions of higher education and Nonprofits are eligible to apply for funding. Cost share requirements include federal: 50% local: 50%. Projects may receive an additional amount up to 30% of the total project cost, based on the needs of the region in which the project will be located.

Submission Requirements: There are no submission deadlines under this opportunity. Applications will be accepted on an ongoing basis until a new NOFO is published, this PWEAA NOFO is cancelled, or all funds have been expended. Applications for submission to EDA are available on Grants.gov. Applicants must register prior to submitting the application.

Eligible Activities:

- Construction
- Non-construction
- Planning
- Technical Assistance
- Revolving Loan Fund

8.2.1.12 US Treasury State and Local Fiscal Recovery Funds

Program Summary: American Rescue Plan Coronavirus State and Local Fiscal Recovery Funds (SLFRF) program funds are intended to provide support local governments to facilitate the ongoing recovery from the COVID-19 pandemic. Funds can also be used to make necessary investments in water, sewer, and broadband infrastructure to address the consequences of deferred maintenance in drinking water systems and removal, management, and treatment of sewage and stormwater, along with additional resiliency measures needed to adapt to climate change. The State of Florida, through the Florida Division of Emergency Management (Division), will disburse Coronavirus Local Fiscal Recovery Funds to non-entitlement units of local government through the Supplemental Resilient Florida Grants program. All county governments in the State of Florida (regardless of population) will receive funding directly from Treasury and must apply directly to Treasury to receive such funding.

Eligibility: Eligible entities include Counties, municipalities and other eligible entities as identified in Florida statute, local governments designated as non-entitlement. Cost share not required. Projects must be complete by Dec. 31, 2026 (no extensions permitted).

Submission Requirements: The City may request their allocation of Coronavirus State and Local Fiscal Recovery Funds through the Treasury Submission Portal (https://api.id.me/en/session/new).

Eligible Activities:

- Planning
- Pre-construction
- Implementation projects that address risks of flooding or sea level rise

8.3 State Funding Opportunities

8.3.1 St. Johns River Water Management District Districtwide Cost Share Funding Program (FY2023-24)

Program Summary: The Cost Share Program is a partnership between the District and local governments to ensure the completion of shovel-ready stormwater/flood protection projects designed to reduce flooding risks and improve water quality. The cost-share funding can support the following project types:

- Improved nutrient treatment processes of existing wastewater treatment facilities
- Pumping stations and storage facilities
- Transmission and distribution systems
- Improved landscape irrigation efficiencies
- Low impact development (LID) projects with a net water quality benefit
- Regional flood control projects
- Natural systems restoration and enhancement

Eligibility: Applications for cost-share funding for projects that benefit the District's core missions from Dec. 1, 2022, through 5 p.m. on Jan. 31, 2023. Projects are eligible for a maximum district cost-share of $3 million per project or per applicant and funding is limited exclusively to construction-related costs. Projects should be completed within two years and must start no later than June 30, 2023. The district will fund up to 25 percent of

the construction costs for selected alternative water supply, water quality, flood protection, and natural systems projects and up to 50 percent for water conservation projects.

Submission Requirements: Applications due January 31, 2023 at 5 p.m. through the Online Application System.

Eligible Activities:

- Construction
- Construction engineering and inspection services
- Water quality best management practices
- Retrofitting of stormwater outfalls with tidal backflow prevention valves
- Reconstruction of weirs, construction of watershed management collection and stormwater treatment systems
- Stormwater management system expansion and reconstruction
- Plumbing retrofits (conservation-related)
- Piping and other materials directly related to construction of the project

8.3.2 Florida Department of Environmental Protection Resilient Florida Program

Program Summary: The Resilient Florida Grant Program includes a variety of grants that are available to counties, municipalities, water management districts, flood control districts and regional resilience entities aimed to address the impacts of flooding and sea level rise that the state faces, eligible applicants may receive funding assistance to analyze and plan for vulnerabilities, as well as implement projects for adaptation and mitigation.

Statewide Flooding and Sea Level Rise Resilience Plan: Grant program aimed to effectively address the impacts of flooding and sea level rise that the state faces, eligible applicants may receive funding assistance to analyze and plan for vulnerabilities, as well as implement projects for adaptation and mitigation. Beginning December 1, 2021, and each December 1 through 2024, the Florida Department of Environmental Protection will develop a Statewide Flooding and Sea Level Rise Resilience Plan. The plan must consist of ranked projects that address risks of flooding and sea level rise to coastal and inland communities in the state. All eligible projects submitted to DEP must be ranked and included in the plan.

Supplemental Resilient Florida Grants: state-directed American Rescue Plan Act Coronavirus State and Local Fiscal Recovery Funds (SLFRF). $20 million allocated for planning and pre-construction. SLFRF funds are a one-time appropriation to the program. The projects funded by the SLFRF are subject to legislative review and approval and must be submitted to the Legislature by Dec. 1, 2022. The projects can be awarded when funds are released by the U.S. Department of Treasury

Eligibility: Counties, municipalities, water management districts, flood control districts and regional resilience entities. Local governments are eligible to apply for implementation project funding after conducting a vulnerability assessment, evaluation, report, or other similar document that demonstrates a risk of flooding or risks due to sea level rise to a critical asset or the project area. Minimum of 50% match unless qualified as a financially disadvantaged small community. Project to be considered for eligibility must be included in the Statewide Flooding and Sea Level Rise Resilience Plan and or Plan update. By September 1 of each (through 2024, county and local government entities, and special districts must submit to DEP a list of proposed projects that address and mitigate the risks of flooding or sea level rise on water supplies or water resources of the state. Each project

included in the plan must have a minimum 50-percent cost share unless the project assists or is within a financially disadvantaged small community.

Submission Requirements: FY23 application cycle information currently not available. FY22 application cycle closed.

Eligible Activities:

- Planning
- Pre-construction
- Implementation projects that address risks of flooding or sea level rise

8.4 Grant Funding Recommendations

The project recommendation list was developed in an effort to pair CIP projects with external funding sources. Identifying appropriate funding agencies was key in determining the types of support available. Both state and federal agencies administer programs that may align with of the long-term funding goals of City. The completion of this assessment revealed that any funding opportunities selected would need to support repair and replacement costs associated with aging infrastructure, while also requiring limited or no cash contributions by the City ("local match").

Once the City is prepared to move forward from prioritization and project selection to proposal development, it will be critical to establish clear milestones to ensure that planning, design, and construction timelines align with application requirements and deadlines. To avoid missing out and the substantial grant funding opportunities available including BIL funding, each project scope/description must clearly demonstrate that the proposed activities are eligible and meet the primary objectives of the federal or state program. While the projects included in the funding table below appear to be in the best position to move forward with an application, eligibility is ultimately determined by the funding agency and each funding agency has their own eligibility criteria.

To strengthen the competitiveness of any application, it may be useful to link the primary need to repair aging City infrastructure with other beneficial outcomes including, for example, enhancing protection against threats in areas that are or have been susceptible to natural hazards or disaster-related events; and/or demonstrating the project will be located in or benefit small or disadvantaged communities. Making the case that the project will reduce hazards and impact vulnerable communities will increase the range of funding options available to the City. For example, the City may be eligible to apply for grant funding offered by FEMA through any of the mitigation and resilience programs if the project can demonstrate the following factors:

- The project is located in a floodplain
- The project will reduce or eliminate flood risk to residents and/or buildings and structures insured under the National Flood Insurance Program (NFIP)
- The project will reduce or eliminate risk to a natural hazard, the facility or equipment has failed or become damaged as a result of extreme weather events and chronic stressors
- The project will cost beneficial and minimize any expected future losses, or
- The project includes studies/plans (ex. project scoping, mitigation planning) yet to be conducted but necessary for pending upgrades or replacement of the facility or equipment.

Based all of the information provided and gathered, including the fiscal needs and challenges identified by the City, the table included below provides an overview of funding that could potentially support CIP projects.

Table 8-2. Funding Recommendations by Project Type

Project Type	Funding Source	Funding Mechanism	Eligible Activities	Cost Share Requirements (Federal/Local)	Funding Cap (Per application)	Application Deadline
Bulkhead Dredging	CWSRF	Low-interest Loan	Stormwater Best Management Practices Retrofits of Stormwater BMPs Stream Restoration Buffer Restoration Upgrades, Repair, Replacement, or Installation and Construction	Low-interest loans with an interest rate at 3%	Project dependent	FY22 Application Closed. FY23 submission info not available.
Bulkhead	(S)/WIFIA	Credit Assistance	Planning and Feasibility Analysis Environmental Review Permitting Preliminary Engineering and Design Work Construction, Reconstruction, Rehabilitation, and Replacement Acquisition of real property including water rights or land relating to the project	Low-cost supplemental loan (0% interest to market rate)	Up to $20M or $5M for Small Community	LOI Submission Open
Bulkhead Dredging	Nonpoint Source	Grant	Construction, Reconstruction, Rehabilitation, and Replacement of Stormwater Infrastructure Activities to Manage, Reduce or Recapture stormwater or subsurface drainage water	60:40	Project dependent	Application Cycle Open
Use of Dredge Material (from canals, waterways, etc.)	BRIC (National Competition)	Grant	Floodplain Restoration Mitigation Reconstruction	75:25	Up to $50M	FY22 Application Closed. FY23 submission info not available.
Bulkhead Dredging	FMA	Grant	Localized flood control Floodwater storage and diversion Floodplain and stream restoration Stormwater management	75:25	Up to $100K Multi-Hazard Mitigation Plans $900K Project Scoping $300K C&CB	FY22 Application Closed. FY23 submission info not available.
Dredging	CDBG-DR	Grant	Preparedness and Mitigation Construction Acquisition Preconstruction (design, engineering, planning) Rehabilitation/reconstruction	N/A	Project dependent	Consult with FDEM for submission
Dredging	CDBG-MIT (Round III)	Grant	Construction Rehabilitation or construction of stormwater management systems	N/A	Project dependent	Consult with FDEO for submission

Table 8-2. Funding Recommendations by Project Type

Project Type	Funding Source	Funding Mechanism	Eligible Activities	Cost Share Requirements (Federal/Local)	Funding Cap (Per application)	Application Deadline
			Improvements to drainage facilities			
Use of Dredge Material (from canals, waterways, etc.)	EDA Public Works	Grant	Construction, Design, and Engineering of Critical Infrastructure	50:50	Up to $30M	Open
Bulkhead Dredging	SLFRF	Grant	Resiliency measures needed to adapt to climate change	N/A	Consult with FDEM	Open Consult with FDEM for submission
Any (Stormwater & Flood Protection)	St. Johns RWMD Cost Share Program	Grant	Construction and Construction engineering Reconstruction of Weirs Construction of Watershed Management Collection and Stormwater Treatment Systems Stormwater Management System Expansion and Reconstruction	N/A	Up to $3M	Applications due January 31, 2023

Table 8-3. Funding Recommendations by Source/Opportunity

Funding Opportunity	Eligible Entities	Program Criteria
Bridge Investment Program https://www.fdot.gov/planning/policy/legislation/Bipartisan-Infrastructure-Law-(BIL).shtm	State, Tribal Government, MPOs (> 200,000 people), Local Governments Special Purpose District	Administered by FDOT Pending release of guidance: grant (BIL) program to support replacement or rehabilitation of culverts to improve flood control and improve habitat connectivity for aquatic species. Planning, Large Project (>$100M), and Project (<$100M) competitive grant program open June to September Up to 5% of funds available for solely culverts Cost Share: TBD
Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) https://www.fdot.gov/planning/policy/legislation/Bipartisan-Infrastructure-Law-(BIL).shtm	State, Tribal Government, MPOs (> 200,000 people), Local Governments Special Purpose District,	Administered by FDOT Pending release of guidance: grant (BIL) program to support planning, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure to increase resilience from the impacts of sea level rise, flooding, wildfires, extreme weather events, and other natural disasters. Cost Share: TBD
Local and Regional Project Assistance Grants (RAISE) https://www.fdot.gov/planning/policy/legislation/Bipartisan-Infrastructure-Law-(BIL).shtm	State, Tribal Government, Local Government	Administered by FDOT Pending release of guidance: grant (BIL) program to support projects to replace or rehabilitate a culvert or prevent

Table 8-3. Funding Recommendations by Source/Opportunity

Funding Opportunity	Eligible Entities	Program Criteria
	Special Purpose District	stormwater runoff for the purpose of improving habitat for aquatic species. Cost Share: TBD
FEMA-PA https://www.floridadisaster.org/dem/recovery/public-assistance-program/	State, Tribal Government, Local Governments, Private Non-Profit Organizations	Administered by FDEM Grant program to support recovery from major disasters or emergencies declared by the president for debris removal and emergency protective measures, repair, replacement or restoration of disaster-damaged, publicly owned facilities. PA funding information for Hurricane Ian and Nicole pending. Cost Share/Local Match: 75%/25% (federal/non-federal)
FEMA-HMGP https://www.floridadisaster.org/dem/mitigation/hazard-mitigation-grant-program/	State, Tribal Government, Local Governments, Private Non-Profit Organizations	Administered by FDEM Grant program to support rebuilding efforts that reduce or mitigate future disaster related loses. Only available following a presidentially declared disaster, however projects do not have to align with a specific disaster. HMGP funding information for Hurricane Ian and Nicole pending. Cost Share/Local Match: 75%/25% (federal/non-federal)
CDBG-DR https://floridajobs.org/community-planning-and-development/assistance-for-governments-and-organizations/disaster-recovery-initiative	State and State Agencies, Local Governments, Non-Profit Organizations, Economic Development Agencies	Administered by DEO Grant program to support disaster relief, long-term recovery, and restoration of infrastructure in a Presidentially declared area for the covered disaster. CDBG-DR funding information for Hurricane Ian and Nicole pending. Cost Share/Local Match: 100% (federal)
CDBG-MIT https://floridajobs.org/rebuildflorida/mitigation	State Agencies, Local Governments, Non-Profits, Educational Institutions	Administered by DEO Grant program to support disaster mitigation projects in areas impacted by presidentially declared disasters. CDBG-DR funding information for Hurricane Ian and Nicole pending. Cost Share/Local Match: 100% (federal)

Notes:
The funding opportunities presented in this Table 2 reflect funding that may *potentially* be available in 2023 to support various mitigation and infrastructure projects. At the time of this report, limited information was available on the specific program criteria, funding cycle timelines, and funding availability. The City is strongly encouraged to review and monitor these programs periodically.

9 Conclusions and Recommendations

9.1 Operational Recommendations

1. Increase SWMS Maintenance Activities

The number and types of maintenance activities indicated in the proposed O&M Plan represent the minimum level of maintenance effort needed to properly maintain the City's SWMS.

2. Implement the CMMS and Improve SWMS Documentation

The City does not currently have a CMMS system and has had issues with NPDES MS4 permit documentation. As an interim measure, an MS-Excel CMMS system has been developed for the City's use along with SOPs and documentation protocols to help improve documentation of SWMS assets and maintenance activities performed.

3. Increase Stormwater Department Staffing

Based on the labor needs to perform the minimum level of maintenance on the City's SWMS, ten additional FTE positions will be needed. The Arcadis departmental financial model assumes these positions would be added over a three-year period.

4. Modernize and Increase the Capital Equipment Fleet

- The current Stormwater Department fleet consists of 24 light vehicles and heavy equipment, of which 5 (21%) appear beyond their useful life. It is recommended that a detailed fleet analysis be conducted to determine an appropriate operational life for each fleet item based on maintenance data and usage rates, and to plan for future replacement needs and costs.
- Based on the equipment needs to perform the minimum level of maintenance on the City's SWMS, five fleet items need to be replaced and one additional vactor truck and one additional backhoe are needed. The addition of more energy efficient light vehicles (i.e., EVs) should be considered for activities that only involve visual inspections.

5. Increase Available Canal Storage Volume

- Include an adjustable weir in the Concha Dam replacement design to allow the City to decrease canal water elevations by approximately 1.5 feet. This will increase the storage capacity of the canal system available at the beginning of a storm event and will reduce peak discharges to the South Prong of the St. Sebastian River. The adjustable weir should be designed so that stored stormwater in the canals will slowly discharge through the weir and the canal storage volume will recover within 14 days following a storm event. Decreasing the peak discharge will also improve downstream water quality by reducing the dilution effect of the fresh water on salinity levels in the St. Sebastian River and the Indian River Lagoon.
- Replace the wood stoplogs on the Hardee Dam with new ones, and lower the control elevation in the Collier Canal by 1.5 feet. Hardee Dam current control elevation of 15.06 ft NGVD29 based on the 2006 *Collier Canal Stormwater Retrofit* Permit Drawings provided in Appendix I.

6. Coordinate Maintenance of the Hardee Dam Spillway with SJRWMD

The SJRWMD was granted a conservation easement dated January 17, 2002, from Collier Club, Inc. and the Collier Club Homeowner's Association during the development of the Collier Club property. According to the easement document, the purpose of the conservation easement is to "*assure that the Property will be retained*

forever in its existing natural condition and to prevent any use of the Property that will impair or interfere with the environmental value of the Property".

Unfortunately, the conservation easement includes the flow path from the Hardee Dam, which has been in place for decades, and based on discussions with City staff, the SJRWMD considers the easement area a "natural area" and does not intend to maintain the original grades and cross section of the flow path. Over time, the flow path will fill in with sediment and vegetation, which will reduce or completely stop the discharge flow from the Hardee Dam during storm events. Without the discharge flow over the dam, the only other way for water to escape from the Collier Canal North is to increase stage to approximately elevation 14 feet, NAVD88 and discharge south through the 48-inch diameter culvert under Sebastian Blvd. This represents a significant reduction of discharge capacity from the Collier Canal North and modeling results indicate that flooding in the area draining to the canal would increase during the 10-year or larger storm events.

After reviewing the easement document, it appears that two problems exist, and it is recommended that these problems be brought to the attention of the SJRWMD:

1. The area of the conservation easement is not natural, as it is a flow way from the Hardee Dam, which was likely constructed in the 1950's or 1960's when the Collier Canal North was constructed during the development of the Sebastian Highlands. An inherent conflict exists between the competing uses of drainage and conservation of existing condition.
2. The easement document contains conflicting prohibitions in Section 2, as prohibitions 2.(c) and (d) appear to directly conflict with 2.(f).

   2.(c). Removing, trimming or destroying trees, shrubs, or other vegetation.

   2.(d). Excavating, dredging or removing loam, peat, gravel, soil, rock or other material substances in such a manner as to affect the surface.

   2.(f). Activities detrimental to drainage, flood control, water conservation, erosion control, soil conservation, or fish and wildlife habitat preservation.

It is also recommended that an additional analysis be performed, but if the intention was to maintain the flow way according to the lines and grades present at the time the conservation easement was recorded, that would not appear to be contrary to the terms of the easement and would likely be sufficient for ongoing drainage maintenance.

7. Obtain TMDL Load Reduction Credits for BMAP Activities

To date, 16 projects have been completed by the City or are currently underway, resulting in load reduction credits of 5,223 lbs./year of TN (15.7% of required reduction) and 620 lbs./year of TP (10.3% of required reduction). While the City's performance appears to be lower than the overall progress reported for CIRL Project Zone SEB, it should be noted that the City has not yet received reduction credits for seven completed projects, including the Stormwater Park. That single project may account for a significant part of the City's required reduction goals. It is recommended that the City continues to obtain TMDL load reduction credits for BMAP activities.

8. Establish a Certification Program for Private Systems

Ensuring that privately-owned BMPs are properly operated and maintained is very important, as they typically discharge into the City's SWMS. For this reason, it is recommended that the City establish a program for annual certifications for all privately-owned stormwater systems. Such a program may include:

- A certification fee, additional revenue to the City's Stormwater Department, to offset processing costs
- Requiring an annual inspection report by a Florida-licensed professional engineer and accompanying digital time-stamped photographs.
- Requiring a certification form, signed and sealed by a Florida-licensed professional engineer documenting that the system is properly maintained and operating as designed and permitted.
- The City has a certification program in its existing Stormwater Fee Credit program for private systems exceeding SJRWMD standards, which could be used to incorporate this recommended maintenance certification for private systems.

9. Reduce Costs Where Possible

- On vacant parcels that have "Quarter Round" installed, the City crews must hand clean the Front Yard swale to prevent damage to the PVC, which is labor-intensive and costly to the City. It is recommended that the City considers removing the "Quarter Round" in these vacant parcels at the next cleaning and eliminate the need for hand cleaning, as the conveyance benefits of the PVC pipe quarters are outweighed by the additional maintenance costs to the City, estimated at approximately $140,000 per year.
- It is recommended that the City considers the need to identify other funding sources for activities unrelated to the SWMS such as sidewalk replacements.

10. SWMS Survey Information Needs

- Continue the development of a City-wide survey monument network that is needed to allow for rapid elevation checks of SWMS components.
- Perform a full bathymetric survey of all canals, waterways, and retention/detention ponds in the SWMS to verify whether dredging is needed to restore the original design grades and storage and conveyance capacity.

9.2 Policy and Local Ordinance Recommendations

Policy 1-2.3.2 – Incorporate Innovative Techniques in the Land Development Code – In accordance with this policy, it is recommended that the City considers allowing the use of stormwater harvesting tanks as a method for residential and commercial properties to meet their required stormwater detention volumes. Such systems should be designed to recover no more than half their available volume within 24 hours following a storm event and recover their full volume within 72 hours.

Code of Ordinances - Section 54-2-7.15(d)

Paragraphs (2) and (3) of this Code section establish that the property owner is responsible for the maintenance of all drainage features on a property, including front yard swales, driveway culverts, side yard swales, and back yard ditches to maintain the proper flow of surface water. For several years, the City has contracted with an outside contractor for the mowing and maintenance of the side yards and back yards. Consider revising the Code to reflect the change in maintenance responsibility.

Code of Ordinances - Sec. 54-3-12.5. - Exemptions.

The City's stormwater system does not have sufficient storage and conveyance capacity to prevent localized flooding in a 10-year storm event, as evidenced by modeling results. The system is operating beyond its design capacity, and in order to improve existing drainage issues, it is recommended that the City consider amending its Land Development Code exemptions as discussed below.

Sec. 54-3-12.5. currently provides that the following activities shall be exempt from the surface water management permitting requirements herein established:

(a) Any maintenance, alteration, renewal, repair, use or improvement of an existing structure which does not change or affect the rate or volume of stormwater runoff, or the construction of any structure or addition thereto which does not create an impervious surface exceeding ten percent of the site or 5,000 square feet, whichever is less.

The clause "*or the construction of any structure or addition thereto which does not create an impervious surface exceeding ten percent of the site or 5,000 square feet, whichever is less."* could be deleted or modified, as it allows for the addition of up to 5,000 square feet (SF) of impervious area without any offsetting storage. The rainfall depth for the 25yr-24hr storm event is 9.17 inches, and in that storm a 5,000 SF concrete slab (or structure) would result in approximately 3,821 cubic feet (28,580 gallons) of runoff, with no storage requirement. The City's SWMS does not have the capacity to convey or store such additional runoff loads, so detention storage of at least the 25-year, 24-hour runoff volume could be required for any additional impervious area.

Code of Ordinances - Sec. 54-3-12.10. - Type "A" permit, stormwater management (drainage)

The requirements for the Type "A" stormwater permit should be modified to include detention storage of at least the 25-year, 24-hour runoff volume as explained above. Per Sec. 54-3-12.1. – Applicability, this requirement would then be applicable to all new construction, development or redevelopment requiring updated code compliance

Appendix A

National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit

FLORIDA DEPARTMENT OF Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Noah Valenstein
Secretary

March 2, 2020

Sent via E-post

Paul Carlisle
City Manager
City of Sebastian
1225 Main Street
Sebastian, FL 32958

Subject: City of Sebastian Phase II Municipal Separate Storm Sewer System (MS4)
NPDES Permit ID Number FLR04E124 (Cycle 4)
Notice of Renewed Permit Coverage - FINAL

Dear Paul Carlisle:

The Florida Department of Environmental Protection has received and processed your submittal of the *Notice of Intent to Use Generic Permit for Discharge of Stormwater from Phase II Municipal Separate Storm Sewer Systems* (NOI), Appendix A and the applicable permit processing fee for renewal of coverage under the Phase II MS4 Generic Permit.

This letter serves to acknowledge that your NOI and Appendix A is complete. The determination of a complete NOI means that your MS4 continues to be covered under the Phase II MS4 Generic Permit. **Your renewed coverage under this permit is effective as of March 2, 2020 and will expire on March 1, 2025.** Your permit identification number remains the same.

Coverage under the Phase II MS4 Generic Permit allows your MS4 to discharge stormwater provided that you implement the Stormwater Management Program (SWMP) included as Appendix A of your NOI annually and comply with all requirements of the Phase II MS4 Generic Permit.

The implementation of the SWMP must occur based on the Schedule of Implementation specified in Appendix A of the approved NOI. Annual Reports are due within six months of the anniversary date of permit coverage. Please note that unless the department requires more frequent reports, annual reports summarizing your SWMP implementation efforts are required for Years 2 and 4 of your five-year permit coverage term, as follows:

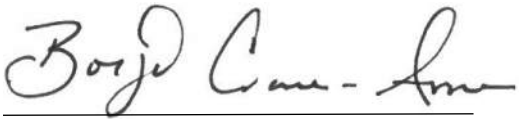
- The Year 2 Annual Report should cover the 12-month period from **March 2, 2021 through March 1, 2022 and is due by September 1, 2022.**

- The Year 4 Annual Report should cover the 12-month period from **March 2, 2023 through March 1, 2024 and is due by September 1, 2024.**

If you have any questions, please contact Borja Crane-Amores phone at (850) 245-7520 or by email at Borja.CraneAmores@floridadep.gov.

Executed in Tallahassee, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION



Borja Crane-Amores
Environmental Administrator
NPDES Stormwater Program
Division of Water Resource Management

Enc: Approved NOI for Cycle 4

cc:
Kimberly Haigler; Environmental Technician

Lisa Frazier; Community Development Director

NOTICE OF INTENT TO USE GENERIC PERMIT FOR DISCHARGE OF STORMWATER FROM PHASE II MUNICIPAL SEPARATE STORM SEWER SYSTEMS (RULE 62-621.300(7)(b), F.A.C.)

For FDEP Internal Use Only
Permit ID: FLR 04E124

INSTRUCTIONS:

- This NOI must be completed and submitted to the Department to authorize use of the Generic Permit for Discharge of Stormwater from Phase II Municipal Separate Storm Sewer Systems ("MS4 GP"), provided in Rule 62-621.300(7)(a), F.A.C.
- The type of municipal separate storm sewer system that qualifies for coverage under the MS4 GP and the applicable Phase II MS4 stormwater management program requirements are specified in the permit. You should familiarize yourself with the MS4 GP before completing this NOI.
- Submit this fully completed NOI, permit fee, and required attachments by mail to the address in the box at right. **DO NOT SUBMIT any materials not in the checklist in Section V. of this NOI.**
- **Please print or type information in the appropriate areas below and complete each section.**

Submit NOI, permit fee, and required attachments to:
NPDES Stormwater Notices Center
M.S. # 3585
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

SECTION I. PHASE II MS4 OPERATOR INFORMATION

Name of the Phase II MS4 Operator: City of Sebastian

Name of the Phase II MS4 Responsible Authority: Paul Carlisle

Title: City Manager

Mailing Address: 1225 Main Street

City: Sebastian | Zip Code: 32958 | County: Indian River

Telephone Number: 772-388-8203

Name of the Designated Phase II MS4 Stormwater Management Program Contact: Tim Walker

Title: Stormwater Utilities Director

Department: Stormwater Utilities

Mailing Address: 1225 Main Street

City: Sebastian | Zip Code: 32958 | County: Indian River

Telephone Number: 772-228-7056

E-mail Address: twalker@cityofsebastian.org

Location of the Phase II MS4 (if different than the mailing address in Section I.C. above):

Street Address: 1225 Main Street

City: Sebastian | Zip Code: 32958 | County: Indian River

Approximate center of the Phase II MS4:
Latitude: 27. ° 783 ' 854 " Longitude: -80. ° 475 ' 915 "

Phase II MS4 ownership status (check one): ☑ Public ☐ State ☐ Federal

G. Total resident population of the Phase II MS4: 24,772

H. Name of the urbanized area(s) the Phase II MS4 is located within (if applicable): NA

I. Name of the Water Management District the Phase II MS4 is located within (check all that apply):
☐ Northwest Florida Water Management District
☐ Suwanee River Water Management District
☐ South Florida Water Management District
☐ Southwest Florida Water Management District
☑ St. John's River Water Management District

Florida Department of Environmental Protection
Received: 8/23/2019
Notices Center

SECTION II. SHARING RESPONSIBILITY

You may rely on another entity to satisfy some or all of your permit obligations if the conditions in Part IX of the MS4 GP are met. Another entity may implement one or more of the measures and/or a component of a measure on your behalf. You may rely on another entity to satisfy all permit obligations (including annual reporting) but only if the entity is permitted under Chapter 62-624, F.A.C. Note the following:

- You will remain responsible for compliance with your permit obligations if the other entity(ies) fails to implement the control measure(s) or a component thereof on your behalf. You must establish a written agreement with the other entity(ies) before submitting this NOI.
- Relying on another entity, or entities, either partially or fully does not preclude you from the obligation to fully complete this NOI, including the information required in Section IV.

A. 1. Has another entity, regulated under Chapter 62-624, F.A.C., agreed to implement all of your permit obligations on your behalf? ☐ Yes ☑ No

If yes, complete Section II.A.2. If no, skip to Section II.B.

2.

Name of Entity:

Contact Name:

Title:

Department:

Mailing Address:

City:	Zip Code:	County:

Telephone Number:

E-mail Address:

B. 1. Has another entity agreed to implement one or more of the minimum control measures (or a component thereof) on your behalf? ☐ Yes ☑ No

If yes, complete Sections II.B.2. and II.B.3. (See the note below for any additional entities)

2. Control measure(s) or component of a control measure to be implemented by the other entity:

3.

Name of Entity:

Contact Name:

Title:

Department:

Mailing Address:

City:	Zip Code:	County:

Telephone Number:

E-mail Address:

Note: For each additional entity sharing stormwater management program responsibilities with you, provide on a separate sheet the information requested in Sections II.B.2. and II.B.3. Title the sheet "Section II.B: Additional Entities Information" and attach it to this NOI.

SECTION III. RECEIVING WATERS

Identify the named receiving waterbodies to which your Phase II MS4 discharges. Include all such waterbodies known to you at the time of this application:

Indian River Lagoon

San Sebastian River

SECTION IV. MINIMUM CONTROL MEASURES

A. Complete the Phase II MS4 Stormwater Management Program (SWMP) Elements Form in Appendix A for each minimum control measure described in Part VI. of the MS4 GP, except the Post-construction Stormwater Management in New Development and Redevelopment minimum control measure if you have chosen the qualifying alternative program option for this measure under Part X. of the permit. If you choose, however, to implement BMPs for the Post-construction measure, please complete a SWMP Elements Form for the measure.

Include in the SWMP Elements Form all best management practices (BMPs) currently in place or planned for each element of each minimum control measure. There is no limit to the number of BMPs you may include. Make copies of the form as necessary to accommodate all of your BMPs. The completed forms, in their entirety, will be considered by the Department to be the outline of your proposed stormwater management program. Attach all completed forms to this NOI.

B. Provide the total number of pages of SWMP Elements Forms that are attached to this NOI for each minimum control measure:

Minimum Control Measure	# of Pages
Public Education and Outreach as to Stormwater Impacts	2
Public Involvement/Public Participation	1
Illicit Discharge Detection and Elimination	1
Construction Site Stormwater Runoff Control	2
Post-construction Stormwater Management in New Development and Redevelopment	0
Pollution Prevention/Good Housekeeping for Municipal Operations	2

SECTION V. MATERIALS TO BE SUBMITTED WITH THIS NOI

Only the following materials are to be submitted to the Department along with your fully completed and signed NOI (check the appropriate box to indicate whether the item is attached or is not applicable):

Attached	N/A	
☑		The permit application fee, as prescribed by Rule 62-4.050(4)(d)(6), F.A.C. Make all check and money orders payable to the Florida Department of Environmental Protection.
☑		A fully completed Phase II MS4 Stormwater Management Program Elements Form (see Appendix A) for <u>each</u> minimum control measure except the Post-construction Stormwater Management in New Development and Redevelopment minimum control measure if you have chosen the qualifying alternative program option for this measure under Part X. of the MS4 GP.
☐	☑	Additional entities information, as required under the note in Section II.B. of this NOI.

DO NOT SUBMIT ANY OTHER MATERIALS
(such as your complete Stormwater Management Plan, ordinances, storm sewer map, public outreach, etc.)

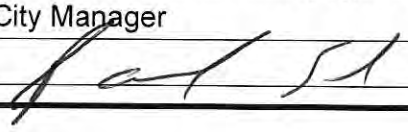
SECTION VI. CERTIFICATION STATEMENT AND SIGNATURE

The Responsible Authority listed in Section I.B. of this NOI must sign the following certification statement:[1]

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name of Phase II MS4 Responsible Authority (type or print): Paul Carlisle

Title: City Manager

Signature:  Date: 8/25/19

[1] Signatory requirements are contained in Rule 62-620.305, F.A.C.

INSTRUCTIONS FOR APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

General Instructions

- Complete this form for each minimum control measure described in Part VI. of the Generic Permit for Discharge of Stormwater from Phase II Municipal Separate Storm Sewer Systems ("MS4 GP") provided in Rule 62-621.300(7)(a), F.A.C., except the Post-construction Stormwater Management in New Development and Redevelopment minimum control measure if you have chosen the qualifying alternative program option for this measure under Part X. of the permit. If you choose, however, to implement BMPs for the Post-construction measure, please complete a SWMP Elements Form for the measure.

- Include all best management practices (BMPs) currently in place or planned for each element of each minimum control measure. There is no limit to the total number of BMPs you may include.

- Make copies of the form as necessary to accommodate all of your BMPs.

- The completed forms, in their entirety, will be considered by the Department to be the outline of your proposed stormwater management program. Attach the forms to the NOI and submit to the Department at the address provided on the NOI.

- **Please print or type information in the appropriate areas of this form.**

Section A.I: MINIMUM CONTROL MEASURE

- Indicate which minimum control measure the BMPs in Section A.II. address. Check only one measure. Use a separate form for each measure.

Section A.II: BEST MANAGEMENT PRACTICES

- Include BMPs only for the measure you have identified in Section A.I. The Department encourages the use of the Florida Land Development Manual: A Guide to Sound Land and Water Management (FDER, 1988) and the U.S. Environmental Protection Agency's National Menu of Best Management Practices for Storm Water Phase II in developing Phase II stormwater management programs. Both are available from the Department.

- Element ID: Table 1 below includes all the minimum control measure elements required under Part IV. of the MS4 GP. Using Table 1, identify which element of the minimum control measure each BMP addresses. For example, a BMP addressing the procedures for site plan review under the Construction Site Stormwater Runoff Control Minimum Control Measure would be labeled as "4d." You must include at least one BMP for each element.

- BMP Number: For each minimum control measure, number the BMPs starting with 01 and continue the numbering in sequential order on any additional forms for the measure. The numbering of the BMPs is for reference purposes only and does not provide additional weight to, nor prioritize, one BMP over another.

- Measurable Goals: List the measurable goal(s) for each BMP. You must include at least one measurable goal for each BMP and may include as many as necessary for the BMP – you are not limited to the four lines provided on the form.

- Schedule for Implementation/Completion: For each measurable goal, include the year each action will be implemented and, as applicable, the interim milestones, completion date, or planned frequency of the action.

- Responsible Entity/Department: Include the name of the entity (if other than the Phase II MS4 Operator) or of the internal department (if it is the Phase II MS4 Operator) responsible for implementing or coordinating each BMP.

Page Numbering

- Once this form has been completed for each minimum control measure, place the forms in an order corresponding to the order of the measures in Table 1 (below) and number the forms accordingly at the bottom of each.

Table 1: Minimum Control Measure Required Elements

Element ID	Description of Minimum Control Measure Required Elements
	1. Public Education and Outreach Minimum Control Measure:
1a	**a)** Implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on water bodies and the steps that the public can take to reduce pollutants in stormwater runoff.
	2. Public Participation/Involvement Minimum Control Measure:
2a	**a)** Comply with State and local public notice requirements when implementing a public involvement/public participation program.
	3. Illicit Discharge Detection and Elimination Minimum Control Measure:
3a	**a)** Develop, if not already completed, a storm sewer system map, showing the location of all known outfalls and the names and location of all surface waters of the State that receive discharges from those outfalls.
3b	**b)** To the extent allowable under State or local law, effectively prohibit through ordinance, or other regulatory mechanism, of non-stormwater (i.e., "illicit") discharges into the storm sewer system and implement appropriate enforcement procedures and actions.
3c	**c)** Develop and implement a plan to detect and eliminate non-stormwater discharges, including illegal dumping, to the MS4.
3d	**d)** Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.
	4. Construction Site Stormwater Runoff Control Minimum Control Measure:
4a	**a)** Develop and implement, to the extent allowable under State or local law, an ordinance or other regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to reduce pollutants in any stormwater runoff to the Phase II MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. Reduction of pollutants associated with stormwater discharges from construction activity disturbing less than one acre must also be included if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more.
4b	**b)** Develop and implement requirements for construction site operators to implement appropriate erosion and sediment control best management practices.
4c	**c)** Develop and implement requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.
4d	**d)** Develop and implement procedures for site plan review that incorporate consideration of potential water quality impacts.
4e	**e)** Develop and implement procedures for receipt and consideration of information submitted by the public.
4f	**f)** Develop and implement procedures for site inspection and enforcement of control measures.
	5. Post-construction Stormwater Management in New Development and Redevelopment Minimum Control Measure: NOT REQUIRED IF USING QUALIFIED ALTERNATIVE PROGRAM
5a	**a)** Use an ordinance or other regulatory mechanism, to the extent allowable under State or local law, to address from post-construction runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into the Phase II MS4. The program must require that controls be in place that would prevent or minimize water quality impacts from new development or redevelopment.
5b	**b)** Develop and implement strategies that include a combination of structural and/or non-structural best management practices (BMPs) appropriate for the community.
5c	**c)** Require adequate long-term operation and maintenance of BMPs.
	6. Municipal Operation Pollution Prevention and Good Housekeeping Minimum Control Measure:
6a	**a)** Develop and implement an operation and maintenance program that has the ultimate goal of preventing or reducing pollutant runoff from MS4 operator activities, such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance.
6b	**b)** Using training materials that are available from EPA, the Department, or other organizations, include employee training to prevent and reduce stormwater pollution from MS4 operator activities.

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- [X] 1. Public Education and Outreach
- [ ] 2. Public Involvement/Participation
- [ ] 3. Illicit Discharge Detection/Elimination
- [ ] 4. Construction Site Stormwater Runoff Control
- [ ] 5. Post-construction Stormwater Management (optional)
- [ ] 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
1a.	01	**City Stormwater Website** Information and links on: Clean Water Program/NPDES, Public Education, History & Restrictions, Comments & Complaints. Educational materials are available for download. Site is updated regularly. A "Contact Us" button prompts residents to email the City regarding their stormwater questions or concerns.	1. Document and report the number of visitors to pages with stormwater specific information. 2. Document and report the number of material downloads. 3. Document and report communications received through the website. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	MIS Department City Clerk
1a.	02	**City Natural Resources Board Website** Information on: Florida Friendly Landscaping, Stormwater, Composting, Landscaping and Fertilizer Ordinance. Site is updated regularly and promoted through the City's Facebook page and on all outreach materials. A "Contact Us" button prompts residents to email the City regarding their environmental questions or concerns.	1. Document and Report the number of website visitors. 2. Document and report communications received through the website. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	MIS Department City Clerk
1a.	03	**Outreach Brochures and Flyers** Developed to educate residents on locally relevant stormwater topics, which are determined through the documentation of citizen request line calls and emails. Materials are distributed throughout the City (Library, City Hall, Building Department, and Community Events.	1. Document and report the number of brochures distributed. 2. Document and report the number of distribution points. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
1a.	04	**Community Presentations** Guest speakers present at Board and Council Meetings on environmental and stormwater topics. Public Meetings are held monthly at City Hall and televised throughout the month on local government channel, and available for streaming through the City's Website. All meeting agendas are available on City's website one week prior.	1. Document and report number of presentations informing the public of the impacts of stormwater discharges on waterbodies and the steps that the public can take to reduce pollutants in stormwater. 2. Document and report number attendees at meetings featuring stormwater specific information.	1. Year 1- Year 5 2. Year 1- Year 5	Environmental Technician
1a.	05	**Community Events** Educate the public through an onsite booth, with presentations and distribution of outreach materials on stormwater topics. There will be photo documentation of booth and presentations.	1. Document and report the number of events where stormwater information was presented and distributed. 2. Document and report the number of materials distributed. 3. Document and report the number of stormwater presentations conducted at community events. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Environmental Technician & Stormwater Department

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- [X] 1. Public Education and Outreach
- [ ] 2. Public Involvement/Participation
- [ ] 3. Illicit Discharge Detection/Elimination
- [ ] 4. Construction Site Stormwater Runoff Control
- [ ] 5. Post-construction Stormwater Management (optional)
- [ ] 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
1a.	06	**Local Government Channel** 24 hour television channel, which is also streamed live on City's website. Live Streams and replays Council and Board Meetings. Displays public notices and stormwater outreach videos and PowerPoint slides. Promotes websites and Citizen Request Line.	1. Document and report SWMP relevant materials posted and duration posted. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	MIS Department
1a.	07	**City Facebook Page** Updates public on current stormwater projects, outreach information, and addresses frequently asked questions and concerns. Streams all public meetings live. Promotes City websites, educational programs, and Citizen Request Line.	1. Document and report "likes" and reposts on stormwater topics. 2. Document and report number of page followers. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	MIS Department
1a.	08	**Community Oyster Garden Project** Cost-share Grant Project designed to educate visitors and volunteers of all ages. Community groups can register for interactive site tours, which engage volunteers and participants of all ages in hands on water quality data collection, species identification and the role of the City's MS4 in maintaining a healthy lagoon.	1. Document and report all volunteer and participant sign-in sheets. 2. Document and report the number of classes presented at site. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
1a.	09	**New Homeowner Folder** Folder delivered at final inspection for all new residential development. Includes materials on stormwater, Florida Friendly Landscaping, water conservation, swale maintenance, IPM, and City Landscaping Ordinances.	1. Document and report the number of new homeowner folders distributed. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Environmental Technician
1a.	10	**Community Events** Stormwater Booth manned by Stormwater Staff available to answer resident questions and to educate on current projects.	1. Document and report number of booth visitors. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Environmental Technician & Stormwater Department

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- ☐ 1. Public Education and Outreach
- ☒ 2. Public Involvement/Participation
- ☐ 3. Illicit Discharge Detection/Elimination
- ☐ 4. Construction Site Stormwater Runoff Control
- ☐ 5. Post-construction Stormwater Management (optional)
- ☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified in Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
2a.	01	**Public Input** Resolution NO. R-15-09 requires that all appointed Boards and Committees include a section for solicitation of "Public Input" on meeting agendas. It will be documented when an agenda features items related to the City's SWMP. All agendas are posted one week prior to the meetings on the City's Website and Facebook Page.	1. Document and report number of public meetings held where the City's SWMP is discussed. 2. Document and report number of attendees at public Board Meetings where the City's SWMP is discussed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	City Clerk
2a.	02	**MS4 Cleanup Events** City partners with local organizations to host two volunteer waterway clean-up events per year. Selection of clean-up sites will be focused on those areas with a direct impact on stormwater quality. Volunteer sign-in sheets will be used to track participants. The events are marketed through the City's Facebook page, website, television channel, community flyers, and the Chamber of Commerce's website, Facebook page, and newsletter.	1. Document and report number of events. 2. Document and report number of volunteers. 3. Document and report weight of litter collected. 4. Document and report the names of clean-up events.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Environmental Technician

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- ☐ 1. Public Education and Outreach
- ☐ 2. Public Involvement/Participation
- ☒ 3. Illicit Discharge Detection/Elimination
- ☐ 4. Construction Site Stormwater Runoff Control
- ☐ 5. Post-construction Stormwater Management (optional)
- ☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified in Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
3a.	01	**Storm Water System Map** GIS Map of City's stormwater system indicates all outfalls, receiving surface water bodies, stormwater structures and retention areas. Any changes in conveyance channels, outfalls, or structural assets will be amended in the map.	1. Document and report any new outfalls. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Stormwater Department & Environmental Technician
3b.	01	**Illicit Discharge Ordinance** City Ordinance, Article VI: Urban Stormwater Quality Management and Discharge Control, prohibits non-stormwater discharges into the MS4 system and implements inspection, reporting, and enforcement procedures.	1. City will maintain the Ordinance and report any changes, or amendments, if applicable. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Stormwater Department
3c.	01	**Illicit Discharge Detection and Inspection** Staff performs daily inspections and review of potential illicit discharges, hazardous disposals, or illegal dumping. Potential illicit discharges are reported to the Police Department Code Enforcement Office for enforcement.	1. Document and report any "Notice of Violations" issued by Code Enforcement. 2. Document and report the penalty and procedure required of each violator. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Police Department Code Enforcement Office
3d.	01	**Illicit Discharge Education: Public** City provides illicit discharge educational materials to residents. Materials are posted on City's Website and distributed through various community events, City Hall, and in new homeowners' packets.	1. Document all educational materials utilized and their distribution points. 2. Document and report the number of materials distributed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
3d.	02	**Illicit Discharge Education: Business** City provides industry specific illicit discharge educational materials to businesses. Materials are posted on City's Website and distributed through community events, and at City Hall as they apply for new or renewal licensing.	1. Document and report all educational materials created, and distribution points. 2. Document and report the number of materials distributed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Building Department

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

☐ 1. Public Education and Outreach	☒ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☐ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
3d.	03	**Illicit Discharge Education: Employees** City requires all new employees view a training video on the proper storage and disposal of waste and hazardous materials. All current staff members are required to attend annual refresher class, which also includes this video.	1. Document and report the number of new employees receiving this training. 2. Document and report the number of existing employees receiving additional training. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Human Resources

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- ☐ 1. Public Education and Outreach
- ☐ 2. Public Involvement/Participation
- ☐ 3. Illicit Discharge Detection/Elimination
- ☒ 4. Construction Site Stormwater Runoff Control
- ☐ 5. Post-construction Stormwater Management (optional)
- ☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified in Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
4a.	01	**Surface Water Management Ordinance** Article XII requires that any land development, which disturbs the soil, implement an erosion and sediment control plan. Such sites are subject to frequent inspections. Chapter 1, Article I and II provides for the general administration of violation and enforcement procedures for non-compliance to the Land Development Code.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Planning and Zoning Department
4b.	01	**Erosion and Sediment Control on Construction Sites** Article XVIII Sec.54-4-18.4 requires that sites greater than an acre, submit a SWPPP as part of their site plans that meets all City Land Development Ordinances, as well as apply for an NOI with the FDEP. The SWPPP, or Erosion and Sediment Control Plan will be reviewed for BMPs as they relate to the proposed construction	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report the number of NOIs received. 3. Document and report the number of active sites. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Planning and Zoning Department
4c.	01	**Construction Site Waste Management** The Surface Water Management Ordinance requires that all construction site operators control discarded materials and provide a sanitary waste facility. Waste management on each site is inspected as part of the scheduled "Erosion Control" inspections.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report number of sites operating under waste control requirement. 3. Document and report number of compliance issues pertaining to waste controls. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Stormwater Department
4d.	01	**Site Plan Review** Article XVII outlines the site plan review procedures. Site plans are thoroughly reviewed by a committee of staff to ensure no adverse effects on water quality or environmentally sensitive areas.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report number of site plans reviewed for construction. 3. Document and report the number of site plans that require special environmental permitting. 4. Document and report the number of site plans approved for construction.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Planning and Zoning Department
4e.	01	**Public Input** The public may provide input on active/proposed construction activities at any time by website submissions, or calls to the Citizen Request Line, which is advertised on the stormwater website, all stormwater educational material, new homeowner packets, and the public television channel. All stormwater related communications are monitored and recorded on spreadsheet by stormwater administrative support staff.	1. Document and report all complaints on potential site violations received through stormwater website or citizen request line. 2. Document and report the number of emails received. 3. Document and report the number of phone calls received to the citizen request line. 4. Document and report the number of follow-up actions.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

☐ 1. Public Education and Outreach	☐ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☒ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
4f.	01	**Construction Site Inspections** City staff will be scheduled through the Building Department to inspect all development sites following initial land clearing activities. Supplemental inspections will be conducted weekly and within 24 hours of a rain event of .5 inch, or greater. Failure of inspection will result in a re-inspection fee, which increases with each additional re-inspection.	1. Document and report number of erosion control inspections performed. 2. Document and report all erosion control re-inspections. 3. Document and report all re-inspection fees charged. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Building Department

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- ☐ 1. Public Education and Outreach
- ☐ 2. Public Involvement/Participation
- ☐ 3. Illicit Discharge Detection/Elimination
- ☐ 4. Construction Site Stormwater Runoff Control
- ☒ 5. Post-construction Stormwater Management (optional)
- ☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
5a.	01	**Alternative Program** City of Sebastian relies on the St. John's River Water Management District and Florida Department of Environmental Protection regulatory criteria by providing stormwater treatment for Environmental Resource Program.	1. Continue to maintain compliance with Florida Department of Environmental Protection and St. John's River Water Management District criteria. 3. 4.	1. Effective upon issuance of MS4 Permit 3. 4.	Florida Department of Environmental Protection & St. John's River Water Management District

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

☐ 1. Public Education and Outreach	☐ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☐ 4. Construction Site Stormwater Runoff Control	☒ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
6a.	01	**Fleet Maintenance** All waste oil, hydraulic fluids, antifreeze, and oil filters from the City's equipment/ fleet maintenance division are properly stored for recycling.	1. Document and report the number of gallons per year of waste oil and hydraulic fluid recycled each year. 2. Document and report the number of gallons per year of antifreeze recycled each year. 3. Document and report the number of oil filters disposed of each year. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Public Works Department
6a.	02	**Catch Basin and Baffle Box Maintenance** The City regularly cleans debris from it catch basins and baffle boxes with a vacuum truck.	1. Document and report the number of baffle boxes cleaned each year and how often. 2. Document and report the total amount of debris collected from baffle boxes each year. 3. Document and report the number of catch basins cleaned each year and how often. 4. Document and report the total amount of debris collected from catch basins each year.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department
6a.	03	**Culvert Pipe Maintenance** Road crossing and driveway culvert pipes are regularly cleared of debris by various methods.	1. Document and report the total number of road crossing culvert pipes cleared each year. 2. Document and report the total amount of debris collected from road crossing culverts each year. 3. Document and report the total number of driveway culvert pipes cleared each year. 4. Document and report the total amount of debris collected from driveway culverts each year.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department
6a.	04	**Pet Waste Collection** The City provides pet waste collection stations at many of its parks and open spaces	1. Document and report the number disposable pet waste bags purchased each year. 2.	1. Year 1- Year 5 2.	Parks and Recreation Department
6a.	05	**Basin Management Plan (BMAP) for Adopted TMDL** In accordance with Section 403.067, F.S., the City of Sebastian must comply with the adopted provisions of the Central Indian River Lagoon BMAP that specify activities to be undertaken by the City of Sebastian. If a BMAP is in development and scheduled to be adopted within two years by DEP and watershed stakeholders, the City of Sebastian shall continue to participate in the BMAP process and comply with the adopted provisions of the BMAP that specify activities to be undertaken by the City during the permit cycle.	1. Continue to participate and implement the scheduled activities defined in the adopted BMAP. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Florida Department of Environmental Protection & Central Indian River Lagoon Stakeholders

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- ☐ 1. Public Education and Outreach
- ☐ 2. Public Involvement/Participation
- ☐ 3. Illicit Discharge Detection/Elimination
- ☐ 4. Construction Site Stormwater Runoff Control
- ☐ 5. Post-construction Stormwater Management (optional)
- ☒ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
6a.	06	**Swales and Ditches Maintenance** The City will inspect and maintain all city-maintained swales, ditches, and canals in order to remove debris and particle matter once per month and additionally as necessary.	1. Document and report the number of miles of swales, ditches, and canals maintained. 2. Document and report the amount of debris collected. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Stormwater Department
6b.	01	**Stormwater Pollution Prevention Training** All City field staff members are required to attend the Green Industries BMP Course. Taught annually by the County's IFAS Extension Office, the class is designed as a water quality and water conservation program. It instructs how MS4 operator activities should be conducted to prevent runoff and leaching of chemicals and fertilizers into water bodies.	1. Document and report the number of new employees receiving training. 2. Document and report the number of current employees receiving refresher courses. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Human Resources Department
6b.	02	**Stormwater Inspectors Training** Stormwater Department Staff are encouraged to attend stormwater inspector training class as it pertains to their duties. The Stormwater Department will pay any fees associated with classes and/or certifications.	1. Document and report the number of employees who attend classes. 2. Document and report the number of employees who are currently certified. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Human Resources Department

Appendix B

Central Indian River Lagoon Basin Management Action Plan

Indian River Lagoon Basin

Central Indian River Lagoon Basin Management Action Plan

Division of Environmental Assessment and Restoration
Water Quality Restoration Program
Florida Department of Environmental Protection

with participation from the
Central Indian River Lagoon Stakeholders

February 2021

2600 Blair Stone Road
Tallahassee, FL 32399-2400
https://floridadep.gov/

Acknowledgments

The *Central Indian River Lagoon Basin Management Action Plan* was prepared as part of a statewide watershed management approach to restore and protect Florida's water quality. It was prepared by the Florida Department of Environmental Protection with participation from the Cenral Indian River Lagoon stakeholders identified below.

Type of Governmental or Private Entity	Participant
Local Governments	Brevard County Indian River County St. Lucie County City of Fellsmere City of Fort Pierce City of Melbourne City of Palm Bay City of Sebastian City of Vero Beach City of West Melbourne Town of Grant-Valkaria Town of Indialantic Town of Indian River Shores Town of Malabar Town of Melbourne Beach Town of Melbourne Village Town of Orchid Town of St. Lucie Village
Community Development Districts	Chaparral Community Development District Emerald Lakes Community Development District Mayfair Community Development District PBR Community Development District Viera East Community Development District
Special Districts	Fellsmere Water Control District Fort Pierce Farms Water Control District Indian River Farms Water Control District Melbourne Tillman Water Control District Sebastian River Improvement District Vero Lakes Water Control District
Federal Agencies	Patrick Air Force Base
Regional and State Agencies	Florida Department of Agriculture and Consumer Services Florida Department of Transportation District 4 Florida Department of Transportation District 5 Florida Turnpike Enterprise Indian River Lagoon Estuary Program South Florida Water Management District St. Johns River Water Management District

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List of Acronyms and Abbreviations

BAM	Biosorption Activated Media
BCUD	Brevard County Utilities Department
BCWMA	Blue Cypress Water Management Area
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CDD	Community Development District
CDS	Continuous Deflection Separation
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
CIRL	Central Indian River Lagoon
CR	County Road
CWA	Clean Water Act
DEM	Division of Emergency Management
DEP	Florida Department of Environmental Protection
DIW	Deep Injection Well
DO	Dissolved Oxygen
DOR	Florida Department of Revenue
DWM	Dispersed Water Management
ECFRPC	East Coast Florida Regional Planning Council
EFDC	Environmental Fluid Dynamics Code
EMC	Event Mean Concentration
EPA	U.S. Environmental Protection Agency
F.A.C.	Florida Administrative Code
FCT	Florida Communities Trust
FDACS	Florida Department of Agriculture and Consumer Services
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FIND	Florida Inland Navigation District
FJV	Fellsmere Joint Ventures
FLWMI	Florida Water Management Inventory
FPFWCD	Fort Pierce Farms Water Control District
FPL	Florida Power and Light
F.S.	Florida Statutes
FSAID	Florida Statewide Agricultural Irrigation Demand (Geodatabase)
ft	Foot
FWRA	Florida Watershed Restoration Act
GIS	Geographic Information System
HMGP	Hazard Mitigation Grant Program
HOA	Homeowner Association
HSPF	Hydrologic Simulation Program–FORTRAN
HWTT	Hybrid Wetland Treatment Technology

IMPLAN	Impact Analysis for Planning
IRCUD	Indian River County Utilities Department
IRFWCD	Indian River Farms Water Control District
IRL	Indian River Lagoon
IRLC	Indian River Lake Conservancy
IWR	Impaired Surface Waters Rule
kg	Kilogram
km	Kilometer
lbs	Pounds
LET	Load Estimation Tool
LPA	Load Per Acre
m	Meter
MAPS	Managed Aquatic Plant System
mgd	Million Gallons Per Day
mg/L	Milligrams Per Liter
MHP	Mobile Home Park
MS4	Municipal Separate Storm Sewer System
mt	Metric Tons
MTWCD	Melbourne-Tillman Water Control District
N/A	Not Applicable
NELAC	National Environmental Laboratory Accreditation Council
NELAP	National Environmental Laboratory Accreditation Program
NEP	National Estuary Program
NGVD	National Geodetic Vertical Datum
NIRL	North Indian River Lagoon
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSLRWCD	North St. Lucie River Water Control District
O&M	Operations and Maintenance
OAWP	Office of Agricultural Water Policy
OSTDS	Onsite Sewage Treatment and Disposal System
PAM	Polyacrylamide
PLSM	Pollutant Load Screening Model
PSA	Public Service Announcement
QA/QC	Quality Assurance/Quality Control
RRLA	Rapid Rate Land Application
RV	Recreational Vehicle
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SIRL	South Indian River Lagoon
SLC	St. Lucie County
SLCU	St. Lucie County Utilities
SOP	Standard Operating Procedure

SR	State Road
SRID	Sebastian River Improvement District
STEM	Science, Technology, Engineering and Mathematics
STEP	Septic Tank Effluent Pumping
STORET	STOrage and RETrieval (Database)
SWET	Soil and Water Engineering Technology
SWIL	Spatial Watershed Iterative Loading
SWMP	Stormwater Management Program
TCRPC	Treasure Coast Regional Planning Council
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VLWCD	Vero Lakes Water Control District
WBID	Waterbody Identification (number)
WCD	Water Control District
WCS	Water Control Structure
WIN	Watershed Information Network (Database)
WMA	Water Management Area
WMD	Water Management District
WWTF	Wastewater Treatment Facility
WWTP	Wastewater treatment plant

Executive Summary

Background

The Indian River Lagoon (IRL) is a 156-mile-long estuary along Florida's east coast. The impaired portions of the IRL are directly adjacent to lands in only Volusia, Brevard, Indian River, and St. Lucie counties. The northern portion of the watershed extends to near the Ponce De Leon Inlet in Volusia County and the southern portion to near the Fort Pierce Inlet at the Indian River County–St. Lucie County boundary line. Because of the large geographical extent of the IRL Basin and the hydrological differences throughout the basin, the Florida Department of Environmental Protection (DEP) determined the best way to address the total maximum daily loads (TMDLs) and impairments for the IRL Basin was to divide the watershed into 3 subbasins: (1) Central IRL (CIRL), (2) North IRL (NIRL), and (3) Banana River Lagoon (BRL). Separate basin management action plans (BMAPs) were developed for each subbasin; this document focuses solely on the CIRL Subbasin. The main stem of the CIRL Subbasin extends from the Melbourne Causeway in Brevard County to Fort Pierce Inlet, and includes the areas drained by the Fort Pierce Farms Canal network and the C-25 Canal (**Figure ES- 1**).

Intense and extensive algal blooms in the IRL began in 2011 and have returned periodically. Harmful algal blooms (HABs) cause shading that stresses seagrass in the IRL, adverse effects on wildlife, and in some cases, detrimental effects on human health. The St. Johns River Water Management District (SJRWMD) launched the Indian River Lagoon Protection Initiative in 2013, including a multiyear investigation that increased the understanding of these blooms. This and other research indicate it is important to persevere with projects that decrease nutrient loads to the IRL, because that approach will limit the severity of HABs and their impacts on the system.

TMDLs

A TMDL is a water quality restoration goal establishing the maximum amount of a pollutant that a waterbody can assimilate without causing exceedances of water quality standards. The nutrient TMDLs for the main stem of the IRL were adopted by DEP in March 2009. The TMDLs focus on the water quality conditions necessary for seagrass regrowth at water depth limits where seagrass historically grew in the lagoon, based on a multiyear composite of seagrass coverage. The median depth limits of seagrass coverage in the IRL decreased over the years because of changes in water quality conditions resulting from anthropogenic influences. As polluted runoff reaches the lagoon, it contributes to conditions that prevent the seagrass from growing in deeper water.

Additionally, TMDLs were adopted in 2013 for certain tributaries to the CIRL, now addressed in this BMAP. For Crane Creek (waterbody identification [WBID] number 3085A), North Prong of the Sebastian River (WBID 3128), South Prong St. Sebastian River Estuary Segment (WBIDs 3129B1 and 3129B2), Sebastian River above Indian River (3129A), and the C-54 Canal (WBID 3135A), no further nutrient load reductions were requested beyond those already established for the main stem seagrass nutrient TMDLs. For Goat Creek (WBID 3107A), the targets were also

set to control nutrient loads from the watershed of the creek to restore seagrass distribution in the IRL proper. No further nutrient reductions beyond those already being requested to protect the main stem seagrasses were included in the Goat Creek TMDLs.

CIRL BMAP

In addition to dividing the overall IRL Watershed into subbasins, the CIRL was further divided into "project zones." The project zone boundaries are based on the distinct hydrology in different areas of the basin and their corresponding annual residence times. These zones are important because the flushing times vary greatly among locations and consequently affect how nutrient reductions will impact these distinct areas of the basin. The project zones identify large areas where projects should be implemented to ensure that the load reductions achieve the desired response for each subbasin. The CIRL Subbasin was split into four project zones, as follows:

- Central A – Melbourne Causeway (U.S. 192) to the north tip of Grant Farm Island.
- Central SEB – Grant Farm Island to Wabasso Causeway (County Road 510).
- Central B – Wabasso Causeway to the boundary between Indian River County and St. Lucie County.
- South IRL (SIRL) – The St. Lucie/Indian River County line to the Fort Pierce Inlet.

TMDLs have not yet been developed for the SIRL; however, because of the connectivity of the SIRL to the other three project zones, the reduction of loads here is critical for achieving the TMDLs for the main stem of the IRL. The SIRL was therefore included in the CIRL BMAP adopted in 2013, and load reductions were developed for the SIRL project zone as part of this BMAP. Additionally, WBIDs 3163 and 3163B (C-25 canal) within the SIRL project zone are impaired for nutrients, as indicated by elevated phosphorus levels and the abundance of macrophytes.

DEP first adopted the CIRL BMAP in 2013 to implement total nitrogen (TN) and total phosphorus (TP) TMDLs in three of the four CIRL Project Zones. BMAPs are designed to be implemented in a phased approach. In 2018, DEP and several local stakeholders were developing several components of an updated BMAP, including the local completion and DEP review of a new water quality model, the Spatial Watershed Iterative Loading (SWIL) Model. The SWIL Model was developed through cooperative funding provided by Brevard County, all of its cities, and Florida Department of Transportation (FDOT) District 5, as well as support from the U.S. Air Force, in an effort to update the data being used to predict loading. In this BMAP update, the SWIL Model is used to estimate loading to the CIRL. The percent reductions adopted in the original TMDL rules are applied as the water quality targets.

This 2020 BMAP was developed based on several changes since the 2013 BMAP was adopted, including updated modeling efforts, boundary adjustments, updated allocations and load

reductions to the responsible stakeholders, updated management actions to achieve nutrient reductions, and a revised monitoring plan to continue to track trends in water quality. This update sets a deadline for achieving load reductions no later than 2035, which is 22 years after the initial BMAP adoption in 2013.

As part of the adaptive management process for this BMAP, DEP will explore refinements to the SWIL Model used to develop BMAP allocations and estimate project credits. This effort could include updates to some of the SWIL Model input layers (e.g., land use, soils, etc.), the verification of watershed boundaries in some areas, revisions to the model period of record, and the validation of predicted flows in selected calibration basins. There are also several optional tasks that could streamline efforts during the load allocation and project calculation processes. The SWIL Model revisions may change the loading estimates presented in this BMAP, and may therefore result in changes to allocations in future iterations of the BMAP. Although the direction and magnitude of those changes is uncertain, DEP anticipates that some may be higher, and some may be lower.

Summary of Load Reductions

DEP requested stakeholders provide information on management actions, including projects, programs, and activities, that may reduce nutrient loads to the CIRL. Management actions are included in the BMAP to address nutrient loads to the lagoon and have to meet several criteria to be considered eligible for credit. The estimated reductions of activities completed to date are provided in **Table ES-1**. **Figure ES- 2** and **Figure ES- 3** show progress towards the TN and TP TMDL load reductions through July 31, 2020.

To achieve the TMDLs, stakeholders must identify and submit additional local projects as well as determine the significant funding that will be necessary. Enhancements to programs addressing basinwide sources will also be required.

Table ES-1. Progress to date in the CIRL BMAP area by project zone

lbs/yr = Pounds per year

Project Zone	TN Reduction (lbs/yr)	% Achieved towards TN Target	TP Reduction (lbs/yr)	% Achieved towards TP Target
A	76,866	29.2	9,267	22.7
SEB	61,065	23.2	23,646	50.9
B	92,410	31.4	14,169	37.4
SIRL	16,718	17.5	3,826	4.0
Total	**247,059**	**27.0**	**50,909**	**23.1**

Source Requirements

Florida law (Section 403.086, Florida Statutes [F.S.], and Chapter 2020-150, Laws of Florida) requires all domestic wastewater facilities directly discharging to surface waters of the state within or connected to the IRL to meet advanced wastewater treatment requirements no later

than July 1, 2025. Additionally, this BMAP sets TN and TP effluent limits in the CIRL for individually permitted domestic wastewater facilities and their associated rapid rate land application (RRLA) effluent disposal systems and reuse activities, unless the owner or operator can demonstrate reasonable assurance that the discharge or associated RRLA or reuse activity would not cause or contribute to a failure to achieve the TMDLs or an exceedance of water quality standards. Local governments must also develop remediation plans to address loads from wastewater facilities and septic systems in the BMAP area.

Agricultural nonpoint sources are a significant contributor of TN and TP loading to the CIRL. Since the adoption of the CIRL BMAP in 2013, some agricultural producers have enrolled in the Florida Department of Agriculture and Consumer Services (FDACS) Best Management Practices (BMP) Program. However, the current enrollment is 25 % of agricultural acres identified in the BMAP. Sufficient agricultural BMP enrollment and implementation verification will be necessary to achieve the TMDLs. FDACS continues to work to improve enrollment percentages in the basin and will be undertaking implementation verification site visits to enrolled producers at least every two years to carry out its statutory authority and fulfill its statutory obligations to facilitate enrollment and implementation verification, pursuant to Paragraphs 403.067(7)(c) and 403.067(7)(d), F.S.

Within five years of the adoption of this BMAP, DEP will evaluate any entity located in the BMAP area that serves a minimum resident population of at least 1,000 individuals who are not currently covered by a municipal separate storm sewer system (MS4) permit and designate eligible entities as regulated MS4s, in accordance with Chapter 62-624, Florida Administrative Code (F.A.C.). In accordance with Subsection 373.4131(6), F.S., DEP and the water management districts are planning to update the stormwater design and operation requirements in Environmental Resource Permit rules and incorporate the most recent scientific information available to improve nutrient reduction benefits.

Water Quality Monitoring

The updated CIRL BMAP monitoring network consists of 44 stations sampled by SJRWMD, South Florida Water Management District, U.S. Geological Survey, Indian River Farms Water Control District, Sebastian River Improvement District, Fort Pierce Farms Water Control District, and North St. Lucie River Water Control District. The monitoring plan also includes research priorities to better understand the lagoon, nutrient sources, and the responses of seagrass to nutrient loading, both internal and external, to the lagoon.

BMAP Cost

The project costs provided for the BMAP may include capital costs as well as those associated with construction, routine operations and maintenance, and monitoring. Many BMAP projects were built to achieve multiple objectives, not just nutrient reductions. Funds for some projects have already been spent, others have been obligated to ongoing projects, and the remainder are yet to be appropriated.

The funding sources for the projects range from local public and private contributions to state and federal legislative appropriations. DEP will continue to work with stakeholders to explore new opportunities for funding assistance to ensure that the activities listed in this BMAP can be maintained at the necessary level of effort and that additional projects can be constructed by 2035.

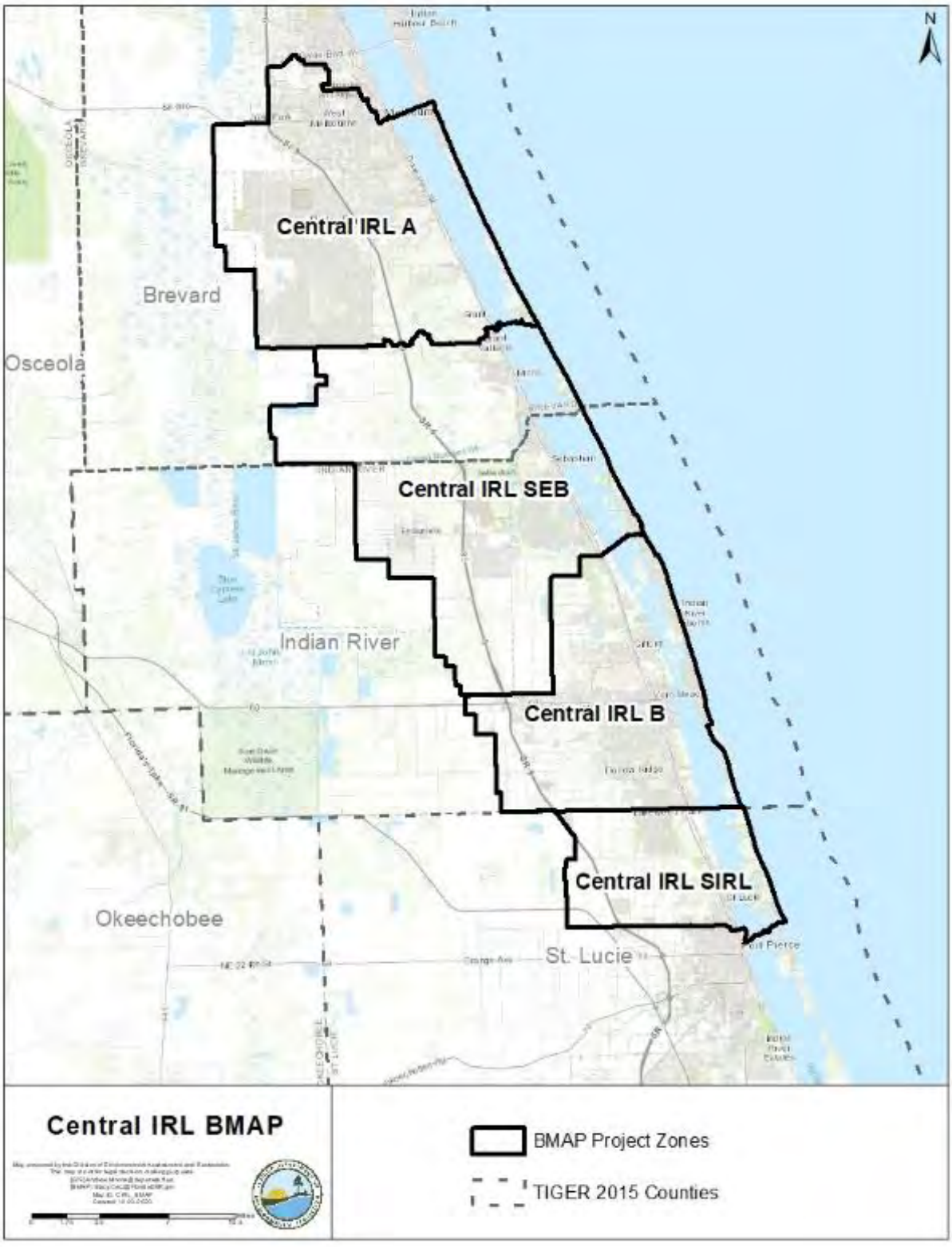

Figure ES- 1. CIRL BMAP area and project zones

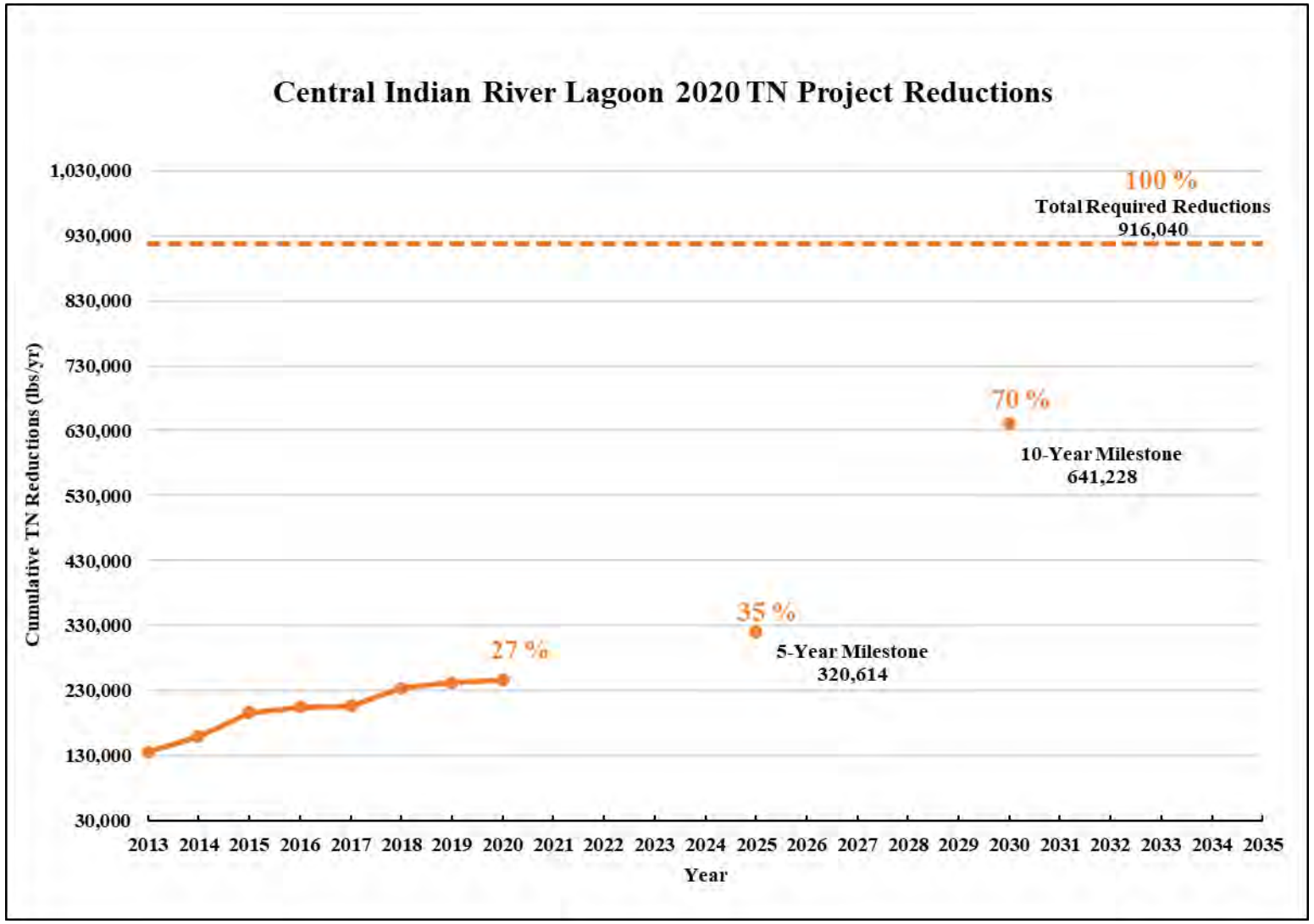

Figure ES- 2. Estimated progress towards the CIRL BMAP TN milestones with projects completed through July 31, 2020

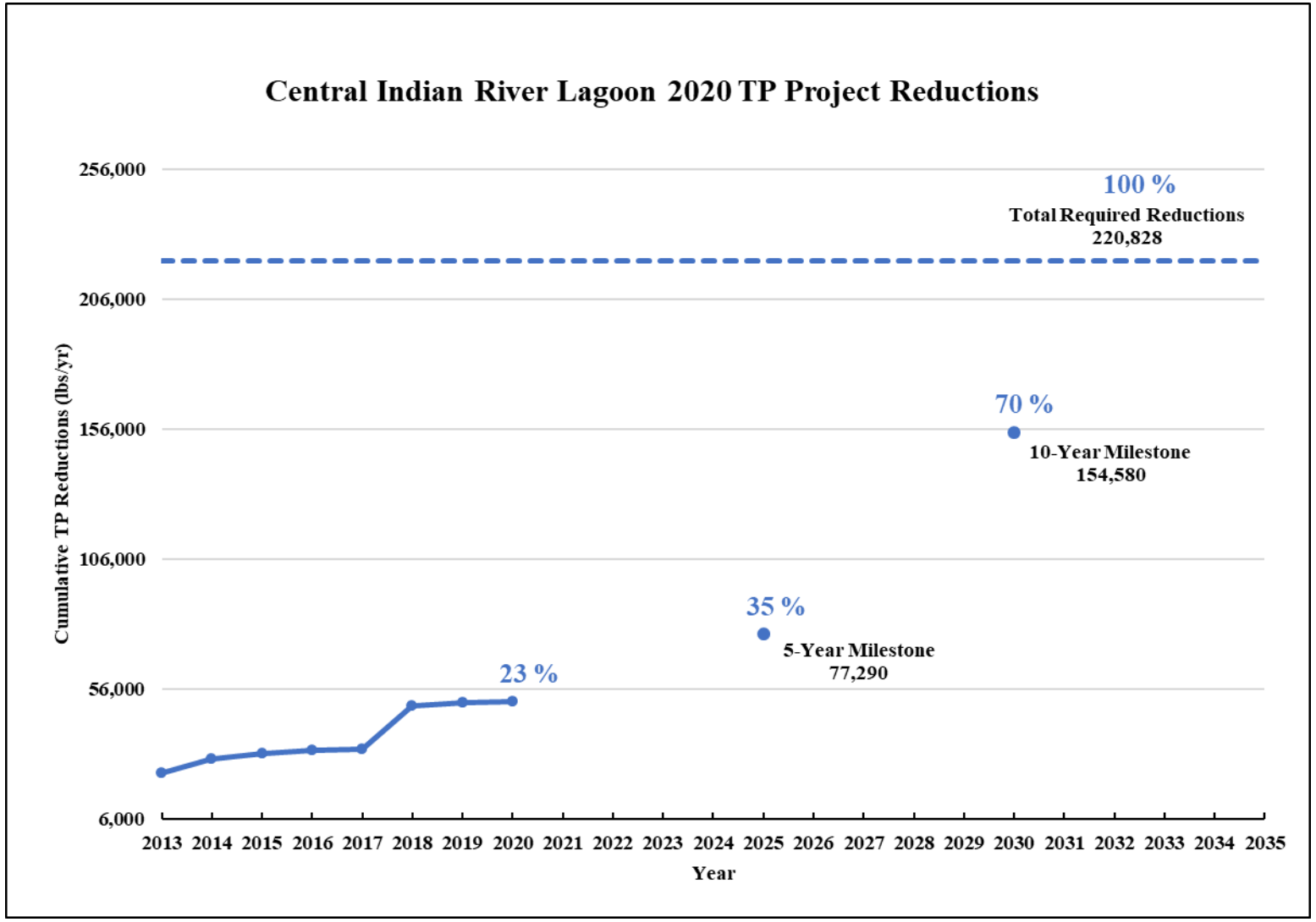

Figure ES- 3. Estimated progress towards meeting the CIRL TP milestones with projects completed through July 31, 2020

Chapter 1. Background Information

1.1 Water Quality Standards and Total Maximum Daily Loads (TMDLs)

Florida's water quality standards are designed to ensure that surface waters fully support their designated uses, such as drinking water, aquatic life, recreation, and agriculture. Currently, most surface waters in Florida, including many of those in the Central Indian River Lagoon (CIRL), are categorized as Class III waters, meaning they must be suitable for recreation and must support fish consumption and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. In addition, many waterbody segments (also known as waterbody identification units, WBIDs) are categorized as Class II waters, which have a designated use of shellfish propagation or harvesting. **Table 1** lists all designated use classifications for Florida surface waters.

Table 1. Designated use attainment categories for Florida surface waters

[1] Class I, I-Treated, and II waters additionally include all Class III uses.

Classification	Description
Class I[1]	Potable water supplies
Class I-Treated[1]	Treated potable water supplies
Class II[1]	**Shellfish propagation or harvesting**
Class III	**Fish consumption; recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife**
Class III-Limited	Fish consumption, recreation or limited recreation, and/or propagation and maintenance of a limited population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (*no current Class V designations*)

Class II waters in the CIRL may be used for aquaculture. The WBIDs that are designated as Class II waters are listed in **Table 2.** If not listed, the remaining WBIDs are Class III waters.

Section 303(d) of the federal Clean Water Act (CWA) requires that each state must identify its impaired waters every two years, including estuaries, lakes, rivers, and streams, that do not meet their designated uses. Florida Department of Environmental Protection (DEP) staff in the Division of Environmental Assessment and Restoration are responsible for assessing Florida's waters for inclusion on the Verified List of Impaired Waters (when a causative pollutant for the impairment has been identified) and Study List (when a causative pollutant for the impairment has not been identified and additional study is needed). These lists are then provided to the U.S. Environmental Protection Agency (EPA) as an update to the state's 303(d) list. In 2009, DEP adopted, by Secretarial Order, revisions to the Verified List of Impaired Waters for the CIRL that identified several estuarine segments as impaired for dissolved oxygen (DO) and nutrients. The DO impairment was based on low DO concentrations measured in milligrams per liter (mg/L), and the nutrient impairment was based on an imbalance in flora and fauna because of decreases in seagrass distribution.

Table 2. Class II waters in the CIRL

Classification	WBID Number	Waterbody Name
Class II	2963A1	Indian River above Sebastian Outlet
Class II	2963B1	Indian River above Melbourne Causeway
Class II	3107A	Goat Creek (marine segment)
Class II	3107B	Goat Creek (freshwater segment)
Class II	3115	Kid Creek
Class II	3119	Trout Creek
Class II	3147	North Canal
Class II	3190	South Indian River (above Ft. Pierce Inlet)
Class II	3190A	Little Jim Bridge
Class II	5003B1	South Indian River (below SR 60)
Class II	5003B2	South Indian River (below SR 60 – Shellfish Portion)
Class II	5003C1	South Indian River (above SR 60)
Class II	5003D1	South Indian River (near St. Sebastian River)
Class II	5003DA	Coconut Point Sebastian Inlet

1.1.1. CIRL TMDLs

TMDLs are water quality restoration goals establishing the maximum amount of a pollutant that a waterbody can assimilate without causing exceedances of water quality standards. The Indian River Lagoon (IRL) TMDLs focus on the water quality conditions necessary for seagrass regrowth at water depth limits where seagrass historically grew in the lagoon, based on a multiyear composite of seagrass coverage. The median depth limits of seagrass coverage in the IRL decreased over the years (see **Section 4.2**) because of changes in water quality conditions resulting from anthropogenic influences.

As polluted runoff reaches the lagoon, it contributes to conditions that prevent the seagrass from growing in deeper water because of elevated light attenuation. The full restoration depth-limit target for seagrass was established for each segment based on a deep edge boundary delineating the composite of 7 years of historical seagrass data for the period from 1943 to 1999. The restoration targets were set at depths where the deep edge of the seagrass beds previously grew and created a maximum depth limit for seagrass distribution. The TMDL targets allowed for a 10 % departure (shoreward) from the full restoration target seagrass depth. The 10 % departure in target depths was selected to be consistent with the water quality criteria in Chapter 62-302, Florida Administrative Code (F.A.C.), which allows for up to a 10 % reduction in the photo compensation point.

To determine nutrient targets and reductions needed to improve lagoon water quality in each subbasin, regression relationships were used between 4 years of loading levels and the same years' seagrass depth limit (the percent departure from the full restoration). Total nitrogen (TN) and total phosphorus (TP) targets were developed from the median concentrations observed where seagrass depth limits were within the 10 % departure (shoreward) from their full

restoration levels. These targets should result in nutrient reductions that allow seagrass to grow almost to the depths previously seen in the area. **Table 3** lists the TMDLs and pollutant load allocations adopted by rule for the CIRL.

Table 3. CIRL TMDLs

NPDES = National Pollutant Discharge Elimination System.

WBID	Waterbody	Parameter	NPDES Stormwater (% reduction)
5003D+2963A	South Indian River + Indian River Above Sebastian Inlet	TN	56
5003D+2963A	South Indian River + Indian River Above Sebastian Inlet	TP	48
5003B+5003C	South Indian River	TN	56
5003B+5003C	South Indian River	TP	48

Additionally, this BMAP addresses adopted TMDLs for certain tributaries to the CIRL. For all the CIRL tributaries, there are biochemical oxygen demand (BOD) TMDLs in rule. Also, for these tributaries—Crane Creek (WBID 3085A), North Prong of the Sebastian River (WBID 3128), South Prong St. Sebastian River Estuary Segment (WBIDs 3129B1 and 3129B2), Sebastian River above Indian River (WBID 3129A), and C-54 Canal (WBID 3135A)—no further nutrient load reductions were requested beyond those already established for the main stem seagrass nutrient TMDLs. For Goat Creek (WBID 3107A), the targets were also set to control nutrient loads from the watershed of the creek to restore seagrass distribution in the IRL proper. No further nutrient reductions beyond those already being requested to protect the main stem seagrasses were included in the Goat Creek TMDLs.

Table 4 lists the tributary TMDLs in the CIRL.

Table 4. CIRL tributary TMDLs

WBID	Waterbody	Parameter	NPDES Stormwater (% Reduction)	Project Zone
3107A	Goat Creek	TN	36	A
3017A	Goat Greek	TP	0	A
3017A	Goat Greek	BOD	72.3	A
3085A	Crane Creek	TN	56	A
3085A	Crane Creek	TP	48	A
3085A	Crane Creek	BOD	80.1	A
3128	North Prong of the Sebastian River	TN	56	SEB
3128	North Prong of the Sebastian River	TP	48	SEB
3128	North Prong of the Sebastian River	BOD	69.7	SEB
3129B1	South Prong St. Sebastian River Estuary Segment	TN	56	SEB
3129B1	South Prong St. Sebastian River Estuary Segment	TP	48	SEB
3129B1	South Prong St. Sebastian River Estuary Segment	BOD	78.2	SEB
3129B2	South Prong St. Sebastian River Estuary Segment	TN	56	SEB
3129B2	South Prong St. Sebastian River Estuary Segment	TP	48	SEB
3129B2	South Prong St. Sebastian River Estuary Segment	BOD	78.2	SEB
3129A	Sebastian River above Indian River	TN	56	SEB
3129A	Sebastian River above Indian River	TP	48	SEB
3129A	Sebastian River above Indian River	BOD	74.2	SEB
3135A	C-54 Canal	TN	56	SEB
3135A	C-54 Canal	TP	48	SEB
3135A	C-54 Canal	BOD	72.3	SEB

1.2 CIRL Basin Management Action Plan (BMAP)

A BMAP is a framework for water quality restoration that contains local and state commitments to reduce pollutant loading through current and future projects and strategies. BMAPs contain a comprehensive set of solutions, such as permit limits on wastewater facilities, urban and agricultural best management practices (BMPs), and conservation programs designed to achieve pollutant reductions established by a TMDL. These broad-based plans are developed with local stakeholders and rely on local input and commitment for development and successful implementation. BMAPs are adopted by DEP Secretarial Order and are legally enforceable.

The Florida Watershed Restoration Act (FWRA), Subparagraph 403.067(7)(a)1., Florida Statutes (F.S.), establishes an adaptive management process for BMAPs that continues until the TMDLs are met. This approach allows for incrementally reducing loadings through the implementation of projects and programs, while simultaneously monitoring and conducting studies to better

understand water quality dynamics (sources and response variables) in each impaired waterbody. The CIRL BMAP was first adopted in February 2013. An adaptive management process that is statutorily required, such as the changes made in this updated BMAP, will continue until the TMDLs are met.

This document serves as an update to the 2013 BMAP. **Figure 1** shows the CIRL BMAP area.

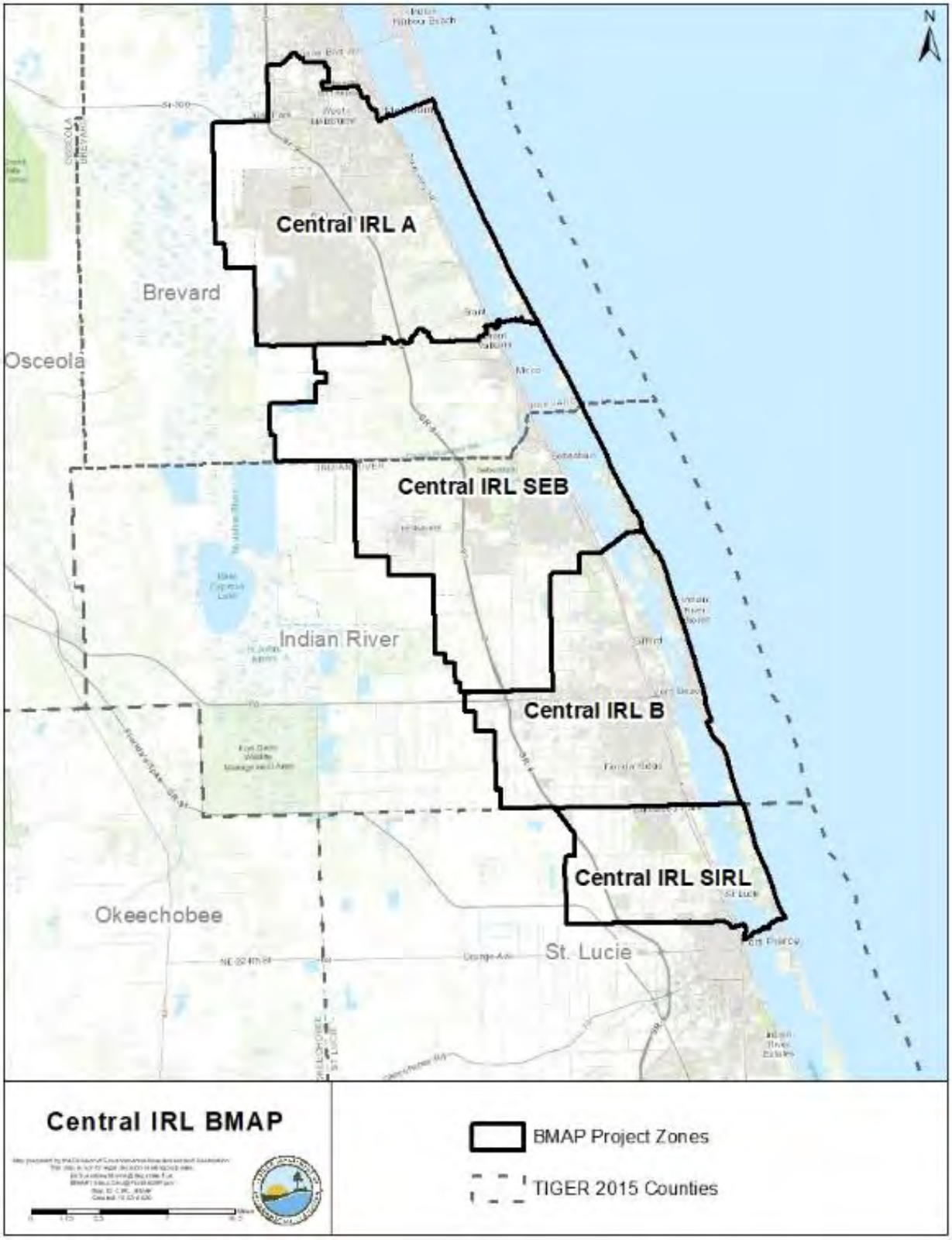

Figure 1. CIRL BMAP area

1.2.1. Pollutant Sources

There are various sources of pollution in the CIRL. Nonpoint (i.e., diffuse) sources in the watershed contribute the majority of TN and TP loads to the CIRL and include urban and agricultural runoff. For additional information on other sources not directly addressable through anthropogenic activities, please refer to **Section 1.2.4**. The St. Lucie Estuary, to the south, is being addressed through the St. Lucie River and Estuary BMAP.

1.2.1.1. Agricultural Nonpoint Sources

The primary agricultural land uses in the CIRL BMAP area are grazing lands, fallow land, citrus, and open lands. Other agricultural land uses include nurseries and horse farms/specialty farms. Most of the horse farms are small, noncommercial hobby farms. Because of urban encroachment, citrus health issues (freeze/disease), and the downturn in the economy, a majority of previously existing citrus operations have been destroyed or abandoned, have significantly lowered their production acreage, or have transitioned to another commodity. In recent years, some of this acreage may have also shifted to nonagricultural/urban uses.

Per Section 403.067, F.S., when DEP adopts a BMAP that includes agriculture, it is the agricultural landowner's responsibility either to implement BMPs adopted by Florida Department of Agriculture and Consumer Services (FDACS) to help achieve load reductions, or to conduct water quality monitoring pursuant to Chapter 62-307, F.A.C. Landowners that do not enroll in the BMP program or conduct water quality monitoring are referred to DEP for enforcement action. To date, the FDACS Office of Agricultural Water Policy (OAWP) has adopted BMP manuals by rule for cow/calf, citrus, vegetable and agronomic crops, nurseries, equine, sod, dairy, poultry, and specialty fruit and nut operations.

To enroll in the BMP Program, landowners first meet with OAWP to determine the BMPs that are applicable to that individual operation. The landowner must then submit to OAWP a Notice of Intent (NOI) to implement the BMPs on the checklist from the applicable BMP manual. Because many agricultural operations are diverse and are engaged in the production of multiple commodities, a landowner may be required to sign multiple NOIs for a single parcel.

OAWP is required to verify that landowners are properly implementing the BMPs identified in their NOIs. Rule 5M-1.008, F.A.C., outlines the procedures used to verify the implementation of agricultural BMPs. BMP implementation is verified through site visits conducted by OAWP staff at least every two years, as required by Subparagraph 403.067(7)(d)3, F.S. Producers not properly implementing BMPs according to the process outlined in Chapter 5M-1, F.A.C., are referred to DEP for enforcement action after attempts at corrective and remedial action are exhausted.

FDACS staff conduct site visits to verify that all BMPs are being properly implemented and to review nutrient and irrigation management records. In addition, OAWP verifies that cost-share items are being implemented correctly. Site visits are prioritized based on the date the NOI was signed, the date of the last BMP verification site visit, and whether the operation has received

cost-share funding. FDACS undertakes these onsite inspections at least every two years and provides DEP with aggregated information on nutrient amounts being applied.

Where water quality problems are detected for agricultural nonpoint sources despite the appropriate implementation of adopted BMPs, a reevaluation of the BMP manuals shall be conducted pursuant to Subparagraph 403.067(7)(c)4., F.S.:

> When water quality problems are demonstrated, despite the appropriate implementation, operation, and maintenance of best management practices and other measures required by rules adopted under this paragraph, the department, a water management district, or the Department of Agriculture and Consumer Services, in consultation with the department, shall institute a reevaluation of the best management practice or other measure. If the reevaluation determines that the best management practice or other measure requires modification, the department, a water management district, or the Department of Agriculture and Consumer Services, as appropriate, shall revise the rule to require implementation of the modified practice within a reasonable time period as specified in the rule.

Where monitoring indicates that progress towards established BMAP goals is not being attained, FDACS, DEP, and the water management districts may determine additional measures that can be implemented to achieve the desired goals, including the reevaluation of BMPs and other measures.. Additional information on the evaluation of BMPs is provided in **Section 2.3.1**.

Under Paragraph 403.067(7)(c), F.S., the proper implementation of FDACS-adopted, DEP-verified BMPs, in accordance with FDACS rules, provides a presumption of compliance with state water quality standards for the pollutants addressed by the BMPs. For the BMAP, the implementation of agricultural BMPs will be documented based on participation in the FDACS BMP Program. **Table 5** and **Table 6** summarize the agricultural land use enrolled in BMP programs for the entire CIRL BMAP area and by project zone, respectively. Enrollment is as of July 2020, and the agricultural acreage in each basin is based on the Florida Statewide Agricultural Irrigation Demand (FSAID) VII Geodatabase. **Appendix C** provides more information on agricultural activities in the CIRL BMAP area.

Table 5. Agricultural land use acreage enrolled summary in the BMP Program in the CIRL BMAP area as of July 2020

Category	Acres
FSAID VII agricultural acres in the BMAP area	72,898
Total agricultural acres enrolled	18,277
% of FSAID VII agricultural acres enrolled	25

Table 6. Agricultural land use acreage enrolled in the BMP Program in the CIRL BMAP area by project zone

Project Zone	Total FSAID VII Agricultural Acres	Agricultural Acres Enrolled	% of Agricultural Acreage Enrolled
A	9,781	355	4
SEB	33,776	12,737	38
B	16,061	2,418	15
SIRL	13,280	2,767	21
Total	**72,898**	**18,277**	**25**

UNENROLLED AGRICULTURAL ACREAGE

Agricultural land use designation is not always indicative of current agricultural activity and consequently presents challenges to estimating load allocations accurately as well as enrolling every agricultural acre in an appropriate BMP manual. To characterize unenrolled agricultural acres, OAWP identified FSAID VII features outside the BMP enrollment areas using geographic information system (GIS) software (see **Appendix C** for details). **Table 7** summarizes the results of that analysis.

Table 7. Summary of unenrolled agricultural land use acreage in the CIRL BMAP area

Note: Because of geometric variations between shapefiles used in the unenrolled agricultural lands analysis performed by OAWP, the unenrolled agricultural acres differ from subtraction of the FSAID VII Agricultural Acres in the BMAP and the Total Agricultural Acres Enrolled referenced in **Table 5**.

Category	Acres
Unenrolled agricultural acres	54,625
Acres identified within slivers of unenrolled agricultural areas	443
Lands without enrollable agricultural activity (e.g., tribal lands, residential development, and parcels with Florida Department of Revenue (DOR) use codes 70-98)	9,335
Total lands with potentially enrollable agricultural activities	**44,847**

As of July 2020, OAWP had enrolled 18,277 agricultural acres in BMPs. Considering the results of the analysis shown in **Table 7**, the total acreage with the potential to have agricultural activities that can be enrolled in the FDACS BMP Program in the watershed is 63,124 acres. Using this adjusted agricultural acreage, 29 % of agricultural acres have been enrolled.

Analyzing land use data and parcel data is a valuable first step in identifying the agricultural areas that provide the greatest net benefits to water resources for enrollment in FDACS' BMP Program, as well as prioritizing implementation verification visits in a given basin. OAWP will continue to enroll agricultural lands in the BMP Program, focusing on intensive operations, including irrigated acreage, dairies and nurseries, parcels greater than 50 acres in size, and agricultural parcels adjacent to waterways.

The next step to help prioritize the enrollment efforts could use the parcel loading information derived from the Spatial Watershed Iterative Loading (SWIL) Model. This effort could help FDACS identify specific parcels with the highest modeled nutrient loading. These parcels could then be targeted for the enrollment and implementation of BMPs, as well as the verification of BMP implementation.

AQUACULTURE

Under the CWA, aquaculture activities are defined as a point source. Since 1992, all aquaculture facilities have been regulated by DEP, the water management district, or both, through a general fish farm permit authorized by Section 403.814, F.S. In 1999, the Florida Legislature amended Chapter 597, F.S., Florida Aquaculture Policy Act, to create a program within FDACS requiring Floridians who commercially culture aquatic species to annually acquire an Aquaculture Certificate of Registration and implement Chapter 5L-3, F.A.C., Aquaculture BMPs. Permit holders must reapply to be certified every year. However, as with agricultural land use in Florida, aquaculture facilities are frequently in and out of production. The facilities for which acreages were provided may no longer be in operation and there may be new companies in different parts of the watershed. In the CIRL Subbasin, 306 acres of aquaculture are estimated to be under certification with the FDACS Division of Aquaculture as of September 2020. For the purposes of the BMAP, OAWP delineated the aquaculture facilities using parcel data. Since the acreages were not delineated to just the tank, pond, or pool areas, in most cases these calculations overestimate the acreages of aquaculture activity.

1.2.1.2. Municipal Separate Storm Sewer Systems (MS4s)

Many of the municipalities in the watershed are regulated by the Florida National Pollutant Discharge Elimination System (NPDES) Stormwater Program. An MS4 is a conveyance or system of conveyances, such as roads with stormwater systems, municipal streets, catch basins, curbs, gutters, ditches, constructed channels, or storm drains.

If an MS4 permittee is identified as a contributor in the BMAP, the permitted MS4 must undertake projects specified in the BMAP. The BMAP projects required to be undertaken by MS4s are detailed for each project zone in **Chapter 3**. Phase I and Phase II MS4s are required to implement stormwater management programs (SWMPs) to reduce pollutants to the maximum extent practicable and address applicable TMDL allocations. Phase I MS4 permits include assessment practices to determine the effectiveness of SWMPs, which can include water quality monitoring. Both Phase I and Phase II MS4 permits include provisions for the modification of SWMP activities, at the time of permit renewal, for consistency with the assumptions and requirements of the adopted BMAP. There are no Phase I MS4 permittees in the CIRL as of September 2020.

PHASE II MS4 STORMWATER PERMIT REQUIREMENTS

Table 8 lists the Phase II MS4s in the CIRL as of September 2020. Under a generic permit, the operators of regulated Phase II MS4s must develop a SWMP that includes BMPs with

measurable goals and a schedule for implementation to meet the following six minimum control measures:

- **Public Education and Outreach** – Implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on waterbodies and the steps that the public can take to reduce pollutants in stormwater runoff.

- **Public Participation/Involvement** – Implement a public participation/involvement program that complies with state and local public notice requirements.

- **Illicit Discharge Detection and Elimination** – Subsection 62-624.200(2), F.A.C., defines an illicit discharge as "…any discharge to an MS4 that is not composed entirely of stormwater…," except discharges under an NPDES permit, or those listed in rule that do not cause a violation of water quality standards. Illicit discharges can include septic/sanitary sewer discharge, car wash wastewater, laundry wastewater, the improper disposal of auto and household toxics, and spills from roadway accidents.

    - Develop, if not already completed, a storm sewer system map showing the location of all outfalls, and the names and location of all surface waters of the state that receive discharges from those outfalls.

    - To the extent allowable under state or local law, effectively prohibit, through ordinance or other regulatory mechanism, nonstormwater discharges into the storm sewer system and implement appropriate enforcement procedures and actions.

    - Develop and implement a plan to detect and address nonstormwater discharges, including illegal dumping, to the storm sewer system.

    - Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper waste disposal.

- **Construction Site Runoff Control** –

    - Implement a regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to reduce pollutants in any stormwater runoff to the Phase II MS4 from construction activity that results in a land disturbance greater than or equal to an acre. Construction activity disturbing less than one acre must also be included if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more.

  - Develop and implement requirements for construction site operators to implement appropriate erosion and sediment control BMPs.
  - Implement requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.
  - Develop and implement procedures for site plan review that incorporate the consideration of potential water quality impacts.
  - Develop and implement procedures for receiving and considering information submitted by the public.
  - Develop and implement procedures for site inspection and the enforcement of control measures.

- **Postconstruction Runoff Control** – Implement and enforce a program to address the discharges of postconstruction stormwater runoff from areas with new development and redevelopment. (**Note**: In Florida, Environmental Resource Permits issued by water management districts typically serve as a Qualifying Alternative Program for purposes of this minimum control measure.)
- **Pollution Prevention/Good Housekeeping** – Implement an operations and maintenance (O&M) program that has the ultimate goal of preventing or reducing pollutant runoff from MS4 operator activities, such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, stormwater system maintenance, and staff training in pollution prevention.

The "NPDES Generic Permit for Discharge of Stormwater from Phase II MS4s," Paragraph 62-621.300(7)(a), F.A.C., also requires that if the permittee discharges stormwater to a waterbody with an adopted TMDL pursuant to Chapter 62-304, F.A.C., then the permittee must revise its SWMP to address the assigned wasteload in the TMDL. Additionally, in accordance with Section 403.067, F.S., if an MS4 permittee is identified in an area with an adopted BMAP or a BMAP in development, the permittee must comply with the adopted provisions of the BMAP that specify activities to be undertaken by the permittee.

DEP can designate an entity as a regulated Phase II MS4 if its discharges meet the requirements of the rule and are determined to be a significant contributor of pollutants to surface waters of the state in accordance with Rule 62-624.800, F.A.C. A Phase II MS4 can be designated for regulation when a TMDL has been adopted for a waterbody or segment into which the MS4 discharges the pollutant(s) of concern. If an MS4 is designated as a regulated Phase II MS4, it is

subject to the conditions of the "NPDES Generic Permit for Stormwater Discharges from Phase II MS4s."

Table 8. Entities in the CIRL designated as Phase II MS4s as of September 2020

Permittee	Permit Number
Brevard County	FLR04E052
Indian River County	FLR04E068
St. Lucie County	FLR04E029
City of Fort Pierce	FLR04E065
City of Melbourne	FLR04E027
City of Palm Bay	FLR04E077
City of Sebastian	FLR04E124
City of Vero Beach	FLR04E010
City of West Melbourne	FLR04E028
FDOT District 4	FLR04E083
FDOT District 5	FLR04E024
Florida Turnpike Authority	FLR04E049
Patrick Air Force Base	FLR04E074
Town of Indialantic	FLR04E030
Town of Indian River Shores	FLR04E009
Town of Malabar	FLR04E050
Town of Melbourne Beach	FLR04E041

1.2.1.3. Septic Systems

Based on data from the Florida Department of Health (FDOH) Florida Water Management Inventory (FLWMI), there are 78,363known or likely septic systems (onsite sewage treatment and disposal systems [OSTDS]) located throughout the CIRL (**Figure 2**). **Table 9** summarizes the number of septic systems by project zone.

Table 9. Septic system counts by project zone

Central Project Zone	Total Number of Septic Systems
A	39,547
SEB	17,369
B	16,178
SIRL	5,269
Total	**78,363**

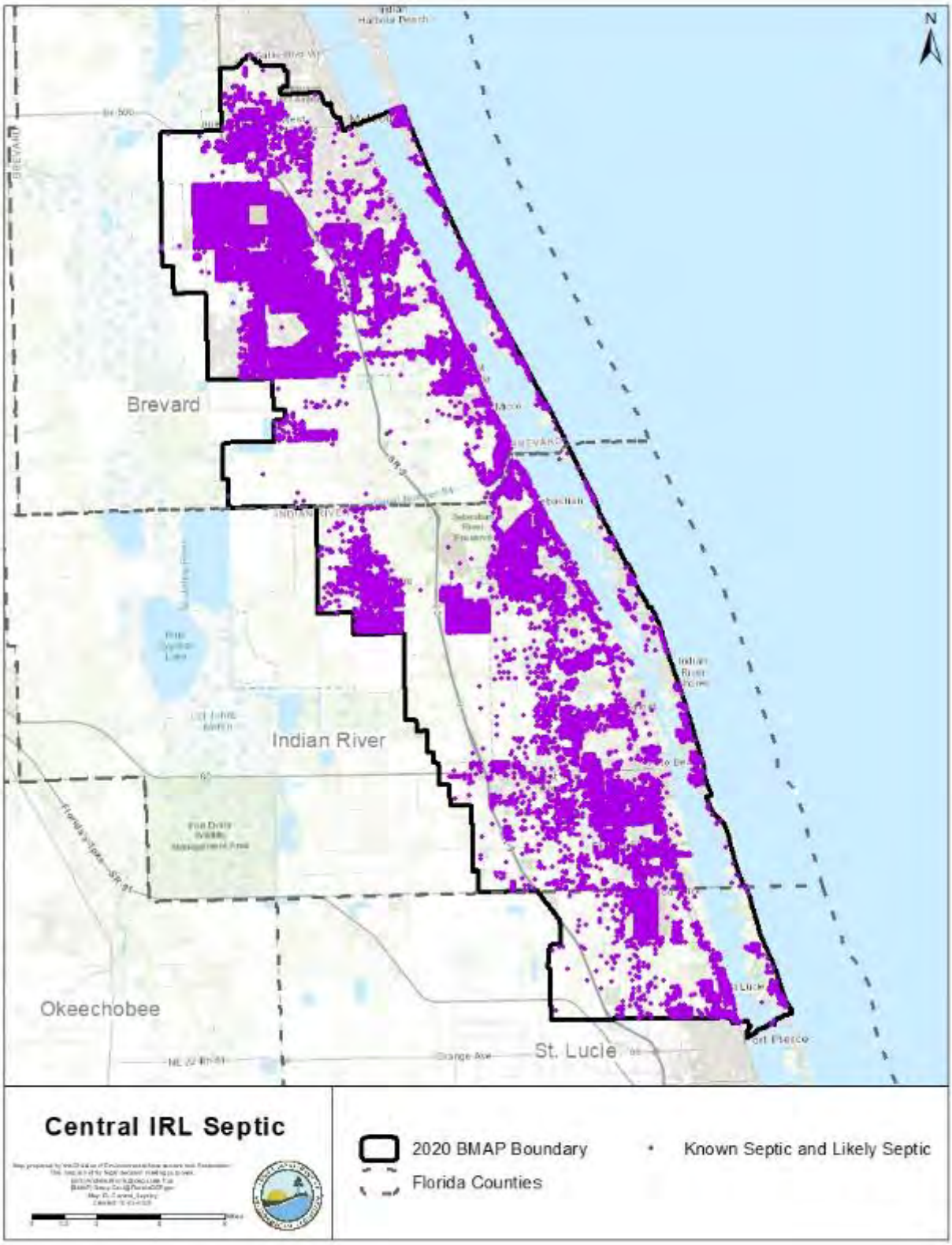

Figure 2. Location of septic systems in the CIRL

1.2.1.4. Urban Nonpoint Sources

Subsubparagraph 403.067(7)(b)2.f., F.S., prescribes the pollutant reduction actions required for nonagricultural pollutant sources that are not subject to NPDES permitting. Non-MS4 sources must also implement the pollutant reduction requirements detailed in a BMAP and are subject to enforcement action by DEP or a water management district if they fail to implement their responsibilities under the BMAP. **Table 10** lists the urban nonpoint sources in the CIRL.

Table 10. Urban nonpoint sources in the CIRL

Type of Entity	Participant
Government Entities and Special Districts	Chaparral Community Development District Emerald Lakes Community Development District Mayfair Community Development District PBR Community Development District Viera East Community Development District Fellsmere Water Control District Fort Pierce Farms Water Control District Indian River Farms Water Control District Melbourne Tillman Water Control District Sebastian River Improvement District Vero Lakes Water Control District

1.2.1.5. Wastewater Treatment Facilities (WWTFs)

As of September 2020, DEP identified 41 individually permitted wastewater facilities or activities in the CIRL Subbasin. A list of wastewater facilities in the CIRL as of September 2020 is provided in **Table 11**, and a map of their locations is shown in **Figure 3**.

Table 11. Wastewater facilities in the CIRL as of September 2020

BCUD = Brevard County Utilities Department; WWTF = Wastewater treatment facility; WWTP = Wastewater treatment plant; DIW = Deep Injection Well; RV = Recreational vehicle; MHP = Mobile home park; SLCU = St. Lucie County Utilities; IRCUD = Indian River County Utilities Department

Facility ID	Facility Name
FL0040622	BCUD-South Beaches WWTF
FL0041122	Melbourne Grant St WWTP & DIW
FL0041637	Indian River County - West Regional WWTF
FL0042293	Barefoot Bay Advanced
FLA010265	Long Point Recreational Park
FLA010272	Discovery Elementary School
FLA010332	West Melbourne, City of - Ray Bullard WWTF
FLA010338	Summit Cove Condominium
FLA010343	Cove At South Beaches Condominium Association WWTF
FLA010346	Pelican Bay MHC WWTF
FLA010347	Southern Comfort Mobile Home Park WWTF
FLA010352	Aquarina Beach Community WWTF
FLA010356	Harris Malabar Facility
FLA010357	South Shores Utility
FLA010359	Treetop Village
FLA010363	Camelot RV Park Inc
FLA010366	Lighthouse Cove WWTF
FLA010374	Indian River Shores Trailer Park WWTF
FLA010400	River Grove Mobile Home Village WWTF
FLA010421	Enchanted Lakes Estates
FLA010431	Indian River County - Central - Gifford WWTF
FLA010434	Indian River County – Residuals Dewatering Facility
FLA010435	Indian River County – South Regional WWTF
FLA010472	Royal Oaks Mobile Home Park WWTF
FLA010475	Sun Ag Mobile Home Park Wastewater Treatment Facility
FLA010492	Su - Rene MHP
FLA013945	SLCU Fairwinds Golf Course WWTF
FLA013946	North Hutchinson Island Regional WWTF
FLA013969	St. Lucie County Utilities Holiday Pines WWTF
FLA013977	Spanish Lakes Country Club Village WWTF
FLA013982	Meadowood
FLA013998	Spanish Lakes Country Club Village WWTF
FLA014025	Cypress Mobile Home Park WWTF
FLA014028	Country Cove MHP
FLA017104	Harbor Branch Oceanographic Institution Post Doc Apartments
FLA021661	Vero Beach, City of
FLA039586	SLCU Lakewood Park WWTF
FLA103357	Palm Bay, City of - WWTF
FLA104299	Indian River County - Sea Oaks WWTF
FLA104388	IRCUD/North Regional WWTF
FLA693782	Palm Bay South Regional WRF

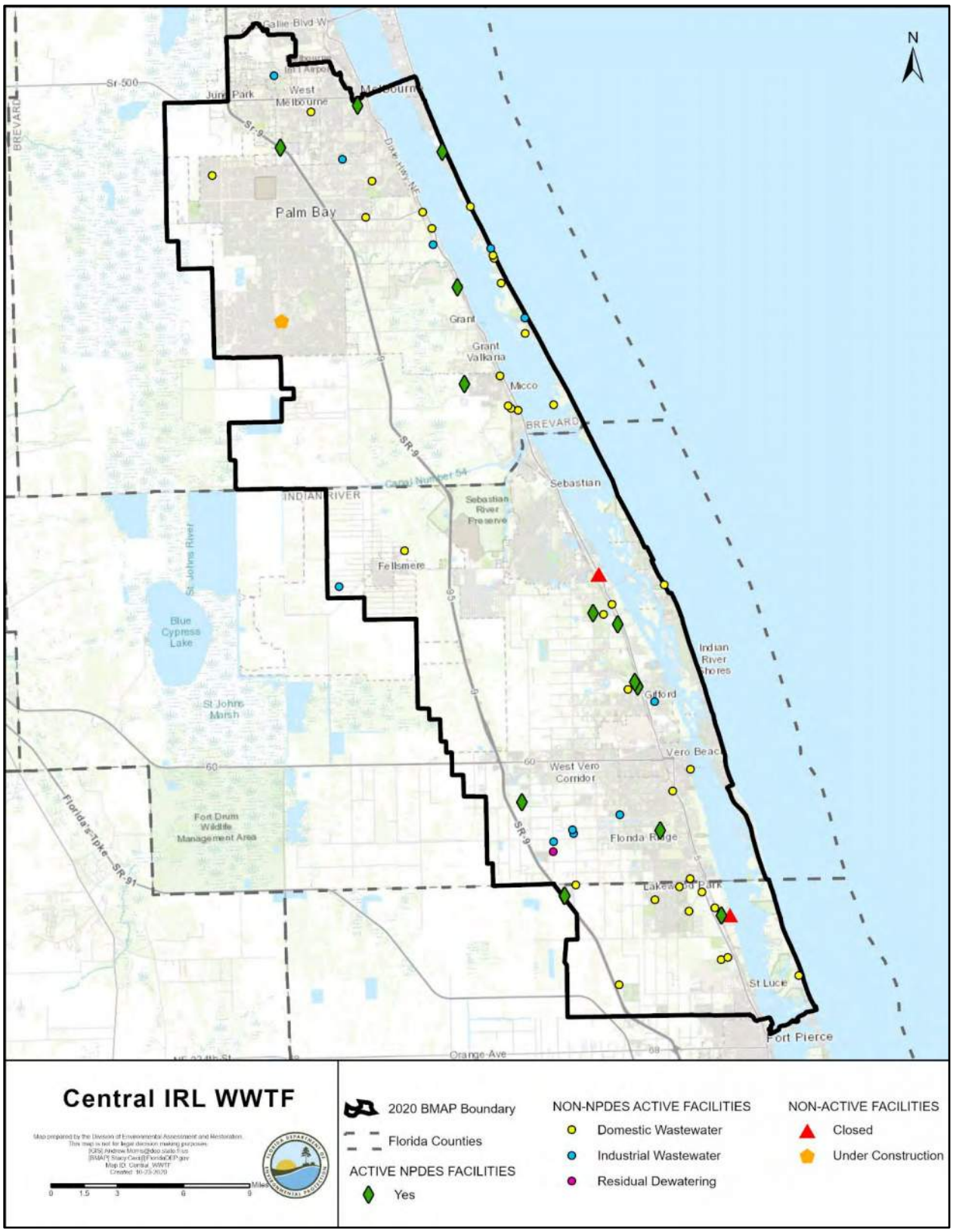

Figure 3. Map of wastewater facilities in the CIRL

1.2.2. Milestones and Tracking Progress

The projects and activities in the BMAP are key to the overall goal of recovering seagrass in the lagoon. The estimated benefits of these implemented activities are tracked to show stakeholder efforts by determining a percentage towards the total required reductions to be achieved at each milestone. Additionally, stakeholders provide DEP with reasonable assurance that they have a plan to achieve the individually assigned reductions required in **Chapter 2**. Subparagraph 403.067(7)(a)6., F.S., indicates that an assessment of progress towards the BMAP milestones shall be conducted every five years, and plan revisions made as appropriate. To meet these requirements, DEP has established milestones for the years 2025, 2030, and 2035. The percent reductions in the milestones apply to the total BMAP required reductions, so as various entities implement their projects, the overall milestones are also being met.

The following percent reduction goals are proposed for each milestone and may be adjusted as the BMAP is adaptively managed through future phases:

- 5-year milestone in 2025: 35 % or 320,614 lbs/yr of TN and 77,290 lbs/yr of TP. Based on model revisions, reset 10-year and 15-year milestones, as needed.
- 10-year milestone in 2030: 70 % or 641,228 lbs/yr of TN and 154,580 lbs/yr of TP.
- 15-year milestone in 2035: 100 % or 916,040 lbs/yr of TN and 220,828 lbs/yr of TP.

By the next milestone in 2025, at least 35 % of the TN and TP required reductions must be met. **Figure ES- 2** and **Figure ES- 3** show the milestones as well as the cumulative TN and TP reductions over time as projects are completed in each reporting period. The deadline established by this BMAP for achieving the full load reductions is 2035, which is 22 years after the initial adoption of the 2013 BMAP.

1.2.3. Assumptions

The water quality impacts of BMAP implementation are based on several fundamental assumptions about the pollutants targeted by the TMDLs, modeling approaches, waterbody response, and natural processes. The following assumptions were used during the BMAP process:

- Certain BMPs were assigned provisional nutrient reduction benefits for load reductions in this BMAP iteration while additional monitoring and research are conducted to quantify their effectiveness. These estimated reductions may change in future BMAP iterations as additional information becomes available.

- The nutrient reduction benefits of the stakeholders' projects were calculated using the best available methodologies. Project-specific monitoring, where available, will be used to verify calculations, and reduction benefits may be adjusted as necessary.

- The TMDLs require TN and TP reductions from the watershed to improve water quality in the CIRL to allow seagrass to grow at greater water depths. High watershed nutrient loadings result in high chlorophyll *a* concentrations in the lagoon, which may indicate algal growth and a reduction in light availability to the seagrass, thus limiting the depth at which seagrass can grow. Therefore, reducing nutrient loading to the CIRL is an important factor in improving seagrass depth limits.

- The allocations do not require load reductions from areas identified as natural land use areas in the modeled land use/land cover information. These loads are considered uncontrollable, background sources, and the stakeholders are not required to make reductions on natural lands. The BMAP allocations focus on urban and agricultural stormwater sources and septic systems in the watershed.

- Water is exchanged between the CIRL and other nearby waterbodies (the North Indian River Lagoon [NIRL], Banana River Lagoon [BRL], and St. Lucie River and Estuary), and water quality conditions in the CIRL may be influenced by conditions in nearby waters. To help address these nearby conditions, separate BMAPs have been adopted for these watersheds.

1.2.4. Considerations

This BMAP requires stakeholders to implement their projects to achieve reductions within the specified period. However, the full implementation of this BMAP will be a long-term, adaptively managed process. While some of the BMAP projects and activities were recently completed or are currently ongoing, several projects require more time to design, secure funding, and construct. Regular followup and continued coordination and communication by the stakeholders will be essential to ensure the implementation of management strategies and assessment of incremental effects.

During the BMAP process, a number of items were identified that should be addressed in future watershed management cycles to ensure that future BMAPs use the most accurate information:

- **Harmful Algal Blooms (HABs)** – HABs cause shading that stresses seagrass in the IRL, adverse effects on wildlife, and in some cases, detrimental effects on human health. Intense and extensive algal blooms in the IRL began in 2011 and have returned periodically, with clear impacts on the extent, density, and depth where seagrasses grow; some fish kills; and, fortunately, little direct impact on human health. Compared with earlier blooms, the recent blooms

have been dominated by smaller species of algae called nanoplankton and picoplankton. SJRWMD launched the Indian River Lagoon Protection Initiative in 2013, including a multiyear investigation that increased the understanding of the blooms. This and other research indicate it is important to persevere with projects that decrease TN and TP loads to the IRL, because that approach will limit the severity of HABs and their impacts on the system.

- **Land Uses** – The loading estimates in the BMAP are based on land uses at a point in time, allowing the model to be calibrated. The loading estimates for this BMAP iteration were based on land use/land cover data from approximately 2015 from the water management districts as well as property appraiser data. Land uses in the model will be updated during future model revisions based on the most recent and accurate data available; this may result in changes to loading estimates.

- **Basin Boundaries** – **Figure 4** shows the previous and updated BMAP boundary. Overall, 1,214 acres were added to the BMAP area and 122,538 acres removed, resulting in a net reduction of 121,144 acres. When the 2013 basin boundary was developed, there was uncertainty about whether some areas drained to the IRL, to the Upper St. Johns River, or to other adjacent waterbodies. The boundaries were adjusted based on the best information available about the hydrology of the IRL, but future adjustments may be made because of flow diversions or updated information.

- **Jurisdictional Boundaries** – Entities may experience shifts in their jurisdictional boundaries over time that require allocation adjustments. Changes to the boundaries and/or allocations for these stakeholders may be made as necessary and reflected in future BMAP iterations.

- **SWIL Model** – The SWIL Model was initially developed through cooperative funding provided by Brevard County, all of its cities, and FDOT District 5, as well as support from the U.S. Air Force, for purposes other than the BMAPs, and DEP will explore refinements that may help improve the future use of the SWIL for the IRL BMAPs. This effort could include updates to some of the SWIL Model input layers, the verification of watershed boundaries in some areas, revisions to the model period of record, and the validation of predicted flows in selected calibration basins. There are also several optional tasks that could streamline efforts during the load allocation and project calculation processes. DEP expects the SWIL Model enhancements to change the loading estimates and the CIRL future allocations. Although the direction and magnitude of those changes are not certain, DEP anticipates that some may be higher, and some may be lower.

- **Community Development District (CDD) Responsibilities** –DEP has had several communications with the CDDs located in the CIRL. CDDs were

assigned allocations only if three criteria were met: (1) there is development—i.e., roads and infrastructure—in the CDD area; (2) the CDD does not discharge to an MS4; and (3) the CDD pays a stormwater fee and receives a refund of this fee. CDDs that did not receive an allocation in this BMAP iteration may receive allocations in future BMAP iterations.

- **Special Districts** – Water control districts (WCDs) and similar types of special districts have been assigned qualitative allocations for the canals and rights-of-way to the special districts, as the districts have control over these portions of their jurisdictions. These districts are required to implement specific canal and right-of-way BMPs to be compliant with the BMAP. The BMPs for each special district are based on the activities and land uses within the district, and reporting on those BMPs is due annually. The specific approach for each special district is described in **Appendix E**, and will be reevaluated in each 5-year BMAP update. The evaluation will be based on the special district's operations, authorities, and utilization of those authorities.

- **Complexity of the Problem** – DEP acknowledges the complexity of the dynamics affecting the water quality of the CIRL; therefore, this BMAP is designed to encompass a wide variety of projects and management strategies that will cumulatively act to significantly reduce nutrient loads. In estuarine-based systems, the interaction with ocean waters and freshwater inflows adds variability to the water quality conditions—including those associated with climate change and sea level rise. Other factors such as inconsistency in annual rainfall amounts, changing land uses and farming practices, and internal nutrient sources such as muck deposits also complicate measuring the benefits of projects and management strategies and understanding the relationship between nutrient loading and the biological response of the seagrass deep edge.

- **Sea Level Rise** – Sea level rise and changes in lagoon water depth over time affect the depth at which seagrass growth is measured for TMDL compliance and for assessing seagrass restoration. Improved depth estimates and seagrass deep edge assessment techniques are needed.

- **Previous Restoration Efforts** – DEP recognizes that stakeholders throughout the watershed have implemented stormwater management projects prior to the implementation of the TMDLs and that these efforts have benefited water quality. Projects completed in 2000 or later are considered for credits and inclusion in the BMAP.

- **Atmospheric Deposition** – Reductions in atmospheric deposition have occurred over time and are expected to continue. This BMAP and all subsequent nutrient reduction requirements and allowable loads factor only those inputs directly from the watershed. DEP will continue to monitor

atmospheric deposition and may address it in future BMAP iterations as part of the adapative management process.

- **Muck Deposition** – Muck deposits contain nutrients that flux into the water column, increasing the abundance of phytoplankton, drift macroalgae, and epiphytes that attenuate light and constrain seagrass growth and propagation. Most IRL muck originates from upland soils and vegetation. For this reason, stringent watershed soil-erosion control and soil/vegetation containment measures are needed. Without such measures in place, muck removal will need to be frequently repeated, which is neither cost-effective nor time efficient. Ideally, muck removal projects should be performed in conjunction with soil and vegetation retention programs, including public awareness activities, that limit the amount of muck material deposited into the IRL. The SWIL Model does not automatically take this process into account; however, guidance documentation has been developed for crediting muck removal projects specifically from the lagoon.

- **Tributary Water Quality Impairments** – DEP has identified tributary nutrient impairments within the SIRL project zone but has not yet set water quality targets with TMDLs. Specifically, WBIDs 3163 and 3163B (C-25 canal) are impaired for nutrients, as indicated by elevated phosphorus levels and the abundance of macrophytes.

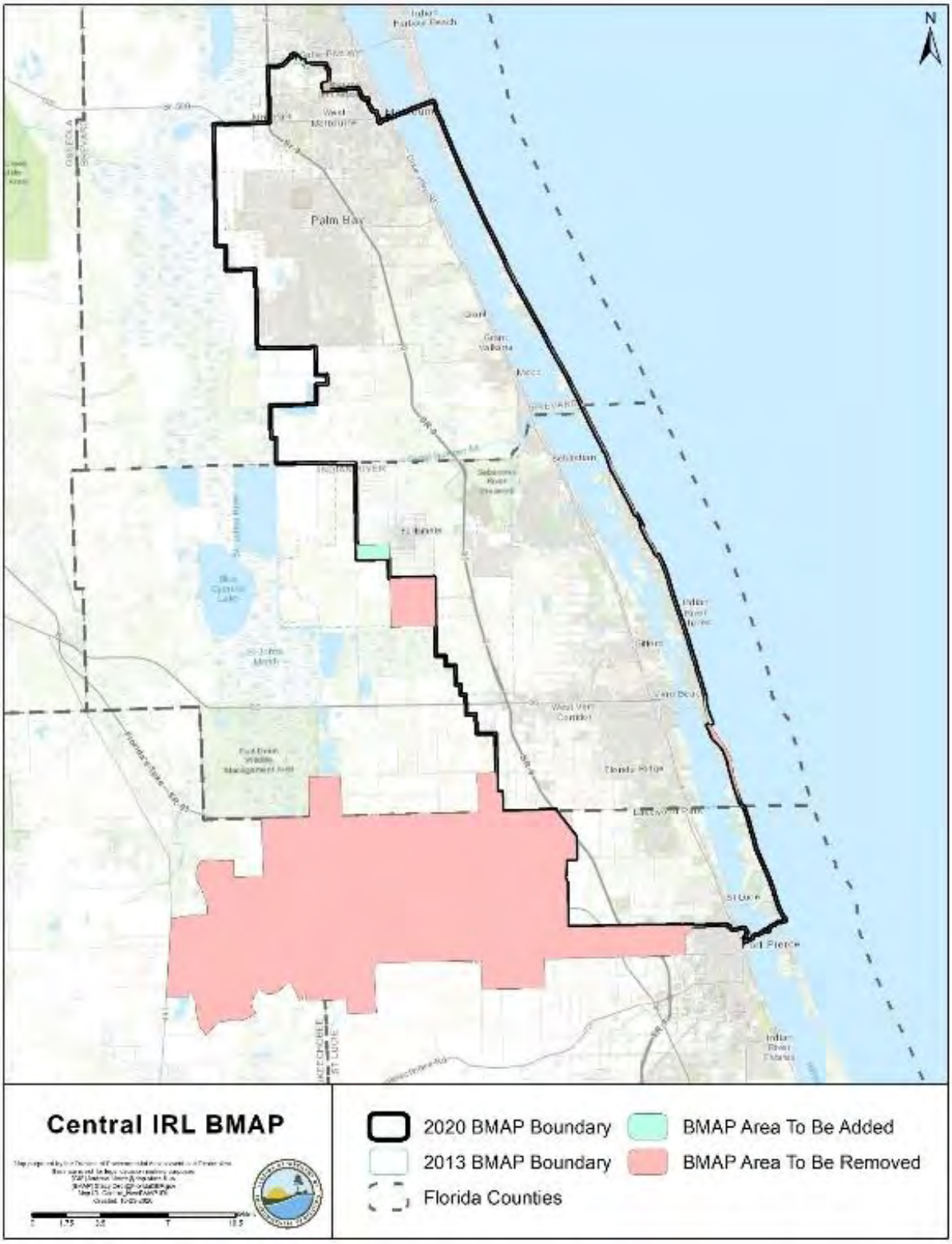

Figure 4. 2013 BMAP area boundary and 2020 BMAP area boundary

1.3 Economic Benefits of the IRL System

The IRL is a valuable ecological and economic asset for the state of Florida and the counties that border the lagoon and its tributaries. It is considered one of the most biologically diverse estuaries in North America and was recognized as part of the National Estuary Program (NEP) in 1990. The lagoon directly and indirectly supports a large part of the region's and the state's economy. The basin supports the multimillion-dollar Indian River citrus industry and boat and marine sales industries. Finfish and shellfish harvesting from the lagoon also contribute to local economies.

An economic study prepared by the East Coast Florida Regional Planning Council (ECFRPC) and Treasure Coast Regional Planning Council (TCRPC) (ECFRPC and TCRPC 2016) estimated the total annual value of the lagoon's benefits at $7.6 billion, measured in 2014 dollars. This does not include the estimated $934 million in annualized real estate value added for property located on or near the IRL (Hazen and Sawyer 2008). The study area spanned from Ponce de Leon Inlet in Volusia County to the Jupiter Inlet in Palm Beach County, and included all of Brevard, Indian River, St. Lucie, and Martin Counties. The economic analysis was primarily conducted using the Impact Analysis for Planning (IMPLAN) Regional Economic Input/Output Model, which estimates direct, indirect, and induced economic effects, as outlined in **Figure 5**.

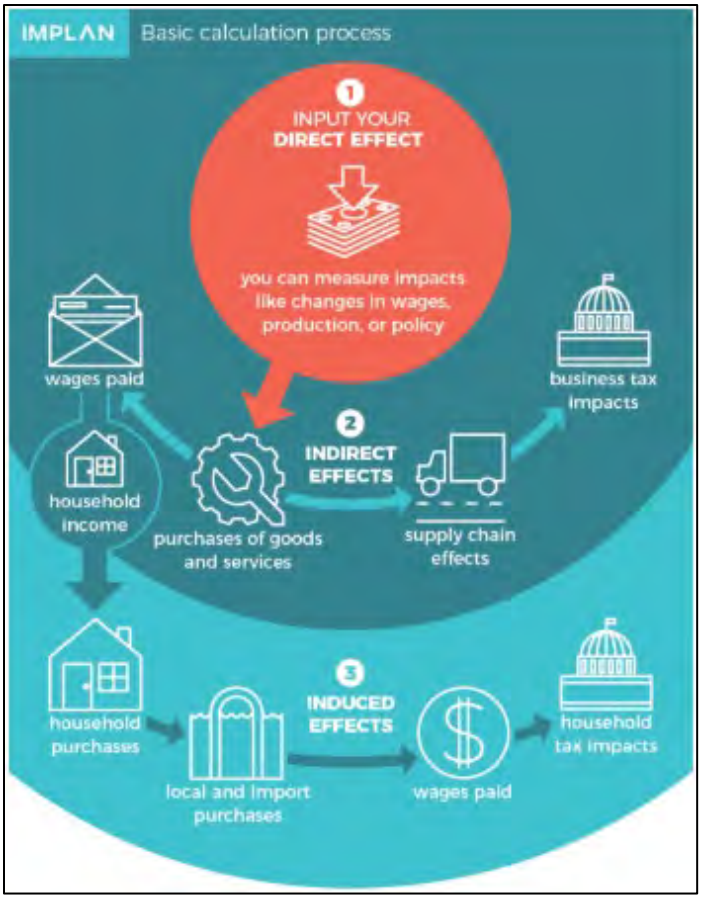

Figure 5. IMPLAN Model calculation process

The primary IRL-related industry groups identified in the study are Living Resources, Marine Industries, Recreation and Visitor-Related, Resource Management, and Defense and Aerospace. The breakdown of the monetary contribution to the IRL regional economy is shown in **Figure 6**.

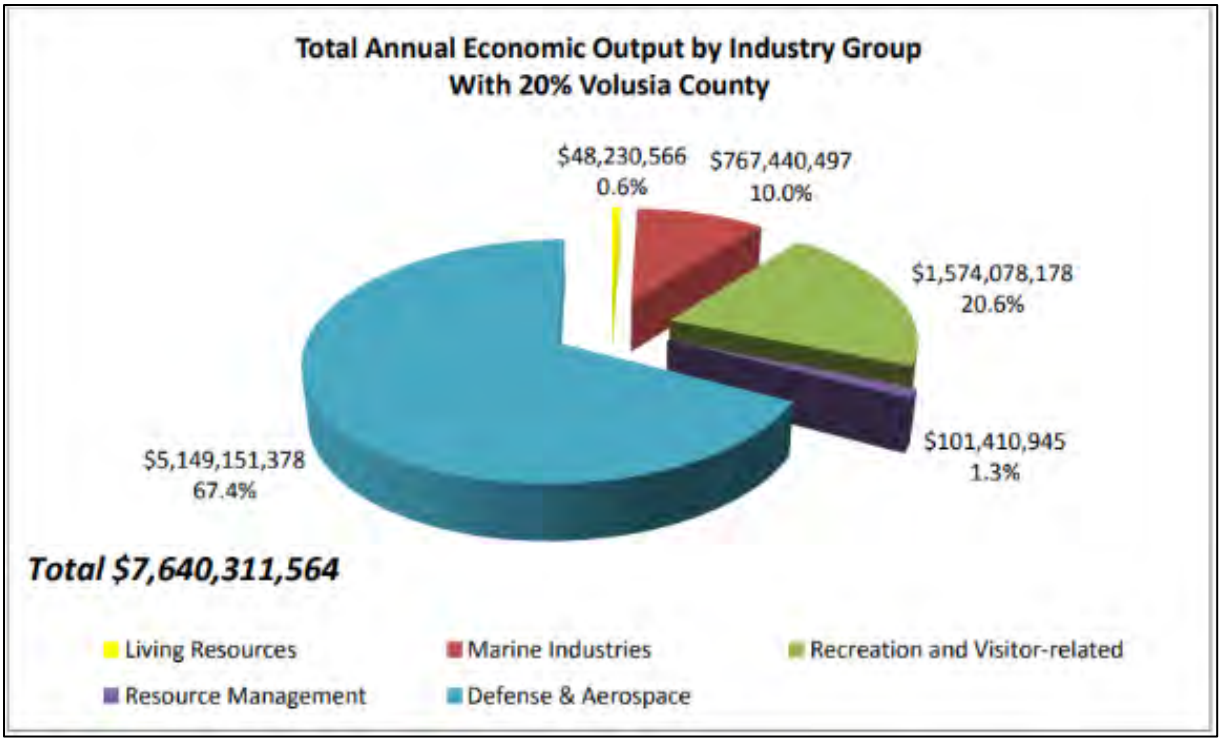

Figure 6. Total annual economic output by industry group in the IRL region, 2014

Money spent on recreation and visitor-related activities generated $1.57 billion of economic benefit. In 2014, over 7.4 million visitors traveled to the IRL region. Between 2.3 and 3.5 million visitors to the IRL region participate in IRL-related recreation, and each visitor spends an average of $162 a day. By 2025, the IRL region is anticipated to receive over 11 million visitors annually.

The study also estimated the cost of a sustainable IRL-based economy and return on investment for achieving water quality and seagrass restoration goals for the IRL. The annualized cost of achieving the nutrient load reductions required by the four BMAPs that span the entire area was estimated at $230 million. When compared with the $7.6 billion valuation of the region's average annual economic output, the return on investment from achieving water quality and seagrass restoration goals is 33 to 1. Therefore, investing in projects and programs to improve the lagoon's water quality and seagrass beds is not only important for environmental considerations but also to improve the regional economy.

Chapter 2. Modeling, Load Estimates, and Restoration Approach

2.1 BMAP Modeling

Nutrient loading estimates were originally calculated for the BMAP using the Pollutant Load Screening Model (PLSM) which was expanded by SJRWMD to represent year 2000 loading (Adkins et al. 2004) in most of the IRL Watershed (excluding the IRL south of the Indian River–St. Lucie County boundary). The seagrass depth limits were developed by SJRWMD based on a series of photo-interpreted seagrass coverages from 1943 through 2001. DEP reviewed these models and the seagrass depth limits and used them to develop the IRL TMDLs that were adopted by rule (Gao 2009).

Through cooperative local effects, all the MS4 permittees within the Brevard County section of the IRL (17 entities) partnered to fund a Study Team to create a new watershed model that would update and refine the information that was used in the PLSM and associated TMDLs for the IRL. One outcome of this study was the development of the SWIL Model, which is intended to incorporate more available data, more recent conditions, and more temporally fine datasets. SWIL is a custom ESRI ArcGIS toolset, originally designed to provide a continuous monthly simulation of runoff over a 16-year period (Applied Ecology 2019).

During 2017 and 2018, while DEP prepared to calculate allocations for the CIRL BMAP, the SWIL Model was proposed as an alternative to the previously used PLSM. Several options were presented for updating allocations during a public meeting in May 2017, and the options were discussed by DEP and stakeholders during and after the meeting. In November 2017, a presentation was made to the IRL NEP Science, Technology, Engineering, and Mathematics (STEM) Committee to provide a technical overview of the SWIL. During the annual public meeting for the IRL BMAPs in December 2018, a proposed path forward was presented that included applying the SWIL to calculate allocations for the IRL BMAPs. A technical presentation was given by the model developer at a public webinar in January 2019 to provide stakeholders with an opportunity to discuss the model further. Finally, during the annual public meeting for the IRL BMAPs in December 2019, a summary of the allocation approach using SWIL was presented.

2.1.1. SWIL Modeling

The initial version of SWIL was developed for the IRL in 2012 (SWIL 1.0). To address several DEP comments and to improve execution and processing time, SWIL 2.0 was released in July 2014. SWIL 3.0 was released in April 2015 with improved model calibration to the measured available gauge data, including a revised method to derive baseflow volumes and loads. SWIL 3.0 also incorporated new evapotranspiration raster datasets. SWIL 4.0 was developed in support of the 3D numerical modeling effort led by the Florida Institute of Technology. Three major changes were performed for SWIL 4.0: (1) Expansion of the model extent to provide nutrient loadings from Ponce Inlet to Fort Pierce; (2) temporal expansion to include 2011 to 2015, for a

total model period of 20 years (1995 to 2015); and (3) the addition of a third land use/treatment time step using data from 2015 (Applied Ecology 2019).

2.1.2. SWIL Calibration

The SWIL 3.0 version was used for calibration using flow data primarily from the CIRL. The five gauged stations included in the calibration are located in the following basins: Crane Creek, Hickory Creek, North and South prongs of the Sebastian River, and Fellsmere Canal. Few data were available in the NIRL and none in the BRL, and so the calibration is based primarily on the CIRL conditions. Also, during the calibration process, a change was made to the normalization process of the baseflow volumes by incorporating "groundwater storage depth," an area-weighted groundwater input variable (Applied Ecology 2015). The calibration was based on simulated 1995–2010 flow volumes compared against measured data at the gauged stations. Since the treatment layer inputs to the model simulation did not incorporate BMPs beyond permit requirements after the year 2000, most projects installed from 2000 onward were not included in the calibration and are not well represented in the SWIL Model loading estimates. Therefore, projects completed from 2000 onward are eligible for BMAP credit.

2.1.3. Allocation Process

To generate average annual TN and TP loads from the IRL Watershed, SWIL was run using rainfall inputs that were thought to be from a representative period covering various conditions from high to low rainfall years. The outputs from this model run were used to generate a GIS-based Load Estimation Tool (LET) that included annual average loads from the watershed and was the basis of the allocation calculations.

The LET based on the SWIL Model can produce polygon outputs with loading data included. The determination of each entity's loading was performed using the LET and a GIS process. Through a series of GIS steps, polygons were generated for each stakeholder. GIS data were used to clip the area within the BMAP boundary associated with each entity's jurisdictional boundary or the codes from the model land cover data related to natural and agricultural lands. The clipping process was done sequentially, as follows:

1. Dispersed Water Management (DWM) or Comprehensive Everglades Restoration Plan (CERP) projects.
2. Roads (FDOT and Florida's Turnpike Enterprise).
3. WCDs and improvement district canals and rights-of-way.
4. Natural lands (land use codes 3000 [not including 3300], 4000, 5000, and 6000).
5. Agriculture (land use codes 2000 and 3300).
6. CDDs, if they meet the criteria.
7. Municipalities.

8. Remaining area assigned to each county.

Loads within DWM or CERP project areas were not included in the total loads for the project zone, since these land uses are being converted to treatment projects. Loads from natural land uses were not assigned to any specific entity's starting load. FDOT, agriculture, CDDs, municipalities, and counties were assigned starting loads based on this sequential process. The WCDs and Sebastian River Improvement District were assigned a qualitative allocation and are required to implement specific BMPs, as discussed in **Appendix E**.

2.1.4. Project Credit Process

The LET was used to calculate updated TN and TP baseloads from all existing project treatment areas in the BMAP. The August 2020 DEP BMP Efficiencies Guidance document was used to determine the appropriate credit calculations for the various project types. Some project types that have credits based on measured data or weighed material, such as street sweeping, did not need to be updated using the LET.

2.2 Calculation of Starting Loads and Allocations

This section describes the process used to calculate the load reductions needed to achieve the TMDLs and to allocate the load reduction requirements to the responsible stakeholders.

2.2.1. Starting Loads and Allocation of Load Reductions

DEP requested to use the SWIL 4.0 Model to update the load allocations for the second cycle of the IRL BMAPs. To develop the loads that represent updated current conditions, the SWIL Model was customized for this use with the following parameters (Applied Ecology 2018):

- A 50 x 50-meter (m) cell size was used, which is a much higher spatial resolution than any previously developed watershed loading models for the IRL.
- Land use corresponds to 2015 conditions and is derived from water management districts land use data, property appraiser data, and local government natural communities land cover, where available.
- Treatment layer (stormwater BMPs) corresponds to development conditions in approximately 2015, excluding any retrofits implemented by the stakeholders in the IRL Watershed. Retrofit projects will need to be retroactively calculated and provided as credits to the stakeholders.
- Period-of-record rainfall that includes 2004 to 2017 data, which allows for a wide range of rainfall conditions to represent the variability in loading to the IRL.

The outputs of this modeling effort can be described as static feature classes that include more than 1.2 million 50 x 50-m cells (as features) each. Each individual cell is associated with an estimated volume and both nitrogen and phosphorus estimated loading for the selected mean period-of-record conditions (Applied Ecology 2018).

For land use and land cover, 2015 conditions were represented as derived from water management district data for nonurban land uses and from local property appraiser datasets for urban land uses. Natural community data from local governments were also incorporated, where available (Brevard County). In addition, field-validated 2015 land use datasets for Patrick Air Force Base, Cape Canaveral Air Force Station, and the Malabar Annex were used in lieu of water management data (Applied Ecology 2018). Land covers were grouped to reflect the available event mean concentrations (EMCs) and C values that would be applied in the model. (Listopad 2020).

DEP used the LET to develop the allocations (see **Figure 7** and **Figure 8**). The percent reduction from the TMDLs was applied to the applicable areas within the BMAP. The TMDL percent reductions are based on segmented areas of the lagoon defined by both DEP WBIDs, along with breaks in the hydrology of the lagoon as defined by SJRWMD. Areas where segments share hydrologic similarity and similar reduction percentages, as noted by the TMDLs, are defined as segment groups. Additionally, during the first phase of BMAP adoption, the hydrology defined by SJRWMD was used to define project zones in order to assess seagrass compliance. Project zones were used to assist in calculating the required reduction and the allocation of each entity within the BMAP. In the CIRL, the total project zone load from the LET was used, and the percent reduction from the TMDL for that project zone was applied to determine the total required reductions per project zone. Natural lands had no reductions applied, and so the SWIL loads from natural land uses were held constant. The land cover codes considered to be "natural lands" include 3000 (upland nonforested; not including 3300), 4000 (upland forests), 5000 (water), and 6000 (wetlands). The allowable load in the project zone was determined by subtracting the required reductions from the total project zone load determined by the LET.

A test was performed to make sure that no reductions would be expected from natural land uses. The weighted average load per acre from natural lands for each project zone was compared with the load per acre from the allowable load. If the allowable load per acre was less than the natural land load per acre, the allowable load was increased to equal the natural load per acre times the acres in the project zone. This process was performed for both TN and TP loads in each project zone. The TN loads were adjusted using the natural load per acre for Project Zones A, B, and SEB. The TP loads were adjusted using the natural load per acre for Project Zone SIRL.

Once the total required reductions for each project zone were defined, the total anthropogenic load for the project zone was examined. Each stakeholder's anthropogenic load was compared with the total anthropogenic load for the project zone to determine its contribution to the total anthropogenic load. This percentage was considered to be representative of the stakeholder's loading contribution, and that percentage of the project zone's required reduction was applied to that stakeholder.

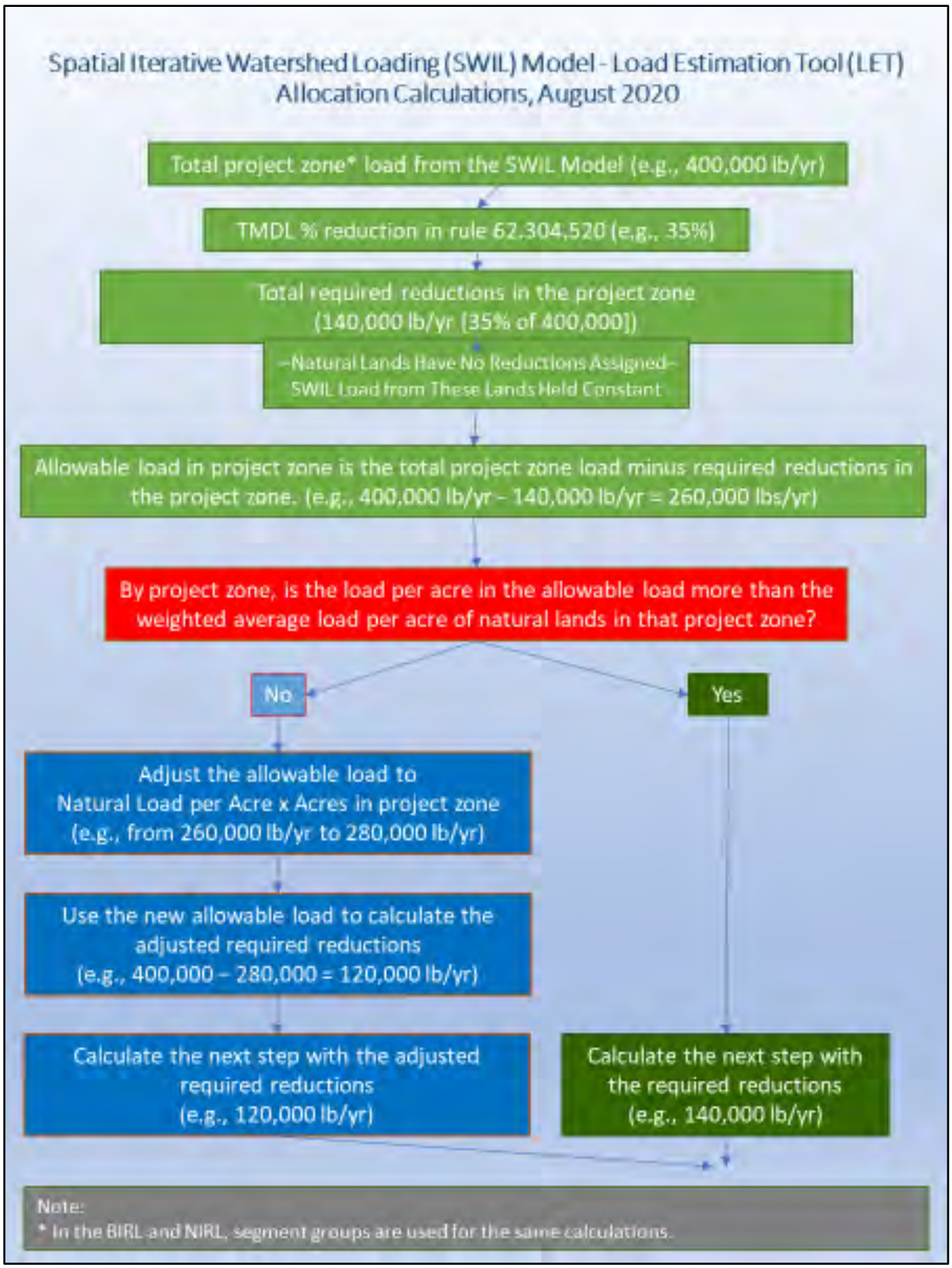

Figure 7. Flow chart of the allocation steps, Part 1 of 2

Figure 8. Flow chart of the allocation steps, Part 2 of 2

The SWIL Model starting loads for each project zone are described in **Table 12**.

Table 12. SWIL Model starting loads

BMAP Area	Project Zone	Starting TN Load (lbs/yr)	% Total Load TN	Starting TP Load (lbs/yr)	% Total Load TP
CIRL	A	616,171	28	85,081	28
CIRL	B	567,009	26	78,837	26
CIRL	SEB	762,595	34	96,865	32
CIRL	SIRL	266,181	12	38,975	13
CIRL Totals	**N/A**	**2,211,955**	**100**	**299,758**	**100**

2.2.1.1. Low-Priority Ranking Determination

Several stakeholders contribute less than 0.30 % of both the TN and TP loading from the watershed to the CIRL. The contribution to the overall nutrient loading from these stakeholders is low enough that reductions from these areas would have essentially no impact on the required reductions for the BMAP during this phase of implementation; therefore, these entities are currently considered a low priority for implementing reductions. Low-priority entities will be evaluated in future phases of BMAP implementation, as their contributions may change over time.

Table 13 summarizes the priority evaluation, and those stakeholders meeting the classification requirements for low priority are highlighted in grey. Stakeholders that met the low-priority classification include the Town of St. Lucie Village, Town of Indialantic, Town of Melbourne Village, Town of Orchid, City of Fort Pierce, U.S. Air Force, and Florida Turnpike. These entities are not required to meet the reduction targets for TN and TP in this phase of BMAP implementation but must continue to adhere to all requirements of its MS4 permit or other permits.

BMAP progress will be reviewed over time, and reduction requirements, including for those stakeholders with this low-priority status, will be modified in a future BMAP update as needed. TN and TP reductions may be needed from the low-priority entities in the future. Therefore, although they do not currently have a reduction responsibility, this does not exempt these stakeholders from such requirements in future BMAP updates. Any actions taken by these entities that result in TN and TP reductions will be documented for credit against any reduction requirements allocated in subsequent BMAP updates.

Table 13. Entity contributions to starting loads with low priority ranking cutoff

*Indicates the stakeholder meets the requirements for low priority.
NA = Not applicable

Entity	TN Starting Load (lbs/yr)	Anthropogenic % of TN in BMAP	TP Starting Load (lbs/yr)	Anthropogenic % of TP in BMAP
Agricultural Producers	477,619	29.82	67,398	29.05
Indian River County	357,237	22.30	51,895	22.37
City of Palm Bay	208,799	13.04	30,198	13.02
St. Lucie County	104,021	6.49	16,773	7.23
Brevard County	89,296	5.57	13,357	5.76
City of Melbourne	63,245	3.95	9,057	3.90
City of Sebastian	61,820	3.86	8,901	3.84
City of Vero Beach	48,755	3.04	7,049	3.04
Town of Grant-Valkaria	47,719	2.98	6,818	2.94
City of West Melbourne	34,398	2.15	5,010	2.16
Town of Malabar	23,093	1.44	3,338	1.44
FDOT District 4	22,731	1.42	2,978	1.28
Town of Indian River Shores	17,525	1.09	2,639	1.14
FDOT District 5	13,058	0.82	1,718	0.74
City of Fellsmere	10,603	0.66	1,544	0.67
Town Melbourne Beach	5,252	0.33	779	0.34
Town of St. Lucie Village*	3,608	0.23	638	0.28
Town of Indialantic*	3,589	0.22	531	0.23
Town of Melbourne Village*	3,194	0.20	475	0.20
Town of Orchid*	2,547	0.16	367	0.16
City of Fort Pierce*	1,854	0.12	305	0.13
U.S. Air Force*	954	0.06	118	0.05
FL Turnpike*	818	0.05	100	0.04
Total for Allocated Entities	**1,601,735**	**100.00%**	**231,986**	**100.00**
Natural Lands	564,616	N/A	61,538	N/A
WCD Canals	45,604	N/A	6,234	N/A
Total	**2,211,955**	**N/A**	**299,758**	**N/A**

2.2.1.2. Required Reductions

The TN and TP reductions required by each entity are shown in **Table 14** and **Table 15**, respectively.

Table 14. TN load required reductions by entity (lbs/yr)

*Indicates the stakeholder meets the requirements for low priority.
** = Adjusted using the natural load per acre.
N/A = Not applicable

Entity	Project Zone A	Project Zone SEB	Project Zone B	Project Zone SIRL	Total
Agricultural Producers	28,912	128,681	74,773	31,287	263,653
Indian River County	N/A	47,223	169,639	N/A	216,862
City of Palm Bay	110,334	1,657	N/A	N/A	111,991
St. Lucie County	N/A	N/A	N/A	49,780	49,780
Brevard County	19,940	27,987	N/A	N/A	47,927
City of Melbourne	33,921	N/A	N/A	N/A	33,921
City of Sebastian	N/A	33,196	N/A	N/A	33,196
City of Vero Beach	N/A	N/A	30,713	N/A	30,713
Town of Grant-Valkaria	20,519	5081	N/A	N/A	25,600
City of West Melbourne	18,449	N/A	N/A	N/A	18,449
FDOT District 4	N/A	3,325	5,976	3,375	12,676
Town of Malabar	12,386	N/A	N/A	N/A	12,386
Town of Indian River	N/A	N/A	11,040	N/A	11,040
FDOT District 5	5,226	1,780	N/A	N/A	7,006
City of Fellsmere	N/A	5,694	N/A	N/A	5,694
Town Melbourne Beach	2,817	N/A	N/A	N/A	2,817
Town of Indialantic*	1,925	N/A	N/A	N/A	0
Town of St. Lucie Village*	N/A	N/A	N/A	1,727	0
Town of Melbourne Village*	1,713	N/A	N/A	N/A	0
Town of Orchid*	N/A	1,368	N/A	N/A	0
City of Fort Pierce*	N/A	N/A	N/A	887	0
U.S. Air Force*	512	N/A	N/A	N/A	0
FL Turnpike*	N/A	N/A	N/A	391	0
Total	**256,654****	**255,992****	**292,141****	**87,447**	**883,711**

Table 15. TP load required reductions by entity (lbs/yr)

*Indicates the stakeholder meets the requirements for low priority.
** = Adjusted using the natural load per acre.
N/A = Not applicable

Entity	Project Zone A	Project Zone SEB	Project Zone B	Project Zone SIRL	Total
Agricultural Producers	4,740	22,286	9,120	7,173	43,319
Indian River County	N/A	8,580	22,231	N/A	30,811
City of Palm Bay	17,041	279	N/A	N/A	17,320
St. Lucie County	N/A	N/A	N/A	11,964	11,964
Brevard County	3,197	5,251	N/A	N/A	8,448
City of Sebastian	N/A	6015	N/A	N/A	6,015
City of Melbourne	5,182	N/A	N/A	N/A	5,182
Town of Grant-Valkaria	3,131	910	N/A	N/A	4,041
City of Vero Beach	N/A	N/A	3,998	N/A	3,998
City of West Melbourne	2,866	N/A	N/A	N/A	2,866
FDOT District 4	N/A	501	724	685	1,910
Town of Malabar	1,910	N/A	N/A	N/A	1,910
Town of Indian River Shores	N/A	N/A	1,497	N/A	1,497
City of Fellsmere	N/A	1,043	N/A	N/A	1,043
FDOT District 5	744	282	N/A	N/A	1,026
Town Melbourne Beach	446	N/A	N/A	N/A	446
Town of St. Lucie Village*	**N/A**	**N/A**	**N/A**	**455**	**0**
Town of Indialantic*	**304**	**N/A**	**N/A**	**N/A**	**0**
Town of Melbourne Village*	**272**	**N/A**	**N/A**	**N/A**	**0**
Town of Orchid*	**N/A**	**248**	**N/A**	**N/A**	**0**
City of Fort Pierce*	**N/A**	**N/A**	**N/A**	**217**	**0**
FL Turnpike*	**N/A**	**N/A**	**N/A**	**72**	**0**
U.S. Air Force*	**67**	**N/A**	**N/A**	**N/A**	**0**
Total	**39,900**	**45,395**	**37,570**	**20,566****	**141,796**

2.3 Basinwide Sources Approach

The basinwide sources approach involves tailoring management strategies to the primary sources of anthropogenic nutrient loading throughout the CIRL Subbasin. The primary source categories included in this approach are agricultural runoff, septic systems, urban stormwater, and wastewater. For additional information on other sources not directly addressed through anthropogenic activities, please refer to **Section 1.2.4**.

2.3.1. Agriculture

When DEP adopts a BMAP that includes agriculture, it is the agricultural landowner's responsibility to properly implement BMPs adopted by FDACS to help achieve load reductions or demonstrate compliance through monitoring . The current enrollment is 25 % of agricultural acres identified in the BMAP (see **Appendix C**). FDACS is undertaking efforts to transmit enrollment notifications to producers and landowners on identified agricultural lands within the BMAP area, which will drive increased enrollment or referral to DEP for water quality monitoring. A more detailed characterization of unenrolled agricultural lands is found in **Appendix C**. FDACS is responsible for verifying that all eligible landowners are enrolled in appropriate BMP programs. Subparagraph 403.067(7)(d)3, F.S. requires FDACS to perform regular onsite inspections, at least every two years, of all agricultural operations enrolled under a BMP manual to ensure that these practices are being properly implemented. Per the requirements of the statute, FDACS is prioritizing implementation verification (IV) efforts in certain basins, including the IRL. From these inspections, FDACS will provide DEP with an annual summary of aggregated fertilizer use in the BMAP area, quantifying total applications and providing information on applications by project zone.

It is anticipated that additional enrollment in agricultural BMPs, along with more frequent implementation verification site visits by FDACS, will increase nutrient reductions from agricultural nonpoint sources. However, further reductions beyond the implementation of required owner-implemented BMPs currently required by the FDACS manuals, may be necessary to achieve the TMDLs. FDACS has committed to updating its existing BMP manuals to incorporate updated BMPs based on the latest scientific and technical research. Subparagraph 403.067(7)(f)1, F.S., requires FDACS to annually develop research plans and legislative budget requests for the following:

- Evaluate and suggest enhancements to the existing adopted agricultural BMPs to reduce nutrient runoff.
- Develop new BMPs that, if proven effective, may be adopted by rule.
- Develop agricultural nutrient runoff reduction projects that willing participants could implement on a site-specific, cooperative basis, in addition to BMPs.

FDACS also provides funding to some agricultural operations to add other practices beyond owner-implemented BMPs. Examples include drainage improvements, fencing, water control structures, precision agriculture technology, and fertigation. SFWMD and SJRWMD are implementing and/or funding projects that encourage low-input agriculture and the use of water quality improvement technologies.

If owner-implemented BMPs fail to achieve water quality improvements, a cooperative agricultural regional water quality improvement element may be developed for this BMAP, subject to the conditions outlined in Subparagraph 403.067(7)(e)1, F.S. DEP, FDACS, and

agricultural producers will cooperatively develop a regional water quality improvement element in the event of the following:

- Agricultural measures have been adopted by FDACS pursuant to Subparagraph 403.067(7)(c)2, F.S., and have been implemented and the waterbody remains impaired.
- Agricultural nonpoint sources contribute to at least 20 % of nonpoint source nutrient discharges.
- DEP determines that additional measures, in combination with state-sponsored regional projects and other management strategies included in the BMAP, are necessary to achieve the TMDLs.

Further nutrient reductions can be achieved through the implementation of additional agricultural projects or activities. Other reductions associated with the implementation and modification of BMPs may be realized through ongoing studies, data collection, and water management district initiatives. These additional projects and practices are to be implemented in conjunction with the BMP Program, which will aim to achieve full enrollment with verification to ensure that the BMAP goals are achieved.

2.3.2. Septic Systems

As required in Subsubparagraph 403.067(7)(a)9.b., F.S., local governments must develop an onsite sewage treatment and disposal system (OSTDS) remediation plan to be adopted as part of the BMAP no later than July 1, 2025. The OSTDS remediation plans must be developed by each local government in cooperation with DEP, FDOH, water management districts, and public and private domestic wastewater facilities.

The OSTDS remediation plan requires entities to identify and address the following:

- Cost-effective and financially feasible projects necessary to achieve the nutrient load reductions required for OSTDS (e.g., sewering, advanced septic system retrofits, prohibiting the installation of new conventional septic systems).
- An inventory of OSTDS based on the best information available.
- OSTDS that would be eliminated through connection to existing or future central domestic wastewater infrastructure in the jurisdiction or domestic wastewater service area of the local government.
- OSTDS that would be replaced with or upgraded to enhanced nutrient-reducing systems.
- Cost of improvements and sources of funding.

Based on data from FDOH, there are 78,363 known and likely septic systems located throughout the CIRL Subbasin. **Table 9** in **Section 1.2.1.3** summarizes the count of septic systems by project zone.

Stakeholders will submit projects describing how septic loads are addressed as part of BMAP reporting and estimate the load reductions associated with each project. The estimated reductions to the lagoon from addressing these septic systems will be based on several factors, including how they are addressed (i.e., connecting to central sewer sends the wastewater to a treatment facility, which does not remove 100 % of the nutrient load) and the amount of attenuation that occurs as the effluent travels through the watershed to the lagoon.

2.3.3. Stormwater

Stormwater from urban areas is a considerable source of nutrient loading to the CIRL, and many of these areas are already regulated under the NPDES Stormwater Program. MS4 permittees are required to develop and implement a stormwater management program. Urban areas located in the BMAP area that are not currently covered by an MS4 permit also significantly contribute, individually or in aggregate, to nutrient loading. Therefore, the NPDES Stormwater Program will, within 5 years of BMAP adoption, evaluate any entity located in the BMAP area that serves a minimum resident population of at least 1,000 individuals that is not currently covered by an MS4 permit and designate eligible entities as regulated MS4s, in accordance with Chapter 62-624, F.A.C.

In accordance with Subsection 373.4131(6), F.S., DEP and the water management districts are planning to update the stormwater design and operation requirements in Environmental Resource Permit rules. These revisions will incorporate the most recent scientific information available to improve nutrient reduction benefits.

2.3.4. Wastewater Treatment

DEP issues permits for facilities and activities to discharge wastewater to surface waters and groundwaters of the state. DEP is authorized by the EPA to issue permits for discharges to surface waters under the NPDES Program. Permits for discharges to groundwater are issued by DEP under state statutes and rules. These wastewater discharge permits establish specific limitations and requirements based on the location and type of facility or activity releasing industrial or domestic wastewaters from a point source.

As of September 2020, there were 41 individually permitted wastewater facilities or activities in the CIRL Subbasin. All new or existing wastewater facilities that dispose of or discharge effluent in the BMAP area are subject to the BMAP provisions, regardless of whether the facility is listed in this BMAP. A preliminary list of wastewater facilities in the CIRL as of September 2020 is provided in **Table 11**, and a map of their locations is shown in **Figure 3** in **Section 1.2.1.5**.

In areas where there is anticipated growth in human population, adequate treatment capacity of domestic wastewater is essential. Domestic wastewater is treated through either WWTFs or OSTDS (septic systems). Where sewer lines are available, Florida law (Section 381.00655, F.S.)

requires a development or property owner to abandon the use of OSTDS and connect to sanitary sewer lines.

Florida law (Section 403.086, F.S., and Chapter 2020-150, Laws of Florida) requires all existing and new domestic wastewater facilities discharging to surface waters of the state within or connected to the IRL to meet advanced waste treatment requirements, as defined in Section 403.086, no later than July 1, 2025. Additionally, this BMAP requires all other individually permitted domestic wastewater facilities to meet the effluent limitations listed in **Table 16** and **Table 17**, unless the owner or operator can demonstrate reasonable assurance that the effluent would not cause or contribute to an exceedance of the TMDLs or water quality standards in groundwater.

To demonstrate reasonable assurance, the owner or operator must provide relevant water quality data, physical circumstances, or other site-specific credible information needed to show the facility would not cause or contribute to the nutrient loading in the BMAP area. This demonstration may include factors such as dilution; site-specific geological conditions; research/studies, including dye tracer tests; and modeling. If DEP concurs with the reasonable assurance demonstration, the effluent limitations established for discharges to ground water may be modified or waived for the facility. New effluent limitations will take effect no later than July 1, 2025.

New and existing domestic wastewater facilities must meet the stringent nutrient wastewater limitations set forth in this BMAP. Any such new facilities (those commencing after the adoption of this BMAP) must be capable of meeting the requirements of this BMAP at the time of permit issuance. For existing domestic wastewater facilities, DEP shall modify the permit limitations and requirements to be consistent with this BMAP at the time of the next permit renewal. If the facility needs additional time to meet the new limits, the permit may include a compliance schedule with a completion date not to exceed four and a half years after the effective date of the permit.

Table 16 and **Table 17** list the TN and TP effluent limitations, respectively, adopted for this BMAP that apply to domestic wastewater facilities unless the owner or operator can demonstrate reasonable assurance as listed above. The effluent limitations for direct surface water discharges and reclaimed water pipelines apply to individually permitted NPDES facilities at the end-of-pipe. Because the limitations for direct surface water discharges are technically-based advanced waste treatment limitations, mixing zones are not authorized for TN and TP. The effluent limitations for discharges to groundwater apply at the compliance well located at the edge of the zone of discharge. The owner or operator may elect to meet the groundwater limitations prior to the edge of the zone of discharge. These effluent limitations are applied as an annual average. For direct surface water discharges, the limitations in Paragraph 62-600.740(2)(b), F.A.C., will be applied in the permit.

Short-term or intermittent industrial discharges are not significant sources of TN or TP in the CIRL Subbasin and are not subject to the limits in **Table 16** and **Table 17.** Intermittent, rainfall-

driven, diffuse overflow releases of wastewater from ponds or basins designed to hold precipitation from a 25-year, 24-hour rainfall event or less frequent rainfall event and that infrequently reaches surface waters are considered insignificant sources of TN and TP, provided the ponds or basins are maintained under normal conditions at or below established water levels. The owners or operators of cooling pond reservoirs must operate each spillway gate either during regular operation or on a test basis to protect the structural integrity of the reservoir. Because of the short duration and low volume of wastewater released during spillway gate testing, releases either on an annual or semiannual basis are considered insignificant sources of TN and TP.

Existing industrial wastewater facilities are not subject to the limits in **Table 16** or **Table 17**. However, these facilities must hold the line and shall not increase the nutrient load to receiving or downstream waters. New industrial wastewater facilities shall meet the limits in **Table 16** and **Table 17**. For industrial wastewater facilities that discharge to surface waters of the state must meet the numeric nutrient criteria in Rules 62-302.531 and 62-302.532, F.A.C.

Additionally, new or renewed wastewater permits in the BMAP area must require at least quarterly sampling of the effluent at the point of discharge or edge of the zone of discharge for TN and TP and the reporting of sampling results in the discharge monitoring reports submitted to DEP.

Table 16. TN effluent limits

mg/L = Milligrams per liter; mgd = Million gallons per day; RRLA = Rapid rate land application

Permitted Average Daily Flow (mgd)	TN Concentration Limits for Direct Surface Discharge (mg/L)	TN Concentration Limits for RRLA Effluent Disposal System (mg/L)	TN Concentration Limits for All Other Disposal Methods, Including Reuse (mg/L)
Greater than or equal to 0.5	3.0	3.0	10.0
Less than 0.5 and greater than or equal to 0.1	3.0	6.0	10.0
Less than 0.1	3.0	10.0	10.0

Table 17. TP effluent limits

Permitted Average Daily Flow (mgd)	TP Concentration Limits for Direct Surface Discharge (mg/L)	TP Concentration Limits for RRLA Effluent Disposal System (mg/L)	TP Concentration Limits for All Other Disposal Methods, Including Reuse (mg/L)
Greater than or equal to 0.5	1.0	1.0	6.0
Less than 0.5 and greater than or equal to 0.1	1.0	3.0	6.0
Less than 0.1	1.0	6.0	6.0

Pursuant to Subsubparagraph 403.067(7)(a)9., F.S., local governments in BMAP areas where DEP determines remediation is necessary to achieve the TMDL must develop wastewater treatment plans to be adopted as part of the BMAP no later than July 1, 2025, when all effluent is required to meet the TN and TP concentrations for Direct Surface Discharge cited in **Table 16** and **Table 17**.

The wastewater treatment plans must be developed by each local government, in cooperation with DEP, the water management district, and the public and private domestic wastewater treatment facilities within the jurisdiction of the local government. A local government is not responsible for a private domestic wastewater facility's compliance with the BMAP unless the facility is operated through a public-private partnership to which the local government is a party.

The wastewater treatment plan requires entities to identify and address the following:

- Provide construction, expansion or necessary facility upgrades to achieve the TMDLs applicable to the domestic WWTF.
- Include the permitted capacity in annual gallons per day for the domestic WWTF.
- Include the average nutrient concentration and the estimated average nutrient load of the domestic wastewater.
- Provide a project timeline of the date when the construction of any facility improvements will begin and be completed and the date when operations of the improved facility will begin.
- Estimate the cost of improvements.
- Identify the responsible parties.

2.4 Seagrass and Water Quality Monitoring Plan

This monitoring plan is designed to track seagrass distribution and to identify long-term water quality trends. Sampling stations, parameters, frequency, and other elements of this strategy may be modified as appropriate to match changing environmental conditions, funding resources, and understanding of the IRL system.

2.4.1. Objectives

The primary and secondary monitoring objectives for the CIRL monitoring plan are described as follows:

Primary Monitoring Objective

- Track seagrass depth extent responses to BMAP implementation.

Secondary Monitoring Objectives

- Track trends in ambient water quality in the CIRL and its watershed, including major tributaries.
- Determine if watershed nutrient loading is decreasing and resulting in improved lagoon water quality, which will allow seagrass to grow to target depths.

Additional information about the seagrass depth and compliance with the TMDL targets is discussed in **Section 4.2**, including the most recent results based on the 2019 aerial mapping data. To read more about the process for analyzing the seagrass data and depth analysis, see **Appendix D**.

2.4.2. Monitoring Parameters, Frequency, and Network

To achieve the primary monitoring objective, the main parameter that will be tracked is the seagrass depth by project zone, which is identified through flyover mapping and aerial photography interpretation. DEP and SJRWMD are partnering to fund and conduct flyovers and mapping. In the past, SJRWMD and partners typically have contracted for seagrass mapping every two to three years, and DEP will continue to work with the district to maintain this frequency for the BMAP monitoring plan as long as resources remain available.

The aerial photography is taken in spring to early summer, during the seagrass growing season. Field sampling conducted around the time of the flights provides data for assessing the accuracy of the maps, and additional field sampling is conducted to address uncertainty regarding areas mapped as seagrass. Using the aerial photography, a map is created showing seagrass extent in the lagoon. These maps are used in evaluations to assess progress towards the TMDL seagrass depth targets for the CIRL. Additional details on the seagrass assessment methodology are contained in **Appendix D**.

To achieve the secondary monitoring objective above, the existing SJRWMD and SFWMD stations in the CIRL BMAP will be monitored. On average, seagrass transects are 1 kilometer (km) away from a long-term water quality station. The monitoring strategy for these stations focuses on the following parameters:

- Total Kjeldahl Nitrogen.
- Nitrite/Nitrate.
- Ammonia.
- Total Nitrogen (TN).
- Total Phosphorus (TP).
- Orthophosphate.
- Chlorophyll *a* (corrected).
- Photosynthetically Active Radiation (PAR).
- True Color.

- Turbidity.
- Total Suspended Solids (TSS).
- Dissolved Oxygen.
- Specific Conductivity.
- pH.
- Salinity.
- Secchi Depth.
- Depth of Collection.
- Total Depth of Sample Site.
- Water Temperature.
- Field Conditions.
- Total Organic Carbon.
- Dissolved Organic Carbon.
- Silica.
- Alkalinity.
- Volatile Suspended Solids.

In addition to the SJRWMD and SFWMD water quality monitoring stations, long-term stations are monitored by the Indian River Farms Water Control District (IRF-WCD), North St. Lucie River WCD (NSLR-WCD) Fort Pierce Farms WCD (FPF-WCD), and Sebastian River Improvement District (SRID) for water quality, and U.S. Geological Survey (USGS) for flow. **Table 18** lists the stations that SJRWMD, USGS, IRF-WCD, NSLR-WCD, FPF-WCD, and SRID currently sample in the CIRL BMAP area, and these stations are shown by project zone in **Figure 9** through **Figure 12.** Data collection generally occurs from three types of stations: flow stations where volume is primarily determined; tributary water quality stations near the junction of tributaries where parameters are sampled as these waters mix with the lagoon; and lagoon water quality stations that measure parameters in the lagoon itself.

Table 18. Monitoring stations in the CIRL BMAP area

Entity	Station ID	Project Zone	Status	Latitude	Longitude	Station Type	Frequency
SJRWMD	CC03	CIRL-A	Active	28.0688	-80.6212	Tributary Water Quality	Monthly
SJRWMD	IRLI23	CIRL-A	Active	28.0699	-80.5689	Lagoon Water Quality	Monthly
SJRWMD	IRLI24	CIRL-A	Active	28.0447	-80.5763	Lagoon Water Quality	Monthly
SJRWMD	IRLI26	CIRL-A	Active	27.9885	-80.5325	Lagoon Water Quality	Monthly
SJRWMD	IRLI27	CIRL-A	Active	27.9469	-80.5284	Lagoon Water Quality	Monthly
SJRWMD	IRLIRJ01	CIRL-A	Active	27.7975	-80.4496	Lagoon Water Quality	Monthly
SJRWMD	IRLTPM	CIRL-A	Active	28.0171	-80.5959	Tributary Water Quality	Monthly
SJRWMD	IRLTUS	CIRL-A	Active	28.0334	-80.5797	Tributary Water Quality	Monthly
SJRWMD	IRLUPGC	CIRL-A	Active	27.9650	-80.5681	Tributary Water Quality	Monthly
USGS	02249500	CIRL-A	Active	28.0792	-80.6297	Flow	Continuous
USGS	02250030	CIRL-A	Active	28.0170	-80.5959	Flow	Continuous
IRFWCD	IRF-1	CIRL-B	Active	27.6397	-80.4294	Tributary Water Quality	Quarterly
IRFWCD	IRF-2	CIRL-B	Active	27.6935	-80.4453	Tributary Water Quality	Quarterly
IRFWCD	IRF-3	CIRL-B	Active	27.5980	-80.4132	Tributary Water Quality	Quarterly
SJRWMD	IRLIRJ04	CIRL-B	Active	27.6921	-80.3869	Lagoon Water Quality	Monthly
SJRWMD	IRLIRJ05	CIRL-B	Active	27.6586	-80.3763	Lagoon Water Quality	Monthly
SJRWMD	IRLIRJ07	CIRL-B	Active	27.6197	-80.3685	Lagoon Water Quality	Monthly
SJRWMD	IRLIRJ08	CIRL-B	Active	27.5898	-80.3561	Lagoon Water Quality	Monthly
SJRWMD	IRLVMC	CIRL-B	Active	27.6493	-80.4003	Tributary Water Quality	Monthly
SJRWMD	IRLVNCODH	CIRL-B	Active	27.6924	-80.4145	Tributary Water Quality	Monthly
SJRWMD	IRLVSC	CIRL-B	Active	27.6052	-80.3826	Tributary Water Quality	Monthly
USGS	02252500	CIRL-B	Active	27.6934	-80.4292	Flow	Continuous
USGS	02253000	CIRL-B	Active	27.6478	-80.4056	Flow	Continuous
USGS	02253500	CIRL-B	Active	27.6034	-80.3898	Flow	Continuous
SJRWMD	IRLI28	CIRL-SEB	Active	27.8882	-80.4851	Lagoon Water Quality	Monthly
SJRWMD	IRLSEBNP	CIRL-SEB	Active	27.8563	-80.5242	Tributary Water Quality	Monthly
SJRWMD	IRLSIR003	CIRL-SEB	Active	27.7695	-80.5058	Tributary Water Quality	Monthly

Entity	Station ID	Project Zone	Status	Latitude	Longitude	Station Type	Frequency
SJRWMD	IRLSUS	CIRL-SEB	Active	27.8544	-80.4913	Tributary Water Quality	Monthly
SJRWMD	IRLUPSFW	CIRL-SEB	Active	27.8303	-80.5348	Tributary Water Quality	Monthly
SRID	SRID-1	CIRL-SEB	Active	27.7486	-80.4949	Tributary Water Quality	Quarterly
USGS	02251000	CIRL-SEB	Active	27.7692	-80.5061	Flow	Continuous
USGS	02251500	CIRL-SEB	Active	27.8558	-80.5244	Flow	Continuous
USGS	02251767	CIRL-SEB	Active	27.8303	-80.5344	Flow	Continuous
FPFWCD	1	CIRL-SIRL	Active	27.4763	-80.3451	Tributary Water Quality	Quarterly
FPFWCD	2	CIRL-SIRL	Active	27.5208	-80.3903	Tributary Water Quality	Quarterly
FPFWCD	3	CIRL-SIRL	Active	27.5209	-80.3985	Tributary Water Quality	Quarterly
FPFWCD	4	CIRL-SIRL	Active	27.5210	-80.4068	Tributary Water Quality	Quarterly
FPFWCD	5	CIRL-SIRL	Active	27.5140	-80.4299	Tributary Water Quality	Quarterly
NSLRWCD	5	CIRL-SIRL	Active	27.4688	-80.3670	Tributary Water Quality	Quarterly
SFWMD	C25S50	CIRL-SIRL	Active	27.4690	-80.3383	Tributary Water Quality	Weekly
SFWMD	IRL34B	CIRL-SIRL	Active	27.4669	-80.3226	Lagoon Water Quality	7x a year (Jan., Feb., Apr., Jun., Jul., Aug., Oct.)
SFWMD	IRL36B	CIRL-SIRL	Active	27.4900	-80.3306	Lagoon Water Quality	7x a year (Jan., Feb., Apr., Jun., Jul., Aug., Oct.)
SFWMD	IRL39B	CIRL-SIRL	Active	27.5401	-80.3451	Lagoon Water Quality	7x a year (Jan., Feb., Apr., Jun., Jul., Aug., Oct.)
SFWMD	IRL31C	CIRL-SIRL	Active	27.4430	-80.2983	Lagoon Water Quality	7x a year (Jan., Feb., Apr., Jun., Jul., Aug., Oct.)
SFWMD	S50_S	CIRL-SIRL	Active	27.4686	-80.3381	Flow	Continuous

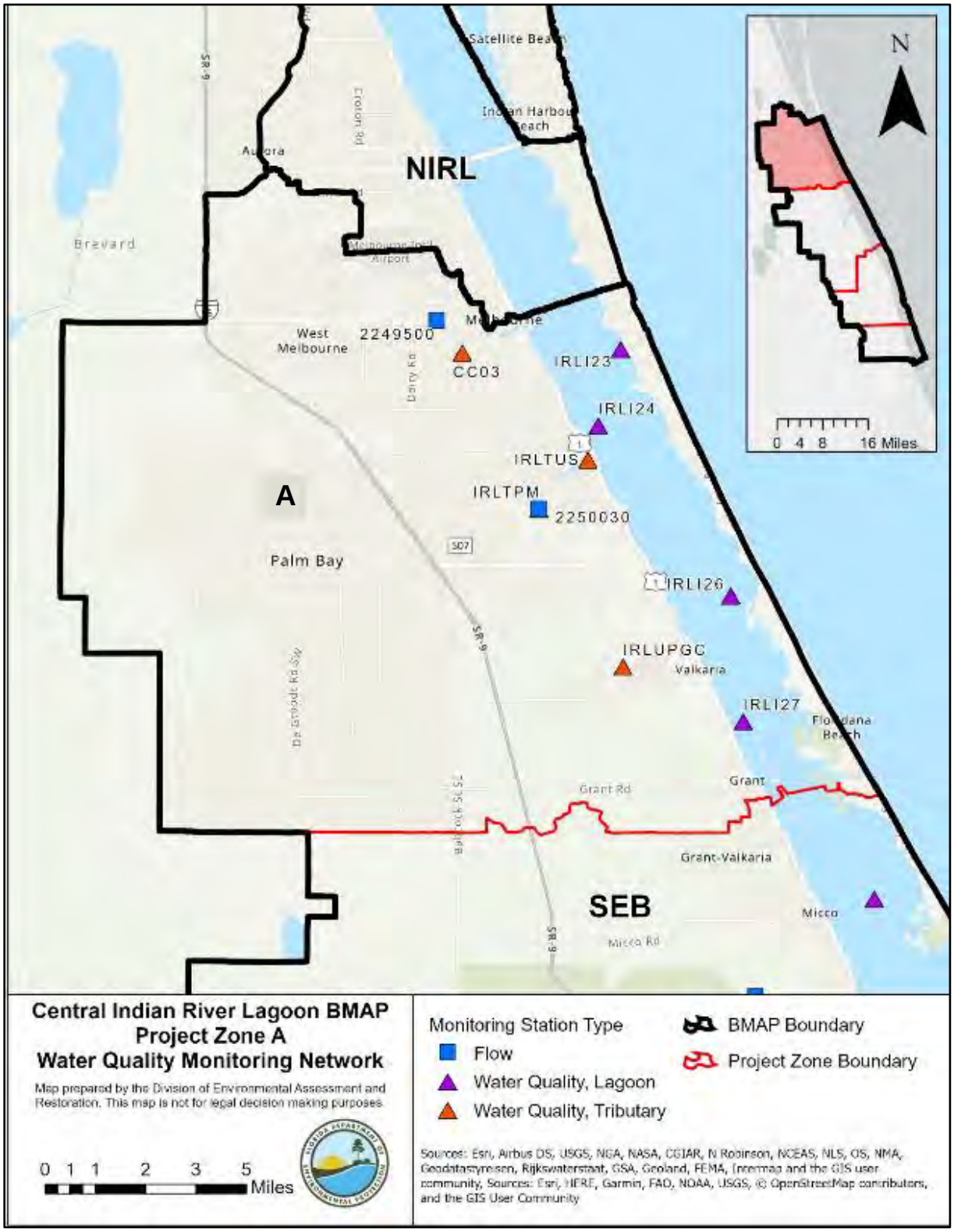

Figure 9. Monitoring network in the Central A Project Zone

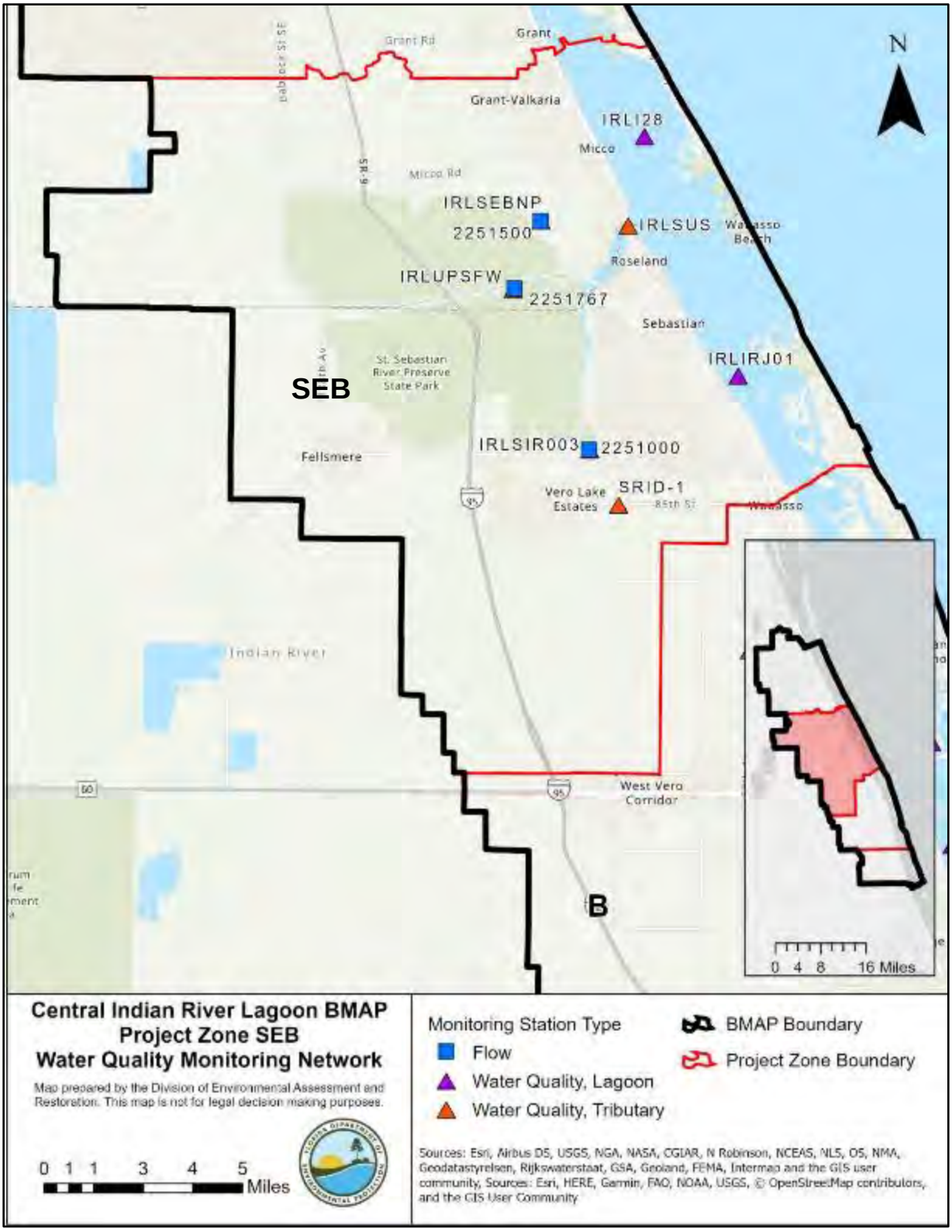

Figure 10. Monitoring network in the Central SEB Project Zone

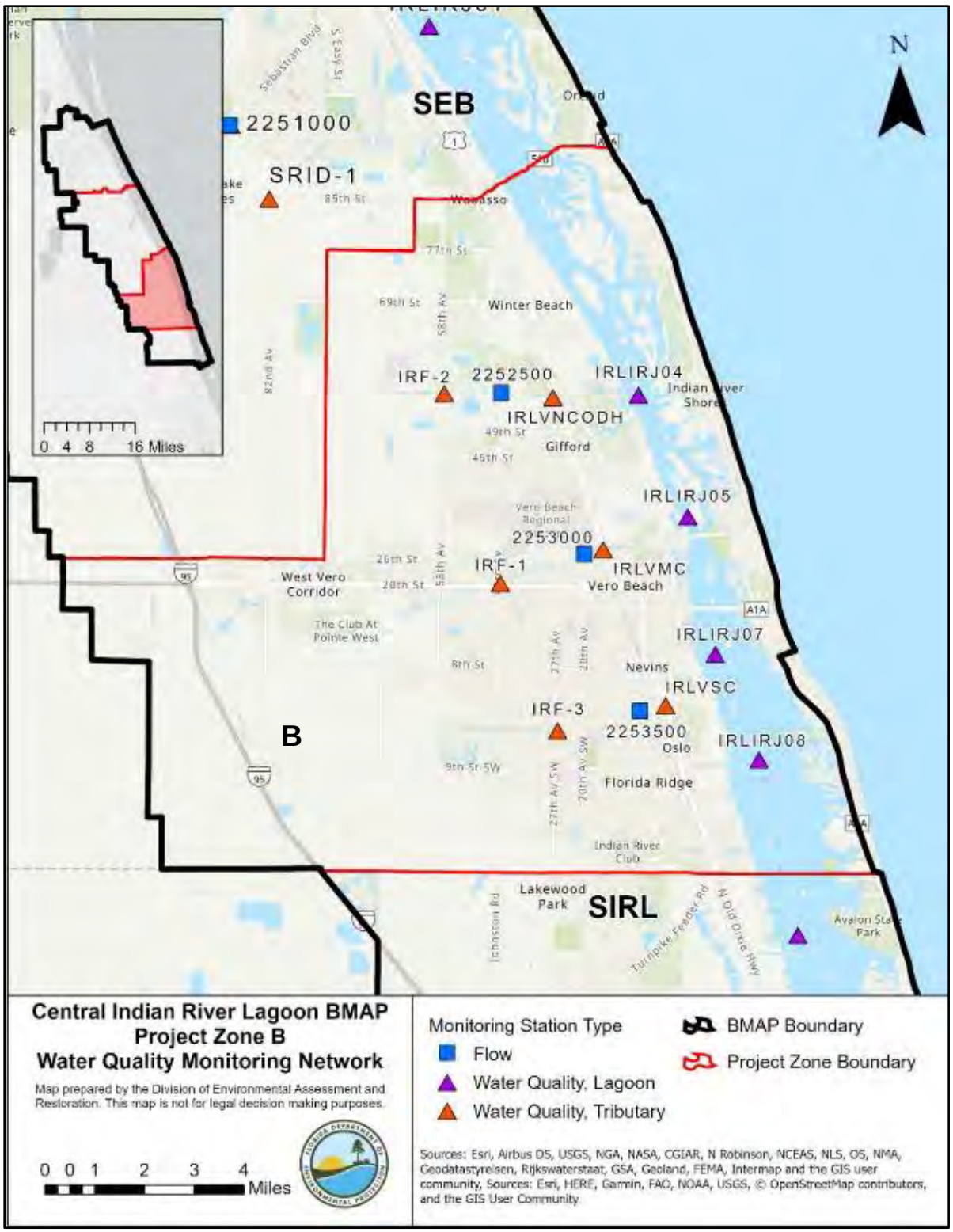

Figure 11. Monitoring network in the Central B Project Zone

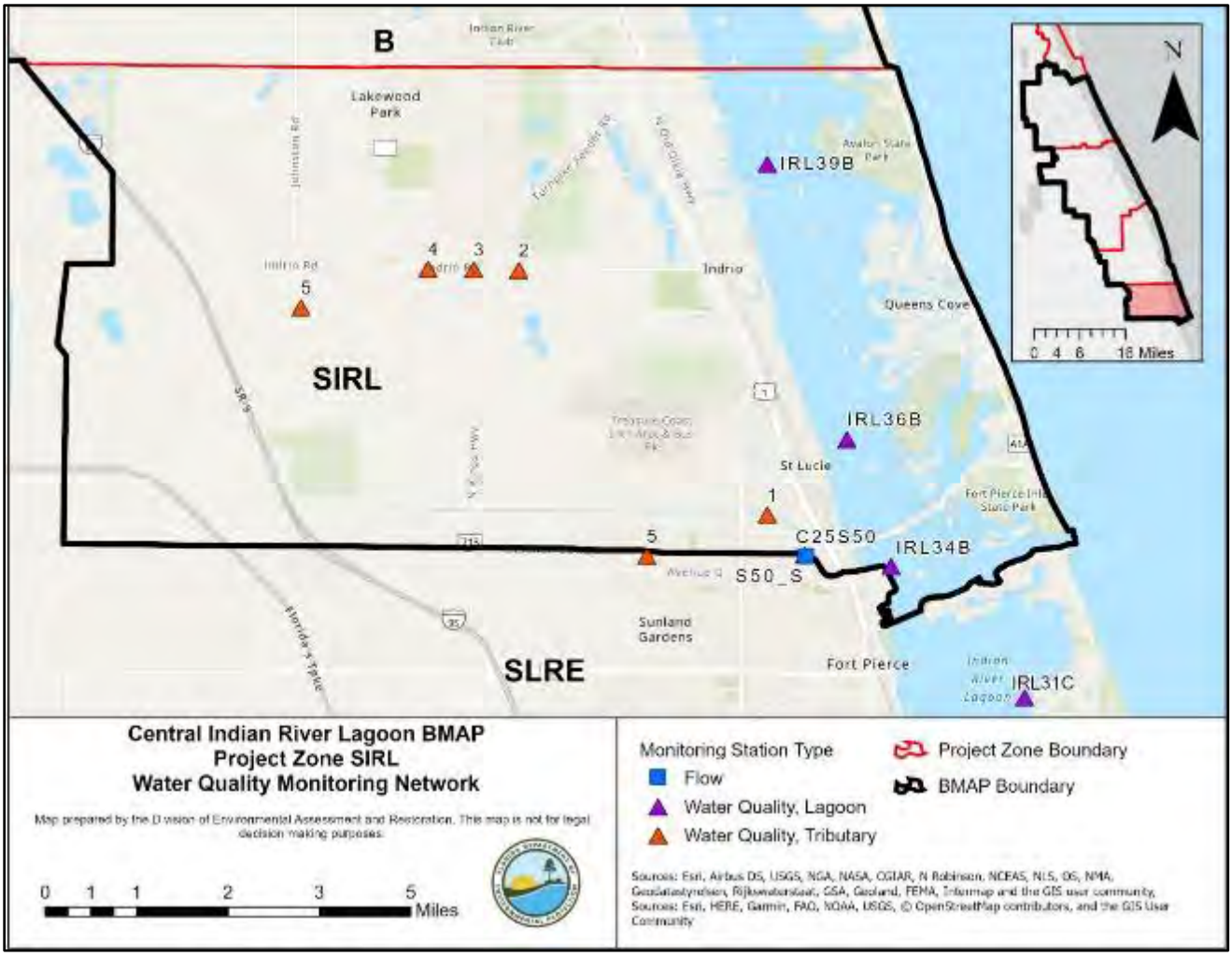

Figure 12. Monitoring network in the Central SIRL Project Zone

2.4.3. Data Management and Assessment

In 2017, the Florida Watershed Information Network (WIN) replaced the Florida Storage and Retrieval (STORET) Database. WIN now serves as the primary repository of ambient water quality data for the state of Florida. Water quality data from the WIN database are used for Impaired Surface Waters Rule (IWR) assessments and TMDL development. Ambient water quality data collected as part of the BMAP will be uploaded into WIN for long-term storage and availability. All BMAP data providers have agreed to upload ambient water quality data to WIN at least quarterly, upon the completion of the appropriate quality assurance/quality control (QA/QC) checks.

Other data relevant to monitoring restoration efforts, such as the extent and abundance of seagrass coverages, groundwater quality, and storm events, may be collected. Stakeholders agree to provide these data to other BMAP partners on request, and when appropriate, for inclusion in

BMAP data analyses and adaptive management evaluations. Data used to assess the biological health of streams and lakes may be provided to DEP staff in the Watershed Assessment Section. For more information on submitting external biological data, visit the DEP website.

The water quality data will be analyzed periodically to determine trends in water quality in the lagoon. Specific statistical analyses were not identified during BMAP development; however, commonly accepted methods of data analysis will be used.

2.4.4. Quality Assurance/Quality Control

Stakeholders participating in the monitoring plan must collect water quality data in a manner consistent with the DEP standard operating procedures (SOPs) for QA/QC. The most current version of these procedures can be downloaded from the DEP website. For BMAP-related data analyses, entities should use National Environmental Laboratory Accreditation Council (NELAC) National Environmental Laboratory Accreditation Program (NELAP)–certified laboratories or other labs that meet the certification and other requirements outlined in the DEP SOPs. SJRWMD staff and contractors collect, process, and preserve samples according to SJRWMD's *Field Standard Operating Procedures for Surface Water Sampling Fiscal Year 2020*. SFWMD staff and contractors collect, process, and preserve samples according to SFWMD's *Field Sampling Quality Manual.*

2.5 Research Priorities

During the BMAP process, the stakeholders identified several research priorities they would like to pursue, if funding becomes available. The investments prompted by the 2011 superbloom generated research topics that include the following:

- Collecting data to update the bathymetry for the IRL Basin, which would be used in evaluations of seagrass depth limits.
- Continuing coordinated monitoring of phytoplankton, periphyton, drift algae, and macroalgae in the basin to gain insights into the cycling of nutrients as well as toxin production and release.
- Data analysis of storm event monitoring at the major outfalls.
- Collecting data on the nutrient load reduction that results from WCD staging/ retaining stormwater runoff.
- Refining load estimates delivered by baseflows and modeling the contributions of baseflows.
- Synthesizing data on nutrient flux/internal recycling of legacy nutrient loads held within IRL sediments and exchanged with the water column.

- Completing the development, calibration, and validation of a water quality model that can be used to design, site, and prioritize projects that reduce nutrient loads (e.g., Hydrologic Simulation Program FORTRAN [HSPF] or SWIL Model coupled with the Environmental Fluid Dynamics Code [EFDC] Model or another model that generates predictions of conditions that may be favorable for seagrass growth).

The stakeholders will continue to work with DEP and IRL NEP to identify other research needs, prioritize these needs, and develop scopes of work to address research priorities as appropriate. This information may be organized in a more detailed research plan that could be used to guide future efforts, as funding becomes available. These research projects are not BMAP requirements but would provide valuable information for future assessments of the health of the CIRL. There are reports and peer-reviewed articles that have been completed to address several of these research priorities. References are provided in **Chapter 5**.

Chapter 3. Project Zones

Section 3.1 through **Section 3.4** provides specific land use and project information on the four project zones in the CIRL. All projects identified as part of this BMAP are listed by project zone. For projects that treat lands in multiple project zones, the nutrient reductions provided in the table are only the estimated reductions for the project zone specified. To calculate the total benefits from these projects, credits from all project zones treated by the project should be summed. The table of existing and planned projects lists those projects submitted by stakeholders to help meet their obligations under the BMAP. Information in the tables was provided by the lead entity and is subject to change as the project develops and more information becomes available.

It should be noted that only projects completed in 2000 and beyond are eligible for BMAP credit. Since the treatment input data for the hydrology calibration was from an earlier period in the model simulation, most projects beyond permit requirements installed from 2000 onward were not included in the calibration and are not well represented in the SWIL Model loading estimates. Therefore, projects completed from 2000 onward are eligible for BMAP credit. Projects completed prior to 2000 are accounted for in the period of record used for calibration of the SWIL Model.

The projects and management strategies are ranked with a priority of high, medium, or low. Projects with a "completed" status were assigned a low priority. Projects classified as "underway" were assigned a medium priority because some resources have been allocated to these projects, but additional assistance may be needed for the projects to be completed. A high priority was assigned to projects listed as "planned," as well as certain "ongoing" projects (i.e., "street sweeping," "catch basin inserts/inlet filter clean out," "public education efforts," "fertilizer cessation," "fertilizer reduction," or "aquatic vegetation harvesting").

3.1 Project Zone A

Project Zone A covers more than 94,742 acres of the CIRL BMAP. As shown in **Table 19**, urban land uses makes up the majority of the project zone with 55.4 % of the area, followed by shrublands with 12.2%. Stakeholders in Project Zone A are agricultural producers, Brevard County, City of Melbourne, City of Palm Bay, City of Melbourne, FDOT District 5, Melbourne-Tillman WCD, Town of Melbourne Beach, Town of Grant-Valkaria, Town of Indialantic, Town of Malabar, Town of Melbourne Village, and U.S. Air Force (Malabar Annex).

Table 19. Summary of land uses in Project Zone A

Note: Land use code 5000 (water) acreage excludes lagoon water in this table.

Level 1 Land Use Code	Land Use Description	Acres	% Total
1000	Urban	52,496	55.4
2000	Agricultural	7,994	8.4
3000	Upland Prairie and Shrublands	11,573	12.2
4000	Upland Forested Areas	8,488	9.0
5000	Water	1,514	1.6
6000	Wetlands	8,283	8.7
7000	Distrurbed Lands	1,213	1.3
8000	Transportation	3,181	3.4
Total		**94,742**	**100.0**

DEP asked stakeholders to provide information on management actions, including projects, programs, and activities, that may reduce nutrient loads to the CIRL. Management actions are included in the BMAP to address nutrient loads to the lagoon and have to meet several criteria to be considered eligible for credit. **Figure 13** and **Figure 14** show progress towards the required TN and TP load reductions allocated to Project Zone A from projects completed through July 31, 2020.

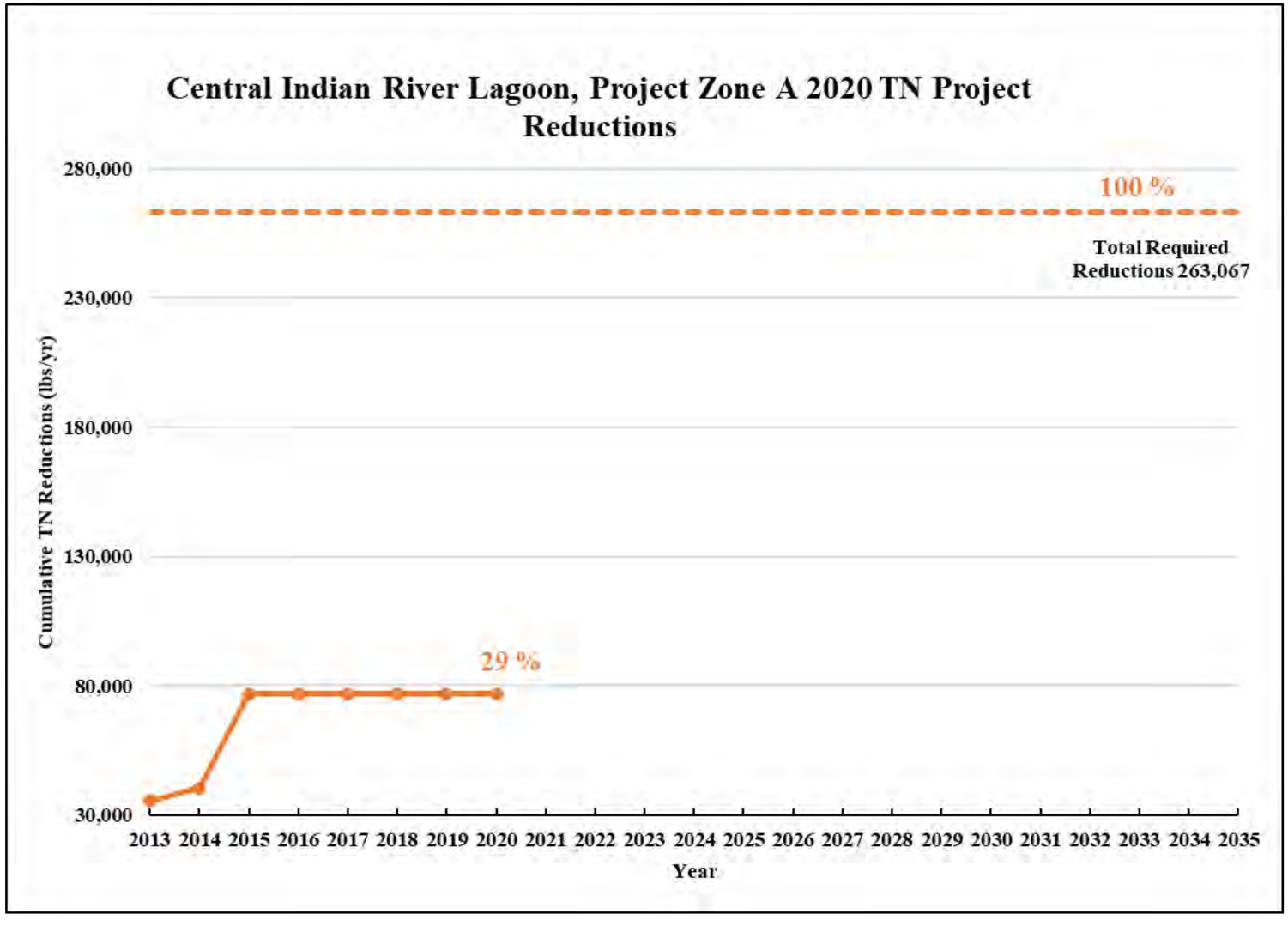

Figure 13. Estimated progress towards meeting the required TN reductions allocated to Project Zone A with projects completed through July 31, 2020

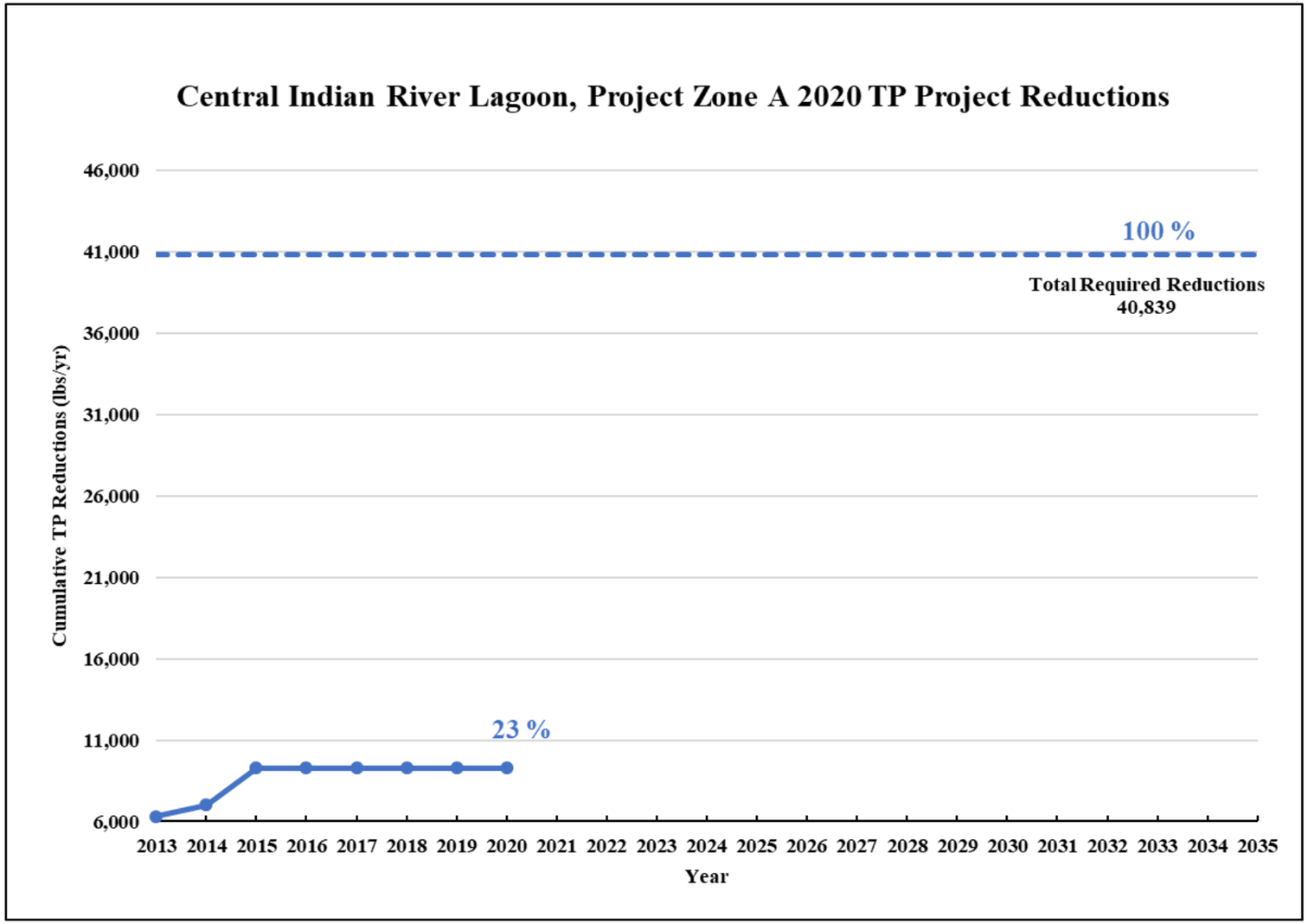

Figure 14. Estimated progress towards meeting the required TP reductions allocated to Project Zone A with projects completed through July 31, 2020

3.1.1. Existing and Planned Projects

Table 20 summarizes the existing and planned projects provided by the stakeholders for Project Zone A.

Table 20. Existing and planned projects in Project Zone A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Brevard County	N/A	BC-01	Tadlock and Goat Creek Baffle Box	Upgraded a 1st generation to a 2nd generation baffle box by adding the nutrient separating screen.	Baffle Boxes-Second Generation	Completed	2000	40	6	22	$43,811	$1,000	N/A	N/A	N/A
Brevard County	N/A	BC-02	Oak Street Drainage Improvements	Swale and baffle box.	BMP Treatment Train	Completed	2003	0	1	0	$660,285	Not provided	Not provided	Not provided	Not provided
Brevard County	N/A	BC-03	Melbourne Shores Ponds	This pond helps alleviate flooding in the south beaches and cleans the stormwater runoff from a 135.9 acre drainage basin.	Wet Detention Pond	Completed	2004	193	70	136	$939,543	Not provided	County	N/A	N/A
Brevard County	W. Melbourne/ Grant-Valkaria/ Malabar/ Melbourne/ Cocoa/ IHB/ Sat. Beach/ Cocoa Beach/ Cape Canaveral	BC-05	Education Efforts	FYN, fertilizer and pet waste ordinances, public service announcements (PSAs), pamphlets, website, illicit discharge program.	Education Efforts	Ongoing	N/A	2,231	335	N/A	$90,000	N/A	County	N/A	N/A
Brevard County	N/A	BC-06	Street Sweeping	Remove debris from 786 linear feet of curb street throughout the county.	Street Sweeping	Ongoing	N/A	55	35	N/A	N/A	$147,076	N/A	N/A	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Brevard County	DEP	BC-07	Valkaria Lakes	Converted borrow pits into detention ponds for stormwater treatment.	Wet Detention Pond	Completed	2014	1,132	256	458	$261,000	Not provided	DEP/ County	$144,598	G0249
Brevard County	City of Melbourne	BC-14	Fountainhead	982,300 lbs of vegetation removed using 113 dump trucks.	Aquatic Vegetation Harvesting	Completed	2013	890	273	Not provided	$39,274	Not provided	Not provided	Not provided	N/A
Brevard County	DEP	BC-15	Corey Road at Hall	Upgraded a 1st generation to a 2nd generation baffle box by adding the nutrient separating screen.	Baffle Boxes-Second Generation	Completed	2015	83	9	52	$12,507	$2,140	DEP	DEP - $275,000	S0648
Brevard County	DEP	BC-16	430 Riverview	Upgraded a 1st generation to a 2nd generation baffle box by adding the nutrient separating screen.	Baffle Boxes-Second Generation	Completed	2015	13	2	8	$30,508	$2,140	DEP	DEP - $275,000	S0648
Brevard County	SJRWMD	BC-17	C-1 Rediversion	This project is designed to help restore the natural drainage flow from the west side of Palm Bay back to the St. Johns River.	Hydrologic Restoration	Completed	2015	35,565	2,038	Not provided	$531,051	Not provided	SJRWMD	Not provided	S0652
Brevard County	N/A	BC-18	Baffle Box/Sediment Trap Cleaning	Increasing cleanout frequency to quarterly.	BMP Cleanout	Ongoing	N/A	1	1	N/A	Not provided	Not provided	Not provided	Not provided	N/A
Brevard County	DEP	BC-19	Turkey Creek Dredging	230,000 cubic yards of material collected.	Muck Removal/Restoration Dredging	Completed	2017	TBD	TBD	N/A	$1,545,522	Not provided	DEP	Not provided	S0714
Brevard County	DEP	BC-20	Multiple Ditch Outfall Denitrification D3	Providing base flow/groundwater treatment in 20 open drainage basins. Each Project will have its own number	Denitrification Walls	Underway	TBD	TBD	TBD	TBD	$1,182,858	TBD	DEP	TBD	LP0511A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Brevard County	N/A	BC-21	Kingsmill Aurora Phase II	Construction of a 5-acre pond with weirs, drop structures, etc.	Wet Detention Pond	Underway	2018	TBD	TBD	1,213	$990,000	TBD	TBD	TBD	N/A
Brevard County	Cities within Brevard County	BC-23	Education Efforts	Fertilizer video, rain barrel workshops, Facebook page, bus wrap, and billboard.	Enhanced Public Education	Ongoing	N/A	N/A	N/A	Not provided	TBD	TBD	Brevard County/ SOIRL	TBD	N/A
Brevard County	SOIRL/ Melbourne	BC-24	Hoag Sewer Conversion	Septic Removal - CIRL - Melbourne, SOIRL-04.	OSTDS Phase Out	Underway	2020	24	N/A	Not provided	$100,000	Not provided	SOIRL/ City	$86,031	N/A
Brevard County	SOIRL	BC-25	M1 Canal BAM - BB#1470	Adding a media to remove nitrogen by denitrification. The media will be added to the side slope of the pond or the bottom of the swale.	Biosorption Activated Media (BAM)	Canceled	2019	N/A	N/A	TBD	$101,300	Not provided	SOIRL	SOIRL - $66,300	N/A
Brevard County	SJRWMD/ SOIRL	BC-27	Crane Creek/M-1 Canal Rediversion Project	The project will treat and restore small storm events and baseflow from 5,300 acres of Lagoon-diverted water.	Hydrologic Restoration	Planned	2020	TBD	TBD	5,300	$9,186,500	Not provided	SOIRL	SOIRL - $2,033,944	N/A
Brevard County	Not provided	BC-29	Riverview Senior Oyster Bar	Construct 320 linear foot oyster bar	Creating/ Enhancing Oyster Reefs	Completed	2018	TBD	TBD	TBD	$30,304	Not provided	SOIRL	SOIRL - $30,304	N/A
Brevard County	Not provided	BC-30	Lagoon House Living Shoreline	Plant 300 mangroves and 1,000 spartina along the shoreline of the Lagoon House.	Creating/ Enhancing Living Shoreline	Completed	2018	TBD	TBD	TBD	$24,000	Not provided	SOIRL	SOIRL - $24,000	N/A
City of Melbourne	N/A	MEL-01	Fee & Apollo Drainage Improvements	No treatment is provided within the existing development; completely a water quality addition.	Wet Detention Pond	Completed	2011	28	40	77	$525,161	Not provided	City	City - $525,161	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Melbourne	N/A	MEL-02	Education Efforts	Irrigation, fertilizer, pet waste management, and landscaping ordinances; pamphlets, presentations, website, illicit discharge program.	Education Efforts	Ongoing	N/A	3,795	543	N/A	Not provided	Not provided	City	Not provided	N/A
City of Melbourne	N/A	MEL-03	Street Sweeping	Street sweeping in the basin and debris removal.	Street Sweeping	Ongoing	N/A	378	187	N/A	N/A	$87,500	City	Not provided	N/A
City of Melbourne	N/A	MEL-04	Participation in FYN	Participation in FYN Program. Credited in MEL-02.	Education Efforts	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Melbourne	N/A	MEL-05	South Croton Baffle Box	Dry retention and baffle box.	BMP Treatment Train	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Melbourne	N/A	MEL-06	Southwest Park Improvements near Florida Avenue	Installation of baffle box along with pipe replacement.	Baffle Boxes-Second Generation with Media	Completed	2017	TBD	TBD	48	$582,153	Not provided	City	City - $582,153	N/A
City of Melbourne	N/A	MEL-07	Melbourne Avenue Existing Baffle Box Upgrade	Upgrade existing 1st generation baffle boxes to 2nd generation baffle boxes with BAM.	Baffle Boxes-Second Generation with Media	Completed	2016	TBD	TBD	13	$12,000	Not provided	City	City - $12,000	N/A
City of Melbourne	SOIRL	MEL-08	Penwood Septic to Sewer Conversion	Providing for 12 lots (4 existing and 8 proposed) to be converted to municipal sewer.	Wastewater Service Area Expansion	Underway	2020	TBD	TBD	TBD	$60,000	TBD	City/ SOIRL	$40,632	N/A
City of Melbourne	SOIRL	MEL-09	Riverview Park Living Shoreline	Construction of a living shoreline with an oyster breakwater.	Creating/ Enhancing Living Shoreline	Underway	2021	TBD	TBD	TBD	$440,000	TBD	City/ SOIRL	$108,790	N/A
City of Melbourne	SOIRL	MEL-10	Hoag Septic to Sewer Conversion	Providing for 12 lots (7 existing and 5 proposed) to be converted to municipal sewer.	Wastewater Service Area Expansion	Underway	2021	TBD	TBD	TBD	$105,000	TBD	City/ SOIRL	$86,031	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Melbourne	SOIRL	MEL-11	Grant Place Baffle Box	2nd Generation baffle box with BAM.	Baffle Boxes- Second Generation with Media	Underway	2020	TBD	TBD	103	$400,000	TBD	City/ SOIRL	$82,481	N/A
City of Melbourne	SOIRL	MEL-12	Roxy Septic to Sewer Conversion	Five lots with septic systems to be converted to municipal sewer.	Wastewater Service Area Expansion	Planned	2021	TBD	TBD	TBD	$265,000	TBD	City/ SOIRL	$88,944	N/A
City of Melbourne	SOIRL	MEL-13	Espanolia Baffle Box	Installation of baffle box along with pipe replacement.	Baffle Boxes- Second Generation with Media	Planned	2022	458	73	61	$550,000	TBD	City/ SOIRL	$105,000	N/A
City of Melbourne	SOIRL/SRF Loan	MEL-14	Grant Street Water Reclamation Facility Improvements	Improvements include rehabilitation of major treatment elements and structures of facility.	WWTF Nutrient Reduction	Planned	TBD	TBD	TBD	TBD	#######	Not provided	City of Melbourne/ SOIRL/ SRF	#######	N/A
City of Palm Bay	N/A	PB-01	Basin 11	Not provided.	Muck Removal/Restoration Dredging	Completed	2009	Not provided	Not provided	Not provided	$1,866,695	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-02	Chace Lane Pond Modifications	Not provided.	Dry Detention Pond	Completed	2001	78	11	91	$20,290	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-03	Glenham Drive Sidewalks Improvements	Not provided.	Dry Detention Pond	Completed	2014	11	2	12	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-04	Basin 7 Stormwater Improvements Phase II	Not provided.	Wet Detention Pond	Completed	2009	352	101	147	$79,109	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-05	Boundary Canal Trail Phase 3	Not provided.	Baffle Boxes- First Generation	Completed	2014	17	12	366	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-06	Boundary Canal Phase II Stormwater Improvement	Not provided.	On-line Retention BMPs	Completed	2014	3,276	383	633	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-07	Boundary Canal Phase I Baffle Box Installation	Not provided.	Baffle Boxes- First Generation	Completed	2014	0	0	633	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-08	Norwood Street Baffle Box Installation	Not provided.	Baffle Boxes- First Generation	Completed	2014	16	12	529	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-09	Basin 1 Drainage Improvements Phase 1 (East of US 1)	Not provided.	Wet Detention Pond	Completed	2007	110	10	137	$22,247	Not provided	Not provided	Not provided	N/A

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City of Palm Bay	N/A	PB-10	Basin 13 Stormwater Improvements	Not provided.	Wet Detention Pond	Completed	2006	143	37	42	$200,419	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-11	Powell's Subdivision Paving & Drainage Improvements	Not provided.	Wet Detention Pond	Completed	2000	176	82	124	$147,478	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-12	Port Malabar Unit 40 Drainage Improvements North	Not provided.	Wet Detention Pond	Completed	2015	737	182	224	$23,778	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-13	Mandarin Ditch (South)	Not provided.	Grass swales without swale blocks or raised culverts	Completed	2006	213	30	73	$308,797	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-14	Basin 3 Main Street Parking Lot	Treatment train with PB-15.	Pervious Pavement Systems	Completed	2008	1,428	206	346	$4,845	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-15	Basin 3 Main Street Improvements Channel Alignment	Treatment train with PB-14.	BMP Treatment Train	Completed	2010	1,604	231	359	$403,561	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-16	Street Sweeping	Not provided.	Street Sweeping	Ongoing	N/A	57	36	N/A	$8,900	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-17	Turkey Creek Maintenance Dredging	Not provided.	Muck Removal/Restoration Dredging	Completed	2007	Not provided	Not provided	Not provided	$255,241	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-18	Turkey Creek Maintenance Dredging - Sump	Not provided.	Muck Removal/Restoration Dredging	Completed	2014	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-19	Anglers Drive	Not provided.	Baffle Boxes- First Generation	Completed	2008	1	1	12	$85,000	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-20	Worth Court	Not provided.	Catch Basin Inserts/Inlet Filter Cleanout	Completed	2014	0	0	5	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	SJRWMD/ DEP	PB-21	Basin 9 (Harris Pond)	Not provided.	Wet Detention Pond	Completed	2010	TBD	TBD	443	$294,519	Not provided	SJRWMD/ DEP	Not provided	Not provided
City of Palm Bay	N/A	PB-22	Wild Rose BMP	Not provided.	Baffle Boxes- First Generation	Completed	2014	0	0	5	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-24	Port Malabar Inlet Inserts	Not provided.	Catch Basin Inserts/Inlet Filter Cleanout	Completed	2010	Not provided	Not provided	29	$19,518	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-25	Kent Street Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2009	1	1	21	$50,000	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-26	PMU1 North (Florin Pond)	Not provided.	Dry Detention Pond	Completed	2000	TBD	TBD	26	$150,000	Not provided	Not provided	Not provided	N/A

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City of Palm Bay	N/A	PB-27	Education Efforts	FYN, ordinances, pamphlets, PSAs, website, illicit discharge program.	Education Efforts	Ongoing	N/A	12,343	1,787	N/A	$1,866,695	N/A	N/A	N/A	N/A
City of Palm Bay	N/A	PB-28	Vance Circle-Drainage Improvements	Not provided.	Catch Basin Inserts/Inlet Filter Cleanout	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Palm Bay	DEP	PB-29	Basin 1 Drainage Improvements Phase 1	Baffle box, modular wetlands, and upward filter.	BMP Treatment Train	Completed	2017	Not provided	Not provided	175	$250,000	Not provided	DEP	DEP - $250,000	S0876
City of Palm Bay	N/A	PB-30	Troutman/ Clearmond Drainage Pond	Roadway widening from rural to urban section with underground drainage.	Dry Detention Pond	Completed	2014	7	1	8	$5,400,000	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-31	Port Malabar Drainage Improvements Central	Modification of existing drainage system redesigned to promote infiltration of stormwater runoff. The system has perforated piping, baffles, and infiltration trenches to encourage percolation.	Exfiltration Trench	Completed	2013	12	2	12	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	N/A	PB-32	Kingswood Drainage Pond	Modification and expansion of existing drainage pond to provide additional stormwater capacity, attenuation, and treatment.	Dry Detention Pond	Completed	2015	61	8	62	Not provided	Not provided	Not provided	Not provided	N/A
City of Palm Bay	DEP	PB-33	Basin 3 Bayfront Community SW Improvements (Koske Pond Phase 1)	Baffle box, modular wetlands, and upward filter.	BMP Treatment Train	Completed	2017	TBD	TBD	Not provided	$500,000	Not provided	DEP	DEP - $500,000	S0801

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City of Palm Bay	SJRWMD/ DEP	PB-34	Stormwater Treatment at City Marina	Baffle box, modular wetlands, and upward filter.	BMP Treatment Train	Planned	TBD	TBD	TBD	TBD	$890,050	TBD	SJRWMD/ DEP	TBD	LP05073
City of Palm Bay	N/A	PB-37	Norwood Baffle Box Retrofit	N/A	Baffle Boxes- First Generation	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Palm Bay	N/A	PB-38	Victoria Pond	N/A	Baffle Boxes- First Generation	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Palm Bay	N/A	PB-39	Goode Park	N/A	Baffle Boxes- First Generation	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Palm Bay	N/A	PB-40	Florin Pond	N/A	Baffle Boxes- First Generation	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Palm Bay	N/A	PB-41	Turkey Creek Shoreline Restoration	Bayfront shoreline restoration to place fill addressing hurricane erosion damage from 2016 and 2017.	Shoreline Stabilization	Completed	2018	TBD	TBD	TBD	$180,000	TBD	DEO	DEO - $177,300/ City - $2,700	N/A
City of Palm Bay	N/A	PB-42	Unit 48 Drainage Improvements - Emerson	Expansion of wet detention system and adjustment of control structures.	Wet Detention Pond	Planned	2019	TBD	TBD	TBD	TBD	TBD	City	TBD	N/A
City of Palm Bay	Brevard County/ Brevard Zoo	PB-43	Bayfront/Palm Bay Living Shoreline at Turkey Creek	Installation of oyster mats and plantings to uptake nutrients from sheet flow.	Creating/ Enhancing Living Shoreline	Canceled	2019	N/A	N/A	TBD	$113,000	TBD	Brevard County	Brevard County - $113,000	N/A
City of Palm Bay	N/A	PB-44	Basin 3 Bayfront Community SW Improvements (Koske Pond Phases 2 and 3)	Expansion of wet pond.	Wet Detention Pond	Planned	2019	TBD	TBD	TBD	TBD	$200	TBD	TBD	N/A
City of Palm Bay	N/A	PB-45	Basin 1 Drainage Improvements Phase 2B Victoria Pond (West of U.S. 1)	Baffle box and upflow filter.	BMP Treatment Train	Planned	2019	TBD	TBD	175	TBD	TBD	TBD	TBD	N/A
City of West Melbourne	N/A	WM-01	Westbrooke	Not provided.	Wet Detention Pond	Completed	2004	23	4	169	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-02	Saddlebrook	Not provided.	Wet Detention Pond	Completed	2004	0	0	40	Not provided	Not provided	Not provided	Not provided	N/A

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City of West Melbourne	N/A	WM-03	Stratford Point	Not provided.	Wet Detention Pond	Completed	2004	23	6	84	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-04	Oak Grove	Not provided.	Wet Detention Pond	Completed	2010	20	5	91	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-05	Manchester Lakes	Not provided.	Wet Detention Pond	Completed	2007	11	2	133	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-06	Havens at Riviera	Not provided.	Wet Detention Pond	Completed	2009	5	4	23	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-07	Cypress/Creek Imagine Schools	Not provided.	Wet Detention Pond	Completed	2009	32	4	72	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-08	Lynnwood	Not provided.	Wet Detention Pond	Completed	2006	3	1	28	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-09	Coastal Commerce	Not provided.	Wet Detention Pond	Completed	2009	12	5	60	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-10	Hammock Landing	Not provided.	Wet Detention Pond	Completed	2009	5	2	76	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-11	Crystal Lakes	Not provided.	Wet Detention Pond	Completed	2009	11	7	91	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-12	Orange View Drive	Not provided.	Baffle Boxes-Second Generation	Completed	2014	90	11	49	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-13	Stephenson Drive	Not provided.	Baffle Boxes-Second Generation	Completed	2014	28	3	14	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-14	Parker Road	Not provided.	Baffle Boxes-Second Generation	Completed	2014	25	3	13	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-15	Laila Drive	Not provided.	Baffle Boxes-Second Generation	Completed	2014	42	5	22	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-16	Doherty Drive	Not provided.	Baffle Boxes-Second Generation	Completed	2014	120	16	66	Not provided	Not provided	Not provided	Not provided	N/A

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City of West Melbourne	N/A	WM-17	Trend Road	Not provided.	Baffle Boxes-Second Generation	Completed	2014	17	2	9	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-18	San Paolo	Not provided.	Baffle Boxes-Second Generation	Completed	2014	6	1	3	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-19	San Paolo West	Not provided.	Baffle Boxes-Second Generation	Completed	2014	17	2	8	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-20	John Carrol	Not provided.	Baffle Boxes-Second Generation	Completed	2014	133	16	75	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-21	Street Sweeping	Not provided.	Street Sweeping	Ongoing	N/A	316	216	N/A	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-22	Inlet Cleaning	Not provided.	BMP Cleanout	Ongoing	N/A	20	2	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
City of West Melbourne	N/A	WM-23	Sawgrass Lakes Ph. I	Not provided.	Wet Detention Pond	Completed	2015	Not provided	Not provided	508	Not provided	Not provided	Private	Not provided	N/A
City of West Melbourne	N/A	WM-24	Manchester Lakes	Not provided.	Wet Detention Pond	Completed	2016	Not provided	Not provided	133	Not provided	Not provided	Private	Not provided	N/A
City of West Melbourne	Brevard County/St. Johns	WM-25	Construction of Sylvan Drive Septic to Sewer Project	Connecting 59 properties to public sewer and abandoning 59 septic tanks	OSTDS Phase Out	Underway	2021	TBD	TBD	60	$2,322,551	TBD	SOIRL/ St. Johns/ City of West Melbourne	#######	N/A
FDACS	Agricultural Producers	FDACS-01	BMP Implementation and Verification	Enrollment and verification of BMPs by agricultural producers. Acres treated based on FDACS OAWP July 2020 Enrollment and FSAID VII. Reductions based on SWIL Model-LET.	Agricultural BMPs	Ongoing	N/A	208	27	234	TBD	TBD	FDACS	TBD	N/A

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FDACS	Agricultural Producers	FDACS-05	FDACS Cost Share Projects	Cost-share projects paid for by FDACS. Acres treated based on FDACS OAWP July 2020 Enrollment. Reductions based on SWIL Model-LET.	Agricultural BMPs	Completed	2020	0	0	TBD	TBD	N/A	FDACS	TBD	N/A
SJRWMD	Not provided	SJRWMD-05	C-10 Water Management Area Project	Construction of a 1,300 acre reservoir with pump station and outfall structure designed to increase the flow restoration to the St. Johns River of the C-1 Rediversion Project to a total of 50% of the average annual flow	Hydrologic Restoration	Planned	TBD	TBD	TBD	Not provided	TBD	Not provided	Ad Valorem	Not provided	Not provided
SJRWMD	DEP/ Brevard County	SJRWMD-06	Crane Creek M-1 Canal Flow Restoration	This project would restore M-1 Canal baseflows and small stormflows west of Evans Road back to the USJRB by constructing an operable diversion structure in the M-1 Canal to divert and treat flows prior to discharging to the USJRB.	Hydrologic Restoration	Underway	2022	TBD	TBD	Not provided	#######	Not provided	Ad Valorem/ DEP/ Brevard County	SJRWMD - $616000/ DEP - $2450000/ Brevard County - $2034000	33,591.00
FDOT District 5	N/A	FDOTD5-01	D5_70010-3528-01	Pond A.	Wet Detention Pond	Completed	2002	1	0	16	Not provided	Not provided	Not provided	Not provided	N/A
FDOT District 5	N/A	FDOTD5-02	D5_70010-3528-02	Pond B.	Wet Detention Pond	Completed	2002	2	0	8	Not provided	Not provided	Florida Legislature	Not provided	N/A

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FDOT District 5	N/A	FDOTD5-03	D5_70012-3503-01 (Missing from model)	Pond WRA 1.	Wet Detention Pond	Completed	Prior to 2013	165	0	22	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-04	D5_70012-3503-02 (Missing from model)	Pond WRA 2.	Wet Detention Pond	Completed	Prior to 2013	0	0	9	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-05	D5_70012-3503-03 (Missing from model)	Pond WRA 3.	Dry Detention Pond	Completed	Prior to 2013	6	1	7	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-06	D5_70050-3544-03	Pond 7B.	Wet Detention Pond	Completed	2004	2	0	5	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-07	D5_70100-3517-01 (Missing from model)	French drains. Project canceled. Start date prior to 2000. BMP is accounted for in new model.	100% On-site Retention	Canceled	Prior to 2013	N/A	N/A	3	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-08	D5_70220-3433-01	Pond C.	Wet Detention Pond	Completed	2000	3	0	9	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-09	D5_70220-3429-01 (Missing from model)	Pond A; Pond 1A under 242251-2 (10/09). Project canceled. Start date prior to 2000. BMP is accounted for in new model.	Wet Detention Pond	Canceled	Prior to 2013	N/A	N/A	20	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-10	D5_70220-3429-02 (Missing from model)	Pond B is now Pond 1B under 241221-2 (10/09). Project canceled. Start date prior to 2000. BMP is accounted for in new model.	Wet Detention Pond	Canceled	Prior to 2013	N/A	N/A	26	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-11	D5_70220-3429-03 (Missing from model)	Pond C is now Pond 2B under 241221-2 (10/09). Project canceled. Start date prior to 2000. BMP is accounted for in new model.	Wet Detention Pond	Canceled	Prior to 2013	N/A	N/A	26	Not provided	Not provided	Florida Legislature	Not provided	N/A

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FDOT District 5	N/A	FDOTD5-12	D5_70220-3429-04 (Missing from model)	Pond D is now Pond 2A under 241221-2 (10/09). Project canceled. Start date prior to 2000. BMP is accounted for in new model.	Wet Detention Pond	Canceled	Prior to 2013	N/A	N/A	22	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-13	D5_409034-01	French drains.	100% On-site Retention	Completed	2005	4	1	0	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-14	Education Efforts	Pamphlets, Illicit Discharge Program.	Education Efforts	Ongoing	N/A	97	13	N/A	Not provided	Not provided	Florida Legislature	N/A	N/A
FDOT District 5	N/A	FDOTD5-15	Fertilizer Cessation	Elimination of fertilizer application in rights-of-way.	Fertilizer Cessation	Completed	2005	1,586	0	101	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-16	Street Sweeping	Street sweeping.	Street Sweeping	Ongoing	N/A	215	117	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
Melbourne Tillman WCD	DEP	MT-01	C-1 Re-Diversion Project	Not provided.	Hydrologic Restoration	Completed	2014	Not provided	Not provided	Not provided	Not provided	Not provided	DEP	Not provided	S0652
Melbourne Tillman WCD	N/A	MT-02	Weir Construction C-69 @ C-1	Not provided.	Control Structure	Completed	2016	Not provided	Not provided	3,830	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-03	Weir Construction C-69 @ C-75	Not provided.	Control Structure	Completed	2016	Not provided	Not provided	2,940	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-04	Weir Construction C-74 @ C-69	Not provided.	Control Structure	Completed	2016	Not provided	Not provided	840	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-05	Windmill Aeration	Not provided.	Stormwater Aeration System	Completed	2016	N/A	N/A	516	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-06	C-9R	Woodchip logs.	Turbidity Reducing Polymers (e.g., Floc logs ®)	Completed	2016	Not provided	Not provided	205	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-07	C-49 Pond	Not provided.	Stormwater - Biological/ Bacteria Treatment	Completed	2016	Not provided	Not provided	238	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-08	C-47	Not provided.	Stormwater - Biological/ Bacteria Treatment	Completed	2016	Not provided	Not provided	480	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-09	C-62	Woodchip logs.	Turbidity Reducing Polymers (e.g., Floc logs ®)	Completed	2016	Not provided	Not provided	120	Not provided	Not provided	Not provided	Not provided	N/A

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Melbourne Tillman WCD	N/A	MT-10	C-84	Not provided.	Stormwater - Biological/ Bacteria Treatment	Completed	2016	Not provided	Not provided	152	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	N/A	MT-11	Harvesting	Hydrilla harvesting.	Aquatic Vegetation Harvesting	Completed	2016	Not provided	Not provided	80	Not provided	Not provided	Not provided	Not provided	N/A
Melbourne Tillman WCD	Not provided	MT-12	Harvesting	Hygrophilia and tape grass harvesting	Aquatic Vegetation Harvesting	Ongoing	N/A	7,550	1,699	141	$30,353	Not provided	User Fees	User Fees - $30,352	N/A
Melbourne Tillman WCD	N/A	MT-13	Control Structure Maintenance	Maintain existing water control structures and any adjustable gates on water control structures.	Control Structure	Underway	TBD	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Melbourne Tillman WCD	N/A	MT-14	Public Education and Outreach	Update website with links and literature related to clean waters and the Indian River Lagoon, and participate in education training to include FSESCI program.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Melbourne Tillman WCD	N/A	MT-15	New Outfall Discharge Requirements	Implement discharge requirements for new outfalls from developments which are greater than required by other agencies to regulate the peak flow into the canals.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Town of Indialantic	N/A	TI-01	Education Efforts	Pamphlets, website, and fertilizer ordinance.	Education Efforts	Ongoing	N/A	144	21	N/A	N/A	N/A	N/A	N/A	N/A
Town of Indialantic	N/A	TI-02	Swale Construction	Not provided.	Grass swales without swale blocks or raised culverts	Underway	TBD	12	2	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
Town of Indialantic	N/A	TI-03	Drainage Inlet Cleaning	Not provided.	BMP Cleanout	Ongoing	N/A	TBD	TBD	Not provided	Not provided	Not provided	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Town of Indialantic	N/A	TI-04	Street Sweeping	Not provided.	Street Sweeping	Ongoing	N/A	28	18	N/A	Not provided	Not provided	Not provided	Not provided	N/A
Town of Indialantic	N/A	TI-05	Lily Park	Not provided.	On-line Retention BMPs	Planned	2018	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A
Town of Melbourne Beach	N/A	MB-01	Basin 9 - Oak Street Pedway	Not provided.	Exfiltration Trench	Completed	2007	115	18	13	$146,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-02	Basin 9 - Oak Street Pedway - Improvement Project	Not provided.	Baffle Boxes- Second Generation	Completed	2007	152	19	86	$146,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-03	Basin 8, 9, and 11 Oak Street Pedway - Improvement Project	Not provided.	Grass swales without swale blocks or raised culverts	Completed	2007	199	30	45	$146,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-04	Basin 1 - Hazard Mitigation Grant Program (HMGP) Flood Water Improvements Project	Not provided.	Baffle Boxes- Second Generation	Completed	2010	150	18	84	$500,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-05	Basin 1 - HMGP Flood Water Improvements Project	Not provided.	Grass swales without swale blocks or raised culverts	Completed	2010	4	1	1	$500,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-06	Basin 9 - HMGP Flood Water Improvements Project	Not provided.	Grass swales without swale blocks or raised culverts	Completed	2010	4	1	1	$500,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-07	Anchor Key Drainage Improvements - Basin 16	Not provided.	Baffle Boxes- First Generation	Completed	2002	0	0	3	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-08	Pelican Key Drainage Improvements - Basin 14	Not provided.	Baffle Boxes- First Generation	Completed	2002	0	0	2	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	DEP	MB-09	Basin 5 - Ocean Ave Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2000	3	2	58	Not provided	Not provided	DEP	Not provided	G0320
Town of Melbourne Beach	N/A	MB-10	Basin 10 - Cherry Drive Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2000	4	3	87	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-11	Basin 15 - Neptune Drive Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2000	0	0	6	Not provided	Not provided	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Town of Melbourne Beach	N/A	MB-12	Basin 17 - Riverview Lane Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2000	0	0	1	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-13	Basin 18 - Riverview Lane Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2000	0	0	6	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-14	CIBs - Basins 4, 6, 10 & 15	Not provided.	Catch Basin Inserts/Inlet Filter Cleanout	Completed	2000	5	4	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-15	Melbourne Beach Chevron	Not provided.	100% On-site Retention	Completed	2010	6	1	1	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-16	Melbourne Beach Library	Not provided.	Dry Detention Pond	Completed	2001	1	0	2	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Beach	N/A	MB-17	Melbourne Beach Town Hall	Not provided.	100% On-site Retention	Completed	2005	14	2	2	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Village	N/A	MV-01	Platt Circle	Not provided.	Baffle Boxes- Second Generation	Completed	2005	48	6	31	$124,000	Not provided	Not provided	Not provided	N/A
Town of Melbourne Village	N/A	MV-02	Education Efforts	FYN, fertilizer ordinance, irrigation ordinance, PSAs, and informational pamphlets.	Education Efforts	Ongoing	N/A	144	21	N/A	Not provided	Not provided	Not provided	Not provided	N/A
Town of Melbourne Village	N/A	MV-02	Dayton Culvert	Restoration of swale and installation of new culvert with baffle box.	Baffle Boxes- Second Generation	Underway	2021	TBD	TBD	TBD	$11,300	Not provided	Not provided	Not provided	N/A

3.2 Project Zone SEB

Project Zone SEB covers more than 117,881 acres of the CIRL BMAP. As listed in **Table 21**, urban land use makes up the largest portion of the project zone with 22.5 % of the area, followed by agriculture with 21.0 %. Stakeholders in Project Zone SEB are agricultural producers, Brevard County, City of Fellsmere, City of Palm Bay, City of Sebastian, FDOT District 4 and District 5, Fellsmere WCD, Indian River County, Sebastian River Improvement District, Town of Grant-Valkaria, Town of Orchid, and Vero Lakes WCD.

Table 21. Summary of land uses in Project Zone SEB

Note: Land use code 5000 (water) acreage excludes lagoon water in this table.

Level 1 Land Use Code	Land Use Description	Acres	% Total
1000	Urban	26,562	22.5
2000	Agricultural	24,726	21.0
3000	Upland Prairie and Shrublands	24,660	20.9
4000	Upland Forested Areas	17,250	14.6
5000	Water	2,256	1.9
6000	Wetlands	18,734	15.9
7000	Disturbed Lands	1,778	1.5
8000	Transportation	1,916	1.6
Total		**117,881**	**100.0**

DEP asked stakeholders to provide information on management actions, including projects, programs, and activities, that may reduce nutrient loads to the CIRL. Management actions are included in the BMAP to address nutrient loads to the lagoon and have to meet several criteria to be considered eligible for credit. **Figure 15** and **Figure 16** show progress towards the required TN and TP load reductions allocated to Project Zone SEB from projects completed through July 31, 2020.

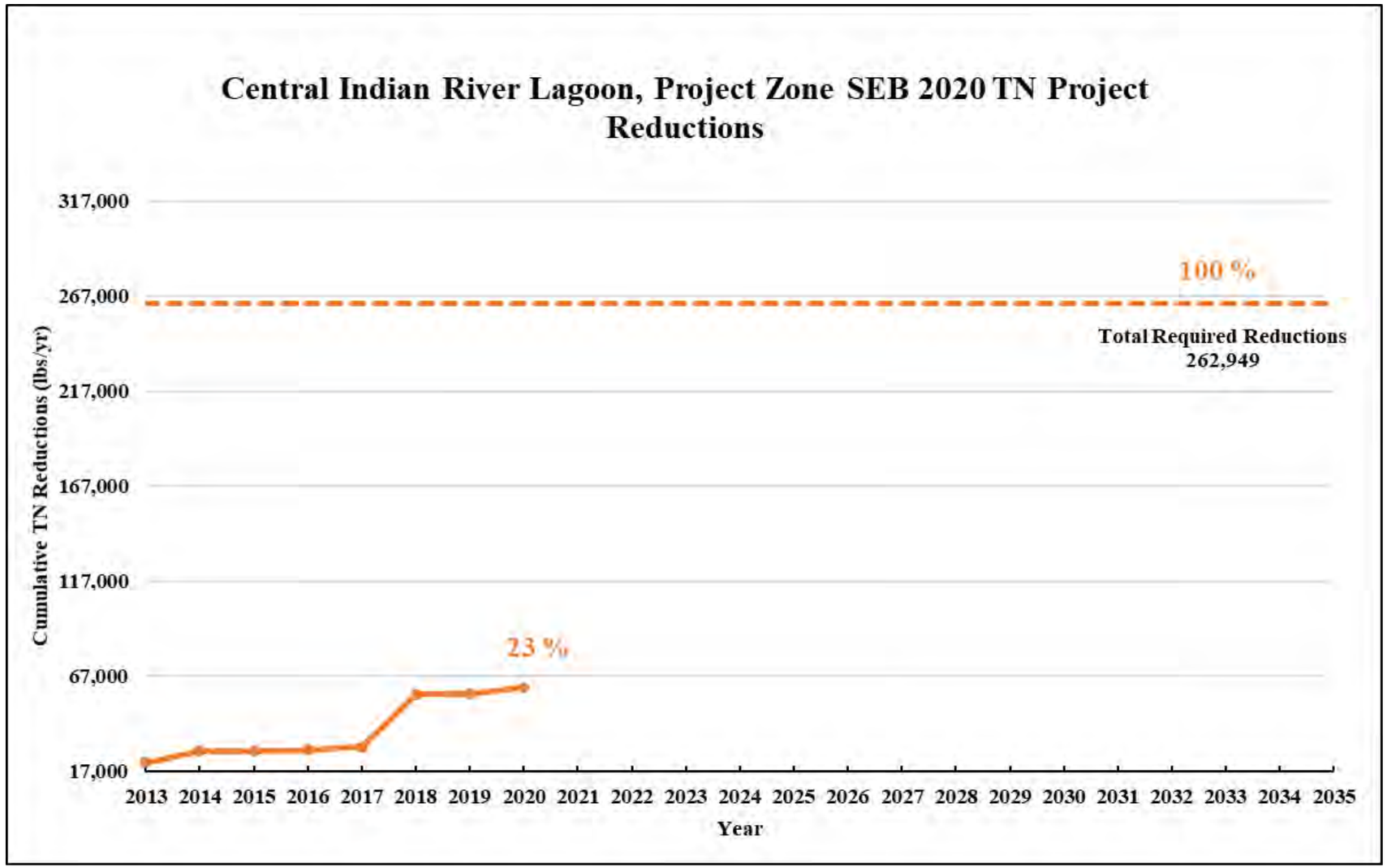

Figure 15. Estimated progress towards meeting the required TN reductions allocated to Project Zone SEB with projects completed through July 31, 2020

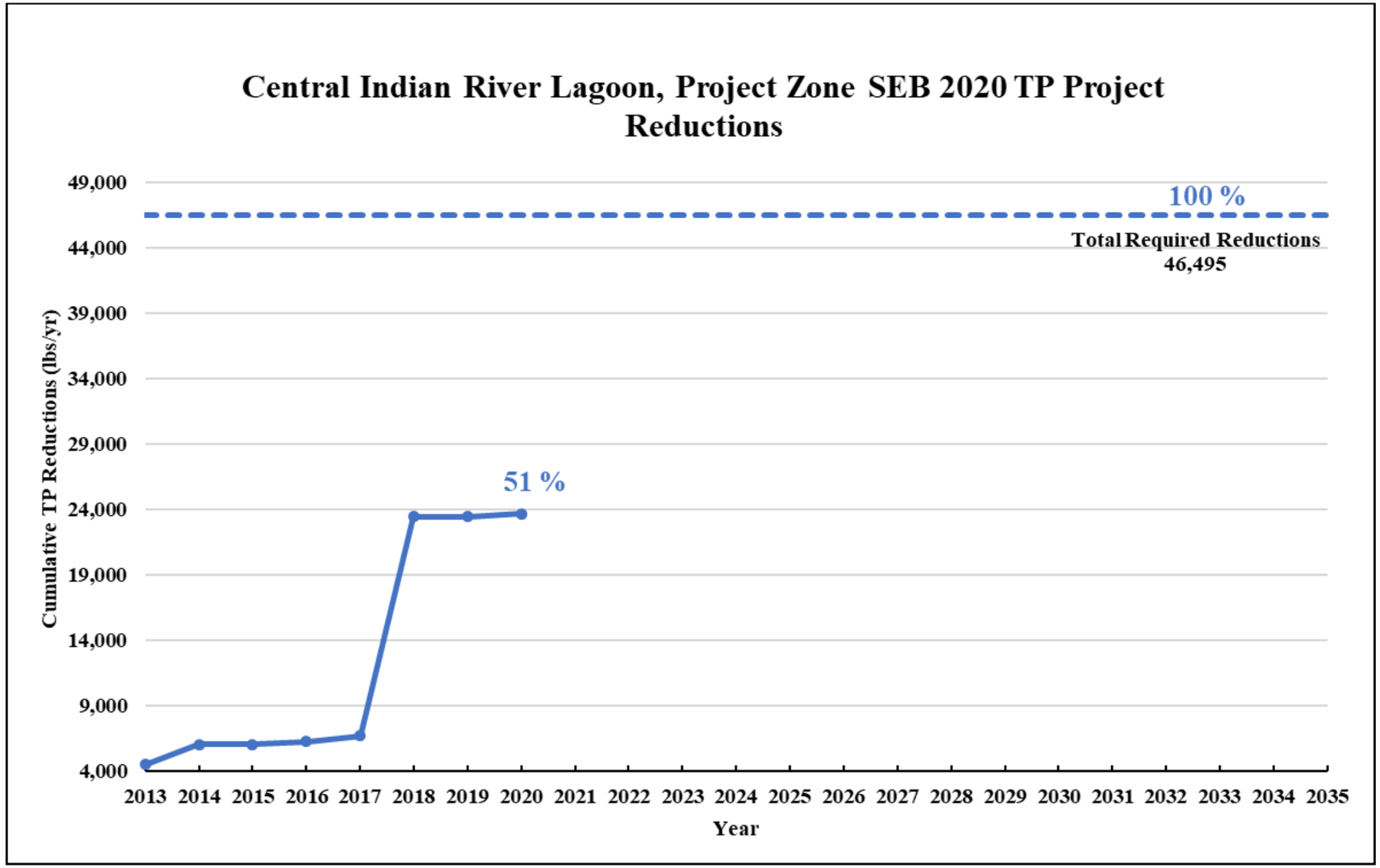

Figure 16. Estimated progress towards meeting the required TP reductions allocated to Project Zone SEB with projects completed through July 31, 2020

3.2.1. Existing and Planned Projects

Table 22 summarizes the existing and planned projects provided by the stakeholders for Project Zone SEB.

Table 22. Existing and planned projects in Project Zone SEB

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Brevard County	N/A	BC-04	Church Street Pond Cleanout	Removed vegetation from pond.	BMP Cleanout	Completed	2014	137	26	172	Not provided	Not provided	County	Not provided	N/A
Brevard County	W. Melbourne/ Grant-Valkaria/ Malabar/ Melbourne/ Cocoa/ IHB/ Sat. Beach/ Cocoa Beach/ Cape Canaveral	BC-05a	Education Efforts	FYN, fertilizer and pet waste ordinances, public service announcements (PSAs), pamphlets, website, illicit discharge program.	Education Efforts	Ongoing	N/A	3,127	466	N/A	N/A	N/A	County	N/A	N/A
Brevard County	N/A	BC-06a	Street Sweeping	Remove debris from 786 linear feet of curb street throughout the county.	Street Sweeping	Ongoing	N/A	58	37	N/A	N/A	N/A	N/A	N/A	N/A
Brevard County	SJRWMD	BC-08	Wheeler Properties (Sebastian River Improvements)	Wet detention pond and wetland enhancement.	Wet Detention Pond	Completed	2012	TBD	TBD	16,404	$3,500,000	$2,000	DEP	Not provided	S0436
Brevard County	N/A	BC-09	Micco I	Exfiltration and denitrification.	BMP Treatment Train	Completed	2016	40	6	52	$175,599	$1,000	DEP	DEP - $355,304	G0358
Brevard County	N/A	BC-10	Micco B	Not provided.	Dry Detention Pond	Canceled	N/A	41	6	N/A	N/A	N/A	N/A	N/A	N/A
Brevard County	N/A	BC-11	Mockingbird Pond	Installation of a floating vegetated island in an existing stormwater retention pond to provide additional nutrient removal.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Completed	2017	23	3	27	$10,923	$1,350	DEP	Not provided	G0430
Brevard County	N/A	BC-12	Church Street Pond MAPS	Installation of a floating vegetated island in an existing stormwater retention pond to provide additional nutrient removal.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Completed	2010	135	21	172	$4,212	$2,106	N/A	N/A	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Brevard County	DEP	BC-13	Wheeler Flemming Grant	Construction of a wet detention pond that will help remove nitrogen and phosphorus from the stormwater adjacent to Fleming Grant Road in southeastern Brevard County.	Wet Detention Pond	Completed	2016	553	182	134	$645,073	$2,000	DEP	DEP - $591,081	G0396
Brevard County	DEP	BC-20a	Multiple Ditch Outfall Denitrification D3	Providing base flow/groundwater treatment in 20 open drainage basins. Each Project will have its own number	Denitrification Walls	Underway	TBD	TBD	TBD	TBD	N/A	TBD	DEP	TBD	LP0511A
Brevard County	SOIRL	BC-26	Flemming Grant BAM - BB#2134	Adding a media to remove nitrogen by denitrification. The media will be added to the side slope of the pond or the bottom of the swale.	Biosorption Activated Media (BAM)	Underway	2020	TBD	TBD	TBD	$181,000	Not provided	LF/SOIRL	$91,588	N/A
Brevard County	Not provided	BC-28	Long Point Park Denitrification	Denitrification wall to remove nitrogen from the groundwater flowing from campground rapid infiltration wet pond into IRL	Denitrification Walls	Completed	2017	TBD	TBD	TBD	$101,854	Not provided	SOIRL	SOIRL - $22,206.73	N/A
Brevard County	Not provided	BC-31	Education Efforts	Fertilizer, grass clippings, and septic system maintenance	Enhanced Public Education	Underway	2017	N/A	N/A	TBD	$375,000	Not provided	SOIRL	SOIRL - $375,000	N/A
Brevard County	Not provided	BC-32	Babcock @C54 - BB#2258	Adding a media to remove nitrogen by denitrification. The media will be added to the side slope of the pond or the bottom of the swale.	Biosorption Activated Media (BAM)	Underway	2020	TBD	TBD	TBD	$84,999	TBD	LF	LF - $35,000	Not provided
City of Fellsmere	Fellsmere WCD	F-01	State Street Improvements and Stormwater Lake Project	Not provided.	Wet Detention Pond	Completed	Prior to 2013	79	22	50	Not provided	Not provided	Not provided	Not provided	N/A
City of Fellsmere	N/A	F-02	Senior League Field Park Improvements	Not provided.	Wet Detention Pond	Completed	2008	4	1	12	Not provided	Not provided	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Fellsmere	N/A	F-03	City Hall/Orange Street Project	Not provided.	Wet Detention Pond	Completed	2018	4	1	8	Not provided	Not provided	Not provided	Not provided	N/A
City of Fellsmere	N/A	F-04	Sunrise Apartments Phase 1 & 2	Not provided.	Wet Detention Pond	Completed	2009	12	5	36	Not provided	Not provided	Not provided	Not provided	N/A
City of Fellsmere	Fellsmere WCD	F-05	Grace Meadows Subdivision	Not provided.	Wet Detention Pond	Completed	2009	4	2	18	Not provided	Not provided	Not provided	Not provided	N/A
City of Fellsmere	N/A	F-07	Solid Waste Transfer Station	Not provided.	Wet Detention Pond	Completed	2008	1	0	5	Not provided	Not provided	Not provided	Not provided	N/A
City of Fellsmere	N/A	F-08	Fertilizer Ordinance	Ordinance.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	53	8	N/A	N/A	N/A	N/A	N/A	N/A
City of Fellsmere	SJRWMD/ Property Owner	F-09	North Regional Lake	Not provided.	Wet Detention Pond	Completed	2017	1,512	456	22	$615,000	$10,000	SJRWMD	SJRWMD - $500,000	N/A
City of Fellsmere	SJRWMD/ Property Owner	F-10	South Regional Lake	Created wetland flow through system.	BMP Treatment Train	Planned	2019	3,025	797	450	$787,187	$5,000	SJRWMD	SJRWMD - $500,000	N/A
City of Fellsmere	N/A	F-11	Alleyway Grading	Convert alleyway system into stormwater treatment system.	Grass swales without swale blocks or raised culverts	Planned	TBD	TBD	TBD	640	$1,260,000	$20,000	City/ Grants	TBD	N/A
City of Fellsmere	N/A	F-12	Stormwater Greenway	Convert unused rights-of-way into stormwater greenways.	Bioswales	Planned	TBD	TBD	TBD	220	$1,750,000	$30,000	City/ Grants	TBD	N/A
City of Fellsmere	N/A	F-13	Additional Regional Treatment	Lake or treatment train system (additional 40 acres required).	Wet Detention Pond	Planned	TBD	TBD	TBD	220	$2,080,000	$50,000	City/ Grants	TBD	N/A
City of Fellsmere	N/A	F-14	Road culverts, stormwater conveyance, paving	Reconstruct road culverts, stormwater conveyance, paving	Grass swales without swale blocks or raised culverts	Planned	TBD	TBD	TBD	TBD	########	TBD	City/ Grants	TBD	N/A
City of Fellsmere	N/A	F-15	Micro system basins	Construct micro system basins for stormwater treatment	BMP Treatment Train	Planned	TBD	TBD	TBD	TBD	$1,000,000	TBD	City/ Grants	TBD	N/A
City of Fellsmere	N/A	F-16	Stormwater data inventory	Develop stormwater data inventory system	Study	Completed	2018	N/A	N/A	N/A	$15,000	N/A	City Stormwater Fund	City Stormwater Fund - $15,000	N/A
City of Fellsmere	IRL NEP	F-17	259 S. Pine Stormwater	Construct swale conveyances, dry retention and control structures for micro basin	Dry Detention Pond	Planned	2019	37	5	7	$130,000	$5,000	City/ Grants	$50,000	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Fellsmere	IRL NEP	F-18	Stormwater Greenway	Convert unused rights-of-way into stormwater greenways.	Creating/ Enhancing Living Shoreline	Planned	2019	TBD	TBD	22	$5,000	$2,500	City/ Grants	$5,000	N/A
City of Fellsmere	Not provided	F-18	97th Street Flood Control	Not provided.	BMP Treatment Train	Planned	TBD	TBD	TBD	107	Not provided	Not provided	Not provided	Not provided	Not provided
City of Palm Bay	N/A	PB-35	Education Efforts	FYN, ordinances, pamphlets, PSAs, website, illicit discharge program.	Education Efforts	Ongoing	N/A	185	25	N/A	N/A	N/A	N/A	N/A	N/A
City of Sebastian	N/A	SEB-01	Main Street/Indian River Drive Improvements	Not provided.	Dry Detention Pond	Completed	2009	6	1	6	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-02	Main Street 4	Not provided.	Dry Detention Pond	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Sebastian	N/A	SEB-03	T-Hangar Development/Access Roads	Not provided.	Dry Detention Pond	Completed	2004	2	0	2	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-04	Louisiana Avenue Improvements Projects	Not provided.	Dry Detention Pond	Completed	2004	3	0	3	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-05	Twin Ditches Stormwater Retrofit	Not provided.	Wet Detention Pond	Completed	2007	241	127	177	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-06	Indian River Drive & Davis Street Baffle Box	Not provided.	Baffle Boxes- First Generation	Completed	2009	1	1	22	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	DEP	SEB-07	Periwinkle Drive Stormwater	Not provided.	Wet Detention Pond	Completed	2008	5	1	48	Not provided	Not provided	DEP	Not provided	G0200
City of Sebastian	DEP	SEB-08	Collier Canal Stormwater Retrofit	Not provided.	Wet Detention Pond	Completed	2010	1,655	444	532	Not provided	Not provided	DEP	Not provided	G0235
City of Sebastian	N/A	SEB-09	Schumann Park Improvements	Not provided.	Dry Detention Pond	Completed	2009	4	1	4	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-10	Fertilizer Ordinance	Ordinance.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	309	45	N/A	N/A	N/A	N/A	Not provided	N/A
City of Sebastian	N/A	SEB-11	Airport Drive	Not provided.	Baffle Boxes- First Generation	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Sebastian	N/A	SEB-12	Presidential Street	Not provided.	Baffle Boxes- First Generation	Completed	2014	TBD	TBD	15	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-13	Powerline Road	Not provided.	Baffle Boxes- First Generation	Completed	2014	TBD	TBD	2	Not provided	Not provided	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Sebastian	N/A	SEB-14	STEP Septic System	Not provided.	Onsite Sewage Treatment and Disposal System (OSTDS) Enhancement	Canceled	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City of Sebastian	N/A	SEB-15	Collier Canal Dredge	Not provided.	Muck Removal/Restoration Dredging	Canceled	N/A	N/A	N/A	22	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-16	Stormwater Park	Not provided.	Wet Detention Pond	Completed	2010	TBD	TBD	162	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-17	Presidential Street	Not provided.	Baffle Boxes- First Generation	Completed	2012	TBD	TBD	24	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-18	Water Quality Testing	Not provided.	Monitoring/Data Collection	Canceled	N/A	N/A	N/A	24	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-19	Drainage Improvements	Not provided.	BMP Treatment Train	Completed	2016	TBD	TBD	1	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-20	Tulip Drainage	Not provided.	On-line Retention BMPs	Completed	2016	TBD	TBD	4	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-21	Septic to Sewer	22 septic systems converted to central sewer.	OSTDS Phase Out	Underway	Not provided	TBD	TBD	TBD	Not provided	Not provided	Not provided	Not provided	N/A
City of Sebastian	N/A	SEB-22	Oyster Point Exfiltration Trench	Exfiltration Trench.	Exfiltration Trench	Completed	2018	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A
City of Sebastian	IRL Council	SEB-23	Community Oyster Garden Project	Community Oyster Garden Outreach Education Project	Education Efforts	Underway	Not provided	N/A	N/A	TBD	TBD	TBD	IRL Council	TBD	N/A
FDACS	Agricultural Producers	FDACS-03	BMP Implementation and Verification	Enrollment and verification of BMPs by agricultural producers. Acres treated based on FDACS OAWP July 2020 Enrollment and FSAID VII. Reductions based on SWIL Model-LET.	Agricultural BMPs	Ongoing	N/A	10,233	1,338	2,196	TBD	TBD	FDACS	TBD	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDACS	Agricultural Producers	FDACS-06	FDACS Cost Share Projects	Cost-share projects paid for by FDACS. Acres treated based on FDACS OAWP July 2020 Enrollment. Reductions based on SWIL Model-LET.	Agricultural BMPs	Completed	2020	3,324	187	TBD	TBD	N/A	FDACS	TBD	N/A
SJRWMD	Banack Family Partnership	SJRWMD-02	Banack Family Partnership	Upgrade irrigation system to better utilize surface water on approximately 80 acres of citrus.	Agricultural BMPs	Completed	2019	167	14	80	$277,388	N/A	Banack Family Partnership/ SJRWMD	Banack Family Partnership - $69,347/ SJRWMD - $208,041	N/A
SJRWMD	IMG Citrus	SJRWMD-03	IMG Citrus Inc.	Purchase of compost and compost spreader for approximately 920 acres of citrus.	Agricultural BMPs	Underway	2020	3,628	794	524	$175,959	N/A	IMG Citrus/ SJRWMD	IMG Citrus - $43,990/ SJRWMD - $131,969	N/A
SJRWMD	Hammon Groves	SJRWMD-04	Hammond Groves Inc.	Design and install a surface water pump station, design and complete a pond restoration project and purchase and install mesh bags for citrus trees on approximately 400 acres of citrus.	Agricultural BMPs	Underway	2020	2,195	199	400	$363,491	N/A	Hammond Groves/ SJRWMD	Hammond Groves - $113,491/ SJRWMD - $250,000	N/A
SJRWMD	Fellsmere Joint Venture	SJRWMD-07	Dispersed Water Storage / Nutrient Reduction Pilot Project with Fellsmere Joint Venture	The District is evaluating benefits of using groves and private lands for retention to reduce excess nutrients. Project will create a ~2000 acre reservoir that should store about 18 mgd and reduce ~24 metric tons (mt) TN and 3 MT TP annually.	Dispersed Water Management	Underway	2022	TBD	TBD	Not provided	########	Not provided	Ad Valorem	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
SJRWMD	Graves Brothers	SJRWMD-08	Dispersed Water Storage / Nutrient Reduction Pilot Project with Graves Brothers	The District is evaluating benefits of using groves and private lands for retention to reduce excess nutrients. Project will create a ~200 acre reservoir that should store about 5 mgd and provide nutrient reductions of ~ 3 mt TN and 1 MT TP annually.	Dispersed Water Management	Underway	2021	TBD	TBD	Not provided	$5,655,000	Not provided	Ad Valorem	Not provided	N/A
SJRWMD	FWC/ NRCS	SJRWMD-09	Fellsmere Water Management Area	A component of the Upper St. Johns River Basin Project constructing a 10,000-acre reservoir to treat agricultural discharges and also benefits the IRL. Project will collectively restore more than 160,000 acres of the St. Johns River headwaters.	Stormwater Reuse/ Wet Detention Pond	Underway	2021	TBD	TBD	Not provided	########	Not provided	Ad Valorem/ FWC/ NRCS	Not provided	Not provided
SJRWMD	FDOT/ Brevard County	SJRWMD-10	Micco Stormwater Park	Two wet-detention ponds and wetland restoration areas, which improve the water quality to the Sebastian River and IRL. The stormwater system infrastructure was complete in 2016 and the park opened in 2018 with educational signs and other site amenities.	Regional Stormwater Treatment	Completed	2018	27,200	16,750	Not provided	$2,816,603	Not provided	Ad Valorem/ FDOT/ Brevard County	Not provided	N/A
FDOT District 4	N/A	FDOT4-03	FM# 228615-1	Resurfacing SR 5 between CR 510 to just south of Harrison Street.	Baffle Boxes-Second Generation	Completed	2007	108	12	289	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-04a	FDOT4 Street Sweeping	Materials from roadway and gutter sweeping.	Street Sweeping	Ongoing	N/A	76	49	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDOT District 4	N/A	FDOT4-09a	Education Efforts	Pamphlets and Illicit Discharge Program.	Education Efforts	Ongoing	N/A	20	2	N/A	N/A	N/A	Florida Legislature	N/A	N/A
FDOT District 4	N/A	FDOT4-10a	Fertilizer Cessation	No longer applying routine fertilizer.	Fertilizer Cessation	Completed	2014	6,045	1,511	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-21a	FM#: 413048-1 (Interstate-95 from St. Lucie/ Indian River County Line to North of State Road 60)	Widening SR 9 from St. Lucie / IRC Line to North of State Rd 60.	100% On-site Retention	Completed	2016	36	4	33	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-22	FM# 411476-1 (Sebastian River Bridge Replacement Project)	SR A1A Sebastian River Bridge replacement.	Grass swales without swale blocks or raised culverts	Completed	2014	0	0	2	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-23	FM# 413049-2	Widening SR 9 from North of SR 60 to Indian River/ Brevard County line.	Grass swales without swale blocks or raised culverts	Completed	2018	554	0	883	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-35A	FM# 431152-1	US-1 lateral ditch restoration.	On-line Retention BMPs	Completed	2016	TBD	TBD	TBD	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 5	N/A	FDOTD5-14a	Education Efforts	Pamphlets, Illicit Discharge Program.	Education Efforts	Ongoing	N/A	33	4	N/A	Not provided	Not provided	Florida Legislature	N/A	N/A
Fellsmere WCD	Sunrise Villas	FWCD-01	Sunrise Villas	Pond designed per two-inch/day limitation rule.	Wet Detention Pond	Completed	2003	5	2	14	TBD	TBD	Private	TBD	N/A
Fellsmere WCD	SJRWMD/ Indian River County/ State	FWCD-02	St. Johns Land Purchase	Conservation land.	Land Use Change	Completed	Prior to 2013	N/A	N/A	2,391	TBD	TBD	SJRWMD	TBD	N/A
Fellsmere WCD	City of Fellsmere/ SJRWMD	FWCD-03	Fellsmere Stormwater Lake and State Street Improvements	Stormwater retrofit improvements. Reduction split 50/50 with the City of Fellsmere.	Wet Detention Pond	Completed	2003	76	21	50	TBD	TBD	SJRWMD/ Fellsmere WCD	TBD	N/A
Fellsmere WCD	Indian River County Habitat for Humanity	FWCD-04	Grace Meadows	Pond designed per two-inch/day limitation rule. Reductions split 50/50 with City of Fellsmere.	Wet Detention Pond	Completed	2009	2	1	18	TBD	TBD	Private	TBD	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Fellsmere WCD	N/A	FWCD-05	2-Inch Limitation Discharges	Establishment of two-inch discharge rule.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	TBD	TBD	N/A	N/A	N/A	N/A	N/A	N/A
Fellsmere WCD	N/A	FWCD-06	Fellsmere WCD Mechanical Canal Maintenance	Canal cleaning/maintenance.	Stormwater System Rehabilitation	Ongoing	N/A	N/A	N/A	N/A	TBD	TBD	Fellsmere WCD	TBD	N/A
Fellsmere WCD	City of Fellsmere	FWCD-07	Historic Fellsmere Master Drainage Plan	Stormwater retrofit improvements. Reductions will be split with the City of Fellsmere once determined.	Regional Stormwater Treatment	Planned	TBD	TBD	TBD	1,661	TBD	TBD	Fellsmere WCD/ City of Fellsmere	TBD	N/A
Fellsmere WCD	City of Fellsmere/ SJRWMD	FWCD-08	South Regional Lake	Created wetland flow through system. Reductions to be split with the City of Fellsmere once determined.	BMP Treatment Train	Underway	TBD	TBD	TBD	627	TBD	TBD	SJRWMD/ City of Fellsmere	TBD	N/A
Fellsmere WCD	City of Fellsmere/ SJRWMD	FWCD-09	North Regional Lake	Reductions to be split with the City of Fellsmere once determined.	Wet Detention Pond	Completed	2018	TBD	TBD	367	TBD	TBD	SJRWMD	TBD	N/A
Fellsmere WCD	Fellsmere Joint Venture (FJV)/ SJRWMD	FWCD-10	Water Dispersion Project	Construction of berms and two pump stations to remove water from outfall canals and store on land.	Dispersed Water Management (DWM)	Planned	TBD	TBD	TBD	TBD	TBD	TBD	SJRWMD	TBD	N/A
Fellsmere WCD	N/A	FWCD-11	Public Education and Outreach	Provide public education to residents of the District that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Fellsmere WCD	N/A	FWCD-12	Assist FDACS with BMP Enrollment Outreach	Assist FDACS, where needed, with identifying and contacting landowners/ producers within the District boundaries for purposes of participating in the relevant FDACS BMP programs.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Indian River County	DEP	IRC-01	Vero Lake Estates Stormwater Improvements - Phase 1	Series of swales and canals in a large development leading to large stormwater detention ponds.	Wet Detention Pond	Completed	2002	7,655	1,993	2,407	$1,572,829	Not provided	DEP	Not provided	WM803
Indian River County	DEP	IRC-02	East Roseland Stormwater Improvements	A stormwater detention pond receiving water from swale systems in a subdivision.	Wet Detention Pond	Completed	2005	216	58	74	$433,134	$2,176	DEP	Not provided	G0061
Indian River County	N/A	IRC-07a	Moorhen Marsh Low Energy Aquatic Plant System	This is a managed aquatic plant system that will remove sediment and suspended solids through settling and filtration by aquatic plant roots. The aquatic plants will be harvested on a regular basis.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Underway	2021	52	7	6,301	$8,705,000	$84,000	County/ SJRWMD/Florida Legislature	Not provided	LPA0018
Indian River County	N/A	IRC-08a	Education Efforts	Fertilizer ordinance, PSAs, website, pamphlets, Illicit Discharge Program, and signs along Indian River Farms WCD canals.	Education Efforts	Ongoing	N/A	5,277	762	N/A	N/A	$52,000	Not provided	Not provided	N/A
Indian River County	N/A	IRC-09a	Street Sweeping	Street sweeping.	Street Sweeping	Ongoing	N/A	91	59	N/A	Not provided	$22,050	Not provided	Not provided	N/A
Indian River County	N/A	IRC-10a	Storm Drain Cleaning with Vacuum Trucks	Nutrient removal from measured data.	BMP Cleanout	Planned	TBD	TBD	TBD	TBD	TBD	$19,067	TBD	TBD	N/A
Indian River County	N/A	IRC-11a	Floating Aquatic Plant Islands in County Stormwater Ponds and Lakes	Nutrient removal from measured data.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Planned	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A
Indian River County	N/A	IRC-13	North Relief Canal Mechanical Vegetation/Debris Removal	Removal of aquatic vegetation containing nitrogen and phosphorus that otherwise, would enter IRL and die, releasing nutrients into the lagoon.	Aquatic Vegetation Harvesting	Planned	TBD	TBD	TBD	6,301	$1,000,000	$50,000	County/ Grants	TBD	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Sebastian River Improvement District	N/A	SRID-01	2-Inch Rule	Establishment of two-inch discharge rule.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sebastian River Improvement District	Not provided	SRID-02	Control Gates	Radial arm control gates.	Control Structure	Planned	TBD	TBD	TBD	9,000	TBD	TBD	SRID	TBD	N/A
Sebastian River Improvement District	N/A	SRID-03	Muck Removal	Vegetation and sediment/muck removal from canals.	Stormwater System Rehabilitation	Ongoing	N/A	Not provided	Not provided	Not provided	Not provided	Not provided	SRID	Not provided	N/A
Sebastian River Improvement District	N/A	SRID-04	Education Efforts	Permit manual on website that encourages the use of BMPs.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sebastian River Improvement District	N/A	SRID-05	Water Conservation	Large regional water conservation/ storage areas.	Off-line Retention BMPs	Planned	TBD	TBD	TBD	TBD	TBD	TBD	SRID	TBD	N/A
Sebastian River Improvement District	Groves Brothers/ SJRWMD	SRID-06	200-Acre Water Dispersion Project	Construction of berms and two pump stations to remove water from outfall canals and store on land.	Dispersed Water Management (DWM)	Underway	2020	TBD	TBD	7,700	$5,650,000	TBD	SJRWMD	SJRWMD - $5,650,000	N/A
Sebastian River Improvement District	N/A	SRID-07	Lateral D System Stormwater Management	Lateral D system stormwater discharge limitation.	Regulations, Ordinances, and Guidelines	Planned	TBD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sebastian River Improvement District	FDACS	SRID-08	Assist FDACS with BMP Enrollment Outreach	Assist FDACS, where needed, with identifying and contacting producers within the district boundaries for purposes of participating in the relevant FDACS BMP programs.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Vero Lakes WCD	N/A	VL-01	Public Education and Outreach	Include annual meeting agenda item to alert the landowner of the existence of the BMAP and requirements for this landowner.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Vero Lakes WCD	FDACS	VL-02	Assist FDACS with BMP Enrollment Outreach	Identify the current landowner and his contact information as shown on the VLWCD records, and encourage participation in the FDACS BMP program.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Vero Lakes WCD	N/A	VL-03	Canal/Ditch Bank Berms	Minimize sediment transport by constructing berms on top of canal/ditch banks and promoting vegetation to cover.	Vegetated Buffers	Underway	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Vero Lakes WCD	N/A	VL-04	Culverts	Regular inspection is made to insure flow is maintained through culverts.	Stormwater System Rehabilitation	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided

3.3 Project Zone B

Project Zone B covers more than 68,938 acres of the CIRL BMAP area. As listed in **Table 23**, urban land uses makes up the majority of the project zone with 55.6 % of the area, followed by agriculture with 19.3 %. Stakeholders in Project Zone B are agricultural producers, City of Vero Beach, FDOT District 4, Fort Pierce Farms WCD, Indian River County, Indian River Farms WCD, and Town of Indian River Shores.

Table 23. Summary of land uses in Project Zone B

Note: Land use code 5000 (water) acreage excludes lagoon water in this table.

Level 1 Land Use Code	Land Use Description	Acres	% Total
1000	Urban	38,344	55.6
2000	Agricultural	13,308	19.3
3000	Upland Prairie and Shrublands	5,984	8.7
4000	Upland Forested Areas	4,456	6.5
5000	Water	1,229	1.8
6000	Wetlands	2,383	3.5
7000	Disturbed Lands	929	1.3
8000	Transportation	2,301	3.3
9000	Open Lands	3	0.0
Total		**68,938**	**100.0**

DEP asked stakeholders to provide information on management actions, including projects, programs, and activities, that may reduce nutrient loads to the CIRL. Management actions are included in the BMAP to address nutrient loads to the lagoon and have to meet several criteria to be considered eligible for credit. **Figure 17** and **Figure 18** show progress towards the required TN and TP load reductions allocated to Project Zone B from projects completed through July 31, 2020.

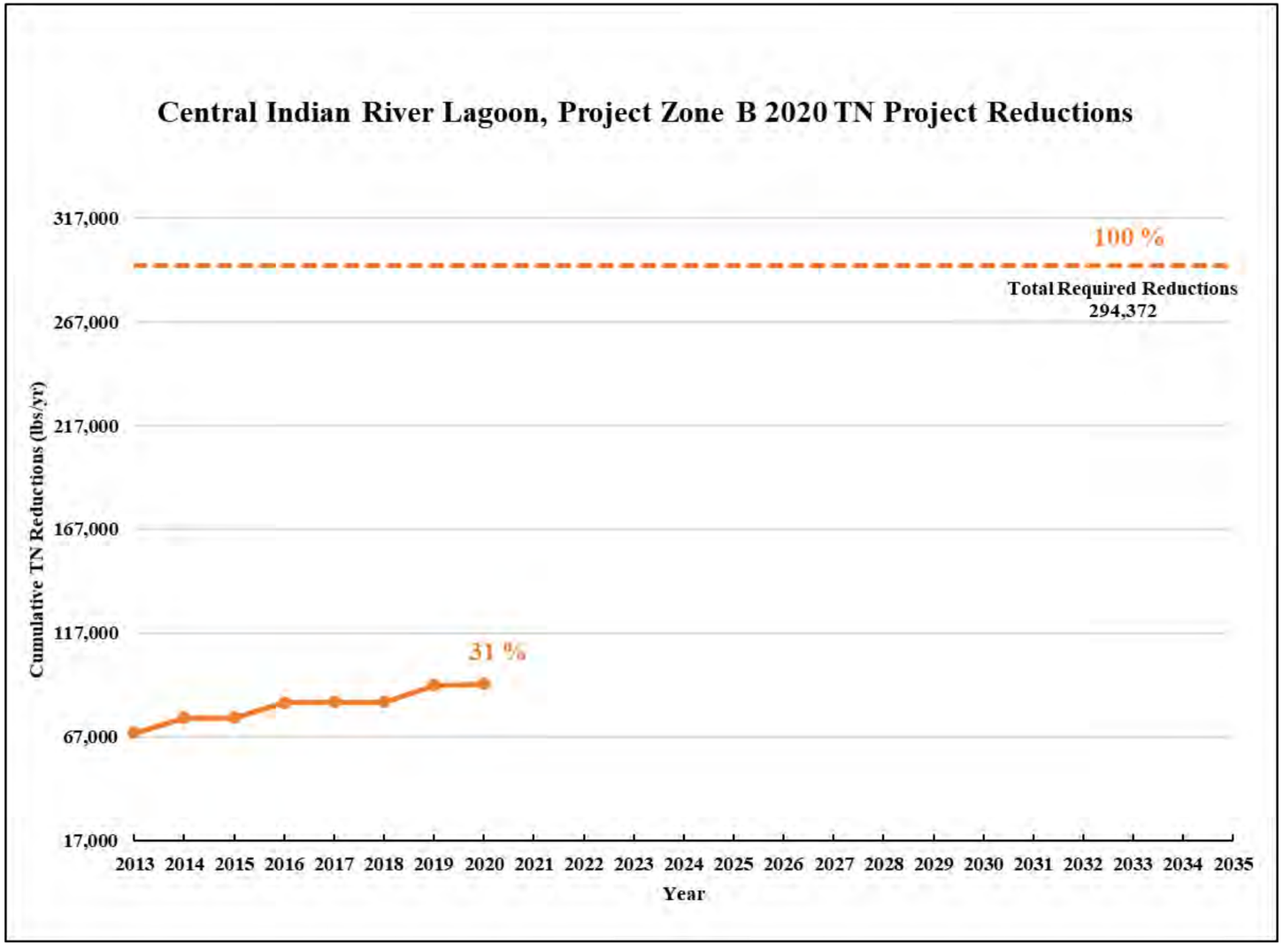

Figure 17. Estimated progress towards meeting the required TN reductions allocated to Project Zone B with projects completed through July 31, 2020

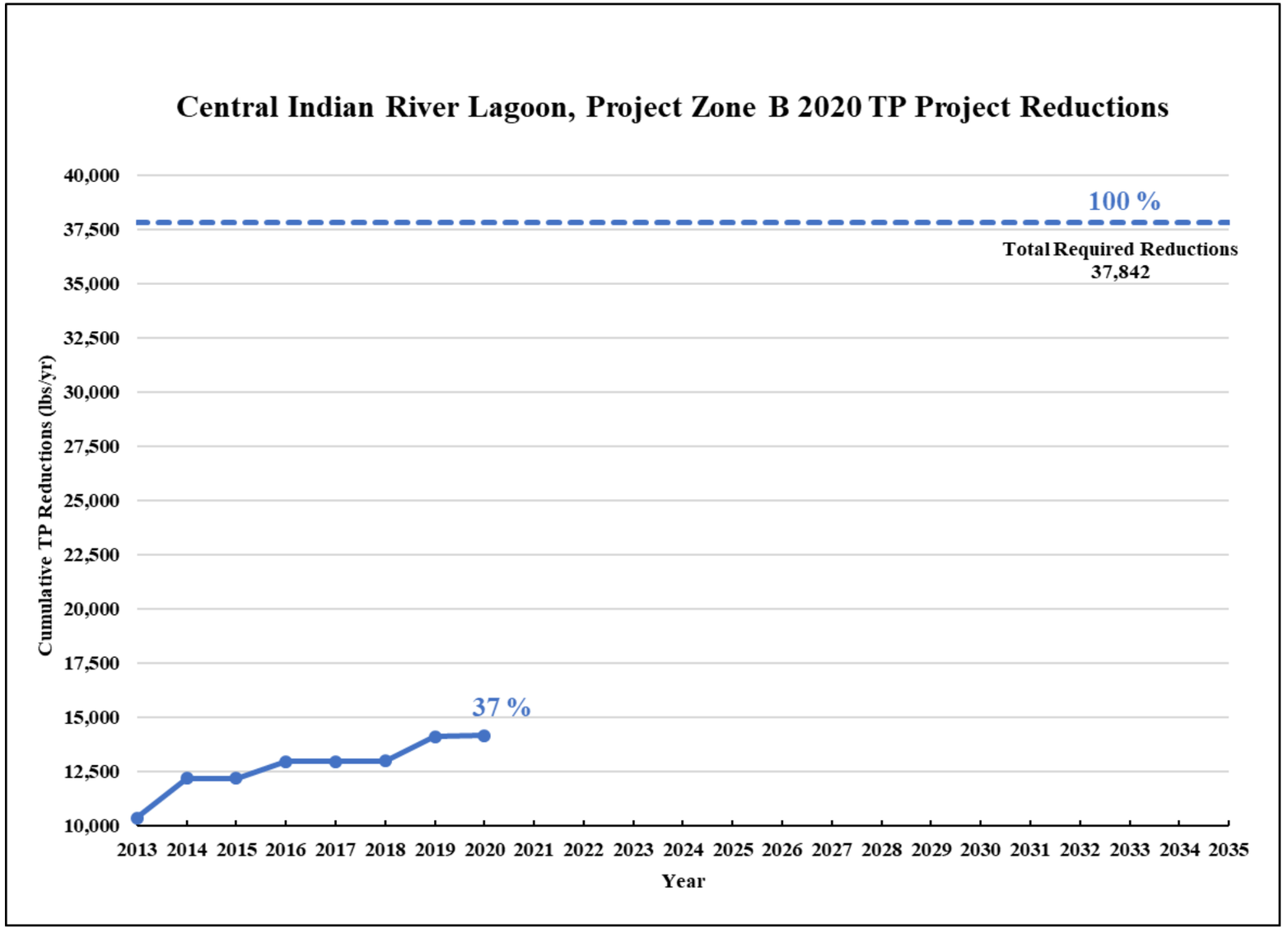

Figure 18. Estimated progress towards meeting the required TP reductions allocated to Project Zone B with projects completed through July 31, 2020

3.3.1. Existing and Planned Projects

Table 24 summarizes the existing and planned projects provided by the stakeholders for Project Zone B.

Table 24. Existing and planned projects in Project Zone B

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Vero Beach	DEP	VB-01	Date Palm Baffle Box	Suntree baffle box with Bold and GoldTM media.	Baffle Boxes-Second Generation	Completed	2017	109	13	7	$200,232	$1,000	COVB/ DEP	COVB - $128,966.54/ DEP - $71,265.73	G0242
City of Vero Beach	N/A	VB-02	10th and 12th Avenue Baffle Boxes	Includes ESI Ecovault® with a debris collection screen and baffle.	Baffle Boxes-Second Generation	Completed	2011	135	16	70	$97,800	$1,000	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-03	Greytwig Baffle Box	Includes ESI Ecovault® with a debris collection screen and baffle.	Baffle Boxes-Second Generation	Completed	2011	51	6	10	$75,000	$1,000	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-04	Education Efforts	FYN, landscape, fertilizer, irrigation, and pet waste ordinances, PSAs, informational pamphlets, website, and IDDE program.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	2,925	423	N/A	N/A	N/A	N/A	N/A	N/A
City of Vero Beach	N/A	VB-05	STEP Septic System	Conversion of existing septic systems to septic tank effluent pumping (STEP) systems.	Onsite Sewage Treatment and Disposal System (OSTDS) Enhancement	Underway	TBD	TBD	N/A	N/A	$500,000	Not provided	COVB	Not provided	N/A
City of Vero Beach	DEP	VB-06	18th Street Outfall	Not provided.	Baffle Boxes-Second Generation	Completed	2013	255	32	131	$161,511	Not provided	COVB/ DEP	COVB - $61,511.01/ DEP - $100,000.00	G0356
City of Vero Beach	DEP	VB-07	Humiston Park Outfall	Not provided.	Exfiltration Trench	Completed	2010	Not provided	Not provided	40	$577,313	Not provided	COVB/ DEP	COVB - $241,312.77/ DEP - $336,000.00	G0228
City of Vero Beach	N/A	VB-08	Bahia Mar Road Outfall	Not provided.	Baffle Boxes-Second Generation	Completed	2012	23	3	13	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-09	Bay Drive Bridge	Not provided.	Baffle Boxes-Second Generation	Completed	2010	3	0	2	Not provided	Not provided	COVB	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Vero Beach	N/A	VB-10	Indian Bay North and South	Not provided.	Baffle Boxes- Second Generation	Completed	2012	21	3	20	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-11	Live Oak Outfall	Not provided.	Baffle Boxes- Second Generation	Completed	2011	113	14	12	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-12	Indian River Drive E at Conn Way	Not provided.	Baffle Boxes- Second Generation	Completed	2012	71	8	69	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-13	River Drive Bridge	Not provided.	Baffle Boxes- Second Generation	Completed	2010	12	1	61	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-14	Lantana Lane	Not provided.	Pervious Pavement Systems	Canceled	2014	N/A	N/A	38	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-15	Royal Palm Pointe	Not provided.	Baffle Boxes- First Generation	Completed	2001	1	1	Not provided	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-16	Deep Injection Well	Not provided.	Wastewater - Deep Injection Well	Completed	2010	15,158	1,403	Not provided	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-17	Street Sweeping	Street sweeper operating 40 hours per week and sweeping approximately 9,600 miles annually.	Street Sweeping	Ongoing	N/A	683	430	N/A	$253,000	$76,800	COVB	COVB- $253,000.00	N/A
City of Vero Beach	N/A	VB-18	Country Club Drive Outfall	Not provided.	Baffle Boxes- First Generation	Completed	2016	1	0	21	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	N/A	VB-19	Mockingbird Drive / Iris Lane	Not provided.	Baffle Boxes- First Generation	Completed	2016	3	2	69	Not provided	Not provided	COVB	Not provided	N/A
City of Vero Beach	Indian River Lagoon Council	VB-20	Vero Isles Inlet Retrofits	Not provided.	Pervious Pavement Systems	Completed	2017	TBD	TBD	51	$339,868	Not provided	COVB/ IRL Council	COVB - $235,314.77/ IRL Council - $104,553.50	N/A
City of Vero Beach	N/A	VB-23	BMP Maintenance	Not provided.	Catch Basin Inserts/Inlet Filter Cleanout	Ongoing	N/A	190	114	Not provided	Not provided	Not provided	COVB	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDACS	Agricultural Producers	FDACS-02	BMP Implementation and Verification	Enrollment and verification of BMPs by agricultural producers. Acres treated based on FDACS OAWP July 2020 Enrollment and FSAID VII. Reductions based on SWIL Model-LET.	Agricultural BMPs	Ongoing	N/A	2,163	352	10,576	TBD	TBD	FDACS	TBD	N/A
FDACS	Agricultural Producers	FDACS-07	FDACS Cost Share Projects	Cost-share projects paid for by FDACS. Acres treated based on FDACS OAWP July 2020 Enrollment. Reductions based on SWIL Model-LET.	Agricultural BMPs	Completed	2020	575	44	TBD	TBD	N/A	FDACS	TBD	N/A
SJRWMD	Lambeth Citrus	SJRWMD-01	Lambeth Citrus Micro Jet Irrigation Replacement	Replace micro-jet system with more efficient one and install soil moisture sensors on 116 acres of citrus.	Agricultural BMPs	Completed	2018	767	168	116	$213,070	N/A	Lambeth Citrus/ SJRWMD	Lambeth Citrus - $53,268 / SJRWMD - $159,803	N/A
FDOT District 4	N/A	FDOT4-01	FM# 228595-1 (Basin 4B)	Widening SR 60 between SR 9 and SR 91.	Wet Detention Pond	Completed	2007	3	2	229	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-02	FM# 228620-1	Resurfacing SR 60 and SR A1A intersection.	100% On-site Retention	Completed	2005	20	3	16	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-04	FDOT4 Street Sweeping	Materials from roadway and gutter sweeping.	Street Sweeping	Ongoing	N/A	90	58	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-05	FM# 228583-5 (Pond 1)	Widening SR 5 from just south of Oslo Road to South Relief Canal.	Wet Detention Pond	Completed	2010	0	0	118	Not provided	Not provided	Florida Legislature	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDOT District 4	N/A	FDOT4-06	FM# 228583-5 (Pond 2)	Widening SR 5 from just south of Oslo Road to South Relief Canal.	Wet Detention Pond	Completed	2010	0	0	52	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-07	FM# 228627-1 (Pond 1)	Widening SR 60 between 82nd Ave to 66th Ave.	Wet Detention Pond	Completed	2010	2	3	149	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-08	FM# 228627-1 (Pond 2)	Widening SR 60 between 82nd Ave to 66th Ave.	Wet Detention Pond	Completed	2010	3	2	89	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-09	Education Efforts	Pamphlets and Illicit Discharge Program.	Education Efforts	Ongoing	N/A	36	5	N/A	N/A	N/A	Florida Legislature	N/A	N/A
FDOT District 4	N/A	FDOT4-10	Fertilizer Cessation	No longer applying routine fertilizer.	Fertilizer Cessation	Completed	2014	7,179	1,795	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-18	FM# 228583-3 (State Road 5/US-1)	Widening SR 5 from South Relief Canal to north of 4th Street.	Wet Detention Pond	Completed	2014	0	0	92	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-19	FM#: 230873-1 (27th Avenue Reconstruction)	27th Avenue reconstruction.	100% On-site Retention	Completed	2014	61	9	49	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-20	FM#: 229966-1 (State Road A1A at the Moorings)	Drainage Improvements for SR A1A at the Moorings (from north of Periwinkle Drive to south of Harbour Drive).	Grass swales without swale blocks or raised culverts	Completed	2014	Not provided	Not provided	2	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-21	FM#: 413048-1 (Interstate-95 from St. Lucie/ Indian River County Line to North of State Road 60)	Widening SR 9 from St. Lucie / IRC Line to North of State Rd 60.	100% On-site Retention	Completed	2016	1,298	166	754	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-29	FM# 228583-2 US 1 Widening (Pond 3)	Widening SR 5 from north of SR 713 to south of Oslo Road (Pond 3).	Wet Detention Pond	Completed	2016	46	3	194	Not provided	Not provided	Florida Legislature	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDOT District 4	City of Vero Beach	FDOT4-30	FM# 403596-1: SR 60 Resurfacing (20th Street Outfall)	Resurfacing SR 60 from 21st Ave to Mockingbird Drive (20th Street outfall).	Baffle Boxes-Second Generation	Completed	2008	155	24	443	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	City of Vero Beach	FDOT4-31	FM# 403596-1: SR 60 Resurfacing (21st Street Outfall)	Resurfacing SR 60 from 21st Ave to Mockingbird Drive (21st Street outfall).	Baffle Boxes-Second Generation	Completed	2008	28	4	107	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	City of Vero Beach	FDOT4-32	FM# 403596-1: SR 60 Resurfacing (23rd Street Outfall)	Resurfacing SR 60 from 21st Ave to Mockingbird Drive (23rd Street outfall).	Baffle Boxes-Second Generation	Completed	2008	217	34	598	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	City of Vero Beach	FDOT4-33	FM# 403596-1: SR 60 Resurfacing (25th and Royal Palm outfall) - Baffle Boxes # 1 and # 2.	Resurfacing SR 60 from 21st Ave to Mockingbird Drive (25th Street and Royal Palm outfall) - Baffle Boxes #1 and #2.	Baffle Boxes-Second Generation	Completed	2008	80	12	265	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	City of Vero Beach	FDOT4-34	FM# 403596-1: SR 60 Resurfacing (25th and Royal Palm outfall) - Baffle Boxes # 1 and # 2.	Combined with FDOT4-33.	Baffle Boxes-Second Generation	Completed	2008	TBD	TBD	51	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-35	FM# 431152-1	US-1 lateral ditch restoration.	On-line Retention BMPs	Completed	2016	TBD	TBD	TBD	Not provided	Not provided	Florida Legislature	Not provided	N/A
Indian River County	DEP	IRC-03	East Gifford Stormwater Improvements	A stormwater detention pond receiving water from swale systems in a subdivision.	Wet Detention Pond	Completed	2004	129	39	44	$686,136	$2,471	DEP	Not provided	WM836
Indian River County	DEP	IRC-04	PC Main Screening System	Nutrient removal from measured data.	Regional Stormwater Treatment	Completed	2009	1,739	476	22,801	$5,331,908	$63,260	DEP	Not provided	G0182
Indian River County	DEP	IRC-05	Egret Marsh Stormwater Park	Nutrient removal from measured data.	Regional Stormwater Treatment	Completed	2010	13,406	3,005	10,104	$7,563,274	$200,189	DEP	Not provided	G0143

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Indian River County	DEP	IRC-06	PC South (Osprey Marsh) Algal Nutrient Removal Facility	Nutrient removal from measured data.	Regional Stormwater Treatment	Completed	2016	6,091	604	9,782	$10,000,000	$600,000	DEP	Not provided	G0353
Indian River County	N/A	IRC-07	Moorhen Marsh Low Energy Aquatic Plant System	This is a managed aquatic plant system that will remove sediment and suspended solids through settling and filtration by aquatic plant roots. The aquatic plants will be harvested on a regular basis.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Underway	2021	4,889	680	6,301	$8,705,000	$84,000	County/ SJRWMD/Florida Legislature	Not provided	LPA0018
Indian River County	N/A	IRC-08	Education Efforts	Fertilizer ordinance, PSAs, website, pamphlets, Illicit Discharge Program, and signs along Indian River Farms WCD canals.	Education Efforts	Ongoing	N/A	16,158	2,352	N/A	N/A	$52,000	Not provided	Not provided	N/A
Indian River County	N/A	IRC-09	Street Sweeping	Street sweeping.	Street Sweeping	Ongoing	N/A	274	176	N/A	Not provided	$22,050	Not provided	Not provided	N/A
Indian River County	N/A	IRC-10	Storm Drain Cleaning with Vacuum Trucks	Nutrient removal from measured data.	BMP Cleanout	Planned	TBD	TBD	TBD	TBD	TBD	$19,067	TBD	TBD	N/A
Indian River County	N/A	IRC-11	Floating Aquatic Plant Islands in County Stormwater Ponds and Lakes	Nutrient removal from measured data.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Planned	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	N/A
Indian River County	N/A	IRC-12	Spoonbill Marsh Project	Nutrient removal from measured data.	Constructed Wetland Treatment	Completed	2010	5,700	247	359	$4,200,000	$329,143	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Indian River County	N/A	IRC-14	South Relief Canal Mechanical Vegetation/Debris Removal	Removal of aquatic vegetation containing nitrogen and phosphorus that otherwise, would enter IRL and die, releasing nutrients into the lagoon.	Aquatic Vegetation Harvesting	Planned	TBD	TBD	TBD	7,155	$1,000,000	$50,000	County/ Grants	Not provided	N/A
Indian River County	SJRWMD/ DEP/ EPA	IRC-15	Osprey Acres Floway and Nature Preserve	This is a managed aquatic plant system that will remove nutrients using aquatic vegetation that will be harvested on a regular basis.	Floating Islands/ Managed Aquatic Plant Systems (MAPS)	Completed	2019	8,058	1,129	9,784	$7,500,000	$50,000	DEP/ SJRWMD/ Florida Legislature	$3,634,536	NS027
Indian River Farms WCD	N/A	IRF-01	Tilting Weir Gates	Not provided.	Control Structure	Completed	Prior to 2013	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
Indian River Farms WCD	N/A	IRF-02	Mechanical Removal of Floating Vegetation	Not provided.	Aquatic Vegetation Harvesting	Ongoing	N/A	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
Indian River Farms WCD	N/A	IRF-03	Establishment of 2-Inch Discharge Rule	Establishment of 2-Inch Discharge Rule.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
Indian River Farms WCD	N/A	IRF-04	Public Education and Outreach	Provide public education to residents of the District that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Indian River Farms WCD	FDACS	IRF-05	Assist FDACS with BMP Enrollment Outreach	Assist FDACS, where needed, with identifying and contacting landowners/ producers within the District boundaries for purposes of participating in the relevant FDACS BMP programs.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Town of Indian River Shores	DEP/ Indian River County	IRS-01	Public Education	Implement FYN Program; adopted fertilizer, landscape, and irrigation ordinances; public website; and inspection of illicit discharges.	Education Efforts	Ongoing	N/A	876	132	N/A	$25,000	$5,000	IRL NEP/ Town	Not provided	N/A
Town of Indian River Shores	DEP	IRS-02	Hurricane Evacuation Stormwater Improvements	Stormwater improvements including exfiltration, polyacrylamide (PAM) blocks, dry retention, swales, and stormwater reuse line.	BMP Treatment Train	Underway	2019	TBD	TBD	36	$1,470,000	$25,000	DEP/ Division of Emergency Management (DEM)/ Johns Island Water Management/ City of Palm Bay	DEP - $550,000/ DEM $637,500	NS036
Town of Indian River Shores	DEP/ SJRWMD/ Indian River Lake Conservancy (IRLC)	IRS-03	Dredging of Indian/Seminole Lane Stormwater Drainage Canal	Removal of accumulated muck that will reduce nutrient loading in the drainage canal.	Muck Removal/Restoration Dredging	Planned	2020	TBD	TBD	54	$350,000	$25,000	DEP/ SJRWMD/ Town	TBD	TBD
Town of Indian River Shores	DEP/ SJRWMD/ IRLC	IRS-04	Pebble Bay Estates Inlet Basket Retrofit	Retrofit inlet baskets on four catch basins in Pebble Bay Estates.	Catch Basin Inserts/Inlet Filter Cleanout	Planned	2021	TBD	TBD	31	$150,000	$15,000	DEP/ SJRWMD/ Town	TBD	TBD
Town of Indian River Shores	IRL NEP	IRS-05	Baffle Box	Installation of baffle box to reduce nutrient loading to lagoon.	Baffle Boxes- Second Generation	Completed	2015	TBD	TBD	54	$122,103	$15,000	IRL NEP/ Town	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Town of Indian River Shores	IRL NEP	IRS-06	Oyster Reef	Construct an oyster bar reef waterside of Indian and Seminole Lanes.	Creating/ Enhancing Oyster Reefs	Planned	2020	N/A	N/A	0	$35,000	$2,500	IRL NEP/ Town	Not provided	N/A
Turnpike Enterprise	N/A	T-01	Street Sweeping	Not provided.	Street Sweeping	Ongoing	N/A	31	20	N/A	$124,000	Not provided	Not provided	Not provided	N/A
Turnpike Enterprise	N/A	T-02	Public Education	No fertilizer on rights-of-way, educational signage, and illicit discharge training.	Education Efforts	Underway	Not provided	8	1	N/A	Not provided	Not provided	Not provided	Not provided	N/A

3.4 Project Zone SIRL

Project Zone SIRL covers more than 34,653 acres of the CIRL BMAP area. As shown in **Table 25**, urban land uses makes up the largest portion of the project zone with 40.6 % of the area, followed by agriculture with 29.2 %. Stakeholders in Project Zone SIRL are agricultural producers, City of Fort Pierce, FDOT District 4, Florida Turnpike Enterprise, Fort Pierce Farms WCD, St. Lucie County, and Town of St. Lucie Village. TMDLs have not yet been developed by DEP for the impaired waterbodies in the SIRL, although there are some tributary TMDLs in this area, as outlined in **Section 1.1.1.**

Table 25. Summary of land uses in Project Zone SIRL

Note: Land use code 5000 (water) acreage excludes lagoon water in this table.

Level 1 Land Use Code	Land Use Description	Acres	% Total
1000	Urban	14,086	40.6
2000	Agricultural	10,130	29.2
3000	Upland Prairie and Shrublands	3,699	10.7
4000	Upland Forested Areas	2,910	8.4
5000	Water	570	1.6
6000	Wetlands	2,500	7.2
7000	Disturbed Lands	110	0.3
8000	Transportation	649	1.9
Total		**34,653**	**100.0**

DEP asked stakeholders to provide information on management actions, including projects, programs, and activities, that may reduce nutrient loads to the CIRL. Management actions are included in the BMAP to address nutrient loads to the lagoon and have to meet several criteria to be considered eligible for credit. **Figure 19** and **Figure 20** show progress towards the required TN and TP load reductions allocated to Project Zone SIRL from projects completed through July 31, 2020.

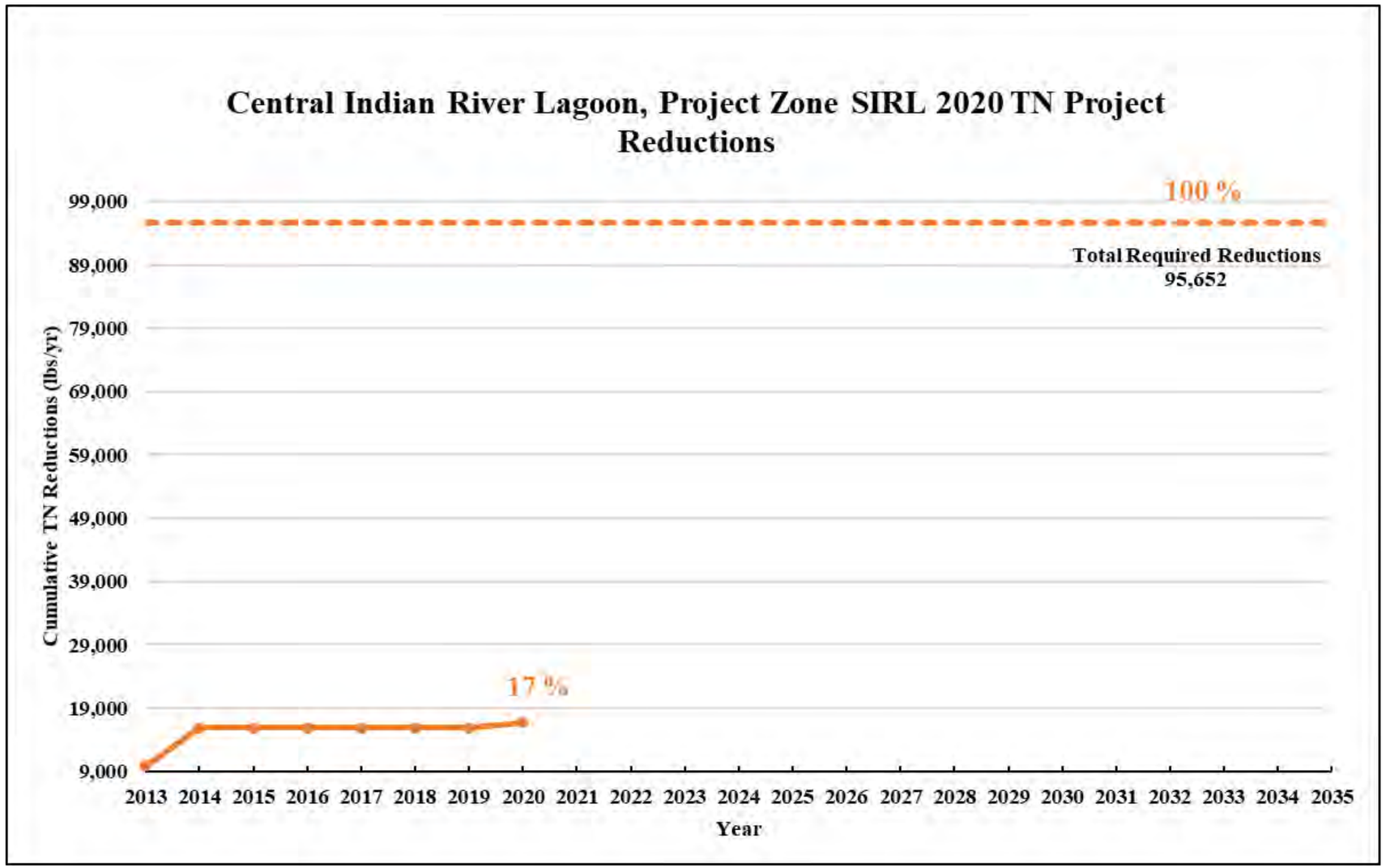

Figure 19. Estimated progress towards meeting the required TN reductions allocated to Project Zone SIRL with projects completed through July 31, 2020

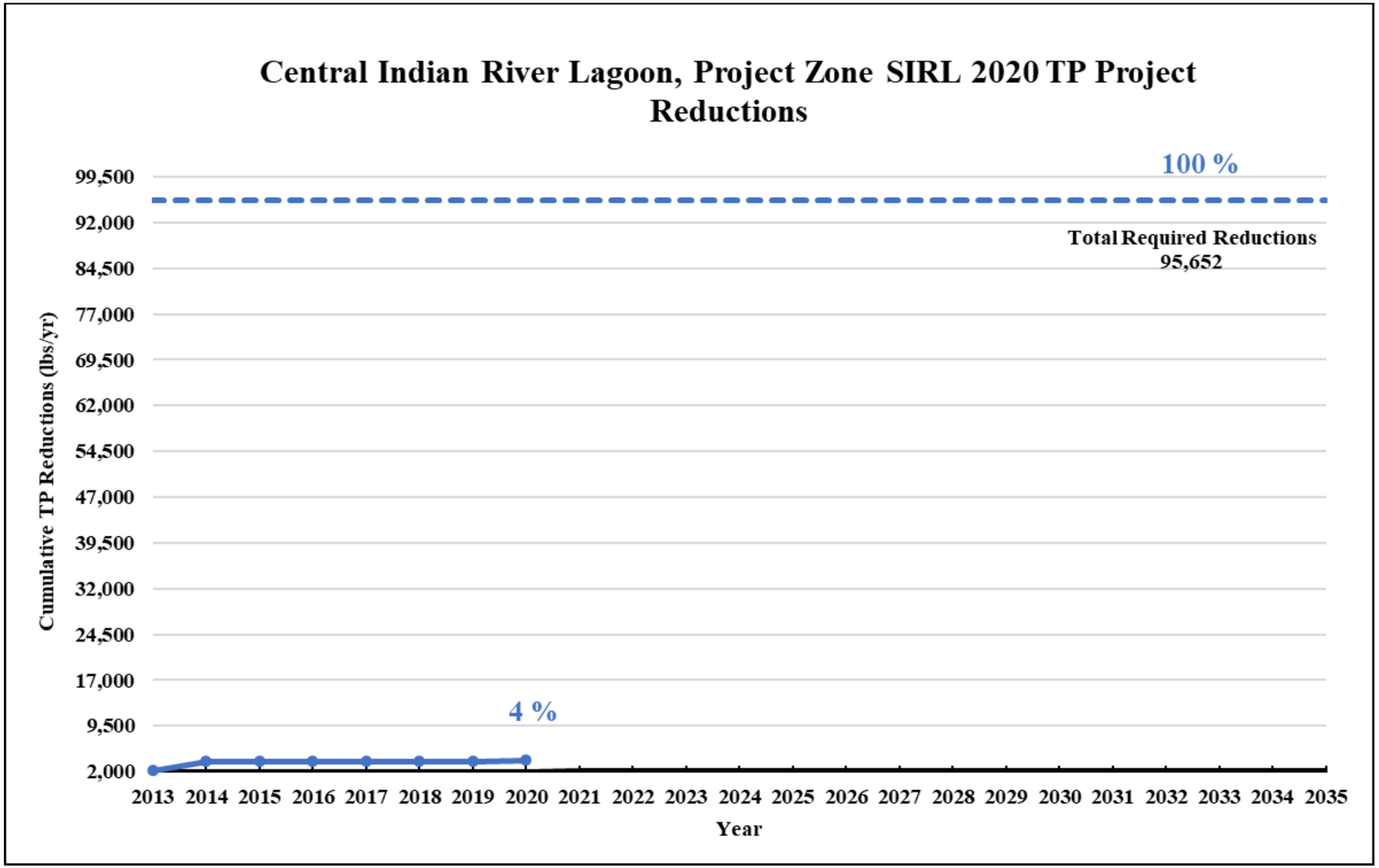

Figure 20. Estimated progress towards meeting the required TP reductions allocated to Project Zone SIRL with projects completed through July 31, 2020

3.4.1. Existing and Planned Projects

Table 26 summarizes the existing and planned projects provided by the stakeholders for Project Zone SIRL.

Table 26. Existing and planned projects in Project Zone SIRL

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
City of Fort Pierce	N/A	FP-05	Street Sweeping	6,599 cubic yards of material.	Street Sweeping	Ongoing	N/A	774	421	N/A	Not provided	Not provided	Not provided	Not provided	N/A
City of Fort Pierce	N/A	FP-07	Education Efforts	Stormwater education shows, pamphlets, presentations, storm drain stenciling, Illicit Discharge Program, and adopted fertilizer ordinance.	Education Efforts	Ongoing	N/A	93	15	N/A	N/A	N/A	N/A	N/A	N/A
FDACS	Agricultural Producers	FDACS-04	BMP Implementation and Verification	Enrollment and verification of BMPs by agricultural producers. Acres treated based on FDACS OAWP July 2020 Enrollment and FSAID VII. Reductions based on SWIL Model-LET.	Agricultural BMPs	Ongoing	N/A	1,745	344	2,378	TBD	TBD	FDACS	TBD	N/A
FDACS	Agricultural Producers	FDACS-08	FDACS Cost Share Projects	Cost-share projects paid for by FDACS. Acres treated based on FDACS OAWP July 2020 Enrollment. Reductions based on SWIL Model-LET.	Agricultural BMPs	Completed	2020	760	120	TBD	TBD	N/A	FDACS	TBD	N/A
FDOT District 4	N/A	FDOT4-04b	FDOT4 Street Sweeping	Materials from roadway and gutter sweeping.	Street Sweeping	Ongoing	N/A	71	46	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-09b	Education Efforts	Pamphlets and Illicit Discharge Program.	Education Efforts	Ongoing	N/A	21	3	N/A	N/A	N/A	Florida Legislature	N/A	N/A
FDOT District 4	N/A	FDOT4-10b	Fertilizer Cessation	No longer applying routine fertilizer.	Fertilizer Cessation	Completed	2014	5,667	1,417	N/A	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-11	FM# 230132-1 (system 1)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 1).	Dry Detention Pond	Completed	2001	TBD	TBD	TBD	Not provided	Not provided	Florida Legislature	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDOT District 4	N/A	FDOT4-12	FM# 230132-1 (system 2)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 2).	Dry Detention Pond	Completed	2001	0	4	126	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-13	FM# 230132-1 (system 3)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 3).	Dry Detention Pond	Completed	2001	5	1	40	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-14	FM# 230132-1 (system 4)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 4).	Dry Detention Pond	Completed	2001	10	1	78	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-15	FM# 230132-1 (system 5)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 5).	Wet Detention Pond	Completed	2001	24	8	61	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-16	FM# 230132-1 (system 6)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 6).	Wet Detention Pond	Completed	2001	8	3	25	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-17	FM# 230132-1 (system 7)	Widening SR 615 between Avenue Q and Industrial Ave Three and constructing new roadway between Industrial Ave Three to SR 5 (system 7).	100% On-site Retention	Completed	2001	65	8	46	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-24	FM# 230279-1 (Kings Highway)	Constructing surface water management system for SR 713 (King's Highway).	Dry Detention Pond	Completed	2003	1	0	6	Not provided	Not provided	Florida Legislature	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
FDOT District 4	N/A	FDOT4-25	FM# 413046-1	Widening SR 9 from south of SR 70 to south of Indrio Rd.	Grass swales without swale blocks or raised culverts	Completed	2014	226	58	454	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-26	FM# 413047-1	Widening SR 9 from Indrio Rd to Indian River County.	Grass swales without swale blocks or raised culverts	Completed	2013	151	40	285	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-27	FM# 230108-1 (Pond 1)	SR 68 from SR 9 to east of CR-607A: widening and new lane construction (60% credit, remaining 40% to SLE).	Wet Detention Pond	Completed	2013	Not provided	Not provided	5	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-28	FM# 230108-1 (Pond 4)	SR 68 from SR 9 to east of CR-607A: widening and new lane construction (60% credit, remaining 40% to SLE).	Wet Detention Pond	Completed	2013	Not provided	Not provided	5	Not provided	Not provided	Florida Legislature	Not provided	N/A
FDOT District 4	N/A	FDOT4-36	FM# 230338-4	Indrio Rd. widening - I-95 to SR-607.	BMP Treatment Train	Canceled	2019	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fort Pierce Farms WCD	N/A	FPF-01	Swale Along Canal 1 Top of Bank (SLRIT Grant 2006-07)	Grassed swale constructed along Canal 1 top of bank, immediately upstream of IRL, to collect stormwater runoff and provide some water quality benefit. Project addressed previous area of bank erosion.	Grass swales without swale blocks or raised culverts	Completed	Prior to 2013	Not provided	Not provided	0	Not provided	Not provided	Not provided	Not provided	N/A
Fort Pierce Farms WCD	N/A	FPF-02	Dry Detention Area Along Canal 1 Top of Bank (SLRIT Grants 2006-07 and 2007-08)	Grassed dry detention area and control structure replacement to address stormwater runoff issues and canal bank erosion immediately upstream of the IRL.	Dry Detention Pond	Completed	Prior to 2013	Not provided	Not provided	3	Not provided	Not provided	Not provided	Not provided	N/A
Fort Pierce Farms WCD	N/A	FPF-03	Discharge Criteria Adopted as Part of Fort Pierce Farms WCD Permit Application Criteria	More stringent than standard pre vs. post; allows for approximately 11 % more volume per development to be detained by stormwater system.	Regulations, Ordinances, and Guidelines	Ongoing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
Fort Pierce Farms WCD	N/A	FPF-04	Mechanical Removal of Aquatic Vegetation	Perform harvest aquatic vegetation within the canals using mechanical processes to the extent practicable to reduce the need for herbicide treatment.	Aquatic Vegetation Harvesting	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Fort Pierce Farms WCD	N/A	FPF-05	Canal Buffer	Create a canal buffer or filter strip to help reduce loading from stormwater runoff to the canals.	Vegetated Buffers	Underway	TBD	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Fort Pierce Farms WCD	FDACS	FPF-06	Assist FDACS with BMP Enrollment Outreach	Assist FDACS, where needed, with identifying and contacting landowners/ producers within the District boundaries for purposes of participating in the relevant FDACS BMP programs.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Fort Pierce Farms WCD	N/A	FPF-07	Public Education and Outreach	Provide public education to residents of the District that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
Fort Pierce Farms WCD	N/A	FPF-08	Control Structure Maintenance	Maintain existing water control structures and any adjustable gates on water control structures.	Control Structure	Underway	TBD	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
North St. Lucie River WCD	N/A	NSLR-01	C-25 Diversion Structure	Replace previous pump structure with gravity flow control structure.	Control Structure	Completed	Prior to 2013	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
North St. Lucie River WCD	N/A	NSLR-02	Invasive Vegetation Removal at Canals 33 and 42	Mechanical removal of invasive vegetation in canals and surrounding banks.	Aquatic Vegetation Harvesting	Completed	Prior to 2013	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
North St. Lucie River WCD	N/A	NSLR-03	Canal Maintenance Program	Ongoing maintenance primarily by mechanical means to keep canals free of exotic and decaying vegetation.	Aquatic Vegetation Harvesting	Ongoing	N/A	N/A	N/A	Not provided	Not provided	$9,400	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
North St. Lucie River WCD	N/A	NSLR-04	Canal Buffer	Create a canal buffer or filter strip to help reduce loading from stormwater runoff to the canals.	Vegetated Buffers	Underway	TBD	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
North St. Lucie River WCD	FDACS	NSLR-05	Assist FDACS with BMP Enrollment Outreach	Assist FDACS, where needed, with identifying and contacting landowners/ producers within the District boundaries for purposes of participating in the relevant FDACS BMP programs.	Agricultural BMPs	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
North St. Lucie River WCD	N/A	NSLR-06	Public Education and Outreach	Provide public education to residents of the District that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.	Education Efforts	Ongoing	N/A	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
North St. Lucie River WCD	N/A	NSLR-07	Control Structure Maintenance	Maintain existing water control structures and any adjustable gates on water control structures.	Control Structure	Underway	TBD	N/A	N/A	N/A	Not provided	Not provided	Not provided	Not provided	Not provided
St. Lucie County	N/A	SLC-01	Education Efforts	FYN; landscaping, irrigation, fertilizer, and pet waste ordinances; PSAs, pamphlets, website, and illicit discharge program.	Education Efforts	Ongoing	N/A	6,241	1,006	N/A	N/A	N/A	N/A	N/A	N/A
St. Lucie County	N/A	SLC-02	Street Sweeping	470 tons/yr collected.	Street Sweeping	Ongoing	N/A	664	299	N/A	Not provided	Not provided	Not provided	Not provided	N/A
St. Lucie County	DEP/ SFWMD/ IRL National Estuary Program (NEP)	SLC-03	Paradise Park Stormwater Improvement	Construction of drainage system providing 75 % treatment of first 1-inch runoff.	Dry Detention Pond	Completed	2014	171	28	168	########	Not provided	DEP/ SFWMD/ IRL NEP	DEP - $225,000/ SFWMD - $304,448/ IRL NEP - $125,000	LP56020
St. Lucie County	N/A	SLC-04	Harmony Heights Stormwater Improvement	Construction of drainage system providing 75 % treatment of first 1-inch runoff.	Dry Detention Pond	Underway	2015	253	44	239	########	TBD	TBD	$511,838	N/A
St. Lucie County	N/A	SLC-05	Taylor Creek Dredging	Three-phase sediment/muck removal project totaling approximately 200,000 cubic yards.	Muck Removal/Restoration Dredging	Completed	2015	Not provided	Not provided	Not provided	$7,500,000	N/A	Not provided	Not provided	N/A

Lead Entity	Partners	Project Number	Project Name	Project Description	Project Type	Project Status	Estimated Completion Date	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	Acres Treated	Cost Estimate	Cost Annual O&M	Funding Source	Funding Amount	DEP Contract Agreement Number
St. Lucie County	N/A	SLC-06	Stan Blum Memorial Boat Launch	Not provided.	Wet Detention Pond	Completed	Prior to 2013	Not provided	Not provided	6	Not provided	N/A	Not provided	Not provided	N/A
St. Lucie County	IRL NEP	SLC-07	San Lucie Plaza Stormwater Master Plan	Construction of drainage system providing 75 % treatment of first 1-inch runoff.	On-line Retention BMPs	Underway	2018	1,210	214	157	########	TBD	TBD	$650,325	N/A
St. Lucie County	N/A	SLC-09	North Hutchinson Island Septic to Sewer Project	538 Homes converted to Central Sewer	Wastewater Service Area Expansion	Underway	Not provided	TBD	TBD	N/A	N/A	N/A	N/A	N/A	N/A
St. Lucie County	N/A	SLC-10	Port of Fort Pierce	Stormwater management system.	Stormwater System Rehabilitation	Completed	2018	N/A	N/A	Not provided	TBD	TBD	Not provided	Not provided	N/A
St. Lucie County	N/A	SLC-11	Swales Material Collected	Roadside swale cleanout and reprofiling.	BMP Cleanout	Underway	TBD	TBD	TBD	N/A	TBD	TBD	TBD	TBD	N/A
St. Lucie County	N/A	SLC-12	St. Lucie County Stormwater Needs Assessment Study	Report that will provide information on identified project opportunities to reduce nutrients, estimated benefits, and costs.	Study	Underway	TBD	N/A	N/A	TBD	$142,380	TBD	TBD	TBD	N/A
St. Lucie Village	N/A	SLV-01	Peninsula Drive	0.75" detention storage for western half of Peninsula Drive where there was no previous treatment.	Wet Detention Pond	Completed	2011	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	N/A
St. Lucie Village	N/A	SLV-02	Education Efforts	Credit for fertilizer ordinance.	Education Efforts	Ongoing	N/A	18	3	N/A	N/A	N/A	N/A	N/A	N/A

Chapter 4. Compliance and Adaptive Management

4.1 Future Growth

To ensure that this BMAP effort can achieve and ultimately maintain the goal of meeting TMDL requirements, the overall restoration strategy must include actions and planning for future growth and development. Any new development would likely fall into two general source categories: (1) urban and (2) agricultural. Nutrient impacts from new development will be addressed through a variety of mechanisms as well as other provisions of Florida law.

While the majority of the restoration projects and programs listed in this BMAP address current loading, the need to plan and implement sound management strategies to address additional population growth in the BMAP area must be considered. DEP has included in this BMAP specific elements to address all current and future WWTF effluent, septic systems, and stormwater sources. Broader laws—such as local land development regulations, comprehensive plans, ordinances, incentives, Environmental Resource Permit requirements, and consumptive use permit requirements—all provide additional mechanisms and avenues for protecting water resources and reducing the impact of new development and other land use changes as they occur. As more information becomes available, the modeling efforts used for determining loading to the lagoon will continue to be refined.

The recommendations presented in **Chapter 2** should be considered by local governments during master planning and land use decision-making efforts. It should also be noted that any additional loading, such as from land use changes from low to high density, or any increase in intensity of use (that may include additional nutrient loadings), will be evaluated during future BMAP review efforts. If an increase in loading has occurred, additional restoration actions will be required to remediate impacts. DEP recommends that all local governments revise their planning and land use ordinance(s) to adequately address all future growth, and consider limitations on growth in sensitive areas, such as lands with a direct hydrologic connection to impaired waterbodies, wetland areas, or coastal areas.

4.2 Compliance

4.2.1. TMDL Compliance

The intent of the TMDLs is to recover the deeper water seagrass habitats, with the biological response of the seagrass being the most important factor in evaluating the success of achieving TMDL targets. To assess progress for the IRL Basin towards the median seagrass depth limit target, a two-step process was used in the A, B, and SEB Project Zones. TMDL targets for Steps 1 and 2 were not established for the lagoon in the SIRL project zone, and so it is excluded from this analysis. For the 2013 BMAP, DEP conducted this two-step evaluation using seagrass data from 2003, 2005, 2006, 2007, and 2009, which were the latest datasets available at the time of the analysis. For the CIRL, all three project zones were determined to be both Step 1 and Step 2 compliant in 2013. Therefore, stakeholders in the CIRL were not required to make additional

reductions at the time and were not assigned detailed allocations in the first iteration of the BMAP.

Since the 2013 BMAP, further evaluations of the seagrass depth limits in the CIRL have been conducted to reassess whether the CIRL project zones have continued to be compliant. **Table 27** and **Table 28** list the results of both steps of these evaluations since 2013, including the number of years that passed Step 2 of the evaluation. In 2020, the evaluation was conducted using the 2013, 2015, 2017, and 2019 seagrass mapping data, which were the latest datasets available at that time. **Figure 21** through **Figure 23** show the results of both steps of the 2020 evaluation for Project Zones A, SEB, and B respectively. None of the 3 project zones with TMDLs was compliant. As indicated in the 2013 BMAP, DEP assigns detailed allocations in project zones where compliance is not maintained.

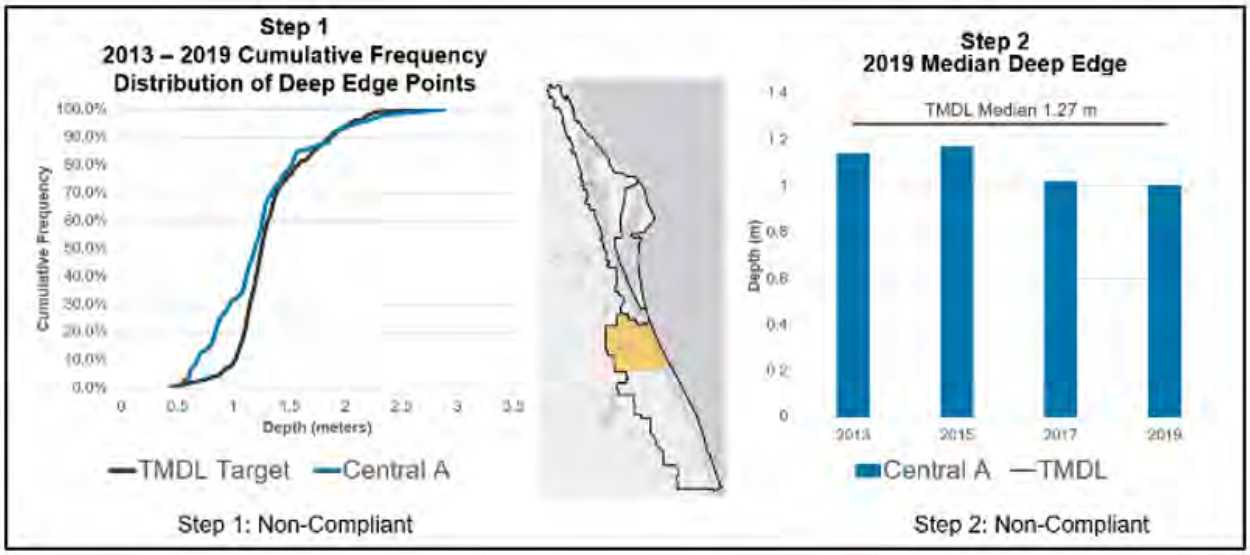

Figure 21. CIRL Project Zone A seagrass evaluation results for Compliance Step 1 and Step 2

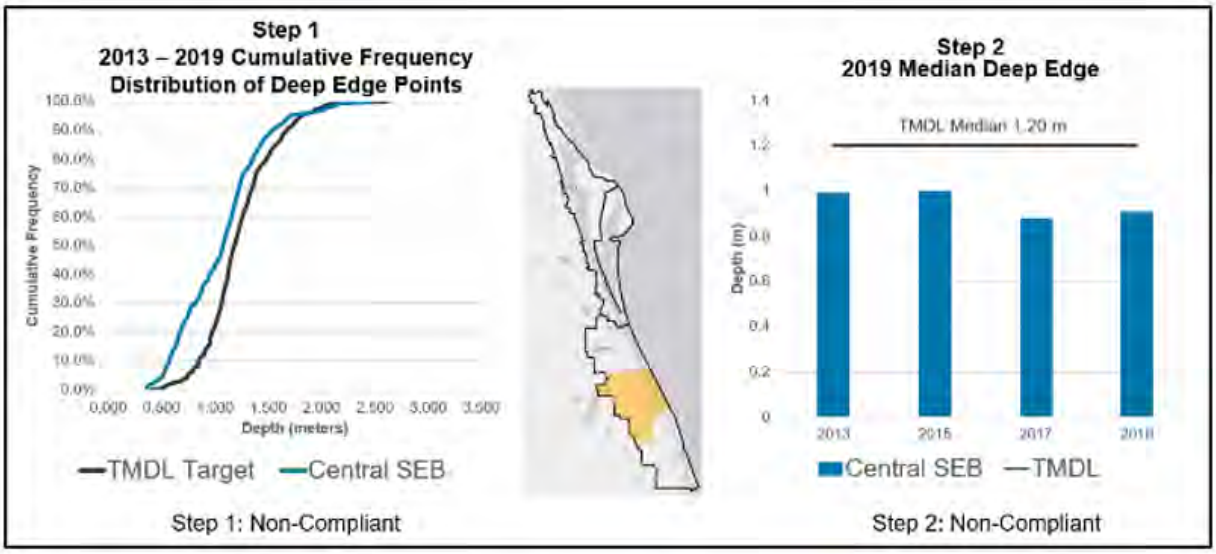

Figure 22. CIRL Project Zone SEB seagrass evaluation results for Compliance Step 1 and Step 2

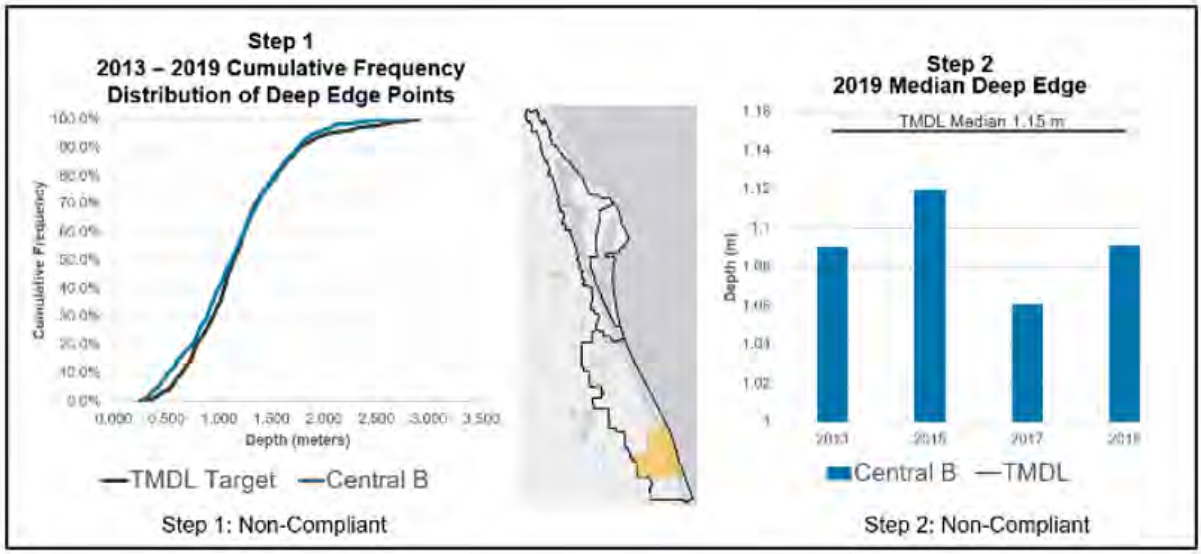

Figure 23. CIRL Project Zone B seagrass evaluation results for Compliance Step 1 and Step 2

Table 27. Seagrass compliance results, Step 1

Step 1	CIRL A	CIRL SEB	CIRL B
2007 – 2013	Pass	Pass	Pass
2009 – 2015	Pass	Pass	Pass
2011 – 2017	Fail	Fail	Fail
2013 – 2019	Fail	Fail	Fail

Table 28. Summary of seagrass compliance results, Step 2

Note: Parentheses indicate number of years passing of those assessed for the compliance period of record.

Step 2	CIRL A	CIRL SEB	CIRL B
2007 – 2013	Fail (2 of 4)	Fail (2 of 4)	Fail (2 of 4)
2009 – 2015	Fail (1 of 4)	Fail (1 of 4)	Fail (1 of 4)
2011 – 2017	Fail (0 of 4)	Fail (0 of 4)	Fail (1 of 4)
2013 – 2019	Fail (0 of 4)	Fail (0 of 4)	Fail (0 of 4)

4.2.2. BMAP Compliance

In addition to IRL TMDL compliance and the measurement of seagrass deep edge recovery, there are other compliance elements related to the BMAP. DEP has set BMAP TN and TP reduction milestones for the years 2025 and 2030 to ensure that significant progress will be made in each five-year increment prior to the 2035 total reduction deadline. The percent reductions in the milestones apply to the total BMAP required reductions; so as various entities implement their projects, the overall milestones are also being met. Individual entities must achieve compliance by meeting their own required reductions by the 2035 deadline, as well as show progress towards the BMAP milestones by planning and implementing projects.

Chapter 5. References

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Appendices

Appendix A. BMAP Projects Supporting Information

The project tables in this BMAP (**Table 20**, **Table 22**, **Table 24**, and **Table 26**) list the implementation status of the BMAP projects as of July 31, 2020. The tables list the TN and TP reductions in lbs/yr attributable to each individual project. These projects were submitted to DEP by responsible entities with the understanding that the projects and activities would be included in the BMAP, thus setting the expectation for each entity to implement the proposed projects and activities to achieve the assigned load reduction estimates in the specified time.

However, the list of projects is meant to be flexible enough to allow for changes that may occur over time. During the annual review of BMAP implementation efforts, project-specific information may be revised and updated, resulting in changes to the estimated reductions for those projects. The revisions may increase or decrease estimated reductions, and DEP will work with stakeholders to address revisions as they are identified.

The project status column is standardized into the following five categories:

- **Canceled:** Project or activity that was planned but will no longer take place. This category includes the cessation of ongoing activities.
- **Completed:** Project, activity, or task that is finished. This category includes fully implemented activities (i.e., ongoing activities) that must continue to maintain assigned credits indefinitely (such as street sweeping, BMP cleanout, catch basin cleanout, public education, fertilizer cessation/reduction, and vegetation harvesting).
- **Planned:** Project or activity that is conceptual or proposed.
- **Underway:** Project or activity that has commenced or initiated but is not completed and is not yet reducing nutrient loads from the treated area.
- **Ongoing:** The lead entity is performing actions each year. This status is used when a project is typically nonstructural and continuous. Ongoing projects are not a continuation of a reduction for a structural project.

Prior to reporting project information, DEP contacts each lead entity to gather new information on projects and confirm previously reported information. The terms used throughout the project tables are defined as follows:

- **Not provided:** Denotes that information was requested by DEP but was not provided by the lead entity.

- **TBD:** To be determined. Denotes that information is not currently available but will be provided by the stakeholder when it is available.
- **N/A:** Not applicable. Denotes that information for that category is not relevant to that project.
- **0: Zero.** Denotes the numeric value for that category as zero.

The project tables are based on current information, and project details may be updated as further information becomes available.

This BMAP requires stakeholders to implement their projects to achieve reductions as soon as practicable. However, the full implementation of the BMAP will be a long-term process. While some of the projects and activities listed in the BMAP were recently completed or are currently ongoing, several projects require more time to design, secure funding, and construct. Unlike the existing and planned projects, these future projects are not yet considered commitments of the entities but rather are intended for future BMAP credit, pending the availability of funding and other resources.

Although BMAP implementation is a long-term process, the goal of this BMAP is to achieve the TMDLs by the 2035 milestone. It is understood that all waterbodies can respond differently to the implementation of reduced loadings to meet applicable water quality standards. Continued coordination and communication by the stakeholders will be essential to ensure that management strategies continue to meet the implementation milestones.

Appendix B. Central IRL Allocation Calculations

The first step in the allocation process was to establish the total TN and TP load, by project zone, from the SWIL Model. This is an important step because the watershed loads to each segment are based on the updated information and model refinements incorporated in the SWIL Model. Starting loads for Project Zone A were adjusted to account for the impact of the C-1 diversion project, which redirects flow to the St. John's River and away from the IRL. **Table B-1** below lists the TN and TP starting loads from the SWIL Model for each project zone and the associated acres of watershed in that segment.

Table B-1. Central IRL starting loads from model

Project Zone	Area (Acres)	TN Starting Load (lbs/yr)	TP Starting load (lbs/yr)
A	106,926	616,171	85,081
SEB	131,576	762,595	96,865
B	77,252	567,009	78,837
SIRL	39,672	267,636	39,232

The TMDLs for the IRL (in Rule 62.304.520, F.A.C.) include a percent reduction from the starting load for TN and TP.

Table B-2 describes the TMDL rule percent reduction for each project zone and lists the WBIDs included in each project zone.

Table B-2. Central IRL BMAP TMDL Required Reduction Percentage

WBIDs	Project Zone	% TN Reduction	% TP Reduction
2936A	A	56	48
5003D	SEB	56	48
5003B & 5003C	B	56	48
3190, 3190A, 3163A, & 3163	SIRL	36	58

The second step in the allocation calculations was to apply the TMDL percent reduction (

Table B-2) for TN or TP to the starting load (**Table B-1**), respectively. **Table B-3** lists the TN and TP reductions needed to meet the TMDL based on these calculations. The allowable load after the reductions are met is called the allocation. To calculate the TN allocation and the TP allocation in the table below, the TN reduction or TP reduction is subtracted from the TN or TP starting load in **Table B-3**.

Table B-3. Central IRL load reductions – starting load * TMDL Required Reduction Percentage

Project Zone	TN Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Reduction (lbs/yr)	TP Allocation (lbs/yr)
A	345,056	271,115	40,839	44,242
SEB	427,053	335,542	46,495	50,370
B	317,525	249,484	37,842	40,995
SIRL	96,349	171,287	22,755	16,477

Now that the total reductions are calculated with the TMDL percent reductions, a test is completed to ensure there are no requirements to make reductions from natural land uses. To test whether the calculated reductions would go beyond reductions for converted land uses (anthropogenic land uses), DEP calculated the weighted average load per acre of natural lands (natural load per acre) in each project zone. The natural load per acre values were calculated from loads associated with natural lands in the initial model output. Any land use adjustments that were later incorporated into the allocation process were not accounted for in the natural load per acre calculations. **Table B-4** outlines the data that were used to calculate the natural load per acre for TN and TP. The acreage and the weighted average loading from only the natural lands were calculated from the SWIL Model, by project zone. The loading for TN and TP was divided by the acres of natural lands, respectively, to derive the natural load per acre and the values were rounded. These natural loads per acre were compared with the allowable loads per acre, as shown in **Table B-5**.

Table B-4. Central IRL allowable load per acre from natural loading

lbs/ac/yr = Pounds per acre per year

Project Zone	Natural	Area (Acres)	TN Natural Lands Load (lbs/yr)	TP Natural Lands Load (lbs/yr)	Natural TN Load (lbs/ac/yr)	Natural TP Load (lbs/ac/yr)
A	Natural Lands	39,344	129,927	14,198	3.30	0.36
SEB	Natural Lands	66,299	251,765	25,077	3.80	0.38
B	Natural Lands	19,726	69,618	7,981	3.53	0.40
SIRL	Natural Lands	14,444	54,669	6,083	3.78	0.42

DEP then calculated the allowable load per acre for each project zone. This is the allocation load divided by the acres in the project zone. The allowable load is calculated for both TN and TP and compared with the weighted average load per acre of natural lands (natural load per acre) in that project zone. If the allowable load per acre is less than the natural load per acre, an adjustment is made. In **Table B-5** below, the allowable loads per acre for TN and TP are shown and "True" is entered if the allowable load per acre is less than the natural load per acre. When the test is "True," an adjustment is made for the TN reduction, TP reduction, or both.

Table B-5. Central IRL allowable load per acre from total allocation

Project Zone	Allowable TN Load Per Acre	Natural TN Load Per Acre (LPA)	Is Allowable TN LPA Less than Natural TN LPA?	Allowable TP LPA	Natural TP LPA	Is Allowable TP LPA Less than Natural TP LPA?	Result
A	2.54	3.30	True	0.41	0.36	FALSE	Use adjustment for TN but no adjustment for TP
SEB	2.55	3.80	True	0.38	0.38	FALSE	Use adjustment for TN but no adjustment for TP
B	3.23	3.53	True	0.53	0.40	FALSE	Use adjustment for TN but no adjustment for TP
SIRL	4.32	3.78	False	0.42	0.42	TRUE	No adjustment for TN but use adjustment for TP

When an adjustment was indicated, the reductions were then adjusted by taking the starting loads from **Table B-1** and subtracting the adjusted allowable load and adjusting the reductions listed previously in **Table B-3**. Only those reductions noted as needing a adjustment (see **Table B-5**) were adjusted. A summary of the TN and TP reductions (adjusted, if applicable) and the TN and TP allocations are listed in **Table B-6**.

Table B-6. Central IRL adjusted load reductions

Project Zone	TN Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Reduction (lbs/yr)	TP Allocation (lbs/yr)
A	263,315	352,856	N/A	N/A
SEB	262,606	499,989	N/A	N/A
B	294,309	272,700	N/A	N/A
SIRL	N/A	N/A	22,570	16,662

After the reductions are calculated for each project zone, the relative starting load in the project zone for each stakeholder is used to assign the entity reductions. The natural lands are separated from each entity's area to assess the relative anthropogenic contributions, so that stakeholders would not be asked to reduce loads from natural lands in their jurisdiction. In **Table B-7**, **Table B-8**, **Table B-9**, and **Table B-10**, natural lands are separated from the starting loads, and so only the anthropogenic loadings are included in the entity loads.

Table B-7. Central IRL Project Zone A entity starting loads from model, natural lands separated

Project Zone	Entity	TN Starting Load (lbs/yr)	TP Starting load (lbs/yr)
A	Natural Lands	272,914	28,068
A	Agricultural Producers	239,638	32,975
A	Brevard County	52,120	7,769
A	City of Fellsmere	10,603	1,544
A	City of Palm Bay	3,087	413
A	City of Sebastian	61,820	8,901
A	FDOT District 4	6,191	741
A	FDOT District 5	3,314	418
A	FWCD	6,122	806
A	Indian River County	87,942	12,696
A	SRID ROW	4,435	561
A	Town of Grant-Valkaria	9,462	1,346
A	Town of Orchid	2,547	367
A	VLWCD	2,401	259
A	**Totals**	**762,595**	**96,865**

Table B-8. Central IRL Project Zone SEB entity starting loads from model, natural lands separated

Project Zone	Entity	TN Starting Load (lbs/yr)	TP Starting load (lbs/yr)
SEB	Natural Lands	272,914	28,068
SEB	Agricultural Producers	239,638	32,975
SEB	Brevard County	52,120	7,769
SEB	City of Fellsmere	10,603	1,544
SEB	City of Palm Bay	3,087	413
SEB	City of Sebastian	61,820	8,901
SEB	FDOT District 4	6,191	741
SEB	FDOT District 5	3,314	418
SEB	FWCD	6,122	806
SEB	Indian River County	87,942	12,696
SEB	SRID ROW	4,435	561
SEB	Town of Grant-Valkaria	9,462	1,346
SEB	Town of Orchid	2,547	367
SEB	VLWCD	2,401	259
SEB	**Totals**	**762,595**	**96,865**

Table B-9. Central IRL Project Zone B entity starting loads from model, natural lands separated

Project Zone	Entity	TN Starting Load (lbs/yr)	TP Starting load (lbs/yr)
B	Natural Lands	99,706	12,113
B	Agricultural Producers	118,698	16,081
B	City of Vero Beach	48,755	7,049
B	FDOT District 4	9,487	1,276
B	FPFWCD	10	1
B	Indian River County	269,295	39,199
B	IRFWCD	3,532	478
B	Town of Indian River Shores	17,525	2,639
B	**Totals**	**567,009**	**78,837**

Table B-10. Central IRL Project Zone SIRL entity starting loads from model, natural lands separated

Project Zone	Entity	TN Starting Load (lbs/yr)	TP Starting Load (lbs/yr)
SIRL	Natural Lands	66,304	7,653
SIRL	Agricultural Producers	65,378	10,057
SIRL	City of Fort Pierce	1,854	305
SIRL	FDOT District 4	7,052	961
SIRL	FL Turnpike	818	100
SIRL	FPFWCD	17,145	2,487
SIRL	SFWMD CP	1,456	257
SIRL	St. Lucie County	104,021	16,773
SIRL	Town of St. Lucie Village	3,608	638
SIRL	**Totals**	**267,636**	**39,232**

After the natural lands were separated from the entity loading estimates based on the SWIL Model, the relative contribution of each entity to the total project zone anthropogenic load was calculated. **Table B-11**, **Table B-12**, **Table B-13**, and **Table B-14** show the percent contribution within the project zone to anthropogenic TN and TP, respectively, by entity. The TN contribution percentage is calculated by dividing the entity anthropogenic TN load by the total anthropogenic TN segment load, and then a similar calculation is performed for each entity's TP load.

Table B-11. Central IRL Project Zone A entity anthropogenic starting loads from model, natural lands separated

Project Zone	Entity	Anthropogenic TN (lbs/yr)	Anthropogenic TP (lbs/yr)	% Contribution to Anthropogenic TN	% Contribution to Anthropogenic TP
A	Natural Lands	0	0	0.00	0.00
A	Agricultural Producers	53,905	8,285	10.99	11.61
A	Brevard County	37,176	5,588	7.58	7.83
A	City of Melbourne	63,245	9,057	12.89	12.69
A	City of Palm Bay	205,713	29,785	41.94	41.73
A	City of West Melbourne	34,398	5,010	7.01	7.02
A	FDOT District 5	9,744	1,300	1.99	1.82
A	MTWCD	11,959	1,641	2.44	2.30
A	Town Melbourne Beach	5,252	779	1.07	1.09
A	Town of Grant-Valkaria	38,257	5,472	7.80	7.67
A	Town of Indialantic	3,589	531	0.73	0.74
A	Town of Malabar	23,093	3,338	4.71	4.68
A	Town of Melbourne Village	3,194	475	0.65	0.67
A	U.S. Air Force	954	118	0.19	0.16
A	**Totals**	**490,479**	**71,377**	**100.00**	**100.00**

Table B-12. Central IRL Project Zone SEB entity anthropogenic starting loads from model, natural lands separated

Project Zone	Entity	Anthropogenic TN (lbs/yr)	Anthropogenic TP (lbs/yr)	% Contribution to Anthropogenic TN	% Contribution to Anthropogenic TP
SEB	Natural Lands	0	0	0.00	0.00
SEB	Agricultural Producers	239,638	32,975	48.94	47.93
SEB	Brevard County	52,120	7,769	10.64	11.29
SEB	City of Fellsmere	10,603	1,544	2.17	2.24
SEB	City of Palm Bay	3,087	413	0.63	0.60
SEB	City of Sebastian	61,820	8,901	12.62	12.94
SEB	FDOT District 4	6,191	741	1.26	1.08
SEB	FDOT District 5	3,314	418	0.68	0.61
SEB	FWCD	6,122	806	1.25	1.17
SEB	Indian River County	87,942	12,696	17.96	18.45
SEB	SRID ROW	4,435	561	0.91	0.82
SEB	Town of Grant-Valkaria	9,462	1,346	1.93	1.96
SEB	Town of Orchid	2,547	367	0.52	0.53
SEB	VLWCD	2,401	259	0.49	0.38
SEB	**Totals**	**489,681**	**68,797**	**100.00**	**100.00**

Table B-13. Central IRL Project Zone B entity anthropogenic starting loads from model, natural lands separated

Project Zone	Entity	Anthropogenic TN (lbs/yr)	Anthropogenic TP (lbs/yr)	% Contribution to Anthropogenic TN	% Contribution to Anthropogenic TP
B	Natural Lands	0	0	0.00	0.00
B	Agricultural Producers	118,698	16,081	25.40	24.10
B	City of Vero Beach	48,755	7,049	10.43	10.56
B	FDOT District 4	9,487	1,276	2.03	1.91
B	FPFWCD	10	1	0.00	0.00
B	Indian River County	269,295	39,199	57.63	58.75
B	IRFWCD	3,532	478	0.76	0.72
B	Town of Indian River Shores	17,525	2,639	3.75	3.96
B	**Totals**	**467,303**	**66,724**	**100.00**	**100.00**

Table B-14. Central IRL Project Zone SIRL entity anthropogenic starting loads from model, natural lands separated

Project Zone	Entity	Anthropogenic TN (lbs/yr)	Anthropogenic TP (lbs/yr)	% Contribution to Anthropogenic TN	% Contribution to Anthropogenic TP
SIRL	Natural Lands	0	0	0.00	0.00
SIRL	Agricultural Producers	65,378	10,057	32.47	31.85
SIRL	City of Fort Pierce	1,854	305	0.92	0.96
SIRL	FDOT District 4	7,052	961	3.50	3.04
SIRL	FL Turnpike	818	100	0.41	0.32
SIRL	FPFWCD	17,145	2,487	8.52	7.88
SIRL	SFWMD CP	1,456	257	0.72	0.81
SIRL	St. Lucie County	104,021	16,773	51.67	53.12
SIRL	Town of St. Lucie Village	3,608	638	1.79	2.02
SIRL	**Totals**	**201,332**	**31,579**	**100.00**	**100.00**

For the unadjusted project zones (for TN, Project Zone SIRL is unadjusted, and for TP, Project Zone A, Project Zone SEB, and Project Zone B are unadjusted), each entity's reduction was calculated by multiplying the total project zone starting load (**Table B-1**) by the project zone required reduction (**Table B-3**) and by the entity's percent contribution to anthropogenic loading, as defined in **Table B-11**, **Table B-12**, **Table B-13**, and **Table B-14**. The calculations for the entity reductions were performed separately for TN and TP. Then, the entity TN and TP allowable loading (allocations) was then computed by subtracting the entity required reductions in **Table B-15**, **Table B-16**, **Table B-17**, and **Table B-18** from the entity anthropogenic starting loads (**Table B-11**, **Table B-12**, **Table B-13**, and **Table B-14**).

Table B-15. Central IRL Project Zone A entity reduction and allowable loading (allocation)

Project Zone	Entity	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Allocation (lbs/yr)
A	Natural Lands	0	0	125,692	13,704
A	Agricultural Producers	37,922	4,740	15,982	3,545
A	Brevard County	26,154	3,197	11,023	2,391
A	City of Melbourne	44,493	5,182	18,752	3,875
A	City of Palm Bay	144,720	17,041	60,992	12,743
A	City of West Melbourne	24,199	2,866	10,199	2,143
A	FDOT District 5	6,855	744	2,889	556
A	MTWCD	8,413	939	3,546	702
A	Town Melbourne Beach	3,695	446	1,557	333
A	Town of Grant-Valkaria	26,914	3,131	11,343	2,341
A	Town of Indialantic	2,525	304	1,064	227
A	Town of Malabar	16,246	1,910	6,847	1,428
A	Town of Melbourne Village	2,247	272	947	203
A	U.S. Air Force	671	67	283	50
A	**Totals**	**345,056**	**40,839**	**271,115**	**44,242**

Table B-16. Central IRL Project Zone SEB entity reduction and allowable loading (allocation)

Project Zone	Entity	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Allocation (lbs/yr)
SEB	Natural Lands	0	0	272,914	28,068
SEB	Agricultural Producers	208,990	22,286	30,649	10,689
SEB	Brevard County	45,454	5,251	6,666	2,519
SEB	City of Fellsmere	9,247	1,043	1,356	500
SEB	City of Palm Bay	2,692	279	395	134
SEB	City of Sebastian	53,913	6,015	7,906	2,885
SEB	FDOT District 4	5,399	501	792	240
SEB	FDOT District 5	2,890	282	424	135
SEB	FWCD	5,339	545	783	261
SEB	Indian River County	76,694	8,580	11,247	4,116
SEB	SRID ROW	3,868	379	567	182
SEB	Town of Grant-Valkaria	8,252	910	1,210	436
SEB	Town of Orchid	2,221	248	326	119
SEB	VLWCD	2,094	175	307	84
SEB	**Totals**	**427,053**	**46,495**	**335,542**	**50,370**

Table B-17. Central IRL Project Zone B entity reduction and allowable loading (allocation)

Project Zone	Entity	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Allocation (lbs/yr)
B	Natural Lands	0	0	99,706	12,113
B	Agricultural Producers	80,654	9,120	38,045	6,961
B	City of Vero Beach	33,128	3,998	15,627	3,051
B	FDOT District 4	6,446	724	3,041	552
B	FPFWCD	6	1	3	1
B	Indian River County	182,982	22,231	86,313	16,968
B	IRFWCD	2,400	271	1,132	207
B	Town of Indian River Shores	11,908	1,497	5,617	1,142
B	**Totals**	**317,525**	**37,842**	**249,484**	**40,995**

Table B-18. Central IRL Project Zone SIRL entity reduction and allowable loading (allocation)

Project Zone	Entity	TN Reduction (lbs/yr)	TP Reduction (lbs/yr)	TN Allocation (lbs/yr)	TP Allocation (lbs/yr)
SIRL	Natural Lands	0	0	66,304	7,653
SIRL	Agricultural Producers	31,287	7,247	34,091	2,810
SIRL	City of Fort Pierce	887	220	967	85
SIRL	FDOT District 4	3,375	692	3,677	268
SIRL	FL Turnpike	391	72	426	28
SIRL	FPFWCD	8,205	1,792	8,940	695
SIRL	SFWMD CP	697	185	759	72
SIRL	St. Lucie County	49,780	12,086	54,241	4,687
SIRL	Town of St. Lucie Village	1,727	460	1,881	178
SIRL	**Totals**	**96,349**	**22,755**	**171,287**	**16,477**

For some project zone calculations (for TN, Project Zones A, SEB, and B, and for TP, Project Zone SIRL), the entity reductions and allowable loads were calculated differently to incorporate the natural load per acre adjustment. Here, the project zone allocation was calculated by multiplying the acres in the project zone (**Table B-4**) by the project zone natural load per acre (**Table B-4**). Next, the entity allocation was computed by multiplying the adjusted project zone allocation (**Table B-6**) by the entity percent contribution to anthropogenic loading (**Table B-11**, **Table B-12**, **Table B-13**, and **Table B-14**). Once the entity allocation was known, then the entity reduction was calculated by subtracting the entity allocation from the entity starting load. The reductions and allocations are shown in **Table B-19**, **Table B-20**, **Table B-21**, and **Table B-22**.

Table B-19. Central IRL Project Zone A entity TN reduction and allowable TN loading at natural load per acre adjustment (allocation)

Project Zone	Entity	Adjusted TN Reduction (lbs/yr)	Adjusted TN Allocation (lbs/yr)
A	Natural Lands	0	125,692
A	Agricultural Producers	28,912	24,993
A	Brevard County	19,940	17,237
A	City of Melbourne	33,921	29,324
A	City of Palm Bay	110,334	95,379
A	City of West Melbourne	18,449	15,949
A	FDOT District 5	5,226	4,518
A	MTWCD	6,414	5,545
A	Town Melbourne Beach	2,817	2,435
A	Town of Grant-Valkaria	20,519	17,738
A	Town of Indialantic	1,925	1,664
A	Town of Malabar	12,386	10,707
A	Town of Melbourne Village	1,713	1,481
A	U.S. Air Force	512	442
A	**Totals**	**263,067**	**353,104**

Table B-20. Central IRL Project Zone SEB entity TN reduction and allowable TN loading at natural load per acre adjustment (allocation)

Project Zone	Entity	Adjusted TN Reduction (lbs/yr)	Adjusted TN Allocation (lbs/yr)
SEB	Natural Lands	0	272,914
SEB	Agricultural Producers	128,681	110,957
SEB	Brevard County	27,987	24,133
SEB	City of Fellsmere	5,694	4,910
SEB	City of Palm Bay	1,657	1,429
SEB	City of Sebastian	33,196	28,624
SEB	FDOT District 4	3,325	2,867
SEB	FDOT District 5	1,780	1,535
SEB	FWCD	3,287	2,834
SEB	Indian River County	47,223	40,719
SEB	SRID ROW	2,381	2,053
SEB	Town of Grant-Valkaria	5,081	4,381
SEB	Town of Orchid	1,368	1,179
SEB	VLWCD	1,289	1,112
SEB	**Totals**	**262,949**	**499,646**

Table B-21. Central IRL Project Zone B entity TN reduction and allowable TN loading at natural load per acre adjustment (allocation)

Project Zone	Entity	Adjusted TN Reduction (lbs/yr)	Adjusted TN Allocation (lbs/yr)
B	Natural Lands	0	99,706
B	Agricultural Producers	74,773	43,926
B	City of Vero Beach	30,713	18,042
B	FDOT District 4	5,976	3,511
B	FPFWCD	6	4
B	Indian River County	169,639	99,656
B	IRFWCD	2,225	1,307
B	Town of Indian River Shores	11,040	6,485
B	**Totals**	**294,372**	**272,637**

Table B-22. Central IRL Project Zone SIRL entity TN reduction and allowable TN loading at natural load per acre adjustment (allocation)

Project Zone	Entity	Adjusted TP Reduction (lbs/yr)	Adjusted TP Allocation (lbs/yr)
SIRL	Natural Lands	0	7,653
SIRL	Agricultural Producers	7,173	2,884
SIRL	City of Fort Pierce	217	87
SIRL	FDOT District 4	685	275
SIRL	FL Turnpike	72	29
SIRL	FPFWCD	1,774	713
SIRL	SFWMD CP	184	74
SIRL	St. Lucie County	11,964	4,809
SIRL	Town of St. Lucie Village	455	183
SIRL	**Totals**	**22,524**	**16,708**

As described above, the entity calculations were performed by project zone. Once these were complete, the information was summarized by entity. In **Table B-23**, the starting loads for each entity are totaled across all the project zones in which they have a land area. Also listed are their relative percentages of anthropogenic load for TN and TP, respectively, in the BMAP area.

Seven stakeholders contribute less than 0.30 % of both the TN and TP loading from the watershed to the NIRL. The contribution to the overall nutrient loading from these stakeholders is low enough that reductions from these areas would have essentially no impact on the required reductions for the BMAP during this phase of implementation; therefore, these entities are currently considered a low priority for implementing reductions. Low-priority entities will be

evaluated in future phases of BMAP implementation, as their contributions may change over time.

Table B-23. Central IRL BMAP entity starting load and percent contribution from anthropogenic loads

*Indicates the stakeholder meets the requirements for low priority.

Entity	Starting TN Load (lbs/yr)	Anthropogenic % TN in BMAP	Starting TP Load (lbs/yr)	Anthropogenic % TP in BMAP
Agricultural Producers	477,619	28.99	67,398	28.29
Brevard County	89,296	5.42	13,357	5.61
City of Fellsmere	10,603	0.64	1,544	0.65
City of Melbourne	63,245	3.84	9,057	3.80
City of Palm Bay	208,799	12.67	30,198	12.68
City of Sebastian	61,820	3.75	8,901	3.74
City of Vero Beach	48,755	2.96	7,049	2.96
City of West Melbourne	34,398	2.09	5,010	2.10
FDOT District 4	22,731	1.38	2,978	1.25
FDOT District 5	13,058	0.79	1,718	0.72
St. Lucie County	104,021	6.31	16,773	7.04
Indian River County	357,237	21.69	51,895	21.78
Town Melbourne Beach	5,252	0.32	779	0.33
Town of Grant-Valkaria	47,719	2.90	6,818	2.86
Town of Indian River Shores	17,525	1.06	2,639	1.11
Town of Malabar	23,093	1.40	3,338	1.40
City of Fort Pierce*	1,854	0.11	305	0.13
FL Turnpike*	818	0.05	100	0.04
Town of Indialantic*	3,589	0.22	531	0.22
Town of Melbourne Village*	3,194	0.19	475	0.20
Town of Orchid*	2,547	0.15	367	0.15
Town of St. Lucie Village*	3,608	0.22	638	0.27
U.S. Air Force*	954	0.06	118	0.05
SRID	4,435	0.27	561	0.24
IRFWCD	3,532	0.21	478	0.20
VLWCD	2,401	0.15	259	0.11
FWCD	6,122	0.37	806	0.34
FPFWCD	17,154	1.04	2,489	1.04
MTWCD	11,959	0.73	1,641	0.69
Totals	**1,647,339**	**100.00**	**238,219**	**100.00**

Table B-24 and **Table B-25** break down the TN and TP reductions for each entity by project zone and in total for the BMAP area.

Table B-24. Central IRL entity TN reductions by project zone

*Indicates the stakeholder meets the requirements for low priority.
WCDs receive qualitative allocations in this BMAP as described in **Appendix E; reductions shown have been calculated in the event of unsatisfactory implementation of qualitative allocation.
† = Adjusted using the natural load per acre.

Entity	A	SEB	B	SIRL	Total
Agricultural Producers	28,912	128,681	74,773	31,287	263,653
Brevard County	19,940	27,987	0	0	47,927
City of Fellsmere	0	5,694	0	0	5,694
City of Vero Beach	0	0	30,713	0	30,713
FDOT District 4	0	3,325	5,976	3,375	12,676
St. Lucie County	0	0	0	49,780	49,780
City of Melbourne	33,921	0	0	0	33,921
City of Palm Bay	110,334	1,657	0	0	111,991
City of Sebastian	0	33,196	0	0	33,196
City of West Melbourne	18,449	0	0	0	18,449
FDOT District 5	5,226	1,780	0	0	7,006
Indian River County	0	47,223	169,639	0	216,862
Town Melbourne Beach	2,817	0	0	0	2,817
Town of Grant-Valkaria	20,519	5,081	0	0	25,600
Town of Indian River Shores	0	0	11,040	0	11,040
Town of Malabar	12,386	0	0	0	12,386
City of Fort Pierce*	0	0	0	887	0
FL Turnpike*	0	0	0	391	0
Town of Indialantic*	1,925	0	0	0	0
Town of Melbourne Village*	1,713	0	0	0	0
Town of Orchid*	0	1,368	0	0	0
Town of St. Lucie Village*	0	0	0	1,727	0
U.S. Air Force*	512	0	0	0	0
SRID	0	2,381**	0	0	0
FWCD	0	3,287**	0	0	0
VLWCD	0	1,289**	0	0	0
MTWCD	6,414**	0	0	0	0
IRFWCD	0	0	2,225**	0	0
FPFWCD	0	0	6	8,205**	0
Totals	**263,067†**	**262,949†**	**294,372†**	**95,652**	**883,711**

Table B-25. Central IRL entity TP reductions by project zone

*Indicates the stakeholder meets the requirements for low priority.
**WCDs receive qualitative allocations in this BMAP as described in Appendix E; reductions shown have been calculated in the event of unsatisfactory implementation of qualitative allocation.
† = Adjusted using the natural load per acre.

Entity	A	SEB	B	SIRL	Total
Agricultural Producers	4,740	22,286	9,120	7,173	43,319
Brevard County	3,197	5,251	0	0	8,448
City of Fellsmere	0	1,043	0	0	1,043
City of Melbourne	5,182	0	0	0	5,182
City of Palm Bay	17,041	279	0	0	17,320
City of Sebastian	0	6,015	0	0	6,015
City of Vero Beach	0	0	3,998	0	3,998
City of West Melbourne	2,866	0	0	0	2,866
FDOT District 4	0	501	724	685	1,910
FDOT District 5	744	282	0	0	1,026
St. Lucie County	0	0	0	11,964	11,964
Indian River County	0	8,580	22,231	0	30,811
Town of Grant-Valkaria	3,131	910	0	0	4,041
Town of Malabar	1,910	0	0	0	1,910
Town Melbourne Beach	446	0	0	0	446
Town of St. Lucie Village*	0	0	0	455	0
City of Fort Pierce*	0	0	0	217	0
FL Turnpike*	0	0	0	72	0
Town of Indian River Shores*	0	0	1,497	0	0
U.S. Air Force*	67	0	0	0	0
Town of Indialantic*	304	0	0	0	0
Town of Melbourne Village*	272	0	0	0	0
Town of Orchid*	0	248	0	0	0
FWCD	0	545**	0	0	0
SRID	0	379**	0	0	0
IRFWCD	0	0	271**	0	0
FPFWCD	0	0	1	1,774**	0
VLWCD	0	175**	0	0	0
MTWCD	939**	0	0	0	0
Totals	**40,839**	**46,495**	**37,842**	**22,341†**	**140,299**

Appendix C. Agricultural Enrollment and Reductions

(Language in this appendix was provided by FDACS.)

All agricultural nonpoint sources in the CIRL BMAP area are statutorily required either to implement FDACS-adopted BMPs or to conduct water quality monitoring prescribed by DEP or the applicable water management district. Under Paragraph 403.067(7)(c), F.S., the proper implementation of FDACS-adopted, DEP-verified BMPs, in accordance with FDACS rules, provides a presumption of compliance with state water quality standards for the pollutants addressed by the BMPs.

FDACS Role in BMP Implementation and Follow-up

When DEP adopts a BMAP that includes agriculture, it is the agricultural landowner's responsibility to enroll in the FDACS BMP Program and implement all applicable FDACS-adopted BMPs to help achieve load reductions. To date, the FDACS OAWP has adopted BMP manuals by rule[1] for cow/calf, citrus, vegetable and agronomic crops, nurseries, equine, sod, dairy, poultry, and specialty fruit and nut operations. All OAWP BMP manuals are periodically revised, updated, and subsequently reviewed and preliminarily verified by DEP before readoption. OAWP intends to update BMP manuals every five years.

To enroll in the FDACS BMP Program, landowners must meet with an OAWP representative to determine the BMPs that are applicable to their operation. The landowner must submit an NOI to an OAWP representative to implement the BMPs on the checklist from the applicable BMP manual. Because many agricultural operations are diverse and are engaged in the production of multiple commodities, a landowner may sign multiple NOIs for a single parcel.

FDACS is required to conduct implementation verification site visits every two years to verify that landowners are implementing BMPs identified in their NOIs. BMP verification site visits are conducted to verify that all BMPs are being implemented properly, to review nutrient and irrigation management records, and to collect records FDACS is required to retain. In addition, FDACS verifies that cost-share items are being appropriately utilized. Procedures used to verify the implementation of agricultural BMPs are outlined in Rule 5M-1.008, F.A.C. Producers not implementing BMPs according to the process outlined in Title 5M-1, F.A.C., are referred to DEP for enforcement action after attempts at corrective and remedial action are exhausted.

Section 403.067, F.S., requires that, where water quality problems persist despite the proper implementation of adopted agricultural BMPs, FDACS must reevaluate the practices, in consultation with DEP, and modify them if necessary. Continuing water quality problems will be detected through the monitoring component of the BMAP and other DEP, SJRWMD, and

[1] https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Best-Management-Practices

SFWMD activities. If a reevaluation of the BMPs is needed, FDACS will also include SJRWMD, SFWMD, and other partners in the process pursuant to Subsection 403.067(7), F.S.

Adopted BMAP Agricultural Land Use and Enrollment

Land use data are helpful as a starting point for estimating agricultural acreage, determining agricultural nonpoint source loads, and developing strategies to reduce those loads in a BMAP area, but there are inherent limitations in the available data. The time of year when land use data are collected (through aerial photography) affects the accuracy of photo interpretation. Flights are often scheduled during the winter months because of better weather conditions and reduced leaf canopies. While these are favorable conditions for capturing aerial imagery, they make photo interpretation for determining agricultural land use more difficult. Agricultural lands are often fallow in the winter months, and this can lead to the incorrect analysis of the photo imagery.

There is also a significant variation in the frequency with which various sources of data are collected and compiled, and older data are less likely to capture the frequent changes that often typify agricultural land use. In addition, it is not always apparent that an agricultural activity is being conducted on the land. Consequently, DEP relies on local stakeholder knowledge and coordination with FDACS to verify agricultural acreage and BMP implementation.

FDACS uses the FSAID Geodatabase to estimate agricultural acreages statewide. FSAID is derived from water management district land use data, and is refined using county property appraiser data, OAWP BMP enrollment data, U.S. Department of Agriculture data for agriculture, such as the Cropland Data Layer and Census of Agriculture, FDACS Division of Plant Industry citrus data, and water management district water use and permitting data, as well as field verification performed by USGS, the water management districts, and OAWP. Ongoing mapping and ground-truthing efforts of the FSAID dataset provide the best available data on the status of agricultural lands in Florida.

In terms of NOIs, enrolled acreage fluctuates when parcels are sold, when leases end or change hands, or when production areas downsize or production ceases, among other reasons. OAWP BMP enrollments are delineated in GIS using county property appraiser parcels. Nonproduction areas such as forest, roads, urban structures, and water features are often included within the parcel boundaries. Conversely, agricultural lands in the FSAID only include areas identified as agriculture. To estimate the agricultural acres enrolled in the BMP Program, OAWP overlays FSAID and BMP enrollment data within GIS to calculate the acres of agricultural land in an enrolled parcel.

To address the greatest resource concerns, OAWP utilizes a phased approach based on commodity type and agricultural acreages, while ensuring that all entities identified as agriculture will be notified. **Table C-1** lists the agricultural acreage based on FSAID VII that is enrolled in the CIRL BMAP area.

Table C-2 lists the agricultural acreage enrolled in the CIRL BMAP area by project zone. **Table C-3** through **Table C-7** list the agricultural land use acreage enrolled in the BMP Program by commodity. **Figure C-1** shows the parcels enrolled in the BMP Program by commodity in the CIRL BMAP area; however, compliance with Section 403.067, F.S., is based on the NOIs and site visits described in **Section 1.2.1.1**.

Table C-1. Agricultural land use acreage enrolled summary in the BMP Program in the CIRL BMAP area as of July 2020

Category	Acres
FSAID VII agricultural acres in the BMAP area	72,898
Total agricultural acres enrolled	18,277
% of FSAID VII agricultural acres enrolled	25

Table C-2. Agricultural land use acreage enrolled in the BMP Program in the CIRL BMAP area by project zone

Project Zone	Total Agricultural Acres	Agricultural Acres Enrolled	% of Agricultural Acreage Enrolled
A	9,781	355	4
B	16,061	2,418	15
SEB	33,776	12,737	38
SIRL	13,280	2,767	21
Total	**72,898**	**18,277**	**25**

Table C-3. Agricultural land use acreage enrolled in the CIRL BMAP area by BMP program

Related OAWP BMP Programs	Agricultural Acres Enrolled
Citrus	4,803
Cow/Calf	10,488
Equine	22
Multiple Commodities	160
Nursery	130
Row/Field Crop	2,675
Total	**18,277**

Table C-4. Agricultural land use acreage enrolled in the BMP Program in Project Zone A

Related OAWP BMP Programs	Agricultural Acres Enrolled
Cow/Calf	348
Nursery	7
Total	**355**

Table C-5. Agricultural land use acreage enrolled in the BMP Program in Project Zone B

Related OAWP BMP Programs	Agricultural Acres Enrolled
Citrus	1,313
Cow/Calf	978
Multiple Commodities	64
Nursery	11
Row/Field Crops	53
Total	**2,418**

Table C-6. Agricultural land use acreage enrolled in the BMP Program in Project Zone SEB

Related OAWP BMP Programs	Agricultural Acres Enrolled
Citrus	2,087
Cow/Calf	7,977
Equine	22
Multiple Commodities	18
Nursery	11
Row/Field Crops	2,622
Total	**12,737**

Table C-7. Agricultural land use acreage enrolled in the BMP Program in Project Zone SIRL

Related OAWP BMP Programs	Agricultural Acres Enrolled
Citrus	1,403
Cow/Calf	1,185
Multiple Commodities	78
Nursery	101
Total	**2,767**

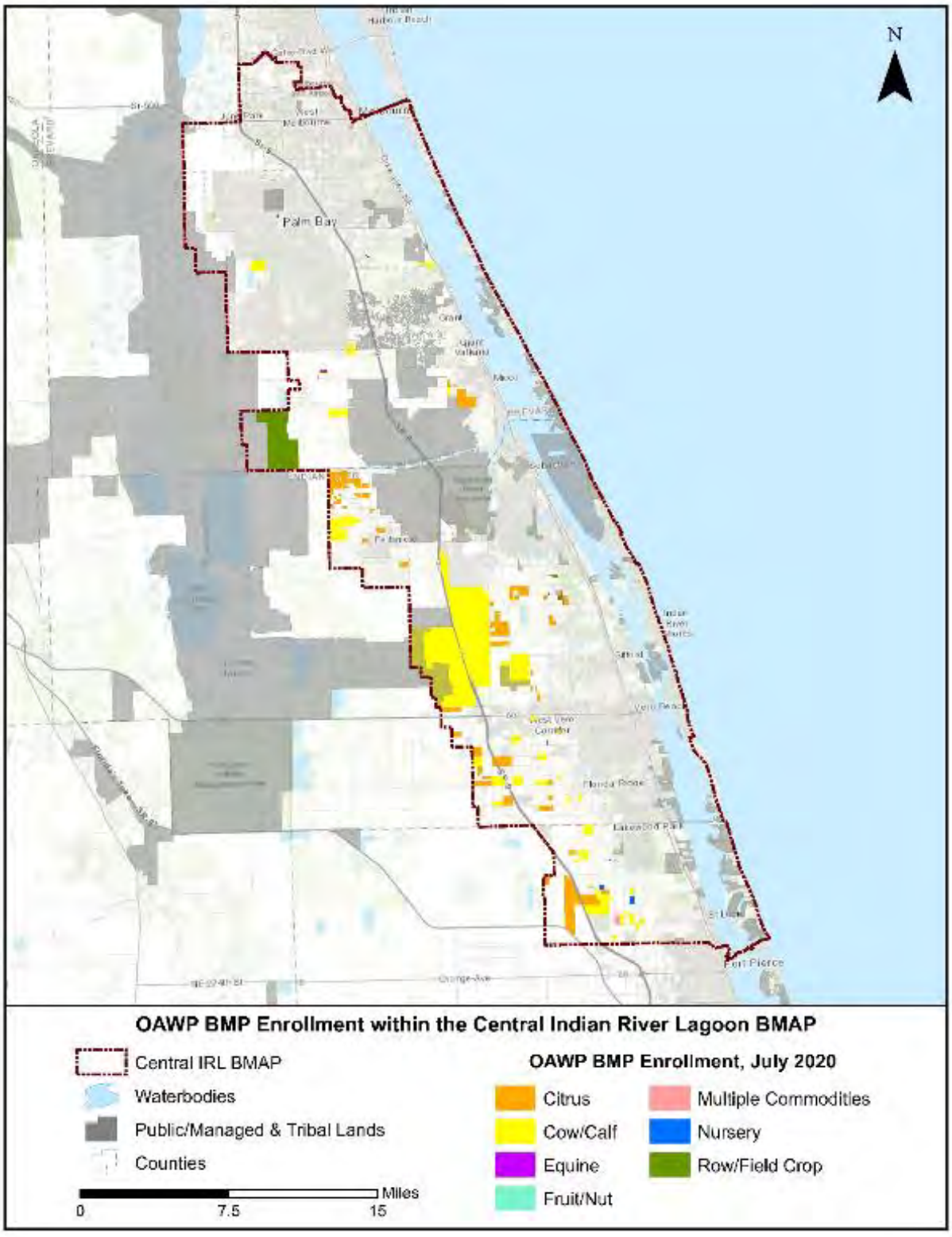

Figure C-1. BMP enrollment in the CIRL BMAP area as of July 2020

Unenrolled Agricultural Acreage

As of July 2020, 25 % of the agricultural acres in the CIRL BMAP area are enrolled in the FDACS BMP Program and are implementing practices designed to improve water quality. FDACS continues to increase enrollment in all BMAPs to meet the BMAP goal of enrolling 100 % of the enrollable agricultural acres in the BMP program. To achieve that goal, land use analyses are conducted to ensure that areas containing commercial agricultural land uses are prioritized. Lands classified as agriculture where the ability to implement agricultural BMPs under the BMP program is limited, such as smaller rural homesteads, receive lower priority for enrollment.

General Considerations

Although land use data have been used as the basis for prioritizing FDACS enrollment efforts, many land use issues not captured by these databases affect enrollment efforts. Many areas within the CIRL BMAP boundaries experience rapid land use changes, especially at the urban/rural boundary. Agricultural lands are regularly converted to residential, industrial, commercial, or multiuse properties, but still appear in various databases as pasture or other rural lands. While these lands are likely to be developed in the near future, the agricultural land use classifications require these properties to comply with the BMP enrollment requirements.

Additionally, the counties' methods of classifying small acreages as agricultural lands can affect the BMP enrollment process. Along with these changes, there are also large agricultural parcels being subdivided but remaining classified as "agriculture." These rural homesteads—also called residential agriculture, rural residential, rural estates, equine communities, ranchettes, and other descriptive names for homes with some acreage and agricultural zoning—present a particular challenge for FDACS. The current BMP manuals and the measures they contain target commercial agricultural production practices and, in many cases, cannot be scaled down to appropriately enroll activities on these smaller, noncommercial agricultural properties. The increasing number of these smaller parcels with noncommercial agricultural activity represents a growing component of unenrolled acreage. It will be necessary to develop a suite of options to apply to these properties or develop a new classification that may subject these types of areas to other requirements to ensure their nutrient loading contribution is being appropriately identified and reduced.

Further, thousands of acres of open land, scrubland, unimproved pasture, and grazing land exist without a readily identifiable agricultural production activity that will fit within the framework of existing FDACS BMP manuals. Also, these types of parcels are usually controlled by many different individuals. It will be necessary to develop a suite of options to apply to these properties or develop a new classification that may subject these types of areas to other requirements to ensure their nutrient loading contribution is being appropriately identified and reduced.

Another challenging area includes those agricultural lands that are inactive or fallow—i.e., lands that, on the day the FDACS representative visits, display no enrollable agricultural activity.

These lands may be part of a rotation implemented by a landowner, scheduled for development, listed for sale, etc. The land use information FDACS receives is used to consistently improve the classification of these areas, but policy options remain limited in scope to ensure the implementation of practices aimed at reducing nutrient inputs from these areas.

Characterization of Unenrolled Agricultural Lands

To characterize unenrolled agricultural acres, OAWP identified FSAID VII features outside the BMP enrollment areas and overlaid these features with property appraiser parcels within GIS. OAWP then identified the number of parcels that encompass the unenrolled agricultural lands and the number of agricultural acres present within the parcels. The parcel owner information, other parcel details, and aerial imagery were used identify parcels that are unlikely to contain agricultural activity. As previously mentioned, OAWP BMP enrollments are initially delineated based on county property appraiser parcel data, even if the entire parcel is not in agriculture, to allow BMPs to be tied to the specific parcels where agricultural activities are occurring. FSAID agricultural lands are delineated based on land use features identified as agriculture and represent a more refined analysis of those areas actually in agricultural production.

Because of differences in the spatial geometries between the OAWP BMP enrollment, FSAID, and property appraiser parcels, when they are combined or compared, the boundaries often do not align precisely, creating "slivers." Slivers are not enrollable because they are an artifact of the geospatial analysis and do not represent lands with active agricultural practices. For example, a sliver can represent the area between the boundary of a parcel and the beginning of a road, canal, easement, etc. A sliver can also represent a small portion of an FSAID feature outside the BMP enrollment areas that is slightly overlapped by a property appraiser parcel. Slivers are often associated with previously enrolled agricultural operations but because of the delineation differences, these slivers are not captured within the enrolled parcel during geoprocessing. When characterizing unenrolled agricultural lands, slivers are excluded. **Figure C-2** shows an example of a sliver created when performing geospatial analysis.

Figure C-2. GIS example of a sliver

Large areas that are identified as agricultural land use but are unlikely to have enrollable agricultural activities include lands owned by the state (Board of Trustees of the Internal Improvement Trust Fund) and water management districts (SJRWMD or SFWMD). It is possible that these lands, in whole or in part, may be leased to other entities that conduct agricultural activities, but such leasing is infrequent. If leasing occurs, the leasing entity will be required to enroll in the BMP Program. Ongoing coordination between FDACS, DEP Division of State Lands, SJRWMD, and SFWMD is needed to ensure that any public lands that are leased for the purposes of agricultural activities are required to implement and enroll in the FDACS BMP Program as a condition of the lease.

Other smaller parcels that have been identified as nonagricultural, but have features that cause them to be identified as agricultural lands in various databases, include those lands associated with utilities, telecommunication companies, churches, FDOT rights-of-way, and airports. The Florida Department of Revenue (DOR) uses code numbers 70 through 98 to identify these types of lands.

Those agricultural lands that have been identified as "fallow," "former [ag]," and "abandoned," as well as brushland/scrubland/open land, comprise 34 % of the total unenrolled agricultural acres in the CIRL BMAP area. These acres are still classified as agricultural land for the purposes of the BMAP nutrient load assessment. There are a variety of potential options to account for these lands, such as enrollment as "temporarily inactive" operations—particularly those that were previously enrolled and are planned to resume production. Another option may be to note the inactive acres at the time of a field visit and perform periodic reassessment on a cyclical basis. The possibility for DEP and FDACS to calculate nutrient reduction credits or adjust nutrient loading rates may also provide opportunities to present more accurate estimates and establish priorities.

Another factor considered in the prioritization of BMP enrollment is the number of agricultural acres on the parcel. Analyzing the number of agricultural acreages on the parcel and commodity type can give an idea of the efforts that are needed to enroll these areas in the FDACS BMP Program and also identify the areas most in need of enrollment. **Figure C-3** summarizes the agricultural acres distributed by agricultural acreage found on each parcel.

Further analysis was done to characterize the parcels based on agricultural acreage and land use type. For graphing purposes, land use distribution is displayed in two charts, one showing the land use for parcels containing 50 acres of agriculture or greater (**Figure C-4**) and a second for parcels containing less than 50 acres of agriculture (**Figure C-5**). Of the 44,847 acres of land identified as having potential agricultural activity, grazing land comprises 48 % of this acreage.

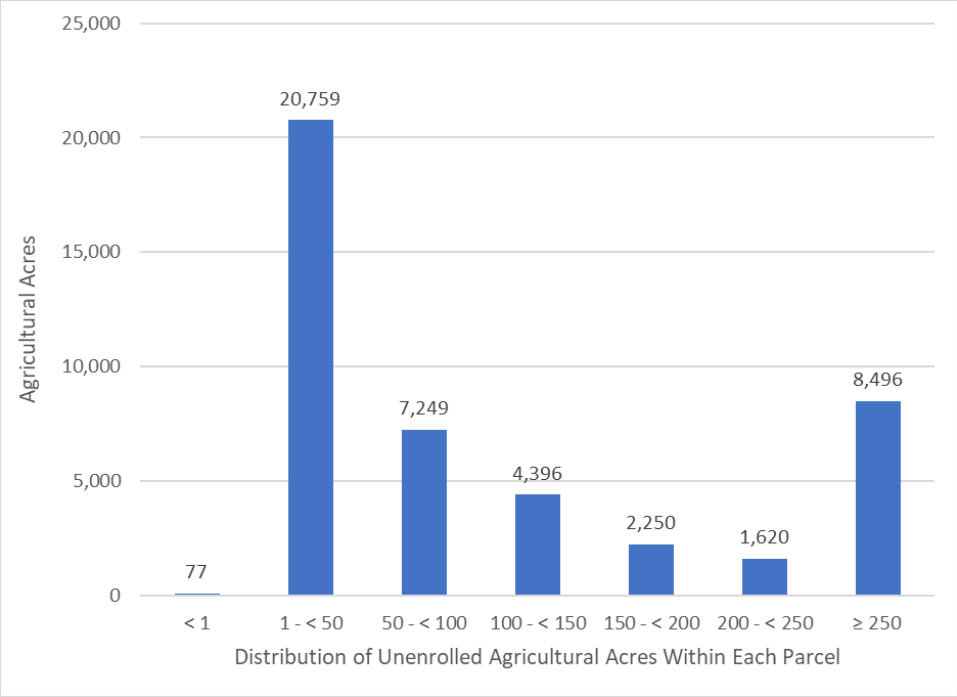

Figure C-3. Distribution of agricultural acreage on parcels with potential agricultural activity in the CIRL BMAP area

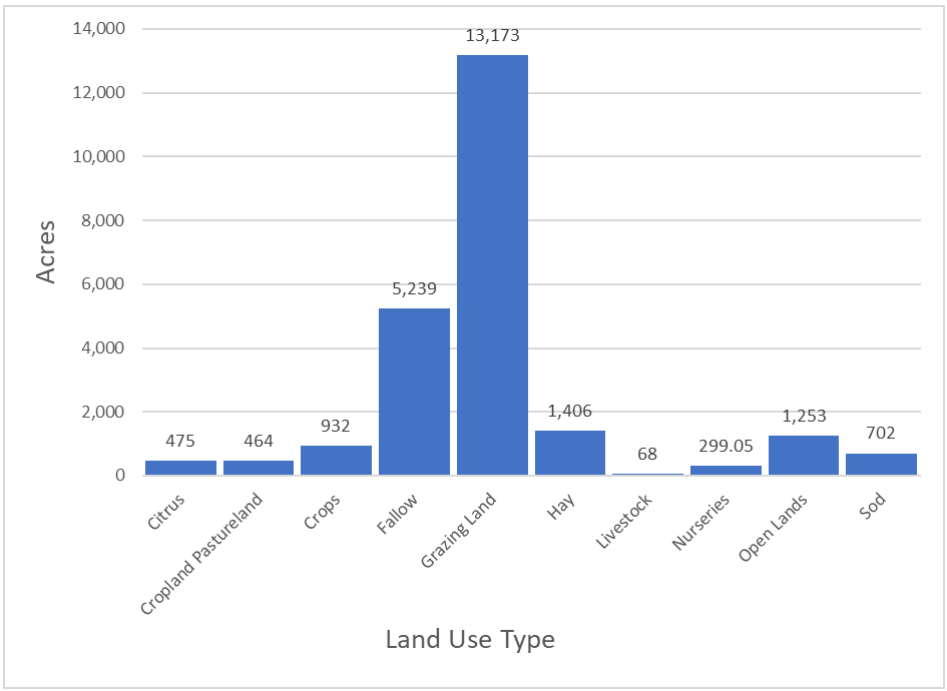

Figure C-4. Agricultural land uses on parcels with 50 acres of agriculture and greater in the CIRL BMAP area

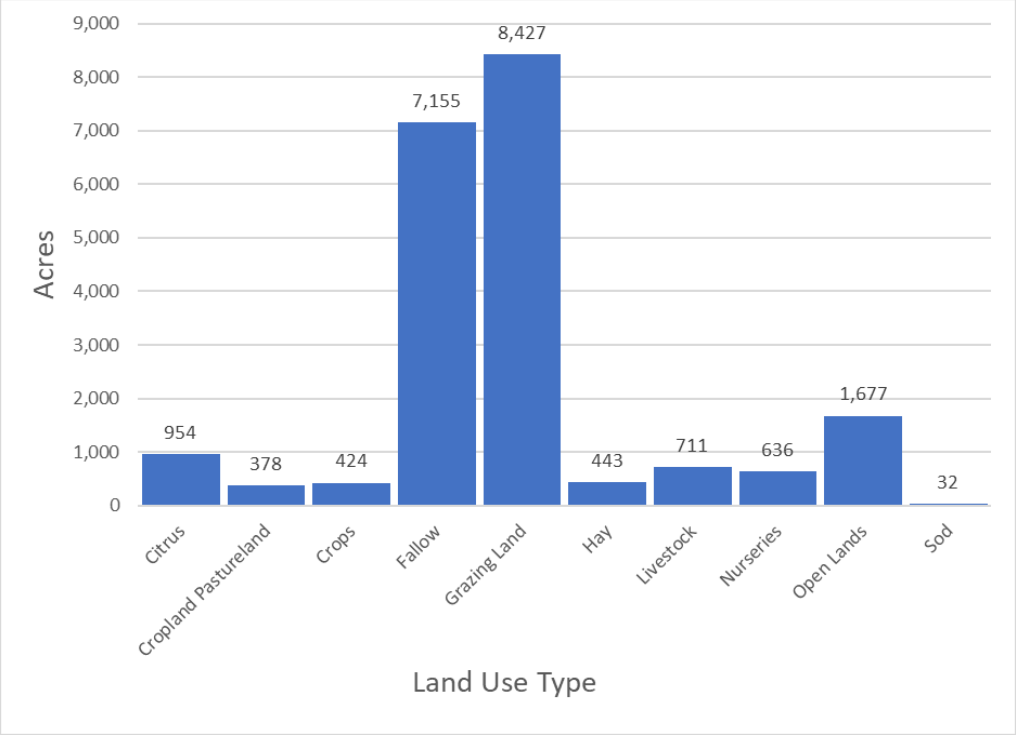

Figure C-5. Agricultural land uses on parcels with less than 50 acres of agriculture in the CIRL BMAP area

Table C-8 lists the total acreage associated with the identified slivers and the lands that are not likely to have enrollable agricultural activities, along with the remaining total of unenrolled agricultural acres in the BMAP area. **Figure C-6** and **Figure C-7** summarize the unenrolled agricultural acres in the CIRL BMAP area by acres of agriculture within the parcels. However, they do not include acreages or parcels associated with slivers or lands that are not likely to have enrollable agricultural activities.

Table C-8. Summary of unenrolled agricultural land use acreage in the CIRL BMAP area

Note: Because of geometric variations between shapefiles used in the unenrolled agricultural lands analysis performed by OAWP, the unenrolled agricultural acres differ from subtraction of the FSAID VII Agricultural Acres in the BMAP and the Total Agricultural Acres Enrolled referenced in **Table B-1**.

Category	Acres
Unenrolled agricultural acres	54,625
Acres identified within slivers of unenrolled agricultural areas	443
Lands without enrollable agricultural activity (e.g., tribal lands, residential development, and parcels with DOR use codes 70-98)	9,335
Total lands with potentially enrollable agricultural activities	**44,847**

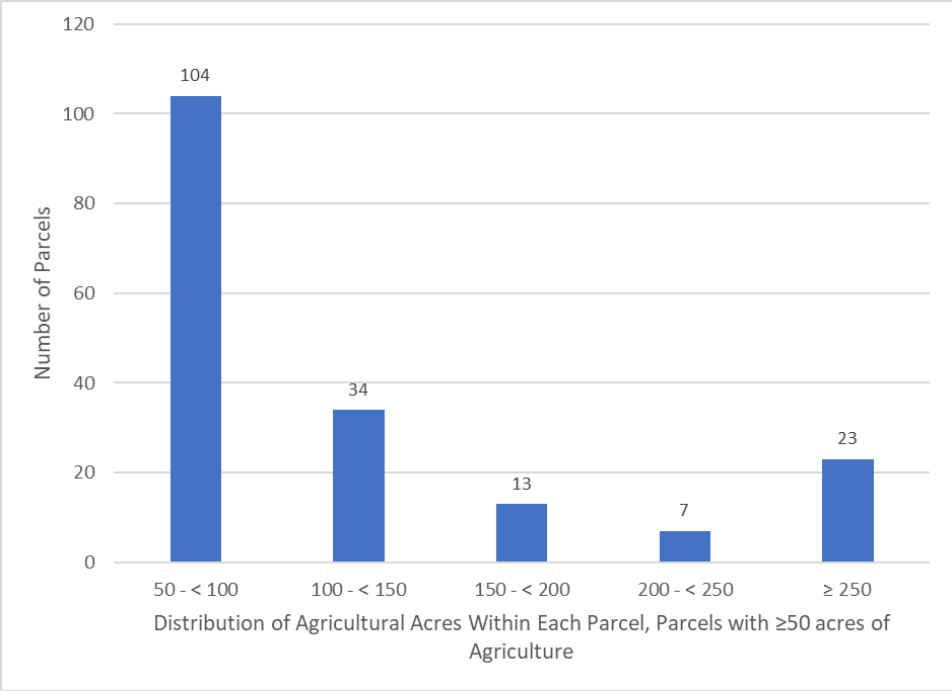

Figure C-6. Number of parcels with 50 acres of agriculture and greater in the CIRL BMAP area

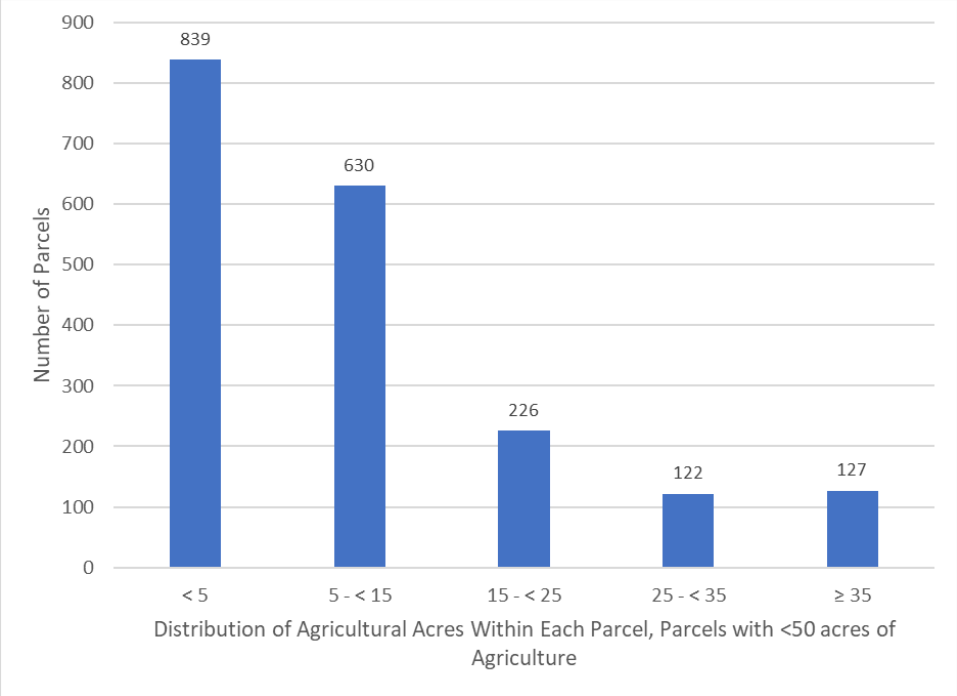

Figure C-7. Number of parcels with less than 50 acres of agriculture in the CIRL BMAP area

Unenrolled agriculture characterization information for each individual project zone, including the distribution of agricultural acres within each parcel and land use type, is shown in **Figure C-8** through **Figure C-15**.

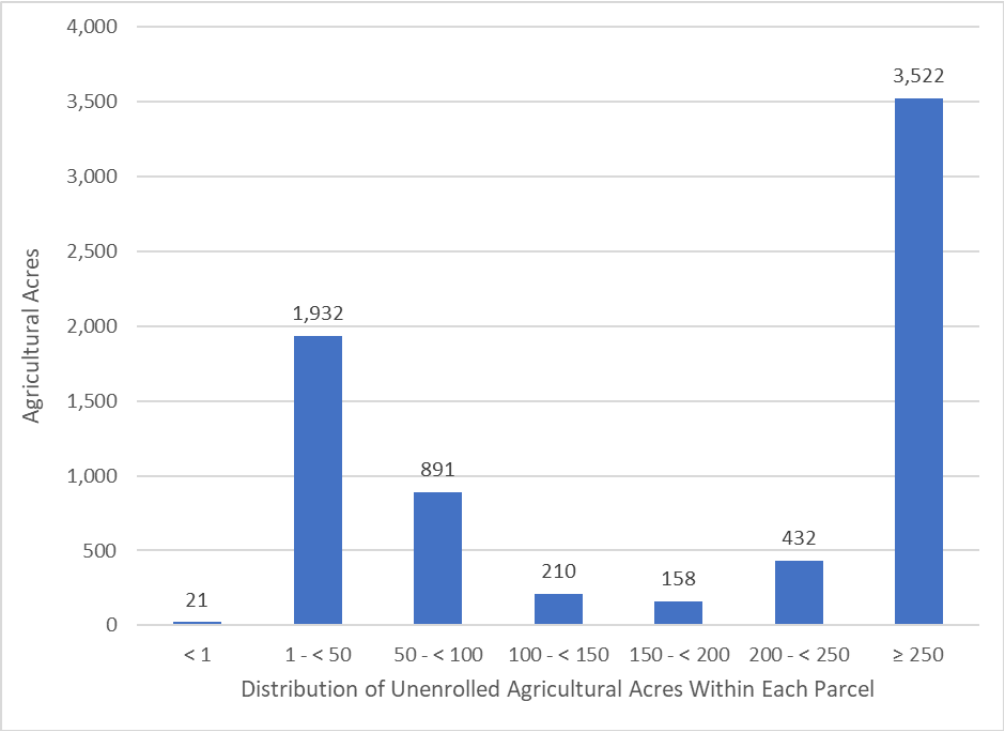

Figure C-8. Distribution of agricultural acreage on parcels with potential agricultural activity, Project Zone A

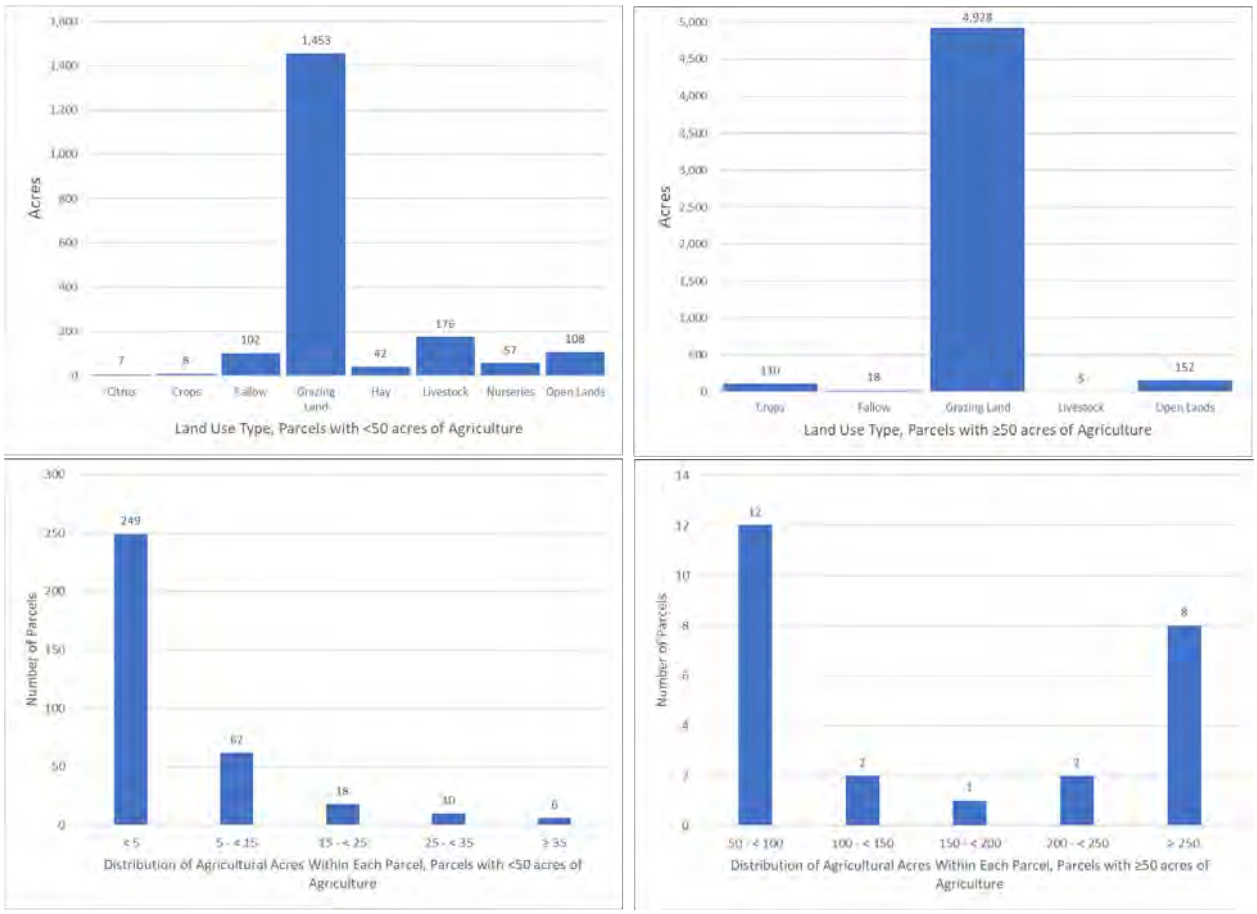

Figure C-9. Land use type and distribution of agricultural acreage, Project Zone A

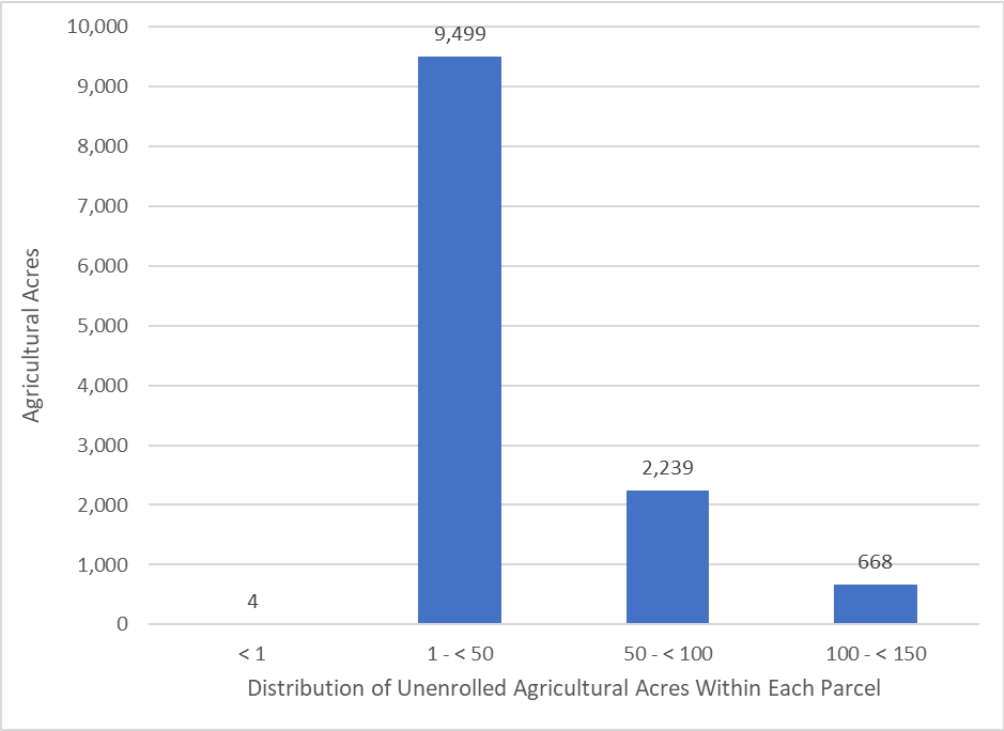

Figure C-10. Distribution of agricultural acreage on parcels with potential agricultural activity, Project Zone B

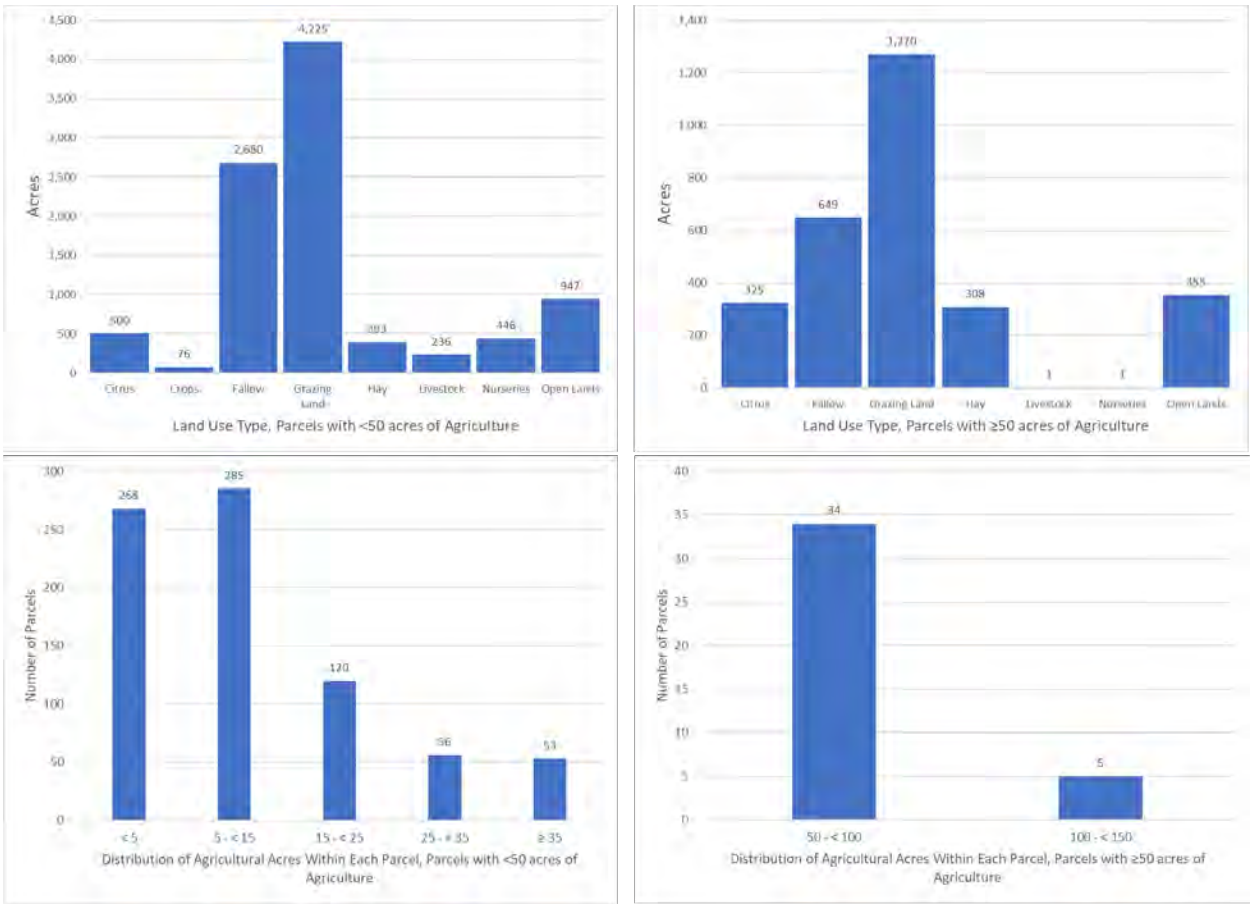

Figure C-11. Land use type and distribution of agricultural acreage by parcel size, Project Zone B

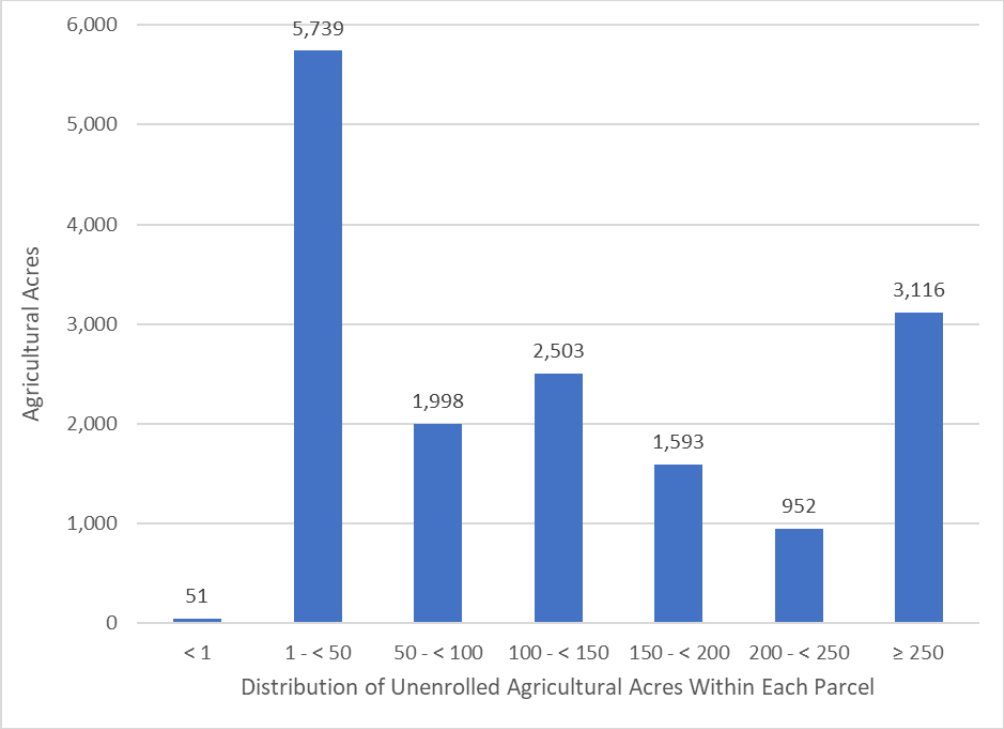

Figure C-12. Distribution of agricultural acreage on parcels with potential agricultural activity, Project Zone SEB

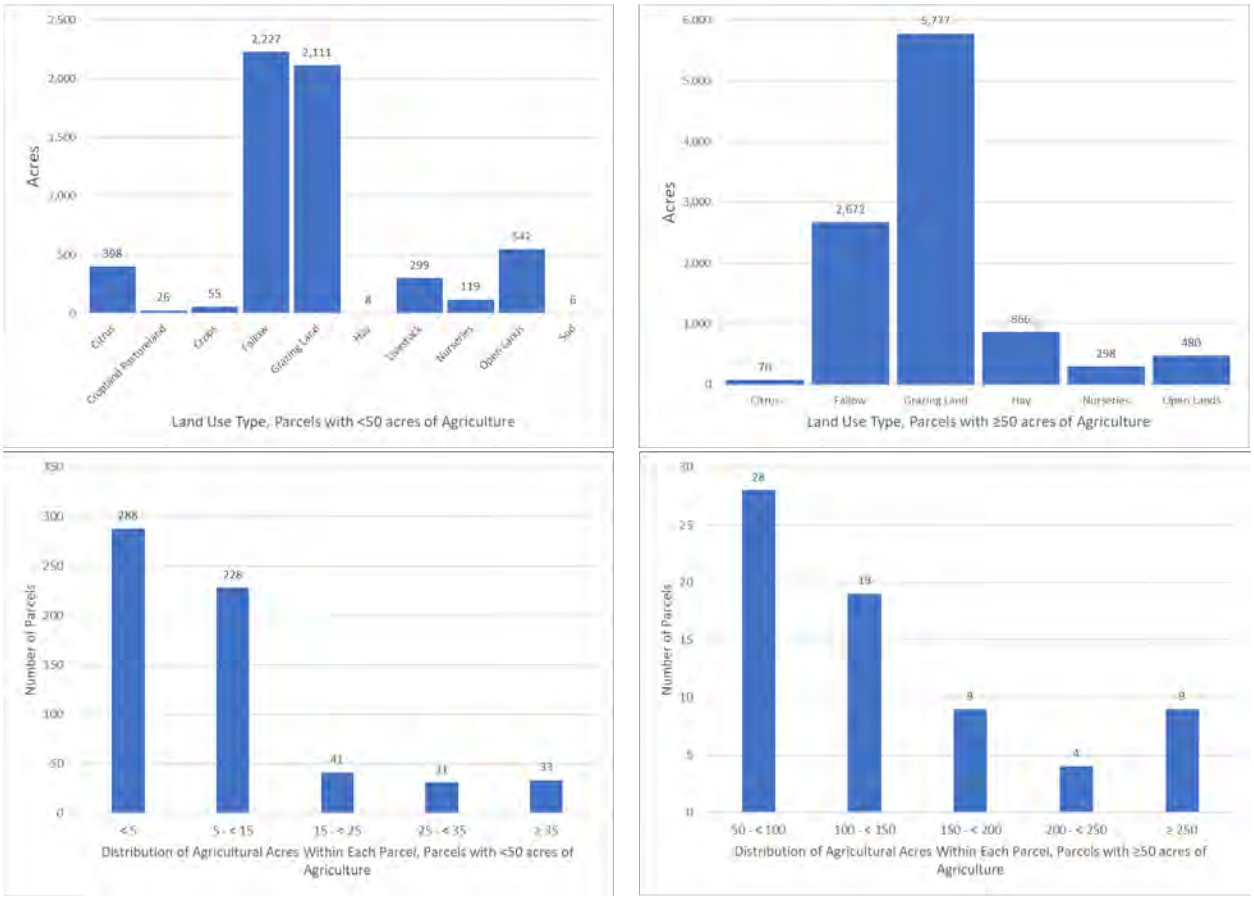

Figure C-13. Land use type and distribution of agricultural acreage by parcel size, Project Zone SEB

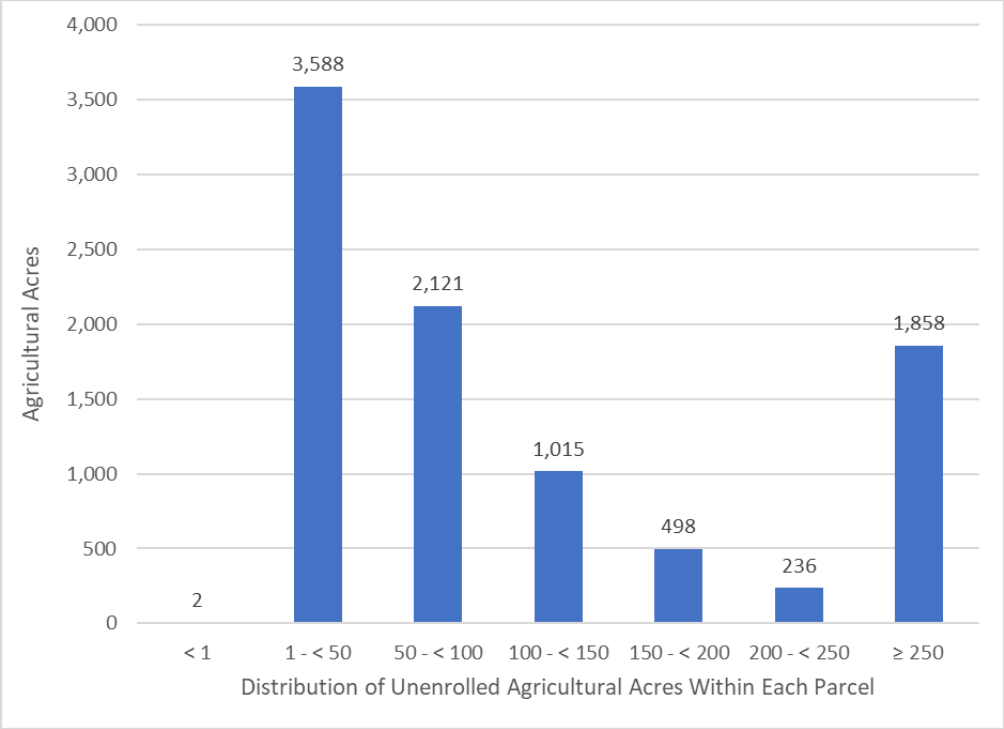

Figure C-14. Distribution of agricultural acreage on parcels with potential agricultural activity, Project Zone SIRL

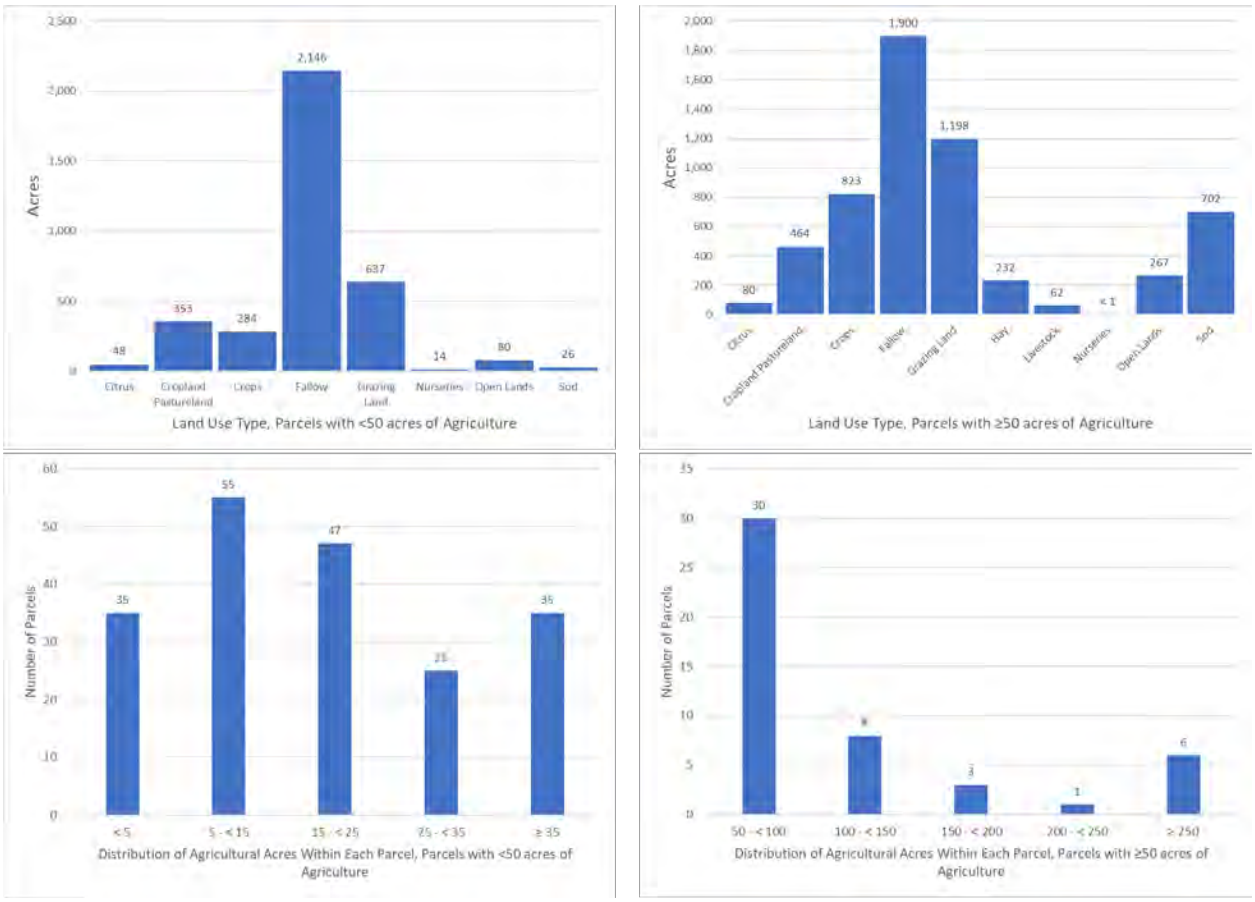

Figure C-15. Land use type and distribution of agricultural acreage by parcel size, Project Zone SIRL

Future Efforts

To address resource concerns, FDACS continues enhancing coordination with producers, agencies, and stakeholders to increase enrollment in the BMP Program. OAWP is sending correspondence to agricultural landowners within BMAP areas that are not currently enrolled in the BMP Program to increase enrollment rates and verify land uses where additional focus may be required to achieve resource protection. This effort is utilizing a phased approach and targeting priority land uses and then using the amount of agricultural acreage for the remaining unenrolled lands, while ensuring that all entities identified as agricultural will be notified. Additionally, OAWP continues to coordinate with industry groups and outreach partners to educate and inform agricultural producers about the BMP Program.

Additional Factors Related to Agricultural Lands and Measuring Progress

Legacy loading can present an additional challenge to measuring progress in many areas of Florida with adopted BMAPs. Based on research, initial verification by DEP, and long-term trends in water quality in the BMAP area, it is expected that current efforts, such as BMP implementation, will continue to provide improvements in overall water quality despite the impacts from legacy loads.

While the implementation of BMPs will improve the water quality in the basin, it is not reasonable to assume that BMP implementation alone can overcome the issues of legacy loads, conversion to more urban environments, and the effects of intense weather events. BMP implementation is one of several complex and integrated components in managing the water resources of a watershed. Additional regional projects, precisely located and operated, may be needed to achieve the TMDLs for the CIRL Subbasin.

Collaboration between DEP, the water management districts, and other state agencies, as well as local governments, federal partners, and agricultural producers, is critical in identifying projects and programs, as well as locating funding opportunities to achieve allocations provided for under this BMAP. To improve water quality while retaining the benefits that agricultural production provides to local communities, wildlife enhancement, and the preservation of natural areas requires a commitment from all stakeholders to implementing protective measures in a way that maintains the viability of agricultural operations.

Recommended Updates to Land Use

BMAP loads and allocations, as well as water supply projections, are based primarily on land use data. Maintaining the most accurate agricultural land use dataset is critical to planning and policy decisions. Although crop changes, technology advances, and land ownership/lessee changes related to agricultural operations create dynamic environments and difficulties in estimating impacts from specific operations, FDACS and DEP continue to coordinate and develop ways to improve accuracy.

DEP and OAWP recognize that land use–related issues consistently occur during BMAP development and/or updates. One of these issues is the differentiation between what is classified as an agricultural land use in the TMDL or BMAP model, and what is no longer an agricultural land use by the time the BMAP is adopted or an update occurs.

OAWP has developed a methodology to identify agricultural land use changes to make adjustments in subsequent models and reports. Using GIS, OAWP compared the SWIL model land use with the latest FSAID land use and BMP enrollment data. OAWP identified areas classified as agriculture by the BMAP modeled land use that do not overlap with the latest FSAID or BMP enrollment data

OAWP reviewed the output of this overlay analysis by using county appraiser data and aerial imagery to determine if the nonoverlapping areas were still in production. It identified 3,113 acres, classified as agriculture in the SWIL land use, that now consist of other land use types such as residential, industrial, or commercial (see **Table C-9**). DEP evaluated the land use changes identified by OAWP and apportioned the associated acres and loads to the appropriate entities after a discussion with each entity.

Often the analyses show changes that have occurred more rapidly than any land use data can capture, such as the transition to residential development. The land use changes are provided to DEP as a GIS shapefile with a description of the information in the county property appraiser

database and aerial imagery reflected for the refinement of the acreage and loading allocated to agriculture in a BMAP area.

Table C-9. Agricultural land use change by project zone

Project Zone	Acres
A	1,639
B	543
SEB	784
SIRL	146
Total	**3,113**

In addition to identifying land use changes in the BMAP area modeled land use, OAWP regularly reviews FSAID data, at times daily or weekly, as it performs other job functions. Any edits or changes are reviewed and considered for inclusion in the next iteration of the FSAID.

Potential Site-Specific Nutrient Management Measures in Addition to BMPs

Beyond enrolling producers in the FDACS BMP Program and verifying implementation, OAWP will also work with producers to identify a suite of agricultural projects and research agricultural technologies that could be implemented on properties where they are deemed technically feasible and if funding is made available. FDACS executes contracts with soil and water conservation districts and other partners to administer cost-share funds and provide technical and administrative support for these districts and other partners. Cost-share funding is being used to implement higher level BMPs, innovative technologies, and regional projects to provide the next added increment of improving and protecting water quality.

Table C-10 identifies the agricultural technologies that received cost-share assistance in the CIRL BMAP area and the associated nutrient reductions based on the 2016 Soil and Water Engineering Technology (SWET) report. Using the nutrient reductions from the report, OAWP developed a methodology to estimate nutrient reductions for NOIs that have received cost-share funding. The NOI boundary, based on property appraiser parcel data, was considered the area treated by the cost-shared agricultural technology or project. For parcels with more than one cost-share project, OAWP identified the order of treatment to determine the reductions for the multiple projects and created a workbook that provided the cost-share agricultural technologies and the formulas to estimate the nutrient reductions.

Table C-10. Cost-share project types and associated nutrient reductions recommended by OAWP

[1] Reductions for this measure not incorporated as part of this exercise.
[2] Reductions for this measure are from Table 5. Estimated Edge of Farm Nutrient Load Reductions for the FDACS Okeechobee BMP Program in the 2016 SWET Report (Bottcher 2016) and is represented in pounds per year per unit (each project is 1 unit).

Project Types	TN Reductions (%)	TP Reductions (%)
Chemigation/fertigation	20	20
Fence	10	10
Irrigation improvements, automation	20	20
Precision agriculture technology	30	10
Weather station[1]	20	5
Well, pipeline, trough, pond, heavy use protection[2]	50	50

Appendix D. Seagrass Analysis

Process to Conduct the Seagrass Depth Limit Compliance Evaluation

The goal of the IRL Basin TMDLs is to recover the deeper seagrass habitats. The seagrass response is the most important factor in evaluating the success of the nutrient TMDLs. Even if the relationship among nutrient loads and seagrass recovery is not as predicted by the regression model, the load reduction requirements themselves will not determine TMDL success. The assessment of success is based on whether the seagrass grows at sufficient depths.

The TMDL seagrass depth limit targets are based on a union coverage of the seagrass mapping data from 1943, 1986, 1989, 1992, 1994, 1996, and 1999. SJRWMD created this union coverage when it set pollutant load reduction goals for the IRL Basin. The TMDL targets are not based on the full restoration of seagrass depths represented by this union coverage; instead, they were set at 90 % of the full restoration estimate. These targets allow for seagrass growth almost to the depths previously seen in the lagoon, while accounting for the fact that changes have been made to the lagoon system that may limit seagrass growth in some areas, such as dredged areas similar to the Intracoastal Waterway.

Compliance with the TMDL seagrass depth limit targets is assessed on a project zone scale using the latest four consecutive data sets of seagrass mapping data. For the assessment years to be compliant with the TMDL seagrass depth limit targets, the data must meet the requirements of a two-step evaluation process.

The first step is a comparison of the TMDL union coverage cumulative frequency distribution curve with the assessment years' union cumulative frequency distribution curve. The cumulative distribution curves show what percentage of the seagrass deep edge is located at different depths. To be compliant, at least 50 % of the assessment years' curve, including the median, must be on or to the right of the TMDL curve.

The second step in the evaluation process is a comparison of the TMDL union coverage median value with each assessment year's median value. To be compliant in the second step, at least three of the four assessment year medians must be equal to or greater than the TMDL median. If the seagrass data from the four assessment years are compliant with both steps of the test, the project zone is achieving the TMDL depth limit target.

A series of GIS steps must be conducted to obtain the data necessary to complete the two-step evaluation process. These steps are as follows:

- Start with the seagrass GIS shapefiles for the four latest assessment years and edit these files to include only Categories 9113 and 9116, which represent seagrass. Other categories in the GIS shapefiles represent algae cover, which should not be included in this assessment. The seagrass shapefiles only represent the location of the seagrass beds.

- Use the dissolve function in GIS to create the union file of the assessment years. This union file results in a coverage of where seagrass beds were located during all four assessment years.
- Transform the polygons to a polyline in the assessment years' union file. This polyline represents the edges of the seagrass beds.
- Draw a 15.8-m buffer around the seagrass polyline that is 7.9 m inside and 7.9 m outside the seagrass bed. The bathymetry layer was created by SJRWMD in 1996, and the bathymetry was measured every 15.2 m. The 15.8 m buffer around the seagrass polyline ensures that 1 bathymetry point will be captured in the GIS analysis.
- Intersect the updated bathymetry shapefile with the seagrass coverage file that was transformed into a polyline. This intersection correlates the depth data with the seagrass locations so that depths along the seagrass bed edge can be determined.
- Intersect the deep edge file to each project zone (BRL A, BRL B, North A, North B, Central A, Central SEB, and Central B).
- Use the select by location function to identify and note points within dredged areas. The dredged areas are removed from this coverage because seagrass is not expected to grow in areas that have been dredged.
- Identify and note points that fall below 0.3 m and above 3.5 m from the coverage. This step is needed because seagrass growing at depths less than 0.3 m are likely not light-limited, and seagrass are not expected to grow at depths greater than 3.5 m.
- Identify and note points from the intersections of holes or bare areas, which do not represent the deep edge of the seagrass bed.
- These steps are also followed separately for each assessment year so that the median value can be calculated.

The final points that represent the seagrass deep edge boundary for the assessment years' union coverage are then exported from GIS into Excel to conduct the two-step evaluation. The depth points are sorted from highest to lowest, and the count of the number of points at each depth is determined. The cumulative count is determined by taking the count for the shallowest depth and adding it to the count for the next shallowest point until the counts for all the depths are added together to yield the total number of depth points. The cumulative count at each depth is divided by the total points to determine the percentage of the seagrass points at each depth. These points are then plotted as a curve on a graph for comparison with the TMDL cumulative distribution curve. For the Step 2 evaluation, the median depth point is calculated for each assessment year using Excel. These medians are then compared with the TMDL median to determine compliance.

The maps in **Figure D-1** through **Figure D-3** include the locations of ground truthing conducted before and during aerial surveys. Additionally, the transect locations where SJRWMD conducts seasonal monitoring are shown. For more information on how SJRWMD and partners conduct seagrass surveys, SJRWMD's SOP is referenced in **Chapter 5**.

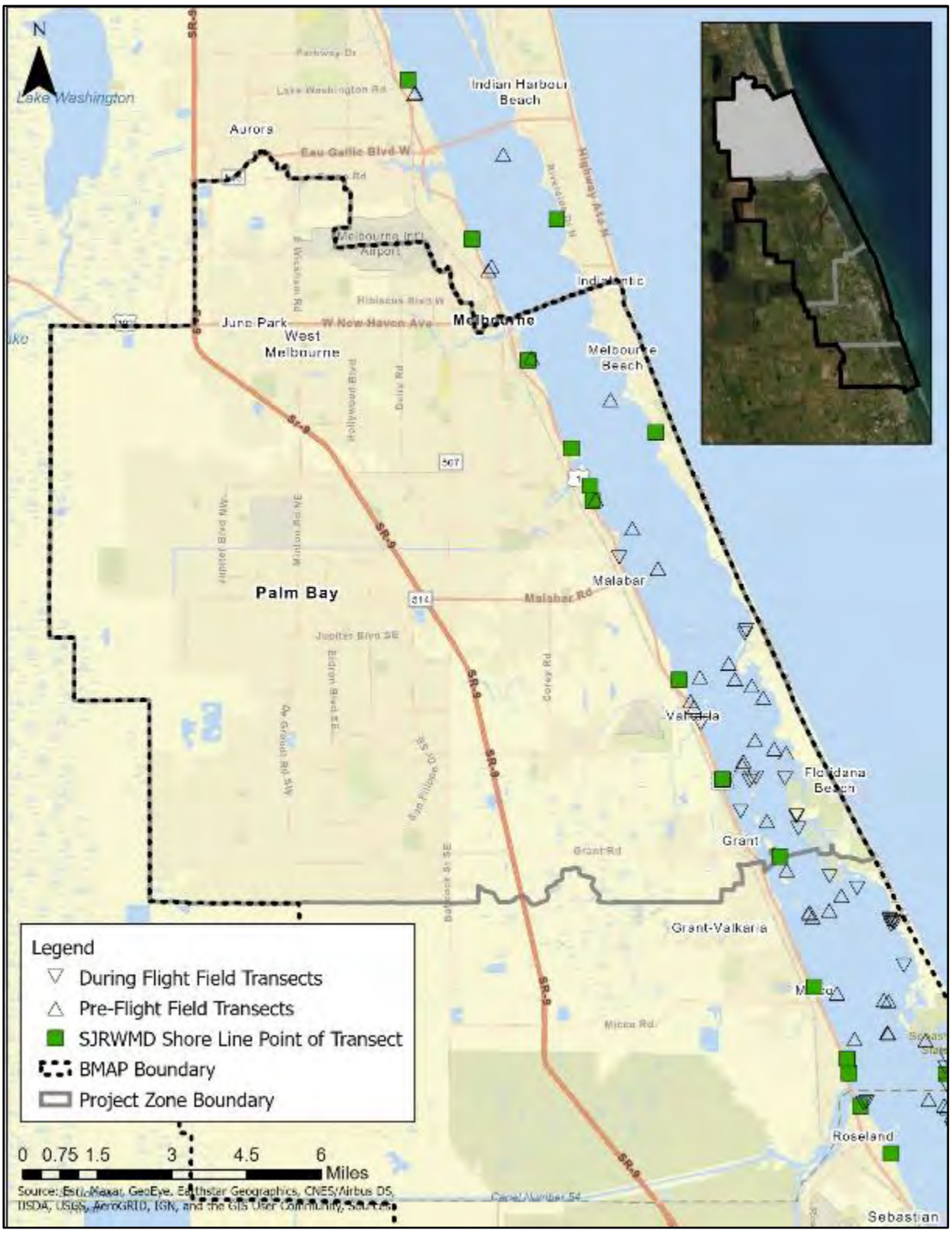

Figure D-1. Map of the seagrass transects in CIRL A

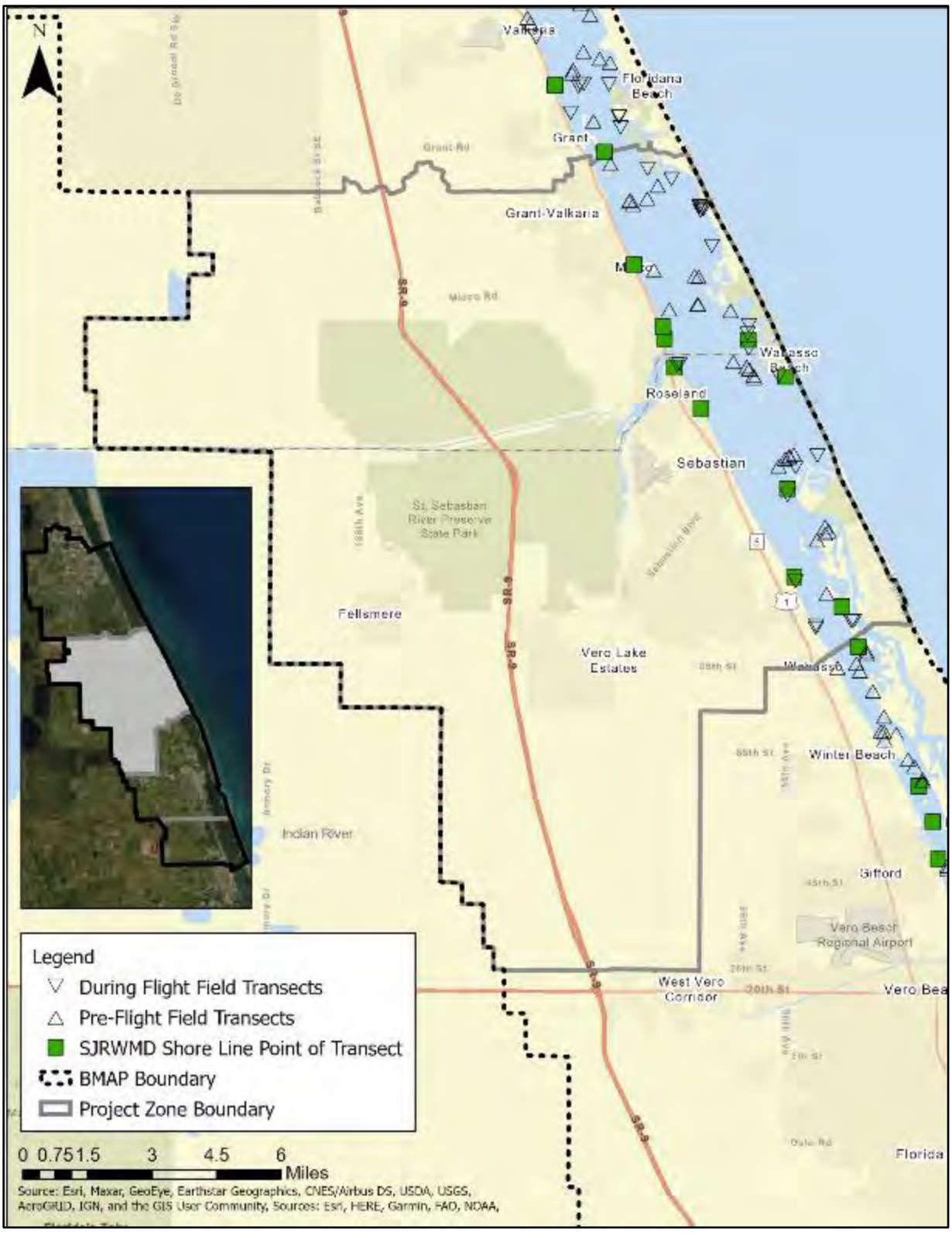

Figure D-2. Map of the seagrass transects in CIRL SEB

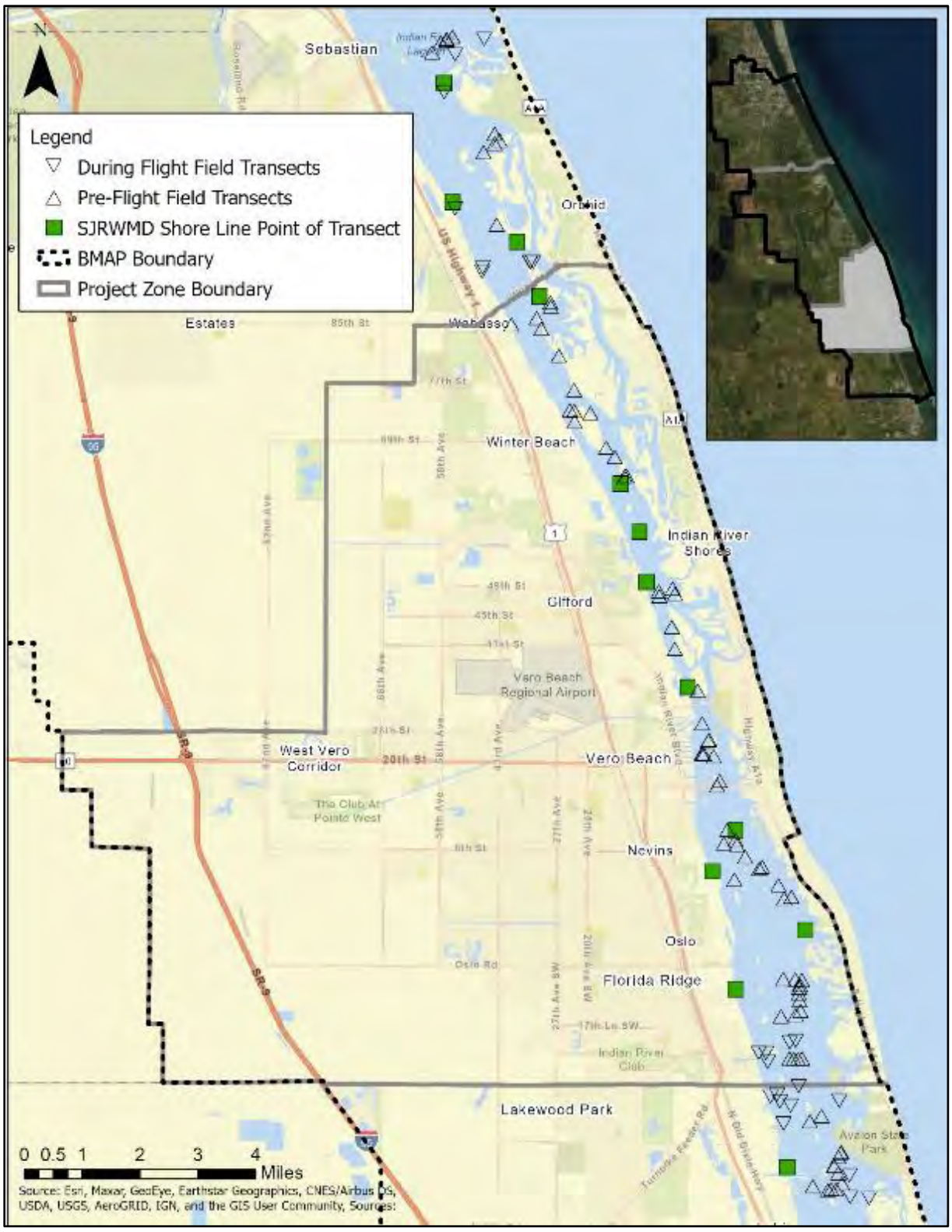

Figure D-3. Map of the seagrass transects in CIRL B

Appendix E. WCDs and Other Special Districts

In the 2013 BMAP, WCDs and other special districts were assigned quantitative (numeric) allocations, which included all agricultural and urban lands within their jurisdictional boundaries that were not part of an MS4. During the development of the 2013 BMAP, there were concerns with this approach, because FDACS is the only entity that can enroll agricultural producers in BMPs, but the WCDs were held responsible for reducing loading from the agricultural areas. In addition, the urban lands within the districts were permitted by the city or county and not under the district's control.

Therefore, this 2020 BMAP assigns qualitative (activity-based) allocations to the special districts for the canals and rights-of-way, as the districts have control over these portions of their jurisdictions. The districts are required to implement specific canal and right-of-way BMPs to be compliant with the BMAP. The BMPs for each special district are based on the activities and land uses in the district, and reporting on those BMPs is due annually. The included BMP plans were prepared and submitted by each individual WCD and reviewed by DEP.

Fellsmere Water Control District (FWCD)

The FWCD (formerly known as the Fellsmere Drainage District) was created April 8, 1919, under the General Drainage Laws of the State of Florida, by a Circuit Court proceeding (St. Lucie County, Case No. RED 533) and currently operates under Chapter 298 of the Florida Statutes, and amendments thereto, as an Independent Single Purpose Special District. The district was created and is responsible for the drainage, flood protection, and control with respect to drainage in times of excess water within its geographical boundaries. The FWCD does not generate any nutrient loading. The district receives the runoff from the lands within the gravity drainage portion of the overall district and conveys the flow to the Fellsmere Main Canal discharge point. The district map is shown in **Figure E-1**.

The original overall district watershed included 50,000 acres of land primarily used for agriculture. The system includes east-west sublateral ditches approximately one-quarter mile on center. Because of the naturally occurring 10 mile ridge (Interstate 95) east of the district; the land generally slopes from east to west. The one-quarter mile ditches flow west into the lateral canals. The lateral canals flow north to the Fellsmere Main Canal.

The Fellsmere Main Canal is located along the north boundary of Indian River County and is graded to drain east through the 10-mile ridge and into the west prong of the St. Sebastian River. A plug in the Fellsmere Main Canal west of Lateral U, and internal control structures in Lateral U near Sublateral Ditch 20 and in Park Lateral near Sublateral Ditch 24, separates the gravity drained watershed and the pumped drained watershed.

With the acquisition of lands and development of the Upper St. Johns River Basin project by SJRWMD, the watershed basin of the original Fellsmere Water Control District has been reduced to 34,000 acres. A majority of the remaining area within the Fellsmere Water Control

District is owned by Fellsmere Joint Ventures (FJV) and is pumped, or partially pumped, into portions of the Upper St. Johns River Basin.

Figure E-1. Map of the Fellsmere WCD

The remaining gravity drained portion of the FWCD is drained by two lateral canals (Park Lateral and Lateral "U"). Generally, Park Lateral drains all the land within FWCD lying east of Park Lateral (including "The Original Town of Fellsmere") and north of Sub-lateral PL-24, containing approximately 14.0 square miles. Park Lateral also partially drains the former "Berry Groves" parcel (now owned by FJV), containing approximately 6 square miles, that is pumped south into the Blue Cypress Water Management Area (BCWMA), during heavy rainfall events.

Lateral "U" Canal gravity drains all the land west of Park Lateral Canal and north of Sublateral U-20, containing approximately 8.4 square miles, and partially drains a portion of its southern basin (between Sublateral U-20 and U-28), containing approximately 2.5 square miles. This area is pumped south into BCWMA during heavy storm events.

The remaining nongravity-drained portions of the district are drained through pump stations, all owned and operated by FJV (SunAg, Inc.), into water management areas of the Upper St. Johns River Basin.

The FJV agricultural land that gravity drains to the CIRL is enrolled and is subject to the BMP Program managed by FDACS.

FWCD developed the *Permit Information and Criteria Manual for Use of or Connection to Works of the District*, the purpose of which is to provide information describing the criteria and permitting requirements relating to the utilization of, and connection to, the works of the FWCD. A copy of the manual and other information associated with FWCD can be found on the district's website: http://www.fellsmerewatercontroldistrict.com/permits.html.

FWCD proposes that the listed BMPs will be implemented and reported as active-based strategies. A specific allocation or nutrient reduction target will not be established. Rather, the FWCD's activities will serve to assist in the control of nutrients as part of the efforts described in the BMAP. Implementation of the BMPs shall provide compliance with the BMAP.

In selecting the BMPs, in coordination with DEP, the function, operation, and budget of FWCD has been considered. Each year, during the annual report information collection period, FWCD will confirm that these activities continue in its canals and rights-of-way. Each BMP includes a description and the required records.

Fellsmere Water Control District BMPs (For the Gravity Drainage Watershed Area Only)

1. Assist FDACS, where needed, with identifying and contacting producers within the district boundaries for purposes of participating in the relevant FDACS BMP programs.

    - Report: Number of landowners contacted to assist FDACS, and the names of landowners.

2. For all new change of land use development projects, exempting single family residences, a FWCD connection permit will require the compliance with the

stormwater discharge limitation policy of 2 inches/24 hours for a 25-year-24-hour storm event. This limitation applies to any 24-hour period (hour 10–34, hour 14-38, etc.) during the 72 hours starting at time 0 of a 25-year, 24-hour storm event.

- Report: The FWCD will provide the developer's engineer with a boundary condition at the connection point to the FWCD system. The boundary condition will include a time stage summary for hours 0 – hour 72 of the 24-hour–25-year event. A list of projects permitted over the year will be provided.

3. Routine maintainence of laterals and sublaterals for drainage and flood protection for land owners. Harvest aquatic vegetation in the canals using mechanical processes along with some necessary herbicide treatment. Vegetation removed from the canals must be disposed of in a location where the material will not be able to reenter the canal. Vegetation harvesting should consider the DEP guidelines in *Removal of Aquatic Vegetation for Nutrient Credits in the Indian River Lagoon (IRL) Basin* (September 2012).

    - Report: Dates when harvesting occurred and disposal location. Report any herbicide treatments and justification for nonmechanical removal of vegetation.

4. Provide public education to residents of the FWCD that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.

    - Report: Provide link or brief summary of the information regarding the encouraged use of BMPs throughout the district.

FORT PIERCE FARMS WATER CONTROL DISTRICT (FPFWCD)

The FPFWCD was originally created in 1919 under the provisions of Chapter 298, F.S., commonly referred to as the General Drainage Law of Florida. The FPFWCD is located in St. Lucie County, and current FPFWCD boundaries encompass roughly 13,000 acres. The FPFWCD is responsible for drainage, flood control and protection, water managemen and the reclamation of lands within FPFWCD boundaries. The FPFWCD owns, operates, and maintains works for water management and regulates their use by others. The water management system generally includes a network of approximately 50 miles of canals, and associated pumps and water control structures. The Phillip C. Gates structure is the main water control structure located within Canal No. 1 that serves to regulate stormwater discharges into the Indian River Lagoon from FPFWCD. The original construction consisted of four 8 foot (ft) by 16 ft radial gates that opened from the bottom at elevation 6 ft National Geodetic Vertical Datum (NGVD). In 2018, FPFWCD completed a retrofit project in which the two outer gates were split at elevation 10 ft-NGVD and the two center gates were split at elevation 8 ft-NGVD. The retrofitted structure reduces sediment deposits downstream of the structure. An aerial map of the FPFWCD boundary (thick

white line) and drainage canals is shown in **Figure E-2**. A more detailed map identifying the canal numbers and associated rights of way is shown in **Figure E-3**.

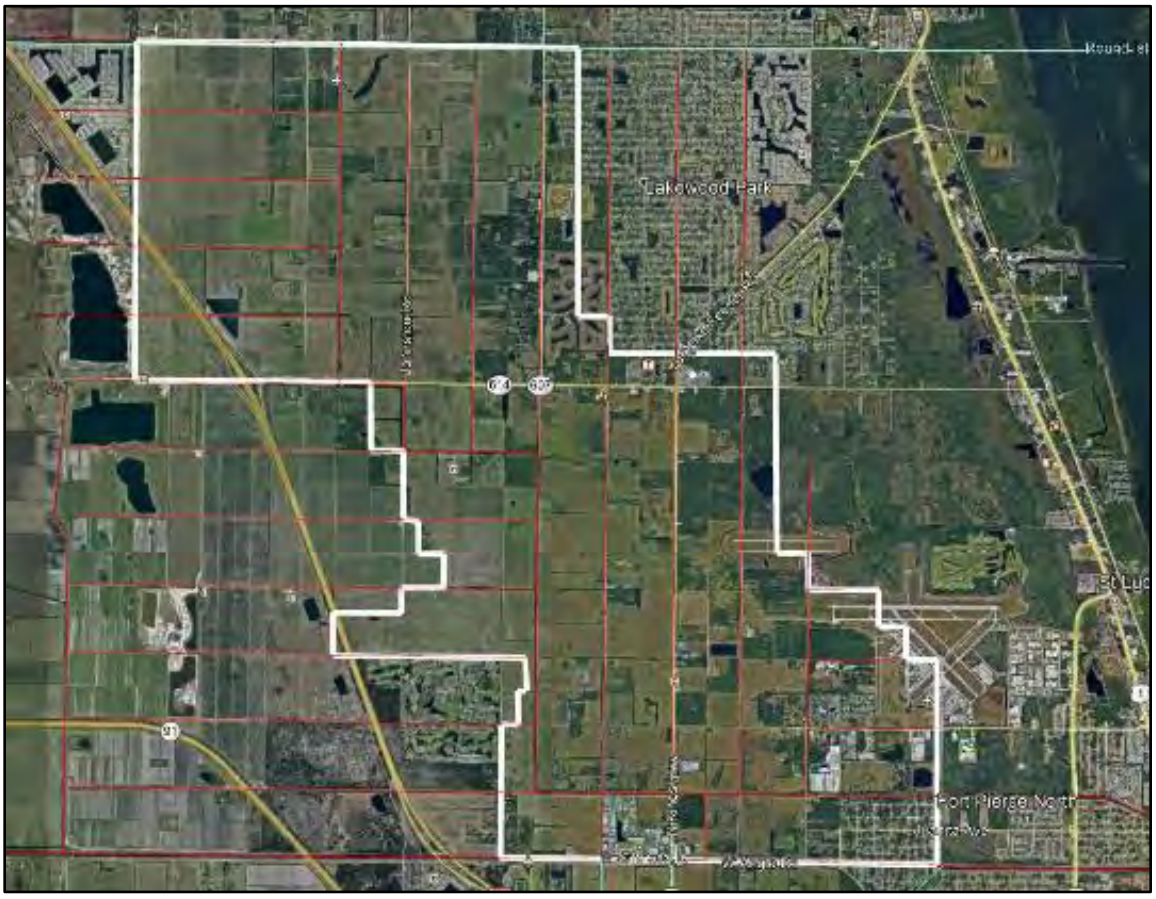

Figure E-2. Map of the FPFWMD

A map generally depicting the agricultural producers enrolled within the FPFWCD is on file with FDACS. Significant stormwater entering the FPFWCD canals is subject to the FDACS program. Additionally, stormwater entering the FPFWCD canals are subject to criteria imposed by other local, state, and federal agencies—including, but not limited to, the City of Fort Pierce, St. Lucie County, SFWMD, DEP, and U.S. Army Corps of Engineers (USACE).

The FPFWCD developed the *Permit Information and Criteria Manual for Use of or Connection to Works of the District*, the purpose of which is to provide information describing the criteria and permitting requirements relating to the utilization of, and connection to, the works of the FPFWCD. A copy of the manual and other information associated with FPFWCD can be found on the district's website: http://fpfwcd.org/.

The FPFWCD proposes that the listed BMPs will be implemented and reported as active-based strategies. A specific allocation or nutrient reduction target will not be established. Rather, the

FPFWCD's activities will assist in the control of nutrients as part of the efforts described in the BMAP. The implementation of the BMPs shall provide compliance with the BMAP.

In selecting the BMPs, in coordination with DEP, the function, operation, and budget of the FPFWCD has been considered, and these listed BMPs should not be considered as cost-effective, technically practical, or applicable to any other water control district within the BMAP area. Each BMP includes a description and the required records.

1. Aquatic Vegetation Control

Description: Perform harvest aquatic vegetation within the canals using mechanical processes to the extent practicable to reduce the need for herbicide treatment. Vegetation removal from the canals shall be placed in a manner as to limit the possibility of the material reentering the canal. Use of herbicide treatments shall be used at locations where canal bank stabilization measures, such as rock riprap, have been installed.

Report: Disposal of material outside of the district's rights-of-way is cost prohibitive at this time and will only be performed when deemed necessary by the district. The FPFWCD shall report herbicide treatment locations and provide a justification for each location.

2. Canal Buffer

Description: Create a canal buffer or filter strip to help reduce loading from stormwater runoff to the canals. Maintenance activities consisting of mowing the canal banks shall be limited to the area outside a minimum distance of 10 feet from the canal top-of-bank. Mowing and maintenance activities shall be done in such a way to prevent grass clippings from entering the canals, where they can decompose and add nutrients.

Report: Width and locations (or percentage of canal banks that include a buffer strip) of vegetated buffer strip. Type and location of any alternative methods of canal buffer or filter strips.

3. Assist FDACS

Description: Assist FDACS, where needed, with identifying and contacting landowners/ producers within the district boundaries for the purposes of participating in the relevant FDACS BMP programs.

Report: Number of landowners/ producers information requested by FDACS and response provided.

4. Public Education and Outreach

Description: Provide public education to residents of the district that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.

Report: Provide a link or brief summary of the information regarding the encouraged use of BMPs throughout the district.

5. Control Structures

Description: Maintain existing water control structures and any adjustable gates on water control structures. The location of each water control structure can be found on the map in **Figure E-3**.

Report: Provide an update on any changes to existing water control structures including, but not limited to structure removal, modification or significant repairs.

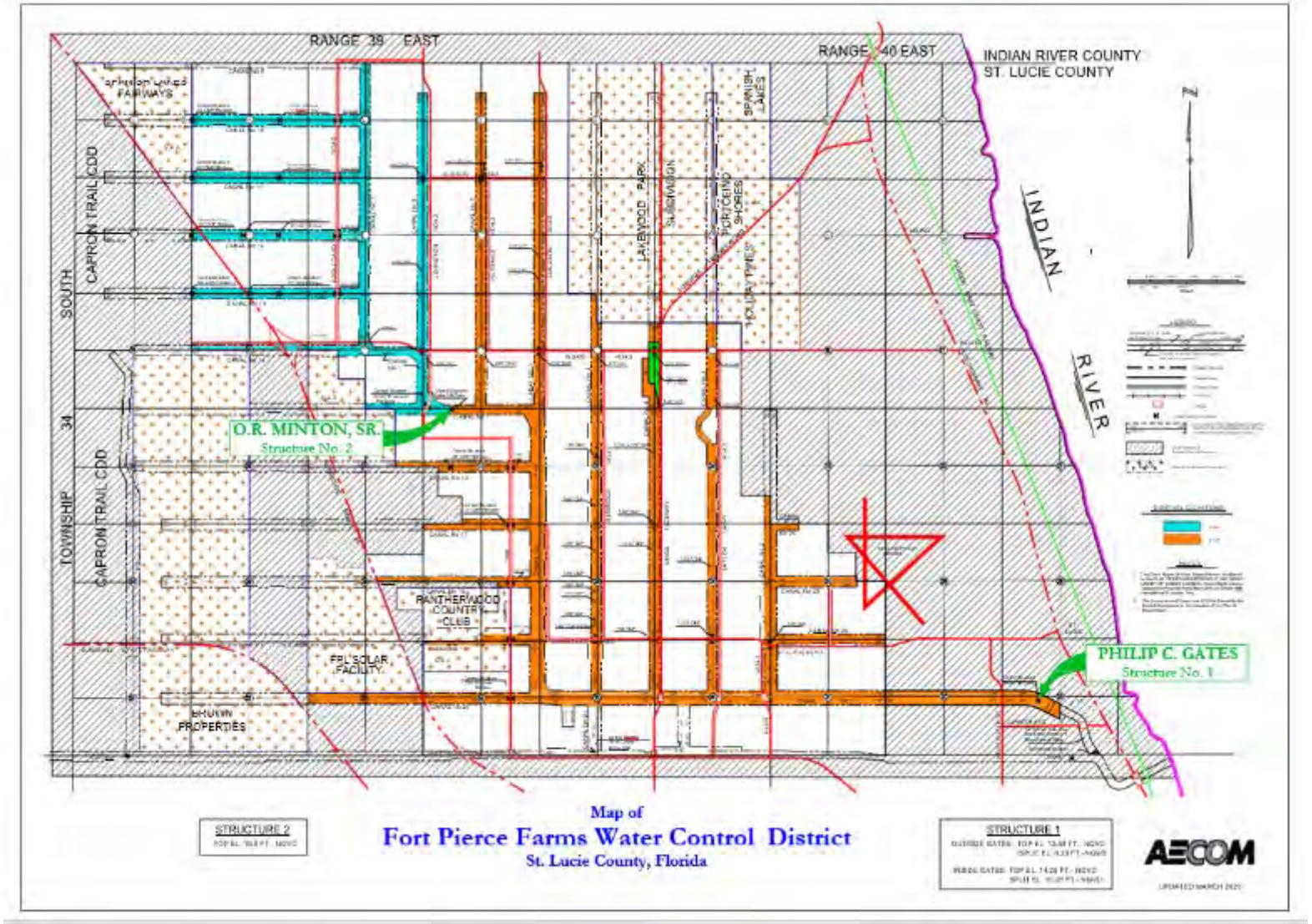

Figure E-3. Map of the FPFWCD

INDIAN RIVER FARMS WATER CONTROL DISTRICT (IRFWCD)

The original Plan of Reclamation of the IRFWCD, formerly known as the Indian River Farms Drainage District, was initially adopted and approved by the Board of Supervisors of the Indian River Farms Drainage District on March 4, 1920.

At that point in time, the Indian River Farms Drainage District was located in St. Lucie County (Indian River County was created in June 1925), and the order approving the Report of Commissioners was approved by the Fifteenth Judicial Circuit in St. Lucie County on August 18, 1921, and recorded in Chancery Order Book 2, Page 493, Public Records of St. Lucie County.

The original Plan of Reclamation (now an integral part of the "Water Control Plan") has long been completed, and the IRFWCD now functions as an operations and maintenance entity of the *Works of Improvements* therein.

In the early to mid 1980s, the IRFWCD approved and undertook a project of evaluation and updating of the original *Works of Improvements of the District*. This study resulted in the creation of a computer model of the District's facilities and various revised recommendations in the operations of the district, including the two-inches-per-day volume discharge limitation.

The district map is shown in **Figure E-4**.

The IRFWCD contains approximately 50,000 gross acres lying within portions of Township 32 and 33 South, Range 39 East and Township 33 South, Range 38 East, and a small portion of Township 33 South, Range 40 East in Indian River County.

The IRFWCD contains the western portion of the City of Vero Beach (primarily west of the ancient coastal dune/ridge located along the Florida East Coast Railroad alignment) and the remainder of the district lies within the unincorporated area of Indian River County.

The 1913 Plat of Indian River Farms Subdivision was originally subdivided into primarily 40-acre, more or less, tracts and developed for agricultural use. With the growth of population and development in the IRFWCD, the gradual conversion of agricultural lands to urbanization has occurred concentrically around the City of Vero Beach (westward from the coast) and along major corridors such as State Road 60, 27th Avenue, 43rd Avenue, 58th Avenue, and Oslo Road (9th Street, S.W.)

The initial canal system was designed and constructed by the Indian River Farms Company in the 1912 to 1917 era, and contained only the Main Outfall Canal.

In early 1919, steps were taken to reorganize the former "district" under the General Drainage Laws of Florida. This new district was modified and reformed into the Indian River Farms Drainage District in May of 1919 and currently operates under Chapter 298, F.A.. This plan

expanded the limits of the original project, adding the north and south relief canals and interconnecting lateral and sublateral canals.

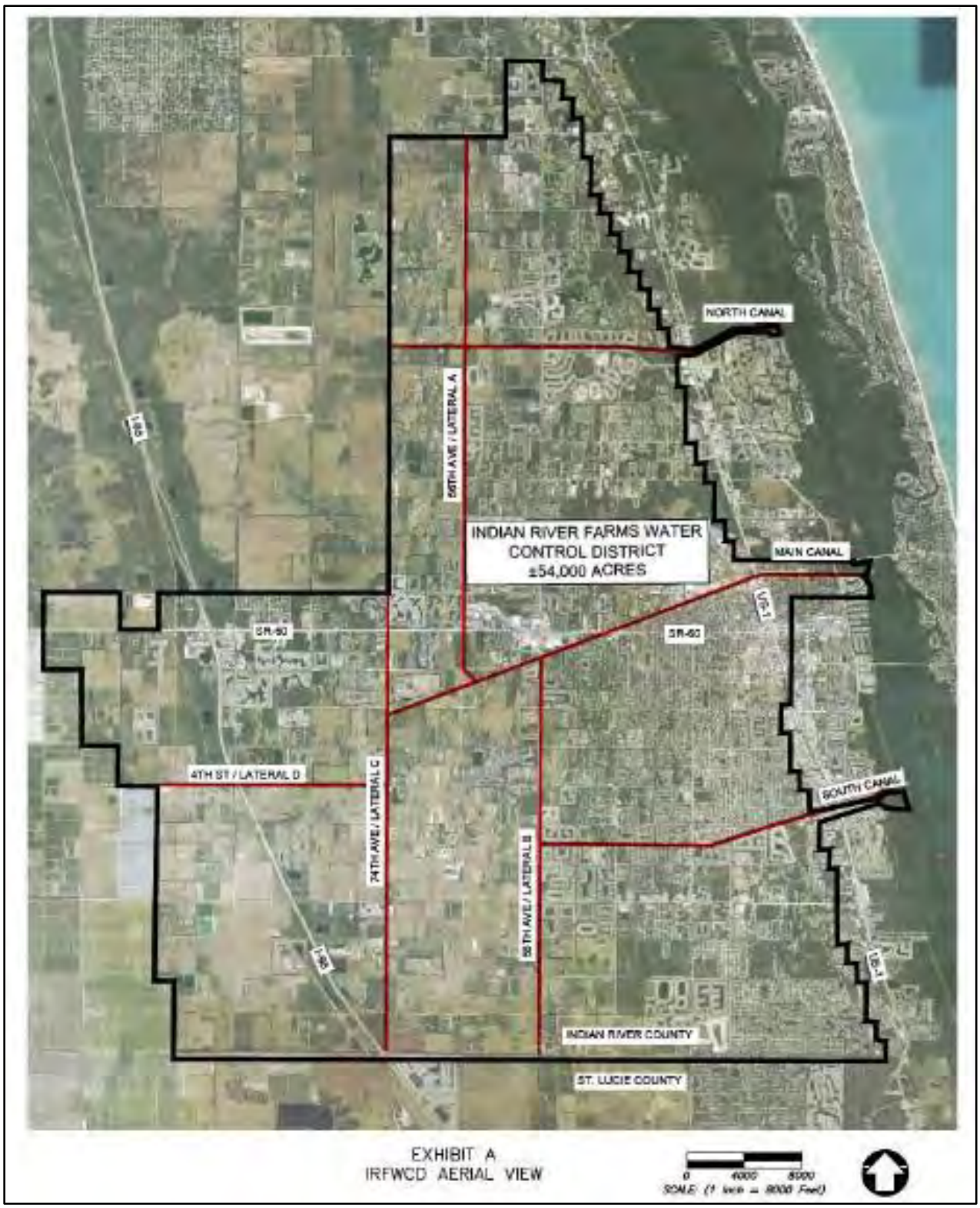

Figure E-4. Map of the IRFWCD

This system was designed and constructed only as a gravity flow drainage district comprising many sublateral canals spaced one-half mile apart (generally along section and one-quarter section lines in an east-west alignment). These sublateral canals discharge into lateral canals (generally running in a north-south direction which, in turn, discharge into three major relief canals) that ultimately outfall into the IRL.

The initial design and construction of the system contained only one structure in the Main Canal. This structure is a drop spillway structure and provides a grade transition from 9.0 ft above sea level upstream to 0.00 ft downstream to prevent erosion and sloughing in the Main Relief Canal.

In the mid-1950s, radial gate water control structures were constructed in the three outfall canals to (1) reduce irrigation requirements, (2) conserve water, and (3) provide a limited source of supplemental irrigation water.

A salinity control weir structure was constructed in the Main Canal downstream of the drop spillway structure in 1962 to protect the City of Vero Beach wellfield from saltwater intrusion, and to provide irrigation water for the Vero Beach Country Club golf course.

In 1963, a fourth radial gate water control structure was added in Lateral "C" Canal (74th Avenue) south of 8th Street to reduce irrigation requirements and provide a limited source of irrigation for landowners in the southwest portion of the district.

The operation of the radial gate structures in the district relate directly to the duration and intensity of storm events and the antecedent rainfall conditions. The gates are kept closed a majority of the time, maintaining a minimum elevation of 15.5 ft, more or less, above sea level upstream of the 3 radial gates located in the 3 outfall canals, and 18.5 ft, more or less, above sea level upstream of the Lateral "C" structure.

These gates are opened, or partially opened, following storm events that create flooding conditions in the respective upstream pool elevations of the structures. The gates are opened only for a few hours to relieve flooding conditions in the affected areas. Following major storm events and complete ground saturation, the gates may be left open for a few days to provide groundwater draw down.

The IRFWCD is isolated from surrounding drainage by a levee (elevation 28.5 ft, more or less, above sea level, 6 ft to 8 ft top width and 1.5 ft to 1 ft side slope) along its north, west, and south boundary and by a coastal/dune ridge along its eastern boundary. It is further protected by adjoining water control districts along its north, west and southern boundaries, and serves no area outside its geographic area.

The IRFWCD proposes that the listed BMPs will be implemented and reported as active-based strategies. A specific allocation or nutrient reduction target will not be established. Rather, the IRFWCD's activities will assist in the control of nutrients as part of the efforts described in the BMAP. The implementation of the BMPs shall provide compliance with the BMAP.

In selecting the BMPs, in coordination with DEP, the function, operation and budget of the IRFWCD has been considered. Each year, during the annual report information collection period, the IRFWCD will confirm that these activities continue in their canals and rights-of-way. Each BMP includes a description and the required records.

Indian River Farms Water Control District BMPs

1. Harvest aquatic vegetation in the canals using mechanical processes along with some necessary herbicide treatment. Vegetation removed from the canals must be disposed of in a location where the material will not be able to reenter the canal. Vegetation harvesting should consider the DEP guidelines in *Removal of Aquatic Vegetation for Nutrient Credits in the Indian River Lagoon (IRL) Basin* (September 2012).

    - Report: Dates when harvesting occurred and disposal location. Report any herbicide treatments and justification for nonmechanical removal of vegetation.

2. For all new change of land use development projects, exempting single-family residences, an IRFWCD connection permit will require the compliance with the stormwater discharge limitation policy of 2 inches/24 hours for a 25-year-24-hour storm event. This limitation applies to any 24-hour period (hour 10–34, hour 14–38, etc.) during the 72-hours starting at time 0 of a 25-year, 24-hour storm event.

    - Report: The IRFWCD model results will provide the developer's engineer with a boundary condition at the connection point to the IRFWCD system. The boundary condition will include a time stage summary for hours 0 – hour 72 of the 24-hour–25-year event. A list of projects permitted over the year will be provided.

3. Provide public education to residents of the district that fosters an understanding of the necessity to reduce nutrient impacts to surface waters.

    - Report: Provide a link or brief summary of the information regarding the encouraged use of BMPs throughout the district.

4. Assist FDACS, where needed, with identifying and contacting producers within the district boundaries for purposes of participating in the relevant FDACS BMP programs.

    - Report: Number of landowners contacted to assist FDACS, and the names of landowners.

MELBOURNE-TILLMAN WATER CONTROL DISTRICT (MTWCD)

The Melbourne-Tillman Water Control District (MTWCD) is a dependent special district authorized by the Florida Legislature under Chapter 2001-336, Laws of Florida, as amended by Chapters 2003-334 and 2010-253, respectively, for the purpose of constructing, reconstructing, and repairing, maintaining, and operating a surface water management system.

It was initially authorized as an independent district in 1922 for land reclamation for agricultural development and operating under Chapter 298, F.S.. It was reorganized as a dependent district in 1986 under Chapter 86-418, Laws of Florida, and codified in the 2001 legislation.

The Board of Directors has the power to establish a water management system to prevent damage from flooding, soil erosion, and excessive drainage; to promote the conservation, development, and proper utilization of surface and ground water; to preserve natural resources, fish, and wildlife; to maintain water quality; and to preserve and protect natural systems within and surrounding the district. The Board may authorize the cleaning, straightening, widening, or the change of course or flow, and alter or deepen any canal, ditch, drain, watercourse, or natural stream within the district boundaries. The building and construction of other works and improvements to preserve and maintain the works of the district are also authorized.

The MTWCD encompasses portions of unincorporated Brevard County, City of West Melbourne, City of Melbourne, City of Palm Bay, Town of Malabar, and Town of Grant-Valkaria. MTWCD is responsible for maintaining a primary network of canals within the district boundary. Various parcels have privately owned outfalls to the canals, with runoff from the remaining lands collected by the various governmental agencies delivering the runoff to the canals.

A map of the MTWCD canals and boundary is shown in **Figure E-5**. The district owns and maintains over 2,300 acres of canal rights-of-way in 163 miles of canals; 50 % has a right-of-way width greater than 100 ft, and 8 % has a right-of-way width greater than 250 feet. The district boundary covers 102 square miles.

The MTWCD proposes that the listed BMPs will be implemented and reported as activity-based strategies. A specific allocation or nutrient reduction target will not be established. The MTWCD's activities will assist in the control of nutrients as part of the efforts described in the IRL BMAP. Implementation of the BMPs shall provide compliance with the BMAP.

The BMPs, in coordination with DEP, are selected with the function, operation, and budget of the MTWCD in consideration, and the BMPs are not intended to be cost-effective, technically practical, or applicable to any other water control district within the BMAP area. Each BMP includes a description and the required record keeping.

It is recognized that the configuration of the canals and rights-of-way are limiting factors to the performance of certain BMP. An annual report confirming the activities identified are reported to DEP, with detailed records kept at the MTWCD office.

Melbourne-Tillman Water Control District BMPs

1. Redirect flows to the St Johns River from the IRL during certain storm conditions. Replacement of the control structure gates (from underflow to over top) in the WCD's structure at the east end of Canal C-1 was completed in 2011.
    - Report: Once completed, reports will be included with those defined in Point 5 below. Establish and maintain a stormwater aeration system at specified locations.
    - Report: Operation type, location (shapefile), and operation. Operation and any maintenance for the structure(s).
2. Introduce turbidity-reducing polymers to canals such as woodchip logs.
    - Report: Operation type, location (shapefile), operation, and monitoring reports. Operation and any maintenance for the structure(s).
3. Establish and maintain biological/bacteria treatment at specified locations.
    - Report: Operation type, location (shapefile), operation, and monitoring reports. Operation and any maintenance for the structure/facility(s)
4. Harvest aquatic vegetation in the canals using mechanical processes instead of herbicide treatment. Vegetation removed from the canals must be disposed of in a location where the material will not be able to reenter the canal. Vegetation harvesting should consider the DEP guidelines in *Removal of Aquatic Vegetation for Nutrient Credits in the Indian River Lagoon (IRL) Basin* (September 2012).
    - Report: Dates when harvesting occurred and disposal location. Report any herbicide treatments and justification for nonmechanical removal of vegetation.
5. Maintain existing water control structure(s).
    - Report: Structure type, location (shapefile), and operation. Operation and any maintenance for the structure(s).
6. Provide education outreach and public involvement efforts as follows:
    - Update website with links and literature related to clean waters and the IRL.
    - Participate in educational training to include the Florida Erosion and Sedimentation Control Inspector program.

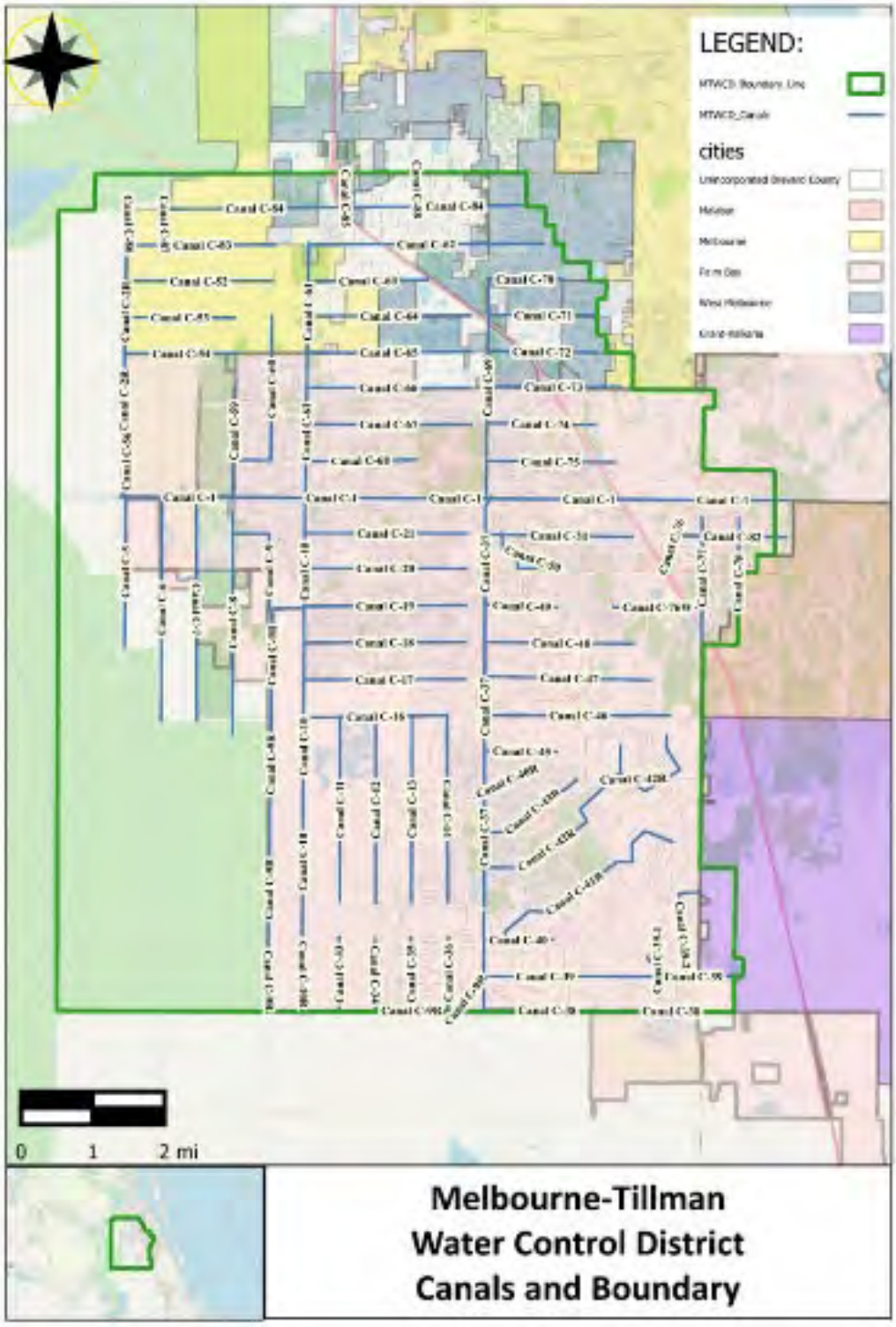

Figure E-5. Map of the MTWCD

SEBASTIAN RIVER IMPROVEMENT DISTRICT (SRID)

The SRID is a "Chapter 189 – Improvement District" that was originally organized as a "Chapter 298 Drainage District." Reorganized under Chapter 189, the district is now known as SRID; however, the district still operates as a single-purpose drainage district.

The Sebastian River Water Control District was initially created by Decree of Incorporation entered by the Circuit Court in 1927 and included approximately 50,000 acres. Following the 1929 Depression, the Plan of Reclamation was scaled back in 1939 to the approximate 11,000 acres of the present day SRID.

The SRID system was designed and constructed as a gravity flow drainage district comprising sublateral canals spaced one-half mile apart in an east to west alignment. These sublateral canals discharge into Lateral Canals C and L which are constructed in a north-south alignment and drain to the north, and discharge into the south fork of the St. Sebastian River that ultimately outfalls into the IRL.

In the late 1950s, radial gate water control structures were constructed in the two outfall canals to (1) reduce irrigation requirements, (2) conserve water, and (3) provide a limited source of supplemental irrigation water.

In 2009, the district undertook a project to create a Survey Inventory of Existing Infrastructure and prepared a report called, "Stormwater Modeling to Evaluate the Works of Improvements of the District." This study resulted in the creation of a computer model of the district's facilities and various revised recommendations for the operations of the district, including the 2-inches-per-day volume discharge limitation.

The SRID contains a few residential areas, churches, a golf course, and schools but remains mostly in agricultural lands that lie within the unincorporated area of Indian River County.

The operation of the radial gate control structures within the district relate directly to the duration and intensity of storm events and the antecedent rainfall conditions. The gates are kept closed the majority of the time, maintaining a minimum elevation of 14.5 and 12.5 ft NAVD, more or less, upstream of the radial gates located in Lateral Canals C and L, respectively.

The district map is shown in **Figure E-6**.

These control gates are opened, or partially opened, following storm events that create flooding conditions in the respective upstream pool elevations of the structures. The gates are opened only for a few hours to relieve flooding conditions in the affected areas. Following major storm events and complete ground saturation, the gates may be left open for a few days to provide groundwater drawdown.

The SRID is isolated from surrounding drainage to the west by a levee. The south and east boundaries are common boundaries with IRFWCD, and each district has levees and boundary canals to manage water within their limits. The north boundary of SRID is isolated with smaller dikes, since the land slopes off the Sebastian River to the north.

The SRID proposes that the listed BMPs will be implemented and reported as active-based strategies. A specific allocation or nutrient reduction target will not be established. Rather, the SRID's activities will assist in the control of nutrients as part of the efforts described in the BMAP. The implementation of the BMPs shall provide compliance with the BMAP.

In selecting the BMPs, in coordination with DEP, the function, operation, and budget of the SRID has been considered. Each year, during the annual report information collection period, the SRID will confirm that these activities continue in its canals and rights-of-way. Each BMP includes a description and the required records.

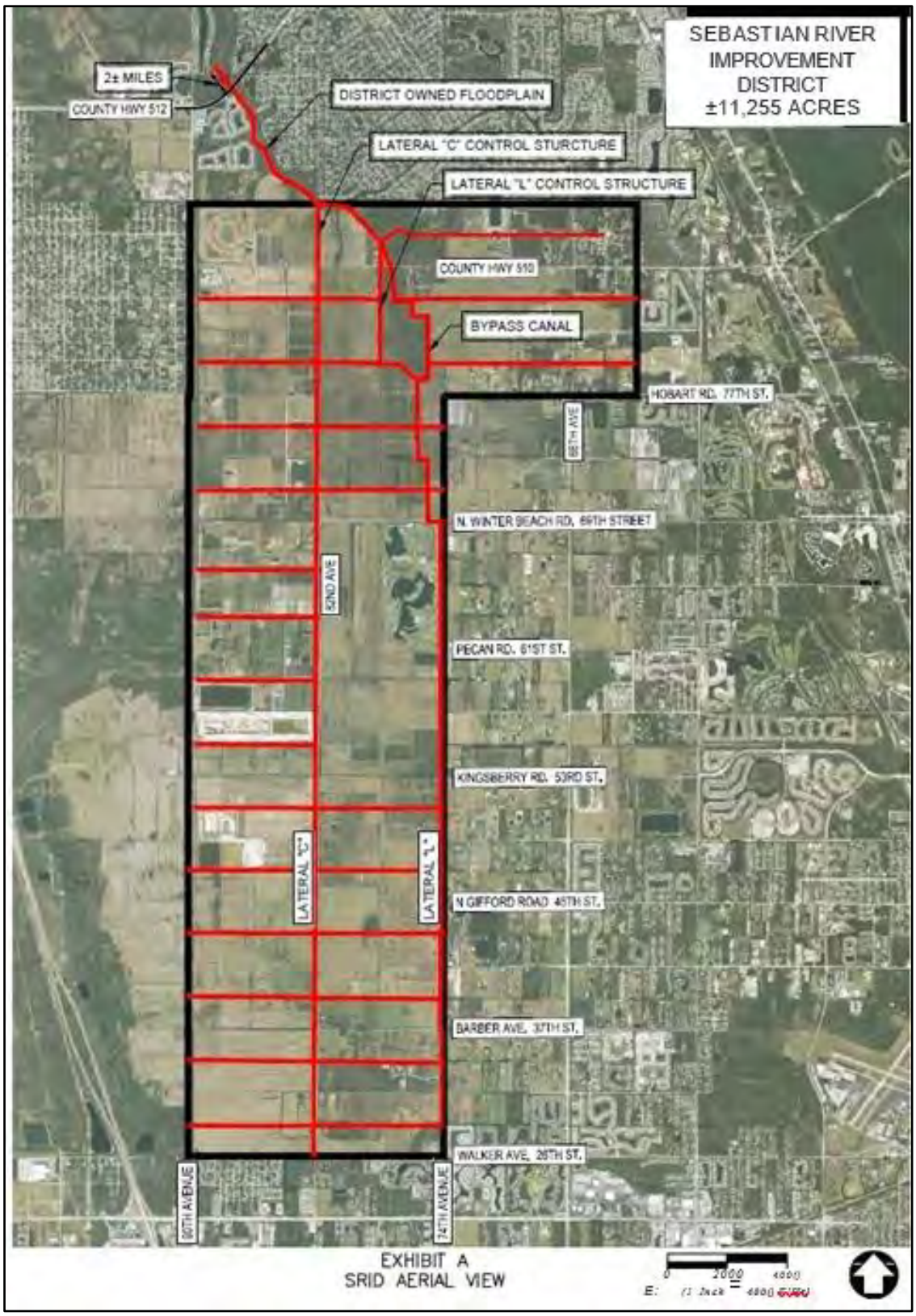

Figure E-6. Map of the SRID

Sebastian River Improvement District BMPs

1. Harvest aquatic vegetation in the canals using mechanical processes along with some necessary herbicide treatment. Vegetation removed from the canals must be of disposed in a location where the material will not be able to reenter the canal. Vegetation harvesting should consider DEP guidelines in *Removal of Aquatic Vegetation for Nutrient Credits in the Indian River Lagoon (IRL) Basin* (September 2012).

    - Report: Dates when harvesting occurred and disposal location.

2. For all new change of land use development projects, exempting single-family residences, a SRID connection permit will require compliance with the stormwater discharge limitation policy of 2 inches/24 hours for any 24-hour period (hour 10–34, hour 14–38, etc.) during a 25-year–24-hour storm event. The SRID will provide the developer's engineer with a boundary condition at the connection point to the SRID system. The boundary condition will include a time stage summary for hours 0–hour 72 of the 24-hour–25-year event.

    - Report: A list of projects permitted over the year will be provided.

3. Assist FDACS, where needed, with identifying and contacting producers within the district boundaries for purposes of participating in the relevant FDACS BMP programs.

    - Report: Number of landowners contacted to assist FDACS, and the names of landowners.

VERO LAKES WATER CONTROL DISTRICT

The Vero Lakes Water Control District (VLWCD) is a Chapter 298 District originally established as Vero Lakes Drainage by Decree of Incorporation of the Ninth Judicial Circuit in Indian River County, dated June 17, 1965. The VLWCD encompasses approximately 6,250 acres located entirely in north Indian River County, Florida. In general, the district is bisected by I-95, with portions of the district lying both east and west of I-95. The entire district is located south of SR 512. See **Figure E-7** to better locate the boundaries of the district (shown in blue).

The entire district is undeveloped, raw land with a single landowner. The entire district is in agriculture for the purpose of cattle raising. The stormwater runoff is collected in various low wetland areas. A primary ditch carries some stormwater from the southwest to the northeast section of the district that lies west of I-95. There are culverts under I-95 that allow some runoff that does not percolate back into the soil to flow east towards the eastern edge of the district.

Eventually, water that does not percolate back into the soil flows east to Lateral D. This does not increase the nutrient load in the runoff. The natural, undeveloped land acts as a filter for any runoff that makes its way east to Lateral D.

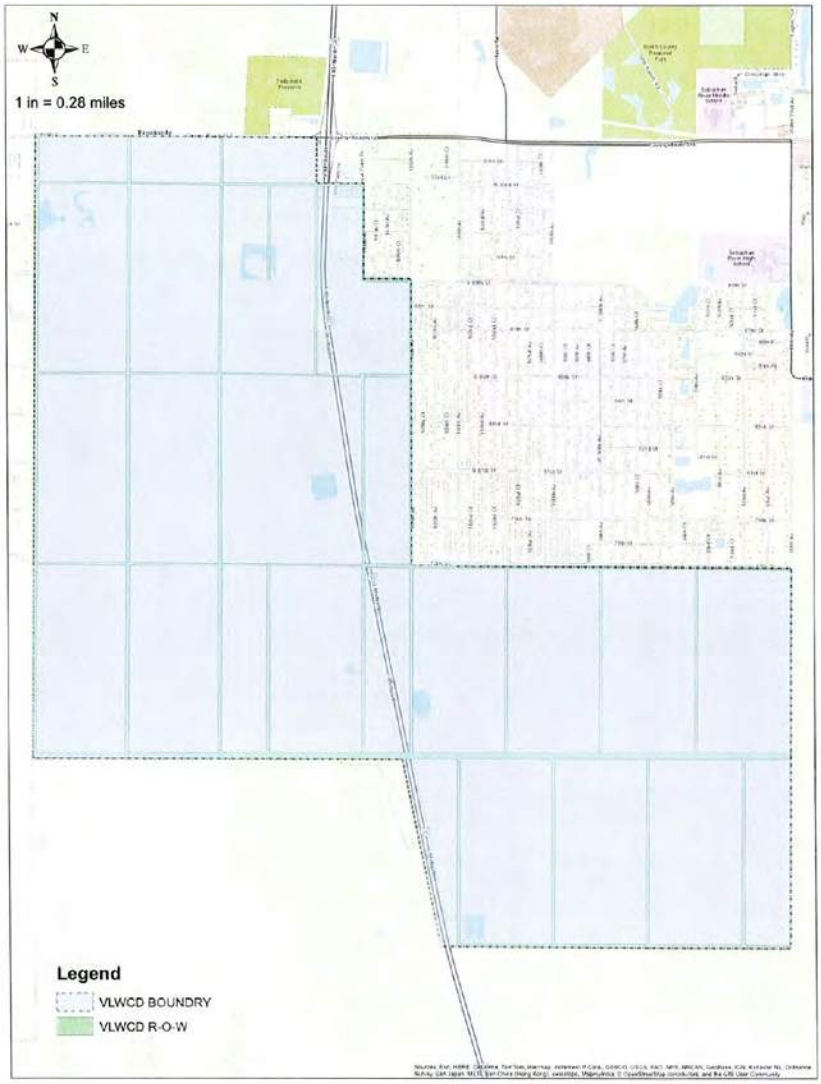

Figure E-7. Map of the VLWCD

The VLWCD proposes that the listed BMPs will be implemented as activity-based strategies. A specific nutrient-based reduction target will not be established. Rather, the VLWCD's activities will assist in the control of nutrients as part of the efforts described in the BMAP. Implementation of the BMPs shall provide compliance with the BMAP.

In selecting the BMPs, in coordination with DEP, the function, operation, and budget of the VLWCD has been considered, and these listed BMPs should not be considered cost-effective,

technically practical, or applicable to any other water control district within the BMAP. Each BMP includes a description and the required records.

The VLWCD will provide DEP with an annual report confirming the following activities:

1. **Public Education and Outreach**

Description: The VLWCD shall include as part of its annual meeting, an agenda item to alert the landowner of the existence of the BMAP and requirements for this landowner.

Report: Annual Landowner's Agenda. A copy of the agenda and material shall be kept on file.

2. **FDACS BMP Assistance**

Description: The VLWCD will provide assistance to FDACS when requested. The VLWCD will identify the current landowner and his contact information as shown on the VLWCD records. The VLWCD will contact the landowner to encourage participation in the FDACS BMP program and encourage him to contact DEP if he have any questions.

Report: Landowner information requested by FDACS and the response provided.

3. **Nutrient Controls**

Description: No nutrients imported via direct land application in the VLWCD rights of way.

Report: Annual verification by VLWCD.

4. **Canal/Ditch Bank Berms**

Description: Minimize sediment transport by constructing berms on top of canal/ditch banks and promoting vegetation to cover. The agricultural pasturelands will continue to drain into the main ditch via smaller tributaries. On a regular basis, sediment is removed from the ditch and Lateral D canal. Vegetation is removed by mechanical methods, and not by herbicide treatment. Bank slopes are maintained at a slope that is flatter to prevent erosion.

Report: Visual observation and dates when sediment is removed.

5. **Control Structures and Culverts**

Description: There are no control structures within the VLWCD. Regular inspection is made to ensure flow is maintained through culverts.

Report: Annual verification by VLWCD.

6. **Fertilizer Cessation**

Description: No application of fertilizer within the VLWCD rights-of-way.

Report: Annual verification by VLWCD.

Appendix C

Indian River Lagoon National Estuary Program Comprehensive Conservation and Management Plan

Looking Ahead to 2030:

A 10-Year Comprehensive Conservation and Management Plan for the Indian River Lagoon, Florida

ONE LAGOON

ONE COMMUNITY · ONE VOICE

INDIAN RIVER LAGOON
NATIONAL ESTUARY PROGRAM

*This Final Draft version of the **Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) – Looking Ahead to 2030** replaces the Preliminary Final Draft version and the original Draft version that were provided to the Indian River Lagoon National Estuary Program (IRLNEP) Management Conference and public on the IRL Council website, www.irlcouncil.com, to facilitate open access to the CCMP and encourage public comments. This Final Draft version will remain open on the IRLNEP website and available for comments until certification of the Final Draft is completed by the U.S. Environmental Protection Agency (USEPA), recommended changes are made (if necessary), and a Final USEPA certified CCMP is reviewed by the IRLNEP Management Conference and adopted by the IRL Council in 2019. All public comments have been and will be recorded and posted on the website.*

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ACRONYMS AND ABBREVIATIONS

AWT	Advanced Wastewater Treatment
BMAP	Basin Management Action Plan
BMP	Best Management Practice
CCMP	Comprehensive Conservation and Management Plan
CERP	Comprehensive Everglades Restoration Plan
DEO	Department of Economic Opportunity
DEP	Department of Environmental Protection
ECERT	East-Central Estuarine Restoration Team
FDACS	Florida Department of Agriculture and Consumer Services
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FWC	Florida Fish and Wildlife Conservation Commission
FIT	Florida Institute of Technology
GIS	Geographic Information System
HAB	Harmful Algal Bloom
IRL	Indian River Lagoon
IRLI^2	Indian River Lagoon Innovator and Investor (Network)
IRLNEP	Indian River Lagoon National Estuary Program
MFC	Marine Fisheries Council
mg/L	Milligrams per Liter
MRC	Marine Resources Council
MSD	Marine Sanitation Device
NASA	National Aeronautics and Space Administration
NEP	National Estuary Program
NERT	Northeast Florida Estuarine Restoration Team
NMFS	National Marine Fisheries Society
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
OAWP	Office of Agricultural Water Policy
ORCA	Ocean Research & Conservation Association
OSTDS	Onsite Sewage Treatment and Disposal System
PFAS	Perfluorinated Alkyl Substances
RAP	Reasonable Assurance Plan
SFWMD	South Florida Water Management District
ShORE	Sharing Our Research with Everyone
SJRWMD	St. Johns River Water Management District
SRF	State Revolving Fund
STEMAC	Science, Technology, Engineering, and Modeling Advisory Committee
SWIM	Surface Water Improvement and Management (Program)
TBD	To Be Determined
TMDL	Total Maximum Daily Load
UF-IFAS	University of Florida Institute of Food and Agricultural Sciences
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WMDs	Water Management Districts
WWTP	Wastewater Treatment Plant

IRL COUNCIL RESOLUTION AND ADOPTION

WHEREAS, the creation of the Indian River Lagoon (IRL) Council (an independent special district of the state of Florida) to serve as the host agency for the IRL National Estuary Program (IRLNEP) was driven by a common goal to improve communication, coordination, leadership, and investment among the federal, state, and local government agencies and private-sector organizations throughout the IRL watershed.

WHEREAS, this vision for change began at the local level on September 13, 2013 when representatives from the six counties along the IRL (Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach) met for the first time as the IRL Counties Collaborative to begin an organized local effort to respond more effectively to declining IRL water quality, recurring harmful algal blooms, and negative impacts to local economies. These discussions led to the creation of the IRL Council in February 2015. The Interlocal Agreement was last amended in 2017.

WHEREAS, the IRL Council began its first fiscal and operational year on October 1, 2015 and worked quickly and strategically to hire staff, relocate the IRLNEP headquarters to Sebastian, Florida, and establish a new IRL Management Conference of citizens, scientists, and community leaders to advise the IRL Council Board of Directors.

WHEREAS, IRL Council creation and IRLNEP reorganization provided an immediate benefit of increased and diversified financial support for IRL restoration from $600,000 of annual federal funding to $2,100,000 annually of mixed federal, state, and local funding. These new revenues allowed for continued and expanded funding for IRL restoration projects consistent with the 2008 IRL Comprehensive Conservation and Management Plan (CCMP).

WHEREAS, in fiscal year 2016–2017, the IRL Council and IRLNEP successfully completed and passed a mandatory five-year program evaluation with U.S. Environmental Protection Agency that is an obligation for continued federal funding and which re-aligned the IRLNEP brand to “One Lagoon – One Community – One Voice” to reflect the commitment to a program that is community-based and consensus-driven.

WHEREAS, the IRL Council and IRLNEP recognize that the IRL CCMP is a science-based pathway to restore ecosystem and economic health to the IRL that is long-term, non-regulatory, consensus-driven, and community-based.

WHEREAS, the IRL Council and IRLNEP Management Conference have adopted the following:

VISION: Healthy Ecosystem – Healthy Communities – Healthy Economy

MISSION: One Lagoon – One Community – One Voice

PROMISE: Clean Water for People and Nature

GOALS:

1. To attain and maintain water and sediment of sufficient quality to support a healthy estuarine lagoon ecosystem;
2. To attain and maintain a functioning, healthy ecosystem which supports endangered and threatened species, fisheries, commerce, and recreation;
3. To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem; and
4. To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore, and enhance the IRL.

NOW THEREFORE BE IT RESOLVED that the IRL Council Board of Directors adopt this revised IRL CCMP (*Looking Ahead to 2030*) with support from our Management Conference advisory committees: Management Board; Science, Technology, Engineering, and Modeling Advisory Committee; and Citizens Advisory Committee. This final CCMP has been revised with input from citizens throughout the IRL watershed.

The IRL Council and IRLNEP will work with our citizens, cities, government agencies, academic institutions, and business community to seek expanded funding for implementation of the CCMP action recommendations.

DONE, ORDERED, AND ADOPTED by the IRL Council Board of Directors on this 14th day of December 2018.

_____ Chris Dzadovsky, Chair St. Lucie County Commission	_____ Deb Denys, Vice Chair Volusia County Council
_____ Susan Adams, Secretary Indian River County Commission	_____ Stacey Hetherington Martin County Commission
_____ Bryan Lober Brevard County Commission	_____ Drew Bartlett Florida Department of Environmental Protection
_____ Doug Bournique St. Johns River Water Management District	_____ Brandon Tucker South Florida Water Management District

U.S. ENVIRONMENTAL PROTECTION AGENCY CONCURRENCE

Placeholder – USEPA concurrence email or letter

MESSAGE FROM IRLNEP EXECUTIVE DIRECTOR

The Indian River Lagoon National Estuary Program (IRLNEP) Management Conference and staff are pleased to present this revised Comprehensive Conservation and Management Plan (CCMP) (*Looking Ahead to 2030*). This CCMP is supported by a Community and Citizen's Guide to the CCMP. The CCMP was developed with significant input from the IRLNEP Management Conference, stakeholders, local communities, and citizens. Thank you all for your thoughts, advice, and comments. This CCMP is a significant revision from the 2008 CCMP update. It responds to the dramatic water quality changes, seagrass losses, and declining fisheries that the Indian River Lagoon (IRL) has faced since the 2011 superbloom.

This IRL CCMP revision also looks beyond the defined IRL watershed to consider connected waters and watersheds more explicitly. This approach includes a formal boundary amendment adopted in 2016 that extends planning to include the southern portion of the Halifax River in Volusia County. This CCMP revision also looks westward at connections with the St. Johns River and connections between the St. Lucie Estuary, Lake Okeechobee, and Everglades restoration, as well as eastward to include inlets connecting the IRL to nearshore waters.

This CCMP revision has been developed in alignment with U.S. Environmental Protection Agency (USEPA) program performance criteria for National Estuary Programs (NEPs) and Section 320 of the 1987 Clean Water Act, as reauthorized by the U.S. Congress in 2016. NEPs promote comprehensive planning for long-term protection of nationally significant estuaries in the United States that are deemed to be threatened by pollution, development, or overuse. Restoration is implemented through collaborative and voluntary efforts by local, city, state, federal, private, and interest group stakeholders convened as a Management Conference. The purpose of the IRLNEP Management Conference is to:

- Assess trends in water quality, natural resources, and uses of the estuary.
- Collect, characterize, and assess data on harmful contaminants, nutrients, and natural resources within the estuarine zone to identify the form and causes of environmental problems.
- Clarify how pollutant loads from legacy (in-place), point, and nonpoint sources affect the estuary's potential uses, water quality, and natural resources viability.
- Develop a CCMP that recommends priority corrective actions and compliance schedules for addressing all sources of pollution and for restoring and maintaining the physical, chemical, and biological integrity of the estuary, including restoration and maintenance of water quality; balanced populations of indigenous shellfish, fish, and wildlife; recreational and commercial activities; and other designated uses of the estuary.
- Develop plans for the coordinated implementation of the CCMP by the federal, state, regional, and local partners participating in the Management Conference.
- Monitor the effectiveness of CCMP actions and track trends in conditions.
- Review all federal financial assistance programs and federal development projects in accordance with Clean Water Act requirements.

The IRL Council and IRLNEP Management Conference and our local community partners will work cooperatively to implement this CCMP revision. This plan recommends the following broad actions that will be necessary to restore and sustain IRL health:

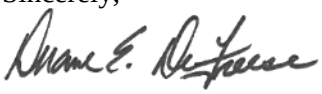
- Take individual and community ***RESPONSIBILITY*** for your impacts on the IRL. If you own or contribute to a problem, fix the problem. Each action decreases IRL vulnerability and builds IRL ***RESILIENCE***.
- ***REDUCE*** nutrients and other pollutants entering the IRL from all sources.

- ***REMOVE*** muck, nutrients, pollutants (including known surface water and groundwater pollutant or toxicant sources that threaten human or lagoon health), litter, invasive species, and human-built impediments to natural water circulation.
- ***REBUILD*** aging and/or inadequate wastewater and stormwater infrastructure to reduce loads of nutrients, other pollutants, and sediments to the IRL.
- ***RESTORE*** impaired natural IRL habitats with priority action for seagrasses, filter feeders, living shorelines, and wetlands with a spatial mosaic that supports biological diversity.
- Invest in scientific ***RESEARCH*** strategically targeted to improve restoration and stewardship of resources, with full support from comprehensive and integrated monitoring of conditions and progress throughout the lagoon.
- ***RESPOND*** to changes and new information quickly, responsibly, and with the best available science.
- Expand public participation, leadership, investment, and ***RESOLVE*** among diverse stakeholder groups throughout the IRL watershed to achieve our mission, "One Lagoon – One Community – One Voice."
- ***REPORT*** activities, projects, challenges, opportunities, and financial expenditures to document trends in the system, evaluate the progress of restoration, and provide transparency and accountability.

In support of this CCMP revision, the IRLNEP assembled a preliminary list of proposed projects that will improve wastewater infrastructure, reduce reliance on conventional septic systems, retain and treat stormwater, rehabilitate habitats, and enhance planning for resilient communities. This list was assembled from data provided by the partners in our Management Conference. This working list of projects will be evaluated and revised annually by the IRLNEP Management Conference to ensure that we have a pipeline of "shovel-ready" projects that can move forward to completion with available funding. The preliminary list of projects clearly demonstrates that IRL improvements will require multiple projects to move forward to completion at varying spatial and temporal scales. This will require proper alignment of project types to available and future funding streams, as well as expanded annual funding at local, state and federal levels.

None of the above actions will occur without public support for expanded and accelerated funding for IRL infrastructure, water quality improvement, and habitat restoration projects. The foundation for that support depends on well-informed and engaged citizens, partners, and policy-makers making sound financial investments in IRL restoration and stewardship. This is a long-term commitment to clean water. The future ecological health of the IRL, economic vitality of our communities, and quality of life depend on it.

Sincerely,



Duane De Freese, Ph.D., Executive Director
IRL Council and IRLNEP

A Call to Action:

"…passionately continue the task of facing seemingly insurmountable challenges to do the right thing for our environment."

Nathaniel "Nat" Pryor Reed (1933-2018)
Jupiter Island, Florida
October 2016
Travels on the Green Highway

THE NATIONAL ESTUARY PROGRAM

The National Estuary Program (NEP) is a non-regulatory program established by the U.S. Congress and administered by the U.S. Environmental Protection Agency (USEPA). The NEP was authorized by Section 320 of the Clean Water Act in 1987. Each estuary in the NEP was designated by the U.S. Congress as an "Estuary of National Significance." Today, 28 estuaries located along the Atlantic, Gulf, and Pacific coasts and in Puerto Rico have been designated as estuaries of national significance.

NEPs reside in a variety of institutional settings, including state and local agencies, universities, and individual nonprofits. In overseeing and managing the national program, USEPA provides annual funding, national guidance, and technical assistance to the local NEPs.

The 28 NEPs develop and implement Comprehensive Conservation and Management Plans (CCMPs), which are long-term plans that contain actions to address challenges and priorities related to water quality and living resources. Work is focused within a study area that includes the estuary and its watershed. NEP challenges and priorities are defined by local, city, state, and federal public agencies, and private-sector and independent-sector interest groups. The NEP is a collaborative, effective, efficient, and adaptable coastal ecosystem-based network. With more than 20 years of experience implementing key provisions of the Clean Water Act, the NEP is the nation's principal watershed program—one that offers a viable, effective method for protecting and managing all types of watershed environments.

NEPs assist the nation in restoration and stewardship of 28 estuaries of national significance that represent a portfolio of natural and human-built assets that drive the coastal economy of the U.S. For example, in 2016, the National Ocean Economics Program estimated the U.S. coastal economy at $13.9 trillion or 83.7% of the U.S. gross domestic product for all coastal states based on 2013 data.[1]

[1] National Ocean Economics Program. 2016 Update. State of the U.S. Ocean and Coastal Economies. Available online at http://midatlanticocean.org/wp-content/uploads/2016/03/NOEP_National_Report_2016.pdf.

INDIAN RIVER LAGOON

An estuary is a coastal waterbody where freshwater tributaries (rivers and streams) meet the waters of the sea. It is this subtle but important mixing of fresh and salt waters that make estuaries the most productive and fragile coastal ecosystems in the world. A lagoon is a special type of estuary that is oriented parallel to the coast and characterized by shallow coastal waters with restricted, but free, exchange with the adjacent open ocean. The Indian River Lagoon (IRL) is a microtidal system that has limited exchange with the ocean through five inlets (Ponce de Leon, Sebastian, Fort Pierce, St. Lucie, and Jupiter). Port Canaveral connects the ocean to the lagoon through an engineered lock system that is used for access by maritime vessels.

The distance between inlets and the small tidal range on the east coast of Florida limits exchange between the ocean and the IRL system. In fact, circulation of water in large portions of the IRL is driven primarily by wind. Because of the long residence times and flow restrictions from land-based development (i.e., causeways, wetland alterations, and past construction practices) in some locations, the IRL is highly sensitive to nutrient and pollutant loadings from the watershed. Inputs from the watershed have continued to increase during recent decades, causing declines in water quality and changes to the ecological and biological integrity of the ecosystem.[2]

The IRL system is composed of three distinct and connected estuaries: the Indian River Lagoon, Banana River Lagoon, and Mosquito Lagoon. The IRL system extends 156 miles from the Ponce de Leon Inlet to Jupiter Inlet. It spans three climate zones, from temperate to subtropical to tropical. It encompasses almost 40% of the east coast of Florida and connects five counties (plus an additional two counties, Palm Beach and Okeechobee, within the watershed), 38 incorporated cities, and approximately 1.6 million residents. The lagoon watershed covers 2,284-square miles, and the lagoon's waters span 353-square miles.

Healthy estuaries provide many ecosystem services and support coastal assets of national significance:

- Serve as centers of biological diversity.
- Provide essential natural habitats that support birds, mammals, fishes, and other wildlife.
- Support a complex food web upon which much marine life depends.
- Act as "bread baskets" for coastal oceans, providing productive nursery areas and habitats that support both commercial and recreational fisheries.
- Provide natural wetland buffers that reduce stormwater runoff, reduce flooding, and treat nutrients and runoff protecting coastal ocean water quality.
- Protect coastal areas from natural hazards, including storm surges, flooding, erosion, and impacts from sea level rise.
- Connect bodies of water for transportation and marine operations.
- Represent waters and complex watersheds that support many of the largest and oldest coastal cities with diverse historical, cultural, and environmental assets.
- Serve as centers of commerce with significant public and private infrastructure, including harbors and ports vital for shipping and transportation; tourism destinations; scientific research, restoration, and education centers; and military installations.
- Improve real estate values for properties on and near the estuary.
- Attract residents and visitors for recreational fishing, boating, swimming, and wildlife viewing.
- Provide many ecosystem services that support America's valuable coastal economy. Nurture an enviable, water-dependent quality of life.

The IRL is home to a rich array of plants and animals whose existence depends on the quality of water within the lagoon. More than 2,000 species of plants, 600 species of fish, 300 species of birds, and 50 threatened or endangered species inhabit the IRL for at least some portion of their lives. Scientists have shown the IRL to be a biologically diverse estuary with approximately 4,000 species documented. Visitors come from across the globe to see the large and diverse number of birds, manatees, and dolphins, or to fish the waters of the lagoon, which also make the IRL an economic driver for the five counties it borders.

[2] Sigua, G., Steward, J., & Tweedale, W. 2000. Environmental Management 25: 199. https://doi.org/10.1007/s002679910016.

A 2016 economic valuation study by the East Central Florida and Treasure Coast Regional Planning Councils estimated the total annual economic output (value received) from the IRL in 2014 was about $7.6 billion. This figure did not include the estimated $934 million in annualized real estate value for properties located on or near the IRL, nor does it include the economic contributions from estuarine-related resources in Volusia County north of the Ponce de Leon Inlet. When both of these economic contributions are considered, total economic output is valued at about $9.9 billion annually.

However, decades of land use activities throughout the IRL watershed have upset the natural balance of this delicate ecosystem. Stormwater runoff from urban and agricultural areas, wastewater treatment plant (WWTP) discharges, inadequate and failing septic systems, and excess fertilizer applications have led to harmful levels of nutrients and sediments entering the lagoon. In addition, these pollutants lead to muck accumulation on the lagoon bottom, which damages healthy sediments and increases internal nutrient exchange. These changes create a lagoon bottom that is not conducive to seagrass, shellfish, or benthic invertebrate growth. Land use changes and urban development have changed the size and drainage patterns of the IRL watershed with the addition of drainage canals, mosquito control ditches, impervious surfaces, and causeways. Development impacts are most pronounced along IRL shorelines where dredge and fill activities, hardened shorelines, and coastal development have altered natural upland-wetland-lagoon connections.

2016 EXPANSION OF THE IRLNEP PLANNING BOUNDARY

At the request of the Volusia County Council (Resolution 2015-133) and with support from the Indian River Lagoon National Estuary Program (IRLNEP) Management Conference, the IRL Council adopted a boundary amendment in 2016 to expand the planning boundary of the IRLNEP northward into the Halifax River (Resolution 2015-04). The addition extends the IRLNEP northern planning boundary by approximately 25 miles and incorporates an additional 198,678 acres of watershed, including six of Volusia County's 16 drainage basins.

The amended boundary acknowledged the benefits of considering connected waters and watersheds in a broad, holistic, and regional approach to ecosystem-based management. Ecosystem-based management is a comprehensive and integrated approach that considers entire ecosystems, including people and infrastructure. By considering the connections within and among coastal watersheds, this approach addressed the cumulative impacts of multiple activities across space and time. This comprehensive, ecological approach ensures the continued provision of services people want and need by maintaining healthy and productive connected ecosystems. The boundary amendment also provided opportunities to better understand and plan for how climate change (including sea level rise) might influence the connectivity of water and wildlife along a north-south gradient that spans the temperate, subtropical, and tropical climate zones. For example, the additional area is part of the Atlantic Flyway for birds and provides pathways for migration of fishes, manatees, and other estuarine species.

IRLNEP MANAGEMENT CONFERENCE

Designation of the IRL as an "Estuary of National Significance," with authorization under Section 320 of the Clean Water Act, was first announced by President George H. W. Bush on Earth Day in 1990 and provided the catalyst for creating the IRLNEP and convening a Management Conference in 1991. The first CCMP was adopted by the Management Conference in 1996. The 1996 CCMP was then updated in 2008. From 1991-2015, the St. Johns River Water Management District (SJRWMD) served as the host agency for the IRLNEP. Dramatic changes to IRL health as the result of an unprecedented pico-cyanobacterial bloom in 2011 ("superbloom"), coupled with damaging seasonal freshwater releases from Lake Okeechobee to the southern IRL, heightened scientific and public concerns for the future of the IRL. These continuing and expanding threats resulted in a call to action from citizens; scientists; and local, state, and federal partners.

In 2013, the Indian River Lagoon Counties Collaborative met for the first time in response to the harmful algal blooms in 2011, 2012, and 2013. The Collaborative was initiated by Martin County Commissioner Ed Fielding, who was joined by Brevard County Commissioner Chuck Nelson, Indian River County Commissioner Peter O'Bryan, Palm Beach County Commissioner Hal Valeche, St. Lucie County Commissioner Chris Dzadovsky, and Volusia County Commissioner Joshua Wagner. The goals of the group were to better understand the causal agents of the algal blooms, create uniform water quality rules and regulations across county lines, and unify in the request for projects and funding from the state and federal legislatures for water quality issues. Over the months that followed, the collaborative engaged USEPA, Florida Department of Environmental Protection (DEP), SJRWMD, and South Florida Water Management District (SFWMD) in discussions to create a new, independent organization responsible for the IRLNEP. This initiative received both programmatic and technical best practices advice from the three other NEPs in Florida (Charlotte Harbor, Tampa Bay, and Sarasota Bay).

The new host agency for the IRLNEP, the IRL Council, was created by interlocal agreement on February 19, 2015, as an independent special district of the state of Florida. The partners to the interlocal agreement (DEP, SJRWMD, SFWMD, Volusia County, Brevard County, St. Lucie County, and Martin County) made commitments to provide annual funding contributions to the IRL Council. Pursuant to the interlocal agreement, IRL Council investors serve as the Board of Directors of the IRL Council and as the policy board of the IRLNEP. On September 8, 2015, an amended interlocal agreement was executed to extend IRL Council membership to include the Indian River County Lagoon Coalition, representing three cities in Indian River County (Vero Beach, Sebastian, and Fellsmere). The first operational fiscal year of the IRL Council began on October 1, 2015. On June 9, 2017, a second restated and amended interlocal agreement transferred representation from the Indian River County Lagoon Coalition to Indian River County Board of County Commissioners. The annual funding commitments from each of the IRL Council partners include $250,000 from DEP, $500,000 from SJRWMD, $500,000 from SFWMD, and $50,000 from each of the five counties (Volusia, Brevard, St. Lucie, Martin, and Indian River). In addition, USEPA contributes $600,000 per year, and the IRL license plate generates about $125,000 per year.

The driving force for the IRLNEP reorganization was a visionary and unified agreement among the participating IRL counties and cities that a new structure and business model for the IRLNEP was needed to achieve the following outcomes:

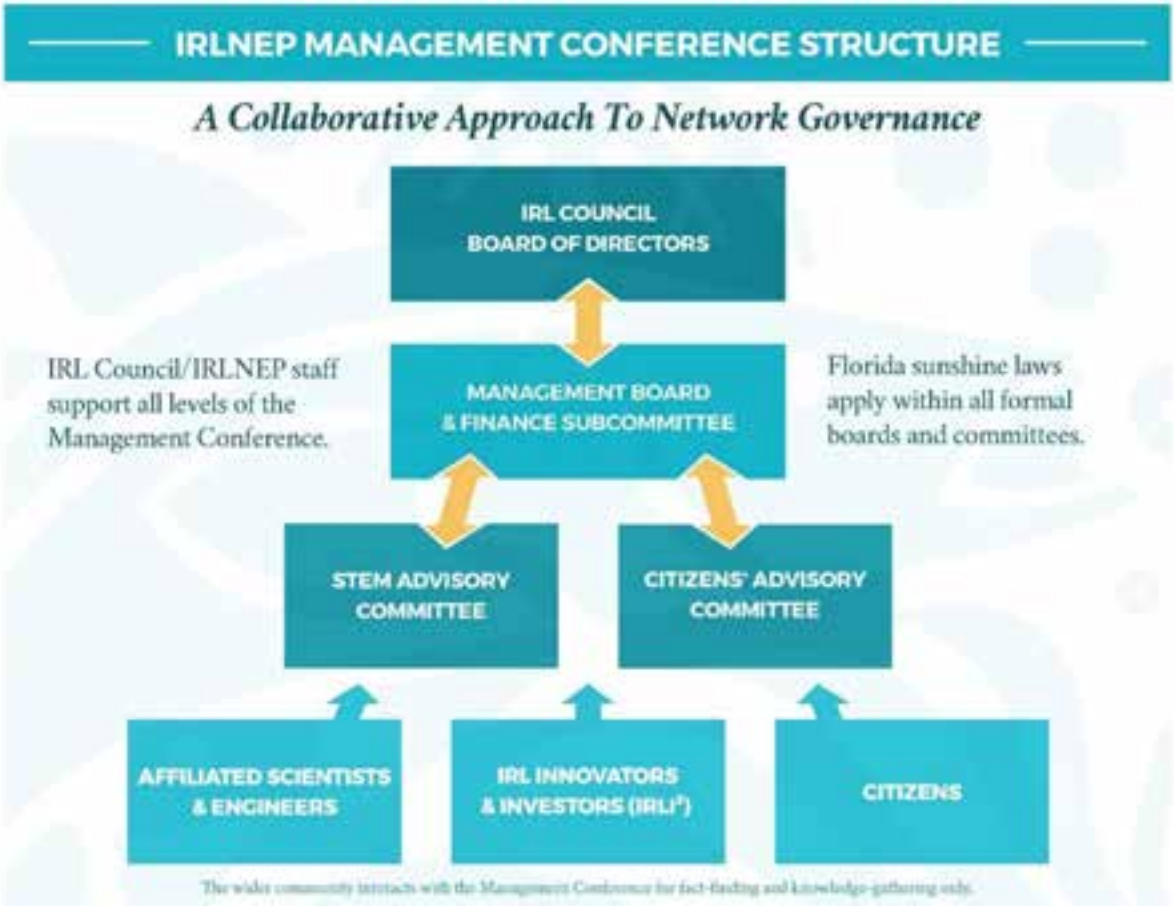
- Solve the urgent problems facing the IRL as a unified, focused, and science-based IRLNEP Management Conference.
- Ensure that the IRLNEP is a fully performing NEP based on USEPA performance measures.
- Enhance local community knowledge and engagement.
- Expand IRLNEP activities to be more inclusive of the entire IRL ecosystem, as well as adjoining systems that influence the lagoon watershed.
- Encourage greater participation from the private-sector.

- Expand and expedite funding for ecosystem restoration at all levels of the public-private-independent sector partnership.

The IRLNEP Management Conference is science-based, non-regulatory, collaborative, community-based, and consensus-driven. It is led by diverse interests from local, state, and federal agencies; academia; community and industry leaders; and citizens dedicated to developing and implementing the vision, mission, goals, and actions of the CCMP. The Management Conference recognizes that no individual organization, agency, or community can protect, restore, and manage the IRL watershed alone. Successful restoration and stewardship of the lagoon will require a common vision and unified effort among citizens and stakeholders throughout the IRL watershed.

The IRL Council created three advisory and oversight committees to provide advice and recommendations: (1) a Management Board comprising administrators and resource managers from local, regional, state, and federal government agencies and organizations, as well as a financial oversight sub-committee; (2) the Science, Technology, Engineering, and Modeling Advisory Committee (STEMAC) that provides scientific and technical expertise, guidance, and oversight from local academic and research institutions; and (3) the Citizens Advisory Committee comprised of local representatives (IRL Ambassadors) representing each of the five counties participating in the IRL Council who are responsible for ensuring that the IRLNEP is connecting to and communicating with local communities and citizens throughout the IRL region. In addition, the IRLNEP staff work directly with industry partners through the IRL Innovator and Investor (IRLI^2) Network.

USEPA serves in an advisory capacity to the IRL Council and is a voting member of the advisory Management Board. USEPA represents a major partner/investor to the IRLNEP consistent with Section 320 of the Clean Water Act and contingent upon Congressional reauthorization of Section 320 and annual Congressional appropriations for the NEP. USEPA also provides technical assistance and support to the IRLNEP Management Conference.



Together, the IRL Council and its Management Board and advisory and oversight committees represent the IRLNEP Management Conference. The Management Conference employs the network governance organizational model defined in Section 320 of the Clean Water Act. The IRLNEP Management Conference represents a more than 100-member citizen and scientist oversight committee that advises the IRL Council Board of Directors as they adopt policies and make annual budget and appropriation decisions to implement the CCMP actions. The IRL Council and IRLNEP staff acknowledge and thank all present and past members of the IRLNEP Management Conference for their support of the IRLNEP reorganization and CCMP revision. The current and former members of the Management Conference at the time of CCMP adoption are shown in the tables below.

IRL Council Board of Directors	IRL Council Board of Directors (alternates)
Chris Dzadovsky (Chair), St. Lucie County Commission	Frannie Hutchinson, St. Lucie County Commission
Deborah Denys (Vice-Chair), Volusia County Council	Billie Wheeler, Volusia County Council
Susan Adams (Secretary), Indian River County Commission	Tim Zorc, Indian River County Commission
Bryan Lober, Brevard County Commission	Rita Pritchett, Brevard County Commission
Stacey Hetherington, Martin County Commission	Doug Smith, Martin County Commission
Drew Bartlett, DEP Deputy Secretary	Thomas Frick, DEP
Doug Bournique, SJRWMD	William Tredik, SJRWMD
Brandon Tucker, SFWMD	Kathy LaMartina, SFWMD
Cesar Zapata, USEPA Region 4 (Advisory)	Jennifer DiMaio, USEPA Region 4 (Advisory)
Former IRL Council Board of Directors and Alternates	
Doug Daniels, Volusia County (2015-2016)	Dick Winger (2016)
Kevin Powers, SFWMD (2015-2017)	Joel Tyson (2015-2017)
Richard Gillmore, Indian River County Lagoon Coalition (2015-2016)	Curt Smith, Brevard County (2015-2018)
Ed Fielding, Martin County (2015-2018)	

IRL Council Management Board					
Jeff Beal, Florida Fish and Wildlife Conservation Commission (FWC)	Anthony Catanese, Florida Institute of Technology (FIT)	Doug Gibson, Volusia League of Cities	Chuck Jacoby, SJRWMD	Mike Littell, Citizen (Financial Subcommittee)	Marty Smithson, Sebastian Inlet Tax District
Vanessa Bessey, Florida Department of Agriculture and Consumer Services (FDACS)	Frank Catino, Brevard County	Stu Glass, Space Coast League of Cities (Financial Subcommittee)	Greg Wilson, Riverside Conservancy (Financial Subcommittee)	Mike McCabe, Melbourne-Tillman Water Control District	Thomas Stratton, Citizen (Financial Subcommittee)
Brad Blais, Mead and Hunt, Inc.	Mark Crosley, Florida Inland Navigation District	Layne Hamilton, U.S. Fish and Wildlife Service (USFWS)	George Jones, Ocean, Research and Conservation Association (ORCA)	Kelli McGee, Natua Strategies (Financial Subcommittee)	Laurilee Thompson, Brevard County Tourism Development Council
Mel Bromberg, WaterSHED International LLC (replacing Jim David, 2016-2018)	Jennifer DiMaio, USEPA Region 4	Clay Henderson, Stetson University	Bill Kerr, BKI, Inc.	Robert Musser, Canaveral Port Authority	William Tredik, SJRWMD
Thomas Campenni, Treasure Coast League of Cities (Financial Subcommittee)	Monte Falls, City of Vero Beach	Chris Hendricks, Sotheby's International Realty	Kathy LaMartina (Vice Chair), SFWMD	Judy Orcutt, Citizen	Robert Ulevich (Chair), Polymath Consulting Services, Inc.
Tom Carey, Volusia County	Joseph Falzone, Raymond James Financial (Financial Subcommittee)	Dianne Hughes, Martin County	Vince Lamb, Citizen	Lynne Phillips, National Aeronautics and Space Administration (NASA)/Kennedy Space Center	Charles Vogt III, Florida Department of Health (FDOH)
Paul Carlisle, City of Sebastian	Sara Davis, DEP (replacing Chris Ferraro, 2016-2018)	Mitch Hutchcraft, King Ranch	Barbara Lenczewski, Florida Department of Economic Opportunity (DEO)	Kevin Shropshire, City of Rockledge	

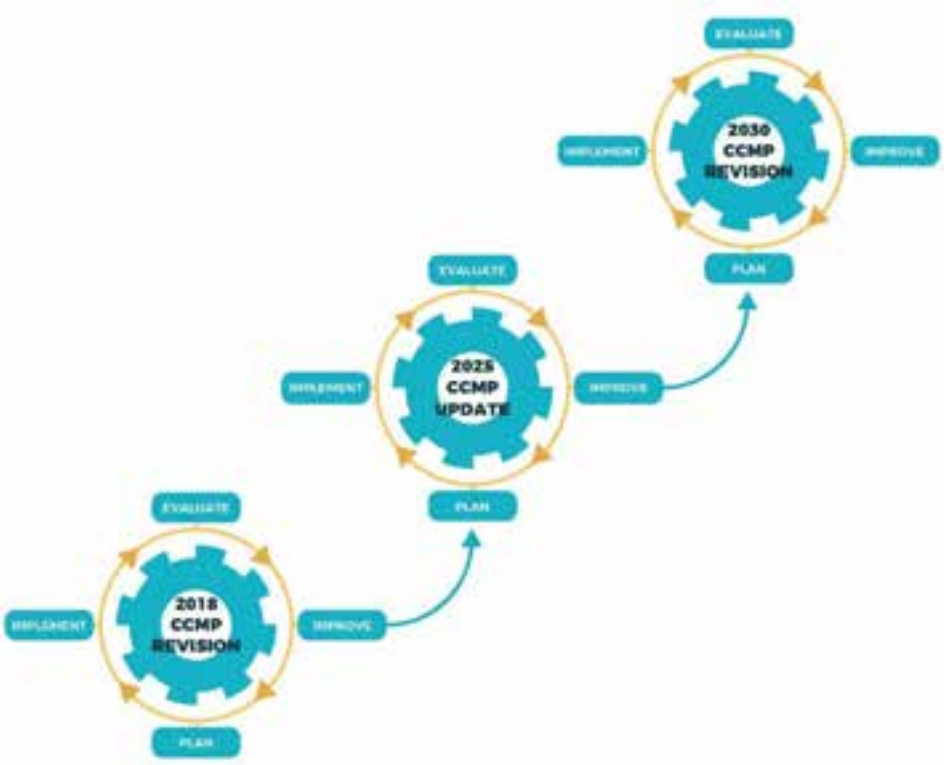
STEMAC				
Anne Birch, The Nature Conservancy	Patti Gorman, SFWMD	Mark Perry, Florida Oceanographic Society	Chris Bodisco, Stetson University	Chris Farrell, Florida Audubon
Mitch Roffer, Citizen	Adeljean Ho (replacing Hyun Jung Cho), Bethune-Cookman University	Chuck Jacoby (Chair), SJRWMD	Leesa Souto, Marine Resources Council (MRC)	Chad Truxall (Vice Chair), Marine Discovery Center
Kevin Johnson, FIT	Megan Stolon, Hubbs SeaWorld Research Institute	Kevin Cooper, Indian River State College	Andrei Ludu, Embry-Riddle Aeronautical University	Richard Paperno, FWC
David Cox, Indian River Soil and Water Conservation District	Dale McGinnis, Eastern Florida State College	Linda Walters, University of Central Florida	Debra Woodall, Daytona State College	Lisa Krimsky, University of Florida Institute of Food and Agricultural Sciences (UF-IFAS)
Edie Widder, ORCA	Bob Day, Citizen	Valerie Paul, Smithsonian Marine Station at Ft. Pierce	Dennis Hanisak, FAU/Harbor Branch Oceanographic Institute	

Citizens' Advisory Committee		
Frank Brownell, Volusia County	Sam Lopez, Brevard County	Leesa Souto, Brevard County
Becky Bruner, Martin County	Jim Moir (Vice-Chair), Martin County	Heather Stapleton, Indian River County
Dave Carlson, St. Lucie County	Gary Ritter, Indian River County	Katie Tripp, Volusia County
Frank Catino (Chair), Brevard County	Billy Rotne, Volusia County	Cynthia Van de Voorde Hall, Indian River County
Mike Conneen, Brevard County	Gayle Ryan, Martin County	Jessy Whales, Volusia County
Ken Grudens, Indian River County	Adam Locke, St. Lucie County	Keith Winsten, Brevard County
Zack Jud, Martin County	Doug Patterson, Brevard County	Graham Cox, Indian River County
Former Citizens' Advisory Committee Members		
David Brigida, St. Lucie County (2016-2018)	Dennis Dickerson, Volusia County (2016-2018)	Billy Gibson, St. Lucie County (2016-2018)
Crystal Lucas, Martin County (2016-2018)		

CCMP implementation requires coordination among a diverse network of individuals, communities, and organizations to integrate local-scale conservation activities with broad-scale goals. Sustained performance and success hinges on effective communication among scientists, resource managers, and policy makers. An effective IRLNEP will provide leadership that advances the shared interests of the Management Conference. There is no one-size-fits-all model for addressing IRL problems nor is there an easy “quick fix.” IRL restoration will require a long-term commitment among all stakeholders and partners to fund and implement restoration and stewardship projects. IRL restoration will require action based on science, evaluation, knowledge, and common sense.

CCMP REVISION: IRLNEP RESPONDS TO A CHANGING LAGOON

This CCMP revision builds on the strengths of the 1996 CCMP and 2008 CCMP update. However, this CCMP revision makes significant changes from previous CCMP action plans to be more responsive to the needs of the IRL and more closely aligned with the NEP Program Evaluation Logic Model and Standardized Performance Measures. Specific CCMP changes since the 2008 CCMP update are documented in **Appendix A**. New CCMP action plan recommendations are identified as "NEW." Most importantly, this revised CCMP shifts its emphasis to an active water quality and habitat restoration focus.



NEPs strive to demonstrate progress on implementing CCMP action plans to meet the objectives of the Clean Water Act and achieve the long-term outcomes of restoring and maintaining the ecological integrity of estuaries of national significance. However, the strength and value of a NEP are tested most when a Management Conference must respond to a combination of factors that shift the trajectory of an estuary from what appeared to be improving health to declining health. Such a shift created the challenges and opportunities facing the IRLNEP today. Since the 2008 CCMP update, the IRLNEP and its Management Conference have been challenged by a combination of events that dramatically reinforced the scientific concerns about the health of the IRL. These events have increased the demands and opportunities for enhanced service and support that the IRLNEP is designed to provide to stakeholders, communities, and citizens.

This CCMP revision incorporates new scientific knowledge, addresses inadequacies of past strategies for restoration and intervention, and responds to new vulnerabilities and emerging threats. Key issues include:

RESPONDING TO A TIPPING POINT: The IRL experienced a dramatic shift from a system where benthic aquatic vegetation was expanding to one dominated by planktonic microalgae following an unprecedented algal bloom in 2011 (now referred to as the "2011 superbloom"). The post-2011 IRL is characterized by intense, recurring, and long-lasting algal blooms; widespread loss of seagrasses; and episodic wildlife mortality events. Ongoing blooms of picocyanobacteria, nanoplanktonic chlorophyte, and the brown tide species that plagued Texas, *Aureoumbra lagunensis*, now appear to be the "new normal" for the central and northern IRL. This shift emphasizes the need for improved scientific understanding of nutrient loads, nutrient cycling, and tipping points for the IRL.

RESPONDING TO LAKE OKEECHOBEE RELEASE EVENTS: Concurrent with these stress-response issues, the southern IRL is impacted seasonally by freshwater releases from Lake Okeechobee during times of high water. During the summers of 2013, 2016, and 2018, billions of gallons of freshwater were released through

the St. Lucie Estuary to the southern IRL. As a result, the St. Lucie Estuary and southern IRL experienced dramatic salinity shifts including sustained freshwater conditions. The combination of freshwater, high nutrients, sediments, and an inoculant of the cyanobacteria *Microcystis* from Lake Okeechobee, in addition to nutrients from the IRL watershed, fueled harmful algal blooms (HABs) in portions of the southern IRL. In 2013, 2016, and again in 2018, these releases initiated an intense *Microcystis* HAB, with reported concentrations of the toxin microcystin exceeding World Health Organization standards. These freshwater releases and HAB events highlight the importance of connections between the watersheds of the IRL and the Everglades and the need to address expansion of the natural boundaries of the IRL watershed as the IRLNEP adopts a revised CCMP. This CCMP revision considers the resource management implications of connected waters and watersheds more explicitly than in past plans.

RESPONDING TO A NEED FOR INTEGRATED, SYSTEMATIC, AND SUSTAINED MONITORING, MAPPING, AND MODELING: More than three decades of peer-reviewed scientific research and other scientific reports have documented the detrimental impacts on water quality generated by nutrients from wastewater treatment systems, septic systems, stormwater conveyances, fertilizers, and muck. This research communicated concerns that continued loading would shift the IRL from a mesotrophic, seagrass-dominated system to a eutrophic, microalgal dominated system. That tipping point may have been reached in 2011, but scientific evidence of a declining lagoon preceded the shift of 2011 by decades, and improvements observed in seagrass growth in the early 2000s may have been caused mostly by drought conditions. Given this ecological shift and the concerted efforts to reduce nutrient loads, there is a growing need to define, coordinate, integrate, and sustain the science that should inform management of the lagoon's water, habitat, living resources, and communities. For example, there is an urgent need to develop and improve lagoon-wide health assessments. There is also a need for ongoing scientific research to better understand the dynamics of the IRL to give policy makers betters options to respond to HABs, fish kills, and other emerging issues including human health threats.

LEVERAGING THE KNOWLEDGE AND EXPERIENCE OF THE NEP NETWORK: Evidence of successful restoration of water quality from other NEPs (Sarasota Bay, Tampa Bay, Puget Sound, Long Island Sound, and Narragansett Bay) as well as Chesapeake Bay provided important guidance for this IRL CCMP revision. The message is clear: focused and expanded efforts to reduce nutrient and other pollutant loads by refurbishing aging and inadequate wastewater systems; removing septic systems with connections to a sewer system or upgrading septic systems to enhanced treatment systems; improving treatment of water carried by large stormwater conveyances; implementing alternative solutions to the current practice of land applying biosolids in the watershed; diverting, consolidating, and treating water carried by small, dispersed urban stormwater conveyances; removing muck; and decreasing residential, commercial, and agricultural use of fertilizer and chemicals and managing yard waste will be required as part of a rigorous diet for the IRL. **Across the spectrum of external and internal sources of pollutant loads, a higher standard is required to rectify past loads, limit current loads, and prepare for the loads associated with growth of the human population that is yet to come.** Another critical next step is to restore filter feeders (clams and oysters), because these populations will have direct impacts on improving water quality. Although natural recovery of seagrasses and fisheries is expected with improved water quality and clarity, additional restoration efforts (seagrass replanting and fish-stock enhancement) may be required.

EVALUATING RISKS ASSOCIATED WITH SEA LEVEL RISE AND CLIMATE CHANGE: Over the next several decades, coastal communities will be challenged to understand and respond to vulnerabilities of natural resource assets, human-built infrastructure, and transportation/supply chains associated with climate change and sea level rise. Understanding potential risks is the critical first step for coastal communities seeking to implement adaptation strategies that decrease risks, build resilience, and in some cases, take advantage of new opportunities.

PATHWAY TO IRL RESTORATION

Successful restoration of the IRL is not an easy target to identify, nor does it equate to reestablishing a single set of desired conditions. Broadly defined, ecosystem restoration attempts to remove or reduce human-induced stressors and return some measure of structural and functional integrity to the system. Due to shifting baseline stressors associated with factors such as human populations growth, coastal urbanization, climate change (including sea level rise), and loss of taxa, restoration of the IRL to an idealized past reference status after removal of human-induced pressure may be difficult to achieve[3]. For this CCMP revision, a healthy IRL provides essential ecosystem functions that deliver sustainable ecosystem services to society. The overarching goal for IRL restoration is to improve water quality and biodiversity as evidenced by a stable range of indicators, discussed below in the Measuring Changes in IRL Vital Signs section.

If you are a citizen, industry leader, regulated stakeholder, community decision-maker, scientist, or government agency, you and all the IRLNEP's many partners have an opportunity to restore the IRL. This CCMP revision represents a non-regulatory restoration plan that is dependent on each individual stakeholder and partner taking the actions necessary to reduce human-impacts to the IRL and its watershed. It is a plan that will require annual evaluation, with USEPA required updates and revisions in the future.

TAKING ACTION

This CCMP revision identifies 10 broad categories of actions that can be considered and implemented by citizens and all IRL stakeholders and partners. They were first envisioned by the Brevard County Save Our Indian River Lagoon Project Plan in 2016 as *REMOVE, REDUCE, RESTORE,* and *RESPOND*. This CCMP revision expands the list of actions to reflect the comprehensive nature of the "One Lagoon – One Community – One Voice" mission of the IRLNEP. This focus of this mission is to approach lagoon restoration with a more unified voice.

[3] Duarte, C. M. et al. 2009. Return to Neverland: Shifting baselines affect eutrophication restoration targets. Estuaries and Coasts 32, 29-36.

IRLNEP: CORE VALUES

In April 2017, the IRL Council and IRLNEP Management Conference adopted the following vision, mission, promise, and goals. Success for a healthy IRL system will only be achieved if the "One Lagoon – One Community – One Voice" mission is successful.

Vision:

Healthy Ecosystem – Healthy Communities – Healthy Economy

Mission:

One Lagoon – One Community – One Voice

Promise:

Clean Water for People and Nature

Goals:

To attain and maintain water and sediment of sufficient quality to support a healthy estuarine lagoon ecosystem;

To attain and maintain a functioning, healthy ecosystem which supports endangered and threatened species, fisheries, commerce and recreation;

To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem; and

To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore and enhance the IRL.

IRLNEP: MEASURING PERFORMANCE AND PROGRESS

To assess NEP progress in achieving long-term CCMP and program goals, USEPA conducts quarterly and annual progress reporting. Every five years, a comprehensive program evaluation is conducted by USEPA for each NEP. USEPA developed NEP Program Evaluation Guidance to assess the effectiveness of NEP actions. The guidance includes performance measures, describes a process for conducting site visits, and provides a feedback loop to help ensure that recommendations for improvement are implemented. This revised CCMP is structured to align with the USEPA Evaluation Model for NEPs and specific Standardized Performance Measures for NEP Core Elements and Sub-Elements:

NEP Performance Measures - Core Elements:

Program Implementation and Reporting

Financial Management – Program Planning and Administration – Outreach and Public Involvement

Ecosystem Status and Trends

Research – Assessment and Monitoring - Reporting

Each activity of a NEP is evaluated based on outputs and outcomes. Outputs represent the deliverables from the workplan and CCMP activities (i.e., products, services, methods, and approaches). Outcomes are the results, impacts, and accomplishments. When possible, outcomes are quantified as measurable changes. USEPA considers three timelines for outcomes:

- Short-term (1 – 2 years) outcomes revolve around improved knowledge.
- Medium-term (3 – 4 years) outcomes revolve around behavioral change.
- Long-term (5 – 10+ years) outcomes revolve around restoration and maintenance of the ecological integrity of estuaries of national significance so that they meet their defined uses.

ROLE OF THE IRLNEP

Throughout this revised CCMP, specific IRLNEP responsibilities will be identified that align with three broad categories of program commitment or action (coordinate, collaborate, and conduct).

Actions	Engagement
Coordinate	Convene partnering entities, ensure open communication to minimize conflicts and/or redundancies, and maximize efficiencies through cooperative ventures.
Collaborate	Join forces with partner agencies and invest staff time and funding into projects.
Conduct	Invest staff time and funding as the lead agency conducting an IRL initiative defined in the IRLNEP Annual Business Plan, budget, and USEPA workplan identifying federally-funded projects.

Over the next decade, the IRLNEP will join with partners in its Management Conference to advance initiatives and actions that restore the IRL, enhance long-term stewardship of the system, and align with authority, vision, mission, promise, and goals of the Clean Water Act. Realization of the complete benefits of the IRL Council Interlocal Agreement and development of the IRLNEP as a fully performing estuary program that represents the entire IRL watershed will require significant and sustained program support (both human and financial resources). IRLNEP leadership actions identified in this CCMP revision represent specific and strategic IRLNEP outputs (deliverables). These actions will be represented as project deliveries in annual USEPA workplans, as well as IRLNEP business plans and budgets. Each IRLNEP leadership action addresses a program need and is an essential prerequisite for effective, science-based ecosystem restoration. When viewed collectively, these leadership actions combine with others that have been completed or are already in progress to form a solid foundation for successful restoration and stewardship of the IRL. Most importantly, the IRLNEP will strive to implement an IRL ecosystem-wide restoration initiative that is effective, efficient, transparent, and inclusive.

IRLNEP Mission	IRLNEP Deliverables from the Action Plans	Tentative Target Date
ONE LAGOON	Annual CCMP project funding and implementation (projects identified and prioritized for IRL Council/IRLNEP funding annually)	Annual; recurring
	Lagoon-wide geographic information system (GIS) asset mapping	Annual; recurring
	Looking Ahead – Science 2030 Report that identifies gaps in knowledge, emerging issues and innovation opportunities	2019; update as needed
	IRL Habitat Restoration Plan anchored by a network of four Regional Restoration Centers identified for IRL restoration, research, citizen engagement, and education (Marine Discovery Center in Volusia County, Brevard Zoo in Brevard County, Harbor Branch Oceanographic Institution in Indian River and St. Lucie Counties, Florida Oceanographic Society in Martin County)	2019-2020
	Climate Ready Estuary Report (risk-based vulnerability assessment and adaptation plan funded by USEPA, in development)	2018-2019
	CCMP Update (USEPA mandate every five years, as needed)	2025
	CCMP Revision (USEPA mandate every 10 years)	2030
	Expanded funding for cost-share projects from local, state, regional, federal, and private funding sources	Annual; recurring
	IRL Projects Plan	2019; update annually
ONE COMMUNITY	Update of 2016 IRL Economic Analysis	2019-2020; update as needed
	Update Boaters Guide to the Indian River Lagoon	To be determined (TBD)
	Emergency Incident Preparation and Response Plan	TBD
	Expansion of IRLI^2 network (IRLNEP leadership to promote and cultivate water and clean technology innovation, technology development, and private-sector industry solutions to IRL and Florida water quality challenges)	Annual; recurring
	Direct support (IRLNEP staff and funding resources) for three established annual lagoon-wide symposia: EDUCATION: ShORE (Sharing Our Research with Everyone) education/research conference hosted by Daytona State College RESEARCH: IRL Science Symposia hosted by Florida Atlantic University/Harbor Branch Oceanographic Institute TECHNOLOGY: IRL Research Institute TechCon hosted by FIT coupled with industry-led incubator/accelerator partnerships for innovation development	Annual; recurring
ONE VOICE	IRL Monitoring Plan	2019-2020
	IRL Communications Plan	2019; update annually
	IRLNEP "One Community – One Voice" Initiative	2019-2020
	"State of the Lagoon" Technical Report (synthesizing the science, identifying stressors, and responding to emerging threats)	Begin initiative in 2019-2020; tentative target for report in 2025

IRL VITAL SIGNS

The Puget Sound Partnership is one of the nation's 28 NEPs, and they developed a Vital Signs wheel that communicated the health of the Puget Sound in a way that was scientifically valid and resonated with the public.[4] The IRLNEP recognized the value and success of the Puget Sound Partnership Vital Signs wheel and applied a similar approach for the IRL. The IRL Vital Signs represent different CCMP action plans or the overarching

[4] Puget Sound Partnership. Vital Signs Website: http://www.psp.wa.gov/vitalsigns/.

measures for determining the health of the IRL. New CCMP action plans or Vital Signs that have been added as part of this CCMP revision are identified as “NEW” in the tables of actions for each Vital Sign.

HOW TO USE THE VITAL SIGNS WHEEL

The IRL Vital Signs wheel presents 32 Vital Signs for IRL health that align with the "One Lagoon – One Community – One Voice" mission of the IRLNEP. Each Vital Sign is important:

- One Lagoon – Water quality, habitat restoration, and living resources issues and actions reside within the One Lagoon segments of the wheel.
- One Community – Community planning, economic development, and coastal resilience issues reside within the Healthy Communities segments of the wheel.
- One Voice – Strategic IRLNEP activities authorized by Section 320 of the Clean Water Act reside within the Communicate, Collaborate, and Coordinate segments of the wheel. Specific outputs (deliverables) and outcomes from this segment represent essential CCMP implementation and financial activities that will drive restoration and stewardship of the IRL.

Every citizen, scientist, local community, public agency, and stakeholder can view Vital Signs individually and collectively as an IRL “Call to Action.” All point inwardly towards the center of the wheel and a healthy lagoon. Identify which Vital Sign(s) correspond to your responsibility, authority, or opportunity. If you are responsible or interested in solving a problem within a Vital Sign, take action and fix the problem. This individual ownership approach respects local home-rule decisions of our communities and allows adaptive and strategic management decisions to be made at all levels of the Management Conference partnership.

MEASURING CHANGES IN IRL VITAL SIGNS

An adage by Peter Drucker is, "*You cannot manage what you do not measure*." Measuring all possible indicators at all times and in all locations would be cost prohibitive and impossible. Nevertheless, measuring key indicators at multiple locations on a frequency that captures important changes and evaluating the data relative to appropriate targets represent a cost-effective approach to documenting status and trends and demonstrating the effectiveness of management actions.

For each of the 32 Vital Signs, specific indicators were identified and will be measured to assess the condition of the Vital Sign (its status) and document how that condition changes through time (any trend). The selection and monitoring of indicators represents a complex process and challenging process. Appropriate and consistent indicators should convey complex information as simple and useful measures of status and trends. Some indicators presented in this CCMP revision have been well studied with ample information available to describe status and trends, whereas other indicators are not well understood. Therefore, some indicators may be reconsidered, modified, or replaced as new information becomes available. The IRLNEP will work with the Management Conference and our partner scientists, managers, and practitioners to advance appropriate indicators and to better understand stressor-response relationships. Overall, indicators can provide:

- Fundamental information on the health of a system.
- Essential measures of the success of management actions and valuable guidance for course corrections including identification of degrading trends that can be or should be reduced or reversed and improving trends that can be or should be facilitated or accelerated.
- Qualitative and quantitative metrics that can provide useful comparisons through time on local, regional, or national scales.
- Easy to understand information that communicates clear messages to diverse target audiences including managers, scientists, and the public.

The following tables show how the IRLNEP mission, Vital Signs, indicators, and targets are related. The most important aspect of CCMP implementation will be to evaluate trends for each Vital Sign, as appropriate, to document improvement or decline in lagoon conditions over time. Identification and quantification of appropriate indicators and targets will be an ongoing challenge and opportunity for the IRLNEP over the next decade.

IRLNEP Mission	Vital Sign Category	Vital Signs	Indicators: The Measures	Targets
ONE LAGOON	Water Quality	Impaired Waters	Total maximum daily loads (TMDLs), basin management action plans (BMAPs), reasonable assurance plans (RAPs), applicable water quality criteria including numeric nutrient criteria, biological response	Total phosphorus, total nitrogen, chlorophyll-a, fecal coliform, metals; BMAP or RAP compliance; meeting water quality criteria and removal from impaired waters list
		Wastewater	WWTP discharge quality; number of septic conversions to advanced septic or sewer; biosolids and reclaimed water nutrient management	Advanced wastewater treatment (AWT); connection of septic systems near surface waters; total phosphorus, total nitrogen, fecal coliform, metals, and pollutant load reductions
		Stormwater	Stormwater discharge to IRL; urban, recreational, and agricultural fertilizer use reductions (pounds or tons); urban and agricultural best management practices (BMPs) implementation; light attenuation coefficient in the lagoon	Freshwater, total phosphorus, total nitrogen, salinity, sediment, fecal coliform, and metal load reduction; annual reductions in fertilizer use; acres treated by BMPs; pre-development runoff equal to post-development runoff; percent light reaching lagoon substrate
		Hydrology and Hydrodynamics	Surface water volume restored to natural flow, groundwater and internal water flows and loads	Hydrologic targets identified and achieved
		Legacy Loads and Healthy Sediments	Healthy sediments; location, acreage, volume, and nutrient loads/flux from muck	Total phosphorus, total nitrogen, hydrogen sulfide, pH, sediment toxicity
		Atmospheric Deposition	Wet-dry atmospheric deposition of nitrogen and pollutants	Total nitrogen and contaminants
		Contaminants of Concern	Types, concentrations, and loads of contaminants of concern	Thresholds levels identified by water quality criteria for human and wildlife health, contaminant concentration, and contaminant load

IRLNEP Mission	Vital Sign Category	Vital Signs	Indicators: The Measures	Targets
ONE LAGOON	Habitat Quality	Seagrasses	Coverage (acres), density, and species diversity; coverage (acres), density, and species diversity of other benthic habitats	Recovery to scientifically defensible reference target; TMDL targets for seagrass
		Filter Feeders	Coverage (acres), density, and condition of live target species in conservation and/or commercial production	Recovery to scientifically defensible reference target
		Living Shorelines	Expansion of functional living shoreline habitats based on quantitative shoreline restoration coupled with evaluation of natural habitat quality and functionality; miles of living shoreline, miles of buffer zone	Miles of eroded or hardened shoreline planted, miles of buffer zones around waterbodies
		Wetlands and Impounded and Altered Marshes	Acres in conservation and management	Acres acquired and conserved, natural wetland functions restored and managed
		Spoil Islands	Islands in conservation, management, and public use	Islands restored, enhanced, and managed
		Land Conservation	Acres in conservation, management, and public use	Acres restored and managed for ecosystem integrity
		Connected Waters and Watersheds	Regional watershed planning and project integration	Volume or area of unimpeded circulation in the IRL, restored flows to St. Johns River, volume retained to groundwater

IRLNEP Mission	Vital Sign Category	Vital Signs	Indicators: The Measures	Targets
ONE LAGOON	Living Resources	Biodiversity	Pelagic and benthic community diversity, population status, and trends; grazers; aquatic trophic cascade	Target complex, not yet established; maintain biodiversity of region
		Species of Concern	Rare, threatened, endangered, and endemic species identification, population trends, and recovery	Targets for species recovery are population, location, and removal from listing
		Invasive Species	Invasive species population reduction and removal	100% removal
		Forage Fishes	Population status and trends	Targets for sustainable populations looking at presence of breeding grounds, species population, and species location
		Commercial and Recreational Fisheries	Population status and trends	Targets for sustained and robust commercial and recreational fishing, sustainable yields and catch, presence of breeding grounds, and species population and location
		HABs	Annual incidence of toxic and non-toxic HAB events	Target reductions for number, intensity, and duration of blooms
		Climate Ready Estuary	Risk-based vulnerabilities identified	Adaptation strategies identified and adopted, projects implemented

IRLNEP Mission	Vital Sign Category	Vital Signs	Indicators: The Measures	Targets
ONE COMMUNITY	Healthy Communities	Vibrant 21st Century Communities	Communities with vision and sustainability plans	Inventory of plans developed and shared
		Trash-Free Waters	Weight/volume of trash recovered annually and hotspots for trash identified	Trash-Free Lagoon by 2030
		Marinas and Boating	Number of clean marinas, number of derelict boats, number of moored vessels	Expanded clean marinas and compliance, 100% reduction in derelict boats, no discharge zone throughout IRL
		Distinctive Lagoon Communities	Urban waterfronts, working waterfronts, and Environmental Justice communities identified	Full engagement between communities and IRLNEP Management Conference
		Emergency Preparation and Response	Emergency preparation and response	Emergency preparation and response plans in place

IRLNEP Mission	Vital Sign Category	Vital Signs	Indicators: The Measures	Targets
ONE VOICE	Communicate – Collaborate – Coordinate	Monitoring and Data Sharing	Monitoring Plan developed and implemented	Comprehensive and integrated lagoon-wide sampling, monitoring and data sharing network and plan in place, economic value of IRL quantified and updated regularly
		State of the Lagoon	Comprehensive, integrated, multi-disciplinary State of the Lagoon Technical Report	Delivery of State of the Lagoon Technical Report every 10 years
		Technology Innovation	Science Plan developed and implemented	Science and technology advancements support and improve resource protection management and environmental resource-based economic stability
		CCMP Implementation and Financing	CCMP revised, funded, and projects tracked and implemented	CCMP restoration project implementation and return on investment
		Citizen Engagement and Education	Communication Plan developed and implemented	Citizen knowledge, engagement, and behavior change to improve lagoon health increases over time
		Federal, State, and Local Policy Opportunities	Local, state, and federal policies align with IRLNEP vision, mission, and goals	Number of policy opportunities and roadblocks identified and altered

IRL HEALTH CONCERN LEVELS

Each IRL Vital Sign was ranked by the IRLNEP Management Conference based on one of four levels of ecosystem health concern.

Levels are shown with this icon and are color-coded as red, dark orange, light orange, and blue and include the level number:

LEVEL 1: CRITICAL – Condition threatens immediate and long-term prognosis for lagoon health. Indicators are unfavorable. Trend is negative. Immediate and aggressive intervention is urgently needed to stop and reverse trend.

LEVEL 2: SERIOUS – Condition threatens long-term prognosis for lagoon health. Trend is unfavorable or uncertain. Favorable outcome is not expected without strategic intervention and long-term stewardship.

LEVEL 3: UNDETERMINED – Insufficient knowledge is available to inform decision-making and resource management for the Vital Sign. Research needs to be identified, funded, and applied to resource management.

LEVEL 4: STABLE OR IMPROVING TREND – Vital Sign is stable or trending towards improvement. Continued intervention is needed. Long-term stewardship efforts are expected to deliver favorable outcomes.

HOW TO USE THIS PLAN

For each Vital Sign, the following information is provided:

- Goals: The specific goals that will be achieved by implementing the actions for the Vital Sign.
- Issue Summary: Description of the issues facing the IRL system for the Vital Sign, using the best available information.
- Strategies: Approaches that should be implemented to achieve the goals for the Vital Sign.
- Action Plan Outputs (Deliverables): Specific deliverables including the responsible and partner entities, estimated costs, potential funding sources, and the IRLNEP role in delivering the output.
- Outcomes: Short-, medium-, and long-term outcomes expected from implementation of the outputs.
- Challenges to Success: Potential challenges to achieving the goals of the Vital Sign.
- Citations: Literature referenced in the above items for each Vital Sign.

The information in the following sections guides the IRL Council and Management Conference in achieving the vision, mission, promise, and goals established for the IRL system.

IMPAIRED WATERS

D. De Freese

Goals:

Achieve water quality standards to remove waterbodies from the Impaired Waters list.

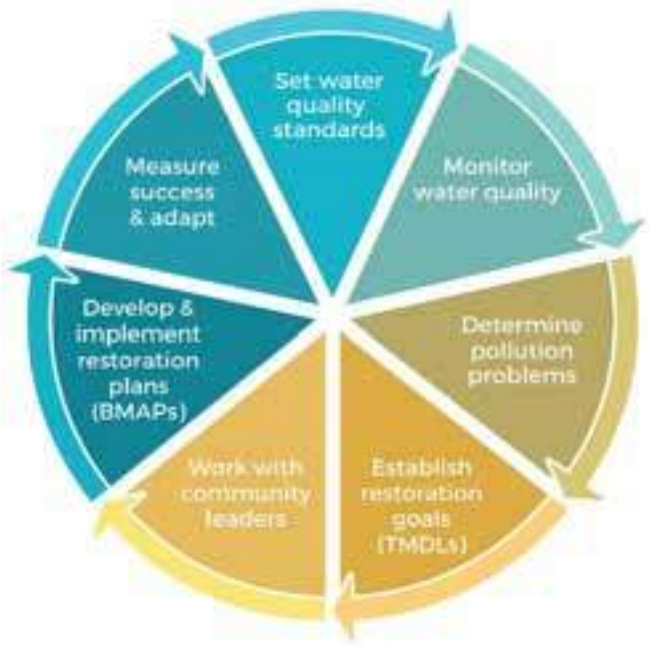
ONE LAGOON

WATER QUALITY

Impaired Waters (Including TMDLs, BMAPs, and RAPs)

GOALS: ***REMOVE*** **or** ***REDUCE*** **anthropogenic pollutant and nutrient loading to the IRL watershed to meet the regulatory targets established by TMDLs, BMAPs, and/or RAPs; achieve the intended biological response criteria; and achieve applicable water quality criteria to** ***REMOVE*** **the waterbody from the Impaired Waters designation list.**

ISSUE SUMMARY: Waters that do not meet state and federal water quality standards for one or more parameters are determined to be "impaired." Under the federal Clean Water Act, this determination requires the development of TMDLs for pollutants causing impairment to the waterbody. For identified pollutants, TMDLs must specify reductions to achieve water quality standards.



As of 2018, the IRL system has verified impairments of water quality standards for nutrients, fecal coliform bacteria, and metals. In March 2009, DEP adopted TMDLs for the IRL watershed, which was determined to be impaired due to excessive amounts of total nitrogen and total phosphorus.[1] The TMDLs focused on the water quality conditions necessary for seagrass regrowth at the depth limits where seagrass historically grew in the watershed, based on a multi-year composite of seagrass coverage. The median depth limits of seagrass coverage in the IRL system have decreased over the years because of deteriorating water quality conditions. In 2013, additional TMDLs were adopted for dissolved oxygen and nutrients for eight tributary segments to the IRL.[2] TMDLs were established in 2008 for dissolved oxygen, total nitrogen, and total phosphorus for the St. Lucie River and Estuary Basin, located at the southern end of the IRL.[3] In addition, DEP adopted nutrient numeric criteria for the entire IRL for total nitrogen, total phosphorus, and chlorophyll-a.

Following TMDL adoption, DEP worked with IRL partners to develop BMAPs to implement the actions needed to achieve the IRL TMDLs. A BMAP is a "blueprint" for restoring impaired waters, and it represents a comprehensive set of strategies—permit limits on wastewater facilities, urban and agricultural BMPs, conservation programs, and financial assistance—designed to implement pollutant reductions established by the TMDLs. BMAPs are adopted by DEP Secretarial order and are enforceable. BMAPs were adopted for the North IRL,[4] Central IRL,[5] and Banana River Lagoon[6] portions of the IRL system in February 2013 and the St. Lucie River and Estuary in June 2013.[7] Revisions to the IRL TMDL and associated model are currently underway.[8,9]

DEP identified the Mosquito Lagoon and Loxahatchee River as impaired, but a TMDL is not required for these waterbodies because partners in these areas are working with DEP to develop RAPs.[10,11] RAPs are similar to BMAPs in that they identify strategies and projects that affected stakeholders will implement to achieve water quality standards within a specified timeframe; however, the RAP is intended to provide reasonable assurance to DEP and USEPA that these pollution control mechanisms will result in reasonable progress toward attainment of

water quality standards and bring these waters into compliance with state and federal criteria in the future so that a TMDL is not needed.

STRATEGIES:

- Participate in TMDL, BMAP, and RAP processes and work to expand partnerships, identify and implement pollutant reduction projects, and obtain funding to meet and work to surpass minimum water quality standards to achieve restoration goals.
- Continue to identify and implement scientific *RESEARCH* projects to better understand nutrient cycles and flux in the IRL to advise revisions of TMDLs, BMAPs, and RAPs.
- Evaluate and achieve stakeholder support for future IRLNEP activities that can help TMDL, BMAP, and RAP implementation and success.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action Plan Outputs	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Impaired Waters-1: Support implementation, review, and update of IRL TMDLs as needed and as best available science evolves.	Use best available science to revise TMDL targets, as needed.	DEP	BMAP partners, IRLNEP Management Conference	TBD	DEP, local governments	Coordinate
Impaired Waters-2: Work with BMAP partners and DEP to support implementation of BMAPs and track progress, compliance, and implementation challenges.	Implement water quality improvement projects with a goal to *REMOVE* waterbody from impaired list.	DEP	BMAP partners, IRLNEP	$4.6 billion*	DEP, local governments, water management districts (WMDs), Florida Legislature	Collaborate
Impaired Waters-3: Support the partners and DEP in the development, adoption, and implementation of the Mosquito Lagoon and Loxahatchee River RAPs. (NEW)	Adopt RAPs for Mosquito Lagoon and Loxahatchee River to guide water quality restoration.	RAP partners	DEP, IRLNEP	Mosquito Lagoon: $39 million; Loxahatchee River: $90 million	DEP, local governments, Florida Legislature	Collaborate
Impaired Waters-4: Evaluate opportunities to incentivize, monetize, and expedite nutrient reduction policies and actions, including water quality credit trading. (NEW)	Expedite water quality improvements.	IRLNEP Management Conference, local governments	DEP	$4.6 billion*	Private investments, local governments, DEP, WMDs, Florida Legislature	Coordinate

*Estimate for Banana River Lagoon, North IRL, Central IRL, and St. Lucie River and Estuary BMAPs.[11]

OUTCOMES:

- **Short-term (1 – 2 years):** Increase local partner participation in these watershed restoration processes.
- **Medium-term (3 – 4 years):** Implement projects and programs to work towards five-year nutrient reduction targets specified in the BMAPs.
- **Long-term (5 – 10+ years):** Meet five-year and ten-year nutrient reduction targets specified in the BMAPs. Meet the five-year targets identified in the Mosquito Lagoon and Loxahatchee River RAPs. Evaluate seagrass response and make recommendations as necessary to revise BMAP activities and TMDL targets. *REMOVE* the waterbody from the Impaired Waters designation list.

CHALLENGES TO SUCCESS:

- Inadequate funding and project ideas to meet required reductions.
- Lack of incentive for regulated stakeholders to surpass required nutrient reductions.
- Legacy loading in the watershed may mask progress towards achieving water quality standards.
- Limited understanding by some of the public on how individual actions impact the lagoon water quality.
- Inadequate data on appropriate spatial and temporal scales, need for multiple lines of evidence, and complexity of modeling and model construction, testing, and validation.
- Lack of planning that results in reactive or hastily implemented projects that may not benefit lagoon water quality.
- Inadequate long-term support for real-time monitoring to assess if water quality targets and standards are being achieved.

CITATIONS:

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4. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin North Indian River Lagoon.
5. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin Central Indian River Lagoon.
6. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin Banana River Lagoon.
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10. Mosquito Lagoon Reasonable Assurance Plan website: http://publicfiles.dep.state.fl.us/DEAR/Mosquito%20Lagoon%20RA/.
11. Loxahatchee River Reasonable Assurance Plan website: http://publicfiles.dep.state.fl.us/DEAR/Loxahatchee_RA_Plan/.

WASTEWATER

Loxahatchee River District

Goals:

Improve wastewater infrastructure to increase capacity and treatment. Achieve advanced wastewater treatment.

ONE LAGOON

WATER QUALITY

Wastewater

GOALS: Improve municipal and industrial wastewater infrastructure throughout the IRL watershed to achieve AWT standards to *REDUCE* or *REMOVE* loads of human and industrial pollutants to the IRL. *REDUCE* vulnerability to WWTP overflows to the IRL. Expand WWTP capacity to accommodate septic to sewer conversions and the region's growing human population.

ISSUE SUMMARY: The 2017 Bureau of Economic and Business Research estimates the population of the five IRL region counties will increase up to 27% between 2017 and 2030.[1] This projected population increase presents various challenges including how to treat and transport increased wastewater with an aging and limited infrastructure. Sea level rise will place additional stress on centralized sewer systems, pipes, and septic systems in low elevation and high-water table areas. Nutrient and other pollutant loads come from various wastewater sources in the IRL, including WWTPs, septic systems, reclaimed water, and biosolids. Each of these sources has its own challenges with respect to waste treatment and management.[2]

WWTPs. Direct WWTP discharges to the lagoon were largely removed because of the federal Clean Water Act (1972) and the Indian River Lagoon System and Basin Act of 1990 (Chapter 90-262, Laws of Florida). The Indian River Lagoon System and Basin Act had three stated goals: (1) elimination of surface water discharges, (2) investigation of feasibility of reuse, and (3) centralization of wastewater collection and treatment facilities. This Act also required local governments to identify areas where package treatment plants and septic systems posed threats to the IRL and implement plans to provide centralized sewage treatment to these areas. Many of the small package WWTPs were removed throughout the basin in response to the Act. In recent years, public concerns have focused on accidental wastewater discharge events associated with hurricanes, tropical storms, heavy rain events, and line breaks. These discharges are associated with aging pipe infrastructure and leaks and/or cracks in underground wastewater lines. These increasing common failures highlight the vulnerability of the aging and inadequate wastewater infrastructure to water inflow/infiltration, wastewater pipe failures, and lift station failures. Conversion of septic systems to centralized sanitary sewer systems will further burden existing aging wastewater infrastructure. Infrastructure improvements to municipal and private WWTPs present multiple community benefits in addition to IRL protection. It is recommended that domestic WWTPs meet AWT standards of 3 milligrams per liter (mg/L) for total nitrogen and 1 mg/L for total phosphorus in the treated effluent. In addition to the domestic WWTPs, there are industrial WWTPs throughout the IRL watershed. Industrial wastewater sources include manufacturing, commercial businesses, mining, agricultural production and processing, and cleanup of petroleum- and chemical-contaminated sites. Industrial wastewater discharges in Florida must provide reasonable assurance for meeting water quality standards for surface water or groundwater to receive a discharge permit from DEP. Maps of the domestic and industrial WWTPs in the IRL watershed are provided in **Appendix B**.

Septic Systems or Onsite Sewage Treatment and Disposal Systems (OSTDS). A 2015 study found that the approximately 300,000 septic systems in the IRL watershed contribute a large nitrogen load to the lagoon.[3] Maps of the OSTDS in the IRL watershed based on FDOH data are provided in **Appendix B**. Storm events also affect septic systems, especially systems that are old, poorly maintained, and/or sited near the IRL and its major tributaries where high water tables may compromise septic system drainfield functions. Sea level rise, changing rain patterns, and elevated water tables will further reduce efficiencies and place additional burdens on OSTDS.[2, 3] In combination, more than 50% of the households in Volusia, Indian River, and Martin Counties are served by OSTDS, as shown in the table below.[4] Traditional septic systems, as well as old or failed systems, provide little or no treatment for nutrients. In addition, failing systems may provide little or no treatment for pathogens. It is recommended that traditional septic systems not be used near the IRL and its tributaries and major canals. In

October 2018, the Brevard County Commission passed an ordinance that requires alternative septic systems on the barrier island and within an identified overlay zone along the IRL.

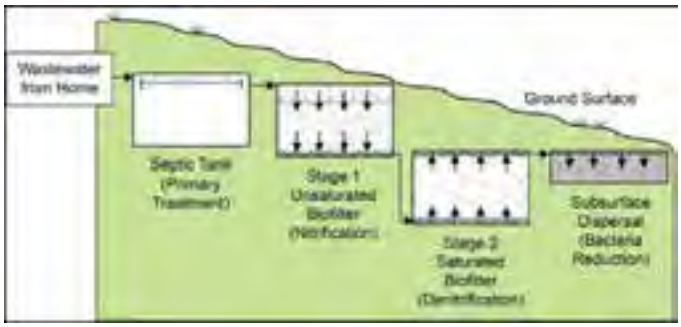
Advanced OSTDS can be used to reduce the nutrient contribution to groundwater. On July 31, 2018, FDOH adopted revised OSTDS rules to authorize in-ground nitrogen reducing biofilters and other "alternative systems." The rule authorizes alternative systems in circumstances where standard systems are not suitable or where alternative systems are more feasible.

County	OSTDS	Municipal	Proportion OSTDS
Volusia	102,831	102,413	50%
Brevard	91,630	117,797	43%
Indian River	30,574	25,968	54%
St. Lucie	34,364	70,649	33%
Martin	29,864	26,201	53%

Source: Barile 2018.

Source: http://www3.epa.gov/npdes/pubs/homeowner_guide_long_customize.pdf

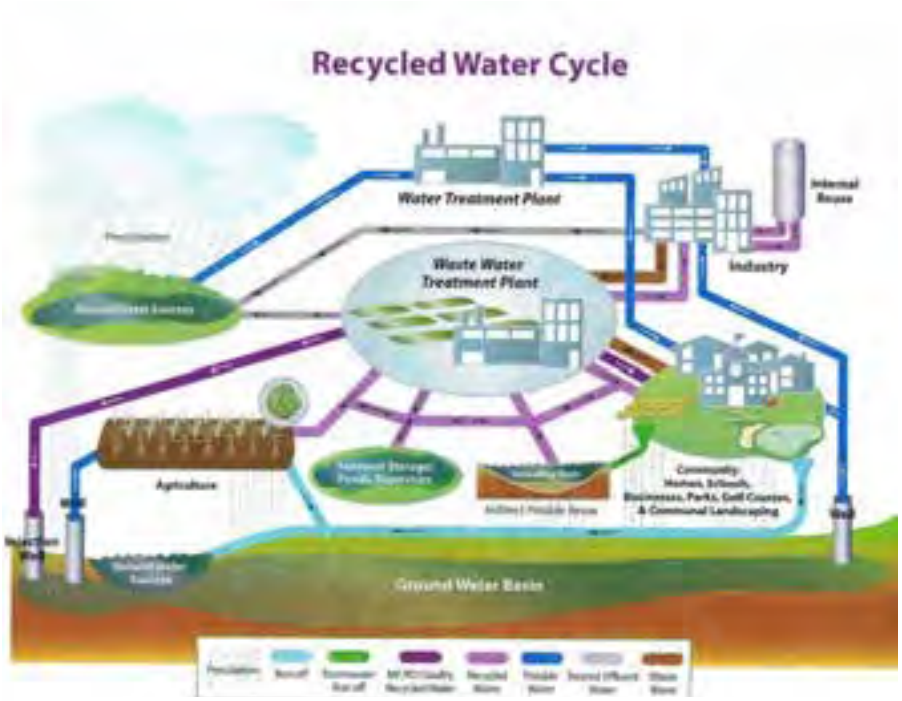
Conventional OSTDS



Source: Hazen and Sawyer[5]

Passive Nitrogen Reduction System

Reclaimed Water. Today, many WWTPs use their treated effluent for irrigation although other options for reclaimed water disposal exist as shown in the graphic. While the use of reclaimed water for irrigation is an excellent approach to conserving potable water, if the reclaimed water is high in nutrients, irrigation with reclaimed water can result in nutrients leaching into the groundwater. Currently, no regulations exist for the concentration of total nitrogen and total phosphorus in reclaimed water for irrigation. In the IRL watershed, reuse discharges from WWTPs range from average annual total nitrogen concentrations of 0.22 to 29.40 mg/L and average annual total phosphorus concentrations of 0.17 to 9.47 mg/L. As part of the



Source: http://ramirezholmes.blogspot.com/2013/07/celebrating-central-dublin-recycled.html

public education and outreach efforts, customers who use reclaimed water for irrigation should be informed of the nutrient content in the reuse water because they can and should eliminate or reduce the amount of fertilizer added to their lawn and landscaping.

Biosolids. Biosolids are the solid, semisolid, or liquid residue generated during the biological wastewater treatment process. Land application of biosolids is allowed on permitted sites at controlled rates in accordance with DEP-established site restrictions and site management requirements. All biosolids applied to land application sites must meet the pathogen reduction requirements for Class AA, Class A, or Class B biosolids. No treatment requirements exist for nutrients when producing biosolids, which may lead to biosolids with high nutrient concentrations being applied in the IRL watershed. As a result, it will be important to track where biosolids are being applied, determine the nutrient content, if possible, and track levels of nutrients in the soil. Chapter 62-640, Florida Administrative Code, does not authorize the land application of biosolids in the St. Lucie River, Lake Okeechobee, and Caloosahatchee River watersheds unless the applicant for a site permit can demonstrate that the nitrogen and phosphorus in the biosolids will not add to nitrogen and phosphorus loadings in the watershed. There is growing public concern that more protective measures are required within the IRL watershed, as well as statewide, to ensure that biosolid nutrient loading to both surface waters and groundwater is strictly managed and controlled. Additional concerns are associated with emerging pollutants that may be present in the biosolids waste stream. DEP recently created a Biosolids Technical Advisory Committee to evaluate current management practices and potential opportunities for enhancements to better protect Florida's water resources. The Technical Advisory Committee includes seven members, who represent academia (two representatives), small utilities, large utilities, environmental interests, agriculture, and haulers.

STRATEGIES:

- Improve existing wastewater infrastructure to accommodate transfer of septic systems.
- Explore new technologies for AWT, such as those that generate power, *REMOVE* contaminants of emerging concern, and reclaim nitrogen and phosphorus separately. Conduct a cost-benefit analysis for these technologies.
- Review permit data to establish current baseline for permitted wastewater discharges into the IRL.
- Refine scientific knowledge about anthropogenic sources, e.g., use of biogeochemical tracers to identify human wastewater sources.
- Implement an OSTDS inspection program to identify and prioritize areas where OSTDS are having the greatest impact and to determine if the OSTDS can be connected to the sewer system or upgraded to an advanced OSTDS.
- Continue to *REDUCE* density of septic systems in the IRL watershed, particularly in high vulnerability and high impact areas. Where connection to centralized sewer is not practical or possible, policies should require use of nitrogen reduction treatment systems in areas that impact IRL surface or groundwater.
- Provide funding for innovative technologies to improve nutrient treatment efficiencies and decrease costs for nitrogen reduction systems where connection to sewer is not possible.
- Work with local governments to create rules and ordinances requiring connection of septic systems to the sewer system within a certain time after sewer is made available, and to allow access by utilities for maintenance of advanced OSTDS.
- Develop strategies and policies to identify areas not suitable for conventional septic systems where alternative systems would be more feasible, and to incentivize or require alternative systems in areas where wastewater treatment is not available.

- *REDUCE* excess use of reclaimed water that supersaturates soils and pollutes groundwater within the IRL watershed.
- Identify new uses for reclaimed water to *REDUCE* discharges.
- Conduct *RESEARCH* to track where all classes of biosolids are being applied and to determine the nutrient and other pollutant content.
- Identify and evaluate alternative technologies for the handling, processing, and disposal of biosolids.
- Conduct *RESEARCH* to quantify nutrient loading associated with application of reclaimed water for irrigation purposes and implement associated fertilizer reductions.
- *REDUCE* and strictly control nutrient and other pollutant loads to surface and ground waters within the IRL watershed from applications of biosolids and use and management of reclaimed water.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Wastewater-1: Ensure compliance with the IRL Act (Chapter 90-262, Laws of Florida, 1990).	Ensure that no nutrients or pollutants from the human waste stream are discharged directly into the IRL or indirectly through groundwater or tributary surface waters.	DEP, local governments	WMDs, interest groups	Staff time from DEP and local governments	Local governments, public and private utility fees, infrastructure improvement funds, State Revolving Fund (SRF) loans	Coordinate and collaborate
Wastewater-2: *REDUCE* or *REMOVE* all wastewater discharges to the IRL (including direct, indirect through reuse, and emergency loadings of nutrients and other pollutants).	Discharge directly from a WWTP or through reuse should not exceed AWT standards. Reclaimed water education, outreach, and enforcement.	Local governments	WMDs, DEP, interest groups	TBD	Local governments, public and private utility fees, infrastructure improvement funds, SRF loans	Coordinate and collaborate
Wastewater-3: *RESEARCH*, identify, and recommend funding sources and alternatives for upgrading WWTP infrastructure and to *REDUCE* or *REMOVE* domestic and industrial effluents.	Expand funding for wastewater infrastructure improvements and *REDUCE* pollutants.	DEP and utilities	USEPA, WMDs, local governments	$40 million for CCMP projects	Local governments, public and private utility fees, infrastructure improvement funds, SRF loans	Coordinate and collaborate
Wastewater-4: Promote the connection of areas served by OSTDS to central sewer or, where connection is not feasible, use of nutrient removing systems in areas identified as "problem" or "potential problem."	Improve the regional wastewater treatment network through innovation, regional consolidation, and strategic transition away from OSTDS.	FDOH, local governments	DEP, WMDs, Natural Resources Conservation Service (NRCS), academia, interest groups	$392 million for CCMP projects	Local governments, public and private utility fees, infrastructure improvement funds, SRF loans	Coordinate and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Wastewater-5: Develop and implement an OSTDS inspection program and education program within the five IRLNEP counties.	Mandatory inspection for all OSTDS.	FDOH, local governments	NRCS, DEP, WMDs, local governments	TBD	Local governments, public and private utility fees, infrastructure improvement funds, SRF loans	Coordinate and collaborate
Wastewater-6: Undertake further studies to quantify the impacts of OSTDS on the IRL with a focus on identifying high priority "problem" and "potential problem" areas.	Evaluate nutrient loads, vulnerabilities, and risks to establish priorities for septic to sewer conversion.	Local governments, DEP	Academia, WMDs	TBD	Local governments, public and private utility fees, infrastructure improvement funds, SRF loans	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Map problem areas and secure funding to upgrade WWTPs to AWT to *REDUCE* nutrients in direct discharges and reuse and/or increase capacity. Begin WWTP retrofits, septic to sewer connections, and septic system upgrades.
- **Medium-term (3 – 4 years):** Continue WWTP upgrades, septic to sewer connections, and septic system upgrades.
- **Long-term (5 – 10+ years):** 100% of WWTPs have been upgraded to AWT standards. Septic to sewer connections and septic system upgrades completed in problem areas.

CHALLENGES TO SUCCESS:

- Lack of adequate recurring cost-share funding for human waste stream infrastructure improvements, such as septic to sewer conversions and WWTP upgrades.
- Inadequate regulatory, non-regulatory, and financial incentives to compel infrastructure improvements.
- Developers and permit agencies may not be familiar with advanced, nutrient reduction OSTDS that would better treat nutrients.
- Inadequate regulatory standards for nutrients in reclaimed water for irrigation, disposal of reclaimed water, and biosolids management and application.

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STORMWATER

Indian River County

Goals:

Reduce stormwater runoff entering the IRL and improve the quality of runoff that enters the lagoon.

ONE LAGOON
WATER QUALITY
Stormwater

GOALS: ***REDUCE*** **unnatural fresh and surface water discharges to the IRL from both large stormwater conveyances and dispersed urban and residential sources.** ***RESTORE*** **water quality in the IRL system. Conduct** ***RESEARCH*** **to better understand natural hydroperiods of the IRL watershed.**

ISSUE SUMMARY: Stormwater contributes significantly to pollutant loads entering the IRL. Multiple factors affect stormwater loading to the IRL including:

- **Land Use Change.** The population in the five-county lagoon region has grown from 743,000 people in 1980 to almost 1.76 million in 2017, which led to an increase in coastal development and urbanization, particularly in the last 100 years.[1, 2, 3, 4] Between 1920 and 1990, the estimated average annual runoff increased 113% in the IRL watershed, and this increase is mostly the result of urbanization.[2]
- **Hydrologic Changes.** Coastal impoundments of marshes, ditching to manage mosquitoes, and ditching to manage water for agricultural, road drainage, flood prevention, and other uses have changed the landscape. Other practices, such as expansion of impermeable surfaces, stormwater diversion and channelization, direct stormwater discharges to the IRL, and riparian and wetland habitat alteration and loss have led to changes in the natural hydrology of the watershed.
- **Nutrient Loads.** As the human population increased, so have the nutrient loads associated with fertilizer use by residential and agricultural stakeholders, as well as other lawncare chemicals, pond maintenance herbicides, and pesticides for homes and businesses.[4]

Each of these factors has reduced the water holding capacity of the IRL watershed resulting in increased flood risks; lowered surface water quality due to runoff of sediments, nutrients, and other pollutants; and resulting negative impacts to IRL living resources from declines in water quality. In addition, considerable economic costs are associated with attempts to manage and reduce the negative impacts of these factors over a range of spatial scales.

Urban Stormwater. A 2017 report produced by SJRWMD and DEP in support of the IRLNEP recommended nine large, regional stormwater project priorities (from over 40 potential projects that were evaluated lagoon-wide). These projects represent high-value priorities to improve stormwater management and water quality in the IRL.[5] The recommended projects are listed in the separate Projects Plan.

A more challenging aspect of stormwater mitigation arises from smaller, dispersed stormwater impacts associated with urban and suburban landscapes. These are best addressed by local BMPs. Stormwater BMPs are designed to treat rain where it falls to address four criteria that are critical to managing urban and dispersed stormwater runoff:

1. Volume: Reduce or delay the volume of stormwater that enters the drainage system.
2. Peak Discharge: Reduce the maximum flow rate into the system by decreasing the stormwater volume and lengthening the duration of discharge.
3. Water Quality: Improve water quality through volume reduction, filtering, and biological and chemical processes.
4. Maintenance: Sustainable practices to ensure proper functioning of BMPs. Grass clippings and cut vegetation should not be allowed to enter BMPs or natural waterbodies and applications of fertilizers, pesticides, and herbicides should occur with a buffer around the BMP or natural waterbody. Where possible, use mechanical harvesting instead of herbicide control for invasive vegetation in waterways.

By constructing small-scale, distributed stormwater management systems at individual sites, stormwater BMPs have the capability to meet multiple stormwater management objectives. Stormwater BMPs use unit processes of the hydrologic cycle, such as infiltration, detention, and evapotranspiration, to meet these objectives. One approach that has shown excellent results is the application of low impact development/green infrastructure stormwater BMPs. The goal of these BMPs is to meet stormwater management objectives by replicating natural elements of the hydrologic cycle that have been lost in urban areas.

Agricultural Stormwater. The Florida Watershed Restoration Act of 1999 directed DEP, FDACS, and WMDs to work together to reduce pollution in Florida's waters, citing BMPs as the best way to accomplish this task for agricultural stormwater. In areas with adopted BMAPs, agricultural producers must either implement FDACS-approved BMPs or conduct water quality monitoring to demonstrate compliance with water quality standards. Agricultural BMPs are guidelines to assist producers in managing water, nutrients, and pesticides to minimize the impact on the state's natural resources. Maps of properties that are enrolled in the FDACS BMP Program within the IRL watershed are provided in **Appendix C**. When properly designed and implemented, agricultural BMPs are practical, cost-effective actions that agricultural producers can take to conserve water and reduce the amount of pesticides, fertilizers, and animal waste that enter surface and ground water resources. BMPs can benefit water quality and water conservation while maintaining or even enhancing agricultural production. Typical agricultural BMPs include:

- Nutrient management to determine nutrient needs and sources and manage nutrient applications (including manure) to minimize impacts to water resources.
- Irrigation management to address the method and scheduling of irrigation to reduce water and nutrient losses to the environment.
- Water resource protection using buffers, setbacks, and swales to reduce or prevent the transport of sediments and nutrients from production areas to waterbodies.

STRATEGIES:

- Support IRL partners to fund, design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL.
- Implement, track, and measure performance outcomes and *REPORT* on BMP activities and projects listed in the BMAPs, RAPs, and IRLNEP Projects Plan throughout the IRL watershed.
- Educate and engage agricultural producers in issues surrounding BMAPs, proper agricultural BMP implementation, and cost-share opportunities.
- Design, deliver, and refine BMPs for both agricultural and urban landscapes to improve stormwater management. Encourage augmentation of BMPs using practices such as littoral zones and aeration.
- Evaluate opportunities for reduction and reuse of stormwater such as through aquifer storage and recovery and deep-water storage.
- Educate urban, recreational, and agricultural landowners on proper use and application rates for fertilizer and chemical applications to reduce excess use.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Stormwater-1: Design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL. (NEW)	Reduced large-volume pulsed stormwater discharges to the IRL and their associated nutrient, sediment, and pollutant loads.	SJRWMD, SFWMD, water control districts, local governments	DEP	$48.8 million – $1.68 billion	DEP, WMDs, local governments	Coordinate and collaborate
Stormwater-2: Develop, improve, and implement BMPs and education programs for stormwater management and freshwater discharges for urban, agriculture, and dispersed residential landscapes.	Encourage effective and responsible design and delivery of BMPs, and education programs for fertilizer use, landscaping, proper use and disposal of chemicals, etc.	FDACS, WMDs, NRCS, DEP, UF-IFAS, local governments	Academia, consultants/ private industry	TBD	DEP, WMDs, FDACS, IRLNEP, local governments	Coordinate and collaborate
Stormwater-3: Update and maintain comprehensive drainage maps of the IRL watershed.	Update drainage maps to reflect changing land use patterns and development patterns.	WMDs, water control districts, local governments	NRCS, IRLNEP	TBD	WMDs, local governments	Coordinate and collaborate
Stormwater-4: Continue reviews of reclamation plans for water control districts and the standard operating procedures and project works of each large drainage system.	Develop and implement strategies to *REDUCE* discharges and pollutant loadings to the IRL from these sources.	Local governments	N/A	TBD	WMDs, local governments	Coordinate and collaborate
Stormwater-5: Upgrade existing urban and agricultural stormwater infrastructure networks to *REDUCE* freshwater discharges, nutrient loads, and other pollutant loads to the IRL.	Improve stormwater network to *REDUCE* loads and be able to *RESPOND* to expected population growth and climate change impacts.	DEP, FDACS, local governments	USEPA, U.S. Department of Agriculture, UF-IFAS, WMDs, interest groups	$508 million for CCMP projects	WMDs, local governments	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Begin implementation of CCMP projects listed in the BMAPs, RAPs, and IRLNEP Projects Plan.
- **Medium-term (3 – 4 years):** Continue implementation of CCMP, BMAP, and RAP projects.
- **Long-term (5 – 10+ years):** Meet BMAP five- and ten-year targets and RAP targets. Make significant progress in decreasing stormwater pollution to the IRL system.

CHALLENGES TO SUCCESS:

- Need for training and implementation of safe and effective BMPs.
- Drainage and estuary characteristics vary significantly from south to north along the IRL; therefore, a one-size-fits-all management approach cannot be taken in the IRL.
- Inadequate funding to implement all necessary projects, including both urban and agricultural BMPs.
- Urban and agricultural BMPs do not always meet the assumed reduction rates for pollutants.

- Lack of planning that results in reactive and costly large-scale projects that provide intermittent benefit to lagoon water quality.
- Desire for a sod only lawn may prevent people from implementing practices that would help to improve the IRL, such as using landscaping that would require minimal fertilizer and irrigation.

CITATIONS:

1. Kim, Y., Engel, B.A., Lim, K.J., Larson, V., and Duncan, B. 2002. Runoff Impacts of Land-Use Change in the IRL Watershed. *Journal of Hydrologic Engineering*.
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HYDROLOGY AND HYDRODYNAMICS

Goals:

Improve understanding of lagoon hydrology and hydrodynamics to improve decision-making and management.

ONE LAGOON

WATER QUALITY

Hydrology and Hydrodynamics

GOALS: Conduct *RESEARCH* to improve understanding of the IRL watershed, groundwater, and hydrology and hydrodynamics to improve decision-making for management of land use impacts to water and reduction of loads of nutrients and other contaminants.

ISSUE SUMMARY: Hydrology is the study of the movement, distribution, and quality of surface and ground waters, and hydrodynamics is the study of the internal circulation of the waters and effects on water quality.

By its very nature as a coastal lagoon, the IRL is a narrow, shallow estuarine system with minimal connection and exchange with the open ocean. The IRL is a complex system that is divided into sub-basins because of inlets and causeways located along its extent. These sub-basins are characterized by different residence/ocean exchange rates based on the ocean tides, weather patterns, and seasons.[1, 2] These sub-basins are also affected by 12 causeways, which create compartments within the IRL.[3] Studies have shown that the removal of extended causeways can improve water quality and acreage available for seagrass.[4,5] Groundwater levels also vary seasonally within the lagoon.[6] Its hydrology has been significantly altered as the area's population continues to grow.[1] Surface water flows and groundwater discharges have been altered by land use changes. It is estimated that groundwater and sub-surface discharge may contribute 45–60% of the total nitrogen and total phosphorus loading to the IRL.[7] Thus, it is important that the IRLNEP and partners continue to work towards a better understanding of the hydrological features of the IRL, including hydrodynamics within the waterbody.

The watershed has been highly altered due to ditching, draining, and impounding for urban, industrial, and agricultural purposes as well as for management of mosquitoes and flood control. In addition, man-made inlets, stabilized inlets, navigational canals, and causeways have also altered the hydrology. It is unlikely that these alterations will be removed completely from the landscape. More importantly, climate change and sea level rise impacts will further alter hydrologic functions throughout the IRL and its watershed in complex ways. Therefore, it is important to understand how the IRL hydrologic system currently operates and develop predictive models to better inform decision making.

Existing reasearch and management documentation from studies in the area could help inform restoration efforts throughout the IRL. For instance, the Comprehensive Everglades Restoration Plan (CERP) IRL-South Feasibility Study, Loxahatchee River Watershed Restoration Plan, and minimum flows and levels for the St. Lucie River and Loxahatchee River provide good examples of using hydrologic modeling to set specific performance measures. Other major waterbodies in the IRL watershed could benefit from this type of planning effort.

STRATEGIES:

- Refine scientific knowledge about IRL hydrology and hydrodynamics to better identify restoration strategies and inform decisions about development.
- Review and revise, as needed, hydrologic and hydrodynamic models used to guide IRL restoration and stewardship decisions and to set performance measures for landscape-level projects.

- Integrate models to better understand interactions of surface water, groundwater, and internal flow characteristics and incorporate findings into management decisions.
- Continue to investigate potential connections and interactions among transportation infrastructure, groundwater flow, surface water flow, and internal flow on IRL water quality and health.
- Convene a project team to develop scope of work for a science-based pilot study to better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of using oceanic exchange as an intervention to enhance IRL internal water flow and *REDUCE* residence time.
- Develop and refine quantitative performance measures for physical and chemical components of regional-scale projects.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Hydrology-1: Support advancements in hydrological model development, verification, and application. (NEW)	Improve understanding of IRL hydrology and water circulation.	IRLNEP Management Conference, Academia	IRLNEP, DEP, WMDs	TBD	IRLNEP, Florida Legislature, academia, DEP	Coordinate and collaborate
Hydrology-2: Apply the best available models to better evaluate connectivity between IRL sub-basins. *REDUCE* negative impacts of road corridors and causeways. (NEW)	Mitigate for human-built interruptions of natural water circulation in the IRL.	IRLNEP Management Conference, academia, Florida Department of Transportation (FDOT), water control districts, local governments	IRLNEP, WMDs	TBD	IRLNEP, Florida Legislature, academia, DEP, FDOT	Coordinate and collaborate
Hydrology-3: Continue evaluation of options to enhance water flow through engineering solutions that have well defined water quality and ecological outcomes. (NEW)	Identify engineering and technology options to *REDUCE* IRL residence time and enhance water flow.	IRLNEP Management Conference, academia, FDOT, water control districts, local governments	IRLNEP, WMDs	TBD	IRLNEP, Florida Legislature, Academia, DEP, FDOT	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Identify funding sources for *RESEARCH* on IRL hydrology and hydrodynamics and the complex influence on the IRL water quality and health. Conduct one public education workshop to improve public understanding.
- **Medium-term (3 – 4 years):** Implement CCMP projects from the Projects Plan to ensure that human-caused hydrological impacts are reduced and natural hydrological functions of the IRL watershed are optimized.
- **Long-term (5 – 10+ years):** Incorporate enhanced understanding of IRL hydrology and hydrodynamics and expected changes to hydrological functions into IRL management decisions and actions.

CHALLENGES TO SUCCESS:

- Difficult to model the highly-altered landscape of the IRL watershed.
- Inadequate funding for *RESEARCH* and projects.
- Difficulty in retrofitting infrastructure that effects hydrology and hydrodynamics within established communities.

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LEGACY LOADS AND HEALTHY SEDIMENTS

Goals:

Remove muck in the IRL to reduce nutrient loads and improve water clarity.

ONE LAGOON

WATER QUALITY

Legacy Loads and Healthy Sediments

GOALS: *REMOVE* and/or *REDUCE* muck in the IRL to REDUCE the legacy load of nutrients and contaminants and improve water clarity. *RESTORE* healthy natural sediments to support seagrasses and associated communities, shellfish, and healthy benthic communities.

ISSUE SUMMARY: The IRL was once a sandy bottom estuary with a modest accumulation of organic detritus from losses of shoreline and aquatic vegetation. As much as 10-20% of the lagoon bottom is now covered with a layer of fine silt and sediment called "muck" that has accumulated over years of excess sedimentation. Muck is defined as black, organic-rich (greater than 10% organic matter), mud-rich (greater than 60% silt + clay), high water content (greater than 75% water by weight, greater than 90% water by volume) sediments. Earlier studies in the IRL reported muck, as defined above, to be most prevalent in the mouths of creeks (e.g., Crane Creek and Turkey Creek), Intracoastal Waterway, and deeper pockets of water near tributaries.[1] A 1989 muck survey of the IRL from the Ponce de Leon Inlet to St. Lucie Inlet concluded that the spatial occurrence of muck was limited to less than 10% of the lagoon[1]. Today, muck flux in the IRL contributes 582 metric tons of total nitrogen (essentially all as dissolved ammonium) and 87 metric tons of total phosphorus (essentially all as dissolved phosphate) that accounts for approximately 37% and 44% of the annual total nitrogen and total phosphorus loads, respectively, in the Banana River Lagoon, North IRL, and Central IRL.[2] Large quantities of muck are also present in the St. Lucie River and Estuary and its major tributaries.

The source of muck is fine sediments and fine biological particles carried in by tributaries, canals, and stormwater systems. The biological material accumulates on the bottom and decomposes. The muck in the lagoon increases turbidity, promotes oxygen depletion in sediments and the water above, stores and releases nutrients, covers the natural bottom, and destroys healthy communities of benthic organisms.[2, 3] Muck builds up in channels and deep pockets where it can reach depths of up to 15 feet. The muck sediment contains nutrients and serves as an internal "legacy load" of nutrients that releases (fluxes) nutrients back into the water column. The Brevard County Save Our Indian River Lagoon Project Plan (2016) estimated that the annual release of nutrients from decaying muck is almost as much as the annual external loading delivered by stormwater and groundwater baseflow combined. The muck deposits in Brevard County alone cover an estimated 15,900 acres of the lagoon system.[4]

Understanding nutrient flux dynamics and the role of legacy nutrients in algal blooms is complex. Organic as well as inorganic nutrients must be considered.[5] Other eutrophication stressors, such as loss of benthic habitat, loss of filter feeders, development of hypoxia/anoxia, and alterations in food webs are additional considerations for resource managers as well as the environmental impacts of these blooms. An emerging concern with the expansion of IRL anoxic muck sediments is the production of hydrogen sulfide as a potential stressor for seagrasses,[6] macrobenthos,[7] and calcium-carbonate shell forming organisms, such as clams and oysters.[8] The relationships among eutrophication, increased temperatures, microbial respiration, dissolved oxygen, and pH (aragonite saturation) are poorly understood for the IRL. There is growing evidence that coastal acidification represents a significant but previously underappreciated environmental threat that requires monitoring and management. Nutrient management plans in acidified estuaries should consider the level of nutrient load reduction required to alleviate low pH conditions and the associated impacts on marine life.[9]

Because of the inorganic/organic composition and desire to remove legacy nutrients from fluxing internally in the IRL, muck dredging is currently the most cost-effective way to address this internal legacy load. The focus for muck removal projects for this CCMP revision is to align with the Brevard County Save Our Indian River Lagoon Project Plan[4] and the muck removal component of the CERP IRL-South project. Emphasis is on large deposits of

muck in open water sites, main canals, navigational canals, and the Intracoastal Waterway and tributaries that may be transporting upstream legacy loads of muck to seagrass and shellfish areas in the main body of the IRL. In Turkey Creek, a tributary to the IRL, about 300 metric tons of nitrogen and 70 metric tons of phosphorus were removed with 160,000 cubic meters of wet muck and sand via environmental dredging during 2016 and 2017. Dredging removed nutrients, fine sediments, and increased water depth and basin volume with positive increases in both salinity and the total inventory of dissolved oxygen.[10]

Muck flux can be a complex biogeochemical process to understand. Ongoing research associated with muck dredging projects suggest that careful consideration of muck location, volumes, area of coverage, and nutrient variability should guide site selection and expected outcomes from muck dredging. Prioritization of project funding, timing, and implementation of source reduction projects versus legacy load reduction projects will prove challenging. The four goals of muck management include: (1) decrease turbidity, (2) restore bottom habitats, (3) improve oxygen content of lagoon water, and (4) decrease nutrients released from muck. Brevard County is using a goal of reducing nutrients from muck flux by 25%,[4] and this is also the goal for this CCMP revision.

STRATEGIES:

- *REDUCE* organic and inorganic sources on land that contribute to muck in the IRL. Harvest floating aquatic vegetation to *REMOVE* this material as a source of muck.
- *REMOVE* high-nutrient legacy loads and muck in high-priority locations both within the lagoon and major canals and tributaries to the lagoon.
- Evaluate opportunities for muck capping and sediment traps instead of dredging.
- Conduct *RESEARCH* to better understand muck nutrient flux and cycling in the lagoon and other eutrophication stressors that may be associated with muck (i.e., micronutrients).
- Conduct *RESEARCH*, including modeling, to understand efficacy, benefit, and risk of muck removal.
- Develop muck maps that include priority areas and *RESEARCH* findings.
- Prioritize, simplify, and expedite restoration project permits, including expanding eligible project types that qualify for general permit consideration.
- Identify beneficial uses for dredged materials to limit the area needed for storage.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Legacy Loads-1: Complete muck mapping of the entire IRL, prioritize muck dredging projects, and *REDUCE* source contributions of sediment and biomass that result in muck formation. (NEW)	Improve knowledge about muck distribution, abundance, and sources and *REDUCE* loading.	Local governments, academia	WMDs, local partners	$35 per cubic yard of muck[4]	Florida Legislature	Coordinate and collaborate
Legacy Loads-2: Continue to couple scientific evaluation and assessment of muck dredging projects to evaluate and optimize the dredging process. (NEW)	Gain knowledge from muck dredging projects to advise decision making and muck management and disposal process.	Local governments, academia	WMDs, local partners	TBD	Florida Legislature	Coordinate and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Legacy Loads-3: Track emerging technologies, innovative approaches or alternatives to dredging, muck capping, upstream controls of muck transport, more efficient approaches to dewatering, enhanced pollutant removal in post-dredge water, and enhanced muck management to improve process efficiency, *REDUCE* costs, and identify beneficial uses of muck residuals. (NEW)	Identify new and emerging technologies to enhance performance, improve efficiency, decrease cost, and decrease risks with muck dredging and management.	Academia, local governments	DEP, IRLNEP, WMDs, local governments, academia, FWC, Florida Inland Navigation District	TBD	TBD	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Muck removal plan is developed, and priority locations are identified.
- **Medium-term (3 – 4 years):** Muck removal is underway in priority locations.
- **Long-term (5 – 10+ years):** Muck is removed from all priority locations to *REDUCE* internal nutrient loads.

CHALLENGES TO SUCCESS:

- Difficulty in addressing sources of muck (i.e., source control, street sweeping, aquatic weed control practices by some local entities and Chapter 298 Districts, lawn care management, and large network of urban stormwater conveyances).
- Cost of muck removal and management.
- Logistics and challenges associated with muck handling, storage, dewatering, and transport.
- Limited land area available for muck storage and management and local community concerns about locations and potential community impacts.
- Difficulties in permitting muck removal projects.
- Inefficiencies in removal of dissolved organic fraction and nutrients in water returned to the lagoon during dredging.
- Continued inputs of muck from incomplete dredging and upland sources.

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ATMOSPHERIC DEPOSITION

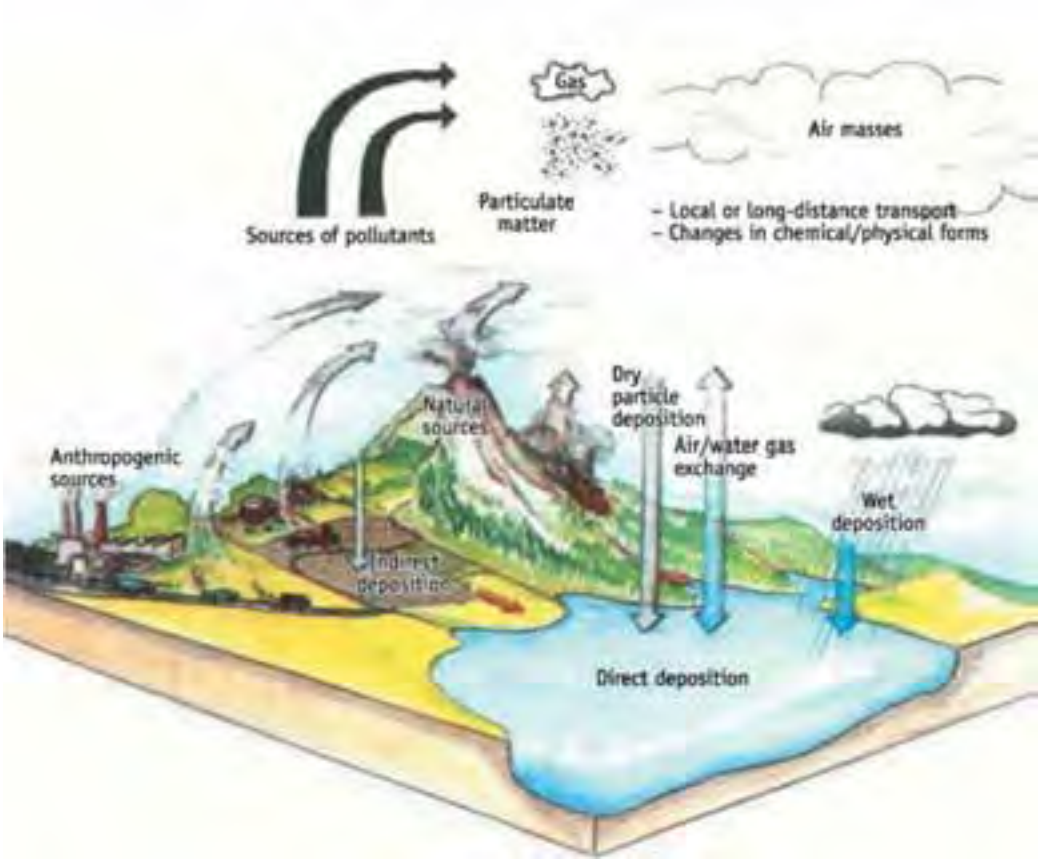
Goals:

Research and monitor atmospheric deposition of nutrients in the IRL to improve management and advise TMDLs and BMAPs.

ONE LAGOON
WATER QUALITY
Atmospheric Deposition

GOALS: Monitor and conduct *RESEARCH* on atmospheric deposition of nutrients and pollutants. Develop and implement strategies to *REDUCE*, *REMOVE*, and *RESPOND* to these impacts.

ISSUE SUMMARY: Atmospheric deposition is a source of nutrients, pollutants, and fine sediments from power plants, cars, and land use activities that fall on the IRL watershed, as shown in the figure below. These atmospheric nutrients and pollutants fall onto the watershed at differing rates during wet and dry seasons. Because of atmospheric conditions and weather patterns, not all nutrients from atmospheric deposition are generated within the watershed, and this factor adds complexity to management of atmospheric deposition sources.



Source: USEPA (2001)[1]

Over recent decades, scientific interest has focused on wet and dry deposition of nitrate stemming from combustion of fossil fuels. Successful decreases in nitrogen oxides emissions in the United States have substantially decreased nitrate deposition. By contrast, emissions of ammonia, an unregulated air pollutant, and resulting deposition of ammonium have grown.[2] Expanded observations demonstrate that deposition of reactive nitrogen in the United States has shifted from a nitrate-dominated to an ammonium-dominated condition.[3] Trends in atmospheric ammonium deposition for the IRL are not well known. A better understanding of status and trends will be an important consideration for refinement of IRL nutrient budgets, TMDLs, and water quality management strategies.

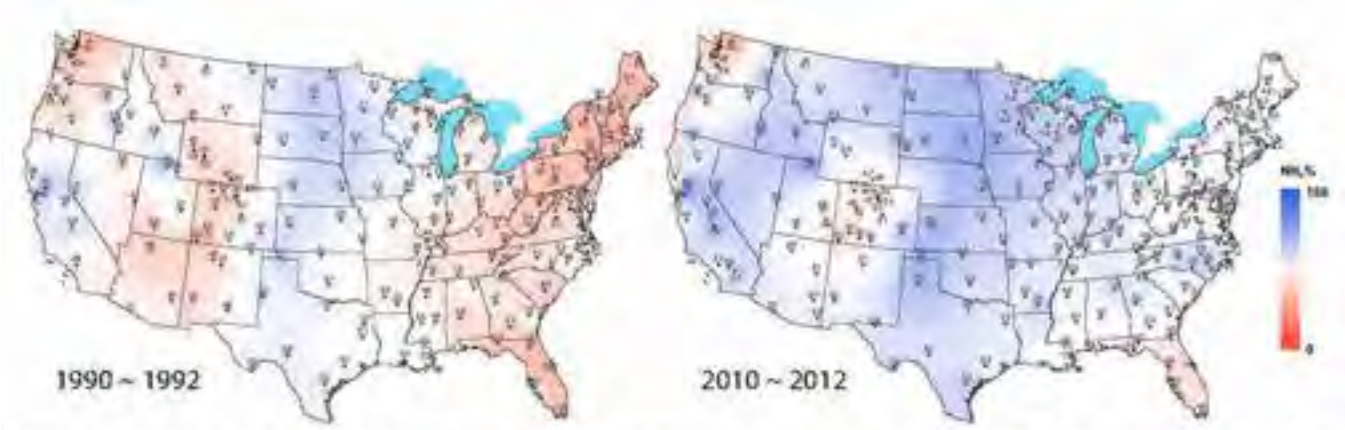


Fig. 1. Comparisons of the 3-y average NH_4^+ percentage of wet inorganic nitrogen deposition across the United States in 1990–1992 (*Left*) and 2010–2012 (*Right*). To help visualize spatial patterns, isopleths were produced by interpolating NH_4^+ mole percentages at individual monitoring sites using a cubic inverse-distance weighting of sites within 500 km of each observation station. The black dots on the map represent locations of sites with 3-y data available for each time period. The NH_4^+ percentage on a molar basis [$(NH_4^+\%) = (NH_4^+)/(NO_3^- + NH_4^+) \times 100\%$] is noted at each site.

In 2018, only a single continuous monitoring station for meteorological conditions and wet/dry deposition of total nitrogen and total phosphorus exists along the IRL. This station is at a former Clean Air Status and Trends Network station (IRL141) located at Coconut Point near Sebastian Inlet (latitude 27.849; longitude -80.4554). SJRWMD funded the station for many years, but funding responsibility transferred to the IRLNEP in 2018 with strong science support from IRLNEP partners at SJRWMD, Wood Group, and Indian River County Health Department.

These data are essential to estimate nutrient loads from atmospheric deposition. As documented in a stakeholder-driven study of IRL TMDL allocations and the Mosquito Lagoon RAP development, atmospheric loads of total nitrogen can represent a sizable portion of the total loads to the IRL.[4, 5] The relative contributions of direct atmospheric deposition of nutrients onto the lagoon varies in different portions of the system depending on the size of the waterbody in that area. Recent research highlights the need to better understand atmospheric nitrogen deposition, impacts and trends on the IRL nutrient budget and potential new implications associated with external nutrient loads that drive HABs.

STRATEGIES:

- Continue to monitor wet/dry atmospheric nutrient deposition along the IRL to advise restoration and management strategies. Expand scope to include additional data for ammonium and estimates of biological fixation and removal of nitrogen versus industrial/anthropogenic nitrogen fixation.
- Determine appropriate monitoring station locations in the southern IRL.
- Evaluate the need for expansion of atmospheric deposition monitoring along the IRL to better understand nutrient deposition (including ammonium) spatial and temporal variability.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Atmospheric Deposition-1: Determine the impacts of atmospheric deposition of nutrients and other pollutants on the nutrient budget, water quality, and resources of the IRL.	Continue data acquisition and analysis for atmospheric nutrient deposition to the IRL to inform nutrient budget refinement and nutrient reduction strategies.	IRLNEP Management Conference	USEPA, DEP, WMDs, academia, local governments, interest groups	TBD	DEP, Florida Legislature	Coordinate and collaborate
Atmospheric Deposition-2: Evaluate need for additional wet and dry atmospheric monitoring stations. (NEW)	Conduct a gap analysis for atmospheric deposition data and make recommendations in the IRL Monitoring Plan.	IRLNEP Management Conference	Academia, WMDs, DEP	TBD	DEP, Florida Legislature	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Develop a plan with recommendations on the scale and scope of an IRL atmospheric nutrient deposition monitoring network required for effective IRL management. Seek funding to expand the network as needed.
- **Medium-term (3 – 4 years):** Implement the recommendations for the atmospheric nutrient deposition monitoring network and collect data to evaluate trends.
- **Long-term (5 – 10+ years):** Synthesize available data to evaluate trends. Use improved understanding of atmospheric wet/dry nitrogen deposition trends to the IRL watershed to revise actions, as needed.

CHALLENGES TO SUCCESS:

- Long-term stable funding for IRL monitoring network equipment and operations and maintenance.
- Identification of a primary scientific investigator to lead the data acquisition, synthesis, and analysis effort over the next decade.

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CONTAMINANTS OF CONCERN

Goals:

Identify contaminant sources to better understand human health and wildlife risks. Remediate contaminated sites.

ONE LAGOON

WATER QUALITY

Contaminants of Concern

GOALS: Conduct *RESEARCH* to identify sources and loads of known contaminants and contaminants of emerging concern to better understand potential ecological, wildlife, and human health risks. Identify mechanisms to *REDUCE* or *REMOVE* these contaminants from the system. *REPORT* findings and *RESPOND* to protect human health and wildlife. Identify and remediate contaminated sites.

ISSUE SUMMARY: Estuaries with large human influences, like the IRL, are vulnerable to chemical contaminants that are delivered through surface and ground water from multiple sources.

Cuyahoga River Fire

In 1969, the Cuyahoga River was so contaminated from discharges from adjacent industry that the river caught on fire. As a result of this incident, degradation of waterbodies throughout the U.S., and a new understanding of the effects human interaction has on the environment, the Clean Water Act was promulgated in 1972. Prior to this legislation, many industrial contaminants of concern were discharged to the ground or directly into our waterways. In 1987, the National Pollution Discharge Elimination System was established to regulate all point source discharges. Under this program, pollutants such as heavy metals, pH, nitrogen, and industry-specific pollutants are monitored for compliance. Even with the Clean Water Act and the regulations that followed, historical and modern-day discharges from gas stations, dry cleaners, industrial facilities, agricultural, and Department of Defense sites continue to seep into the IRL through contaminated groundwater. Some known contaminants of concern, while regulated under the Clean Water Act, do not have defined cleanup criteria or specific regulations for cleanup; therefore, the investigation and remediation of these chemicals are unenforced.

One such class of chemicals is perfluoroalkyl substances (PFAS), which are synthetic chemicals that have been used in fire-fighting foam and other industrial and household products for more than 50 years. They have been identified in the plasma of dolphins and alligators in the IRL as well as fish tissue in waters across the U.S.[1] These chemicals have been shown to cause liver, immune, and developmental toxicity in animals. They bioaccumulate and biomagnify, are persistent in the environment, and have shown negative health effects at very low doses. PFAS are still not well understood and are considered contaminants of emerging concern.

The term “contaminant of emerging concern” is used by USEPA and other agencies to identify chemicals and other substances that have no regulatory standard, have been recently “discovered” in natural waterways (often because of improved analytical chemistry detection levels), and potentially cause harmful effects in aquatic life at environmentally relevant concentrations. They are pollutants not currently included in routine monitoring programs and may be candidates for future regulation depending on their (eco)toxicity, potential health effects, public perception, and frequency of occurrence in environmental media. Contaminants of emerging concern are not necessarily new chemicals. They include

pollutants that have often been present in the environment but whose presence and significance are only now being evaluated.[2]

Contaminants of Emerging Concern		
Industrial Chemicals	**Agricultural Chemicals**	**Pharmaceuticals**
Polybrominated diphenyl ethers (flame retardants, furniture foam, and plastics)	Organochlorine pesticides	Blood pressure medicines
Perfluorooctane sulfonate	Alkylphenols	Antidepressants
Perfluorooctanoic acid	Glyphosate	Ibuprofen
Other PFAS chemicals	Antibiotics	Antibiotics
Nano-scale chemicals		Endocrine disrupters

Microplastics are another contaminant of emerging concern in the IRL. Generally, between 0.04–0.2 inches in size, microplastics are small plastic particles usually derived from the breakdown of larger plastic marine debris. Another source is from the direct manufacture of microfibers used in synthetic clothing and microbeads, such as those found in cleansers and cosmetics. The Microbead-Free Waters Act of 2015 banned the manufacturing and delivery of rinse-off cosmetics with microbeads, so this source of microplastics will be reduced over time.[3]

A study published in 2018, quantified the amount and diversity of microplastics in water and soft tissues of eastern oysters (*Crassostrea virginica*) and Atlantic mud crabs (*Panopeus herbstii*) in Mosquito Lagoon. One-liter water samples had an average of 23.1 microplastic pieces, and microplastics were also found in crabs and adult oysters.[4] Recognition that microplastics represent a threat to ocean and estuarine environments, both from particulate pollution and potential toxicity, suggests that further research is needed in the IRL. The properties of plastics also allow for adsorption of persistent organic pollutants,[5] and concentration of toxins and heavy metals.[6,7] These plastics also include biofilms, which can carry HAB species and pathogenic microbes.[8,9]

In addition, two other categories of environmental contaminants receiving considerable public attention and concern are pesticides and herbicides, especially the active biocide glyphosate found in common weed killers. With these two categories of compounds, concerns about environmental and human health remain controversial and are in continuous scientific and public debate. The application of any potential toxicant near the surface waters of the IRL must follow label instructions for safe application, and chemicals should only be applied when necessary. For products containing the biocide glyphosate, two recent peer-reviewed scientific papers suggest that residential and commercial applicators should take special precautions when applying these products near surface waterbodies. Wang, et al.[10] concluded from lab experiments with phytoplankton that glyphosate could be used as a phosphorus source by some species, is toxic to some other species, and may have no effects on others. These differential effects suggest that the continued use of glyphosate and increasing concentration of this herbicide in coastal waters will likely have a significant impact on coastal marine phytoplankton community structure. Mercurio et al.[11] demonstrated that glyphosate was moderately persistent in marine waters under low light conditions and is highly persistent in the dark. The authors concluded that little degradation would be expected during flood plumes, which could potentially deliver dissolved and sediment bound glyphosate far from shore.

Glyphosate is not generally considered in most marine monitoring programs despite being one of the most widely used herbicides in the IRL watershed. Recent work has also reported that surfactants and wetting agents in commercial glyphosate formulations are themselves more toxic or increase the bioavailability and toxicity of glyphosate to non-target species.[12,13] Changes in agricultural production, such as reductions in citrus, throughout the IRL watershed may result in changes in the amount of these chemicals used.

An additional, and often overlooked, pollutant of emerging concern is thermal pollution from urban/suburban runoff from roadways and parking lots and industrial sources (primarily power plant cooling water discharges). Temperature governs the rates of biological organization at all levels (e.g., from biochemical reactions to metabolism of whole organisms). Therefore, changes in temperature associated with thermal pollution can influence the IRL at the species level, such as manatee migrations, all the way to rates of ecosystem processes and

functions (i.e., nutrient cycling and decomposition). Recent studies have shown that increasing temperature can influence harmful cyanobacteria blooms.[14]

STRATEGIES:

- Educate the public about IRL contaminants and best practices to *REDUCE* contaminant loads by funding projects, programs, and/or campaigns to increase public awareness.
- Identify, *RESEARCH*, and *REDUCE* sources and impacts of contaminants of emerging concern.
- Seek innovative and cost-effective wastewater treatment technologies to *REDUCE* the pollutant waste load to surface and ground waters.
- Ensure all IRL counties have an active Small Quantity Generator Assessment, Notification, and Verification Program.
- Seek innovative and cost-effective wastewater treatment technologies to *REDUCE* the pollutant waste load to surface and ground waters.
- Evaluate opportunities to implement a program to promote xeriscaping to *REDUCE* the use of pesticides and herbicides, with a possible monetary incentive for changing lawn to xeriscape.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Contaminants of Concern-1: Monitor and *RESEARCH* to better understand contaminants of concern within the IRL system. (NEW)	Increase knowledge about contaminant types, sources, transport, pathways, loads, and wildlife burdens.	DEP, FWC, FDOH	IRLNEP, local governments, WMDs	TBD based on extent and type of monitoring implemented	USEPA, WMDs, DEP, FWC, grants	Coordinate and collaborate
Contaminants of Concern-2: Implement actions to *REMOVE* or *REDUCE* contaminant loads to the IRL system. (NEW)	Decrease known contaminant loads from all sources.	DEP, federal land managers, wastewater utilities, commercial industry, agriculture	Local governments, homeowners	TBD based on the types of actions needed to reduce the source of contaminants	Federal, state, and local governments; industries; grants; loans	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Sources of pollutants are known and action plans to *REDUCE* the sources and alleviate the impacts are in place and prioritized.
- **Medium-term (3 – 4 years):** Action plans are implemented to *REDUCE* pollutants in the IRL system.
- **Long-term (5 – 10+ years):** Pollutants affecting the IRL are significantly reduced from current conditions.

CHALLENGES TO SUCCESS:

- Funding to adequately assess the concentrations of contaminants of concern within the IRL system, and appropriate monitoring tests to measure the low concentrations of contaminants.
- Sufficient *RESEARCH* on the impacts of these contaminants and how to properly remediate them.
- Lack of understanding on the effects of complex mixtures of organic chemicals on plants, animals, and the IRL system.
- Communication opportunities to reach a majority of the public.

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SEAGRASSES

Goals:

Implement a comprehensive strategy to remove seagrass stressors, restore seagrasses, and sustain seagrass-dependent species.

ONE LAGOON

HABITATS

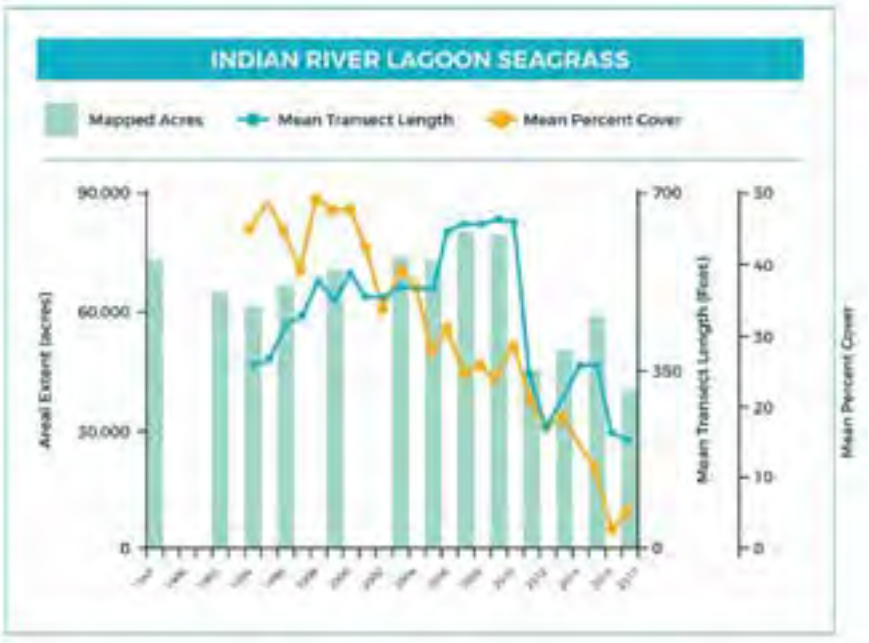
Seagrasses

GOALS: Implement a comprehensive, coordinated, and integrated IRL strategy to *REMOVE* stressors to seagrasses in the IRL and *RESTORE* seagrass habitats to support and sustain healthy water quality and seagrass dependent species.

ISSUE SUMMARY: Seven species of seagrasses are found in the IRL: turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), Johnson's seagrass (*Halophila johnsonii*), star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and widgeon grass (*Ruppia maritima*).[1] Each has subtle but different optimum salinity requirements. These seven species of seagrasses each have unique survival strategies for growth.

For more than 25 years, seagrass distribution, area coverage, and health have been considered a barometer of IRL health. Within seagrass communities, a single acre of seagrass can produce over 10 tons of leaves per year. This vast biomass provides food, habitat, and nursery areas for a myriad of adult and juvenile vertebrates and invertebrates. Further, a single acre of seagrass may support as many as 40,000 fish and 50 million small invertebrates. Because seagrasses support such high biodiversity, and because of their sensitivity to changes in water quality, they have become recognized as important indicator species that reflect the overall health of coastal ecosystems.[2] In addition, seagrass adds dissolved oxygen during daytime photosynthesis, is important in nutrient cycling, and recent studies seem to indicate that they can buffer the system from ocean acidification.[1,2,3] Therefore, seagrasses are a key component not only in the IRL system but in waterbodies throughout the state. DEP has estimated that each acre of seagrass in Florida has an economic value of approximately $20,500 per year, which translates into a statewide economic benefit of $55.4 billion annually. However, since the 2011 superbloom, the IRL has experienced extensive seagrass loss with the figure below documenting 52% less acreage than was present in 2009.[4,5] In addition, seagrass beds do not extend as far offshore, with seagrass transects in 2017 being 70% shorter than they were in 2009.[5]

The IRL system has seagrass targets for Banana River Lagoon, North IRL, and Central IRL,[6] as well for the southern IRL,[7] which are based upon light penetration in the lagoon and associated water quality parameters. These targets are not being achieved with the current conditions in the lagoon system.



Although seagrass recovery will begin when water quality, sediment quality, and the microbial biome improve in the IRL, many seagrasses are slow to recolonize. Proactive planting is a restoration technique that can complement and enhance natural recovery. Whether it is the relocation of an entire bed or removal

of random plugs from an existing bed, the use of donor beds may help with seagrass restoration. Nutritional improvements, wave protection, and herbivore exclosures can also be used to help with restoration. To date, seagrass restoration within the IRL has been limited, small in scale, and costly. The size of restoration may change in the future based on seagrass response to improving conditions. The IRLNEP Management Conference recognizes the potential need for seagrass restoration intervention. IRLNEP will work with science and restoration partners (including industry) to identify and evaluate new techniques to enhance and expedite seagrass restoration success.

STRATEGIES:

- Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide to provide a clear picture of seagrass and epiphytes abundance, distribution, and trends.
- Improve water clarity and quality in the IRL to sustain IRL seagrass recovery.
- Develop and assess seagrass nursery techniques and planting strategies in strategic areas to determine the feasibility of accelerating recovery.
- Implement a program of protection from human activity, restoration, and management activities needed to maintain, protect, and *RESTORE* the IRL seagrass community.
- Evaluate new seagrass restoration techniques by funding innovative pilot projects and partnerships.
- Prioritize, simplify, and expedite restoration project permits including expanding eligible project types that qualify for general permit consideration.
- Evaluate the current state of IRL feedback mechanisms and nutrient cycling to assess the ability of the system to function as a coastal filter.[8]
- Refine the existing IRL seagrass restoration targets using new technology for measuring light attenuation.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Seagrass-1: Implement a program of protection, restoration, and management activities.	Maintain, protect, and *RESTORE* the IRL seagrass community.	DEP, FWC, WMDs, IRLNEP Management Conference	Local governments, interest groups	Planting costs range from $10,000 to $200,000 per acre depending on conditions[9]; additional costs for stock, staff time, and monitoring	DEP, FWC, USFWS, National Park Service (NPS), academia, interest groups	Coordinate and collaborate
Seagrass-2: Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide. (NEW)	Provide a clear picture of seagrass abundance, distribution, and trends.	DEP, FWC, WMDs, IRLNEP Management Conference	IRLNEP Management Conference partners, FIT, Florida Oceanographic Society, Harbor Branch Oceanographic Institute	$250,000-$300,000 annually	DEP, WMDs, FWC, USFWS, NPS, academia, interest groups	Coordinate and collaborate
Seagrass-3: Fund innovative pilot projects and partnerships. (NEW)	Evaluate new seagrass restoration techniques.	IRLNEP, academic research partners, private companies	WMDs	Planting costs range from $10,000 to $200,000 per acre depending on conditions[9]; additional costs for stock, staff time, and monitoring	DEP, FWC, USFWS, NPS, academia, interest groups	Conduct, coordinate, and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Seagrass-4: Develop a Habitat Restoration Plan for the IRL system. (NEW)	Prepare a Habitat Restoration Plan to meet USEPA performance measures for NEPs.	IRLNEP Management Conference	Local governments, WMDs, FWC, academia, Northeast Florida Estuarine Restoration Team (NERT), East-Central Estuarine Restoration Team (ECERT)	$50,000	IRLNEP	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate ongoing monitoring and ensure efforts are coordinated. Begin seagrass restoration in key areas of the IRL, where possible.
- **Medium-term (3 – 4 years):** Observe seagrass recovery and expansion of its distribution in sub-basins of the IRL with improving water quality. Evaluate the need for a seagrass nursery to assist with restoration.
- **Long-term (5 – 10+ years):** *RESTORE* IRL seagrasses to targets in the relevant BMAPs.

CHALLENGES TO SUCCESS:

- Water clarity and quality will determine seagrass recovery timeline.
- Muck removal is required in many areas to provide adequate substrate for seagrass recovery and expansion.
- Impact of climate change on IRL water quality and depth will increase restoration challenges.

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FILTER FEEDERS

Goals:

Better understand shellfish stressors, restore filter feeders, and maintain healthy water quality to sustain fisheries.

ONE LAGOON

HABITATS

Filter Feeders

GOALS: Conduct *RESEARCH* to better understand stressors and root causes for the decline of filter feeders in the IRL. *RESTORE* selected bivalve populations, with a focus on restoring oyster and clam populations to support and sustain goals for both habitat conservation and sustainable commercial harvests.

ISSUE SUMMARY: Reef-forming oysters have declined globally by approximately 85%,[1] and the abundance and extent of oyster reef habitat (*Crassostrea virginica*) in the IRL is likely even further depleted. Similarly, the abundance of the hard clam, *Mercenaria mercenaria*, has declined precipitously following two significant peaks in fishery landings in the 1980s and 1990s.[2]

The loss of large bivalves from estuarine and lagoon systems results in a diminished level of overall ecosystem benefits, including water column filtration, denitrification in surrounding sediments, and production of reef-associated species that support recreational and commercial fisheries.[3] Filtration pressure is considered an important driver of benthic and water coupling,[4] and as such, it plays a critical role in maintaining water quality in estuarine systems at various scales. It is likely that filtration pressure at local scales (feet to tens of feet) can improve water clarity and support growth of seagrass and benthic microalgae, while filtration at estuarine scales (miles to tens of miles) has historically been an important mechanism for removing particulate organic material and moving nutrients into the benthos for processing at scales that match watershed inputs.[5]

Several recent studies in Mosquito Lagoon have been conducted to evaluate the benefits of oysters on lagoon water quality. One study investigated key biogeochemical properties (e.g., nutrient pools and microbial community size and activity) in the sediments of dead reefs; 1-, 4-, and 7-year old restored reefs; and natural reference reefs of the eastern oyster, *Crassostrea virginica*. The study found that measured biogeochemical properties increased significantly by one-year post restoration, relative to dead reefs, and then remained constant as the reefs continued to age. The study demonstrated the role of live intertidal oyster reefs as biogeochemical hotspots for nutrient cycling and burial.[6] Another study measured denitrification rates and nutrient sequestration and bioavailability of oyster beds. The study found that denitrification rates are higher underneath restored oyster reefs and that oyster reefs provide nitrogen retention. Oysters provide a continuous mechanism for nitrogen removal and have the potential to increase IRL resiliency to nutrient loads and mitigate internal nutrient loads.[7]

IRL shellfish populations can be impacted by several stressors. These stressors include poor water quality, poor sediment quality, harmful algal blooms, changes in food types and availability, changes in predator populations, salinity changes, overexploitation, and ocean acidification. These stressors and their synergistic actions are complex, and they are likely to influence species differently at each stage of their life cycles. A better understanding of these stressors and conditions is essential to optimize the siting, timing, and scale of projects to restore filter feeders.

STRATEGIES:

- Conduct mapping and condition analysis of existing habitats, delineate the areas suitable for restoration, and establish targets for key ecosystem services using a lagoon-wide filter feeder suitability analysis.[3]
- Quantify ecological and socioeconomic benefits associated with restoring oyster reef habitat, hard clams, and other bivalve populations.[8,9]
- Develop a comprehensive filter feeder management plan, using data from the above ecological and socioeconomic benefits such as filtration capacity, denitrification, and fisheries enhancement to inform restoration and management goals and that address multiple objectives of ecosystem value (habitat), commercial fisheries yield, genotypic variation, and aquaculture.
- Prioritize, simplify, and expedite restoration project permits, including expanding eligible project types that qualify for general permit consideration. Evaluate need for a restoration-only permit to streamline the permitting process.
- Understand the historic and current oyster and clam distribution and abundance throughout the lagoon through communications and data sharing among scientists, wild shellfish harvesters, and aquaculture lease holders. Integrate science-based and experienced-based IRL conditions and trends for successful filter feeder restoration.
- Consider a strategic and diversified approach to filter feeder restoration that integrates site selection (including watershed and shoreline influences), water quality, water flow, water depth, natural and artificial substrates, and traditional wild harvest techniques like relaying.
- Assess and expand existing bivalve nursery operations for the benefit of commercial and restoration purposes and conduct research regarding culture and out planting techniques.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Filter Feeders-1: *RESEARCH* spatially explicit data on the extent and condition of existing filter feeder habitat. (NEW)	Identify the extent and condition of existing filter feeder habitat.	DEP, USFWS, FWC	IRL Management Conference partners, academia, WMDs	TBD	DEP, local governments, IRLNEP	Coordinate and collaborate
Filter Feeders-2: *REPORT* spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat, incorporated into maps and online platforms. (NEW)	Identify spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat.	DEP, USFWS, FWC	IRL Management Conference partners, WMDs	TBD	DEP, local governments, IRLNEP	Coordinate and collaborate
Filter Feeders-3: Develop a filter feeder management plan working with public, private and independent sector partners. (NEW)	Identify goals for management and restoration of filter feeder habitat to assist with restoration of recreational and commercial fisheries.	DEP, FDACS USFWS, FWC	NERT, ECERT, WMDs, IRL Management Conference partners	TBD	DEP, local governments, IRLNEP, Florida Inland Navigation District (funding for reef balls)	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Determine the quantitative basis for measuring denitrification and filtration benefits from filter feeders.

- **Medium-term (3 – 4 years):** Develop a nitrogen budget and spatially-explicit nitrogen accounting framework to support the use of denitrification in overall nutrient management at the watershed scale.
- **Long-term (5 – 10+ years):** Filter feeders restored across a broad spatial distribution that supports a sustainable oyster fishery and aquaculture endeavors.

CHALLENGES TO SUCCESS:

- Continued water quality/quantity issues not suitable to sustain oyster/shellfish populations in some parts of the IRL.
- Availability of adequate, stable recurring funding for effective, efficient, and timely program and project implementation.
- Complexity of management of the shellfish resource.
- Availability of dry goods and supply chain of shell and spat needed for projected scale of restoration.

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LIVING SHORELINES

Goals:

Identify priority locations for living shoreline restorations and rebuild green infrastructure to contribute to coastal resilience.

ONE LAGOON

HABITATS

Living Shorelines

ACTION: Conduct *RESEARCH* to identify key locations along the IRL and tributaries that would benefit from living shorelines. *RESTORE* natural shorelines. *REBUILD* both natural and hardened shorelines that have been impacted by erosion or storm surge. Incorporate living components into armored shorelines where a hybrid solution is feasible and amenable to the owner. *REPORT* the performance, value, and cost-benefit of living shorelines as natural infrastructure that decreases storm surge vulnerability and contributes to coastal *RESILIENCE*.

ISSUE SUMMARY: Historically, efforts to protect shorelines have involved hardened structures, such as seawalls, rock revetments, or bulkheads, to dampen or reflect wave energy. However, shoreline hardening interrupts natural shoreline processes, reduces nursery habitat for marine species and foraging habitat for wading birds, degrades water quality, and can increase erosion processes. Hardened shorelines are often the default method of shoreline protection selected by property owners to "hold-the-line" along the edge of their properties.[1]

A more environmentally friendly option that provides similar benefits is a living shoreline. A living shoreline is a protected, stabilized coastal edge made of natural materials such as plants, sand, or rock. Unlike a hardened structure, which impedes the growth of plants and animals, living shorelines grow over time. Living shorelines are a natural shoreline management approach that provides erosion control benefits; protects, restores, or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials. Living shorelines are an innovative and cost-effective technique for coastal management.[2]

A 2015 report by Restore America's Estuaries[3] found that living shorelines:

- Prevent erosion caused by everyday weather, boat wakes, and long-term sea level rise more effectively than hardened structures in many cases.
- Prevent catastrophic storm damage more effectively than hardened structures in many cases.
- Avoid many of the adverse effects that hardened structures usually have on the adjacent aquatic and terrestrial ecosystems and associated ecosystems services.
- Grow stronger over time through natural processes, while hardened structures often deteriorate and may, if not maintained, ultimately fail.

The use of living shorelines is being encouraged across the state. The Coastal Wildlife Conservation Initiative is led by FWC in partnership with multiple agencies to address coastal issues that affect wildlife and their habitats while considering human needs. One priority issue for the initiative is replacing traditional hardened methods of shoreline stabilization with more natural living shorelines that not only provide shoreline stabilization but also habitat for wildlife while maintaining natural coastal processes.[4] The Florida Master Naturalist Program through UF-IFAS has been holding special topic classes throughout the state including one on coastal shoreline restoration, which was recently completed in the IRL. This class provides training in the restoration of living shorelines, oyster reefs, mangroves, and marsh, with focus on ecology, benefits, methods, and monitoring techniques.[5]

Studies are also underway locally to determine the most effective living shoreline designs given conditions in the lagoon. One study evaluated the wave energy attenuation from four types of living shorelines: (1) a control with sediment only, (2) oysters, (3) cordgrass, and (4) a combination of oysters plus cordgrass. This study found that the combination of live oysters plus one-year old cordgrass was the most effective. This design reduced 67% of the wave energy created by a single recreational boat wake, compared to bare sediment.[6] Information from these types of studies will help to plan appropriate types of living shorelines throughout the lagoon system.

STRATEGIES:

- Work with IRL restoration partners to implement a strategic, science-based and comprehensive living shoreline restoration program
- Support the planning, funding, implementation, and coordination of living shoreline projects throughout the IRL.
- Develop recommendations for site location, design, construction, and standardized metrics for projects to ensure consistent performance and monitoring.
- Coordinate the sharing and transfer of living shoreline information and tools to IRL partners, including resource managers, federal, state, and local agencies, contractors, and homeowners.
- Work with regulatory agencies at federal, state, and local levels to streamline permitting for living shoreline projects and incorporate living shorelines into local comprehensive plans as the preferred technique to stabilize shorelines.
- Prioritize, simplify, and expedite restoration permits including expanding eligibility for general permits.
- Implement a hybrid approach to combine living components with engineered structures where wave energy and shoreline configuration necessitate armor. These hybrid combinations provide ecosystem services for species that need habitat and improve coastal *RESILIENCE* to erosion.
- Develop comprehensive strategies throughout the IRL system, following a similar approach used by Brevard County[7] and Volusia County to assess shoreline hardening and plan for living shoreline projects.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Living Shorelines-1: *RESEARCH* and *REPORT* science-based siting, planning, design, and construction criteria. (NEW)	Improve siting, design, and construction of living shorelines throughout the IRL.	IRLNEP, USFWS, FWC	Florida Master Naturalist Program, resource managers; federal, state, and local agencies; contractors; homeowners; Riverside Conservancy; academia; NERT; ECERT	TBD	DEP, WMDs, IRLNEP, local governments	Conduct, coordinate, and collaborate
Living Shorelines-2: Develop standardized metrics and protocols for living shoreline projects. (NEW)	Ensure consistent performance and monitoring.	NERT, ECERT	DEP, FWC, U.S. Army Corps of Engineers (USACE), WMDs, NERT, ECERT	TBD	DEP, WMDs, local governments	Coordinate and collaborate
Living Shorelines-3: *RESEARCH* and *REPORT* on living shoreline information. (NEW)	Provide resources to IRL partners.	IRLNEP	Florida Master Naturalist Program, resource managers; federal, state, and local agencies; contractors; homeowners; academia; NERT; ECERT	TBD	IRLNEP, local governments	Conduct, coordinate, and collaborate
Living Shorelines-4: Streamline permitting for living shoreline projects. (NEW)	Reduce barriers to project construction.	USACE, USFWS, DEP, FWC, WMDs, local governments	Federal, state, and local agencies; contractors; homeowners	TBD	USACE, USFWS, DEP, FWC, WMDs, local governments	Coordinate and collaborate
Living Shorelines-5: Incorporate living shoreline guidance into local comprehensive plans. (NEW)	Make living shorelines the preferred shoreline restoration approach.	Local governments	Landowners and developers, NERT, ECERT	TBD	Local governments	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Promote living shoreline restoration in areas with high erosion and/or sediment loads to the IRL and as an alternative or hybrid solution for seawall replacement for waterfront homes.
- **Medium-term (3 – 4 years):** Continue living shoreline restoration projects throughout the IRL as identified in the CCMP and in other local and regional restoration plans.
- **Long-term (5 – 10+ years):** Continue to implement living shorelines projects as needed.

CHALLENGES TO SUCCESS:

- Homeowner and community acceptance of living shorelines as a sufficiently protective and cost-effective alternative for bulkheads, sea walls, and rip rap.
- Limited knowledge of living shoreline techniques in coastal construction companies.
- Funding sources and manpower to complete projects.
- Sufficient dry goods and supply chain to meet needs.
- Local comprehensive plans and permitting.

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WETLANDS AND ALTERED MARSHES

Goals:

Restore and protect wetlands and refine wetland management strategies to support biodiversity and coastal resilience.

ONE LAGOON

HABITATS

Wetlands and Impounded and Altered Marshes

GOALS: ***RESTORE*** **and protect wetlands, wetland-upland transitions, and impounded or altered marshes throughout the IRL watershed.** ***RESPOND*** **to opportunities to refine wetland management strategies to support IRL biodiversity and coastal** ***RESILIENCE*****. Conduct** ***RESEARCH*** **and** ***RESPOND*** **to future wetland management challenges associated with sea level rise.**

ISSUE SUMMARY: Wetlands within the IRL region play a key role in maintaining a healthy ecosystem. They provide a wide variety of ecological functions, including serving as habitat for various species, providing water quality protection and improvement, supporting the food chain, providing flood storage, and buffering the lagoon from activities that occur on adjacent uplands.

Urban, industrial, and agricultural development have contributed to the loss of wetlands in the IRL region. By 1980, it was estimated that 8% of Florida's estuarine habitat had been lost to development.[1] Within the IRL region, 27% of the mangrove acreage in the Fort Pierce area alone was lost between 1940 and 1987.[2] It is likely that similar losses of wetlands occurred near other urban centers in the IRL region. Upland wetlands provide critical water storage that is important to hydrologic and salinity regimes, and they filter nutrients and suspended solids. These wetlands are under increasing pressure from upland development. In addition, tidal wetlands associated with tributaries are vulnerable to hydrologic changes, and these wetlands are important habitats for critical life stages of fishery species such as juvenile redfish, snook, and blue crabs. Some of these areas, such as along the North Fork of the St. Lucie River, have been examined for restoration efforts.[3]

E. Netterstrom

In addition to direct wetlands loss, more than 40,000 acres of wetlands were impounded or ditched for mosquito control purposes and isolated from the IRL.[4] A mosquito control impoundment is a salt marsh or mangrove forest with an earthen dike around the perimeter that allows the area to be artificially flooded during mosquito breeding seasons, and machines called draglines were used to dig ditches and create piles of spoil in other marshes, especially further north in the system. Both approaches were designed to reduce breeding by salt marsh mosquitoes because females will not lay their eggs in standing water or on dry soil in piles of spoil. They lay their eggs on moist soil, and the eggs hatch when flooded by tides or rainfall; therefore, holding water on marshes permanently or during their breeding seasons prevents mosquito production.[5] Both methods effectively controlled mosquitoes, but they also isolated the wetlands from the IRL or eliminated wetland plants. Thus, the water quality and habitat benefits of these wetlands to the IRL were largely lost.

The creation of the Subcommittee on Managed Marshes of the Florida Coordinating Council for Mosquito Control in 1986, and the allocation of funds for research on wetlands management by various entities including the Florida Coastal Management Program proved to be critical in advancing ecologically sound mosquito control in Florida without reverting to heavy reliance on pesticides. In fact, new approaches yield more functional wetland, without an increase in breeding by salt marsh mosquitoes. In recent decades, amphibious excavators have restored wetlands by replacing spoil in ditches dug by draglines and grading them to the elevation of nearby

marsh, and most impoundments have been managed by rotational impoundment management, breaching of dikes, or other means to fully or seasonally reconnect the marsh with IRL waters. In most of the lagoon, impoundments represent the majority of the restored wetlands.

Installing culverts through the dikes that isolate areas of wetlands in impoundments is the most cost-effective means for reintegrating wetlands into the IRL system. By using pumps, operable weirs, and one-way valves, these reconnected wetlands continue to provide seasonal control of mosquitos and support management actions designed to benefit wildlife of interest. For the impounded marshes within the SJRWMD jurisdiction, 98% of affected wetlands are targeted for rehabilitation, with reconnection completed for 79% of those wetlands. The remaining 2% of wetlands are unlikely to be rehabilitated, in large part because they are managed for specific purposes that are incompatible with reconnection, e.g., open water for waterfowl, or they are surrounded by developed areas. In addition, the St. Lucie County Mosquito Control District manages 4,000 acres of coastal mangrove swamps and salt marshes for mosquito control using an ecosystem management approach for salt marsh mosquito control that does not require pesticides.

Sub-lagoon within SJRWMD	Mosquito Lagoon	Banana River Lagoon/ Newfound Harbor	North IRL	Central IRL	Total
Reconnected (Acres)	5,360	3,722	14,801	3,150	27,033
Targeted for Rehabilitation (Acres)	1,396	1,257	4,227	124	7,004
Not Targeted for Rehabilitation (Acres)	0	100	740	0	840
Total (Acres)	6,756	5,079	19,768	3,274	34,877

Management of wetland impoundments has varied over time. For many years, most management activities in impoundments were limited to water level manipulations using pumps or artesian wells. In recent years, culverts have been installed in the dikes of most impoundments to re-establish the vital connection between the impounded marshes and the IRL. In certain situations, dikes have been entirely removed. Restoration of the connection between formerly impounded wetlands and the open waters of the lagoon not only benefits water quality but also improves the habitat quality of the formerly impounded wetlands, providing additional habitat to many IRL species dependent on coastal wetlands for all or a portion of their life cycles.

These revised management practices have not been implemented in all impounded marshes because many of the remaining impounded wetlands in the IRL are privately owned, and many of these landowners are reluctant to allow changes in current management practices. However, local, state, and federal regulation of development or construction within wetlands has reduced the rate of wetland loss.

The five lagoon counties have ordinances to reduce the impacts and/or loss of wetland acreage and function.

- **Volusia County**: https://www.volusia.org/core/fileparse.php/4742/urlt/Division11WetlandAlterationPermits1-30-2014.pdf
- **Brevard County:** http://www.brevardfl.gov/docs/default-source/natural-resources-documents/article-x-division-4-wetland-protection-2014-09.pdf
- **Indian River County**: http://indianrivercounty.elaws.us/code/coor_apxid487171_titleix_ch928
- **St. Lucie County:** https://library.municode.com/fl/st._lucie_county/codes/land_development_code?nodeId=CHVIREPRST_6.02.00ENSELA_6.02.03WEPR

- **Martin County**: https://library.municode.com/fl/martin_county/codes/land_development_code?nodeId=LADERE_ART4SIDEST_DIV1WESHPR_S4.2WEPRST

STRATEGIES:

- Eliminate further destruction of wetlands through land acquisition of privately owned wetlands, ordinances, and other mechanisms.
- Identify opportunities for wetlands restoration for all types of hydrologic impact such as impounding, drag lining, ditching, berms, and tributary oxbow isolation. Work with private property owners to reconnect waters.
- Identify opportunities for mitigation banking and wetlands creation.
- Work with IRLNEP partners, the Sub-Committee on Managed Marshes, and mosquito control districts to continue responsible wetland and impoundment management to benefit the IRL, support IRL biodiversity and protect human health from insects.
- Re-evaluate wetland management strategies regarding key parameters such as dissolved oxygen, acidity, and primary and secondary production of fishery species.
- Work with county mosquito control districts to expand funding opportunities for living shoreline restoration when impoundment dikes require maintenance or repairs after post-storm erosion and storm surge events.
- Implement restoration of tidal wetlands in tributaries, focusing on rehydration and reconnection of historical flow and headwaters.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Wetlands-1: *RESEARCH* and develop new and improved wetland BMPs with a focus on understanding wetland responses to sea level rise and climate change.	Understand wetland responses to sea level rise and climate change.	NRCS, DEP	WMDs, academia, interest groups, FWC, Subcommittee on Managed Marshes	TBD	NRCS, WMDs, DEP, academia, NOAA, National Fish and Wildlife Foundation	Coordinate and collaborate
Wetlands-2: Establish or enhance wetland or shoreline setback buffers.	Protect wetlands from development and invasive species.	Local governments	WMDs, academia, interest groups	TBD	Local governments	Coordinate and collaborate
Wetlands-3: Implement innovative programs and incentives supporting wetlands protection and management on privately-owned lands and marshes managed by private, non-profit organizations. When necessary, acquire ownership or control of crucial wetlands.	Create wetland opportunities on public and private land and create public/private partnerships.	Brevard Environmentally Endangered Lands Program, DEP's Division of State Land, Florida Forever	Local governments, forest and agricultural land owners, mosquito control districts, interest groups, NERT, ECERT	TBD	Florida Land Acquisition Trust Fund, local governments	Coordinate and collaborate
Wetlands-4: Continue projects and programs to *RESTORE* shorelines with a focus on enhancing and managing mosquito impoundment dikes with living shoreline restoration.	Create a more natural environment and enhance biodiversity.	FWC, DEP	WMDs, local governments, interest groups, NOAA, mosquito control districts, Subcommittee on Managed Marshes, NERT, ECERT	TBD	FWC, WMDs, DEP, local governments	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate the status and needs of wetlands and impounded and altered marshes throughout the IRL.
- **Medium-term (3 – 4 years):** Implement CCMP projects to ensure IRL wetlands and marshes are restored and protected. Support the use of wetland sites as living laboratories for *RESEARCH* related to evaluating wetland changes and management needs (including BMPs) in response to climate change and sea level rise.
- **Long-term (5 – 10+ years):** Implement IRL wetland and marsh management as a coordinated network of BMPs to sustain diverse habitats and biodiversity in the IRL.

CHALLENGES TO SUCCESS:

- Re-establishing functional wetlands is difficult and costly. Therefore, focus should be on protection of existing wetlands and natural wetland functions.
- Management approaches for mosquito impoundments and managed marshes must balance mosquito control with habitat restoration goals. A whole ecosystem perspective is needed to incorporate biological diversity and water quality into lagoon-wide marsh management.
- Inadequate long-term funding.
- Challenges of sea level rise to current and future management strategies.

CITATIONS:

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4. Rey, J.R. and Kain, T.1989. A Guide to Salt Marsh Impoundments of Florida. Florida Medical Entomological Laboratory, Publication. Vero Beach.
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SPOIL ISLANDS

Goals:

Update the Spoil Islands Management Plan for the IRL with a focus on improved public access, management, and water quality.

ONE LAGOON

HABITATS

Spoil Islands

GOALS: Update and revise the IRL Spoil Islands Management Plan with a focus on maintenance, habitat *RESTORATION* and island enhancement, IRL water quality improvements, and provision of public access based on the best available science and sound habitat management principles.

ISSUE SUMMARY: Spoil islands are human-made islands, often created as a byproduct of channel dredging. To promote boating and commerce throughout Florida, countless channels were dredged through the state's shallow inshore and coastal waters to provide enough depth for vessels. The material dredged to create these channels is called "spoil." In the past, the practice was to deposit the spoil in piles along the edge of the channels as the dredging operation progressed, which created spoil islands throughout the IRL.[1,2]

Although not natural, spoil islands have become an integral habitat type throughout the IRL ecosystem since their creation in the 1940s and 1950s. Spoil islands are often surrounded by seagrass beds and mangrove fringe, which provide habitat for a variety of organisms important to the ecology and economy of the region. Spoil island uplands can support a variety of flora and fauna, both native and invasive, as well as provide an opportunity for recreation by the public. Erosion, invasive species, human-use impacts, and sea level rise pose the most important threats to spoil islands in the IRL. In 1990, The Spoil Island Management Plan[2] was drafted by DEP (then Florida Department of Natural Resources) with support from the Florida Inland Navigation District. The plan was an assessment of the resources on each of the islands, with recommendations for management strategies based on designations that were suggested at the time and still in place today.

Spoil islands currently fall under three basic designations: recreation, education, and conservation. Recreation islands are further broken down into "active" and "passive." Detailed information on island designations and locations can be found online on the IRL Aquatic Preserves Spoil Island Project website.[3] The designations assigned to the islands managed by IRL Aquatic Preserves are not legally binding and are used as management decision tools. As the management plan is updated, many islands will undergo changes in their designations based on more current resource assessments and public use patterns.

Two spoil islands in the region have been designated by FWC as Critical Wildlife Areas, BC-49 in Brevard County and MC-2 in Martin County.[4] Lands designated as Critical Wildlife Areas are protected under the Florida Administrative Code and are closed to public access. Both islands are important bird rookeries that were impacted by human activities. The Critical Wildlife Areas designation provides an important layer of protection to these areas. As natural areas along the region are developed, the spoil islands will become more important to wildlife.

To date, successful spoil island restoration/enhancement projects include those conducted on SL-3 and SL-15 in St. Lucie County. The 5.7-acre SL-3 enhancement project involved the replacement of the Australian pine and Brazilian pepper community with native wetland and hammock plant species. The 10.5-acre SL-15 project entailed removal of exotic vegetation and 90,000 cubic yards of sediment to create coastal hammock, mangrove, and seagrass habitats. Large-scale projects such as island scraping can be coupled with muck capping projects as the islands represent a suitable sediment source.

Spoil island restoration immediately post-project (left) and ten years later (right)

Spoil Island Working Group. In 1997, the IRL Aquatic Preserves office created the Spoil Islands Working Group to coordinate IRL spoil island activities and research. The Working Group is composed of numerous stakeholders including federal, state, county, local interest groups, and university partners.[3] The Spoil Islands Working Group functions as an issue-specific working group of Florida's NERT and ECERT. All stakeholders work closely with the IRLNEP on habitat restoration issues for the IRL. A priority for the Working Group is to draft an updated IRL Spoil Islands Management Plan. The updated management plan, along with stakeholder input, will align management decisions with goals outlined in the IRL Aquatic Preserves approved management plan. The plan will also be aligned with this CCMP revision. Once completed, the updated Spoil Island Management Plan will provide an example for other spoil island managers throughout the state and country.

Leave No Trace Program. In 2017, the IRL Aquatic Preserves office partnered with the Leave No Trace Center for Outdoor Ethics to address impacts associated with recreational use of the spoil islands. The IRL and its spoil islands were designated as a 2017 hotspot. The Hot Spots Program identifies areas suffering from severe impacts of outdoor activities that can thrive again with Leave No Trace solutions. In 2017, week-long outreach activities were held in the region to educate recreational users and land managers about Leave No Trace principals and BMPs to help reduce impacts to the spoil islands and areas around the IRL. The main issue that the program aims to address is human waste left on spoil islands, which is both a social and water quality issue.

Friends of the Spoil Islands. Friends of the Spoil Islands is the approved Citizen Support Organization for the IRL Aquatic Preserves office. The Friends of the Spoil Islands is responsible for providing funds for the hosting and management of the Spoil Island Project website, financing a web-based public user survey account that gathers data on recreational use of spoil islands, financing the Leave No Trace Program, and holding public interest funds that are used throughout the aquatic preserves. The group has also created the only limited mobility access spoil island in the IRL region through a grant from the IRLNEP.

STRATEGIES:

- Work closely with DEP, IRL Aquatic Preserves office, Florida Inland Navigation District, and Spoil Island Working Group to update the IRL Spoil Island Management and the DEP Aquatic Preserve's Island Designation System, as needed.
- Work closely with IRL Aquatic Preserves staff to implement and expand the Leave No Trace Program as part of the IRLNEP Trash-Free Waters Initiative.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Spoil Islands-1: Create a central electronic repository for spoil island maps, documents, sources. (NEW)	Develop a repository and centralized electronic file location for spoil island information.	IRL Aquatic Preserves, Friends of the Spoil Islands Working Group, NERT, ECERT	IRLNEP Management Conference	$21,000 allocated by IRL Aquatic Preserves for a position	DEP, FWC	Coordinate and collaborate
Spoil Islands-2: Update the IRL Spoil Management Plan and implement identified projects. (NEW)	Update the IRL Spoil Island Management Plan and implement spoil island habitat restoration and enhancement and public access projects.	IRL Aquatic Preserves, Friends of the Spoil Islands Working Group, NERT, ECERT	IRLNEP Management Conference	$50,000 to update the plan; cost for projects to be determined based on plan update	DEP, FWC, Florida Inland Navigation District, IRLNEP	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Revised IRL Spoil Island Management Plan is completed and adopted.
- **Medium-term (3 – 4 years):** High priority habitat restoration projects on IRL spoil islands are identified, funded, and underway.
- **Long-term (5 – 10+ years):** IRL spoil islands represent an integrated network of conservation, habitat restoration, and public recreation.

CHALLENGES TO SUCCESS:

- Funding for habitat restoration and spoil island maintenance.
- Sea level rise will threaten the natural resources and public access values of spoil islands.
- Boat wakes erode the shorelines.
- Human use of island with bird rookeries conflicts with listed species protection.

CITATIONS:

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3. IRL Aquatic Preserves. 2018. Spoil Island Project. www.spoilislandproject.org.
4. FWC. 2018. Critical Wildlife Areas. http://myfwc.com/CWA.

LAND CONSERVATION

Goals:

Promote land conservation to provide water quality improvement, flood prevention, and restoration of natural hydroperiods.

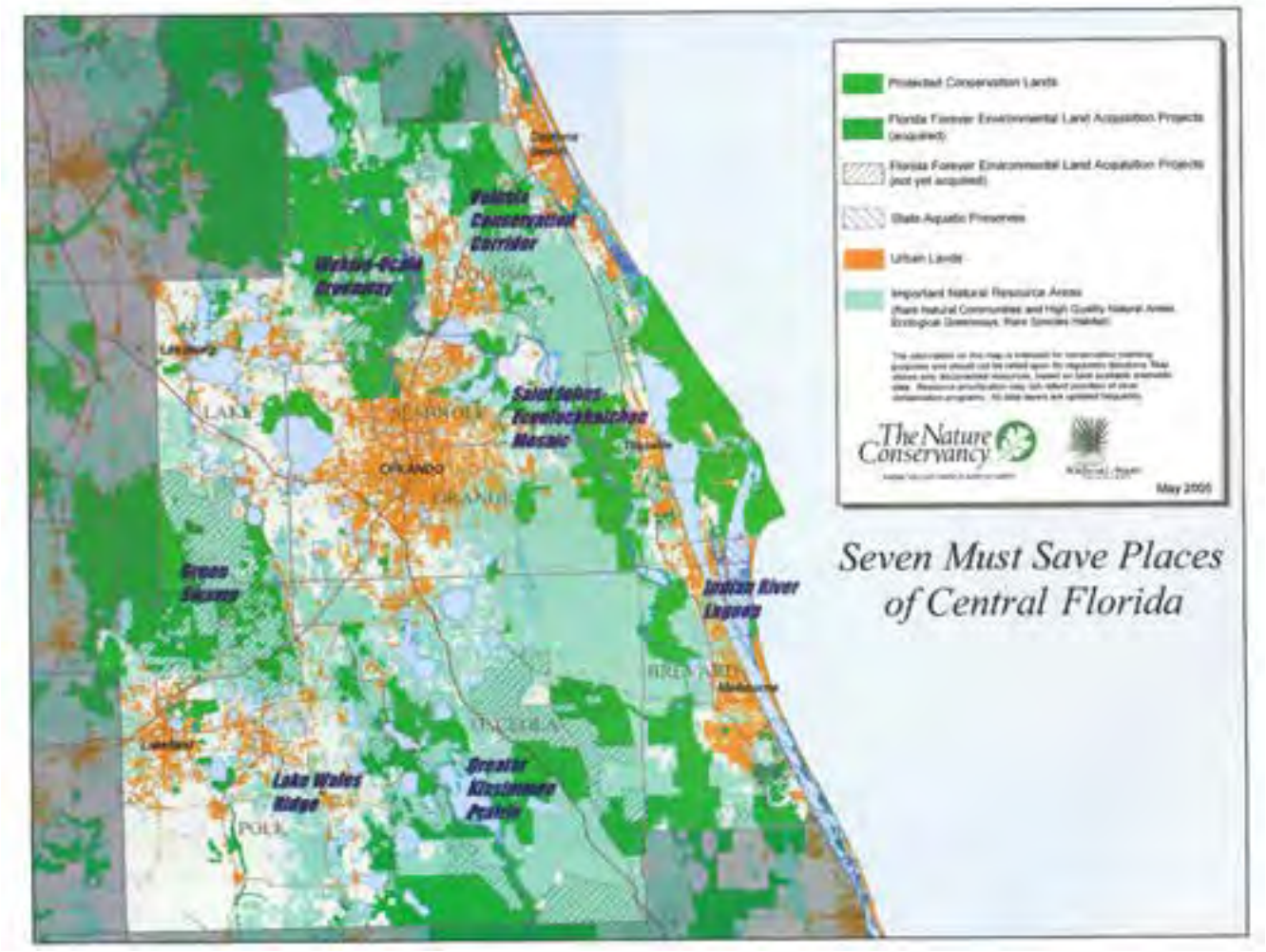
ONE LAGOON

HABITATS

Land Conservation

GOALS: Promote conservation of land. Pursue strategic initiatives that will *REDUCE* freshwater, sediment, nutrient, and pollutant loads to the IRL and *REBUILD* natural land-water connections to provide water quality improvement, provide flood prevention, and *RESTORE* natural hydroperiods.

ISSUE SUMMARY: IRL water quality is directly affected by activities on the land surrounding the lagoon. Coastal development, stormwater runoff, and alteration or destruction of coastal and nearby habitats affect the natural and human-built assets of the IRL. Upland and wetland areas adjacent to the IRL serve as important travel corridors or habitat for many species. Protection of these upland-wetland-lagoon linkages is important to many of the region's biological resources, and it provides essential protective services to human-built communities along the IRL. In addition, in 2005, Naturally Central Florida recognized IRL as one of seven regional "jewels of our natural world" and "must save" places for Central Florida.[1]



Willing seller – willing buyer land acquisition is an important non-regulatory tool that respects private property rights. It is the most effective management tool to protect biological integrity and diversity in coastal estuary watersheds. Strategic acquisition of land for public use provides many benefits to the IRL and its coastal communities (i.e., protection of natural habitats and species, wetland areas for stormwater conveyance and treatment, groundwater recharge areas, public access and use areas, and coastal resilience to flooding and storm surge events). Land acquisition has supported the creation of more than 50 destinations for nature, heritage, and cultural tourism along the IRL.

Local land conservation programs can work in concert with state and federal initiatives.[2] The IRL watershed has a long and successful history of acquiring lands for conservation at private, local, state, and federal levels. Statewide programs, such as Preservation 2000 and Florida Forever, acquired 2.4 million acres statewide. Locally, Volusia, Brevard, Indian River, St. Lucie, and Martin counties adopted tax-supported land conservation programs in the 1990s. In 2014, Florida voters ratified the Florida's Water and Land Legacy amendment which dedicates more than $20 billion to land and water conservation over the next 20 years. Consistent with this, the Florida Legislature re-initiated Florida Forever and Florida Communities Trust funding in 2018. Among the Florida Forever projects is the Indian River Lagoon Blueway, which was placed on the list in 1998. The project area contains 27,451 acres in five counties. Over the last 20 years, 8,018 acres have been acquired at a cost of $45 million leaving 19,433 remaining to be acquired. Private, non-profit organizations have been significant and active land acquisition partners. The Nature Conservancy, The Trust for Public Land, The Richard King Mellon Foundation, and the Indian River Land Trust have provided considerable land acquisition support over the past decades. The Indian River Land Trust is one of the only private, non-profit organizations that acquires and manages lands along the lagoon. Since 2009, the Indian River Land Trust has acquired more than 925 acres and over 8.5 miles of IRL frontage.[3]

As a result of land conservation activities over multiple decades, there are now tens of thousands of acres of publicly owned lands and waters managed for conservation purposes, including five national wildlife refuges, one national seashore, seven state parks, and numerous county and municipal parks and preserves. Management of these lands should incorporate restoration goals for the lagoon as well as provision for public access.

Acquisition of fee-simple title is not the only pathway to manage lands for conservation and restoration purposes. Less than fee options, such as conservation easements, are powerful tools for conservation that allow private landowners to provide lands for conservation. The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development from taking place on the land in perpetuity while the land remains in private hands. Conservation easements protect land for future generation, while allowing owners to retain many private property rights and to live on and use their land, at the same time potentially providing them with tax benefits.

An innovative, cooperative land-use agreement being used in Florida is the Dispersed Water Management Program. This program encourages private property owners to retain water on their land rather than drain it, accept and detain regional runoff for storage and use, or provide both. Landowners typically become involved in the program through cost-share cooperative projects, easements, or payment for environmental services. Managing water on these lands is one tool that can accelerate water storage projects, reduce flood risks, and divert high-volume stormwater discharges away from coastal estuaries.

In addition, FDACS has the Rural and Family Lands Protection Program, which is an agricultural land preservation program designed to protect important agricultural lands through the acquisition of permanent agricultural land conservation easements. The program is designed to protect valuable agricultural lands, create easement documents that work together with agricultural production to ensure sustainable agricultural practices and reasonable protection of the environment without interfering with agricultural operations, and protect natural resources in conjunction with the economically viable agricultural operations. This program recognizes that a thriving rural economy with a strong agricultural base and viable rural communities is essential to Florida's future.

It also protects agricultural lands in the path of development so that Florida will continue to maintain a viable agricultural sector in our state's economic base, and the citizens of Florida can continue to enjoy rural landscapes and open space, and in so doing, provide simultaneous protection of environmentally significant areas.[4]

STRATEGIES:

- Acquire sufficient lands through fee simple or less than fee simple acquisition strategies to achieve the intended outcomes for IRL restoration and ecosystem health.
- Develop and update lagoon-wide maps of publicly-owned conservation lands integrating existing and planned restoration projects to communicate a lagoon-wide picture of the network of conservation lands, ongoing site activities, and needs.
- Evaluate needs, opportunities, and funding sources to acquire environmentally-sensitive lands along the IRL with special focus on inholdings and additions on existing management units, opportunities and funding sources for less than fee conservation easements, opportunities and funding sources for dispersed water management on existing public and privately conservation lands, and development of a protocol for rapid buy-out response for high-risk, frequently flooded properties.
- Review and update Florida Forever Plans within the IRL watershed, including the Indian River Blueway Florida Forever Project.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Land-1: Continue coordination of efforts to identify, classify, acquire, and manage environmentally sensitive lands.	Manage sensitive lands with strategic conservation outcomes throughout the IRL region.	Local governments, DEP, WMDs, private landowners	IRLNEP, Indian River Land Trust, interest groups, Riverside Conservancy	TBD	Florida Land Acquisition Trust Fund, local governments, private	Coordinate and collaborate
Land-2: Support recurring funding of the Land Acquisition Trust Fund and other funding sources.	Acquire and manage conservation lands for long-term land management and stewardship.	Florida Legislature	DEP, FWC, local governments, interest groups	TBD	Florida Land Acquisition Trust Fund, local governments	Coordinate and collaborate
Land-3: Support public acquisition of environmentally sensitive lands that are deemed essential for long-term protection and management of IRL resources, CCMP implementation, and stormwater projects. (NEW)	Help protected species and *REDUCE* risk vulnerability for natural and human-built infrastructure from storm events, erosion, or sea level rise.	Local governments, DEP, WMDs, private landowners	IRL NEP Management Conference	TBD	Florida Land Acquisition Trust Fund, local governments	Coordinate and collaborate
Land-4: Develop and implement incentives to promote conservation of privately-owned environmentally sensitive lands and provision of cost-effective dispersed water management projects.	Promote conservation of privately-owned sensitive lands and provision of cost-effective dispersed water management projects.	Local governments, DEP, WMDs, private landowners, water control districts, FDACS	IRL NEP Management Conference	TBD based on conservation method	Florida Land Acquisition Trust Fund, local governments	Coordinate and collaborate
Land-5: Promote acquisition of lands for public access to the IRL.	Create public access to the IRL.	Local governments, DEP, WMDs, private landowners	IRL NEP Management Conference	TBD	Florida Land Acquisition Trust Fund, local governments, private	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Identify and target highest priority lands required for CCMP restoration project implementation. Integrate land acquisition considerations into coastal *RESILIENCE* and adaptation planning.
- **Medium-term (3 – 4 years):** Begin land acquisition activities as needed for CCMP implementation.
- **Long-term (5 – 10+ years):** Continue land acquisition along the IRL. Implement an acquisition strategy to prepare for sea level rise impacts to coastal areas.

CHALLENGES TO SUCCESS:

- Lack of funding, including emergency response reserves, and/or willing sellers.
- Rapid population growth and coastal development may increase land prices beyond a cost-benefit threshold.
- Emergency "*REBUILD* quick" decisions are typically made without consideration for land acquisition as a strategy to address long-term risk exposure.

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CONNECTED WATERS AND WATERSHEDS

Sebastian Inlet District

Goals:

Improve understanding and management of waters influencing the IRL.

ONE LAGOON

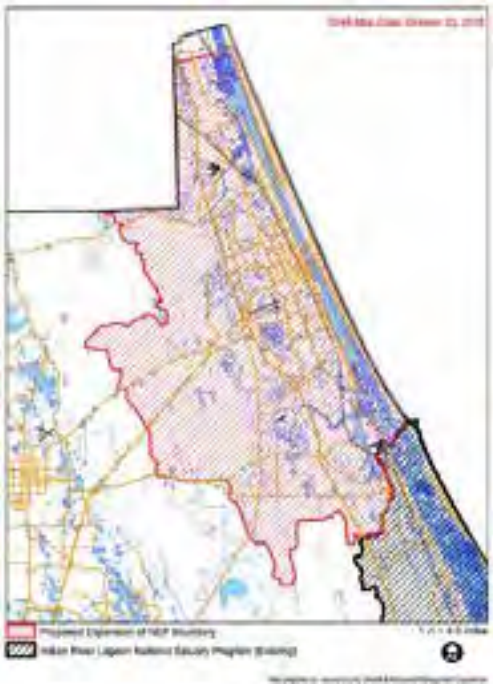
HABITATS

Connected Waters and Watersheds

GOALS: Conduct and share *RESEARCH* to improve understanding and management of waters that influence the IRL. *RESTORE* natural connections and water flow to *REDUCE* freshwater discharges to the IRL. *REPORT* regularly to IRLNEP partners working in connected and adjacent waters and watersheds. *RESPOND* to opportunities for shared projects and potential threats.

ISSUE SUMMARY: All of Florida's surface and groundwaters are connected either directly by natural or man-made connections or indirectly through the water cycle. Restoring the health of the IRL will require resource managers to look beyond watershed boundaries. Communication, cooperation, coordination, and collaboration among many resource managers and stakeholders will be essential. For the IRL, key surface water and watershed connections include Lake Okeechobee and the Everglades, St. Johns River, and Atlantic Ocean. To be effective at IRL ecosystem-wide restoration, the IRLNEP must communicate, cooperate, and coordinate with regional restoration initiatives on connected and adjacent waters and watersheds.

IRL-Halifax Planning Boundary (2016). In 2015, in response to a request by Resolution 2015-133 (November 5, 2015) of the Volusia County Council, the IRLNEP Management Conference evaluated and accepted an IRLNEP planning boundary amendment to include the southern section of the Halifax River north of Ponce Inlet in Volusia County. The boundary amendment extended the northern boundary of the CCMP planning boundary 25 miles north and included 198,678 watershed acres and 6,555 surface water acres. The IRL-Halifax Planning Boundary was reviewed and supported by IRLNEP Management Conference (i.e., Citizens Advisory Committee, STEMAC, and Management Board). Final IRL Council Board approval occurred on November 18, 2016. A number of considerations influenced the decision. IRLNEP targets a broad range of issues and engages local communities in the process to maintain the integrity of the whole system, which includes its chemical, physical, and biological properties, as well as its economic, recreational, and aesthetic values; six of Volusia County's 16 drainage basins contribute to the Halifax River, including the Outstanding Florida Waters of the Tomoka River and Spruce Creek; the Halifax River merges with Spruce Creek and the Mosquito Lagoon as an integrated estuarine system which requires a holistic approach to ensure the health and success of regional restoration and stewardship; and climate change and sea level rise compel coastal managers to look at large-scale features and changes to evaluate risk-based vulnerabilities and develop adaptation strategies.



Everglades Restoration. The Everglades is a World Heritage Site, an International Biosphere Reserve, and one of the world's largest ecosystem restoration projects. Today, the south Florida landscape is a highly altered system of canals and ditches that began to drain the land a century ago and pave the way for agriculture and urban development. To protect the region from flooding, Lake Okeechobee was connected to the IRL by the Okeechobee Waterway and the St. Lucie River, which is a major tributary to the southern IRL. During wet seasons, large freshwater discharges from the St. Lucie River watershed and from Lake Okeechobee are made to control water levels and offer flood protection across the SFWMD area.[1] A number of these high-volume

freshwater releases have occurred since the 2008 CCMP (2013, 2016, 2017, and 2018). These seasonally recurring releases drastically alter the normal IRL salinity regime. The release volume and duration determine the severity of the salinity impacts to the estuary and lagoon. These release events also convey large loads of sediment and nutrients to the system, and they can transport algae from Lake Okeechobee and watershed canals capable of triggering HABs. This happened in 2016 when 30.4% of the total inflow, 36.0% of the total nitrogen load, and 25.1% of the total phosphorus load to the St. Lucie Estuary came from Lake Okeechobee.[1] The releases triggered a severe bloom of *Microcystis* with associated production of the microcystin toxin that posed threats to the health of the ecology, livestock, and humans. A similar event occurred in 2018.

To reduce nutrient pollution to the St. Lucie Estuary and the IRL, SFWMD and USACE plan to implement the IRL-South project, part of CERP. The IRL-South project includes: (1) construction and operation of four new large-scale above-ground reservoirs to capture water from the C-23, C-24, C-25, and C-44 canals for increased storage; (2) construction and operation of four new stormwater treatment areas for the C-23/C-24 North, C-23/C-24 South, C-25, and C-44 basins; (3) restoration of about 92,100 acres of upland/wetland areas and habitat; (4) redirection of water from the C-23/C-24 basin to the North Fork of the St. Lucie River to attenuate freshwater flows to the estuary; (5) about 7.9 million cubic yards of muck removal from the St. Lucie River Estuary; and (6) about 900 acres of oyster shell, reef balls, and artificial submerged aquatic vegetation near muck removal sites for habitat improvement. The CCMP efforts should coordinate with CERP, such as with the C-44 Reservoir and Stormwater Treatment Area component of the IRL-South project that is under construction.[2]

St. Johns River. The St. Johns River begins its northerly journey to the Atlantic Ocean from a drainage basin west of the City of Vero Beach in Indian River County. The 2,000-square-mile basin that makes up the headwaters of the river is known as the Upper St. Johns River Basin. In the early 1900s, the upper basin was diked and drained for agricultural purposes. By the early 1970s, 62% of the marsh was gone, and canals were constructed for urban and agricultural purposes to divert water from the basin east to the IRL. The alterations diminished water quality in the lagoon and degraded the upper basin's remaining marshes. In 1977, SJRWMD and USACE began a long-term flood control project to revitalize the upper basin. The Upper St. Johns River Basin Project reclaimed drained marshlands by creating reservoirs and replumbing existing canals. The project goals included improving water quality, reducing freshwater discharges to the IRL, providing for water supply, and restoring and enhancing wetland habitat. The Upper Basin project was completed in May 2016, and the project is now subject to a long-term maintenance plan.[3] Projects have also been completed to re-divert C-54, C-10, C-1, and Crane Creek to restore freshwater flows to the St. Johns River and reduce freshwater discharges and associated pollutant loads from reaching the IRL.[3] Restoration efforts are also underway in both the Middle and Lower St. Johns River basins as part of existing TMDLs and BMAPs, as well as SJRWMD projects. Continued coordination is needed to ensure that the restoration goals for both the St. Johns River and IRL can be achieved.

Ocean Inlets. The IRL has five inlets that provide direct connections to the Atlantic Ocean, allowing for animal migration between the productive estuary and nearshore coastal waters, and provide tidal exchange of the lagoon system. Inlets have opened and closed over the long geological history of the lagoon. These inlets are important in controlling the residence time of water within lagoon segments and influence the transport of materials through the lagoon. These transport and exchange processes have presumably varied considerably over time as the number and arrangement of inlets changed. With coastal construction and inlet stabilization, the degree of variation in the IRL system has been lowered, although even today dredging and other modifications of the inlets influence water quality of the lagoon. The five inlets include:

- Ponce de Leon (Ponce) Inlet is the most natural inlet, which has been open since colonial times and has since been artificially stabilized.
- Sebastian Inlet is a man-made inlet that was constructed in 1924, closed by natural forces in 1941, and reopened in 1947.[4] It is now stabilized.
- Fort Pierce Inlet is a man-made inlet near the site of the Indian River Inlet and was dredged and stabilized in 1921.
- St. Lucie Inlet was built as a small connection between the IRL and ocean in 1844 and was later dredged in 1892.
- Jupiter Inlet is a natural inlet at the south end of the IRL that has been stabilized to eliminate migration.

Segment	Average Residence Time (Days)
Mosquito Lagoon[8]	
ML1	4
ML2	8
ML3-4	76
Banana River Lagoon[9]	
BR1-2	148
BR3-5	96
BR-6	11
BR-7	3
North IRL[9]	
IR1-3	47
IR4	3
IR5	47
IR6-7	30
IR8	9
IR9-11	35
Central IRL[9]	
IR12	12
IR13	1
IR14-15	6
IR16-20	9
IR21	1
South IRL[10]	
South IRL	16

The natural opening and closing of these inlets was part of the coastal geological dynamics of eastern Florida. In this microtidal, high wave energy environment, natural sand transport favors long (20–60 mile) barrier islands with abundant wash over terraces and wash over fans and infrequent tidal inlets. Typically, temporary inlets caused by over wash during storm events are rapidly sealed by tidal and longshore current driven sand transport.[5]

In addition to these inlets, there are other connections. One connection to the ocean is at Port Canaveral, which was constructed between 1951 and 1955 in an area where no known inlet had previously existed. The connection consists of an engineered lock system that is used specifically for access by maritime vessels. This lock system limits the exchange of water between the Banana River Lagoon and ocean to times when the locks are open. Another connection is for the Mosquito Lagoon to the IRL through the man-made Haulover Canal, which was constructed during the 19th Century.

The Banana River Lagoon, North IRL, and southern Mosquito Lagoon do not have inlets and, therefore, they have long residence times, which create their valued ecology and means that water in these areas is not exchanged with the ocean rapidly, so nutrients can build up leading to algal blooms. One option to help this condition is to increase exchange by adding culverts, pumps, weirs, or inlets to provide new connections to the Atlantic Ocean. However, artificial exchange projects are expensive and complex. They can move nutrients, muck, and pollutants from one location to another without delivering intended water quality benefits. Local municipalities are concerned about shoreline erosion and stormwater infrastructure efficiency with enhanced circulation and elevated water levels. Because of the complex nature of biological response to changing water quality conditions, there are also concerns among the scientific community regarding unintended and undesirable consequences. The amount of exchange needed to have a beneficial impact on the system without causing harm is also unknown. One issue of concern is artificial shifting of salinity and nutrient regimes that might favor certain HAB species. SJRWMD has been conducting studies to evaluate potential options to provide additional exchange for the lagoon system.[6,7] The IRLNEP is pursuing discussions with IRL scientists and engineers to evaluate options and develop a scope of work for a pilot project designed to better evaluate costs, benefits, and associated risks. In addition, the IRLNEP is working with Port Canaveral and FIT to model IRL water flow and internal compartmentalization of water segments by causeways, bridges, and other human-built structures to advise future FDOT and local roadway, causeway, and bridge infrastructure improvement decisions.

STRATEGIES:

- Seek opportunities to communicate, cooperate, and coordinate with agencies and partners in the connected watersheds of the IRL system to identify measures to achieve goals for both the IRL and its connected waters.
- Integrate the IRL-Halifax Planning Boundary into all IRLNEP and CCMP considerations and activities.
- Expand efforts with SFWMD and other partners in the IRL-South CERP project to support expanded and accelerated funding for water storage as part of Everglades restoration to *REDUCE* nutrient laden freshwater discharges to the IRL.
- Expand efforts with SJRWMD and other partners in the restoration of the St. Johns River to support funding for expanded efforts, with a focus on restoring a more natural drainage divide and flow of freshwater that includes using public and private lands to retain, treat and manage releases, with a goal to eliminate discharges to the IRL.
- Work with IRLNEP Management Conference and interested science and engineering partners to develop a detailed scope of work for a science-based pilot project to evaluate the effects of enhanced oceanic exchange for the IRL, where appropriate.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Connected Waters-1: Incorporate the IRL-Halifax Planning Boundary area into all IRLNEP discussions, CCMP action plans, and CCMP implementation activities. (NEW)	Incorporate IRL-Halifax Planning Boundary into all IRLNEP discussions.	IRLNEP	Volusia County and local governments, SJRWMD, DEP	TBD	Local governments, IRLNEP	Conduct, coordinate, and collaborate
Connected Waters-2: Support expanded and accelerated funding for Everglades restoration. (NEW)	Significantly *REDUCE* or stop large volume freshwater releases from Lake Okeechobee and St. Lucie River watershed.	USACE, SFWMD	Local governments	$16.4 billion for CERP	Federal and state legislative appropriations	Coordinate and collaborate
Connected Waters-3: Support expanded and accelerated funding to *RESTORE* the St. Johns River. (NEW)	*RESTORE* freshwater flow direction, retention, treatment, and managed release.	SJRWMD, USACE	Local governments	Initially $105.2 million*	SJRWMD, state legislative appropriations	Coordinate and collaborate
Connected Waters-4: Evaluate water quality habitats and species composition around inlets and develop management recommendations. (NEW)	Implement projects that protect lagoon-nearshore ocean connections for species of concern, improve water quality, and support biodiversity.	IRLNEP, USACE	Canaveral Port Authority	TBD	State and federal grants, IRLNEP	Conduct, coordinate, and collaborate
Connected Waters-5: Better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of enhancing oceanic exchange and develop a pilot project, as appropriate. (NEW)	Develop a pilot project to enhance oceanic exchange, as appropriate.	DEP	IRLNEP Management Conference, local governments, inlet districts	TBD based on connection type and location	IRLNEP Management Conference, state and federal grants	Coordinate and collaborate

* For the Sottile Canal, C-54/Fellsmere Main Canal, C-1, C-10, and Crane Creek projects.

OUTCOMES:

- **Short-term (1 – 2 years):** Enhanced communication, coordination, and cooperation among partners in connected watersheds. Complete enhanced water flow pilot project planning and, if scientifically feasible and supported by the IRL Management Conference and partners, seek funding to move forward with design and engineering work.
- **Medium-term (3 – 4 years):** Coordinated and cooperative efforts are successful in expanding and accelerating local, state, and federal cost-share funding for projects.
- **Long-term (5 – 10+ years):** Citizens, communities, and partners within the IRL watershed and connected waters and watersheds understand and appreciate the complex nature of the system and the opportunities and challenges.

CHALLENGES TO SUCCESS:

- Cost of individual efforts and diversity of partners engaged in watershed restoration and management.
- Tendency for people and programs to think and prioritize with only a local perspective.
- The need to balance re-diversion and storage with maintaining flood protection.
- Climate change and increasing storm intensity add to the challenge of managing watershed connectivity.

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BIODIVERSITY

R. Spratt

Goals:

Develop a long-term management strategy to restore and protect biological diversity in the IRL.

ONE LAGOON

LIVING RESOURCES

Biodiversity

GOALS: Conduct comprehensive biodiversity *RESEARCH* to develop a long-term management strategy to *RESTORE, REBUILD,* and protect the biological diversity of the IRL.

ISSUE SUMMARY: More than 4,000 species of plants and animals live in the IRL watershed, including more than 2,200 animal species and more than 2,100 plant species.[1] The IRL is one of the most biologically diverse estuaries in North America.[2]

The IRL and its surrounding region is a complex coastal landscape consisting of a broad variety of habitats that support many plant and animal species. Much of the biological diversity found in the region results from both physical features of the lagoon and the overlapping of the temperate and sub-tropical climate zones.[2,3] Additional influences from ocean inlets and the proximity to the Gulf Stream in the southern IRL also contribute to the rich biological diversity of the system.

The goal of biodiversity conservation has been described as the conservation of diversity at three levels: (1) ecosystem, (2) species, and (3) genetic.[3] Developing a representative system of protected areas is often considered an effective way to achieve this goal in the marine environment. For the IRL, habitat alteration and loss drive this management strategy towards the restoration of damaged habitats or creation/rehabilitation of damaged habitats.

Some species, communities, and habitats have been the subject of several studies, while little information is available on others. Numerous studies and several management activities have attempted to address the status and maintenance of biological diversity in the IRL region. In 1995, the IRLNEP hosted a lagoon-wide biodiversity science conference to better understand the biodiversity status of the IRL.[3]

A comprehensive biodiversity management strategy for the IRL region must focus on four broad objectives: (1) restoration of IRL water quality, (2) restoration of natural habitats that support water quality and species richness/abundance, (3) species-specific restoration actions for species of concern, and (4) implementation of management strategies to enhance resilience of the IRL system.

Protecting and managing biodiversity will require improved knowledge of the elements of this regional ecosystem and how these elements interact. Acquiring the necessary knowledge and developing and implementing a strategy to protect and manage regional biodiversity in the IRL will require the coordination, cooperation, and collaboration of a wide variety of entities ranging from academia to regulatory and management agencies to local governments to individuals residing in the region.

The IRLNEP has taken a first step towards building that lagoon-wide coalition by working with NERT.[4] NERT was created in 2010 as a voluntary, grassroots effort to bring partners together to develop regional landscape-level habitat initiatives focused on the restoration and enhancement of estuarine habitats. In 2015, NERT expanded its regional network of habitat restoration scientists to form ECERT. Together, these habitat restoration partners cover the full planning boundary of the IRLNEP.

STRATEGIES:

- Improve scientific understanding through *RESEARCH* of IRL biodiversity and trends.
- Advise IRL restoration and management actions required to protect, maintain, and if needed, *RESTORE* IRL biodiversity.
- Work with the Smithsonian Marine Station at Fort Pierce to update and expand the online IRL Species Inventory that provides comprehensive information on all aspects of IRL biodiversity. It was first completed in 1995.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Biodiversity-1: Acquire and effectively manage the IRL network of conservation lands and wetlands as a tool to preserve, protect, and *RESTORE* the biological diversity, functional integrity, and productivity.	Improve habitats to maximize species biodiversity.	Federal, state, and local agencies; private conservation groups	IRLNEP Management Conference	TBD	Federal, state, and local agencies; private conservation groups	Coordinate and collaborate
Biodiversity-2: Work to continue, expand, update, and improve the IRL species inventory.	Update knowledge of species within IRL watershed.	Smithsonian	IRLNEP Management Conference USFWS, Merritt Island Wildlife Association, Florida Audubon Society	TBD	Smithsonian, IRLNEP conservation groups	Coordinate and collaborate
Biodiversity-3: Integrate biodiversity considerations in habitat restoration and planning activities.	Increase biodiversity within IRL watershed.	NERT, ECERT, IRLNEP	IRLNEP Management Conference	TBD	IRNEP Management Conference	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Create an updated IRL species inventory. Support efforts within the IRL science community to evaluate status and trends of IRL biodiversity.
- **Medium-term (3 – 4 years):** Evaluate status and trends of IRL biodiversity using data from the updated species inventory.
- **Long-term (5 – 10+ years):** Update actions based on latest data, status, and trends with consideration for long-term impacts of climate change, including sea level rise.

CHALLENGES TO SUCCESS:

- Cost and time intensive to update inventory.
- Lagoon-wide studies of biological diversity are scientifically complex and often require a multi-disciplinary perspective at multiple spatial and temporal scales.
- Climate change (including sea level rise) and invasive species are causing shifts that may permanently change IRL biodiversity.

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SPECIES OF CONCERN

Goals:

Evaluate population trends. Manage to reduce stressors on species of concern. Take actions that sustain species to allow delisting.

ONE LAGOON

LIVING RESOURCES

Species of Concern

GOALS: Conduct and/or continue *RESEARCH* to evaluate status and population trends of IRL species of concern. *REMOVE* and/or *REDUCE* stressors and threats to species of concern. *RESPOND* to opportunities for species-specific management action that will *RESTORE* sustainable levels for populations of species of concern.

ISSUE SUMMARY: The IRL region has more than 50 species that are listed as endangered, threatened, or species of special concern, and more than 70 others that are considered rare. Included are a variety of plants and animals ranging from small, seldom-seen species, such as the mangrove rivulus fish *(Rivulus marmoratus)*, to large and well-publicized ones, such as the Florida manatee *(Trichecus manatus latirostris)*. Wildlife protection is covered by a number of laws at local, state, and federal levels.[1,2,3] Also included as federally protected species are marine mammals, including cetaceans (whales and dolphins), sirenians (manatees), and otters. The Endangered Species Act of 1973 is the primary legislation that provides a framework to conserve and protect species listed as endangered and threatened and their habitats.[1] The U.S. Marine Mammal Protection Act protects all marine mammals.[2] The Bald and Golden Eagle Protection Act also provides specific protection to the significant eagle population along the lagoon. In addition, FWC is authorized to list and protect imperiled species separate from the Endangered Species Act.

Several factors are responsible for the endangerment and diminishing numbers of species with special status. Habitat loss is a primary cause of declining population size for many species. As the IRL region developed, much of the habitat important to these species was destroyed or altered reducing habitat quality. While Endangered Species Act listings and federal regulation provide a level of regulatory protection for specific plants or animals that are deemed threatened or endangered, many rare or imperiled species are never listed. State, regional, and local conservation efforts are best positioned to implement proactive conservation and restoration strategies to protect rare, threatened, and endangered species. The IRL region has many significant conservation success stories that were driven by state and regional leadership (including recovery of the manatee, sea turtles, and several bird species). Unfortunately, dramatic water quality declines in the IRL, recurring algal blooms, loss of seagrasses, habitat alteration, habitat fragmentation, habitat degradation, invasive species, and complex stressors from sea level rise and other effects of climate change will challenge recovery efforts for some species. A list of species of concern can be found on the Smithsonian Marine Station at Fort Pierce[4] and USFWS websites.[5]

While individual species recovery plans continue to be developed as required by federal law, a trend has been to integrate these species recovery plans into a single ecosystem-based multi-species plan. Indian River, St. Lucie, and Martin Counties are within the South Florida Multi-Species Recovery Plan, which covers 68 federally listed species through efforts to protect 23 identified ecosystems.

STRATEGIES:

- Implement action plans that align with and support recovery efforts for species of concern.
- Develop a comprehensive list of species of concern and track status and population trends.
- Identify habitat needs of species of concern and develop strategies to protect, *RESTORE*, and maintain those habitats.
- Develop a multi-species recovery plan for species of concern within the IRL.
- Develop a watch list of non-listed species with significant population declines.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Species of Concern-1: Identify IRL species of concern and track status and population trends.	Track status and population trends for species of concern in IRL watershed.	IRLNEP Management Conference, The Nature Conservancy, USFWS, FWC	USFWS, National Marine Fisheries Society (NMFS), FWC, WMDs, local governments, Audubon Society	TBD	IRLNEP, The Nature Conservancy, USFWS, FWC	Coordinate and collaborate
Species of Concern-2: Align the CCMP with adaptive management or recovery plans for species of concern.	Refine understanding of species of concern in IRL watershed.	IRLNEP, USFWS, NMFS, FWC	DEP, academia, interest groups	TBD	IRLNEP, USFWS, NMFS, FWC	Conduct, coordinate, and collaborate
Species of Concern-3: Improve enforcement of regulations for species of concern found in the IRL region.	Improve enforcement for species of concern.	USFWS, NMFS, FWC	DEP, local governments	TBD	USFWS, NMFS, FWC	Coordinate and collaborate
Species of Concern-4: Protect and manage natural habitats that support species of concern found within the IRL region.	Manage habitats for species of concern.	IRLNEP Management Conference partners, agencies, private landowners, private land trusts	USFWS, NMFS, FWC, WMDs, local governments, interest groups	TBD	TBD	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance and status of species of concern to the health and biodiversity of the IRL ecosystem and economy. Refer to CCMP action recommendations to species-specific recovery plans and plans available on the IRLNEP website.
- **Medium-term (3 – 4 years):** Implement CCMP water quality and habitat restoration projects that support and align with species recovery plans. Support scientific *RESEARCH* to better understand emerging risks, challenges to species recovery, and potential resource management conflicts.
- **Long-term (5 – 10+ years):** Work with IRL agencies and organizations involved in recovery of species of concern to evaluate and track progress and *REPORT* on trends to the public.

CHALLENGES TO SUCCESS:

- Inadequate funding available to monitoring all the species of concern.
- The size and spatial/temporal complexity of the IRL can be a challenge for scientists conducting population assessments.
- Invasive species and climate change impacts.

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INVASIVE SPECIES

Goals:

Remove invasive species and improve watershed management to support native habitats and communities.

ONE LAGOON

LIVING RESOURCES

Invasive Species

GOALS: ***REMOVE*** **invasive species from the IRL, its contributing waters, and its watershed. Conduct** ***RESEARCH*** **to improve management and understanding of invasive species in the IRL watershed to help** ***RESTORE*** **native habitats and communities. Be prepared to** ***RESPOND*** **quickly to eradicate newly introduced invasive species.**

NOAA

ISSUE SUMMARY: Non-native and non-indigenous are terms that have been used to describe plants and animals that are not native to an area. While many non-native species are relatively benign due to difficulties in reproduction or propagation, other species are characterized as invasive when they thrive in their new environment, reproducing, growing, and spreading rapidly or uncontrollably. This rapid growth and reproduction can have consequences for the health and biodiversity of the IRL, often resulting in invaders overwhelming native species, the loss or degradation of valuable habitats or the displacement or loss of native animal or plant species.

In 2006–2007, the authors of the IRL Species Inventory focused on assessing the status of nonindigenous species in the IRL region. They identified approximately 240 species in the region as exotic or cryptogenic, and of those, 170 species were new to the inventory.[1] When the species database was updated in 2014, approximately 215 non-native species were identified in the region.[1, 2]

STRATEGIES:

- Establish a stand-alone Invasive Species Commission to coordinate invasive species inventory and eradication effort.
- Continue monitoring invasive species in IRL watershed. Assist partners in development and implementation of species eradication or control strategies. Work with partners to educate public about invasive species threats.
- Update IRL invasive species inventory and track eradication and control activities.
- Assist IRL Management Conference partners with communication and coordination about invasive species eradication and management, including opportunities for volunteering.
- Develop a citizen science and engagement campaign (“see something – say something”) to assist partners with early detection and rapid response that quickly address invasive species.
- Provide support to not-for-profit organizations that work to control invasive populations.
- Encourage the commercial harvest of invasive species as a management tool.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Invasive Species-1 Support the inventory and assessment of invasive fauna and flora within the IRL watershed.	Improve understanding and management of invasive species.	DEP, FDACS, FWC, WMDs	USFWS, NMFS, academia, interest groups, local governments	TBD	DEP, FDACS, FWC, WMDs, USFWS	Coordinate and collaborate
Invasive Species-2: Provide standardized information to IRL partners about invasive species and their eradication and management. Prepare an early detection and rapid response plan.	Provide consistent information and plan for partners.	DEP, FDACS, FWC, WMDs	USFWS, NMFS, academia, interest groups, local governments	TBD	DEP, FDACS, FWC, WMDs	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Identify IRL partners and programs involved in IRL invasive species eradication and control activities. Share opportunities to volunteer with the public.
- **Medium-term (3 – 4 years):** Document progress with eradication and control of invasive species in the IRL watershed.
- **Long-term (5 – 10+ years):** Quantify 10-year progress of invasive species eradication and control in IRL watershed.

CHALLENGES TO SUCCESS:

- Management of invasive species can prove difficult as they are often prolific and can outcompete native species.
- Management of invasive plant species through chemical methods can add nutrients and chemicals to the lagoon system.
- Long-term, recurring funding will be required to sustain aggressive eradication and control activities.

CITATIONS:

1. IRL Species Inventory. 2018. Website: http://www.sms.si.edu/IRLSpec/index.htm.
2. Smithsonian Institution. 2018. Website: https://www.sms.si.edu/IRLSpec/Nonnatives.htm.

FORAGE FISHES

H. McVay

Goals:

Restore water quality and habitats to sustain abundant and diverse populations of forage fishes in the IRL.

ONE LAGOON

LIVING RESOURCES

Forage Fishes

GOALS: ***RESEARCH*** **forage fish abundance, trends, and threats.** ***RESTORE*** **water quality and natural habitats to sustain abundant and diverse forage fish populations and other species that depend on forage fish.** ***REPORT*** **the importance of forage fish and trends in their abundances to partners and stakeholders. Elevate public awareness and understanding of the importance of forage fish to a healthy IRL.**

ISSUE SUMMARY: It is estimated that between 75% and 90% of the original mangrove and salt marshes that bordered the IRL have either been lost or impacted, resulting in negative impacts to water quality and loss of habitat for fisheries.[1] The diverse fish fauna of the IRL and its coastal region has been a crucial factor leading to general recognition of the lagoon as a high diversity estuarine system.

Gilmore (1995) documented 782 species of fishes in 140 families in the IRL region with 397 species from the IRL system. Long-term quantitative studies of IRL fish communities reveal high species richness in specific habitats, such as estuarine-ocean inlet seagrass meadows and nearby ocean reef fish communities (214 species from seagrasses and 282 from ocean inlets).[2] Of these species, many forage fish species serve as an essential food resource for commercially and recreationally important predatory fish and other species of IRL wildlife, including many species of resident and migratory birds. As such, the proper management of forage fish species is critical sustaining the lagoon as a recreational and commercial centerpiece of the region.

Source: pewtrusts.org

Florida has been a leader in forage fish management. Forage fish fisheries in Florida's waters are relatively small, no fisheries that turn their catches into fish meal or oil are operational in the state, and gear limitations set in the mid-1990s have kept harvest levels low. Only small nets, less than 500 square feet, are allowed in nearshore and inshore waters, and entangling or gill nets are prohibited throughout state waters. Locally, commercial harvest of forage fishes represents an important commercial bait fishery for the recreational fishing industry with an estimated statewide economic value of $8 billion annually.

The most immediate threats to IRL forage species include declining water quality, HABs (especially the brown tide organism, *Aureoumbra lagunensis*, that impacts seagrasses and fishes), loss of essential natural habitats, and climate change.[3] On a global level, commercial demand is surging for forage fish, which are used for pet food, cosmetics, nutritional supplements, fertilizer, and feed for animals and aquaculture operations. The importance of effective forage fish management and conservation was recognized in 2015 by FWC in a formal resolution that proclaimed FWC will manage forage fishes to ensure sufficient abundance and diversity of their populations to sustain abundant fisheries stocks and other species that depend on forage fish and to maintain Florida's reputation as the "Fishing Capital of the World."[4] Restoring

healthy forage fish populations will also ensure that the IRL region remains a world-class destination for viewing birds and wildlife.

STRATEGIES:

- Work closely with FWC and partners involved in commercial and recreational fisheries to ensure that populations of IRL forage fish remain diverse, abundant, and able to sustain IRL living resources, ecosystem health, and vibrant commercial and recreational fishing activities.
- Assess zooplankton populations and ecology in IRL watershed as food sources for forage fish.
- Identify and map essential habitats for forage fishes in the IRL to advise and assist water quality and habitat restoration strategies and prioritization of projects.
- Provide an updated inventory and a scientific assessment of the sizes and health of populations of forage fish in the IRL.
- Develop a science-based strategy for estimating the abundance and diversity of forage fishes required to support sustainable populations of other species (especially recreationally and commercially valuable fish species) in the IRL.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Forage Fishes-1: Support *RESEARCH* and assessments to identify and map suitable habitats and spawning habitats for forage fishes and track population size and health. (NEW)	Identify suitable habitats for forage fishes and track the health of populations.	FWC	IRLNEP, academia	TBD	FWC, IRLNEP, grants, private-sector support	Coordinate and collaborate
Forage Fishes-2: Continue to support scientific assessments of forage fish population size and health. (NEW)	Improve understanding and management of IRL fisheries and consider restocking species where needed.	FWC	IRLNEP, academia	TBD	FWC, IRLNEP, grants, private-sector support	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance of forage fishes and essential fish habitats to the health of the IRL system health and the regional economy. Implement water quality and habitat restoration projects in the CCMP to ensure IRL forage fish populations remain diverse, abundant, and sufficient to support IRL living resources.
- **Medium-term (3 – 4 years):** Continue water quality and habitat restoration projects in the CCMP to ensure IRL forage fish populations remain diverse, abundant, and sufficient to support IRL living resources. Improved water quality in the IRL system is supporting seagrass recovery, and important forage fish habitat.
- **Long-term (5 – 10+ years):** Water quality improvements can be documented throughout IRL watershed. Forage fish population recovery is underway.

CHALLENGES TO SUCCESS:

- Declining water quality and HABs since 2011 appear to have shifted the IRL trophic structure with unknown consequences to larval and forage fishes.

- Poor water quality and recurring algal blooms have resulted in a historic loss of seagrasses, an essential fish habitat.
- Inadequate funding for expanded, long-term, lagoon-wide *RESEARCH* on the status and trends in populations of forage fish.

CITATIONS:

1. Taylor, S.D. 2012. Removing the Sands (Sins?) of Our Past: Dredge Spoil Removal and Saltmarsh Restoration along the Indian River Lagoon, Florida (USA). *Wetlands Ecological Management* 20: 213–218.
2. Gilmore, R.G. 1995. Environmental and Biogeographic Factors Influencing Ichthyofaunal Diversity: Indian River Lagoon. July 1995. Bulletin of Marine Science, Miami, FL. 57(1):153-170.
3. Shenker, J.M. 2009. *Sustainability 2009: The Next Horizon*. G. L. Nelson and I. Hronszky, Editors. American Institute of Physics Conference Proceedings. Volume 1157. pp 39-47.
4. FWC. 2015. Resolution June 25, 2015. Sarasota, Florida.

COMMERCIAL AND RECREATIONAL FISHERIES

Cox's Seafood Market

Goals:

Restore water quality in the IRL to support sustainable commercial and recreational fisheries.

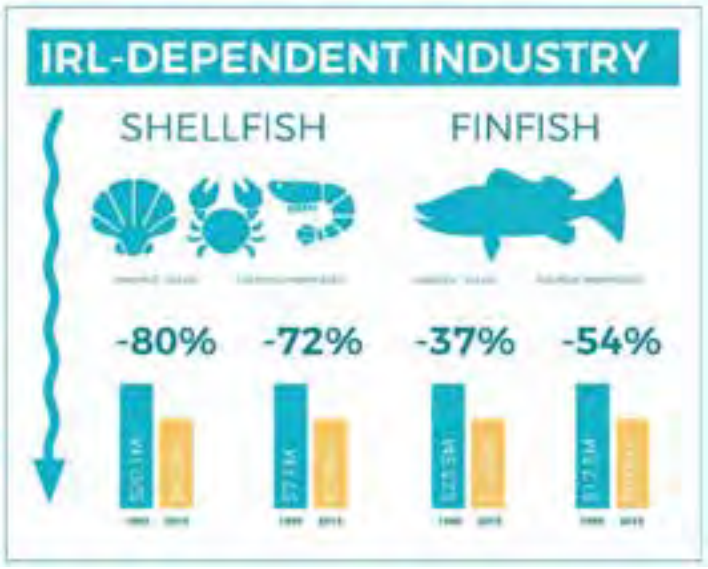
ONE LAGOON

LIVING RESOURCES

Commercial and Recreational Fisheries

GOALS: Conduct fisheries *RESEARCH* to help *REBUILD* IRL commercial and recreational fisheries. *RESTORE* IRL fish populations to support world-class recreational fishing and sustainable commercial harvest.

ISSUE SUMMARY: In the IRL region, fishing has been a commercially valuable activity, a recreational pastime, and a means of subsistence for centuries. Fish populations in the IRL are some of the richest and most diverse in the United States with more than 700 species identified.



Data from a 2016 economic analysis conducted by Treasure Coast and East Central Florida Regional Planning Councils and funded by DEO reported that the IRL-dependent fishing industry was in decline. Commercially harvested clams, oysters, crabs, and shrimp were worth $12.6 million at the docks in 1994. Adjusted for inflation, this 1994 amount was $20.1 million in 2015 dollars. The overall value of the commercial clam, oyster, crab, and shrimp harvest for 2015 was $4.3 million, representing a nearly 80% decline since 1994.[1]

From approximately 1994 to 2015, shellfish harvest declined from 7.1 million pounds to 2 million pounds, or almost 72%. IRL counties showing the sharpest decline in value and pounds harvested were Volusia, Brevard, and Martin. The commercial fin fishery fared slightly better, but still showed significant declines in value and pounds landed. In 1990, the estimated value of commercial finfish landed was worth $13 million. Adjusted for inflation, this 1990 amount was $23.5 million in 2015 dollars. The overall value of the commercial finfish harvest for 2015 was estimated at $14.8 million—a decline of 37%. Pounds of finfish landed also declined during that same period, from 17.3 million pounds to 8 million pounds or almost 54%. IRL counties showing the sharpest declines in value and pounds harvested were Brevard, Indian River, and Martin.[1] However, it is important to note that in July 1995, an amendment to the Florida Constitution made it unlawful to use entangling nets, such as gill nets, and limited the use of other nets, such as seines, cast nets, and trawls in Florida waters. Therefore, the fishing industry was impacted by this change in allowable gear, which made staying in the industry cost prohibitive for some fisherman and impacted the amount of shellfish and finfish harvested.

FWC conducts Marine Fisheries-Dependent Monitoring and Marine Fisheries-Independent Monitoring. The Fisheries-Dependent Monitoring collects and analyzes catch-and-effort data to monitor trends in commercial and recreational fisheries throughout Florida. These data provide assessments of how management regulations affect harvest and fishers. The Fisheries-Independent Monitoring monitors the status and abundance of recreational and commercial fishes from six estuaries around the state.[2] Recent data from the Fisheries-Independent Monitoring Program generally show fisheries stocks in the IRL to be stable, although smaller than historical numbers have been observed. The data from this program allow the development of annual abundance models of juvenile fishes.

These models may be used to predict the availability of a species and provide the information needed to determine fisheries management measures and to assess the effectiveness of those measures after they are enacted.

Recreational fishing guides and commercial fishers throughout the lagoon have reported that poor water quality and declining fishery quality have impacted their ability to make a living. Seasonal large volume freshwater releases from Lake Okeechobee to the St. Lucie Estuary and southern IRL have catastrophic impacts to both the recreational fishing industry and regional tourism. Chronic, recurring algal blooms and poor water quality in the Banana River Lagoon and central-northern IRL have impacted recreational fishing and tourism since the algal superbloom in 2011. Over 30 fish mortality events were reported in the Mosquito Lagoon during the *Aureoumbra* bloom of 2012. Since that time, small recurring fish mortality events have been associated with algal blooms and low dissolved oxygen levels. In March 2016, an intensive and large fish mortality event co-occurred with an *Aureoumbra* bloom in the Banana River Lagoon that impacted hundreds of thousands of fish, multiple species and age classes, and many prized recreational fish species. The long-term impacts of these recurring algal blooms, loss of seagrasses, and fish mortality events are not well understood.

Saltwater recreational fishing in Florida is estimated at $8.0 billion annually and supports 114,898 jobs.[3] For the recreational fishing guide and commercial fisher making a living on the IRL, water quality and high-quality fishing are the foundation of their businesses. Ten years ago, the IRL was known as the "Redfish Capital of the World." Many redfish tournaments were held every year, and the IRL was featured on numerous televised fishing shows. It has been years since a redfish tournament was held in the IRL. Television's celebrity fishing guides have moved on to more productive areas, as have many of the local fishing guides.

Without water quality improvements, the IRL may never support a viable and sustainable recreational and commercial finfish and shellfish fishery. Most of the commercial fishers have been forced out of work or changed occupations, no longer able to make a living plying the once productive waters. Accelerated water quality and habitat restoration is required and, once achieved, a second-phase restoration effort may require fish stock enhancement. This will require proactive planning and capacity development for aquaculture facilities and fish stock breeding programs associated with the IRL regional restoration center network. Ultimately, a sustainable commercial fishing industry is the high-bar for clean water and estuary restoration. If fish and shellfish stocks can support sustainable healthy harvest, then those same stocks will support a robust recreational fishery.

STRATEGIES:

- Improve IRL water quality to *RESTORE* oyster reefs, clam beds, seagrasses, and living shorelines.
- Determine if fish-stock enhancement may be necessary and take proactive steps to provide aquaculture facility support.
- Implement a strategic, coordinated, and science-based recovery plan for both recreational and commercial fisheries.
- Encourage catch and release management to aid with issues from fish population declines to potential safety issues from fish consumption.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Fisheries-1: Conserve, protect, *RESTORE*, and manage the commercial and recreational finfish and shellfish resources in the IRL region to support a sustainable harvest.	*RESTORE*, protect, and manage commercial and recreational fisheries.	FWC, Marine Fisheries Council (MFC)	NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments	TBD	FWC, MFC, local governments	Coordinate and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Fisheries-2: Continue to support and expand *RESEARCH* initiatives and coordinated finfish and shellfish management strategies specific to the IRL.	Expand *RESEARCH* to identify appropriate management strategies.	FWC, MFC	NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments	TBD	FWC, MFC, local governments	Coordinate and collaborate
Fisheries-3: Improve effectiveness of fish habitat conservation and restoration efforts by identifying and characterizing critical spawning, nursery, and forage areas within the IRL and its tributaries. (NEW)	Use existing and new tools to integrate information and conduct assessments to inform restoration and conservation efforts.	FWC, MFC	NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments	TBD	FWC, MFC, local governments	Coordinate and collaborate
Fisheries-4: Identify, inventory, and assess finfish breeding and important habitats within the IRL.	Implement appropriate management and restoration strategies for finfish.	FWC, MFC	NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments	TBD	FWC, MFC, local governments	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance of commercial and recreational fishes and essential fish habitats to the health of the IRL ecosystem and economy. Improve communication and cooperation among the commercial and recreational fishing industry sectors.
- **Medium-term (3 – 4 years):** Implement CCMP water quality and habitat restoration projects to ensure that IRL commercial and recreational fish populations remain diverse, abundant, and sufficient to support IRL living resources.
- **Long-term (5 – 10+ years):** Water quality, habitat quality and fisheries quality have recovered to support a re-emergence of the IRL as a world-class fishery and the IRL commercial and recreational fishing industry as a sustainable, high-quality, community-supported multi-species fishery.

CHALLENGES TO SUCCESS:

- Poor water quality and recurring algal blooms have resulted in a historic loss of seagrasses, an essential fish habitat. The timeline to recovery may be too long to save traditional commercial fishing and high-quality recreational fishing industry interests along some parts of the IRL.
- Inadequate funding for aggressive and strategic implementation of projects to improve water quality.
- Inadequate lagoon-wide monitoring.

CITATIONS:

1. Treasure Coast and East Central Florida Regional Planning Councils. 2016. Indian River Lagoon Economic Valuation Update. Report available at www.onelagoon.org.
2. FWC Marine Fisheries Research. Website: http://myfwc.com/research/about/programs/mfr.
3. FWC. 2017. The Economic Impact of Saltwater Fishing in Florida. http://myfwc.com/conservation/value/saltwater-fishing/.

HARMFUL ALGAL BLOOMS

Goals:

Advance understanding of the triggers for harmful algal bloom occurance and toxicity to reduce their frequency and intensity.

ONE LAGOON

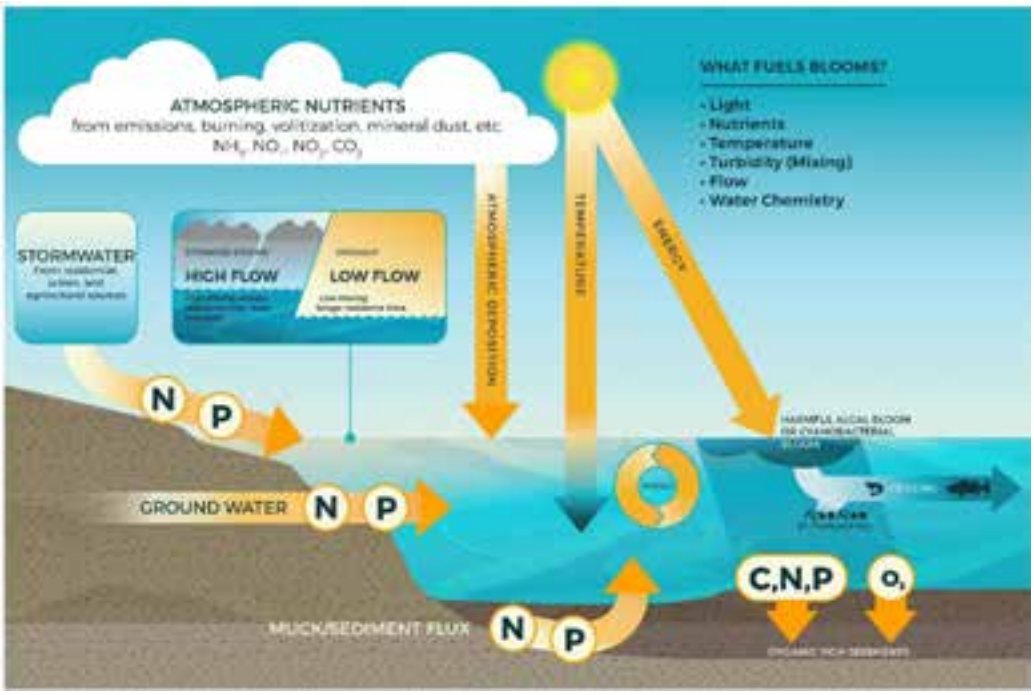
LIVING RESOURCES

Harmful Algal Blooms (HABs)

GOALS: Advance *RESEARCH*, coordination, and understanding of the causes of HABs to *REDUCE* their frequency, intensity, and duration. Effectively and efficiently *RESPOND* to HAB emergence and secondary impacts including toxicity in some species, low dissolved oxygen concentrations as blooms decline, and associated fish and wildlife morbidity and mortality events. Improve scientific understanding of toxic algal blooms and human health risks. *REPORT* IRL algal bloom status and trends.

ISSUE SUMMARY: This IRL CCMP revision applies a broad definition to IRL HABs. HABs occur when colonies of algae—microscopic plants that live in the sea and freshwater—grow out of control and sometimes produce toxic or other harmful effects on people, fish, shellfish, marine mammals, birds, seagrass, and other ecological components. Human illnesses caused by HABs are rare, but they can be debilitating or even fatal.[1] HABs are often associated with large-scale marine mortality events and have been associated with several types of shellfish poisonings.[2]

Since 1996, several additional events and discoveries have occurred that raised concerns about aquatic animal health and biotoxins associated with algal blooms in the IRL. In 2002, 19 cases of puffer fish poisoning were reported to state and federal health officials following consumption of puffers caught in the Titusville area. Subsequent investigation found that a common algal species in the lagoon was producing a toxin that entered the food chain, ultimately resulting in puffers becoming toxic. Microalgae and associated toxins were also thought to be implicated in a 2001 event where several dolphins died in the north-central IRL and Banana River Lagoon in what was termed an "unusual mortality event" as well as several fish kills, horseshoe crab mortalities, and similar events. Lesions on fishes in the southern IRL region have also caused public concern. These issues and incidents are reviewed in more detail in the 2006 publication *Indian River Lagoon Biotoxin & Aquatic Animal Heath: History and Background Report*.[3] To address these emerging issues, the IRLNEP and FWC jointly established the IRL Biotoxin and Aquatic Animal Health Working Group, which evaluated projects and actions to improve communications and coordination among the various individuals and organizations, enhance knowledge of HAB events, and determine the cause or causes of HAB events and management actions that may be taken to address them.



A dramatic ecological state-shift from a benthic aquatic vegetation system to one dominated by planktonic microalgae began in the IRL in 2011 with an unprecedented bloom of a nanoplanktonic green alga and picocyanobacteria (now referred to as the "2011 superbloom"). In response to the superbloom, SJRWMD convened a group of experts to evaluate the potential causes and to prepare a plan of investigation. The post-2011 IRL is now characterized by intense, recurring, and long-lasting algal bloom conditions of multiple species, widespread loss of seagrass habitat, and episodic wildlife mortality events. Ongoing blooms of pico-cyanobacteria, dinoflagellates, and the Texas brown tide species, *Aureoumbra lagunensis*, appear to be the "new normal" for the central and northern IRL. These ecosystem shifts challenge scientific understanding of nutrient enrichment thresholds, nutrient and carbon cycling, and tipping points for the IRL.[4,5]

Blooms in 2011, 2012, 2013, 2015-2016, and 2018 of small-celled phytoplankton in Mosquito Lagoon, North IRL, and Banana River Lagoon share conditions associated with prominent blooms of small-celled phytoplankton in other ecosystems, such as the brown tide events involving *Aureoumbra* in Texas[6] and picocyanobacteria blooms in Florida Bay.[7] Common characteristics include shallow restricted estuaries with long water residence times, varying salinity regimes, high-light attenuation caused by persistently high phytoplankton biomass, and declines in benthic primary producer biomass, such as seagrasses. The continuing and shifting character of phytoplankton blooms in Mosquito Lagoon, North IRL, and Banana River Lagoon provides some insights into future management challenges. Correlations between rainfall levels, external nutrient loads, and bloom activity support the hypothesis that reductions in anthropogenic nutrient sources have potential to reduce the frequency and intensity of blooms.[8]

Concurrent with these ecosystem-wide stress-response issues, the southern IRL was severely impacted by massive seasonal freshwater release events from Lake Okeechobee during times of high water. In summer 2013 (the "Lost Summer"), billions of gallons of freshwater were released east through the St. Lucie Estuary and southern IRL. As a result, the St. Lucie Estuary and southern IRL experienced catastrophic salinity shifts to sustained freshwater conditions. The combination of freshwater, high nutrients, and an inoculant of the cyanobacteria *Microcystis* from Lake Okeechobee fueled cyano-HABs of *Microcystis* in portions of the southern IRL. In 2016, large-volume, high-velocity freshwater releases from Lake Okeechobee from February through November ("the Lost Year") fueled an intense *Microcystis* cyanobacteria HAB, with reported microcystin toxin concentrations that greatly exceeded World Health Organization standards. A similar event occurred in 2018. The 2013, 2016, and 2018 events highlight the close watershed connections between the IRL and Everglades ecosystem and the need to look beyond the historic watershed boundaries of the IRL.

It is important to note that cyanobacteria interact with many bacterial members within their natural environment. For instance, the University of Central Florida recently found that the exact species that is causing the HABs in the IRL serves as "food" for the growth of other harmful microorganisms, such as the agent of cholera (*Vibrio cholerae*) and, based on preliminary data, *Vibrio vulnificus* (the flesh-eating bacterium that has caused problems in Florida before). In addition, it is possible that the changes in the IRL are not only directly fostering growth of cyanobacteria but also negatively affecting the survival or prevalence of bacterial species that might establish an antagonistic relationship with the cyanobacteria, which allows the HABs to grow unchecked. Monitoring the IRL bacterial communities could help to predict and prevent this from occurring.

STRATEGIES:

- *REDUCE* nutrients from external and internal sources to decrease concentrations that fuel blooms.
- *RESEARCH* causation factors for IRL HABs and document progress towards decreasing occurrence.
- Continue to provide a forum for scientific discussions and management regarding IRL HABs and trends.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
HAB-1: Support continuation of the IRL 2011 Consortium, which would function as a formal task force supported by the IRLNEP and which would develop a HAB *RESEARCH* and Restoration Response Plan. (NEW)	Prepare a *RESEARCH* and response plan.	IRLNEP	NMFS. USFWS, DEP, WMDs, Sea Grant, academia, interest groups	TBD	IRLNEP, local governments	Conduct, coordinate, and collaborate
HAB-2: Seek partnerships and funding to pursue *RESEARCH* priorities identified by the IRL 2011 Consortium that align with IRLNEP Management Conference management priorities. (NEW)	Improve knowledge and management of HABs in IRL watershed.	FWC, IRLNEP, academia	DEP, WMDs, FDOH, interest groups, local governments	TBD	DEP, WMDs, IRLNEP, local governments	Conduct, coordinate, and collaborate
HAB-3: Continue funding and scientific partnerships to understand HABs toxicity and risks to human and wildlife health. (NEW)	Improve knowledge of toxicity and health impacts	IRLNEP Management Conference, NOAA, DEP, FDOH	Academia, interest groups	TBD	NOAA, DEP, FDOH	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Monitor and conduct *RESEARCH* on the causes and effects of IRL HABs.
- **Medium-term (3 – 4 years):** Incorporate new findings into management plans.
- **Long-term (5 – 10+ years):** Implement projects to *REDUCE* causative pollutants and factors for HABs.

CHALLENGES TO SUCCESS:

- HABs and cyanobacterial blooms are carried with ocean currents, so they may occur in areas outside of the IRL watershed and then be transported into the area.
- Understanding of HABs, impacts, and toxicity.
- Interactions of trophic levels and the effects on naturally managing blooms is not well understood.
- Regime shifts to ecosystem domination by a lower trophic level are difficult and slow to overcome.

CITATIONS:

1. NOAA. What is a HAB? Website: http://www.noaa.gov/what-is-harmful-algal-bloom.
2. Ehrhart, L.M. and Redfoot, W.E. 1995. Composition and Status of Marine Turtle Assemblage of the Indian River Lagoon System. Bulletin of Marine Science. 57:279 – 280.
3. Provancha and Van den Ende. 2006. Indian River Lagoon Biotoxin and Aquatic Animal Heath: History and Background Report.
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5. Phlips, E.J. and Badylak, S. 2013. Phytoplankton Abundance and Composition in the Indian River Lagoon 2011–2012. Annual Report 2012 for St. Johns River Water Management District. 29 pp.
6. Buskey, E.J., Liu, H., Collumb, C., and Guilherme, J. 2001. The Decline and Recovery of a Persistent Texas Brown Tide Algal Bloom in the Laguna Madre. Estuaries Vol. 24, No. 3, p. 337–346.
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8. Phlips, E.J., Badylak, S., Christman, M., Wolny, J., Brame, J., Garland, J., Hall, L., Hart, J., Landsberg, J., Lasi, M., Lockwood, J., Paperno, R., Scheidt, D., Staples, A., and Steidinger, K. 2011. Scales of temporal and spatial variability in the distribution of harmful algae species in the Indian River Lagoon, Florida, USA. *Harmful Algae* 10: 277–290.

CLIMATE-READY ESTUARY

FEMA

Goals:

Understand coastal vulnerabilities to climate change. Manage adaptively, and improve community resilence.

ONE LAGOON AND ONE COMMUNITY

LIVING RESOURCES & HEALTHY COMMUNITIES

Climate Ready Estuary

GOALS: ***RESEARCH*** **IRL risk-based vulnerabilities to climate change and sea level rise to make informed adaptation planning decisions.** ***RESPOND*** **to threats and opportunities. Make management decisions that improve IRL** ***RESILIENCE*** **to storm events and long-term risks.** ***REPORT*** **findings and scientific advancements to partners in the IRLNEP Management Conference and communities.**

ISSUE SUMMARY: The IRL is vulnerable to the impacts of climate change, including sea level rise. Climate stressors include changes in annual air and water temperatures, precipitation patterns, intensity of storms, ocean acidification, and sea level rise. These will cause changes to the IRL that will challenge resource management and stewardship. Most scientists agree that these impacts already are being felt.

Martin County

There are potential solutions that can improve resiliency and time is of the essence for these solutions to be realized. Identifying risks associated with climate change, including sea level rise, is the first step. The second phase is to adopt a plan to reduce potential impacts of these risks. The USEPA Climate Ready Estuaries Program has identified ten steps to help NEPs identify, analyze, prioritize, and reduce their climate change risks. These steps fall into two activity categories: (1) risk-based vulnerability assessment, and (2) action plan – determining a course of action.[1]

Anticipated risk-based vulnerabilities extend beyond the water quality and ecosystem health of the IRL to human-built infrastructure, transportation corridors, integrity of traditional supply chains for goods and services, human health, communication networks, and homeland security. The economy and quality of life of the IRL region is closely linked to its natural and human built assets. When discussing future climate change scenarios, human-built and natural assets need to be considered as one interdependent and integrated coastal ecosystem.[2,3,4] Anticipated risk-based vulnerabilities include the water quality and ecosystem health of the IRL, as well as all aspects of infrastructure, transportation corridors, supply chains for goods and services, human health, communication networks, and homeland security.

Adapting to these climate change stressors will require much wider consideration than

traditional hazard risk management. Adaptation involves integration of strategies for both the natural environment and human-built environment to be resilient to a range of future conditions. For this reason, adaptive management will require significant community engagement and a process for long-term strategic planning and decision-making. The figure provides a ten-step process structured around five broad questions.[5]

Some infrastructure assets for vulnerability consideration include:

- Transportation corridors (roadways, bridges, and rail).
- Kennedy Space Center and regional aviation and aerospace assets (such as Harris Corporation, Northrup Grumman, Space X, and Blue Origin).
- Military facilities and operations that support national defense and homeland security (U.S. Coast Guard (USCG) Stations at Ponce Inlet, Port Canaveral, and Fort Pierce; Naval Ordnance Test Unit at Cape Canaveral; Patrick Air Force Base; Cape Canaveral Air Force Station; 45th Space Wing; and 920th Rescue Wing).
- Ports (Port Canaveral, which is one of the busiest cruise ports in the world; Port of Fort Pierce, which has a vision for growth as a mega-yacht destination).
- Wastewater and stormwater infrastructure vulnerable to flooding and overflow to the IRL.

In addition to infrastructure, there will be changes to the natural environment (e.g., seagrass beds and mangroves), which should also be monitored over time.

The IRLNEP has initiated a risk-based vulnerability assessment (fiscal year 2017-2018) and adaptation planning process (fiscal year 2018-2019) as a result of grant awards from the USEPA Climate Ready Estuaries Program. Results of the risk-based vulnerability assessment identified 154 management objectives related to climate change. Five climate change stressors were evaluated based on impacts to IRL sediment and water quality, natural resources, and stakeholder engagement: (1) warmer temperature, (2) changing precipitation, (3) increased storminess, (4) acidification, and (5) sea level rise.[6] The vulnerability assessment and adaptation planning technical documents will be shared with the IRLNEP Management Conference and community partners to advise CCMP implementation.

STRATEGIES:

- Develop a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL in alignment with the USEPA Climate Ready Estuary guidance.
- Rethink infrastructure design standards and locations to build *RESILIENCE* into coastal infrastructure (including bridges, causeways, WWTPs, road elevations, stormwater configurations, septic systems along low elevation shorelines, energy network and grids, and living shorelines instead of bulkheads).
- Encourage local government to adopt adaptation action areas within their comprehensive plans.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Climate Ready Estuary-1: Prepare a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL. (NEW)	Prepare a plan and share findings with IRLNEP partners.	IRLNEP with contractor support	IRLNEP Management Conference	$100,000	USEPA supplemental funding, IRLNEP Management Conference	Conduct, collaborate, and coordinate
Climate Ready Estuary-2: Identify opportunities to integrate infrastructure *RESILIENCE* into community planning. (NEW)	Work with IRL communities and partners to consider and integrate infrastructure ***RESILIENCE*** into community planning.	IRLNEP Management Conference	DEP Coastal Resilience Program, DEO, transportation planning organizations, economic development agencies, tourism industry, public and private-sector partners	N/A	USEPA, grants, private-sector support	Conduct, collaborate, and Coordinate

OUTCOMES:

- **Short-term (1 – 2 years):** IRLNEP Management Conference partners have improved awareness and understanding of climate change, including sea level rise, vulnerabilities and adaptation strategies.
- **Medium-term (3 – 4 years):** IRLNEP Management Conference partners begin implementation of adaptation plans to improve IRL *RESILIENCE*.
- **Long-term (5 – 10+ years):** Significant progress is made by IRLNEP Management Conference partners to position the IRL as a climate ready estuary.

CHALLENGES TO SUCCESS:

- Insufficient data and/or lack of trust for science.
- Focus on challenges rather than opportunities.
- Lack of technical and financial resources.
- Perception that local community actions will have no impact.
- Existing legal and regulatory environment.
- Obtaining buy in from more local governments within the IRL watershed that climate adaptation and *RESILIENCE* planning is of vital importance and policies and projects should be coordinated.

CITATIONS:

1. USEPA. 2014. Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans. Office of Water EPA 842-K-14-002. 120p.
2. Nicholls, R.J. 2011. Planning for the impacts of sea level rise. *Oceanography* 24(2):144–157, doi:10.5670/oceanog.2011.34.
3. Ng, A.K.Y, Becker, A., Cahoon, S., Chen, S-L. Earl, P., and Yang, Z. 2016. Climate Change and Adaptation Planning for Ports. Edited book in the series, Routledge Studies in Transport Analysis. Routledge, NY. 286 p.
4. Lawrence, J., Bell, R., Blackett, P., Stephens, S., and Allan, S. 2018. National guidance for adapting to coastal hazards and sea-level rise: Anticipating change, when and how to change pathway. Environmental Science and Policy 82:100–107.
5. Bell, R., Lawrence, J., Allan, S., Blackett, P., and Stephens, S. 2017. Coastal Hazards and Climate Change. Ministry for the Environment. Government of New Zealand. 279 p.
6. RW Parkinson Consulting, Inc. and The Balmoral Group. 2018. Risk-Based Vulnerability Assessment of the Indian River Lagoon to Climate Change. Prepared for: Indian River Lagoon Council.

VIBRANT 21ST CENTURY COMMUNITIES

Goals:

Rebuild infrastructure to be Lagoon-Friendly, sustainable, and resilient. Research economic value and trends.

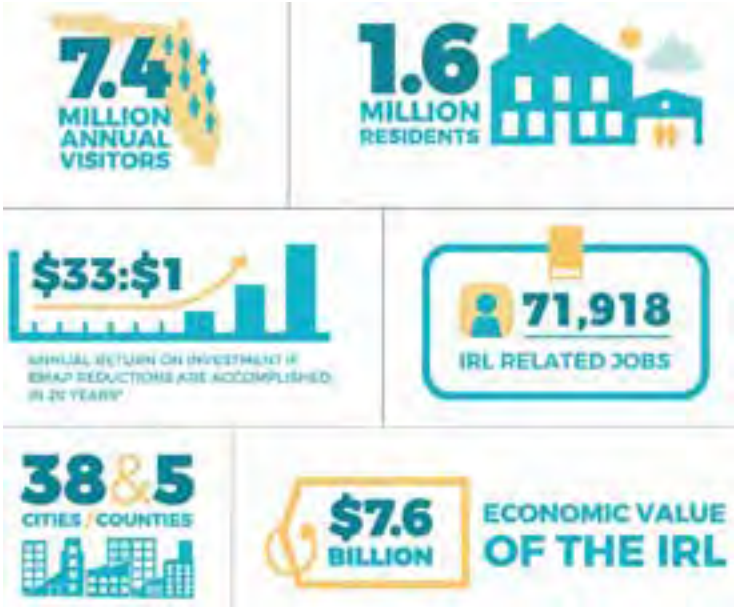
ONE COMMUNITY

HEALTHY COMMUNITIES

Vibrant 21st Century Communities

ACTION: Update *RESEARCH* on IRL economic value and trends, at least every five years or as needed, in response to abrupt economic changes, threats, and opportunities. *REBUILD* human-built infrastructure along the IRL to be more Lagoon-Friendly ™, more sustainable, and more resilient. *RESPOND* to 21st Century changing environmental, economic, and societal needs, challenges, and opportunities. *REPORT* regularly to the IRL regional business and economic development community to ensure that CCMP implementation advances the "One Lagoon – One Community – One Voice" Mission.

ISSUE SUMMARY: IRL health and regional economic health are inter-dependent. News of poor water quality, HABs, and fish mortality events harm the regional tourism economy, threaten lagoon-related small businesses, impact commercial and residential property values, influence employee and employer recruitment success, and diminish the global brand of the region as a high value destination to live, work, and play. The IRLNEP recognized the essential need to have balanced participation and leadership from the public, independent, and private sectors to implement an effective and long-lasting restoration and stewardship plan for the IRL. For many years, active and engaged private-sector involvement in CCMP implementation was missing. This involvement was a strategic consideration of the IRL Council and reorganization of the IRLNEP in 2015–2016. The new IRLNEP Management Conference structure and network governance model was designed to encourage and cultivate increased participation from private-sector business and industry throughout the five-county IRL region.[1] This goal was achieved through strategic private-sector appointments by the IRL Council Board of Directors to the IRLNEP Management Conference and creation of the IRLI[2] Network.



The economic importance of estuaries to local communities, the state of Florida, and the nation cannot be overstated. In 2016, the economic value of the IRL was estimated at $7.6 billion annually with a return of $33 to every $1 invested.[2] An independent economic study by Brevard County through the Save Our Indian River Lagoon Project Plan in 2016 calculated return on investment by applying a net present value analysis.[3] It was estimated that at least a total present value of $6 billion was tied to restoration of the IRL of which approximately $2 billion in benefits were realized from restoration efforts and an estimated $4 billion in damages were anticipated if the IRL was not brought back to health during the next decade. If the restoration plan was viewed purely as a financial investment

that paid the $2 billion in benefits alone (i.e., not counting the avoidance of the $4 billion loss), the projected pretax internal rate of return was 10%, if the plan took 20 years to implement. However, if plan implementation could be accelerated to occur over 5 years instead of 20 years, the return on investment rose significantly to 26% because the benefits of restoration would begin to accrue much faster. This analysis demonstrated that an accelerated restoration timeline was a smart financial decision.

In addition to providing economic, cultural, and ecological benefits to communities, estuaries also deliver invaluable ecosystem services.[4] Ecosystem services include, but are not limited to, raw materials and food, coastal infrastructure protection and resilience, erosion control, water purification, maintenance of fisheries, carbon sequestration, aesthetic values, quality of life values, and support of estuary-dependent industry-sectors (i.e., tourism, recreation, education and research).

However, the IRL is a human-dominated ecosystem with many stressors directly linked to human-built infrastructure (i.e., inadequate and aging WWTPs and pipe networks, septic systems, stormwater conveyances, nutrient and pollutant impacts from reclaimed water and biosolid management, and impacts from transportation corridors, bridges, causeways and public access). IRL coastal communities are also vulnerable to tropical storm events and associated flooding, storm surge, and high winds. These risks and vulnerabilities are compounded by aging infrastructure and/or poorly planned, designed, and built infrastructure.

Twenty-first century planning for sustainable cities and communities is a complex process that must integrate economic, environmental, and societal considerations. Eight critical factors have been identified for smart city initiatives: (1) management and organization, (2) technology, (3) governance, (4) policy context, (5) people and communities, (6) economy, (7) built infrastructure, and (8) natural environment.[5] These factors, and others such as responding to climate change, form the basis of an integrative framework that can be used to examine how local governments envision and implement smart city initiatives, sustainability initiatives, green infrastructure, and Lagoon-Friendly ™ and resilient coastal infrastructure development.

STRATEGIES:

- Coordinate, integrate, and communicate the connected environmental, economic, and quality of life values of the IRL to the regional businesses and industries. Seek opportunities to partner with the tourism industry, ports and maritime industries, commercial fishing industry, recreational fishing industry, aviation and aerospace industry, economic development organizations, and others to achieve Lagoon-Friendly ™ goals.
- Quantify and track the economic value of the IRL with special attention to estimating return on investment from restoration, IRL-dependent jobs, and the influence of clean water on corporate relocations, employee recruitment and retention, and residential/commercial development.
- Ensure that the IRL business community, including tourism industry, maritime industry and ports, commercial fishing industry, recreational fishing industry, aviation and aerospace, economic development organizations, real estate, and other interested private-sector partners are included and actively engaged in the IRLNEP Management Conference.
- Work with partners on the Management Conference and local elected officials to update the IRL Economic Analysis produced in 2016 by the Treasure Coast and East Central Florida Regional Planning Councils at a minimum of every five years, with special attention to include estimates for estuary-dependent industries, jobs, and return on investment.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Vibrant Communities-1: Work closely with the business community and industry clusters along the IRL to ensure effective cooperation and communication associated with CCMP implementation. (NEW)	Engage the business community and industry clusters in CCMP implementation.	IRLNEP	DEO, Space Florida, Visit Florida, Enterprise Florida, CareerSource Florida, Port Canaveral, Port Fort Pierce, Treasure Coast and East Central Florida Regional Planning Councils, chambers of commerce, economic development commissions, tourist development councils	IRLNEP staff activity	IRLNEP	Conduct, Coordinate, and collaborate
Vibrant Communities-2: Update the IRL economic analysis produced in 2016 by the Treasure Coast and East Central Florida Regional Planning Councils every five years. (NEW)	Provide the latest economic information for the IRL watershed.	IRLNEP	DEO, Treasure Coast and East Central Florida Regional Planning Councils	$300,000 for IRL economic update every 5 years	IRLNEP	Conduct, coordinate, and collaborate
Vibrant Communities-3: Promote lagoon-related nature and heritage tourism development for residents and visitors. (NEW)	Promote efforts to advance appreciation and knowledge about the IRL through tourism activities, events, and volunteer activities.	Tourist development organizations, Brevard Zoo, not-for-profit organizations, IRL destinations	IRLNEP	N/A	IRLNEP	Coordinate and collaborate
Vibrant Communities-4: Conduct community planning workshops to plan for Vibrant 21st Century communities. (NEW)	Conduct community vision planning workshop(s).	IRLNEP	IRLNEP Management Conference Partners, local governments	$25,000–$50,000	USEPA Section 320	Conduct, collaborate, and coordinate

OUTCOMES:

- **Short-term (1 – 2 years):** IRLNEP is viewed by the regional business community as the leading lagoon-wide organization to promote and cultivate productive, effective, efficient, and cooperative partnerships with the private-sector. Quantify and track the economic value of the IRL with special attention to return on investment from restoration; IRL-dependent jobs; and the influence of clean water on corporate relocations, employee recruitment and retention, and residential/commercial development.
- **Medium-term (3 – 4 years):** Private-sector partnerships develop new revenue streams for CCMP implementation and support new technological innovations to advance IRL restoration and management. The IRLNEP is recognized as a successful bridge between industry and academic partners in the STEMAC to promote innovative industry-academic partnerships in applied research and development of new coastal restoration methodologies, technologies, and commercial products. Update the IRL Economic Analysis every five years to coincide with CCMP updates (five years) and CCMP revisions (10 years).
- **Long-term (5 – 10+ years):** The IRLNEP helps to advance the IRL region and the state of Florida as a national center of excellence for innovation in clean-water technologies and innovative coastal management strategies. For 2030, in advance of the next CCMP revision, evaluate long-term (10-year) economic trend for the IRL with special attention to restoration of the IRL watershed.

CHALLENGES TO SUCCESS:

- Traditional communication challenges and presumed conflicts between industry and environmental interests.
- Water quality declines in the IRL can impact coordinated state and federal activities and assets (i.e., ports, expansion of commercial aviation and space ventures, Kennedy Space Center, and military bases and operations). To protect these commercial activities and assets, continue federal support for the IRLNEP funding appropriations as a non-regulatory core water program pursuant to Section 320 of the Clean Water Act.
- Funding for comprehensive, lagoon-wide economic analysis.
- Challenges to accurately quantify ecosystem services.
- Difficulty securing accurate economic metrics from the private sector.
- The North American Industry Classification System does not generally include government-owned establishments, even when their primary activity would be classified in industries covered by the economic census. Because of these exclusions, economic census data for industries in many sectors might appear to be incomplete. In addition, the job classifications often do not reflect 21st Century workforce changes and emerging workforce job categories.

CITATIONS:

1. De Freese, D. 2016. Rethinking the Indian River Lagoon National Estuary Program: Challenges and Opportunities for Enhanced Ecosystem Restoration and Management. American Water Resources Association Annual Conference. Orlando, FL. Presentation online at: http://www.awra.org/meetings/Orlando2016/doc/powerpoint/Session%2044%20830%20de%20Freese.pdf.
2. Treasure Coast and East Central Florida Regional Planning Councils. 2016. Indian River Lagoon Economic Valuation Update. Report available at www.onelagoon.org.
3. Tetra Tech and Closewaters. Brevard County Save Our Indian River Lagoon Plan. 2016. Report available at www.onelagoon.org.
4. Barbier, E. B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C., and Silliman, B.R. 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs, 81(2), pp. 169–193.
5. Chourabi, H., Nan, T., Walker, S., Gil-Garcia, J.R., Mellouli, S. Nahon, K. Pardo, T.A., and Scholl, H.J. 2012. Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences. System Sciences. pp 2289 – 2297.

TRASH-FREE WATERS

Coastal Connections

Goals:

Implement a Trash-Free Lagoon campaign in all lagoon counties.
Enhance coordination, report hot spots, and successes.

ONE COMMUNITY

HEALTHY COMMUNITIES

Trash-Free Waters

GOALS: *REDUCE* trash by implementing a lagoon-wide trash-free waters campaign, "Trash-Free Lagoon 2030." Enhance efforts to *REMOVE* trash by coordinating with local organizations and partners in the IRLNEP Management Conference. *REPORT* trash hotspots and trash removal success stories.

ISSUE SUMMARY: Trash is a common and recurring problem in the waters of the IRL and along its shorelines. It is especially notable along causeways and certain "trash hotspots" where vehicle access and high-volume recreation occur. Plastic debris is much more than an aesthetic problem. Of all trash, plastic has the greatest potential to harm the environment, wildlife, and humans because of its persistence. It can be found floating at the surface, suspended in the water column, or deposited on or in bottom sediments. Discarded fishing line and rope can cause animal entanglements. Trash is transported by wind and currents throughout the IRL and out to the ocean though inlets. Once ingested, plastics and other debris can result in intestinal tract blockages causing animals to starve. Reports from animal necropsies (autopsies on dead animal) have found marine debris in the stomachs of sea turtles, birds, bottlenose dolphins, manatees, and oysters.

Photo of stomach contents of dead bottlenose dolphin in the Indian River Lagoon. Plastic bags, beach towels, food wrappers (Photo: Hubbs-SeaWorld Research Institute).

There is a growing awareness and concern about microplastics and microfibers in the lagoon and adjacent ocean waters. Microplastics come from a variety of sources, including from larger plastic debris that degrades into smaller pieces. One type of microplastic is microfibers, which are used to make mats, knits, and weaves for apparel, upholstery, industrial filters, and cleaning products. Microfibers are not biodegradable and when washed, can release microfibers that are then processed at WWTPs and discharged to waterbodies. Another type of microplastic is microbeads, which are very tiny pieces of exfoliants in health and beauty products, such as some cleansers and toothpastes. These tiny plastic particles are found in almost all species, including filter feeders like oysters. The particles are so small they pass easily through wastewater treatment systems. Recent research by the University of Central Florida has shown that Mosquito Lagoon oysters are already impacted by microplastic pollution.[1] Over a longer term, chemical breakdown products of plastics can concentrate toxic chemicals in animal tissues.[2]

STRATEGIES:

- Work with local partners, municipalities, tourism development councils, restaurants and businesses, and organizations (such as Keep America Beautiful affiliates and other non-profits) to implement a strategic and coordinated Trash-Free Lagoon campaign.
- Identify and map trash hotspots throughout the IRL and identify opportunities to address through BMPs such as stormwater litter traps.

- Take actions, where necessary, to increase availability and management of trash containers, microfilament recycling bins, and pick-up spots in high-use areas.
- Implement a high-visibility, high-impact "Trash-Free Lagoon" public awareness campaign through videos, social media, and graphic imagery.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Trash-Free Waters 1: Identify and map IRL hotspots for trash, develop education projects that *REDUCE* and/or *REMOVE* trash, and seek funding for projects from the USEPA Trash-Free Waters Program. (NEW)	Educate the community through the Trash-Free Lagoon campaign and provide funds for trash removal and abatement.	IRLNEP	USEPA, local organizations, Keep America Beautiful local affiliates	$25,000 for GIS mapping, $50,000 for Trash-Free Lagoon campaign	USEPA Trash-Free Waters Program, IRLNEP	Conduct, coordinate, and collaborate
Trash-Free Waters-2: Identify and *REMOVE* derelict boats and fishing gear throughout the IRL. (NEW)	*REMOVE* derelict vessels and fishing gear.	IRLNEP	DEP, FWC, Florida Department of Law Enforcement, USCG, Marine Cleanup Initiative Inc, 4Ocean	Derelict vessel removal cost averages $350 to $450 per vessel length	DEP, IRLNEP	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Communicate the impacts of trash on the IRL. Implement the Trash-Free Lagoon campaign with partners.
- **Medium-term (3 – 4 years):** Make progress towards achieving the goal of Trash-Free Lagoon by 2030.
- **Long-term (5 – 10+ years):** Trash is an unusual and rare occurrence along the IRL shorelines and in its waters. Trash Free Lagoon by 2030.

CHALLENGES TO SUCCESS:

- Funding long-term programs and having the financial and human resources and reserves to be able to *RESPOND* to emergency situations.
- Keeping partners engaged and interested in trash removal.
- Changing culture to Lagoon-Friendly ™.

CITATIONS:

1. Robbins, M. and Walters, L. 2018. Plastics Under a Microscope. Accumulation of Microplastics in Oyster Spat in the Mosquito Lagoon. Undergraduate research poster. Florida Undergraduate Research Conference. Eastern Florida State College. Melbourne, Florida.
2. USEPA. 2018. Trash-Free Waters Website: https://www.epa.gov/trash-free-waters.

MARINAS AND BOATING

Goals:

Reduce negative impacts through boater education. Update the Boater's Guide to focus on good practices and safe recreation.

ONE COMMUNITY

HEALTHY COMMUNITIES

Marinas and Boating

GOALS: ***REDUCE*** **impacts from marina and boating activities. Educate boating population to take** ***RESPONSIBILITY*** **and be Lagoon-Friendly™. Update and re-publish the highly acclaimed IRLNEP** ***Boaters Guide to the Indian River Lagoon*** **to focus on boater waste management, safe boating practices, lagoon community boat ramps and recreational destinations, and emergency call contacts.**

ISSUE SUMMARY: Boating has been a traditional use of the IRL since Native Americans and early settlers used the lagoon as a primary route for travel and commerce. While the lagoon continues to be heavily used by boaters, today's boating is primarily a recreational activity with commercial activity mostly located on the Intracoastal Waterway.

The number of boats and boaters decreased following the 2008 recession; however, the boating industry has been growing rapidly in recent years. In 2016, 102,803 boats were registered in Volusia, Brevard, Indian River, Martin, and St. Lucie counties. While recreational use of the lagoon is important for the economy of the region, as well as for the enjoyment of its residents and visitors, heavy use can strain the sensitive natural resources of the lagoon.

While most boaters use great care in the operation and maintenance of their boats, some uses and behaviors may affect the health of the lagoon. Approximately 10% of the vessels registered in the IRL region are greater than 26 feet in length and are required to have some form of marine sanitation device (MSD) on board. In 1992, the Clean Vessel Act was signed into law to reduce water pollution by prohibiting vessels from discharging raw sewage into fresh water or coastal saltwater.[1] Discharges from MSDs, pollutants generated by fueling and operating boat motors, detergents from boat cleaning, and metals (especially copper) or other materials leaching from bottom paints can affect water quality. The impacts of these pollutants can range from slight perturbations to acute toxicity in the water column and sediments to threats to the public health.

Boat traffic itself can damage the lagoon. Boat wakes may erode shorelines and break up oyster reefs, and if care is not taken to avoid shallow areas, boat propellers may dig into the bottom, destroying seagrass and/or benthic habitat. In addition to possible damage to the boat, prop scars can be enlarged by scouring currents, leading to expanding seagrass loss and turbidity.

Other recreational impacts can include littering or improper disposal of trash. Manatees, sea turtles, dolphins, fish and birds can be injured or killed by ingesting or becoming entangled in discarded fishing line, nets, plastic bags or other debris.

Numerous marinas and similar facilities have been constructed along the IRL to provide services for boaters and access by the public. Because of their proximity to the lagoon, these facilities have a high potential to impact lagoon resources if they are not operated and managed carefully. Boaters, especially those on live-aboard boats, have a responsibility to comply with Florida law and be Lagoon-Friendly™. While the extent of the problem is not known, in May 2017 in response to multiple citizen complaints about irresponsible boat owners and captains, FWC enforcement officers issued 15 citations over a two-night detail for MSD violations, made an arrest on an outstanding warrant, and issued multiple warnings for other violations. Under Florida Statutes, violations relating to marine sanitation carry a civil penalty of $250 for a first offense, $750 for a second offense, and $1,000 for a third offense.

Boater education and engagement programs, such as the Florida Clean Boater, Clean Marina, and Clean and Resilient Marina programs, promote boater awareness and improved operation and maintenance of boats and marina facilities, bring boaters and marina operators the tolls needed to minimize their potential impacts on the IRL's resources.

STRATEGIES:

- Provide education to boaters on Clean Boater Program and to marinas on the Clean Marina Program. Communicate about boating BMPs for marinas and boaters.
- Ensure that MSDs are working and pumped out properly. Discuss regulatory policy options with enforcement agencies.
- Develop an inventory and map of certified Clean Marinas along the IRL.
- Collect information on IRL boater education courses and help distribute materials that contain environmental awareness elements, updates on existing guides, and similar materials.
- Work with county partners to identify who has approved boat facility siting plans. Work with Brevard County to identify opportunities to review, update, or support their comprehensive maritime management master plan.
- Establish and maintain beneficial marine infrastructure to promote safe boating and habitat protection.
- Promote increasing the number of law enforcement staff assigned to patrol the IRL, and staff time committed to patrolling the IRL.
- Collect data as available on agency enforcement activities (i.e., resource evaluations, number of resource protection zones established, manatee strikes and prop scar data, impacts to seagrass beds and oyster reefs).

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Boating-1: Eliminate waste discharges and MSD impacts on the public health and IRL resources.	Eliminate or *REDUCE* the nutrient and pathogen discharges to the IRL.	DEP, FWC, USCG, local governments	Florida Sea Grant, marine industry, USCG Auxiliary	TBD	DEP, FWC, USCG, local governments	Coordinate and collaborate
Boating-2: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the IRL and develop and distribute targeted public education and outreach products to *REDUCE* impacts.	Provide for a safer IRL waterway and *REDUCE* impacts to IRL natural resources.	DEP, FWC, USCG, local governments	FWC, DEP, USCG Auxiliary, local governments, interest groups	TBD	DEP, FWC, USCG, local governments	Coordinate and collaborate
Boating-3: Update and distribute the *Boaters Guide to the Indian River Lagoon*. (NEW)	Update and distribute the guide.	IRLNEP	IRLNEP Management Conference, private industry partners	$50,000 - $100,000	USEPA Section 320 funding	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Build stronger ties between the IRLNEP and the boating and marine industry sector. Assist DEP, FWC, USCG Auxiliary, and other maritime interests to assist expansion with boater education programs and outreach.
- **Medium-term (3 – 4 years):** Work with state and private partners to quantify improvements in boater and marina compliance. Elevate clean marinas with effective and efficient pump-out and waste management standards as a Florida brand for clean water excellence. Marine industry associations are a strong partner with IRLNEP.
- **Long-term (5 – 10+ years):** *REDUCE* impacts on IRL water quality and habitats from boating and marina activities.

CHALLENGES TO SUCCESS:

- Inadequate funding for FWC enforcement coverage along the IRL.
- Diverse and independent nature of the boating and marina community.
- Inadequate local policies and regulatory oversight to prevent marinas from becoming live-aboard boat communities with insufficient wastewater pump-out facilities.

CITATIONS:

1. DEP Clean Vessel Act Grant Program. Website: https://floridadep.gov/OSI/CVA.

DISTINCTIVE LAGOON COMMUNITIES

Wild Ocean Seafood Market

Goals:

Respond to the the unique needs of communities having urban waters, working waterfronts, and environmental justice populations.

ONE COMMUNITY

HEALTHY COMMUNITIES

Distinctive Lagoon Communities

GOALS: ***RESPOND*** **to the unique needs of three categories of IRL coastal communities that contribute to the rich history, culture, human diversity, infrastructure, and economic value of the IRL watershed.**

ISSUE SUMMARY: Each of the 38 incorporated cities, numerous unincorporated communities and villages, and the counties have unique identities, histories, and connections to the IRL. However, there are three distinctive community categories within the IRL watershed that contribute in significant ways to the rich history, culture, human diversity, infrastructure, economic value, and coastal identity of the IRL watershed. Together, these communities form a foundation for the IRL's unique identity and brand.

Urban Waters: Cities share one key characteristic: they are full of people, buildings, and businesses. Because everyone shares the same relative space, air, and water, environmental impacts are concentrated in smaller areas, including waterways. In the decades to come, most of the mainland coast of the IRL will be characterized by high density development. Throughout the U.S. and Florida, urban waters receive large amounts of pollution from a variety of sources, including industrial discharges, mobile sources (e.g., cars/trucks), residential/commercial wastewater, trash, and polluted stormwater runoff from urban landscapes. This pollution creates public and environmental health hazards, such as waterbodies that are not safe for swimming. In addition, urban patterns of development often make waterways inaccessible to adjacent neighborhoods. Lack of access limits a community's ability to reap the benefits of living close to the water, whether through recreation, fishing, or access to real estate. IRL communities can make planning and development decisions to preserve community values for water access and use.

Working Waterfronts: The Waterfronts Florida Program offers help to coastal governments to revitalize their working waterfronts by providing resources for land acquisition and technical assistance for planning.[1] The Waterfronts Florida Partnership Program was created by the Florida Coastal Management Program in 1997 to address the physical and economic decline of traditional working waterfront areas. Since 1997, a total of 24 communities have received designation as Waterfronts Florida Partnership Communities. During the designation process, a community receives intensive technical assistance from DEO, resulting in a new or refined, community-designed vision plan (special area management plan) to guide the revitalization of the community's designated waterfront area. During the first phase of designation, a community establishes its Waterfronts Florida Partnership, prepares a community-designed vision plan to guide the revitalization of the traditional working waterfront area, and begins implementation of the vision plan, as appropriate. The visioning process and resulting document identify the community's issues and their plans for addressing the following priority areas: public access to the waterfront, hazard mitigation, environmental and cultural resource protection, and enhancement of

the viable traditional economy or economic restructuring. During the second phase, the community continues to implement its vision plan, focusing on incorporating its vision into the comprehensive plan and undertaking priority projects that will further its efforts to revitalize and preserve the working waterfront. The public dialogue and the partnerships developed with state agencies, private organizations, and other Waterfronts Florida communities across the state enable a designated community to identify proactive solutions to address community concerns and to implement them. Designated communities along the IRL and within the IRLNEP IRL-Halifax planning boundary include Daytona Beach (Volusia County), Oak Hill (Volusia County), Old Eau Gallie (Brevard County), and Port Salerno (Martin County). In addition, the Stan Mayfield Working Waterfronts Florida Forever grant program was created by the 2008 Legislature and is administered by Florida Communities Trust. To fund the program, the Legislature provided 2.5% of the total Florida Forever program appropriation. In the IRL watershed, the City of Sebastian, Blue Crab Cove (also known as Griffis Landing) on Merritt Island, and Port Salerno in Martin County have received grants towards creating Working Waterfronts.[2]

USEPA Environmental Justice Communities: Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The 25th anniversary of the creation of USEPA's Office of Environmental Justice occurred in 2017, and it is a testament to the USEPA's commitment to furthering environmental justice by addressing the environmental and public health concerns of minority, low-income, tribal, and indigenous communities. USEPA has developed an environmental justice mapping and screening tool called EJSCREEN, which is based on nationally consistent data and an approach that combines environmental and demographic indicators in maps and reports.[3] Data from this tool can be used to implement the CCMP actions. This CCMP revision incorporates aspects of environmental justice throughout each of the action plans, as water quality, habitat, and living resources seek to be preserved for all communities to enjoy. Furthermore, there are CCMP actions that call for access to the lagoon, so that all can enjoy the IRL as One Community, as well as actions to monitor and report the status of all areas of the IRL, which will allow all communities to speak and be heard with One Voice.

STRATEGIES:

- Provide technical assistance and support to distinctive IRL communities to assist with vision plan implementation, incorporating vision objectives into local comprehensive plans, and supporting local priority projects that revitalize and sustain community health and welfare.
- Look for opportunities to redevelop viable waterfront areas to create livable waterfront communities.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Distinctive Communities-1: For, Urban Waters, ensure the high density human population is Lagoon-Friendly ™. (NEW)	Maintain sustainable, Lagoon-Friendly ™, and economically viable urban waters areas.	IRLNEP	DEO, DEP	TBD	USEPA, DEP, economic development councils	Conduct, coordinate, and collaborate
Distinctive Communities-2: For Working Waterfronts, coordinate with local communities to maintain the commercial use. (NEW)	Promote working waterfronts and help enhance communities by providing economic, educational, recreational, social, and employment opportunities.	IRLNEP	DEO, DEP	TBD	USEPA, DEP, economic development councils	Conduct, coordinate, and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Distinctive Communities-3: For Environmental Justice Communities, identify the unique challenges and opportunities along the lagoon for underrepresented and underserved communities. (NEW)	Provide support and information to underrepresented and underserved communities to promote being Lagoon-Friendly ™.	IRLNEP	DEO, DEP	TBD	USEPA, DEP, economic development councils	Conduct, coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Identify and map the locations of each distinctive community and working waterfront.
- **Medium-term (3 – 4 years):** Support the development of community action plans.
- **Long-term (5 – 10+ years):** Promote and enhance the quality of life in the distinctive communities in a Lagoon-Friendly ™ manner.

CHALLENGES TO SUCCESS:

- Funding for community cost-share projects to preserve and revitalize working waterfronts.
- Challenges to rethink and redefine a sustainable working waterfront.
- Resources to provide project funding and education for underrepresented and underserved communities.
- Limited access to the shoreline and other IRL resources for distinctive communities creates a lack of ownership.

CITATIONS:

1. DEO. 2018. Website: http://www.floridajobs.org/community-planning-and-development/programs/community-planning-table-of-contents/waterfronts-florida-program.
2. Lampl Herbert Consultants. 2010. Linking Commercial Fishing to Land Use Planning: The Stan Mayfield Working Waterfronts Florida Forever Grant Program. Research conducted under a grant from Gulf & South Atlantic Fisheries Foundation, Inc.
3. USEPA. EJSCREEN: Environmental Justice Screening and Mapping Tool. Website: https://www.epa.gov/ejscreen.

EMERGENCY PREPARATION AND RESPONSE

NASA

Goals:

Identify the role of the IRLNEP during emergencies and develop coordinated plans with partners to respond to emergencies.

ONE COMMUNITY

HEALTHY COMMUNITIES

Emergency Preparation & Response

GOALS: Identify the role of the IRLNEP during emergencies that impact the IRL and its communities. Develop coordinated plans with IRLNEP Management Conference partners and responsible local, state, and federal entities to prepare, *RESPOND,* and *RECOVER* after an emergency in the IRL watershed.

ISSUE SUMMARY: In recent years, several environmental incidents have occurred with the potential to significantly affect the IRL's environmental resources. These incidents include HABs, unusual mortality events, seasonal releases from Lake Okeechobee, frosts and freezes, discovery of aquatic invasive species in various areas of the IRL (Australian spotted jellyfish, green mussel, lion fish, and Charru mussel [*Mytella charruana*]), land- or water-based pollutant spills, vessel stranding and abandonment, fish kills, and hurricanes and major storm events. These events have the potential to alter the character and biodiversity of the IRL's ecosystem and potentially impact the health and safety of people and their communities.

Most pollutant spills—oil, hazardous materials, wastewater—have an established notification and regulatory response that involves contacting the DEP Office of Emergency Response.[1] Other teams are established to respond to marine mammal and sea turtle strandings.[2] A hotline has been implemented for response to fish kills and algal blooms; however, emergency assessment for many other categories of environmental incidents is largely organized on an *ad hoc* basis.

To address the issue, an IRLNEP incident risk assessment and response workshop is proposed to discuss potential incident risks, identify key agency roles and responsibilities, develop a communication strategy, and define the IRLNEP role in providing emergency preparation, response, and recovery support to its Management Conference and community partners.

STRATEGIES:

- Identify ways for the IRLNEP to aid and support in preparation for, response to, and recovery from emergency situations in the IRL to help understand the potential problems, identify key partners, gather resources and funding mechanism(s), and be a conduit for communication and consistency throughout the lagoon.
- Share an inventory of classes of incidents and events that could impact water and habitat quality or human health, safety, and welfare in the IRL to develop responses, as necessary, to *REDUCE* risks or *RESPOND* to events effectively and efficiently.
- Identify a pre-disaster emergency response and coordination plan, hazard mitigations, and a succession plan for continuity of operations.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Emergency-1: Evaluate the role and ability of the IRLNEP to assist local communities and emergency management agencies in times of emergencies that impact the IRL. (NEW)	*REPORT* on the role of the IRLNEP in emergency planning and response.	IRLNEP Management Conference	Federal, state and local emergency planning and response agencies.	IRLNEP staff time	IRLNEP	Conduct, collaborate, and communicate

OUTCOMES:

- **Short-term (1 – 2 years):** Coordinate with partners and other NEPs about the role of IRLNEP in emergency management and develop a report with the IRLNEP's role.
- **Medium-term (3 – 4 years):** Coordinate with partners to quickly and efficiently *RESPOND* to emergencies in accordance with defined emergency response roles.
- **Long-term (5 – 10+ years):** Continue to assess and modify the plan to best address emergencies that arise.

CHALLENGES TO SUCCESS:

- Coordination and communication among multiple agencies and organizations during an emergency.
- Limited staff and financial capacity of the IRLNEP.

CITATIONS:

1. DEP State Office of Emergency Response. 2018. Website: https://floridadep.gov/OER.
2. FWC. 2018 Website: http://www.myfwc.com/seaturtle/.

MONITORING AND DATA SHARING

Atkins

Goals:

Coordinate and integrate monitoring, data sharing, and mapping efforts throughout the IRL. Identify gaps and evaluate trends.

ONE VOICE

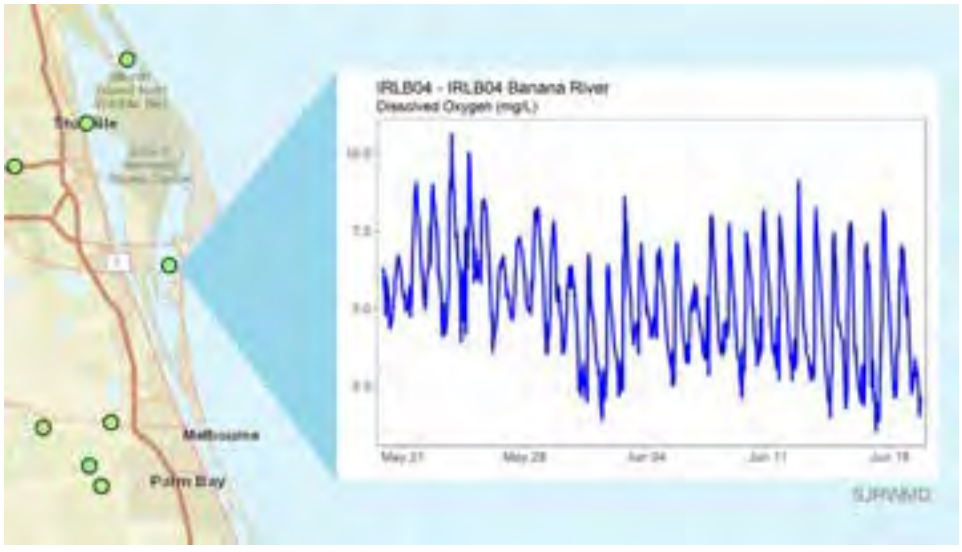
COMMUNICATE – COLLABORATE – COORDINATE

Monitoring and Data Sharing

GOALS: Coordinate IRL monitoring, data sharing, and mapping throughout the IRL and its watershed. *RESPOND* to gaps in monitoring and data collection and the need to evaluate trends and changes. *REPORT* the shared findings from the IRL monitoring network to inform IRL partners and stakeholders about status and trends related to the health of the IRL.

ISSUE SUMMARY: Monitoring the sediment, water quality, and biological resources of the IRL is important not only to determine the current condition of the estuary but also to ascertain the effectiveness of restoration. Having adequate and reliable data allows standards to be established and provides a framework for future comparisons. Monitoring networks must be in place and maintained before critical changes occur to the lagoon if we are to understand why and how the changes occurred. Mapping and GIS tools are a powerful way to convey these data quickly, and modeling can be used to evaluate future monitoring locations and parameters. Information gleaned from mapping and GIS evaluations should then be used to identify innovative technologies to address existing and newly identified problems, such as climate change impacts on the IRL. For these reasons, it is important to regularly monitor the conditions and resources of the IRL and evaluate these data.

Concerned citizens and agencies alike monitor the lagoon's water quality. A long-term comprehensive, coordinated network was established by the IRL Surface Water Improvement and Management (SWIM) Program in 1989,[1] including participants from Volusia, Brevard, and Indian River Counties; DEP; NASA; SFWMD; and SJRWMD. MRC, in partnership with DEP, established the IRL Watch Water Quality Monitoring Program in 1989.[2] The network consists of more than 90 stations located throughout the IRL that are monitored on a weekly basis. MRC and FIT are also under contract with Brevard County to probe the lagoon to identify the presence and depths of muck on the IRL floor. Many of the same entities involved in the IRL SWIM monitoring network also monitor or study the biological resources of the lagoon. Fixed seagrass transects located throughout the lagoon are monitored by SJRWMD, SFWMD, and partners to assess the health and extent of the seagrass community. Seagrasses in the IRL are mapped every two to three years through aerial photography to determine current seagrass extent and document any changes that occurred in the period between map developments. Several organizations, such as the University of Central Florida and the Brevard Zoo,[3] are contracted by Brevard County to monitor oyster survival and recruitment from restoration efforts. In the Southern IRL and St. Lucie River, the CERP Restoration Coordination and Verification Program has been monitoring oysters and benthic infauna on a regular basis since 2005.



Throughout the IRL watershed are numerous educational and research institutions that contribute to the body of scientific knowledge concerning the lagoon. Universities, such as FIT,

University of Central Florida, Florida Atlantic University, Stetson University, Bethune-Cookman University, University of Florida, and others conduct faculty and student research and monitoring. Research entities, such as Harbor Branch Oceanographic Institute, Smithsonian Marine Station, and ORCA, conduct ongoing research and monitoring.

This CCMP revision promotes scientific integrity, honesty, objectivity, and accountability, and it integrates science with the social, economic, and education needs and values of the community. Achieving these goals will be dependent upon the development of a coordinated, integrated, and well-managed IRL field research site network with access and support for facilities. It will be important to create central data repositories to ensure all data are coordinated and provided in a specific format. Existing databases, such as the Watershed Information Network maintained by DEP, water quality and environmental data maintained by SJRWMD, and DBHYDRO maintained by SFWMD can be used.

STRATEGIES:

- Provide monitoring of the IRL and evaluate the data through maps and models to validate ongoing projects and identify potential problems and sources of problems in the IRL.
- Provide a consistent, long-term funding source to maintain the necessary monitoring network.
- Effect change in plans and practices through collection, analysis, and interpretation of data.
- Increase muck monitoring and mapping to better understand the amount and locations of muck and the potential for nutrient release to the water column, as well as turbidity caused by muck resuspension.
- Continue monitoring of biological resources, such as seagrasses and oysters, to evaluate the impacts of restoration.
- Provide funding and support for science symposia, outreach, technology transfer, workshops, and events.
- Consolidate data on a regular basis and in a standardized format into more user-friendly platforms using GIS, Environmental Visualization Software, Tableau, and other modeling and data management tools.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Monitoring 1: Develop a comprehensive IRL monitoring plan. (NEW)	Evaluate roles and responsibilities and identify gaps, opportunities, and challenges to delivering a comprehensive monitoring network.	IRLNEP	IRLNEP Management Conference partners	$50,000	USEPA Section 320 funds	Conduct, coordinate, and collaborate
Monitoring-2: Monitor IRL indicators at appropriate spatial and temporal scales to understand the status and trends associated with key indicators of the system's health. (NEW)	Obtain appropriate data to better understand the status and trends for key indicators.	IRLNEP Management Conference	90+ partners including SJRWMD, SFWMD, DEP, MRC, Smithsonian Institute, ORCA, Harbor Branch Oceanographic Institute, interest groups, local governments	A minimum of $100,000 annually to coordinate and have a reserve for emergency monitoring need; additional $75,000–$100,000 if expanding the atmospheric monitoring station network.	IRLNEP Section 320 annual funding, partner support and grants	Coordinate and collaborate

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Montioring-3: Support expansion of and adequate funding for the IRL Citizens Water Quality Monitoring Program.	Data quality control, standardized methodology, and integration of data into IRL health status evaluations.	IRLNEP Management Conference	90+ water quality monitoring and data user partners, MRC, Florida Oceanographic Society, Marine Discovery Center, Brevard Zoo, Counties, Water Control Districts	Included in Monitoring-2	IRLNEP Section 320 annual funding, partner support and grants	Coordinate and collaborate
Monitoring-4: Identify, develop, and apply next-generation smart sensors, remote sensing technologies, big data analytics, and surveillance components to monitor and deliver an IRL water quality dashboard in real time. (NEW)	Create an IRL water quality dashboard.	IRLNEP Management Conference	ORCA, Harris Corporation, Embry-Riddle Aeronautical University, NOAA, academia, Cardinal Systems, HydroPlus Engineering, robotics groups	TBD	TBD	Coordinate and collaborate
Monitoring-5: Advance the 10 scientific *RESEARCH* priorities identified by the STEMAC in the 2018 *Looking Ahead – Science 2030 Report*. Work with IRL partners to seek funding to implement priority *RESEARCH* projects within the 10 priorities. (NEW)	Provide an annual update on how the 10 *RESEARCH* priorities were advanced and revise priorities as needed.	IRLNEP Management Conference	Agencies, academia, interest groups	TBD based on research needed for 10 priorities	Agencies, local governments	Coordinate and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate existing monitoring projects and programs to ensure long-term viability of existing monitoring networks and prepare a monitoring plan that identifies responsible entities, gaps, and potential funding sources. Assemble issue-specific task forces to identify *RESEARCH* projects, responsible entities, and funding sources for each of the ten priorities identified by the STEMAC in the *Looking Ahead – Science 2030 Report*.
- **Medium-term (3 – 4 years):** Implement identified changes to the monitoring network. Add a monitoring requirement for projects funded through the IRLNEP, as appropriate. Begin implementation of *RESEARCH* projects for the ten priorities identified by the STEMAC in the *Looking Ahead – Science 2030 Report*.
- **Long-term (5 – 10+ years):** Create a real-time database and conduct real-time modeling to distribute available data to a larger group and understand what is happening and predict what will happen in the near- and long-term in the IRL. Complete the *RESEARCH* projects and incorporate findings into the next CCMP revision and into management of the IRL's resources.

CHALLENGES TO SUCCESS:

- Money tends to be available for "shovel-ready projects" that can provide a more tangible benefit than data. Sediment, water quality, and biological data collected through monitoring provide the information required to evaluate what is happening, what needs to change, and what has changed because of actions.

A value needs to be placed on the data that provides efficiency and validity to projects and the dollars that fund them.

- Various entities collect data in the IRL system, and these efforts need to remain coordinated and collaborative so that they are efficient and effective. In addition, the increased concern about the health of the IRL system offers an opportunity to convey useful and actionable information in more effective ways to raise the level of coordination and integration of data to better *RESTORE* and sustain the health of the IRL.

CITATIONS:

1. SJRWMD and SFWMD. 1989. Surface Water Improvement and Management (SWIM) Plan for Indian River Lagoon.
2. MRC. 2018. http://www.mrcirl.org/our-programs/indian-river-lagoonwatch.
3. Brevard Zoo. 2018. Restore Our Shores Program. https://restoreourshores.org/.

STATE OF THE LAGOON

Florida Institute of Technology

Goals:

Develop a "State of the Lagoon" Technical Report that addresses ecosystem status, stressors, trends, and emerging concerns.

ONE VOICE

Communicate – Collaborate – Coordinate

State of the Lagoon

GOALS: Collect, synthesize, and analyze IRL data and *RESEARCH* findings to develop a "State of the Lagoon Technical Report" that addresses the health of the IRL, ecosystem stressors, indicators, and trends. *REPORT* the findings. Apply the findings to advise CCMP updates and revisions.

ISSUE SUMMARY: One requirement of the Clean Water Act is to assess trends in water quality, natural resources, and uses of the estuary.[1] To meet this objective and to comply with USEPA core performance measures for NEPs regarding the reporting of ecosystem status and trends,[2] the IRLNEP will bring together Management Conference partners, including the IRL Science and Management Working Group, as well as other practitioners from universities, organizations, and agencies to develop a "State of the Lagoon Technical Report" in advance of ten-year CCMP revisions. The report will present and track appropriate IRL indicators and Vital Signs to evaluate key stressors to the IRL and its watershed; assess chemical, physical, and biological conditions; describe past and current trends; look ahead to potential future changes; and identify data and research essential to advancing understanding of changes and emerging issues.

STRATEGIES:

- Create an IRL technical task force and fund the activities of the technical task force to develop a "State of the Lagoon Technical Report" with a target delivery date of 2025. That technical report will serve as the scientific foundation for advising the next revision of the CCMP due in 2030.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
State of the IRL-1: Provide support for a "State of the Lagoon Technical Report" to be released every ten years. (NEW)	Produce a "State of the Lagoon Technical Report" in advance of 5-year CCMP updates and 10-year revisions.	IRLNEP Management Conference	Universities, organizations, and agencies	$450,000 (funded over 4 years)	IRLNEP and Management Conference	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Identify and *RESOLVE* data gaps and monitoring needs required to conduct effective ecosystem health analyses. Build a multi-disciplinary scientific and technical task force willing and able to implement and coordinate report development. Begin report development.
- **Medium-term (3 – 4 years):** Present a draft report for Management Conference review.
- **Long-term (5 – 10+ years):** Finalize report and publicly rollout report in conjunction with an IRLNEP Scientific Summit or Florida Atlantic University/Harbor Branch Oceanographic Institute IRL Science Symposium. Prepare an update to the "State of the Lagoon Technical Report" every ten years in advance of CCMP revisions.

CHALLENGES TO SUCCESS:

- Gaps in monitoring and data make indicator identification and analysis challenging and sometimes impossible.
- Long-term studies with large data sets that have not been published in peer-reviewed journals may be difficult to access for use and analysis.
- Large trans-disciplinary teams and multi-agency partnerships face challenges in coordination, cooperation, and communication.
- Multi-year funding to support the comprehensive work needed to develop a strong science-based report based on leading-edge scientific knowledge.

CITATIONS:

1. Federal Water Pollution and Control Act, as Amended through P.L. 107–303, November 27, 2002. 234 P. https://www.epa.gov/sites/production/files/2017-08/documents/federal-water-pollution-control-act-508full.pdf.
2. USEPA. 2016. National Estuary Program – Program Evaluation Guidance. https://www.epa.gov/sites/production/files/2015-09/documents/2011-final-nep-pe-guidance.pdf.

TECHNOLOGY INNOVATION

University of Sydney

Goals:

Research innovative technologies and emerging commercial opportunities that could assist in IRL restoration and stewardship.

ONE VOICE

Communicate – Collaborate – Coordinate

Technology Innovation

GOALS: ***RESEARCH*** **innovative technologies and emergence of commercial opportunities that will assist with restoration and stewardship of the IRL.** ***REPORT*** **findings.** ***RESPOND*** **to industry needs and desires to communicate more effectively with IRL partners. Work with industry and economic development partners to position Florida and the IRL region as a leader in clean water innovation, research, and technology development.**

ISSUE SUMMARY: Clean water is essential for the environment, industry, society, and individuals to survive and thrive. As coastal populations grow and existing water infrastructure ages and becomes inadequate, four areas of water innovation are needed: (1) talent, (2) technology, (3) infrastructure, and (4) investment.[1] The development and deployment of innovative technologies and processes; new applications of existing technology; production changes; and organizational, management, and cultural changes can improve the condition and sustainability of the IRL water resources.[2]

The fragmented framework governing the water sector in Florida and throughout the United States constrains innovation and commercialization by creating barriers to entry and reducing the viability and economic value of private-sector market development. During the highly publicized 2016 algal blooms and fish mortality events in the IRL, dozens of small business and technology companies approached the IRLNEP with innovative technology solution proposals. All discussed multiple challenges to market entry and commercial success, which included no central point for market entry, risk aversion by public agencies, distrust of for-profit companies, regulation and permit challenges, lack of financial support for pilot projects, lack of private-sector investment capital, and complex/slow governmental processes that eroded return on investment. For many of these corporate interests, quantitative data on performance and proof of efficacy were also lacking for one or several critical criteria, including effectiveness; efficiency; ability to scale; environmental safety; sustainability; capital, operational, and maintenance costs; and life-cycle costs compared to traditional and proven approaches.

STRATEGIES:

- Provide an objective and easy to access industry and technology directory on the IRLNEP website for existing and emerging water quality restoration, habitat restoration, and water quality monitoring technologies.
- Create a technology review panel to evaluate proposals received for new technologies.
- Develop a white paper on technological opportunities related to water and industry cluster (geographic concentration of interconnected institutions in a particular field) development for the IRL region.[3] Work with the FIT IRL Research Institute to expand its annual technical conference. Work with the Economic Development Commission of the Space Coast, DEO, and clean technology sector partners to promote *RESEARCH*, development, and commercialization of technologies related to water.
- Launch the IRLNEP water technology directory on the www.onelagoon.org website and update the directory on a regular basis.
- Advance an incubator program in partnership with Groundswell Startups and other interested partners to help commercialize the most promising technological opportunities that need pilot funding and third-party monitoring to move from the lab and bench-scale experiments to field applications.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Technology Innovation-1: Work with IRLNEP IRLI[2], industry leaders, economic development organizations, and startup incubators/accelerators to help drive IRL regional economic, technology, and talent development. (NEW)	Support development of an IRL region and Florida water technology industry cluster.	IRLNEP Management Conference	FIT IRL Tech-Con, industry incubators, economic development organizations, DEO, USEPA	IRLNEP event sponsorship ($5,000–$10,000 annually)	IRLNEP, public- and private-sector sponsors	Conduct, coordinate, and collaborate
Technology Innovation-2: Continue to support and develop a water technology directory for the www.onelagoon.org website. (NEW)	Share technology knowledge and industry contacts with IRL resource managers and Association of NEPs.	IRLNEP Management Conference	Private-sector industry willing to submit directory information	IRLNEP staff time, possible student internships, estimated at < $5,000 annually	IRLNEP	Conduct, coordinate, and collaborate
Technology Innovation-3: Evaluate options for a regular, sustainable, and cost-effective water quality monitoring network using autonomous sampling. (NEW)	Evaluate and communicate about emerging monitoring technologies.	IRLNEP Management Conference	Embry-Riddle Aeronautical University, NOAA, academia, Cardinal Systems, HydroPlus Engineering, robotics interest groups	IRLNEP staff time (< $10,000 annually = 10% of Executive Director time)	Grants, National Science Foundation, NOAA, NASA, Office of Naval Research	Coordinate and collaborate

OUTCOME:

- **Short-term (1 – 2 years):** Launch the IRLNEP technology directory on www.onelagoon.org.
- **Medium-term (3 – 4 years):** Deliver a Florida water technology conference in the IRL region with partners from industry, academia, and state/regional economic development agencies.
- **Long-term (5 – 10+ years):** Build the IRL regional reputation as an industry cluster for technology, innovation and excellence related to water.

CHALLENGES TO SUCCESS:

- Funding to evaluate and implement new technologies to improve water quality and to better understand the IRL system.
- Building industry and market trust in the IRLNEP directory.
- Providing third-party verified quantifiable value to IRL partners and industry partners.

CITATIONS:

1. U.S. Council on Competitiveness. 2016. Leverage. Phase I Sector Study: Water and Manufacturing. 36p.
2. USEPA. 2018. Promoting Technology Innovations for Clean and Safe Water - Water Technology Innovation. https://www.epa.gov/sites/production/files/2014-04/documents/clean_water_blueprint_final.pdf.
3. De Freese, D. and Coffee, R. 2018. Viewpoint: Opportunities for Clean Water Technology and Innovation. IRLNEP White Paper in development.

CCMP IMPLEMENTATION AND FINANCING

Goals:

Work with IRL partners to implement the CCMP. Fund projects and programs that restore the IRL to health.

ONE VOICE

Communicate – Collaborate – Coordinate

CCMP Implementation and Financing

GOALS: IRL communities, partners, and citizens work in cooperation to align their individual and collective interests and actions to take *RESPONSIBILITY* to achieve the "One Lagoon – One Community – One Voice" Mission. Identify, fund, and implement CCMP projects and actions to *RESTORE* the IRL. Align CCMP activities to provide enhanced *RESILIENCE* for the IRL and its human communities.

ISSUE SUMMARY: The IRLNEP is the only IRL organization with the responsibility to develop a long-term, watershed-based, non-regulatory, and community-driven CCMP for the IRL and to work with partners to implement the plan.[1,2]

For IRL ecosystem restoration and management to deliver on multiple environmental, infrastructure, and societal targets (i.e., water quality, habitat improvement, economic vitality, community resilience, and quality of life), the process of restoration and management must create a lagoon-wide, unified, and scale-dependent approach that applies and integrates the best available natural and social sciences to resource management with full participation, engagement, and support of IRL citizens, community leaders, scientists, resource managers, and policy makers.

For this CCMP to be successful, there is a need for stable, recurring funding to implement the actions, projects, research, monitoring, and reporting included in this plan. Without additional funding, the existing annual funding from the IRLNEP Management Conference plus the funding available to local entities is insufficient to achieve restoration at the scale and timeline needed for the IRL system to recover. Identifying additional source(s) of funding will be key to implementing the actions in this plan.

STRATEGIES:

- Implement and communicate the "One Lagoon – One Community – One Voice" mission as a foundation for building local, state, and federal support for IRL restoration and management with participation from the public, private, and independent sectors throughout the IRL region.
- Complete the CCMP revision in fiscal year 2018-2019. IRL Council formally adopts the CCMP revision after USEPA review and certification in early 2019.
- Fine tune CCMP targets and indicators as necessary, track performance, and communicate progress.
- Continue to identify and secure expanded and expedited cost-share funding for CCMP project implementation throughout the IRL watershed.
- Work with funding partners and investors to secure dedicated matching funds at a level commensurate with the needs of the IRL.
- Seek opportunities for funding IRL restoration through sources such as the Water and Land Legacy Amendment (often referred to as Amendment 1).
- Increase federal funding for each of the 28 NEPs authorized by Section 320 of the Clean Water Act with a goal of $1 million annual base funding per NEP to implement CCMP restoration actions.

ACTION PLAN OUTPUTS (DELIVERABLES):

Actions	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Implementation-1: Develop a finance plan for CCMP development and implementation, project and program funding, and program delivery with a focus on restoration, scientific *RESEARCH*, monitoring, and citizen engagement. (NEW)	Deliver all USEPA performance measures representative of an "excellent" performing NEP.	IRLNEP Management Conference	Local IRL partners, federal partners, private-sector investors, and industry partners from tourism, real estate development, and other clean water-dependent industries	$2.1 million minimum base funding for IRLNEP pursuant to the 2015 IRL Council Interlocal Agreement, as amended from time to time; full CCMP project implementation is estimated at $1.5 billion	**Annual Funding**: USEPA ($600,000), SJRWMD ($500,000), SFWMD ($500,000), DEP ($250,000), Volusia County ($50,000), Brevard County ($50,000), Indian River County ($50,000), St. Lucie County ($50,000), Martin County ($50,000), IRL license plate ($125,000) **Project Funding**: Priority need is a stable, recurring funding source for local-state cost-share projects	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Secure and expand funding that accelerates implementation of CCMP priority activities and partners' projects to include, but not be limited to, expanded IRL Council base annual funding and expanded local, state, and federal cost-share funding. All IRL partners and stakeholders are investing time, talent, and/or funds to fulfill CCMP actions to *RESTORE* and manage the IRL.
- **Medium-term (3 – 4 years):** Expansion of strategic partnerships and expansion/diversification of funding opportunities to implement priority projects and programs. IRL region is unified in its support of the CCMP for IRL restoration and stewardship.
- **Long-term (5 – 10+ years):** Document improvements in water quality and natural habitat improvements in the IRL based on Vital Signs and science-based indicators. Evaluate the return on investment for management practices implemented.

CHALLENGES TO SUCCESS:

- Overcoming stakeholder's narrow spatial and short-term temporal perspectives to embrace "One Lagoon – One Community – One Voice" as a shared regional, statewide and national identity.
- Availability of adequate, stable recurring funding for effective, efficient, and timely program and project implementation.

CITATIONS:

1. IRLNEP Management Conference governance model (www.onelagoon.org).
2. Clean Water Act. 40 Code of Federal Regulations 320 – of the Clean Water Act, as amended. https://www.gpo.gov/fdsys/granule/CFR-2002-title40-vol1/CFR-2002-title40-vol1-part35-subpart320.

CITIZEN ENGAGEMENT AND EDUCATION

Florida Oceanographic Society

Goals:

Engage and educate the public about lagoon restoration.
Provide hands-on stewardship opportunities.

ONE VOICE

COMMUNICATE – COLLABORATE – COORDINATE

Citizen Engagement and Education

GOALS: ***REPORT*** **on needs and progress and educate and engage the public on the need to** ***RESTORE*** **and manage the IRL's natural resources.** ***RESPOND*** **to opportunities to fund and implement "hands on" opportunities for citizen engagement that promote and produce well-informed citizens and communities that become IRL ambassadors for Lagoon-Friendly ™ behaviors.** ***REBUILD*** **community-lagoon connections that promote the identity, well-being, and unique qualities of IRL communities.**

ISSUE SUMMARY: The recent fish mortality events and algal blooms have brought national attention to the IRL and highlighted a need to increase restoration activities. Federal, state, and local agencies charged with management of the lagoon's resources, as well as environmental groups, are working towards restoration, which includes actively seeking to educate and involve the public in the protection and enhancement of the estuary and its resources.

A key event in public involvement and education in the IRL region was the passage of the SWIM Act by the Florida Legislature in 1987. This legislation not only included the IRL in the SWIM program as a priority waterbody of state concern but also mandated a program to involve and educate the public about efforts to protect and restore SWIM waterbodies. The IRL SWIM public involvement and education efforts were coordinated by SJRWMD and SFWMD. In 1991, the IRLNEP was established. As the IRLNEP goals of citizen involvement and education are closely related to those of the SWIM program, IRLNEP joined the IRL SWIM program in their public involvement and education. Following the adoption of the IRL CCMP in 1996, the IRLNEP and IRL SWIM programs were merged to continue the implementation of public involvement and education efforts.

Maintaining and nurturing public interest and involvement in the protection and preservation of the IRL and its resources requires a substantial investment of money, time, and effort. These efforts must continue beyond the initial CCMP development and adoption phase to continue to promote implementation of CCMP actions. Several studies have been completed to evaluate the effectiveness of public education and outreach campaigns in the IRL watershed. One study conducted in the IRL found that physical and virtual field trips both promoted learning about the area.[1] In 2012, Good Education Solutions, under contract with Brevard County and nine of its municipalities, and in partnership with Keep Brevard Beautiful followed by partnership with the Brevard Zoo, created a public education campaign called "Blue Life."[2] The purpose of this campaign is to provide information to the public about sources of pollution and what lifestyle choices people can make to protect and improve water quality. To determine the effectiveness of this educational campaign on behavior changes, Brevard County contracted with Praecipio Economics Finance Statistics to conduct a survey before the campaign implementation in 2012 and after the campaign was in place for two years in 2015. When comparing the results from the 2012 and 2015 surveys, the study unambiguously showed that people in 2015 were better informed about stormwater issues than in 2012, and that behavior that affects water quality in the area has, in general, improved.[3]

In addition to the Blue Life education program, the Be Floridian Now program educates the public along the IRL and is the east coast version of the Be Floridian Program from the Tampa Bay Estuary Program.[4] This program was started in 2015 and focused on matching the right plants to the right places, using water wisely, and reducing or eliminating fertilizers and pesticides. Indian River County, Martin County, St. Lucie County, and Volusia County, as well as the City of Port St. Lucie, City of Stuart, City of Fort Pierce, and Town of Sewell's Point, participate in this program, which is coordinated by MRC.

The IRLNEP also recently launched the Lagoon-Friendly ™ education campaign to promote the "One Lagoon – One Community – One Voice" mission. This campaign promotes actions associated with landscaping, such as determining whether additional fertilizers or pesticides are needed, following package directions and using the proper amounts for the area being treated, spot-treating problem areas with pesticides rather than spreading them over the entire yard, using slow-release fertilizers and less toxic pest controls, using native plants in landscaping, and leaving a five-foot buffer zone around ponds free from fertilizers and pesticides. This campaign also includes actions for good housekeeping, including keeping trash, pet waste, and yard waste out of storm drains; taking waste motor oil, antifreeze, paint, or other hazardous household chemicals to proper collection sites; washing cars in a carwash rather than in a driveway; and repairing cars with oil leaks. In addition, this campaign includes clean boating practices, such as maintaining boat engines to prevent leaking of oils and fuels into the lagoon, keeping trash secured onboard and disposing of it properly on land, operating boats at speeds that protect wildlife and seagrasses and preventing shoreline erosion, and using MSDs properly and designated pump-out facilities instead of dumping untreated wastes overboard.

Engaging citizens in data collection and restoration enhances their understanding of lagoon threats and opportunities for improvement. MRC engages citizens in water quality monitoring. The Florida Institute of Oceanography engages the public in oyster restoration. Brevard County has invested in local not-for-profit organizations to build their capacity for engaging the public in citizen science. This investment includes initiating and funding a diverse array of programs, such as oyster gardening and oyster restoration on projects through Brevard Zoo, rain barrel workshops coordinated by MRC, muck finders training and field data collection guided by FIT and coordinated by MRC, and muck toxicity measurement coordinated by MRC and guided by ORCA. Brevard County continues to look for ways to engage the public in meaningful citizen science coordinated by grass roots, non-profit organizations.

Martin County and UF-IFAS Sea Grant Extension have partnered to implement the Water Ambassador training program. The purpose of this program is to increase awareness and foster behavioral changes related to the reduced use of fertilizer and pesticides. The program provides interested citizens with information on lagoon-friendly practices. Participants learn about Florida's drainage history, the nine principals of Florida Friendly landscaping, estuary friendly living, how/why to reduce stormwater in runoff from the homeowner's property, and the Martin County fertilizer ordinance. The goal of the program is to create Water Ambassadors, who take on the role of educator and activist within the community to help spread information on reducing pollutants in runoff and protecting local waterways.

Local conservation organizations and environmental education facilities are an important part of engaging the public to learn more about the lagoon and to participate in local restoration projects and citizen science. Examples include the Lagoon Academy, "shuck and share" oyster restoration projects, Audubon Advocates for the IRL, and "lagoon watch" citizen science program. Local facilities, such as the Marine Discovery Center in New Smyrna Beach, Brevard Zoo, MRC, Harbor Branch Oceanographic Institute, and Environmental Learning Center, promote environmental education, engage citizens, and promote citizen science.

New and important partners are emerging throughout the IRL region with strong interest in enhancing citizen knowledge, engagement, and behavior change. Recent changes in Florida Statutes in 2018 provided expanded flexibility in how tourist development taxes can be spent. In response, the Brevard County Tourist Development Council announced the availability of up to $900,000 in annual grant funds for projects that demonstrate a benefit to the health of the IRL and a positive impact to Brevard County tourism.

STRATEGIES:

- Educate and engage the public about the challenges that the natural resources in the IRL face and what they can do to *RESTORE* and protect these resources.
- Implement additional surveys to determine which portions of the education campaigns are working and where changes need to be made in the messaging.
- Communicate a clear and unified message for IRL restoration that is compelling, factually accurate, and easy for the public to understand and embrace.

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Communicate-1: Facilitate implementation of the IRL CCMP consistent with "One Lagoon – One Community – One Voice" mission. (NEW)	Fund and implement CCMP citizen science engagement projects.	IRLNEP Management Conference	DEP, FWC, Sea Grant, local governments, interest groups	IRLNEP staff time	IRLNEP	Conduct, coordinate, and collaborate
Communicate-2: Develop and implement an IRLNEP multi-year Communication Plan.	Develop a Communication Plan pursuant to USEPA NEP performance measures.	IRLNEP Management Conference	IRLNEP Management Conference partners	$150,000 per year	USEPA Section 320 funding; local, state, and federal funds; grants; private-sector support	Conduct, coordinate, and collaborate
Communicate-3: Implement public education programs including the "One Community – One Voice" initiative to promote community place-based identities and Lagoon-Friendly ™ behaviors. (NEW)	Develop and apply performance metrics to measure behavior change.	IRLNEP Management Conference	Local governments, interest groups	$50,000 per year	USEPA Section 320 funding; local, state, and federal funds; grants; private-sector support	Conduct, coordinate, and collaborate

OUTCOMES:

- **Short-term (1 – 2 years):** Provide support for existing education campaigns and ensure a clear and consistent message is provided throughout the IRL system. Incorporate the "One Lagoon – One Community – One Voice" mission into the education messaging.
- **Medium-term (3 – 4 years):** Increase public, private, and independent sector participation and involvement in Lagoon-Friendly ™ activities.
- **Long-term (5 – 10+ years):** Lagoon-Friendly ™ practices are consistently applied throughout the IRL watershed.

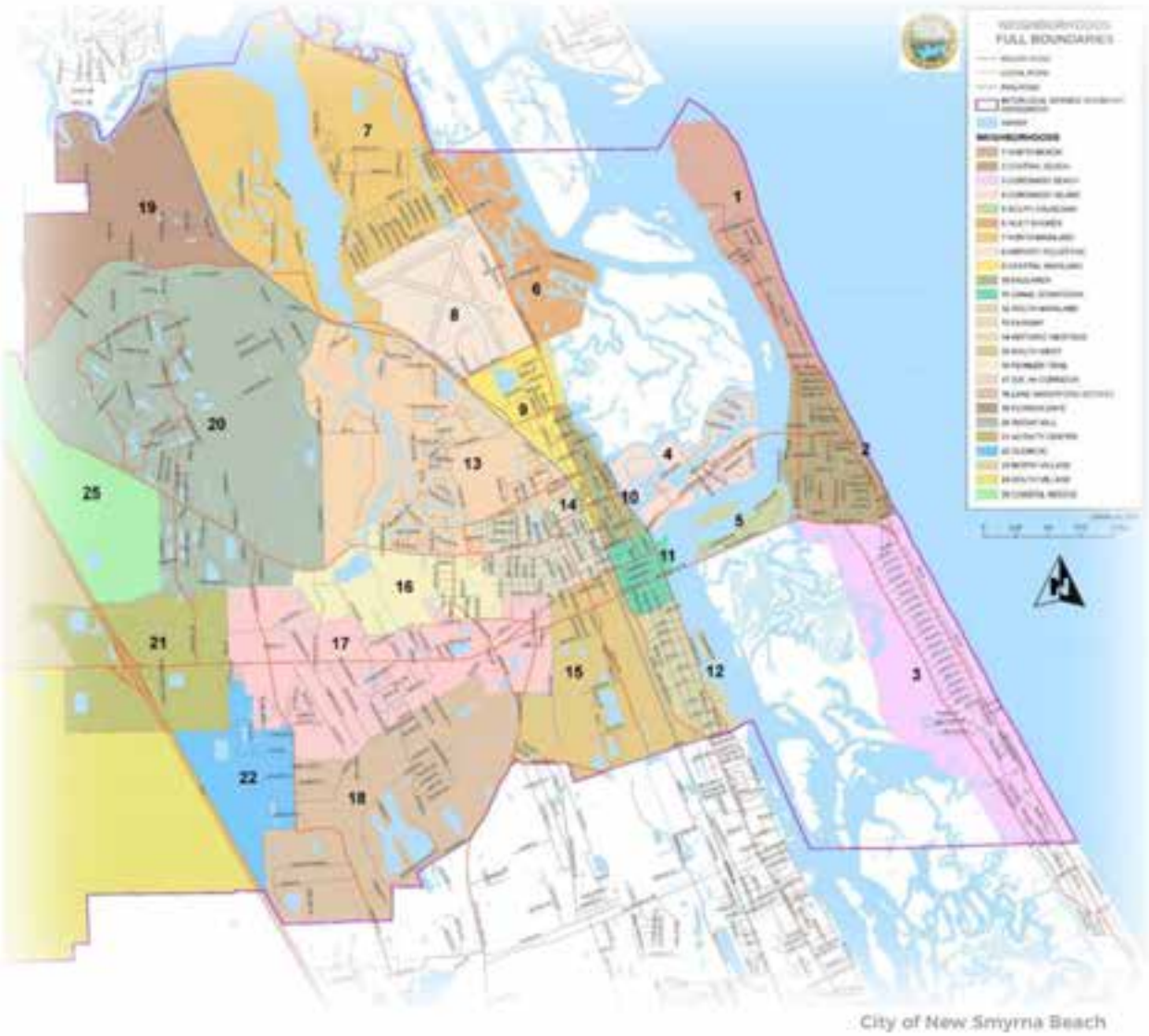
CHALLENGES TO SUCCESS:

- Availability of funds to increase education, outreach, and engagement, and to evaluate existing programs to determine where modifications are needed.
- Delivering information effectively and in a way that will result in behavior changes and measuring those changes.
- Individuals desire for a sod only lawn may prevent them from implementing practices that would help to improve the IRL.

CITATIONS:

1. Garner, L.C. and Gallo, M.A. 2005. Field Trips and their Effect on Student Achievement and Attitudes: A Comparison of Physical Versus Virtual Field Trips to the IRL. Journal of College Science Teaching.
2. Blue Life Florida. 2018. https://brevardzoo.org/conservation-programs/blue-life-florida/.
3. Praecipio Economics Finance Statistics. 2016. The Blue Life Campaign and its Impact on Stormwater-Related Knowledge, Familiarity, Information and Behavior: Evidence from a Survey-Based Analysis of Brevard County Residents (2012 & 2015). Prepared for Brevard County.
4. Be Floridian Now. 2018. http://befloridiannow.org/.

POLICY OPPORTUNITIES



City of New Smyrna Beach

Goals:

Align the CCMP to local comprehensive plans and evaluate state and federal policies to determine opportunities to implement the CCMP.

ONE VOICE

COMMUNICATE – COLLABORATE – COORDINATE

Federal, State, and Local Policy Opportunities

GOALS: Identify opportunities to align the CCMP with local comprehensive plans and land development regulations to more effectively *RESTORE* the IRL. Evaluate state and federal policies that may impact the ability to implement the CCMP actions and coordinate with agencies to determine policy opportunities moving forward. *RESPOND* to policy changes and new policy opportunities. *REPORT* policy best practices and success stories.

ISSUE SUMMARY: While local comprehensive plans[1,2,3,4,5] are critical big-picture blueprints that set the direction for a community's growth, a diverse suite of tools, including land development regulations, guidance manuals, and codes of ordinances, are vital to implementing the broader vision. Enhanced restoration and protection could be achieved by incorporating CCMP actions directly into these existing planning tools. This CCMP revision provides multiple areas in which concrete, actionable guidance could be incorporated into both comprehensive plans and land development regulations. The IRLNEP can work with local governments to (1) prioritize CCMP actions that are suitable for inclusion in local government comprehensive plans, land development regulations, or other guidance documents; (2) identify relevant elements, goals, objectives, and policies in local government regulatory frameworks to serve as the most appropriate vehicle for incorporating CCMP priority actions; and (3) provide model language based on CCMP goals and actions for local government consideration.

At the state and federal level, policy decisions can have profound effects on resource management and restoration decisions, funding appropriations, and inter-agency coordination and cooperation. At the state level, continued implementation, regulatory oversight, and refinement of TMDLs, BMAPs, and water quality/land use regulations is essential for continued statewide water quality restoration. At the federal level, continued reauthorization of the Clean Water Act and the NEP are central to the IRLNEP restoration mission. Reauthorization of the Water Resources Development Act is essential to Everglades and southern IRL restoration. Authorization laws establish, continue, or modify federal programs, and they are often a prerequisite under House and Senate rules (and sometimes under statute) for Congress to appropriate budget authority for programs.

A broad range of state and federal agencies and programs have an impact on the lagoon and will be important to efforts to restore it. USACE and the Florida Inland Navigation District are responsible for maintaining the Atlantic Intracoastal Waterway which stretches the entire length of the IRL. NASA (Kennedy Space Center) is the largest property owner within the watershed, and 140,000 acres of Kennedy Space Center is managed as the Merritt Island National Wildlife Refuge. In addition, there are four other National Wildlife Refuges, Canaveral National Seashore, and seven state parks. USFWS, National Marine Fisheries, and FWC protect listed species. FDOT is responsible for multiple bridges and causeways, which divide the lagoon into segments. State organizations including DEP, FDOH, FDACS, and WMDs are also responsible for programs that affect the lagoon.

STRATEGIES:

- Work with local governments to identify and prioritize actions from the CCMP and incorporate actions into the appropriate elements of local comprehensive plans, land development regulations, codes of ordinances, or other guidance documents.
- Provide model language based on CCMP actions that can be adopted or adapted by local governments in their planning and guidance documents.

- Coordinate with state and federal agencies to retain existing policies that support IRL restoration, revise existing policies to enhance restoration performance, or develop new policies to assist with IRL restoration and stewardship efforts.
- Coordinate federal land and water management plans to seek cooperation between federal, state, and local agencies to promote policies and projects within the CCMP

ACTION PLAN OUTPUTS (DELIVERABLES):

Action	Output Intent	Responsible Lead Agencies or Organizations	Partner Agencies or Organizations	Estimated Cost	Funding Source	IRLNEP Role
Policy Considerations-1: Work with local governments to identify and prioritize CCMP actions and incorporate into local planning regulations and documents. (NEW)	Identify opportunities to align Lagoon-Friendly ™ practices with revised or new local comprehensive plan directives.	5 counties and 38 municipalities	IRLNEP Management Conference	TBD based on extent of revisions	Local governments	Coordinate, collaborate, and conduct
Policy Considerations-2: Evaluate state policies that affect the IRL system and work with state agencies to revise or develop new policies to promote restoration. (NEW)	Identify opportunities to revise or develop new statewide policies to *RESTORE* water quality, *RESTORE* natural habitats, expand ecosystem monitoring, and fund IRL projects.	DEP, FWC, FDACS, FDOT, FDOH	IRLNEP Management Conference	TBD based on extent of revisions	State agencies	Coordinate, collaborate, and conduct
Policy Considerations-3: Evaluate federal policies that affect the IRL system and work with federal agencies to revise or develop new policies to promote restoration. (NEW)	Identify opportunities to revise or develop new federal policies to *RESTORE* water quality, *RESTORE* natural habitats, expand ecosystem monitoring, and fund IRL projects.	USEPA, NOAA, Department of Defense, NASA	IRLNEP Management Conference	TBD based on extent of revisions	Federal agencies	Coordinate, collaborate, and conduct

OUTCOMES:

- **Short-term (1 – 2 years):** Identify CCMP actions that are most appropriate for each local government to include in their local planning regulations. Evaluate existing state and federal policies that affect restoration and determine where revisions or new policies are needed.
- **Medium-term (3 – 4 years):** Begin to incorporate CCMP actions into local government planning regulations. Coordinate with state and federal agencies to incorporate revisions to existing policies and to develop new policies, where needed.
- **Long-term (5 – 10+ years):** Incorporation of CCMP actions into local, state, and federal planning efforts to improve restoration success.

CHALLENGES TO SUCCESS:

- Local regulations from five counties and 38 municipalities may need to be modified to include CCMP actions, which requires coordination with numerous boards and councils.
- Support will be needed from local representatives to modify local, state, and federal policies, and changing these policies can be time consuming and difficult.

CITATIONS:

1. Brevard County Comprehensive Plan. http://www.brevardfl.gov/PlanningDev/CompPlan.
2. Indian River County Comprehensive Plan. http://www.irccdd.com/planning_division/Comp_Plan.htm.
3. Martin County Comprehensive Plan. https://www.martin.fl.us/government/departments/growth-management-department/comprehensive-planning.
4. St. Lucie County Comprehensive Plan. http://www.stlucieco.gov/departments-services/a-z/planning-and-development-services/planning/comprehensive-planning.
5. Volusia County Comprehensive Plan. https://www.volusia.org/services/growth-and-resource-management/planning-and-development/long-range-planning/comprehensive-plan.stml.

APPENDIX A. CCMP CHANGES 2008-2018

2008 CCMP Update			2018 CCMP Revision		
Issue	**Goal**	**Action**	**Issue**	**Goal**	**Action**
Point Source Discharges (PS)	To ensure compliance with the Indian River Lagoon Act and to reduce, eliminate or mitigate industrial wastewater discharges to the Indian River Lagoon.	PS-1: Ensure Compliance with the Indian River Lagoon Act (Chapter 90-262, Laws of Florida, 1990)	Wastewater	Improve municipal and industrial wastewater infrastructure throughout the IRL watershed to achieve AWT standards to REDUCE or REMOVE loads of human and industrial pollutants to the IRL. REDUCE vulnerability to WWTP overflows to the IRL. Expand WWTP capacity to accommodate septic to sewer conversions and the region's growing human population.	Wastewater-1: Ensure compliance with the IRL Act (Chapter 90-262, Laws of Florida, 1990).
		PS-2: Ensure that any proposed changes or exceptions from the Indian River Lagoon Act are consistent with the original intent and purpose of the Act and will not reduce they effectiveness of the Act.			
		PS-3: Reduce or eliminate industrial discharges to the IRL.			Wastewater-2: REDUCE or REMOVE all wastewater discharges to the IRL (including direct, indirect, and emergency loadings of nutrients and other pollutants).
		PS-4: Investigate and recommend funding alternatives for the upgrading of WWTPs.			Wastewater-3: RESEARCH, identify, and recommend funding sources and alternatives for upgrading WWTP infrastructure and to REDUCE or REMOVE domestic and industrial effluents.
		PS-5: Investigate and promote alternatives to deep well disposal of domestic and industrial effluents.			
On-Site Sewage Disposal Systems (OSDS)	Determine the impacts of OSDS on the resources of the Indian River Lagoon and to develop and implement strategies to address these impacts.	OSDS-2: Develop and Implement an OSDS inspection program within the six lagoon counties.			Wastewater-5: Develop and implement an OSTDS inspection program and education program within the five IRLNEP counties.
		OSDS-3: Undertake further studies of the OSDSs in the region to quantify the impacts of OSDSs on the IRL and to further quantify the extent of the "problem" and "potential problem" areas.			Wastewater-6: Undertake further studies to quantify the impacts of OSTDS on the IRL with a focus on identifying high priority "problem" and "potential problem" areas.
		OSDS-4: Promote the connection of areas served by OSTDS to central sewer service or, where connection to central sewer is not feasible, promote the development and use of alternative or advanced OSTDS technologies offering improved treatment in areas identified in the IRL SWIM studies as "problem" or "potential problem" for OSTDS. Identify and publicize potential funding sources that could be used to connect areas served by OSTDS to central sewer or support the development and use of alternative or advanced OSTDS technologies.			Wastewater-4: Promote the connection of areas served by OSTDS to central sewer or, where connection is not feasible, use of nutrient removing systems in areas identified as "problem" or "potential problem."

2008 CCMP Update			2018 CCMP Revision		
Issue	**Goal**	**Action**	**Issue**	**Goal**	**Action**
Freshwater and Stormwater Discharges (FSD)	To develop and implement strategies to address the impacts of freshwater and stormwater discharges on the resources of the Indian River Lagoon.	FSD-1: Complete or continue the diagnostic, management or pilot projects related to stormwater or freshwater discharges being planned or undertaken by federal, state, regional and local governments.	Stormwater	REDUCE unnatural fresh and surface water discharges to the IRL from both large stormwater conveyances and dispersed urban and residential sources. RESTORE water quality in the IRL system. Conduct RESEARCH to better understand natural hydroperiods of the IRL watershed.	Stormwater-1: Design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL. **(NEW)**
		FSD-2: Continue implementation of the NPDES nonpoint source (stormwater) permitting program throughout the Indian River Lagoon region.			
		FSD-3: Develop, implement and update pollutant load reduction goals (PLRGs) for all areas of the Indian River Lagoon.			
		FSD-4: Develop and implement best management practices (BMPs) for the management of stormwater, agricultural and fresh water discharges.			Stormwater-2: Develop, improve, and implement BMPs and education programs for stormwater management and freshwater discharges for urban, agriculture, and dispersed residential landscapes.
		FSD-5: Update and enhance comprehensive drainage maps of the Indian River Lagoon basin.			Stormwater-3: Update and maintain comprehensive drainage maps of the IRL watershed.
		FSD-6: Reduce the impacts of muck on the Indian River Lagoon.			
		FSD-7: Amend local government comprehensive growth management plans and land development regulations to incorporate the goals, objectives and actions found in the IRL CCMP.			
		FSD-9: Strengthen existing stormwater or freshwater discharge management programs.			
		FSD-10: Encourage the proper use of fertilizers, herbicides, pesticides and reuse water.			
		FSD-11: Educate residents and property owners about the impacts of freshwater and stormwater discharges on the Indian River Lagoon and what they can do to reduce these impacts.			Stormwater-4: Continue reviews of reclamation plans for water control districts and the standard operating procedures and project works of each large drainage system.

2008 CCMP Update			2018 CCMP Revision		
Issue	**Goal**	**Action**	**Issue**	**Goal**	**Action**
		FSD-12: Continue reviews of plans of reclamation for water control districts and the standard operating procedures and project works of each large drainage system and agricultural drainage system. Develop and implement strategies to reduce discharges and pollutant loadings to the Indian River Lagoon from these sources.			Stormwater-5: Upgrade existing urban and agricultural stormwater infrastructure networks to REDUCE freshwater discharges, nutrient loads, and other pollutant loads to the IRL.
		FSD-13: Upgrade existing urban and agricultural stormwater systems to reduce pollutant loadings to the Indian River Lagoon.			
		FSD-14: Develop and implement appropriate mechanisms to fund and undertake the operation, maintenance and improvement of urban and agricultural stormwater management systems to reduce pollutant loadings.			
Marina and Boat Impacts (MB)	To reduce impacts to the Indian River Lagoon from boating activities and to engage the boating public and marine industries as active participants in the protection and restoration of Indian River Lagoon resources.	MB-1: Implement the Clean Marina Program throughout the Indian River Lagoon.	Marinas and Boating	Reduce impacts from marina and boating activities. Educate boating population to take responsibility and be Lagoon-Friendly™. Update and re-publish the highly acclaimed IRLNEP *Boaters Guide to the Indian River Lagoon* to focus on boater waste management, safe boating practices, lagoon community boat ramps and recreational destinations, safe boating practices, and emergency call contacts.	
		MB-2: Implement boat facility siting plans and update these plans as new data and information are available.			
		MB-3: Prevent pollutant spills and discharges and protect the resources of the Indian River Lagoon from the impacts of any spills or discharges.			
		MB-5: Provide educational materials and programs, such as the Clean Boater Program and boater's guides, to owners and operators of boats and personal watercraft.			MB-5 combined with MB-6 in current Boating-2
		MB-6: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the Indian River Lagoon.			Boating-2: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the IRL and develop and distribute targeted public education and outreach products to reduce impacts.
		MB-7: Eliminate the impacts of waste discharges and marine sanitation devices on the public health and Indian River Lagoon resources.			Boating-1: Eliminate waste discharges and MSD impacts on the public health and IRL resources.

2008 CCMP Update			2018 CCMP Revision		
Issue	**Goal**	**Action**	**Issue**	**Goal**	**Action**
		MB-8: Monitor boating impacts to Indian River Lagoon natural resources. Where appropriate, establish resource protection zones and monitor their effectiveness.			Boating-3: Update and distribute the *Boaters Guide to the Indian River Lagoon*. **(NEW)**
Atmospheric Deposition of Pollution (AD)	To determine the impacts of atmospheric deposition of pollutants on the resources of the Indian River Lagoon and to develop and implement strategies to address these impacts.	AD-1: Determine the impacts of atmospheric deposition of pollutants on the water quality and resources of the Indian River Lagoon.	Atmospheric Deposition	Monitor and conduct RESEARCH on atmospheric deposition of nutrients and pollutants. Develop and implement strategies to REDUCE, REMOVE, and RESPOND to these impacts.	Atmospheric Deposition-1: Determine the impacts of atmospheric deposition of nutrients and other pollutants on the nutrient budget, water quality, and resources of the IRL.
					Atmospheric Deposition-2: Evaluate need for additional wet and dry atmospheric monitoring stations. **(NEW)**
Total Maximum Daily Loads (TMDLs)	Full implementation of basin management action plans (BMAPs) to meet total maximum daily loads (TMDLs) developed for the Indian River Lagoon.	TMDL-1: Develop, implement, and update TMDLs for all areas of the Indian River Lagoon.	Impaired Waters (Including TMDLs, BMAPs, and RAPs)	REMOVE or REDUCE anthropogenic pollutant and nutrient loading to the IRL watershed toby meeting the regulatory targets established by TMDLs, BMAPs, and/or RAPs; achieving the intended biological response criteria; and achieving applicable water quality criteria to removing the waterbody from the Impaired Waters designation list.	Impaired Waters-1: Support implementation, review, and update of IRL TMDLs as needed and as best available science evolves.
		TMDL-2: Coordinate development and implementation of BMAPs with Florida Department of Environmental Protection.			Impaired Waters-2: Work with BMAP partners and DEP to support implementation of BMAPs and track progress, compliance, and implementation challenges.
		TMDL-3: Support implementation of Basin Management Action Plans (BMAPs) for all basins requiring TMDLs.			Impaired Waters-3: Support the partners and DEP in the development, adoption, and implementation of the Mosquito Lagoon and Loxahatchee River RAPs. **(NEW)**
					Impaired Waters-4: Evaluate opportunities to incentivize, monetize, and expedite nutrient reduction policies and actions including water quality credit trading. **(NEW)**
Biodiversity (BD)	Develop and implement a coordinated scientific conservation and management strategy to preserve, protect and restore biodiversity in the Indian River Lagoon.	BD-1: Coordinate biodiversity activities within the Indian River Lagoon region.	Biodiversity	Conduct comprehensive biodiversity RESEARCH to develop a long-term management strategy to RESTORE, REBUILD, and protect the biological diversity of the IRL.	Biodiversity-3: Integrate biodiversity considerations in habitat restoration and planning activities.
		BD-2: Acquire and effectively manage environmentally sensitive lands as a tool to preserve, protect and restore the biological diversity, functional integrity and productivity of the Indian River Lagoon region.			Biodiversity-1: Acquire and effectively manage the IRL network of conservation lands and wetlands as a tool to preserve, protect, and restore the biological diversity, functional integrity, and productivity.
		BD-4: Create and maintain a species inventory for the Indian River Lagoon.			Biodiversity-2: Work to continue, expand, update, and improve the IRL species inventory.
Seagrass Protection, Restoration And Management (SG)	To protect and restore seagrass integrity and functionality in the Indian River Lagoon by reducing anthropogenic impacts and	SG-1: Implement a program of protection, restoration and management activities needed to maintain, protect and restore the seagrass/SAV community of the Indian River Lagoon.	Seagrasses	Implement a comprehensive, coordinated, and integrated IRL strategy to REMOVE stressors to seagrasses in the IRL and RESTORE seagrass habitats to support and sustain healthy	Seagrass-1: Implement a program of protection, restoration, and management activities.

2008 CCMP Update			2018 CCMP Revision		
Issue	**Goal**	**Action**	**Issue**	**Goal**	**Action**
	attaining and maintaining water quality capable of supporting a healthy, productive and sustainable submerged aquatic vegetation community meeting the seagrass coverage and depth targets developed by the water management districts for the Indian River Lagoon.			water quality and seagrass dependent species.	Seagrass-2: Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide. **(NEW)**
					Seagrass-3: Fund innovative pilot projects and partnerships. **(NEW)**
					Seagrass-4: Develop a Habitat Restoration Plan for the IRL system. **(NEW)**
Wetlands (W)	Preserve, protect, restore and enhance the wetland resources of the Indian River Lagoon region.	W-1: Implement programs that protect the ecological services of wetlands.	Wetlands and Impounded and Altered Marshes	RESTORE and protect wetlands, wetland-upland transitions, and impounded or altered marshes throughout the IRL watershed. RESPOND to opportunities to refine wetland management strategies to support IRL biodiversity and coastal RESILIENCE. Conduct RESEARCH and RESPOND to future wetland management challenges associated with sea level rise.	
		W-2: Regular review and updating of wetlands protection rules and regulations.			
		W-3: Establish or enhance wetland or shoreline setback buffers.			Wetlands-2: Establish or enhance wetland or shoreline setback buffers.
		W-4: Implement innovative programs and incentives supporting wetlands protection and management on privately owned lands. When necessary, acquire ownership or control of crucial wetlands.			Wetlands-3: Implement innovative programs and incentives supporting wetlands protection and management on privately-owned lands and marshes managed by private, non-profit organizations. When necessary, acquire ownership or control of crucial wetlands.
		W-5: Continue the restoration and rehabilitation of impacted or impounded coastal wetlands.			
		W-6: Continue projects and programs to restore shorelines.			Wetlands-4: Continue projects and programs to restore shorelines with a focus on enhancing and managing mosquito impoundment dikes with living shoreline restoration.
		W-7: Promote the removal of trash and litter from wetlands, shorelines and islands.			
		W-8: Undertake research to develop new and improved wetland management best management practices (BMPs).			Wetlands-1: RESEARCH and develop new and improved wetland BMPs with a focus on understanding wetland responses to sea level rise and climate change.
Land Acquisition And Protection (LA)	Develop and implement a coordinated strategy to protect environmentally endangered habitats within	LA-1: Continue coordination of efforts to identify, classify, acquire and manage environmentally sensitive lands throughout the Indian River Lagoon region.	Land Conservation	Promote conservation of land through acquisition and other forms of stewardship. Pursue strategic land acquisition initiatives that will REDUCE freshwater, sediment,	Land-1: Continue coordination of efforts to identify, classify, acquire, and manage environmentally sensitive lands.

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	the Indian River Lagoon basin through acquisition.			nutrient, and pollutant loads to the IRL and REBUILD natural land-water connections to provide both water quality improvement, provide flood prevention, and RESTORE natural hydroperiods.	Land-3: Support public acquisition of environmentally sensitive lands that are deemed essential for long-term protection and management of IRL resources, CCMP implementation, and stormwater projects. **(NEW)**
		LA-3: Support continuation and expansion of state funding initiatives for long-term acquisition programs for conservation lands.			Land-2: Support recurring funding of the Land Acquisition Trust Fund and other funding sources.
		LA-4: Develop and implement incentives to promote conservation of privately owned environmentally sensitive lands.			Land-4: Develop and implement incentives to promote conservation of privately-owned environmentally sensitive lands and provision of cost-effective dispersed water management projects.
		LA-5: Promote the acquisition of lands for public access to the Indian River Lagoon.			Land-5: Promote acquisition of lands for public access to the IRL.
Endangered and Threatened Species (ETS)	Protect endangered and threatened species found in the Indian River Lagoon region.	ETS-1: Develop, implement, update or refine adaptive management or recovery plans for the endangered, threatened and species of special concern found in the Indian River Lagoon region.	Species of Concern	Conduct and/or continue RESEARCH to evaluate status and population trends of IRL species of concern. REMOVE and/or REDUCE stressors and threats to species of concern. RESPOND to opportunities for species-specific management action that will RESTORE sustainable levels for populations of species of concern.	Species of Concern-2: Align the CCMP with adaptive management or recovery plans for species of concern.
		EYS-2: Improve enforcement of regulations protecting endangered, threatened or species of special concern in the Indian River Lagoon region.			Species of Concern-3: Improve enforcement of regulations for species of concern found in the IRL region.
		ETS-3: Protect and manage the critical habitats of endangered, threatened or species of special concern found within the Indian River Lagoon region through land acquisition and other land protection measures.			Species of Concern-4: Protect and manage natural habitats that support species of concern found within the IRL region.
		ETS-5: Encourage private land owners to manage lands for endangered species, threatened species, and species of special concern found within the Indian River Lagoon region.			
		ETS-6: Identify endangered, threatened and species of special concern distribution and critical habitats throughout the Indian River Lagoon.			Species of Concern-1: Identify IRL species of concern and track recovery progress status and population trends.

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Fisheries (F)	Conserve, protect, and restore the fin and shellfish resources of the Indian River Lagoon.	F-1: Conserve, protect, restore and manage the finfish and shellfish resources in the Indian River Lagoon region.	Commercial and Recreational Fisheries	Conduct fisheries RESEARCH to help REBUILD IRL commercial and recreational fisheries. RESTORE IRL fish populations to support world-class recreational fishing and sustainable commercial harvest.	Fisheries-1: Conserve, protect, RESTORE, and manage the commercial and recreational finfish and shellfish resources in the IRL region to support a sustainable harvest.
		F-3: Support and expand research initiatives and coordinated finfish and shellfish management strategies specific to the Indian River Lagoon.			Fisheries-2: Continue to support and expand research initiatives and coordinated finfish and shellfish management strategies specific to the IRL.
		F-4: Identify, inventory and assess finfish and shellfish habitats within the Indian River Lagoon and implement appropriate management and restoration strategies.			Fisheries-4: Identify, inventory, and assess finfish breeding and important habitats within the IRL.
					Fisheries-3: Improve effectiveness of fish habitat conservation and restoration efforts by identifying and characterizing critical spawning, nursery, and forage areas within the IRL and its tributaries. **(NEW)**
Biotoxins and Aquatic Animal Health (BAH)	Improve knowledge of biotoxin and aquatic animal health issues to protect public health and the resources of the Indian River Lagoon.	BAH-1: Implement a lagoon-wide, multi-species, multi-disciplinary approach to determine the status of emerging infectious diseases in the Indian River Lagoon, assess trends and identify underlying causes.	Harmful Algal Blooms (HABs)	Advance RESEARCH, coordination, and understanding of the causes of HABs to REDUCE their frequency, intensity, and duration. Effectively and efficiently RESPOND to HAB emergence and secondary impacts including toxicity in some species, low dissolved oxygen concentrations as blooms decline, and associated fish and wildlife morbidity and mortality events. Improve scientific understanding of toxic algal blooms and human health risks. REPORT IRL algal bloom status and trends.	HAB-1: Support continuation of the IRL 2011 Consortium, which would function as a formal task force supported by the IRLNEP and which would develop a HAB Research and Restoration Response Plan. **(NEW)**
		BAH-2: Continue support of the Biotoxin and Aquatic Animal Health Working Group and the goals of this working group.			HAB-2: Seek partnerships and funding to pursue research priorities identified by the IRL 2011 Consortium that align with IRLNEP Management Conference management priorities. **(NEW)**
		BAH-3: Complete or continue the projects identified in the Preliminary Strategic Plan for Algal Toxins and Aquatic Animal Health in the Indian River Lagoon.			HAB-3: Continue funding and scientific partnerships to understand HABs toxicity and risks to human and wildlife health. (NEW)
Climate Change (CC)	Support and implement policies and strategies developed to address impacts resulting from climate change in the Indian River Lagoon.	CC-1: Track state, national and international actions and research concerning climate change issues that affect the Indian River Lagoon.	Climate Ready Estuary	RESEARCH IRL risk-based vulnerabilities to climate change and sea level rise to make informed adaptation planning decisions. RESPOND to threats and opportunities. Make management decisions that improve IRL RESILIENCE to storm events and long-term risks. REPORT findings and scientific advancements to partners in	Climate Ready Estuary-1: Prepare a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL. **(NEW)**
		CC-2: Support Indian River Lagoon-based research that considers and integrates global climate change issues and seeks practical scientific, technological and public policy solutions.			Climate Ready Estuary-2: Identify opportunities to integrate infrastructure resilience into community planning. **(NEW)**

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		CC-3: Provide information to local governments and residents of the Indian River Lagoon region about impacts of climate change and actions they can take to reduce these impacts.		the IRLNEP Management Conference and communities.	
Invasive Fauna and Flora (IFF)	Identify, control or eradicate invasive, non-native fauna and flora in the Indian River Lagoon.	IFF-1: Support the inventory and assessment of non-native invasive fauna and flora within the Indian River Lagoon basin.	Invasive Species	REMOVE invasive species from the IRL, its contributing waters, and its watershed. Conduct RESEARCH to improve management and understanding of invasive species in the IRL watershed to help RESTORE native habitats and communities. Be prepared to RESPOND quickly to eradicate newly introduced invasive species.	Invasive Species-1 Support the inventory and assessment of invasive fauna and flora within the IRL watershed.
		IFF-2: Support development and implementation of management plans for eradication or control of non-native invasive plants and animals found in the Indian River Lagoon region.			
		IFF-3: Coordinate the formation of "Rapid Assessment" teams to assess the extent of recently discovered invasions and provide recommendations for management or eradication.			IFF-3 and IFF-4 combined into Invasive Species-2
		IFF-4: Engage residents in management and eradication of exotic invasive species by providing standardized information to residents of the Indian River Lagoon region about non-native invasive plants and animals and their management and eradication.			Invasive Species-2: Provide standardized information to IRL partners about invasive species and their eradication and management. Prepare an early detection and response plan.
Public Involvement and Education (PIE)	Facilitate implementation of the Indian River Lagoon (IRL) Comprehensive Conservation and Management Plan (CCMP) through public involvement and education.	PIE-1: Facilitate implementation of the Indian River Lagoon (IRL) Comprehensive Conservation and Management Plan (CCMP) through public involvement and education.	Citizen Engagement and Education	Report on needs and progress, and educate, and engage the public on the need to Restore and manage the IRL's natural resources. RESPOND to opportunities to fund and implement "hands on" opportunities for citizen engagement that promote and produce well-informed citizens and communities that become IRL ambassadors for Lagoon-Friendly ™ behaviors. REBUILD community-lagoon connections that promote the identity, well-being, and unique qualities of IRL communities.	Communicate-1: Facilitate implementation of the IRL CCMP consistent with "One Lagoon – One Community – One Voice" mission. (NEW)
		PIE-2: Develop, implement and refine a communications plan to inform stakeholders and government officials about the resources of the Indian River Lagoon, the economic and ecological value of these resources and threats to the continued viability of these resources			Communicate-2: Develop and implement an IRLNEP multi-year Communication Plan.
		PIE-4: Increase public and governmental involvement in activities designed to protect and restore the resources of the Indian River Lagoon.			

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		PIE-5: Strategically prioritize and implement public education programs based on pollution potential, perceived likelihood for behavior change, resource availability, and opportunities that arise.			Communicate-3: Implement public education programs including the "One Community - One Voice" initiative to promote community place-based identities and Lagoon-Friendly™ behaviors. (NEW)
IRL CCMP Implementation (FI)	Establish a modified management structure that will oversee the implementation of the Indian River Lagoon Comprehensive Conservation and Management Plan (IRL CCMP) and provide for an organization to support its activities	FI-1: Continue the Indian River Lagoon Advisory Board's role of oversight, monitoring, and guidance of implementation of the IRL CCMP.	CCMP Implementation and Financing	IRL communities, partners, and citizens work in cooperation to align their individual and collective interests and actions to take RESPONSIBILITY to achieve the "One Lagoon – One Community – One Voice" Mission. Identify, fund, and implement CCMP projects and actions to RESTORE the IRL. Align CCMP activities to provide enhanced Resilience for the IRL and its human communities.	Implementation-1: Develop a finance plan for CCMP development and implementation, project and program funding, and program delivery with a focus on restoration, scientific research, monitoring, and citizen engagement. (NEW)
		FI-2: Continue measurement of progress of CCMP implementation activities.			
Data And Information Management Strategy (DIM)	Develop and implement a strategy to coordinate the management and dissemination of data and information concerning the Indian River Lagoon	DIM-1: Continue projects and strategies related to data and information management.	Monitoring and Data Sharing	Coordinate IRL monitoring, data sharing, and mapping throughout the IRL and its watershed. RESPOND to gaps in monitoring and data collection and the need to evaluate trends and changes. REPORT the shared findings from the IRL monitoring network to inform IRL partners and stakeholders about status and trends related to the health of the IRL.	Monitoring 1: Develop a comprehensive IRL monitoring plan. **(NEW)**
					Monitoring-2: Monitor IRL indicators at appropriate spatial and temporal scales to understand the status and trends associated with key indicators of the system's health. **(NEW)**
		DIM-3: Improve public access to published research and reports specific to the Indian River Lagoon.			Monitoring-4: Identify, develop, and apply next-generation smart sensors, remote sensing technologies, big data analytics, and surveillance components to monitor and deliver an IRL water quality dashboard in real time. **(NEW)**
		DIM-4: Ensure appropriate water quality and benthic data and information concerning the Indian River Lagoon is entered into and available through the storage and retrieval (STORET) system or its successor.			Monitoring-5: Advance the 10 scientific research priorities identified by the STEMAC in the 2018 *Looking Ahead – Science 2030 Report.* Work with IRL partners to seek funding to implement priority research projects within the 10 priorities. **(NEW)**
Monitoring (MON)	To develop and maintain a monitoring network which will provide adequate and reliable data and information on water quality, sediment quality and the biological resources	MON-1: Continue projects related to monitoring the resources of the Indian River Lagoon and address gaps in data as needed.			
		MON-2: Continue the Citizens Water Quality Monitoring Program.			Montioring-3: Support expansion of and adequate funding for the IRL Citizens Water Quality Monitoring Program.

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	of the Indian River Lagoon to support mapping, modeling and management decisions.	MON-3: Provide support for the development of a triennial report on the state of the Indian River Lagoon.	State of the Lagoon	Collect, synthesize, and analyze IRL data and RESEARCH findings to develop a "State of the Lagoon Technical Report" that addresses the health of the IRL, ecosystem stressors, indicators, and trends. REPORT the findings. Apply the findings to advise CCMP updates and revisions.	State of the IRL-1: Provide support for a "State of the Lagoon Technical Report" to be released every ten years. **(NEW)**
Indian River Lagoon Scientific Research (SR)	Development of a scientific research vision and implementation strategy for the Indian River Lagoon	SR-1: Create an Indian River Lagoon Science and Management Working Group charged with the development and implementation of a scientific research vision and implementation strategy for the Indian River Lagoon. This strategy should be consistent with and complimentary to statewide research strategies identified by the Florida Coastal and Ocean Resources Council and national coastal priorities.	Technology Innovation	RESEARCH innovative technologies and emergence of commercial opportunities that will assist with restoration and stewardship of the IRL. REPORT findings. RESPOND to industry needs and desires to communicate more effectively with IRL partners. Work with industry and economic development partners to position Florida and the IRL region as a leader in clean water innovation, research, and technology development.	Technology Innovation-1: Work with IRLNEP IRLI[2], industry leaders, economic development organizations, and startup incubators/accelerators to help drive IRL regional economic, technology, and talent development. **(NEW)**
		SR-2: Include the value of scientific research in any studies of the Indian River Lagoon regional economy.			Technology Innovation-2: Continue to support and develop a water technology directory for the www.onelagoon.org website. **(NEW)**
		SR-3: Expand and diversify funding for scientific research in the Indian River Lagoon.			Technology Innovation-3: Evaluate options for a regular, sustainable, and cost-effective water quality monitoring network using autonomous sampling. **(NEW)**
Environmental Incident Assessment And Response (EIAR)	Rapid assessment of and response to significant environmental incidents that may affect the resources of the Indian River Lagoon.	EIAR-1: Inventory existing rapid assessment and response programs within the Indian River Lagoon region and identify classes of incidents not addressed by these programs.	Emergency Preparation and Response	Identify the role of the IRLNEP during emergencies that impact the IRL and its communities. Develop coordinated plans with IRLNEP Management Conference partners and responsible local, state, and federal entities to prepare, Respond, and Recover after an emergency in the IRL watershed.	Emergency-1: Evaluate the role and ability of the IRLNEP to assist local communities and emergency management agencies in times of emergencies that impact the IRL. **(NEW)**
		EIAR-2: Create and maintain an inventory of support services and equipment available within the Indian River Lagoon region.			
		EIAR-3: Develop assessment and response strategies and protocols for significant environmental incidents not addressed by existing programs.			
Economic Analysis (EA)		EA-1: Undertake an analysis of the economic benefits of the Indian River Lagoon to the economy of the region on a recurring basis.	Vibrant 21st Century Communities	Update RESEARCH on IRL economic value and trends, at least every five years or as needed, in response to abrupt economic changes, threats, and opportunities. REBUILD human-built	Vibrant Communities-1: Work closely with the business community and industry clusters along the IRL to ensure effective cooperation and communication associated with CCMP implementation. **(NEW)**

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				infrastructure along the IRL to be more Lagoon-Friendly ™, more sustainable, and more resilient. RESPOND to 21st Century changing environmental, economic, and societal needs, challenges, and opportunities. REPORT regularly to the IRL regional business and economic development community to ensure that CCMP implementation advances the "One Lagoon – One Community – One Voice" Mission.	Vibrant Communities-2: Update the IRL economic analysis produced by the Treasure Coast and East Central Florida Regional Planning Councils every five years. **(NEW)**
					Vibrant Communities-3: Promote lagoon-related nature and heritage tourism development for residents and visitors. **(NEW)**
					Vibrant Communities-4: Conduct community planning workshops to plan for Vibrant 21st Century communities. **(NEW)**
			Hydrology and Hydrodynamics	Conduct RESEARCH to improve understanding of the IRL watershed, groundwater, and hydrology and hydrodynamics to improve decision-making for management of land use impacts to water and reduction of loads of nutrients and other contaminants.	Hydrology-1: Support advancements in hydrological model development, verification, and application. **(NEW)**
					Hydrology-2: Apply the best available models to better evaluate connectivity between IRL sub-basins. Reduce negative impacts of road corridors and causeways. **(NEW)**
					Hydrology-3: Continue evaluation of options to enhance water flow through engineering solutions that have well defined water quality and ecological outcomes. **(NEW)**
			Legacy Loads and Healthy Sediments	REMOVE and/or REDUCE muck in the IRL to REDUCE the legacy load of nutrients and contaminants and improve water clarity. RESTORE healthy natural sediments to support seagrasses and associated communities, shellfish, and healthy benthic communities.	Legacy Loads-1: Complete muck mapping of the entire IRL, prioritize muck dredging projects and site selection for seagrass and filter feeder restoration projects, and REDUCE source contributions of sediment and biomass that result in muck formation. **(NEW)**
					Legacy Loads-2: Continue to couple scientific evaluation and assessment of muck dredging projects to evaluate and optimize the dredging process. **(NEW)**
					Legacy Loads-3: Track emerging technologies, innovative approaches or alternatives to dredging, muck capping, upstream controls of muck transport, more efficient approaches to dewatering, enhanced pollutant removal in post-dredge water, and enhanced muck management to improve process efficiency, reduce costs, and identify beneficial uses of muck residuals. **(NEW)**

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			Contaminants of Concern	Conduct RESEARCH to identify sources and loads of known contaminants and contaminants of emerging concern to better understand potential ecological, wildlife, and human health risks. Identify mechanisms to REDUCE or REMOVE these contaminants from the system. REPORT findings and RESPOND to protect human health and wildlife. Identify and remediate contaminated sites.	Contaminants of Concern-1: Monitor and research to better understand contaminants of emerging concern within the IRL system. **(NEW)**
					Contaminants of Concern-2: Implement actions to REMOVE or REDUCE contaminant loads to the IRL system. **(NEW)**
			Filter Feeders	Conduct RESEARCH to better understand stressors and root causes for the decline of filter feeders in the IRL. RESTORE selected bivalve populations, with a focus on restoring oyster and clam populations to support and sustain both habitat conservation and sustainable commercial harvests.	Filter Feeders-1: RESEARCH spatially explicit data on the extent and condition of existing filter feeder habitat. **(NEW)**
					Filter Feeders-2: REPORT spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat, incorporated into maps and online platforms. **(NEW)**
					Filter Feeders-3: Develop a filter feeder management plan working with public, private and independent sector partners. **(NEW)**
			Living Shorelines	Conduct RESEARCH to identify key locations along the IRL and tributaries that would benefit from living shorelines. RESTORE natural shorelines. REBUILD both natural and hardened shorelines that have been impacted by erosion or storm surge. Incorporate living components into armored shorelines where a hybrid solution is feasible and amenable to the owner. REPORT the performance, value, and cost-benefit of living shorelines as natural infrastructure that decreases storm surge vulnerability and contributes to coastal RESILIENCE.	Living Shorelines-1: RESEARCH and REPORT science-based siting, planning, design, and construction criteria. **(NEW)**
					Living Shorelines-2: Develop standardized metrics and protocols for living shoreline projects. **(NEW)**
					Living Shorelines-3: RESEARCH and REPORT on living shoreline information. **(NEW)**
					Living Shorelines-4: Streamline permitting for living shoreline projects. **(NEW)**
					Living Shorelines-5: Incorporate living shoreline guidance into local comprehensive plans. **(NEW)**
			Spoil Islands	Update and revise the IRL Spoil Islands Management Plan for the IRL with a focus on maintenance, habitat	Spoil Islands-1: Create a central electronic repository for spoil island maps, documents, sources. **(NEW)**

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				restoration and enhancement of islands, IRL water quality improvements, and provision of public access based on the best available science and sound habitat management principles.	Spoil Islands-2: Update the IRL Spoil Management Plan and implement identified projects. **(NEW)**
			Connected Waters and Watersheds	Conduct and share RESEARCH to improve understanding and management of waters that influence the IRL region. RESTORE natural connections and water flow to reduce freshwater discharges to the IRL. REPORT regularly to IRLNEP partners working in connected and adjacent waters and watersheds. RESPOND to opportunities for shared projects and potential threats.	Connected Waters-1: Incorporate the IRL-Halifax Planning Boundary area into all IRLNEP discussions, CCMP action plans, and CCMP implementation activities. **(NEW)**
					Connected Waters-2: Support expanded and accelerated funding for Everglades restoration. **(NEW)**
					Connected Waters-3: Support expanded and accelerated funding to restore the St. Johns River. **(NEW)**
					Connected Waters-4: Evaluate water quality habitats and species composition around inlets and develop management recommendations. **(NEW)**
					Connected Waters-5: Better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of enhancing oceanic exchange and develop a pilot project, as appropriate. **(NEW)**
			Forage Fishes	RESEARCH forage fish abundance, trends, and threats. RESTORE water quality and natural habitats to sustain abundant and diverse forage fish populations and other species that depend on forage fish. REPORT the importance of forage fish and trends in their abundances to partners and stakeholders. Elevate public awareness and understanding of the importance of forage fish to a healthy IRL.	Forage Fishes-1: Support research and assessments to identify and map suitable habitats and spawning habitats for forage fishes and track population size and health. **(NEW)**
					Forage Fishes-2: Continue to support scientific assessments of forage fish population size and health. **(NEW)**
			Trash-Free Waters	REDUCE trash by implementing a lagoon-wide trash-free waters campaign – "Trash-Free Lagoon 2030." Enhance efforts to REMOVE trash by coordinating with local organizations	Trash-Free Waters 1: Identify and map IRL hotspots for trash, develop education projects that REDUCE and/or REMOVE trash, and seek funding for projects from the USEPA Trash-Free Waters Program. **(NEW)**

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				and partners in the IRLNEP Management Conference. REPORT trash hotspots and trash removal success stories.	Trash-Free Waters-2: Identify and remove derelict boats and fishing gear throughout the IRL. **(NEW)**
			Distinctive Lagoon Communities	RESPOND to the unique community needs of three categories of IRL coastal communities that contribute to the rich history, culture, human diversity, infrastructure, and economic value of the IRL watershed.	Distinctive Communities -1: For, Urban Waters, ensure the high-density human population is Lagoon-Friendly ™. **(NEW)**
					Distinctive Communities-2: For Working Waterfronts, coordinate with local communities to maintain the commercial use. **(NEW)**
					Distinctive Communities-3: For Environmental Justice Communities, identify the unique challenges and opportunities along the lagoon for underrepresented and underserved communities. **(NEW)**
			Federal, State, and Local Policy Opportunities	Identify opportunities to align the CCMP with local comprehensive plans and land development regulations to more effectively RESTORE the IRL. Evaluate state and federal policies that may impact the ability to implement the CCMP actions and coordinate with agencies to determine policy opportunities moving forward. RESPOND to policy changes and new policy opportunities. REPORT policy best practices and success stories.	Policy Considerations-1: Work with local governments to identify and prioritize CCMP actions and incorporate into local planning regulations and documents. **(NEW)**
					Policy Considerations-2: Evaluate state policies that affect the IRL system and work with state agencies to revise or develop new policies to promote restoration. **(NEW)**
					Policy Considerations-3: Evaluate federal policies that affect the IRL system and work with federal agencies to revise or develop new policies to promote restoration. **(NEW)**

APPENDIX B. WASTEWATER MAPS

Figure B-1: Overview of domestic and industrial WWTPs in the IRLNEP area

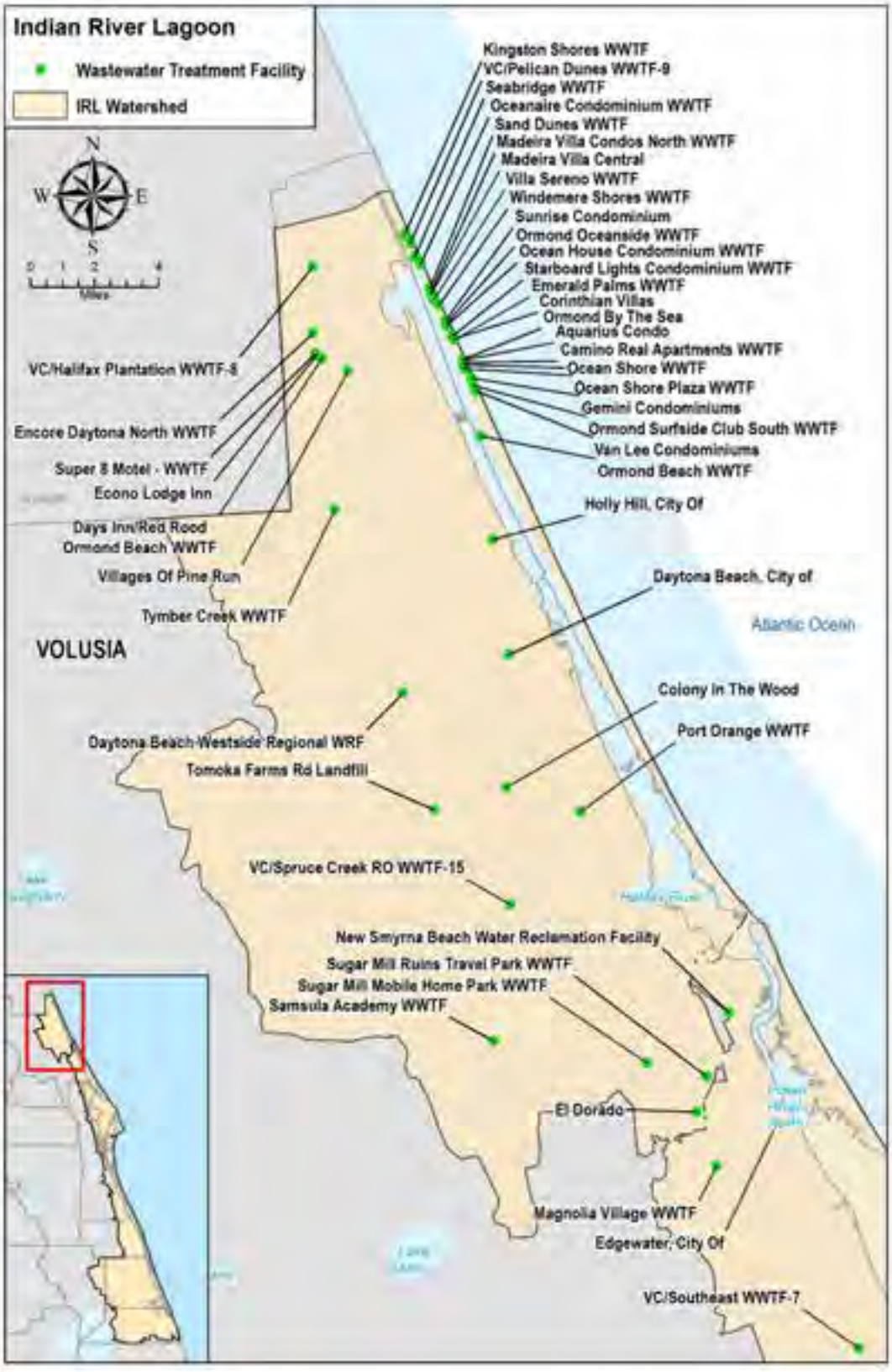

Figure B-2: Domestic and industrial WWTPs in Volusia County in the IRLNEP area

Figure B-3: Domestic and industrial WWTPs in Volusia and northen Brevard Counties in the IRLNEP area

Figure B-4: Domestic and industrial WWTPs in central Brevard County in the IRLNEP area

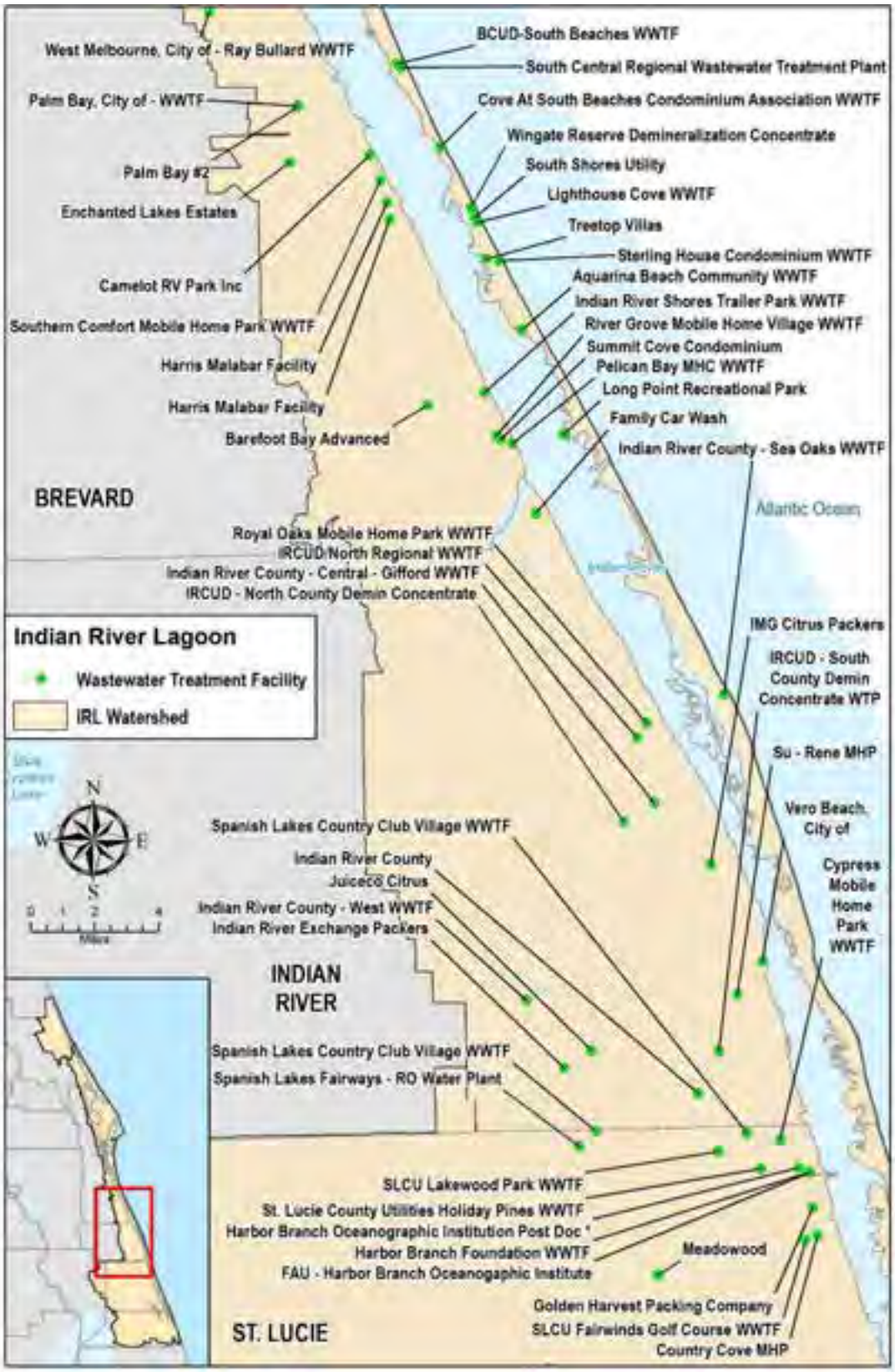

Figure B-5: Domestic and industrial WWTPs in southern Brevard, Indian Rver, and northern St. Lucie Counties in the IRLNEP area

Figure B-6: Domestic and industrial WWTPs in western St. Lucie, western Martin, and Okeechobee Counties in the IRLNEP area

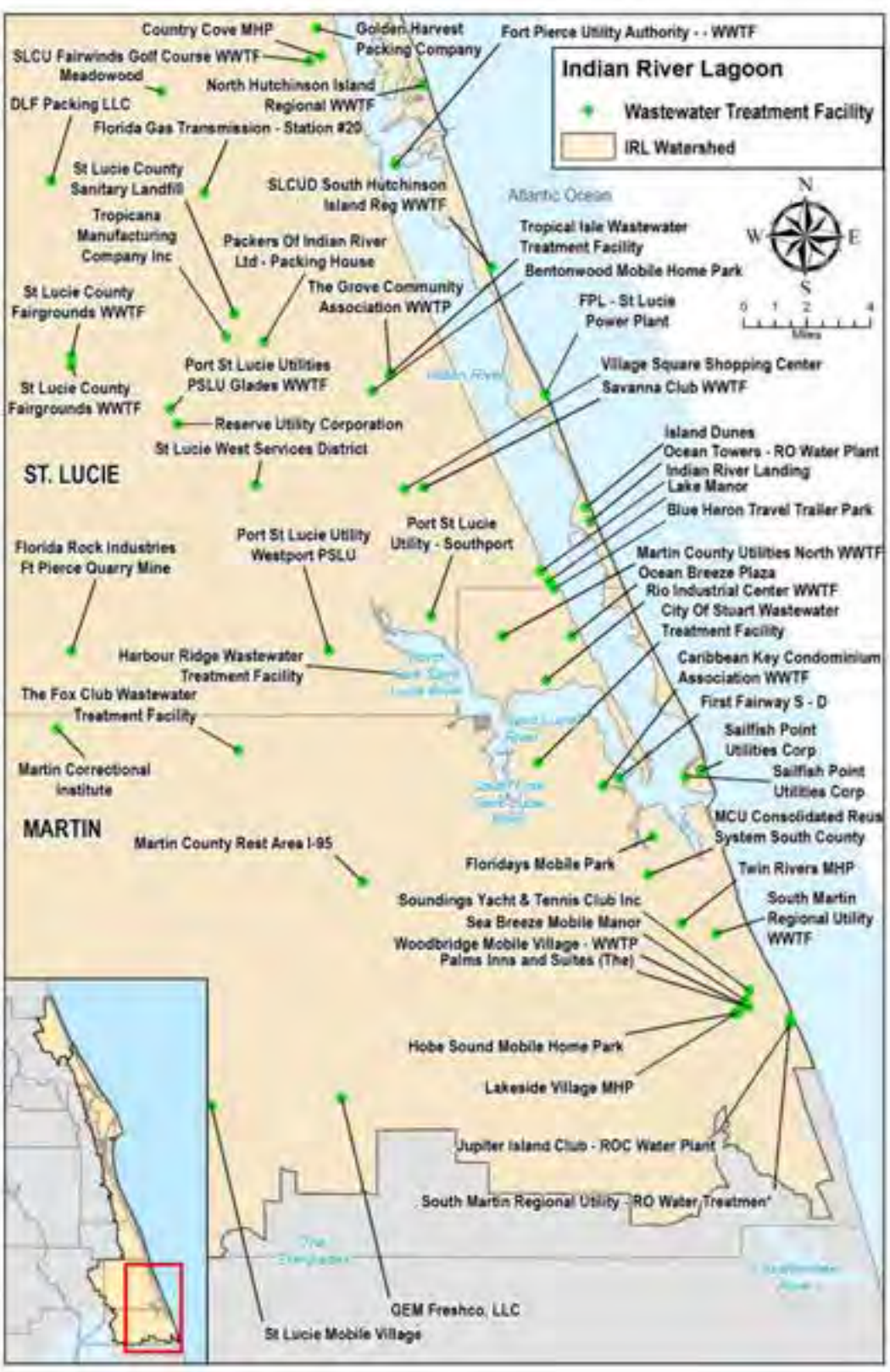

Figure B-7: Domestic and industrial WWTPs in eastern St. Lucie and eastern Martin Counties in the IRLNEP area

Figure B-8: Overview of septic systems in the IRLNEP area

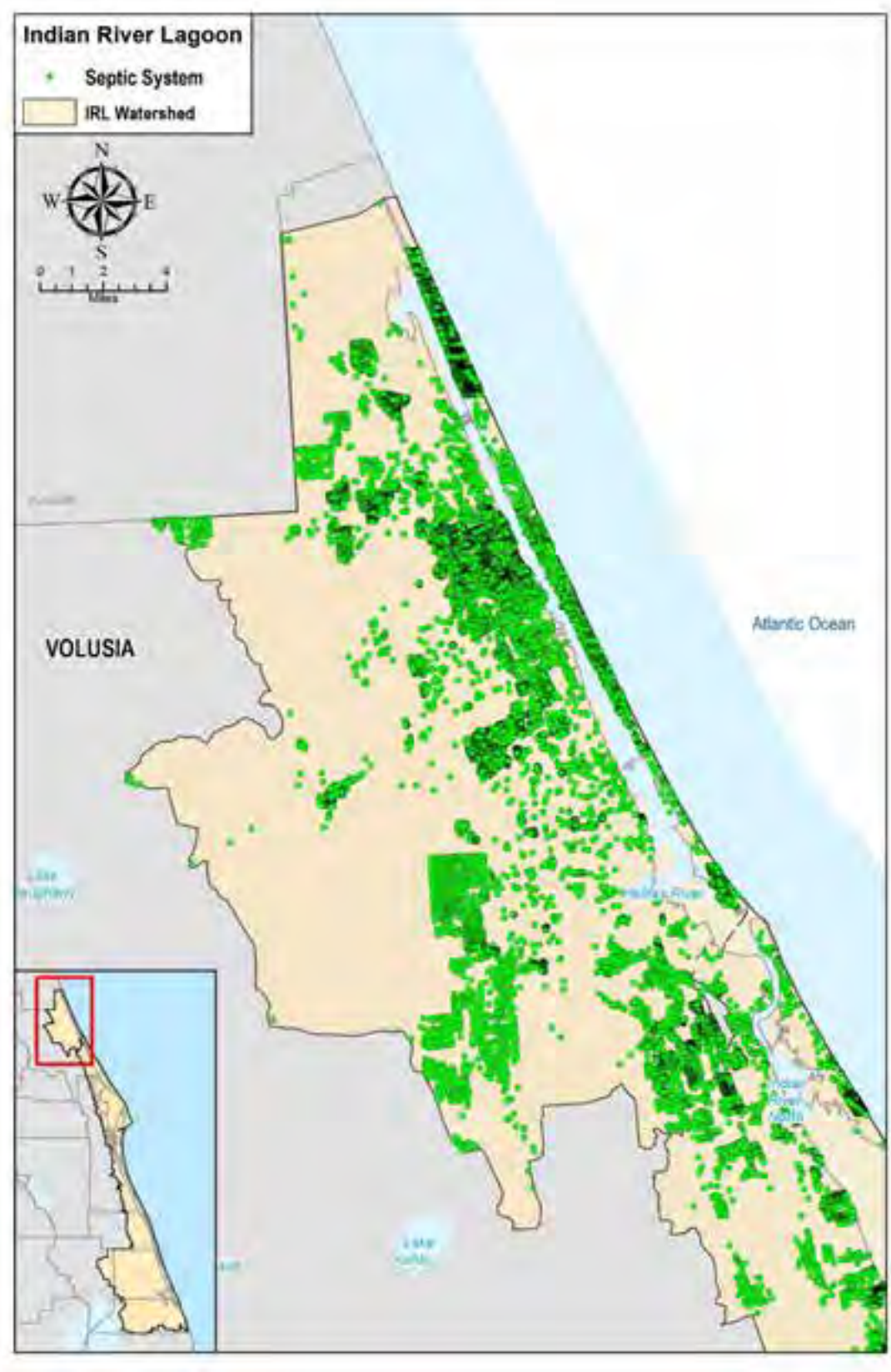

Figure B-9: Septic systems in Volusia County in the IRLNEP area

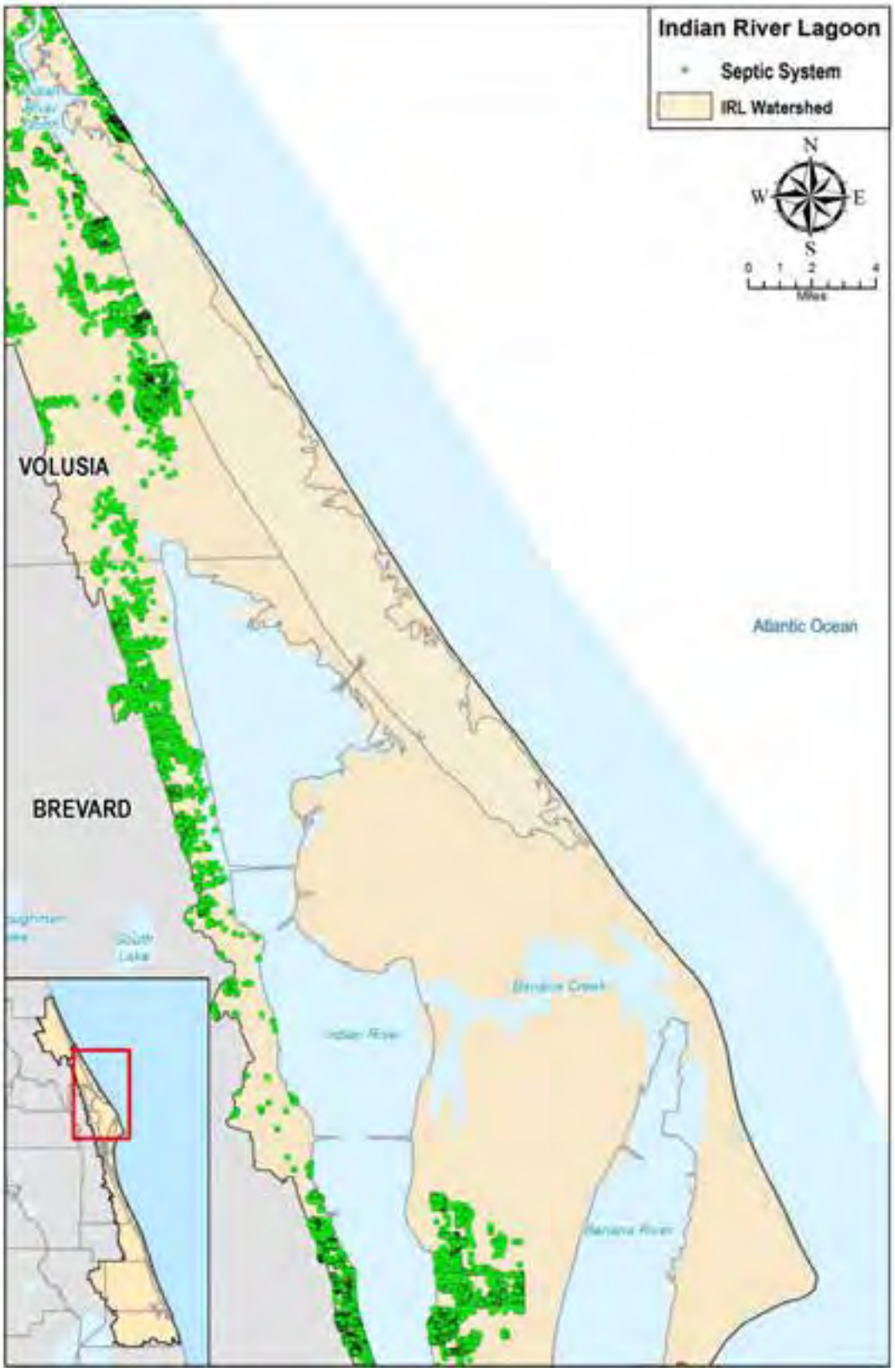

Figure B-10: Septic systems in southern Volusia and northern Brevard Counties in the IRLNEP area

Figure B-11: Septic systems in central Brevard County in the IRLNEP area

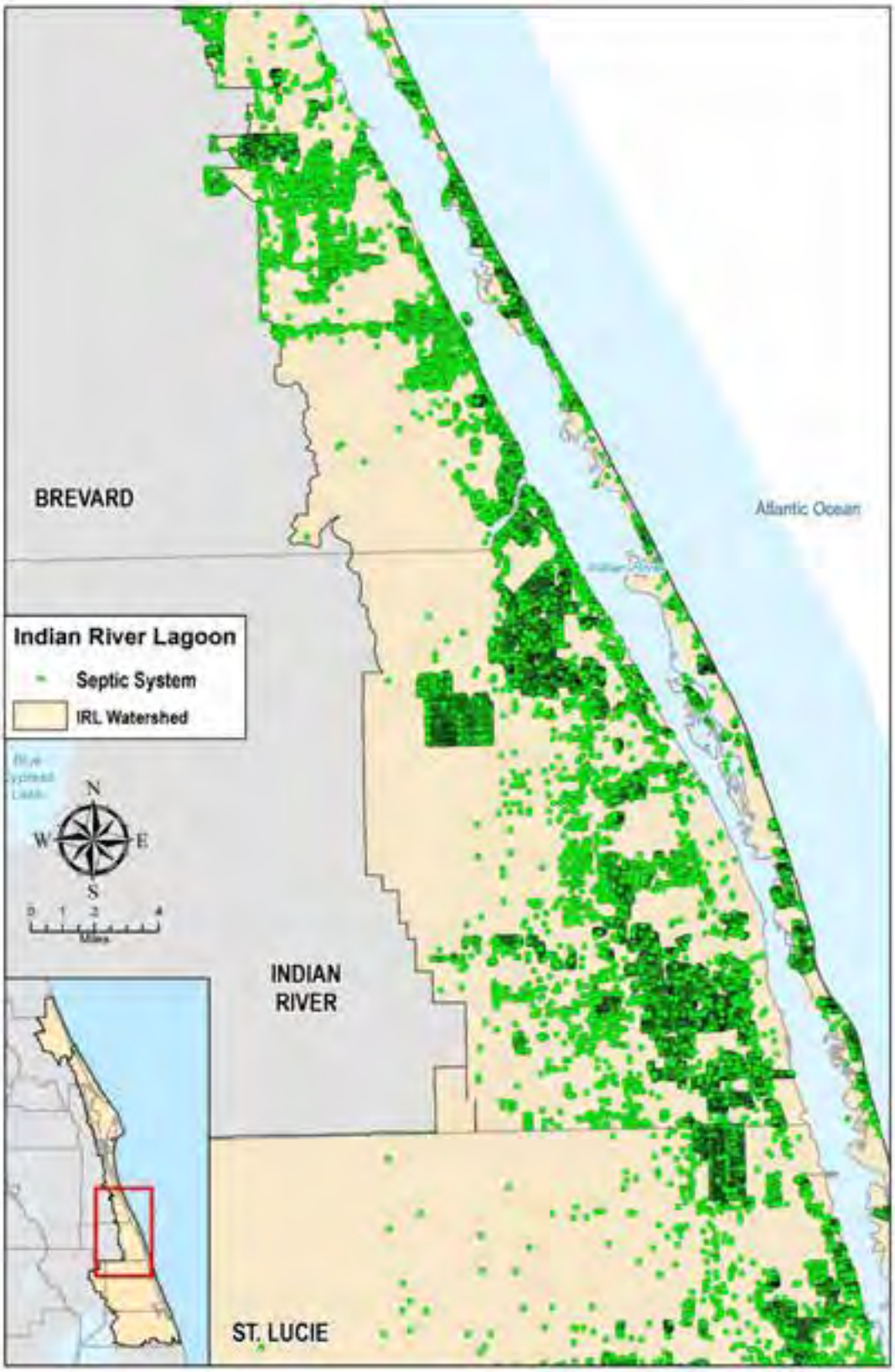

Figure B-12: Septic systems in southern Brevard, Indian River, and northern St. Lucie Counties in the IRLNEP area

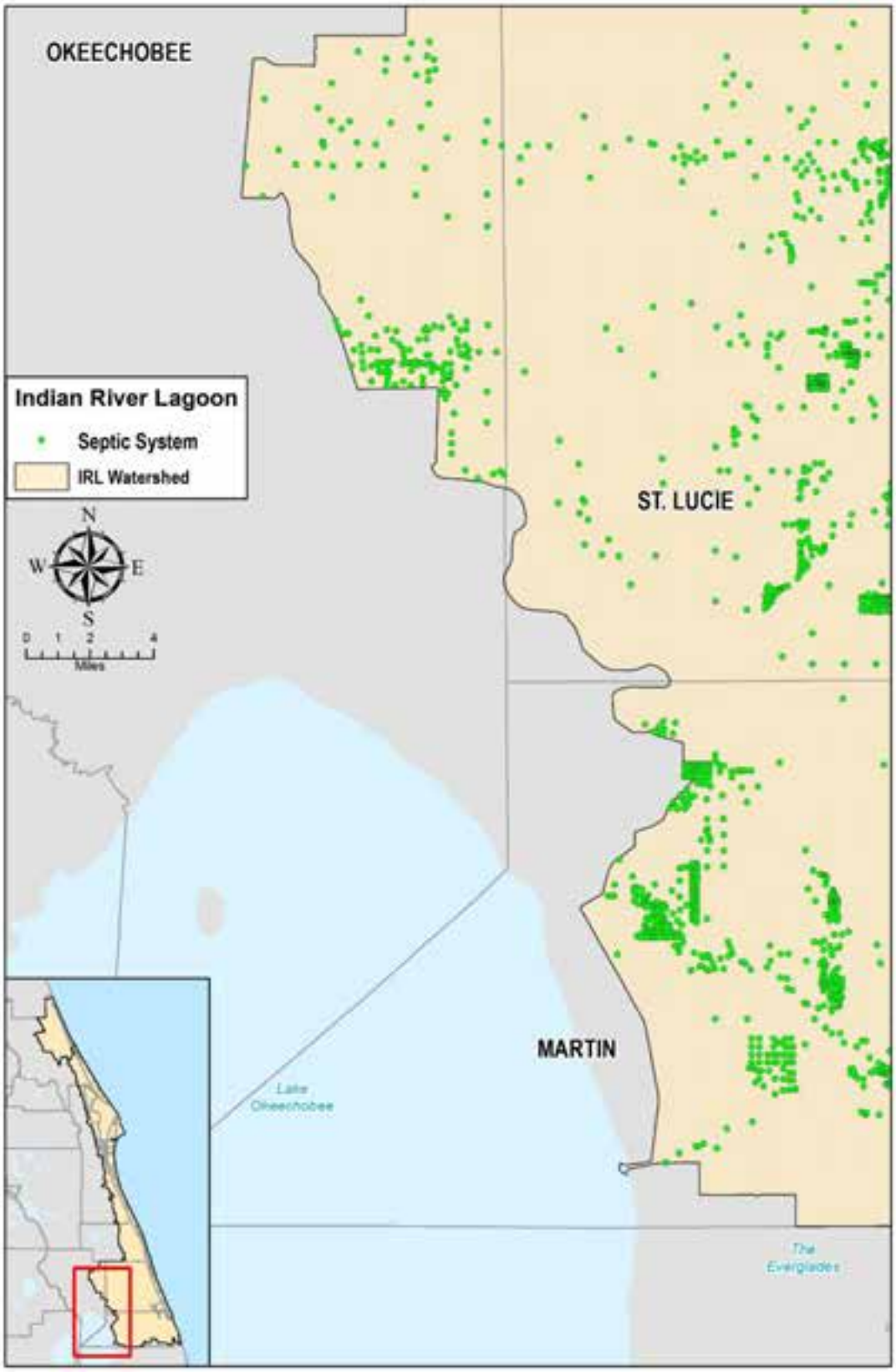

Figure B-13: Septic systems in western St. Lucie, western Martin, and Okeechobee Counties in the IRLNEP area

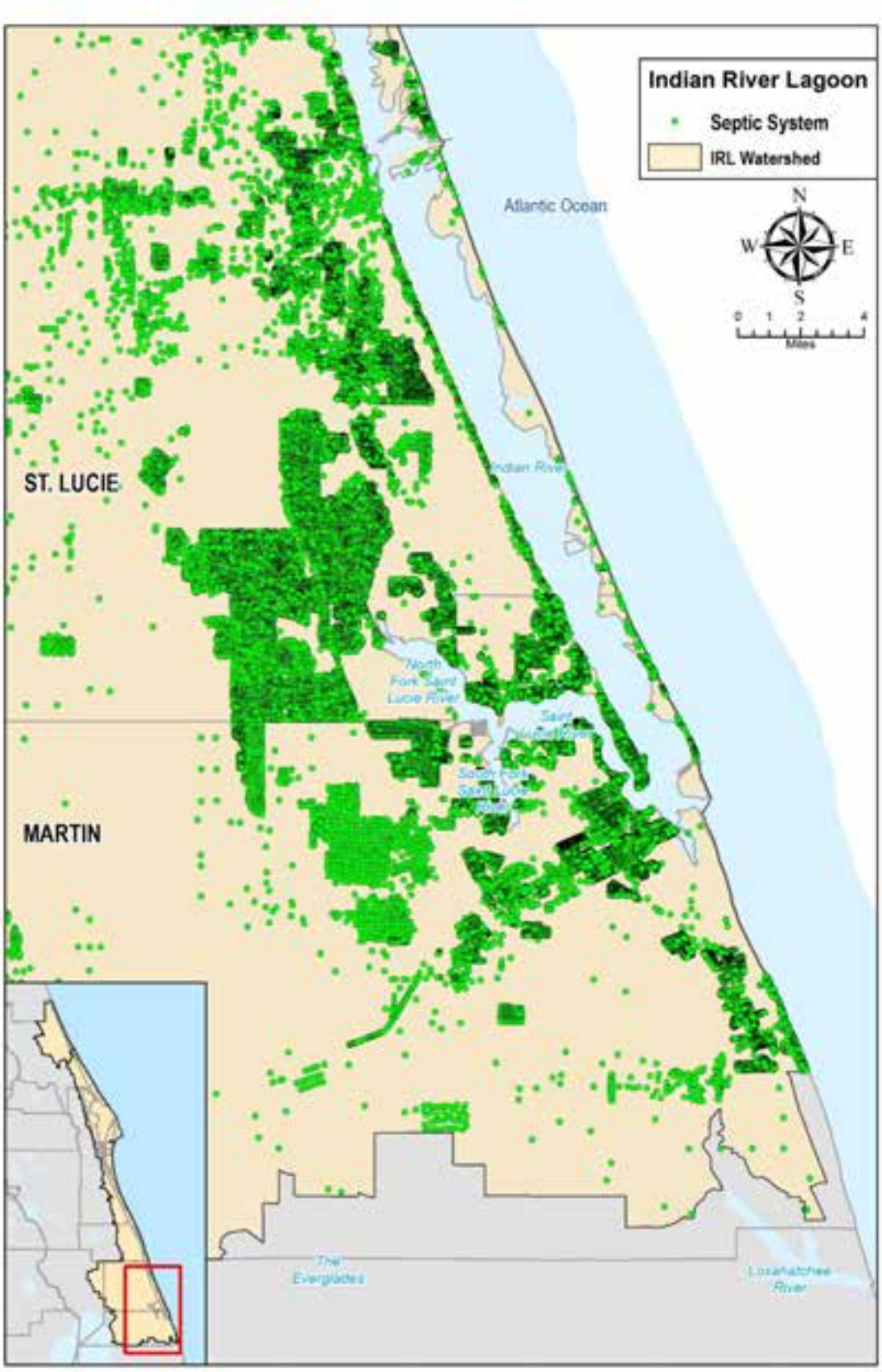

Figure B-14: Septic systems in eastern St. Lucie and eastern Martin Counties in the IRLNEP area

APPENDIX C. AGRICULTURAL BMP ENROLLMENT

Implementation of Agricultural Best Management Practices

The Florida Watershed Restoration Act of 1999 directed DEP, FDACS, and WMDs to work together to reduce pollution in Florida's waters, citing BMPs as the best way to accomplish this task. BMPs are the future of agriculture in Florida, and are guidelines advising producers how to manage the water, nutrients, pesticides, herbicides, and other potential pollutants that agriculture uses to minimize impacts on the state's natural resources. Through the Office of Agricultural Water Policy (OAWP), Florida Forest Service, and Division of Aquaculture, FDACS develops, adopts, and assists producers in implementing agricultural BMPs to improve water quality and conservation. Adopted BMPs are initially verified by DEP as reducing nutrient loss to the environment. OAWP BMPs are published in commodity-specific manuals that cover key aspects of water quality and water conservation. The BMP categories include:

- Nutrient management practices that help determine appropriate source, rate, timing, and placement of nutrients (both organic and inorganic) to minimize impacts to water resources.
- Irrigation and water table management practices that address methods for irrigating to reduce water and nutrient losses to the environment and maximize the efficient use and distribution of water.
- Water resource protection practices, such as buffers, setbacks, and swales to reduce or prevent the transport of nutrients and sediments from production areas to water resources.

The Notice of Intent to implement BMPs and BMP checklist are incorporated into each manual. Information on the BMP manuals and field staff contact information can be obtained at: http://www.freshfromflorida.com/Divisions-Offices/Agricultural-Water-Policy. Printed BMP manuals can be obtained by contacting OAWP field staff.

OAWP outreach to solicit enrollment extends to all types of agricultural operations but is more intensive in BMAP areas because of the relationship of BMPs to the presumption of compliance with water quality standards in a BMAP area. FDACS field staff work with producers to enroll them in the BMP program by signing a Notice of Intent. Enrollment is based on the expectation that producers recognize and address the water quality and conservation issues associated with their operations. Upon completion of all information in the BMP checklist, a Notice of Intent must be signed by the landowner or the landowner's authorized agent (who may be the producer if the producer is not the landowner). **Table C-1** summarizes FDACS BMP Program enrollment within the IRLENP area. **Figure C-1** shows the agricultural acres enrolled in the FDACS BMP Program in the IRLNEP area as of July 31, 2018.

Table C-1. FDACS BMP enrollment in the IRLNEP area

BMP Manual	Acres Enrolled
Citrus	81,505
Conservation Plan Rule	1,316
Cow/Calf	133,448
Dairy	5,757
Equine	704
Fruit/Nut	11
Lake Okeechobee Protection Plan	13,154
Multiple Commodities	25,156
Nursery	1,758
Row/Field Crops	38,813
Sod	1,275
Total	**302,897**

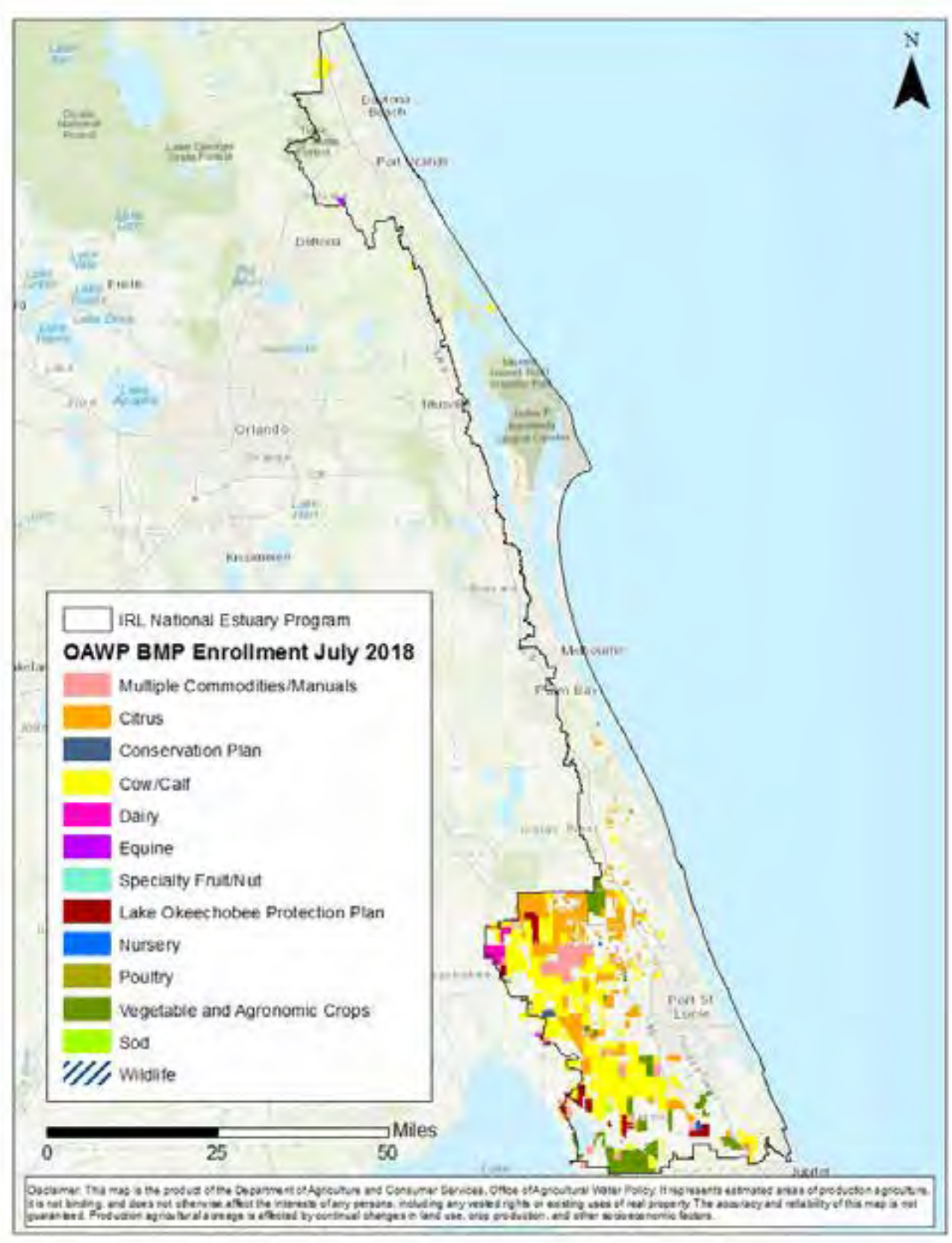

Figure C-1. BMP enrollment in the IRLNEP area as of July 31, 2018

FDACS OAWP Role in BMP Implementation and Follow-Up

OAWP works with producers to submit Notices of Intent to implement the BMPs applicable to their operations, provides technical assistance to growers, and distributes cost-share funding, as available, to eligible producers for selected practices. OAWP follows up with growers through site visits to evaluate the level of BMP implementation and record keeping, identify areas for improvement, if needed, and discuss cost-share opportunities.

When DEP adopts a BMAP that includes agriculture, it is the agricultural producer's responsibility to implement BMPs adopted by FDACS to help achieve load reductions. If land use acreage corrections and BMP implementations do not meet the current agricultural load reduction allocation, it may be necessary to develop and implement additional projects and practices that reduce nutrients from agricultural nonpoint sources and will require additional funding sources and producer participation. In that case, FDACS will work with DEP and water management districts to identify appropriate options for achieving further agricultural load reductions.

Section 403.067, Florida Statutes, requires that, where water quality problems are demonstrated despite the proper implementation of adopted agricultural BMPs, FDACS must reevaluate the practices, in consultation with DEP and stakeholders, and modify them if necessary. Continuing water quality problems will be detected through the BMAP monitoring component and other DEP and water management district activities. If a reevaluation of the BMPs is needed, FDACS will also include water management districts and other partners in the process.

OAWP Implementation Verification Program

OAWP established an Implementation Assurance Program in 2005 in the Suwannee River Basin as part of the multi-agency/local stakeholder Suwannee River Partnership. In early 2014, OAWP began to streamline the Implementation Assurance Program to ensure consistency statewide and across commodities and BMP manuals. The Implementation Assurance Program was based on interactions with producers during site visits by OAWP staff and technicians as workload allowed. For the visits, field staff and technicians used a standard form (not BMP specific) developed in 2014, that focused on nutrient management, irrigation management, and water resource protection BMPs common to all BMPs that were adopted by rule. Once completed, these paper forms were submitted to OAWP staff and compiled into a spreadsheet, and the data were reported annually.

On November 1, 2017, the OAWP's Implementation Verification rule (Chapter 5M-1, Florida Administrative Code) became effective. The Implementation Verification Program provides the basis for assessing the level of BMP implementation and for identifying enrolled producers who require assistance with BMP implementation. The components of the Implementation Verification Program are (1) site visits, (2) implementation status reporting on common practices that apply across all BMP manuals, (3) technical assistance, and (4) external reporting. Implementation verification is confirmed by field staff through site visits and by producers through annual self-verification of the common practices.

Site visits to agricultural operations by OAWP field staff and contract technicians are the most effective means to determine the level of BMP implementation. These visits also provide an opportunity to identify needs for assistance with implementation and explore potential improvements. Resource limitations prevent site visits from occurring on all enrolled operations every year, and for that reason, site visits are prioritized. The program objective is for field staff to conduct site visits for 5–10% of active Notices of Intent each year, with approximately 10% of the site visit locations selected randomly.

Per the Implementation Verification rule, each year producers participating in the BMP program will be requested to report on the implementation of common practices for their operations. Lack of response from enrollees with parcels in a BMAP area raises the priority of the operation for a site visit from field

staff. Where a need is identified, OAWP may facilitate technical assistance for the producer from UF-IFAS or other resources, including third-party vendors. In some cases, cost-share support may be available. Data from producers and site visits will be used to complete the OAWP's annual report on the status of BMP implementation as required by Section 403.0675(2), Florida Statutes.

BMP Enrollment Data and Manuals

OAWP maintains a database on the implementation of BMPs for producers enrolled in BMP programs and creates spatial data that show agricultural BMP enrollment by manual statewide.

FDACS OAWP has adopted BMPs for commodities shown in **Table C-2**. The BMPs are designed to improve water quality while maintaining agricultural production. Each BMP manual covers key aspects of water quality and water conservation. These manuals are located at https://www.freshfromflorida.com/Business-Services/Water/Agricultural-Best-Management-Practices.

Table C-2. FDACS BMP manuals

Manual	Adoption Date	Rule Reference	Next Review
Cow/Calf	2009	5M-11	Under Review
Sod	2008	5M-9	Under Review
Specialty Fruit and Nut	2011	5M-13	Under Review
Equine	2012	5M-14	Under Review
Citrus	2013	5M-16	Under Review
Nursery	2014	5M-6	2019
Vegetable and Agronomic Crops	2015	5M-8	2018
Dairy	2016	5M-17	2021
Poultry	2016	5M-19	2021
Small Farms	Pending	Pending	Pending

Appendix D

Integrated Pest Management Plan

Integrated Pest Management Plan

For City's Stormwater Conveyance System

SEPTEMBER 2021

CITY OF SEBASTIAN
HOME OF PELICAN ISLAND

SWIPM.PLAN.V1

ACKNOWLEDGEMENTS

This Integrated Pest Management Plan is the collaborative product of hard work, in-depth discussion, thoughtful review, and peer-reviewed scientific research conducted over five (5) months, by the following charter members of the **Stormwater IPM Sub-Committee**:

Natural Resources Board Members
Thomas Carrano
Jessica Lovell
Charles Stadelman

Scientific Advisors
Ruth Callaghan, CEAC (Certified Environmental Analytical Chemist)
Dr. Graham Cox, Pelican Island Audubon Society
Nickie Monroe, University of Florida- IFAS Indian River County Extension Office

City Staff
Brian Benton, Leisure Services Director
Kimberly Haigler, Environmental Planner/IPM Coordinator

The IPM Sub-Committee hereby approves this IPM Plan, in its entirety, on the 19th day of July, 2021.

The Natural Resources Board hereby approves this IPM Plan, in its entirety, on the 3rd day of August, 2021.

The aforementioned collectively present this IPM Plan and accompanying Resolution (R-21-14) for City Council approval on the 8th day of September, 2021.

The City of Sebastian's IPM Program is a Sustainable Sebastian Initiative.
For more information about Sustainable Sebastian please visit:
https://www.sebastiannrb.com/

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I. INTRODUCTION

Scope

The City of Sebastian's **stormwater conveyance system** encompasses 9 miles of **canals**, 80 miles of **ditches**, and over 15 ponds and **retention areas**. Other **stormwater** assets include: 310 **culvert pipes** and **catch basins**, 7 **baffle boxes**, as well as countless **swales**, road crossing pipes, **dams**, **weirs**, **rights-of-way**, and a **seawall** canal perimeter. The Stormwater and Public Works Departments are charged with maintaining all of these features so that the treatment, transportation, and storage capacity of the entire conveyance system is preserved, while also ensuring the safety of City staff, residents, structures, wildlife, and the surrounding natural waters.

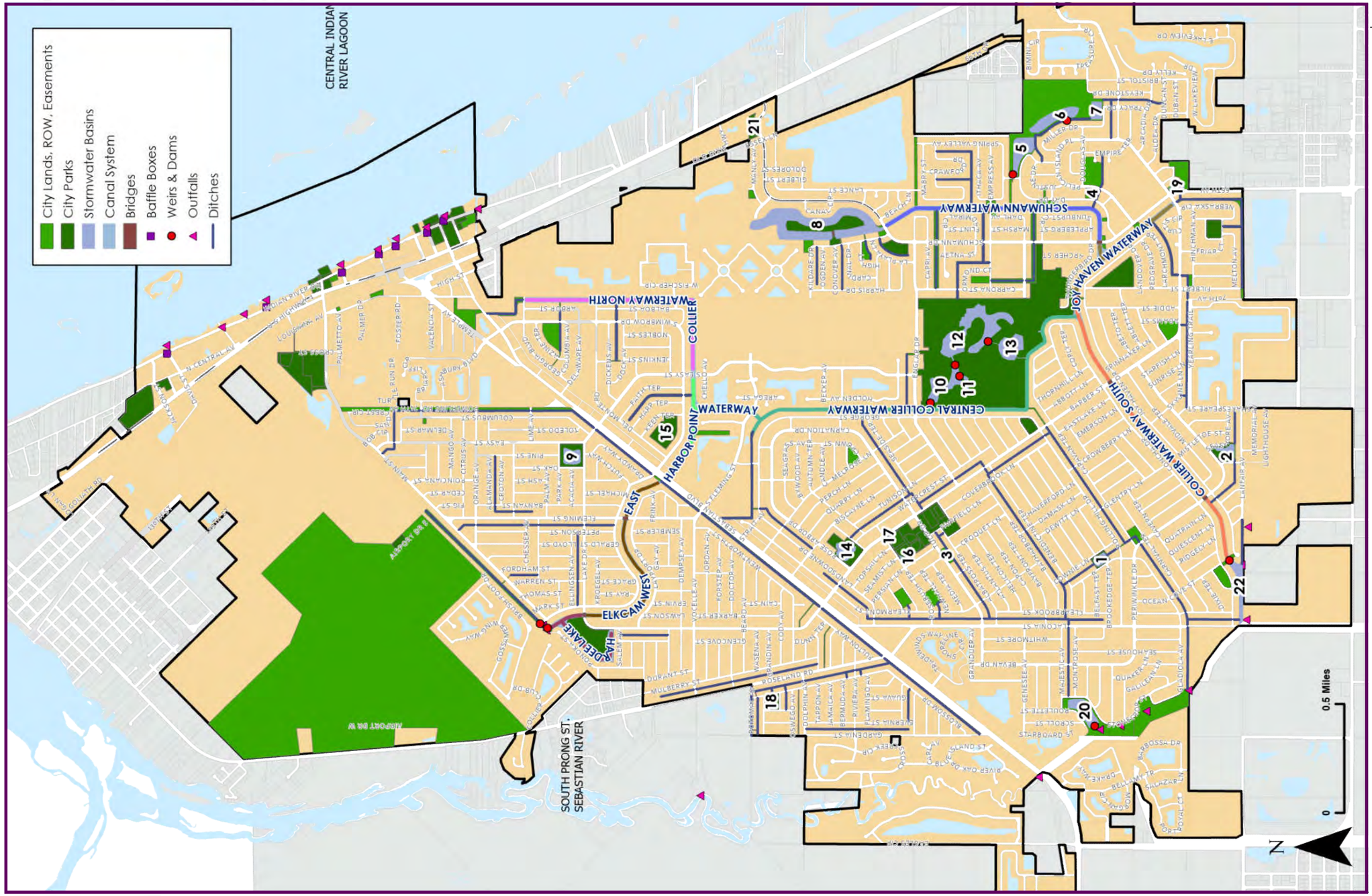
The City of Sebastian is bordered on the east by the Indian River Lagoon (IRL) and on the west by the St. Sebastian River (SSR). Both of these waterways are environmentally sensitive, support a large number of native species, and are integral to the natural health of our region. Therefore, the City must also serve as a steward to the IRL and SSR by ensuring that the stormwater entering these waterways is as healthy as possible.

Noxious aquatic vegetation will be the only "pest" addressed in this plan. While there are species of fish, shellfish and insects present within the stormwater system, which are classified as **"invasive"**, none besides the mosquito have achieved populations which require management. Mosquito Control is handled by the Indian River County Mosquito Control District and is exempt from the City's IPM Plan.

In order to best manage pests within the stormwater system, while also protecting environmental health, City staff and contractors will continue utilizing the principles of **Integrated Pest Management (IPM)** through the implementation of this IPM Plan. Please note that this plan will not apply to any stormwater features located within any planned unit development (PUD), as these subdivisions have direct contracts with the water management district to design and maintain their own stormwater system. Also, not covered by this plan is the City's cemetery, parks, or other properties, as these assets are managed collectively by the City's Leisure Services Department and are addressed in a separate "Parks and Properties IPM Plan," which was adopted by City Council on October 14th, 2020.

Otters are year-round residents in our stormwater conveyance system.

Figure 1: *Map of City's Stormwater Assets*



#	STORMWATER BASIN NAME
1	Cheltenham Pond
2	Periwinkle Pond
3	Tulip Pond
4	Pelican Island Pl. Detention Area
5	Day Drive Retention Area
6-7	Miller Drive Detention Area
8	Schumann Lake
9	Easy Street Lake
10-13	Stormwater Treatment Area
14	Garden Club Park Pond
15	Bark Park Pond
16-17	Barber Street Park Ponds
18	Blossom Drive Pond
19	Barber Street Retention Area
20	Stonecrop Retention Area
21	Historic Park Pond
22	Concha Basin

ASSET SUMMARY

- **Canals: 9 miles**
- **Ditches: 80 miles**
- **Basins: 22**
- **Baffle Boxes: 7**
- **Weirs/ Dams: 12**
- **Bridges: 4**
- **IRL Outfalls: 10**
- **SSR Outfalls: 8**

IPM Sub-Committee

In October of 2020, the Stormwater IPM Sub-Committee was formed to assist City staff in the development of an Integrated Pest Management Plan for the City of Sebastian's stormwater conveyance system. The sub-committee is to be comprised of the Stormwater Director, Leisure Services Director, IPM Coordinator, three **Natural Resource Board** Members, and two local scientific consultants.

The role of the IPM Sub-Committee is to assist in the development of a cohesive IPM Plan, advise on pest management issues, and evaluate the City's progress towards the goals of the IPM Plan. The Sub-Committee will review and approve the annual IPM report before it is presented to City Council. As part of the annual review, Sub-Committee Members will evaluate the current techniques and products to ensure they are based on the best available technologies and scientific information available. Recommendations will be made regarding changes to the annual reporting process and the IPM Plan document.

In the development of the initial Stormwater IPM Plan, the IPM Sub-Committee will meet bi-monthly. Following adoption of the final IPM Plan by City Council, the committee will meet annually, unless more frequent meetings are needed, as determined by staff. All IPM Sub-Committee meetings will be held in compliance with Florida's Sunshine Laws, with public notice, posted agenda, and minutes taken by a recording secretary.

IPM Coordinator

In order to provide for the planning and oversight of the IPM program, the position of IPM Coordinator is established. The appointed IPM Coordinator shall be a member of City staff who is in a position related to environmental or planning, who shall coordinate with the Stormwater Director. Together, they will lead the creation and implementation of the IPM Plan, which will apply to the City's pest management activities on all of its stormwater ponds, canals, and ditches. Their responsibilities will also include the following:

- Serve as liaison to IPM Sub-Committee
- Monitor that City staff and contractors are adhering to the IPM Plan Standard Operating Procedures (SOPs)
- Maintenance of accurate records on IPM implementation and use
- Keep records of staff training in Erosion and Sediment Control, Green Business Best Management Practices, and staff pesticide applicator certification
- Assure the inclusion of City IPM policies and practices in any applicable third party contracts or purchase orders for pest management
- Implement outreach efforts and maintain City's IPM Website.

The IPM Coordinator will prepare an annual report of the City's IPM activities, which will be reviewed each March, by the IPM Sub-Committee, Leisure Services Director, and the Stormwater Director in an effort to assess the effectiveness of pest control methods, feasibility of new methods and technologies, and decide whether revision of the IPM Plan is required.

IPM Plan

A **pest**, by definition is any plant, animal, or pathogen which causes disease, inflicts damage, or out-competes a more desirable species for an area. In addition, a pest may be aesthetically undesired, or threaten to impact human/animal health. However, for the purposes of this plan, noxious aquatic weeds are the only pest of concern.

According to the "Florida Aquatic Plant Management Act," Section 369.22, Florida Statute, the uncontrolled growth of this vegetation poses a variety of environmental, health, safety, and economic problems *(Appendix K)*. This legislation charges the Florida Fish and Wildlife Conservation Commission (FWC) with the supervision and control of aquatic plant management. Therefore, the FWC establishes that a "**noxious aquatic plant**", is any part or whole of an aquatic plant which has the potential to hinder the growth of beneficial plants, to interfere with irrigation or navigation, or to adversely affect the public welfare or the natural resources of the state.

The "Florida Aquatic Plant Management Act" recommends that the management of these aquatic plants be carried out primarily through "maintenance programs," as they achieve more effective management at a lower overall cost.

The City adopts this IPM Plan as its aquatic vegetation **maintenance control program** and adopts the following definition of Integrated Pest Management as established by the City's IPM Sub-Committee:

> "To promote the most **sustainable** pest management methods, based on planning and prevention; which aim to minimize risks to human and environmental health through the limited use of pesticides, while also remaining economically feasible."

Goals

- Protect environmental resources by reducing the amount of pollutants entering surface and ground water and minimizing effects on native plants, animals and habitats
- Ensure effective, economic pest management within the City's stormwater conveyance system, while minimizing health risks to the public, City staff, and the environment
- Promote the transparency of the City's pest management activities
- Increase public awareness of IPM methods and benefits

IPM Program

IPM Policy. The Stormwater IPM plan, as well as future modifications or amendments will be reviewed and voted on initially and annually by the IPM Sub-Committee, Natural Resources Board, and then presented to City Council for final approval. The plan will then be incorporated as City policy through the adoption of Resolution R-21-14 by City Council *(Appendix A)*.

IPM Program Coordination. The Stormwater Director, Leisure Services Director, and the IPM Coordinator are responsible for coordinating, tracking, and reporting the implementation of the City's IPM Program.

Tracking Pesticide Use. City Staff and Contractors conducting pest management activities within the City's **stormwater conveyance system** are required to record thorough field data. Accurate records will be maintained on herbicide use and all non-chemical methods utilized, these records will be accessible for reference. All records will be retained for 1 year and stored on the City's Laser fiche system per record retention schedule.

Staff Training. All City employees who, within the scope of their duties, direct maintenance activities on the stormwater system will be trained on the City's IPM Policies. A certification course on Green Business Best Management Practices will be provided through partnership with the University of Florida Indian River County Extension Office as needed. Stormwater and Public Works staff also receives certification training on Sediment and Erosion Control. The training sessions are coordinated by the Human Resources Director, who will track employees' attendance and ensure that City field staff holds an active certification.

Licensed Applicators. At this time, City staff will not be applying any herbicides on the surface of, or within ten feet of aquatic areas. All aquatic herbicide applications will be performed by a State licensed contractor.

Information Resources for Staff. The IPM coordinator will act as a resource for City staff to help identify new pests and pest related concerns, and to assist in determining the best course of action consistent with the established IPM Program's Standard Operating Practices (SOPs). The IPM Coordinator will also seek out and provide access to expert resources when needed.

Public Outreach. Education and outreach efforts will include distribution of information, either created internally, or obtained through partnership with local and state government agencies. The IPM Coordinator will coordinate and keep records of the following:

- A City webpage where the public may obtain information on IPM practices for their property, view the City's IPM Plan, annual IPM reports, IPM Sub-Committee minutes, and pest management treatment records.
- The City's efforts to promote the reduction of urban pesticide use through social media, the City's website, print and television media.
- The City's outreach to pest control operators (PCO's) and landscapers.
- Distribution of IPM information and resources at public outreach and community events.
- IPM information distributed to residents through the "New Homeowner Folders" during the final planning and zoning inspection.
- Updates and status reports following the annual report and as requested by City officials.

Contract Provisions. The Procurement Coordinator will review **contract** provisions and/or amendment(s) to agreements that provide pest management services within city maintained ponds, canals and ditches covered under this IPM Plan. All such **contractors** shall be required to review and sign the "contractor agreement" *(Appendix B)*. Contract work will be monitored to ensure that City IPM policies and practices are adhered to by all contractors performing pest management work.

Regulatory Reporting. The IPM Coordinator will handle reporting to regulatory agencies, which credit the adoption of an IPM Plan as a Best Management Practice (BMP).

- Incorporate the IPM Plan into the Florida Department of Environmental Protections (FDEP)'s **National Pollutant Discharge and Elimination System (NPDES) Phase II, MS4 Permit** Cycle 4, Year 2 Annual Report (September, 2022) and the Cycle 5 NOI (September, 2024) as a new BMP for Element 6: Pollution Prevention/ Good Housekeeping.
- Add as new project and update through the statewide Basin Management Action Plan (BMAP) annual report on water quality projects.
- Add as new activity and provide update to the Indian River Lagoon Council for the Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) annual report on lagoon-related accomplishments.

The Blossom Pond benefits from fountain aeration.

Community IPM Cycle

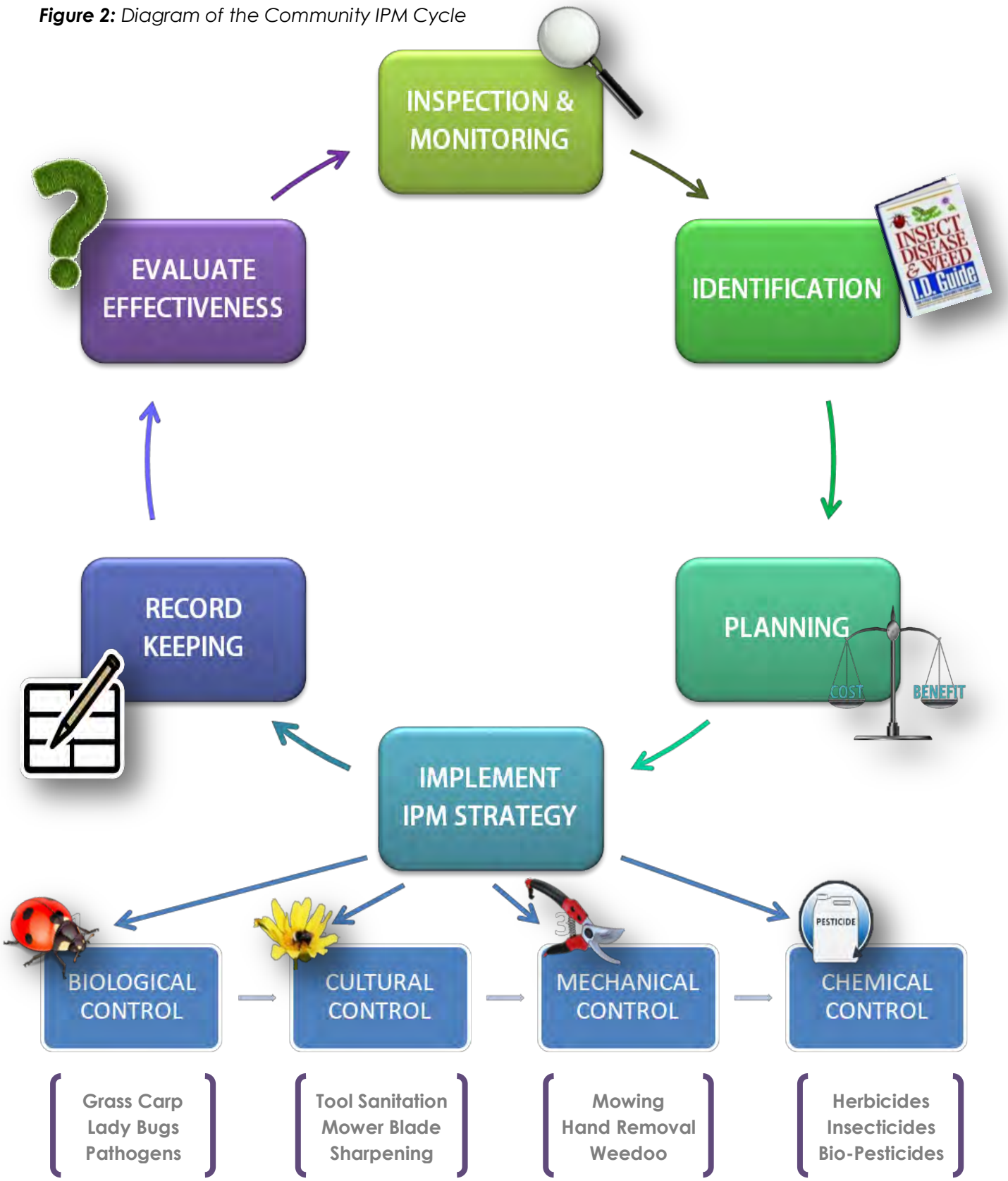
This established cycle *(Figure 2)* will serve as the guideline for IPM Plan development and is based on planning and prevention, with the use of chemicals as the last resort for pest control.

1. **Inspection and Monitoring:** Staff and contractors routinely scout the waters and surrounding landscapes to locate pests. **Noxious aquatic vegetation** populations are monitored by visual checks.
2. **Identification:** Plants must be accurately identified. Life history attributes are to be known for each species identified. This step is key to effective treatment.
3. **Planning:** The focus is on prevention- what it takes to keep noxious vegetation out. Determine what action is needed and whether a threshold has been crossed. Proper techniques and timing are for required management.
4. **Implement Strategy:** All pest management strategies are classified as biological, cultural, mechanical, or chemical. All methods are combined to maintain pests at acceptable thresholds.
    - Biological Control: enhances natural enemy populations by creating habitat or adding populations
    - Cultural Control: Disrupts the pest's environment by removing pest attractants or utilizing pest resistant variety of desired species
    - Mechanical: Creates physical barrier to pest entry
    - Chemical Control: the last tool in the IPM toolbox, the goal is evaluate costs and benefits to choose the least-toxic and most feasible option available that will do the job
5. **Record Keeping:** Accurate record keeping is essential to a successful IPM program. Data must be kept on control methods implemented, purchase orders, and chemical usage by contractors. Determine if control methods were effective by knowing what has changed through trap counts and observation.
6. **Evaluate Effectiveness:** Document if the program is meeting expectations. Establish if all actions have been in compliance with the City's IPM Standard Operating Procedures (SOPs). Assess what was learned and determine whether the plan needs revised.

City staff uses a vacuum truck to remove sediments and vegetation from a catch basin

A juvenile alligator hangs out in Periwinkle Pond.

Figure 2: *Diagram of the Community IPM Cycle*



Standard Operating Procedures

When selecting and implementing a pest management strategy, from this plan, the following will be considered by City Staff:

Site Factors. Use and function of the waters and surrounding landscape.

- Considering the use and function of the assets and the surrounding landscape, stormwater features are divided into four functional categories *(Figure 3)* in which the action threshold and methods are determined:
  - Structures: including **dams**, **weirs**, **spillways**, **catch basins**, **baffle boxes**, **culvert pipes**, **inlets**, **outlets**, and **outfalls**. These assets have a virtually zero tolerance for plant growth, as they must stay clear of vegetation and debris at all times in order to function.
  - Canals: shoreline and seawall vegetation is acceptable and often encouraged. However, vegetation must be controlled to the seawall perimeters so that the storage and flow of the waterways is maintained.
  - Ponds: shoreline **emergent vegetation** is beneficial and encouraged. However, when the vegetation is not maintained, it can quickly take over open water areas, reduce stormwater storage capacity and degrade habitat quality.
  - Ditches: along with **dry detention areas**, and **rights-of-way (ROW)** areas have the highest tolerance threshold for vegetative growth, maintenance required is minimal.
- Erosion and runoff potential of site
- Proximity to other surface, surficial, and groundwater resources

Figure 3: *Stormwater Asset Classification Table*

STRUCTURES	CANALS	PONDS	DITCHES
Dams	Elkcam Waterway	Retention Ponds	ROWs
Weirs	Collier Waterway	Detention Ponds	Dry DAs
Spillways	Schumann Lake	Retention Areas	Swales
Catch Basins	Hardee Lake	Treatment Areas	
Baffle Boxes	Harbor Waterway	Stormwater Basins	
Culvert Pipes	Schumann Waterway		
Inlets	Harbor Pt. Waterway		
Outlets	Joy Haven Waterway		
Outfalls	Seawall Perimeter		

Costs. Both short and long term costs, as they relate to:

- Costs of the material or method
- Application and labor costs
- Effectiveness and duration of effects on pest populations
- Overall feasibility

Other Factors. Additional factors relevant to the selection

- Special equipment or storage required for method
- Method of delivery
- Terrestrial Fertilizer application must adhere to the standards of the City's Fertilizer Ordinance, Ch.50 Sec.50-5 *(Appendix C)*
- How all criteria may be affected by weather conditions
- Previous pesticide applications on site and interval between treatments
- Chemical application set-backs from slopes along waterways
- Possibility of pest resistance
- Equipment cleaning consideration before and after use
- Potential synergistic effects of pesticide combinations

The following considerations are addressed through the use of the **Environmental Impact Quotient (EIQ)**, which is explained on page 24:

Health and Safety Concerns. Potential effects on City staff and residents.

- Toxicological properties and potential health effects of materials or methods
- Equipment operation safety issues
- Staff safety and injury concerns

Environmental Considerations. Protection of native plants, animals and **pollinators**.

- Consider toxicity or potential harm caused by the method to non-target organisms and habitat.
- Potential for **bioaccumulation** of materials within soils and groundwater
- Know if there is potential for negative effects from any pest control method or lack thereof on any federally or state **protected species** that may be in the area
- Be aware of any nesting birds in the area and potential affects the method may cause
- Understand the effects the method may have on pollinators
- The effects of reduced control of invasive plants or pests to native biodiversity

Product Characteristics. Specific product features

- Possible residual effect and decomposition products
- Volatility and flammability
- Product formulation, recommended dilution and package size
- **Leachability** and **solubility**

Roseate Spoonbills graze at the temporary pond at the Friendship Park dry detention area.

II. Key Aquatic Pests

Overview

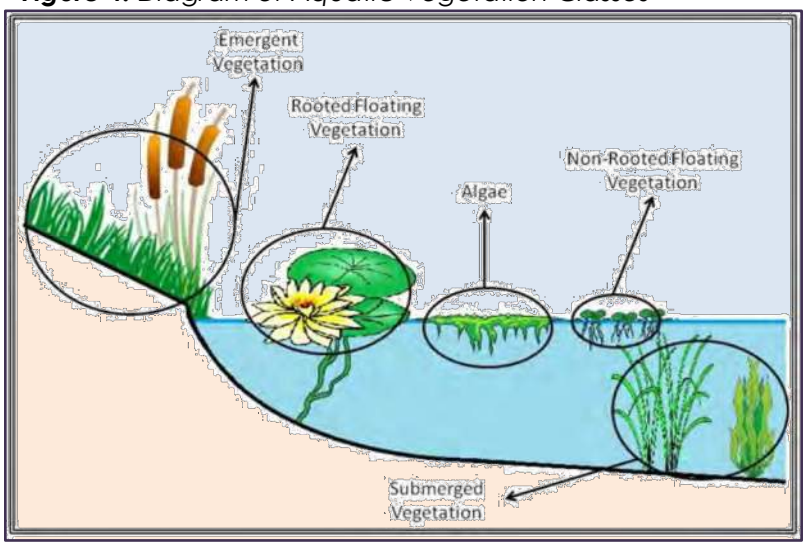
This plan will only address the management of **noxious aquatic vegetation** pests within the **stormwater conveyance system**. While vegetation is certainly a natural and integral element of any water body, species characteristics and environmental conditions can cause the aquatic vegetation to become a pest within a specific location, requiring diligent monitoring and control.

Aquatic Vegetation Classes

Any plants that are able to establish, grow, and reproduce in water, whether year-round or seasonal, is considered aquatic vegetation. There are three primary classes *(Figure 4)* of aquatic vegetation, each presenting unique management challenges:

- **Emergent:** erect, rooted, herbaceous plants growing in water or on a substrate that is at least periodically inundated with water
- **Floating:** leaves that float on the water surface. Their roots may be attached in the substrate or floating in the water column, includes algae.
- **Submersed:** Rooted plants with flaccid or limp stems with most of their vegetative mass located below the water surface, although small portions may extend above the water.

Figure 4: *Diagram of Aquatic Vegetation Classes*



Pros and Cons

Native aquatic vegetation plays a vital and irreplaceable role in an aquatic ecosystem. These plants provide shelter, habitat and food for many important species of fish, birds, insects, and other wildlife. Shoreline vegetation is critical to preventing erosion and filtering sediments and nutrients from entering the waterbody. Many species of aquatic vegetation also help improve water quality by uptaking excess nutrients from the water and settling sediments out of the water column as they slow the movement of water.

At times aquatic vegetation can become a huge management concern in both natural and stormwater systems. In a natural ecosystem, non-native vegetation can out compete native vegetation, adversely affecting habitat quality and biodiversity. In fact, an overgrowth of aquatic vegetation can actually alter entire ecosystems. In man-made aquatic systems, vegetation can block flood control, clog pipes and damage structures. The stormwater conveyance system must preserve the storage and flow of water in order to remain effective.

Invasive aquatic vegetation, in particular, has several common traits which makes it very difficult to control and nearly impossible to eradicate:

- Very rapid growth (exponential), which can quickly cover very large areas.
- Can survive in a wide variety of temperature, light, water, and soil conditions.
- Reproduce multiple ways, including seeds, buds, fragments, and shoots from roots.

Native aquatic vegetation is more adapted to the local system and tends to stay within its niche, contributing to biodiversity. However, under specific environmental conditions they too can form dense monocultures that require management as well. Therefore the term "**noxious aquatic vegetation**" includes any native or non-native vegetation requiring control within the stormwater system.

Figure 5: *Table of the City's Key Aquatic Pests*

COMMON NAME	SCIENTIFIC NAME	CLASS	STATUS
Hydrilla	*Hydrilla vericillata*	Submersed	Invasive, Non-Native
Water Hyacinth	*Eichornia crassipies*	Floating	Invasive, Non-Native
Primrose Willow	*Ludwigia sp.*	All	Native
Spatterdock	*Nuphar advena*	Floating	Native
Duckweed	*Lemna minor*	Floating	Native
Cattail	*Typha sp.*	Emergent	Native
Torpedo Grass	*Panicum repens*	All	Invasive, Non-Native
Green Algae	*Chlorophyta sp.*	Submersed	All
Salvinia	*Salvinia molesta*	Floating	Invasive, Non-Native
Alligator Weed	*Alternanthera philoxeroides*	All	Invasive, Non-Native

Without early detection and rapid response, noxious aquatic vegetation can not only cause ecological and structural harm but can also result extensive economic costs. In the United States alone, invasive weed damage and management costs exceed $30 billion each year. Each day, invasive aquatic weeds cover an additional 4,500 acres of public lands and waters across the country. The key to avoiding these costs is to be proactive and create a plan for **maintenance control**.

III. STRUCTURES

Overview

Stormwater assets classified as "structures" includes all **dams**, **weirs**, **spillways**, **catch basins**, **baffle boxes**, **culvert pipes**, **inlets**, **outlets**, and **outfalls**. There are over 100 such structures across the stormwater system. These assets have a virtually zero tolerance for plant growth; they must stay clear of vegetation and debris at all times in order to function.

Do Nothing Option

There are numerous ways that aquatic plants can interfere with the operating of water management structures, as each structure is unique in its design and/or purpose. Overgrowth of aquatic vegetation around and within these structures can greatly impede the flow of water, block gates opened or closed, often when the operation of these structures is the most critical. These structures are often critical to flood control during major rain events. The damage caused to the structures and by the resulting flooding problems can become very costly to repair. Therefore, the tolerance threshold for **noxious aquatic vegetation** growth, before action is taken is considered the very low for these assets.

Non-Chemical Methods

In order to eradicate vegetation, the following cultural and mechanical methods will be conducted routinely as part of standard proactive maintenance procedures within the City's stormwater system:

- **Excavation.** Sediments can build up at outfalls and create a substrate for vegetation to establish. At times of low outfall, City staff may clear the outfall areas with equipment to mechanically remove any vegetation and accumulated sediments.
- **Vacuum Removal.** A vacuum truck is utilized to remove all accumulated sediments and vegetative debris from catch basins and baffle boxes as needed. Note that these assets are never sprayed with herbicides.
- **Manual Removal.** When safe and practicable, vegetation will be removed by hand from structures as part of routine inspections.
- **Replacement of Structures.** Structure design has been modified over time to be more resistant to pest establishment and damage. The defective or aging structures should be replaced with these upgraded versions, when applicable.

IV. CANALS

Overview

Stormwater assets classified as "**canals**" include the entire interconnected system of wide, mostly sea walled waterways. Altogether, the City maintains over 9 miles of canals and **seawalls**. It is acknowledged that aquatic vegetation provides an important ecological function in the canals. However, the City must be careful that the storage and flow capacity of these important waterways is protected.

Do Nothing Option

The overgrowth of aquatic vegetation within the canal system can greatly impede the flow of water, crucial for flood control throughout the City. The canals are also frequently utilized for kayaking and fishing. These recreational opportunities are hindered when dense vegetation blocks access and affects the habitat quality by altering the water's chemistry and decreasing light penetration.

Finally, and most importantly, the canal system has multiple direct outfalls to the St. Sebastian River (SSR). Any vegetation that is not properly maintained in the canal system is easily introduced into this State protected freshwater system. For this reason, the "Florida Aquatic Plant Management Act," Section 369.22, Florida Statute (*Appendix K*) requires that all public and private water owners enact a "**maintenance program**" for aquatic vegetation. Therefore, the tolerance threshold for **noxious aquatic vegetation** growth, before action is taken is considered moderate for these assets.

Non-Chemical Methods

In order to control vegetation, the following cultural and mechanical methods will be conducted routinely as part of standard proactive maintenance procedures within the City's stormwater system:

- **Excavation.** When areas of the canal system are at their lowest storage, the City can access the canal bottoms with equipment to mechanically remove the vegetation and accumulated sediments.
- **Mechanical Removal by Contractor.** During periods where invasive vegetation has spread too extensively at a location to be brought back under control by routine methods, a contractor may be hired with the equipment to cut and remove the vegetation by boat.
- **Sediment and Erosion Control at Development Sites.** In compliance with City Ordinance No. 54-3-11.2. (*Appendix J*) and the City's MS4 **NPDES** Permit (*Appendix L*), proper erosion and sediment control at all sites of development is required to be established and maintained throughout the duration of the project and is inspected regularly for compliance. Sediments directly washing off a site, and into the canals created a mound of substrate for vegetation to establish and carry nutrients which many invasive species thrive on.

- **Planting Native Emergent Vegetation.** In areas of the canal where seawalls are not installed, maintaining a healthy, natural shoreline of native vegetation will help prevent the pest vegetation from re-establishing and enhance the habitat and aesthetic quality of the waterways.

Local resident fishes off the Concha Dam into the Concha Basin.

Bobcats and other wildlife use the canal and ditch rights-of-way to travel between conservation areas.

City staff works hard to remove sediments and vegetation from the City's vast system of ditches.

V. PONDS

Overview

There are 17 stormwater ponds throughout the City. These include all of the ponds located within City parks, as well as the interconnected ponds of the **Stormwater Treatment Area**, and the multiple ponds of the Day Drive **Retention Area**. Pond vegetation provides an ecological as well as an aesthetic benefit. If left to grow uncontrolled, however, the flood control and safety of these properties can be impaired.

Do Nothing Option

Overgrowth of aquatic vegetation in the ponds can very quickly reduce their stormwater storage capacity, especially in the smaller ponds. This accelerated **succession** can cause localized flooding problems in a very short time.

All of the stormwater ponds are connected to the entire stormwater conveyance system. Aquatic vegetation can block the water flow in and out of the pond. Many species of tall grasses growing around the pond edges can create dense thickets which readily hide dangerous wildlife and can prohibit police and park visitors from seeing beyond; this creates a serious safety concern. Four of the City's ponds also contain a fountain for **aeration** and algae control. Dense vegetation can damage the fountains by clogging the pump system or blocking the spray. The tolerance threshold for noxious vegetation growth, before action is taken is considered high for these assets.

Non-Chemical Methods

In order to control vegetation, the following cultural and mechanical methods will be conducted routinely as part of standard proactive maintenance procedures within the City's stormwater system:

- **Excavation.** When all or parts of the ponds are at their lowest storage, the City can access the pond bottoms and edges with equipment to mechanically remove the vegetation and accumulated sediments.
- **Mechanical Removal by Contractor.** During periods where invasive vegetation has spread too extensively at a location to be brought back under control by routine methods, a contractor may be hired with the equipment to cut and remove the vegetation by boat.
- **Fountain Aeration.** A fountain installed in the center of the pond provides water circulation and increases the dissolved oxygen of the water. This inhibits vegetation growth and increases the habitat quality for aquatic animals as well. Currently, there are only 4 ponds with fountains.
- **Planting Native Emergent Vegetation.** Maintaining a healthy, natural shoreline of native vegetation will help prevent the **noxious aquatic vegetation** from re-establishing and enhance the habitat and aesthetic quality of the pond.

VI. DITCHES, RIGHTS-OF-WAY, DRY RETENTION AREAS

Overview

The stormwater conveyance system is an expansive spider web connected by a massive 80 mile network of **ditches**. Within the ditches, vegetation assists with the infiltration of the water through the soil and stabilizes the steep banks. However, the growth of **noxious aquatic vegetation** must also be controlled enough to preserve the flow of the entire stormwater system.

Along-side many of the City's water retaining assets are the **rights-of-way** areas such as designated access roads, **drainage easements, buffer zones,** and **swales**. In these areas, groundcover is important to stabilize the soil from erosion; however, it is critical that the vegetation not become so overgrown that it blocks maintenance access to the ponds, canals and ditches.

Dry retention areas are located throughout the City and they are areas of lower elevation, which only hold water during periods of heavy rainfall. They are designed to overflow excess water into nearby water features through catch basins and pipes. Keeping dry retention areas vegetated is important to preventing compaction and increasing water infiltration. Too much vegetation can decrease the storage capacity and block the flow of stormwater towards other features.

Do Nothing Option

The overgrowth of aquatic vegetation around in the ditches and dry retention areas can eventually decrease their storage capacity, creating localized flooding problems. The ditch vegetation can cause very costly blockages in the road crossing culvert pipes. Many of the ditches bisect blocks of residential lots and an overgrowth of woody vegetation from the ditches threatens utility and residential structures. Overgrowth in rights-of-way areas prevents staff and contractors from performing proper maintenance of structures, canals, ponds, and ditches. The tolerance threshold for **noxious aquatic vegetation** growth, before action is taken is considered very high for these assets.

Non-Chemical Methods

In order to control vegetation, the following cultural and mechanical methods will be conducted routinely as part of standard proactive maintenance procedures within the City's stormwater system. These assets are virtually never treated with herbicides. The City maintains a separate mowing contract (*Appendix I*) to address the control of vegetation in these areas:

- **Excavation.** When the ditches are at their lowest storage, the City can access the **ditch** bottoms with equipment and mechanically remove the vegetation and accumulated sediments.
- **Sediment and Erosion Control at Development Sites.** In compliance with City Ordinance No. 54-3-11.2. (*Appendix J*) and the City's **NPDES Permit** (*Appendix L*), proper erosion

and sediment control at all sites of development is required to be established and maintained throughout the duration of the project and is inspected regularly for compliance. Sediments directly washing off a site, and into the ditches build a mound of **substrate** for vegetation to establish and carry nutrients which many invasive species thrive on. These sediments can travel with stormwater and enter the canals as well.

- **Mowing.** The City maintains a contract for mowing of all right-of-way areas and ditch banks. Mowing the ditch banks reduces the self-seeding of the pest vegetation while still allowing the vegetation to remain established as it plays an important role in stabilizing the banks and filtering nutrients and sediments.
- **Mow at correct height.** Mowing to low can thin out and starve the vegetation and mowing too high or not often enough can facilitate the further spread of the plants.
- **Always mow with sharp blades and Sanitize Tools.** Dull mower blades cause uneven cutting and weaken the grasses. Vegetation can easily spread among sites by hitchhiking seeds and plant fragments on un-sanitized mowing and maintenance equipment. Cleaning these tools between areas minimizes the transport of **noxious aquatic vegetation**.

Water flows between ponds, through the reconstructed rocky spillway at the Stormwater Treatment Area.

A massive mat of Torpedo Grass dominates this canal.

VII. FURTHER NON-CHEMICAL RECOMMENDATIONS

Future Considerations

In addition to the cultural and mechanical **noxious aquatic vegetation** control methods currently being implemented within the City's stormwater conveyance system, observations of the areas and sub-committee member research prompted the following recommendations for future consideration *(Figure 6):*

- **Seawall Reconstruction.** **Seawalls** border most of the City's canal system. The seawalls stabilize the canal banks and help hold back nutrient laden run-off from residential and commercial landscapes, forcing it to filter downward through the soil profile before entering surficial or ground waters. In many areas the seawalls are damaged and/or failing and in need of replacement.
- **Skimmer Device.** Large device that requires electricity and is easily movable between **ponds**. Water and material are pumped into an onshore filtration unit which is effective in removing duckweed, water meal, azolla, but not larger aquatic plants. Should these species become a frequent problem in the ponds, the purchase of this device is recommended.
- **Expanded Excavation of Open Water Areas.** **Excavation** of canal, pond, and ditch bottoms to de-muck the nutrient rich deposits that comprise the top layer of the **substrate** and remove seawall sediments, which readily accommodate noxious aquatic vegetation growth
- **Environmental Enhancements.** Creation of a self-maintaining **littoral shelf** with native aquatic vegetation, which will provide healthy habitat and nutrient filtration.
- **Pathogens.** The control of some noxious aquatic vegetation can be aided by aerobic **pathogens**, such as specific bacteria or fungus, which are amended to the **herbicides** or the water itself. While these bio herbicides are currently under research and review, many studies have shown that when partnered with added **aeration**, they may help provide more effective long-term control. It is also recommended that the **pathogens** be added fresh daily which will also require specialized equipment and dedicated staff. The best candidates for this method are small to medium sized ponds, during periods of very little in/outflow, which have existing aeration.
- **Stormwater Fee Credits.** Utilize the existing Stormwater Fee Credit Program to incentivize commercial property owners to install a **buffer zone** of **emergent vegetation** along their stormwater features. Also, enhanced outreach efforts could increase participation in the existing program.
- **Nutrient Management.** Excess nutrients in an aquatic system are known to be one of the largest contributors to noxious aquatic vegetation overgrowth. It is recommended that the City continue championing programs like the septic to sewer conversion grants and oyster reef restoration projects and outreach regarding the City's Fertilizer Ordinance (*Appendix C*). City staff should continue to seek participation in similar programs that help to further reduce nutrient outputs into waterbodies.

BIOLOGICAL, CULTURAL, AND MECHANICAL CONTROLS						
	Control Method	**Vegetation Type**	**Asset Classification**	**Description**	**How to Implement**	**Currently in Use?**
BIOLOGICAL	**Pathogens**	Limited	All	Some plant pathogens, such as bacteria, enzymes, or fungi, can stress aquatic plants – commercially available pathogens(bioherbicides) are under research evaluation	Usually combined with herbicides to provide more effective long-term control. Requires areas of still water and is often paired with direct aeration	No
CULTURAL	**Always Mow with Sharp Blades**	Emergent	Ditches	Dull mower blades cause uneven cutting and weaken the grass blades. Vegetation along sloping shorelines is crucial to shoreline stabilization and the prevention of sediment and nutrient laden runoff entering the waters.	Ensure that staff sharpens all mower blades on a consistent schedule and when necessary. The City and the contractor has the tools and trained staff to accomplish this.	Yes
	Minimizing Nutrient Inputs	All	All	Reducing the amount of Nitrogen and Phosphorus entering the conveyance system to the maximum extent practicable.	Ferilizer Ordinance, NPDES Compliance, erosion control ordinance and inspections, BMAP participation, stormwater park ponds, resident outreach.	Yes
	Native Shoreline Plantings	Emergent	Ponds, Canals	Native shoreline plantings will attract natural predators, prevent the establishment of invasive aquatics, filter water entering the waterbody, and support a healthy aquatic ecosystem.	As the budget allows or in working with local non-profit groups begin to introduce more plantings of florida freshwater shoreline natives to our accessible shorelines.	Yes
	Maintain Updated Chemical and Fertilizer Application Equipment	All	All	Maintaining updated chemical and fertilizer application equipment is necessary to adhere to the label requirements for applications to ensure equipment is calibrated. Updated motorized equipment cleans more efficiently, calibrates and hold calibration more accurately and deteriorated parts can be easily replaced.	Staff will stay up-to-date on the equipment and ensure that equipment is replaced as necessary to ensure the correct calibrations are applied per the label. Staff will also maintain servicing all parts necessary as recommended from the manufacturer.	Yes
	Direct Aeration	Algae	All	Bottom-up hypnolimnetic aeration provides oxygen for microorganisms to more efficiently break down muck and nutrients, effectively reducing algal growth. Also can prevent fish kills in small ponds. Aeration is especially helpful in water bodies with limited circulation	Would specifically be reccommended at structural choke points where muck accumulates and used in correlation with the addition of pathogens.	No
	Fountains	Algae	Ponds	Fountains help move the water from the pond's surface to the bottom. Aeration by the fountain oxygenates the water, keeping hydrogen sulfide gas from collecting at the bottom and ultimately, significantly reducing the amount of this gas in the pond. Effectively reduces algae, duckweed and watermeal.	Many ponds already have fountains installed. Future addition of fountains in other ponds is advisable where site conditions are favorable.	Yes
	Mow at Correct Height	All	Ditches	Mowing shoreline vegetation at the correct height will ensure that we promote healthy grass and maintain shoreline stabilization	Ensure that staff and contractors are not mowing the shoreline grasses so short that it poses a risk to the plant and root health	Yes
	Tool Sanitation	All	All	Pests can easily spread among sites on unsanitized equipment. Many aquatic pests multiply easily from small pieces of vegetation. Cleaning mowers, tractors, and equipment between areas minimizes pest transport.	Stormwater Staff and contractors must wash down and clean all equipment as frequently as possible, especially when leaving areas with pest problems.	Yes
MECHANICAL	**Dredging/ Excavation**	All	Canals, Ponds, Ditches	Plants and sediments are removed-increases water depth,restores storage capacity, and removes nutrient rich sediments. Ideal for highly impacted areas.	Heavy equipment requires broad access path to areas. This is not for natural areas as the turbidity is greatly incresed and nutrients are released into water column	Yes
	Manual Weed Pulling	Emergent	Structures	Where safe and applicable, manual weed eradication will involve staff manually pulling weeds.	Areas where it is safe and applicable can have manual weed eradication.	Yes
	Vacuum Removal	All	Structures	A vacuum truck is utilized by City staff to remove all accumulated sediments and vegetative debris from all catch basins	Staff cleans out these structures regularly and keeps record of how much debris is removed.	Yes
	Mechanical Removal	All, except duckweed, watermeal	Ponds, Canals, Some structures	Removal of vegetation by specially designed aquatic harvesters. Cut vegetation is removed and piled on shoreline for disposal. This process must be repeated throughout the growing season to maintain control. This process disturbs the sediments in the substrate and is non-selective, often removing fish and other fauna in the process. This method can be very costly.	Only about 50% of the City's canal system is accessible by this type of equipment and most of the shoreline is privately-owned with very limited access for piling and removing the cut vegetation. This method is reccommended when the location and cost are feasible.	Yes
	Skimmer Device	Duckweed, Watermeal, Azolla	Ponds	Large device that requires electricity and is easily movable between ponds. which is effective in removing small floating vegetation.	Water and material are pumped into an onshore filtration unit. Vegetation is piled onto shoreline by conveyor, then must be manually removed off site.	No

Figure 6: *Table of Recommended Non-Chemical Control Methods*

VIII. AQUATIC HERBICIDE USE METHODOLOGY

Minimal chemical controls are to be utilized in collaboration with biological, mechanical, and cultural control methods, as listed on *Figure* 6. The non-chemical control methods are being implemented by City staff and contractors as part of routine maintenance of the stormwater conveyance system, but alone cannot always reduce **noxious aquatic vegetation** populations below tolerance thresholds; therefore, the City will support these efforts with an aquatic weed spraying program. The use of aquatic herbicides requires extensive species and product knowledge, highly specialized licensing, and years of work experience to master. For this reason, aquatic **herbicide** application will not be conducted by City staff, but rather by a reputable and certified aquatic plant management contractor. The pesticides used as part of this IPM program will only be those that have met federal and state approval standards for aquatic use, as research has found them to be the most effective and pose the least risk to environmental and human health. This integrated pest management strategy is aimed at reducing the total amount of herbicides needed over the long term.

Planning Pesticide Application

Inspection and Monitoring. Frequent surveillance and proper identification of noxious aquatic vegetation is integral to the early detection and rapid response that minimizes herbicide use. Before chemical control methods are utilized, the certified applicator will properly identify the plant, weather, and location. All inspection and application data will be recorded in the field by the certified applicator on the "Field Treatment Sheets" Form *(Appendix D)*.

Application Methods. Aquatic herbicides may be applied directly to the plants, directly to the water, or to the plant and the water simultaneously. The method of application utilized is greatly dependent on the individual species' characteristics and growth habit. Also considered is the location, the time of year, weather, water-oxygen levels, in addition to numerous other variables which may be indicated on the product's label. If the species is not in its growth season, it may not uptake and be affected by a systemic herbicide. Environmental conditions, such as high winds, low temperatures, or heavy rainfall may dictate that the use of certain herbicides is not permissible. These limitations are indicated on the label and of course, the LABEL IS THE LAW.

Discouraged Procedures. Large-scale broadcast applications increase the risks to non-target plant/ animal species and increase the chance of **herbicide resistance**. While invasive plants are the primary target for control, native plants should only be treated when their localized populations are approaching nuisance levels, impeding the functions of the stormwater system. Additionally, the full labeled application rate of an aquatic herbicide is often significantly higher than what may be the lowest effective rate for a target species. Careful attention must be paid to what is recommended for the target plant. These procedures should be avoided whenever possible, unless such applications may be reasonably expected to

result in an overall reduction in **herbicide** use when compared with all other practicable alternatives.

Buffer Zones. The "IPM Plan for City Parks and Properties" provides that as park landscapes are treated with pesticides or fertilizers near stormwater features, a **buffer zone** must be observed in order to protect the shoreline integrity and water quality. Therefore, no terrestrial application of pesticides or fertilizers may occur within a minimum of 10 feet from these features by City staff or by landscape contractors. These areas contain emergent wetland vegetation and are to only be treated for **noxious aquatic vegetation** by the licensed aquatic herbicide contractor. Native emergent vegetation should be protected to the maximum extent possible.

Concentrations & Application Rates. Proper herbicide application entails applying the minimum amount of product to provide effective control. For this reason, the herbicide manufacturers spend millions of dollars to determine the rate, and therefore the amount, that the herbicide should be applied at. These products rarely arrive from the manufacturer ready to use for commercial applications. It is up to the applicator to dilute or mix the product with water, and appropriate adjuvants, or other herbicides, according to the specific directions for aquatic use on the product label. If fact, what is visibly seen being applied in the field is approximately only 1-5% actual herbicide, the rest is water. The exact concentration of the active ingredient in the herbicide mixture is critical to its effectiveness. Too little product in the mixture may result in reduced efficacy, while too much may result in injury to the treated surface, illegal residues, impacts to the surrounding environment, or unnecessary expense. While the instructions for mixing the product involve simple calculations, it is important that all measurements be made accurately, carefully, and with the most precise measuring equipment available.

Directions for mixing and applying aquatic herbicides come in two general scenarios: rate per volume of water (herbicide concentration) or rate per area of land (lb. or qt. per acre). Mixing directions will vary. Herbicides that are mixed by concentration generally have specific directions for application. Some insecticide application directions may state to apply until spray runs off the target plant. Some herbicide application directions may state to apply only enough spray material to wet the leaves uniformly. Proper calibration of equipment and knowing how fast it is moving is crucial to controlling how much herbicide is being applied. The applicator must read the label to know how much product to apply and what method of application to use. THE LABEL IS THE LAW.

Safety Data Sheets. A binder of product labels and **safety data sheets (SDS)** for all approved herbicides will be provided to City staff and third party contractors whom apply, or may come in direct contact with the herbicides. In addition, this data will be available on the City's IPM website.

Aquatic Herbicide Selection

There are seventeen **herbicide** active ingredients (chemical compounds) approved by the state for use in Florida waters. These active ingredients may be formulated and sold under various trade names. There are more than 100 different registered trade names currently in use in Florida. A comprehensive list of approved herbicides for use within the City's **stormwater conveyance system** has been compiled by the IPM Sub-Committee. All trade names which have been previously, or are currently used by our spraying contractors are listed on this table, categorized by their active ingredient. The "Approved Herbicide and Adjuvant Table" includes pertinent chemical attributes such as: active ingredients and their percentages, EPA Registration #, targeted plant class, labeled signal word, and a cost rating per 1000 ft². *(Figure 7)*. Selection of herbicides for aquatic use should be based upon a combination of a low Environmental Impact Quotient (EIQ), low cost, and maximum efficacy.

Mode of Action. Each active ingredient varies in how they affect the plant's tissues, or disrupt biological processes, in order to damage the plant. The sequences of events initiated by the herbicide, which begin with absorption and end eventually with the plant's death, are considered the herbicide's **mode of action (MOA)**. Herbicides with the same MOA will have the same translocation pattern within the plant and cause similar injury symptoms. All individual EPA approved aquatic herbicides have a single active ingredient and therefore a single MOA. The repeated use of same MOA herbicides is frequently associated with the eventual creation of a plant hybrid which is less susceptible to herbicide management. This potential for hybridization is a great operational concern in managing aquatics.

Herbicide Resistance. Single MOA compounds have also proven to be more prone to resistance development, which is unique to Florida's aquatic systems. For this reason, aquatic herbicides have to be carefully used in order to prevent **herbicide resistance**. Resistance management strategies are an important component of a successful long-term integrated pest management program for aquatic plants. The Weed Science Society of America (WSSA) has classified the active ingredients for aquatic herbicides into groupings. The "WSSA group" number describes the possibility of a plant population developing resistance after repeated use. To prevent/mitigate herbicide resistance, it is advised to rotate or combine herbicide MOAs , which will help reduce the selective pressure applied by any one product. For example: Imazypyr and glyphosate-based herbicides are combined to effectively treat torpedo grass without harming the surrounding bulrush and native grasses.

Chemical Adjuvants. An important component to herbicide application is the use of a class of chemicals called **adjuvants**. Adjuvants do not directly affect the plant but they can greatly affect the physical characteristics of the applied product(s). Adjuvants can be added to the application solution in order to increase leaf coverage, assist with herbicide uptake, prevent chemical drift to non-target species, and control and sink submersed treatments. Knowledge of basic adjuvant chemistry and proper use of adjuvants helps increase the efficacy of the treatment, reduce effects on non-target species, and ultimately reduce the amount of

herbicide applied. Overall adjuvants are important to protecting water quality and ensuring the environmental and economic sustainability of the IPM program. All adjuvants used by the contractors will be included in the "Approved Herbicide and Adjuvant" Table as well.

Environmental Impact Quotient (EIQ). To best create a comparison among chemical methods, the **Environmental Impact Quotient (EIQ)** Method will be applied. Developed by Cornell University, the EIQ is a numerical model for general pesticide selection. The formula takes into account factors such as: toxicity to humans, leachability to groundwater, runoff potential, soil persistence, and the effects on non-target terrestrial and aquatic species. *(Appendix F)* The risk of each chemical is the product of its overall toxicity and the potential for exposure. Cornell has a published table of commonly used chemicals and their calculated scores. The EIQ was developed for terrestrial use and the numbers may not be as accurate for all products when used in an aquatic system, however, it remains the most feasible comparison tool available. (Kovatch, et.al, 1992)

Field Use EIQ. However, since the risk of a chemical's use increases with the amount that is applied, it is necessary to take into account the rate of application. In order to accomplish this, the EIQ is multiplied by the % of the active ingredient and the rate of application to create the Field Use EIQ Rating. The **field use EIQs** for all chemicals applied over a period of time can then be summed to create a field number that can then be compared to assess the reduction in environmental impacts among years or seasons. The Field Use EIQ can also be utilized to compare when multiple applications of a low EIQ pesticide, such as a bio pesticide, are required versus when single applications are required of a higher EIQ pesticide *(Appendix F)*. (Kovatch, et.al, 1992)

Bio-Herbicides. In the IPM Sub-Committee's quest to provide pest management options that are not only effective, but also have the least possible risk to human and environmental health, **bio-herbicide** options were reviewed extensively. Bio-herbicides, also called "natural" or "organic" herbicides, are non-synthetic and contain only naturally occurring substances. These products break down rapidly in sunlight or especially in water. This means that they do not persist long in the environment and therefore pose the least risk to non-target organisms.

There are potential risks associated with the application of natural products that the IPM Sub-Committee must consider when reviewing herbicide options for the "Approved Herbicide and Adjuvant Table." It is important to note that all herbicides, whether natural or synthetic, carry inherent risks and require safety precautions. The ability to break down fast can also mean that multiple applications are required to match the efficacy of the synthetic chemical option. Multiple applications can drastically increase the cost and the risks of the product. Because bio herbicides are made of natural substances, they often are exempt from the Environmental Protection Agency (EPA) review process. Therefore, there is little to no data on the long-term risks or efficacy in aquatic systems. Bio-herbicides have only proven minimally effective on the dense cell structure of aquatic plants.

Of those that are registered by the EPA, many are not registered for sale in Florida, due to the lack of data. A licensed applicator may not legally use an aquatic herbicide that is not state registered in this manner, per Florida Statutes: 482 and 487. Bio-herbicides that are registered may not be mass produced for commercial use and therefore may be priced too high for use over large areas, or simply not readily available. The lack of EPA review and state registration also means that they are produced by a variety of different sources, which often results in inconsistent potency and efficacy among producers and even within different batches from the same producer. For these reasons, there no bio-herbicides named on the "Approved Herbicide and Adjuvant Table."

Herbicide Restrictions. In the development of a thorough and reasonable IPM Plan for aquatic plants, it is not advisable to prohibit the use of any IPM Method or herbicide active ingredient which has been EPA and State approved. Unforeseeable conditions may arise in which the contractor is limited in what will be effective at reducing **noxious aquatic vegetation** populations. In addition, the IPM Sub-Committee recognizes that the applicator must constantly alter the herbicide solutions/combinations and rotate herbicides applied in order to reduce overall herbicide use, increase the efficacy of treatments, reduce effects on non-target species, and protect water quality. Therefore, no herbicide active ingredient on the "Approved Herbicide and Adjuvant Table" *(Figure 7)* will be exempted, limited, or restricted from use.

Prior to the use of any new herbicide which is not included on this table, a "Pesticide Exemption Form" (*Appendix G*) must be completed by the applicator and submitted to the Leisure Services Director, Stormwater Director, IPM Coordinator, and City Manager for signed approval. This form is to be submitted four days prior to proposed application date. The form requires justification for the use of the pesticide. However, should a new herbicide trade name, containing the same concentration, or less, of active ingredient(s) as already appears on the table be preferred by the spraying contractor, the exemption form must be completed and submitted to the IPM Coordinator, but approval will not be required.

Treatment Notification

The City shall provide the public with notification of planned aquatic herbicide applications, 24 hours prior, through the City's IPM website. Visitors to the City's IPM website may view specific information about upcoming treatments and opt to join an email list to receive regular notifications directly.

In addition, the Aquatic Herbicide Notification Sign *(Appendix E)* will be completed and posted at time of application, at all major public points of entry (including kayak launches), or areas with direct access to the treated area pursuant to state and/or federal law, the City's IPM Plan, and according to product label instructions. Signage will remain in place for 48 hours following the application, unless the manufacturer's product label specifies a longer posting period. Signs shall be of standardized design, printed in color, laminated, and contain the name of the herbicide product, target plant, date and time applied, required re-entry interval

and the phone number for the Citizen Request Line, where they may request more information.

Conditional Exemptions. The Stormwater Director, Leisure Services Director, and IPM Coordinator may grant authorization to apply an herbicide within the stormwater system without providing a 24 hour online notification. Authorization requires that there is a compelling need to use the herbicide, such as immediate threat to public health, safety, City property, or substantial economic detriment. Online notification will be posted as soon as possible. All documentation of this exemption must be retained and included in the annual report. On-site signage shall not be required in right-of-way locations that the general public is not authorized to use for recreation, or pedestrian purposes, such as those that are completely fenced in or separated by seawall, or otherwise inaccessible.

The sun sets on the Elkcam Waterway.

Water lilies, Torpedo Grass, and Water Hyacinth all flourish in a ditch bordering fertilized lawns.

Water flows freely at the Hardee Dam following a massive mechanical removal project.

Figure 7: *Approved Herbicide and Adjuvant Table* (SWIPM.APT.V1)

ACTIVE INGREDIENT	ACTION	TRADE NAME	EPA REG. #	WSSA RESISTANCE MGT. GROUP	ACTIVE INGREDIENT	LABELED SIGNAL WORD*	EIQ	Maximum Use Rate	FIELD USE EIQ	EIQ ECOLOGICAL COMPONENT**	TRAITS	TARGET CLASS	TARGET SPECIES	PRODUCT COST	COST RATING/ ACRE ***
Alkanolamide	adjuvant	Cohere	NA	NA	90.00%	warning	NA	NA	NA	NA	spreader, sticker	NA	NA	$138 per 2.5 gals	$
methelated seed oil	adjuvant	Alligare MSO 1 SunEnergy	NA	NA	100.00%	warning	30.9	NA	NA	NA	surfactant	NA	NA	$61.25 per 2.5 gals	$
polyacrylamide	adjuvant	Accuracy Polycontrol 2	NA	NA	30%	warning	NA	NA	NA	NA	deposition & drift retardant	NA	NA	$129.77 per 1 gal	$
D-limonene	adjuvant	Kammo Plus	NA	NA	100%	warning	NA	NA	NA	NA	surfactant	NA	NA	$92.51 per 1 gal	$
polyoxlkane ethers	adjuvant	Induce	NA	NA	90%	warning	NA	NA	NA	NA	wetter, spreader	NA	NA	$136.39 per 2.5 gals	$
Bispyribac	herbicide	Tradewind (powder)	59639-165	2	80%	caution	11.47	2oz/acre	1.1	2.3	systemic, selective	submersed, floating	Hydrilla	$1,175.95 per 2 lbs	$$$$
Carfentrazone	herbicide	Stingray Speedzone	279-3279-67690 2217-833	14	21.3% 28.6%	caution	20.2	13.5 oz/acre 5 pints/acre	3.6 28.9	8.5 68.0	contact, selective	emergent, floating	Primrose, Water Lettuce, Hyacinth	$205.95 per 1 qt	$$
Copper	herbicide, algaecide	copper sulfate (crystals)	56576-1	NA	99%	danger	61.9	1.75 lbs/acre	107.2	256.8	contact, non-selective	submersed	algae	$45.95 per 1 gal	$
Diquat	herbicide	Tribune Reward	100-1390 100-1091	22	37.30%	caution	39.2	.5 gal/acre	58.5	111.3	contact, non-selective	submersed, emergent floating	hyacinth, water lettuce, salvinia, mosquito fern	$221.95 per 1 gal	$
Endothall	hebicide	Aquathol	70506-176	Unknown	40.30%	danger	24	9.4 fl oz/ acre	38.7	82.1	contact/systemic, non-selective	submersed	hydrilla, filementous algae	$135.95 per 1 gal	$$
Florpyrauxifen	herbicide	ProcellaCOR SC Clipper	67690-79	4	26.50%	caution	NA	6.75 oz/acre-ft	NA	NA	systemic, non-selective	submersed, emergent, floating	hydrilla, hyacinth, primrose, watermilfoil	$595.95 per 5 lbs	$$$
Flumioxazin	herbicide	Clipper Schooner Semera (granule)	59639-120-91234	14	51%	caution	23.97	3 oz/acre	2.3	4.8	contact, non-selective	submersed, emergent, floating	algal mats, hydrilla, cabomba, water lettuce, duckweed, salvinia, spatterdock, water lilly	$300 per 5 gals	$$
Fluridone	herbicide	Avast	67690-30	12	41.70%	caution	8	2.1 lb/acre	7	12.3	systemic, non-selective	submersed	hydrilla, duckweed	$2,215.95 per 1 gal	$$$$
Glyphosate	herbicide	Roundup Custom AquaNeat	228-365	9	53.80%	caution	15.3	6 pints/acre	49.5	113	systemic, non-selective	emergent, floating	grasses, cattail, primrose, tussocks	$89.95 per 2.5 gals	$
Imazamox	herbicide	Clearcast	241-437-67690	2	12.10%	caution	19.5	1 gal/acre	18.9	41.2	systemic, selective	submersed, emergent, floating	cattail, wild taro, hyacinth	$355.95 per 1 gal	$$$
Imazapyr	herbicide	Polaris AQ Ecomazapyr 2	241-426-228	2	28.70%	caution	22.3	4 pints/acre	25.6	61.9	systemic, non-selective	emergent	tussocks, cattail, torpedo-grass, rush, melaleuca	$235.95 per 2.5 gals	$$
Penoxsulam	herbicide	Galleon SC	67690-47	2	21.70%	caution	18.72	5.6 fl oz/acre	1.4	2.6	systemic	emergent, floating, submersed	hydrilla, hyacinth	$695.95 per 1 qt.	$$
Peroxides	algaecide	GreenCleenPRO	70299-15	Unclassified	2760%	danger	16	.5 lb/ 1000 ft2	96.2	72.1	contact, non-selective	submersed, algae	planktonic algae, esp. blue-green	$139.95 per 50 lbs	$
Sethoxydim	herbicide	Segment	7969-88	1	13%	caution	20.89	40 oz/ acre	6.8	16.6	systemic, selective	emergent	grasses	$707.06 per 2.5 gals	$$$
Topramezone	herbicide	Oasis	7969-339-67690	27	29.70%	caution	27.17	16 fl oz/ acre	8.1	19	systemic	submersed	hydrilla, hyacinth	$811.95 per 1 qt	$$$
Triclopyr	herbicide	Garlon 3A Trycera	62719-37 5905-580	4	44.4% 29.4%	danger	11	8 qt/acre	78.1 51.7	142.1 94.1	systemic	submersed, emergent	brazilian pepper, broadleaf, hyacinch, water milfoil	$69.95 per 1 qt	$
2, 4-D	herbicide	Weedar 64 (liquid) Rugged (liquid)	71368-1 1381-247	4	46% 38.4%	danger	20.67 16.67	1gal/acre 4.12 gal/acre	56.4 53.0	128.8 121	systemic, selective	submersed, emergent, floating	milfoil, hyacinth	$23.95 per 1 gal	$

*** LABELED SIGNAL WORD**

CAUTION: The pesticide product is slightly toxic if eaten, absorbed through the skin, inhaled, or it causes skin irritation.
WARNING: Indicates the pesticide product is moderately toxic if eaten, absorbed through the skin, inhaled, or it causes moderate eye or skin irritation.
DANGER: The pesticide is highly toxic by at least one route of exposure. It may be corrosive, causing irreversible damage to the skin or eyes. Alternatively, it may be highly toxic if eaten, absorbed through the skin, or inhaled. If this is the case, then the word "POISON" must also be included in red letters on the front panel of the product label

**** EIQ ECOLOGICAL COMPONENT**

= Combined score for effects on (Fish)+(Bird) +(Bee)+ (Beneficial)

***** COST/ ACRE RATNG**

$ = LESS THAN $10.00
$$ = $11.00-30.00
$$$ =$31.00-59.00
$$$$ = OVER $60.00

IX. DATA MANAGEMENT

Accurate records are essential for the success of an IPM program. They provide staff with historical, site-specific knowledge of **noxious aquatic vegetation** growth and herbicide application. With this information, it can be predicted when certain plant problems are likely to occur. Effective record-keeping can also call attention to patterns of noxious vegetation outbreaks and associations among plant populations, as well as provide valuable data for assessment of the IPM Program.

Data Recording & Collection

Field Data. All Non-Chemical pest control activities conducted within the stormwater system will be recorded on the "Monthly IPM Log" *(Appendix H)*. Before chemical control methods are utilized, the licensed applicator will need to properly identify the plant. All information regarding the species of plant, along with the date, time, location, herbicide applied, application rate, and applicator will be recorded on the "Field Treatment Sheet" *(Appendix D)* each time that herbicides are applied. These sheets will be completed manually in the field by the certified applicator and submitted to the IPM Coordinator monthly so that the data may be digitally compiled and stored.

Quality Control. Staff will conduct random post-spraying visual assessments. In particular, specific problem areas will be followed-up on with contractor, as appropriate. Notes will be added to "field treatment sheets" *(Appendix D)*.

Purchase Orders. All purchase orders for chemicals or IPM related equipment and materials will be submitted annually to the IPM Coordinator.

Contractors. All contractors who manage **noxious aquatic vegetation** on City owned, leased, or managed property shall be required to adhere to the guidelines established in the City's Stormwater IPM Plan. Contractors must sign the "Contractor Agreement" *(Appendix B)* and maintain complete records of all chemical and non-chemical pest control activities. When applicable, a "Pesticide Exemption Form" must be submitted. "Aquatic Herbicide Notification Signage" must also be posted per the IPM plan requirements. A summary of these activities must be submitted to the IPM Coordinator monthly, or upon completion of the job. These records must include "field treatment sheets" for all herbicide applications.

Program Transparency

All records and information regarding the IPM Program will be made available to employees and the public through the City's IPM Program Website and upon request, in accordance with the Freedom of Information Act, Florida Statute: 119.

Annual Report & Evaluation

The IPM Coordinator will maintain all records relevant to the IPM Program, in order to prepare an annual report of the City's IPM activities. The annual report will be reviewed, each March, by the IPM Sub-Committee and City staff in an effort to assess the effectiveness of all pest control methods, feasibility of new methods and technologies, and to decide whether revision of the IPM Plan is required. The annual report will include the following elements:

- A summary of all field treatment sheet data
- All non-chemical plant control methods implemented
- Summarized data presented in tables and graphs to depict trends in usage and Field use EIQ
- A discussion of all restricted chemical wavier forms submitted
- Purchase orders for all herbicides
- Plant management challenges reported by staff and contractors
- Determine if the results have met expectations, or if the IPM plan requires modification
- Summary of all public outreach activities conducted
- Any proposed modifications to the "Approved Herbicide and Adjuvant Table"
- Suggestions for amendments to the IPM Plan and policy
- Summary of all staff training activities

The "watering hole," is a scenic spot along the St. Sebastian River, at the Stonecrop outfall area.

An overgrowth of Water Hyacinth blocks up the weir at the Stonecrop outfall.

X. FUTURE RECOMMENDATIONS

The IPM Sub-Committee acknowledges that this plan does not encompass every aspect of integrated pest management, nor could it address every possible scenario that may arise as this plan is incorporated into City policy. For this reason, the sub-committee members are in consensus that they shall reconvene six (6) months following adoption of this plan in order to closely review the data collected and address any inconsistencies, or amendments needed.

For future consideration the Sub-Committee Members make the following recommendations:

- Cornell University's **EIQ** is designed for crop and turf grass applications; there are no other similar numerical pesticide evaluation methods designed specifically for aquatic herbicide use. The committee agrees that the EIQ is still useful and will provide a good numerical comparison of chemicals used over time. During future annual reviews of this plan, committee members will research for updates to the EIQ, or the creation of other numerical comparison methods which are better suited.
- The collection of data for purposes of monitoring impact to native plants, animals, and pollinators from the conduct of all plant management activities is not being required. The field EIQ formula assumes that native plants, animals, and pollinators are all present and measures potential risks to them by using the score assigned to the active ingredient and incorporating the area covered and frequency of application. Should future review of data that are being collected indicate excessive or regular use of chemicals, a more quantitative approach may be needed.
- At the time that this IPM plan was drafted, there are no **bio-herbicides** that are state-approved for use on aquatic vegetation. It is therefore recommended that the IPM Coordinator check the state website regularly, so that as soon as one is available, it may be approved for inclusion into the "Approved Herbicides and Adjuvants Table."
- This plan addresses **noxious aquatic vegetation** as the only "pest" of the stormwater conveyance system, however, the committee realizes this may not always be the case and upon future annual reviews, the need for control of insects or pathogens may need to be addressed.

City staff works hard year-round to mechanically remove vegetation and sediments to keep the stormwater moving.

Appendix A: R-21-14

RESOLUTION NO.R-21-14

A RESOLUTION OF THE CITY OF SEBASTIAN, INDIAN RIVER COUNTY, FLORIDA, SUPPORTING THE "INTEGRATED PEST MANAGEMENT (IPM) PLAN FOR THE CITY'S STORMWATER CONVEYANCE SYSTEM" TO BE IMPLEMENTED INTO CITY POLICY; PROVIDING FOR SCRIVENER'S ERRORS; PROVIDING FOR EFFECTIVE DATE.

WHEREAS, City Council believes that a commitment to the environment is integral to a thriving and livable community; are in support of the "Sustainable Sebastian" Initiative (R-19-30), and are committed to keeping sustainability in mind while supporting the ecological, economic, and social needs of our community, and

WHEREAS, the Stormwater Integrated Pest Management (IPM) Sub-Committee was created in November, 2020 by request of the City Council, to assist City staff in the development of an IPM Plan for the City's stormwater conveyance system, and

WHEREAS, The "Florida Aquatic Plant Management Act," Section 369.22, Florida Statute recognizes that the uncontrolled growth of noxious aquatic vegetation in the waters of Florida poses a variety of environmental, health, safety, and economic problems and charges the owners of the waters with the implementation of a "maintenance control program" to decrease the growth and spread of noxious aquatic plants, and

WHEREAS, the control of noxious aquatic vegetation is required in order to maintain an effective stormwater conveyance system which provides for the movement, storage, and treatment of the City's stormwater.

WHEREAS, to adopt an *integrated pest management* policy is to promote the most sustainable noxious aquatic plant management methods, based on planning and prevention; which aim to minimize risks to human and environmental health by promoting biological, physical, mechanical, and cultural plant control methods, and through the limited use of chemicals, while also remaining economically feasible.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF SEBASTIAN, INDIAN RIVER COUNTY, FLORIDA, as follows:

SECTION 1. SUPPORT FOR THE *"IPM PLAN FOR THE CITY'S STORMWATER CONVEYANCE SYSTEM"*. The City Council hereby is in support of the "IPM Plan for the City's Stormwater Conveyance System", which shall be implemented into City policy and regularly reviewed, by the Leisure Services Director, Stormwater Director, IPM Coordinator, IPM Sub-Committee, and City Council to ensure that the four following goals are being achieved to the maximum extent practicable:

- Protect environmental resources by reducing the amount of pollutants entering surface and ground water, minimizing effects on native plants, animals and habitats
- Ensure effective, economic plant management within city-maintained waters and waterways, while minimizing health risks to the public, City staff, and the environment
- Promote the transparency of the City's aquatic plant management activities
- Increase public awareness of IPM methods and benefits

SECTION 2. CONFLICT. All resolutions or parts of resolutions in conflict herewith are hereby repealed.

SECTION 3. SCRIVENER'S ERRORS. Sections of this resolution may be renumbered or re-lettered and corrections of typographical errors which do not affect the intent may be authorized by the City Manager, or the City Manager's designee, without need of further action of the City Council by filing a corrected copy of same with the City Clerk.

SECTION 4. EFFECTIVE DATE. This resolution shall take effect immediately upon its adoption.

The foregoing Resolution was moved for adoption by Councilmember Hill. The motion was seconded by Councilmember Jones and, upon being put into a vote, the vote was as follows:

Mayor Ed Dodd	aye
Vice Mayor Jim Hill	aye
Councilmember Bob McPartlan	aye
Councilmember Christopher Nunn	aye
Councilmember Fred Jones	aye

The Mayor thereupon declared this Resolution duly passed and adopted this 8th day of September, 2021.

CITY OF SEBASTIAN, FLORIDA

By: _____
Ed Dodd, Mayor

ATTEST:

Jeanette Williams, MMC
City Clerk

Approved as to Form and Content for
Reliance by the City of Sebastian Only:

Manny Anon, Jr., City Attorney

Appendix B: Contractor Agreement

Administrative Services Department
Procurement Division
1225 Main Street
Sebastian, FL 32958
(772) 388-8232

STORMWATER IPM PLAN CONTRACTOR AGREEMENT

The Contractor, _____, hereby agrees to all of the
(Company Name)
following:

- Review and follow the City's IPM Plan for the stormwater conveyance system completely
- Inform and train employees of the IPM Plan's policies and procedures.
- Use only herbicides/ adjuvants listed in the "Approved Herbicide and Adjuvant Table", and apply in accordance with rates/methods on the associating label.
- Complete the "Field Treatment Sheets" completely with every pesticide application.
- Should there be a need to apply an approved pesticide with a higher percent active ingredient than listed on the table or a pesticide which is not named on the table, a "Pesticide Exemption Form" must be completed and submitted to the Stormwater Director at least four (4) days before proposed application date.
- Notify the Stormwater Director at least three (3) business days before pesticide application. Provide the location, date and anticipated chemicals being used.
- Post the completed "Aquatic Herbicide Notification Signage" at time of application, in accordance with the IPM Plan requirements.
- Report monthly to the IPM Coordinator with all treatment sheets and detailed invoices

I am a legal agent of the above named company and am fully authorized to sign and bind the above listed Company to this IPM Plan Contractor.

Print Name: _____ Title: _____

Signature: _____ Date: _____

Appendix C: City Fertilizer Ordinance

City of Sebastian

Code of Ordinances

CH.50 Sec. 50-5. - Florida-friendly fertilizer use on urban landscapes.

(a) *Findings.* As a result of impairment to the City of Sebastian's surface waters caused by excessive nutrients, or, as a result of increasing levels of nitrogen in the surface and/or ground water within the aquifers or springs within the boundaries of the City of Sebastian, the city council has determined that the use of fertilizers on lands within the City of Sebastian creates a contributing risk that adversely effects surface and/or ground water.

(b) *Purpose and intent.* This section regulates the proper use of fertilizers by any applicator; requires proper training of commercial and institutional fertilizer applicators; establishes training and licensing requirements; establishes a prohibition application period; specifies allowable fertilizer application rates and methods, fertilizer-free zones, low maintenance zones, and exemptions. The ordinance requires the use of Best Management Practices which provide specific management guidelines to minimize negative secondary and cumulative environmental effects associated with the misuse of fertilizers. These secondary and cumulative effects have been observed in and on the City of Sebastian's natural and constructed stormwater conveyances, rivers, creeks, canals, springs, lakes, estuaries and other water bodies. Collectively, these water bodies are an asset critical to the environmental, recreational, cultural and economic well-being of the City of Sebastian's residents and the health of the public. Overgrowth of algae and vegetation hinder the effectiveness of flood attenuation provided by natural and constructed stormwater conveyances. Regulation of nutrients, including both phosphorus and nitrogen contained in fertilizer, will help improve and maintain water and habitat quality.

(c) *Definitions.* For this chapter, the following terms shall have the meanings set forth in this section unless the context clearly indicates otherwise.

"*Administrator*" means the city manager, or any other city official designated by the city manager.

"*Application*" or "*apply*" means the actual physical deposit of fertilizer to turf or landscape plants.

"*Applicator*" means any person who applies fertilizer on turf and/or landscape plants in the City of Sebastian.

"*Board*" or "*governing board*" means City Council of the City of Sebastian.

"*Best Management Practices*" means turf and landscape practices or combinations of practices based on research, field-testing, and expert review, determined to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality, conserving water supplies and protecting natural resources.

"*Commercial fertilizer applicator*" , except as provided in F.S. § 482.1562(9), means any person who applies fertilizer for payment or other consideration to property not owned by the person or firm applying the fertilizer or the employer of the applicator.

"*Fertilize*", "*fertilizing*", or "*fertilization*" means the act of applying fertilizer to turf, specialized turf, or landscape plants.

"*Guaranteed analysis*" means the percentage of plant nutrients or measures of neutralizing capability claimed to be present in a fertilizer.

"*Institutional applicator*" means any person, other than a private, non-commercial or a commercial applicator (unless such definitions also apply under the circumstances), that applies fertilizer for the purpose of maintaining turf and/or landscape plants. Institutional applicators shall include, but shall not

be limited to, owners, managers or employees of public lands, schools, parks, religious institutions, utilities, industrial or business sites and any residential properties maintained in condominium and/or common ownership.

"*Landscape plant*" means any native or exotic tree, shrub or groundcover (excluding turf).

"*Low maintenance zone*" means an area a minimum of ten feet wide adjacent to water courses which is planted and managed in order to minimize the need for fertilization, watering, mowing, etc.

"*Person*" means any natural person, business, corporation, limited liability company, partnership, limited partnership, association, club, organization, an/or any group of people acting as an organized entity.

"*Prohibited application period*" means June 1 through September 30 or the time period during which a flood watch or warning, or a tropical storm water or warning, or a hurricane watch or warning is in effect for any portion of the City of Sebastian, issued by the National Weather Service, or if heavy rainfall is likely.

"*Sebastian Approved Management Practices Training Program*" means a training program approved per F.S. § 403.9338, or any more stringent requirements set forth in this Chapter that includes the most current version of the Florida Department of Environmental Protection's "Florida-Friendly Best Management Practices for Protection of water Resources by the Green Industries, 2008" as revised and approved by the administrator.

"*Saturated soil*" means a soil in which the voids are filled with water. Saturation does not require flow. For the purpose of this section, soils shall be considered saturated if standing water is present or the pressure of a person standing on the soil causes the release of free water.

"*Slow release*" , "*controlled release*" , "*timed release*" , "*slowly available*" or "*water insoluble nitrogen*" means nitrogen in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant longer than a reference rapid or quick release product.

"*Turf*" , "*sod*" , or "*lawn*" means a piece of grass-covered soil held together by the roots of the grass.

"*Urban landscape*" means pervious areas on residential, commercial, industrial, institutional, highway right-of-way, or other nonagricultural lands that are planted with turf or horticultural plants. For the purposes of this section, agriculture has the same meaning as in F.S. § 570.02.

(d) *Applicability*. This section shall be applicable to and shall regulate all applicators of fertilizer and areas of application of fertilizer within the City of Sebastian unless such applicator is specifically exempted by the terms of this section from the regulatory provision of this section. This section shall be prospective only, and shall not impair any existing contracts.

(e) *Timing of fertilizer application*. No applicator shall apply fertilizers containing nitrogen and/or phosphorus to turf and/or landscape plants during the prohibited application period, or to saturated soils.

(f) *Fertilizer free zones.* Fertilizer shall not be applied within ten feet of any pond, stream, watercourse, lake, canal, or wetland as defined by the Florida Department of Environmental Protection (Chapter 62-340, Florida Administrative Code) or from the top of a seawall. If more stringent City of Sebastian Code regulations apply, this provision does not relieve the requirement to adhere to the more stringent regulations. Newly planted turf and/or landscape plants may be fertilized in this zone only for a 60-day period beginning 30 days after planting if need to allow the plants to become well established. Caution shall be used to prevent direct deposition of nutrients into the water.

(g) *Low maintenance zones.* A voluntary ten-foot low maintenance zone is strongly recommended, but not mandated, from any pond, stream, water course, lake, wetland or from the top of a seawall. A swale/berm system is recommended for installation at the landward edge of this low maintenance zone to capture and filter runoff. If more stringent City of Sebastian Code regulations

apply, this provision does not relieve the requirement to adhere to the more stringent regulations. No mowed or cut vegetative material may be deposited or left remaining in this zone or deposited in the water. Care should be taken to prevent the over-spray of aquatic weed products in this zone.

(h) *Fertilizer content and application rates.*

(1) No fertilizer containing phosphorous shall be applied to turf or landscape plants in the City of Sebastian unless a soil or plant tissue deficiency is verified by a University of Florida, Institute of Food and Agriculture Sciences, approved testing methodology. In the case that a deficiency has been verified, the application of a fertilizer containing phosphorous shall be in accordance with the rates and directions for the Central Region of Florida as provided by Rule 5E-1.003(2), Florida Administrative Code. Deficiency verification shall be no more than two years old. However, recent application of compost, manure, or top soil shall warrant more recent testing to verify current deficiencies.

(2) The nitrogen content of fertilizer applied to turf or landscape plants within the City of Sebastian shall contain at least 50 percent slow release nitrogen per guaranteed analysis label.

(3) Fertilizers applied to an urban lawn or turf within the City of Sebastian shall be applied in accordance with requirements and directions set forth on the label or tag for packaged fertilizer products, or in the printed information accompanying the delivery of bulk fertilizer products, as provided by Rule 5E-1.003(2), Florida Administrative Code, Labeling Requirements For Urban Turf Fertilizers. All packaged and bulk fertilizer products sold in the City of Sebastian shall be sold in packages with labels or tags, or, if sold in bulk, be accompanied by printed information, which complies with the requirements of Rule 5E-1.003(2), Florida Administrative Code.

(4) Fertilizer containing nitrogen or phosphorus shall not be applied before seeding or sodding a site, and shall not be applied for the first 30 days after seeding or sodding, except when hydro-seeding for temporary or permanent erosion control in an emergency situation (wildfire, etc.), or in accordance with the Stormwater Pollution Prevention Plan for that site.

(i) *Application practices.*

(1) Spreader deflector shields are required when fertilizing via rotary (broadcast) spreaders. Deflectors must be positioned such that fertilizer granules are deflected away from all impervious surfaces, fertilizer-free zones and water bodies, include wetlands.

(2) Fertilizer shall not be applied, spilled or otherwise deposited on any impervious surfaces.

(3) Any fertilizer applied, spilled, or deposited, either intentionally or accidentally, on any impervious surface shall be immediately and completely removed to the greatest extent practicable.

(4) Fertilizer released on an impervious surface must be immediately contained and either legally applied to turf or any other legal site, or returned to the original or other appropriate container.

(5) In no case shall fertilizer be washed, swept, or blown off impervious surfaces into stormwater drains, ditches, conveyances, or water bodies.

(j) *Management of grass clipping and vegetative matter.* In no case shall grass clippings, vegetative material, and/or vegetative debris be washed, swept, or blown off into stormwater drains, ditches, conveyances, water bodies, wetlands, or sidewalks or roadways. Any material that is accidentally so deposited shall be immediately removed to the maximum extent practicable.

(k) *Exemptions.* The provisions set forth in the chapter shall not apply to:

(1) Bona fide farm operations as defined in the Florida Right to Farm Act, F.S. § 823.14;

(2) Other properties not subject to or covered under the Florida Right to Farm Act that have pastures used for grazing livestock;

(3) Any lands used for bona fide scientific research, including, but not limited to, research on the effects of fertilizer use on urban stormwater, water quality, agronomics, or horticulture.

(4) Golf courses when landscaping is performed within the provisions of the Florida Department of Environmental Protection document, "Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses", these provisions shall be followed when applying fertilizer to golf course practice and play areas;

(5) Athletic fields at public parks and school facilities that apply the concepts and principles embodied in the Florida Green BMPs, while maintaining the health and function of their specialized turf areas;

(6) Vegetable gardens owned by individual property owners or a community, and trees grown for their edible fruit.

(l) *Training.*

(1) All commercial and institutional applicators or fertilizer within the City of Sebastian, shall abide by and successfully complete the six-hour training program in the "Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries" offered by the Florida Department of Environmental Protection through the University of Florida Extension "Florida-Friendly Landscapes" program, or an approved equivalent.

(2) Private, non-commercial applicators are encouraged to follow the recommendations of the University of Florida IFAS Florida Yards and Neighborhoods program when applying fertilizers.

(m) *Licensing of commercial applicators.*

(1) Prior to January 1, 2014, all commercial applicators of fertilizer with the City of Sebastian, shall abide by and successfully complete training and continuing education requirements in the "Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries", offered by the Florida Department of Environmental Protection through the University of Florida IFAS "Florida-Friendly Landscapes" program, or an approved equivalent program, prior to obtaining a City of Sebastian Local Business Tax Receipt for any category of occupation which may apply any fertilizer to turf and/or landscape plants.

(2) After December 31, 2013, all commercial applicators of fertilizer within the City of Sebastian, shall have and carry in their possession at all times when applying fertilizer, evidence of certification by the Florida Department of Agriculture and Consumer Services as a Commercial Fertilizer Applicator per 5E-14.117(18) F.A.C.

(3) All businesses applying fertilizer to turf and/or landscape plants (including but not limited to residential lawns, golf courses, commercial properties, and multi-family and condominium properties) must ensure that at least one employee has a "Florida-Friendly Best Management Practices for Protection of Water Resources by the Green Industries" training certificate prior to the business owner obtaining a local business tax receipt. Owners for any category of occupation which may apply and fertilizer to turf and/or landscape plants shall provide proof of completion of the program to the City of Sebastian.

(n) *Enforcement.* The provisions of this section may be enforced pursuant to any method provided for by the Code or Ordinances or general law.

(Ord. No. O-12-06, § 1, 5-9-12; Ord. No. O-14-02, § 1, 3-26-14)

Appendix D: Field Treatment Sheets

AQUATIC VEGETATION CONTROL, INC.

DAILY PROGRESS REPORT FOR ENVIRONMENTAL MANAGEMENT

Field Treatment Sheets

DATE:

CUSTOMER	PROJECT NAME/JOB	T&M Billable
City of Sebastian	Sebastian Canals	Y

JD Gillenwalters

POSITION	START TIME	END TIME	EFFECTIVE HRS	LUNCH HRS	TRAVEL HRS	SURVEY HRS	PLAN/PREP HRS	TOTAL HRS
Applicator								
Crew Supervisor								
Crew Member								
Site Manager								
Project Manager								

RESOURCES		
SOURCE	NAME	HOURS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

EQUIPMENT		
EQUIP NO.	DESCRIPTION	HOURS

WEATHER INFORMATION		
WIND MEASURMENTS		
TIME	VEL	DIR

I acknowledge that data presented is accurate.

Signature:

I acknowledge that data presented has been verified.

Manager:

Comments

Status

☐ On-going

☐ Completed

☐ Data Entered

Billing Type

T&M

AVC.CANAL.V1

AQUATIC VEGETATION CONTROL, INC.

DAILY PROGRESS REPORT FOR ENVIRONMENTAL MANAGEMENT

Field Treatment Sheets

DATE:

CUSTOMER	PROJECT NAME/JOB	T&M Billable	
City of Sebastian	Sebastian Ponds	Y	JD Gillenwalters

POSITION	START TIME	END TIME	EFFECTIVE HRS	LUNCH HRS	TRAVEL HRS	SURVEY HRS	PLAN/PREP HRS	TOTAL HRS
Applicator								
Crew Supervisor								
Crew Member								
Site Manager								
Project Manager								

RESOURCES		
SOURCE	NAME	HOURS
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

EQUIPMENT		
EQUIP NO.	DESCRIPTION	HOURS

WEATHER INFORMATION		
WIND MEASURMENTS		
TIME	VEL	DIR

I acknowledge that data presented is accurate.

Signature:

I acknowledge that data presented has been verified.

Manager:

Comments

Status

☐ On-going

☐ Completed

☐ Data Entered

Billing Type

T&M

AVC.POND.V1

Appendix E: Aquatic Herbicide Notification Sign

RESTORATION IN PROGRESS

CAUTION

As a part of Sebastian's work to restore and maintain a healthy and functional stormwater conveyance system, noxious aquatic vegetation is being treated with approved herbicides by state-licensed applicators, in compliance with the City's Integrated Pest Management Policy.

Thank you for your cooperation.

TARGET PLANT(S): _____

AREA TREATED: _____

HERBICIDE(S): _____

RE-ENTRY PERIOD: _____

APPLICATION DATE: _____

APPLICATION TIME: _____

For more information, contact the City's Citizen Request Line:

(772) 581-0111

SUSTAINABLE SEBASTIAN

To learn more about Sebastian's IPM Program and other Sustainable Sebastian initiatives please visit the Natural Resources Board Website:

SWIPM.PNS.V1

Appendix F: Environmental Impact Quotient Formula

Environmental Impact Quotient (EIQ) Formula:

EIQ={C[(DT*5)+(DT*P)]+

[(C*((S+P)/2)*SY)+(L)]+

[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]}/3

- **DT = dermal toxicity** ability of a substance to cause local reaction and/or systemic poisoning in people or animals by contact with the skin
- **C = chronic toxicity** Harmful effects caused in repeated exposure situations
- **SY = systemicity** ability of the product to be translocated to other tissues which have not received the product directly
- **F = fish toxicity** risk to fish, the most sensitive aquatic vertebrate to toxicity
- **L = leaching potential** risk of moving through the soil profile, leaching, and getting into groundwater
- **R = surface loss potential** susceptible to loss through runoff and erosion during high-intensity rainfall events
- **D = bird toxicity** risk to birds, which are the vertebrates most sensitive to toxicity
- **S = soil half-life persistence**, or the "lasting-power" of a pesticide within the soil
- **Z = bee toxicity** risk to the essential pollinators
- **B = beneficial arthropod toxicity** risk to non-target organisms which are an important group of microorganisms that work to maintain ecosystem health
- **P = plant surface half-life**. Persistence, or the "lasting- power" of a pesticide on the surface of the leaves, stems, and fruit

Once an EIQ value has been established for the active ingredient of each pesticide, field use calculations can begin. To accurately compare pesticides and pest management strategies, the dose, the formulation or percent active ingredient of the product and the frequency of application of each pesticide needs to be determined. To account for different formulations of the same active ingredient and different use patterns, a simple equation called the EIQ Field Use Rating was developed. This rating is calculated by multiplying the EIQ value for the specific chemical obtained in the tables by the percent active ingredient in the formulation by the rate per acre used (usually in pints or pounds of formulated product).

EIQ FIELD USE RATING = EIQ x % ACTIVE INGREDIENT x RATE

Source: Kovach, J., Petzoldt, C., Degni, J., and Tette, J. 1992. A method to measure the environmental impact of pesticides. New York's Food and Life Sciences Bulletin 139:1–8

Appendix G: Aquatic Pesticide Exemption Form

AQUATIC PESTICIDE EXEMPTION FORM

This form is to be submitted for approval in order to request exemption for use of a product that is:
1) Not classified on the "Approved Pesticide Table" OR
2) Contains a higher concentration active ingredient than listed on the table
Form to be submitted to the Stormwater Director for approval at least 4 days before application

Name: _____ Date: _____
Department/Contractor: _____

PESTICIDE

Date(s) of Proposed Use: _____
Product Name: _____
Active Ingredient(s): _____
Concentration: _____
Application Rate: _____
EPA Registration #: _____
Target Pest(s): _____

LOCATION

Site Name: _____
General Area Description: _____

JUSTIFICATION

Reason for Use: _____

Explanation of any Previous Control Methods: _____

Strategy to Prevent Future Exemptions: _____

APPROVAL

Stormwater Dir. Approval: _____ Date: _____
IPM Coordinator Approval: _____ Date: _____
City Manager Approval: _____ Date: _____

Appendix H: Monthly IPM Log

MONTHLY IPM LOG

FOR STORMWATER SYSTEM

MONTH:_____

DATE	LOCATION	CLEAR CULVERT PIPE	VACUUM CATCH BASIN	VACUUM BAFFLE BOX	POND MECHANICAL	CANAL MECHANICAL	MANUAL REMOVAL	.	.	.	.				COMMENTS

SWIPM.MIL.V1

CITY OF SEBASTIAN

STORMWATER DEPARTMENT

Appendix I: City Mowing Contract Details

EXHIBIT A
TECHNICAL SPECIFICATIONS

A. Scope of Work

Furnish all supervision, labor, materials, supplies, equipment and tools necessary to perform mowing maintenance services at various locations throughout the City of Sebastian, on an as needed basis and as designated by the City of Sebastian. Services include but are not limited to power blade edging, trash pickup, fertilization of turf, fertilization of trees and plants, shrubbery trimming, tree trimming and dead limb removal; quarter round cleaning.

Contractor shall furnish all vehicles, trucks and equipment with company name and phone number on the sides of the vehicles or units or visible to the public.

Contractor shall make sure all area of work clean-up and debris is cleared after completing the mowing or cleaning.

B. Work Areas

Mowing shall be done in the City Right of Way areas for the unimproved lots on all collector and City unit roads as well as in Collier Creek respectively. The sites have been divided in two categories according to the frequency of service and site type. There are nine (9) **Collector Road Right of Way** areas, which shall be mowed approximately **twenty-four (24) times per year**. The Collector Roads are as follows:

1. Barber Street
2. Schumann Drive
3. Wimbrow Drive
4. Fleming Street
5. Main Street
6. Laconia Street
7. Easy Street
8. Englar Drive
9. Powerline Road

All **other Right of Way areas** along City Unit Roads excluding the Collector Roads shall be done approximately 9 times per year. Lots in alleyways are included in this group.
Also, mowing shall be done **four (4) times per year** of all the ditches listed on *Exhibit B - Ditches Mowing Map*.

The Contractor is responsible for the cutting of rear ditches within easement boundaries in such a manner that a clear line of sight is seen within the easement, both side to side and top to bottom.

The Contractor shall mow the grass/turf to a height, which shall not exceed four (4) inches. The Contractor shall perform in conjunction with the mowing activity all the necessary edging and trimming of grass around all fixed obstacles and structures located along and within designated areas including but not limited to catch basins, posts, poles, trees, etc. Contractor shall leave area in a neat and uniform condition after mowing.

Other mowing services will be done as determined in the comments section listed on *Form C - Bid Price Form* and upon request by the City on an as needed basis.

The City of Sebastian reserves the right to add work sites over and above the ones shown on *Exhibit B – Ditches Mowing Map* supplied as a part of this Bid and/or deletes any of the designated work locations shown on the previously cited map.

C. Work Requirements

The Contractor is responsible for mowing the full extent of the designated length and width of each Right of Way area. Any Right of Way areas, which cannot be mowed the entire width due to the existing field conditions, shall be mowed from the roadway to two (2) feet behind the swale water flow line as a minimum or as otherwise directed by the City of Sebastian.

Prior to starting any mowing activity, the Contractor shall remove and dispose of any litter and debris such as palm fronds, tree-shrub limbs and cuttings, glass, paper, cans, tires, hub caps, boxes, wood, cable and any other materials encountered in the designated mowing areas using all means necessary.

The Contractor shall mow the grass/turf to a height, which shall not exceed four (4) inches. The Contractor shall perform in conjunction with the mowing activity all the necessary edging and trimming of grass around all fixed obstacles and structures located along and within designated areas including but not limited to sidewalks, curbs, gutters, posts, poles, trees, shrubs, fire hydrants, end walls, flower beds, buildings, etc. Contractor shall leave area in a neat and uniform condition after mowing. **Note: grassy areas between the road and the sidewalk are to be mowed by the Contractor whether the area is improved or unimproved as some homeowners tend not to mow this area.**

Curb and sidewalk edging shall be accomplished by mechanical methods only. No herbicide applications shall be done for edging purposes. The Contractor shall edge the back of curbs and gutters. Gutters shall be left in a neat condition and free of grass, weeds and related clippings, such that drainage is not impaired.

Work shall be performed in drainage swales. The Contractor shall maintain the existing slopes during the performance of the work. In areas with standing water and/or too wet to support mechanical mowing equipment, work shall be performed utilizing hand-trimming methods. These areas shall be left in a neat and uniform condition, and all cut debris shall be removed from the drainage swales immediately to prevent possible drainage obstructions.

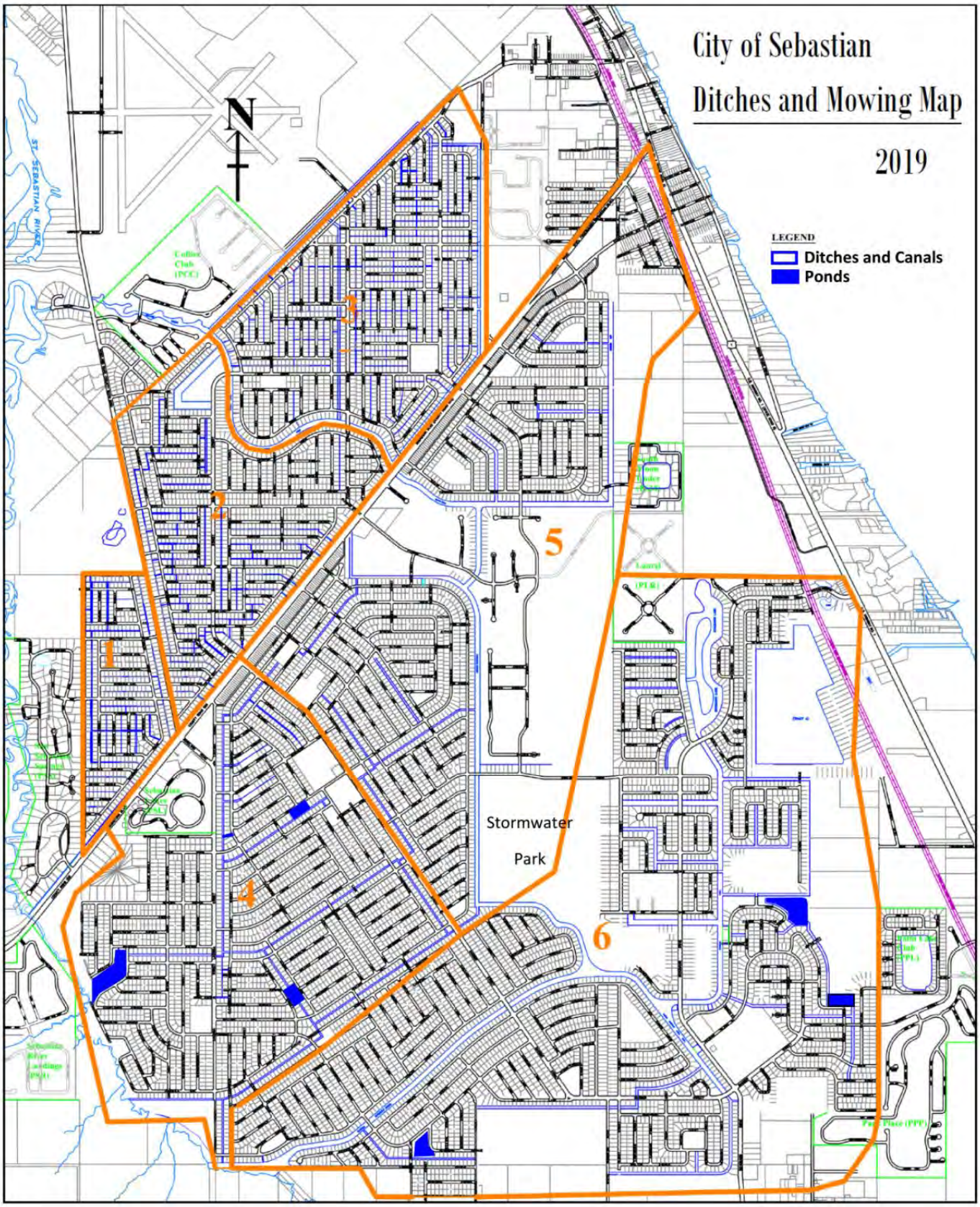
The Contractor shall be responsible for the immediate clean-up of litter and cut debris thrown or dragged by his equipment onto adjacent property and roadways.

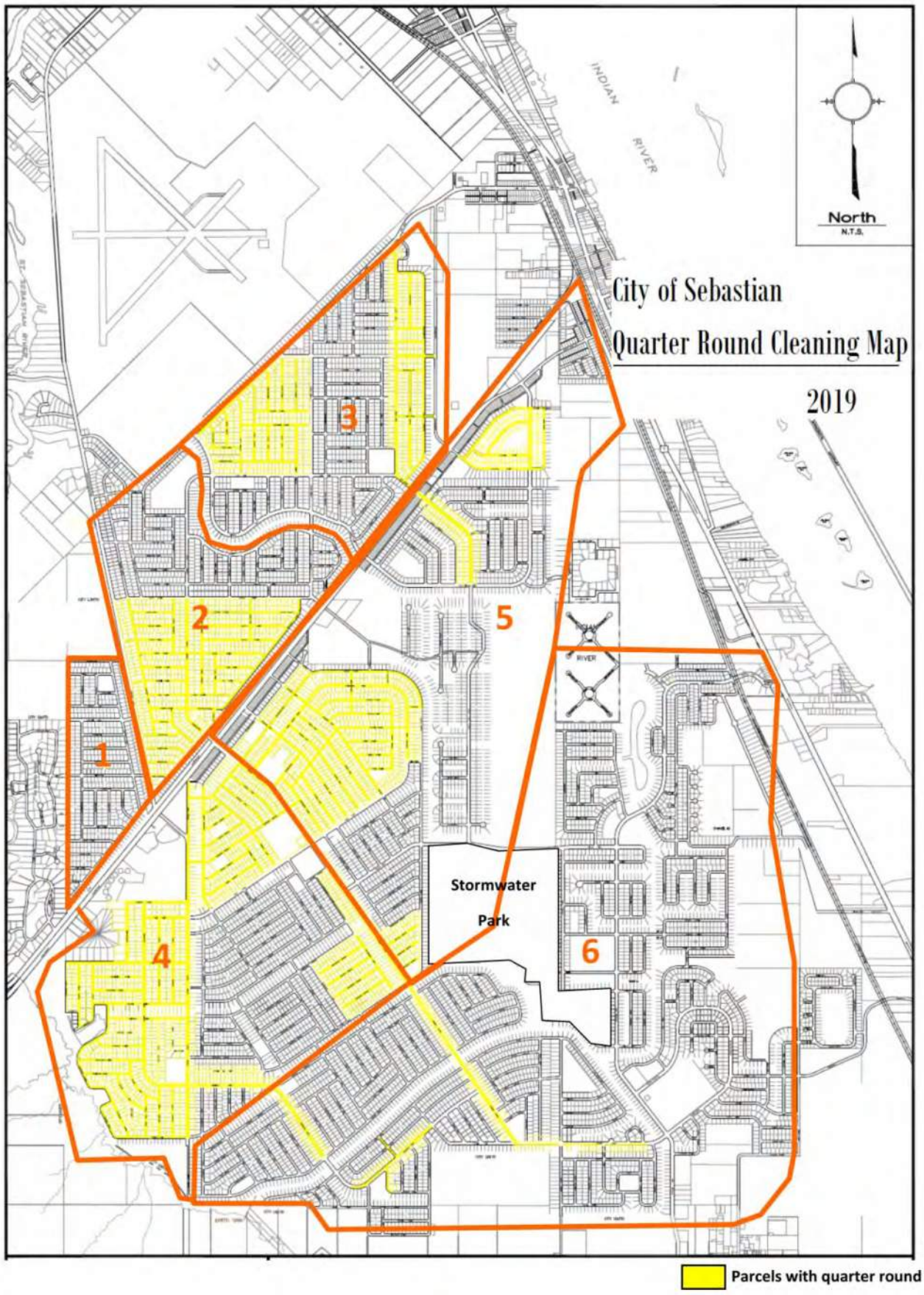
The Contractor shall be responsible for the proper disposal of all litter and debris removed by them from the designated mowing areas.

Stockpiling of debris on or along the designated work areas shall not be permitted. If the City deems that stockpiling is necessary it shall be done at specific locations approved by the City. Mowing operations shall be performed in such manner that it will not create excessive airborne dust and other particulates as determine by the City of Sebastian.

The Contractor shall exercise the necessary care during all work activities and avoid damages to any private and/or public structures and vegetation including but not limited to utilities, signs, poles, fences, concrete structures, culvert pipes, sprinkler heads, storm water swale line/slopes, trees, shrubs, planting beds, mulching rings, etc. Damages caused by the Contractor shall be reported immediately to the City. The Contractor shall be responsible for the repairs of damages caused by them to any private or public property.

The City and the Contractor will agree on the best way to accomplish repairs. The work to repair the damages may be performed by the Contractor or by others. Work shall be performed as soon as reasonably possible. Damages caused by the Contractor, subcontractor or supplier shall be reported by the Contractor immediately to the City of Sebastian. Vandalism or storm damage shall be reported to the City as soon as possible.


City of Sebastian
Ditches and Mowing Map
2019
N
LEGEND
Ditches and Canals
Ponds
1
2
3
4
5
6
Stormwater
Park


INDIAN RIVER
North
N.T.S.
City of Sebastian
Quarter Round Cleaning Map
2019
1
2
3
4
5
6
Stormwater
Park
Parcels with quarter round

City of Sebastian
Stormwater Park Mowing Map
2019
HOLDEN AV HOLDEN CT
ENGLAR DR
ENGLAR DR
GEORGE ST
CAPRI AV
CAPRONA ST
ORMAND CT
EMPRESS A
S EASY ST
GEORGE ST
CARAVAN TER
SURESIDE LN
TEABERRY LN
THORNHILL LN
ABBOTT LN
BARBER ST
CHALOUPE TER
COPLY TER
CONCHA DR
CHERRY CT
Do not mow

Appendix J: City Sediment Control Ordinance

City of Sebastian

Code of Ordinances

Article XI, Sec. 54-3-11.2. - Soil Erosion and Sedimentation Control.

(a) Required soil erosion and sedimentation control plan. In order to prevent both soil erosion and sedimentation, a soil erosion and sedimentation control plan shall be required as a part of an application for a subdivision construction permit, site plan review, plot plan review of a single-family residential lot and whenever a development will involve any clearing, removal of native or protected vegetation, grading, transporting, or other form of disturbing land by the movement of earth.

(b) Erosion control measures. All measures necessary to minimize soil erosion and to control sedimentation in the disturbed land area shall be implemented. The following protection shall be provided for all disturbed areas: minimize velocities of water runoff and wind erosion, maximize protection of disturbed areas from stormwater runoff, and prevent or retain sedimentation within the development site as early as possible following disturbances. A list of major problem areas for erosion and sedimentation control follows. For each one, the purpose(s) of requiring control is described. Soil erosion and sedimentation control measures for all such areas shall be provided with a view toward achieving the specific purpose listed below for which a control plan is required:

(1) Erodable slopes: Prevent detachment and transportation of soil particles from slope.

(2) Streams, streambeds, streambanks, bodies of water, lake shorelines: Prevent detachment and transportation of soil particles.

(3) Drainageways: Prevent detachment and transportation of soil particles (which would otherwise deposit in streams, bodies of water, or wetlands); promote deposit or sediment loads (traversing these areas) before these reach bodies of water.

(4) Land adjacent to streams, ponds, lakes, and wetlands: Prevent detachment and transportation of soil particles. The applicant shall not adversely impact aquatic vegetation within the sensitive transition zone located between the upland and the mean high water line (ordinary high water line for non-tidal waters). No such vegetation shall be disturbed without approval of the city. Any such approval shall be based on a demonstrated necessity that promotes the overall public health, safety and welfare. Furthermore, any such disturbance of aquatic vegetation shall be compensated by re-vegetation based on a plan approved by the city as stipulated herein. The applicant shall coordinate plans for riverfront development with the Florida Department of Environmental Protection as well as the U.S. Army Corps of Engineers where tidal waters might be impacted. Where deemed appropriate, the site plan shall include the planting of native indigenous aquatic plant vegetation to promote stability of the shoreline.

(5) Enclosed drainage structure: Prevent sedimentation in structure, erosion at outfall of system and deposit of sediment loads within system or beyond it.

(6) Large flat surface areas (unpaved): Prevent detachment of soil particles and their off-site transportation.

(7) Impervious surfaces: Prevent the detachment and transportation of soil (in response to an increase in the rate and/or volume of runoff of the site or its concentration caused by impervious surfaces).

(8) Borrow and stockpile areas: Divert runoff from face of slopes exposed in the excavation process; convey runoff in stabilized channels to stable disposal points; leave borrow areas and stockpiles in stable condition.

(c) Applicability. Appropriate measures shall be taken during land clearing and building operations to assure that exposed, destabilized or otherwise altered soil is expeditiously covered with an acceptable erosion control material. The provision shall be applicable to the act of subdividing and installation of related improvements as well as during the development review process including the period during which improvements may occur as well as the length of time soil may be exposed to the environment. The tree and native vegetation protection ordinance shall be applicable to all clearing and grading activities and shall include specifications for management principles guiding the removal or placement of vegetation and landscaping design. Regulations shall also require developers to take precautionary measures, where necessary, to avert destruction or damage to native vegetation.

Appendix K: Florida Aquatic Plant Management Act

State of Florida

State Statutes

Title XXVII Chapter 369.22. – Aquatic Plant Management.

(1)This section shall be known as the "Florida Aquatic Plant Management Act."(2)For the purpose of this section, the following words and phrases shall have the following meanings:

(a) "Commission" means the Fish and Wildlife Conservation Commission.

(b) "Aquatic plant" is any plant growing in, or closely associated with, the aquatic environment and includes "floating," "emersed,""submersed," and "ditch bank" species.(c)A "maintenance program" is a method for the management of aquatic plants in which control techniques are utilized in a coordinated manner as determined by the commission.

(d) An "eradication program" is a method for the management of aquatic plants in which control techniques are utilized in a coordinated manner in an attempt to kill all the aquatic plants on a permanent basis in a given geographical area.

(e) A "complaint spray program" is a method for the management of aquatic plants in which weeds are allowed to grow unhindered to a given level of undesirability, at which point eradication techniques are applied in an effort to restore the area in question to are relatively low level of infestation.

(f) "Waters" means rivers, streams, lakes, navigable waters and associated tributaries, canals, meandered lakes, enclosed water systems, and any other bodies of water.(g)"Districts" means the six water management districts created by law and named, respectively, the Northwest Florida Water Management District, the Suwannee River Water Management District, the St. Johns River Water Management District, the Southwest Florida Water Management District, the Central and Southern Florida Flood Control District, and the Ridge and Lower Gulf Coast Water Management District; and on July 1, 1975, shall mean the five water management districts created by chapter 73-190, Laws of Florida, and named, respectively, the Northwest Florida Water Management District, the Suwannee River Water Management District, the St. Johns River Water Management District, the Southwest Florida Water Management District, and the South Florida Water Management District.

(3) The Legislature recognizes that the uncontrolled growth of aquatic plants in the waters of Florida poses a variety of environmental, health, safety, and economic problems. The Legislature acknowledges the responsibility of the state to cope with the uncontrolled and seemingly never-ending growth of aquatic plants in the waters throughout Florida. It is, therefore, the intent of the Legislature that the state policy for the management of aquatic plants in waters of state responsibility be carried out under the general supervision and control of the commission. It is the intent of the Legislature that the management of aquatic plants be carried out primarily by means of maintenance programs, rather than eradication or complaint spray programs, for the purpose of achieving more effective management at a lower long-range cost. It is also the intent of the Legislature that the commission guide, review, approve, and coordinate all aquatic plant management programs within each of the water management districts as defined in paragraph (2)(g). It is the intent of the Legislature to account for the costs of aquatic plant management programs by watershed for comparison purposes.

(4)The commission shall supervise and direct all management programs for aquatic plants, as provided in this section, so as to protect human health, safety, and recreation and, to the greatest degree practicable, prevent injury to plant, fish, and animal life and to property.(5)When state funds are involved, or when waters of state responsibility are involved, it is the duty of the commission to guide, review, approve, and coordinate the activities of all public bodies, authorities, state agencies, units of local or county government, commissions, districts, and special districts engaged in operations to manage or eradicate aquatic plants. The commission may delegate all or part of such functions to any appropriate state agency, special district, unit of local or county government, commission, authority, or other public body. However, special attention shall be given to the keeping of accounting and cost data in order to prepare the annual fiscal report required in subsection (7).

(6)The commission may disburse funds to any district, special district, or other local authority for the purpose of operating a program for managing aquatic plants in the waters of state responsibility upon:

(a)Approval by the commission of the management techniques to be used by the district or authority; and

(b)Review and approval of the program of the district or authority by the commission.(7)The commission shall prepare an annual report on the status of the aquatic plant management program which shall be posted on the commission's Internet website.

(8)The commission shall have the authority to cooperate with the United States and to enter into such cooperative agreements or commitments as the commission may determine necessary to carry out the control or eradication of water hyacinths, alligator weed, and other noxious aquatic plant growths from the waters of the state and to enter into contracts with the United States obligating the state to indemnify and save harmless the United States from any and all claims and liability arising out of the initiation and prosecution of any project undertaken under this section. However, any claim or claims required to be paid under this section shall be paid from money appropriated to the aquatic plant management program.

(9)The commission may delegate various aquatic plant management functions to any appropriate state agency, special district, unit of local or county government, commission, authority, or other public body. The recipient of such delegation shall, in accepting commitments to engage in aquatic plant management activities, be subject to the rules of the commission. In addition, the recipient shall render technical and other assistance to the commission in order to carry out most effectively the purposes of s. 369.20.

(10)The commission is directed to use biological agents for the management of aquatic plants when determined to be appropriate by the commission.

(11)The commission shall adopt rules pursuant to ss. 120.536(1) and 120.54 to implement the provisions of this section conferring powers or duties upon it and perform any other acts necessary for the proper administration, enforcement, or interpretation of this section, including adopting rules and forms governing reports.

(12)No person or public agency shall control, eradicate, remove, or otherwise alter any aquatic plants in waters of the state unless a permit for such activity has been issued by the commission, or unless the activity or waters are expressly exempted by commission rule. The commission shall develop standards

by rule which shall address, at a minimum, chemical, biological, and mechanical control activities; an evaluation of the benefits of such activities to the public; specific criteria recognizing the differences between natural and artificially created waters; and the different amount and quality of littoral vegetation on various waters. Applications for a permit to engage in aquatic plant management activities, including applications to engage in management activities on sovereign submerged lands, shall be made to the commission. In reviewing such applications, the commission shall consider the criteria set forth in subsection (4) and, in accordance with applicable rules, shall take final agency action on permit applications for the use of aquatic plant activities on sovereign submerged lands.

(13)The commission has the power to enforce this section in the same manner and to the same extent as provided in ss. 379.501-379.504.

(14)Activities that are exempt from permitting pursuant to s. 403.813(1)(r) are granted a mixing zone for turbidity for a distance not to exceed 150 meters downstream in flowing streams or 150 meters in radius in other water bodies as measured from the cutter head, return flow discharge, or other points of generation of turbidity.

History.—ss. 1, 2, ch. 74-65; s. 4, ch. 80-129; s. 33, ch. 83-218; s. 16, ch. 84-254; s. 2, ch. 89-151; s. 188,ch. 94-356; s. 76, ch. 98-200; s. 92, ch. 99-245; s. 7, ch. 2008-150; s. 31, ch. 2009-86.

Note.—Former s. 372.932.

Appendix L: City MS4 NPDES Permit

APPENDIX A
PHASE II MS4 STORMWATER MANAGEMENT PROGRAM (SWMP) ELEMENTS FORM

SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

[X] 1. Public Education and Outreach	[ ] 3. Illicit Discharge Detection/Elimination	[ ] 5. Post-construction Stormwater Management (optional)
[ ] 2. Public Involvement/Participation	[ ] 4. Construction Site Stormwater Runoff Control	[ ] 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
1a.	01	**City Stormwater Website** Information and links on: Clean Water Program/NPDES, Public Education, History & Restrictions, Comments & Complaints. Educational materials are available for download. Site is updated regularly. A "Contact Us" button prompts residents to email the City regarding their stormwater questions or concerns.	1. Document and report the number of visitors to pages with stormwater specific information. 2. Document and report the number of material downloads. 3. Document and report communications received through the website. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4	MIS Department City Clerk
1a.	02	**City Natural Resources Board Website** Information on: Florida Friendly Landscaping, Stormwater, Composting, Landscaping and Fertilizer Ordinance. Site is updated regularly and promoted through the City's Facebook page and on all outreach materials. A "Contact Us" button prompts residents to email the City regarding their environmental questions or concerns.	1. Document and Report the number of website visitors. 2. Document and report communications received through the website. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	MIS Department City Clerk
1a.	03	**Outreach Brochures and Flyers** Developed to educate residents on locally relevant stormwater topics, which are determined through the documentation of citizen request line calls and emails. Materials are distributed throughout the City (Library, City Hall, Building Department, and Community Events.	1. Document and report the number of brochures distributed. 2. Document and report the number of distribution points. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
1a.	04	**Community Presentations** Guest speakers present at Board and Council Meetings on environmental and stormwater topics. Public Meetings are held monthly at City Hall and televised throughout the month on local government channel, and available for streaming through the City's Website. All meeting agendas are available on City's website one week prior.	1. Document and report number of presentations informing the public of the impacts of stormwater discharges on waterbodies and the steps that the public can take to reduce pollutants in stormwater. 2. Document and report number attendees at meetings featuring stormwater specific information.	1. Year 1- Year 5 2. Year 1- Year 5	Environmental Technician
1a.	05	**Community Events** Educate the public through an onsite booth, with presentations and distribution of outreach materials on stormwater topics. There will be photo documentation of booth and presentations.	1. Document and report the number of events where stormwater information was presented and distributed. 2. Document and report the number of materials distributed. 3. Document and report the number of stormwater presentations conducted at community events. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Environmental Technician & Stormwater Department

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SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

- [x] 1. Public Education and Outreach
- [ ] 2. Public Involvement/Participation
- [ ] 3. Illicit Discharge Detection/Elimination
- [ ] 4. Construction Site Stormwater Runoff Control
- [ ] 5. Post-construction Stormwater Management (optional)
- [ ] 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
1a.	06	**Local Government Channel** 24 hour television channel, which is also streamed live on City's website. Live Streams and replays Council and Board Meetings. Displays public notices and stormwater outreach videos and PowerPoint slides. Promotes websites and Citizen Request Line.	1. Document and report SWMP relevant materials posted and duration posted. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4	MIS Department
1a.	07	**City Facebook Page** Updates public on current stormwater projects, outreach information, and addresses frequently asked questions and concerns. Streams all public meetings live. Promotes City websites, educational programs, and Citizen Request Line.	1. Document and report "likes" and reposts on stormwater topics. 2. Document and report number of page followers. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	MIS Department
1a.	08	**Community Oyster Garden Project** Cost-share Grant Project designed to educate visitors and volunteers of all ages. Community groups can register for interactive site tours, which engage volunteers and participants of all ages in hands on water quality data collection, species identification and the role of the City's MS4 in maintaining a healthy lagoon.	1. Document and report all volunteer and participant sign-in sheets. 2. Document and report the number of classes presented at site. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
1a.	09	**New Homeowner Folder** Folder delivered at final inspection for all new residential development. Includes materials on stormwater, Florida Friendly Landscaping, water conservation, swale maintenance, IPM, and City Landscaping Ordinances.	1. Document and report the number of new homeowner folders distributed. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Environmental Technician
1a.	10	**Community Events** Stormwater Booth manned by Stormwater Staff available to answer resident questions and to educate on current projects.	1. Document and report number of booth visitors. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Environmental Technician & Stormwater Department

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☐ 1. Public Education and Outreach	☐ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☒ 2. Public Involvement/Participation	☐ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
2a.	01	**Public Input** Resolution NO. R-15-09 requires that all appointed Boards and Committees include a section for solicitation of "Public Input" on meeting agendas. It will be documented when an agenda features items related to the City's SWMP. All agendas are posted one week prior to the meetings on the City's Website and Facebook Page.	1. Document and report number of public meetings held where the City's SWMP is discussed. 2. Document and report number of attendees at public Board Meetings where the City's SWMP is discussed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4	City Clerk
2a.	02	**MS4 Cleanup Events** City partners with local organizations to host two volunteer waterway clean-up events per year. Selection of clean-up sites will be focused on those areas with a direct impact on stormwater quality. Volunteer sign-in sheets will be used to track participants. The events are marketed through the City's Facebook page, website, television channel, community flyers, and the Chamber of Commerce's website, Facebook page, and newsletter.	1. Document and report number of events. 2. Document and report number of volunteers. 3. Document and report weight of litter collected. 4. Document and report the names of clean-up events.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Environmental Technician

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☐ 1. Public Education and Outreach	☒ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☐ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
3a.	01	**Storm Water System Map** GIS Map of City's stormwater system indicates all outfalls, receiving surface water bodies, stormwater structures and retention areas. Any changes in conveyance channels, outfalls, or structural assets will be amended in the map.	1. Document and report any new outfalls. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4	Stormwater Department & Environmental Technician
3b.	01	**Illicit Discharge Ordinance** City Ordinance, Article VI: Urban Stormwater Quality Management and Discharge Control, prohibits non-stormwater discharges into the MS4 system and implements inspection, reporting, and enforcement procedures.	1. City will maintain the Ordinance and report any changes, or amendments, if applicable. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Stormwater Department
3c.	01	**Illicit Discharge Detection and Inspection** Staff performs daily inspections and review of potential illicit discharges, hazardous disposals, or illegal dumping. Potential illicit discharges are reported to the Police Department Code Enforcement Office for enforcement.	1. Document and report any "Notice of Violations" issued by Code Enforcement. 2. Document and report the penalty and procedure required of each violator. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Police Department Code Enforcement Office
3d.	01	**Illicit Discharge Education: Public** City provides illicit discharge educational materials to residents. Materials are posted on City's Website and distributed through various community events, City Hall, and in new homeowners' packets.	1. Document all educational materials utilized and their distribution points. 2. Document and report the number of materials distributed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Environmental Technician
3d.	02	**Illicit Discharge Education: Business** City provides industry specific illicit discharge educational materials to businesses. Materials are posted on City's Website and distributed through community events, and at City Hall as they apply for new or renewal licensing.	1. Document and report all educational materials created, and distribution points. 2. Document and report the number of materials distributed. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Building Department

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☐ 1. Public Education and Outreach	☒ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☐ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
3d.	03	**Illicit Discharge Education: Employees** City requires all new employees view a training video on the proper storage and disposal of waste and hazardous materials. All current staff members are required to attend annual refresher class, which also includes this video.	1. Document and report the number of new employees receiving this training.	1. Year 1- Year 5	Human Resources
			2. Document and report the number of existing employees receiving additional training.	2. Year 1- Year 5	
			3.	3.	
			4.	4	

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☐ 1. Public Education and Outreach	☐ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
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SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
4a.	01	**Surface Water Management Ordinance** Article XII requires that any land development, which disturbs the soil, implement an erosion and sediment control plan. Such sites are subject to frequent inspections. Chapter 1, Article I and II provides for the general administration of violation and enforcement procedures for non-compliance to the Land Development Code.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4	Planning and Zoning Department
4b.	01	**Erosion and Sediment Control on Construction Sites** Article XVIII Sec.54-4-18.4 requires that sites greater than an acre, submit a SWPPP as part of their site plans that meets all City Land Development Ordinances, as well as apply for an NOI with the FDEP. The SWPPP, or Erosion and Sediment Control Plan will be reviewed for BMPs as they relate to the proposed construction	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report the number of NOIs received. 3. Document and report the number of active sites. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Planning and Zoning Department
4c.	01	**Construction Site Waste Management** The Surface Water Management Ordinance requires that all construction site operators control discarded materials and provide a sanitary waste facility. Waste management on each site is inspected as part of the scheduled "Erosion Control" inspections.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report number of sites operating under waste control requirement. 3. Document and report number of compliance issues pertaining to waste controls. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4.	Stormwater Department
4d.	01	**Site Plan Review** Article XVII outlines the site plan review procedures. Site plans are thoroughly reviewed by a committee of staff to ensure no adverse effects on water quality or environmentally sensitive areas.	1. Document and report any changes or amendments to the ordinance, if applicable. 2. Document and report number of site plans reviewed for construction. 3. Document and report the number of site plans that require special environmental permitting. 4. Document and report the number of site plans approved for construction.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Planning and Zoning Department
4e.	01	**Public Input** The public may provide input on active/proposed construction activities at any time by website submissions, or calls to the Citizen Request Line, which is advertised on the stormwater website, all stormwater educational material, new homeowner packets, and the public television channel. All stormwater related communications are monitored and recorded on spreadsheet by stormwater administrative support staff.	1. Document and report all complaints on potential site violations received through stormwater website or citizen request line. 2. Document and report the number of emails received. 3. Document and report the number of phone calls received to the citizen request line. 4. Document and report the number of follow-up actions.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department

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SECTION A.I. MINIMUM CONTROL MEASURE (check only one)

☐ 1. Public Education and Outreach	☐ 3. Illicit Discharge Detection/Elimination	☐ 5. Post-construction Stormwater Management (optional)
☐ 2. Public Involvement/Participation	☒ 4. Construction Site Stormwater Runoff Control	☐ 6. Pollution Prevention/Good Housekeeping

SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
4f.	01	**Construction Site Inspections** City staff will be scheduled through the Building Department to inspect all development sites following initial land clearing activities. Supplemental inspections will be conducted weekly and within 24 hours of a rain event of .5 inch, or greater. Failure of inspection will result in a re-inspection fee, which increases with each additional re-inspection.	1. Document and report number of erosion control inspections performed.	1. Year 1- Year 5	Building Department
			2. Document and report all erosion control re-inspections.	2. Year 1- Year 5	
			3. Document and report all re-inspection fees charged.	3. Year 1- Year 5	
			4.	4	

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SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
5a.	01	**Alternative Program** City of Sebastian relies on the St. John's River Water Management District and Florida Department of Environmental Protection regulatory criteria by providing stormwater treatment for Environmental Resource Program.	1. Continue to maintain compliance with Florida Department of Environmental Protection and St. John's River Water Management District criteria.	1. Effective upon issuance of MS4 Permit	Florida Department of Environmental Protection & St. John's River Water Management District
			3.	3.	
			4.	4.	

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SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
6a.	01	**Fleet Maintenance** All waste oil, hydraulic fluids, antifreeze, and oil filters from the City's equipment/ fleet maintenance division are properly stored for recycling.	1. Document and report the number of gallons per year of waste oil and hydraulic fluid recycled each year. 2. Document and report the number of gallons per year of antifreeze recycled each year. 3. Document and report the number of oil filters disposed of each year. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4	Public Works Department
6a.	02	**Catch Basin and Baffle Box Maintenance** The City regularly cleans debris from it catch basins and baffle boxes with a vacuum truck.	1. Document and report the number of baffle boxes cleaned each year and how often. 2. Document and report the total amount of debris collected from baffle boxes each year. 3. Document and report the number of catch basins cleaned each year and how often. 4. Document and report the total amount of debris collected from catch basins each year.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department
6a.	03	**Culvert Pipe Maintenance** Road crossing and driveway culvert pipes are regularly cleared of debris by various methods.	1. Document and report the total number of road crossing culvert pipes cleared each year. 2. Document and report the total amount of debris collected from road crossing culverts each year. 3. Document and report the total number of driveway culvert pipes cleared each year. 4. Document and report the total amount of debris collected from driveway culverts each year.	1. Year 1- Year 5 2. Year 1- Year 5 3. Year 1- Year 5 4. Year 1- Year 5	Stormwater Department
6a.	04	**Pet Waste Collection** The City provides pet waste collection stations at many of its parks and open spaces	1. Document and report the number disposable pet waste bags purchased each year. 2.	1. Year 1- Year 5 2.	Parks and Recreation Department
6a.	05	**Basin Management Plan (BMAP) for Adopted TMDL** In accordance with Section 403.067, F.S., the City of Sebastian must comply with the adopted provisions of the Central Indian River Lagoon BMAP that specify activities to be undertaken by the City of Sebastian. If a BMAP is in development and scheduled to be adopted within two years by DEP and watershed stakeholders, the City of Sebastian shall continue to participate in the BMAP process and comply with the adopted provisions of the BMAP that specify activities to be undertaken by the City during the permit cycle.	1. Continue to participate and implement the scheduled activities defined in the adopted BMAP. 2. 3. 4.	1. Year 1- Year 5 2. 3. 4.	Florida Department of Environmental Protection & Central Indian River Lagoon Stakeholders

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SECTION A.II. BEST MANAGEMENT PRACTICES (BMPs) For The Minimum Control Measure Identified In Section A.I. Of This Form

Element ID	BMP Number	A Description of BMP	B Measurable Goal(s)	C Schedule for Implementation/Completion	D Responsible Entity/Department
6a.	06	**Swales and Ditches Maintenance** The City will inspect and maintain all city-maintained swales, ditches, and canals in order to remove debris and particle matter once per month and additionally as necessary.	1. Document and report the number of miles of swales, ditches, and canals maintained. 2. Document and report the amount of debris collected. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4	Stormwater Department
6b.	01	**Stormwater Pollution Prevention Training** All City field staff members are required to attend the Green Industries BMP Course. Taught annually by the County's IFAS Extension Office, the class is designed as a water quality and water conservation program. It instructs how MS4 operator activities should be conducted to prevent runoff and leaching of chemicals and fertilizers into water bodies.	1. Document and report the number of new employees receiving training. 2. Document and report the number of current employees receiving refresher courses. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Human Resources Department
6b.	02	**Stormwater Inspectors Training** Stormwater Department Staff are encouraged to attend stormwater inspector training class as it pertains to their duties. The Stormwater Department will pay any fees associated with classes and/or certifications.	1. Document and report the number of employees who attend classes. 2. Document and report the number of employees who are currently certified. 3. 4.	1. Year 1- Year 5 2. Year 1- Year 5 3. 4.	Human Resources Department

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Appendix M: Glossary of Terms

IPM Glossary of Terms

Aeration	The use of pumps and/or fountains to diffuse oxygen into the water column of a waterbody to increase the levels of dissolved oxygen within the water which enhances the natural breakdown of pollutants and excess nutrients.
Baffle Boxes	An underground structure, installed at outlet and outfall points. Baffle boxes have a series of settling chambers, whose primary function is to remove sediment, debris, trash, and their associated pollutants from stormwater before it enters a larger waterbody. The boxes are vacuum cleaned and the material is properly disposed of, preventing the sediment, debris and trash from ever entering the water body.
Beneficial Species	An organism which naturally feeds upon, out-competes, or otherwise hinders the growth of pest populations, i.e. Ladybug, Air potato Beetle.
Best Management Practice (BMP)	Actions that are taken based upon current science and technology that have been proven to be effective, with the least detriment to public health and safety, wildlife and the local ecosystems.
Bioaccumulation	The gradual accumulation of substances, such as pesticides or other chemicals in an organism that occurs when a substance is absorbed at a rate faster than that which the substance is lost by catabolism and/or excretion.
Biodiversity	The naturally occurring variety of species that coexist in an area.
Bio-Herbicide	Any herbicide which is either derived from naturally occurring compounds and minerals or produced by the metabolism or excretions of living organisms, such as animals, plants, and bacteria.
Broadcast Application	The general distribution of a substance over the entire surface of an area. In comparison to "spot application" in which the substance is applied directly to a specific location.
Buffer Zone	A predetermined distance surrounding a body of water where fertilizer and pesticide applications are prohibited.
Canal	A man-made waterway/channel with a width ten (10) feet or greater, created for recharge, collection, storage, and the movement of stormwater.

Catch Basin	A reservoir or well into which surface water runoff drains into, in order to catch and retain sediments and other floatable and suspended materials entering the stormwater system or natural waterway.
Chemical	Any substance consisting of matter. This includes any liquid, solid, or gas. A chemical may be a pure substance (an element) or any mixture (a solution, compound, or gas). A chemical may occur naturally or can be created artificially.
Complaint Control Program	Emergency control of noxious aquatic vegetation that relies heavily on chemical controls to bring a species population back down to an acceptable threshold where it can then be controlled by a **maintenance control program.** The need for complaint control occurs when a management entity has failed to establish an effective maintenance program or following a period of mandated non-spraying (moratorium).
Contract	A legally binding written agreement, including but not limited to a contract, lease, permit, license or easement, between a person, firm, corporation, or other entity, including but not limited to: Federal government, State of Florida, County government, City government or any subdivision thereof which grants a right to use, lease, or occupy property of the City for a specified purpose or purposes.
Contractor	A person, firm, or corporation or other entity, including any governmental authority of a political unit or organization, or any subdivision thereof that enters into a contract with the City for services.
Conveyance System	The interconnected ponds, ditches, and canals that are designed to collect, store, and transport stormwater throughout the City.
Culvert	An underground pipe that transports stormwater between catch basins, swales, ditches, ponds, and canals.
Dam	A barrier constructed to hold back water and raise its level, forming a reservoir.
Detention Area	An area where stormwater is temporarily stored, or detained, and is eventually allowed to drain slowly when water levels recede in the receiving channel. Detention areas are often referred to as dry ponds or dry detention areas.
Ditch	An open constructed channel with its top width less than 10 feet at design flow, may serve as detention or retention area.

Drop Inlets	Collects stormwater from a parking lot, or other similar impervious surface. Drop inlets collect runoff from roads and parking lots and convey it to an underground storm drain system.
Dry Detention Area	See "**Detention Area**"
EIQ	A formula developed for agriculture and turfgrass applications to provide pesticide applicators with numerical guide regarding the relative environmental and health impacts associated with their pesticide options to ensure that they utilize the best management practices regarding their pesticide selection.
Emergent Vegetation	Wetland vegetation that is characterized by erect, rooted, herbaceous plants growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content, excluding mosses and lichens. This vegetation is typically along the shoreline and present for most of the growing season in most years and is usually dominated by perennial plants.
Endangered Species	A protected species, as listed by the Federal Government or the State of Florida that has the potential to become extinct in the near future, either worldwide or in a particular political jurisdiction without the additional protections provided by law. "Endangered" is the highest level of conservation status in the U.S.
Eradication	The complete removal of noxious aquatic vegetation to the point where it is unlikely to return. Eradication of noxious aquatic plants is virtually impossible and is NOT the goal of a **control management program**.
Field Use EIQ Rating	A rating calculated by multiplying the EIQ value for the specific pesticide active ingredient listed in the tables by the percentage of active ingredient in the formulation by the rate per acre used. The rating allows comparisons of potential environmental impacts associated with the use of a particular pesticide and the potential impact of its application. This serves as a practical tool for the use of best management practices in pesticide application.
Fertilizer	A chemical or natural substance added to soil or land to increase its ability to grow vegetation. The substance usually contains a percentage of organic or inorganic nitrogen, phosphorus and Potassium to enhance plant and root growth and/or flowering.
Floating Vegetation	Aquatic vegetation with leaves that float on the water surface. Their roots may be attached in the substrate or floating in the water column.

Fungicide	A substance (pesticide) that is intended to be used for the prevention, control and/ or eradication of fungal pests.
Herbicide	A substance (pesticide) that is intended to be used for the prevention, control and/ or eradication of noxious vegetation.
Herbicide Resistance	The inherited ability of an individual plant to survive a herbicide application that would kill a normal population of the same species. Most commonly found in aquatic plants, such as hydrilla.
Inlet	A device located above the mean high water line that admits surface waters to the stormwater drainage system.
Insecticide	A substance (pesticide) that is intended to be used for the prevention, control and/ or eradication of insect pests.
Invasive	Non-native species that causes ecological, physical, or economic harm in a new environment, beyond its natural range.
Irrigation	The application of water from a well, reservoir or other water supply across a land to assist in the health and durability of a cultivated plant species.
Key Pests	Pests which are encountered at an unacceptable population level at least once a year. Key pests are often cyclic in their impact and may only require control in specific location(s), based on their habitat requirements and the use or purpose of the location.
Leachability	The ability of a pesticide to travel downward through the soil profile where it can contribute to groundwater contamination. The potential for contamination is a product of the pesticide's ingredients and soil characteristics.
Littoral Zone	The area of land that extends from the highest point of the shoreline or abutment which is rarely or seasonally inundated with surface water to the highest point that is permanently submerged.
Littoral Shelf	The area of land between the shoreline of a body of water and the banks surrounding it. When planted, it can create a natural barrier around the waterbody to absorb excess nutrients and pollutants from the land and add to both the function and natural aesthetics of the area.
Maintenance Control Program	A method for the management of aquatic plants in which techniques are used in a coordinated manner, on a continuous or periodic basis, in order to maintain the target plant population at the lowest feasible level funding and technology will permit. This is the goal of the IPM Program.

Mode of Action (MOA)	The way in which the **herbicide** controls susceptible plants. It usually describes the biological process or enzyme in the plant that the herbicide interrupts, affecting normal plant growth and development.
Native Species	An indigenous species. Any species that is normally present in a particular ecosystem as a result of natural processes, with no human intervention. Natives may be adversely affected by the introduction of exotic species, contributing a reduction in biodiversity.
Natural Resources Board	A volunteer board comprised of City residents, created with the mission to improve the quality of life in Sebastian by nurturing the beneficial relationship between our citizens and our environment by protecting, preserving, and promoting our natural resources.
Nematode	Any of the phylum, Nematoda, consisting of round worms most of which are free-living in soil or water. Many nematodes are parasitic in plants and animals and may be very host-specific. Nemotodes may be classified as a **pest** or are often utilized as a **biological control** for another pest.
Non-Native	Often referred to as alien, exotic, nonindigenous, or introduced species, are those that occur in areas outside of their natural geographic range.
Noxious Aquatic Vegetation	Any aquatic vegetation (**native** or **non-native**) which has growth that has spread beyond the tolerance threshold in that it threatens structures or decreases the **stormwater conveyance system**'s ability to store and move water.
Outfall	A terminal point where collected surface and storm water runoff is discharged from a pipe system or culvert into a body of water. The outfall is the final **outlet** of a drainage system.
Outlet	The point at which water discharges from a stormwater pipe or drain into a pond, ditch, or canal.
Pathogen	Any disease-producing organism or virus. Pathogens may be classified as a pest or are often utilized as a biological control for another pest.
Pest	Any plant (weed), vertebrate (bird, rodent, or other mammal), invertebrate (insect, tick, mite, or snail), nematode, or pathogen (bacteria, virus, or fungus), which may cause disease, inflict damage, or out-compete the native or more desirable species for an area. In addition, a pest may be aesthetically undesired, or threaten to impact human and/or animal health/safety.

Pesticide	Any substance or combination of substances which is intended to be used for preventing, destroying, repelling, or mitigating any pest; this includes herbicides, insecticides, bio pesticides, fungicides, and the like.
Phase II MS4 Permit	FDEP permit issued to the City every 5 years, which contains all of the approved BMPs which the stormwater department must implement in order to protect local surface and subsurface water quality.
Pond	A natural or man-made waterbody with a defined perimeter and limited in size. A retention basin, also referred to as a wet pond, wet detention basin or stormwater management pond (SWMP). A pond includes a permanent pool of water in its design.
Pollinators	A living organism that helps carries pollen from the male part of the flower (stamen) to the female part of the same or another flower (stigma) Pollinators are viewed as "beneficial species" and an integral member of the ecosystem.
Retention Area	An area where **stormwater** is held or retained stormwater on a permanent basis. These areas are used to store large amounts of stormwater until it eventually infiltrates downward into groundwater or the water reaches an elevation that it spills over into an outlet, sending it through the conveyance system.
Protected Species	Any species that is protected from harm due to anthropogenic activities such as land development and hunting through state or federal government legislation.
Right-of-Way	An Easement, a privilege to pass over the land of another, whereby the holder of the easement acquires only a reasonable and temporary access of the property and the owner of the land retains the benefits and privileges of ownership consistent with the easement. Examples of the City's rights-of-way include roadside swales and access paths to maintain stormwater assets.
Safety Data Sheets	The data sheets that are federally required for all hazardous chemicals. Sheets must contain all of the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. Any entity creating, storing, distributing, or applying these chemicals must have these SDS's on-site and accessible to all staff.

Seawall	A retaining wall located along the perimeter of a water body, designed to maintain a fixed shoreline at a specific elevation above the seasonal high water mark of the adjacent waterbody. Seawalls can help prevent erosion and surface water runoff.
Sediment	Fine soil particles that have been detached from the land by erosion and are deposited into a body of water through surface water runoff, often mixing with decaying organic matter to create a muddy **substrate**. Sediments can suspend in the water, decreasing clarity and often contributing nutrients and other pollutants into the water.
Solubility	The measure of the ability of a substance to dissolve in a solvent, such as water. Pesticides that are highly soluble in water dissolve/dilute easily and are more likely to surface and groundwater.
Spillway	A device within a dam that regulates the height of the water on the inflow side, creating a reservoir or storage area for water, and maintains the **dam**'s structural integrity by allowing surplus water to be released on the outlet side.
Stormwater	Rainwater that runs off impermeable surfaces such as rooftops, paved streets, highways, and parking lots. Stormwater can also come from semipermeable surfaces hard such as lawns, playing fields, and from gravel roads and parking lots before it flows into the stormwater conveyance system. Stormwater can also travel through shallow aquifers or groundwater, seeping into **ponds**, **canals**, and **ditches** that intersect the groundwater table.
Submersed Aquatic Vegetation	Rooted plants that exist within the sublittoral zone, which have flaccid or limp stems with most of their vegetative mass located below the water surface, although small portions may extend above the water.
Sustainable (ecological)	The quality of not being detrimental to the environment, thereby maintaining long-term ecological balance without depleting the existing natural resources, or altering the native biodiversity.
Substrate	The collection of inundated soil and **sediments** that comprise the "ground" at the bottom of a waterbody.
Swale	A man-made, grassed, shallow, depression designed to be part of stormwater **runoff** collection and drainage conveyance system. Swales are characterized by its relatively gentle side slopes, and shallow depth when wet, designed to hold **stormwater** for 72 hours following a storm event.

Threatened Species	Any species that is vulnerable to becoming **endangered** in the near future, either worldwide or in a particular political jurisdiction. Moderate level of conservation status
Total Maximum Daily Load (TMDL)	Total Maximum Daily Load is a calculation of the maximum amount of a **pollutant** that a waterbody can receive and still meet water quality standards set by Federal, State, or local governments.
Weedoo	A specific brand of specialized airboat designed to cut and collect aquatic vegetation from shallow waterways.
Weir	A low head **dam** constructed to form a barrier across the width of a **canal** or river, to either raise the water level on the upstream side or regulate the rate of flow on the downstream side. Many times **spillways** are installed within a weir to allow seasonal manipulation of the water depth and flow.

This IPM Plan is Coordinated and Written by:
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Appendix E

United States Department of Agriculture /
Natural Resources Conservation Service Soil Survey Report

United States Department of Agriculture

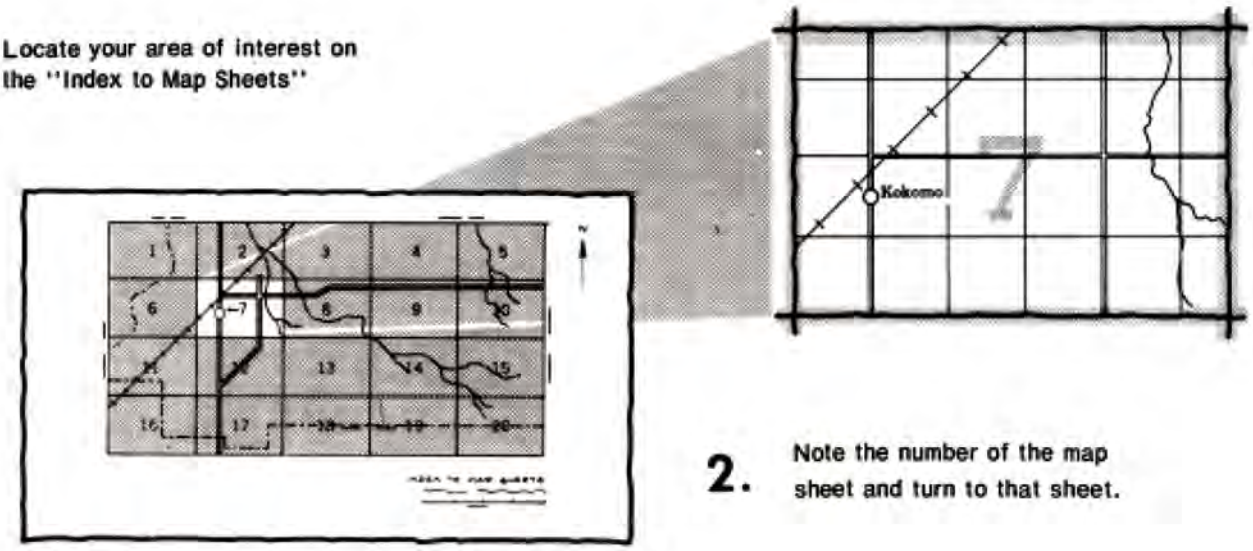
Soil Conservation Service

In cooperation with University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations, and Soil Science Department, and Florida Department of Agriculture and Consumer Services

Soil Survey of Indian River County, Florida

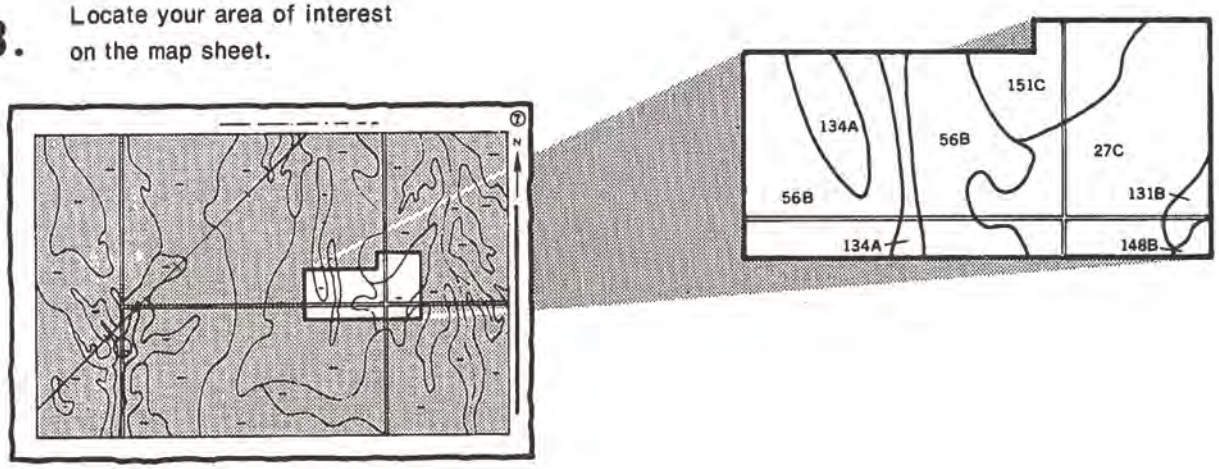
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"

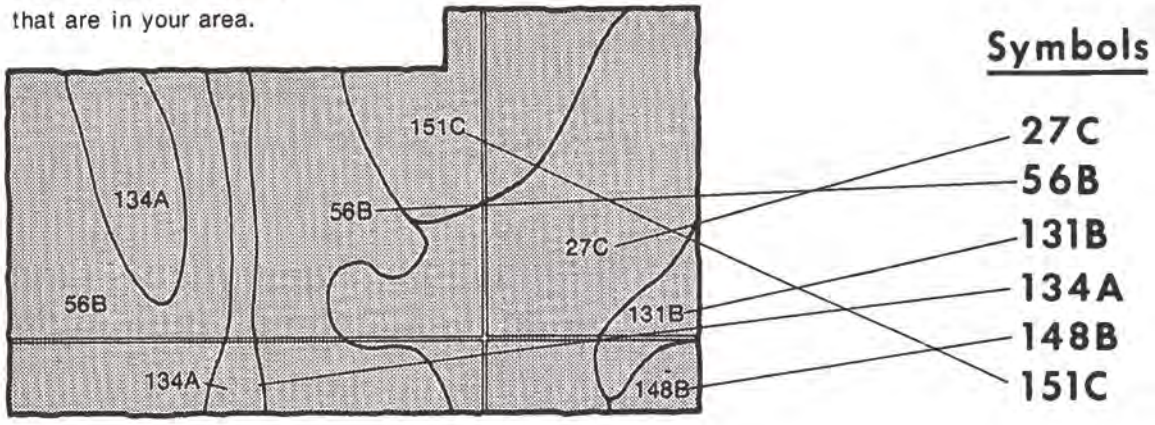


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.

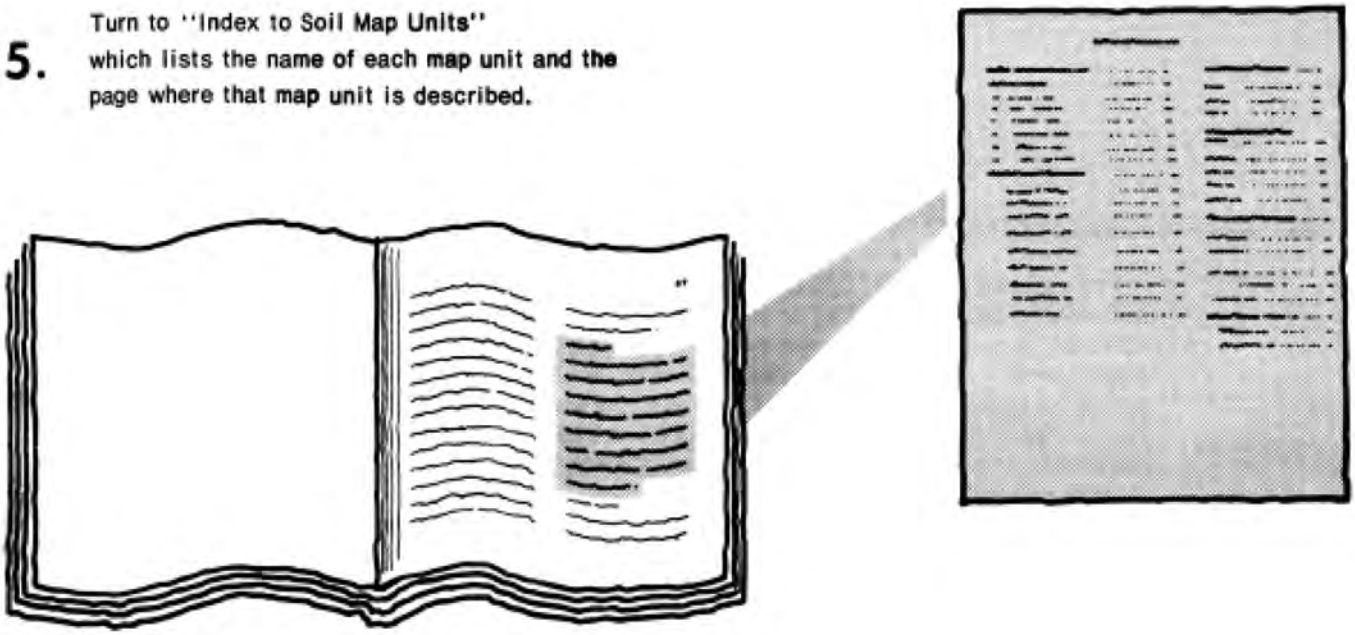


4. List the map unit symbols that are in your area.

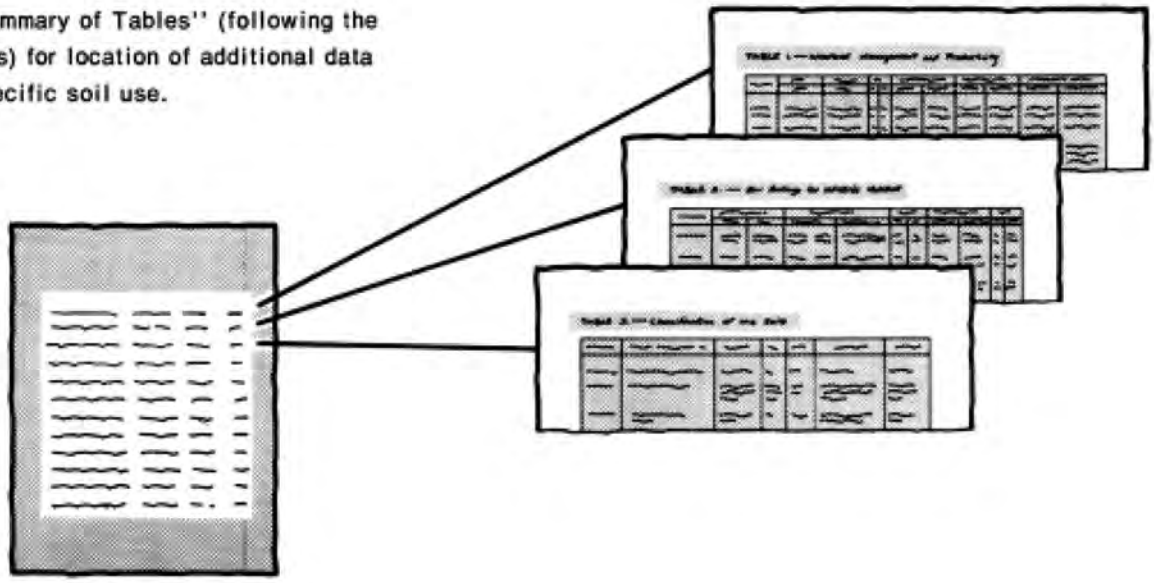


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This soil survey was made cooperatively by the Soil Conservation Service; the University of Florida, Institute of Food and Agricultural Sciences, Agricultural Experiment Stations, and Soil Science Department; and the Florida Department of Agriculture and Consumer Services. It is part of the technical assistance furnished to the Indian River Soil and Water Conservation District. The Indian River County Board of Commissioners contributed financially to accelerate the completion of the fieldwork for this survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

This survey supersedes the Indian River Area soil survey published in 1913.

Cover: The Indian River is separated from the Atlantic Ocean by a barrier island that is broken only by inlets. The river serves as a transportation artery and has many recreational uses.

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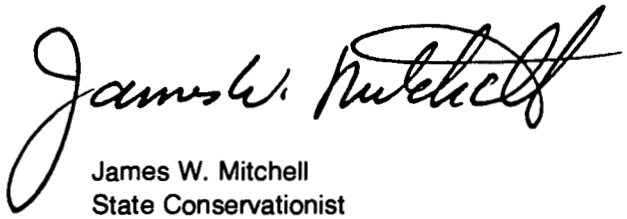
Foreword

This soil survey contains information that can be used in land-planning programs in Indian River County, Florida. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

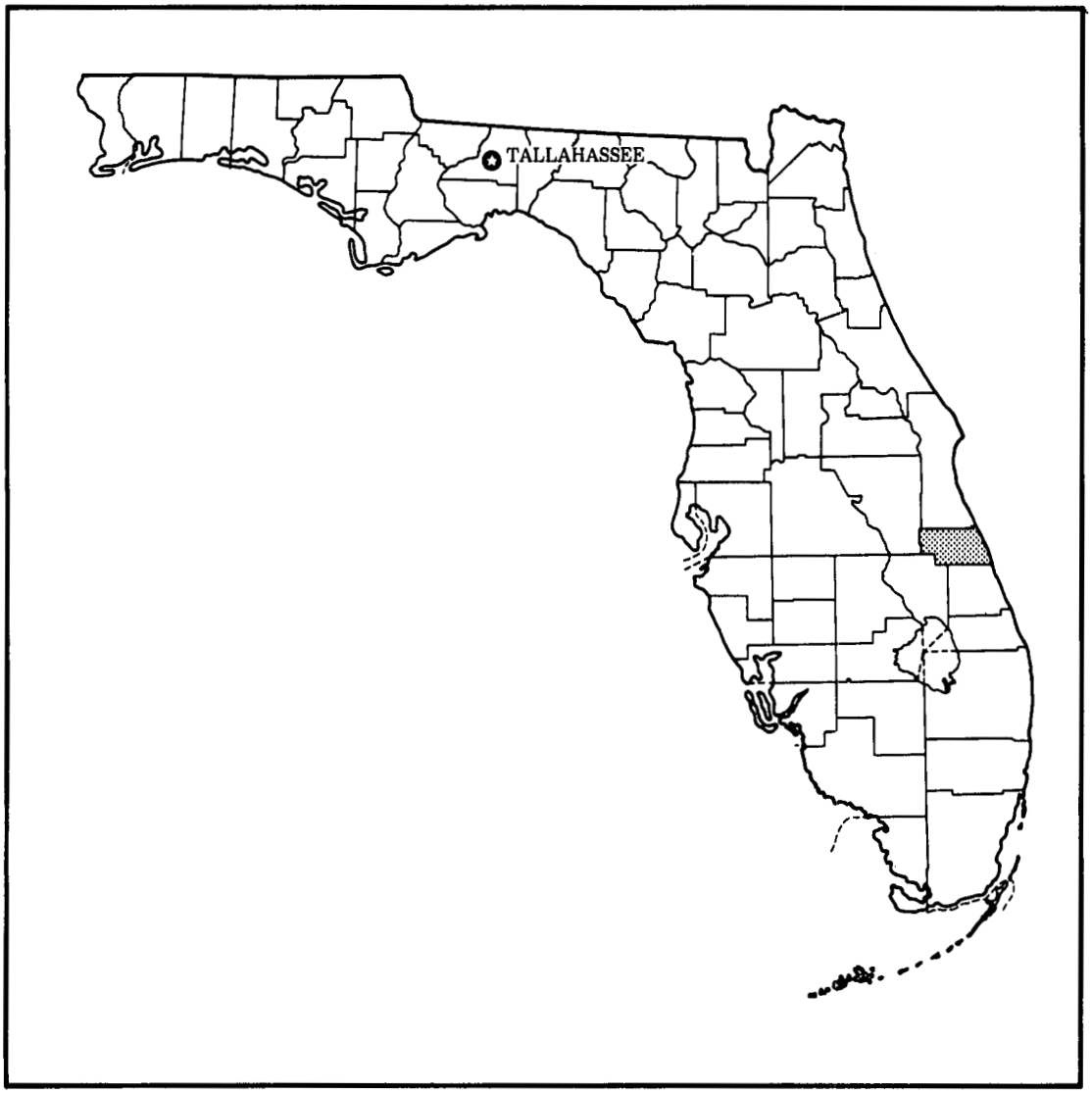
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



James W. Mitchell
State Conservationist
Soil Conservation Service



Location of Indian River County in Florida.

Soil Survey of Indian River County, Florida

By Carol A. Wettstein, Chris V. Noble, and James D. Slabaugh,
Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
In cooperation with
University of Florida, Institute of Food and Agricultural Sciences,
Agricultural Experiment Stations, and Soil Science Department,
and Florida Department of Agriculture and Consumer Services

INDIAN RIVER COUNTY is in the southeastern part of peninsular Florida. It is bordered on the north by Brevard County, on the west by Osceola and Okeechobee Counties, on the south by Okeechobee and St. Lucie Counties, and on the east by the Atlantic Ocean.

The land area in the county covers 318,119 acres or about 497 square miles. The survey area includes 345,383 acres or about 540 square miles. This includes 11,237 acres of freshwater areas throughout the county and 16,027 acres of saltwater in the Indian River.

The county is about 23 miles long and about 28 miles wide at the widest part. Vero Beach, the county seat, is in the eastern part of the county on the west shore of the Indian River.

The economy of Indian River County is fairly well diversified. It mainly consists of tourism, agriculture (the center of the Indian River citrus belt), and light industry. The mild winter temperatures, miles of unspoiled beaches, and numerous recreational activity areas attract many tourists and retirees from all over the world.

General Nature of the Survey Area

In this section, environmental and cultural factors that affect the use and management of soils in Indian River County are described. These factors are climate; history and development; physiography, relief, and drainage; water resources; farming; recreation; and transportation.

Climate

The climate of Indian River County is characterized by long, warm, humid summers and mild winters. The moderating influence of the Atlantic Ocean and the Gulf stream on maximum temperatures in summer and minimum temperatures in winter is strong along the immediate coast, but it diminishes slightly a few miles inland. Because of the moderation of winter and summer temperatures, the climate of Indian River County is considered to be humid and subtropical. The average year round temperature is 73.4 degrees F.

Although the mean annual air temperature seldom varies more than a degree or two from year to year, the annual rainfall may vary 100 percent *(6)*. Yearly rainfall generally is from 50 to 55 inches. September generally has the most rainfall with June, October, and August following next in order. The period of least rain usually occurs from November to April.

The moist, unstable air in the county results in frequent showers that are generally of short duration. Thunderstorms are frequent during the summer, occurring on an average of every other day. Sometimes these storms are heavy, and 2 or 3 inches of rain falls in 1 to 2 hours. More than 60 percent of the annual rainfall occurs during these summer thunderstorms. Winter and spring rains generally are not so intense as summer thunderstorms. Summarized climatic data *(7, 17, 18)* based on records collected at Vero Beach are shown in table 1.

Daylong rains are rare and almost always are associated with a tropical storm. Tropical storms can affect the area any time from late in May through mid-November. Storms of hurricane force with winds of 74 miles per hour or more may be expected in this area about once every 30 years *(11)*.

Extended periods of dry weather can occur in any season, but such periods are most common in spring and fall. Dry periods in April and May generally are of shorter duration than those in fall, but they tend to be more serious because temperatures are higher and the need for moisture is greater in April and May.

Hail falls occasionally during thunderstorms, but the hail is generally small and seldom causes much damage. Snowfall is almost unknown in Indian River County; although, snow flurries occurred throughout south Florida in the winter of 1976-77.

The geographic position of Vero Beach and Indian River County benefits from the prevailing southeasterly breezes. Cold continental air is modified as it travels over water or flows down the Florida Peninsula before reaching the Indian River County area. The coldest temperatures and infrequent frosts occur on the second or third night after the arrival of the cold air because heat is lost through radiation. Frosts and freezing temperatures are rare in the coastal areas but occur occasionally in inland areas. The most recent and most severe freeze that has occurred in the county was in January 1982 with a low of 14.6 degrees F. This was recorded in the southwest section of the county. An important citrus growing industry has been established because of the nearly frost-free winters. Freeze data shown in table 2 were taken at Vero Beach *(7)* and are representative for the area.

Summer temperatures are tempered by the ocean breeze and by the frequent formation of cumulus clouds, which somewhat shade the land without completely obscuring the sun. Temperatures of 88 degrees F. or higher have occurred in all months. A temperature as high as 100 degrees F. has occurred in the past. August is the warmest month and has an average maximum temperature of about 90 degrees F. This temperature is common from June through September.

Flying weather generally is very good in Indian River County, and "instrument" weather occurs only rarely. Since the air has no taint of industrial smoke, the air is clean and very little smog occurs.

Prevailing winds generally are southeasterly except in March when southerly winds prevail. Windspeed generally is between 10 and 15 miles per hour in the afternoon and from 5 to 10 miles per hour at night.

History and Development

The original inhabitants of the Indian River area about 400 years ago were the Ais Indians. These inhabitants were later named the Seminole Indians. The Ais Indians, who occupied this territory long before Ponce de Leon discovered Florida in 1513, were nonagricultural people who lived by hunting, fishing, and eating berries *(8)*. Because of disease and raids by white settlers, they disappeared from this area between 1700 and 1760.

In 1820, the area was ceded to the United States. In March of 1821, General Andrew Jackson became provisional Governor of Florida. During the first legislative council held in 1824, four new counties, including one named Mosquito County, were formed. In 1844, one year before Florida became a state, Santa Lucia County was formed from an area of Mosquito County. In 1845, Mosquito County was renamed Orange County, and at the same time, Santa Lucia County was renamed Brevard County *(11)*.

In 1845, the county of Brevard was bounded by St. Johns County, the Indian River boundary line, and Alachua County. In 1905, the legislature separated an area from Brevard County, which became known as St. Lucie County. Finally, an area was removed from St. Lucie County and created the county that officially became Indian River County on June 29, 1925.

During the Seminole Wars, a military post, which was known as Fort No. 2 and was later called Fort Vinton, was established in 1839 to protect the settlers in the territory. This territory later became part of Indian River County *(11)*.

The area of Johns Island was first settled in 1880. Since the island was practically frostproof, it became one of the most productive areas on the river for the growing of beans.

The community of Gifford was first settled between 1893 and 1894 when the Florida East Coast Railroad was extending its system along the coast. Fellsmere, in the north central part of the county, was founded in 1912. Because of its extensive marshlands, this was once one of the best areas in the state for frogging until drainage systems were created and caused the marshes to disappear. Other communities, such as Viking, Crawford's Point, Oslo, Indian River Shores, Indrio, Ixora Park, Orchid, Roseland, Rockridge, Sebastian, Tropicolony, Wabasso, and Winter Beach, were established along the Indian River, and agricultural interests flourished within the area.

Prior to the actual creation of Indian River County in 1925, the first permanent settlers traveled from the New York area by boat and railroad and came to Vero Beach in 1887. Vero Beach later became the county seat. The city of Vero Beach, which was only a small community of three houses and a general store in the 1880's, has grown to a population of over 16,000. Because of its location along the Indian River and resulting climate, Vero Beach is referred to as the city "Where the Tropics Begin."

Physiography, Relief, and Drainage

Indian River County is in the coastal lowlands of the Atlantic Coastal Plain physiographic province *(10)*. The coastal lowlands consist of an area of low relief that represents several ancient marine terraces. These ancient terraces mark where the sea coast was in past

geologic times *(6)*. The county can be divided into four physiographic subdivisions—the Eastern Valley, the Osceola Plain, the Atlantic Coastal Ridge, and Ten Mile Ridge *(21)*, (fig. 1).

The **Eastern Valley** is between the Atlantic Coastal Ridge to the east and the Osceola Plain to the west. It is the largest physiographic region in the county and extends the entire length of the county. The Pamlico Terrace, one of two terraces in Indian River County, encompasses the Eastern Valley. Most of the terrace is less than 25 feet above sea level but ranges from about 15 to 30 feet above sea level. The areas of flatlands occurring on this terrace consist mostly of flatwoods that have numerous, small depressions, low hammocks, and grassy sloughs. The soils are predominantly nearly level and wet and have a sandy surface layer and loamy material at various depths. Native vegetation is mostly pines, sawpalmetto, and pineland threeawn interspersed with areas of maidencane and scattered cabbage palm. The St. Johns Marsh also is on the Pamlico Terrace. It consists of freshwater swamps and marshes. Native vegetation includes red maple, redbay, cypress, willows, sawgrass, maidencane, and ferns. The soils are predominantly nearly level and very wet. These soils are organic throughout or have a moderately thick, organic layer that is underlain by a loamy subsoil. Most of the Eastern Valley has been planted to citrus, crops, or improved pasture grasses, or it is used for native range.

The **Osceola Plain** is in the western part of the county. It begins at the western edge of St. Johns Marsh at an altitude of about 25 feet and begins a gradual rise that flattens out to become the Talbot Terrace. Elevation mostly ranges from about 30 feet to about 60 feet above sea level. This area consists of flatwoods, low knolls, and ridges. In these areas are scattered depressions and poorly defined drainageways. The soils are

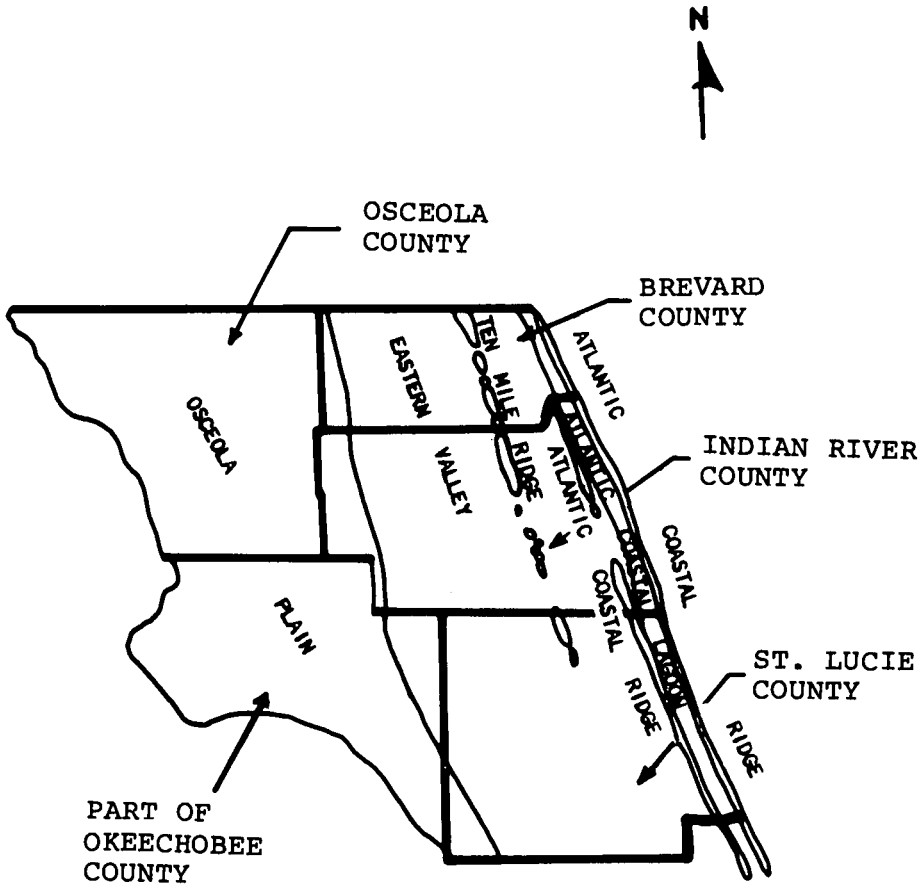


Figure 1.—Physiography of Indian River County and the surrounding area.

predominantly nearly level, wet, and sandy and have a dark sandy subsoil. In a few areas, the soils that are adjacent to the St. Johns Marsh have a sandy surface layer and a deep loamy subsoil. Native vegetation consists of pines, sawpalmetto, sand live oak, pineland threeawn, and maidencane. Most of this region is used for native range or has been planted to improved pasture grasses.

The **Atlantic Coastal Ridge** is in the eastern part of the county. It is bordered on the east by the Atlantic Ocean. The Atlantic Coastal Ridge consists of relic beach ridges that formed by wind and wave action along the shore. It rises to a maximum height of about 25 feet above sea level. The Indian River separates the present day barrier island from the mainland. The part of the Atlantic Coastal Ridge on the mainland is an elongated broken ridge that reaches altitudes of more than 50 feet. This ridge is a remnant of an offshore bar that was formed in the Pamlico Sea *(6)*. The soils on the mainland ridge are predominantly nearly level to gently sloping, very dry, and sandy. Native vegetation consists of sand pine, sand live oak, slash pine, rosemary, sawpalmetto, scrub oak, and pineland threeawn. The ridge on the barrier island consists of beach, primary dune, trough, inland dune, and back dune. The soils on the ridge of the barrier island are nearly level to gently sloping, wet to extremely dry, and sandy. These soils have varying amounts of shell fragments. Natural vegetation is sawpalmetto, sand live oak, cabbage palm, seagrape, and sea-oats. Many areas of the Atlantic Coastal Ridge on the mainland are used for urban development, and on the barrier island they are used for urban development and recreation.

The **Ten Mile Ridge** is in the Eastern Valley about 7 miles west of the Coastal Ridge. This intermittently occurring, less pronounced ridge ranges from about 25 to 35 feet above sea level. This ridge is made up of flatwoods, low knolls, and ridges. The soils on Ten Mile Ridge are nearly level to level, wet to somewhat dry, and sandy. Some of these soils have a dark, sandy subsoil that is underlain by loamy material. The native vegetation on the knolls and ridges consists of slash pine, longleaf pine, sand live oak, and sawpalmetto; on the flatwoods, it consists of slash pine, sawpalmetto, waxmyrtle, pineland threeawn, and bluestems. Most of Ten Mile Ridge is used for native range.

The low ridges that occur within the county have a great effect on surface water drainage, although this has been altered by manmade drainage systems. A few small streams enter the eastern part of the county from areas of higher elevation from the west. The St. Johns Marsh is also in the eastern part of the county and is the headwaters of the St. Johns River. It has no well defined channels or prominent streams except Blue Cypress Lake. Natural drainage is to the north through the entire width of the marsh.

Originally the area between the Atlantic Coastal Ridge and the Ten Mile Ridge was swampy. This area had no prominent stream channels other than the South Prong of Sebastian Creek that is to the north. Manmade drainage systems, such as the Main Canal and the North and South Relief Canals, extensively altered the natural flow pattern.

Water Resources

Water resources are of vital importance to the economy and future development of Indian River County. The importance of suitable water resources will continually need to be recognized as the development of new citrus groves increases. Citrus is a high value economic crop in the county, but also it is the largest user of agricultural water. The population in Indian River County increased from 36,000 in 1970 to approximately 60,000 in 1980. By 1982, an additional increase in population was estimated at 11.7 percent. This population increase has created the growing competition for the water resources in the county, especially since the availability of potable water is limited *(4, 6)*.

Indian River County has three main sources of water. These sources are surface and ground water bodies, a shallow aquifer, and the Floridan Aquifer (fig. 2).

The first major source of water supply is surface and ground water bodies. The surface water of the county is being used for irrigation in increasing quantities *(6)*. The trends indicate that such usage of water will probably exceed that of ground water. Ground water is the subsurface water in the zone of saturation; that is, the zone in which all soil pore spaces are filled with water under pressure no greater than atmospheric pressure. With the drainage of wetlands, especially in the area of the St. Johns Marsh, the amount of available surface water storage areas has been reduced. This situation will improve if the St. Johns Water Management District is successful in their attempt to acquire lands as water storage areas.

The yearly rainfall in Indian River County is 50 to 55 inches. Almost two-thirds of it occurs during the summer and early in the fall. Large streams do not exist in the county. Runoff is to the north through the St. Johns Marsh, into the St. Johns River basin, and eastward to the Indian River through several improved channels and canals. Blue Cypress Lake is the only large body of freshwater in the county. The Indian River, technically a lagoon between the mainland and an offshore bar, is at sea level and is highly saline *(6)*.

A second major source of water supply is a shallow aquifer consisting of variable compositions of sand, shell fragments, and some silt and clay. This shallow aquifer underlies all of the county. Its base reaches to a depth of 150 feet. This aquifer is underlain by the Hawthorn Formation, which acts as a confining bed or aquiclude and impedes upward movement of water from the

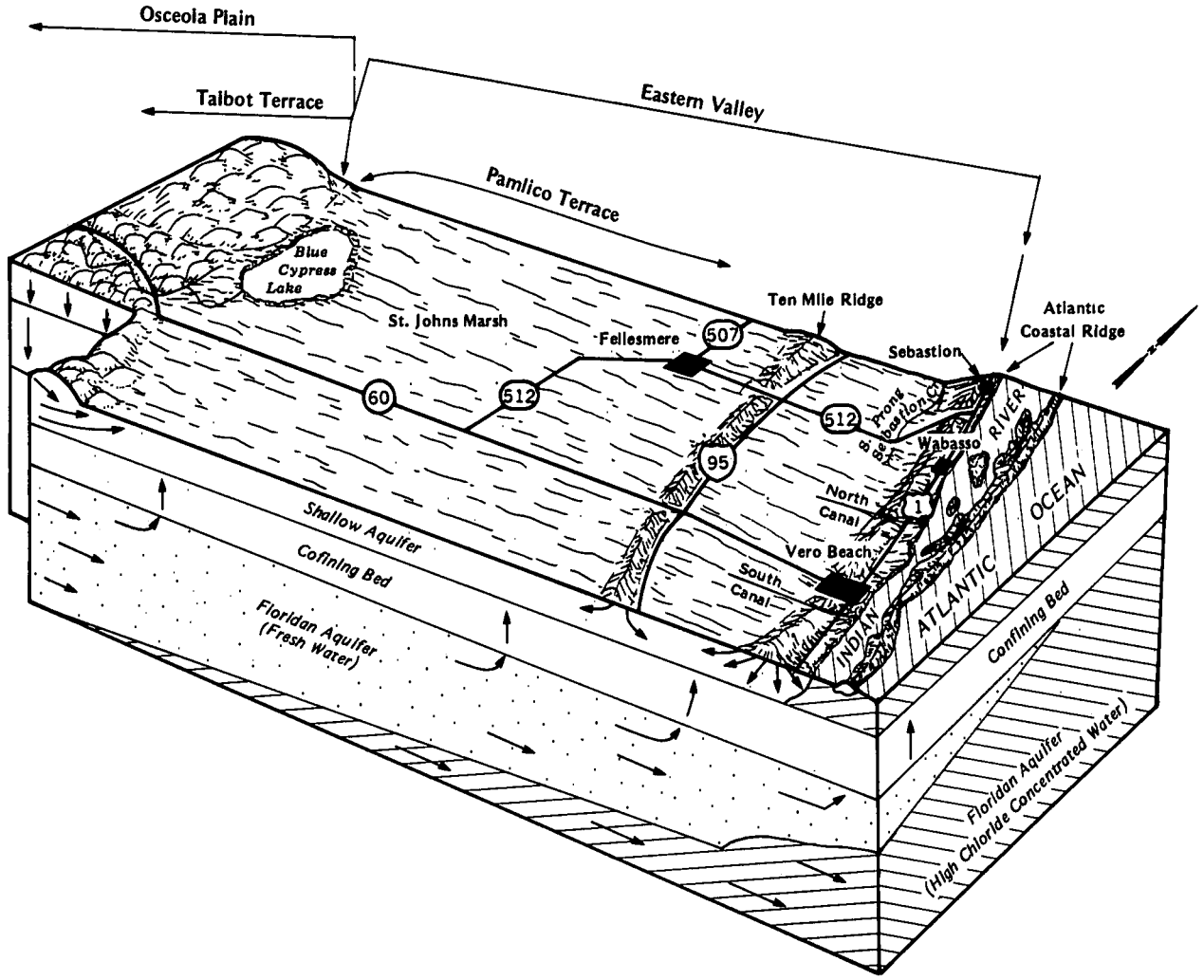


Figure 2.—Physiographic subdivisions of Indian River County (Eastern Valley, Pamlico terrace; Osceola Plain, Talbot terrace; Atlantic Coastal Ridge, mainland, barrier island; and Ten Mile Ridge) and water resources showing principal aquifers and movement of the ground water.

underlying Floridan Aquifer. Water from the shallow aquifer is of good quality and has a chloride concentration that is usually less than 60 milligrams per liter. This aquifer is the principal source for both municipal and domestic use. Recharge is primarily from the rainfall which occurs in the county. This shallow aquifer receives some recharge of water which is withdrawn for irrigation from the Floridan Aquifer within the drainage districts. Two areas within the county have the best potential for meeting the future demands of withdrawal for water. These areas are in the eastern third and the extreme western part of the county. The shallow aquifer near the Indian River consists of discontinuous layers, or lenses, or cemented or impermeable materials that appear to act as a barrier to saltwater intrusion from the river. Extensive development of this shallow aquifer for municipal water supply should be monitored to maintain water quality and quantity.

The third major source of water supply is the Floridan Aquifer, which underlies the county at a depth of 300 to

600 feet. This aquifer consists of Eocene and Oligocene carbonate rocks. This is a confined or artesian aquifer. Recharge to this aquifer is almost entirely from the area that is west and outside of the county. Discharge from the aquifer is from wells that are scattered throughout the surface area. These wells are primarily used for irrigation, and the artesian wells that are left open naturally discharge to the ocean. The quality of water from this aquifer varies greatly throughout the county. The water from this aquifer has a high chloride concentration that generally increases as the depth increases. Because of the chloride concentration, this water is used for irrigation of citrus and improved pasture but is not used for public supply. Rainfall and ground water help to dilute the chloride concentration and help make the water suitable for irrigation.

Two additional sources of water that are available for future development are the surface water (nonsaline) and water (saline) from the Indian River. The nonsaline surface water is discharged into the Indian River from the canal network of three drainage districts in the county. Most of this water occurs as storm runoff and has a wide variation in chloride concentration. The floodwater from drainage districts can be stored in areas that are similar to the St. Johns Marsh and pumped back to the district when needed. The saline water is almost unlimited in supply and can be used for thermoelectric coolings.

Farming

Farming has always been an important factor in the economy of Indian River County. Before 1900, Johns Island and other areas of the barrier island were known for producing truck crops, such as beans, and for growing pineapples and citrus. Some areas also were used for raising hogs.

Beans, strawberries, tomatoes, and other garden crops and citrus were grown from Roseland to the Winter Beach area. When the network of canals and ditches that were dug in the early 1900's began draining the lowlands, the hammocks and highlands became dry. Irrigation became necessary and expensive, which resulted in truck farming gradually giving way to citrus production in these areas. At one time, large amounts of tomatoes and other crops were grown in the area south of Fellsmere and north of Florida State Road 60. Because tomatoes were susceptible to nematodes and disease, the freezing weather and the requirement that land be newly cleared for use each year made the growing of these crops too costly.

In the early 1920's, experimental sugar cane plantings were conducted in Fellsmere. A mill was constructed in 1932 and a refinery was added in 1935. This was the only factory in Florida that produced refined sugar from domestically grown sugar cane. This sugar mill closed in 1966 and gave way to citrus production, to ranching, and to raising tropical fish. The raising of tropical fish has been severely affected by the recent freezing temperatures. In 1923, a muck plant was built in Fellsmere to experiment in the making of fertilizer from muck. This operation was discontinued 2 years later because of the costly process involved.

The main farming enterprise in Indian River County today is citrus production. In 1982, approximately 62,700 acres was planted to citrus. Additional citrus acreage comes into production each year *(7)*. Most of this acreage is in oranges and grapefruit, and some small acreages are in tangelos and tangerines. At present, the western part of Indian River County is open for the development of new groves, but limitations of water for irrigation is a restricting factor for the future.

The second most important agricultural interest in Indian River County is cattle raising. About 125,000 acres is used for livestock. This includes approximately 62,200 acres that is used for improved pasture for beef and dairy production *(7, 19)*. Most of this pasture consists of improved bahiagrass and white clover. In 1983, only one dairy farm was in the survey area. Hogs are still raised in the county.

Various crops, such as field corn, sorghum, soybeans, and rice, are grown on approximately 7,200 acres in the western one-third of the county. The soils on this acreage are mainly organic. In some small areas, sweet corn, cabbage, tomatoes, melons, and strawberries are also grown.

Each year, urban development has encroached on many acres of land that if left undeveloped would have good potential for agricultural use. Because of wetness, many of the soils in these areas have severe limitations for most agricultural use. But, with today's technology, which includes intensive management and a good water control system to remove excess water rapidly and to provide water during dry periods, these soils are well suited to most agricultural uses.

Recreation

A wide variety of recreational activity areas are available in Indian River County. These areas include 23 miles of coastline, Indian River, Sebastian Inlet, Sebastian River, and Blue Cypress Lake. These areas offer many recreational activities for those who enjoy freshwater or saltwater fishing, boating, birding, surfing, shellfishing, or sunbathing.

The Sebastian Inlet is a state recreation area that is well known for its excellent fishing. There are two jetties in the inlet, as well as areas for camping and other recreational facilities. Near the inlet is the McLarty Museum. This museum houses the treasures that were salvaged from Spanish shipwrecks off the Florida coast. Also in the Sebastian Inlet area is the Pelican Island Wildlife Refuge, which has been designated as the first

national wildlife refuge in the nation. This refuge was established in 1903.

At Vero Beach are other recreation attractions, such as Dodgertown, which serves as the spring training camp for the Los Angeles Dodgers and, during the summer, is home for their farm team, the Vero Beach Dodgers. This facility is also used as a summer camp for the New Orleans Saints during July and August. In the Vero Beach area are many golf courses, tennis courts, and shuffleboard facilities. There are also many playgrounds and parks throughout the county.

Transportation

Indian River County is served by several major highways. U.S. Highway 1 and Florida State Road A1A are in the eastern part of the county, parallel to the coast. U.S. Highway 1 is on the mainland, and Florida State Road A1A serves as the major road that extends the entire length of the county on the barrier island. U.S. Interstate 95 crosses through the eastern one-third of the county in a north to south direction. Florida State Road 60 extends westward from Vero Beach to Yeehaw Junction in Osceola County. The Sunshine State Parkway, which is also called the Florida Turnpike, crosses the far southwestern edge of the county in two places. Restricted access to this road is at Yeehaw Junction and Ft. Pierce in St. Lucie County. Several county roads connect the outlying towns or the outlying areas, such as Fellsmere, with the major roads in the county.

The Florida East Coast Railway runs north to south, basically parallel to U.S. Highway 1. The Sebastian Inlet at the north end of the county provides access from the Indian River and Intracoastal Waterway out to the Atlantic Ocean.

The two commercial airports in the county are in Vero Beach and Sebastian. There are several private landing fields in the county. Bus service is available throughout the area. A few large trucking firms that have facilities for handling interstate trade also serve the area.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material from which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area are generally collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management

were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. In the detailed soil map units, these latter soils are called inclusions or included soils. In the general soil map units, they are called soils of minor extent.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or a building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The soils in the survey area vary widely in their potential for major land uses. Table 3 shows the extent of the map units shown on the general soil map. It lists the suitability and potential of each of the map units for major land uses and shows soil properties that limit use. Soil ratings are based on the practices commonly used in the survey area to overcome soil limitations. These ratings reflect the ease of overcoming the limitations. They also reflect the problems that will persist even if such practices are used.

Each map unit is rated for *cropland, pasture, woodland, sanitary facilities, building sites,* and *recreation areas*. Cultivated crops are those grown extensively in the survey area. Pasture is improved pasture grasses grown extensively in the survey area. Woodland refers to areas of native trees. Sanitary facilities include septic tank absorption fields and trench sanitary landfills. Building sites include residential, commercial, and industrial developments. Recreation areas are campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic.

Soils of the Sand Ridges

The one map unit in this group consists of nearly level to gently sloping, excessively drained and moderately well drained soils in high dunelike areas. These soils are sandy throughout. This map unit is in the eastern part of Indian River County. It is on the mainland coastal ridge along U.S. Highway 1 and extends from Brevard County to St. Lucie County.

1. Astatula-Archbold-St. Lucie

Nearly level to gently sloping, excessively drained and moderately well drained soils that are sandy to a depth of 80 inches or more

This map unit consists of deep, nearly level to gently sloping, sandy soils on high, discontinuous dunelike ridges (fig. 3). These soils are on the Atlantic Coastal Ridge, which extends in a north-south direction from Brevard County to St. Lucie County parallel to the Indian River.

The natural vegetation is sand pine, sand live oak, slash pine, rosemary, Chapman oak, sawpalmetto, pricklypear cacti, pineland threeawn, lichens, and reindeer moss.

This map unit makes up about 5,728 acres, or about 1.8 percent of the survey area. It is about 27 percent Astatula soils, 14 percent Archbold soils, 14 percent St. Lucie soils, and 45 percent soils of minor extent.

Astatula soils are excessively drained. Typically, the surface layer is grayish brown sand about 4 inches thick. The subsurface layer is brown sand about 1 inch thick. The substratum to a depth of 80 inches or more is brownish yellow sand.

Archbold soils are moderately well drained. Typically, the surface layer is gray sand about 2 inches thick. Underlying that is sand to a depth of 80 inches or more. The upper 36 inches of the underlying sand is white, the next 13 inches is light gray, and the lower 29 inches or more is gray.

St. Lucie soils are excessively drained. Typically, the surface layer is gray sand about 3 inches thick. Below that is white sand to a depth of 80 inches or more.

The soils of minor extent in this map unit are Orsino, Paola, and Jonathan soils.

Some areas of this map unit are used for urban development. Part of the cities of Vero Beach, Sebastian, and Roseland has been developed on these soils. Also, some commercial buildings and many houses have been built in the areas of this map unit. Some small areas are used for citrus or as sources of fill material.

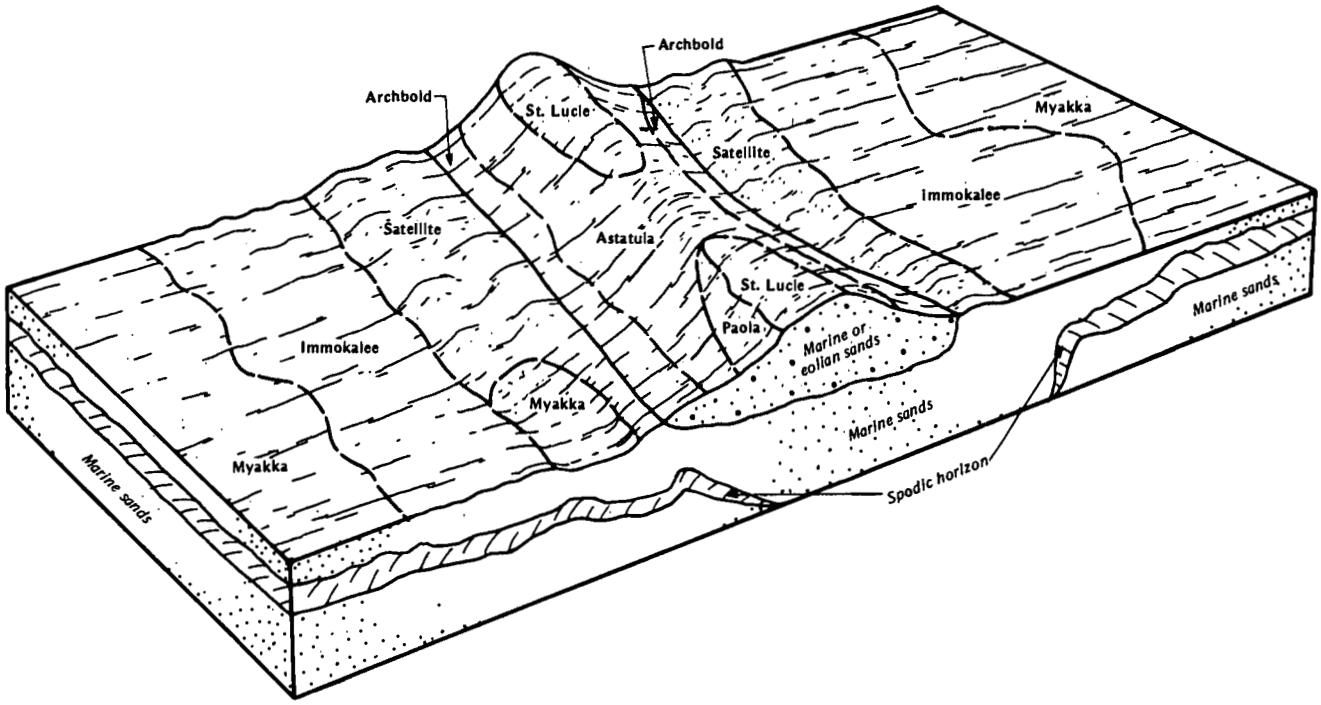


Figure 3.—Typical pattern of soils and parent material in the Astatula-Archbold-St. Lucie map unit and the Immokalee-Myakka-Satellite map unit.

Soils of the Coastal Islands and Tidal Marshes

The two map units in this group consist of nearly level to gently sloping, poorly drained to excessively drained soils that are sandy throughout and contain shell fragments. The map units also consist of some level, very poorly drained soils that formed in loamy or clayey tidal deposits that have very low soil strength. These soils are on low, gently undulating dunelike ridges, on elongated sloughs, on the higher dunelike ridges of the barrier island, and on islands and mangrove tidal swamps. Some soils are in nearly level areas that were former sloughs and tidal marshes. These areas have been drained and filled with sand or with mixed sand and shell fragments. These materials were derived from river dredging or from hauling and filling operations. The soils of the coastal islands and tidal marshes are in the eastern part of Indian River County.

2. Canaveral-Captiva-Palm Beach

Nearly level to gently sloping, somewhat poorly drained to moderately well drained, poorly drained, and well drained to excessively drained sandy soils that contain shell fragments

This map unit consists of nearly level to gently sloping soils. These soils are on low, gently undulating dunelike ridges, in elongated sloughs, and on the higher dunelike ridges of the barrier island (fig. 4). There is only one area of this map unit, and it makes up the barrier island, which extends the length of the survey area and is adjacent to the Atlantic Ocean.

The natural vegetation in most areas of this map unit is sawpalmetto, sand live oak, cabbage palm, wild-coffee, waxmyrtle, and seagrape. The natural vegetation on the outer edge of the higher dunelike ridges that are adjacent to the ocean is Spanish-bayonet and sea-oats. Introduced vegetation consists of thick stands of Australian pine and Brazilian pepper.

This map unit makes up about 6,308 acres, or about 2 percent of the survey area. It is about 40 percent Canaveral soils, 27 percent Captiva soils, 25 percent Palm Beach soils, and 8 percent soils of minor extent.

Canaveral soils are on low, gently undulating dunelike ridges. These soils are somewhat poorly drained to moderately well drained. Typically, the surface layer is 5 inches thick. It is dark gray and gray fine sand that is

about 10 percent sand-size shell fragments. The underlying material to a depth of 80 inches or more is light gray, light yellowish brown, very pale brown, and light brownish gray fine sand that is about 10 to 40 percent sand-size multicolored shell fragments.

Captiva soils are poorly drained. These soils are on narrow, elongated sloughs between the low, dunelike ridges and the mangrove swamps. Typically, the surface layer is about 8 inches thick. It is very dark gray fine sand that is about 2 percent shell fragments. The underlying material to a depth of 80 inches or more is grayish brown, olive gray, and greenish gray fine sand that is about 2 to 15 percent shell fragments.

Palm Beach soils are well drained to excessively drained. These soils are on the higher dunelike ridges parallel to the coastline. Typically, the surface layer is very dark gray sand about 4 inches thick. The underlying material, to a depth of about 65 inches, is grayish brown and pale brown sand that has stratified layers of shell fragments throughout. Below that to a depth of 80 inches or more is very pale brown sand.

Areas of minor extent in this map unit are Beaches.

The soils in most areas of this map unit are in natural vegetation. A large area near the town of Orchid is used for citrus. Increasing acreages are being developed for residential and recreation uses.

3. McKee-Quartzipsamments-St. Augustine

Level, very poorly drained, loamy soils that have very low soil strength; some nearly level, somewhat poorly drained to moderately well drained soils that are sand or mixed sand and shell fragments; and some level, somewhat poorly drained soils that are mixed sand and shell fragments

This map unit consists of level soils on mangrove islands and in swamps that are inundated daily by high tides. It also consists of nearly level soils in areas that were former sloughs and tidal marshes. These areas have been drained and filled with sand or with mixed sand and shell fragments, or they have been drained and filled with mixed sand, shell fragments, and loamy and silty sediment. These materials resulted from river dredging or from hauling and filling operations. Most of these areas include the islands in the Indian River and those areas that are adjacent to the river on the eastern edge of the mainland and on the western edge of the barrier island. The soils in this map unit extend from Brevard County to St. Lucie County.

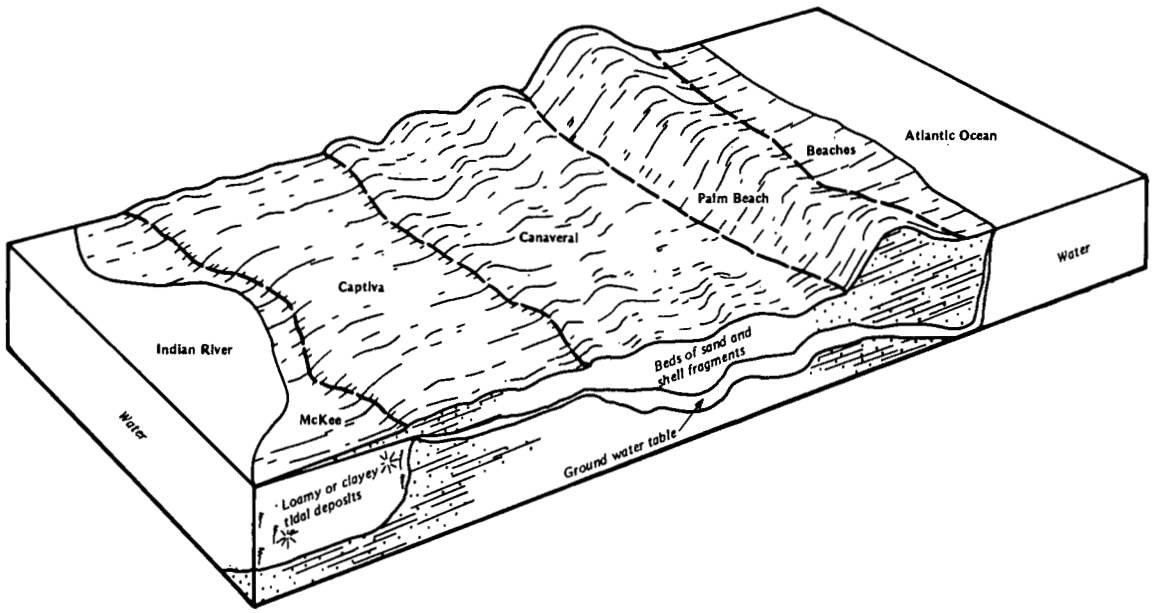


Figure 4.—Typical pattern of soils and parent material in the Canaveral-Captiva-Palm Beach association. These soils make up a cross section of soils on the barrier island.

The natural vegetation in the tidal swamps consists of red, black, and white mangrove, sea rocket, seashore paspalum, seashore saltgrass, and scattered cabbage palm. In many of the areas, the soils that were formed by fill material and earthmoving operations have introduced vegetation that consists of thick stands of Australian pine, Brazilian pepper, and various weeds and grasses.

This map unit makes up about 7,232 acres, or about 2.3 percent of the survey area. It is about 50 percent McKee soils, 21 percent Quartzipsamments soils, 15 percent St. Augustine soils, and 14 percent soils of minor extent.

McKee soils are on the existing mangrove islands and swamps (fig. 5). Tidal water inundates most of the areas at high tide. These soils are very poorly drained. They have very low soil strength and are generally very fluid when squeezed in the hand; the soils in some areas range from very fluid to slightly fluid. Typically, the surface layer is covered by a layer of very dark grayish brown mucky clay loam about 1 inch thick. The underlying material is a layer of very dark gray clay loam to a depth of about 15 inches, grayish green to dark greenish gray clay loam to a depth of about 60 inches, and dark gray sandy loam to a depth of 80 inches or more.

Quartzipsamments soils are on islands and in tidal marshes and sloughs. These areas have been drained and filled with material that resulted from river dredging or from hauling and filling operations. These soils are somewhat poorly drained, but in areas where the fill material is deeper, they can range from somewhat poorly drained to moderately well drained. Typically, the surface layer is mottled light yellowish brown fine sand about 17 inches thick. Below that, to a depth of about 60 inches, is fine sand in various shades of gray, brown, and yellow that is mixed with about 10 percent shell fragments, and underlying that is gray sand to a depth of 80 inches or more.

St. Augustine soils were formed by dredge and fill materials and then spread over the surface of former tidal areas. They are somewhat poorly drained. Typically, the surface layer consists of fill material that is about 30 inches thick. It is light brownish gray sand that contains shell fragments. The underlying material, to a depth of 45 inches, is a mixture of grayish brown sand, fragments of dark gray silty clay loam, and olive gray loamy sand. Below that to a depth of 80 inches or more is a mixture of greenish gray sand and fragments of gray loamy sand. Some areas have a thin organic layer at a depth of 40 inches or more.

The soils of minor extent in this map unit are Kesson and Riomar soils and Arents.

The areas of McKee soils remain in natural vegetation, whereas most areas of Quartzipsamments and St. Augustine soils have been developed for residential use.

Soils of the Flatwoods, Low Knolls, and Ridges

The four map units in this group consist of nearly level, poorly drained and somewhat poorly drained soils. These soils are in broad areas of flatwoods; in slightly higher areas of flatwoods that are surrounded and intersected by broad, low sloughs, poorly defined drainageways, hammocks, and depressional areas; and on low knolls and ridges on the flatwoods. Some soils are sandy throughout, some have a loamy subsoil at a depth of more than 40 inches, and some have a dark sandy subsoil. In some places, these soils are underlain by loamy material at a depth of less than 40 inches. In other areas, they are underlain by loamy material at a depth of more than 40 inches. These soils are mostly in the eastern and extreme western parts of Indian River County.

4. Immokalee-Myakka-Satellite

Nearly level, poorly drained and somewhat poorly drained soils; some are sandy throughout, and some have a dark sandy subsoil

This map unit consists of soils on long, narrow ridges, low knolls on the flatwoods, in broad areas of flatwoods, and in scattered depressions (see fig. 3). These soils are in the eastern one-third of Indian River County and are adjacent to the Atlantic Coastal Ridge on the Ten Mile Ridge along U.S. Interstate 95, north of Florida State Road 60. Small areas of these soils are in the extreme western part of the survey area and are adjacent to the Osceola County line. Part of the cities of Sebastian and Vero Beach is in this map unit.

The natural vegetation in most areas of knolls and ridges is south Florida slash pine, longleaf pine, sand live oak, sawpalmetto, fetterbush, and pineland threeawn. Vegetation on the flatwoods is south Florida slash pine, sawpalmetto, running oak, inkberry, fetterbush, waxmyrtle, pineland threeawn, bluestems, and panicums.

This map unit makes up about 15,711 acres, or about 4.9 percent of the survey area. It is about 33 percent Immokalee soils, 31 percent Myakka soils, 14 percent Satellite soils, and 22 percent soils of minor extent.

Immokalee soils are poorly drained. These soils are on broad flatwoods. Typically, the surface layer is very dark gray fine sand about 5 inches thick. The subsurface layer is light gray fine sand to a depth of 35 inches. The subsoil is very dark gray fine sand to a depth of about 55 inches. Below that to a depth of 80 inches or more is brown fine sand.

Myakka soils are poorly drained. These soils are on broad flatwoods. Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is fine sand to a depth of 28 inches. The upper 15 inches of the subsurface layer is grayish brown, and the lower 8 inches is light brownish gray. The subsoil extends to a

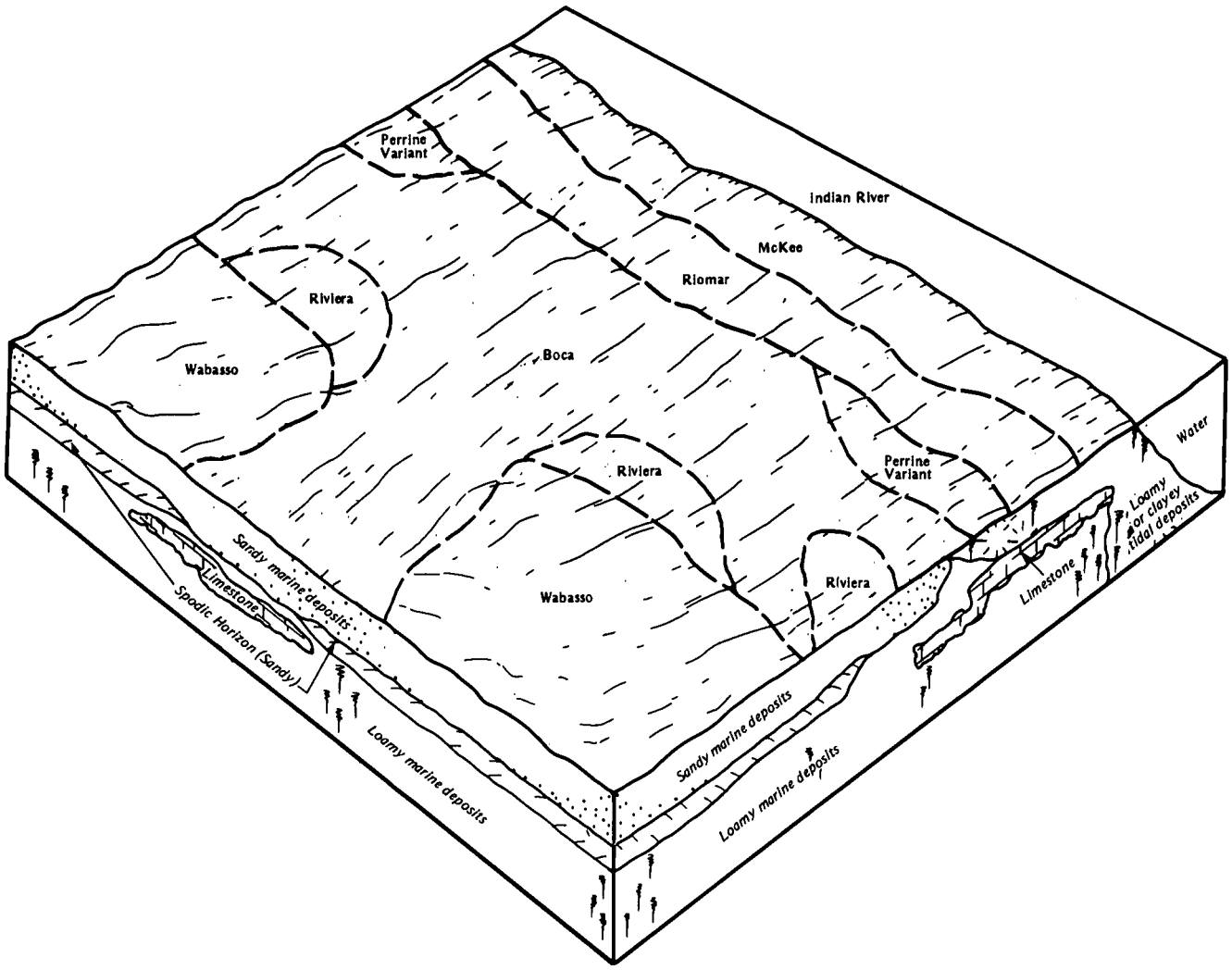


Figure 5.—Typical pattern of soils and parent material in the Boca-Wabasso-Riviera map unit. The adjacent Riomar and McKee soils are in the tidal marsh.

depth of 68 inches. The upper 3 inches of the subsoil is black fine sand, the next 8 inches is dark reddish brown fine sand, the next 11 inches is black fine sand, the next 8 inches is partially weakly cemented, black fine sand, and the lower 10 inches is very dark grayish brown fine sand. The substratum to a depth of 80 inches or more is dark brown fine sand.

Satellite soils are somewhat poorly drained. These soils are on long, narrow ridges and low knolls on the flatwoods. Typically, the surface layer is dark gray fine sand about 4 inches thick. The underlying material is light brownish gray, grayish brown, and dark grayish brown fine sand to a depth of 80 inches or more.

The soils of minor extent in this map unit are Pomello, Pompano, and Archbold soils.

The soils in most areas of this map unit are in natural vegetation. Some large areas are used for residential and urban development. Some small areas are used for citrus.

5. EauGallie-Oldsmar-Wabasso

Nearly level, poorly drained soils that have a dark sandy

subsoil; some have a subsoil that is underlain by loamy material at a depth of less than 40 inches, and some have a subsoil that is underlain by loamy material at a depth of more than 40 inches

This map unit consists of soils in broad areas of flatwoods and in scattered small wet depressions. These soils are mostly in the eastern one-third of Indian River County, primarily west of the Atlantic Coastal Ridge. The soils in this map unit extend from Brevard County to St. Lucie County. Other areas of soils in this map unit are scattered throughout the eastern one-half of the survey area, which includes the areas around Fellsmere and also those areas east of Ten Mile Ridge. Part of the cities of Sebastian, Vero Beach, Vero Lake Estates, Vero Beach Highlands, and Fellsmere is in this map unit.

The natural vegetation is south Florida slash pine, scattered live oak and laurel oak, sawpaletto, inkberry, fetterbush, waxmyrtle, pineland threeawn, bluestems, and panicums.

This map unit makes up about 45,165 acres, or about 14.2 percent of the survey area. It is about 44 percent EauGallie soils, 18 percent Oldsmar soils, 9 percent Wabasso soils, and 29 percent soils of minor extent.

EauGallie soils are poorly drained. Typically, the surface layer is black grading to dark gray fine sand about 15 inches thick. The subsurface layer is gray fine sand to a depth of about 26 inches. The subsoil extends to a depth of about 62 inches. The upper part of the subsoil is black grading to brown fine sand coated with organic matter about 21 inches thick. The lower 15 inches is grayish brown or gray sandy loam. The substratum is light brownish gray loamy fine sand to a depth of 80 inches or more.

Oldsmar soils are poorly drained. Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is light brownish gray fine sand to a depth of about 32 inches. The subsoil extends to a depth of about 62 inches. The upper 18 inches of the subsoil is black, dark reddish brown, and dark brown fine sand. The lower 12 inches is grayish brown sandy loam. The substratum is light brownish gray loamy fine sand to a depth of 80 inches or more.

Wabasso soils are poorly drained. Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is gray fine sand to a depth of about 24 inches. The subsoil extends to a depth of 48 inches. The upper part of the subsoil is black and very dark gray fine sand that is coated with organic matter, and the lower part is dark brown and brown sandy loam. The substratum to a depth of 80 inches or more is brown loamy fine sand.

The soils of minor extent in this map unit are Chobee, Holopaw, Lokosee, Malabar, Manatee, Pepper, Riviera, and Electra soils.

The soils in most areas of this map unit are in natural vegetation. Some areas are used for urban development, citrus, improved pasture, and native range.

6. Myakka-Immokalee

Nearly level, poorly drained soils that have a dark sandy subsoil

This map unit consists of soils in broad areas of flatwoods, scattered small wet depressions, and long, narrow, poorly defined drainageways. These soils are mostly in the western one-third of Indian River County. The soils in this map unit extend from Brevard County to Okeechobee County and to adjoining Osceola County.

The natural vegetation is south Florida slash pine, scattered live oak, sawpalmetto, running oak, inkberry, fetterbush, waxmyrtle, pineland threeawn, bluestems, and panicums.

This map unit makes up about 30,205 acres, or about 9.5 percent of the survey area. It is about 51 percent Myakka soils, 31 percent Immokalee soils, and 18 percent soils of minor extent.

Myakka soils are poorly drained. Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is fine sand to a depth of 28 inches. The upper 15 inches of the subsurface layer is grayish brown, and the lower 8 inches is light brownish gray. The subsoil extends to a depth of 68 inches. It is black fine sand in the upper 3 inches, dark reddish brown fine sand in the next 8 inches, black fine sand in the next 11 inches, black fine sand that is partially weakly cemented in the next 8 inches, and very dark grayish brown fine sand in the lower 10 inches. The substratum to a depth of 80 inches or more is dark brown fine sand.

Immokalee soils are poorly drained. Typically, the surface layer is very dark gray fine sand about 5 inches thick. The subsurface layer is light gray fine sand to a depth of 35 inches. The subsoil is very dark gray fine sand to a depth of about 55 inches. The substratum to a depth of 80 inches or more is brown fine sand.

The soils of minor extent in this map unit are Floridana, Holopaw, Pompano, Pomello, and Samsula soils.

The soils in most areas of this map unit are in natural vegetation. Several large areas are used for improved pasture. Other areas are used for native range and woodland.

7. EauGallie-Myakka-Riviera

Nearly level, poorly drained soils; some have a loamy subsoil at a depth of less than 40 inches, some have a dark sandy subsoil at a depth of 20 to 30 inches, and some are sandy throughout and have a dark sandy subsoil at a depth of 20 to 30 inches

This map unit consists of soils in slightly higher areas of flatwoods. These areas are surrounded and intersected by broad, low sloughs, poorly defined drainageways, hammocks, and depressional areas. The areas of this map unit are along the Indian River County and Okeechobee County line, south of Padgett Branch

and southward to Fort Drum Creek. Also, another area of these soils is south of Gum Slough to the Okeechobee County line.

The natural vegetation in the areas of flatwoods consists of slash pine, sawpalmetto, waxmyrtle, inkberry, scattered cabbage palm, pineland threeawn, bluestems, and panicums. In the lower surrounding areas on broad, low flats and in poorly defined drainageways, the vegetation consists of scattered slash pine, cabbage palm, laurel oak, sawpalmetto, blue maidencane, pineland threeawn, panicums, and sedges. In the depressional areas, the vegetation consists of St.-Johnswort, maidencane, waxmyrtle, sand cordgrass, and various other water-tolerant weeds and grasses.

This map unit makes up about 3,389 acres, or about 1.1 percent of the survey area. It is about 24 percent EauGallie soils, 23 percent Myakka soils, 14 percent Riviera soils, and 39 percent soils of minor extent.

EauGallie soils are on the flatwoods. Typically, the surface layer is black grading to dark gray fine sand about 15 inches thick. The subsurface layer is gray fine sand to a depth of about 26 inches. The subsoil extends to a depth of about 62 inches. The upper 21 inches of the subsoil is black grading to brown fine sand that is coated with organic matter. The lower 15 inches is grayish brown or gray sandy loam. The substratum is light brownish gray loamy fine sand to a depth of 80 inches or more.

Myakka soils are on the flatwoods. Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer extends to a depth of 28 inches. The upper 15 inches of the subsurface layer is grayish brown fine sand, and the lower 8 inches is light brownish gray fine sand. The subsoil extends to a depth of 68 inches. It is black fine sand in the upper 3 inches, dark reddish brown fine sand in the next 8 inches, black fine sand in the next 11 inches, black fine sand that is partially weakly cemented in the next 8 inches, and very dark grayish brown fine sand in the lower 10 inches. The substratum to a depth of 80 inches or more is dark brown fine sand.

Riviera soils are in low hammocks, poorly defined drainageways, and broad, low sloughs. Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer, to a depth of 26 inches, is light gray and light brownish gray fine sand. The subsoil extends to a depth of 40 inches. The upper 5 inches of the subsoil is gray sandy loam that has intrusions and pockets of grayish brown and dark grayish brown fine sand. The lower 9 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray and greenish gray loamy fine sand that has a few pockets of light brownish gray fine sand.

The soils of minor extent in this map unit are Boca, Delray, Floridana, Holopaw, Malabar, Manatee, Pineda, and Pompano soils.

The soils in most areas of this map unit are in natural vegetation. These areas are used as native rangeland. Some areas are in improved pasture. One small area south of Florida State Road 60 is used for citrus.

Soils of the Sloughs, Poorly Defined Drainageways, and Hammocks

The four map units in this group consist of nearly level, poorly drained and very poorly drained soils. These soils are on broad, low flats and in sloughs, depressions, and poorly defined drainageways. These areas are interspersed with low hammocks and small scattered areas of flatwoods. Some of these soils have a loamy subsoil within a depth of 20 inches of the surface, or at a depth of 20 to 40 inches, or at a depth of more than 40 inches. Some soils are loamy throughout and have a dark colored surface layer, some have a dark sandy subsoil underlain by loamy material at a depth of less than 40 inches, or they have a loamy subsoil underlain by hard limestone at a depth of 40 inches. In some areas, the soils are sandy throughout and have a dark sandy subsoil within a depth of 20 to 30 inches of the surface. In other areas, these sandy soils do not have a dark sandy subsoil within a depth of 20 to 30 inches of the surface. These map units are mostly in the central part and eastern one-third part of Indian River County. They extend from Brevard County to St. Lucie County and also extend east of the Atlantic Coastal Ridge and are adjacent to the tidal marshes on the mainland part of the survey area. Another area of these soils is immediately west of the St. Johns Marsh and extends from Brevard County to Okeechobee County.

8. Riviera-Pineda-Wabasso

Nearly level, poorly drained soils; some have a loamy subsoil at a depth of 20 to 40 inches, and some have a dark sandy subsoil underlain by loamy material at a depth of less than 40 inches

This map unit consists of soils in broad sloughs, depressions, and poorly defined drainageways. These areas are interspersed with low hammocks and small scattered areas of flatwoods. The largest area of this map unit is in the central part of Indian River County, west of U.S. Interstate 95. These areas extend from Brevard County to St. Lucie County. Other areas of the soils in this map unit are scattered throughout the eastern one-third of the survey area, which includes a long, narrow area between the Atlantic Coastal Ridge and Ten Mile Ridge. Part of the cities of Fellsmere, Vero Lake Estates, and Fleming Grant is in this map unit.

In the areas of sloughs and poorly defined drainageways and in areas that are interspersed with depressions and low hammocks, the natural vegetation is south Florida slash pine, cabbage palm, waxmyrtle, scattered sawpalmetto, laurel oak, pineland threeawn,

blue maidencane, and various sedges and grasses. In the depressional areas, the native vegetation includes blue maidencane, St.-Johnswort, pipewort, starrush, scattered cabbage palm, waxmyrtle, sedges, and other water-tolerant grasses. On the flatwoods, the native vegetation consists of slash pine, scattered cabbage palm, sawpalmetto, waxmyrtle, inkberry, pineland threeawn, bluestems, and panicums.

This map unit makes up about 78,276 acres, or about 24.6 percent of the survey area. It is about 33 percent Riviera soils, 29 percent Pineda soils, 24 percent Wabasso soils, and 14 percent soils of minor extent.

Riviera soils are in broad sloughs, poorly defined drainageways, low hammocks, and depressions. Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer extends to a depth of 26 inches. The upper 11 inches of the subsurface layer is light gray fine sand, and the lower 12 inches is light brownish gray fine sand. The subsoil extends to a depth of 40 inches. The upper 5 inches of the subsoil is gray sandy loam that has intrusions and pockets of grayish brown and dark grayish brown fine sand. The lower 9 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray and greenish gray loamy fine sand.

Pineda soils are in broad sloughs, low hammocks, and depressions. Typically, the surface layer is black fine sand about 4 inches thick. The subsurface layer, to a depth of 9 inches, is light brownish gray fine sand. The subsoil extends to a depth of 40 inches. The upper 4 inches of the subsoil is yellow fine sand that has intrusions of yellowish brown loamy fine sand. The next 10 inches is yellow fine sand. The lower 17 inches is gray and greenish gray sandy loam. The substratum to a depth of 80 inches or more is greenish gray loamy sand. Shell fragments are in the lower 28 inches of the substratum.

Wabasso soils are on flatwoods. Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is gray fine sand to a depth of about 24 inches. The subsoil extends to a depth of 48 inches. The upper part of the subsoil is black and very dark gray fine sand that is coated with organic matter, and the lower part is dark brown and brown sandy loam. The substratum to a depth of 80 inches or more is brown loamy fine sand.

The soils of minor extent in this map unit are Boca, Chobee, Floridana, Manatee, Oldsmar, Holopaw, Malabar, and Winder soils.

The soils in most areas of this map unit are in natural vegetation. Many areas are used for citrus and native range (fig. 6). A few areas have been developed for residential use, or are in improved pasture.

9. Winder-Riviera-Manatee

Nearly level, poorly drained and very poorly drained soils that have a loamy subsoil at a depth of 20 inches or at a depth of 20 to 40 inches; some are loamy throughout and have a dark surface layer

This map unit consists of soils in broad sloughs, depressions, and poorly defined drainageways. These areas are interspersed with low hammocks. Areas of these soils are scattered throughout the central part of Indian River County. One large area is just south of Florida State Road 60 and west of U.S. Interstate 95, adjacent to the St. Lucie County line. Other areas of the soils in this map unit are located between Ten Mile Ridge and the Atlantic Coastal Ridge in the eastern one-third of the survey area and also west of Fellsmere, adjoining St. Johns Marsh and Brevard County.

The natural vegetation in most areas of this map unit consists of south Florida slash pine, cabbage palm, waxmyrtle, laurel oak, scattered sawpalmetto, pineland threeawn, little blue maidencane, chalky bluestem, sand cord grass, sawgrass, and various sedges and grasses. In the depressional areas, the native vegetation consists of red maple, cypress, water oak, waxmyrtle, scattered cabbage palm, and an understory of ferns and water-tolerant grasses. Other vegetation in more open depressional areas includes maidencane, pickerelweed, smartweed, St.-Johnswort, and Carolina willow.

This map unit makes up about 36,412 acres, or about 11.5 percent of the survey area. It is about 54 percent Winder soils, 22 percent Riviera soils, 8 percent Manatee soils, and 16 percent soils of minor extent.

Winder soils are poorly drained and are in low hammocks, depressions, and poorly defined drainageways. Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is grayish brown fine sand to a depth of about 17 inches. The subsoil extends to a depth of 65 inches. The upper 6 inches of the subsoil is grayish brown sandy loam that has grayish brown loamy sand intrusions. The lower part is gray sandy loam. The substratum to a depth of 80 inches or more is greenish gray loamy sand and shell fragments.

Riviera soils are poorly drained to very poorly drained and are in broad sloughs, poorly defined drainageways, low hammocks, and depressions. Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer extends to a depth of 26 inches. The upper 11 inches of the subsurface layer is light gray fine sand, and the lower 12 inches is light brownish gray fine sand. The subsoil extends to a depth of 40 inches. The upper 5 inches of the subsoil is gray sandy loam that has intrusions and pockets of grayish brown and dark grayish brown fine sand. The lower 9 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray and greenish gray loamy fine sand.

Manatee soils are very poorly drained and are in sloughs, depressions, poorly defined drainageways, and on broad, low flats. Typically, the surface layer is black

Figure 6.—Young citrus trees planted on beds help provide good surface drainage on poorly drained soils in the Riviera-Pineda-Wabasso map unit. Insulators are used for freeze protection and for disease and insect control.

loamy fine sand about 12 inches thick. The subsoil is fine sandy loam, sandy loam, and loamy fine sand to a depth of 39 inches. The upper 10 inches of the subsoil is very dark gray, the next 9 inches is dark gray, and the lower 8 inches is dark grayish brown. The substratum extends to a depth of 80 inches or more. The upper 12 inches of the substratum is light brownish gray loamy fine sand. The lower 29 inches or more is light gray loamy fine sand and shell fragments.

The soils of minor extent in this map unit are Chobee, EauGallie, Floridana, Pineda, Oldsmar, Jupiter, and Wabasso soils.

Most areas of this map unit are used for citrus. The soils in a few areas remain in natural vegetation or have been developed for residential use.

10. Boca-Wabasso-Riviera

Nearly level, poorly drained soils; some have a loamy subsoil underlain by hard limestone at a depth of 40 inches, some have a dark sandy subsoil underlain by loamy material at a depth of less than 40 inches, and some have a loamy subsoil at a depth of 20 to 40 inches

This map unit consists of soils in sloughs and poorly defined drainageways. These areas are interspersed with low hammocks and scattered areas of flatwoods. The only area of this map unit is in the extreme east-central part of Indian River County, which is east of the Atlantic Coastal Ridge and adjacent to the tidal marshes on the mainland (see fig. 5).

If present, the natural vegetation in most areas is south Florida slash pine, cabbage palm, waxmyrtle, scattered sawpalmetto, laurel oak, pineland threeawn, blue maidencane, and various sedges and grasses. In the flatwoods, the native vegetation consists of slash pine, scattered cabbage palm, sawpalmetto, waxmyrtle, inkberry, pineland threeawn, bluestems, and panicums.

This map unit makes up about 4,223 acres, or about 1.3 percent of the survey area. It is about 34 percent Boca soils, 13 percent Wabasso soils, 10 percent Riviera soils, and 43 percent soils of minor extent.

Boca soils are on the flatwoods. Typically, the surface layer is dark gray fine sand about 7 inches thick. The subsurface layer is fine sand to a depth of about 20 inches. The upper 7 inches of the subsurface layer is grayish brown, and the lower 6 inches is brown. The subsoil is yellowish brown fine sandy loam to a depth of 24 inches. Below that is a layer of fractured limestone.

Wabasso soils are on the flatwoods. Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is gray fine sand to a depth of about 24 inches. The subsoil extends to a depth of about 48 inches. The upper part of the subsoil is black

and very dark gray fine sand that is coated with organic matter, and the lower part is dark brown and brown sandy loam. The substratum to a depth of about 80 inches or more is brown loamy fine sand.

Riviera soils are in sloughs and poorly defined drainageways. These areas are interspersed with low hammocks. Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer, to a depth of 26 inches, is light gray fine sand in the upper 11 inches, and light brownish gray fine sand in the lower 12 inches. The subsoil extends to a depth of 40 inches. The upper 5 inches of the subsoil is gray sandy loam that has intrusions and pockets of grayish brown and dark grayish brown fine sand. The lower 9 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray and greenish gray loamy fine sand.

The soils of minor extent in this map unit are Chobee, EauGallie, Jupiter, Oldsmar, Perrine Variant, Pompano, Floridana, St. Augustine, Quartzipsamments, and Arents soils.

Most areas of this map unit are used for citrus, although some large areas have been developed for residential use. A few areas remain in natural vegetation.

11. Myakka-Holopaw-Pompano

Nearly level, poorly drained soils that are sandy to a depth of more than 40 inches; some have a dark sandy subsoil at a depth of 20 to 30 inches, and some have a loamy subsoil at a depth of more than 40 inches

This map unit consists of soils on broad, low flats and in sloughs, poorly defined drainageways, and depressional areas. These areas are interspersed with slightly higher areas of flatwoods. The four areas that make up this map unit are west of St. Johns Marsh. They extend from Brevard County southward to the Okeechobee County line. These four areas are separated by major drainageways, which are Blue Cypress Creek, Padgett Branch, Fort Drum Creek, and Gum Slough. These drainageways empty into St. Johns Marsh.

The natural vegetation on the broad, low flats and in sloughs and poorly defined drainageways consists of scattered slash pine, cabbage palm, and laurel oak, waxmyrtle, maidencane, and a variety of other water-tolerant grasses and sedges. In the depressional areas, the native vegetation consists of baldcypress, red maple, waxmyrtle, Carolina willow, St.-Johnswort, maidencane, and other water-tolerant weeds and grasses. The slightly higher areas of flatwoods consists mainly of slash pine, sawpalmetto, pineland threeawn, waxmyrtle, cabbage palm, and various weeds and grasses.

This map unit makes up about 15,948 acres, or about 5 percent of the survey area. It is about 19 percent Myakka soils, 19 percent Holopaw soils, 19 percent Pompano soils, and 43 percent soils of minor extent.

Myakka soils are poorly drained and are in the slightly higher areas of flatwoods, which are interspersed throughout this map unit. Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is fine sand to a depth of 28 inches. The upper 15 inches of the subsurface layer is grayish brown, and the lower 8 inches is light brownish gray. The subsoil extends to a depth of 68 inches. It is black fine sand in the upper 3 inches, dark reddish brown fine sand in the next 8 inches, black fine sand in the next 11 inches, black fine sand that is partially weakly cemented in the next 8 inches, and very dark grayish brown fine sand in the lower 10 inches. The substratum to a depth of 80 inches or more is dark brown fine sand.

Holopaw soils are poorly drained to very poorly drained and are on broad, low flats and in poorly defined drainageways and depressional areas. Typically, the surface layer is very dark gray and dark grayish brown fine sand about 12 inches thick. The subsurface layer extends to a depth of 45 inches. The upper 18 inches of the subsurface layer is pale brown fine sand, and the lower 15 inches is grayish brown fine sand. The subsoil is grayish brown sandy loam with pockets of brown fine sand that extends to a depth of about 62 inches. The substratum to a depth of 80 inches or more is olive gray loamy fine sand.

Pompano soils are poorly drained to very poorly drained and are in sloughs, poorly defined drainageways, and depressional areas. Typically, the surface layer is 16 inches thick. The upper 3 inches of the surface layer is very dark gray fine sand, and the lower 13 inches is dark grayish brown fine sand. The underlying layers are light brownish gray and grayish brown fine sand to a depth of 80 inches or more.

The soils of minor extent in this map unit are Boca, Chobee, Delray, EauGallie, Floridana, Gator, Jupiter, Immokalee, Manatee, Oldsmar, Pineda, Riviera, and Wabasso soils.

Most areas of this map unit are in improved pasture or native rangeland. Some areas that have been drained and cleared for cropland or pasture have since been left idle and have reverted back to various types of wetlands.

Soils of the Freshwater Swamps and Marshes

The two map units in this group consist of nearly level, poorly drained to very poorly drained soils. These soils are in freshwater swamps and marshes, on broad, low flats, and in poorly defined drainageways and depressions that are adjacent to or that drain into the western edge of the St. Johns Marsh. Some of these soils are organic throughout, some have a moderately thick organic layer underlain by a sandy clay loam subsoil, and some have a thin organic surface layer underlain by a loamy subsoil within a depth of 20 to 40 inches of the surface. Also, some of these soils have a

dark surface layer that is 10 inches or more thick and have a loamy subsoil at a depth of 20 to 40 inches or at a depth of more than 40 inches. Some of these soils do not have a dark surface layer that is 10 inches or more thick but have a loamy subsoil at a depth of 20 to 40 inches or at a depth of more than 40 inches. These soils are associated with St. Johns Marsh and the major drainageways that empty into the marsh. These map units are in the western part of Indian River County and extend from Brevard County to St. Lucie County.

12. Terra Ceia-Gator-Canova

Nearly level, very poorly drained soils; some are organic throughout, some have a moderately thick organic layer underlain by a sandy clay loam subsoil, and some have a thin organic surface layer underlain by a loamy subsoil at a depth of 20 to 40 inches

This map unit consists of nearly level, very poorly drained soils in freshwater swamps and marshes (fig. 7). The one area of this map unit is the St. Johns Marsh in the western part of Indian River County. The soils in this map unit extend from Brevard County to St. Lucie County.

The natural vegetation consists of a dense swamp growth of red maple, redbay, cypress, Carolina willow, primrose willow, waxmyrtle, pickerelweed, sawgrass,

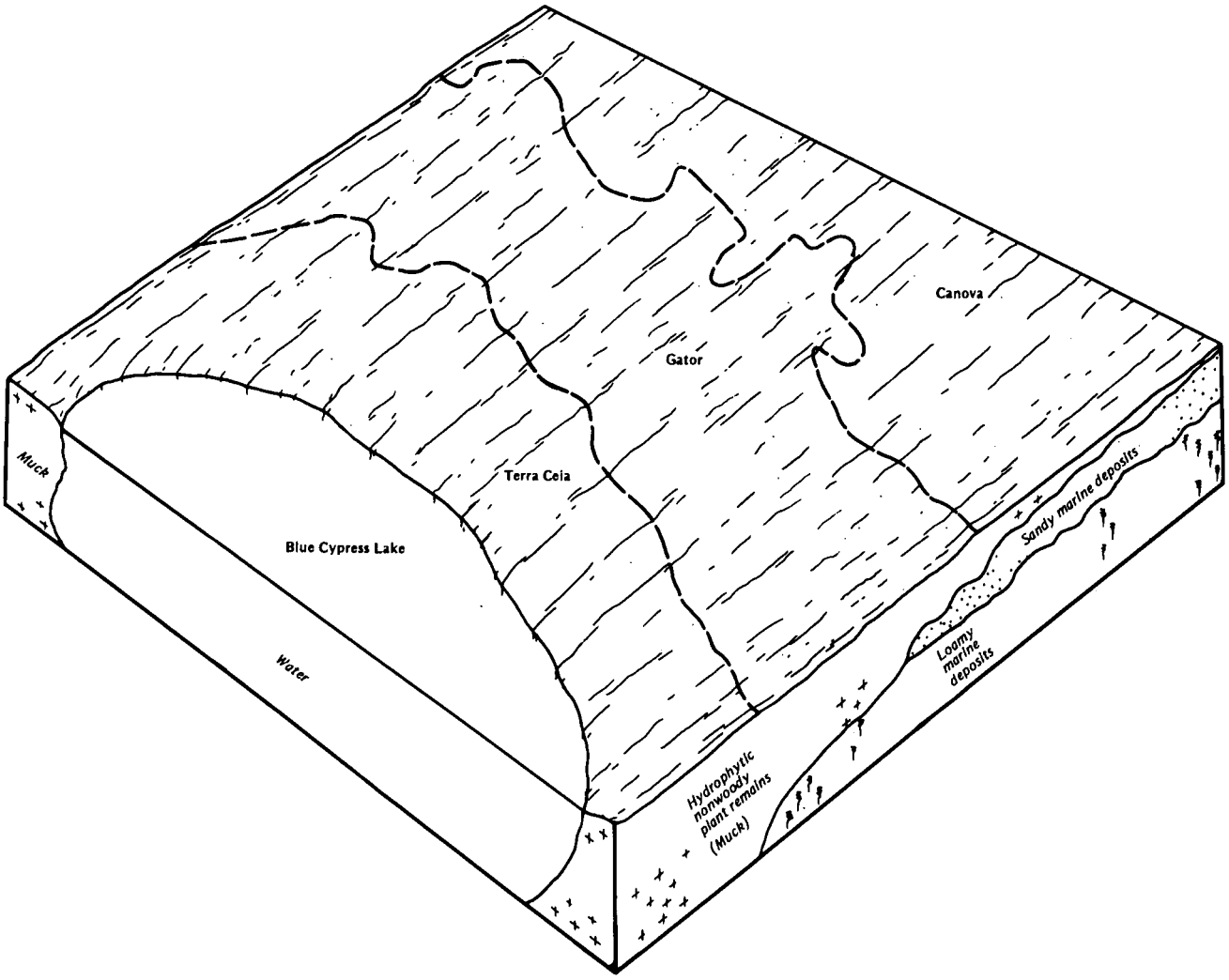


Figure 7.—Typical pattern of soils and parent material in the Terra Ceia-Gator-Canova map unit.

cattail, buttonbush, arrowhead, ferns, cutgrass, and maidencane.

This map unit makes up about 60,513 acres, or about 19 percent of the survey area. It is about 58 percent Terra Ceia soils, 21 percent Gator soils, 18 percent Canova soils, and 3 percent soils of minor extent.

Typically, Terra Ceia soils have a surface layer that is black muck about 38 inches thick. Below that is very dark grayish brown muck to a depth of 60 inches or more.

Typically, Gator soils have a surface layer that is very dark brown muck about 26 inches thick. The next layer is very dark gray sandy loam to a depth of 30 inches. Underlying that to a depth of 40 inches is dark gray sandy clay loam. The next layer is greenish gray sandy clay loam and sandy loam with calcium carbonate accumulations to a depth of about 62 inches. Below that to a depth of 80 inches or more is greenish gray loamy sand.

Canova soils typically have a surface layer of black and very dark brown muck about 12 inches thick. The next layer is black sand to a depth of 13 inches. Below that, to a depth of 24 inches, is gray to grayish brown sand. The subsoil extends to a depth of about 40 inches. The upper 10 inches of the subsoil is grayish brown sandy clay loam that has common coarse tongues of grayish brown sand. The lower 6 inches is gray sandy clay loam. The substratum to a depth of 80 inches or more is greenish gray sandy clay loam and sandy loam with calcium carbonate concretions and accumulations.

The soils of minor extent in this map unit are Chobee, Delray, Floridana, Riviera, and Winder soils.

Most areas of this map unit are in natural vegetation. Some areas have been drained and cleared and are used for improved pasture or for corn, sorghum, and other crops. Also, a small area that has a thin surface layer of muck is used for citrus production.

13. Floridana-Delray-Holopaw

Nearly level, poorly drained to very poorly drained soils; some have a loamy subsoil at a depth of 20 to 40 inches, some have a loamy subsoil at a depth of more than 40 inches, and some have a dark surface layer that is 10 inches or more thick

This map unit consists of soils on broad, low flats and in poorly defined drainageways and depressions that are adjacent to or that drain into the western edge of St. Johns Marsh. Three areas make up this map unit and extend from Brevard County southward to the Okeechobee County line. Branches extend westward from these areas by following the watercourses of Blue Cypress Creek, Padgett Branch, and Fort Drum Creek.

The natural vegetation on the broad, low flats and in the poorly defined drainageways consists of scattered slash pine, laurel oak, cabbage palm, scattered sawpalmetto, waxmyrtle, maidencane, sedges, and other water-tolerant grasses. In the depressional areas, the native vegetation consists of red maple, cypress, water oak, redbay, waxmyrtle, Carolina willow, and an understory of ferns and water-tolerant grasses. Other vegetation in more open depressional areas includes maidencane, pickerelweed, arrowhead, sand cordgrass, St.-Johnswort, primrose willow, ferns, and cattail.

This map unit makes up about 9,009 acres, or about 2.8 percent of the survey area. It is about 25 percent Floridana soils, 25 percent Delray soils, 15 percent Holopaw soils, and 35 percent soils of minor extent.

Floridana soils are very poorly drained and are in depressional areas. These soils are predominantly throughout the major watercourses or drainageways that empty into St. Johns Marsh. Typically, the surface layer is about 14 inches thick. The upper 8 inches of the surface layer is black sand. The lower 6 inches is light brownish gray sand. The subsoil is gray sandy clay loam to a depth of 37 inches. The substratum is gray sandy loam to a depth of 53 inches, dark gray sandy loam to a depth of 68 inches, and light gray sandy clay loam to a depth of 80 inches or more.

Delray soils are very poorly drained. These soils are in depressional areas along the extreme western edge of St. Johns Marsh. They intermittently are throughout the major watercourses or drainageways that empty into the marsh. Typically, the surface layer is about 21 inches thick. The upper 3 inches of the surface layer is black muck, the next 14 inches is black fine sand, and the lower 4 inches is very dark grayish brown sand. The subsurface layer, to a depth of 45 inches, is very dark grayish brown and grayish brown sand. The subsoil is dark grayish brown sandy clay loam to a depth of about 52 inches. The substratum to a depth of 80 inches or more is gray sandy loam.

Holopaw soils are poorly drained to very poorly drained and are on broad, low flats and in poorly defined drainageways adjacent to the western edge of St. Johns Marsh. These soils are also in depressional areas throughout the major watercourses or drainageways that empty into the marsh. Typically, the surface layer is very dark gray and dark grayish brown fine sand about 12 inches thick. The subsurface layer extends to a depth of about 45 inches. The upper 18 inches of the subsurface layer is pale brown fine sand, and the lower 15 inches is grayish brown fine sand. The subsoil is grayish brown sandy loam that has pockets of brown fine sand that extends to a depth of about 62 inches. The substratum to a depth of 80 inches or more is olive gray loamy fine sand.

The soils of minor extent in this map unit are Chobee, Gator, Manatee, Oldsmar, Pompano, and Samsula soils.

Most areas of this map unit are in natural vegetation. Some areas that were drained and cleared for cropland or pasture have since been left idle, and these areas have reverted back to various types of wetlands. Some areas remain as improved pasture.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A number identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Pineda fine sand, depressional, is one of several phases in the Pineda series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Boca-Urban land complex is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

1—Canaveral fine sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and somewhat poorly drained to moderately well drained. It is on low, dunelike ridges and side slopes bordering sloughs and mangrove swamps. The mapped areas range from 20 to about 300 acres. Slopes are smooth to convex.

Typically, the surface layer is about 5 inches thick. It is dark gray grading to gray fine sand mixed with about 10 percent sand-size shell fragments. The underlying layers are light gray, light yellowish brown, very pale brown, and light brownish gray fine sand mixed with about 10 to 40 percent sand-size, multicolored shell fragments to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Quartzipsamments, St. Augustine, Palm Beach, and Captiva soils. Also included are soils that are similar to Canaveral soil but have a thicker, dark colored surface layer or have steeper slopes, and also some soils that are similar but have a thin discontinuous ledge of limestone at various depths. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 10 to 40 inches of the surface for 2 to 6 months and within a depth of 60 inches for most of the remainder of the year. Permeability is very rapid, and the available water capacity is very low. Natural fertility and the organic matter content are very low.

Native vegetation consists of sand live oak, cabbage palm, scattered sawpalmetto, southern magnolia, and scattered slash pine. The understory consists of inkberry, pineland threeawn, and various weeds and grasses. In many areas are Australian pine, cabbage palm, and a sparse ground cover of various grasses and sedges.

Under natural conditions, this Canaveral soil is not suited to cultivated crops or improved pasture grasses. Low available water capacity and low natural fertility severely reduce the variety of grasses that can be grown on this soil.

Under natural conditions, this soil is poorly suited to citrus. However, if intensive management practices are used, including irrigation and regular applications of fertilizer, this soil has fair suitability for citrus. A close-growing cover crop between trees protects the soil from blowing.

This soil generally is not used for rangeland or forest land. Canaveral soil is in the South Florida Coastal Strand ecological plant community.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to help overcome excessive wetness. The sandy surface layer should be stabilized for recreational uses. Water control measures and sealing and lining of trench sanitary landfills and sewage lagoons with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored. Native plants are best suited to landscaping because of the droughtiness of the soil.

This Canaveral soil is in capability subclass VIs.

2—Chobee loamy fine sand. This soil is nearly level and very poorly drained. It is in depressions and poorly defined drainageways and on broad, low flats. The mapped areas range from 5 to 10 acres in isolated depressions and from 5 to 100 acres or more in other areas. Slopes are smooth to concave. They are dominantly less than 1 percent but range to 2 percent.

Typically, the surface layer is black loamy fine sand about 5 inches thick. The subsoil extends to a depth of about 46 inches. The upper 12 inches of the subsoil is black sandy loam, the next 11 inches is very dark gray sandy clay loam, the next 7 inches is dark grayish brown sandy loam, and the lower 11 inches is gray sandy loam. The substratum extends to a depth of 80 inches or more. The upper 8 inches of the substratum is gray loamy fine sand, and the lower 26 inches or more is greenish gray loamy fine sand.

Included with this soil in mapping are small areas of Floridana, Manatee, and Winder soils. Also included are small areas of soils that are similar to Chobee soil but have up to 4 inches of organic material on the surface. Also there are a few areas of soils that have a limestone ledge below the subsoil at a depth of 20 to 40 inches or more and have a thin, soft marl layer in the upper part of the subsoil. The included soils make up less than 20 percent of the map unit.

The water table is within a depth of 10 inches of the surface for more than 6 months during most years. It is above the surface for short periods after heavy rainfall and at a depth of 10 to 30 inches for short periods during dry seasons. The available water capacity is medium throughout. Permeability is moderate in the surface layer, moderately slow to slow in the subsoil, and moderate in the substratum.

A large part of this soil is used for citrus, but some areas are being used for improved pasture. The natural vegetation in the depressional areas consists of red maple, cypress, water oak, waxmyrtle, scattered cabbage palm, and an understory of ferns and water-tolerant grasses. On other open marsh areas are maidencane, pickerelweed, smartweed, Carolina willow, and patches of sawgrass.

Under natural conditions, this Chobee soil is too wet for cultivated crops, citrus, and improved pasture. Management practices needed are bedding, crop rotation, and regular applications of fertilizer. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter.

The suitability of this soil for citrus is good if a water control system that maintains good soil aeration to a depth of about 4 feet is provided. Planting trees in beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between the tree rows to help control erosion. Regular applications of fertilizer are needed.

The suitability of this soil for improved pasture grasses is good. A water control system is needed for rapid removal of excess surface water. If adequately fertilized, high yields of pangolagrass, bahiagrass, and white clover can be obtained. Grazing should be controlled to maintain plant vigor.

The potential productivity of this soil for pine trees is high, but a water control system is needed to remove excessive surface water if the production potential is to be realized. South Florida slash pine is better adapted to this soil than other trees. Equipment limitations and seedling mortality are the main concerns in management.

This soil is well suited to desirable range plant production. The dominant forage consists of blue maidencane, chalky bluestem, and blue joint panicum. Management practices should include deferred grazing. Chobee soil is in the Slough range site.

This soil has severe limitations for sewage lagoons, sanitary landfills, and shallow excavations. Water control measures are needed to overcome excessive wetness. This soil has severe limitations for dwellings without basements, small commercial buildings, local roads and streets, and playgrounds. Limitations are also severe for septic tank absorption fields. Installing water control measures, adding fill material, and mounding the septic tank absorption field can help overcome excessive wetness.

This Chobee soil is in capability subclass IIIw.

3—EauGallie fine sand. This soil is deep, nearly level, and poorly drained. It is on broad flatwoods. The

mapped areas range from 20 to 700 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is black grading to dark gray fine sand about 15 inches thick. The subsurface layer is gray fine sand to a depth of about 26 inches. The subsoil extends to a depth of about 62 inches. The upper 21 inches of the subsoil is black, very dark gray, dark reddish brown, dark brown, brown fine sand. The lower 15 inches is grayish brown or gray sandy loam. The substratum is light brownish gray loamy fine sand to a depth of about 80 inches.

Included with this soil in mapping are small areas of Myakka, Pepper, Wabasso, and Oldsmar soils. Also included are soils in scattered small wet depressions. The included soils make up less than 15 percent of the map unit.

In most years, the water table is at a depth of less than 10 inches of the surface for 2 to 4 months during the wet season and within a depth of 40 inches for more than 6 months. Permeability is rapid in the surface and subsurface layers and moderate to moderately rapid in the subsoil and substratum. The available water capacity is very low in the surface and subsurface layers, low to medium in the subsoil, and low in the substratum. Natural fertility is low.

Most areas of this soil are in natural vegetation. However, in areas that have been cleared, the dominant use is for citrus. The natural vegetation is south Florida slash pine, sawpalmetto, wiregrass, cabbage palm, waxmyrtle, bluestems, panicums, and various other grasses.

Citrus trees are well suited to this soil if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. A suitable cover crop should be maintained between tree rows. Regular applications of fertilizer and lime are needed.

This EauGallie soil has very severe limitations for cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures used, this soil has fair suitability for many vegetable crops. A water control system is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has good suitability for improved pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of the soil for pine trees is moderately high. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, and chalky bluestem. Management practices should include deferred grazing and brush control. EauGallie soil is in the South Florida Flatwoods range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of slow permeability. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This EauGallie soil is in capability subclass IVw.

4—Immokalee fine sand. This nearly level, poorly drained soil is on broad flatwoods. The mapped areas range from 5 to 300 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is very dark gray fine sand about 5 inches thick. The subsurface layer is light gray fine sand to a depth of 35 inches. The subsoil is very dark gray fine sand to a depth of about 55 inches. Below that to a depth of 80 inches or more is brown fine sand.

Included with this soil in mapping are small areas of Myakka, Oldsmar, Pomello, Pompano, and Myakka depressional soils. Also included are areas of soils that are similar to Immokalee soil but have a subsoil that is more than 28 inches thick. The included soils make up 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 10 to 40 inches for more than 6 months and at a depth of less than 10 inches for 1 to 3 months during the wet season. Permeability is rapid in the surface and subsurface layers and underlying material, and it is moderate in the subsoil. The available water capacity is very low in the surface and subsurface layers and underlying material, and it is moderate in the subsoil. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation consisting of south Florida slash pine and scattered live oak. The understory consists of sawpalmetto, running oak, inkberry, fetterbush, waxmyrtle, pineland threeawn, bluestems, panicums, and various other grasses.

Suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. Regular applications of lime and fertilizer are needed.

Under natural conditions, this Immokalee soil is poorly suited to cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures are used, this soil has fair suitability for many vegetable crops. A water control system is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Other good management practices are seedbed preparation, including bedding of rows, and regular application of fertilizer and lime.

This soil has good suitability for improved pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, south Florida bluestem, and chalky bluestem. Management practices should include deferred grazing and brush control. Immokalee soil is in the South Florida Flatwoods range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Immokalee soil is in capability subclass IVw.

5—Myakka fine sand. This nearly level, poorly drained soil is on broad flatwoods. The mapped areas range from 20 to 350 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is fine sand to a depth of about 28 inches. The upper 15 inches of the subsurface layer is grayish brown, and the lower 8 inches is light brownish gray. The subsoil extends to a depth of about 68 inches. It is black fine sand in the upper 3 inches of the subsoil, dark reddish brown fine sand in the next 8 inches, black fine sand in the next 11 inches, black fine sand that is partially weakly cemented in the next 8 inches, and very dark grayish brown fine sand in the lower 10 inches. The substratum to a depth of 80 inches or more is dark brown fine sand.

Included with this soil in mapping are small areas of EauGallie, Immokalee, Pompano, Riviera, and Myakka depressional soils. Also included are areas of soils that are similar to Myakka soil but have a thicker, dark colored surface layer, some soils in scattered small wet depressions, and also soils that are similar to Myakka soil but have a layer of shell fragments or limestone at a depth of more than 60 inches. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 10 to 40 inches for more than 6 months and at a depth of less than 10 inches for 1 to 3 months during the wet season. Permeability is rapid in the surface and subsurface layers and substratum, and it is moderate to moderately rapid in the subsoil. The available water capacity is very low in the surface and subsurface layers and substratum, and it is moderate in the subsoil. Natural fertility and organic matter content are low.

Most areas of this soil are in natural vegetation consisting of south Florida slash pine. The understory consists of sawpalmetto, running oak, inkberry, fetterbush, waxmyrtle, pineland threeawn, bluestems, panicums, and other grasses.

Suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. A suitable cover crop should be maintained between tree rows to control erosion and protect the soil from blowing. Regular applications of lime and fertilizer are needed.

This Myakka soil has very severe limitations to cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures are used, it has a fair suitability for many vegetable crops. A water control system generally is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has a good suitability for improved pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are normally needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, and chalky bluestem. Management practices should include deferred grazing and brush control. Myakka soil is in the South Florida Flatwoods range site.

This soil has severe limitations for dwellings without basements, small commercial buildings, local roads and streets, and sewage lagoons. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons can reduce excessive seepage. This soil has severe limitations for septic tank absorption fields, recreational uses, trench sanitary landfills, and shallow excavations. Septic tank absorption fields may need to be enlarged because the permeability of this soil is lower than is acceptable. Water control measures help overcome excessive wetness. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Side walls of shallow excavations should be shored.

This Myakka soil is in capability subclass IVw.

6—Oldsmar fine sand. This soil is deep, nearly level, and poorly drained. It is on broad flatwoods. The mapped areas range from 20 to 300 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is light brownish gray fine sand to a depth of about 32 inches. The subsoil extends to a depth of about 62 inches. The upper 18 inches of the subsoil is black, dark reddish brown, and dark brown fine sand, and the lower 12 inches is grayish brown sandy loam. The substratum is light brownish gray loamy fine sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of EauGallie, Holopaw, Malabar, and Wabasso soils. Also included are soils in scattered small wet depressions. The included soils make up less than 15 percent of the map unit.

In most years, the water table is at a depth of less than 10 inches of the surface for 2 to 4 months during the wet season and within a depth of 40 inches for more than 6 months. Permeability is rapid in the surface and subsurface layers, moderate to moderately rapid in the upper part of the subsoil, and slow in the lower part. The available water capacity is very low in the surface and subsurface layers and low to medium in the subsoil. Natural fertility is low.

Most areas of this soil are in natural vegetation. However, in areas that have been cleared, the dominant use is for citrus. The natural vegetation consists of south Florida slash pine, sawpalmetto, inkberry, rusty lyonia, blackroot, pennyroyal, pineland threeawn, chalky bluestem, panicum, and various other weeds and grasses.

Suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. A suitable cover crop should be maintained between tree rows to control erosion and protect the soil from blowing. Regular applications of fertilizers and lime are needed.

This Oldsmar soil has very severe limitations for cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures are used, this soil has fair suitability for many vegetable crops. A water control system is needed to remove excess water in wet seasons and provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has good suitability for improved pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderately high. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, and chalky bluestem. Management practices should include deferred grazing and brush control. Oldsmar soil is in the South Florida Flatwoods range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of slow permeability. Sealing or lining of sewage lagoons can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Oldsmar soil is in capability subclass IVw.

7—Palm Beach sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and well drained to excessively drained. It is on dunelike ridges that are parallel to the coastline. The acreage mapped is in one linear unit that varies from 100 feet in width to more than 1,600 feet. This map unit is adjacent to the beach. Slopes are mainly 0 to 5 percent but can range from 0 to 8 percent (fig. 8).

Figure 8.—A dune crossover on Palm Beach sand provides beach access but primarily serves as a form of erosion control to insure dune stabilization.

Typically, the surface layer is very dark gray sand about 4 inches thick. The underlying material to a depth of 65 inches is sand that has stratified layers of shell fragments throughout. The upper 16 inches of the underlying material is grayish brown sand, and the lower 45 inches is pale brown sand. Below that to a depth of 80 inches or more is very pale brown sand.

Included with this soil in mapping are small areas of Canaveral soils. Also included are areas of soils that have a thick, dark surface layer. The included soils make up less than 10 percent of the map unit.

This soil is low in natural fertility and organic matter content. It is moderately alkaline throughout. Permeability is very rapid, and the available water capacity is very low. This soil is droughty. It has no water table within a depth of 80 inches.

A large part of the acreage is in natural vegetation. The natural vegetation consists of cabbage palm, scrub oak, sawpalmetto, seagrape, and pricklypear cacti (fig. 9).

This Palm Beach soil is not suited to cropland, citrus, or improved pasture because of droughtiness and low fertility. Some areas of this soil are used for sites for buildings or recreation use.

This soil generally is not used for woodland or rangeland. Palm Beach soil is in the South Florida Coastal Strand ecological plant community.

This soil has slight limitations for septic tank absorption fields, dwellings with or without basements, and local roads and streets. No corrective measures are needed. Land shaping may be needed on the more sloping areas. Limitations are severe for recreational uses, sanitary landfills, sewage lagoons, and shallow excavations. The sandy surface layer must be stabilized for recreational uses, and land shaping may be needed on the more sloping areas. Sealing or lining of sanitary

landfills and sewage lagoons with impervious soil material generally reduces excessive seepage. Shoring of sidewalls for shallow excavations is needed.

This Palm Beach soil is in capability subclass VIIs.

8—Paola sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and excessively drained. It is on the Atlantic Coastal Ridge. The mapped areas range from about 10 to 100 acres. Slopes are smooth to convex.

Typically, the surface layer is dark gray sand about 2 inches thick. The subsurface layer is grayish brown sand to a depth of about 9 inches. Below that is yellowish brown and strong brown sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Archbold, Astatula, Pomello, Satellite, and St. Lucie soils. Also included are areas of soils that are similar to Paola soil but have a thicker subsurface layer. The included soils make up less than 20 percent of the map unit.

The water table is a depth of more than 6 feet throughout the year. Permeability is very rapid, and the available water capacity is very low throughout. Natural fertility and the organic matter content are very low.

Most areas of this soil remain in native vegetation consisting of sand pine, scrub live oak, rosemary, sawpalmetto, Chapman oak, goldleaf goldaster, pricklypear cacti, mosses, and lichens. Scrub hickory trees are in some areas.

This Paola soil is not suited to cultivated crops, citrus, or improved pasture. Droughtiness and low natural fertility are the main limitations. Suitability for citrus is poor. Citrus production is only fair if intensive management practices are used. Management practices should include irrigation and regular applications of fertilizer and lime. A close-growing cover crop must be maintained between tree rows to protect the soil from blowing.

The potential productivity for pine trees is low. Equipment limitations and seedling mortality are the main concerns in management. Sand pine is the best tree to plant.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, scrub oak, indiangrass, creeping bluestem, beaked panicums, and perennial legumes. Although this site is seldom grazed by livestock, it does furnish winter

Figure 9.—An area of native vegetation on Palm Beach sand on high dunelike ridges on the barrier island along the Atlantic coast.

protection. Paola soil is in the Sand Pine Scrub range site.

This soil has slight limitations for septic tank absorption fields, dwellings without basements, and local roads and streets. No corrective measures are needed, but the proximity to a stream or canal should be considered when installing a septic tank absorption field to prevent lateral seepage and pollution. This soil has slight limitations for small commercial buildings. Land shaping may be needed on the more sloping soils. This soil has severe limitations for recreational uses, trench sanitary landfills, and shallow excavations. The sandy surface layer should be stabilized for recreational uses, and land shaping may be needed on the more sloping soils. Sealing or lining of trench sanitary landfills with impervious soil material generally reduces excessive seepage. Sidewalls of shallow excavations should be shored. This soil has severe limitations for sewage lagoons. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage.

This Paola soil is in capability subclass VIs.

9—Pepper sand. This soil is deep, nearly level, and poorly drained. It is on broad flatwoods. The mapped areas range from 20 to 400 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is 8 inches thick. The upper 2 inches of the surface layer is very dark gray sand, and the lower 6 inches is dark gray sand. The subsurface layer is gray sand to a depth of about 22 inches. The subsoil extends to a depth of 60 inches or more. It is black noncemented sand in the upper 5 inches of the subsoil, black strongly cemented sand in the next 5 inches, dark brown sand in the next 7 inches, dark grayish brown sand in the next 8 inches, and grayish brown sandy loam in the lower 13 inches or more.

Included with this soil in mapping are small areas of EauGallie, Malabar, Myakka, Oldsmar, and Wabasso soils. Also included are a few areas of soils that are not weakly cemented and also a few areas of soils that have only fragments of weakly cemented spodic bodies. The included soils make up less than 20 percent of the map unit.

In most years, the water table is at a depth of less than 10 inches of the surface for 2 to 4 months during the wet season and within a depth of 40 inches for more than 6 months. Permeability is rapid in the surface and subsurface layers and slow to very slow in the subsoil. The available water capacity is very low in the surface and subsurface layers and low to medium in the subsoil. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, sawpalmetto, running oak, inkberry, waxmyrtle, fetterbush, pineland threeawn, chalky bluestem, panicums, and various other weeds and grasses.

The suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. A suitable cover crop should be maintained between rows to control erosion and protect the soil from blowing. Regular applications of fertilizer and lime are needed.

This Pepper soil is poorly suited to cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures are used, this soil is moderately well suited to many vegetable crops. A water control system is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has good suitability for improved pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderately high. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, south Florida bluestem, and chalky bluestem. Management practices should include deferred grazing and brush control. Pepper soil is in the South Florida Flatwoods range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of slow permeability. Sealing or lining of sewage lagoons can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Pepper soil is in capability subclass IVw.

10—Riviera fine sand. This soil is nearly level and poorly drained. It is on low hammocks and in poorly defined drainageways and broad, low sloughs. The mapped areas range from 20 to 50 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer is 23 inches thick. The upper 11 inches of the subsurface layer is light gray fine sand, and the lower 12 inches is

light brownish gray fine sand. The subsoil extends to a depth of 40 inches. The upper 5 inches of the subsoil is gray sandy loam that has intrusions and pockets of grayish brown and dark grayish brown fine sand. The lower 9 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray and greenish gray loamy fine sand that has a few pockets of light brownish gray fine sand.

Included with this soil in mapping are small areas of Holopaw, Floridana, Manatee, Oldsmar, Pineda, Wabasso, and Winder soils. Also included are areas of soils that have a weakly stained layer of organic material above the subsoil and extending into it and also other areas of soils that have small fragments or nodules of iron cemented sandstone or calcareous material at a depth of 10 to 30 inches. The included soils make up less than 15 percent of the map unit.

The water table is within a depth of 10 inches of the surface for 1 to 6 months and between a depth of 10 to 40 inches for more than 6 months. It recedes to a depth of more than 40 inches during extended dry periods. The water table is above the surface for short periods after heavy rainfall. The available water capacity is very low in the surface and subsurface layers, low in the upper part of the subsoil and moderate in the lower part, and low in the substratum. Permeability is rapid in the surface and subsurface layers, slow to very slow in the subsoil, and moderately rapid in the substratum. Natural fertility and the organic matter content are low.

A large part of the acreage of this soil has been cleared and is planted to citrus (fig. 10). Natural vegetation consists of scattered slash pine, cabbage palm, waxmyrtle, scattered palmetto, laurel oak, blue maidencane, pineland threeawn, creeping bluestem, south Florida bluestem, sand cordgrass, low panicums, and various weeds and grasses.

Under natural conditions, this Riviera soil is poorly suited to cultivated crops. However, it is fairly suited to vegetable crops if a water control system is installed to remove excess water rapidly and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

Suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover

Figure 10.—These citrus trees planted on beds have a close-growing cover crop to protect the soil from blowing.

crop between tree rows protects the soil from blowing. Regular applications of fertilizers should be applied.

This soil has good suitability for pasture and hay crops. Pangolagrass, improved bahiagrass, and clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizer, and controlled grazing.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and seedling mortality are the main concerns in management.

This soil is highly suited to desirable range plant production. The dominant forage is creeping bluestem, chalky bluestem, and blue maidencane. Management practices should include deferred grazing and brush control. Riviera soil is in the Cabbage Palm Flatwoods range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material generally reduces excessive seepage. Mounding of the septic tank absorption field can help overcome excessive wetness. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored.

This Riviera soil is in capability subclass IIIw.

11—St. Lucie sand, 0 to 8 percent slopes. This soil is deep, nearly level to sloping, and excessively drained. It is on the Atlantic Coastal Ridge and other elevated knolls on the flatwoods. The mapped areas range from about 20 to 200 acres. Slopes generally are uniform.

Typically, the surface layer is gray sand about 3 inches thick. The underlying material is white sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Archbold, Astatula, Paola, Pomello, and Satellite soils. Also included are small areas of soils that are similar to St. Lucie soil but have a brownish yellow fine sand layer at a depth of 70 inches or more. Because of the excavation of St. Lucie soil for fill material, the soils in these areas have short, steep slopes that range from 20 to 40 percent. The included soils make up less than 15 percent of the map unit.

The water table is at a depth of more than 72 inches. The available water capacity is very low, and permeability is very rapid. Natural fertility and the organic matter content are very low.

Most areas of this soil are in native vegetation consisting of sand pine, scrub and sand live oak, sawpalmetto, Florida rosemary, pricklypear cacti, goldleaf goldaster, lichens, and deer moss. Pineland threeawn and bluestems are the most common native grasses, but these grasses can be quite sparse because of the droughty nature of the soil.

Under natural conditions, this soil is not suited to cultivated crops, citrus, or improved pasture because it is very droughty and has low natural fertility. Response to fertilizers is low. Irrigation water moves through the soil rapidly, and little moisture is retained for plant use.

The potential productivity for pine trees is low. Equipment limitations and seedling mortality are the main concerns in management. Sand pine is the preferred tree to plant.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, scrub oak, indiangrass, creeping bluestem, beaked panicums, and perennial legumes. Although this site is seldom grazed by livestock, it does furnish winter protection. St. Lucie soil is in the Sand Pine Scrub range site.

This soil has slight limitations to septic tank absorption fields, dwellings without basements, and local roads and streets. No corrective measures are needed, although the proximity to a stream or canal should be considered in the placement of a septic tank absorption field to prevent lateral seepage and pollution. This soil has slight limitations for small commercial buildings. Land shaping may be needed on the more sloping areas. This soil has severe limitations for recreational uses, trench sanitary landfills, and shallow excavations. The sandy surface layer should be stabilized for recreational uses, and land shaping may be needed on the more sloping areas. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls for shallow excavations should be shored. This soil has severe limitations for sewage lagoons. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage.

This St. Lucie soil is in capability subclass VIIs.

12—Archbold sand, 0 to 5 percent slopes. This soil is nearly level to sloping and moderately well drained. It is on the Atlantic Coastal Ridge and other elevated knolls on the flatwoods. The mapped areas range from 20 to 200 acres. Slopes are smooth to convex.

Typically, the surface layer is gray sand about 2 inches thick. The underlying material extends to a depth of more than 80 inches. The upper 36 inches of the underlying material is white sand, the next 13 inches is light gray sand, and the lower 29 inches or more is gray sand.

Included with this soil in mapping are small areas of Astatula, Jonathan, Orsino, Pomello, and Satellite soils. The included soils make up less than 15 percent of the map unit.

The water table is at a depth of 40 to 60 inches for more than 6 months during most years, between a depth

of 24 to 40 inches for about 1 to 4 months during the wet season, and at a depth of more than 80 inches during droughty periods. Permeability is very rapid throughout. The available water capacity is very low. Natural fertility and the organic matter content are very low.

Most areas of this soil remain in natural vegetation. The natural vegetation consists of slash pine, sand pine, sawpalmetto, scrub oak, fetterbush, running oak, turkey oak, longleaf pine, indiangrass, broomsedge bluestem and other bluestem species, and pineland threeawn.

In its natural state, this Archbold soil is poorly suited to cultivated crops. Citrus is fairly well suited if good management practices are used. Management practices include irrigation and regular applications of fertilizer and lime. A close-growing cover crop between trees protects the soil from blowing.

This soil has poor suitability for improved pasture grasses. Intensive management practices are needed to overcome soil limitations, which include droughtiness and low fertility. Bahiagrass is better adapted to this soil than most other grasses. Clover is not suited to this soil.

The potential productivity of this soil for pine trees is moderately high. Seedling mortality and equipment limitations are the main concerns in management. South Florida slash pine and sand pine are the preferred trees to plant.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, scrub oak, indiangrass, creeping bluestem, beaked panicums, perennial legumes, and various other grasses. Although this site is seldom grazed by livestock, it does furnish winter protection. Archbold soil is in the Sand Pine Scrub range site.

This soil is well suited to dwellings without basements, small commercial buildings, and local roads and streets. No corrective measures are needed. These soils have severe limitations for septic tank absorption fields and recreational uses. Water control measures are needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored. These soils have severe limitations for trench sanitary landfills and sewage lagoons. Sealing or lining of trench sanitary landfills and sewage lagoons with impervious soil material can reduce excessive seepage. Water control measures are needed for trench sanitary landfills.

This Archbold soil is in capability subclass VIs.

13—Wabasso fine sand. This soil is nearly level and poorly drained. It is on broad flatwoods. Individual mapped areas are 20 to 300 acres. Slopes are 0 to 2 percent.

Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is gray fine sand to a depth of about 24 inches. The subsoil extends to a depth of about 48 inches. The upper 8 inches of the subsoil is black fine sand that is coated with colloidal organic matter. The next 3 inches is very dark gray fine sand. The next 6 inches is dark brown sandy loam. The lower 7 inches is brown fine sandy loam. The substratum to a depth of about 80 inches or more is brown loamy fine sand.

Included with this soil in mapping are small areas of Boca, EauGallie, Oldsmar, Riviera, and Winder soils. Also included are areas of soils that are similar to Wabasso soil but have a thicker, dark colored surface layer and also some areas of soils in scattered small wet depressions. The included soils make up less than 15 percent of the map unit.

The water table is at a depth of 10 to 40 inches for more than 6 months in most years and at a depth of less than 10 inches for 1 to 2 months. The available water capacity is very low in the surface and subsurface layers, medium in the subsoil, and low in the substratum. Permeability is rapid in the surface and subsurface layers, moderate in the sandy part of the subsoil, and slow or very slow in the loamy part. Natural fertility is low.

Most areas of this soil are in citrus, although some areas remain in natural vegetation. The natural vegetation consists of slash pine, scattered cabbage palm, sawpalmetto, waxmyrtle, fetterbush, inkberry, pineland threeawn, bluestems, panicums, and other grasses.

The suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. A suitable cover crop should be maintained between tree rows to control erosion and protect the soil from blowing. Regular applications of lime and fertilizer are needed.

This Wabasso soil has very severe limitations for cultivated crops because of wetness and the sandy texture in the root zone. However, if a water control system is installed and soil improving measures are used, this soil has fair suitability for many vegetable crops. A water control system is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has good suitability for pasture. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of lime and fertilizers are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderately high. Equipment limitations, seedling

mortality, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, and chalky bluestem. Management practices should include deferred grazing and brush control. Wabasso soil is in the South Florida Flatwoods range site.

This soil has severe limitations for dwellings without basements, small commercial buildings, local roads and streets, and sewage lagoons. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of slow permeability. Sealing or lining of sewage lagoons can reduce excessive seepage. This soil has severe limitations for septic tank absorption fields, recreational uses, trench sanitary landfills, and shallow excavations. Water control measures generally are needed to overcome excessive wetness. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Wabasso soil is in capability subclass IIIw.

14—Winder fine sand. This soil is nearly level and poorly drained. It is on low hammocks and in poorly defined drainageways. The mapped areas range from 10 to 35 acres. Slopes are concave and range from 0 to 2 percent.

Typically, the surface layer is very dark gray fine sand about 7 inches thick. The subsurface layer is grayish brown fine sand to a depth of about 17 inches. The subsoil extends to a depth of 65 inches. The upper 6 inches of the subsoil is grayish brown sandy loam that has yellowish brown mottles and grayish brown loamy sand intrusions. The next 11 inches is gray sandy loam that has yellowish brown and yellow mottles, the next 14 inches is gray sandy loam that has yellowish brown and light olive brown mottles, and the lower 17 inches is gray sandy loam that has light olive brown mottles. The substratum to a depth of 80 inches or more is greenish gray loamy sand and shell fragments.

Included with this soil in mapping are small areas of Chobee, Jupiter, Manatee, Pineda, and Riviera soils. Also included are soils that are similar to Winder soil that have a dark surface layer more than 7 inches thick and also soils that have accumulations of calcium carbonate concretions in the subsurface layer and in the upper part of the subsoil. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is within a depth of 0 to 10 inches of the surface for 2 to 4 months and between a depth of 10 to 40 inches for about 4 to 6 months or more. Only for short periods in dry seasons is the water table below a depth of 40 inches. The available water capacity is very low in the surface and subsurface layers. It is moderate in the subsoil and low in the substratum. Permeability is slow in the subsoil and rapid in the surface and subsurface layers. Natural fertility is low.

Most of the acreage of this soil has been cleared and planted to citrus. The natural vegetation consists of cabbage palm, laurel oak, and slash pine and an understory of waxmyrtle, blue maidencane, chalky bluestem, sand cordgrass, sawgrass, sedges, and other water-tolerant grasses and weeds.

This Winder soil has severe limitations for cultivated crops. It has fair suitability for vegetable crops if a water control system is installed to remove excess water rapidly and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

Citrus trees are well suited to this soil if a water control system is installed to help maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizers are needed.

The suitability of this soil is good for pasture and hay crops. Pangolagrass, improved bahiagrass, and clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizers, and controlled grazing.

The potential productivity of this soil for pine trees is high. Slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and seedling mortality are additional concerns in management.

This soil is poorly suited to desirable range plant production. The vegetative community consists of cabbage palm, live oak, scattered sawpalmetto, grapevine, and wild coffee. Because of the dense canopy of palm trees, this site is a preferred shading and resting area for cattle. As a result, this range site generally is severely grazed. Management practices should include deferred grazing, brush control, and proper stocking. Winder soil is in the Cabbage Palm Hammocks range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to help overcome excessive wetness.

This Winder soil is in capability subclass IIIw.

15—Manatee loamy fine sand. This soil is nearly level and very poorly drained. It is in depressions and poorly defined drainageways and on broad, low flats.

The mapped areas range from 5 to 10 acres in isolated depressions and from 5 to 100 acres or more in other areas. Slopes are smooth to concave. They dominantly are less than 1 percent but range from 1 to 2 percent.

Typically, the surface layer is black loamy fine sand about 12 inches thick. The subsoil extends to a depth of about 31 inches. The upper 10 inches of the subsoil is very dark gray fine sandy loam, the next 9 inches is dark gray sandy loam, and the lower 8 inches is dark grayish brown loamy fine sand. The substratum extends to a depth of 80 inches or more. The upper 12 inches of the substratum is light brownish gray loamy fine sand. The lower 29 inches or more is light gray loamy fine sand and shell fragments.

Included with this soil in mapping are small areas of Chobee, Floridana, and Winder soils. Also included are small areas of soils that are similar to Manatee soil but have a surface layer that is lighter in color. The included soils make up less than 20 percent of the map unit.

The water table is within a depth of 10 inches of the surface for more than 6 months during most years or above the surface for short periods after heavy rainfall. It is at a depth of 10 to 30 inches for short periods during dry seasons. The available water capacity is medium. Permeability is moderate. Natural fertility is medium.

A large part of this soil is used for citrus. Some areas are used for improved pasture. The natural vegetation in depressional areas consists of red maple, cypress, water oak, waxmyrtle, scattered cabbage palm, and an understory of ferns and water-tolerant grasses. In other open marsh areas are maidencane, cutgrass, pickerelweed, smartweed, St.-Johnswort, Carolina willow, and patches of sawgrass.

Under natural conditions, this Manatee soil is too wet for cultivated crops, citrus, and improved pasture. If water control is adequate, the suitability is good for these uses. A properly designed and maintained water control system should rapidly remove the excess surface water. Other management practices needed are good seedbed preparation, including bedding of rows, crop rotation, and regular applications of fertilizer. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter.

This soil is well suited to citrus if a water control system is installed to help maintain good soil aeration to a depth of about 4 feet. Planting trees in beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between the rows to control erosion. Regular applications of fertilizer are needed.

This soil has good suitability for most improved pasture grasses. A water control system is needed to rapidly remove the excess surface water. High yields of pangolagrass, bahiagrass, and white clover can be obtained if they are adequately fertilized. Grazing should be controlled to maintain plant vigor.

The potential productivity of this soil for pine trees is high, but a water control system is needed to remove excess surface water if the production potential is to be realized. South Florida slash pine is the preferred tree to plant. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Manatee soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Adding fill material and mounding of the septic tank absorption field help overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Manatee soil is in capability subclass IIIw.

16—Pineda fine sand. This soil is nearly level and poorly drained. It is on low hammocks and in broad, poorly defined sloughs. The mapped areas range from 10 to 200 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is black fine sand about 4 inches thick. The subsurface layer is light brownish gray fine sand to a depth of about 9 inches. The subsoil extends to a depth of about 40 inches. The upper 14 inches of the subsoil is yellow fine sand with brownish yellow mottles, and the lower 17 inches is gray and greenish gray sandy loam that has yellowish brown, dark brown and light olive brown and olive yellow mottles. The upper 4 inches of the loamy subsoil material has intrusions of yellowish brown loamy fine sand. The substratum extends to a depth of 80 inches or more. The upper 12 inches of the substratum is greenish gray loamy sand, and the lower 28 inches is greenish gray loamy sand mixed with shell fragments.

Included with this soil in mapping are small areas of EauGallie, Riviera, Wabasso, and Winder soils. Also included are a few areas of soils that have a thin layer of very friable, calcareous material at a depth of 10 to 30 inches. The included soils make up less than 20 percent of the map unit.

The water table is above the surface for a short period after heavy rainfall. It is within a depth of 10 inches of the surface for 1 to 6 months and at a depth of 10 to 40 inches for more than 6 months. The available water capacity is very low in the surface and subsurface layers and the substratum. It is very low in the upper part of the subsoil and moderate in the lower part. Permeability is rapid in the surface and subsurface layers, rapid in the

upper part of the subsoil and slow or very slow in the lower part, and moderately rapid in the substratum. Natural fertility and the organic matter content are low.

A large part of the acreage of this soil has been cleared and is planted to citrus. Natural vegetation consists of scattered slash pine, cabbage palm, waxmyrtle, scattered sawpalmetto, blue maidencane, pineland threeawn, low panicums, other bluestem species, and various weeds and grasses.

This Pineda soil has severe limitations for cultivated crops. It has fair suitability for vegetable crops if a water control system is installed to remove excess water rapidly and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

Suitability of this soil for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizers are needed.

This soil has good suitability for pasture and hay crops. Pangolagrass, improved bahiagrasses, and clover grow well if properly managed. A water control system is needed to remove excess surface water after heavy rains. Management practices should include regular applications of fertilizers and controlled grazing.

The potential productivity of this soil for pine trees is moderately high. Slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and seedling mortality are concerns in management.

This soil is highly suited to desirable range plant production. The dominant forage is blue maidencane, chalky bluestem, and bluejoint panicum. Management practices should include deferred grazing. Pineda soil is in the Slough range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Pineda soil is in capability subclass IIIw.

17—Quartzipsamments, 0 to 5 percent slopes. This soil is nearly level to gently sloping and moderately well drained to somewhat poorly drained. It consists of thick deposits of sand and of mixed sand and shell fragments. This fill material is the result of earthmoving operations. The soil in this map unit is used to fill such areas as sloughs, marshes, shallow depressions, swamps, and other low-lying areas above their natural ground levels. The mapped areas range from about 10 to 300 acres.

No one pedon represents this map unit, but one of the most common profiles has a surface layer of light yellowish brown fine sand that has brownish yellow mottles about 17 inches thick. The next layer, to a depth of about 30 inches, is brownish yellow fine sand mixed with 5 percent shell fragments. The next layer, to a depth of 35 inches, is yellowish brown fine sand that has very dark grayish brown mottles. Below that, to a depth of about 60 inches, is dark grayish brown fine sand that has very dark gray streaks and yellowish brown splotches and is mixed with 10 percent shell fragments. The underlying material to a depth of 80 inches or more is gray sand.

Included with this soil in mapping are small areas of soils that have slopes that are more than 5 percent, which is the result of stockpiling. Also included are some areas of pits and areas of former St. Lucie, Astatula, or Paola soils that were excavated to a depth of about 10 to 20 feet and also some areas of soils on Johns Island that are moderately well drained because of the amount of fill material that has been added. The included soils make up about 15 percent of the map unit.

The water table varies with the amount of fill material and artificial drainage within the map unit. In most years, it is at a depth of 24 to 36 inches below the surface of the fill for 2 to 4 months. It is below a depth of 40 inches during extended dry periods. Permeability is very rapid, and the available water capacity is very low. Reaction is slightly acid to alkaline. The content of shell fragments ranges from about 5 to 50 percent.

Most areas of this soil are used for urban development. The existing vegetation consists of south Florida slash pine, scattered sawpalmetto, and various weeds.

Quartzipsamments have not been assigned to a capability subclass.

18—Captiva fine sand. This soil is nearly level and poorly drained. It is in narrow, elongated sloughs that are between low, dunelike ridges and mangrove swamps. The mapped areas range from 10 to 200 acres. Slopes are smooth and range from 0 to 1 percent.

Typically, the surface layer is very dark gray fine sand mixed with about 2 percent shell fragments. It is about 8 inches thick. The underlying material to a depth of 80 inches or more is grayish brown, olive gray, and greenish gray fine sand mixed with about 2 to 15 percent shell fragments.

Included with this soil in mapping are small areas of Canaveral, Kesson, and Quartzipsamments soils. Also included are soils that are similar to Captiva soil but

have a thin light colored surface horizon and have a thin discontinuous ledge of limestone at various depths. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 10 to 40 inches for 6 to 9 months or more and within a depth of 10 inches of the surface for 1 to 3 months during the wet season. In some years, the soil is covered by standing water for about 1 month. Permeability is rapid in the surface layer and very rapid in the underlying layers. The available water capacity is medium in the surface layer and low to very low in the subsurface layer. Natural fertility and the organic matter content are low.

A large part of the acreage has been cleared and planted to citrus. If present, natural vegetation consists of cabbage palm, tamarind, Australian pine, waxmyrtle, strangler fig, wild coffee, and leatherleaf fern.

The suitability of this soil for citrus trees is fair if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting trees on beds lowers the effective depth of the water table. Water control measures are needed to remove excess surface water after heavy rains and prohibit saltwater intrusion. A suitable cover crop should be maintained between tree rows. Regular applications of lime and fertilizer are needed.

Under natural conditions, this Captiva soil is poorly suited to cultivated crops because of wetness. However, if water control measures are used, this soil has fair suitability for many vegetable crops. A water control system is needed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

This soil has fair suitability for improved pasture. Improved bahiagrass grows well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of fertilizer are needed. Overgrazing should be prevented.

This soil generally is not used for pine trees.

This soil generally is not used for rangeland. Captiva soil is in the South Florida Coastal Strand ecological plant community.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. Sealing or lining of sewage lagoons can reduce excessive seepage. The sandy surface should be stabilized for recreational uses. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Captiva soil is in capability subclass IVw.

20—Beaches. This map unit consists of nearly level to sloping, narrow strips of tide and surf washed sands and shell fragments. Beaches are along the Atlantic Ocean shoreline. They commonly are a mixture of moderately alkaline sand and fine shell fragments.

Beaches range from less than 100 feet to about 300 feet in width. About half of the beach area may be flooded daily during high tides, and all of the beaches can be flooded by storm tides. Most beaches have a uniform gentle slope to the water's edge, although the shape and slope can change with every storm.

Beaches are generally devoid of vegetation, although some sparse growth of sea-oats, or railroad vine, or other salt-tolerant plants is near the inland edges.

Depth to the water table is highly variable depending on distance from the shore, elevation of the beach, and the tidal condition. Commonly, the water table ranges from a depth of 0 to 6 feet.

These areas generally are not used for rangeland or woodland. They are included in the South Florida Coastal Strand ecological plant community.

Beaches are not suited to any use except for recreation and as habitat for wildlife. Severe erosion is often a problem during severe storms. Because the beaches have great esthetic value, they are an important part of the coastline.

Beaches have not been assigned to a capability subclass.

21—Pomello sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and moderately well drained. It is on low ridges and knolls on the flatwoods. The mapped areas range from 20 to 150 acres. Slopes are smooth to convex.

Typically, the surface layer is gray sand about 2 inches thick. The subsurface layer extends to a depth of about 61 inches. The upper 18 inches of the subsurface layer is white sand, and the lower 41 inches is light gray sand. The subsoil extends to a depth of about 80 inches or more. The upper 4 inches of the subsoil is dark reddish brown sand, the next 12 inches is black sand, and the lower 8 inches is very dark gray sand.

Included with this soil in mapping are small areas of Immokalee, Myakka, Satellite, and Archbold soils. Also included are areas of soils that are similar to Pomello soil but have a thin brownish yellow layer just below the surface layer, also areas of soils that have a subsoil below a depth of 50 inches, and areas of soils that have a weakly cemented subsoil. The included soils make up less than 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 24 to 40 inches for about 1 to 4 months during the wet season and at a depth of 40 to 60 inches during the drier seasons. Permeability is very rapid in the surface and subsurface layers and

moderately rapid in the subsoil. The available water capacity is very low in the surface and subsurface layers and medium in the subsoil. Natural fertility and the organic matter content are very low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, scrub live oak, sawpalmetto, fetterbush, rusty lyonia, running oak, indiangrass, pineland threeawn, grassleaf goldaster, flag pawpaw, mosses and lichens, panicums, bluestems, and various other grasses. Sand pine is in some areas.

This soil is poorly suited to citrus trees. Only fair yields can be obtained if the level of management is high. A water control system is necessary to maintain the water table at a depth of about 4 feet during the wet season and to provide water for irrigation during periods of low rainfall. Regular applications of fertilizer and lime are needed for maximum yields. A suitable cover crop should be maintained between tree rows to protect the soil from blowing.

This Pomello soil is poorly suited to cultivated crops, but if intensive management practices are used, a few special crops can be grown. The adapted crops are limited unless intensive management practices are followed. For maximum yields, irrigation should be provided and fertilizer and lime should be applied according to the need of the crop.

The suitability for growing improved pasture grasses is fair. Bahiagrass is better suited to this soil than other grasses. Droughtiness is the major limitation except during the wet season. Regular applications of lime and fertilizer are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. Seedling mortality, plant competition, and equipment mobility are the main concerns in management. South Florida slash pine and sand pine are the preferred trees to plant.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, and scrub oak. Although this site is seldom grazed by livestock, it does furnish winter protection. Pomello soil is in the Sand Pine Scrub range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. It has moderate limitations for dwellings without basements and small commercial buildings. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. The very rapid permeability of this soil causes pollution of ground water in areas of septic tank absorption fields. Water control measures and sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Water control measures are needed, and sidewalls of shallow excavations should be shored.

This Pomello soil is in capability subclass VIs.

22—Urban land. More than 70 percent of this miscellaneous area is covered by urban facilities, such as shopping centers, parking lots, industrial buildings, houses, streets, sidewalks, airports, and related facilities. The natural soil cannot be observed. Soils in the unoccupied areas in this map unit, such as on lawns, vacant lots, playgrounds, and parks, mostly consist of Astatula, Boca, EauGallie, Paola, and St. Lucie soils. These soils generally have been altered by grading and shaping or have been covered to a depth of about 12 inches by fill material. This fill material consists of sandy and loamy materials that in places contain limestone and shell fragments. These areas of soils are so small that it was not practical to map them separately.

Urban land has not been assigned to a capability subclass.

23—Arents, 0 to 5 percent slopes. This soil consists of material dug from several areas that have different kinds of soil. This fill material is the result of earthmoving operations. This soil is used to fill such areas as sloughs, marshes, shallow depressions, swamps, and other low-lying areas above their natural ground levels.

The surface layer is about 30 to 50 inches thick. It is very dark gray, dark gray, dark grayish brown, and yellowish brown fine sand or sand mixed with discontinuous grayish brown and light brownish gray loamy textured fragments. Fragments and thin discontinuous lenses of a dark colored sandy subsoil are also scattered through the matrix. Below that is undisturbed soil to a depth of 80 inches. The upper 2 inches of the undisturbed soil is commonly black, the next 20 inches is light gray or gray, and the lower 8 inches is black or very dark brown. The fill material that formed this soil was from excavated areas of EauGallie, Riviera, and Wabasso soils. Texture ranges from fine sand to sandy clay loam.

Included with this soil in mapping are small areas of soils that are similar to Arents soil but have slopes of more than 5 percent, which is a result of stockpiling. Also included are areas that are used as sanitary landfills and contain up to 50 percent or more of solid waste materials. These areas are delineated as "Sanitary landfill" on the soil map. Fragments of shells, whole shells, and a few rock fragments are also present in some areas of fill material. Inclusions make up less than 10 percent of the map unit.

Most soil properties are variable. However, permeability is moderately rapid to rapid. The water table varies with the amount of fill material and artificial drainage in any mapped area. In most years, the water table is at a depth of 24 to 36 inches for 2 to 4 months. During extended dry periods, no water table is within 5

feet of the surface. Reaction ranges from slightly acid to alkaline.

These soils mainly are used for urban development. The existing vegetation consists of south Florida slash pine and various scattered weeds. Some small areas that have natural vegetation of cabbage palm, sawpalmetto, waxmyrtle, Brazilian pepper, greenbriar, and various weeds and grasses are scattered throughout the map unit.

Arents have not been assigned to a capability subclass.

24—Floridana sand. This soil is nearly level and very poorly drained. It is in poorly defined drainageways on broad, low flats. The mapped areas range from 10 to 150 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is black sand about 14 inches thick. The subsurface layer is light brownish gray sand to a depth of 20 inches. The subsoil extends to a depth of about 37 inches. The upper 14 inches of the subsoil is gray sandy clay loam. The next 3 inches is gray sandy clay loam that has pockets of soft calcium carbonate. The substratum extends to a depth of 80 inches or more. The upper 31 inches of the substratum is gray or dark gray sandy loam that has pockets of soft calcium carbonate masses. The lower 12 inches is light gray sandy clay loam that has yellowish brown and greenish gray mottles.

Included with this soil in mapping are small areas of Chobee, Manatee, Riviera, and Winder soils. Also included are small areas of soils that are similar to Floridana soil but have a thin layer of muck on the surface. The included soils make up 15 percent of the map unit.

The water table is above the surface for short periods after heavy rainfall or within a depth of 10 inches of the surface for more than 6 months during most years. It is at a depth of 10 to 30 inches for short periods during dry seasons. Permeability is rapid in the surface and subsurface layers and slow to very slow in the subsoil and substratum. The available water capacity is medium to high in the surface layer and subsoil and low in the subsurface layer. Natural fertility is medium, and the organic matter content is high.

Many areas of this soil are drained and used for citrus or cultivated crops. Natural vegetation consists of sand cordgrass, maidencane, St.-Johnswort, scattered waxmyrtle, Carolina willow, pickerelweed, cutgrass, primrose willow, sawgrass, and other water-tolerant grasses.

Under natural conditions this Floridana soil is not suited to cultivated crops. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil has fair suitability for many vegetable crops. Good management practices are good seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. However, the suitability for citrus trees is fair if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly. A water control system is needed to maintain good drainage to a depth of about 4 feet. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

In its natural state, this soil is poorly suited to improved pasture. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass and improved bahiagrass grow well if properly managed. Regular applications of fertilizer and lime are needed. Controlled grazing is necessary.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. This Floridana soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material is needed for septic tank absorption fields, local roads and streets, small commercial buildings, and playgrounds. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Floridana soil is in capability subclass IIIw.

25—St. Augustine sand. This soil is nearly level and somewhat poorly drained. It formed from dredge and fill materials from small manmade harbors that were spread over the surface of former tidal areas. The mineral soils in these areas are very poorly drained. The fill material consists of a mixture of sand, shell fragments, and loamy and silty sediment. The mapped areas are adjacent to

the Indian River and are about 10 to 100 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the fill material in the surface layer is about 30 inches thick. It is light brownish gray sand that contains shell fragments and a few medium distinct yellowish brown streaks. Next is a mixture of grayish brown sand, fragments of dark gray silty clay loam, and olive gray loamy sand to a depth of about 45 inches. Below that is a mixture of greenish gray sand and fragments of gray loamy sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of fill material that do not have loamy pockets or layers. Also included are some areas of soils that have a thin or weakly pronounced organic layer at a depth of more than 60 inches and some areas of soils that are poorly drained. The included soils make up less than 15 percent of the map unit.

The water table is at a depth of 20 to 40 inches for 2 to 6 months in most years. It is above a depth of 20 inches during periods of high rainfall. In some areas, daily tides influence the water table. These soils are subject to flooding for very brief periods during the hurricane season. Permeability is rapid in the sand and muck fill material and slow to very slow in the loamy and silty clay loam. The available water capacity is very low in the sandy part of the fill material and moderate to high in the loam, silty clay loam, and organic layers.

Some areas have been developed for urban use, but most of the acreage consists of stands of Australian pine, Brazilian pepper, sea daisy, and weedy grasses.

This soil is not used for cropland, improved pasture, citrus, woodland, wildlife, or rangeland. It consists of mixed soil material used to fill low tidal areas to make them more suitable for building sites or other urban use. The suitability for urban use is fair, but wetness and flooding for very brief periods are limiting factors. Onsite investigation is recommended for all uses.

This St. Augustine soil is in capability subclass VIIs.

26—St. Augustine fine sand, organic substratum. This soil is nearly level and somewhat poorly drained. It formed from dredge and fill materials from river channels and small manmade harbors that were spread over the surface of former tidal areas. The organic soils in these areas are very poorly drained. The overlying fill material consists of a mixture of sand, shell fragments, and loamy and silty sediment. The thickness of this fill material ranges from 40 to 60 inches. Slopes are smooth and range from 0 to 2 percent.

Typically, the fill material in the surface layer is about 40 inches thick. This fill material is very dark gray fine sand and shell fragments. Below that is 19 inches of gray sand and shell fragments and pockets of sandy clay loam. The next 14 inches is greenish gray fine sand. The next 3 inches is grayish green clay loam. Underlying is the natural undisturbed soil in which the upper 20 inches is dark brown muck. Below that to a depth of 80 inches or more is gray sand mixed with about 50 percent shell fragments.

Included with this soil in mapping are small areas of fill material that do not have loamy pockets or layers, areas of fill material that are less than 40 inches thick. Also included are some areas of soils that have a thin or weakly pronounced organic layer and some areas of soils that are poorly drained. The included soils make up less than 25 percent of the map unit.

The water table is at a depth of 20 to 40 inches for 2 to 6 months in most years. It is above a depth of 20 inches during periods of high rainfall. In some areas, daily tides influence the water table. These soils are subject to flooding for very brief periods during the hurricane season. Permeability is very rapid in the sandy fill material and slow to very slow in the loamy and silty clay layers. Permeability is rapid in the underlying organic and sandy layers. The available water capacity is very low in the sandy part of the fill material and underlying natural layers and moderate to high in the loamy, silty clay, and organic layers.

Some small areas have been developed for urban use, but most of the acreage consists of stands of Australian pine, Brazilian pepper, and weedy grasses.

This soil is not used for cropland, improved pasture, citrus, woodland, wildlife, or rangeland. It consists of mixed soil material that is used to fill low tidal areas. The suitability for urban use is low because of low strength of the organic layers and subsidence. Onsite investigation is recommended for all uses.

This St. Augustine soil is in capability subclass VIIs.

27—Boca-Urban land complex. This complex consists of Boca fine sand and Urban land. The soils in this map unit are so intermingled that it was not practical to map them separately at the scale used in mapping. The mapped areas of this complex are rectangular or short and broad. They range from 25 to 200 acres. Slopes are 0 to 2 percent.

About 50 to 70 percent of the complex consists of nearly level Boca soil or of Boca soil that has been reworked or reshaped but is still recognizable as Boca soil. The open areas in this complex consist of Boca soil. The areas are mostly lawns, vacant lots, or playgrounds (fig. 11). About 20 to 30 percent of the mapped area is Urban land. This land is used for houses, streets, driveways, buildings, parking lots, and other related uses.

Typically, the surface layer of Boca soil is 14 inches thick. It is pale brown and dark grayish brown fine sand fill material. The underlying material, to a depth of 30 inches, is 3 inches of very dark gray fine sand, 7 inches of grayish brown fine sand, and 6 inches of light olive gray sandy loam. Below that is a layer of hard limestone containing fractures and solution holes.

Included in mapping are some areas of Chobee, EauGallie, Floridana, and Jupiter soils. Also included are

Figure 11.—The soils in this Boca-Urban land complex have severe limitations for sanitary facilities, building site development, and recreational uses.

a few areas that are about 80 percent Urban land or a few areas that are only 10 percent Urban land. The included soils make up about 15 percent of this map unit.

Areas of the soils that have been modified by grading and shaping are not as extensive in the older communities as in the newer ones. Sandy and loamy materials, fragments of hard limestone and shell material from drainage ditches, or material that is hauled in are often used to fill low areas. In undrained areas, the water table is at a depth of 10 to 30 inches for 2 to 6 months and within a depth of 10 inches of the surface during the wet season. Drainage systems have been established in most areas. Depth to the water table is dependent upon the functioning of the drainage system.

Present land use precludes the use of this soil for cultivated crops, citrus, improved pasture, rangeland, or woodland.

This complex has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Mounding may be needed for septic tank absorption fields because of wetness and the shallow depth to bedrock. Sealing or lining of sewage lagoons can reduce excessive seepage. Many of these areas have been previously drained or modified by grading or shaping. Some water control measures,

including adding of fill material and installing a drainage system to remove excess surface water after heavy rains, may be necessary for building site development. Because of the moderate depth to bedrock, excavation is difficult. The sandy surface layer should be stabilized for recreational uses.

This complex has not been assigned to a capability subclass.

28—EauGallie-Urban land complex. This complex consists of EauGallie fine sand and Urban land. The soils in this map unit are so intermingled that it was not practical to map them separately at the scale used in mapping. The mapped areas of this complex are rectangular or elongated. They range from 25 to 350 acres. Slopes are 0 to 2 percent.

About 55 to 65 percent of the complex consists of nearly level EauGallie soil or of EauGallie soil that has been reworked or reshaped but is still recognizable as EauGallie soil. The open areas in this complex consist of EauGallie soil. These areas are mostly lawns, vacant lots, or playgrounds. About 25 to 30 percent of the mapped area is Urban land. This land is used for houses, streets, driveways, buildings, parking lots, and other related uses.

Typically, EauGallie soil has a black fine sand surface layer about 5 inches thick. The subsurface layer is light gray fine sand to a depth of about 23 inches. The subsoil extends to a depth of 80 inches or more. The upper 13 inches of the subsoil is black fine sand. The next 19 inches is dark reddish brown and dark brown fine sand. The next 13 inches is light brownish gray fine sand. The lower 12 inches or more is grayish brown sandy loam.

Included in mapping are some areas of Immokalee, Myakka, and Oldsmar soils. Also included are a few areas that are about 80 percent Urban land, or a few areas that are only 10 percent Urban land. The included soils make up about 15 percent of this map unit.

Areas of the soils that have been modified by grading and shaping are not as extensive in the older communities as in the newer ones. Sandy and loamy material from drainage ditches or material that is hauled in are often used to fill low areas. In undrained areas, the water table is at a depth of 10 to 40 inches for periods of 2 to 6 months and is within 10 inches of the surface during the wet season. Drainage systems have been established in most areas. The depth to the water table is dependent upon the functioning of the drainage system.

Present land use precludes using this soil for cultivated crops, citrus, improved pasture, rangeland, or woodland.

The soils in this complex have severe limitations for sanitary facilities. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. Sealing or lining of sewage lagoons with impervious soil material can reduce excessive seepage. The limitations to use for building sites and recreational uses are moderate. Many of the soils in these areas have been previously drained or modified by grading and shaping. Some water control measures, including the addition of fill material and installing of a drainage system to remove excess surface water after a heavy rain, may be necessary. The sidewalls of shallow excavations should be shored. The sandy surface layer should be stabilized for recreational uses.

This complex has not been assigned to a capability subclass.

29—Immokalee-Urban land complex. This complex consists of Immokalee fine sand and Urban land. The soils in this map unit are so intermingled that it was not practical to map them separately at the scale used in mapping. The mapped areas of this complex are rectangular or elongated. They range from 20 to 250 acres. Slopes are 0 to 2 percent.

About 60 to 70 percent of the complex consists of nearly level Immokalee soil or of Immokalee soil that has been reworked or reshaped but is still recognizable as Immokalee soil. The open areas in this complex consist of Immokalee soil. These areas are mostly lawns, vacant lots, or playgrounds. About 20 to 30 percent of the mapped area is Urban land. This land is used for houses, streets, driveways, buildings, parking lots, and other related uses.

Typically, Immokalee soil has a black fine sand surface layer about 7 inches thick. The subsurface layer is light brownish gray and light gray fine sand to a depth of about 42 inches. The subsoil is black and very dark gray fine sand to a depth of about 58 inches. The substratum to a depth of 80 inches or more is dark brown and dark grayish brown fine sand.

Included in mapping are some areas of EauGallie and Oldsmar soils. Also included are a few areas that are about 80 percent Urban land or a few areas that are only 10 percent Urban land. The included soils make up about 15 percent of this map unit.

Areas of the soils that have been modified by grading and shaping are not as extensive in the older communities as in the newer ones. Sandy material from drainage ditches or material that is hauled in are often used to fill low areas. In undrained areas, the water table is at a depth of 10 to 40 inches for 2 to 6 months and within a depth of 10 inches of the surface during the wet season. Drainage systems have been established in most areas. Depth to the water table is dependent upon the functioning of the drainage system.

Present land use precludes the use of this soil for cultivated crops, citrus, improved pasture, rangeland, or woodland.

This complex has severe limitations for sanitary facilities. Water control measures are needed to

overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. Sealing or lining of sewage lagoon areas can reduce excessive seepage. The limitations for building site development and recreational uses are moderate. Many of these areas have been previously drained or modified by grading and shaping. Some water control measures, including adding of fill material and installing a drainage system to remove excess surface water after heavy rains, may be necessary. Sidewalls of shallow excavations should be shored. The sandy surface layer should be stabilized for recreational uses.

This complex has not been assigned to a capability subclass.

31—Jupiter fine sand. This soil is shallow, nearly level, and poorly drained. It is on low flats and hammocks. The mapped areas range from 5 to 50 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is fine sand about 12 inches thick. The upper 5 inches of the surface layer is black, and the lower 7 inches is very dark brown. Below that is hard, fractured limestone.

Included with this soil in mapping are small areas of Boca, Pineda, Riviera, and Winder soils. Also included are small areas of soils that are similar to Jupiter soil but have a thin layer of loamy material or marl underlain by limestone, some areas of soils that are similar but have less than 10 inches of sandy material underlain by limestone, small areas of soils that are similar but have a lighter colored sandy surface, and some soils in scattered spots of exposed limestone. The included soils make up less than 20 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of less than 10 inches of the surface for 2 to 4 months in the wet season. Some areas of this soil are covered with shallow water for brief periods. In drained areas, the water table fluctuates with the water level of the canals and ditches. It recedes to a depth below the limestone in the dry season. Permeability is rapid in the sandy layer above the bedrock. The hard limestone is impermeable but has sufficient fractures and solution holes to permit water movement. The available water capacity is low to medium in the sandy layer. Natural fertility and the organic matter content are medium.

Many areas of this soil are used for citrus. Natural vegetation consists of water oak, cabbage palm, strangler fig, Florida holly, scattered slash pine, wild coffee, wild grape, greenbriar, ferns, and a few various weeds and sprigs of grasses.

Under natural conditions, this Jupiter soil is very poorly suited to cultivated crops because of wetness and shallow depth to bedrock. However, if a water control system is installed to remove excess water rapidly, this soil is suitable for adapted vegetable crops. The shallow depth to bedrock makes the installation of an adequate system very difficult. Row crops should be placed on beds. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizers should be applied according to the need of the crop.

This soil has fair suitability for citrus only after a properly designed water control system has been installed and intensive management practices are used. A water control system is needed to maintain a good drainage system to a depth of about 4 feet. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizers are needed.

This soil has fair suitability for improved pasture grasses. Pangolagrass, improved bahiagrasses, and white clover grow well if properly managed. Water control measures are needed to remove excess surface water after heavy rains. Regular applications of fertilizers are needed. Grazing should be controlled to prevent overgrazing and to maintain plant vigor.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and windthrow hazard are the main concerns in management.

This soil is poorly suited to desirable range plant production. The vegetative community consists of cabbage palm, live oak, scattered sawpalmetto, grapevine, and wild coffee. Because of the dense canopy of palm trees, this site is a preferred shading and resting area for cattle. As a result, this range site generally is severely grazed. Management practices should include deferred grazing, brush control, and proper stocking. Jupiter soil is in the Cabbage Palm Hammocks range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Fill material is needed to overcome the shallow depth to bedrock. Sealing or lining of sewage lagoons and sanitary landfills with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Because of the shallow depth to bedrock, excavation is difficult. The use of special equipment may be required.

This Jupiter soil is in capability subclass IVw.

32—Jonathan sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and somewhat excessively drained. It is on the Atlantic Coastal Ridge and on slightly elevated knolls on the flatwoods. These soils mainly are in the eastern part of the county. The

mapped areas range from 30 to 200 acres. Slopes are smooth to convex.

Typically, the surface layer is dark gray sand about 3 inches thick. The subsurface layer is white sand to a depth of about 75 inches. The subsoil to a depth of 80 inches or more is dark reddish brown sand that is 60 to 75 percent strongly cemented.

Included with this soil in mapping are small areas of Immokalee, Pomello, and St. Lucie soils. Also included are areas of soils that are similar to Jonathan soil but are better drained. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 40 to 60 inches for 1 to 4 months during the wet season. It is below 60 inches for the remainder of the year. Permeability is moderately rapid to very rapid in the surface and subsurface layers and slow or very slow in the subsoil. The available water capacity is very low in the surface and subsurface layers and medium in the subsoil. Natural fertility and the organic matter content are very low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, sand pine, scattered scrub hickory, scrub live oak, Chapman oak, rosemary, pricklypear cacti, grassleaf goldaster, flag pawpaw, mosses and lichens, pineland threeawn, and various other grasses.

This Jonathan soil is not suited to cultivated crops because of droughtiness and sandy texture. A ground cover of close-growing plants is needed between the tree rows to protect the soil from blowing. A properly designed irrigation system is needed to maintain optimum moisture and obtain high yields.

This soil has poor suitability for improved pasture grasses. Deep-rooted plants, such as coastal bermudagrass and bahiagrass, are well adapted species to plant, but yields are reduced by periodic droughts. Regular applications of fertilizer and lime are needed. Controlled grazing is needed to help maintain plant vigor.

The potential productivity of this soil for pine trees is low. South Florida slash pine and sand pine are the recommended trees to plant. Equipment limitations and seedling mortality are the main concerns in management.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, and scrub oak. Although this site is seldom grazed by livestock, it does furnish winter protection. Jonathan soil is in the Sand Pine Scrub range site.

This soil has slight limitations for dwellings without basements, small commercial buildings, and local roads and streets. No corrective measures are needed. This soil is well suited to septic tank absorption fields and playgrounds. Some water control measures are needed for septic tank absorption fields to lower the water table during wet seasons. The sandy surface layer should be stabilized for playground use. This soil has severe limitations for trench sanitary landfills, sewage lagoons, and shallow excavations. Sealing or lining of landfills and lagoons with impervious soil material can reduce excessive seepage. Water control practices are needed for trench sanitary landfills. Sidewalls should be shored for shallow excavations.

This Jonathan soil is in capability subclass VIs.

33—Astatula sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and excessively drained. It is on the Atlantic Coastal Ridge. The mapped areas range from about 20 to 200 acres. Slopes are smooth to convex.

Typically, the surface layer is grayish brown sand about 4 inches thick. The subsurface layer is brown sand about 1 inch thick. The underlying material to a depth of 80 inches or more is brownish yellow or strong brown sand.

Included with this soil in mapping are small areas of Paola, Pomello, and St. Lucie soils. Because of excavation of the Astatula soils for fill material, some included soils have short, steep slopes that range from 5 to 40 percent. The included soils make up less than 15 percent of the map unit.

This soil has no water table within a depth of 6 feet throughout the year. Permeability is very rapid, and the available water capacity is very low throughout. Natural fertility and the organic matter content are very low.

Most areas of this soil remain in natural vegetation consisting of cabbage palm, scrub hickory, longleaf and sand pine, sawpalmetto, sand live oak, and scrub oak. Pineland threeawn and bluestems are the most common native grasses, but these grasses can be quite sparse in occurrence because of the droughty nature of the soil.

Under natural conditions, this Astatula soil is not suited to cultivated crops. It has poor suitability for vegetable crops and citrus. A ground cover of close-growing plants between the tree rows should be maintained to protect the soil from blowing. A properly designed irrigation system is needed to maintain optimum moisture and obtain high yields. Regular applications of fertilizer and lime are also needed.

This soil has poor suitability for improved pasture grasses. Deep-rooted plants, such as coastal bermudagrass and bahiagrass, are well adapted to this soil, but yields are reduced by periodic droughts. Regular applications of fertilizer and lime are needed. Controlled grazing is needed to help maintain plant vigor.

The potential productivity of this soil for pine trees is low. Slash pine and sand pine are the preferred trees to plant. Equipment limitations and seedling mortality are the main concerns in management.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, scrub oak, indiangrass, creeping bluestem,

beaked panicums, and perennial legumes. Although this site is seldom grazed by livestock, it does furnish winter protection. Astatula soil is in the Sand Pine Scrub range site.

This soil has slight limitations for septic tank absorption fields, dwellings without basements, and local roads and streets. No corrective measures are needed, although the proximity to a stream or canal should be considered in the placement of a septic tank absorption field to prevent lateral seepage and pollution. This soil is also well suited to small commercial buildings. Land shaping may be needed on the more sloping areas. This soil has severe limitations for playgrounds, trench sanitary landfills, and shallow excavations. The sandy surface should be stabilized for playground use, and land shaping may be needed on the more sloping areas. Sealing or lining of trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Astatula soil is in capability subclass VIs.

34—Satellite fine sand. This soil is nearly level and somewhat poorly drained. It is on low knolls and ridges on the flatwoods. The mapped areas range from 10 to 250 acres. Slopes are smooth to convex and range from 0 to 2 percent.

Typically, the surface layer is dark gray fine sand about 4 inches thick. The underlying material is light brownish gray, grayish brown, and dark grayish brown fine sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Archbold, Immokalee, Myakka, Pomello, and Pompano soils. The included soils make up less than 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 18 to 24 inches for 2 to 6 months and at a depth of 40 to 72 inches for 6 months or more. Permeability is very rapid, and the available water capacity is very low. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, longleaf pine, sand live oak, sawpalmetto, pineland threeawn, indiangrass, bluestems, fetterbush, and various other sedges and grasses.

The suitability of this soil for citrus trees is fair if good management practices are used. A water control system is necessary to maintain the water table at a depth of about 4 feet during the wet season and to provide for subsurface irrigation during periods of low rainfall. Regular applications of fertilizer and lime help to obtain good yields. A suitable cover crop should be maintained between tree rows to prevent soil blowing.

This Satellite soil is poorly suited to cultivated crops, but if intensive management practices are used, a few special crops can be grown. A water control system should be installed to remove excess water in wet seasons and to provide for subsurface irrigation in dry seasons. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Applications of fertilizer and lime should be applied according to the need of the crop.

The suitability for growing improved pasture grasses is fair. Bahiagrass and pangolagrass will grow when properly managed. Regular applications of lime and fertilizer are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. Seedling mortality is the main concern in management. South Florida slash pine is preferred for planting.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, and scrub oak. Although this site is seldom grazed by livestock, it does furnish winter protection. Satellite soil is in the Sand Pine Scrub range site.

This soil has severe limitations for sanitary facilities and building site development. It has moderate limitations for local roads and streets and recreation use. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. The very rapid permeability of this soil can cause pollution of ground water in areas of septic tank absorption fields. Water control measures and sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored. Water control measures are needed.

This Satellite soil is in capability subclass VIs.

35—McKee mucky clay loam. This soil is level and very poorly drained. It is in mangrove islands and swamps. This soil formed in unconsolidated loamy or clayey tidal deposits and is inundated by fluctuating tides twice a day. These areas are at or near sea level and are in and adjacent to the Indian River (fig. 12). Individual mapped areas range from 10 to 450 acres. Slopes are less than 1 percent.

Typically, the surface layer is very dark grayish brown mucky clay loam about 1 inch thick. The underlying material is very dark gray clay loam to a depth of 15 inches, grayish green to dark greenish gray sandy clay to a depth of about 60 inches, and dark gray sandy loam to a depth of 80 inches or more. Most layers are very fluid when squeezed in the hand, and some layers range from very fluid to slightly fluid.

Included with this soil in mapping are small areas of soils that are similar to McKee soil but have limestone boulders at a depth of more than 40 inches, also some small areas of soils that are similar but have limestone boulders at a depth of less than 40 inches, and some areas of soils that are similar but have a thin organic

Figure 12.—This red and black mangrove is in an area of McKee mucky clay loam.

surface. Also included are soils in areas that have a high content of sand or soil in some areas that have been affected by drainage. These soils do not behave as fluid when subjected to pressure. In addition, included are some small areas of soils that contain a high amount of sulfites that become extremely acid when drained and exposed to air. The included soils make up less than 20 percent of the map unit.

Under natural conditions, McKee soil remains saturated. Soil strength is low. The water content may be as high as 80 percent at field condition. Fluctuating tides overwash the surface layer twice daily. Natural fertility is high for saltwater-tolerant plants. The organic matter content is very high.

The native vegetation consists of red, black, and white mangroves, and in some areas it consists of sea rocket, saltwort, perennial glasswort, seashore saltgrass, and seashore paspalum. The red mangroves, which have an extensive prop root system and shed floating seed pods, are mainly along the river's edge and along ditches where tidal water is deeper. The black and white mangroves, which propagate by sending up pneumatophores or erect extensions of their root systems above the soil surface, are mainly on slightly higher elevations.

Because of tidal flooding and low soil strength, this McKee soil is not suited to cropland, citrus, improved pasture, or woodland. Drainage of these soils would probably cause them to become so acid that they could not support much plant growth. However, if accessible by an elevated road or levee, these soils are well suited to beekeeping for mangrove honey production.

This soil generally is not used for rangeland. McKee soil is in the Mangrove Swamps ecological plant community.

This soil is not suited to urban use because of tidal flooding and low soil strength.

McKee soil is in mangrove swamps, which are unique and biologically productive areas that are very important to many species of fish and wildlife. Many sport and

commercial finfish, shellfish, and other crustaceans use these areas as spawning grounds. Mangrove swamps also serve as protective barriers in estuaries against excessive wave action during tropical storms.

This McKee soil is in capability subclass VIIIw.

36—Boca fine sand. This soil is nearly level and poorly drained. It is on the flatwoods, but most of the acreage is in citrus groves. The mapped areas range from 10 to 200 acres. Slopes are smooth and range from 0 to 2 percent.

Typically, the surface layer is dark gray fine sand about 7 inches thick. The subsurface layer is fine sand to a depth of about 20 inches. The upper 7 inches of the subsurface layer is grayish brown, and the lower 6 inches is brown. The subsoil is yellowish brown fine sandy loam to a depth of 24 inches. Below that is a layer of fractured limestone.

Included with this soil in mapping are small areas of Jupiter, Pineda, and Riviera soils. Also included are soils that are similar to Boca soil but have limestone at a depth of less than 20 inches. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is within a depth of 10 inches of the surface for 2 to 4 months. It recedes to a depth below the limestone for about 6 months. Permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity is low in the surface layer, very low in the subsurface layer, and medium in the subsoil. Natural fertility and the organic matter content are low.

Natural vegetation consists of sawpalmetto, pineland threeawn, indiangrass, bluestems, panicums, south Florida slash pine, and waxmyrtle. Many areas of this soil are in citrus groves.

Under natural conditions, this Boca soil is not suitable for cultivated crops because of wetness and shallow depth to bedrock. However, if intensive management practices and soil improving measures are used and a good water control system is installed to remove excess water rapidly, this soil is fairly suited to many vegetable crops. A good water control system is needed to remove excess water in wet seasons and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Other good management practices are seedbed preparation, including bedding of rows, and applying fertilizer according to the need of the crop.

This soil has fair suitability for citrus only if a properly designed water control system is installed. A water control system to maintain good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A cover crop should be maintained between the tree rows to protect the soil from blowing in dry weather and washing away during heavy rain. Regular applications of fertilizer and lime are needed.

Boca soil has fair suitability for improved pasture grasses. Bahiagrass, pangolagrass, and white clover grow well if properly managed. Water control measures are needed to remove excess surface water after heavy rains. Regular applications of fertilizer and lime are needed. Grazing should be controlled to prevent overgrazing and to maintain plant vigor.

The potential productivity of this soil for pine trees is high. Water control is needed before the potential can be attained. Seedling mortality, equipment limitations, and plant competition are the main concerns in management. South Florida slash pine is the preferred tree to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, south Florida bluestem, and chalky bluestem. Boca soil is in the South Florida Flatwoods range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench landfills with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Because of the moderate depth to bedrock, excavation is difficult. The use of special equipment may be required.

This Boca soil is in capability subclass IIIw.

39—Malabar fine sand. This soil is nearly level and poorly drained. It is in low, narrow to broad sloughs and poorly defined drainageways and on flats. The mapped areas range from 20 to 250 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is very dark grayish brown fine sand about 3 inches thick. The subsurface layer extends to a depth of 17 inches. The upper 7 inches of the subsurface layer is light brownish gray fine sand, and the lower 7 inches is light yellowish brown fine sand. The subsoil extends to a depth of 65 inches. The upper 24 inches of the subsoil is brownish yellow and reddish yellow fine sand. The next 5 inches is dark grayish brown sandy clay loam. The lower 19 inches is gray sandy loam. The substratum to a depth of 80 inches or more is gray loamy sand.

Included with this soil in mapping are small areas of Holopaw, Lokosee, Oldsmar, Pineda, and Riviera soils. Also included are soils in small depressional areas that are ponded. The included soils make up less than 15 percent of the map unit.

The water table is at a depth of less than 10 inches of the surface for 2 to 6 months and between a depth of 10 and 40 inches for most of each year. Permeability is rapid in the surface and subsurface layers. It is rapid in the upper part of the subsoil and slow to very slow in the lower part and moderately rapid in the substratum. The

available water capacity is low to very low in the surface and subsurface layers. It is low to very low in the upper part of the subsoil and moderate in the lower part and low in the substratum. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of slash pine, cabbage palm, scattered sawpalmetto, waxmyrtle, inkberry, maidencane, creeping bluestem, pineland threeawn, laurel oak, bulrush, greenbrier, panicums, and various other sedges and grasses.

This Malabar soil is poorly suited to cultivated crops. However, it is moderately well suited to vegetable crops if a water control system is installed to remove excess surface water rapidly and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

The suitability for citrus trees is good if a water control system is installed to maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizers are needed.

The suitability of this soil for pasture and hay crops is good. Pangolagrass, improved bahiagrasses, and clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizer, and controlled grazing.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and seedling mortality are the main concerns in management.

This soil is well suited to desirable range plant production. The dominant forage is creeping bluestem, chalky bluestem, and blue maidencane. Management practices should include deferred grazing and brush control. Malabar soil is in the Cabbage Palm Flatwoods range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures and fill material are needed to overcome excessive wetness (fig. 13). Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations need to be shored.

This Malabar soil is in capability subclass IVw.

40—Gator muck. This soil is nearly level and very poorly drained. It is in freshwater swamps and marshes. The mapped areas range from 20 to 1,500 acres. Slopes are smooth and are less than 1 percent.

Typically, the surface layer is very dark brown muck about 26 inches thick. The underlying material extends to a depth of about 80 inches. The upper 4 inches of the underlying material is very dark gray sandy clay loam, the next 19 inches is dark gray sandy clay loam, and the next 13 inches is greenish gray sandy clay loam that has few to common light gray calcium carbonate accumulations. Below that is greenish gray sandy clay loam that has yellowish brown sandy loam stains and splotches.

Included with this soil in mapping are small areas of Chobee, Floridana, and Terra Ceia soils. Also included are small areas of soils that are similar to Gator soil but have a thin layer of fibers from woody plants in the organic layer. The included soils make up less than 20 percent of the map unit.

Under natural conditions, the water table is above the surface for most of the year. In drained areas, the water table is controlled at a depth of 10 to 36 inches or according to the need of the crop. The water table is at or above the surface for short periods after heavy rainfall and during the normal periods of high seasonal rainfall. Permeability is rapid in the surface layer and moderately slow to slow in the underlying material. The available water capacity is very high in the organic surface layer and medium in the underlying material. Natural fertility and the organic matter content are high.

Some areas of this soil are drained and used for improved pasture and crops. Natural vegetation consists of a dense swamp growth of red maple, red bay, cypress, Carolina willow, primrose willow, waxmyrtle, pickerelweed, sawgrass, cattail, buttonbush, arrowhead, ferns, maidencane, and other water-tolerant grasses. Areas of this soil provide cover for deer and are excellent habitat for wading birds and other wetland wildlife.

This Gator soil is not suitable for cultivated crops under natural conditions. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess surface water rapidly, this soil has good suitability for many vegetable crops. A properly designed water control system is needed to remove the excess water when crops are on the soil and to maintain the water table near the surface to help prevent subsidence of organic material needed for crop and pasture production. Good management practices include seedbed preparation and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In its natural state, this soil is not suited to citrus trees. It is poorly suited even if intensive management

Figure 13.—This area of Malabar fine sand is in sloughs and poorly defined drainageways.

practices, such as bedding of rows, are used and the water control system is adequate.

In its natural state, this soil is not suited to improved pasture grasses. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is good. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. The water control system should maintain the water table near the surface to prevent excess subsidence of the organic material. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

This soil is not suited to pine trees.

This soil generally is not used for rangeland. Gator soil is in the Swamp Hardwoods ecological plant community.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses because of ponding and excess humus. Water control measures are needed to overcome excessive wetness. Organic materials, which have low soil strength, should be removed and backfilled with a suitable soil material for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored, and water control measures should be used. Mounding may be needed for septic tank absorption fields.

This Gator soil is in capability subclass IIIw.

41—Canova muck. This soil is nearly level and very poorly drained. It is in freshwater swamps and marshes. The mapped areas range from 100 to 1,800 acres. Slopes are smooth to concave and range from 0 to 1 percent.

Typically, the organic surface layer is black and very dark brown muck about 12 inches thick underlain by 1

inch of black sand. The subsurface layer, to a depth of 24 inches, is gray to grayish brown sand. The subsoil extends to a depth of about 40 inches. The upper 10 inches of the subsoil is grayish brown sandy clay loam that has common coarse tongues of grayish brown sand, and the lower 6 inches is gray sandy clay loam that has few light gray and yellowish brown calcium carbonate concretions. The substratum to a depth of 80 inches or more is greenish gray sandy clay loam and sandy loam that have common to many light gray calcium carbonate concretions and soft calcium carbonate accumulations.

Included with this soil in mapping are small areas of Gator, Delray, Floridana, Chobee, Winder, and Riviera soils. Also included are small areas of soils that are similar to Canova soil but have a subsoil that is at a depth of more than 30 inches. The included soils make up less than 20 percent of the map unit.

Under natural conditions, the water table is above the surface for most of the year. In drained areas, the water table is controlled at a depth of 10 to 36 inches or according to the need of the crop. The water table is at or above the surface for short periods after heavy rainfall and during the normal periods of high seasonal rainfall. Permeability is rapid in the surface and subsurface layers and moderately slow to slow in the subsoil and substratum. The available water capacity is very high in the organic surface layer, low in the mineral subsurface layer, and medium to high in the subsoil and underlying material. Natural fertility is medium, and the organic matter content is high.

Many areas of this soil are drained and are used for improved pasture. Natural vegetation consists of maidencane, cutgrass, Carolina willow, primrose willow, pickerelweed, sawgrass, cattail, buttonbush, arrowhead, and other water-tolerant grasses.

Under natural conditions, this Canova soil is not suited to cultivated crops. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess surface water rapidly, this soil has a fair suitability for many vegetable crops. Good management practices are seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. However, citrus trees have a fair suitability if intensive management practices are used. These practices and measures include the mixing of the organic material and the sandy mineral material or by removing the material and backfilling with a suitable soil material. Also, a water control system should be installed to remove excess surface water rapidly. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

In its natural state, this soil is not suited to improved pasture. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is good. Improved pangolagrass, bahiagrass, and white clover grow well if properly managed. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Canova soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses because of ponding and excess humus. Water control measures are needed to overcome wetness. Organic materials need to be removed and backfilled with suitable soil material for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shaped, and water control measures are needed. Mounding may be needed for septic tank absorption fields.

This Canova soil is in capability subclass IIIw.

42—Terra Ceia muck. This soil is nearly level and very poorly drained. It is in freshwater marshes. The mapped areas range from 1,800 to 15,000 acres. Slopes are smooth and are less than 1 percent.

Typically, the surface layer is black muck about 38 inches thick. Below that is very dark grayish brown muck to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Gator soils. Also included are small areas of soils that are similar to the Terra Ceia soil but have thin layers that contain fibers from woody plants at a depth of 30 to 51 inches. The included soils make up less than 20 percent of the map unit.

Under natural conditions, the water table is above the surface for most of the year. In drained areas, the water table is controlled at a depth of 10 to 36 inches or controlled according to the need of the crop. The water table is at or above the surface for short periods after heavy rainfall and during the normal periods of high seasonal rainfall. Permeability is rapid throughout, but internal drainage is impeded by the shallow water table.

The available water capacity is very high throughout. The natural fertility is high, and the organic matter content is very high.

In some areas, this soil is drained and used for improved pasture and crops. Natural vegetation consists of a dense swamp growth of red maple, redbay, cypress, Carolina willow, waterprimrose willow, waxmyrtle, pickerelweed, sawgrass, cattail, buttonbush, arrowhead, ferns, maidencane, and other water-tolerant grasses. Areas of this soil provide cover for deer and are excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this Terra Ceia soil is not suited to cultivated crops. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil has good suitability for many vegetable crops. A properly designed water control system should be installed and maintained to remove the excess water when crops are on the land and to keep the soil saturated at all other times. Good management practices include seedbed preparation and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In its natural state, this Terra Ceia soil is not suited to citrus trees. It is poorly suited to this use even if intensive management practices, such as bedding of rows, are used and the water control system is adequate.

In its natural condition, this soil is not suited to improved pasture grasses; however, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is good. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. The water control system should maintain the water table near the surface to prevent excess subsidence of the organic material. Regular applications of fertilizer and lime are needed. Grazing should be controlled to maintain plant vigor.

This soil is not suited to pine trees.

This soil generally is not used for rangeland. Terra Ceia soil is in the Swamp Hardwoods ecological plant community.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses because of ponding and excess humus. Water control measures are needed to overcome excessive wetness. Because of low strength, the organic surface layer must be removed and backfilled with a soil material that is suitable for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored, and water control measures are needed to overcome excessive wetness. Mounding may be needed for septic tank absorption fields.

This Terra Ceia soil is in capability subclass IIIw.

44—Perrine Variant fine sandy loam. This soil is nearly level and poorly drained. It is on narrow to broad, elongated, low flats. This soil is primarily adjacent to tidal areas along the Indian River. The mapped areas range from 5 to 200 acres. Slopes are smooth to concave and are dominantly less than 1 percent.

Typically, the surface layer is very dark gray fine sandy loam about 6 inches thick. The underlying material is gray sandy clay loam to a depth of about 24 inches. The lower 4 inches of the underlying material has fragments and small white to light brownish gray carbonate nodules. Below that to a depth of 36 inches is a ledge of hard, continuous limestone.

Included with this soil in mapping are Chobee and Boca soils. The included soils make up about 15 percent of the map unit.

For more than 6 months in most years, under natural conditions, the water table is within 10 inches of the surface about 30 to 50 percent of the time. Permeability is moderately slow or moderate. The available water capacity is medium in the surface layer and medium to high in the subsurface layer. The natural fertility is high, and the organic matter content is moderate.

Most areas have been cleared for citrus. If present, the natural vegetation consists of cabbage palm, water oak, Brazilian pepper, waxmyrtle, sedges, reeds, and various grasses. Areas that are nearer to the coast include American and white mangrove trees, sea rocket, saltwort, and perennial glasswort.

Under natural conditions, this Perrine Variant soil has severe limitations for cultivated crops because of wetness and shallow depth to bedrock. If a water control system is installed and maintained, this soil has fair suitability for fruit and vegetable crops. A water control system is needed to remove excess water during wet periods, provide for subsurface irrigation, and prohibit saltwater intrusion because of the soil's proximity to the coast. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Other good management practices are seedbed preparation, including bedding of rows, and applying fertilizer according to the need of the crop.

This Perrine Variant soil is poorly suited to citrus even if a properly designed water control system is installed. A water-control system that maintains good drainage to a depth of about 4 feet is needed. Planting trees on beds lowers the effective depth of the water table and depth to the shallow limestone. Removal of the limestone ledges allows for saltwater intrusion. Therefore, it is further necessary to plant trees on beds. A cover crop should be maintained between the trees, and regular applications of fertilizer are needed.

This soil has fair suitability for improved pasture grasses. Bahiagrass and pangolagrass grow well if properly managed. Water-control measures are needed to remove excess surface water after heavy rains and to prohibit saltwater intrusion. Regular applications of fertilizer are needed. Grazing should be controlled to maintain plant vigor.

This soil is not suited to pine trees. The shallow depth to limestone and wetness are the main limitations.

This soil generally is not used for rangeland. In its natural condition, Perrine Variant soil is in the Salt Marsh ecological plant community.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. The shallow depth to bedrock and wetness are the main limiting factors. Mounding is needed for septic tank absorption fields. Because of the shallow depth to bedrock and hardness of limestone, excavation is difficult. The use of special equipment may be required.

This Perrine Variant soil is in capability subclass IIIw.

45—Myakka fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 100 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is black fine sand about 4 inches thick. The subsurface layer is gray fine sand to a depth of about 17 inches. The subsoil extends to a depth of about 65 inches. The upper 3 inches of the subsoil is weakly cemented black fine sand. The next 18 inches is dark brown fine sand. The next 12 inches is black fine sand. The lower 15 inches is dark grayish brown sand. The substratum to a depth of 80 inches or more is light gray sand.

Included with this soil in mapping are small areas of Immokalee, Pompano, and Samsula soils. Also included are soils that are similar to the Myakka soil but have a muck or mucky fine sand surface layer less than 15 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months or more each year. The water table is within a depth of 10 inches of the surface for 2 to 4 months, and it is at a depth of 10 to 40 inches for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers and in the substratum. It is moderate or moderately rapid in the subsoil. The available water capacity is low in the surface layer, very low in the subsurface layer and substratum, and moderate in the subsoil. The natural fertility is low, and the organic matter content is low.

Natural vegetation consists of blue maidencane, broomsedge, St.-Johnswort, waxmyrtle, red maple, sand cordgrass, milkwort, chalky bluestem, white bracted sedge, pipewort, arrowhead, water hyacinth, and various other water-tolerant weeds and grasses.

This soil has poor suitability for cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil is moderately suited to vegetable crops. Good management practices are crop rotation and seedbed preparation, including bedding of rows. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

Under natural conditions, this Myakka soil is not suited to citrus trees. It is poorly suited to this use even if intensive management practices are used and the water control system is adequate.

This soil has fair suitability for improved pasture if very intensive management practices and soil improving measures are used and a water control system is installed. Pangolagrass and improved bahiagrass grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of fertilizer and lime are needed. Grazing should be controlled to maintain plant vigor.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted tree to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. This Myakka soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material to raise the level of the land surface is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Myakka soil is in capability subclass VIIw.

46—Orsino fine sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and moderately well drained. It is on slightly higher ridges and knolls adjacent to Sebastian Creek. The mapped areas range from 40 to 100 acres. Slopes are smooth to convex.

Typically, the surface layer is gray fine sand about 2 inches thick. The subsurface layer is white fine sand to a depth of about 23 inches. The subsoil is dark reddish brown and brown fine sand that has discontinuous lenses of brown and reddish brown fine sand to a depth of 43 inches. The next layer is very pale brown fine sand to a depth of 62 inches. Below that to a depth of 80 inches or more is light gray fine sand.

Included with this soil in mapping are small areas of Satellite, St. Lucie, Electra, Oldsmar, Pomello, and Immokalee soils. The included soils make up less than 15 percent of the map unit.

In most years, under natural conditions, the water table is between a depth of 40 and 60 inches for 6 months or more but recedes to a depth of more than 60 inches during droughty periods. Permeability is very rapid. The available water capacity is very low. Natural fertility and the organic matter content are very low.

Most areas of this soil are in natural vegetation consisting of slash pine, sand pine, sand live oak, scattered blackjack oak, turkey oak, and scrub oak. The understory consists of pineland threeawn, indiangrass, bluestems, grassleaf goldaster, and various other grasses and forbs.

This soil has fair suitability for citrus trees. A close-growing cover crop should be maintained between the tree rows to protect the soil from blowing and washing away during heavy rains. High yields of fruit can be obtained in some years without irrigation, but a properly designed irrigation system to maintain optimum moisture is generally necessary.

This Orsino soil has poor suitability for cultivated crops. Droughtiness and rapid leaching of plant nutrients reduce the variety of adapted crops that can be grown and reduce crop yields. Row crops should be planted on contourlike strips that alternate with strips of close-growing crops. Close-growing crops are needed in the crop rotation at least three-fourths of the time. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. An intensively managed irrigation system is needed, and fertilizer and lime should be applied according to the need of the crop.

This soil has fair suitability for pasture and hay crops. Deep-rooting plants, such as coastal bermudagrass and bahiagrass, are well adapted to this soil, but yields are reduced by droughts. Regular applications of fertilizer and lime should be applied. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. Equipment limitations, seedling mortality, and plant competition are the main concerns in management. South Florida slash pine and sand pine are the preferred trees to plant.

This soil is poorly suited to desirable range plant production. The vegetative community consists of a dense, woody understory of sawpalmetto, Florida rosemary, and scrub oak. Although this site is seldom grazed by livestock, it does furnish winter protection. Orsino soil is in the Sand Pine Scrub range site.

This soil has moderate limitations for septic tank absorption fields. Septic tank absorption fields may need to be enlarged because of wetness. The proximity to a stream or canal should be considered in the placement of a septic tank absorption field to prevent lateral seepage and pollution. The limitations are slight for dwellings without basements, small commercial buildings, and local roads and streets. Land shaping may be needed on the more sloping areas. This soil has severe limitations for sewage lagoons, trench sanitary landfills, shallow excavations, and recreational uses. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Water control measures are needed to lower the water table. Sidewalls of shallow excavations need to be shored. The sandy surface layer should be stabilized for recreational uses, and land shaping may be needed on the more sloping areas.

This Orsino soil is in capability subclass IVs.

47—Holopaw fine sand. This soil is nearly level and poorly drained. It is on broad, low flats and in poorly defined drainageways. The mapped areas range from 10 to 50 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is very dark gray and dark grayish brown fine sand about 12 inches thick. The subsurface layer extends to a depth of about 45 inches. The upper 18 inches of the subsurface layer is pale brown fine sand, and the lower 15 inches is grayish brown fine sand. The subsoil is grayish brown sandy loam that has pockets of brown fine sand to a depth of about 62 inches. The substratum to a depth of 80 inches or more is olive gray loamy fine sand.

Included with this soil in mapping are small areas of Riviera, EauGallie, Oldsmar, and Malabar soils. Also included are areas of soils that have a weakly stained layer of organic matter above the subsoil and that are in small depressional areas that are ponded. The included soils make up less than 15 percent of the map unit.

The water table is within a depth of 10 inches of the surface for 2 to 6 months each year. It is above the surface for short periods after heavy rainfall. Permeability is rapid in the surface and subsurface layers and is moderately rapid in the subsoil. The available water capacity is low to very low in the surface and subsurface layers, medium in the subsoil, and low in the substratum. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of scattered slash pine, cabbage palm, scattered sawpalmetto, waxmyrtle, blue maidencane, pineland threeawn, panicums, sedges, and other water-tolerant grasses.

Under natural conditions, this Holopaw soil is poorly suited to cultivated crops. However, it has a fair suitability for vegetable crops if a water control system is installed to remove excess water rapidly and provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

This soil has good suitability for citrus trees if a properly designed water control system is installed to maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

The suitability of this soil for pasture and hay crops is good. Pangolagrass, improved bahiagrass, and clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizer, and controlled grazing.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary to remove excess surface water. Equipment limitations and seedling mortality are the main concerns in management.

This soil is well suited to desirable range plant production. The dominant forage consists of blue maidencane, chalky bluestem, and blue joint panicum. Management practices should include deferred grazing. Holopaw soil is in the Slough range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored.

This Holopaw soil is in capability subclass IVw.

48—Electra sand, 0 to 5 percent slopes. This soil is nearly level to gently sloping and somewhat poorly drained. It is on knolls on the flatwoods and is adjacent to natural drainageways. The mapped areas range from 20 to 300 acres. The areas that are along streams are generally elongated. Slopes are smooth to convex.

Typically, the surface layer is dark gray sand about 5 inches thick. The subsurface layer is light gray sand to a depth of about 30 inches. The subsoil extends to a depth of about 80 inches. The upper 17 inches of the subsoil is dark reddish brown sand and brown loamy sand. The lower 33 inches or more is light brownish gray sandy loam that has strong brown mottles.

Included with this soil in mapping are small areas of Immokalee and Oldsmar soils. Also included are soils that are similar to Electra soil but are moderately well drained. The included soils make up about 15 percent of the map unit.

In most years, under natural conditions, the water table is at a depth of 25 to 40 inches for cumulative periods of 4 months during the drier periods. Permeability is rapid in the surface and subsurface layers and moderate to slow in the sandy part of the subsoil and slow in the loamy part. The available water capacity is low to very low in the surface and subsurface layers and medium in the subsoil. Natural fertility and the organic matter content are very low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, scattered long leaf pine, scrub oak, sawpalmetto, fetterbush, rusty lyonia, running oak, flag pawpaw, pineland threeawn, and various other grasses, vines, and forbs.

Under natural conditions this Electra soil is not suited to cultivated crops because of droughtiness and the sandy texture in the root zone. Citrus and vegetable crops have fair suitability if good management practices are used. A properly designed irrigation system is necessary to maintain optimum moisture and obtain high yields. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Regular applications of fertilizer and lime are needed. A ground cover of close-growing plants should be maintained between tree rows to protect the soil from blowing.

This soil has fair suitability for improved pasture grasses. Deep-rooted plants, such as coastal bermudagrass and bahiagrass, are well adapted to droughty conditions. Regular applications of fertilizer and lime are needed. Controlled grazing is needed to maintain plant vigor.

The potential productivity of this soil for pine trees is moderate. Equipment limitations and seedling mortality are the main concerns in management. South Florida slash pine and sand pine are the preferred trees to plant.

This soil is moderately suited to desirable range plant production. The dominant forage is creeping bluestem, lopsided indiangrass, pineland threeawn, south Florida bluestem, and chalky bluestem. Management practices should include deferred grazing and brush control. Electra soil is in the South Florida Flatwoods range site.

This soil is very well suited to dwellings without basements, small commercial buildings, and local roads and streets. No corrective measures are needed. This soil has severe limitations for septic tank absorption fields and recreational uses. Water control measures are needed for septic tank absorption fields, and the proximity to a stream should be considered in its placement to prevent lateral seepage and pollution. The sandy surface layer should be stabilized for playground

use. This soil has severe limitations for trench sanitary landfills, shallow excavations, and sewage lagoons. Water control measures are needed. Sealing or lining of trench sanitary landfills and sewage lagoons with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored.

This Electra soil is in capability subclass VIs.

49—Pompano fine sand. This soil is nearly level and poorly drained. It is in sloughs and poorly defined drainageways. The mapped areas range from 10 to 100 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is 16 inches thick. The upper 3 inches of the surface layer is very dark gray fine sand. The lower 13 inches is dark grayish brown fine sand. The underlying material is fine sand to a depth of 80 inches or more. The upper 44 inches of the underlying material is light brownish gray; and the lower 20 inches or more is grayish brown.

Included with this soil in mapping are small areas of Immokalee, Holopaw, and Myakka soils. Also included are areas of soils that are similar to Pompano soil but have a weakly stained layer of organic matter at a depth of more than 20 inches and also some areas of Pompano soils that are occasionally flooded. The included soils make up less than 20 percent of the map unit.

In most years, under natural conditions, the water table is within a depth of 10 inches of the surface for 2 to 6 months. During the drier months, it is within a depth of 30 inches for more than 9 months each year. Some areas are subject to sheet flow during periods of high rainfall. Permeability is rapid, and the available water capacity is very low. Natural fertility and the organic matter content are low.

Most areas of this soil are in natural vegetation. The natural vegetation consists of south Florida slash pine, laurel oak, sawpalmetto, cabbage palm, blue maidencane, pineland threeawn, sand cordgrass, low panicums, and various weeds and grasses.

The suitability of this soil for citrus trees is fair, if a properly designed water control system is installed to maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of lime and fertilizers are needed.

Under natural conditions, this Pompano soil is poorly suited to cultivated crops because of wetness and sandy texture. The number of adapted crops that can be grown is limited if very intensive management practices are not followed. If good management practices are used, this soil has fair suitability for cropland. A water control system to remove excess water rapidly and provide for subsurface irrigation is necessary. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

This soil has good suitability for pasture and hay crops. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizer and lime, and controlled grazing.

The potential productivity of this soil for pine trees is moderate. Equipment limitations and seedling mortality are the main concerns in management. Water control measures are necessary to remove excess surface water. South Florida slash pine is the best adapted specie to plant.

This soil is well suited to desirable range plant production. The dominant forage consists of blue maidencane, chalky bluestem, and blue joint panicum. Management practices should include deferred grazing. Pompano soil is in the Slough range site.

This soil has severe limitations for sanitary facilities, building site development, and recreational uses. Water control measures are needed to overcome excessive wetness. Septic tank absorption fields may need to be enlarged because of wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored. Water control measures are needed.

This Pompano soil is in capability subclass IVw.

50—Pits. This map unit consists of open excavations from which soil and shell fragments have been removed for use as fill material when constructing roads and streets and for building site development. Most areas of this map unit include mounds of waste material piled between the excavated overburden, unusable material, or fill material. This fill material will be used as needed. Some small areas that contain water are included. Pits are locally called borrow pits. They range in size from small to large.

Pits have not been assigned to a capability subclass.

51—Riviera fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 200 acres. Slopes are mostly concave, but a few slopes along slight ridges are smooth to convex. They range from 0 to 2 percent.

Typically, the surface layer is very dark gray fine sand about 2 inches thick. The subsurface layer extends to a depth of about 28 inches. The upper 23 inches of the subsurface layer is light gray fine sand, and the lower 3 inches is gray fine sand. The subsoil extends to a depth

of about 45 inches. The upper 3 inches of the subsoil is dark gray sandy clay loam that has intrusions and pockets of gray and dark gray fine sand. The lower 14 inches is olive gray sandy clay loam. The substratum to a depth of 80 inches or more is light olive gray sandy loam and loamy sand mixed with shell fragments.

Included with this soil in mapping are small areas of Wabasso, Chobee, Floridana, Holopaw, Manatee, Oldsmar, Pineda, and Winder soils. Also included are areas of soils that have a thin organic surface layer and also some Riviera soils that are flooded for about 1 to 3 months. These soils are in the south prong of Sebastian Creek. The included soils make up less than 15 percent of the map unit.

This Riviera soil is ponded for 6 to 9 months or more each year. The water table is within 10 inches of the surface for 2 to 4 months and between a depth of 10 and 40 inches for most of the remainder of the year. The available water capacity is very low in the surface and subsurface layers, moderate in the subsoil, and low to moderate in the substratum. Permeability is rapid in the surface and subsurface layers, slow to very slow in the subsoil, and slow to moderately rapid in the substratum. Natural fertility and the organic matter content are low.

Natural vegetation consists of blue maidencane, St.-Johnswort, scattered cypress trees, red maple, waxmyrtle, sand cordgrass, milkwort, white bracted sedge, pipewort, arrowhead, water hyacinth, and various other water-tolerant weeds and grasses.

This Riviera soil has poor suitability for cultivated crops. However, it has fair suitability for vegetable crops if a good water system is installed to protect the soil from ponding and to remove excess surface water rapidly. Good management practices include crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crops.

This soil has poor suitability for citrus trees. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizers are needed.

This soil has fair suitability for pasture and hay crops. Pangolagrass and improved bahiagrass grow well if proper water control measures are provided to remove excess surface water after heavy rains. Regular applications of fertilizer are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Riviera soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce seepage. Fill material is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Riviera soil is in capability subclass VIIw.

52—Oldsmar fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 4 to 30 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is black fine sand about 5 inches thick. The subsurface layer is gray and light gray fine sand to a depth of 35 inches. The subsoil extends to a depth of 65 inches or more. The upper 17 inches of the subsoil is black, dark reddish brown, and dark brown fine sand. The lower 13 inches is grayish brown sandy loam. Below that is light brownish gray loamy fine sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of EauGallie, Malabar, Pineda, Riviera, and Floridana soils. Also included are soils that are similar to Oldsmar soil but have a muck or mucky fine sand surface layer less than 15 inches thick and also a few small areas of soils that have a sandy subsoil that is not as well developed as that in Oldsmar soil. These soils also are lighter colored rather than the typical black color. The included soils make up less than 20 percent of the map unit.

This Oldsmar soil is ponded for 6 to 9 months or more each year. The water table is within 10 inches of the surface for 2 to 4 months and between a depth of 10 and 40 inches for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers. It is moderate to moderately rapid in the sandy upper part of the subsoil and slow in the loamy lower part. The available water capacity is very low in the surface and subsurface layers and medium in the subsoil. Natural fertility and the organic matter content are low.

Natural vegetation consists of blue maidencane, broomsedge, St.-Johnswort, bulrush, pipewort, ferns, pickerelweed, white bracted sedge, and various other

water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

This Oldsmar soil is not suited to cultivated crops because of ponding. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil has fair suitability for vegetable crops. Good management practices include crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. It has poor suitability even if intensive practices are used and the water control system is adequate.

Under natural conditions, this soil is not suited to pasture. However, this soil has fair suitability for improved pasture if very intensive management practices and soil improving measures are used and a water control system is installed. Pangolagrass and improved bahiagrass grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of fertilizer and lime are needed. Grazing should be controlled to maintain plant vigor.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations, seedling mortality, and plant competition are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. This soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Oldsmar soil is in capability subclass VIIw.

53—Manatee mucky loamy fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 50 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is black mucky loamy fine sand about 8 inches thick. The subsoil extends to a depth of about 42 inches. The upper 16 inches of the subsoil is black sandy loam that has few dark grayish brown fine sand splotches. The lower 18 inches is very dark gray sandy loam. Below that is dark grayish brown loamy fine sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Chobee, Floridana, Holopaw, Malabar, Pineda, Riviera, Samsula, and Winder soils. Also included are soils that are similar to this Manatee soil but have a muck surface layer more than 15 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months or more during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is moderately rapid in the surface layer and moderate in the subsoil and underlying material. The available water capacity is low to medium throughout. Natural fertility is medium, and the organic matter content is high.

Natural vegetation consists of sawgrass, blue maidencane, pickerelweed, red maple, cypress, scattered waxmyrtle, sedges, ferns, and other water-tolerant grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

This Manatee soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil has fair suitability for many vegetable crops. Important management practices are seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. It has poor suitability even if intensive management practices, such as bedding of rows, are used and the water control system is adequate.

This soil has poor suitability for improved pasture. Intensive management practices and soil improving measures should be used and a water control system should be installed to remove excess surface water rapidly. Pangolagrass and improved bahiagrass grow well if properly managed. Water control measures are needed to remove the excess surface water after heavy rains. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

This soil generally is not used for woodland because of wetness.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Manatee soil is in the Freshwater Marshes and Ponds range site.

Ponding is a severe limitation for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Fill material is needed for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored, and water control measures are needed. Mounding may be needed for septic tank absorption fields.

This Manateee soil is in capability subclass VIIw.

54—Riomar clay loam. This soil is nearly level and very poorly drained and is frequently flooded. It is in mangrove swamps adjacent to the Indian River. This soil formed in loamy or clayey tidal deposits that are underlain by limestone. Tidal water inundates most of these areas at high tide. Some areas in the counties have been leveled off and are used as mosquito control structures. Individual mapped areas range from 10 to 260 acres. Slopes are less than 1 percent.

Typically, the surface layer is very dark gray clay loam that has few to common pockets of very dark grayish brown muck about 8 inches thick. The substratum extends to a depth of about 25 inches but can range from 20 to 40 inches. The upper 7 inches of the substratum is very dark gray clay loam. The lower 10 inches is dark greenish gray sandy clay. Below that is hard limestone bedrock that has few to common solution holes. The upper 15 inches of the soil in the bedrock is very fluid when squeezed in the hand, and the lower 10 inches is slightly fluid.

Included with this soil in mapping are small areas of McKee soils. Also included are a few areas of soils that have limestone bedrock between a depth of 40 and 80 inches and a few areas of soils that have limestone at a depth of less than 20 inches. Also included are soils that have a high content of sand and some small areas of soils that have been affected by drainage. These soils do not behave as fluid when subjected to pressure. The included soils make up less than 20 percent of the map unit.

Riomar soil remains saturated. Soil strength is low. The water content can be as high as 80 percent at field condition. Fluctuating tides overwash the surface layer twice daily. Permeability is very slow to slow, and the available water capacity is very high in the upper 15 inches of the substratum and high in the lower 10 inches. Natural fertility is high for saltwater-tolerant plants. The organic matter content is very high.

The native vegetation consists of red, black, and white mangrove trees, and in some areas, it consists of sea rocket, saltwort, perennial glasswort, seashore saltgrass, and seashore paspalum. The red mangroves, which have an extensive prop root system and shed floating seed pods, are mainly along the river's edge and along ditches where tidal water is deeper. The black and white mangroves, which propagate by sending up pneumatophores or erect extensions of their root systems above the soil surface, are mainly on slightly higher elevations.

Because of tidal flooding and low soil strength, this Riomar soil is not suited to cropland, citrus, improved pasture, or woodland. Drainage of these soils would probably cause them to become so acid that they could not support much plant growth. However, if accessible by an elevated road or levee, this soil is well suited to beekeeping for mangrove honey production.

This soil generally is not used for rangeland. Riomar soil is in the Mangrove Swamps ecological plant community.

This soil is not suited to urban use because of tidal flooding and low soil strength.

This soil is in mangrove swamps, which are unique and biologically productive areas that are very important to many species of fish and wildlife. Many sport and commercial finfish, shellfish, and other crustaceans use these areas as spawning grounds and nurseries. Offshore birds use these areas as rookeries and feeding grounds. Mangrove swamps also serve as protective barriers in estuaries against excessive wave action during tropical storms.

This Riomar soil is in capability subclass VIIIw.

55—Floridana mucky fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 100 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is about 19 inches thick. The upper 14 inches of the surface layer is black mucky fine sand, and the lower 5 inches is very dark gray fine sand. The subsurface layer is grayish brown sand to a depth of 35 inches. The subsoil extends to a depth of about 50 inches. The upper 9 inches of the subsoil is dark grayish brown sandy clay loam, and the lower 6 inches is dark grayish brown sandy loam. The substratum to a depth of 80 inches or more is grayish brown loamy fine sand.

Included with this soil in mapping are small areas of Chobee, Manatee, Riviera, Holopaw, Winder, and Samsula soils. Also included are soils that are similar to Floridana soil but have a muck surface layer that is more than 15 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers and slow to very slow in the subsoil. The available water capacity is medium in the surface layer, subsoil, and substratum and low in the subsurface layer. Natural fertility is medium, and the organic matter content is high.

Natural vegetation consists of sand cordgrass, maidencane, St.-Johnswort, scattered waxmyrtle, and other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

This Floridana soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. However, even if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil still has poor suitability for many vegetable crops. Important management practices are good seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suitable for citrus trees. However, citrus trees grow fairly well if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

In its natural state, this soil is not suited to improved pasture grasses. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass and improved bahiagrass grow well if properly managed. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

This Floridana soil generally is not used for woodland because of ponding and because a suitable drainage outlet is not available.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Floridana soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material to raise the level of the land surface is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Floridana soil is in capability subclass VIIw.

56—Pineda fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 4 to 50 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is grayish brown fine sand about 2 inches thick. The subsurface layer, to a depth of 11 inches, is light brownish gray fine sand. The subsoil extends to a depth of about 52 inches. The upper part of the subsoil, to a depth of 32 inches, is brownish yellow and light yellowish brown fine sand. The lower part is gray and greenish gray sandy loam that has light olive brown and olive brown mottles. Intrusions of light yellowish brown fine sand extend from the upper part of the subsoil into the sandy loam lower part. The substratum to a depth of 80 inches or more is greenish gray loamy fine sand.

Included with this soil in mapping are small areas of Floridana, Riviera, Malabar, Holopaw, Oldsmar, Wabasso, and Winder soils. The included soils make up less than 15 percent of the map unit.

This Pineda soil is ponded for 6 to 9 months or more each year. The water table is within 10 inches of the surface for 2 to 4 months and at a depth of 10 to 40 inches for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers. It is rapid in the upper part of the subsoil and slow or very slow in the lower part and moderately rapid in the substratum. The available water capacity is very low in the surface and subsurface layers. It is very low in the upper part of the subsoil and moderate in the lower part and very low in the substratum. Natural fertility and the organic matter content are low.

Natural vegetation consists of blue maidencane, broomsedge, St.-Johnswort, pipewort, white bracted sedge, milkwort, scattered waxmyrtle, sand cordgrass, cabbage palm, bluestems, and various other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

This Pineda soil is very poorly suited to cultivated crops. However, it is moderately well suited to vegetable crops if a water control system is installed to protect the soil from ponding and to remove excess surface water rapidly. Good management includes bedding of rows and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and

maintain organic matter. Fertilizer should be applied according to the need of the crop.

Under natural conditions, citrus trees are poorly suited to this soil. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting trees on beds lowers the effective depth of the water table. A close-growing cover crop sould be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

This soil has fair suitability to pasture and hay crops. Pangolagrass and improved bahiagrass grow well if properly managed. A water control system should be installed to remove excess surface water after heavy rains. Regular applications of fertilizer are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth to the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods of high water levels reduce the grazing value of the site. Pineda soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material to raise the level of the land surface is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Pineda soil is in capability subclass VIIw.

57—Holopaw fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 4 to 50 acres. Slopes are concave and are less than 1 percent.

Typically, the surface layer is dark gray fine sand about 8 inches thick. The subsurface layer is grayish brown fine sand to a depth of about 47 inches. The subsoil, to a depth of 65 inches, is dark gray and grayish brown sandy loam that has pockets of grayish brown fine sand. The substratum to a depth of 80 inches or more is olive gray loamy fine sand that has pockets of grayish brown fine sand.

Included with this soil in mapping are small areas of Floridana, Manatee, Malabar, Pineda, and Riviera soils. Also included are soils that are similar to Holopaw soil but have a muck or mucky fine sand surface layer less than 15 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months or more each year. The water table is within 10 inches of the surface for 2 to 4 months and between a depth of 10 and 40 inches for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers and is moderately slow to moderate in the subsoil. The available water capacity is low to very low in the surface and subsurface layers, medium in the subsoil, and low in the substratum. Natural fertility and the organic matter content are low.

Natural vegetation consists of blue maidencane, broomsedge, St.-Johnswort, waxmyrtle, panicums, sand cordgrass, white bracted sedge, pipewort, stiff paspalum, and various other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this Holopaw soil is not suited to cultivated crops. However, even if a complete water control system is installed to protect the soil from ponding and to remove excess water rapidly, this soil still has poor suitability for vegetable crops. Good management practices include crop rotation and use of soil improving crops and crop residue to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

This soil has poor suitability for citrus trees. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be planted between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

This soil has fair suitability for pasture and hay crops. Pangolagrass and improved bahiagrass grow well if properly managed. A water control system should be installed to remove excess surface water after heavy rains. Regular applications of fertilizer are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Seedling mortality, plant competition, and equipment limitations are concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Holopaw soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material to raise the level of the land surface is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Holopaw soil is in capability subclass VIIw.

58—Samsula muck. This soil is nearly level and very poorly drained. It is in depressions, poorly defined drainageways, and freshwater marshes and swamps. The mapped areas range from 3 to 150 acres. Slopes are concave and are less than 2 percent.

Typically, the surface layer is about 38 inches thick. The upper 20 inches of the surface layer is black, well decomposed muck, the next 6 inches is very dark gray muck, and the lower 12 inches is very dark gray sand. The underlying material is gray sand to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Delray, Floridana, Myakka, and Pompano depressional soils. Also included are soils that are similar to Samsula soil but have a muck surface layer that is less than 15 inches thick or have pockets of muck in the upper part of the mineral layer. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is rapid throughout. Internal drainage is slow and is inhibited by the water table. The available water capacity is very high in the organic material and very low in the underlying sand. Natural fertility is medium, and the organic matter content is very high.

Most areas of this soil are in natural vegetation consisting of cypress, red maple, St.-Johnswort, sawgrass, pickerelweed, sedges, maidencane, ferns, and other water-tolerant grasses. Areas of this soil provide cover for deer and excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this Samsula soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil has fair suitability to some vegetable crops. A properly designed and maintained water control system removes the excess water when crops are on the soil and keeps the soil saturated at all other times. Good management practices include seedbed preparation and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. It has poor suitability even if intensive management practices, such as bedding of rows, are used and the water control system is adequate.

In its natural state, this soil has poor suitability for improved pasture grasses. However, if a water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. The water control system should maintain the water table near the surface to prevent excess subsidence of the organic material. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

This soil is not suited to pine trees.

This soil generally is not used for rangeland. Samsula soil is in the Cypress Swamp ecological plant community.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses because of ponding and excess humus. Water control measures are needed to overcome excessive wetness. Organic materials need to be removed and backfilled with suitable soil material for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored. Water control measures are needed. Mounding may be needed for septic tank absorption fields.

This Samsula soil is in capability subclass VIIw.

59—Lokosee fine sand. This soil is nearly level and poorly drained. It is in poorly defined drainageways and on low hammocks and low, broad flats adjacent to the flatwoods. The mapped areas range from 20 to 300 acres. Slopes are smooth to concave and range from 0 to 2 percent.

Typically, the surface layer is black fine sand about 3 inches thick. The subsurface layer is grayish brown fine sand to a depth of about 10 inches. The subsoil extends to a depth of 80 inches or more. The upper 19 inches of the subsoil is mottled very pale brown and brownish yellow sand, the next 16 inches is strong brown and very pale brown sand. The next 10 inches is dark brown sand, and the next 25 inches is light brownish gray and pale brown sand. Below that is greenish gray sandy clay loam.

Included with this soil in mapping are small areas of Malabar, Holopaw, Pineda, Riviera, Oldsmar, and EauGallie soils. Also included are areas of soils that do not have a light colored subsurface layer or a light colored subsoil between the weakly stained layer and the argillic horizon, areas of soils that have pockets or intrusions of overlying sandy material that extend into the

argillic horizon, and some areas of soils that have a calcareous layer below the subsurface layer. The included soils make up less than 15 percent of the map unit.

The water table is within a depth of 10 inches of the surface for 2 to 4 months and between a depth of 10 to 40 inches for more than 6 months. During extended dry seasons, it recedes to a depth of more than 40 inches. The available water capacity is low in the surface and subsurface layers. It is low in the upper part of the subsoil and moderate in the lower part. Permeability is rapid in the surface and subsurface layers. It is rapid in the upper part of the subsoil and slow or very slow in the lower part. Natural fertility and the organic matter content are low.

A large part of the acreage has been cleared and is in improved pasture or citrus. Natural vegetation consists of scattered slash pine, cabbage palm, inkberry, waxmyrtle, scattered sawpalmetto, blue maidencane, pineland threeawn, sand cordgrass, chalky bluestem, creeping bluestem, low panicums, and various weeds and grasses.

This Lokosee soil has poor suitability for cultivated crops. However, it has fair suitability for vegetable crops if a water control system is installed to remove excess water rapidly and to provide for subsurface irrigation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Seedbed preparation should include bedding of rows. Fertilizer should be applied according to the need of the crop.

This soil has fair suitability for citrus trees if a properly designed water control system is installed to maintain the water table at a depth of about 4 feet. Planting the trees on beds provides good surface drainage. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

This soil has good suitability for pasture and hay crops. Pangolagrass, improved bahiagrasses, and clover grow well if properly managed. Management practices should include a water control system to remove excess surface water after heavy rains, regular applications of fertilizer, and controlled grazing.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are needed to remove excess surface water. Equipment limitations and seedling mortality are the main concerns in management.

This soil is well suited to desirable range plant production. The dominant forage is creeping bluestem, chalky bluestem, and blue maidencane. Management practices should include deferred grazing and brush control. Lokosee soil is in the Cabbage Palm Flatwoods range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses. Water control measures and fill material are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Mounding may be needed for septic tank absorption fields. The sandy surface layer should be stabilized for recreational uses. Sidewalls of shallow excavations should be shored.

This Lokosee soil is in capability subclass IVw.

60—Pompano fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 100 acres. Slopes are concave and range from 0 to 1 percent.

Typically, the surface layer is black fine sand about 6 inches thick. The underlying material extends to a depth of 80 inches or more. The upper 4 inches of the underlying material is gray fine sand that has few to common dark gray splotches and streaks, and the lower 70 inches or more is gray fine sand.

Included with this soil in mapping are small areas of Myakka and Manatee soils. Also included are small areas of soils that are similar to Pompano soil but have an organic surface layer up to 10 inches thick and also small areas of soils that have a weakly stained layer of organic material at a depth of more than 20 inches. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is rapid throughout. The available water capacity is very low. Natural fertility and the organic matter content are low.

Natural vegetation consists of baldcypress, scattered cabbage palm, red maple, waxmyrtle, Carolina willow, St. Johnswort, maidencane, stiff paspalum, sedges, and other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. Even if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil still has poor suitability for vegetable crops. Good management practices are seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. It has poor suitability even if intensive management practices, such as bedding of rows, are used and the water control system is adequate.

In its natural state, this soil has poor suitability for improved pasture grasses. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Controlled grazing is needed.

The potential productivity of this soil for pine trees is moderate. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations and seedling mortality are the main concerns in management.

This soil generally is not used for rangeland. Pompano soil is in the Cypress Swamp ecological plant community.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses because of ponding. Water control measures are needed to overcome excessive wetness. Fill material to raise the level of the land surface is needed for urban use. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Sidewalls of shallow excavations should be shored. Water control measures are needed. Mounding may be needed for septic tank absorption fields.

This Pompano soil is in capability subclass VIIw.

61—Delray muck. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 200 acres. Slopes are concave and are less than 2 percent.

Typically, the surface layer is about 21 inches thick. The upper 3 inches of the surface layer is black muck, the next 14 inches is black fine sand, and the lower 4 inches is very dark grayish brown sand. The subsurface layer, to a depth of 45 inches, is very dark grayish brown and grayish brown sand. The subsoil is dark grayish brown sandy clay loam to a depth of 52 inches. The substratum to a depth of 80 inches or more is gray sandy loam.

Included with this soil in mapping are small areas of Floridana, Holopaw, and Oldsmar depressional soils. Also included are soils that are similar to Delray soil but do not have a muck surface layer or do not have pockets of muck throughout the surface layer and also an area of soils that have a muck surface layer that is more than 15 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is rapid in the surface and subsurface layers and moderate to moderately rapid in the subsoil. The available water capacity is medium in the surface layer and subsoil and low in the subsurface layer. Natural fertility is medium, and the organic matter content is high.

Natural vegetation consists of cypress, pickerelweed, maidencane, arrowhead, sand cordgrass, sedges, rushes, ferns, and other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this Delray soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. Even if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly, this soil still has poor suitability for many vegetable crops. Good management practices are seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. However, the suitability for citrus trees is fair if intensive management practices and soil improving measures are used and a water control system is installed to remove excess water rapidly. A water control system that maintains good drainage to a depth of about 4 feet is needed. Planting the trees on beds lowers the effective depth of the water table. A close-growing cover crop should be maintained between tree rows to protect the soil from blowing. Regular applications of fertilizer are needed.

In its natural state, this soil is not suited to improved pasture grasses. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

The potential productivity of this soil for pine trees is moderately high. South Florida slash pine is the best adapted specie to plant. Water control measures are necessary before trees can be planted. Equipment limitations, plant competition, and seedling mortality are the main concerns in management.

This soil is moderately suited to desirable range plant production. The dominant forage is maidencane and cutgrass. Because the depth of the water table fluctuates throughout the year, a natural deferment from grazing occurs. This rest period increases forage production, but these periods during high water levels reduce the grazing value of the site. Delray depressional soil is in the Freshwater Marshes and Ponds range site.

This soil has severe limitations for building site development, sanitary facilities, and recreational uses.

Water control measures are needed to overcome excessive wetness. Sealing or lining of sewage lagoons and trench sanitary landfills with impervious soil material can reduce excessive seepage. Fill material to raise the level of the land surface is needed for septic tank absorption fields, local roads and streets, and small commercial buildings and for playground use. Sidewalls of shallow excavations should be shored. Mounding may be needed for septic tank absorption fields.

This Delray soil is in capability subclass VIIw.

62—Chobee mucky loamy fine sand, depressional. This soil is nearly level and very poorly drained. It is in depressional areas. The mapped areas range from 5 to 100 acres. Slopes are concave and range from 0 to 1 percent.

Typically, the surface layer is 5 inches of black mucky loamy fine sand. The subsoil extends to a depth of about 42 inches. The upper 5 inches of the subsoil is black sandy clay loam, the next 18 inches is very dark gray sandy clay loam that has few medium pockets of loamy sand, and the lower 14 inches is dark gray sandy clay loam that has few grayish brown and very dark gray streaks and splotches. The substratum extends to a depth of 80 inches or more. The upper 8 inches of the substratum is greenish gray sandy loam that has gray and dark gray mottles and streaks along root channels. The lower 30 inches or more is greenish gray loamy sand that has few dark gray streaks along root channels and few light gray shell fragments.

Included with this soil in mapping are small areas of Floridana and Manatee depressional soils. Also included are small areas of soils that are similar to Chobee soil but have an organic surface layer that generally is 2 to 4 inches thick but in a few places it can be up to 10 inches thick. The included soils make up less than 20 percent of the map unit.

This soil is ponded for 6 to 9 months during most years. The water table is within 10 inches of the surface for most of the remainder of the year. Permeability is rapid in the surface layer, moderately slow to very slow in the subsoil, and moderately rapid in the substratum. The available water capacity is high in the surface layer and moderate in the subsoil and substratum. Natural fertility and the organic matter content are high.

Natural vegetation consists of red maple, cabbage palm, scattered cypress, sawgrass, waxmyrtle, Carolina willow, ferns, sedges, pickerelweed, greenbrier, and other water-tolerant weeds and grasses. Areas of this soil provide excellent habitat for wading birds and other wetland wildlife.

Under natural conditions, this Chobee soil is not suited to cultivated crops because of ponding. Most areas do not have a suitable drainage outlet, which makes an adequate drainage system difficult to establish. However, if intensive management practices and soil improving measures are used and a water control system is installed to remove excess surface water rapidly, this soil has fair suitability for many vegetable crops. Good management practices are seedbed preparation, including bedding of rows, and crop rotation. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter. Fertilizer and lime should be applied according to the need of the crop.

In the natural state, this soil is not suited to citrus trees. It has poor suitability even if intensive management practices, such as bedding of rows, are used and the water control system is adequate.

In its natural state, this soil has poor suitability for improved pasture grasses. However, if an adequate water control system is installed to remove excess surface water after heavy rains, suitability is fair. Pangolagrass, improved bahiagrass, and white clover grow well if properly managed. Regular applications of fertilizer and lime are needed. Overgrazing should be prevented.

This soil is not suited to pine trees. The potential productivity is very low for this use.

This soil generally is not used for rangeland. Chobee soil is in the Swamp Hardwoods ecological plant community.

Ponding is a severe limitation to use of this soil for building site development, sanitary facilities, and recreational uses. Water control measures are needed to overcome excessive wetness. Fill material to raise the level of the land surface is needed for many urban uses. Sidewalls of shallow excavations should be shored. Water control measures should be used. Mounding may be needed for septic tank absorption fields.

This Chobee soil is in capability subclass VIIw.

63—Kesson muck. This soil is nearly level and very poorly drained and is frequently flooded. It is in tidal swamps and marshes. This soil formed in thick marine deposits of sand and shell fragments. These swamps and marshes are at or near sea level and are adjacent to the Indian River. Tidal water inundates most of these areas at high tide. Some areas of this soil have been leveled off and are used as mosquito control structures. Individual mapped areas range from 20 to 100 acres. Slopes are less than 1 percent.

Typically, the surface layer is about 6 inches thick. It is dark reddish brown muck that is about 30 percent unrubbed fiber and less than 5 percent rubbed. The underlying material is grayish brown and dark greenish gray fine sand mixed with about 15 to 25 percent sand-size shell fragments to a depth of 80 inches or more.

Included with this soil in mapping are small areas of Pompano, Captiva, and McKee soils. Also included are soils that are similar to Kesson soil but have an organic surface layer 8 to 15 inches thick. The included soils make up less than 15 percent of the map unit.

Under natural conditions, this soil is flooded during normal high tides. Permeability is moderately rapid. The available water capacity is high in the surface layer and low in the underlying materials. Natural fertility is high for saltwater-tolerant plants. The organic matter content is high.

The native vegetation consists of red, black, and white mangroves. In some areas are searocket, saltwort, perennial glasswort, seashore saltgrass, and seashore paspalum.

Because of tidal flooding, Kesson soil is not suited to cropland, citrus, improved pasture, rangeland, or woodland. Kesson soils are in the Mangrove Swamps ecological plant community.

This soil is in mangrove swamps, which are unique and biologically productive areas that are very important to many species of fish and wildlife. Many sport and commercial finfish, shellfish, and other crustaceans use these areas as spawning grounds and nurseries. Birds use these areas as rookeries and feeding grounds. Mangrove swamps also serve as protective barriers in estuaries against excessive wave action during tropical storms.

This soil is not suited to urban use because of tidal flooding.

This Kesson soil is in capability subclass VIIIw.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern that is in harmony with nature.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 132,000 acres in Indian River County was used for crops and pasture in 1983 *(7)*. Of this total, about 63,000 acres was planted to citrus, mainly oranges and grapefruit. Small acreages of tangelos and tangerines also were grown. Of the total acreage in the county, about 62,000 acres was used for improved pasture. About 7,000 acres was used for various crops, such as field corn, sorghum, soybeans, and rice. Some small areas were planted to sweet corn, cabbage, tomatoes, melons, strawberries, and nursery plants.

The western and northern parts of the county are generally well suited to increased citrus and vegetable production. Approximately 150,000 acres of potentially good cropland is presently used for pasture, native range, and woodland. Conversion of this land to crops would require overcoming serious limitations or hazards, such as wetness, rapid permeability, and low natural fertility. A water control system to remove excess water in wet seasons and also to provide water through subsurface irrigation in dry seasons is needed if citrus and vegetable crops are to be grown. In addition, by implementing the latest crop production technology along with the information provided by this soil survey, food production would be increased on all cropland in the survey area.

Although the potential for increased food production exists in Indian River County, several factors must also be considered in selecting crops and growing sites. Among these factors are the economic conditions, the risk of possible adverse weather conditions, the availability of suitable drainage outlets, the availability of an adequate supply of freshwater for irrigation, and environmental considerations. The environmental considerations include possible pollution of nearby waters and the desirability of planners and developers to use the land for urban use.

While considering the possibilities of increasing food production in the county, knowledge of soils and soil properties is necessary. Some of the major soil properties that should be considered are water and wind erosion, wetness, soil fertility, and tilth.

Soil erosion is mainly a hazard on disturbed soil in areas where development for urban use or farming operations occur. Soil erosion by water during intense storms lowers the productivity of the soil by washing away the more fertile topsoil. It also increases the pollution of streams by sediment, which, as an end result, detracts from the quality of water for municipal use, for recreational uses, and for use as habitat for fish and wildlife. Erosion control practices include the use of a protective surface cover to reduce runoff and increase infiltration by mulching and by temporarily seeding of vegetation.

Wind erosion is a major problem on the sandy soils and on the muck soils in the survey area. Wind erosion reduces soil fertility by removing fine soil particles and organic matter; damages crops and young citrus trees by sandblasting; spreads diseases, insects, and weed seeds; creates health hazards and cleaning problems in urban areas that have been cleared of vegetation; and lowers air quality. Maintaining a vegetative cover and surface mulching minimize soil blowing.

Clearing and disturbing only the minimum area needed for work and improvements, mulching, seeding, and using cover crops reduce soil and wind erosion. Information about erosion control practices for each kind of soil is available from the local office of the Soil Conservation Service.

Soil drainage is a major concern in management on most soils that are presently used for crops and pasture. Under natural conditions, approximately 75 percent of the soils in the county is either poorly drained or very poorly drained. Some soils, such as Floridana, Chobee, and Manatee soils, are naturally so wet that the growing of crops or pasture is generally not feasible without extensive water control systems. However, if a good water control system is installed to remove excess water rapidly, these wet soils are moderately suited to many vegetable crops and improved pasture. In addition, many of the poorly drained soils, such as Myakka, Riviera, and Immokalee soils, have a sandy surface layer and a low available water capacity and are droughty during dry periods. In managing these soils, a water control system is needed to remove excess water in wet periods and provide water through subsurface irrigation in dry periods. The design of the drainage and irrigation system varies according to the kind of soil and to the kinds of crops and pasture that are to be grown on the soil.

Successful citrus production, which is extensively practiced on the poorly drained soils throughout the county, requires intensive management. To maintain the water table at a depth of about 4 feet, a water control system is needed. Also, planting trees on beds is an effective way to lower the water table. Management practices, such as flood irrigation and low volume or drip irrigation, should be used on poorly drained soils during dry periods, and also these practices should be used to protect against frost damage.

Some soils, such as Pepper soils, have a weakly cemented subsoil; and some, such as Winder soils, have a shallow, loamy subsoil. These subsoils act as restricting layers and impede the movement of water through the soil. The wet soils that have a weakly cemented subsoil or a shallow, loamy subsoil often remain wet long after the wet period. A cemented subsoil or other impervious layer can be a severe limitation to soil drainage, which is required for most uses, but it can be used to advantage to maintain a shallow water table, which is required for specific crops.

Organic soils, such as Terra Ceia and Gator soils, need special drainage and irrigation systems to prevent the oxidation and subsidence of these soils. These systems are needed to keep the water table at the highest practical level for the crop, for tilling during the growing season, and for raising the water table to the surface the remainder of the time. Information about a water control system designed for each kind of soil is available from the local office of the Soil Conservation Service.

Soil fertility is naturally low in most of the soils in the county. The dark surface mineral soils, such as Chobee, Delray, Floridana, and Jupiter soils, have more organic matter and more plant nutrients. Organic soils, such as Terra Ceia and Gator soils, require special fertilizers because they are low in copper, selenium, and other trace elements.

Many of the soils in the county have a surface layer that is naturally strongly acid. Applications of lime are required to raise the pH level sufficiently if clover and other crops that need neutral pH are grown on these strongly acid soils. The level of nitrogen, available phosphorus, and potash are naturally low in most of the mineral soils. On all the soils, additions of lime and fertilizer should be based on the results of soil tests, on crop-growth requirements, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth refers to the condition of the soil in relation to plant growth. It is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular, porous, and easily cultivated. Most of the mineral soils in the county have a sandy surface layer that is light in color and low in organic matter. Generally, the structure of the surface layer of such soils is weak, or the soils are structureless. If the soil becomes very dry, a slight crust tends to form on the surface, which impedes the rate of infiltration and increases runoff. Regular additions of crop residue and other organic material improve soil structure. Soil improving crops and crop residue should be used to protect the soil from erosion and maintain organic matter.

Pastures in the county are used to produce forage for beef cattle, cow-calf operations, and dairy cattle. The

major perennial pasture grass grown in the county consists primarily of improved bahiagrass. A mixture of white clover and improved bahiagrass is also grown in the area. Some farmers overseed rye on bahiagrass pastures in the fall for winter and spring grazing.

Differences in the amount and kind of pasture yields are closely related to the kind of soil. Effective pasture management should include maintaining adequate moisture levels in droughty soils; water control measures to remove excess surface water after heavy rains on soils with a high water table; regular applications of lime and fertilizers; and pasture rotation to prevent overgrazing. Table 5 shows, for each kind of soil, the estimated annual production of forage in animal-unit months for the major forage plants presently grown in the survey area.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for use as cropland. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major, and generally expensive, landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals III through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *w* or *s* to the class numeral, for example, IIe. The letter *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage), and *s* shows that the soil is limited mainly because it is shallow, droughty, or stony.

The soils in class V are subject to little or no erosion, but they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation. Class V contains only the subclasses indicated by *w* or *s*.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Clifford W. Carter and Greg Hendricks, range conservationists, Soil Conservation Service, assisted in preparing this section.

Native grasses, forbs, and browse plants from rangeland are an important resource to livestock producers in Indian River County. This forage is readily available. It is economical and provides important roughage needed by cattle. There are approximately 65,301 acres of rangeland in Indian River County, or about 21 percent of the survey area. Most of this range acreage is in the western one-half and northern one-third of the county.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil, the range site and the total annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. Potential production refers to the amount of herbage that can be expected to grow on a well managed range site. Yields are expressed in table 7 in terms of pounds of air-dry herbage per acre for range in excellent condition in favorable, average, and unfavorable years. Favorable years are those in which climatic factors, such as rainfall and temperature, are favorable for plant growth. Moisture content in the plants varies as the growing season progresses and is not a measure of productivity. Herbage refers to total vegetation produced and does not reflect forage value or grazing potentials. Explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. Total production includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants, but it does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an average year, growing conditions are about normal. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Range Sites

A range site has the potential to support a native plant community typified by an association of species different from that of other range sites. The differentiation is based upon significant differences in kind of species or total productivity. Each site has significant differences in the kinds and amounts of native plant vegetation it produces, and each requires different management.

The vegetation that originally grew on a range site is called the native plant vegetation. It generally is the most productive and most suitable vegetation for livestock on that particular site, and it maintains itself as long as the environment does not change.

The native plant vegetation consists mainly of three kinds of plants—decreasers, increasers, and invaders. *Decreasers* generally are the most palatable native plants, and they decrease in abundance if the range is under continuous heavy grazing. *Increasers* are plants less palatable to livestock; they increase for a while under continued heavy grazing, but are finally eliminated. *Invaders* are plants native to the site in small amounts, but they have little value for forage. These invaders tend

to increase as the range site deteriorates from excessive grazing over a period of years.

Range condition is a measure of the current productivity of the range in relation to its potential. Four condition classes are used to measure range condition. These are—

- Excellent condition—Producing 76 to 100 percent of the potential
- Good condition—Producing 51 to 75 percent of the potential
- Fair condition—Producing 26 to 50 percent of the potential
- Poor condition—Producing 0 to 25 percent of the potential

Only about 15 percent of the natural vegetative communities are in excellent condition for use as range in Indian River County. The amount that is in fair and poor condition is estimated at about 60 percent.

The productivity of the range sites is closely related to the natural drainage of the soil and to the soils' fertility. The wettest soils, such as those in marshes and sloughs, produce the most vegetation. The deep, droughty soils of the sand ridges normally produce the least amount of herbage annually.

All sites tend to be slightly wetter in this county than they are in more northern counties. The wetness has some adverse effects on livestock health and mobility. However, these conditions are offset by the increased grass production, resulting from additional moisture.

Management of the range sites should be planned with the potential productivity in mind. Sites with the highest production potential should be given highest priority if economic considerations are important. Major management considerations revolve around livestock grazing—the length of time that the sites are grazed, the time of the year that they are grazed, and the length of time and the season that the sites are rested. Other management considerations are the grazing pattern of livestock within a pasture that contains more than one range site and the palatability of the dominant plants within the site. Manipulation of a range site often involves mechanical brush control, controlled burning, and especially controlled livestock grazing. Predicting the effects of these practices on range sites is important. Proper management results in maximum sustained production, conservation of the soil and water resources, and improvement of the habitat for many wildlife species.

There are six range sites in Indian River County that are important to the livestock industry. Also in the county are several other sites or ecological plant communities, but they have little livestock use. The most important in terms of acreage are the South Florida Flatwoods and the Slough range sites. A brief description of these six range sites follows.

South Florida Flatwoods—This range site consists of nearly level areas. Scattered to numerous pine trees are common, and sawpalmetto, inkberry and other woody plants also are scattered throughout. This range site produces an abundant quantity of grasses. Creeping bluestem is the dominant grass with significant amounts of indiangrass, chalky bluestem, panicum, and pineland threeawn. As these grasses deteriorate because of uncontrolled livestock grazing and annual burning, sawpalmetto and pineland threeawn increase significantly. Because of their higher palatability, bluestem, panicum, and indiangrass decrease. If the range site is in excellent condition, annual production is approximately 6,000 pounds of air-dry herbage per acre in favorable growth years to 3,000 pounds per acre in unfavorable growth years. The relative percentages of total annual production in excellent condition are approximately 75 percent grasses and grasslike plants, 10 percent forbs, and 15 percent woody plants and trees. Boca, EauGallie, Electra, Immokalee, Myakka, Oldsmar, Pepper, and Wabasso soils are included in this range site.

Slough—This range site consists of open grassland where nearly level areas act as broad natural drainage courses in the flatwoods. The potential plant community is dominated by blue maidencane, chalky bluestem, and toothache grass. These grasses are all readily grazed by livestock. If overgrazing continues for prolonged periods, carpetgrass, pineland threeawn, and sedges replace the better grasses. Average annual production of air-dry plant material from all sources varies from about 8,000 pounds per acre in areas that are in excellent condition in favorable growing years to approximately 4,000 pounds per acre in unfavorable years. If range conditions are excellent, the annual vegetation production is approximately 85 percent grasses and grasslike plants, 15 percent forbs, and a few woody plants and trees. Chobee, Holopaw, Pineda, and Pompano soils are included in this range site.

Freshwater Marshes and Ponds—This range site is an open grassland marsh or pond. It has potential for producing significant amounts of maidencane and cutgrass. The water level fluctuates throughout the year. During periods of high water, there is a natural deferment from livestock grazing. This site is a preferred grazing area, but prolonged overgrazing causes deterioration of the vegetative community. Overgrazing causes pickerelweed to increase, and, in some places, causes sawgrass to increase. Prolonged overgrazing causes buttonbush, willows, and waxmyrtle to increase. If in excellent condition, the fresh marshes and ponds sites are capable of producing in excess of 10,000 pounds of air-dry material per acre in favorable growing years. Production in unfavorable growing years is approximately 5,000 pounds per acre. If the site is in excellent condition, the annual vegetative production is approximately 80 percent grasses and grasslike plants, 15 percent forbs, and 5 percent woody plants and trees. Canova, Delray, Floridana, Floridana depressional, Holopaw depressional, Manatee, Manatee depressional,

Myakka depressional, Oldsmar depressional, Pineda depressional, and Riviera depressional soils are included in this range site.

Cabbage Palm Hammocks—This range site is on nearly level, slightly higher "islands" in broad nearly level areas. The areas are generally 1 to 5 acres, and they are scattered throughout the landscape. The site has low potential for producing forage plants because of a dense canopy of cabbage palm trees. These are preferred shading and resting areas for cattle and, as such, are usually severely denuded. Creeping bluestem and beaked panicum are the dominant grasses when the site is in excellent condition. In a deteriorated state, however, carpetgrass and several threeawn species dominate the understory. Because of reduced sunlight, the photosynthectic process is not able to produce adequate plant sugars; therefore, desirable forage plants that grow in shaded areas lose much of their palatability. This plant community is preferred as a resting area and is rarely used as a grazing area. If in excellent condition, the Cabbage Palm Hammocks site is capable of producing 3,500 pounds of air-dry material in favorable growing years. Production in unfavorable years is only about 1,500 pounds per acre. If the site is in excellent condition, the annual production is approximately 55 percent grasses and grasslike plants, 20 percent forbs, and 25 percent woody plants and trees. Winder and Jupiter soils are included in this range site.

Sand Pine Scrub—This range site is on high dunelike sand ridges. It has limited potential for producing native forage plants. This site supports a fairly dense stand of sand pine and a dense, woody understory. Livestock do not use this site if other range sites are available. Principal forage plants are bluestems, indiangrass, and panicum. Numerous legumes and forbs grow in these areas. Average annual production of air-dry plant material from all sources varies from approximately 3,500 pounds per acre in areas that are in excellent condition in favorable growing years to approximately 1,500 pounds per acre in unfavorable growing years. If the range site is in excellent condition, the total annual production is approximately 40 percent grasses and grasslike plants, 20 percent forbs, and 40 percent woody plants and trees. Archbold, Astatula, Jonathan, Orsino, Paola, Pomello, Satellite, and St. Lucie soils are included in this range site.

Cabbage Palm Flatwoods—This range site consists of nearly level areas characterized by cabbage palm and sawpalmetto trees scattered throughout the landscape. This site is a preferred livestock grazing area. It produces a high quality and quantity of forage plants if it is in excellent condition. Creeping, chalky, and south Florida bluestems are the dominant forage grasses along with several desirable panicum species. Pineland threeawn and sawpalmetto increase as the area deteriorates. If the range is in excellent condition, the average annual production of air-dry plant material from all sources is approximately 9,000 pounds per acre in favorable years and approximately 4,500 pounds per acre in unfavorable years. The total annual production is approximately 70 percent grasses and grasslike plants, 15 percent forbs, and 15 percent woody plants and trees. Lokosee, Malabar, and Riviera soils are included in this range site.

Other ecological plant communities in Indian River County and their respective soils that are not placed in a native range site are: South Florida Coastal Strand (Beaches and Canaveral, Captiva, and Palm Beach soils); Cypress Swamp (Samsula soils); Mangrove Swamp (McKee, Riomar, and Kesson soils); Salt Marsh (Perrine Variant soils); and Swamp Hardwoods (Chobee depressional, Gator, Pompano depressional, and Terra Ceia soils). These sites generally provide little forage for livestock and most are not accessible for cattle grazing *(5, 15)*.

Woodland Management and Productivity

Paul Palmiotto, urban forester, Florida Division of Forestry, helped prepare this section.

Forests in Indian River County *(12)* make up about 44,071 acres, or 13.85 percent of the total land area. Of this acreage, 36,925 acres is commercial forest land, and 7,146 acres is unproductive forest land. In the commercial forest areas, there are five main forest types: longleaf-slash, oak-pine, scrub oak-sand hickory, oak-hickory, and oak-gum-cypress.

The *longleaf-slash pine* forest type makes up 15,429 acres. This forest type is commonly on the EauGallie-Oldsmar-Wabasso, Myakka-Immokalee, and EauGallie-Myakka-Riviera soil map units. In Indian River County, the longleaf-slash type is in areas that are 2.5 to 3 miles wide. These areas are west of the Atlantic Coastal Ridge that extends the length of the county and in the western part of Indian River County, west of Blue Cypress Lake. This forest type is characterized by longleaf or slash pines, single or in combination, that makes up a plurality of the stocking. Common associates are laurel oak, live oak, myrtle oak, cabbage palm, redbay, and waxmyrtle.

The *oak-pine* forest type makes up 8,991 acres. This forest type is commonly on EauGallie-Oldsmar-Wabasso and Riviera-Pineda-Wabasso soil map units. In Indian River County the oak-pine forest type is in a broad band around U.S. Interstate Highway 95. In the southern part of the county, the band varies from 3 to 4 miles wide at U.S. Interstate Highway 95, and in the northern part, it varies from 8 to 10 miles wide. The oak-pine forest type is characterized mostly by hardwoods, generally upland oak, but pines make up 25 to 50 percent of the stocking. Common associates include gum, laurel oak, myrtle oak, redbay, and widely scattered slash pine. This forest type grows in conjunction with interspersed poorly defined drainageways or sloughs, which support red maple,

coastal plain willow, loblolly-bay, sweetbay, and scattered cypress domes.

The *scrub oak-sand hickory* forest type makes up 5,994 acres. This forest type is commonly on the Astatula-Archbold-St. Lucie and Immokalee-Myakka-Satellite soil map units. In Indian River County, the scrub oak-sand hickory forest type is on the Atlantic Coastal Ridge, which runs north and south and extends the length of the county. This ridge is near the coast, and its western boundary is just west of U.S. Highway 1. Sand pine, turkey oak, sand live oak, and sand hickory are the major species. In the Roseland area, a cedar called *callistris* has been extensively planted and has now become naturalized.

The *oak-hickory* forest type includes forests in which upland oak or hickory, single or in combination, makes up a plurality of the stocking. If pines make up 25 to 50 percent of the stocking, this forest type would be classified as oak-pine. Common associates are sand hickory, scrub oak, laurel oak, sand live oak, Chapman oak, and myrtle oak.

The *oak-gum-cypress* forest type includes bottom land forests in which tupelo, blackgum, sweetgum, oak, or southern cypress, single or in combination, make up a plurality of the stocking. If pines make up 25 to 50 percent of the stand, it would be classified oak-pine. This forest type is commonly on the Floridana-Delray-Holopaw soil map unit. Common associates include baldcypress, red maple, tupelo, elm, willow, loblolly-bay, sweetbay, pond apple, hackberry and water hickory. There are 6,511 acres of this forest type in Indian River County. This forest type is primarily around the creeks leading to Blue Cypress Lake.

Seven major general soil map units in Indian River County support the major forest types and other areas of ecological importance.

The Myakka-Immokalee soil map unit is in the western part of the county, west of Blue Cypress Lake. On these soils are longleaf pine, south Florida slash pine, laurel oak, live oak, cabbage palm, and water oak.

The EauGallie-Oldsmar-Wabasso and Riviera-Pineda-Wabasso soil map units are in a broad band around U.S. Interstate Highway 95 and also between the Atlantic Coastal Ridge and Ten Mile Ridge. These bands vary from 3 to 4 miles wide in the southern part of the county and from 8 to 10 miles wide in the northern part. On these soils are widely scattered south Florida slash pine interspersed with poorly defined drainageways or sloughs that support red maple, coastal plain willow, loblolly-bay, sweetbay, and scattered cypress domes.

The Astatula-Archbold-St. Lucie and Immokalee-Myakka-Satellite soil map units are primarily along the Atlantic Coastal Ridge, which runs north and south and extends the length of the county. This ridge is near the coast, and its western boundary is just west of U.S. Highway 1. Sand pine, turkey oak, sand live oak, and sand hickory are the major trees. In Roseland, a cedar called the *callistris* has been extensively planted and has now become naturalized.

The Canaveral-Captiva-Palm Beach soil map unit is on the barrier island. The dominant vegetation consists of oak-bay-cabbage palm hammocks, including stoppers, strangler fig, gumbo limbo, and other West Indies species. However, the exotic Australian pine and Brazil peppertree are invading species.

The McKee-Quartzipsamments-St. Augustine soil map unit is along the Indian River and in various mosquito impoundment areas. The mangrove swamp plant association is on these soils. Red, white, black, and buttonwood mangroves are the dominant vegetation on these soils, but Australian pine and Brazil peppertree are invading species. Mangrove swamps are of vital importance to the estuarine food chain, and they provide valuable habitat for wildlife.

Timber management in Indian River County consists of natural regeneration on sites burned by wildfire or on sites that have been control burned to increase forage and to reduce excessive "rough," which is a dangerous fire hazard.

There is no market for pulpwood in the county because most woodlands are cleared for urban expansion and the wood is burned or deposited in landfill areas.

Presently, the more productive areas for forest management is in the western part of the county. Timber management is economical and should be encouraged. Improved slash pines and south Florida slash pines, are better suited to planting in this area. More detailed information on woodland management can be obtained from the local offices of the Soil Conservation Service, the State of Florida Division of Forestry, and the Cooperative Extension Service.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol (woodland suitability) for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 2 indicates high productivity; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *w* indicates excessive water in or on the soil and *s* indicates sandy texture. If a soil has more than one limitation, the priority is as follows: w and s.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in a well-managed woodland. The risk is *slight* if the expected soil loss is small.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. Site index was determined at age 25 years for south Florida slash pine and 50 years for all other species. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Additional information on planning windbreaks and screens and on planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service, or from a nursery.

Recreation

The mild climate and wide variety of recreational facilities available throughout Indian River County attracts many people of all interests and ages to the area. With the rapid increase in population, including permanent winter residents and retirees, the need for more open space, outdoor recreation facilities, and cultural attractions will continue to grow. In 1984, approximately 1,400 acres was utilized for park and recreational facilities and for areas for beach access or walkways. As urbanization increases, the knowledge of soil properties can assist in planning and in the selecting of sites for additional recreation areas.

In table 9, the soils of the survey area are rated according to the limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as moderate or severe. *Moderate* means that limitations are somewhat restrictive and can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that one or more soil property is unfavorable and that limitations can be offset by soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes

and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes, stones, or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Wildlife has long been an important natural resource of Indian River County. The importance of wildlife dates as far back as 400 years ago when the original inhabitants of this area, the Ais Indians, lived mainly by hunting and fishing. Since that time, habitat for wildlife has diminished greatly with about 63,000 acres being used for citrus production and with other large areas being used for improved pasture or for urban development. Wetlands, which are excellent areas for wildlife habitat, are also being rapidly degraded and lost with the spread of introduced plant species, such as Brazilian peppertree and melaleuca trees.

The most extensive areas of good habitat are in the undeveloped rangeland in the western part of the county and in the natural areas of the St. Johns Marsh. Habitat for wetland wildlife is prevalent in both of these areas and is used by various species of wading birds and by reptiles and amphibians. The main game species in these wetlands are white-tailed deer, wild turkey, bobwhite quail, mourning doves, and feral hogs. Numerous nongame wildlife species, which include songbirds, woodpeckers, owls, raptorial birds, and armadillos, are also present in these areas.

Other areas of minor extent, but that are just as valuable, are the ocean beaches. These beaches are used for nesting by the endangered green and leatherback turtle and by the classified threatened loggerhead turtle. These beach areas also serve as feeding grounds for gulls, sandpipers, and plovers. The barrier island and estuarine habitat areas support such wildlife as raccoons, various birds, and reptiles. The mangrove islands in the Indian River serve as rookery and roosting areas for all types of wading birds and for the endangered brown pelican. These islands and their aquatic proximity serve as nursery and feeding areas for many marine fish and crustaceans.

Although land development and human population growth has continually increased during the last few decades, particularly, on the barrier island, there has continually been significant appreciation and recognition of the value of this natural resource by local, State and Federal concerns, as witnessed by the establishment of the First National Wildlife Refuge at Pelican Island in 1903 and by creating the Florida State Recreation Areas at Sebastian Inlet *(5)*. Other indications of concern for preserving habitat and ensuring water quality are shown by the proceedings to adopt a wetlands protection ordinance by the city of Vero Beach. Indian River County does not have a specific wetlands protection ordinance, although protection of about 110,000 acres of wetlands in the county is included in a stormwater management and flood protection ordinance. In addition, the State of Florida and Indian River County are acting to preserve environmentally sensitive coastal areas by participating in a "Save Our Coast" program. This program provides funding to purchase beach property and other coastal tracts.

Endangered or threatened species that habitat the county include the bald eagle, the American alligator, and the West Indian manatee. The bald eagle has only one known active nesting site in this area. A detailed list of endangered species and information on range and habitat can be obtained from the local office of the Soil Conservation Service.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining

the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, cowpeas, sunflowers, and millet.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are pangolagrass, bahiagrass, and white clover.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, partridge pea, and beggarweed.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, red maple, cabbage palm, elderberry, blackberry, huckleberry, grape, sawpalmetto, and briars.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and cypress.

Wetland plants are annual and perennial, wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, maidencane, cattail, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, mourning doves, meadowlark, field sparrow, cottontail rabbits, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, thrushes, woodpeckers, squirrels, gray fox, raccoon, bobcats, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, egrets, herons, gallinules, limpkin, shore birds, alligators, and otters.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils

may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations must be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to: evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are somewhat restrictive for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if one or more soil property or site feature is unfavorable for the intended use and should be corrected by special design, soil reclamation, or planned maintenance before the site can be adapted to the intended use.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are

easily overcome; *moderate* if soil properties or site features are somewhat restrictive for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if one or more soil property or site feature is unfavorable for the intended use and should be corrected by special design, soil reclamation, or planned maintenance before the site can be adapted to the intended use.

This table also gives the restrictive features that affect each soil for drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material: It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine particle-size distribution, saturated hydraulic conductivity, bulk density, and water content. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20, or higher, for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 22.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area, or from nearby areas, and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils. The results of physical, chemical, and mineralogical analyses of representative pedons in Indian River County are given in tables 19, 20, and 21.

Clay as a soil separate, or component, consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage in each major soil layer is stated in inches of water per inch of soil. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of

less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur over a sustained period without affecting crop productivity. The rate is expressed in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various water features and table 18 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Dual hydrologic groups, B/D and C/D, are used for certain wet soils that can be artificially drained and where normal drainage practices do not drain the soils well enough to attain Group A level.

Flooding, the temporary covering of the soil surface by flowing water, is caused by overflowing streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall or snowmelt is not considered flooding. Standing water in swamps and marshes or in a closed depreciation is considered ponding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur.

Frequency, duration, and probable dates of occurrence are estimated. Frequency generally is expressed as *none, rare,* or *frequent. None* means that flooding is not probable. *Rare* means that flooding is unlikely but possible under unusual weather conditions (there is a near 0 to 5 percent chance of flooding in any year). *Frequent* means that flooding occurs often under normal weather conditions (there is more than a 50 percent chance of flooding in any year). Duration is expressed as *very long* if more than 7 days. The time of year that floods are most likely to occur is expressed in months. November-May, for example, means that flooding can occur during the period November through May. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information on flooding is based on evidence in the soil profile, namely, thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons, which are characteristic of soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. The water table in 32 pedons, representing 20 soil series, was measured twice a month during the course of the soil survey. The pedons were selected as typical of the series as mapped in the county, and they were as far removed as possible from any source of artificial drainage. The measurements of the water tables for three of the major series are shown in (fig. 14). Additional water table data can be obtained from the local office of the Soil Conservation Service. Precipitation for 1982 and 1983 was above normal. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table, that is, *perched* or *apparent;* and the months of the year that the water table commonly is highest. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

The two numbers in the "High water table-Depth" column indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. "More than 6.0" indicates that the water table is below a depth of 6 feet or that the water table exists for less than a month.

Table 18 gives the depth and hardness of bedrock and cemented pan, shows expected initial and total subsidence, and gives the risk of corrosion for uncoated steel and concrete.

Depth to bedrock is given in the table if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. A pan that is classified as thin is less than 3 inches thick if continuously indurated, or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 18 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in table 18 is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium

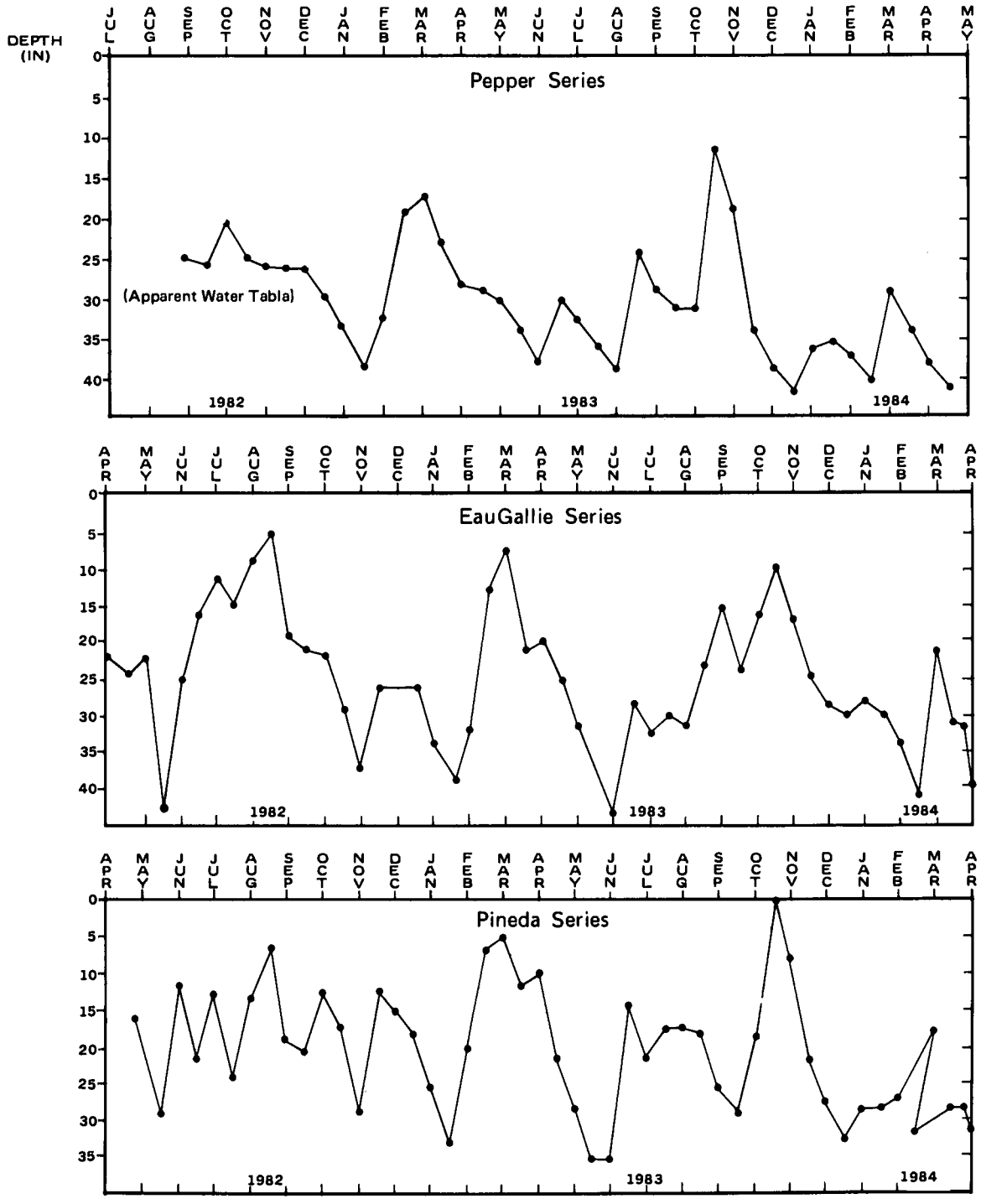


Figure 14.—Variation in depth of water table in the Pepper, EauGallie, and Pineda series.

content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severely corrosive environment. The steel in installations that intersect soil

boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and the amount of sulfates in the saturation extract.

Physical, Chemical, and Mineralogical Analyses of Selected Soils

Dr. Victor W. Carlisle and Dr. Mary E. Collins, professor and assistant professor, respectively, University of Florida, Soil Science Department, prepared this section.

Parameters for physical, chemical, and mineralogical properties of representative pedons sampled in Indian River County are presented in tables 19, 20, and 21. The analyses were conducted and coordinated by the Soil Characterization Laboratory at the University of Florida. Detailed profile descriptions of soils analyzed are given in the section "Soil Series and Their Morphology." Laboratory data and profile information for additional soils in Indian River County, as well as for other counties in Florida, are on file at the Soil Science Department, University of Florida.

Typifying pedons were sampled from pits at carefully selected locations. Samples were air-dried, crushed, and sieved through a 2-millimeter screen. Most analytical methods used are outlined in Soil Survey Investigations Report No. 1 *(16)*.

Particle-size distribution was determined using a modified pipette method with sodium hexametaphosphate dispersion. Hydraulic conductivity and bulk density were determined on undisturbed soil cores. Water retention parameters were obtained from duplicate undisturbed soil cores placed in tempe pressure cells. Weight percentages of water retained at 100 centimeters water (1/10 bar) and 345 centimeters water (1/3 bar) were calculated from volumetric water percentages divided by bulk density. Samples were ovendried, ground to pass a 2-millimeter sieve, and the 15-bar water retention was determined. Organic carbon was determined by a modification of the Walkley-Black wet combustion method.

Extractable bases were obtained by leaching soils with normal ammonium acetate buffered at pH 7.0. Sodium and potassium in the extract were determined by flame emission. Calcium and magnesium were determined by atomic absorption spectrophotometry. Extractable acidity was determined by the barium chloride-triethanolamine method at pH 8.2. Cation exchange capacity was calculated by summation of extractable bases and extractable acidity. Base saturation is the ratio of extractable bases to cation exchange capacity expressed in percent. The pH measurements were made with a glass electrode using a soil-water ratio of 1:1; a 0.01 molar calcium chloride solution in a 1:2 soil-solution ratio; and normal potassium chloride solution in a 1:1 soil-solution ratio.

Electrical conductivity determinations were made with a conductivity bridge on 1:1 soil to water mixtures. Iron and aluminum extractable in sodium dithionite-citrate were determined by atmoic absorption spectrophotometry. Aluminum, carbon, and iron were extracted from probable spodic horizons with 0.1 molar sodium pyrophosphate. Determination of aluminum and iron was by atomic absorption and extracted carbon by the Walkley-Black wet combustion method.

Mineralogy of the clay fraction less than 2 microns was ascertained by X-ray diffraction. Peak heights at 18 angstrom, 14 angstrom, 7.2 angstrom, and 4.31 angstrom positions represent montmorillonite, interstratified expandable vermiculite, 14-angstrom intergrades, kaolinite, and quartz, respectively. Peaks were measured, summed, and normalized to give the percent of soil minerals identified in the X-ray diffractograms. These percentage values do not indicate absolute determined quantities of soil minerals but do imply a relative distribution of minerals in a particular mineral suite. Absolute percentages would require additional knowledge of particle size, crystallinity, unit structure substitution, and matrix problems.

Sands are the dominant particle-size fractions in nearly all horizons of all pedons (table 19). More than 90 percent sand occurred throughout the entire pedon depths of the Archbold, Astatula, Canaveral, Jonathan, Orsino, Palm Beach, Paola and St. Lucie soils. Boca, Canova, Electra, Floridana, Pepper, and Immokalee soils contained more than 90 percent sand to a depth of more than 20 inches.

Archbold, Astatula, Canaveral, Jonathan, Jupiter, Orsino, Palm Beach, Paola and St. Lucie soils contained less than 5 percent clay throughout their profiles. Clay content increased considerably within a depth of 40 inches in the Boca, Canova, and Floridana soils, and it also increased considerably below a depth of 40 inches in the Electra and Pepper soils. Since there is a general tendency for clays to move downward with percolating water, the amount of translocated clay often reveals the state and degree of soil development.

Silt content usually ranged between 0 and 10 percent; however, silt content in excess of 20 percent occurred in some horizons of the Floridana and Perrine Variant soils. Conversely, pedons with less than 2 percent silt in all horizons occurred in the Archbold, Palm Beach, Paola, and St. Lucie soils. In the Astatula, Canaveral, Jonathan, Orsino, and Pepper soils only one or two horizons had more than 2 percent silt.

Fine sands dominated the sand fractions in the Boca, Canaveral, Electra, Jupiter, and Orsino soils. All horizons

of Boca, Canaveral, Electra, Jupiter, and Orsino soils contained more than 50 percent very fine and fine sands, and some horizons in the Immokalee soil contained like amounts. Medium sand generally ranged between 20 and 50 percent; however, all horizons of the Archbold, Astatula, Jonathan, Palm Beach, Paola, Pepper, and St. Lucie soils contained more than 50 percent medium sand, and all horizons of the Boca and Orsino soils contained less than 10 percent. Very fine sands commonly ranged between 0 and 10 percent. Coarse sands generally occurred in amounts of less than 15 percent and very coarse sands seldom exceeded 0.5 percent.

Hydraulic conductivity values of 5 centimeters per hour or less were recorded in some horizons of Boca, Canova, Electra, Manatee, and Pepper soils, and high values of 100 centimeters per hour or more were recorded for some horizons of the Astatula, Jonathan, Palm Beach, Paola, Pepper, and St. Lucie soils. Design and function of septic tank absorption fields are affected by such low and high hydraulic conductivity values. Some clay enhanced subsoil horizons occurring in the Boca, Canova, Electra, and Manatee soils had hydraulic conductivity values of less than 1 centimeter per hour. Plant available water capacity can be estimated from bulk density and water content data. Generally, soils that are excessively drained or have sandy textures, such as the Archbold, Astatula, Palm Beach, Paola and St. Lucie soils, contain low amounts of organic matter and retain less plant available water. Also the upper part of the Immokalee, Electra, and Jonathan soils contain low amounts of organic matter. Droughtiness is a common characteristic of these sandy soils, particularly those soils that are moderately well drained, well drained, and excessively drained. A relatively large amount of plant available water is retained in Canova, Manatee, and Perrine Variant soils.

Chemical soil properties (table 20) show that less than 20 milliequivalent per hundred grams of extractable bases are present in most Indian River County soils. All horizons of the Archbold, Astatula, Jonathan, Orsino, and St. Lucie soils contained less than 1 milliequivalent per hundred grams extractable bases. Electra, Immokalee, Paola, and Pepper soils contained only three or less horizons that have extractable bases in excess of 1 milliequivalent per hundred grams and values of less than 15 milliequivalents per hundred grams commonly occurred in most other soils. Canaveral, Canova, Floridana, Gator, Manatee, Palm Beach, and Perrine Variant soils contained horizons that exceeded 15 milliequivalents per hundred grams extractable bases. The mild, humid climate in Indian River County results in depletion of basic soil cations (calcium, magnesium, sodium, and potassium) through leaching.

Calcium was by far the dominant base in all soils with amounts ranging from 0.01 to 77.25 milliequivalents per hundred grams. Magnesium occurred in amounts exceeding 1 milliequivalent per hundred grams in some horizons of the Boca, Canova, Electra, Floridana, Gator, Jupiter, Manatee, Palm Beach, Pepper, and Perrine Variant soils. Much lower but detectable amounts of magnesium occurred in all horizons except one horizon in the Jonathan soil. Sodium generally occurred in amounts of less than 1 milliequivalent per hundred grams. Most Indian River County soils contained very low amounts of potassium with only two horizons of Canova and Perrine Variant soils exceeding 1 milliequivalent per hundred grams. Potassium was nondetectable in one or more horizons of the Archbold, Astatula, Electra, Jonathan, Orsino, Pepper, and St. Lucie soils.

Values for exchange capacity, an indication of plant nutrient capacity, exceeded 20 milliequivalents per hundred grams in the surface horizon of Canova, Gator, Manatee, Palm Beach, and Perrine Variant soils. Cation exchange capacity exceeded 20 milliequivalents per hundred grams in at least one horizon below the surface in the Canova, Electra, Floridana, Gator, Immokalee, Manatee, Pepper, and Perrine Variant soils. Exceptional high exchange capacity of more than 100 milliequivalents per hundred grams was determined in three horizons. Soils that have low cation exchange capacities in the surface horizon, such as the Jonathan series, require only small amounts of lime to significantly alter both the base status and soil reaction in the upper horizons. Generally, soils of low inherent soil fertility are associated with low values for extractable bases and low cation exchange capacities, and fertile soils are associated with high values for extractable bases, high base saturation values, and high cation exchange capacities.

Organic carbon content exceeded 2 percent only in the surface horizon of the Boca, Canova, Floridana, Gator, Jupiter, Manatee, and Perrine Variant soils. The surface and subsurface horizons of the Canova and Gator soils were very high in organic carbon content (more than 30 percent) because of the high amounts of sapric (organic) material. In Spodosols, organic carbon content exceeded 2 percent only in the spodic horizon of the Electra, Immokalee, and Pepper soils. Organic carbon content was less than 1 percent in all horizons of Archbold, Astatula, Orsino, Paola, and St. Lucie soils. Organic carbon content generally decreased rapidly with increased depth except in the Spodosols. These soils have a Bh horizon that contains enhanced amounts of organic carbon. Since organic carbon is directly related to soil nutrient and water retention capacities of sandy soils, management practices that conserve and maintain organic carbon content are highly desirable.

Electrical conductivity values were generally very low, exceeding 0.2 millimhos per centimeter, in one horizon of the Canaveral soil and throughout the Perrine Variant pedon. These data indicate that soluble salt content

except in the immediate coastal areas is insufficient to detrimentally affect the growth of salt-sensitive plants.

Soil reaction in water usually ranged between pH 4.0 and 7.0; however, reactions in excess of 8.0 occurred in horizons of the Boca, Canova, Gator, Palm Beach, and Perrine Variant series. With few exceptions, soil reaction was 0.1 to 1.2 pH units lower in calcium chloride and potassium chloride than in water. Maximum plant nutrient availability is usually attained when soil reaction is between pH 6.5 and 7.5; however, under Florida conditions, maintaining soil reaction above pH 6.5 is not economically feasible for most agricultural production purposes.

Sodium pyrophosphate extractable iron did not exceed 0.10 percent in the Bh horizon of Immokalee, Jonathan, and Orsino soils. The ratio of pyrophosphate extractable carbon and aluminum to clay in Electra, Immokalee, Jonathan, and Orsino soils was sufficient to meet the chemical criteria for spodic horizons.

Citrate-dithionite extractable iron in the argillic horizon was generally less than 1 percent. These values in the Bh horizon ranged from 1.22 percent in the Boca soil to no detectable amount in the Jonathan soil.

Aluminum extracted by citrate-dithionite from the Bt horizon ranges from 0.02 percent in the Manatee soil to 0.13 percent in the Electra soil. Amounts of iron and aluminum in Indian River County soils are not sufficient to detrimentally affect phosphorus availability.

Sand fractions of 2 to 0.05 millimeters were siliceous with quartz overwhelmingly dominant in all pedons. Calcite was determined only in the Ckg2 horizon of the Perrine Variant soil. Crystalline mineral components of the clay fraction of less than 0.002 millimeters are reported in table 21 for major horizons of the pedons sampled. The clay mineralogical suite was composed of montmorillonite, a 14-angstrom intergrade, kaolinite, and quartz.

Montmorillonite occurred in all pedons sampled except in the Perrine Variant soil. In most pedons, the clay fraction was dominated by montmorillonite. The 14-angstrom intergrade minerals occurred in all horizons in the Astatula, Boca, Jonathan, Orsino, Palm Beach, and Paola soils but were not present in all horizons of the Electra, Immokalee, Pepper, and St. Lucie pedons. Kaolinite occurred in all soils sampled. Quartz occurred in all soils except in one horizon of the Perrine Variant pedon.

Montmorillonite appears to have been inherited by Indian River County soils and is probably the least stable mineral component in the present environment. Subsoils in Canova, Floridana, and Manatee pedons contain relatively large amounts of montmorillonitic clays that can result in considerable volume change from shrinking when dry and swelling when wet. Clay-sized quartz has primarily resulted from decrements of the silt fraction. Soils dominated by montmorillonite and 14-angstrom intergrades have high cation exchange capacities and retain more plant nutrients than soils dominated by kaolinite or quartz.

Engineering Index Test Data

Table 22 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." The soil samples were tested by the Soils Laboratory, Florida Department of Transportation, Bureau of Materials and Research.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(14)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or on laboratory measurements. Table 23 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Spodosol.

SUBORDER. Each order is divided into suborders, primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquod (*Aqu*, meaning water, plus *od*, from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquods (*Hapl*, meaning minimal horizonation, plus *aquod*, the suborder of the Spodosols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquods.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy, siliceous, hyperthermic Typic Haplaquods.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. There can be some variation in the texture of the surface layer or of the substratum within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (13)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (14)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Archbold Series

The soils of the Archbold series are hyperthermic, uncoated Typic Quartzipsamments. They are moderately well drained, very rapidly permeable soils that formed in thick deposits of marine or eolian sand. These nearly level to sloping soils are on the Atlantic Coastal Ridge and other elevated knolls on the flatwoods. In most years, the water table is at a depth of 40 to 60 inches for more than 6 months but recedes to a depth of more than 80 inches during droughty periods. The slope ranges from 0 to 5 percent.

Archbold soils are associated with Astatula, Immokalee, Jonathan, Myakka, Orsino, Paola, Pomello, Satellite, and St. Lucie soils. Astatula, Paola, and St. Lucie soils are excessively drained. Jonathan soils are somewhat excessively drained and have an ortstein horizon. Orsino and Pomello soils are moderately well drained and have a spodic horizon. In addition, Orsino soils have a Bh horizon. Immokalee and Myakka soils are poorly drained and have a spodic horizon. Satellite soils are somewhat poorly drained.

Typical pedon of Archbold sand, 0 to 5 percent slopes; in an area on the coastal ridge, about 0.75 mile west of U.S. Highway 1, about 0.5 mile north of Indian River County Road 510; SE1/4NW1/4SE1/4, sec. 29, T. 31 S., R. 39 E.

A—0 to 2 inches; gray (10YR 5/1) sand; single grained; loose; common fine and medium roots; mixture of uncoated sand grains and organic matter, salt-and-pepper appearance; neutral; abrupt smooth boundary.
C1—2 to 38 inches; white (10YR 8/1) sand; single grained; loose; common fine and medium roots; neutral; gradual wavy boundary.
C2—38 to 51 inches; light gray (10YR 7/1) sand; single grained; loose; few fine and medium roots; slightly acid; gradual wavy boundary.
C3—51 to 80 inches; gray (10YR 6/1) sand; single grained; loose; few fine and medium roots; medium acid.

Reaction ranges from extremely acid to medium acid in the A horizon and from strongly acid to slightly acid in the C horizon. Texture is sand or fine sand to a depth of more than 80 inches. About 5 percent or less silt and clay is at a depth of 10 to 40 inches.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 1. It has a varying amount of fine black (10YR 2/1) organic matter granules. Thickness is 2 to 5 inches.

The C horizon has hue of 10YR, value of 7, and chroma of 2; or hue of 10YR, value of 7 or 8, and chroma of 1. In some pedons, the C horizon has hue of 10YR, value of 6, and chroma of 1 at a depth of more than 40 inches.

Astatula Series

The soils of the Astatula series are hyperthermic, uncoated Typic Quartzipsamments. They are excessively drained, very rapidly permeable soils that formed in thick deposits of marine or eolian sand. These nearly level to gently sloping soils are on the Atlantic Coastal Ridge. The water table is at a depth of more than 72 inches. The slope ranges from 0 to 5 percent.

Astatula soils are associated with Immokalee, Paola, Pomello, and St. Lucie soils. Immokalee and Pomello soils are more poorly drained than the Astatula soils and have a Bh horizon. Paola soils have a light colored E horizon. St. Lucie soils are gray to light gray.

Typical pedon of Astatula sand, 0 to 5 percent slopes; west of Old Dixie Highway; NE1/4NW1/4NW1/4, sec. 31, T. 33 S., R. 39 E.

A—0 to 4 inches; grayish brown (10YR 5/2) sand; single grained; loose; common fine and very fine, few medium roots; strongly acid; clear smooth boundary.
AC—4 to 5 inches; brown (10YR 5/3) sand; dark brown (10YR 4/3) organic stains around root channels; single grained; loose; many fine and very fine, few coarse and medium roots; strongly acid; clear smooth boundary.
C1—5 to 14 inches; brownish yellow (10YR 6/6) sand; single grained; loose; common fine and medium roots; medium acid; gradual smooth boundary.
C2—14 to 71 inches; brownish yellow (10YR 6/8) sand; dark brown (10YR 4/3) stains around roots; single grained; loose; few fine and medium roots; strongly acid; abrupt smooth boundary.
C3—71 to 80 inches; strong brown (7.5YR 5/8) sand; few medium yellowish red (5YR 4/6) soft iron accumulations; single grained; loose; strongly acid.

Less than 5 percent silt and clay is at a depth of 10 to 40 inches. Reaction is strongly acid or medium acid.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. This horizon is a mixture of organic matter and uncoated sand grains. Thickness is 3 to 7 inches. Texture is sand or fine sand. The AC horizon, if present, has hue of 10YR, value of 5, and chroma of 3. Thickness is 0 to 2 inches. Texture is sand or fine sand.

The C horizon has hue of 7.5YR, value of 5, and chroma of 8; or hue of 10YR, value of 6, and chroma of 6 to 8. Texture is sand or fine sand.

Boca Series

The soils of the Boca series are loamy, siliceous, hyperthermic Arenic Ochraqualfs. They are poorly drained, moderately permeable soils that formed in moderately thick beds of sandy and loamy marine sediment underlain by a hard, limestone ledge that has numerous fractures and solution holes. These nearly level soils are mostly in the citrus groves, but some are on the flatwoods. In most years, the water table is within a depth of 10 inches of the surface for 2 to 4 months during the rainy season. The slope ranges from 0 to 2 percent.

Boca soils are associated with Jupiter, Myakka, Pineda, Riviera, Wabasso, and Winder soils. Jupiter soils have a mollic epipedon and do not have an argillic horizon. Myakka and Wabasso soils have a Bh horizon and are not underlain by limestone. Pineda, Riviera, and Winder soils have an argillic horizon that does not rest

on limestone. In addition, Pineda soils have a Bw horizon.

Typical pedon of Boca fine sand; in a citrus grove, about 1/2 mile east of U.S. Highway 1, on 37th Avenue (across from north entrance of Vero Beach Hospital), 1,000 feet north along Field Road, 100 feet west; SE1/4NE1/4, sec. 23, T. 32 S., R. 39 E.

Ap—0 to 7 inches; dark gray (10YR 4/1) fine sand; single grained; loose; common fine roots; moderately alkaline; clear smooth boundary.

E—7 to 14 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; moderately alkaline; clear smooth boundary.

EB—14 to 20 inches; brown (10YR 4/3) fine sand; single grained; loose; mildly alkaline; abrupt smooth boundary.

Bt—20 to 24 inches; mixed yellowish brown (10YR 5/6, 5/4) fine sandy loam; weak fine subangular blocky structure; very friable, slightly sticky and nonplastic; moderately alkaline; abrupt irregular boundary.

R—24 inches; hard fractured, calcareous limestone.

The thickness of the solum and depth to limestone in the dominant part of a pedon range from 22 to 40 inches. In solution holes and fractures, the depth to limestone ranges from 22 to 50 inches or more. Depth to the argillic horizon ranges from 20 to 36 inches in more than half of the pedons.

Reaction ranges from medium acid to moderately alkaline in the A, E and EB horizons and from slightly acid to moderately alkaline in the Bt horizon.

The A or Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1. Thickness ranges from 6 to 9 inches. The E horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. Thickness ranges from 7 to 15 inches. The EB horizon has hue of 10YR, value of 5, and chroma of 4; or hue of 10YR, value of 4, and chroma of 3. Thickness is 0 to 15 inches. Texture of the A, Ap, E, and EB horizons is sand or fine sand.

The Bt horizon has hue of 10YR, value of 5, and chroma of 4 to 6; or hue of 2.5Y, value of 6, and chroma of 2 and has mottles of yellowish brown. Texture is sandy loam, fine sandy loam, or sandy clay loam. Thickness is 4 to 12 inches.

The layer of hard limestone has many fractures and solution holes. The bedrock is 6 to 18 inches thick. The upper surface of the bedrock is smooth, and the lower surface is quite irregular. Layers of sand to sandy loam are below the bedrock. Some of these sand to sandy loam layers have a variable content of shell fragments.

The Boca soils are taxadjuncts to the Boca series because the yellowish brown color in the Bt horizon is outside of the defined range for the series. They are similar in use, management, and behavior to the soils of the Boca series.

Canaveral Series

The soils of the Canaveral series are hyperthermic, uncoated Aquic Quartzipsamments. They are somewhat poorly drained to moderately well drained, very rapidly permeable soils that formed in thick deposits of sand and fine shell fragments. These nearly level to gently sloping soils are on low dunelike ridges and on side slopes bordering sloughs and mangrove swamps. In most years the water table is at a depth of 10 to 40 inches for 2 to 6 months. The slope ranges from 0 to 5 percent.

Canaveral soils are associated with Palm Beach, St. Augustine, Quartzipsamments, and Captiva soils. Palm Beach soils are excessively drained. Captiva soils are poorly drained and have a dark colored surface layer. St. Augustine soils are mixed sandy, loamy, and silty soils. These materials resulted from dredging and filling operations. Quartzipsamments are sandy soils. This material resulted from filling and earthmoving operations.

Typical pedon of Canaveral fine sand, 0 to 5 percent slopes; 500 feet west of Florida State Road A1A; SE1/4SE1/4NE1/4, sec. 15, T. 31 S., R. 39 E.

A—0 to 5 inches; dark gray (10YR 4/1) fine sand grading to gray (10YR 5/1) in the lower part; single grained; loose; common fine and medium and coarse roots; about 10 percent sand-size shell fragments; mildly alkaline; strongly effervescent; clear wavy boundary.

C1—5 to 9 inches; light gray (10YR 7/2) fine sand; single grained; loose; 10 percent sand-size shell fragments; common fine and medium, few coarse roots; mildly alkaline; gradual wavy boundary.

C2—9 to 17 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; common medium roots; 10 percent multicolored sand-size shell fragments; neutral; strongly effervescent; gradual smooth boundary.

C3—17 to 49 inches; very pale brown (10YR 7/3) fine sand; single grained; loose; few fine and medium roots; 20 percent multicolored sand-size shell fragments; mildly alkaline; strongly effervescent; clear wavy boundary.

C4—49 to 61 inches; light brownish gray (2.5Y 6/2) fine sand; common medium prominent light yellowish brown (10YR 6/4) mottles; single grained; loose; 35 percent multicolored sand-size shell fragments; few shell fragments up to 1 inch in diameter; mildly alkaline; strongly effervescent; clear wavy boundary.

C5—61 to 80 inches; light brownish gray (10YR 6/2) fine sand; few fine prominent light yellowish brown (10YR 6/4) mottles; single grained; loose; 40 percent multicolored sand-size shell fragments; mildly alkaline; strongly effervescent.

Reaction ranges from neutral to moderately alkaline in all horizons to a depth of 80 inches or more. Shell fragments cause these soils to be strongly effervescent with dilute 0.1 normal hydrochloric acid. All horizons are sand or fine sand that is mixed with varying amounts of sand-size shell fragments.

The A horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Thickness is 4 to 8 inches. The content of shell fragments ranges from 5 to 10 percent.

The C horizon has hue of 10YR, value of 4 to 7, and chroma of 1 to 4; or hue of 2.5Y, value of 6, and chroma of 2. The C horizon is a mixture of fine sand or sand and multicolored shell fragments. In some pedons, the C horizon is stratified sand and shell fragments. The content of shell fragments ranges from 5 to 60 percent.

Canova Series

The soils of the Canova series are fine-loamy, siliceous, hyperthermic Typic Glossaqualfs. They are very poorly drained, moderately permeable soils that formed in sandy and loamy marine sediment under favorable conditions for the accumulation of organic material. These nearly level soils are in freshwater swamps and marshes. Under natural conditions, the water table is above the surface for most of the year. In drained areas, it is controlled at a depth of 10 to 36 inches or controlled according to the need of the crop. The water table is at or above the surface for short periods after heavy rainfall and during normal periods of high seasonal rainfall. The slope is 0 to 1 percent.

Canova soils are associated with Chobee, Delray, Floridana, Gator, Terra Ceia, Wabasso, and Winder soils. Chobee, Delray, and Floridana soils have a mollic epipedon. Gator and Terra Ceia soils are organic soils. Wabasso soils are poorly drained and have a spodic horizon. Winder soils do not have an organic surface layer and are poorly drained.

Typical pedon of Canova muck; in a pasture, 7.5 miles west of Fellsmere, 3.5 miles west of Indian River County Road 512, 0.9 mile east of Lateral Q Canal, 150 feet west of Mile Canal; Block 21W; NE1/4SE1/4NE1/4, sec. 35, T. 31 S., R. 36 E.

Oap—0 to 6 inches; black (10YR 2/1) muck; about 10 percent fiber, less than 5 percent rubbed; weak medium subangular blocky structure resemblance; friable; common fine roots; dark brown (10YR 4/3) sodium pyrophosphate extract; extremely acid (pH 4.1 in 0.01 molar calcium chloride solution); abrupt wavy boundary.

Oa—6 to 12 inches; very dark brown (10YR 2/2) muck; about 20 percent fiber, 2 percent rubbed; weak medium subangular blocky structure resemblance; friable; common fine roots; dark brown (10YR 4/3) sodium pyrophosphate extract; extremely acid (pH 4.2 in 0.01 molar calcium chloride solution); abrupt smooth boundary.

A—12 to 13 inches; black (10YR 2/1) sand; single grained; loose; common light gray (10YR 7/1) uncoated sand grains; few fine roots; strongly acid; abrupt wavy boundary.

E1—13 to 21 inches; gray (10YR 6/1) sand; single grained; loose; few fine roots; slightly acid; gradual wavy boundary.

E2—21 to 24 inches; grayish brown (10YR 5/2) sand; single grained; loose; few fine roots; slightly acid; abrupt irregular boundary.

Btg1—24 to 34 inches; grayish brown (2.5Y 5/2) sandy clay loam; common fine and medium yellowish brown (10YR 5/6) streaks around roots; weak coarse prismatic structure parting to moderate medium subangular blocky structure; slightly sticky and slightly plastic; common coarse tongues of grayish brown (10YR 5/2) sand around sandy clay loam prisms, 8 to 10 inches apart; common fine and very fine roots; medium acid; gradual wavy boundary.

Btg2—34 to 40 inches; gray (5Y 5/1) sandy clay loam; few coarse distinct very dark grayish brown (10YR 3/2) and common fine distinct yellowish brown (10YR 5/4) streaks along root channels; weak coarse prismatic structure parting to weak medium subangular blocky structure; slightly sticky and slightly plastic; few light gray and yellowish brown calcium carbonate concretions; few fine roots; mildly alkaline; abrupt wavy boundary.

Cgk1—40 to 49 inches; greenish gray (5GY 5/1) sandy clay loam; common fine prominent yellowish brown (10YR 5/6) mottles and common fine distinct light gray (10YR 7/1) calcium carbonate concretions and soft calcium carbonate accumulations; strongly effervescent; weak medium subangular blocky structure; slightly sticky and nonplastic; few very fine roots; moderately alkaline; clear wavy boundary.

Cgk2—49 to 56 inches; greenish gray (5GY 6/1) sandy clay loam; few fine and medium distinct yellowish brown (10YR 5/4) mottles and many fine light gray (10YR 7/2) calcium carbonate concretions; strongly effervescent; weak medium subangular blocky structure; slightly sticky and nonplastic; few very fine roots; moderately alkaline; clear wavy boundary.

Cg—56 to 80 inches; greenish gray (5G 6/1) sandy loam; weak medium subangular blocky structure; slightly sticky and nonplastic; moderately alkaline.

Canova soils are extremely acid to medium acid in the O horizon, strongly acid or medium acid in the A horizon, slightly acid or neutral in the E horizon, medium acid to moderately alkaline in the Btg horizon, and moderately alkaline in the Cgk and the Cg horizons.

The thickness of the organic material ranges from 5 to 15 inches. The Oa horizon has hue of 5YR or 10YR, value of 2, and chroma of 1 or 2; or hue of 5YR, value of 3, and chroma of 1 through 3. The fiber content is less

than 33 percent unrubbed and less than 5 percent rubbed. Sodium pyrophosphate extract has hue of 10YR, value of 2 through 4, and chroma of 4 or less; or hue of 10YR, value of 5, and chroma of 2 through 8; or hue of 10YR, value of 6, and chroma of 3 through 8; or hue of 10YR, value of 7, and chroma of 4 through 8. Texture is muck.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. If present, this horizon has few or common 10YR 7/1 uncoated sand grains. Texture is sand or fine sand. Thickness ranges from 1 to 6 inches.

The E horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2. Texture is sand or fine sand. Thickness ranges from 6 to 11 inches.

The Btg horizon has hue of 10YR or 5Y, value of 4 or 5, and chroma of 1; or hue of 2.5Y, value of 4 or 5, and chroma of 2; or hue of 5GY, value of 5, and chroma of 1 and has mottles and streaks in shades of yellow and brown. Texture is sandy clay loam or sandy loam. The clay content is 18 to 28 percent. The silt content is less than 15 percent. It has few or common vertical sandy streaks or tongues and none or few calcium carbonate accumulations. Thickness ranges from 7 to 24 inches.

The Cgk and Cg horizons have hue of 5GY, 5Y, or 5G, value of 5 or 6, and chroma of 1. These horizons have mottles and streaks in shades of yellow and brown. Texture is sandy clay loam or sandy loam that has lenses of sand or loamy sand. In the Cgk and Cg horizons are few to many, fine and medium, soft and hard light gray, white, and yellowish brown fragments of carbonatic material and shell fragments.

Captiva Series

The soils of the Captiva series are siliceous, hyperthermic Mollic Psammaquents. They are poorly drained, rapidly permeable soils that formed in thick marine deposits of sand and fine shell fragments. These nearly level soils are in narrow, elongated sloughs between low dunelike ridges and mangrove swamps. In most years, the water table is at a depth of 10 to 40 inches for 6 to 9 months or more and within a depth of 10 inches of the surface for 1 to 3 months. In some years, the soil is flooded for about 1 month. The slope ranges from 0 to 1 percent.

Captiva soils are associated with Canaveral and Kesson soils. Canaveral soils are on higher elevations than Captiva soils and are better drained. Kesson soils are very poorly drained, have a high sulfur content, and are subject to tidal flooding.

Typical pedon of Captiva fine sand; in a brushy area, 3/4 mile south of Indian River County Road 510, 500 feet east of Jungle Trail; NW1/4SW1/4SE1/4, sec. 26, T. 31 S., R. 39 E.

A—0 to 8 inches; very dark gray (10YR 3/1) fine sand; weak fine granular structure; very friable; many fine and few medium roots; about 2 percent shell fragments; moderately alkaline; slightly effervescent; clear smooth boundary.

C—8 to 16 inches; grayish brown (10YR 5/2) fine sand; common medium distinct dark grayish brown (10YR 4/2) and few medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; few fine and medium roots; about 2 percent shell fragments; moderately alkaline; slightly effervescent; gradual smooth boundary.

Cg1—16 to 25 inches; olive gray (5Y 5/2) fine sand; single grained; loose; about 15 percent shell fragments; moderately alkaline; strongly effervescent; clear wavy boundary.

Cg2—25 to 80 inches; greenish gray (5GY 5/1) fine sand; single grained; loose; about 10 percent shell fragments; moderately alkaline; strongly effervescent.

Reaction is moderately alkaline to a depth of 80 inches or more. Shell fragments cause these soils to be slightly effervescent to strongly effervescent with dilute 0.1 normal hydrochloric acid. All horizons are sand or fine sand that is mixed with varying amounts of shell fragments.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. Thickness is 6 to 9 inches. The content of shell fragments ranges from 2 to 20 percent.

The Cg horizon has hue of 10YR, value of 5 to 7, and chroma of 1 to 3; or hue of 5Y, value of 5 or 6, and chroma of 2; or hue of 5GY, value of 5 or 6, and chroma of 2; or hue of 5GY, value of 5 or 6, and chroma of 1 and has streaks and mottles of dark grayish brown, grayish brown, or yellowish brown. The C horizon is a mixture of fine sand, sand, and shell fragments. In some pedons the C horizon is stratified sand and shell fragments. The content of shell fragments ranges from 5 to 60 percent. The shell fragments that are more than 2 millimeters in size make up less than 35 percent of the horizon.

Chobee Series

The soils of the Chobee series are fine-loamy, siliceous, hyperthermic Typic Argiaquolls. They are very poorly drained, slowly permeable to very slowly permeable soils that formed in thick beds of moderately fine marine sediment. These nearly level soils are in depressional areas, in poorly defined drainageways, and on broad, low flats. Under natural conditions, they are covered with shallow water or have a water table within a depth of 10 inches of the surface for more than 6 months during most years. The slope is dominantly less than 1 percent but ranges to 2 percent.

Chobee soils are associated with Floridana, Manatee, Riviera, Pineda, and Winder soils. Floridana soils have thick sandy surface and albic horizon. Manatee soils are in the coarse loamy family. Riviera and Pineda soils have

an argillic horizon at a depth of 20 to 40 inches. In addition, Pineda soils have a Bw horizon. Winder, Riviera, and Pineda soils do not have a mollic epipedon and also have tongues of E horizon extending into the Bt horizon.

Typical pedon of Chobee loamy fine sand; in an area of citrus, 1.75 miles south of Florida State Road 60, 0.5 mile west of Range Line Road; NW1/4SW1/4NE1/4, sec. 13, T. 33 S., R. 38 E.

Ap—0 to 5 inches; black (10YR 2/1) loamy fine sand; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.

Bt1—5 to 17 inches; black (10YR 2/1) sandy loam; massive, parts to moderate medium subangular blocky structure; slightly sticky and slightly plastic; neutral; clear wavy boundary.

Bt2—17 to 28 inches; very dark gray (10YR 3/1) sandy clay loam; few fine prominent yellowish brown (10YR 5/8) mottles; few fine distinct strong brown (7.5YR 5/6) streaks along old root channels; massive, parts to moderate medium subangular blocky structure; slightly sticky and slightly plastic; slightly acid; gradual wavy boundary.

Bt3—28 to 35 inches; dark grayish brown (10YR 4/2) sandy loam; common fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; slightly sticky and slightly plastic; slightly acid; clear wavy boundary.

Bt4—35 to 46 inches; gray (5Y 6/1) sandy loam; common medium distinct dark gray (10YR 4/1) and few fine prominent yellowish brown (10YR 5/8) mottles; medium fine subangular blocky structure; slightly sticky and slightly plastic; slightly acid; gradual smooth boundary.

Cg1—46 to 54 inches; gray (5Y 6/1) loamy fine sand; weak fine subangular blocky structure; slightly sticky; slightly acid; gradual wavy boundary.

Cg2—54 to 80 inches; greenish gray (5GY 5/1) loamy fine sand; massive, parts to weak medium subangular blocky structure; slightly sticky; moderately alkaline.

The thickness of the solum is more than 40 inches.

The A horizon or the Ap horizon has hue of 10YR, value of 2, and chroma of 1; or it is neutral with value of 2. Texture is loamy fine sand or sandy loam. A few pedons have texture of mucky fine sand. Reaction is slightly acid or neutral. Thickness ranges from 4 to 15 inches.

The Bt horizon has hue of 10YR, value of 2 to 4, and chroma of 1; or hue of 10YR, value of 4, and chroma of 2; or hue of 2.5Y, value of 3 or 4, and chroma of 1; or hue of 5Y, value of 6, and chroma of 1 and can have yellowish brown or strong brown mottles. Texture is sandy loam or sandy clay loam. The clay content of the control section ranges from 18 to 35 percent. Reaction ranges from slightly acid to moderately alkaline. The total thickness ranges from 30 to 50 inches.

The Cg horizon has hue of 5Y or 5GY, value of 5 or 6, and chroma of 1. This horizon can have mottles. Texture is loamy sand, loamy fine sand, or sandy loam. In some pedons, this horizon is a mixture of loamy sand and shell fragments. Also, some pedons have concretions or splotches of calcium carbonates. Reaction ranges from neutral to moderately alkaline. This horizon can be calcareous.

Delray Series

The soils of the Delray series are loamy, siliceous, hyperthermic Grossarenic Argiaquolls. They are very poorly drained soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are in depressions and in poorly defined drainageways. The Delray soils are rapidly permeable in the A and E horizons and moderately permeable to moderately rapidly permeable in the Bt horizon. In most years, the water table is above the surface for 2 to 6 months and is within a depth of 10 inches for 6 to 9 months. The slope is less than 2 percent.

Delray soils are associated with Canova, Floridana, Gator, Holopaw, and Malabar soils. Canova soils have a thin layer of organic material underlain by a Bt horizon within a depth of 20 inches of the surface. Floridana soils have a Bt horizon at a depth of 20 to 40 inches. Gator soils are organic. Holopaw and Malabar soils are poorly drained and do not have a mollic epipedon. In addition, Malabar soils have a Bw horizon.

Typical pedon of Delray muck; in a partially cleared depressional area; SE1/2SE1/4NW1/4, sec. 24, T. 31 S., R. 35 E.

Oa—0 to 3 inches; black (5YR 2/1) muck; weak fine subangular blocky structure resemblance; very friable; about 55 percent fiber unrubbed, 5 percent rubbed; common fine roots; dark brown (10YR 4/3) sodium pyrophosphate extract; slightly acid; clear smooth boundary.

A1—3 to 17 inches; black (10YR 2/1) fine sand; high organic matter content; few coarse distinct grayish brown streaks and splotches; weak medium granular structure; friable; common fine roots; slightly acid; gradual wavy boundary.

A2—17 to 21 inches; very dark grayish brown (10YR 3/2) sand; few medium faint very dark gray splotches; single grained; loose; few fine roots; very slightly acid; clear wavy boundary.

E1—21 to 38 inches; grayish brown (10YR 5/2) sand; single grained; loose; very slightly acid; clear wavy boundary.

E2—38 to 45 inches; dark grayish brown (10YR 4/2) sand; single grained; loose; neutral; abrupt wavy boundary.

Btg1—45 to 52 inches; dark grayish brown (10YR 4/2) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; slightly sticky and nonplastic; few fine roots; mildly alkaline; clear smooth boundary.

BCg—52 to 80 inches; gray (5Y 6/1) sandy loam; few medium distinct light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; slightly sticky and nonplastic; few fine roots; mildly alkaline.

The thickness of the solum is more than 50 inches. Reaction ranges from medium acid to slightly acid in the Oa and A horizons and slightly acid to mildly alkaline in the E, Btg, BCg horizons and, if present, in the Cg horizon.

The Oa horizon has hue of 10YR or 5YR, value of 2, and chroma of 1; or it is neutral with value of 2. Organic fiber content ranges from about 15 to 60 percent unrubbed and less than 10 percent rubbed. Thickness ranges from 0 to 6 inches.

The A or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or it is neutral with value of 2 and can have few medium very dark gray, dark gray, or grayish brown sand splotches or pockets. Texture is sand, fine sand, mucky loamy fine sand, or mucky fine sand. Organic matter content ranges from about 2 to 18 percent. Thickness ranges from 14 to 20 inches.

The E horizon has hue of 10YR, value of 4 to 6, and chroma of 2. This horizon can have very dark gray or dark gray splotches or thin streaks along root channels. Texture is sand or fine sand. Thickness ranges from 20 to 39 inches.

The Btg horizon has hue of 5GY or 5Y, value of 5 or 6, and chroma of 2; or hue of 10YR, value of 4, and chroma of 2. This horizon can have mottles in shades of gray, yellow, or brown. Texture is sandy loam, fine sandy loam, or sandy clay loam. Thickness ranges from 7 to 28 inches. The BCg horizon has hue of 5Y or 5GY, value of 5 or 6, and chroma of 1. This horizon can have light olive brown or olive yellow mottles. Texture is sandy loam or loamy sand.

In some pedons, a Cg horizon, if present, has hue of 5Y or 5GY, value of 5 or 6, and chroma of 1. The Cg horizon also, has pockets of marl or shell and calcium carbonate fragments. Texture is fine sandy loam or loamy fine sand.

EauGallie Series

The soils of the EauGallie series are sandy, siliceous, hyperthermic Alfic Haplaquods. They are poorly drained, moderately permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are on broad flatwoods. In wet seasons, the water table is within a depth of 10 inches of the surface for 2 to 4 months. In most years, the water table is at a depth of 48 inches for more than 6 months. The slope ranges from 0 to 2 percent.

EauGallie soils are associated with Myakka, Oldsmar, Pepper, Wabasso, and Winder soils. Myakka soils do not have an argillic horizon. Oldsmar soils have a Bh horizon that is deeper than the Bh horizon in the EauGallie soils. Pepper soils have an ortstein horizon. Wabasso soils have a Bt horizon at a shallower depth than the Bt horizon in the EauGallie soils. Winder soils do not have a Bh horizon.

Typical pedon of EauGallie fine sand; on the flatwoods, 1/2 mile north of Florida State Road 60, east of U.S. Interstate Highway 95, 1/4 mile east on Old Subdivision Road; NW1/4NE1/4, sec. 3, T. 33 S., R. 38 E.

Ap—0 to 5 inches; black (10YR 2/1) fine sand; weak fine granular structure; very friable; very strongly acid; clear wavy boundary.

A—5 to 15 inches; dark gray (10YR 4/1) fine sand; single grained; loose; very strongly acid; clear smooth boundary.

E—15 to 26 inches; gray (10YR 5/1) fine sand; single grained; loose; very strongly acid; abrupt wavy boundary.

Bh1—26 to 30 inches; black (10YR 2/1) fine sand; moderate fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

Bh2—30 to 34 inches; very dark gray (10YR 3/1) fine sand; weak fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

Bh3—34 to 37 inches; dark reddish brown (5YR 3/2) fine sand; weak fine granular structure; very friable; strongly acid; clear smooth boundary.

Bh4—37 to 42 inches; dark brown (10YR 3/3) fine sand; single grained; loose; strongly acid; clear smooth boundary.

BE—42 to 47 inches; brown (10YR 5/3) fine sand; single grained; loose; strongly acid; abrupt wavy boundary.

Btg1—47 to 54 inches; grayish brown (2.5Y 5/2) sandy loam; few medium distinct dark brown (7.5YR 4/4) streaks and common medium brown (10YR 5/3) mottles; weak medium subangular blocky structure; slightly sticky and slightly plastic; medium acid; clear wavy boundary.

Btg2—54 to 62 inches; gray (5Y 6/1) sandy loam; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

Cg—62 to 80 inches; light brownish gray (10YR 6/2) loamy fine sand; single grained; loose; medium acid.

The thickness of the solum is more than 50 inches. Depth to the spodic horizon ranges from 15 to 30 inches, and depth to the argillic horizon ranges from 40 to 80 inches. The A, E, and Bh horizons are sand or fine sand.

The A horizon, if rubbed, has hue of 10YR, value of 2 to 4, and chroma of 1. If value is less than 3.5, thickness is less than 10 inches. Unrubbed colors often have a salt-and-pepper appearance. The E horizon has hue of 10YR, value of 6 or 7, and chroma of 1 or 2; or it has hue of 10YR, value of 5, and chroma of 1. The total thickness of the A and E horizons is less than 30 inches. Reaction ranges from very strongly acid to moderately alkaline in areas where the surface layer has been limed.

The Bh horizon has hue of 5YR, value of 2 or 3, and chroma of 1 or 2; or hue of 10YR, value of 2 or 3, and chroma of 1 to 3. The sand grains are well coated with organic matter. The thickness of the Bh horizon ranges from 3 to 36 inches. Reaction ranges from very strongly acid to slightly acid. The BE horizon, if present, has hue of 10YR, value of 4 or 5, and chroma of 3. The thickness of the BE horizon ranges from 0 to 17 inches. Texture is fine sand. In some pedons an E' horizon is present, and it has hue of 10YR, value of 5 or 6, and chroma of 2. Texture is sand or fine sand. The thickness of the E' horizon ranges from 0 to 11 inches. The Btg horizon has hue of 10YR, value of 5 or 6, and chroma of 3; or hue of 10YR, value of 5, and chroma of 2; or hue of 2.5Y, value of 5, and chroma of 2; or hue of 5Y, value of 5 or 6, and chroma of 1; or hue of 5Y, value of 5, and chroma of 2. Few or common, fine or medium brown yellowish brown, or brownish yellow mottles can be present throughout. Texture is sandy loam or sandy clay loam. The thickness of the Btg horizon ranges from about 6 to 20 inches. Reaction ranges from strongly acid to slightly acid.

The Cg horizon has hue of 10YR or 5Y, value of 6, and chroma of 1 or 2. Texture is sand or loamy fine sand. In some pedons, the C horizon can have up to 16 percent light gray shell fragments that are about 1 centimeter in size. Reaction ranges from medium acid to mildly alkaline.

Electra Series

The soils of the Electra series are sandy, siliceous, hyperthermic Arenic Ultic Haplohumods. They are deep, somewhat poorly drained, slowly permeable or very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level to gently sloping soils are on knolls on the flatwoods and in adjacent drainageways. The water table is at a depth of 25 to 40 inches for 4 consecutive months during most years and recedes to a depth or more than 40 inches during drier periods. The slope ranges from 0 to 5 percent.

Electra soils are associated with Immokalee, Oldsmar, and Orsino soils. Immokalee and Oldsmar soils are poorly drained. In addition, Immokalee soils do not have an argillic horizon, and Oldsmar soils are less acid than Electra soils. Orsino soils are moderately well drained and do not have an argillic horizon.

Typical pedon of Electra sand, 0 to 5 percent slopes; in an area adjacent to the south prong of Sebastian Creek; NW1/4NW1/4SW1/4, sec. 23, T. 31 S., R. 38 E.

A—0 to 5 inches; dark gray (10YR 4/1) sand; single grained; loose; common fine and few medium roots; very strongly acid; clear smooth boundary.

E—5 to 30 inches; light gray (10YR 7/1) sand; single grained; loose; common medium and many fine roots; very strongly acid; abrupt wavy boundary.

Bh1—30 to 33 inches; dark reddish brown (5YR 3/2) sand; weak medium subangular blocky structure; weakly cemented in less than 50 percent of the horizon; friable; sand grains well coated with organic matter; few fine and common medium roots; extremely acid; gradual wavy boundary.

Bh2—33 to 36 inches; dark reddish brown (5YR 3/3) loamy sand; few medium yellowish red (5YR 4/6) moderately cemented nodules 1/2 inch in diameter; moderate medium subangular blocky structure; weakly cemented in less than 50 percent of the horizon; friable; sand grains well coated with organic matter; few fine roots; extremely acid; clear wavy boundary.

BE—36 to 47 inches; brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; few fine and medium roots; extremely acid; abrupt wavy boundary.

Btg1—47 to 59 inches; light brownish gray (10YR 6/2) sandy loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; slightly sticky when wet and nonplastic; few fine and medium roots; sand grains coated and bridged with clay; extremely acid; gradual smooth boundary.

Btg2—59 to 80 inches; light brownish gray (10YR 6/2) sandy loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; slightly sticky and nonplastic; strongly acid.

The thickness of the solum is more than 80 inches. Depth to the spodic horizon is about 30 inches, and depth to the argillic horizon is more than 40 inches. Reaction ranges from extremely acid to strongly acid.

The A horizon has hue of 10YR, value of 4, and chroma of 1. Thickness ranges from 2 to 5 inches. The E horizon has hue of 10YR, value of 7, and chroma of 1; or hue of 10YR, value of 6, and chroma of 2 and can have dark brown streaks or mottles. Texture of the A and E horizon is sand or fine sand. The total thickness of the A and E horizons ranges from 30 to 37 inches.

The Bh horizon has hue of 10YR, value of 3, and chroma of 1; or hue of 5YR, value of 3, and chroma of 2 or 3; or it is neutral, with value of 2, and chroma of 0. Texture is sand, fine sand, or loamy sand. Thickness of the Bh horizon ranges from 6 to 17 inches. In some pedons is a BE horizon that has hue of 7.5YR, value of

4, and chroma of 4; or hue of 10YR, value of 5, and chroma of 4. In addition, some pedons have an E' horizon of sand or fine sand that has hue of 10YR, value of 6, and chroma of 3. This E' horizon has dark yellowish brown and yellowish brown mottles. The Btg horizon has hue of 10YR, value of 6, and chroma of 2 or 3; or hue of 10YR, value of 5, and chroma of 4 and can have brownish yellow or olive brown mottles or very dark brown stains along old root channels. Texture is sandy loam or fine sandy loam.

Floridana Series

The soils of the Floridana series are loamy, siliceous, hyperthermic Arenic Argiaquolls. They are very poorly drained, slowly permeable to very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are in depressions, in poorly defined drainageways, and on broad, low flats. The water table is above the surface for short periods after heavy rainfall or within a depth of 10 inches for more than 6 months during most years. It is at a depth of 10 to 30 inches for short periods during dry seasons. Depressional areas are ponded for 6 months or more. The slope is less than 2 percent.

Floridana soils are associated with Chobee, Manatee, Oldsmar, Wabasso, Riviera, and Winder soils. Chobee and Manatee soils have a Bt horizon at a depth of less than 20 inches. The remaining associated soils do not have a mollic epipedon and are poorly drained. In addition, Oldsmar and Wabasso soils have a spodic horizon, and Winder soils have a Bt horizon at a depth of less than 20 inches.

Typical pedon of Floridana sand; in an area of citrus; NW1/4SW1/4NW1/4, sec. 7, T. 31 S., R. 37 E.

Ap—0 to 5 inches; black (10YR 2/1) sand, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; friable; few very fine, common fine and medium roots; neutral; gradual wavy boundary.

A—5 to 14 inches; black (10YR 2/1) sand, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; few very fine, common fine and medium roots; neutral; clear wavy boundary.

E—14 to 20 inches; light brownish gray (10YR 6/2) sand; single grained; loose; common fine, few medium roots; slightly acid; abrupt wavy boundary.

Btg1—20 to 30 inches; gray (10YR 5/1) sandy clay loam; common fine and medium distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; slightly sticky and slightly plastic; few fine and medium pockets and streaks of black (N 2/0) along old root channels; slightly acid; gradual irregular boundary.

Btg2—30 to 34 inches; gray (10YR 5/1) sandy clay loam; many fine and medium distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; slightly sticky and slightly plastic; few fine and medium black (N 2/0) pockets and streaks along old root channels; mildly alkaline; clear irregular boundary.

BCg—34 to 37 inches; gray (5Y 6/1) sandy clay loam; many fine and medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; many fine and medium white (10YR 8/1) pockets of soft calcium carbonate; strongly effervescent; mildly alkaline; gradual irregular boundary.

Cgk1—37 to 53 inches; gray (10YR 6/1) sandy loam; few medium distinct gray (10YR 4/1) and few fine prominent yellowish brown (10YR 5/8) streaks; weak medium subangular blocky structure; slightly sticky and nonplastic; common fine white (10YR 8/1) calcium carbonate masses; strongly effervescent; moderately alkaline; clear wavy boundary.

Cgk2—53 to 68 inches; dark gray (10YR 4/1) sandy loam; common coarse distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; slightly sticky and nonplastic; common white (10YR 8/1) calcium carbonate concretions 1/8 to 1 inch in diameter; strongly effervescent; moderately alkaline; clear wavy boundary.

Cgk3—68 to 80 inches; light gray (10YR 6/1) sandy clay loam; few fine distinct yellowish brown (10YR 5/6) and few fine distinct greenish gray (5GY 6/1) mottles; weak fine subangular blocky structure; nonsticky and slightly plastic; slightly effervescent; mildly alkaline.

The thickness of the solum is more than 35 inches. Reaction ranges from very strongly acid to neutral in the A and Ap horizons and from slightly acid to moderately alkaline throughout the rest of the pedon.

The A or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or it is neutral with value of 2. Texture is sand, fine sand, or mucky fine sand. Thickness ranges from 12 to 21 inches.

The E horizon has hue of 10YR, value of 4 to 7, and chroma of 1 or 2. Texture is sand or fine sand. Thickness ranges from 6 to 10 inches.

The Btg horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2; or hue of 5Y, value of 5, and chroma of 1 or 2 and can have mottles of gray, yellow, and brown. Texture is sandy loam or sandy clay loam. Some pedons have pockets of loamy fine sand or calcium carbonate fragments and nodules 1 millimeter to 4 millimeters in size. Thickness ranges from 10 to 20 inches. The BCg horizon has hue of 10YR or 5Y, value of 4 to 6, and chroma of 1 or 2. This horizon can have mottles of gray, yellow, and brown. Texture is sandy loam, fine sandy loam, or sandy clay loam. Some pedons have pockets of loamy fine sand, calcium carbonate fragments, and nodules that are 1 millimeter

to 3 millimeters in size, or accumulations of soft marly material. Thickness ranges from 3 to 28 inches.

The Cgk horizon has hue of 10YR, 5Y, or 5GY, value of 4 to 6, and chroma of 1. Texture is loamy sand, sandy loam, or sandy clay loam. This horizon can have pockets of marl or shell and calcium carbonate fragments.

Gator Series

The soils of the Gator series are loamy, siliceous, euic, hyperthermic Terric Medisaprists. They are very poorly drained, moderately slowly permeable soils that formed in moderately thick beds of hydrophytic plant remains underlain by beds of loamy and sandy marine sediment. These nearly level soils are in freshwater swamps and marshes. Under natural conditions, the water table is above the surface for most of the year except during extended dry periods. In drained areas, the water table is controlled at a depth of 10 to 36 inches or controlled according to the need of the crop. The water table is at or above the surface for short periods after heavy rainfall and during normal periods of high seasonal rainfall. The slope is 0 to 1 percent.

Gator soils are associated with Terra Ceia, Canova, Delray, and Floridana soils. Terra Ceia soils have organic layers that are more than 51 inches thick. Canova, Delray, and Floridana soils are mineral soils. In addition, Canova soils have a thin surface layer of organic material and an argillic horizon within a depth of 20 inches of the surface. Floridana and Delray soils have a mollic epipedon. In addition, Floridana soils have an argillic horizon at a depth of 20 to 40 inches, and Delray soils have an argillic horizon at a depth of 40 to 80 inches.

Typical pedon of Gator muck (fig. 15); in a pasture, 8.5 miles west of Fellsmere, 0.5 mile west of Lateral Q Canal, 0.15 mile north of Ditch 13; Block 13 J; NW1/4NW1/4NE1/4, sec. 22, T. 31 S., R. 36 E.

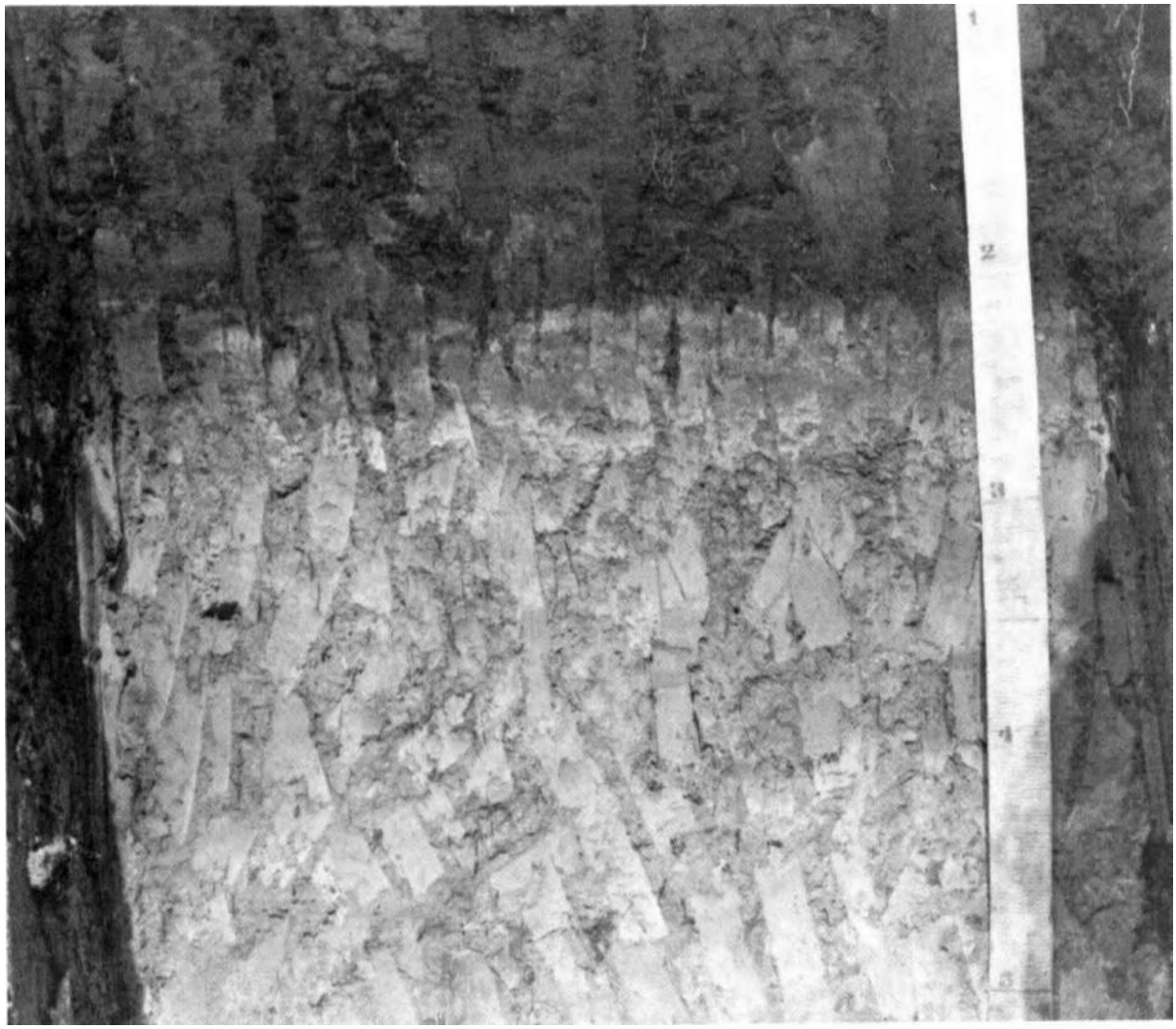


Figure 15.—Profile of Gator muck underlain by sandy clay and sandy clay loam material. This soil is well suited to improved grasses.

Oap—0 to 6 inches; very dark brown (10YR 2/2) muck; about 10 percent fiber unrubbed, less than 5 percent rubbed; weak fine subangular blocky structure; very friable; common fine and very fine roots; light yellowish brown (10YR 6/4) sodium pyrophosphate extract; slightly acid (pH 5.3 in 0.01 molar calcium chloride solution); clear smooth boundary.

Oa—6 to 26 inches; very dark brown (10YR 2/2) muck; few common dark brown (10YR 3/3) streaks; about 40 percent fiber unrubbed, 5 percent rubbed; moderate medium subangular blocky structure; friable; many fine and very fine roots; brown (10YR 5/3) sodium pyrophosphate extract; slightly acid (pH 4.4 in 0.01 molar calcium chloride solution); abrupt smooth boundary.

Cg1—26 to 30 inches; very dark gray (10YR 3/1) sandy clay loam; weak fine subangular blocky structure; slightly sticky and slightly plastic; many fine and very fine roots; few fine dark gray stains along root channels; very strongly acid after drying; abrupt smooth boundary.

Cg2—30 to 44 inches; dark gray (10YR 4/1) sandy clay loam; moderate medium subangular blocky structure; common (nonintersecting) pressure faces on peds; slightly sticky and plastic; common fine roots; medium acid after drying; gradual wavy boundary.

Cg3—44 to 49 inches; dark gray (N 4/0) sandy clay loam; moderate medium subangular blocky structure; slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

Cg4—49 to 54 inches; greenish gray (5GY 5/1) sandy clay loam; moderate medium subangular blocky structure; slightly sticky and slightly plastic; common fine and medium distinct yellowish brown (10YR 5/4) stains; few fine and medium light gray (10YR 7/1) calcium carbonate accumulations; slightly effervescent; mildly alkaline; gradual wavy boundary.

Cg5—54 to 62 inches; greenish gray (5GY 5/1) sandy clay loam; moderate fine subangular blocky structure; slightly sticky and nonplastic; common medium distinct yellowish brown (10YR 5/4) mottles; common coarse light gray (5Y 7/1) calcium carbonate accumulations; strongly effervescent; few fine roots; moderately alkaline; clear wavy boundary.

Cg6—62 to 80 inches; greenish gray (5GY 5/1) sandy clay loam; weak fine subangular blocky structure; nonsticky and nonplastic; common medium distinct dark gray (5Y 4/1) streaks along old root channels; common medium prominent yellowish brown (10YR 5/8) sandy loam stains and splotches; slightly effervescent; moderately alkaline.

The thickness of organic material and depth to mineral material are less than 51 inches and commonly range from 22 to 46 inches. Soil reaction is slightly acid to mildly alkaline by the Hellige-Truog method in the Oap and Oa horizons. After drying, it is very strongly acid to moderately alkaline in the Cg1, Cg2, and Cg3 horizons and is neutral to moderately alkaline in the Cg4, and Cg5 horizons and in the Cg6 horizon, if present.

The Oa or Oap horizon has hue of 10YR, 5YR, or N, value of 2, and chroma of 2 or less; or hue of 5YR, value of 2 or 3, and chroma of 2 or less. Sodium pyrophosphate extract colors have hue of 10YR, value of 2 through 4, and chroma of 4 or less; or hue of 10YR, value of 5, and chroma of 2 through 4; or hue of 10YR, value of 5 or 6, and chroma of 3 or 4.

The Cg1, Cg2, and Cg3 horizons have hue of 10YR, value of 2 through 4, and chroma of 1; or hue of 10YR, value of 2, and chroma of 2; or they are neutral with value of 2 through 4 and can have mottles and streaks in shades of brown or gray. Texture is sandy loam, sandy clay loam, or sandy clay. Clay content is 18 to 40 percent. If the clay content in these horizons is more than 35 percent, the weighted average particle size of the mineral layer in the control section still qualifies for a loamy family.

The Cg4, Cg5, and Cg6 horizons have hue of 5GY or 5Y, value of 5, and chroma of 1 and can have light olive brown, olive brown, and olive yellow mottles and streaks. Texture is sandy clay loam or sandy loam that has lenses of sand and loamy sand. Few to common, fine and medium, soft and hard light gray fragments of carbonatic material are in this horizon. In some pedons, the Cg6 horizon is loamy sand.

Holopaw Series

The soils of the Holopaw series are loamy, siliceous, hyperthermic Grossarenic Ochraqualfs. They are poorly drained, moderately slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are on broad low flats, in poorly defined drainageways, and in depressional areas. The water table is within a depth of 10 inches of the surface for 2 to 6 months each year. The depressional areas are ponded for 6 to 9 months or more. The slope ranges from 0 to 2 percent.

Holopaw soils are associated with EauGallie, Malabar, Oldsmar, Pineda, Riviera, and Wabasso soils. EauGallie, Oldsmar, and Wabasso soils have a spodic horizon. Malabar soils have a Bw horizon. Pineda and Riviera soils have an argillic horizon at a depth of 20 to 40 inches. In addition Pineda soils have a Bw horizon.

Typical pedon of Holopaw fine sand; in a broad, low flat planted to slash pine, about 1.25 miles south of Indian River County Road 512; NE1/4NW1/4NW1/4, sec. 26, T. 31 S., R. 37 E.

Ap—0 to 5 inches; very dark gray (10YR 3/1) fine sand; mixture of organic matter and light gray sand grains, salt-and-pepper appearance when dry; weak fine

granular structure; very friable; common fine roots; slightly acid; gradual wavy boundary.
A—5 to 12 inches; dark grayish brown (10YR 4/2) fine sand; single grained; loose; few medium and fine roots; slightly acid; clear smooth boundary.
E1—12 to 30 inches; pale brown (10YR 6/3) fine sand; single grained; loose; few medium roots; slightly acid; clear smooth boundary.
E2—30 to 45 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; slightly acid; abrupt wavy boundary.
Btg—45 to 62 inches; grayish brown (10YR 5/2) sandy loam; few fine faint yellowish brown mottles; moderate medium subangular blocky structure; slightly sticky and slightly plastic; common pockets of brown (10YR 5/3) fine sand; neutral; gradual wavy boundary.
Cg—62 to 80 inches; olive gray (5Y 5/2) loamy fine sand; weak fine subangular blocky structure; nonsticky and nonplastic; few pockets of brown (10YR 5/3) fine sand; neutral.

The thickness of the solum ranges from 50 to 80 inches or more. Reaction is slightly acid or neutral in the surface and subsurface layers and is slightly acid to moderately alkaline in the subsoil and substratum.

The A or Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 2 or less. Thickness ranges from 2 to 13 inches, but if value is 3 or less, the thickness is less than 7 inches.

The E horizon has hue of 10YR, value of 4 to 7, and chroma of 2 or less. This part of the E horizon can have yellowish brown mottles; or the E horizon has hue of 10YR, value of 6, and chroma of 3. Texture of the A and E horizons is sand or fine sand. The total thickness is more than 40 inches.

The Btg horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 or less and has mottles in shades of brown and yellow. Texture is sandy loam, fine sandy loam, or sandy clay loam. Many pedons have pockets and lenses of sand or fine sand. Thickness ranges from 12 to 20 inches. The BCg horizon, if present, has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 or less. Texture is sandy loam or fine sandy loam. Some pedons do not have a BCg horizon.

The Cg horizon has hue of 10YR or 5Y, value of 5, and chroma of 2 or less. Texture is sand, fine sand, loamy fine sand, or loamy sand.

Immokalee Series

The soils of the Immokalee series are sandy, siliceous, hyperthermic Arenic Haplaquods. They are poorly drained, moderately permeable soils that formed in beds of sandy marine sediment. These nearly level soils are on broad flatwoods. In most years, the water table is within a depth of 10 inches of the surface for 1 to 3 months and at a depth of 10 to 40 inches for 6 to 9 months. The slope ranges from 0 to 2 percent.

Immokalee soils are associated with Astatula, Myakka, Oldsmar, Pomello, Pompano, and Satellite soils. Astatula soils do not have a Bh horizon within a depth of 30 inches of the surface and are excessively drained. Myakka soils have a Bh horizon at a depth of 20 to 30 inches. Pomello soils are better drained than Immoaklee soils. Oldsmar soils have an argillic horizon at a depth of more than 40 inches. Pompano soils do not have a Bh horizon. Satellite soils do not have a Bh horizon and are somewhat poorly drained.

Typical pedon of Immokalee fine sand; on the flatwoods, 20 feet east of Indian River County Road 505, about 500 feet north of entrance to MacDonald State Campground; SW1/4, sec. 22, T. 31 S., R. 38 E.

A—0 to 5 inches; very dark gray (10YR 3/1) fine sand; mixture of organic matter and light gray sand grains, salt-and-pepper appearance when dry; weak fine granular structure; very friable; many fine and few medium roots; very strongly acid; clear smooth boundary.
E—5 to 35 inches; light gray (10YR 7/1) fine sand; single grained; loose; common medium and few fine roots; very strongly acid; abrupt wavy boundary.
Bh—35 to 55 inches; very dark gray (5YR 3/1) fine sand; single grained; loose; sand grains well coated with organic matter; few fine roots; very strongly acid; clear wavy boundary.
BC—55 to 80 inches; brown (10YR 5/3) fine sand; weak fine subangular blocky structure; very friable; strongly acid.

Depth to the spodic horizon ranges from 33 to 50 inches. Texture is sand or fine sand throughout. Reaction ranges from very strongly acid to medium acid. In some pedons that have shell fragments at a depth of 50 inches or more, the reaction is mildly alkaline.

The A or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or hue of 10YR, value of 4, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. Thickness ranges from 2 to 9 inches.

The E horizon has hue of 10YR, value of 5 to 8, and chroma of 1; or hue of 10YR, value of 5, and chroma of 2. In some pedons, a transitional horizon 1/2 inch to 2 inches thick is between the base of the E horizon and the Bh horizon. Thickness ranges from 25 to 41 inches. In addition, some pedons have a dense mat of partially decomposed medium and fine roots underlain by the Bh horizon.

The Bh horizon has hue of 10YR or 5YR, value of 2 or 3, and chroma of 1; or hue of 10YR or 5YR, value of 3, and chroma of 2. Some pedons have very dark grayish brown streaks or fragments of weakly cemented spodic bodies. Some pedons also can be weakly cemented in

less than 50 percent of any subhorizon. Thickness ranges from 12 to 28 inches. Some pedons have an E' and Bh' horizon below the Bh horizon. The E' and Bh' horizons have hue of 10YR, value of 5 to 8, and chroma of 1; or hue of 10YR, value of 5, and chroma of 2; or hue of 10YR or 5YR, value of 2 or 3, and chroma of 1; or hue of 10YR or 5YR, value of 3, and chroma of 2. The BC horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. Some pedons have a BC&Bh horizon. The Bh part of the BC&Bh horizon has hue of 10YR or 5YR, value of 2 or 3, and chroma of 1; or hue of 10YR or 5YR, value of 3, and chroma of 2.

The C horizon, if present, has hue of 10YR, value of 4 or 5, and chroma of 2.

Jonathan Series

The soils of the Jonathan series are sandy, siliceous, hyperthermic, ortstein Typic Haplohumods. They are somewhat excessively drained, slowly permeable to very slowly permeable soils that formed in thick beds of sandy marine sediment. These nearly level to gently sloping soils are on the Atlantic Coastal Ridge and on slightly elevated knolls on the flatwoods. The water table is at a depth of 40 to 60 inches for 1 to 4 months during periods of extremely high precipitation. It is below 60 inches for most of the remainder of the year. The slope ranges from 0 to 5 percent.

Jonathan soils are associated with Immokalee, Myakka, Pomello, Satellite, and St. Lucie soils. These associated soils do not have an ortstein layer. In addition, Immokalee and Myakka soils are poorly drained. Pomello soils have a spodic horizon within a depth of 50 inches of the surface and are moderately well drained. Satellite and St. Lucie soils do not have a spodic horizon. St. Lucie soils are excessively drained, and Satellite soils are somewhat poorly drained.

Typical pedon of Jonathan sand, 0 to 5 percent slopes; on the undisturbed flatwoods, about 1/4 mile west of railroad crossing, 0.45 mile south of South Gifford Road, 1/2 mile south of power substation; SW1/4SE1/4SW1/4, sec. 26, T. 32 S., R. 39 E.

A—0 to 3 inches; dark gray (10YR 4/1) sand; single grained; loose; many fine and very fine roots; strongly acid; clear smooth boundary.

E1—3 to 75 inches; white (10YR 8/1) sand; single grained; loose; many fine and medium and few coarse roots that decrease in number; medium acid; abrupt wavy boundary.

Bhm—75 to 80 inches; dark reddish brown (5YR 3/2) sand; thin 1 centimeter black (5YR 2/1) surface layer; strong medium subangular blocky structure; 60 to 75 percent strongly cemented; firm or very firm; very strongly acid.

The thickness of the solum is more than 80 inches. Depth to the spodic horizon is more than 50 inches. Texture is sand or fine sand throughout. Reaction ranges from very strongly acid to medium acid in the A and E horizons and extremely acid to very strongly acid in the Bh horizon.

The A horizon has hue of 10YR, value of 4 through 7, and chroma of 1. Thickness ranges from 1 to 6 inches. The E horizon has hue of 10YR, value of 7 or 8, and chroma of 1. This horizon has stains and streaks of darker colors in old root channels. The total thickness of the A and E horizons is more than 50 inches.

In some pedons, a transitional layer is present between the E and Bh horizons. It has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. In addition, a dense mat of partially decomposed fine and medium roots is underlain by the Bh horizon in some pedons.

The Bh horizon has hue of 10YR, value of 2, and chroma of 1 or 2; or hue of 5YR, value of 3, and chroma of 2 or 3. Cementation is variable in most pedons, but more than half of the Bh horizon in each pedon is weakly to strongly cemented. In some pedons, this horizon has pockets of E horizon material.

In a few pedons, a C horizon is at a depth of 80 inches. It has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. Texture is sand or fine sand.

Jupiter Series

The soils of the Jupiter series are sandy, siliceous, hyperthermic Lithic Haplaquolls. They are poorly drained, rapidly permeable soils that formed in thin beds of sandy marine sediment underlain by fractured limestone bedrock. These nearly level soils are on low flats and hammocks. They are saturated during the wet periods. The slope ranges from 0 to 2 percent.

Jupiter soils are associated with Boca, Chobee, Floridana, Manatee, Wabasso, and Winder soils. Chobee, Floridana, Manatee, Wabasso, and Winder soils are not underlain by limestone and have an argillic horizon. Boca, Wabasso, and Winder soils do not have a mollic epipedon. In addition, Boca soils are underlain by limestone at a depth of 22 to 40 inches. Also, Boca soils have an argillic horizon.

Typical pedon of Jupiter fine sand; on a low hammock, about 1-1/4 mile north of the St. Lucie-Indian River County line; NE1/4SW1/4SE1/4, sec. 28, T. 33 S., R. 39 E.

A1—0 to 5 inches; black (10YR 2/1) fine sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; many fine and common medium roots; many fine interstitial pores; common dark grayish brown (10YR 4/2) uncoated sand grains; slightly acid; clear wavy boundary.

A2—5 to 12 inches; black (10YR 2/1) fine sand, very dark brown (10YR 2/2) dry; single grained; loose; common fine and few coarse roots; slightly acid; abrupt irregular boundary.

2R—12 inches; hard fractured limestone bedrock; fractures 1 inch to 4 inches wide, filled with A2 material, mixed with carbonatic material in places; smooth to wavy rock surface, underside irregular and broken.

Depth to limestone ranges from 10 to 20 inches in the main part of each pedon but is at a depth of more than 20 inches where fractures occur. Reaction ranges from slightly acid to moderately alkaline throughout.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or it is neutral with value of 2. Uncrushed colors have a salt-and-pepper appearance. Texture is sand or fine sand. Thickness ranges from 7 to 20 inches.

In some pedons, a C horizon is between the A horizon and the limestone. The C horizon has hue of 10YR, value of 4, and chroma of 2; or hue of 10YR, value of 5 through 7, and chroma of 1 or 2. Texture is sand or fine sand. Thickness ranges from 0 to 6 inches. Also in some pedons, a thin, discontinuous layer of soft weathered limestone is on the surface of the bedrock.

The 2R horizon is limestone bedrock that has many fractures and a few solution holes. The limestone is 10 to 24 inches or more thick. Solution holes contain light gray to yellowish brown sand, sandy loam, marl, or mixed loamy sand and marl material.

Kesson Series

The soils of the Kesson series are siliceous, hyperthermic Typic Psammaquents. They are deep, very poorly drained, moderately rapidly permeable soils that formed in thick marine deposits of sand and shell fragments. These nearly level soils are in tidal swamps and marshes. These swamps and marshes are adjacent to the Indian River. Under natural conditions, this soil is flooded during normal high tides. The slope is less than 1 percent.

Kesson soils are associated with Captiva, McKee, Pompano, Canaveral, and Palm Beach soils. Palm Beach soils are excessively drained. Canaveral soils are somewhat poorly drained to moderately well drained. Pompano and Captiva soils are poorly drained. In addition, Captiva, Pompano, Canaveral, and Palm Beach soils do not have a muck surface. McKee soils are clay loam in texture to a depth of 60 inches or more and are very fluid when squeezed in the hand.

Typical pedon of Kesson muck; 1,000 feet west of Florida State Road A1A; NE1/4SW1/4, sec. 20, T. 30 S., R. 369 E.

Oa—0 to 6 inches; dark reddish brown (5YR 3/2) muck; weak medium subangular blocky structure resemblance; friable; about 30 percent fiber unrubbed, less than 5 percent rubbed; many very fine roots; strongly alkaline; abrupt smooth boundary.

C1—6 to 30 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; many very fine and fine roots; few fine and medium pockets of dark reddish brown muck; about 15 percent shell fragments; strongly alkaline; calcareous; gradual irregular boundary.

C2—30 to 38 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; few very fine and fine roots; common fine and medium very dark grayish brown (10YR 3/2) streaks; about 20 percent shell fragments; moderately alkaline; calcareous; clear smooth boundary.

Cg—38 to 80 inches; dark greenish gray (5GY 4/1) fine sand; single grained; loose; few very fine roots; about 25 percent shell fragments; few shell fragments 3 to 30 millimeters in diameter; calcareous; moderately alkaline.

Reaction ranges from mildly alkaline to strongly alkaline, and the soil is calcareous. It does not become extremely acid when dry. Below the Oa horizon, the texture is sand or fine sand.

The Oa horizon has hue of 10YR or 5YR, value of 2 or 3, and chroma of 1 or 2. Thickness of the Oa horizon is 0 to 7 inches. The fiber content ranges from 30 to 40 percent unrubbed and is less than 10 percent rubbed. An A horizon can be present in some pedons.

The C horizon has hue of 10YR, value of 2 to 5, and chroma of 2 or 3. This horizon can have a few, fine and medium pockets of dark reddish brown or black muck. Thickness ranges from 4 to 40 inches. The content of shell fragments ranges from 5 to 20 percent. The Cg horizon has hue of 10YR, 5Y, or 5GY, value of 4 to 6, and chroma of 1 or 2; or hue of 5GY or 5G, value of 4, and chroma of 1. The content of shell fragments ranges from 3 to 30 percent.

Lokosee Series

The soils of the Lokosee series are loamy, siliceous, hyperthermic Grossarenic Ochraqualfs. They are poorly drained, slowly or very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are on low hammocks, on broad low flats that are adjacent to the flatwoods, and in poorly defined drainageways. In most years, the water table is within a depth of 10 inches of the surface for 2 to 4 months and at a depth of 10 to 40 inches for more than 6 months. During extended dry periods, it recedes to a depth of more than 40 inches. The slope ranges from 0 to 2 percent.

Lokosee soils are associated with Holopaw, Pineda, Riviera, Oldsmar, and EauGallie soils. Pineda and Riviera soils have an argillic horizon at a depth of 20 to 40 inches. Holopaw and Riviera soils do not have a high chroma Bw horizon. Oldsmar and EauGallie soils have a spodic horizon.

Typical pedon of Lokosee fine sand; in a poorly defined drainageway in Vero Lake Estates; SW1/4NW1/4SW1/4, sec. 34, T. 31 S., R. 38 E.

A—0 to 3 inches; black (10YR 2/1) fine sand; single grained; loose; many fine and medium roots; very strongly acid; clear smooth boundary.
E—3 to 10 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; common fine and medium roots; slightly acid; gradual smooth boundary.
Bw1—10 to 19 inches; mottled very pale brown (10YR 7/4) and brownish yellow (10YR 6/6) sand; single grained; loose; few fine and medium roots; neutral; clear smooth boundary.
Bw2—19 to 30 inches; strong brown (7.5YR 5/8) sand; common medium and coarse prominent very pale brown (10YR 7/4) mottles; single grained; loose; neutral; clear smooth boundary.
Bw3—30 to 35 inches; very pale brown (10YR 7/4) sand; many coarse distinct brownish yellow (10YR 6/6) mottles; single grained; loose; neutral; clear smooth boundary.
Bh—35 to 45 inches; dark brown (10YR 4/3) sand; single grained; loose; slightly acid; clear smooth boundary.
E'1—45 to 50 inches; light brownish gray (10YR 6/2) sand; few fine faint dark grayish brown mottles; single grained; loose; slightly acid; gradual smooth boundary.
E'2—50 to 70 inches; pale brown (10YR 6/3) sand; common medium prominent greenish gray (5GY 5/1) sandy loam pockets; single grained; loose; neutral; abrupt irregular boundary.
Btg—70 to 80 inches; greenish gray (5GY 5/1) sandy clay loam; common fine prominent very dark grayish brown (10YR 3/2) streaks; weak medium subangular blocky structure; very friable; slightly sticky and nonplastic; moderately alkaline.

The thickness of the solum ranges from 46 to 80 inches or more. The combined thickness of the A, E, Bw, and Bh horizons is more than 40 inches. Reaction in the A horizon ranges from very strongly acid to slightly acid. Reaction in the underlying horizons ranges from slightly acid to moderately alkaline.

The A or Ap horizon has hue of 10YR, value of 2 through 4, and chroma of 1 or 2. Thickness ranges from 3 to 7 inches. If the value is 3 or less, the A horizon is less than 6 inches thick. Texture is sand or fine sand.

The E and E' horizons have hue of 10YR, value of 5 to 7, and chroma of 2 or 3. Texture is sand or fine sand.

The Bw horizon has hue of 10YR, value of 6 or 7, chroma of 4 through 8; or hue of 7.5YR, value of 5 to 7, and chroma of 6 to 8. Thickness of the Bw horizon ranges from 16 to 25 inches. Texture is sand or fine sand. The Bh horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. Thickness ranges from 4 to 20 inches. Texture is sand or fine sand. The Btg horizon has hue of 10YR, value of 4 through 6, and chroma of 1 or 2; or hue of 2.5Y or 5GY, value of 5, and chroma of 1 or 2 and can have very dark grayish brown or yellowish brown streaks and mottles. Texture is sandy loam, fine sandy loam, or sandy clay loam. In some pedons, this horizon has few, fine to coarse streaks or pockets of coarser material.

The Cg horizon, if present, has hue of 10YR, value of 5 or 6, and chroma of 1 or 2; or hue of 5Y, value of 6, and chroma of 1. Texture is sand, fine sand, or loamy fine sand.

Malabar Series

The soils of the Malabar series are loamy, siliceous, hyperthermic Grossarenic Ochraqualfs. They are poorly drained, slowly permeable to very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are in low, narrow to broad sloughs, on flats, and in poorly defined drainageways. The water table is at a depth of less than 10 inches of the surface for 2 to 6 months each year and at a depth of 10 to 40 inches for most of the remainder of the year. The slope ranges from 0 to 2 percent.

Malabar soils are associated with EauGallie, Floridana, Oldsmar, Pineda, Riviera, and Wabasso soils. EauGallie, Oldsmar, and Wabasso soils have a spodic horizon. Floridana soils have a mollic epipedon and are very poorly drained. Pineda soils have an argillic horizon at a depth of 20 to 40 inches. Riviera soils do not have a high chroma Bw horizon.

Typical pedon of Malabar fine sand; on a low, broad flat, about 0.2 mile south of Oslo Road, 0.3 mile west of 33rd Avenue; NE1/4SW1/4NW1/4, sec. 27, T. 33 S., R. 39 E.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) fine sand; mixture of organic matter and light gray sand grains, salt-and-pepper appearance when dry; weak fine granular structure; very friable; many fine and few medium roots; slightly acid; gradual smooth boundary.
E1—3 to 10 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; common fine and few medium roots; medium acid; gradual wavy boundary.
E2—10 to 17 inches; light yellowish brown (10YR 6/4) fine sand; few fine distinct brownish yellow (10YR 6/8) mottles; single grained; loose; few fine roots; slightly acid; clear smooth boundary.
Bw1—17 to 34 inches; brownish yellow (10YR 6/8) fine sand; single grained; loose; few fine and medium roots; neutral; clear smooth boundary.
Bw2—34 to 41 inches; reddish yellow (7.5YR 7/6) fine sand; single grained; loose; neutral; abrupt wavy boundary.

Btg1—41 to 46 inches; dark grayish brown (10YR 4/2) sandy clay loam; few fine distinct yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; slightly sticky and nonplastic; neutral; gradual wavy boundary.
Btg2—46 to 55 inches; gray (10YR 5/1) sandy loam; few fine faint light brownish gray mottles; weak medium subangular blocky structure; slightly sticky and nonplastic; moderately alkaline; gradual wavy boundary.
BCg—55 to 65 inches; gray (10YR 6/1) sandy loam; weak fine subangular blocky structure; slightly sticky and nonplastic; moderately alkaline; gradual wavy boundary.
Cg—65 to 80 inches; gray (5Y 6/1) loamy sand; weak fine subangular blocky structure; nonsticky and nonplastic; moderately alkaline.

The thickness of the solum ranges from 46 to 80 inches or more. Reaction ranges from medium acid to slightly acid in the surface and subsurface layers and from slightly acid to moderately alkaline in the subsoil and substratum.

The A or Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Thickness ranges from 2 to 4 inches.

The E horizon has hue of 10YR, value of 6, chroma of 2 to 4; or hue of 10YR, value of 7, and chroma of 2 and can have brownish yellow, grayish brown, or dark grayish brown mottles or stains. Texture of the A and E horizons is sand or fine sand. Total thickness of the E horizon ranges from 9 to 14 inches.

The Bw horizon has hue of 10YR, value of 5 or 7, and chroma of 4 to 8; or hue of 10YR, value of 6, and chroma of 3 to 8; or hue of 7.5YR, value of 7, and chroma of 6. Texture is sand or fine sand. Thickness ranges from 24 to 37 inches. The Btg and BCg horizons have hue of 10YR, value of 4 to 7, and chroma of 1 or 2; or hue of 5Y, value of 5 or 6, and chroma of 1 or 2 and can have mottles of dark yellowish brown, yellow, light olive brown, or light brownish gray. Texture is sandy loam, fine sandy loam, or sandy clay loam. A few intrusions of a coarser-textured material from overlying horizons are in the Btg horizon in many pedons. The BCg horizon can also have loamy fine sandy texture. The total thickness ranges from 12 to 24 inches or more.

The Cg horizon has hue of 5Y, value of 5 or 6, chroma of 1. It is sand, fine sand, or loamy sand.

Manatee Series

The soils of the Manatee series are coarse-loamy, siliceous, hyperthermic Typic Argiaquolls. They are very poorly drained, moderately permeable soils that formed in sandy and loamy marine sediment. These nearly level soils are in depressions, in poorly defined drainageways, and on broad, low flats. Under natural conditions, the Manatee soils are covered with shallow water, or they have a water table within a depth of 10 inches of the surface for more than 6 months of most years. Runoff is slow. The slope is dominantly less than 1 percent but ranges to 2 percent.

Manatee soils are associated with Chobee, EauGallie, Floridana, Jupiter, Pineda, Riviera, Wabasso, and Winder soils. Chobee soils are in the fine-loamy family. Floridana soils have a thick sandy surface layer and an albic horizon. EauGallie, Jupiter, and Wabasso soils are poorly drained and are in slightly higher positions on the landscape than Manatee soils. In addition, EauGallie and Wabasso soils have a spodic horizon, and Jupiter soils are underlain by limestone at a depth of less than 20 inches. Pineda and Riviera soils are poorly drained and have an argillic horizon at a depth of 20 to 40 inches. In addition, Pineda soils have a Bw horizon. Winder soils are poorly drained. They do not have a mollic epipedon and have tongues of E horizon extending into the Bt horizon.

Typical pedon of Manatee loamy fine sand; in a former area of citrus, 0.2 mile south of Florida State Road 60 and Kings Highway intersection; SE1/4NE1/2SE1/4, sec. 5, T. 33 S., R. 39 E.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; common fine and few medium roots; mildly alkaline; gradual wavy boundary.
A—6 to 12 inches; black (10YR 2/1) loamy fine sand; weak fine subangular blocky structure; slightly sticky and slightly plastic; common fine roots; mildly alkaline; gradual wavy boundary.
Bt—12 to 22 inches; very dark gray (10YR 3/1) fine sandy loam; moderate fine subangular blocky structure; slightly sticky and slightly plastic; few fine and medium roots; moderately alkaline; gradual wavy boundary.
Btg—22 to 31 inches; dark gray (10YR 4/1) sandy loam; few fine faint dark brown mottles; moderate fine subangular blocky structure; slightly sticky and slightly plastic; few fine roots; moderately alkaline; gradual smooth boundary.
BCg—31 to 39 inches; dark grayish brown (10YR 4/2) loamy fine sand; few fine faint yellowish brown and common fine distinct grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; slightly sticky and slightly plastic; few fine roots; moderately alkaline; clear wavy boundary.
Cg1—39 to 51 inches; light brownish gray (2.5Y 6/2) loamy fine sand; few fine faint light yellowish brown and few fine distinct brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; slightly sticky and slightly plastic; moderately alkaline; clear smooth boundary.
Cg2—51 to 80 inches; light gray (5Y 7/1) loamy fine sand and shell fragments; massive; slightly sticky and slightly plastic; moderately alkaline.

Reaction is medium acid to mildly alkaline in the A horizon and mildly alkaline to moderately alkaline in the B and C horizons.

The Ap and A horizons have hue of 10YR, value of 2, and chroma of 1. These horizons are loamy fine sand and fine sand. Thickness ranges from 10 to 12 inches.

The Bt horizon has hue of 10YR, value of 2 to 4, and chroma of 1; or hue of 10YR, value of 4, and chroma of 2; or it is neutral with value of 2. The Bt horizon has mottles of brown and grayish brown. This horizon is loamy fine sand, fine sandy loam, and sandy loam. Thickness ranges from 3 to 13 inches. The Btg horizon has hue of 10YR or 5Y, value of 4 through 7, and chroma of 1. Texture is fine sandy loam, sandy loam, or sandy clay loam. Some pedons have small pockets or streaks of fine sand or loamy fine sand. Thickness ranges from 9 to 29 inches.

The BC horizon, if present, has hue of 10YR, value of 4, and chroma of 1 or 2; or hue of 2.5Y, value of 6, and chroma of 2 and can have yellowish brown, light yellowish brown, or brownish yellow mottles. This horizon is loamy fine sand or sandy loam. Thickness ranges from 0 to 14 inches.

The Cg horizon has hue of 5GY or 5Y, value of 5 or 6, and chroma of 1; or hue of 5Y, value of 7, and chroma of 1; or hue of 2.5Y, value of 6, and chroma of 2 and can have dark grayish brown or yellowish brown mottles. Texture is fine sand, loamy fine sand, and sandy loam. Shell fragments are in some pedons.

McKee Series

The soils of the McKee series are fine, montmorillonitic, nonacid, hyperthermic Typic Hydraquents. They are very poorly drained, very slowly permeable soils that formed in loamy or clayey tidal deposits. These level soils are on mangrove islands and in swamps that are at or near sea level. Under natural conditions, these soils remain saturated, and most areas are inundated twice daily by fluctuating tides. Many areas in the county have been leveed and are used as mosquito control structures. The slope is less than 1 percent.

McKee soils are associated with Kesson, Quartzipsamments, St. Augustine, and Riomar soils. Kesson soils formed in thick marine deposits of sand and shell fragments. Quartzipsamments are moderately well drained to somewhat poorly drained, and St. Augustine soils are somewhat poorly drained. These soils were formed by dredging and filling operations, and this dredge and fill material was spread over the surface of former tidal areas and mangrove islands along the Intracoastal Waterway. In addition, Quartzipsamments soils consist of mixed sand and shell material, and St. Augustine soils consist of a mixture of sand, shell fragments, loamy and silty sediment, and a few fragments of organic material. Riomar soils are underlain by limestone at a depth of 20 to 40 inches.

Typical pedon of McKee mucky clay loam; in a mangrove swamp, about 1.1 miles east of U.S. Highway 1 and South Gifford Road intersection, 1/4 mile west of Indian River, 40 feet north of mosquito impoundment road; SW1/4SE1/4NE1/4, sec. 25, T. 32 S., R. 39 E.

A—0 to 1 inch; very dark grayish brown (10YR 3/2) mucky clay loam; massive; nonsticky; very fluid, flows easily between fingers when squeezed, leaves little or no residue in hand; few to common fragments of partly decomposed wood; about 20 percent organic matter; strongly saline; moderately alkaline; abrupt wavy boundary.

Cg1—1 to 15 inches; very dark gray (10YR 3/1) clay loam; massive; nonsticky; very fluid, flows easily between fingers when squeezed; about 5 percent organic matter; many fine and medium roots that decrease with depth; strongly saline; moderately alkaline; clear smooth boundary.

Cg2—15 to 40 inches; grayish green (5G 4/2) sandy clay; massive; slightly sticky; very fluid, flows easily between fingers when squeezed; few fine and medium roots; strongly saline; moderately alkaline; gradual smooth boundary.

Cg3—40 to 60 inches; dark greenish gray (5GY 4/1) sandy clay; massive; slightly sticky; very fluid, flows easily between fingers when squeezed; few fine and medium roots; strongly saline; moderately alkaline; gradual smooth boundary.

Cg4—60 to 80 inches; dark gray (5Y 4/1) sandy loam; massive; slightly sticky; very fluid to slightly fluid, flows with some difficulty between fingers when squeezed; moderately saline; moderately alkaline.

This soil has *n* value of more than 1 in all mineral horizons to a depth of 40 inches or more and *n* value ranging from more than 0.7 to 1 at a depth of more than 40 inches. Soil salinity is more than 16 millimhos per centimeter to a depth of 60 inches and ranges from 8 to 16 millimhos per centimeter to a depth of 60 inches. Reaction ranges from neutral to moderately alkaline throughout. Some areas of soils have a high amount of sulfide that becomes extremely acid after prolonged exposure to air. The mineral layers in the 10- to 40-inches control section are about 35 to 59 percent clay content. A few pedons have an organic surface layer that is 1 inch to 4 inches thick. Some pedons are underlain by limestone at a depth of more than 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 2 or less; or hue of 5YR, value of 2, and chroma of 2 or less; or hue of 5Y, value of 4 or 5, and chroma of 1; or it is neutral with value of 4 or less. Texture is clay, clay loam, sandy clay, mucky clay loam, or silty clay. Few to common fragments of partly

decomposed wood and leaves are in this horizon. Thickness ranges from 0 to 3 inches.

The Cg horizon has hue of 10YR, value of 2 or 3, and chroma of 1; or hue of 5Y, 5GY, 5G, or 5BG, value of 4 through 6, and chroma of 1; or it is neutral with value of 4 or less. Texture is clay, clay loam, sandy clay, or silty clay to a depth of 40 inches or more. Below that are textures of sandy clay loam, sandy loam, and fine sandy loam. Some pedons have a 2Cg horizon that has texture of fine sand, sand, or sand mixed with shell fragments at a depth of more than 60 inches.

The combined thickness of the A and Cg horizons is more than 40 inches.

Myakka Series

The soils of the Myakka series are sandy, siliceous, hyperthermic Aeric Haplaquods. They are poorly drained, moderately permeable to moderately rapidly permeable soils that formed in beds of sandy marine sediment. These nearly level soils are on broad flatwoods and in depressions. In most years, the water table is within a depth of 10 inches of the surface for 1 to 3 months and at a depth of 10 to 40 inches for 6 to 9 months. Depressional areas are ponded for 6 months or more each year. The slope ranges from 0 to 2 percent.

Myakka soils are associated with EauGallie, Immokalee, Jonathan, Oldsmar, Pepper, Pomello, and Archbold soils. EauGallie and Pepper soils have an argillic horizon below the Bh horizon. In addition, Pepper soils have an ortstein horizon. Jonathan soils have an ortstein horizon and are better drained than the Myakka soils. Immokalee and Pomello soils have a Bh horizon that is deeper than the Bh horizon in the Myakka soils. In addition, Pomello soils are better drained than the Myakka soils. Oldsmar soils have a Bh horizon at a depth of more than 30 inches and have an argillic horizon at a depth of more than 40 inches. Archbold soils do not have a Bh horizon and are moderately well drained.

Typical pedon of Myakka fine sand; on the flatwoods, 1/4 mile east of intersection of Kings Highway and North Winter Beach Road, 100 feet north of North Winter Beach Road; SW1/4SE1/4SW1/4, sec. 4, T. 32 S., R. 39 E.

A—0 to 5 inches; black (10YR 2/1) fine sand; weak fine granular structure; very friable; many fine and common medium roots; slightly acid; clear smooth boundary.

E1—5 to 20 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; common medium and few fine roots; medium acid; gradual smooth boundary.

E2—20 to 28 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; common medium roots; medium acid; abrupt wavy boundary.

Bh1—28 to 31 inches; black (10YR 2/1) fine sand; weak fine subangular blocky structure; friable; dense mat of partially decomposed fine and medium roots in the upper part; sand grains well coated with organic matter; strongly acid; clear wavy boundary.

Bh2—31 to 39 inches; dark reddish brown (5YR 3/3) fine sand; weak fine subangular blocky structure; friable; few fine distinct very dark gray (5YR 3/1) streaks; medium acid; clear smooth boundary.

Bh3—39 to 50 inches; black (5YR 2/1) fine sand; weak fine subangular blocky structure; friable; sand grains well coated with organic matter; medium acid; clear smooth boundary.

Bh4—50 to 58 inches; black (10YR 2/1) fine sand; weak fine subangular blocky structure; friable; less than 50 percent weakly cemented; sand grains well coated with organic matter; medium acid; clear smooth boundary.

Bh/BC—58 to 68 inches; very dark grayish brown (10YR 3/2) fine sand; single grained; loose; medium acid; clear smooth boundary.

BC—68 to 80 inches; dark brown (10YR 3/3) fine sand; single grained; loose; medium acid.

The thickness of the solum is more than 60 inches. Depth to the spodic horizon ranges from 16 to 29 inches. The texture is sand or fine sand. Reaction ranges from extremely acid to slightly acid. In some pedons that have shell fragments at a depth of 50 inches or more, reaction ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. The E horizon has hue of 10YR, value of 5 to 7, and chroma of 1; or hue of 10YR, value of 5 or 6, and chroma of 2. The total thickness of the A and E horizons is less than 30 inches.

The Bh horizon has hue of 5YR or 10YR, value of 2 or 3, and chroma of 1 to 3; or it is neutral with value of 2. Some pedons have very dark gray streaks or fragments of weakly cemented spodic bodies. In addition, some pedons have a dense mat of partially decomposed medium and fine roots overlying the Bh horizon and also can be weakly cemented in less than 50 percent of any subhorizon. The thickness of the Bh horizon ranges from 9 to 30 inches. The BC horizon and the BC part of the Bh/BC horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. The Bh part has hue of 5YR or 10YR, value of 2 or 3, and chroma of 1 to 3.

Some pedons have an E' and B'h horizon below the Bh horizon. Colors are similar to those of the E horizon and the Bh horizon.

The C horizon, if present, has hue of 10YR, value of 5, chroma of 1 or 2.

Oldsmar Series

The soils of the Oldsmar series are sandy, siliceous, hyperthermic Alfic Arenic Haplaquods. They are poorly

drained, slowly permeable soils that formed in sandy and loamy marine sediment. These nearly level soils are on broad flatwoods and in depressional areas on the flatwoods. In most years, the water table is at a depth of 10 to 40 inches for more than 6 months and at a depth of less than 10 inches for 1 to 2 months. The slope ranges from 0 to 2 percent.

Oldsmar soils are associated with EauGallie, Holopaw, Lokosee, Malabar, Pineda, Riviera, and Wabasso soils. Holopaw, Lokosee, Malabar, Pineda, and Riviera soils do not have a Bh horizon. Lokosee, Malabar, and Pineda soils have a Bw horizon. Pineda and Riviera soils have an argillic horizon within a depth of 20 to 40 inches of the surface. EauGallie soils have a spodic horizon within a depth of 30 inches. Wabasso soils have an argillic horizon within a depth of 40 inches.

Typical pedon of Oldsmar fine sand; on the flatwoods, about 0.3 mile east of U.S. Interstate Highway 95, 150 feet north of Indian River-St. Lucie County line; SE1/4SW1/4SW1/4, sec. 31, T. 33 S., R. 39 E.

A—0 to 5 inches; black (10YR 2/1) fine sand; weak fine granular structure; very friable; many fine and few medium roots; strongly acid; clear smooth boundary.

E—5 to 32 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; few medium and fine roots; medium acid; abrupt wavy boundary.

Bh1—32 to 35 inches; black (5YR 2/1) fine sand; weak fine subangular blocky structure; friable; few fine roots; sand grains well coated with organic matter; slightly acid; clear wavy boundary.

Bh2—35 to 43 inches; dark reddish brown (5YR 3/2) fine sand; weak fine subangular blocky structure; friable; sand grains well coated with organic matter; very slightly acid; abrupt wavy boundary.

Bh3—43 to 50 inches; dark brown (10YR 3/3) fine sand; single grained; loose; few very dark gray (10YR 3/1) streaks and pockets; slightly acid; abrupt wavy boundary.

Btg—50 to 62 inches; grayish brown (2.5Y 5/2) sandy loam; weak medium subangular blocky structure; slightly sticky and slightly plastic; sand grains coated and bridged with clay; slightly acid; gradual smooth boundary.

Cg—62 to 80 inches; light brownish gray (10YR 6/2) loamy fine sand; massive; slightly sticky; slightly acid.

The thickness of the solum is more than 60 inches. Depth to the spodic horizon ranges from 32 to 35 inches, and depth to the argillic horizon ranges from 42 to 50 inches. The A, E, and Bh horizons are sand or fine sand.

The A horizon has hue of 10YR, value of 2 to 4, and chroma of 1; or hue of 10YR, value of 3, and chroma of 2. Unrubbed colors often have a salt-and-pepper appearance. The E horizon has hue of 10YR, value of 5 or 7, and chroma of 1; or hue of 10YR, value of 6, and chroma of 2. The total thickness of the A and E horizons is more than 30 inches. Reaction ranges from strongly acid to neutral or from strongly acid to moderately alkaline if the surface has been limed. Some pedons have a dense mat of partially decomposed medium and fine roots underlain by a Bh horizon.

The Bh horizon has hue of 5YR, value of 2, and chroma of 1; or hue of 5YR, value of 3, and chroma of 2; or hue of 10YR, value of 2, and chroma of 1. Hue of 10YR, value of 3 or 4, and chroma of 3 are at a lower depth as a transitional horizon. The Bh horizon can be weakly cemented in less than 50 percent of each pedon. Thickness ranges from 5 to 18 inches. Reaction is medium acid or slightly acid. The Btg horizon has hue of 2.5Y, 5Y, or 10YR, value of 5 or 6, and chroma of 2; or hue of 2.5Y, 5Y, or 10YR, value of 4, and chroma of 1; or hue of 5GY, value of 1, and chroma of 6 and can have dark grayish brown mottles. Texture is fine sandy loam, sandy loam, or sandy clay loam. Depth to the Btg horizon ranges from 42 to 50 inches. In some pedons, the Btg horizon is underlain by loamy fine sand or loamy sand and shell fragments.

The Cg horizon is at a depth of more than 50 inches. Reaction ranges from slightly acid to moderately alkaline.

Orsino Series

The soils of the Orsino series are hyperthermic, uncoated Spodic Quartzipsamments. They are moderately well drained, very rapidly permeable soils that formed in sandy marine and eolian deposits. These nearly level to gently sloping soils are on slightly elevated ridges and knolls that are adjacent to streams and drainageways. A water table is at a depth of 40 to 60 inches for 6 months or more during most years. The slope ranges from 0 to 5 percent.

Orsino soils are associated with Immokalee, Satellite, and St. Lucie soils. Immokalee soils have a spodic horizon and are poorly drained. Satellite and St. Lucie soils do not have a B horizon within a depth of 80 inches. In addition, Satellite soils are somewhat poorly drained and St. Lucie soils are excessively drained.

Typical pedon of Orsino fine sand, 0 to 5 percent slopes; in a wooded area, about 400 feet west of Indian River County Road 505, in the MacDonald State Campground; NE1/4NE1/4SW1/4, sec. 22, T. 31 S., R. 38 E.

A—0 to 2 inches; gray (10YR 5/1) fine sand; single grained; loose; many fine and medium and few coarse roots; very strongly acid; clear wavy boundary.

E—2 to 23 inches; white (10YR 8/1) fine sand; single grained; loose; common fine and medium and few coarse roots; very strongly acid; abrupt irregular boundary.

Bw1&Bh—23 to 26 inches; dark reddish brown (5YR 3/2) fine sand in discontinuous lenses 1 centimeter to 5 centimeters thick, separated by brown (7.5YR 4/4) fine sand; single grained; loose; few fine and coarse and common medium roots; very strongly acid; clear irregular boundary.

Bw2&Bh—26 to 43 inches; brown (7.5YR 4/4) fine sand; common coarse prominent dark reddish brown (5YR 3/2) discontinuous lenses 1 centimeter to 3 centimeters thick; single grained; loose; many fine and medium and few coarse roots; very strongly acid; gradual wavy boundary.

BC—43 to 62 inches; very pale brown (10YR 7/3) fine sand; few medium distinct brownish yellow (10YR 6/6) streaks; single grained; loose; few fine and medium roots; very strongly acid; gradual irregular boundary.

C—62 to 80 inches; light gray (10YR 7/2) fine sand; few fine and medium 1 centimeter to 3 centimeters in diameter prominent black (10YR 2/1) spodic bodies, firm to weakly cemented; single grained; loose; few fine and medium roots; strongly acid.

Reaction ranges from very strongly acid to medium acid throughout. Texture is sand or fine sand to a depth of 80 inches or more. The content of silt and clay is less than 5 percent in the 10- to 40-inch control section.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 1. Thickness is less than 5 inches.

The E horizon has hue of 10YR, value of 7 or 8, and chroma of 1 or 2. Thickness ranges from about 14 to 32 inches.

In the Bw&Bh horizon, the Bw part has hue of 10YR, value of 5, and chroma of 4 to 8; or hue of 10YR, value of 6, and chroma of 3 to 6; or hue of 7.5YR, value of 4, and chroma of 4. Light gray or white tongues of the E horizon extend into the Bw&Bh horizon. In some pedons, thin discontinuous layers or lenses of the Bh horizon are at the place of contact between the E horizon and the Bw&Bh horizon. These layers and the Bh part of the Bw&Bh horizon have hue of 10YR, value of 2 or 3, and chroma of 2; or hue of 5YR, value of 3, and chroma of 2 to 4; or hue of 10YR, value of 4, and chroma of 3. The Bh horizon also occurs as weakly cemented to noncemented bodies or splotches. The Bw&Bh horizon ranges from about 14 to 30 inches. The BC horizon, if present, has hue of 10YR, value of 5, and chroma of 4 to 8; or hue of 10YR, value of 6, and chroma of 3 to 6; or hue of 7.5YR, value of 4, and chroma of 4; or hue of 10YR, value of 6 or 7, and chroma of 3 or 4; or hue of 10YR, value of 8, and chroma of 1 to 4 and can have yellowish brown, brownish yellow, or yellow stains or mottles. Thickness of the BC horizon ranges from 0 to more than 27 inches.

The C horizon, if present, has hue of 10YR, value of 6 or 7, and chroma of 3 or 4; or hue of 10YR, value of 8, and chroma of 1 to 4.

Palm Beach Series

The soils of the Palm Beach series are hyperthermic, uncoated Typic Quartzipsamments. They are well drained to excessively drained, very rapidly permeable, droughty soils that formed in thick beds of marine sand and shell fragments. These nearly level to gently sloping soils are on dunelike ridges that are parallel to the coast. The slope ranges from 0 to 5 percent.

Palm Beach soils are associated with Canaveral and St. Augustine soils. Canaveral soils are more poorly drained and are in lower positions on the landscape than Palm Beach soils. The somewhat poorly drained St. Augustine soils were formed by dredging and filling operations. These soils consist of mixed mineral materials and shell fragments.

Typical pedon of Palm Beach sand, 0 to 5 percent slopes; in an area of dense, subtropical hardwoods and shrubs, about 0.1 mile north of Jungle Trail, 75 feet east of Florida State Highway A1A; NE1/4NE1/4, sec. 1, T. 32 S., R. 40 E.

A—0 to 4 inches; very dark gray (10YR 3/1) sand; single grained; loose; common fine and medium roots; about 10 percent sand-size shell fragments; moderately alkaline; strongly effervescent; abrupt smooth boundary.

C1—4 to 20 inches; grayish brown (10YR 5/2) sand; single grained; loose; few fine roots; about 40 percent sand-size shell fragments; moderately alkaline; strongly effervescent; clear smooth boundary.

C2—20 to 65 inches; pale brown (10YR 6/3) sand; single grained; loose; about 30 percent sand-size shell fragments; moderately alkaline; strongly effervescent; clear smooth boundary.

C3—65 to 80 inches; very pale brown (10YR 7/3) sand; single grained; loose; about 50 percent sand-size shell fragments; moderately alkaline; strongly effervescent.

All horizons have weak to strong effervescence when mixed with dilute hydrochloric acid. Reaction is moderately alkaline throughout. Texture is sand or fine sand.

The A horizon has hue of 10YR, value of 3 to 5, and chroma of 1 or 2. Sand-size shell fragments make up 5 to 20 percent, by volume, of the A horizon. Thickness ranges from 2 to 10 inches.

The C horizon has hue of 10YR, value of 4 to 7, and chroma of 1 to 3. In most pedons, the C horizon is made up of stratified layers of fine sand and shells or shell fragments. Mostly, sand-size shell fragments range from 5 to more than 50 percent. These fragments are 1 centimeter or more in diameter.

Paola Series

The soils of the Paola series are hyperthermic, uncoated Spodic Quartzipsamments. They are excessively drained, very rapidly permeable soils that formed in thick deposits of marine or eolian sand. These nearly level to gently sloping soils are on the Atlantic Coastal Ridge. The water table is at a depth of more than 72 inches. The slope ranges from 0 to 5 percent.

Paola soils are associated with Archbold, Astatula, Pomello, Satellite, and St. Lucie soils. Astatula soils do not have an E horizon. Satellite, St. Lucie, and Archbold soils do not have a B horizon. In addition, Satellite soils are somewhat poorly drained, and Archbold soils are moderately well drained. Pomello soils have a spodic horizon and are moderately well drained.

Typical pedon of Paola sand, 0 to 5 percent slopes; 300 feet west of Old Dixie Highway; SE1/4SW1/4, sec. 30, T. 33 S., R. 40 E.

A—0 to 2 inches; dark gray (10YR 4/1) sand; single grained; loose; many very fine and fine, common and few coarse roots; slightly acid; clear wavy boundary.

E—2 to 9 inches; grayish brown (10YR 5/2) sand; single grained; loose; common medium, few fine and coarse roots; medium acid; clear wavy boundary.

B/E—9 to 12 inches; yellowish brown (10YR 5/4) sand; single grained; loose; many medium, few fine and coarse roots; strongly acid; gradual wavy boundary.

Bw—12 to 80 inches; strong brown (7.5YR 5/8) sand; single grained; loose; many fine and medium and few coarse roots to a depth of 42 inches that decrease with depth; very strongly acid.

Reaction is very strongly acid to slightly acid throughout. Texture is sand to a depth of more than 80 inches.

The A horizon has hue of 10YR, value of 4 to 6, and chroma of 1. It is 2 to 5 inches thick. The E horizon has hue of 10YR, value of 6 to 8, and chroma of 1; or hue of 10YR, value of 5, and chroma of 2. The total thickness of the A and E horizons ranges from about 8 to 23 inches.

In the B/E horizon, the B part has hue 10YR, value of 5 to 7, and chroma of 4 to 8; or hue of 7.5YR, value of 5, and chroma of 8. Some pedons have weakly cemented, dark yellowish brown sandy concretions. The Bw horizon generally extends to a depth of more than 80 inches. This horizon has hue of 10YR, value of 5 to 7, and chroma of 4 to 8; or hue of 7.5YR, value of 5, and chroma of 8.

Pepper Series

The soils of the Pepper series are sandy, siliceous, hyperthermic, ortstein Alfic Haplaquods. They are poorly drained, slowly permeable or very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are on broad flatwoods. In most years, the water table is within a depth of 10 inches of the surface for 2 to 4 months in wet periods and within a depth of about 40 inches for more than 6 months. The slope ranges from 0 to 2 percent.

Pepper soils are associated with EauGallie, Floridana, Malabar, Myakka, Riviera, Oldsmar, Wabasso, and Winder soils. EauGallie, Myakka, Oldsmar, and Wabasso soils do not have an ortstein horizon. In addition, Myakka soils do not have an argillic horizon, and Oldsmar soils have a spodic horizon at a depth of more than 30 inches. Floridana, Malabar, Riviera, and Winder soils do not have a spodic horizon. In addition, Floridana soils have a mollic epipedon and are very poorly drained, and Malabar soils have a high chroma Bw horizon.

Typical pedon of Pepper sand; on the flatwoods, 100 feet west of Indian River County Road 609, 0.5 mile north of Oslo Road; NE1/4NE1/4SE1/4, sec. 23, T. 33 S., R. 38 E.

A1—0 to 2 inches; very dark gray (10YR 3/1) sand; weak fine granular structure; very friable; many very fine and common medium and few coarse roots; very strongly acid; abrupt smooth boundary.

A2—2 to 8 inches; dark gray (10YR 4/1) sand; single grained; loose; many very fine, common medium and few coarse roots; very strongly acid; clear wavy boundary.

E—8 to 22 inches; gray (10YR 5/1) sand; single grained; loose; common very fine and fine roots; very strongly acid; abrupt wavy boundary.

Bh—22 to 27 inches; black (10YR 2/1) sand; moderate fine subangular blocky structure; friable; many fine decomposed roots; sand grains well coated with organic matter; extremely acid; clear wavy boundary.

Bhm—27 to 32 inches; black (10YR 2/1) sand; massive; firm; strongly cemented; many fine decomposed roots; sand grains well coated with organic matter; extremely acid; clear wavy boundary.

Bh'—32 to 39 inches; dark brown (10YR 3/3) sand, weak fine subangular blocky structure; very friable; very strongly acid; clear wavy boundary.

BE—39 to 47 inches; dark grayish brown (10YR 4/2) sand; weak fine subangular blocky structure; very friable; very strongly acid; abrupt wavy boundary.

Btg—47 to 60 inches; grayish brown (10YR 5/2) sandy loam; weak medium subangular blocky structure; few fine faint dark grayish brown streaks; slightly sticky and nonplastic; strongly acid.

The thickness of the solum is more than 50 inches. Depth to the spodic horizon ranges from 22 to 28 inches, and the depth to the argillic horizon ranges from 42 to 70 inches.

The A horizon has rubbed hue of 10YR, value of 2 to 4, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. Thickness ranges from 6 to 8 inches. Texture is sand or fine sand. Reaction ranges from very strongly acid to medium acid. The E horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2. Reaction ranges from very strongly acid except where the surface layer has been limed. Texture is sand or fine sand. The total thickness of the A and E horizons is less than 30 inches. Some pedons have a dense mat of partially decomposed medium and fine roots that is underlain by the Bh horizon.

The Bh horizon has hue of 10YR or 5YR, value of 2 or 3, and chroma of 1 to 3; or it is neutral with value of 2. Reaction ranges from extremely acid to slightly acid. Texture is sand or fine sand. Sand grains are well coated with organic matter.

The Bhm horizon has hue of 10YR or 5YR, value of 2 or 3, and chroma of 1 to 3; or it is neutral with value of 2. In more than half of each pedon, this weakly cemented subhorizon is 1 inch or more thick. Consistence is very firm in weakly cemented parts of the Bhm horizon to very friable in the parts that are not cemented. Sand grains are well coated with organic matter. Texture is sand or fine sand. Reaction ranges from extremely acid to slightly acid.

The Bh' horizon has hue of 10YR, value of 3, and chroma of 3; or hue of 10YR, value of 4, and chroma of 2. Reaction ranges from extremely acid to slightly acid. Texture is fine sand. Thickness ranges from 1 to 4 inches.

Some pedons have a BE horizon between the Bh' and Btg horizons. If present, it has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Texture is fine sand. Thickness ranges from 1 to 8 inches. Reaction is strongly acid or very strongly acid.

The Btg horizon has hue of 10YR, value of 4 or 5, and chroma of 2; or hue of 5Y, value of 5 or 6, and chroma of 2; or hue of 2.5Y, value of 6, and chroma of 2 and can have dark brown and olive brown mottles or streaks. Texture is sandy loam, fine sandy loam, or sandy clay loam. Thickness ranges from about 8 to 20 inches. Reaction ranges from strongly acid to mildly alkaline.

The Cg horizon, if present, has hue of 5Y or 2.5Y, value of 6, and chroma of 2; or hue of 5Y, value of 5, and chroma of 1. Texture is loamy sand or loamy fine sand. Reaction ranges from slightly acid to mildly alkaline.

Perrine Variant

The soils of the Perrine Variant are fine-loamy, carbonatic, hyperthermic Typic Fluvaquents. They are poorly drained, moderately slowly permeable to moderately permeable soils that formed in calcareous, sandy and loamy sediment of marine or freshwater origin. These nearly level soils are on narrow to broad, elongated, low flats. Under natural conditions, the water table is within 10 inches of the surface about 30 to 50 percent of the time for more than 6 months in most years. In some places, the water table fluctuates with the tide. The slope is less than 1 percent.

Perrine Variant soils are associated with Chobee and Boca soils. Chobee soils are very poorly drained and have a Bt horizon at a depth of less than 20 inches. These soils are not underlain by limestone. Boca soils have an argillic horizon.

Typical pedon of Perrine Variant fine sandy loam; in an area cleared for citrus, 1-1/2 miles east of U.S. Highway 1, about 500 feet north of North Winter Beach Road; SW1/4SW1/4SW1/4, sec. 2, T. 32 S., R. 39 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) fine sandy loam; weak fine subangular blocky structure; very friable; common fine and medium roots; neutral; clear smooth boundary.

Cgk1—6 to 20 inches; gray (10YR 5/1) sandy clay loam; weak fine subangular blocky structure; friable; common fine and medium roots; dark yellowish brown stains along old root channels; few fine shell fragments; strongly effervescent, moderately alkaline; gradual irregular boundary.

Cgk2—20 to 24 inches; gray (10YR 5/1) sandy clay loam; weak fine subangular blocky structure; slightly sticky; common fine shell fragments and small white to light brownish gray carbonate nodules and limestone pieces; few medium roots; strongly effervescent, moderately alkaline; abrupt irregular boundary.

R—24 to 36 inches; hard continuous ledge of light brownish gray limestone.

Thickness and depth to weathered limestone bedrock range from 20 to 40 inches. Reaction is neutral to moderately alkaline in the A or Ap horizon and moderately alkaline in the Cgk horizon.

The A or Ap horizon has hue of 10YR, value of 3, and chroma of 1 or 2. A thin layer of organic material covers the A horizon in some pedons. The total thickness of the A or Ap horizon ranges from 5 to 9 inches. The A horizon has none to strong effervescence in 0.1 normal hydrochloric acid. Texture is fine sandy loam. In some farming areas, sand and loamy fine sand fill has been added to the surface.

The Cgk horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2 and can have dark brown or dark yellowish brown stains along root channels. Texture is loam or sandy clay loam. The Cgk horizon is strongly effervescent in 0.1 normal hydrochloric acid. Few to common fine shell fragments and small white carbonate nodules are present in some pedons. Thickness ranges from 14 to 19 inches.

The R horizon is a hard continuous ledge of light brownish gray to brownish yellow limestone. The surface

is smooth to wavy. Solution holes are few and extend 1 foot to 2 feet into the limestone. They are filled with sand, silt loam, loam, or soft carbonatic material. Some pedons have a few inches of limestone fragments in a matrix of almost liquid carbonates underlain by a rock surface.

Pineda Series

The soils of the Pineda series are loamy, siliceous, hyperthermic Arenic Glossaqualfs. They are deep, poorly drained, slowly permeable to very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are on low hammocks and in broad, poorly defined sloughs. In most years, the water table is within a depth of 10 inches of the surface for 1 to 6 months and at a depth of 10 to 40 inches for more than 6 months. It recedes to a depth of more than 40 inches during extended dry periods. The slope ranges from 0 to 2 percent.

Pineda soils are associated with EauGallie, Jupiter, Riviera, Wabasso, and Winder soils. EauGallie and Wabasso soils have a spodic horizon. In Jupiter soils, limestone is at a depth of about 20 inches. Riviera and Winder soils do not have a Bw horizon. In addition, Winder soils have an argillic horizon at a depth of about 20 inches.

Typical pedon of Pineda fine sand; in a grove, about 3 miles west of Vero Beach; NW1/4NW1/4SW1/4, sec. 6, T. 33 S., R. 40 E.

Ap—0 to 4 inches; black (10YR 3/1) fine sand; single grained; loose; few medium and many fine roots; slightly acid; clear wavy boundary.

E—4 to 9 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; slightly acid; clear smooth boundary.

Bw1—9 to 17 inches; yellow (10YR 7/6) fine sand; few medium distinct brownish yellow (10YR 6/8) mottles; single grained; loose; slightly acid; gradual smooth boundary.

Bw2—17 to 23 inches; yellow (10YR 7/8) fine sand; few medium distinct brownish yellow (10YR 6/8) mottles; single grained; loose; slightly acid; abrupt irregular boundary.

Btg1—23 to 27 inches; gray (10YR 5/1) sandy loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; sand grains coated and bridged with clay; few large yellowish brown (10YR 5/4) loamy fine sand tongues and pockets; slightly acid; clear wavy boundary.

Btg2—27 to 31 inches; gray (5Y 5/1) sandy loam; few fine distinct dark brown (10YR 4/3) and light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; neutral; gradual smooth boundary.

BCg—31 to 40 inches; greenish gray (5GY 5/1) sandy loam; few medium distinct light olive brown (2.5Y 5/6) and few fine faint olive yellow mottles; weak moderate subangular blocky structure; moderately alkaline; clear smooth boundary.

Cg1—40 to 52 inches; greenish gray (5GY 5/1) loamy sand; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; moderately alkaline; clear smooth boundary.

Cg2—52 to 80 inches; greenish gray (5GY 6/1) loamy sand; 3 percent shell fragments; massive; neutral.

The thickness of the solum is 40 to 80 inches. The combined thickness of the A and Bw horizons is 20 to 40 inches. The A and B horizons range from strongly acid to mildly alkaline. The C horizon is slightly acid to moderately alkaline.

The A or Ap horizon has hue of 10YR, value of 2 through 4, and chroma of 1; or hue of 10YR, value of 5, and chroma of 2. Thickness ranges from 2 to 9 inches. Texture is sand or fine sand.

The E horizon has hue of 10YR, value of 5 or 6, and chroma of 2. Thickness ranges from 5 to 9 inches. Texture is sand or fine sand.

The Bw horizon has hue of 10YR, value of 5 to 7, and chroma of 6 to 8. The E' horizon has hue of 10YR, value of 6 to 8, and chroma of 3 or 4. Thickness of the Bw horizon ranges from 4 to 16 inches. Texture is sand or fine sand. In some pedons, a thin discontinuous dark brown to black Bh horizon is at the base of the Bw horizon. The Btg horizon is sandy loam or sandy clay loam. Tongues of a coarser material extend into this horizon from the horizons above. This material has hue of 10YR, value of 6 to 8, and chroma of 3 or 4. Texture is sand or fine sand. The Btg horizon has hue of 10YR, 5Y, or 5BG, value of 5, and chroma of 1; or hue of 5Y, value of 4, and chroma of 1; or hue of 2.5Y, value of 4, and chroma of 2. Mottles are yellowish brown, olive, or olive yellow. The BCg horizon, if present, has hue of 5GY or 2.5Y, value of 5, and chroma of 1 or 2. Texture ranges from sandy loam to sandy clay loam. Thickness ranges from 13 to 27 inches.

The Cg horizon has hue of 5Y, 5GY, or 5BG, value of 5, and chroma of 1 or 2; or hue of 5GY, value of 6, and chroma of 1. Texture ranges from loamy fine sand to sandy clay loam. The Cg horizon consists of few to many sand-size shell fragments.

Pomello Series

The soils of the Pomello series are sandy, siliceous, hyperthermic Arenic Haplohumods. They are moderately well drained, moderately rapidly permeable soils that formed in thick beds of sandy marine sediment. These nearly level to gently sloping soils are on low ridges and knolls on the flatwoods. The water table is at a depth of 24 to 40 inches for about 1 to 4 months during wet

periods and at a depth of 40 to 60 inches during drier periods. The slope ranges from 0 to 5 percent.

Pomello soils are associated with Astatula, Immokalee, Myakka, Satellite, and Archbold soils. Immokalee and Myakka soils are poorly drained. Astatula, Satellite, and Archbold soils do not have a spodic horizon. In addition, Astatula soils are excessively drained, and Satellite soils are somewhat poorly drained.

Typical pedon of Pomello sand, 0 to 5 percent slopes; on a low knoll on the flatwoods; NW1/4NW1/4SE1/4, sec. 7, T. 31 S., R. 39 E.

A—0 to 2 inches; gray (10YR 5/1) sand, when rubbed, mixture of organic matter and light gray sand, salt-and-pepper appearance when dry; weak fine granular structure; very friable; few fine and medium roots; strongly acid; clear smooth boundary.

E1—2 to 20 inches; white (10YR 8/1) sand; single grained; loose; few fine and medium roots; few grayish brown streaks along root channels; medium acid; gradual smooth boundary.

E2—20 to 61 inches; light gray (10YR 7/1) sand; single grained; loose; few roots; few thin dark grayish brown streaks along old root channels; medium acid; abrupt wavy boundary.

Bh1—61 to 65 inches; dark reddish brown (5YR 2/2) sand; weak fine subangular blocky structure; friable; thin decomposed extending root mat on surface; few fine roots; strongly acid; gradual smooth boundary.

Bh2—65 to 72 inches; black (N 2/0) sand; weak medium subangular blocky structure; friable; few dark reddish brown splotches; strongly acid; gradual smooth boundary.

Bh3—72 to 80 inches; very dark gray (5YR 3/1) sand; weak fine subangular blocky structure; very friable; medium acid.

Depth to the spodic horizon ranges from 33 to 65 inches but is predominantly at a depth of more than 50 inches. The texture is sand or fine sand throughout. Reaction ranges from very strongly acid to medium acid.

The A horizon has hue of 10YR, value of 3 to 5, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. Thickness ranges from 1 to 6 inches.

The E horizon has hue of 10YR, value of 6 to 8, and chroma of 1; or hue of 10YR, value of 7, and chroma of 2 and can have dark gray streaks along root channels. The total thickness of the A and E horizons is more than 30 inches.

The Bh horizon has hue of 5YR, value of 2 or 3, and chroma of 1 to 3; or hue of 10YR, value of 2, and chroma of 1 or 2; or it is neutral with value of 2; or has hue of 7.5YR, value of 3, and chroma of 2. Some pedons have weakly cemented fragments of Bh bodies. These fragments make up less than half of the Bh horizon or have a thin mat of decomposed roots on the surface. The BC horizon, if present, has hue of 10YR, value of 3 or 4, and chroma of 3; or hue of 7.5YR, value of 4, and chroma of 2.

The C horizon, if present, has hue of 10YR, value of 5 or 6, and chroma of 1; or hue of 10YR, value of 5, and chroma of 2.

The Pomello soils are taxadjuncts to the Pomello series because depth to the Bh horizon is outside the defined range for the series than is typical. These soils are similar in use, management, and behavior to the soils of the Pomello series.

Pompano Series

The soils of the Pompano series are siliceous, hyperthermic Typic Psammaquents. They are poorly drained, rapidly permeable soils that formed in thick deposits of sandy marine sediment. These nearly level soils are in sloughs and poorly defined drainageways. The water table is within a depth of 10 inches of the surface for 2 to 6 months each year. During the drier periods, it is within a depth of about 30 inches for more than 9 months each year. Some areas are occasionally flooded for 2 to 7 days in some years. The slope ranges from 0 to 2 percent.

Pompano soils are associated with Immokalee, Myakka, Satellite, and Orsino soils. Immokalee and Myakka soils have a spodic horizon. Satellite soils are somewhat poorly drained. Orsino soils are moderately well drained and have stains of organic matter.

Typical pedon of Pompano fine sand; in a slough; SW1/4NE1/4, sec. 8, T. 32 S., R. 38 E.

A1—0 to 3 inches; very dark gray (10YR 3/1) fine sand; mixture of organic matter and light gray sand, salt-and-pepper appearance when dry; single grained; loose; many fine and common medium roots; very strongly acid; gradual wavy boundary.

A2—3 to 16 inches; dark grayish brown (10YR 4/2) fine sand; single grained; loose; common fine and few medium roots; very strongly acid; clear smooth boundary.

C1—16 to 60 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; few medium roots; very strongly acid; clear smooth boundary.

C2—60 to 80 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; strongly acid.

Reaction ranges from very strongly acid to mildly alkaline throughout. Texture is sand or fine sand to a depth of 80 inches or more.

The A1 horizon has hue of 10YR, value of 2 to 4, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. Thickness ranges from 3 to 6 inches. The A2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2. Thickness ranges from 0 to 13 inches.

The C horizon has hue of 10YR, value of 5 to 7, and chroma of 3 or less. This horizon can have pale brown, brownish yellow, or brown mottles and streaks.

Riomar Series

The soils of the Riomar series are fine, montmorillonitic, nonacid, hyperthermic Typic Hydraquents. They are very poorly drained, very slowly permeable soils that formed in loamy or clayey tidal deposits. These nearly level soils are on mangrove islands and in swamps that are at or near sea level. Under natural conditions, these soils remain saturated, and most areas are inundated twice daily by fluctuating tides. Many areas in the county have been leveed and are used as mosquito control structures. The slope is less than 1 percent.

Riomar soils are associated with Kesson, McKee, Quartzipsamments, and St. Augustine soils. Kesson soils formed in thick marine deposits of sand and shell fragments. Quartzipsamments soils are moderately well drained to somewhat poorly drained, and St. Augustine soils are somewhat poorly drained. These soils were formed by dredging and filling operations. These dredge and fill materials were spread over the surface of former tidal areas and mangrove islands along the Intracoastal Waterway. Quartzipsamments soils consist of mixed sand and shell fragments. St. Augustine soils consist of a mixture of sand, shell fragments, loamy and silty sediment, and a few fragments of organic material. McKee soils are not underlain by limestone within a depth of 40 inches of the surface.

Typical pedon of Riomar clay loam; in a mangrove swamp; just north of North Winder Beach Road and Levee Road intersection, 250 feet west of Indian River; NE1/4SE1/4SW1/4SW1/4, sec. 2, T. 32 S., R. 39 E.

A—0 to 8 inches; very dark gray (5Y 3/1) clay loam; massive; nonsticky; very fluid, flows easily between fingers when squeezed, leaves little or no residue in hand; few to common fragments of partly decomposed wood; strongly saline; moderately alkaline; abrupt wavy boundary.

Cg1—8 to 15 inches; very dark gray (5Y 3/1) clay loam; massive; nonsticky; very fluid, flows easily between fingers when squeezed; about 5 percent organic matter; many fine and medium roots that decrease with depth; strongly saline; moderately alkaline; clear smooth boundary.

Cg2—15 to 25 inches; dark grayish green (5G 4/1) sandy clay; massive; slightly sticky; very fluid, flows easily between fingers when squeezed; few fine and medium roots; strongly saline; moderately alkaline; abrupt smooth boundary.

R—25 inches; hard limestone bedrock.

This soil has *n* value of more than 1 in all mineral horizons. Soil salinity is more than 16 millimhos per centimeter. Reaction ranges from neutral to moderately alkaline throughout. Some areas of soils contain a high amount of sulfide that becomes extremely acid after prolonged exposure to air. A few pedons have an organic surface layer that is 1 to 4 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 2 or less; or hue of 5YR, value of 2, and chroma of 2 or less; or hue of 5Y, value of 3 to 5, and chroma of 1; or it is neutral with value of 4 or less. Texture is clay, clay loam, mucky clay loam, or silty clay. Few to common fragments of partly decomposed wood and leaves are in this horizon. Thickness ranges from 5 to 10 inches.

The Cg horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or hue of 5Y, 5GY, 5BG, or 5G, value of 3 through 6, and chroma of 1; or it is neutral with value of 4 or less. Texture is clay, clay loam, or sandy clay.

Riviera Series

The soils of the Riviera series are loamy, siliceous, hyperthermic Arenic Glossaqualfs. They are poorly drained, slowly permeable to very slowly permeable soils that formed in beds of sandy and loamy marine sediment. These nearly level soils are on low hammocks, in poorly defined drainageways, on broad, low flats, and in depressional areas. The water table is within a depth of 10 inches of the surface for 1 to 6 months and at a depth of 10 to 40 inches for more than 6 months in most years. It recedes to a depth of more than 40 inches during extended dry periods. The depressional areas are ponded for 6 to 9 months or more each year. The slope ranges from 0 to 2 percent.

Riviera soils are associated with Chobee, Floridana, Holopaw, Manatee, Oldsmar, Pineda, Wabasso, and Winder soils. Oldsmar and Wabasso soils have a spodic horizon. Pineda soils have a Bw horizon. Chobee, Floridana, and Manatee soils have a mollic epipedon and are very poorly drained. Holopaw soils have an argillic horizon at a depth of more than 40 inches. Winder soils have an argillic horizon at a depth of less than 20 inches.

Typical pedon of Riviera fine sand; on a broad, low flat, about 0.5 mile west of Kings Highway and Citrus Road intersection; SE1/4SE1/4NE1/4, sec. 17, T. 33 S., R. 39 E.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) fine sand; single grained; loose; few medium and many fine roots; slightly acid; clear wavy boundary.

E1—3 to 14 inches; light gray (10YR 7/2) fine sand; single grained; loose; few medium and fine roots; slightly acid; gradual smooth boundary.

E2—14 to 26 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; few medium roots; slightly acid; abrupt irregular boundary.

Btg/E—26 to 31 inches; gray (5Y 5/1) sandy loam; few coarse prominent yellowish brown (10YR 5/6) mottles; few fine tongues and pockets of grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) fine sand extending from the E horizon; moderate medium subangular blocky structure; friable, slightly sticky; sand grains coated and bridged with clay; slightly acid; clear wavy boundary.

Btg—31 to 40 inches; gray (5Y 6/1) sandy loam; common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; slightly sticky; sand grains coated and bridged with clay; slightly acid; gradual wavy boundary.

Cg1—40 to 52 inches; gray (5Y 5/1) loamy fine sand; few medium pockets of light brownish gray (10YR 6/2) fine sand; weak fine subangular blocky structure; very friable, slightly sticky; mildly alkaline; gradual wavy boundary.

Cg2—52 to 80 inches; greenish gray (5GY 6/1) loamy fine sand; weak fine subangular blocky structure; very friable; slightly sticky; moderately alkaline.

The thickness of the solum is 40 to 80 inches. The combined thickness of the A and E horizons is 20 to 40 inches. Reaction is slightly acid or neutral in the A and Ap horizons and ranges from slightly acid to moderately alkaline in all of the other horizons.

The A or Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Thickness ranges from 3 to 9 inches. The texture is sand or fine sand.

The E horizon has hue of 10YR, value of 6 or 7, and chroma of 1 or 2; or hue of 10YR, value of 5, and chroma of 1. Thickness ranges from 15 to 29 inches. The texture is sand or fine sand.

The Btg/E horizon has hue of 10YR, value of 4, and chroma of 2; or hue of 10YR, value of 6 or 7, and chroma of 1; or hue of 5Y, value of 5, and chroma of 1 and can have few to common yellowish brown mottles. The texture of the B part is sandy loam or sandy clay loam. Tongues or vertical intrusions of sand or fine sand from the E horizon extend into the B part of this horizon. In some places, small fragments or nodules of iron, cemented sandstone, or calcareous material are in the Btg/E horizon. Thickness ranges from 5 to 19 inches.

The Btg horizon has hue of 10YR, value of 3 to 7, and chroma of 1 or 2; hue of 5Y, value of 5 or 6, and chroma of 1; or hue of 5GY or 5BG, value of 5, and chroma of 1 and can have yellowish brown, light olive brown, or dark grayish brown mottles. The texture is sandy loam, fine sandy loam, or sandy clay loam. In some places, small fragments or nodules of iron, cemented sandstone, or calcareous material are present in the Btg horizon. Thickness ranges from 4 to 12 inches.

Some pedons have a BCg horizon that has hue of 5GY, value of 5, and chroma of 1. The texture is loamy sand or sandy loam. Thickness ranges from 0 to 9 inches.

The Cg horizon has hue of 5Y or 5GY, value of 5 or 6, and chroma of 1; or hue of 10YR, value of 6 or 7, and chroma of 1. The texture ranges from loamy fine sand to a mixture of sand and shell fragments or to a mixture of loamy sand with shell fragments and calcium carbonate nodules.

Samsula Series

The soils of the Samsula series are sandy or sandy-skeletal, siliceous, dysic, hyperthermic Terric Medisaprists. They are very poorly drained, rapidly permeable soils that formed in moderately thick beds of hydrophytic nonwoody plant residue. These nearly level soils are in small depressions, poorly defined drainageways, and freshwater marshes and swamps. The water table is at or above the surface except during extended dry periods. The slope is less than 2 percent.

Samsula soils are associated with Delray, Floridana, Manatee, Myakka, and Pompano soils. Delray, Floridana, and Manatee soils have a mollic epipedon and an argillic horizon. Myakka and Pompano soils are sandy mineral soils and are poorly drained. In addition, Myakka soils have a spodic horizon.

Typical pedon of Samsula muck; in a depressional area, about 1/2 mile south of the entrance to Rollins Blue Cypress Ranch, north of Yee Haw Junction; NE1/4NW1/4NW1/4, sec. 32, T. 31 S., R. 35 E.

Oa1—0 to 20 inches; black (10YR 2/1) muck; about 20 percent fiber, less than 5 percent rubbed; weak medium subangular blocky structure resemblance; friable; common fine and very fine roots, few medium roots; dark brown (10YR 4/3) sodium pyrophosphate extract; very strongly acid by Hellige-Truog method; gradual smooth boundary.

Oa2—20 to 26 inches; very dark gray (10YR 3/1) muck; about 10 percent fiber, less than 5 percent rubbed; weak medium granular structure; friable; few fine and medium roots; about 20 percent mineral material; brown (10YR 5/3) sodium pyrophosphate extract; very strongly acid by Hellige-Truog method; gradual wavy boundary.

2A—26 to 38 inches; very dark gray (10YR 3/1) sand; single grained; loose; few fine and medium roots; very strongly acid; clear wavy boundary.

2Cg—38 to 80 inches; gray (10YR 5/1) sand; single grained; loose; very strongly acid.

The thickness of the organic material ranges from 16 to 35 inches. Reaction of the organic material ranges from 4 to 5.5 by the Hellige-Truog method. The underlying mineral material is very strongly acid or medium acid.

The Oa horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or hue of 5YR, value of 2, and chroma of 1. The fiber content is less than 33 percent unrubbed and less than 5 percent rubbed. Sodium pyrophosphate extract has hue of 10YR, value of 2 through 4, and chroma of 4 or less; or hue of 10YR, value of 5, and chroma of 2 through 8; or hue of 10YR, value of 6, and chroma of 3 through 8; or hue of 10YR, value of 7, and chroma of 4 through 8. The 2A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Texture is sand or fine sand. Thickness ranges from 6 to 18 inches.

The 2Cg horizon has hue of 10YR, value of 5 or 6, and chroma of 1. Texture is sand or fine sand.

Satellite Series

The soils of the Satellite series are hyperthermic, uncoated Aquic Quartzipsamments. They are somewhat poorly drained, very rapidly permeable soils that formed in thick beds of sandy marine sediment. These nearly level soils are on low knolls and ridges on the flatwoods. The water table is at a depth of 18 to 40 inches for 2 to 6 months and at a depth of 40 to 72 inches for 6 months or more in most years. The slope ranges from 0 to 2 percent.

Satellite soils are associated with Immokalee, Myakka, Orsino, Pomello, and Pompano soils. Immokalee, Myakka, and Pomello soils have spodic horizons. In addition, Immokalee and Myakka soils are poorly drained, and Pomello soils are moderately well drained. Pompano soils are in lower positions on the landscape than Satellite soils and are poorly drained. Orsino soils are better drained than the Satellite soils.

Typical pedon of Satellite fine sand; in a wooded area adjacent to a power line north of Indian River County Road 512; SW1/4NW1/4SE1/4, sec. 19, T. 31 S., R. 38 E.

A—0 to 4 inches; dark gray (10YR 4/1) fine sand; mixture of organic matter and light gray sand grains, salt-and-pepper appearance when dry; single grained; loose; common very fine and medium roots; strongly acid; clear wavy boundary.

C1—4 to 35 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; common fine medium and few coarse roots; slightly acid; gradual wavy boundary.

C2—35 to 60 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; few medium and coarse roots; slightly acid; gradual smooth boundary.

C3—60 to 80 inches; dark grayish brown (10YR 4/2) fine sand; single grained; loose; slightly acid.

Reaction ranges from very strongly acid to mildly alkaline throughout. Texture is sand or fine sand.

The A horizon has hue of 10YR, value of 3 or 4, and chroma of 1. Unrubbed colors often have a salt-and-pepper appearance. Thickness ranges from 2 to 7 inches.

The C horizon has hue of 10YR, value of 5 to 7, and chroma of 1 or 2; or hue of 10YR, value of 4, and chroma of 2 and may have mottles or streaks of pale brown, dark grayish brown, or grayish brown.

St. Augustine Series

The soils of the St. Augustine series are sandy, siliceous, hyperthermic Udalfic Arents. These nearly level soils are adjacent to the Indian River. They are somewhat poorly drained, moderately rapidly permeable to rapidly permeable soils that were formed by dredging and filling operations. The dredge and fill material was spread over the surface of former tidal areas. The original soils in these tidal areas are very poorly drained. The fill material consists of a mixture of sand, shell fragments, loamy and silty sediment, and a few fragments of organic material. The water table is at a depth of 20 to 40 inches for 2 to 6 months in most years. It is at a depth of less than 20 inches during periods of high rainfall. In some areas, the water table is still partially influenced by daily tides. These soils are subject to flooding for very brief periods during the hurricane season. The slope is 0 to 2 percent.

St. Augustine soils are associated with Canaveral, Captiva, Quartzipsamments, and McKee soils. Canaveral and Captiva soils are sandy mineral soils that consist of layers of stratified sand and shell fragments. In addition, Captiva soils are poorly drained and have a mollic epipedon. Quartzipsamments soils were formed by filling and earthmoving operations and do not have fragments of fine textured material. McKee soils are very poorly drained. They are in mangrove islands and swamps and have a clayey mineral horizon.

Typical pedon of St. Augustine sand; in an area designated for urban development, 0.2 mile north of Florida State Road 656; SW1/4, sec. 5, T. 33 S., R. 40 E.

C1—0 to 30 inches; light brownish gray (10YR 6/2) sand; few medium distinct yellowish brown (10YR 5/6) streaks; single grained; loose; about 30 percent, by volume, multicolored shell fragments 1 millimeter or less; moderately alkaline; abrupt wavy boundary.

C2—30 to 45 inches; mixed grayish brown (10YR 5/2) sand and dark gray (5Y 4/1) silty clay loam, common medium distinct fragments of olive gray (5Y 4/2) loamy sand; massive; friable; about 55 percent shell fragments less than 3 millimeters; few fragments of very dark grayish brown muck; moderately alkaline; clear smooth boundary.

Cg—45 to 80 inches; mixed greenish gray (5GY 5/1) sand and gray (N 5/0) lenses of loamy sand; massive; friable; moderately alkaline.

St. Augustine soils are moderately alkaline throughout. The thickness of the fill material ranges from 40 to 80 inches or more. The content of shell fragments ranges from less than 5 percent to 70 percent. Weighted average of shell content that is 2 millimeters or larger in the control section is less than 20 percent. Shell fragments are stratified in some pedons. Depth to the loamy or clayey bodies is less than 40 inches.

The C1 horizon has hue of 10YR, value of 4 to 7, and chroma of 1 or 2 and can have mottles in shades of gray, brown, and yellow. Texture is sand or fine sand. Fragments of shells or lenses of loamy material can be mixed with the sand or fine sand. Thickness ranges from 6 to 30 inches. The C2 horizon has hue of 10YR, value of 4 to 7, and chroma of 1 or 2 and can have mottles in shades of gray, brown, and yellow. Texture is sand, fine sand, or loamy sand. Silty clay loam, clay loam, or sandy clay loam bodies that range from few to common are always in some part of this horizon. They have hue of 5GY or 5Y, value of 4 or 5, and chroma of 1 or 2. Shell fragments and fragments of histic material are few to common. Thickness ranges from 10 to 30 inches. The Cg horizon has hue of 5Y, 5GY, or 5BG, value of 4 to 6, and chroma of 1; or it is neutral with value of 5. Texture is sand, fine sand, or loamy sand. This horizon can have lenses of silty clay loam, clay loam, or sandy clay loam. Few to many shell fragments that are less than 3 millimeters in size are in this horizon.

Some pedons have a 2C organic horizon at a depth of more than 40 inches.

St. Lucie Series

The soils of the St. Lucie series are hyperthermic, uncoated Typic Quartzipsamments. They are excessively drained, very rapidly permeable soils that formed in thick deposits of marine or eolian sand. These nearly level to sloping soils are on the Atlantic Coastal Ridge and other elevated knolls on the flatwoods. The water table is at a depth of more than 72 inches. The slope ranges from 0 to 8 percent.

St. Lucie soils are associated with Astatula, Paola, Pomello, Satellite, and Archbold soils. Astatula soils do not have an E horizon, and they have a brownish yellow C horizon. Paola soils have an E and B/E horizon. Pomello soils have a Bh horizon and are moderately well drained. Satellite and Archbold soils are more poorly drained than St. Lucie soils.

Typical pedon of St. Lucie sand, 0 to 8 percent slopes; west of U.S. Highway 1; SE1/4SW1/4SW1/4, sec. 31, T. 33 S., R. 40 E.

A—0 to 3 inches; gray (10YR 5/1) rubbed sand; single grained; loose; many fine and medium roots; mixture of uncoated sand grains and fine organic matter granules unrubbed; very strongly acid; clear smooth boundary.

C—3 to 80 inches; white (10YR 8/1) sand; single grained; loose; few fine, common medium and few coarse roots decreasing with depth; few medium dark brown (7.5YR 3/2, 4/2) stains around root channels; medium acid.

Reaction is very strongly acid to slightly acid. The pedon is fine sand or sand to a depth of 80 inches. It does not have a subsurface diagnostic horizon within a depth of 80 inches.

The A horizon is a mixture of uncoated quartz sand grains and black organic matter granules. It has rubbed hue of 10YR, value of 5 or 6, and chroma of 1. The thickness of the A horizon ranges from 2 to 4 inches.

The C horizon has hue of 10YR, value of 7 or 8, and chroma of 1 or 2.

Terra Ceia Series

The soils of the Terra Ceia series are euic, hyperthermic Typic Medisaprists. They are deep, very poorly drained, rapidly permeable, organic soils that formed in thick deposits of hydrophytic plant residue. These nearly level soils are in freshwater marshes. Under natural conditions, the water table is at or above the surface except during extended dry periods. Runoff is slow. Slope is less than 1 percent.

Terra Ceia soils are associated with Gator and Canova soils. Gator soils have less than 51 inches of organic material that is underlain by sandy or clayey material. Canova soils are mineral soils.

Typical pedon of Terra Ceia muck; in an area of the St. Johns Marsh, about 1/2 mile south of Ditch 13; SW1/4SW1/4NE1/4, sec. 28, T. 31 S., R. 36 E.

Oa1—0 to 38 inches; black (10YR 2/1) muck; weak medium subangular blocky structure; friable; about 10 percent fiber unrubbed, 1 percent rubbed; few fine roots; dark brown (10YR 4/3) sodium pyrophosphate extract; slightly acid (pH 4.7 in 0.01 molar calcium chloride solution); gradual wavy boundary.

Oa2—38 to 60 inches; very dark grayish brown (10YR 3/2) muck; weak medium subangular blocky structure; friable; about 45 percent fiber unrubbed, 5 percent rubbed; brown (10YR 5/3) sodium pyrophosphate extract; slightly acid (pH 4.5 in 0.01 molar calcium chloride solution).

The thickness of the organic material and the depth to mineral material are more than 51 inches and commonly are 60 inches or more. Reaction ranges from slightly acid to moderately alkaline by the Hellige-Truog method or 4.5 or more in 0.01 molar calcium chloride.

The Oap horizon, if present, has hue of 10YR, value of 2, and chroma of 1; or it is neutral and has value of 2. Fiber content is less than 15 percent unrubbed.

Thickness depends on the depth of plowing but commonly ranges from 9 to 12 inches thick. The Oa horizon has hue of 5YR, value of 2, and chroma of 1 or 2; or hue of 5YR, value of 3, and chroma of 2; or hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or it is neutral and has value of 2. Fiber content is less than 33 percent unrubbed, or more than 33 percent unrubbed if fiber content is less than 16 percent of its volume after rubbing. Sodium pyrophosphate extract of all organic horizons have hue of 10YR, value of 2 to 4, and chroma of 4 or less; or hue of 10YR, value of 5, and chroma of 2 to 6; or hue of 10YR, value of 6, and chroma of 3 to 6; or hue of 10YR, value of 7, and chroma of 4 to 6. Mineral content at a depth of 20 to 52 inches ranges from about 5 to 10 percent. The underlying materials are sandy, loamy or clayey.

Wabasso Series

The soils of the Wabasso series are sandy, siliceous, hyperthermic Alfic Haplaquods. They are poorly drained, slowly permeable or very slowly permeable soils that formed in sandy and loamy marine sediment. These nearly level soils are on broad flatwoods. In most years, the water table is at a depth of 10 to 40 inches for more than 6 months and at a depth of less than 10 inches of the surface for 1 to 2 months. The slope ranges from 0 to 2 percent.

Wabasso soils are associated with Boca, EauGallie, Myakka, Oldsmar, Riviera, and Winder soils. Boca, Riviera, and Winder soils do not have a Bh horizon. In addition, Boca soils are underlain by limestone within a depth of 40 inches of the surface. EauGallie and Oldsmar soils have a Bt horizon at a depth of more than 40 inches. Myakka soils do not have a Bt horizon.

Typical pedon of Wabasso fine sand; on the flatwoods, 0.3 mile north of Florida State Road 60 in the Paradise Park subdivision; SE1/4NW1/4NE1/4, sec. 2, T. 33 S., R. 38 E.

A—0 to 7 inches; very dark gray (10YR 3/1) fine sand; weak, fine granular structure; very friable; many fine and medium roots; strongly acid; gradual wavy boundary.

E—7 to 24 inches; gray (10YR 7/1) fine sand; single grained; loose; common fine and medium roots; strongly acid; abrupt wavy boundary.

Bh1—24 to 27 inches; black (10YR 2/1) fine sand; weak fine subangular blocky structure; friable; common fine and medium roots; sand grains well coated with colloidal organic matter; medium acid; gradual smooth boundary.

Bh2—27 to 32 inches; black (10YR 2/1) fine sand; weak medium subangular blocky structure; friable; few fine and medium roots; sand grains well coated with colloidal organic matter; medium acid; clear smooth boundary.

Bh3—32 to 35 inches; very dark gray (10YR 3/1) fine sand; weak fine subangular blocky structure; friable; few fine and medium roots; medium acid; abrupt smooth boundary.

Bt1—35 to 41 inches; dark brown (10YR 3/3) sandy loam; few fine distinct very dark gray (10YR 3/1) streaks; moderate medium subangular blocky structure; slightly sticky and slightly plastic; few fine and medium roots; medium acid; gradual wavy boundary.

Bt2—41 to 48 inches; brown (10YR 4/3) fine sandy loam; weak medium subangular blocky structure; slightly sticky and slightly plastic; few fine and medium roots; medium acid; gradual wavy boundary.

C1—48 to 62 inches; brown (10YR 5/3) loamy fine sand; weak fine subangular blocky structure; slightly sticky; few fine roots; neutral; clear wavy boundary.

C2—62 to 80 inches; brown (7.5YR 5/2) loamy fine sand; weak fine subangular blocky structure; slightly sticky; few fine roots; neutral.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. Thickness ranges from 5 to 8 inches, but if value is less than 3.5, the thickness is less than 8 inches. The E horizon has hue of 10YR, value of 5 to 7, and chroma of 1; or hue of 10YR, value of 6, and chroma of 2. Thickness ranges from 14 to 22 inches. Reaction ranges from very strongly acid to medium acid. Texture is sand or fine sand. The total thickness of the A and E horizons is less than 30 inches. Some pedons have a mat of fine and medium roots underlain by the Bh horizon.

The Bh horizon has hue of 5YR, value of 2 or 3, and chroma of 1; or hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or hue of 10YR, value of 3, and chroma of 3. Sand grains are coated with organic matter. Texture is sand or fine sand, and moist consistency ranges from loose to firm. Thickness ranges from 5 to 12 inches. Reaction ranges from very strongly acid to slightly acid. The Bt horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3; or hue of 5Y, value of 4 to 6, and chroma of 1 or 2; or hue of 2.5Y; value of 4 or 5, and chroma of 2; or hue of 2.5Y, value of 6, and chroma of 1. This horizon can have few or common, fine or medium light olive brown or yellowish brown mottles and very dark gray or black streaks and pockets. Texture is fine sandy loam, sandy loam, or sandy clay loam. Reaction ranges from medium acid to moderately alkaline. The Bt horizon is 13 to 22 inches thick.

The C horizon has hue of 5Y, value of 5 or 6, and chroma of 2; or hue of 5Y, value of 6, and chroma of 3; or hue of 5GY, value of 6, and chroma of 1; or hue of 10YR, value of 4 or 5, and chroma of 3; or hue of 10YR, value of 6, and chroma of 1 to 3; or hue of 7.5YR, value of 5, and chroma of 2. Texture is sand, loamy sand, loamy fine sand, a mixture of sand or loamy sand and shell fragments, or a mixture of sand or loamy sand that

consists dominantly of shell fragments. Thickness is more than 15 inches. Reaction ranges from neutral to moderately alkaline.

Winder Series

The soils of the Winder series are fine-loamy, siliceous, hyperthermic Typic Glossaqualfs. They are deep, poorly drained, very slowly permeable soils that formed in thick beds of sandy and loamy marine sediment. These nearly level soils are in poorly defined drainageways, and on hammocks. In most years, under natural conditions, the water table is at a depth of 0 to 10 inches for 2 to 4 months and at a depth of 10 to 40 inches for about 4 to 6 months or more. The slope is 0 to 2 percent.

Winder soils are associated with Chobee, Jupiter, Manatee, Pineda, Riviera and Wabasso soils. Chobee, Jupiter, and Manatee soils have a mollic epipedon. In addition, Jupiter soil is underlain by limestone within a depth of 20 inches of the surface, and Chobee and Manatee soils are very poorly drained. Pineda and Riviera soils have an argillic horizon at a depth of 20 to 40 inches. Wabasso soils have a spodic horizon.

Typical pedon of Winder fine sand; in a poorly defined drainageway; NW1/4NW1/4NW1/4, sec. 31, T. 33 S., R. 38 E.

A—0 to 7 inches; very dark gray (10YR 3/1) fine sand; single grained; loose; common fine and few medium roots; very slightly acid; clear smooth boundary.

E—7 to 17 inches; grayish brown (10YR 5/2) fine sand; many fine distinct dark gray (10YR 4/1) splotches; single grained; loose; few fine and medium and coarse roots; slightly acid; gradual irregular boundary.

B/E—17 to 23 inches; grayish brown (10YR 5/2) sandy loam; common medium prominent yellowish brown (10YR 5/8) mottles; common grayish brown (10YR 5/2) loamy sand intrusions; weak medium subangular blocky structure; slightly sticky and nonplastic; mildly alkaline; gradual wavy boundary.

Btg1—23 to 34 inches; gray (5Y 6/1) sandy loam; few medium prominent yellowish brown (10YR 5/8) and few coarse distinct yellow (10YR 7/6) mottles; weak medium subangular blocky structure; slightly sticky and nonplastic; moderately alkaline; clear wavy boundary.

Btg2—34 to 48 inches; gray (10YR 6/1) sandy loam; few and common fine and medium distinct yellowish brown (10YR 5/6) and common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; slightly sticky and nonplastic; moderately alkaline; gradual smooth boundary.

BCg—48 to 65 inches; gray (5Y 6/1) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; slightly sticky and nonplastic; moderately alkaline; gradual smooth boundary.

2Cg—65 to 80 inches; greenish gray (5GY 6/1) loamy sand and shell fragments; massive; parting to weak fine subangular blocky structure; few light greenish gray soft calcium carbonate masses; slightly sticky and nonplastic; moderately alkaline.

Reaction ranges from medium acid to moderately alkaline in the A, E, and B horizons. The C horizon is very slightly acid to moderately alkaline.

The A or Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 1. Texture is fine sand or loamy fine sand. Thickness ranges from 2 to 7 inches.

The E horizon has hue of 10YR, value of 5 to 7, and chroma of 1 or 2; or hue of 10YR, value of 4, and chroma of 1. Texture is fine sand or loamy fine sand. Thickness ranges from 7 to 10 inches. The combined thickness of the A and E horizons is less than 20 inches.

The B/E horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. Texture of the B part of the B/E horizon is sandy loam or sandy clay loam. The texture of the E part is fine sand, loamy sand, or loamy fine sand. Thickness ranges from 5 to 8 inches. The Btg horizon has hue of 10YR, value of 4 to 6, and chroma of 1; or hue of 5Y or 5GY, value of 5 or 6, and chroma of 1; or it is neutral with value of 6 and has mottles of brown, yellow, or gray. Texture is sandy loam or sandy clay loam. In some pedons, this horizon has a small accumulation of light gray or white calcareous material throughout. Thickness ranges from 24 to 28 inches. Some pedons have a BC horizon that has hue of 10YR, value of 4 to 6, and chroma of 1; or hue of 5Y or 5GY, value of 5 or 6, and chroma of 1; or it is neutral with value of 6 and has mottles of brown, yellow, or gray. Texture is sandy loam or sandy clay loam.

The 2Cg horizon has hue of 5Y or 5GY, value of 5 or 6, and chroma of 1. Texture is loamy sand and sandy clay loam, or it is a mixture of loamy fine sand and shell fragments. Accumulations of soft calcium carbonate and concretions in some pedons are mixed with loamy sand.

Formation of the Soils

In this section, the factors of geology and processes of soil formation are described and related to the soils in the survey area.

Factors of Soil Formation

Soil is produced by forces of weathering acting on the parent material that has been deposited or accumulated by geologic agencies. The kind of soil that forms depends on five major factors. These factors are—

- the type of parent material
- the climate under which the soil material has existed since accumulation
- the plant and animal life in and on the soil
- the relief, or lay of the land
- the length of time the forces of soil formation have acted on the soil material.

The five soil-forming factors are interdependent; each modifies the effect of the others. Any one of the five factors can have more influence than the others on the formation of a soil and can account for most of its properties. For example, if the parent material is quartz sand, the soil generally has weakly expressed horizons. The effect of the parent material is modified greatly in some places by the effects of climate, relief, and plants and animals in and on the soil. As a soil forms, it is influenced by one or more of the five factors, but in some places one factor has a predominant effect. A modification or variation in any of these factors results in a different kind of soil.

Parent Material

Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineralogical composition of the soil.

The parent material of most of the soils of Indian River County is unconsolidated marine sediment of the Pleistocene and Recent geological ages. The thickness of the Pleistocene material is less than 20 feet in the western part of the county grading to 100 feet in the eastern part. Most of this material consists of undifferentiated sediment, including sands, clays, shell beds, and thin limestone units. In addition, these undifferentiated sediments are overlain by windblown sands and sea-deposited sandy and shelly material in a narrow band along the present coastline. Organic matter accumulations of Recent times and in varying amounts also serve as the parent material for some soils of Indian River County.

Myakka and Immokalee soils are representative of soils that formed in thick beds of loose sand in which the transfer of organic matter and reduced iron occurred and formed a spodic horizon. EauGallie, Oldsmar, and Wabasso soils formed an argillic horizon by translocation of clayey material in stratified sediment. Astatula, Paola, and St. Lucie soils formed in Recent windblown quartz sand on the Atlantic Coastal Ridge. Canaveral, Captiva, and Palm Beach soils formed in sand and shell material of Recent sea deposits on the barrier island. Gator and Terra Ceia soils formed in Recent accumulations of organic material in low wet places.

Climate

Indian River County has a humid-subtropical climate. Extreme temperatures are moderated by the Atlantic Ocean and the Indian River; however, these bodies of water contribute to the high humidity of the area. The average rainfall is about 55 inches a year. In summer, the climate is uniform throughout the county.

Few differences among the soils are caused by the climate; however, the climate aids in rapid decomposition of organic matter, and it also hastens chemical reactions in the soil. The heavy rainfall leaches the soils of most plant nutrients and produces a strongly acid condition in many of the sandy soils. Rain also carries the less soluble fine particles downward. Consequently, many of the soils acted upon by these climatic conditions are sandy, have low organic matter content, low natural fertility, and low available water capacity.

Plants and Animals

Plants have been the principal biological factor in the formation of soils in the survey area. Animals, insects, bacteria, and fungi have been important agents. Plants and animals furnish organic matter, nitrogen, and plant nutrients to the soils and cause differences in soil structure and porosity. In places, tree roots and crayfish have penetrated the loamy subsoil and mixed the sandy surface layer with the subsoil.

Microorganisms, including bacteria and fungi, help to weather and break down minerals and to decompose

organic matter. These organisms are most numerous in the upper few inches of the soil. Earthworms and some small animals inhabit the soil, alter its chemical composition, and mix it with other soil material. The native vegetation in the survey area has affected soil formation more than other living organisms.

Man has influenced the formation of soils by clearing the forests, cultivating the soils, draining wet areas, and introducing different kinds of plants. The complex of living organisms that affect soil formation has been drastically changed as a result of man's activities. Except for loss of organic matter and minor erosion in places, few results of man's activities are yet apparent.

Relief

Relief has affected the formation of soils in Indian River County mainly through its influence on soil-water relationships. Other factors of soil formation generally associated with relief, such as erosion, temperature, and plant cover, are of minor importance.

Three general areas—flatwoods, swamps and marshes, and the coastal ridges—are in the survey area. Among these general areas are differences in soils that are directly related to relief.

The soils on the flatwoods have a high water table and are periodically wet to the surface. Therefore, these soils are not as highly leached as those of the coastal ridges. The soils in the swamps and marshes are covered with water for long periods; in many places, they have high organic matter content. The soils on the coastal ridges are at a higher elevation than those on the flatwoods and in swamps and marshes. The deep, sandy soils on the ridges are mostly excessively drained and are not influenced by ground water. These soils are more subject to erosion than soils in other parts of the county.

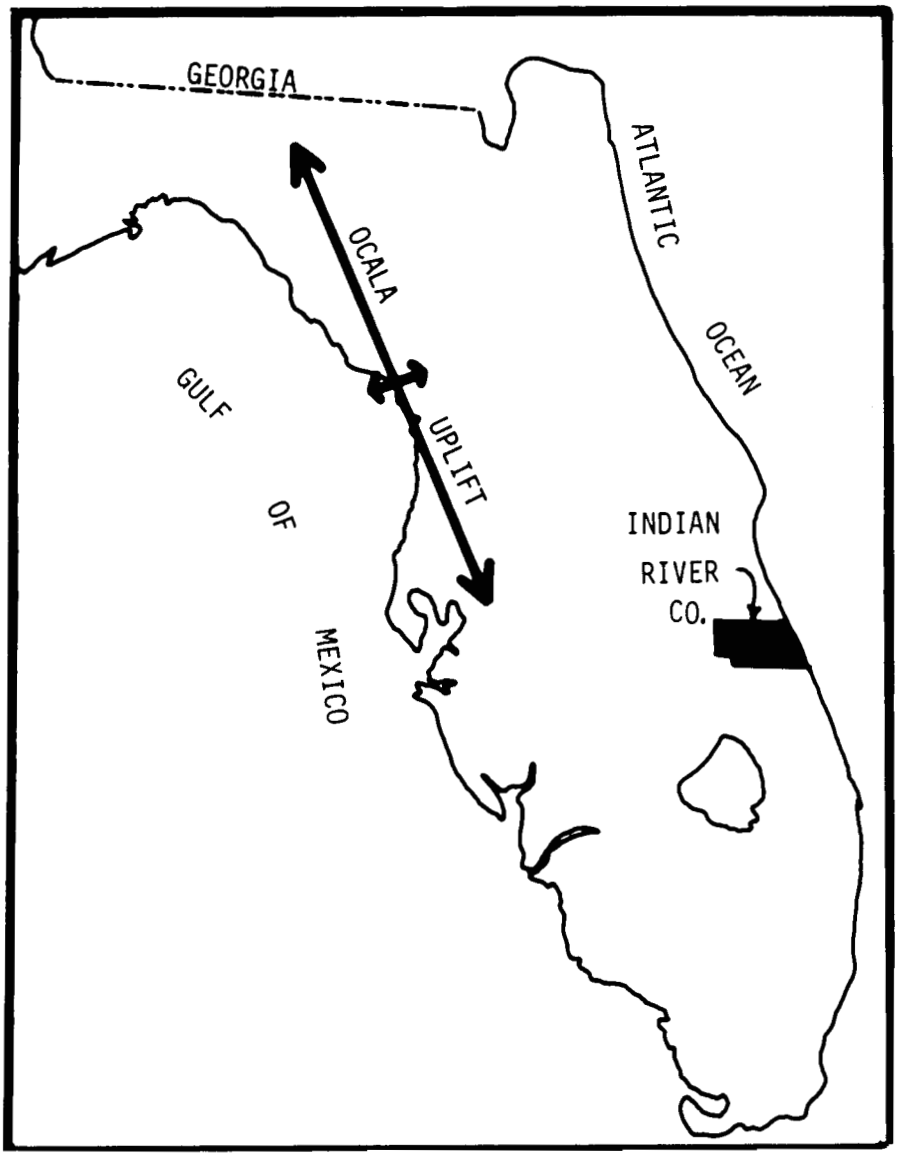


Figure 16.—Location map of Indian River County and Ocala Uplift.

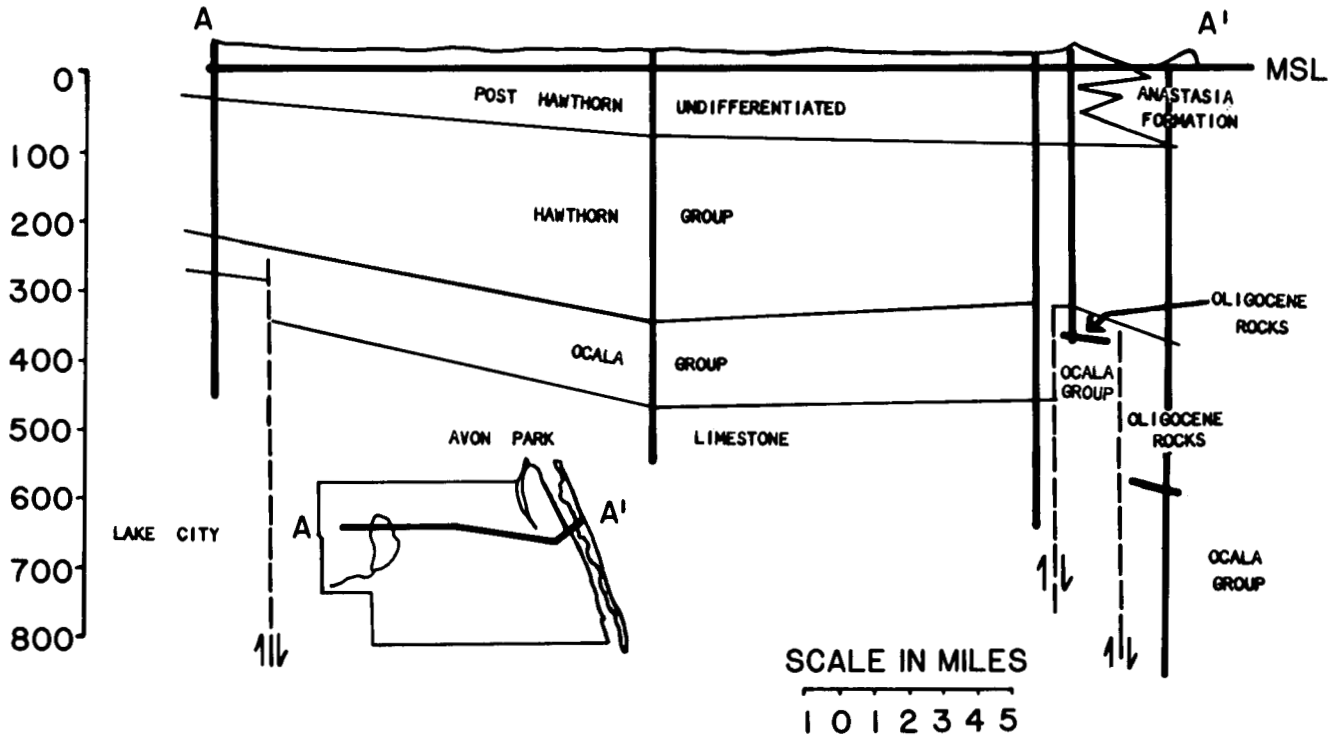


Figure 17.—West to east cross section of the stratigraphy of Indian River County.

Time

Time is an important factor in soil formation. The physical and chemical changes brought about by climate, living organisms, and relief are slow. The length of time needed to convert raw geological material into soil varies according to the nature of the geological material and the interaction of the other factors. Some basic minerals from which soils are formed weather fairly rapidly; other minerals are chemically inert and show little change over long periods. The translocation of fine particles within the soil to form the various horizons is variable under different conditions, but the processes always take a relatively long time.

In Indian River County, the dominant geological materials are inactive. The sands are almost pure quartz and are highly resistant to weathering. The finer textured silt and clay are the product of earlier weathering.

In terms of geological time, relatively little time has elapsed since the material in which the soil in the county has developed was laid down or emerged from the sea. The loamy and clayey horizon formed in place through processes of clay translocation.

Processes of Soil Formation

Soil morphology refers to the process involved in the formation of the soil horizon or soil horizon differentiation. The differentiation of horizons in soils in Indian River County is the result of accumulation of organic matter, leaching of carbonates, reduction and transfer of iron, or accumulation of silicate clay minerals. Sometimes more than one of these processes are involved.

Some organic matter has accumulated in the upper layers of most of the soils to form an A horizon. The quantity of organic matter is small in some of the soils but fairly large in others.

Carbonates and salts have been leached in all of the soils. The effects of leaching have been indirect in that the leaching permitted the subsequent translocation of silicate clay material in some soils. Most of the soils in the county are leached to varying degrees.

The process of chemical reduction, or gleying, is evident in many of the soils in Indian River County except for the excessively drained soils. Gleying is caused by wetness. Gray matrix color in the B horizon of

many soils and grayish mottles in other soils indicate the reduction of iron. In some sandy soils, however, gray color is that of the sand grains. Some horizons contain reddish brown mottles and concretions, which indicate the segregation of iron and fluctuating water table.

The translocation of silicate clay, colloidal organic matter, and iron oxides has contributed to horizon development in many of the soils in the county. Movement of clay, organic matter, or iron is evident in many of the soils that have a light colored, leached E horizon, that have a Bt or Bh horizon in which sand grains are bridged and coated with clay or colloidal organic matter, or that have a few patchy clay films on ped faces and in root channels. Compared with the other processes involved in soil formation, the translocation of silicate clay may be of minor importance in the formation of an horizon in the soils of Indian River County.

Geology

Thomas M. Scott, Florida Geological Survey, Bureau of Geology, Department of Natural Resources, helped prepare this section.

Indian River County is located in east-central Florida southeast of the crest of the Ocala Uplift (fig. 16). It is underlain by a thick sequence (nearly 10,000 feet) of sedimentary rocks (carbonates, sands, and clays) overlying a basement complex of igneous and metamorphic rocks. These rocks range in age from approximately 90 million years old for the basement rocks to recent sediment at the surface.

The upper 1,000 feet of sediments in Indian River County is limestone, dolomite, sand, clay, and shell beds ranging in age (52 million years) from middle Eocene to recent. The sediments of the middle Eocene age (52 million years) through the lower Oligocene age (25 million years) are porous carbonates that make up the Floridan aquifer. The overlying sediments are predominantly clastics (sand and clay) ranging in age from 25 million years (Miocene age) to the recent sediments found along the present coastline. This section of younger sediments contains the shallow aquifer that is of great importance to the county *(6)*.

The deepest formation to be discussed is the middle Eocene age Avon Park Limestone. This unit consists of cream to tan and brown colored limestone and dolomite. The Avon Park Limestone may be 250 feet thick. It yields water from porous zones in some areas of the county *(6)*. Water from this formation is typically high in chloride concentration and is used for irrigation only.

Immediately overlying the Avon Park Limestone is the Ocala Group of limestone. The upper Eocene age Ocala Group includes three formations, the Inglis, Williston, and Crystal River *(9)*. The entire group is composed of limestone. The Williston and Inglis formations are tan to white, granular, porous limestone. The Crystal River Formation consists of white, granular to pasty, porous to massive limestone. The Ocala Group varies from 50 feet thick to a maximum thickness of 225 feet. These units yield poor quality water that is high in chlorides and is used primarily for irrigation.

In part of the county, the Ocala Group is overlain by undifferentiated rocks of possible Oligocene age (36 to 25 million years). These sediments are gray to cream colored, clayey, often sandy, muddy limestone. This unit yields poor quality water and a poor quantity of water. The Oligocene age rocks only occur in the easternmost part of the county. This unit is up to 200 feet thick.

The Hawthorn Group of Miocene age (25 to 13 million years) and early Pliocene age (24 to 3 million years) overlies the Oligocene sediments where they occur. The Hawthorn Group lies on the Ocala Group where the Oligocene rocks are absent. The contact of the Ocala and Hawthorn groups is an unconformity that represents 11 to 12 million years of missing sediments. The Hawthorn Group consists of interbedded limestone, dolomite, sand, and clay. These sediments contain minor amounts of phosphate (generally 1 to 5 percent). The Hawthorn Group is up to about 250 feet thick in Indian River County. Very little water is produced from the Hawthorn sediments.

The Hawthorn Group is overlain by the undifferentiated post-Hawthorn sediments throughout most of the county. However, along the coast, the Anastasia Formation of Pleistocene age (1.6 to .01 million years) overlies the Hawthorn Group. The undifferentiated sediments include sand, clay, shell beds, and thin limestone units that have been variously assigned to the Tamiami Formation, Caloosahatchee Formation, and/or the Fort Thompson Formation. Currently, the formational assignment is in doubt, and these sediments are referred to the undifferentiated category. These sediments range in age from early Pliocene through Pleistocene (3 to .01 million years). This unit underlies most of Indian River County. The undifferentiated unit can provide moderate amounts of water in areas where it is permeable.

The Anastasia Formation occurs only in a band along the present coastline. This unit generally does not extend more than 5 miles inland. The Anastasia Formation is composed of quartz sand and shell material. The Anastasia Formation is best known for its more lithified shell beds, called coquina, that were extensively used as a building and facing material along the east coast of Florida. The induration of the sediments in this unit varies considerably from completely unlithified to well indurated. This unit represents an ancient beach deposit and can provide moderate amounts of water to shallow wells.

Several early authors have suggested the presence of faults in Indian River County *(3, 20)*. One proposal was that a fault existed in the western part of the county

where this formed the boundary of the Osceola Low *(20)*. Another proposal was that this same fault was projected into this area from Brevard County. Additionally, it was attributed that the existence of Oligocene rocks in the eastern part of the county was because of faulting *(3)*.

Today, there still is some question as to the actual existence of faults in Indian River County. The present data base is such that the stratigraphy can be interpreted without using faults. If the faults do exist they are quite old. They do not appear to cut the sediments of the Hawthorn group and, as a result, have not been active for at least 26 million years.

The stratigraphy of the county (figs. 17 and 18) is presented with the faults. The faults are dashed to indicate the uncertainty about their existence. Arrows along the faults indicate direction of movement.

Surface outcrops in Indian River County occur along many canals and some of the beach areas. The outcrops in the county expose only the Anastasia Formation and the undifferentiated post-Hawthorn sediments.

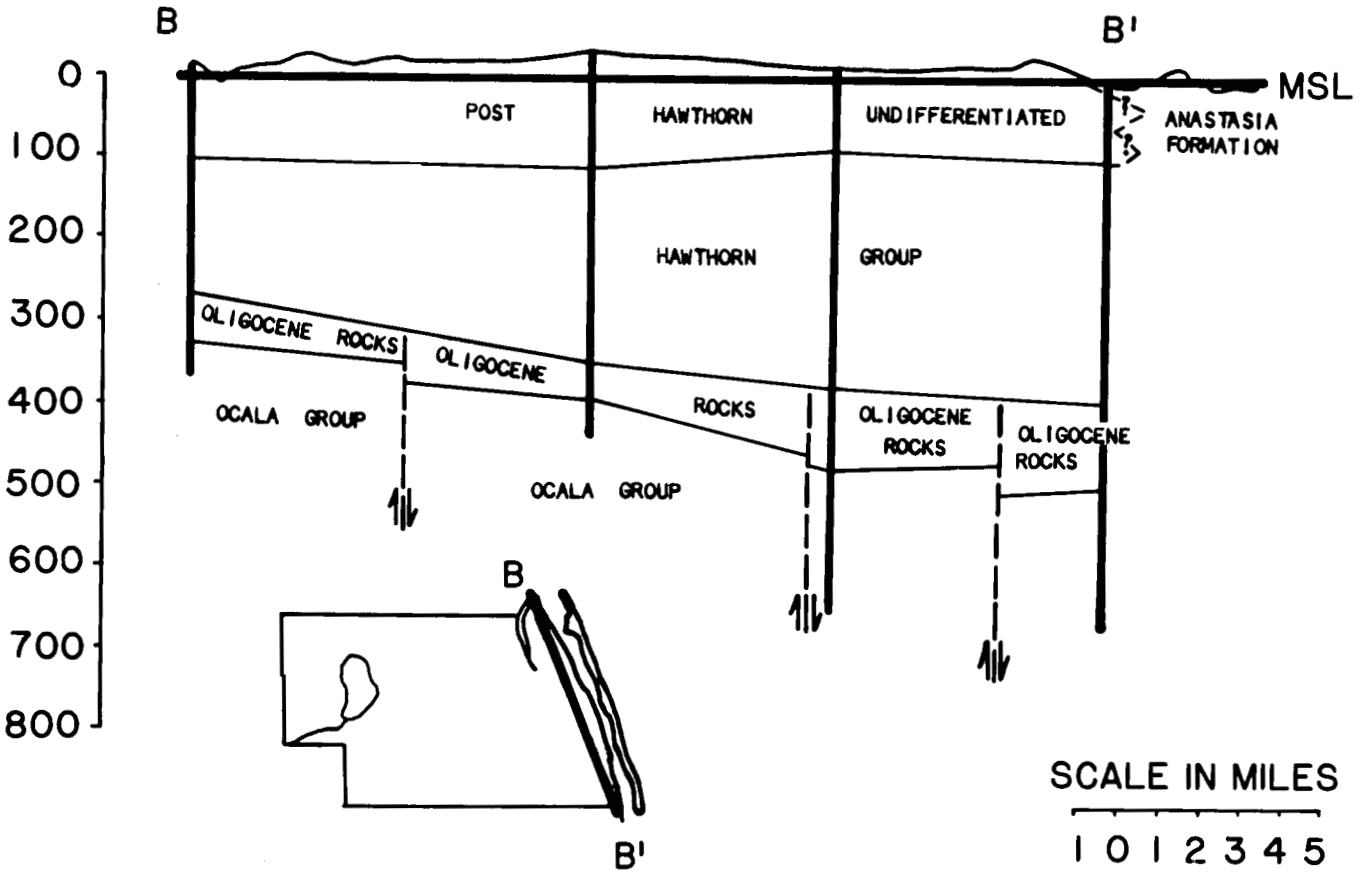


Figure 18.—North to south cross section of the stratigraphy of Indian River County.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Absorption field. The area into which a subsurface system of tile or perforated pipe distributes effluent from a septic tank into natural soil.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. Soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding. A partial method of controlling excess water for the growth of citrus and other crops by using regularly spaced shallow ditches and beds.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). The volume of soft soil decreases excessively under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazingland for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Ecological plant community. A grouping of similar soils, plants, and animals. This concept is used to recognize and study the interaction of groups of living organisms with their environment. Soils that have a designated ecological plant community are not generally used for rangeland because of their proximity to urban areas, although they support native vegetation; they are precluded because of unpalatable vegetation; or access to the community is prohibited by a high water table or other barrier. Recognized ecological plant communities are:

Cypress swamp.—This community occurs in depressions and poorly defined drainageways. Pond cypress is the dominant tree, along with red maple, willow, maidencane, and other water-tolerant plants. The water table is at or above the surface most of the year.

Mangrove swamps.—This community occurs along saltwater shorelines and on islands within the intracoastal waterway. The predominant vegetation occurs as a thicket of fleshy leaved, woody plants containing red, black, or white mangrove, depending on the elevation and tidal influx.

Salt marsh.—This community occurs as an open expanse of grasses, sedges, rushes, and other low growing salt-tolerant plants; or as a matrix of interconnected, manmade (mosquito ditches) or shallow natural channels surrounded by mangroves, Brazilian peppertree, and scattered cabbage palm, influenced by tidal flux.

South Florida coastal strand.—This community occurs on nearly level to sloping soils adjacent to the Atlantic Ocean. It has vegetation that is adapted to, as well as influenced by the salt and air water environment. The predominant vegetation is sawpalmetto, seagrape, and sea-oats.

Swamp hardwoods.—This community occurs as a dense stand of primarily deciduous trees (red maple, redbay cypress) interspersed with woody shrubs (willow), and other water-tolerant plants. These areas are subject to periodic ponding.

Effervescence. As used in this survey, the bubbling of carbon dioxide when dilute hydrochloric acid is applied to calcium carbonates.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, such as fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay are in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil restrict the growth of most plants.

Excess sulfur (in tables). An excessive amount of sulfur is in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Fast intake (in tables). The movement of water into the soil is rapid.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fill. Material used to raise the surface level of the land to a desired level.

Fine textured soil. Sandy clay, silty clay, and clay.

Flatwoods. Broad, nearly level, low ridges of poorly drained, dominantly sandy soils that have a characteristic vegetation of open pine forest and an understory of sawpalmetto and pineland threeawn.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant that is not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green-manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Hammock. A densely wooded area, slightly elevated above adjacent areas that has characteristic natural vegetation of cabbage palm, oaks, and pine with an understory of sawpalmetto, shrubs, and grasses.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is, in part, a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as accumulation of clay, sesquioxides, humus, or a combination of these; prismatic or blocky structure; redder or browner colors than those in the A horizon; or a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock (unweathered bedrock) beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the plants that are the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material. This contrasts with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Land shaping. Rearrangement of soil materials by cutting and filling to form a more suitable site for the intended use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Marl. An unconsolidated mineral deposited in marine or fresh water. It consists chiefly of silt- and clay-size particles of calcium carbonate.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mosquito impoundment. Areas of tidal marsh or tidal swamp, which are diked to maintain a certain water level to prevent breeding of mosquitos. Water control structures can be used and altered to allow fish movement in and out of the marshes.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Mounding. Filling the area for the absorption field with suitable soil material to the level above the water table needed to meet local and state requirements.

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

No water (in tables). Too deep to ground water.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Ortstein. The B horizon in a spodosol that is cemented by organic matter, by accumulated sesquioxides, or by both.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10

square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Subsurface tunnels or pipelike cavities are formed by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). In these areas, surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of the acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rippable. Rippable bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). There is a shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Salty water (in tables.) Water is too salty for consumption by livestock.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk

density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil improving crops. A cover crop that adds nitrogen and other nutrients to the soil during fallow rotation.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in organic matter content than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, such as zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). There is a risk of caving or sloughing on banks of fill material.

Water control. Regulating the water table as needed by means of canals, ditches, tile, pumping, or any other appropriate method.

Water table. The upper limit of the soil that is wholly saturated with water.

Water table, apparent.—A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, perched.—A water table standing above an unsaturated zone. In places an upper or perched water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced by atmospheric agents in rocks or other deposits at or near the earth's surface. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of course grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. This contrasts with poorly graded soil.

Wetness. (in tables). Soil that is wet during the intended period of use.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Based on data recorded at Vero Beach, Florida]

Month	Temperature					Precipitation		
				Mean number of days with temperatures of--			Mean number of days with rainfall of--	
	Normal monthly mean	Normal daily maximum	Normal daily minimum	90 °F or higher	32 °F or lower	Normal total	0.10 inch or more	0.50 inch or more
	°F	°F	°F	°F	°F	In		
January----	61.4	70.0	46.0	0	4	1.92	2	1
February---	69.1	71.0	48.0	0	0	2.16	8	3
March------	70.2	79.0	54.0	0	0	1.74	6	5
April------	73.7	82.0	51.0	2	0	2.05	9	4
May--------	74.4	83.0	66.0	0	0	5.58	11	4
June-------	80.5	88.0	70.0	14	0	5.58	11	6
July-------	81.6	91.0	71.0	25	0	3.81	13	8
August-----	81.7	91.0	72.0	19	0	6.68	13	5
September--	80.1	89.0	72.0	18	0	8.31	17	7
October----	74.9	85.0	64.0	2	0	2.24	6	3
November---	71.9	85.0	60.0	0	0	3.51	8	5
December---	67.5	80.0	53.0	0	0	3.78	8	1
Total----	79.9	74.0	53.0	80	4	55.00	112	52

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Based on data recorded at Vero Beach, Florida]

Freeze threshold temperature	Mean date of last spring occurrence	Mean date of first fall occurence	Mean number of days between dates	Years of record spring	Number of occurences in spring	Years of record fall	Number of occurrences in fall
32 °F----	January 18, 1982 (32 °F)	January 15, 1982 (30 °F)	(*)	17	(*)	17	(*)
28 °F----	January 12, 1982 (25 °F)	December 25, 1983 (24 °F)	(*)	17	(*)	17	(*)

*When the frequency of occurrence in either spring or fall is 1 year and in 10 or less, mean dates are not given.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT

[The overall rating for the soil unit is based on the rating for the most dominant soil or soils]

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
1. Astatula-Archbold-St. Lucie:	1.8	---	Very poor---	Poor-------	Low----------	Severe---------	Slight--------	Severe.
Astatula----------	---	27	Very poor: droughty, very low fertility.	Poor: droughty, very low, fertility.	Low: equipment limitations, seedling mortality.	Severe: seepage, too sandy.	Slight--------	Severe: too sandy.
Archbold----------	---	14	Poor: droughty, very low fertility.	Fair-------	Low: equipment limitations, seedling mortality.	Severe: wetness, seepage, too sandy.	Slight--------	Severe: too sandy.
St. Lucie---------	---	14	Not suited: droughty, very low fertility.	Very poor: droughty, very low fertility.	Very low: seedling mortality, equipment limitations.	Severe: poor filter, too sandy, seepage.	Slight--------	Severe: too sandy.
Minor soils--------	---	45	---	---	---	---	---	---
2. Canaveral-Captiva-Palm Beach:	2.0	---	Very poor---	Poor-------	Moderate----------	Severe---------	Severe--------	Severe.
Canaveral---------	---	40	Very poor: droughty, very low fertility.	Poor: droughty, very low fertility.	Moderate: seedling mortality, equipment limitations.	Severe: wetness, seepage, too sandy.	Severe: wetness.	Severe: wetness, too sandy.
Captiva----------	---	27	Poor: wetness.	Fair: wetness.	Moderate: seedling mortality, equipment limitations.	Severe: wetness, seepage, too sandy.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Palm Beach---------	---	25	Not suited: droughty, very low fertility.	Not suited: droughty, very low fertility.	Very low: seedling mortality, equipment limitations.	Severe: poor filter, seepage, too sandy.	Slight--------	Severe: too sandy.
Minor soils	---	8	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
3. McKee-Quartzipsamments-St. Augustine:	2.3	---	Not suited	Not suited	Not suited	Severe	Severe	Severe.
McKee	---	58	Not suited	Not suited	Not suited	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness, subsides.	Severe: flooding, too clayey, excess salt.
Quartzipsamments	---	21	Not suited	Not suited	Not sutied	Severe: wetness, seepage.	Severe: cutbanks cave, wetness.	Severe: too sandy.
St. Augustine	---	15	Not suited	Not suited	Not suited	Severe: wetness, poor filter, seepage.	Severe: cutbanks cave, flooding.	Severe: flooding, too sandy.
Minor soils	---	6	---	---	---	---	---	---
4. Immokalee-Myakka-Satellite:	4.9	---	Fair	Good	Moderate	Severe	Severe	Severe.
Immokalee	---	33	Fair: wetness, low fertility, droughty.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Myakka	---	31	Fair: wetness, low fertility, droughty.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Satellite	---	14	Poor: droughty, low fertility.	Fair: droughty, low fertility.	Moderate: seedling mortality, equipment limitations.	Severe: seepage, wetness, poor filter.	Severe: cutbanks cave, wetness.	Severe: too sandy, wetness.
Minor soils	---	22	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
5. EauGallie-Oldsmar-Wabasso:	14.2	---	Fair	Good	Moderately high	Severe	Severe	Severe.
EauGallie	---	44	Fair: wetness, low fertility.	Good: wetness.	Moderately high: equipment limitations, seedling mortality, plant competition.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Oldsmar	---	18	Fair: wetness, low fertility, droughty.	Good: wetness.	Moderately high: seedling mortality, equipment limitations.	Severe: wetness, too sandy.	Severe: wetness, cutbanks cave.	Severe: too sandy, wetness.
Wabasso	---	9	Fair: wetness, low fertility.	Good: wetness.	Moderately high: seedling mortality, equipment limitations.	Severe: wetness, percs slowly, seepage.	Severe: wetness.	Severe: wetness, percs slowly, too sandy.
Minor soils	---	29	---	---	---	---	---	---
6. Myakka-Immokalee:	9.5	---	Fair	Good	Moderate	Severe	Severe	Severe.
Myakka	---	51	Fair: wetness, low fertility.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy
Immokalee	---	31	Fair: wetness, low fertility.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy
Minor soils	---	18	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
7. EauGallie-Myakka-Riviera:	1.1	---	Fair	Good	Moderately high	Severe	Severe	Severe.
EauGallie	---	24	Fair: wetness, low fertility, droughty.	Good: wetness.	Moderately high: equipment limitations, seedling mortality, plant competition.	Severe: wetness, seepage, too sandy.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Myakka	---	3	Fair: wetness, low fertility, droughtiness.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Riviera	---	14	Fair: wetness, low fertility.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, seepage, percs slowly.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy, percs slowly.
Minor soils	---	39	---	---	---	---	---	---
8. Riviera-Pineda-Wabasso:	24.6	---	Fair	Good	Moderately high	Severe	Severe	Severe.
Riviera	---	33	Fair: wetness, low fertility.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, percs slowly.
Pineda	---	29	Fair: wetness, low fertility.	Good: wetness.	Moderately high: seedling mortality, equipment limitations.	Severe: wetness, percs slowly, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, percs slowly, too sandy.
Wabasso	---	24	Fair: wetness, low fertility.	Good: wetness.	Moderately high: seedling mortality, equipment limitations.	Severe: wetness, percs slowly, seepage.	Severe: wetness.	Severe: wetness, percs slowly.
Minor soils	---	14	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
9. Winder-Riviera-Manatee:	11.5	---	Fair	Good	High	Severe	Severe	Severe.
Winder	---	54	Fair: wetness, low fertility.	Good: wetness.	High: equipment limitations, seedling mortality, plant competition.	Severe: percs slowly, wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy, percs slowly.
Riviera	---	22	Fair: wetness, low fertility.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, seepage, percs slowly.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy, percs slowly.
Manatee	---	8	Good: wetness.	Good: wetness.	High: equipment limitations, seedling mortality, plant competition.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness.
Minor soils	---	16	---	---	---	---	---	---
10. Boca-Wabasso-Riviera:	1.3	---	Fair	Fair	High	Severe	Severe	Severe.
Boca	---	34	Fair: wetness, low fertility.	Fair: wetness.	High: equipment limitations, seedling mortality.	Severe: depth to rock, wetness.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Wabasso	---	13	Fair: wetness, low fertility.	Good: wetness.	Moderately high: seedling mortality, equipment limitations.	Severe: wetness, percs slowly, seepage.	Severe: wetness.	Severe: wetness, percs slowly.
Riviera	---	10	Fair: wetness, low fertility.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, seepage, percs slowly.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy, percs slowly.
Minor soils	---	43	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
11. Myakka-Holopaw-Pompano:	5.0	---	Fair	Good	Moderate	Severe	Severe	Severe.
Myakka	---	19	Fair: wetness, low fertility.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, seepage.	Severe: wetness, cutbanks cave.	Severe: wetness, too sandy.
Holopaw	---	19	Fair: wetness, low fertility, droughtiness.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, poor filter, seepage.	Severe: cutbanks cave, wetness.	Severe: wetness, too sandy.
Pompano	---	19	Fair: wetness, low fertility, droughtiness.	Good: wetness.	Moderate: equipment limitations, seedling mortality.	Severe: wetness, poor filter, seepage.	Severe: cutbanks cave, wetness.	Severe: wetness, too sandy.
Minor soils	---	43	---	---	---	---	---	---
12. Terra Ceia-Gator-Canova:	19.0	---	Good	Good	Not suited	Severe	Severe	Severe.
Terra Ceia	---	58	Good: ponding.	Good: ponding.	Not suited	Severe: ponding, poor filter, excess humus.	Severe: excess humus, ponding, low strength.	Severe: ponding, excess humus.
Gator	---	21	Good: ponding.	Good: ponding.	Not suited	Severe: ponding, excess humus, seepage.	Severe	Severe: ponding, excess humus.
Canova	---	18	Fair: ponding.	Good: ponding.	High: equipment limitations, seedling mortality.	Severe: ponding, seepage, excess humus.	Severe: ponding.	Severe: ponding, excess humus.
Minor soils	---	3	---	---	---	---	---	---

See footnotes at end of table.

TABLE 3.--SOIL RATINGS AND LIMITATIONS FOR SELECTED USES, BY GENERAL SOIL MAP UNIT--Continued

Map unit symbol, map unit name, and component soils	Percent of survey area	Percent of map unit	Soil suitability for--		Potential productivity and limitations for--	Degree and kind of limitations for--		
			Cropland	Pasture	Pine trees	Sanitary facilities *	Building sites **	Recreation areas
13. Floridana-Delray-Holopaw:	2.8	---	Poor--------	Fair-------	Moderately high-------	Severe---------	Severe--------	Severe.
Floridana----------	---	25	Poor: ponding, wetness.	Fair: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: ponding, percs slowly, seepage.	Severe: cutbanks cave, ponding.	Severe: ponding, percs slowly.
Delray----------	---	25	Poor: ponding, wetness.	Fair: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: ponding, seepage.	Severe: ponding, cutbanks cave.	Severe: ponding.
Holopaw----------	---	15	Fair: wetness, low fertility, droughtiness.	Good: wetness.	Moderately high: equipment limitations, seedling mortality.	Severe: wetness, poor filter, seepage.	Severe: cutbanks cave, wetness.	Severe: wetness, too sandy.
Minor soils--------	---	35	---	---	---	---	---	---

* Ratings apply to septic tank absorption fields and trench sanitary landfills.
** Ratings apply to dwellings without basements, small commercial buildings, and local roads and streets.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Canaveral fine sand, 0 to 5 percent slopes	2,533	0.7
2	Chobee loamy fine sand	2,024	0.6
3	EauGallie fine sand	21,974	6.4
4	Immokalee fine sand	16,494	4.8
5	Myakka fine sand	20,917	6.1
6	Oldsmar fine sand	11,342	3.3
7	Palm Beach sand, 0 to 5 percent slopes	1,599	0.5
8	Paola sand, 0 to 5 percent slopes	283	0.1
9	Pepper sand	1,004	0.3
10	Riviera fine sand	30,858	8.9
11	St. Lucie sand, 0 to 8 percent slopes	865	0.3
12	Archbold sand, 0 to 5 percent slopes	815	0.2
13	Wabasso fine sand	23,971	6.9
14	Winder fine sand	20,616	6.0
15	Manatee loamy fine sand	3,028	0.9
16	Pineda fine sand	22,004	6.4
17	Quartzipsamments, 0 to 5 percent slopes	2,558	0.7
18	Captiva fine sand	1,739	0.5
20	Beaches	487	0.1
21	Pomello sand, 0 to 5 percent slopes	2,710	0.8
22	Urban land	775	0.2
23	Arents,0 to 5 percent slopes	2,188	0.6
24	Floridana sand	2,660	0.8
25	St. Augustine sand	724	0.2
26	St. Augustine fine sand, organic substratum	437	0.1
27	Boca-Urban land complex	287	0.1
28	EauGallie-Urban land complex	1,357	0.4
29	Immokalee-Urban land complex	454	0.1
31	Jupiter fine sand	1,001	0.3
32	Jonathan sand, 0 to 5 percent slopes	206	0.1
33	Astatula sand, 0 to 5 percent slopes	1,596	0.5
34	Satellite fine sand	2,451	0.7
35	McKee mucky clay loam	3,773	1.1
36	Boca fine sand	1,626	0.5
39	Malabar fine sand	4,032	1.2
40	Gator muck	12,767	3.7
41	Canova muck	11,156	3.2
42	Terra Ceia muck	35,487	10.3
44	Perrine Variant loamy fine sand	285	0.1
45	Myakka fine sand, depressional	5,134	1.5
46	Orsino fine sand, 0 to 5 percent slopes	408	0.1
47	Holopaw fine sand	5,718	1.7
48	Electra sand, 0 to 5 percent slopes	769	0.2
49	Pompano fine sand	2,936	0.9
50	Pits	50	*
51	Riviera fine sand, depressional	8,364	2.4
52	Oldsmar fine sand, depressional	841	0.2
53	Manatee mucky loamy fine sand, depressional	1,912	0.6
54	Riomar clay loam	515	0.1
55	Floridana mucky fine sand, depressional	3,502	1.0
56	Pineda fine sand, depressional	4,312	1.2
57	Holopaw fine sand, depressional	3,192	0.9
58	Samsula muck	2,396	0.7
59	Lokosee fine sand	407	0.1
60	Pompano fine sand, depressional	2,754	0.8
61	Delray muck	3,119	0.9
62	Chobee mucky loamy fine sand, depressional	410	0.1
63	Kesson muck	324	0.1
	Water	27,264	7.9
	Total	345,410	100.0

* Less than 0.1 percent.

TABLE 5.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Map symbol and soil name	Land capability	Oranges	Grapefruit	Corn	Tomatoes	Bahiagrass	Grass-clover	Pangola-grass
		Box	Box	Bu	Ton	AUM*	AUM*	AUM*
1---------- Canaveral	VIs	400	525	---	---	---	---	---
2---------- Chobee	IIIw	425	500	---	6.0	---	15.0	13.0
3---------- EauGallie	IVw	375	575	---	8.0	8.0	12.0	10.0
4---------- Immokalee	IVw	350	550	---	15.0	---	---	8.0
5---------- Myakka	IVw	350	550	---	15.0	9.0	---	9.0
6---------- Oldsmar	IVw	325	575	---	8.0	---	---	10.0
7---------- Palm Beach	VIIs	---	---	---	---	---	---	---
8---------- Paola	VIs	250	300	---	---	---	---	---
9---------- Pepper	IVw	350	450	---	13.0	10.0	12.0	9.0
10---------- Riviera	IIIw	425	575	---	---	---	12.0	10.0
11---------- St. Lucie	VIIs	---	---	---	---	---	---	---
12---------- Archbold	VIs	400	525	---	---	5.5	---	---
13---------- Wabasso	IIIw	400	600	---	13.0	---	12.0	10.0
14---------- Winder	IIIw	250	425	---	8.0	9.0	12.0	10.0
15---------- Manatee	IIIw	425	500	---	8.0	---	14.0	10.0
16---------- Pineda	IIIw	425	575	---	13.0	---	12.0	10.0
17.** Quartzipsamments								
18---------- Captiva	IVw	300	400	---	---	8.0	10.0	---
20.** Beaches								

See footnotes at end of table.

TABLE 5.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Map symbol and soil name	Land capability	Oranges	Grapefruit	Corn	Tomatoes	Bahiagrass	Grass-clover	Pangola-grass
		Box	Box	Bu	Ton	AUM*	AUM*	AUM*
21---------- Pomello	VIs	250	400	---	---	---	---	---
22.** Urban land								
23.** Arents								
24---------- Floridana	IIIw	---	---	---	14.0	---	13.0	10.0
25, 26---------- St. Augustine	VIIs	---	---	---	---	---	---	---
27---------- Boca-Urban land	---	---	---	---	---	---	---	---
28---------- EauGallie-Urban land	---	---	---	---	---	---	---	---
29---------- Immokalee-Urban land	---	---	---	---	---	---	---	---
31---------- Jupiter	IVw	375	500	---	16.0	---	---	---
32---------- Jonathan	VIs	---	---	---	---	3.0	---	---
33---------- Astatula	VIs	350	400	---	---	3.0	---	---
34---------- Satellite	VIs	---	---	---	---	5.0	---	---
35---------- McKee	VIIIw	---	---	---	---	---	---	---
36---------- Boca	IIIw	350	525	---	16.0	---	---	9.0
39---------- Malabar	IVw	325	575	---	13.0	---	12.0	10.0
40---------- Gator	IIIw	---	---	170	---	14.0	---	13.0
41---------- Canova	IIIw	---	---	---	6.0	14.0	---	15.0
42---------- Terra Ceia	IIIw	---	---	170	---	14.0	---	12.0
44---------- Perrine Variant	IIIw	300	350	---	8.0	---	---	---

See footnotes at end of table.

TABLE 5.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Map symbol and soil name	Land capability	Oranges	Grapefruit	Corn	Tomatoes	Bahiagrass	Grass-clover	Pangola-grass
		Box	Box	Bu	Ton	AUM*	AUM*	AUM*
45---------- Myakka	VIIw	---	---	---	---	---	---	---
46---------- Orsino	IVs	350	450	---	---	5.0	---	---
47---------- Holopaw	IVw	375	575	---	7.0	8.0	10.0	10.0
48---------- Electra	VIs	---	---	---	---	6.0	---	---
49---------- Pompano	IVw	300	400	---	13.0	8.0	10.0	10.0
50.** Pits								
51---------- Riviera	VIIw	---	---	---	---	---	---	---
52---------- Oldsmar	VIIw	---	---	---	---	---	---	---
53---------- Manatee	VIIw	---	---	---	---	---	---	---
54---------- Riomar	VIIIw	---	---	---	---	---	---	---
55---------- Floridana	VIIw	---	---	---	---	---	---	---
56---------- Pineda	VIIw	---	---	---	---	---	---	---
57---------- Holopaw	VIIw	---	---	---	---	---	---	---
58---------- Samsula	VIIw	---	---	---	---	---	---	---
59---------- Lokosee	IVw	375	400	---	8.0	---	12.0	10.0
60---------- Pompano	VIIw	---	---	---	---	---	---	---
61---------- Delray	VIIw	---	---	---	---	---	---	---
62---------- Chobee	VIIw	---	---	---	---	---	---	---
63---------- Kesson	VIIIw	---	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns			Subclass
		Erosion [e]	Wetness [w]	Soil problem [s]	Climate [c]
		Acres	Acres	Acres	Acres
I	---	---	---	---	---
II	---	---	---	---	---
III	166,482	---	166,482	---	---
IV	87,972	---	87,564	408	---
V	---	---	---	---	---
VI	11,363	---	---	11,363	---
VII	39,561	---	35,936	3,625	---
VIII	4,612	---	4,612	---	---

TABLE 7.--RANGELAND PRODUCTIVITY

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Map symbol and soil name	Range site	Potential annual production for kind of growing season (dry weight)		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
2--- Chobee	Slough---	8,000	6,000	4,000
3--- EauGallie	South Florida Flatwoods---	6,000	4,500	3,000
4--- Immokalee	South Florida Flatwoods---	6,000	4,500	3,000
5--- Myakka	South Florida Flatwoods---	6,000	4,500	3,000
6--- Oldsmar	South Florida Flatwoods---	6,000	4,500	3,000
8--- Paola	Sand Pine Scrub---	3,500	2,500	1,500
9--- Pepper	South Florida Flatwoods---	6,000	4,500	3,000
10--- Riviera	Cabbage Palm Flatwoods---	9,000	6,500	4,500
11--- St. Lucie	Sand Pine Scrub---	3,500	2,500	1,500
12--- Archbold	Sand Pine Scrub---	3,500	2,500	1,500
13--- Wabasso	South Florida Flatwoods---	6,000	4,500	3,000
14--- Winder	Cabbage Palm Hammocks---	3,500	2,500	1,500
15--- Manatee	Freshwater Marshes And Ponds---	10,000	8,500	5,000
16--- Pineda	Slough---	8,000	6,000	4,000
21--- Pomello	Sand Pine Scrub---	3,500	2,500	1,500
24--- Floridana	Freshwater Marshes And Ponds---	10,000	8,500	5,000
31--- Jupiter	Cabbage Palm Hammocks---	3,500	2,500	1,500
32--- Jonathan	Sand Pine Scrub---	3,500	2,500	1,500
33--- Astatula	Sand Pine Scrub---	3,500	2,500	1,500
34--- Satellite	Sand Pine Scrub---	3,500	2,500	1,500

TABLE 7.--RANGELAND PRODUCTIVITY--Continued

Map symbol and soil name	Range site	Potential annual production for kind of growing season (dry weight)		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
36---------- Boca	South Florida Flatwoods----------	6,000	4,500	3,000
39---------- Malabar	Cabbage Palm Flatwoods----------	9,000	6,500	4,500
41---------- Canova	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
45---------- Myakka	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
46---------- Orsino	Sand Pine Scrub----------	3,500	2,500	1,500
47---------- Holopaw	Slough----------	8,000	6,000	4,000
48---------- Electra	South Florida Flatwoods----------	6,000	4,500	3,000
49---------- Pompano	Slough----------	8,000	6,000	4,000
51---------- Riviera	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
52---------- Oldsmar	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
53---------- Manatee	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
55---------- Floridana	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
56---------- Pineda	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
57---------- Holopaw	Freshwater Marshes And Ponds----------	10,000	8,500	5,000
59---------- Lokosee	Cabbage Palm Flatwoods----------	9,000	6,500	4,500
61---------- Delray	Freshwater Marshes And Ponds----------	10,000	8,500	4,500

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
1---------- Canaveral	4s	Slight	Severe	Severe	Slight	Moderate	Sand pine----------	70	Slash pine, South Florida slash pine.
							Slash pine----------	70	
							South Florida slash pine ----------	35	
2---------- Chobee	2w	Slight	Severe	Moderate	Slight	Severe	Slash pine----------	90	Slash pine, South Florida slash pine.
							Longleaf pine-------	70	
							South Florida slash pine ----------	55	
3---------- EauGallie	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine----------	80	Slash pine, South Florida slash pine.
							Longleaf pine-------	70	
							South Florida slash pine ----------	45	
4---------- Immokalee	4w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine----------	70	Slash pine, South Florida slash pine.
							Longleaf pine-------	65	
							South Florida slash pine ----------	35	
5---------- Myakka	4w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine----------	70	Slash pine, South Florida slash pine.
							Longleaf pine-------	60	
							South Florida slash pine ----------	35	
6---------- Oldsmar	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine----------	80	Slash pine, South Florida slash pine.
							Longleaf pine-------	65	
							South Florida slash pine ----------	45	
8---------- Paola	5s	Slight	Moderate	Severe	Slight	Slight	Sand pine----------	50	Sand pine.
							Sand live oak-------	---	
9---------- Pepper	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine----------	80	Slash pine.
							Longleaf pine-------	65	

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
10---------- Riviera	3w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine----------	80	Slash pine.
							Longleaf pine-------	70	
11---------- St. Lucie	5s	Slight	Severe	Moderate	Slight	Slight	Sand pine----------	60	Sand pine.
							Sand live oak-------	---	
12---------- Archbold	5s	Slight	Severe	Moderate	Slight	Slight	Sand pine----------	60	Sand pine.
							South Florida slash pine ----------	35	
13---------- Wabasso	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine----------	80	Slash pine, South Florida slash pine.
							South Florida slash pine ----------	45	
14---------- Winder	2w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine----------	90	Slash pine, South Florida slash pine.
							South Florida slash pine ----------	55	
15---------- Manatee	2w	Slight	Severe	Severe	Slight	Moderate	Slash pine----------	90	Slash pine.
							Longleaf pine-------	75	
							South Florida slash pine ----------	68	
							Red maple----------	---	
16---------- Pineda	3w	Slight	Moderate	Severe	Slight	Moderate	Slash pine----------	80	Slash pine.
							Longleaf pine-------	70	
							South Florida slash pine ----------	45	
							Cabbage palm--------	---	
18---------- Captiva	4w	Slight	Severe	Severe	Slight	Moderate	South Florida slash pine ----------	35	South Florida slash pine.
21---------- Pomello	4s	Slight	Moderate	Severe	Moderate	Moderate	Slash pine----------	70	Sand pine, slash pine, South Florida slash pine.
							Longleaf pine-------	60	
							Sand pine----------	60	
							South Florida slash pine ----------	35	

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
24---------- Floridana	3w	Slight	Severe	Severe	Slight	Moderate	Slash pine---------- Longleaf pine------- South Florida slash pine ---------- Cabbage palm--------	90 75 55 ---	Slash pine, South Florida slash pine.
27:* Boca---------- Urban land.	2w	Slight	Moderate	Moderate	Slight	Moderate	South Florida slash pine ----------	55	South Florida slash pine.
28:* EauGallie--------- Urban land.	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine---------- Longleaf pine------- South Florida slash pine ----------	80 70 45	Slash pine, South Florida slash pine.
29:* Immokalee--------- Urban land.	4w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine---------- Longleaf pine------- South Florida slash pine ----------	70 65 35	Slash pine, South Florida slash pine.
31---------- Jupiter	4w	Slight	Severe	Moderate	Moderate	Moderate	South Florida slash pine ----------	35	South Florida slash pine.
32---------- Jonathan	5s	Slight	Moderate	Severe	Slight	Slight	Sand pine----------	45	Sand pine.
33---------- Astatula	5s	Slight	Severe	Moderate	Slight	Slight	Sand pine---------- Turkey oak---------- Bluejack oak-------- Blackjack oak-------	60 --- --- ---	Sand pine.

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
34---------- Satellite	4s	Slight	Moderate	Severe	Slight	Moderate	Slash pine----------	70	Slash pine, sand pine, South Florida slash pine.
							Longleaf pine-------	60	
							Sand pine----------	65	
							South Florida slash pine ----------	35	
							Sand live oak-------	---	
35---------- McKee	---	---	---	---	---	---	American mangrove---	---	
36---------- Boca	2w	Slight	Moderate	Moderate	Slight	Moderate	South Florida slash pine ----------	55	South Florida slash pine.
39---------- Malabar	3w	Slight	Moderate	Severe	Slight	Moderate	Slash pine----------	80	Slash pine, South Florida slash pine.
							Longleaf pine-------	70	
							South Florida slash pine ----------	45	
41---------- Canova	2w	Slight	Severe	Moderate	Slight	Moderate	Slash pine----------	90	Slash pine.
							Longleaf pine-------	75	
45---------- Myakka	4w	Slight	Severe	Severe	Severe	Severe	Pond pine----------	60	South Florida slash pine.
46---------- Orsino	4s	Slight	Moderate	Severe	Slight	Moderate	Slash pine----------	70	Slash pine, sand pine, South Florida slash pine.
							Longleaf pine-------	60	
							Sand pine----------	70	
							South Florida slash pine ----------	35	
							Sand live oak-------	---	
							Turkey oak----------	---	
47---------- Holopaw	3w	Slight	Moderate	Severe	Slight	Moderate	Slash pine----------	80	Slash pine, South Florida slash pine.
							Longleaf pine-------	70	
							South Florida slash pine ----------	45	
							Cabbage palm--------	---	

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
48--Electra	4s	Slight	Moderate	Severe	Slight	Slight	Slash pine Sand pine Longleaf pine South Florida slash pine	70 65 65 35	Slash pine, sand pine, South Florida slash pine.
49--Pompano	4w	Slight	Severe	Severe	Slight	Moderate	Slash pine South Florida slash pine	70 45	Slash pine, South Florida slash pine.
51--Riviera	4w	Slight	Severe	Severe	Severe	Severe	Pond pine	60	
52--Oldsmar	4w	Slight	Severe	Severe	Slight	Severe	Pond pine	60	
53--Manatee	2w	Slight	Severe	Severe	Slight	Moderate	Pond pine	65	
54--Riomar	---	---	---	---	---	---	American mangrove	---	
55--Floridana	3w	Slight	Severe	Severe	Slight	Severe	Pond pine Cypress	65 ---	Pond pine, South Florida slash pine, slash pine.
56--Pineda	4w	Slight	Severe	Severe	Severe	Severe	Pond pine	60	
57--Holopaw	3w	Slight	Moderate	Severe	Slight	Severe	Pond pine	60	South Florida slash pine, slash pine.
59--Lokosee	3w	Slight	Moderate	Moderate	Moderate	Moderate	Slash pine Longleaf pine Water oak Live oak South Florida slash pine	80 70 --- --- 45	Slash pine, South Florida slash pine.

See footnote at end of table.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Map symbol and soil name	Ordination symbol	Management concerns					Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
60---------- Pompano	4w	Slight	Severe	Severe	Severe	Severe	Pond pine----------	60	
61---------- Delray	3w	Slight	Severe	Severe	Slight	Severe	Pond pine----------	65	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1--- Canaveral	Severe: wetness, too sandy.	Severe: too sandy.	Severe: too sandy, wetness.	Severe: too sandy.	Severe: droughty.
2--- Chobee	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
3--- EauGallie	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, droughty.
4--- Immokalee	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
5--- Myakka	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness.
6--- Oldsmar	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, percs slowly.	Severe: wetness, too sandy.	Severe: wetness, droughty.
7--- Palm Beach	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
8--- Paola	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
9--- Pepper	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, cemented pan.	Severe: wetness, too sandy.	Severe: wetness, thin layer.
10--- Riviera	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness.
11--- St. Lucie	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
12--- Archbold	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
13--- Wabasso	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, percs slowly.	Severe: wetness, too sandy.	Severe: wetness.
14--- Winder	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, percs slowly.	Severe: wetness, too sandy.	Severe: wetness.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
15--- Manatee	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
16--- Pineda	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, percs slowly.	Severe: wetness, too sandy.	Severe: wetness, droughty.
17*--- Quartzipsamments	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
18--- Captiva	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
20.* Beaches					
21--- Pomello	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
22.* Urban land					
23*--- Arents	Severe: too sandy.	Severe: too sandy.	Moderate: slope, wetness.	Severe: too sandy.	Severe: droughty.
24--- Floridana	Severe: wetness, percs slowly, too sandy.	Severe: wetness, too sandy, percs slowly.	Severe: too sandy, wetness, percs slowly.	Severe: wetness, too sandy.	Severe: wetness.
25--- St. Augustine	Severe: flooding, too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
26--- St. Augustine	Severe: flooding, too sandy, excess salt.	Severe: too sandy, excess salt.	Severe: too sandy, excess salt.	Severe: too sandy.	Severe: excess salt.
27:* Boca---	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
Urban land.					
28:* EauGallie---	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: wetness, droughty.
Urban land.					

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
29:* Immokalee	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
Urban land.					
31--- Jupiter	Severe: wetness, too sandy, depth to rock.	Severe: wetness, too sandy, depth to rock.	Severe: too sandy, wetness, depth to rock.	Severe: wetness, too sandy.	Severe: wetness, thin layer.
32--- Jonathan	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
33--- Astatula	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
34--- Satellite	Severe: wetness, too sandy.	Severe: too sandy.	Severe: too sandy, wetness.	Severe: too sandy.	Severe: droughty.
35--- McKee	Severe: flooding, wetness, excess salt.	Severe: wetness, too clayey, excess salt.	Severe: flooding, wetness, excess salt.	Severe: wetness, too clayey.	Severe: excess salt, wetness, flooding.
36--- Boca	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
39--- Malabar	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
40--- Gator	Severe: ponding, percs slowly, excess humus.	Severe: ponding, excess humus, percs slowly.	Severe: excess humus, ponding, percs slowly.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
41--- Canova	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
42--- Terra Ceia	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
44--- Perrine Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, thin layer.
45--- Myakka	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding.
46--- Orsino	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
47--Holopaw	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
48--Electra	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
49--Pompano	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
50.* Pits					
51--Riviera	Severe: ponding, percs slowly, too sandy.	Severe: ponding, too sandy, percs slowly.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding.
52--Oldsmar	Severe: ponding, too sandy, percs slowly.	Severe: ponding, too sandy, percs slowly.	Severe: too sandy, ponding, percs slowly.	Severe: ponding, too sandy.	Severe: ponding, droughty.
53--Manatee	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
54--Riomar	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess salt, percs slowly.	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, excess humus.	Severe: flooding, wetness, excess salt.
55--Floridana	Severe: ponding, percs slowly, too sandy.	Severe: ponding, too sandy, percs slowly.	Severe: too sandy, ponding, percs slowly.	Severe: ponding, too sandy.	Severe: ponding.
56--Pineda	Severe: ponding, percs slowly, too sandy.	Severe: ponding, too sandy, percs slowly.	Severe: too sandy, ponding, percs slowly.	Severe: ponding, too sandy.	Severe: ponding.
57--Holopaw	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding, droughty.
58--Samsula	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
59--Lokosee	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness, droughty.
60--Pompano	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding, droughty.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
61--- Delray	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
62--- Chobee	Severe: ponding, percs slowly.	Severe: ponding, percs slowly.	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.
63--- Kesson	Severe: flooding, wetness.	Severe: wetness, excess salt.	Severe: wetness, flooding.	Severe: wetness.	Severe: excess salt, flooding, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1---- Canaveral	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
2---- Chobee	Poor	Poor	Poor	Fair	Poor	Good	Good	Poor	Poor	Good.
3---- EauGallie	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
4---- Immokalee	Poor	Poor	Fair	Poor	Poor	Fair	Poor	Poor	Poor	Poor.
5---- Myakka	Poor	Fair	Fair	Poor	Poor	Fair	Poor	Fair	Poor	Poor.
6---- Oldsmar	Poor	Fair	Fair	Poor	Fair	Poor	Poor	Fair	Fair	Poor.
7---- Palm Beach	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
8---- Paola	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
9---- Pepper	Poor	Fair	Fair	Poor	Fair	Poor	Poor	Fair	Fair	Poor.
10---- Riviera	Poor	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Fair.
11---- St. Lucie	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
12---- Archbold	Very poor.	Poor	Poor	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.
13---- Wabasso	Poor	Poor	Poor	Poor	Good	Fair	Poor	Poor	Fair	Poor.
14---- Winder	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
15---- Manatee	Poor	Poor	Fair	Poor	Fair	Good	Good	Poor	Poor	Good.
16---- Pineda	Poor	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor	Fair.
17.* Quartzipsamments										
18---- Captiva	Poor	Fair	Fair	Fair	Poor	Good	Good	Poor	Fair	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Map symbol and soil name	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
20.* Beaches										
21---------- Pomello	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
22.* Urban land										
23.* Arents										
24---------- Floridana	Poor	Poor	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
25, 26---------- St. Augustine	Very poor.	Very poor.	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor.
27:* Boca----------	Poor	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor	Fair.
Urban land.										
28:* EauGallie---------	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
Urban land.										
29:* Immokalee---------	Poor	Poor	Fair	Poor	Poor	Fair	Poor	Poor	Poor	Poor.
Urban land.										
31---------- Jupiter	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Poor	Fair.
32---------- Jonathan	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
33---------- Astatula	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
34---------- Satellite	Very poor.	Poor	Poor	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
35---------- McKee	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Fair	Good	Very poor.	Very poor.	Fair.
36---------- Boca	Poor	Fair	Fair	Poor	Poor	Good	Fair	Fair	Poor	Fair.
39---------- Malabar	Poor	Poor	Poor	Poor	Poor	Fair	Fair	Poor	Poor	Fair.
40---------- Gator	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Good	Good	Very poor.	Very poor.	Good.
41---------- Canova	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Map symbol and soil name	Potential for habitat element							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
42---- Terra Ceia	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
44---- Perrine Variant	Poor	Fair	Fair	Very poor.	Very poor.	Good	Good	Poor	Very poor.	Good.
45---- Myakka	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Fair	Good	Very poor.	Very poor.	Good.
46---- Orsino	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
47---- Holopaw	Poor	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
48---- Electra	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
49---- Pompano	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor	Poor	Fair.
50.* Pits										
51---- Riviera	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
52---- Oldsmar	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Fair	Good	Very poor.	Very poor.	Good.
53---- Manatee	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
54---- Riomar	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Fair	Good	Very poor.	Very poor.	Fair.
55---- Floridana	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
56---- Pineda	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
57---- Holopaw	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
58---- Samsula	Very poor.	Very poor.	Poor	Fair	Very poor.	Good	Good	Very poor.	Poor	Good.
59---- Lokosee	Poor	Fair	Fair	Fair	Fair	Poor	Poor	---	Fair	Poor.
60---- Pompano	Very poor.	Very poor.	Poor	Poor	Poor	Good	Good	Very poor.	Poor	Good.
61---- Delray	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
62---- Chobee	Poor	Poor	Poor	Fair	Poor	Good	Good	Poor	Poor	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Map symbol and soil name	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
63---------- Kesson	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1---------- Canaveral	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Severe: droughty.
2---------- Chobee	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
3---------- EauGallie	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
4---------- Immokalee	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
5---------- Myakka	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
6---------- Oldsmar	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
7---------- Palm Beach	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
8---------- Paola	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
9---------- Pepper	Severe: cemented pan, cutbanks cave, wetness.	Severe: wetness.	Severe: wetness, cemented pan.	Severe: wetness.	Severe: wetness.	Severe: wetness, thin layer.
10---------- Riviera	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
11---------- St. Lucie	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
12---------- Archbold	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Slight---------	Severe: droughty.
13---------- Wabasso	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
14---------- Winder	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
15---------- Manatee	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
16---------- Pineda	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
17.* Quartzipsamments						
18---------- Captiva	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
20.* Beaches						
21---------- Pomello	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: droughty.
22.* Urban land						
23.* Arents						
24---------- Floridana	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
25---------- St. Augustine	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Moderate: wetness, flooding.	Severe: droughty.
26---------- St. Augustine	Severe: cutbanks cave, excess humus, wetness.	Severe: flooding.	Severe: flooding, wetness, low strength.	Severe: flooding.	Moderate: wetness, flooding.	Severe: excess salt.
27:* Boca----------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
Urban land.						
28:* EauGallie--------	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
Urban land.						
29:* Immokalee--------	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
Urban land.						

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
31--Jupiter	Severe: depth to rock, wetness.	Severe: wetness.	Severe: wetness, depth to rock.	Severe: wetness.	Severe: wetness.	Severe: wetness, thin layer.
32--Jonathan	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Severe: droughty.
33--Astatula	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
34--Satellite	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Severe: droughty.
35--McKee	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: excess salt, wetness, flooding.
36--Boca	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
39--Malabar	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
40--Gator	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, excess humus.
41--Canova	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.
42--Terra Ceia	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, excess humus.
44--Perrine Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, thin layer.
45--Myakka	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
46--Orsino	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Severe: droughty.
47--Holopaw	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
48--Electra	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Severe: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
49---------- Pompano	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
50.* Pits						
51---------- Riviera	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
52---------- Oldsmar	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, droughty.
53---------- Manatee	Severe: ponding, cutbanks cave.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
54---------- Riomar	Severe: depth to rock, wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, depth to rock.	Severe: flooding, wetness, shrink-swell.	Severe: depth to rock, low strength, wetness.	Severe: flooding, wetness, excess salt.
55---------- Floridana	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
56---------- Pineda	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
57---------- Holopaw	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, droughty.
58---------- Samsula	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, excess humus.
59---------- Lokosee	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty.
60---------- Pompano	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, droughty.
61---------- Delray	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.
62---------- Chobee	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
63---------- Kesson	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: excess salt, flooding, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1---------- Canaveral	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
2---------- Chobee	Severe: wetness, percs slowly.	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
3---------- EauGallie	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, wetness, seepage.
4---------- Immokalee	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
5---------- Myakka	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
6---------- Oldsmar	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
7*---------- Palm Beach	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
8*---------- Paola	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
9---------- Pepper	Severe: cemented pan, wetness, percs slowly.	Severe: seepage, cemented pan, wetness.	Severe: wetness, too sandy.	Severe: cemented pan, seepage, wetness.	Poor: area reclaim, seepage, too sandy.
10---------- Riviera	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
11*---------- St. Lucie	Slight----------	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12*---------- Archbold	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
13---------- Wabasso	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: wetness.	Poor: seepage, too sandy, wetness.
14---------- Winder	Severe: percs slowly, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness, thin layer.
15---------- Manatee	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
16---------- Pineda	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
17.** Quartzipsamments					
18---------- Captiva	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
20.** Beaches					
21---------- Pomello	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
22.** Urban land					
23.** Arents					
24---------- Floridana	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness, seepage.	Poor: wetness.
25---------- St. Augustine	Severe: wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
26---------- St. Augustine	Severe: wetness, poor filter.	Severe: seepage, flooding, excess humus.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27:**					
Boca	Severe: depth to rock, wetness.	Severe: seepage, depth to rock, wetness.	Severe: depth to rock, wetness, too sandy.	Severe: area reclaim, seepage, too sandy.	Poor: seepage, too sandy, wetness.
Urban land.					
28:**					
EauGallie	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, wetness, seepage.
Urban land.					
29:**					
Immokalee	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Urban land.					
31 Jupiter	Severe: depth to rock, wetness.	Severe: seepage, depth to rock, wetness.	Severe: depth to rock, seepage, wetness.	Severe: depth to rock, seepage, wetness.	Poor: area reclaim, seepage, too sandy.
32 Jonathan	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
33* Astatula	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
34 Satellite	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
35 McKee	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness, excess salt.	Severe: flooding, wetness.	Poor: wetness, excess salt, hard to pack.
36 Boca	Severe: depth to rock, wetness.	Severe: seepage, depth to rock, wetness.	Severe: depth to rock, wetness, too sandy.	Severe: area reclaim, seepage, too sandy.	Poor: seepage, too sandy, wetness.
39 Malabar	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, too sandy, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
40---------- Gator	Severe: ponding, percs slowly, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, thin layer.
41---------- Canova	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, seepage.	Severe: seepage, ponding.	Poor: ponding.
42---------- Terra Ceia	Severe: ponding, poor filter.	Severe: seepage, excess humus.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
44---------- Perrine Variant	Severe: depth to rock, ponding.	Severe: depth to rock, ponding.	Severe: depth to rock, ponding.	Severe: depth to rock, ponding.	Poor: area reclaim, ponding.
45---------- Myakka	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
46*---------- Orsino	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
47---------- Holopaw	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
48---------- Electra	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
49---------- Pompano	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
50.** Pits					
51---------- Riviera	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
52---------- Oldsmar	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
53---------- Manatee	Severe: ponding.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.

See footnotes at end of table.

TABLE 12--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
54--Riomar	Severe: flooding, depth to rock, wetness.	Severe: depth to rock, flooding, wetness.	Severe: flooding, depth to rock, wetness.	Severe: flooding, wetness, depth to rock.	Poor: hard to pack, too clayey, wetness.
55--Floridana	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: ponding, seepage.	Poor: ponding.
56--Pineda	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
57--Holopaw	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
58--Samsula	Severe: ponding, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
59--Lokosee	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
60--Pompano	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
61--Delray	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
62--Chobee	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, ponding.
63--Kesson	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.

* There may be a hazard of contamination of ground water in areas that have a large number of septic tank absorption fields because of inadequate filtration of the effluent.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
1--- Canaveral	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
2--- Chobee	Poor: wetness.	Improbable: excess fines.	Improbable: too sandy.	Poor: wetness.
3--- EauGallie	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
4--- Immokalee	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
5--- Myakka	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
6--- Oldsmar	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
7--- Palm Beach	Good	Probable	Improbable: too sandy.	Poor: too sandy.
8--- Paola	Good	Probable	Improbable: too sandy.	Poor: too sandy.
9--- Pepper	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: area reclaim, too sandy, wetness.
10--- Riviera	Poor: wetness.	Probable	Improbable: excess fines.	Poor: too sandy, wetness.
11--- St. Lucie	Good	Probable	Improbable: too sandy.	Poor: too sandy.
12--- Archbold	Good	Probable	Improbable: too sandy.	Poor: too sandy.
13--- Wabasso	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
14--- Winder	Poor: wetness.	Probable	Probable	Poor: too sandy, wetness.
15--- Manatee	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
16--- Pineda	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
17--- Quartzipsamments	Fair: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy.
18--- Captiva	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
20.* Beaches				
21--- Pomello	Fair: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy.
22.* Urban land				
23--- Arents	Fair: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy.
24--- Floridana	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
25--- St. Augustine	Fair: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy.
26--- St. Augustine	Fair: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, excess salt.
27:* Boca---	Poor: thin layer, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
Urban land.				
28:* EauGallie---	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
Urban land.				
29:* Immokalee---	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
Urban land.				
31--- Jupiter	Poor: area reclaim, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: area reclaim, too sandy, wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
32--Jonathan	Good	Probable	Improbable: too sandy.	Poor: too sandy.
33--Astatula	Good	Probable	Improbable: too sandy.	Poor: too sandy.
34--Satellite	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
35--McKee	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey, excess salt.
36--Boca	Poor: thin layer, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
39--Malabar	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
40--Gator	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
41--Canova	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
42--Terra Ceia	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
44--Perrine Variant	Poor: area reclaim, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
45--Myakka	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
46--Orsino	Good	Probable	Improbable: too sandy.	Poor: too sandy.
47--Holopaw	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
48--Electra	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
49--Pompano	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
50.* Pits				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
51--- Riviera	Poor: wetness.	Probable---	Improbable: excess fines.	Poor: too sandy, wetness.
52--- Oldsmar	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
53--- Manatee	Poor: ponding.	Improbable: excess fines.	Improbable: excess fines.	Poor: ponding.
54--- Riomar	Poor: area reclaim, low strength, wetness.	Improbable: excess fines, thin layer.	Improbable: excess fines, thin layer.	Poor: thin layer, excess salt, wetness.
55--- Floridana	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
56--- Pineda	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
57--- Holopaw	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, wetness.
58--- Samsula	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: excess humus, wetness.
59--- Lokosee	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
60--- Pompano	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: too sandy, wetness.
61--- Delray	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: wetness.
62--- Chobee	Poor: wetness.	Improbable: excess fines.	Improbable: too sandy.	Poor: wetness.
63--- Kesson	Poor: wetness.	Probable---	Improbable: too sandy.	Poor: excess salt, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
1---------- Canaveral	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
2---------- Chobee	Slight---------	Severe: wetness.	Severe: slow refill, cutbanks cave.	Percs slowly---	Wetness, fast intake, soil blowing.	Wetness, rooting depth, percs slowly.
3---------- EauGallie	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Fast intake, wetness, droughty.	Wetness, droughty.
4---------- Immokalee	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
5---------- Myakka	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
6---------- Oldsmar	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill.	Percs slowly, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty.
7---------- Palm Beach	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
8---------- Paola	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
9---------- Pepper	Severe: seepage, cemented pan.	Severe: seepage, piping, wetness.	Severe: no water.	Percs slowly, cemented pan, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty, cemented pan.
10---------- Riviera	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Wetness, percs slowly.	Wetness, droughty, fast intake.	Wetness, droughty, percs slowly.
11---------- St. Lucie	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
12---------- Archbold	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
13---------- Wabasso	Severe: seepage.	Severe: seepage, wetness.	Severe: slow refill.	Percs slowly, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty.
14---------- Winder	Moderate: seepage.	Severe: wetness.	Severe: slow refill, cutbanks cave.	Percs slowly---	Wetness, droughty, fast intake.	Wetness, droughty, percs slowly.
15---------- Manatee	Moderate: seepage.	Severe: wetness.	Severe: cutbanks cave.	Favorable------	Wetness, fast intake, soil blowing.	Wetness.
16---------- Pineda	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill, cutbanks cave.	Percs slowly, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty, percs slowly.
17.* Quartzipsamments						
18---------- Captiva	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty, rooting depth.
20.* Beaches						
21---------- Pomello	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Droughty.
22.* Urban land						
23.* Arents						
24---------- Floridana	Severe: seepage.	Severe: wetness.	Severe: slow refill, cutbanks cave.	Percs slowly---	Wetness, fast intake, soil blowing.	Wetness, percs slowly.
25---------- St. Augustine	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Droughty.
26---------- St. Augustine	Severe: seepage.	Severe: seepage, piping, excess salt.	Severe: salty water, cutbanks cave.	Cutbanks cave, excess salt.	Wetness, droughty, fast intake.	Excess salt, droughty.
27:* Boca----------	Severe: seepage.	Severe: seepage, piping, wetness.	Moderate: depth to rock, cutbanks cave.	Depth to rock, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty, depth to rock.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
27:* Urban land.						
28:* EauGallie	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Fast intake, wetness, droughty.	Wetness, droughty.
Urban land.						
29:* Immokalee	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
Urban land.						
31--- Jupiter	Severe: depth to rock.	Severe: seepage, piping, wetness.	Severe: depth to rock, cutbanks cave.	Depth to rock, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty, depth to rock.
32--- Jonathan	Severe: seepage.	Severe: seepage, piping.	Severe: slow refill, cutbanks cave.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
33--- Astatula	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
34--- Satellite	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
35--- McKee	Slight---	Severe: hard to pack, wetness, excess salt.	Severe: salty water.	Flooding, subsides, excess salt.	Wetness, flooding, excess salt.	Wetness, excess salt.
36--- Boca	Severe: seepage.	Severe: seepage, piping, wetness.	Moderate: depth to rock, cutbanks cave.	Depth to rock, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty, depth to rock.
39--- Malabar	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill, cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
40--- Gator	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, percs slowly, subsides.	Ponding, soil blowing, percs slowly.	Wetness, percs slowly.
41--- Canova	Severe: seepage.	Severe: ponding.	Severe: cutbanks cave.	Ponding, subsides.	Ponding, soil blowing, droughty.	Wetness, droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
42---------- Terra Ceia	Severe: seepage.	Severe: excess humus, ponding.	Slight---------	Ponding, subsides.	Ponding, soil blowing.	Wetness.
44---------- Perrine Variant	Moderate: depth to rock.	Severe: thin layer, ponding.	Severe: depth to rock.	Ponding, depth to rock.	Ponding, depth to rock.	Wetness, depth to rock.
45---------- Myakka	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
46---------- Orsino	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
47---------- Holopaw	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
48---------- Electra	Severe: seepage.	Severe: seepage, piping.	Severe: slow refill, cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Droughty.
49---------- Pompano	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
50.* Pits						
51---------- Riviera	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, percs slowly.	Ponding, droughty, fast intake.	Wetness, droughty, percs slowly.
52---------- Oldsmar	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty, percs slowly.
53---------- Manatee	Moderate: seepage.	Severe: ponding, seepage, piping.	Severe: cutbanks cave.	Ponding--------	Ponding, fast intake, soil blowing.	Wetness.
54---------- Riomar	Moderate: depth to rock.	Severe: thin layer, wetness, excess salt.	Severe: salty water, depth to rock, slow refill.	Percs slowly, depth to rock, flooding.	Wetness, percs slowly, depth to rock.	Wetness, excess salt, depth to rock.
55---------- Floridana	Severe: seepage.	Severe: ponding.	Severe: slow refill, cutbanks cave.	Ponding, percs slowly.	Ponding, fast intake, soil blowing.	Wetness, percs slowly.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Grassed waterways
56---------- Pineda	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, percs slowly, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty, percs slowly.
57---------- Holopaw	Severe: seepage.	Severe: seepage. piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
58---------- Samsula	Severe: seepage.	Severe: excess humus, ponding.	Severe: cutbanks cave.	Ponding, subsides.	Ponding, soil blowing.	Wetness.
59---------- Lokosee	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
60---------- Pompano	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
61---------- Delray	Severe: seepage.	Severe: seepage, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding--------	Wetness.
62---------- Chobee	Moderate: seepage.	Severe: ponding, piping, seepage.	Severe: slow refill, cutbanks cave.	Ponding, percs slowly.	Ponding, fast intake, soil blowing.	Wetness, percs slowly.
63---------- Kesson	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: salty water, cutbanks cave.	Flooding, cutbanks cave, excess salt.	Wetness, excess salt.	Wetness, excess salt, droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated. Some soils may have Unified classifications and USDA textures in addition to those shown. In general, the dominant classifications and textures are shown]

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
1---------- Canaveral	0-6	Fine sand---------	SP	A-3	100	100	90-100	1-4	---	NP
	6-80	Fine sand, sand, coarse sand.	SP	A-3	70-100	70-95	65-90	1-3	---	NP
2---------- Chobee	0-5	Loamy fine sand, sandy loam.	SM-SC, SC, SM	A-2-4	100	100	80-99	13-25	<40	NP-20
	5-46	Sandy clay loam	SC	A-2-6, A-2-7, A-6, A-7	100	100	85-99	25-45	35-45	20-25
	46-80	Loamy sand, fine sand, sandy clay loam.	SP-SM, SM, SC, SM-SC	A-2-4, A-2-6, A-6, A-7	100	100	80-99	12-45	<45	NP-25
3---------- EauGallie	0-5	Fine sand---------	SP, SP-SM	A-3	100	100	80-98	2-5	---	NP
	5-26	Sand, fine sand	SP-SM, SM	A-3, A-2-4	100	100	80-98	5-20	---	NP
	26-47	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	80-98	2-12	---	NP
	47-62	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	100	100	80-98	20-35	<40	NP-20
	62-80	Sand, loamy sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	100	100	80-98	5-25	---	NP
4---------- Immokalee	0-5	Fine sand---------	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
	5-35	Fine sand, sand	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
	35-55	Fine sand, sand	SP-SM, SM	A-3, A-2-4	100	100	70-100	5-21	---	NP
	55-80	Fine sand, sand	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
5---------- Myakka	0-28	Fine sand---------	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
	28-58	Sand, fine sand, loamy fine sand.	SM, SP-SM	A-3, A-2-4	100	100	85-100	5-20	---	NP
	58-80	Sand, fine sand	SP, SP-SM	A-3	100	100	85-100	2-8	---	NP
6---------- Oldsmar	0-32	Fine sand---------	SP, SP-SM	A-3	100	100	80-100	2-10	---	NP
	32-50	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2-4, A-3	100	100	80-100	5-20	---	NP
	50-62	Fine sandy loam, sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	85-100	20-35	20-35	5-15
7---------- Palm Beach	0-80	Sand, fine sand	SP-SM, SP, SW	A-1-b, A-3, A-2-4	100	90-100	15-90	1-5	---	NP
8---------- Paola	0-12	Sand----------	SP	A-3	100	100	85-100	1-2	---	NP
	12-80	Sand, fine sand	SP	A-3	100	100	80-100	1-4	---	NP
9---------- Pepper	0-8	Sand----------	SP, SP-SM	A-3	100	100	85-95	2-10	---	NP
	8-22	Sand, fine sand	SP, SP-SM	A-3	100	100	85-95	2-10	---	NP
	22-39	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	85-95	5-25	---	NP
	39-47	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	85-95	5-20	---	NP
	47-60	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC	A-2-4	100	100	85-100	20-35	<28	NP-7

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
10---------- Riviera	0-26	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-100	4-12	---	NP
	26-31	Sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4	100	100	80-100	15-35	<35	NP-15
	31-40	Sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	80-100	20-35	20-40	4-20
	40-80	Sand, fine sand, loamy sand.	SP, SP-SM	A-3, A-1, A-2-4	60-80	50-75	40-70	3-10	---	NP
11---------- St. Lucie	0-80	Sand----------	SP	A-3	100	100	70-95	1-4	---	NP
12---------- Archbold	0-4	Sand----------	SP	A-3	100	100	89-99	1-3	---	NP
	4-80	Sand, fine sand	SP, SP-SM	A-3	100	100	89-99	1-6	---	NP
13---------- Wabasso	0-24	Fine sand--------	SP, SP-SM	A-3	100	100	95-100	2-10	---	NP
	24-35	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	95-100	5-20	---	NP
	35-48	Sandy loam, fine sandy loam, sandy clay loam.	SC, SM-SC	A-2-4, A-2-6	100	100	95-100	20-35	20-30	5-13
	48-80	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	95-100	5-20	---	NP
14---------- Winder	0-17	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-100	2-12	---	NP
	17-23	Loamy sand, sandy loam, fine sandy loam.	SM	A-2-4	100	100	80-100	15-25	<35	NP-10
	23-34	Sandy clay loam	SC	A-2-4, A-2-6	100	100	80-100	18-35	20-40	9-26
	34-65	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4	60-80	50-75	40-70	15-35	<35	NP-20
	65-80	Sand, fine sand, loamy sand.	SP, SP-SM, SM	A-3, A-2-4	60-80	50-75	40-70	3-20	<35	NP-10
15---------- Manatee	0-12	Loamy fine sand	SP-SM, SM	A-3, A-2-4	100	100	85-100	8-15	---	NP
	12-31	Fine sandy loam, sandy loam.	SM-SC, SC	A-2-4	100	100	90-100	18-30	<30	4-10
	31-39	Fine sandy loam, sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2-4	95-100	90-100	85-100	13-30	<30	NP-10
	39-80	Fine sandy loam, sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2-4	60-100	50-100	50-100	13-30	<30	NP-10
16---------- Pineda	0-23	Fine sand--------	SP, SP-SM	A-3	100	100	80-95	2-5	---	NP
	23-40	Sandy loam, fine sandy loam, sandy clay loam.	SC, SM-SC	A-2-4, A-2-6	100	100	80-95	15-35	20-30	4-12
	40-80	Sand, loamy sand, fine sand.	SP-SM, SM	A-3, A-2-4	100	100	80-95	4-15	---	NP
17*---------- Quartzipsamments	0-80	Fine sand--------	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
18---------- Captiva	0-8	Fine sand--------	SP-SM, SM	A-3, A-2-4	100	80-90	80-90	5-15	---	NP
	8-16	Sand, fine sand	SP, SP-SM	A-3	100	85-95	85-95	2-10	---	NP
	16-80	Coarse sand, sand, fine sand.	SP	A-3	100	80-90	75-85	1-4	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
20.* Beaches										
21---------- Pomello	0-61	Fine sand--------	SP, SP-SM	A-3	100	100	60-100	1-8	---	NP
	61-72	Coarse sand, sand, fine sand.	SP-SM, SM	A-3, A-2-4	100	100	60-100	6-15	---	NP
	72-80	Coarse sand, sand, fine sand.	SP, SP-SM	A-3	100	100	60-100	4-10	---	NP
22.* Urban land										
23.* Arents										
24---------- Floridana	0-14	Sand----------	SP-SM, SM	A-3, A-2-4	100	100	80-90	5-25	---	NP
	14-20	Fine sand, sand	SP, SP-SM	A-3	100	100	80-90	2-10	---	NP
	20-37	Sandy loam, fine sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	85-95	20-40	20-40	7-26
	37-80	Sandy clay loam, sandy loam, loamy sand.	SM, SM-SC, SC	A-2-4	100	95-100	85-95	11-35	<40	NP-20
25---------- St. Augustine	0-30	Sand----------	SP, SP-SM	A-3	85-95	80-95	80-90	2-5	---	NP
	30-45	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	85-95	80-95	80-90	5-15	---	NP
26---------- St. Augustine	0-40	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-95	2-12	---	NP
	40-60	Muck----------	PT	---	---	---	---	---	---	---
	60-80	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	85-95	80-95	80-90	5-15	---	NP
27:* Boca----------	0-17	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-99	2-12	---	NP
	17-24	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	80-99	2-12	---	NP
	24-30	Sandy loam, sandy clay loam, fine sandy loam.	SC	A-2-4, A-6, A-2-6	100	100	80-99	17-40	16-37	5-20
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---
Urban land.										
28:* EauGallie-------	0-23	Fine sand--------	SP, SP-SM	A-3	100	100	80-98	2-5	---	NP
	23-36	Sand, fine sand	SP-SM, SM	A-3, A-2-4	100	100	80-98	5-20	---	NP
	36-68	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	80-98	2-12	---	NP
	68-80	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	100	100	80-98	20-35	<40	NP-20
Urban land.										
29:* Immokalee-------	0-7	Fine sand--------	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
	7-42	Fine sand, sand	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
	42-58	Fine sand, sand	SP-SM, SM	A-3, A-2-4	100	100	70-100	5-21	---	NP
	58-80	Fine sand, sand	SP, SP-SM	A-3	100	100	70-100	2-10	---	NP
Urban land.										

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
31----------	0-5	Fine sand--------	SP-SM	A-3, A-2-4	100	100	85-95	5-12	---	NP
Jupiter	5-11	Sand, fine sand	SP, SP-SM	A-3	100	100	85-95	2-5	---	NP
	11	Weathered bedrock	---	---	---	---	---	---	---	---
32----------	0-3	Sand----------	SP	A-3	100	100	70-100	1-4	---	NP
Jonathan	3-75	Fine sand, sand	SP	A-3	100	100	70-100	1-4	---	NP
	75-80	Fine sand, sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	70-100	5-15	---	NP
33----------	0-4	Sand----------	SP, SP-SM	A-3	100	100	75-99	1-7	---	NP
Astatula	4-80	Sand, fine sand	SP, SP-SM	A-3	100	100	75-99	1-7	---	NP
34----------	0-4	Fine sand--------	SP	A-3	100	100	60-95	1-4	---	NP
Satellite	4-80	Coarse sand, sand, fine sand.	SP	A-3	100	100	60-95	1-4	---	NP
35----------	0-1	Mucky clay loam	CH	A-7	100	100	95-100	70-85	65-80	45-55
McKee	1-60	Clay, clay loam, sandy clay.	CH	A-7	100	100	90-100	60-85	51-80	29-50
	60-80	Fine sand, loamy fine sand, sandy loam.	SM	A-2-4, A-4	100	90-100	75-90	15-40	---	NP
36----------	0-6	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-99	2-12	---	NP
Boca	6-20	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	80-99	2-12	---	NP
	20-30	Sandy loam, sandy clay loam, fine sandy loam.	SC	A-2-4, A-6, A-2-6	100	100	80-99	17-40	16-37	5-20
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---
39----------	0-17	Fine sand--------	SP, SP-SM	A-3	100	100	80-90	2-10	---	NP
Malabar	17-41	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	80-90	3-12	---	NP
	41-65	Sandy clay loam, fine sandy loam, sandy loam.	SC, SM-SC	A-2, A-4, A-6	100	100	80-90	22-40	20-40	4-15
	65-80	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	100	100	80-90	5-20	---	NP
40----------	0-26	Muck----------	PT	A-8	---	---	---	---	---	---
Gator	26-80	Loam, fine sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	95-100	80-99	25-46	20-40	4-28
41----------	0-12	Muck----------	PT	---	---	---	---	---	---	---
Canova	12-24	Sand, fine sand	SP, SP-SM	A-3	100	100	75-100	3-10	---	NP
	24-34	Sandy loam, fine sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	75-95	15-35	20-40	7-25
	34-80	Sandy clay loam, sandy loam.	SC	A-2-4, A-2-6	100	100	75-95	18-35	20-40	9-26

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
42----------	0-60	Muck----------	PT	A-8	---	---	---	---	---	---
Terra Ceia	60-80	Sand, fine sand, loamy sand.	SP, SP-SM	A-3, A-2-4	100	100	80-90	2-12	---	NP
44----------	0-6	Fine sandy loam	SM-SC, SC	A-4	95-100	80-100	75-95	20-40	20-30	4-10
Perrine Variant	6-24	Sandy clay loam, loam.	CL	A-4, A-6	95-100	80-100	75-95	51-70	24-40	8-20
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---
45----------	0-17	Fine sand--------	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
Myakka	17-65	Sand, fine sand, loamy fine sand.	SM, SP-SM	A-3, A-2-4	100	100	85-100	5-20	---	NP
	65-80	Sand, fine sand	SP, SP-SM	A-3	100	100	85-100	2-8	---	NP
46----------	0-29	Fine sand--------	SP	A-3	100	100	85-95	1-3	---	NP
Orsino	29-80	Sand, fine sand	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
47----------	0-45	Fine sand--------	SP, SP-SM	A-3	100	95-100	70-95	2-10	---	NP
Holopaw	45-62	Sandy loam, sandy clay loam, fine sandy loam.	SM, SM-SC	A-2-4	100	95-100	70-99	15-30	<25	NP-7
	62-80	Loamy sand, loamy fine sand, fine sand.	SM	A-2-4	100	95-100	70-99	11-20	---	NP
48----------	0-5	Sand----------	SP, SP-SM	A-3	100	95-100	75-99	3-10	---	NP
Electra	5-30	Sand, fine sand	SP, SP-SM	A-3	100	95-100	75-99	3-10	---	NP
	30-47	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2-4	100	100	80-99	8-15	---	NP
	47-80	Sandy clay loam, sandy clay, fine sandy loam.	SC, SM-SC	A-2, A-4, A-6	100	100	80-99	20-45	20-40	4-20
49----------	0-80	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	75-100	1-12	---	NP
Pompano										
50.*										
Pits										
51----------	0-26	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	80-100	4-12	---	NP
Riviera	26-29	Sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4	100	100	80-100	15-35	<35	NP-15
	29-45	Sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	80-100	20-35	20-40	4-20
	45-80	Sand, fine sand, loamy sand.	SP, SP-SM	A-3, A-1, A-2-4	60-80	50-75	40-70	3-10	---	NP
52----------	0-35	Fine sand--------	SP, SP-SM	A-3	100	100	80-100	2-10	---	NP
Oldsmar	35-52	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2-4	100	100	80-100	5-20	---	NP
	52-80	Sandy loam, fine sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	85-100	20-35	20-35	5-15

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
53---------- Manatee	0-8	Mucky loamy fine sand.	SP-SM, SM	A-3, A-2-4	100	100	85-100	8-15	---	NP
	8-24	Fine sandy loam, sandy loam.	SM-SC, SC, SM	A-2-4	100	100	90-100	18-30	<30	NP-10
	24-42	Fine sandy loam, sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2-4	95-100	90-100	85-100	13-30	<30	NP-10
	42-80	Fine sandy loam, sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2-4	60-100	50-100	50-100	13-30	<30	NP-10
54---------- Riomar	0-8	Clay loam--------	CH, CL	A-7	100	100	95-100	70-85	43-56	23-33
	8-15	Clay loam, clay	CL	A-7	100	100	90-100	60-85	43-56	23-33
	15-25	Sandy clay, clay loam.	CH	A-7	100	100	90-100	60-85	51-71	29-45
	25	Weathered bedrock	---	---	---	---	---	---	---	---
55---------- Floridana	0-19	Mucky fine sand	SP-SM, SM	A-3, A-2-4	100	100	80-90	5-25	---	NP
	19-35	Sand, fine sand	SP, SP-SM	A-3	100	100	80-90	2-10	---	NP
	35-50	Sandy loam, fine sandy loam, sandy clay loam.	SM-SC, SC	A-2-4, A-2-6	100	100	85-95	20-40	20-40	7-26
	50-80	Loamy fine sand	SP-SM, SM	A-3, A-2-4	100	100	85-95	5-15	---	NP
56---------- Pineda	0-32	Fine sand--------	SP, SP-SM	A-3	100	100	80-95	2-5	---	NP
	32-52	Sandy loam, fine sandy loam, sandy clay loam.	SM, SC, SM-SC	A-2-4, A-2-6	100	100	80-95	15-35	20-30	4-12
	52-80	Sand, loamy sand	SP-SM, SM	A-3, A-2-4	100	100	80-95	5-15	---	NP
57---------- Holopaw	0-47	Fine sand--------	SP, SP-SM	A-3	100	95-100	70-95	2-10	---	NP
	47-65	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC	A-2-4	100	95-100	70-95	15-30	<25	NP-7
	65-80	Loamy sand, loamy fine sand, fine sand.	SM	A-2-4	100	95-100	70-95	11-20	---	NP
58---------- Samsula	0-26	Muck-------------	PT	---	---	---	---	---	---	---
	26-80	Sand, fine sand, loamy sand.	SP-SM, SM, SP	A-3, A-2-4	100	100	80-100	2-20	---	NP
59---------- Lokosee	0-10	Fine sand--------	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
	10-35	Sand, fine sand	SP, SP-SM	A-3, A-2-4	100	100	85-100	3-12	---	NP
	35-45	Sand, fine sand	SP-SM, SM	A-3, A-2-4	100	100	85-100	5-20	---	NP
	45-70	Sand, fine sand	SP, SP-SM	A-3	100	100	85-100	2-10	---	NP
	70-80	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	100	100	85-100	20-35	<35	NP-14
60---------- Pompano	0-80	Fine sand--------	SP, SP-SM	A-3, A-2-4	100	100	75-100	1-12	---	NP
61---------- Delray	0-3	Muck-------------	PT	---	---	---	---	---	---	---
	3-21	Sand, loamy sand, fine sand.	SP-SM, SM, SM-SC	A-2-4, A-3	100	100	95-100	5-20	<20	NP-5
	21-45	Fine sand, sand	SP-SM	A-3, A-2-4	100	100	95-100	5-12	---	NP
	45-80	Sandy loam, fine sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2-4, A-2-6	100	100	95-100	20-35	<40	NP-15

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	4	10	40	200		
	In								Pct	
62---------- Chobee	0-5	Mucky loamy fine sand.	SP-SM, SM	A-3, A-2-4	100	100	95-100	5-20	<40	NP-10
	5-50	Sandy loam, fine sandy loam, sandy clay loam.	SP-SM, SM, SC, SM-SC	A-2-4, A-2-6, A-6, A-7	100	100	85-99	12-45	<45	NP-25
	50-80	Fine sand, loamy sand.	SP-SM, SM	A-2-4	100	100	80-99	12-25	<40	NP-10
63---------- Kesson	0-6	Muck----------	PT	---	---	---	---	---	---	NP
	6-30	Sand, fine sand	SP, SP-SM	A-3	90-100	90-100	90-100	2-10	---	NP
	30-38	Sand, fine sand	SP, SP-SM	A-3	70-100	65-95	60-95	2-10	---	NP
	38-80	Sand, fine sand	SP, SP-SM	A-3	90-100	90-100	90-100	2-10	---	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cc	In/hr	In/in	pH	Mmhos/cm					Pct
1----------	0-6	<2	1.25-1.50	>20	0.02-0.05	6.6-8.4	<2	Low-------	0.10	5	2	<1
Canaveral	6-80	<2	1.25-1.50	>20	0.02-0.05	6.6-8.4	<2	Low-------	0.10			
2----------	0-5	7-15	1.45-1.50	2.0-6.0	0.10-0.15	6.1-7.3	<2	Low-------	0.10	5	2	2-7
Chobee	5-46	20-35	1.55-1.75	<0.2	0.12-0.17	7.4-8.4	<2	Moderate	0.32			
	46-80	7-20	1.60-1.75	0.2-6.0	0.06-0.10	7.4-8.4	<2	Low-------	0.20			
3----------	0-5	<5	1.25-1.50	6.0-20	0.02-0.07	4.5-6.0	<2	Low-------	0.10	5	2	2-8
EauGallie	5-26	1-8	1.45-1.60	0.6-6.0	0.15-0.25	4.5-6.5	<2	Low-------	0.15			
	26-47	1-5	1.45-1.65	6.0-20	0.02-0.05	4.5-7.8	<2	Low-------	0.10			
	47-62	13-31	1.55-1.70	0.06-2.0	0.10-0.20	4.5-7.8	<2	Low-------	0.20			
	62-80	1-13	1.45-1.55	0.6-6.0	0.05-0.15	4.5-7.8	<2	Low-------	0.15			
4----------	0-5	1-5	1.20-1.50	6.0-20	0.05-0.10	3.6-6.0	<2	Low-------	0.10	5	2	1-2
Immokalee	5-35	1-5	1.45-1.70	6.0-20	0.02-0.05	3.6-6.0	<2	Low-------	0.10			
	35-55	2-7	1.30-1.60	0.6-2.0	0.10-0.25	3.6-6.0	<2	Low-------	0.15			
	55-80	1-5	1.40-1.60	6.0-20	0.02-0.05	3.6-6.0	<2	Low-------	0.10			
5----------	0-28	<2	1.35-1.55	6.0-20	0.02-0.05	3.6-6.5	<2	Low-------	0.10	5	2	<2
Myakka	28-58	1-8	1.45-1.60	0.6-6.0	0.10-0.20	3.6-6.5	<2	Low-------	0.15			
	58-80	<2	1.48-1.70	6.0-20	0.02-0.10	3.6-6.5	<2	Low-------	0.10			
6----------	0-32	<2	1.48-1.61	6.0-20	0.02-0.05	3.6-7.3	<2	Low-------	0.10	5	2	1-2
Oldsmar	32-50	2-8	1.42-1.59	0.2-6.0	0.10-0.15	3.6-7.3	<2	Low-------	0.15			
	50-62	15-30	1.60-1.69	<0.2	0.10-0.15	6.1-8.4	<2	Low-------	0.24			
7----------	0-80	<2	1.25-1.50	>20	0.02-0.05	7.4-8.4	<2	Low-------	0.10	5	1	.5-1
Palm Beach												
8----------	0-12	<2	1.45-1.60	>20	0.02-0.05	4.5-7.3	<2	Low-------	0.10	5	1	<.5
Paola	12-80	<3	1.45-1.60	>20	0.02-0.05	4.5-7.3	<2	Low-------	0.10			
9----------	0-8	<2	1.32-1.44	6.0-20	0.05-0.10	3.6-6.0	<2	Low-------	0.10	5	2	1-4
Pepper	8-22	<2	1.43-1.57	6.0-20	0.02-0.05	3.6-6.0	<2	Low-------	0.10			
	22-39	4-13	1.47-1.59	<0.2	0.10-0.15	3.6-6.5	<2	Low-------	0.20			
	39-47	2-8	1.47-1.59	0.2-2.0	0.05-0.10	3.6-6.5	<2	Low-------	0.15			
	47-60	10-30	1.49-1.70	<0.6	0.10-0.15	5.6-7.8	<2	Low-------	0.24			
10----------	0-26	1-6	1.40-1.65	6.0-20	0.05-0.08	4.5-7.3	<2	Low-------	0.10	4	2	.1-2
Riviera	26-31	12-25	1.50-1.70	<0.2	0.10-0.14	6.1-8.4	<2	Low-------	0.24			
	31-40	15-25	1.50-1.70	<0.2	0.12-0.15	6.1-8.4	<2	Low-------	0.24			
	40-80	1-8	1.40-1.65	0.6-6.0	0.05-0.08	7.9-8.4	<2	Low-------	0.15			
11----------	0-80	<2	1.50-1.60	>20	0.02-0.05	3.6-7.3	<2	Low-------	0.10	5	1	<1
St. Lucie												
12----------	0-4	0-1	1.50-1.60	>20	0.03-0.05	3.6-5.5	<2	Low-------	0.10	5	1	.5-1
Archbold	4-80	0-1	1.50-1.60	>20	0.02-0.03	3.6-5.5	<2	Low-------	0.10			
13----------	0-24	<5	1.25-1.55	6.0-20	0.02-0.05	4.5-6.5	<2	Low-------	0.10	5	2	1-4
Wabasso	24-35	1-12	1.50-1.75	0.6-2.0	0.10-0.15	4.5-7.3	<2	Low-------	0.15			
	35-48	12-30	1.60-1.80	<0.2	0.10-0.15	5.1-8.4	<2	Low-------	0.24			
	48-80	2-12	1.40-1.70	6.0-20	0.05-0.10	7.4-8.4	<2	Low-------	0.10			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cc	In/hr	In/in	pH	Mmhos/cm					Pct
14----------	0-17	1-6	1.40-1.65	6.0-20	0.03-0.08	5.6-7.8	<2	Low-------	0.10	5	2	.1-2
Winder	17-23	10-18	1.45-1.65	0.2-0.6	0.06-0.10	6.1-7.8	<2	Low-------	0.20			
	23-34	20-30	1.60-1.70	<0.2	0.10-0.15	6.6-8.4	<2	Low-------	0.24			
	34-65	15-30	1.50-1.70	<0.2	0.06-0.12	7.4-8.4	<2	Low-------	0.24			
	65-80	6-13	1.40-1.65	6.0-20	0.03-0.10	7.4-8.4	<2	Low-------	0.15			
15----------	0-12	2-8	1.20-1.40	2.0-6.0	0.15-0.20	5.6-7.8	<2	Low-------	0.10	5	2	4-15
Manatee	12-31	10-20	1.50-1.65	0.6-2.0	0.10-0.15	6.6-7.8	<2	Low-------	0.24			
	31-39	6-20	1.55-1.70	0.6-2.0	0.08-0.15	7.4-8.4	<2	Low-------	0.24			
	39-80	6-20	1.55-1.70	0.6-2.0	0.08-0.15	7.4-8.4	<2	Low-------	0.24			
16----------	0-23	1-8	1.30-1.60	6.0-20	0.02-0.05	4.5-7.3	<2	Low-------	0.10	5	2	.5-6
Pineda	23-40	10-25	1.50-1.70	<0.2	0.10-0.15	5.1-8.4	<2	Low-------	0.24			
	40-80	3-12	1.45-1.60	2.0-6.0	0.02-0.05	5.6-8.4	<2	Low-------	0.10			
17----------	0-80	1-3	1.50-1.65	6.0-20	0.03-0.05	4.5-7.3	<2	Low-------	0.10	5	2	<.5
Quartzipsamments												
18----------	0-8	1-3	1.30-1.55	6.0-20	0.10-0.15	7.4-7.8	<2	Low-------	0.10	5	2	---
Captiva	8-16	1-3	1.45-1.65	>20	0.05-0.10	7.9-8.4	<2	Low-------	0.10			
	16-80	1-3	1.50-1.65	>20	0.05-0.10	7.9-8.4	<2	Low-------	0.10			
20.*												
Beaches												
21----------	0-61	<2	1.35-1.65	>20	0.02-0.05	4.5-6.0	<2	Low-------	0.10	5	1	<1
Pomello	61-72	<2	1.45-1.60	2.0-6.0	0.10-0.30	4.5-6.0	<2	Low-------	0.15			
	72-80	<2	1.35-1.65	6.0-20	0.02-0.05	4.5-6.0	<2	Low-------	0.10			
22.*												
Urban land												
23----------	0-50	1-10	1.35-1.55	6.0-20	0.02-0.08	6.6-8.4	<2	Low-------	0.10	5	2	<.5
Arents	50-72	1-10	1.35-1.55	6.0-20	0.02-0.08	5.6-8.4	<2	Low-------	0.10			
	72-80	1-10	1.35-1.55	6.0-20	0.02-0.08	5.6-6.5	<2	Low-------	0.10			
24----------	0-14	3-10	1.40-1.49	6.0-20	0.10-0.20	4.5-8.4	<2	Low-------	0.10	5	2	6-15
Floridana	14-20	1-7	1.52-1.58	6.0-20	0.05-0.10	4.5-8.4	<2	Low-------	0.10			
	20-37	15-30	1.60-1.69	<0.2	0.10-0.20	4.5-8.4	<2	Low-------	0.24			
25----------	0-30	0-2	1.30-1.40	6.0-20	0.02-0.05	6.1-8.4	<2	Low-------	0.10	5	2	1-3
St. Augustine	30-45	4-12	1.40-1.55	2.0-20	0.05-0.10	6.1-8.4	<2	Low-------	0.15			
26----------	0-27	2-5	1.35-1.45	6.0-20	0.05-0.10	7.4-8.4	8-16	Low-------	0.10	5	2	1-3
St. Augustine	27-30	---	0.25-0.35	6.0-20	0.15-0.20	3.6-6.5	>16	Low-------	----			
27:*												
Boca----------	0-17	<2	1.30-1.55	6.0-20	0.05-0.10	5.1-8.4	<2	Low-------	0.10	5	2	1-3
	17-24	<2	1.50-1.60	6.0-20	0.02-0.05	5.1-8.4	<2	Low-------	0.17			
	24-30	14-30	1.55-1.65	0.6-2.0	0.10-0.15	5.1-8.4	<2	Low-------	0.20			
	30	---	---	---	---	---	---	----------	----			
Urban land.												

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cc	In/hr	In/in	pH	Mmhos/cm					Pct
28:*												
EauGallie	0-23	<5	1.25-1.50	6.0-20	0.02-0.07	4.5-6.0	<2	Low	0.10	5	2	2-8
	23-36	1-8	1.45-1.60	0.6-6.0	0.15-0.25	4.5-6.5	<2	Low	0.15			
	36-68	1-5	1.45-1.65	6.0-20	0.02-0.05	4.5-7.8	<2	Low	0.10			
	68-80	13-31	1.55-1.70	0.06-2.0	0.10-0.20	4.5-7.8	<2	Low	0.20			
Urban land.												
29:*												
Immokalee	0-7	1-5	1.20-1.50	6.0-20	0.05-0.10	3.6-6.0	<2	Low	0.10	5	2	1-2
	7-42	1-5	1.45-1.70	6.0-20	0.02-0.05	3.6-6.0	<2	Low	0.10			
	42-58	2-7	1.30-1.60	0.6-2.0	0.10-0.25	3.6-6.0	<2	Low	0.15			
	58-80	1-5	1.40-1.60	6.0-20	0.02-0.05	3.6-6.0	<2	Low	0.10			
Urban land.												
31	0-5	2-8	1.35-1.50	6.0-20	0.12-0.18	6.1-8.4	<2	Low	0.10	2	2	1-3
Jupiter	5-11	1-3	1.50-1.65	6.0-20	0.02-0.08	6.1-8.4	<2	Low	0.17			
	11	---	---	---	---	---	---	---	---			
32	0-3	<0-3	1.30-1.55	6.0-20	0.05-0.08	4.5-5.5	<2	Low	0.10	5	2	1-2
Jonathan	3-75	<0-3	1.40-1.70	6.0-20	0.01-0.05	5.1-6.0	<2	Low	0.24			
	75-80	1-8	1.55-1.75	<0.2	0.10-0.15	3.6-5.0	<2	Low	0.28			
33	0-4	1-3	1.25-1.50	>20	0.04-0.10	4.5-6.5	<2	Low	0.10	5	2	.5-2
Astatula	4-80	1-3	1.45-1.60	>20	0.02-0.05	4.5-6.5	<2	Low	0.10			
34	0-4	1-3	1.10-1.45	>20	0.02-0.10	4.5-7.8	<2	Low	0.10	5	2	.5-2
Satellite	4-80	.5-2	1.35-1.55	>20	0.02-0.05	4.5-7.8	<2	Low	0.10			
35	0-1	50-65	0.15-0.50	<0.2	0.12-0.20	6.1-8.4	>16	High	0.17	3	2	10-25
McKee	1-60	35-65	0.25-0.60	0.2-0.6	0.12-0.20	6.6-8.4	>16	High	0.17			
	60-80	3-10	1.25-1.50	>2.0	0.05-0.10	6.6-8.4	>16	Low	0.10			
36	0-6	<2	1.30-1.55	6.0-20	0.05-0.10	5.1-8.4	<2	Low	0.10	5	2	1-3
Boca	6-20	<2	1.50-1.60	6.0-20	0.02-0.05	5.1-8.4	<2	Low	0.17			
	20-30	14-30	1.55-1.65	0.6-2.0	0.10-0.15	5.1-8.4	<2	Low	0.20			
	30	---	---	---	---	---	---	---	---			
39	0-17	<4	1.20-1.55	6.0-20	0.03-0.08	5.1-8.4	<2	Low	0.10	5	2	1-2
Malabar	17-41	1-5	1.50-1.75	6.0-20	0.05-0.10	5.1-8.4	<2	Low	0.10			
	41-65	10-25	1.60-1.70	<0.2	0.10-0.15	5.1-8.4	<2	Low	0.24			
	65-80	1-8	1.50-1.70	2.0-20	0.05-0.08	5.1-8.4	<2	Low	0.15			
40	0-26	0-1	0.10-0.30	6.0-20	0.30-0.40	<4.-5.0	<2	Low	---	---	2	55-85
Gator	26-80	13-20	1.60-1.70	<0.2	0.10-0.15	6.1-8.4	<2	Low	0.32			
41	0-12	---	0.20-0.40	6.0-20	0.10-0.20	4.5-6.5	<2	Low	0.10	5	2	35-75
Canova	12-24	1-6	1.35-1.50	6.0-20	0.02-0.05	5.1-8.4	<2	Low	0.10			
	24-34	15-25	1.60-1.70	0.6-6.0	0.10-0.15	5.6-8.4	<2	Low	0.28			
	34-80	20-30	1.60-1.70	0.6-2.0	0.10-0.15	7.4-8.4	<2	Low	0.28			
42	0-60	---	0.15-0.35	6.0-20	0.30-0.50	4.5-8.4	<2	Low	---	2	2	>60
Terra Ceia	60-80	2-10	1.35-1.50	6.0-20	0.02-0.08	4.5-8.4	<2	Low	---			
44	0-6	10-18	0.90-1.20	0.6-2.0	0.15-0.20	7.9-8.4	<2	Low	0.32	2	4L	2-5
Perrine Variant	6-24	18-30	1.50-1.65	0.6-2.0	0.15-0.20	7.9-8.4	<2	Low	0.32			
	24	---	---	---	---	---	---	---	---			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cc	In/hr	In/in	pH	Mmhos/cm					Pct
45----------	0-17	<2	1.36-1.44	6.0-20	0.02-0.05	3.6-6.5	<2	Low-------	0.10	5	2	1-2
Myakka	17-65	2-8	1.47-1.59	0.6-6.0	0.10-0.15	3.6-6.5	<2	Low-------	0.15			
	65-80	<2	1.48-1.61	6.0-20	0.02-0.05	3.6-6.5	<2	Low-------	0.10			
46----------	0-29	<1	1.35-1.55	>20	0.02-0.08	3.6-6.0	<2	Low-------	0.10	5	2	<1
Orsino	29-80	<2	1.35-1.55	>20	0.02-0.08	3.6-6.0	<2	Low-------	0.10			
47----------	0-45	1-7	1.35-1.60	6.0-20	0.07-0.10	5.1-7.3	<2	Low-------	0.10	5	2	1-4
Holopaw	45-62	13-28	1.60-1.70	0.2-2.0	0.15-0.20	5.1-8.4	<2	Low-------	0.20			
	62-80	7-13	1.50-1.60	6.0-20	0.05-0.10	5.1-8.4	<2	Low-------	0.15			
48----------	0-5	1-6	1.40-1.55	6.0-20	0.05-0.10	3.6-6.5	<2	Low-------	0.10	5	1	1-2
Electra	5-30	1-6	1.45-1.70	6.0-20	0.02-0.07	3.6-6.5	<2	Low-------	0.10			
	30-47	1-6	1.50-1.70	0.6-2.0	0.10-0.15	3.6-5.5	<2	Low-------	0.15			
	47-80	18-38	1.60-1.75	<0.2	0.10-0.15	3.6-5.5	<2	Low-------	0.32			
49----------	0-80	<5	1.30-1.65	6.0-20	0.02-0.05	4.5-7.8	<2	Low-------	0.10	5	2	1-5
Pompano												
50.*												
Pits												
51----------	0-26	1-6	1.40-1.65	6.0-20	0.05-0.08	4.5-7.3	<2	Low-------	0.10	4	2	.1-2
Riviera	26-29	12-25	1.50-1.70	<0.2	0.10-0.14	6.1-8.4	<2	Low-------	0.24			
	29-45	15-25	1.50-1.70	<0.2	0.12-0.15	6.1-8.4	<2	Low-------	0.24			
	45-80	1-8	1.40-1.65	0.6-6.0	0.05-0.08	7.9-8.4	<2	Low-------	0.15			
52----------	0-35	<2	1.48-1.61	6.0-20	0.02-0.05	3.6-7.3	<2	Low-------	0.10	5	2	1-2
Oldsmar	35-52	2-8	1.42-1.59	0.2-6.0	0.10-0.15	3.6-7.3	<2	Low-------	0.15			
	52-80	15-30	1.60-1.69	<0.2	0.10-0.15	6.1-8.4	<2	Low-------	0.24			
53----------	0-8	2-8	1.00-1.20	2.0-6.0	0.15-0.25	5.6-7.8	<2	Low-------	0.10	5	2	15-30
Manatee	8-24	10-20	1.50-1.65	0.6-2.0	0.10-0.15	6.6-8.4	<2	Low-------	0.24			
	24-42	6-20	1.55-1.70	0.6-2.0	0.08-0.15	7.4-8.4	<2	Low-------	0.24			
	42-80	6-20	1.55-1.70	0.6-2.0	0.08-0.15	7.4-8.4	<2	Low-------	0.24			
54----------	0-8	30-65	0.15-0.50	<0.06	0.17-0.19	6.1-8.4	>16	High------	0.17	3	2	10-25
Riomar	8-15	35-65	0.25-0.60	<0.06	0.16-0.18	6.6-8.4	>16	High------	0.17			
	15-25	35-65	0.50-0.80	0.06-0.2	0.16-0.18	6.6-8.4	>16	High------	0.24			
	25	---	---	---	---	---	---	----------	----			
55----------	0-19	3-10	1.40-1.49	6.0-20	0.10-0.20	4.5-8.4	<2	Low-------	0.10	5	2	6-15
Floridana	19-35	1-7	1.52-1.53	6.0-20	0.05-0.10	4.5-8.4	<2	Low-------	0.10			
	35-50	15-30	1.60-1.69	<0.2	0.10-0.20	4.5-8.4	<2	Low-------	0.24			
	50-80	3-10	1.55-1.70	6.0-20	0.05-0.07	4.5-8.4	<2	Low-------	0.10			
56----------	0-32	1-8	1.30-1.60	6.0-20	0.02-0.05	4.5-7.3	<2	Low-------	0.10	5	2	.5-6
Pineda	32-52	10-25	1.50-1.70	<0.2	0.10-0.15	5.1-8.4	<2	Low-------	0.24			
	52-80	3-12	1.45-1.60	2.0-6.0	0.02-0.05	5.6-8.4	<2	Low-------	0.10			
57----------	0-47	1-7	1.35-1.60	6.0-20	0.03-0.10	5.1-7.3	<2	Low-------	0.10	5	2	1-4
Holopaw	47-65	13-28	1.60-1.70	0.2-2.0	0.10-0.20	5.1-8.4	<2	Low-------	0.20			
	65-80	7-13	1.50-1.60	6.0-20	0.05-0.10	5.1-8.4	<2	Low-------	0.15			
58----------	0-26	---	0.25-0.50	6.0-20	0.20-0.25	4.5-5.5	<2	Low-------	----	2	2	>20
Samsula	26-80	1-14	1.35-1.55	6.0-20	0.02-0.05	3.6-5.5	<2	Low-------	0.17			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	G/cc	In/hr	In/in	pH	Mmhos/cm					Pct
59----------	0-10	<4	1.20-1.55	6.0-20	0.02-0.08	4.5-7.3	<2	Low--------	0.10	5	2	1-3
Lokosee	10-35	1-5	1.45-1.55	6.0-20	0.05-0.10	5.6-8.4	<2	Low--------	0.10			
	35-45	2-8	1.60-1.80	0.6-6.0	0.05-0.10	5.6-8.4	<2	Low--------	0.15			
	45-70	1-5	1.55-1.80	6.0-20	0.02-0.08	6.1-8.4	<2	Low--------	0.10			
	70-80	18-30	1.60-1.80	<0.2	0.10-0.15	6.1-8.4	<2	Low--------	0.24			
60----------	0-80	<5	1.30-1.65	6.0-20	0.02-0.05	4.5-7.8	<2	Low--------	0.10	5	2	1-5
Pompano												
61----------	0-3	---	0.15-0.35	6.0-20	0.30-0.50	5.6-7.3	<2	Low--------	0.10	5	2	25-35
Delray	3-21	3-13	1.35-1.45	6.0-20	0.10-0.15	5.6-7.3	<2	Low--------	0.10			
	21-45	1-7	1.50-1.65	6.0-20	0.05-0.08	6.1-7.3	<2	Low--------	0.10			
	45-80	13-30	1.45-1.60	0.6-6.0	0.10-0.15	6.6-7.8	<2	Low--------	0.24			
62----------	0-5	2-8	1.25-1.45	6.0-20	0.15-0.25	5.1-6.5	<2	Low--------	0.10	2	2	6-12
Chobee	5-50	10-30	1.40-1.45	<0.2	0.12-0.17	5.6-8.4	<2	Low--------	0.15			
	50-80	0-15	1.45-1.50	2.0-6.0	0.10-0.15	5.6-7.8	<2	Low--------	0.15			
63----------	0-6	---	0.15-0.35	6.0-20	0.30-0.50	7.4-9.0	>16	Low--------	0.10	5	2	25-35
Kesson	6-30	1-4	1.50-1.65	2.0-20	0.05-0.10	7.4-9.0	>16	Low--------	0.10			
	30-38	1-4	1.55-1.70	2.0-20	0.05-0.15	7.4-9.0	>16	Low--------	0.10			
	38-80	2-8	1.45-1.65	2.0-20	0.05-0.15	7.4-9.0	>16	Low--------	0.10			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Map symbol and soil name	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
1---------- Canaveral	C	None----------	---	---	1.0-3.0	Apparent	Jun-Nov
2---------- Chobee	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
3---------- EauGallie	B/D	None----------	---	---	0-1.0	Apparent	Jun-Oct
4---------- Immokalee	B/D	None----------	---	---	0-1.0	Apparent	Jun-Nov
5---------- Myakka	B/D	None----------	---	---	0-1.0	Apparent	Jun-Nov
6---------- Oldsmar	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
7---------- Palm Beach	A	None----------	---	---	>6.0	---	---
8---------- Paola	A	None----------	---	---	>6.0	---	---
9---------- Pepper	D	None----------	---	---	0-1.0	Perched	Jun-Oct
10---------- Riviera	C/D	None----------	---	---	0-1.0	Apparent	Jun-Dec
11---------- St. Lucie	A	None----------	---	---	>6.0	---	---
12---------- Archbold	A	None----------	---	---	3.5-6.0	Apparent	Jun-Nov
13---------- Wabasso	B/D	None----------	---	---	0-1.0	Apparent	Jun-Oct
14---------- Winder	B/D	None----------	---	---	0-1.0	Apparent	Jun-Dec
15---------- Manatee	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
16---------- Pineda	B/D	Rare----------	---	---	0-1.0	Apparent	Jun-Nov
17.* Quartzipsamments							
18---------- Captiva	B/D	None----------	---	---	0-0.5	Apparent	Jun-Oct

See footnotes at end of table.

TABLE 17.--WATER FEATURES--Continued

Map symbol and soil name	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
20.* Beaches							
21---------- Pomello	C	None----------	---	---	2.0-3.5	Apparent	Jul-Nov
22.* Urban land							
23.* Arents							
24---------- Floridana	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
25---------- St. Augustine	C	Rare----------	---	---	1.5-3.0	Apparent	Jul-Oct
26---------- St. Augustine	B	Rare----------	---	---	2.0-3.0	Apparent	Jun-Oct
27:* Boca---------- Urban land.	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
28:* EauGallie---------- Urban land.	B/D	None----------	---	---	0-1.0	Apparent	Jun-Oct
29:* Immokalee---------- Urban land.	B/D	None----------	---	---	0-1.0	Apparent	Jun-Nov
31---------- Jupiter	B/D	None----------	---	---	0-1.0	Apparent	Jun-Nov
32---------- Jonathan	B	None----------	---	---	3.0-5.0	Apparent	Jun-Oct
33---------- Astatula	A	None----------	---	---	>6.0	---	---
34---------- Satellite	C	None----------	---	---	1.0-3.5	Apparent	Jun-Nov
35**---------- McKee	D	Frequent--------	Very long-----	Jan-Dec	+2-0	Apparent	Jan-Dec
36---------- Boca	B/D	None----------	---	---	0-1.0	Apparent	Jun-Feb
39---------- Malabar	B/D	None----------	---	---	0-1.0	Apparent	Jun-Nov
40**---------- Gator	D	None----------	---	---	+2-1.0	Apparent	Jun-Dec

See footnotes at end of table.

TABLE 17.--WATER FEATURES--Continued

Map symbol and soil name	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
41**--- Canova	B/D	None---	---	---	+2.-0	Apparent	Jan-Dec
42**--- Terra Ceia	B/D	None---	---	---	+1-1.0	Apparent	Jan-Dec
44**--- Perrine Variant	D	None---	---	---	+1-1.0	Apparent	Jun-Nov
45**--- Myakka	D	None---	---	---	+2-1.0	Apparent	Jun-Feb
46--- Orsino	A	None---	---	---	3.5-5.0	Apparent	Jun-Dec
47--- Holopaw	B/D	None---	---	---	0-1.0	Apparent	Jun-Nov
48--- Electra	C	None---	---	---	2.0-3.5	Apparent	Jul-Oct
49--- Pompano	B/D	None---	---	---	0-1.0	Apparent	Jun-Nov
50.* Pits							
51**--- Riviera	D	None---	---	---	+2-1.0	Apparent	Jun-Dec
52**--- Oldsmar	D	None---	---	---	+2-1.0	Apparent	Jun-Feb
53**--- Manatee	D	None---	---	---	+2.-1.0	Apparent	Jun-Feb
54**--- Riomar	D	Frequent---	Very long---	Jan-Dec	+2-0	Apparent	Jan-Dec
55**--- Floridana	D	None---	---	---	+2-1.0	Apparent	Jun-Feb
56**--- Pineda	D	None---	---	---	+2-1.0	Apparent	Jun-Dec
57**--- Holopaw	D	None---	---	---	+2-1.0	Apparent	Jun-Apr
58**--- Samsula	B/D	None---	---	---	+2-1.0	Apparent	Jan-Dec
59--- Lokosee	B/D	None---	---	---	0-1.0	Apparent	Jul-Nov
60**--- Pompano	D	None---	---	---	+2-1.0	Apparent	Jun-Feb
61**--- Delray	D	None---	---	---	+2-1.0	Apparent	Jun-Dec

See footnotes at end of table.

TABLE 17.--WATER FEATURES--Continued

Map symbol and soil name	Hydrologic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Months
					Ft		
62**--------- Chobee	D	None----------	---	---	+2.-1.0	Apparent	Jun-Dec
63--------- Kesson	D	Frequent--------	Very long-----	Jan-Dec	0-0.5	Apparent	Jan-Dec

* See description of the map unit for composition and behavior characteristics of the map unit.
** In the "High water table--Depth" column, a plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 18.--SOIL FEATURES

[The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Map symbol and soil name	Bedrock		Cemented pan		Subsidence		Risk of corrosion	
	Depth	Hardness	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
	In		In		In	In		
1---------- Canaveral	>60	---	---	---	---	---	Moderate-------	Low.
2---------- Chobee	>60	---	---	---	---	---	Moderate-------	Low.
3---------- EauGallie	>60	---	---	---	---	---	High----------	Moderate.
4---------- Immokalee	>60	---	---	---	---	---	High----------	High.
5---------- Myakka	>60	---	---	---	---	---	High----------	High.
6---------- Oldsmar	>60	---	---	---	---	---	Moderate-------	High.
7---------- Palm Beach	>60	---	---	---	---	---	Low-----------	Low.
8---------- Paola	>60	---	---	---	---	---	Low-----------	High.
9---------- Pepper	>60	---	15-30	Thin	---	---	High----------	Moderate.
10---------- Riviera	>60	---	---	---	---	---	High----------	High.
11---------- St. Lucie	>60	---	---	---	---	---	Low-----------	Moderate.
12---------- Archbold	>60	---	---	---	---	---	Low-----------	Moderate.
13---------- Wabasso	>60	---	---	---	---	---	Moderate-------	High.
14---------- Winder	>60	---	---	---	---	---	High----------	Low.
15---------- Manatee	>60	---	---	---	---	---	High----------	Low.
16---------- Pineda	>60	---	---	---	---	---	High----------	Low.
17.* Quartzipsamments								
18---------- Captiva	>60	---	---	---	---	---	Low-----------	Low.
20.* Beaches								

See footnote at end of table.

TABLE 18.--SOIL FEATURES--Continued

Map symbol and soil name	Bedrock		Cemented pan		Subsidence		Risk of corrosion	
	Depth	Hardness	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
	In		In		In	In		
21---------- Pomello	>60	---	---	---	---	---	Low----------	High.
22.* Urban land								
23.* Arents								
24---------- Floridana	>60	---	---	---	---	---	Moderate-------	Low.
25---------- St. Augustine	>60	---	---	---	---	---	High----------	High.
26---------- St. Augustine	>60	---	---	---	---	---	High----------	Moderate.
27:* Boca---------- Urban land.	24-40	Soft	---	---	---	---	High----------	Moderate.
28:* EauGallie---------- Urban land.	>60	---	---	---	---	---	High----------	Moderate.
29:* Immokalee---------- Urban land.	>60	---	---	---	---	---	High----------	High.
31---------- Jupiter	8-20	Soft	---	---	---	---	High----------	Low.
32---------- Jonathan	>60	---	50-75	Thin	---	---	Low----------	High.
33---------- Astatula	>60	---	---	---	---	---	Low----------	High.
34---------- Satellite	>60	---	---	---	---	---	Low----------	Moderate.
35---------- McKee	>60	---	---	---	12-48	12-48	High----------	High.
36---------- Boca	24-40	Soft	---	---	---	---	High----------	Moderate.
39---------- Malabar	>60	---	---	---	---	---	High----------	Low.
40---------- Gator	>60	---	---	---	2-6	20-23	High----------	High.
41---------- Canova	>60	---	---	---	3-6	8-12	High----------	Low.

See footnote at end of table.

TABLE 18.--SOIL FEATURES--Continued

Map symbol and soil name	Bedrock		Cemented pan		Subsidence		Risk of corrosion	
	Depth	Hardness	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
	In		In		In	In		
42---------- Terra Ceia	>60	---	---	---	16-20	50-60	Moderate-------	Moderate.
44---------- Perrine Variant	7-20	Soft	---	---	---	---	High----------	Low.
45---------- Myakka	>60	---	---	---	---	---	High----------	High.
46---------- Orsino	>60	---	---	---	---	---	Low-----------	Moderate.
47---------- Holopaw	>60	---	---	---	---	---	High----------	Moderate.
48---------- Electra	>60	---	---	---	---	---	Low-----------	High.
49---------- Pompano	>60	---	---	---	---	---	High----------	Moderate.
50.* Pits								
51---------- Riviera	>60	---	---	---	---	---	High----------	High.
52---------- Oldsmar	>60	---	---	---	---	---	Moderate-------	High.
53---------- Manatee	>60	---	---	---	---	---	High----------	Low.
54---------- Riomar	20-40	Hard	---	---	12-48	12-48	High----------	High.
55---------- Floridana	>60	---	---	---	---	---	Moderate-------	Low.
56---------- Pineda	>60	---	---	---	---	---	High----------	Low.
57---------- Holopaw	>60	---	---	---	---	---	High----------	Moderate.
58---------- Samsula	>60	---	---	---	16-20	30-36	High----------	High.
59---------- Lokosee	>60	---	---	---	---	---	High----------	Low.
60---------- Pompano	>60	---	---	---	---	---	High----------	Moderate.
61---------- Delray	>60	---	---	---	---	---	Moderate-------	Low.
62---------- Chobee	>60	---	---	---	---	---	High----------	High.

See footnote at end of table.

TABLE 18.--SOIL FEATURES--Continued

Map symbol and soil name	Bedrock		Cemented pan		Subsidence		Risk of corrosion	
	Depth	Hardness	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
	In		In		In	In		
63---------- Kesson	>60	---	---	---	---	---	High----------	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--PHYSICAL ANALYSIS OF SELECTED SOILS

Soil name and sample number	Depth	Horizon	Particle-size distribution								Hydraulic conductivity (saturated)	Bulk density (field moisture)	Water content		
			Sand						Silt	Clay					
			Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Total (2.0-0.05)	(0.05-0.002)	(<0.002)			1/10 bar	1/3 bar	15 bar
	In		Mm	Mm	Mm	Mm	Mm	Mm	Mm	Mm	Cm/hr	G/cc	Pct (wt)		
Archbold:															
S82FL-061-006-1	0- 2	A	0.0	4.6	65.5	28.2	1.0	99.3	0.3	0.4	---	---	---	---	---
S82FL-061-006-2	2-18	C1	0.0	5.3	61.9	31.3	1.0	99.5	0.0	0.5	80.2	1.53	3.8	1.9	0.9
S82FL-061-006-3	18-38	C1	0.0	5.5	57.6	35.0	1.2	99.3	0.1	0.6	63.7	1.56	2.7	2.0	0.9
S82FL-061-006-4	38-51	C2	0.0	4.5	53.4	40.2	1.3	99.4	0.0	0.6	80.8	1.55	3.0	2.7	0.9
S82FL-061-006-5	51-80	C3	0.1	8.5	61.7	28.0	1.0	99.3	0.0	0.7	60.5	1.58	2.6	2.3	0.7
Astatula:															
S82FL-061-015-1	0- 4	A	0.0	7.3	70.2	21.1	0.8	99.4	0.0	0.6	105.4	1.38	2.6	1.7	0.4
S82FL-061-015-2	4- 5	A1C	0.0	5.4	68.4	24.1	0.9	98.8	0.1	1.1	---	---	---	---	---
S82FL-061-015-3	5-14	C1	0.0	5.4	69.0	23.4	0.8	98.6	0.3	1.1	143.5	1.47	2.3	1.6	0.3
S82FL-061-015-4	14-44	C2	0.0	6.9	66.5	24.4	0.9	98.7	0.3	1.0	---	---	---	---	---
S82FL-061-015-5	44-71	C2	0.1	8.7	64.0	25.1	0.6	98.5	0.2	1.3	---	---	---	---	---
S82FL-061-015-6	71-80	C3	0.1	7.6	59.9	28.5	0.9	97.0	2.2	0.8	---	---	---	---	---
Boca:															
S82FL-061-002-1	0- 7	Ap	0.2	1.6	5.8	70.4	14.7	92.7	3.8	3.5	22.6	1.09	20.3	14.8	6.5
S82FL-061-002-2	7-14	E	0.2	2.0	7.1	73.0	13.1	95.4	2.8	1.8	11.2	1.53	7.3	3.7	0.7
S82FL-061-002-3	14-20	Bw	0.7	3.1	7.9	68.5	13.1	93.3	2.7	4.0	8.5	1.41	11.3	7.1	1.8
S82FL-061-002-4	20-24	Bt	2.8	3.4	6.1	57.3	12.4	82.0	3.1	14.9	0.8	1.48	21.0	17.8	6.9
Canaveral:															
S82FL-061-008-1	0- 5	A	0.0	0.4	23.2	67.9	3.8	97.3	0.0	2.7	24.3	1.35	9.8	7.0	2.3
S82FL-061-008-2	5- 9	C1	0.0	0.5	20.6	73.0	4.6	98.3	0.0	1.7	27.6	1.52	5.2	4.3	1.2
S82FL-061-008-3	9-17	C2	0.0	0.3	18.4	73.8	4.9	97.4	0.4	2.2	35.5	1.42	5.3	4.0	0.6
S82FL-061-008-4	17-34	C3	0.0	0.7	18.5	74.8	4.0	98.0	0.6	1.4	50.6	1.39	5.6	4.4	1.3
S82FL-061-008-5	34-49	C3	0.0	1.3	18.0	73.0	5.4	98.4	0.0	1.6	48.0	1.46	4.6	3.8	1.0
S82FL-061-008-6	49-61	C4	0.0	0.8	17.1	73.3	5.1	96.4	2.1	1.5	20.7	1.42	9.0	6.7	2.0
S82FL-061-008-7	61-80	C5	0.2	4.1	24.7	52.2	9.4	90.6	8.0	1.4	30.9	1.38	8.3	6.1	1.2
Canova:															
S82FL-061-011-1	0- 6	Oap	---	---	---	---	---	---	---	---	11.0	0.40	139.3	115.7	37.2
S82FL-061-011-2	6-12	Oa	---	---	---	---	---	---	---	---	69.7	0.40	148.8	110.0	26.9
S82FL-061-011-3	12-13	A	0.2	13.8	66.2	18.2	0.5	98.9	0.0	1.1	---	---	---	---	---
S82FL-061-011-4	13-21	E1	0.2	14.6	62.0	20.0	1.7	98.5	0.4	1.1	68.4	1.54	3.5	2.6	0.3
S82FL-061-011-5	21-24	E2	0.2	13.1	61.4	20.7	1.6	97.0	1.4	1.6	31.6	1.62	3.9	2.7	0.2
S82FL-061-011-6	24-34	Btg1	0.1	9.0	42.1	14.4	1.2	66.8	5.2	28.0	0.1	1.62	20.4	18.6	9.5
S82FL-061-011-7	34-40	Btg2	0.2	10.1	44.4	14.1	1.1	69.9	4.7	25.4	10.0	1.71	17.9	15.4	8.1
S82FL-061-011-8	40-49	Cgk1	0.4	10.5	41.3	13.6	1.3	67.1	9.5	23.4	11.2	1.78	13.6	11.8	5.4
S82FL-061-011-9	49-56	Cgk2	0.9	7.4	35.7	17.6	2.1	63.7	13.8	22.5	0.0	1.84	14.5	12.5	6.0
S82FL-061-011-10	56-80	Cg	0.6	9.3	42.8	21.8	1.7	76.2	5.8	18.0	0.2	1.82	13.8	11.1	5.6

TABLE 19.--PHYSICAL ANALYSIS OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Particle-size distribution: Sand: Very coarse (2.0-1.0)	Sand: Coarse (1.0-0.5)	Sand: Medium (0.5-0.25)	Sand: Fine (0.25-0.1)	Sand: Very fine (0.1-0.05)	Sand: Total (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Hydraulic conductivity (saturated)	Bulk density (field moisture)	Water content: 1/10 bar	Water content: 1/3 bar	Water content: 15 bar
	In		Mm	Mm	Mm	Mm	Mm	Mm	Mm	Mm	Cm/hr	G/cc	Pct(wt)		
Electra:															
S82FL-061-007-1	0- 5	A	0.0	3.2	33.6	47.4	13.6	97.8	1.1	1.1	24.3	1.49	5.7	3.6	1.3
S82FL-061-007-2	5-17	E1	0.1	3.5	30.2	47.0	17.1	97.9	1.5	0.6	17.1	1.56	4.4	3.1	0.9
S82FL-061-007-3	17-30	E2	0.1	4.5	28.2	48.5	16.5	97.8	1.5	0.7	16.8	1.54	3.9	2.1	0.8
S82FL-061-007-4	30-33	Bh1	0.1	4.0	25.6	44.1	15.5	89.3	5.4	5.3	22.6	1.28	17.8	14.5	4.0
S82FL-061-007-5	33-36	Bh2	0.0	3.6	23.4	43.0	16.8	86.8	6.4	6.8	4.5	1.30	24.9	20.8	6.5
S82FL-061-007-6	36-47	EB	0.0	3.4	23.2	44.0	18.8	89.4	6.9	3.7	10.7	1.52	8.9	6.1	1.6
S82FL-061-007-7	47-59	Btg1	0.0	4.0	27.2	38.8	10.0	80.0	2.8	17.2	0.3	1.63	19.4	17.1	7.2
S82FL-061-007-8	59-72	Btg2	0.1	4.4	28.8	38.4	7.7	79.4	2.7	17.9	0.5	1.66	16.5	14.1	5.8
Floridana:															
S83FL-061-017-1	0- 5	Ap	0.3	10.5	47.5	29.5	4.3	92.1	2.1	5.8	---	---	---	---	---
S83FL-061-017-2	5-14	A	0.2	10.2	47.7	31.0	4.5	93.1	2.3	4.1	---	---	---	---	---
S83FL-061-017-3	14-20	E	0.3	14.4	51.4	28.0	3.9	98.0	1.4	0.6	---	---	---	---	---
S83FL-061-017-4	20-30	Btg1	0.2	8.2	35.8	22.7	3.4	70.3	5.5	24.2	---	---	---	---	---
S83FL-061-017-5	30-34	Btg2	0.2	7.6	35.0	23.1	3.7	69.6	6.9	23.5	---	---	---	---	---
S83FL-061-017-6	34-37	BCg	1.8	7.4	26.2	18.0	3.2	56.6	22.4	21.0	---	---	---	---	---
S83FL-061-017-7	37-53	Cgk1	1.0	7.6	27.6	20.0	3.8	60.0	21.0	19.0	---	---	---	---	---
S83FL-061-017-8	53-68	Cgk2	5.4	10.0	24.4	19.6	5.2	64.6	15.4	20.0	---	---	---	---	---
S83FL-061-017-9	68-80	Cgk3	0.6	5.6	26.6	31.4	7.6	71.8	7.2	21.0	---	---	---	---	---
Gator:															
S83FL-061-016-1	0- 6	Oap	---	---	---	---	---	---	---	---	---	---	---	---	---
S83FL-061-016-2	6-26	Oa	---	---	---	---	---	---	---	---	---	---	---	---	---
S83FL-061-016-3	26-30	Cg1	0.2	6.6	28.6	23.1	8.5	67.0	11.5	21.5	---	---	---	---	---
S83FL-061-016-4	30-44	Cg2	0.0	5.0	23.0	17.2	5.4	50.6	16.2	33.2	---	---	---	---	---
S83FL-061-016-5	44-49	Cg3	0.0	5.4	22.6	17.0	5.6	50.6	14.4	35.0	---	---	---	---	---
S83FL-061-016-6	49-54	Cg4	0.2	5.2	23.2	17.4	5.6	51.6	15.0	33.4	---	---	---	---	---
S83FL-061-016-7	54-62	Cg5	0.7	7.1	25.4	17.9	5.1	56.2	19.6	24.2	---	---	---	---	---
S83FL-061-016-8	62-80	Cg6	0.7	7.9	31.7	22.9	7.2	70.4	9.4	20.2	---	---	---	---	---
Immokalee:															
S82FL-061-003-1	0- 8	Ap	0.0	3.8	48.2	40.1	4.6	96.6	1.7	1.7	30.3	1.39	7.8	4.8	1.5
S82FL-061-003-2	8-13	E1	0.0	3.0	49.5	39.8	5.3	97.6	1.5	0.8	41.4	1.17	9.6	7.5	1.7
S82FL-061-003-3	13-33	E2	0.0	3.1	47.8	41.3	5.9	98.1	1.0	0.9	25.6	1.47	3.9	2.6	0.6
S82FL-061-003-4	33-36	Bh1	0.0	3.5	42.3	38.5	4.1	88.4	7.1	4.5	26.3	1.21	19.5	15.0	2.3
S82FL-061-003-5	36-41	Bh1	0.0	2.9	40.2	41.1	5.3	89.5	5.5	5.0	21.6	1.32	16.9	12.8	2.4
S82FL-061-003-6	41-47	Bh3	0.0	3.3	40.4	42.5	5.8	92.0	3.5	4.5	11.0	1.45	13.7	10.6	2.7
S82FL-061-003-7	47-64	BC	0.0	3.5	42.0	45.0	5.4	95.9	2.2	1.9	27.9	1.52	5.9	4.2	0.9
S82FL-061-003-8	64-72	Bhb	0.0	3.2	41.3	46.5	4.6	95.6	2.9	1.5	9.2	1.55	8.9	6.5	1.1
S82FL-061-003-9	72-80	C	0.0	3.1	40.6	44.0	4.3	92.0	2.5	5.5	8.0	1.62	6.8	4.2	0.9

TABLE 19.--PHYSICAL ANALYSIS OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Particle-size distribution								Hydraulic conductivity (saturated)	Bulk density (field moisture)	Water content		
			Sand						Silt	Clay					
			Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Total (2.0-0.05)	(0.05-0.002)	(<0.002)			1/10 bar	1/3 bar	15 bar
	In		Mm	Mm	Mm	Mm	Mm	Mm	Mm	Mm	Cm/hr	G/cc	Pct (wt)		
Jonathan:															
S83FL-061-019-1	0- 3	A	0.1	15.1	65.1	17.4	1.3	99.0	0.8	0.2	---	---	---	---	---
S83FL-061-019-2	3-26	E	0.2	16.0	61.9	19.5	1.5	99.1	0.2	0.7	---	---	---	---	---
S83FL-061-019-3	26-51	E	0.3	17.4	57.3	22.3	1.9	99.2	0.4	0.4	---	---	---	---	---
S83FL-061-019-4	51-75	E	0.8	18.6	56.3	22.1	1.2	99.0	0.1	0.9	---	---	---	---	---
S83FL-061-019-5	75-80	Bhm	0.1	12.7	56.7	23.5	0.4	93.4	3.3	3.3	---	---	---	---	---
Jupiter:															
S82FL-061-009-1	0- 5	A1	0.0	1.2	28.4	52.6	12.8	95.0	4.9	0.1	---	---	---	---	---
S82FL-061-009-2	5-12	A2	0.0	1.6	28.3	52.2	12.4	94.5	2.4	3.1	---	---	---	---	---
Manatee:															
S82FL-061-005-1	0- 3	Ap	0.1	4.2	42.3	32.0	6.6	85.2	5.0	9.8	12.2	1.21	24.0	18.5	7.9
S82FL-061-005-2	3- 8	A	0.0	3.9	42.7	31.2	6.1	83.9	8.5	7.6	6.0	1.44	17.5	13.4	5.2
S82FL-061-005-3	8-16	BA	0.0	3.1	39.3	32.5	7.2	82.1	7.5	10.4	1.9	1.46	16.4	14.1	5.7
S82FL-061-005-4	16-30	Bt	0.0	3.4	37.5	30.1	6.9	77.9	10.4	11.7	0.0	1.61	16.5	14.2	5.1
S82FL-061-005-5	30-42	Btg1	0.0	3.6	38.9	31.1	6.9	80.5	4.3	15.2	0.0	1.60	18.1	15.7	5.7
S82FL-061-005-6	42-54	Btg2	0.0	4.2	42.8	29.4	5.0	81.4	5.6	13.0	0.1	1.57	16.2	13.6	5.4
S82FL-061-005-7	54-74	Cg	2.8	11.2	46.4	25.2	2.8	88.4	4.6	7.0	---	---	---	---	---
Orsino:															
S83FL-061-020-1	0- 2	A	0.0	0.3	8.5	72.4	16.1	97.3	2.3	0.4	---	---	---	---	---
S83FL-061-020-2	2-23	E	0.0	0.3	8.0	73.7	15.4	97.4	1.3	1.3	---	---	---	---	---
S83FL-061-020-3	23-26	Bw1&Bh	0.0	0.3	7.3	71.8	15.1	94.5	1.8	3.7	---	---	---	---	---
S83FL-061-020-4	26-43	Bw2&Bh	0.0	0.3	7.4	72.7	15.1	95.5	1.8	2.7	---	---	---	---	---
S83FL-061-020-5	43-62	BC	0.0	0.3	6.6	74.4	15.2	96.5	1.0	2.5	---	---	---	---	---
S83FL-061-020-6	62-80	C	0.0	0.2	5.5	71.4	15.3	92.4	3.6	4.0	---	---	---	---	---
Palm Beach:															
S83FL-061-020-1	0- 6	A	0.5	10.2	64.9	21.3	0.5	97.4	0.9	1.7	---	---	---	---	---
S83FL-061-020-2	6-18	C1	0.2	10.8	63.6	22.8	0.5	97.9	0.7	1.4	---	---	---	---	---
S83FL-061-020-3	18-49	C2	0.1	3.1	61.3	33.8	0.4	98.7	0.3	1.0	---	---	---	---	---
S83FL-061-020-4	49-80	C2	0.1	3.6	65.8	29.1	0.3	98.9	0.2	0.9	---	---	---	---	---
Paola:															
S82FL-061-013-1	0- 2	A	0.1	9.2	73.6	16.3	0.3	99.5	0.0	0.5	67.1	1.39	7.9	5.3	2.1
S82FL-061-013-2	2- 9	E	0.0	8.2	69.8	19.8	0.6	98.4	0.6	1.0	94.7	1.42	4.2	2.8	1.0
S82FL-061-013-3	9-12	B/E	0.0	8.2	69.7	20.2	0.7	98.8	0.2	1.0	101.3	1.62	2.4	1.5	0.3
S82FL-061-013-4	12-36	Bw	0.0	8.3	68.2	20.6	0.6	97.7	0.5	1.8	146.0	1.56	2.5	1.5	0.5
S82FL-061-013-5	36-58	Bw	0.0	7.8	61.2	27.2	1.0	97.2	0.4	2.4	130.1	1.48	1.9	1.2	0.4
S82FL-061-013-6	58-80	Bw	0.1	9.3	60.1	27.0	1.1	97.6	0.5	1.9	128.5	1.52	2.0	1.1	0.3

TABLE 19.--PHYSICAL ANALYSIS OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Particle-size distribution								Hydraulic conductivity (saturated)	Bulk density (field moisture)	Water content		
			Sand						Silt	Clay					
			Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Total (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)			1/10 bar	1/3 bar	15 bar
	In		Mm	Mm	Mm	Mm	Mm	Mm	Mm	Mm	Cm/hr	G/cc	Pct (wt)		
Pepper:															
S82FL-061-010-1	0- 2	A1	0.1	19.4	66.5	12.8	0.6	99.4	0.1	0.5	128.0	1.31	5.2	4.1	1.5
S82FL-061-010-2	2- 8	A2	0.2	13.5	69.0	15.1	0.9	98.7	0.5	0.8	105.0	1.50	3.6	2.8	0.9
S82FL-061-010-3	8-22	E	0.3	13.5	64.3	19.1	1.8	99.0	0.1	0.9	93.3	1.59	3.8	3.3	0.6
S82FL-061-010-4	22-27	Bh	0.5	13.7	59.1	18.4	1.6	93.3	2.9	3.8	2.0	0.94	46.2	38.0	9.1
S82FL-061-010-5	27-32	Bhm	0.3	13.1	60.0	20.0	1.7	95.1	1.2	3.7	2.5	1.44	17.0	14.1	3.4
S82FL-061-010-6	32-39	B'h	0.4	11.3	58.5	20.3	1.9	92.4	1.8	5.8	---	---	---	---	---
S82FL-061-010-7	39-47	BE	0.5	14.2	60.2	18.1	1.8	94.8	1.9	3.3	---	---	---	---	---
S82FL-061-010-8	47-60	Btg	0.5	13.3	53.8	13.9	1.1	82.6	2.1	15.3	---	---	---	---	---
Perrine Variant:															
S82FL-061-001-1	0- 6	Ap	1.1	6.5	19.6	35.6	8.9	71.7	13.2	15.1	6.8	0.89	38.2	31.0	13.0
S82FL-061-001-2	6-20	Ckg1	2.1	5.9	10.9	21.7	7.7	48.3	26.6	25.1	4.3	1.26	26.1	22.8	15.5
S82FL-061-001-3	20-24	Ckg2	6.2	8.6	11.1	19.9	8.4	54.2	21.0	24.9	2.6	1.36	24.0	21.2	10.4
St. Lucie:															
S82FL-061-014-1	0- 3	A	0.0	8.3	67.8	22.7	1.0	99.8	0.0	0.2	69.0	1.55	3.4	2.6	1.5
S82FL-061-014-2	3-30	C	0.0	8.9	66.6	22.9	1.1	99.5	0.1	0.4	101.0	1.63	2.2	1.9	0.8
S82FL-061-014-3	30-56	C	0.1	16.1	63.8	18.2	1.0	99.2	0.1	0.7	124.5	1.52	2.3	1.9	0.6
S82FL-061-014-4	56-80	C	0.3	23.3	60.5	14.7	0.7	99.5	0.0	0.5	125.3	1.58	1.6	1.2	0.3

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS

Soil name and sample number	Depth	Horizon	Extractable bases					Extractable acidity	Sum of cations	Base saturation	Organic carbon	Electrical conductivity	pH			Pyrophosphate extractable			Citrate dithionite extractable	
			Ca	Mg	Na	K	Sum						H_2O (1:1)	$CaCl_2$ 0.1M (1:2)	KCl 1N (1:1)	C	Fe	Al	Al	Fe
	In		----Milliequivalents/100 grams of soil---							Pct	Pct	Mmho/cm				Pct	Pct	Pct	Pct	Pct
Archbold:																				
S82FL-061-006-1	0- 2	A	---	0.06	0.01	0.01	0.08	---	---	---	0.37	0.02	---	---	---	---	---	---	---	---
S82FL-061-006-2	2-18	C1	---	0.01	0.01	0.00	0.02	0.35	0.48	27	0.12	0.01	---	---	---	---	---	---	---	---
S82FL-061-006-3	18-38	C1	0.04	0.01	0.01	0.00	0.06	0.32	0.38	16	0.07	0.01	6.5	5.8	5.6	---	---	---	---	---
S82FL-061-006-4	38-51	C2	0.04	0.01	0.01	0.00	0.06	0.22	0.28	21	0.09	0.01	6.1	5.4	4.8	---	---	---	---	---
S82FL-061-006-5	51-80	C3	0.05	0.01	0.01	0.00	0.07	0.75	0.82	9	0.08	0.01	5.8	4.8	4.3	---	---	---	---	---
Astatula:																				
S82FL-061-015-1	0- 4	A	0.19	0.06	0.02	0.01	0.28	---	---	---	0.45	0.02	5.4	4.4	4.0	---	---	---	---	---
S82FL-061-015-2	4- 5	A/C	0.06	0.02	0.02	0.01	0.11	---	---	---	0.36	0.02	5.2	4.4	4.1	---	---	---	---	---
S82FL-061-015-3	5-14	C1	0.03	0.02	0.01	0.01	0.07	---	---	---	0.27	0.01	5.8	5.0	4.7	---	---	---	0.02	0.24
S82FL-061-015-4	14-44	C2	0.01	0.01	0.01	0.00	0.03	---	---	---	0.12	0.01	5.5	5.2	5.0	---	---	---	0.04	0.27
S82FL-061-015-5	44-71	C2	0.02	0.01	0.01	0.00	0.04	---	---	---	0.09	0.02	5.1	5.0	4.9	---	---	---	0.05	0.34
S82FL-061-015-6	71-80	C3	0.03	0.02	0.01	0.01	0.07	---	---	---	0.14	0.02	5.1	5.0	5.0	---	---	---	0.11	0.38
Boca:																				
S82FL-061-002-1	0- 7	Ap	9.07	1.97	0.06	0.23	11.33	3.33	14.66	77	2.31	0.15	7.9	6.9	8.1	---	---	---	---	---
S82FL-061-002-2	7-14	E	1.50	0.37	0.03	0.05	1.95	0.76	2.71	72	0.56	0.07	7.9	7.0	8.3	---	---	---	---	---
S82FL-061-002-3	14-20	Bw	2.90	1.07	0.12	0.24	4.33	1.79	6.12	71	0.68	0.07	7.8	6.9	8.2	---	---	---	---	---
S82FL-061-002-4	20-24	Bt	8.62	3.91	0.64	0.59	13.76	2.73	16.49	83	0.68	0.12	8.0	7.1	7.9	---	---	---	0.12	1.22
Canaveral:																				
S82FL-061-008-1	0- 5	A	6.90	0.82	0.12	0.10	7.94	4.05	11.88	66	1.69	0.09	---	---	---	---	---	---	---	---
S82FL-061-008-2	5- 9	C1	1.02	0.17	0.04	0.03	1.26	1.55	2.81	45	0.30	0.03	---	---	---	---	---	---	---	---
S82FL-061-008-3	9-17	C2	5.82	0.21	0.14	0.05	6.22	1.98	8.20	76	0.42	0.09	---	---	---	---	---	---	---	---
S82FL-061-008-4	17-34	C3	11.05	0.14	0.09	0.01	11.29	0.00	11.29	100	0.18	0.08	7.2	5.8	6.5	---	---	---	---	---
S82FL-061-008-5	34-49	C3	12.07	0.14	0.10	0.01	12.32	0.00	12.32	100	0.15	0.10	7.4	6.3	7.4	---	---	---	---	---
S82FL-061-008-6	49-61	C4	18.00	0.47	0.27	0.01	18.75	0.00	18.75	100	0.10	0.14	7.6	6.5	8.2	---	---	---	---	---
S82FL-061-008-7	61-80	C5	15.94	0.58	1.27	0.01	17.80	0.00	17.80	100	0.04	0.65	7.6	6.5	8.5	---	---	---	---	---
Canova:																				
S82FL-061-011-1	0- 6	Oap	28.75	5.76	0.59	1.38	36.48	97.20	133.68	27	50.03	0.08	4.4	4.1	3.9	---	---	---	---	---
S82FL-061-011-2	6-12	Oa	23.50	1.48	0.63	0.41	26.02	73.93	99.95	26	31.49	0.08	4.6	4.2	4.1	---	---	---	---	---
S82FL-061-011-3	12-13	A	4.95	0.22	0.12	0.05	5.34	7.10	12.44	43	3.08	0.07	5.1	4.5	4.5	---	---	---	---	---
S82FL-061-011-4	13-21	E1	0.64	0.03	0.03	0.01	0.71	0.00	0.71	100	0.34	0.06	6.2	5.6	5.6	---	---	---	---	---
S82FL-061-011-5	21-24	E2	0.90	0.06	0.04	0.01	1.01	0.00	1.01	100	0.18	0.06	6.5	6.1	6.0	---	---	---	---	---
S82FL-061-011-6	24-34	Btg1	13.52	1.56	0.29	0.13	0.42	4.75	5.17	---	0.54	0.07	5.8	5.4	4.9	---	---	---	0.04	0.16
S82FL-061-011-7	34-40	Btg2	25.50	1.44	0.25	0.07	27.26	3.23	30.49	89	0.21	0.09	7.7	7.2	7.1	---	---	---	0.04	0.23
S82FL-061-011-8	40-49	Cgk1	28.00	1.32	0.25	0.11	29.68	2.46	32.14	92	0.22	0.10	7.8	7.4	7.4	---	---	---	---	---
S82FL-061-011-9	49-56	Cgk2	30.00	1.15	0.18	0.11	31.44	2.29	33.73	93	0.18	0.08	8.1	7.7	7.6	---	---	---	---	---
S82FL-061-011-10	56-80	Cg	22.75	1.07	0.13	0.06	24.01	1.26	25.27	95	0.12	0.08	8.3	7.6	7.6	---	---	---	---	---

See footnote at end of table.

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Extractable bases					Extractable acidity	Sum of cations	Base saturation	Organic carbon	Electrical conductivity	pH			Pyrophosphate extractable			Citrate dithionite extractable	
			Ca	Mg	Na	K	Sum						H_2O (1:1)	$CaCl_2$ 0.1M (1:2)	KCl 1N (1:1)	C	Fe	Al	Al	Fe
	In		----Milliequivalents/100 grams of soil---							Pct	Pct	Mmho/cm				Pct	Pct	Pct	Pct	Pct
Electra:																				
S82FL-061-007-1	0- 5	A	0.26	0.11	0.03	0.01	0.41	3.40	3.81	11	0.57	0.02	4.6	3.7	3.4	---	---	---	---	---
S82FL-061-007-2	5-17	E1	0.04	0.02	0.01	0.00	0.07	0.86	0.93	8	0.07	0.01	4.6	4.1	4.0	---	---	---	---	---
S82FL-061-007-3	17-30	E2	0.04	0.01	0.01	0.00	0.06	0.74	0.80	8	0.05	0.01	4.7	4.4	4.4	---	---	---	---	---
S82FL-061-007-4	30-33	Bh1	0.31	0.16	0.07	0.02	0.56	11.36	11.92	5	1.63	0.03	4.1	3.8	3.8	0.67	0.01	0.13	0.08	0.02
S82FL-061-007-5	33-36	Bh2	0.23	0.10	0.16	0.02	0.51	29.04	29.55	2	2.43	0.06	4.2	4.0	4.0	1.68	0.12	0.55	0.64	0.19
S82FL-061-007-6	36-47	EB	0.06	0.02	0.03	0.00	0.11	7.54	7.65	1	0.49	0.02	4.2	4.2	4.3	---	---	---	---	---
S82FL-061-007-7	47-59	Btg1	0.42	0.82	0.14	0.05	1.43	9.09	10.52	14	0.15	0.03	4.1	3.8	4.0	---	---	---	0.13	0.81
S82FL-061-007-8	59-72	Btg2	0.54	1.19	0.15	0.07	1.95	9.48	11.43	7	0.12	0.03	---	3.9	3.9	---	---	---	0.09	0.30
Floridana:																				
S83FL-061-017-1	0- 5	Ap	14.75	1.28	0.05	0.36	16.44	3.17	19.61	84	2.16	0.02	7.1	6.9	7.1	---	---	---	---	---
S83FL-061-017-2	5-14	A	10.00	0.99	0.04	0.22	11.25	3.98	15.23	74	1.72	0.05	6.6	6.5	6.8	---	---	---	---	---
S83FL-061-017-3	14-20	E	0.37	0.07	0.00	0.02	0.46	0.52	0.98	47	0.15	0.01	6.5	6.2	6.6	---	---	---	---	---
S83FL-061-017-4	20-30	Btg1	19.75	1.89	0.32	0.18	22.14	5.69	27.83	80	0.23	0.09	6.2	6.1	5.9	---	---	---	0.04	0.11
S83FL-061-017-5	30-34	Btg2	28.00	1.44	0.31	0.11	29.86	4.50	34.36	87	0.16	0.11	7.5	7.4	7.5	---	---	---	0.04	0.09
S83FL-061-017-6	34-37	BCg	45.00	0.99	0.26	0.09	46.34	3.61	49.95	93	0.12	0.11	7.8	7.7	7.8	---	---	---	---	---
S83FL-061-017-7	37-53	Cgk1	44.00	0.90	0.24	0.09	45.23	3.28	48.51	93	0.08	0.11	7.9	7.8	7.9	---	---	---	---	---
S83FL-061-017-8	53-68	Cgk2	36.00	1.07	0.21	0.07	37.35	3.49	40.84	91	0.02	0.09	7.9	7.8	7.9	---	---	---	---	---
S83FL-061-017-9	68-80	Cgk3	36.00	2.02	0.19	0.14	38.35	5.41	43.76	88	0.03	0.05	7.7	7.6	7.6	---	---	---	---	---
Gator:																				
S83FL-061-016-1	0- 6	Oap	77.25	8.44	0.60	0.54	86.83	40.06	126.88	68	45.38	0.02	5.8	5.3	5.2	---	---	---	---	---
S83FL-061-016-2	6-26	Oa	70.50	7.82	1.16	0.27	79.75	75.63	155.38	51	50.78	0.05	4.7	4.4	4.3	---	---	---	---	---
S83FL-061-016-3	26-30	Cg1	20.00	0.82	0.35	0.14	21.31	12.86	34.17	62	2.11	0.16	---	---	---	---	---	---	---	---
S83FL-061-016-4	30-44	Cg2	27.00	2.06	0.53	0.30	29.89	11.91	41.80	72	0.41	0.11	---	---	---	---	---	---	---	---
S83FL-061-016-5	44-49	Cg3	35.75	2.06	0.52	0.34	38.67	9.27	47.94	81	0.33	0.09	7.0	7.1	6.9	---	---	---	---	---
S83FL-061-016-6	49-54	Cg4	34.25	2.06	0.51	0.32	37.14	7.76	44.90	83	0.27	0.06	7.6	7.4	7.4	---	---	---	---	---
S83FL-061-016-7	54-62	Cg5	42.50	1.23	0.39	0.22	44.34	4.60	48.94	91	0.19	0.04	7.9	7.7	7.7	---	---	---	---	---
S83FL-061-016-8	62-80	Cg6	33.75	1.03	0.47	0.18	35.43	3.81	39.24	90	0.12	0.06	8.1	7.5	7.8	---	---	---	---	---
Immokalee:																				
S82FL-061-003-1	0- 8	Ap	1.01	0.34	0.04	0.12	1.51	6.73	8.24	18	1.40	0.03	6.0	5.0	5.3	---	---	---	---	---
S82FL-061-003-2	8-13	E1	0.16	0.10	0.02	0.03	0.39	2.18	2.49	12	0.43	0.03	5.8	4.1	4.7	---	---	---	---	---
S82FL-061-003-3	13-33	E2	0.14	0.03	0.01	0.01	0.19	0.99	1.18	16	0.22	0.02	5.8	4.3	5.1	---	---	---	---	---
S82FL-061-003-4	33-36	Bh1	0.41	0.22	0.10	0.11	0.84	20.70	21.54	4	4.89	0.07	4.3	3.1	3.4	1.50	0.00	0.15	0.09	0.02
S82FL-061-003-5	36-41	Bh2	0.21	0.13	0.04	0.08	0.46	22.00	22.46	2	2.90	0.07	4.1	2.2	3.4	2.43	0.00	0.22	0.13	0.01
S82FL-061-003-6	41-47	Bh3	0.17	0.11	0.06	0.04	0.38	21.67	22.05	2	1.58	0.04	4.3	3.3	3.5	1.60	0.01	0.20	0.17	0.02
S82FL-061-003-7	47-64	BC	0.05	0.02	0.03	0.02	0.12	9.51	9.67	1	1.07	0.03	4.5	3.9	4.1	---	---	---	---	---
S82FL-061-003-8	64-72	Bhb	0.04	0.01	0.02	0.01	0.08	6.59	6.67	1	0.59	0.03	4.5	4.2	4.5	0.11	0.01	0.12	0.10	0.01
S82FL-061-003-9	72-80	C	0.06	0.05	0.03	0.03	0.17	5.50	5.67	3	0.32	0.06	4.3	4.0	4.4	---	---	---	---	---

See footnote at end of table.

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Extractable bases					Extractable acidity	Sum of cations	Base saturation	Organic carbon	Electrical conductivity	pH			Pyrophosphate extractable			Citrate dithionite extractable	
			Ca	Mg	Na	K	Sum						H_2O (1:1)	$CaCl_2$ 0.1M (1:2)	KCl 1N (1:1)	C	Fe	Al	Al	Fe
	In		----Milliequivalents/100 grams of soil---							Pct	Pct	Mmho/cm				Pct	Pct	Pct	Pct	Pct
Jonathan:																				
S83FL-061-019-1	0- 3	A	0.33	0.05	0.00	0.00	0.38	2.03	2.41	16	0.34	0.00	5.1	4.4	4.5	---	---	---	---	---
S83FL-061-019-2	3-26	E	0.05	0.01	0.00	0.00	0.06	0.45	0.51	12	0.01	0.00	5.7	5.3	5.6	---	---	---	---	---
S83FL-061-019-3	26-51	E	0.04	0.01	0.00	0.00	0.05	0.57	0.62	8	0.02	0.00	5.7	5.3	5.2	---	---	---	---	---
S83FL-061-019-4	51-75	E	0.01	0.00	0.00	0.00	0.01	0.60	0.61	2	0.02	0.00	5.5	5.3	5.1	---	---	---	---	---
S83FL-061-019-5	75-80	Bhm	0.14	0.03	0.03	0.00	0.20	17.36	17.56	1	1.64	0.00	4.7	4.4	4.3	1.44	0.06	0.19	0.03	0.00
Jupiter:																				
S82FL-061-009-1	0- 5	A1	8.37	1.36	0.05	0.24	10.02	8.25	18.27	55	3.53	0.06	---	4.5	4.4	---	---	---	---	---
S82FL-061-009-2	5-12	A2	7.12	1.07	0.05	0.08	8.32	3.20	11.52	72	1.84	0.06	6.2	5.4	5.5	---	---	---	---	---
Manatee:																				
S82FL-061-005-1	0- 3	Ap	13.00	2.06	0.08	0.29	15.43	6.89	22.32	69	2.84	0.07	6.5	6.1	6.1	---	---	---	---	---
S82FL-061-005-2	3- 8	A	9.35	1.36	0.10	0.17	10.98	11.19	22.17	50	2.40	0.05	5.7	5.5	5.2	---	---	---	---	---
S82FL-061-005-3	8-16	BA	7.62	1.77	0.13	0.04	9.56	7.96	17.52	55	1.29	0.03	5.4	4.7	4.7	---	---	---	0.03	0.03
S82FL-061-005-4	16-30	Bt	8.85	3.50	0.24	0.03	12.62	6.12	18.74	67	1.06	0.04	5.5	5.0	5.1	---	---	---	0.02	0.04
S82FL-061-005-5	30-42	Btg1	9.15	3.95	0.52	0.07	13.69	4.38	18.07	76	0.42	0.09	6.2	5.7	5.7	---	---	---	0.02	0.11
S82FL-061-005-6	42-54	Btg2	18.50	3.09	0.39	0.09	22.07	3.34	25.41	87	0.13	0.13	6.8	6.2	6.5	---	---	---	---	---
S82FL-061-005-7	54-74	Cg	17.75	1.32	0.23	0.05	19.35	1.42	20.77	93	0.19	0.12	7.5	6.5	6.9	---	---	---	---	---
Orsino:																				
S83FL-061-018-1	0- 2	A	0.15	0.14	0.08	0.04	0.41	4.87	5.28	8	0.86	0.01	4.2	3.6	3.4	---	---	---	---	---
S83FL-061-018-2	2-23	E	0.03	0.02	0.01	0.00	0.06	1.83	1.89	3	0.15	0.00	4.9	4.0	3.9	---	---	---	---	---
S83FL-061-018-3	23-26	Bw1&Bh	0.11	0.09	0.06	0.01	0.27	5.55	5.82	5	0.35	0.00	4.8	4.3	4.4	0.49	0.09	0.06	0.03	0.02
S83FL-061-018-4	26-43	Bw2&Bh	0.06	0.06	0.05	0.01	0.18	4.33	4.51	4	0.21	0.01	4.8	4.5	4.6	0.91	0.07	0.06	0.04	0.01
S83FL-061-018-5	43-62	BC	0.03	0.02	0.00	0.00	0.05	1.95	2.00	3	0.08	0.00	4.8	4.6	4.8	---	---	---	---	---
S83FL-061-018-6	62-80	C	0.09	0.04	0.03	0.01	0.17	4.14	4.31	4	0.10	0.00	4.7	4.5	4.7	---	---	---	---	---
Palm Beach:*																				
S83FL-061-020-1	0- 6	A	21.25	1.44	0.26	0.05	23.00	1.40	24.40	94	1.36	0.02	7.4	7.2	7.5	---	---	---	---	---
S83FL-061-020-2	6-18	C1	15.50	0.27	0.17	0.01	15.95	0.18	16.13	99	0.31	0.01	8.3	7.6	8.5	---	---	---	---	---
S83FL-061-020-3	18-49	C2	12.50	0.22	0.13	0.01	12.86	0.00	12.86	100	0.09	0.07	8.7	7.8	9.0	---	---	---	---	---
S83FL-061-020-4	49-80	C2	11.75	0.18	0.14	0.01	12.08	0.00	12.08	100	0.08	0.08	8.8	7.8	9.1	---	---	---	---	---
Paola:																				
S82FL-061-013-1	0- 2	A	1.32	0.34	0.04	0.02	1.72	1.11	2.83	61	0.96	0.05	6.2	5.6	5.8	---	---	---	---	---
S82FL-061-013-2	2- 9	E	0.36	0.13	0.03	0.01	0.53	0.25	0.78	68	0.50	0.05	5.7	4.5	4.3	---	---	---	---	---
S82FL-061-013-3	9-12	B/E	0.13	0.04	0.03	0.01	0.21	---	---	---	0.28	0.05	5.1	4.3	4.0	---	---	---	---	---
S82FL-061-013-4	12-36	Bw	0.04	0.03	0.04	0.01	0.12	0.34	0.46	26	0.17	0.05	5.0	4.4	4.1	---	---	---	---	---
S82FL-061-013-5	36-58	Bw	0.03	0.02	0.03	0.01	0.09	0.03	0.12	75	0.10	0.05	4.8	4.4	4.3	---	---	---	---	---
S82FL-061-013-6	58-80	Bw	0.06	0.04	0.03	0.01	0.14	0.01	0.15	7	0.06	0.05	4.7	4.4	4.3	---	---	---	---	---

See footnote at end of table.

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Extractable bases					Extractable acidity	Sum of cations	Base saturation	Organic carbon	Electrical conductivity	pH			Pyrophosphate extractable			Citrate dithionite extractable	
			Ca	Mg	Na	K	Sum						H_2O (1:1)	$CaCl_2$ 0.1M (1:2)	KCl 1N (1:1)	C	Fe	Al	Al	Fe
	In		----Milliequivalents/100 grams of soil---							Pct	Pct	Mmho/cm				Pct	Pct	Pct	Pct	Pct
Pepper:																				
S82FL-061-010-1	0- 2	A1	0.55	0.20	0.02	0.02	0.79	2.77	3.56	22	1.20	0.03	4.7	3.7	3.3	---	---	---	---	---
S82FL-061-010-2	2- 8	A2	0.18	0.06	0.02	0.01	0.27	0.66	0.93	29	0.52	0.02	4.9	3.7	3.5	---	---	---	---	---
S82FL-061-010-3	8-22	E	0.06	0.02	0.01	0.00	0.09	0.12	0.21	43	0.18	0.03	4.9	4.1	3.8	---	---	---	---	---
S82FL-061-010-4	22-27	Bh	0.39	2.10	0.32	0.01	2.82	41.96	44.78	6	7.28	0.07	4.0	3.3	3.1	4.53	0.12	0.19	0.16	0.15
S82FL-061-010-5	27-32	Bhm	0.24	1.19	0.24	0.00	1.67	31.59	33.26	5	4.94	0.07	4.0	3.5	3.4	2.96	0.04	0.21	0.16	0.13
S82FL-061-010-6	32-39	B'h	0.08	0.16	0.05	0.00	0.29	8.51	8.80	3	0.91	0.05	4.8	4.2	4.1	0.65	0.04	0.24	0.13	0.15
S82FL-061-010-7	39-47	BE	0.09	0.13	0.03	0.00	0.25	1.96	2.21	11	0.42	0.04	5.0	4.4	4.2	---	---	---	---	---
S82FL-061-010-8	47-60	Btg	0.47	2.02	0.16	0.05	2.70	3.80	6.50	42	0.25	0.04	5.1	4.1	3.9	---	---	---	---	---
Perrine Variant:																				
S82FL-061-001-1	0- 6	Ap	33.50	5.76	0.30	1.37	40.93	4.31	45.24	90	5.68	0.32	7.2	6.5	6.4	---	---	---	---	---
S82FL-061-001-2	6-20	Ckg1	25.75	2.43	1.41	0.19	29.78	1.38	31.16	96	2.32	0.55	8.0	7.1	7.6	---	---	---	---	---
S82FL-061-001-3	20-24	Ckg2	27.00	1.36	1.61	0.12	30.09	1.50	31.59	95	1.00	0.55	8.3	7.3	8.1	---	---	---	---	---
St. Lucie:																				
S82FL-061-014-1	0- 3	A	0.41	0.13	0.02	0.02	0.58	---	---	---	0.89	0.05	4.9	3.8	3.5	---	---	---	---	---
S82FL-061-014-2	3-30	C	0.02	0.02	0.01	0.01	0.06	---	---	---	0.08	0.01	5.8	4.6	4.4	---	---	---	---	---
S82FL-061-014-3	30-56	C	0.02	0.01	0.00	0.00	0.03	---	---	---	0.03	0.01	5.9	5.0	4.6	---	---	---	---	---
S82FL-061-014-4	56-80	C	0.02	0.02	0.01	0.00	0.05	---	---	---	0.06	0.01	6.1	5.4	4.9	---	---	---	---	---

* Palm Beach data reflects effects of saltspray becaue of proxmity to ocean.

TABLE 21.--CLAY MINERALOGY OF SELECTED SOILS

Soil name and sample number	Depth	Horizon	Clay minerals			
			Montmorillonite	14 angstrom intergrade	Kaolinite	Quartz
	In		Pct	Pct	Pct	Pct
Archbold:						
S82FL-061-006-1	0- 2	A	68	---	13	19
S82FL-061-006-3	18-38	C1	---	---	10	90
S82FL-061-006-5	51-80	C3	---	---	---	100
Astatula:						
S82FL-061-015-1 1/	0- 4	A	48	22	7	23
S82FL-061-015-4 1/	14-44	C2	18	33	6	43
S82FL-061-015-6 1/	71-80	C3	42	21	7	30
Boca:						
S82FL-061-002-1	0- 7	Ap	40	17	8	35
S82FL-061-002-3	14-20	Bw	36	32	13	19
S82FL-061-002-4	20-24	Bt	50	25	14	11
Canaveral:						
S82FL-061-008-1	0- 5	A	75	---	10	15
S82FL-061-008-4	17-34	C3	82	---	7	11
S82FL-061-008-7	61-80	C5	87	---	6	7
Canova:						
S82FL-061-011-6	24-34	Btg1	70	---	21	9
S82FL-061-011-10	56-80	Cg	88	---	7	5
Electra:						
S82FL-061-007-1	0- 5	A	35	---	12	53
S82FL-061-007-4	30-33	Bh1	15	23	21	41
S82FL-061-007-8	59-72	Btg2	54	---	29	17
Immokalee:						
S82FL-061-003-1	0- 8	Ap	14	17	9	60
S82FL-061-003-4	33-36	Bh1	36	---	11	53
S82FL-061-003-9	72-80	C	40	9	39	12
Manatee:						
S82FL-061-005-1	0- 3	Ap	86	---	6	8
S82FL-061-005-3	8-16	BA	91	---	5	4
S82FL-061-005-5	30-42	Btg1	86	---	6	8
S82FL-061-005-7	54-74	Cg	93	---	4	3
Paola:						
S82FL-061-013-1 2/	0- 2	A	32	36	16	16
S82FL-061-013-4 2/	12-36	Bw	22	56	15	7
S82FL-061-013-6	58-80	Bw	29	52	9	10
Pepper:						
S82FL-061-010-1	0- 2	A1	---	---	20	80
S82FL-061-010-4 1/	22-27	Bh	---	11	15	74
S82FL-061-010-8	47-60	Btg	29	12	51	8
Perrine Variant:						
S82FL-061-001-1 3/	0- 6	Ap	---	---	35	61
S82FL-061-001-3 4/	20-24	Ckg2	---	---	---	---

See footnotes at end of table.

TABLE 21.--CLAY MINERALOGY OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Clay minerals			
			Montmorillonite	14 angstrom intergrade	Kaolinite	Quartz
	In		Pct	Pct	Pct	Pct
St. Lucie:						
S82FL-061-014-1 1/	0- 3	A	37	15	9	39
S82FL-061-014-4	56-80	C	---	---	---	100

1/ Detectable amounts of feldspars present.
2/ Detectable amounts of dolomite present.
3/ 4 percent chlorite mineral.
4/ 100 percent chlorite mineral.

TABLE 22.--ENGINEERING INDEX TEST DATA

[Tests performed by the Florida Department of Transportation (FDOT) in cooperation with the U.S. Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway and Transportation Officials (AASHTO). See the section "Soil Series and Their Morphology" for location of pedon sampled. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	FDOT report number	Classification		Mechanical analysis[1]								Liquid limit	Plasticity index	Moisture density[3]	
		AASHTO[2]	Unified (Estimated)	Percentage smaller than--				Percentage smaller than--						Maximum dry density	Optimum moisture
				No. 4	No. 10	No. 40	No. 200	.05 mm	.02 mm	.005 mm	.002 mm				
												Pct		Lb/ft^3	Pct
Archbold sand: 4/ (S82FL-061-006-2,3)	5														
C1 -- 2-38		A-3(00)	SP-SM	100	100	87	6	0	0	0	0	NP	NP	100.1	15.4
Astatula sand: 4/ (S82FL-061-015-5)	16														
C2 -- 14-71		A-3(00)	SP	100	100	83	2	2	2	0	0	NP	NP	103.8	13.9
Canaveral fine sand: 4/ (S82FL-061-008-4)	8														
C3 -- 17-49		A-3(00)	SP	100	100	98	3	2	0	0	0	NP	NP	99.7	15.6
Canova muck: 4/ (S82FL-061-011-4,5)	9, 10, 11														
E1, E2 -- 13-24		A-3 (00)	SP	100	100	75	3	3	2	1	1	NP	NP	104.5	12.2
Btg1 -- 24-34		A-2-6	SC	100	100	81	29	28	26	25	24	40	25	108.1	12.6
Cgk1, Cgk2 -- 40-56		A-2-6	SC	100	87	70	29	27	25	19	16	30	18	118.3	13.1
Electra sand: 4/ (S82FL-061-007-4,5)	6, 7														
Bh1, Bh2 -- 30-36		A-2-4 (00)	SM	100	100	92	14	12	6	3	3	NP	NP	98.0	17.2
Floridana fine sand: 4/ (S83FL-061-017-4)	19														
Btg1 -- 20-30		A-2-6	SC	100	100	85	29	29	27	25	25	40	26	113.8	12.7
Gator muck: 4/ (S83FL-061-016-4)	17, 18														
Cg2 -- 30-44		A-6	SC	100	95	84	46	45	42	31	26	38	27	111.8	15.6

See footnotes at end of table.

TABLE 22.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	FDOT report number	Classification		Mechanical analysis[1]								Liquid limit	Plasticity index	Moisture-density[3]	
		AASHTO[2]	Unified (Estimated)	Percentage smaller than--				Percentage smaller than--						Maximum dry density	Optimum moisture
				No. 4	No. 10	No. 40	No. 200	.05 mm	.02 mm	.005 mm	.002 mm				
												Pct		Lb/ft^3	Pct
Immokalee sand: 5/ (S82FL-061-003-2,3,4, 5,6)	2, 3														
E1, E2 -- 8-33		A-3(00)	SP	100	100	90	3	3	2	1	1	NP	NP	102.1	13.4
Bh1, Bh2, Bh3 -- 33-47		A-3(00)	SP-SM	100	100	93	9	7	5	2	1	NP	NP	101.6	14.5
Jonathan sand: 4/ (S83FL-061-019-1,2, 3,4)	21														
E -- 3-75		A-3(00)	SP	100	100	72	1	0	0	0	0	NP	NP	102.4	15.1
Manatee loamy sand: 6/ (S82FL-061-005-4)	4														
Bt -- 16-30		A-2-4	SM-SC	100	100	92	20	19	16	13	12	23	6	106.7	8.0
Orsino fine sand: 4/ (S83FL-061-018-3,4)	20														
Bw1&Bh, Bw2&Bh -- 23-43		A-3(00)	SP-SM	100	100	99	9	6	4	2	1	NP	NP	102.6	14.6
Palm Beach fine sand: 7/ (S83FL-061-020-3,4)	22														
C2 -- 18-80		A-3(00)	SP	100	100	87	2	2	2	1	1	NP	NP	101.4	16.3
Paola sand: (S82FL-061-013-4,5,6)	14														
Bw -- 12-80		A-3(00)	SP	100	100	82	3	2	1	0	0	NP	NP	105.5	13.0

See footnotes at end of table.

TABLE 22.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	FDOT report number	Classification		Mechanical analysis[1]								Liquid limit	Plasticity index	Moisture density[3]	
		AASHTO[2]	Unified (Estimated)	Percentage smaller than--				Percentage smaller than--						Maximum dry density	Optimum moisture
				No. 4	No. 10	No. 40	No. 200	.05 mm	.02 mm	.005 mm	.002 mm				
												Pct		Lb/ft^3	Pct
Perrine Variant fine sandy loam: 8/ (S82FL-061-001-1,2,3) Ckg1, Ckg2 -- 6-24	1	A-2-6	SC	100	91	68	29	28	26	19	14	35	15	108.2	16.5
St. Lucie sand: 4/ (S82FL-061-014-2,3,4) C -- 3-80	15	A-3(00)	SP	100	100	73	1	0	0	0	0	NP	NP	102.4	14.5

1/ Mechanical analyses according to AASHTO designation T88-78. Results by this procedure differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-sized fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

2/ Based on AASHTO Designation H145-73.

3/ Based on AASHTO Designation T99-74.

4/ Typical pedon - See section "Soil Series and Their Morphology" for location of pedons.

5/ Type location: Indian River County, Florida; northwest corner of the intersection of 74th Court and 25th Street SW south of Vero Beach; SE1/4 sec. 36, T. 33 S., R. 39 E.

6/ Type location: Indian River County, Florida; 1/4 mile south of S.R. 60 on Kings Highway; 256 feet west along field road just north of citrus trees, then 100 feet north into a field; SE1/4NE1/4SE1/4 sec. 5, T. 33 S., R. 39 E. This soil is a taxadjunct since the permeability is too slow.

7/ Type location: Indian River County, FLorida; 0.7 mile south of Wabasso Beach Park, 300 feet east of S.R. A1A, 100 feet north of trail; NE1/4NW1/4SE1/4 sec. 25, T. 31 S., R. 39 E.

8/ This soil is a taxadjunct to the Perrine series because it contains more sand than allowed in the official series.

TABLE 23.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Archbold	Hyperthermic, uncoated Typic Quartzipsamments
Arents	Arents
Astatula	Hyperthermic, uncoated Typic Quartzipsamments
*Boca	Loamy, siliceous, hyperthermic Arenic Ochraqualfs
Canaveral	Hyperthermic, uncoated Aquic Quartzipsamments
Canova	Fine-loamy, siliceous, hyperthermic Typic Glossaqualfs
Captiva	Siliceous, hyperthermic Mollic Psammaquents
Chobee	Fine-loamy, siliceous, hyperthermic Typic Argiaquolls
Delray	Loamy, siliceous, hyperthermic Grossarenic Argiaquolls
EauGallie	Sandy, siliceous, hyperthermic Alfic Haplaquods
Electra	Sandy, siliceous, hyperthermic Arenic Ultic Haplohumods
Floridana	Loamy, siliceous, hyperthermic Arenic Argiaquolls
Gator	Loamy, siliceous, euic, hyperthermic Terric Medisaprists
Holopaw	Loamy, siliceous, hyperthermic Grossarenic Ochraqualfs
Immokalee	Sandy, siliceous, hyperthermic Arenic Haplaquods
Jonathan	Sandy, siliceous, hyperthermic, ortstein Typic Haplohumods
Jupiter	Sandy, siliceous, hyperthermic Lithic Haplaquolls
Kesson	Siliceous, hyperthermic Typic Psammaquents
Lokosee	Loamy, siliceous, hyperthermic Grossarenic Ochraqualfs
Malabar	Loamy, siliceous, hyperthermic Grossarenic Ochraqualfs
Manatee	Coarse-loamy, siliceous, hyperthermic Typic Argiaquolls
McKee	Fine, montmorillonitic, nonacid, hyperthermic Typic Hydraquents
Myakka	Sandy, siliceous, hyperthermic Aeric Haplaquods
Oldsmar	Sandy, siliceous, hyperthermic Alfic Arenic Haplaquods
Orsino	Hyperthermic, uncoated Spodic Quartzipsamments
Palm Beach	Hyperthermic, uncoated Typic Quartzipsamments
Paola	Hyperthermic, uncoated Spodic Quartzipsamments
Pepper	Sandy, siliceous, hyperthermic, ortstein Alfic Haplaquods
Perrine Variant	Fine-loamy, carbonatic, hyperthermic Typic Fluvaquents
Pineda	Loamy, siliceous, hyperthermic Arenic Glossaqualfs
*Pomello	Sandy, siliceous, hyperthermic Arenic Haplohumods
Pompano	Siliceous, hyperthermic Typic Psammaquents
Quartzipsamments	Quartzipsamments
Riomar	Fine, montmorillonitic, nonacid, hyperthermic Typic Hydraquents
Riviera	Loamy, siliceous, hyperthermic Arenic Glossaqualfs
Samsula	Sandy or sandy-skeletal, siliceous, dysic, hyperthermic Terric Medisaprists
Satellite	Hyperthermic, uncoated Aquic Quartzipsamments
St. Augustine	Sandy, siliceous, hyperthermic Udalfic Arents
St. Lucie	Hyperthermic, uncoated Typic Quartzipsamments
Terra Ceia	Euic, hyperthermic Typic Medisaprists
Wabasso	Sandy, siliceous, hyperthermic Alfic Haplaquods
Winder	Fine-loamy, siliceous, hyperthermic Typic Glossaqualfs

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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Our records indicate that you have received a copy of the Soil Survey of Indian River County. Some of the data in Table 1 on page 134 is suspect. This supplemental table provides more accurate data.

SUPPLEMENTAL TABLE 1.--TEMPERATURE AND PRECIPITATION

	Temperature					Precipitation		
			Mean number of days with temperatures of --				Mean number of days With rainfall of--	
Month	Normal Monthly mean	Normal daily maximum	Normal daily Minimum	90°F or higher	32 °F or lower	Normal Total	0.10 inch or more	0.50 inch or more
	°F	°F	°F			In		
Jan.	61.9	72.2	51.6			2.43		
Feb.	62.5	72.8	52.2			2.86		
March	67.2	77.3	57.1			3.05		
April	71.7	81.2	62.2			2.59		
May	76.2	85.2	67.0			4.39		
June	79.4	87.9	70.9			6.52		
July	81.1	89.7	72.4			5.76		
Aug.	81.4	89.9	72.9			5.39		
Sept.	80.2	87.9	72.4			7.96		
Oct.	75.2	83.3	67.1			5.94		
Nov.	68.9	77.9	59.8			2.55		
Dec.	63.4	72.4	53.3			1.97		
Total	72.4	81.5	63.2			51.41		

REFERENCE

Climatography of the United States No. 81 (Florida)
Monthly Normal Temperature, Precipitation, and Heating
and Cooling Degree Days 1951-80,
NOAA - National Oceanic and Atmospheric Administration,
National Climatic Center, Asheville, N.C. Sept. 1982

Appendix F

NOAA National Geodetic Survey Coordinate Conversion and Transformation Tool

NGS Coordinate Conversion and Transformation Tool (NCAT)

National Geodetic Survey

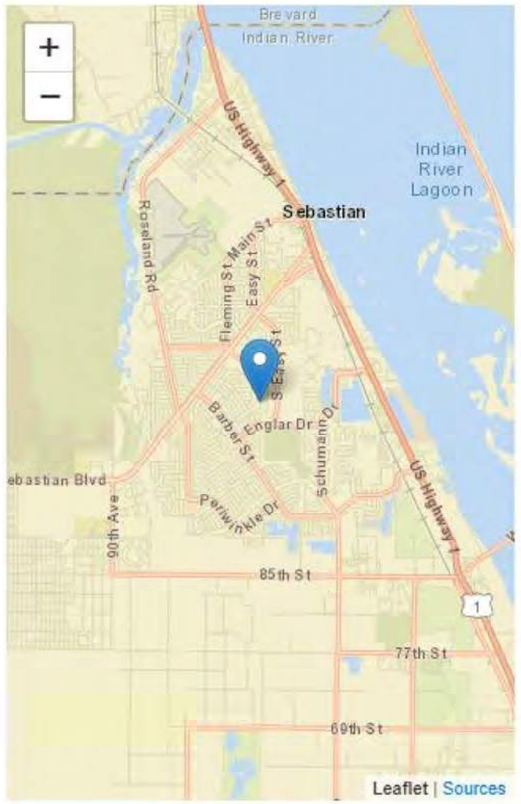
NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

Single Point Conversion | Multipoint Conversion | Web services | Downloads | Tutorial & FAQs | About NCAT

Convert/Transform from: ☐ Horizontal ● Horizontal+height ☐ XYZ

Select the type of horizontal coordinate: ● Geodetic lat-long ☐ SPC ☐ UTM ☐ USNG

Select a height ☐ Ellipsoidal ● Orthometric



Enter lat-lon in decimal degrees

Lat 27.7819866385

Lon -80.4793167114

or degrees-minutes-seconds

Lat N 27-46-55.15190

Lon W 080-28-45.54016

or drag map marker to a location of interest

Input reference frame (historically called 'horizontal datum') NAD83(2011)

Output reference frame (historically called 'horizontal datum') NAD83(2011)

Don't see a reference frame in the list? Click **here** *to learn more.*

Orthometric Height 22.500

Units of height US Survey Feet

Input geopotential datum (historically called 'vertical datum') NGVD29

Output geopotential datum (historically called 'vertical datum') NAVD88

SPC zone Auto Pick (default zor

Submit

Click blue bar(s) to expand/collapse

Transformed Coordinate

Input Coordinate		Output Coordinate		Total Change + Uncertainty	
Latitude	N27° 46' 55.15190" N274655.15190 27.7819866385	Latitude	N27° 46' 55.15190" N274655.15190 27.7819866385	Latitude	0.00000" ±0.000000" (0.000 m ±0.0000 m)*
Longitude	E279° 31' 14.45984" W0802845.54016 -80.4793167114	Longitude	E279° 31' 14.45984" W0802845.54016 -80.4793167114	Longitude	0.00000" ±0.000000" (0.000 m ±0.0000 m)*
Ellipsoid Height (usft)	Not given	Ellipsoid Height (usft)	Not given	Ellipsoid Height	Not given
Orthometric Height (usft)	22.500	Orthometric Height (usft)	21.037	Orthometric Height	-1.463 usft ±0.043 usft
Reference Frame	NAD83(2011)	Reference Frame	NAD83(2011)		
Geopotential Datum	NGVD29	Geopotential Datum	NAVD88		

*Approximate value to aid interpretation and not an actual distance. See **TM NOS NGS 82** for more details.

Converted Coordinate

Customize Export

Appendix G

NOAA Atlas 14 Precipitation Frequency Data

NOAA Atlas 14, Volume 9, Version 2
Location name: Sebastian, Florida, USA*
Latitude: 27.7891°, Longitude: -80.479°
Elevation: 18.54 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

AMS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Annual exceedance probability (1/years)								
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500	1/1000
5-min	**0.585** (0.475-0.733)	**0.740** (0.598-0.929)	**0.858** (0.690-1.08)	**1.02** (0.791-1.32)	**1.14** (0.866-1.50)	**1.26** (0.928-1.71)	**1.39** (0.978-1.93)	**1.56** (1.06-2.23)	**1.68** (1.11-2.45)
10-min	**0.856** (0.695-1.07)	**1.08** (0.876-1.36)	**1.26** (1.01-1.59)	**1.49** (1.16-1.94)	**1.67** (1.27-2.20)	**1.85** (1.36-2.50)	**2.03** (1.43-2.83)	**2.28** (1.55-3.26)	**2.47** (1.63-3.59)
15-min	**1.04** (0.848-1.31)	**1.32** (1.07-1.66)	**1.53** (1.23-1.93)	**1.82** (1.41-2.36)	**2.04** (1.55-2.69)	**2.26** (1.66-3.05)	**2.48** (1.75-3.45)	**2.78** (1.88-3.97)	**3.01** (1.99-4.37)
30-min	**1.58** (1.29-1.98)	**2.00** (1.62-2.51)	**2.32** (1.87-2.93)	**2.76** (2.14-3.58)	**3.09** (2.35-4.08)	**3.42** (2.52-4.63)	**3.77** (2.66-5.24)	**4.22** (2.87-6.04)	**4.58** (3.02-6.65)
60-min	**2.07** (1.68-2.60)	**2.63** (2.13-3.30)	**3.05** (2.46-3.85)	**3.61** (2.80-4.68)	**4.03** (3.06-5.31)	**4.45** (3.27-6.01)	**4.87** (3.43-6.77)	**5.43** (3.68-7.76)	**5.85** (3.87-8.51)
2-hr	**2.56** (2.09-3.19)	**3.26** (2.65-4.07)	**3.78** (3.06-4.74)	**4.47** (3.48-5.75)	**4.98** (3.80-6.51)	**5.48** (4.04-7.35)	**5.98** (4.24-8.25)	**6.64** (4.52-9.41)	**7.13** (4.74-10.3)
3-hr	**2.81** (2.30-3.48)	**3.61** (2.94-4.48)	**4.20** (3.41-5.25)	**4.98** (3.89-6.38)	**5.56** (4.25-7.24)	**6.13** (4.54-8.19)	**6.70** (4.76-9.20)	**7.44** (5.08-10.5)	**7.99** (5.33-11.5)
6-hr	**3.24** (2.66-3.99)	**4.26** (3.49-5.26)	**5.05** (4.12-6.26)	**6.10** (4.80-7.81)	**6.91** (5.33-8.97)	**7.73** (5.76-10.3)	**8.56** (6.13-11.7)	**9.67** (6.66-13.6)	**10.5** (7.07-15.0)
12-hr	**3.72** (3.07-4.55)	**5.04** (4.15-6.18)	**6.11** (5.00-7.52)	**7.60** (6.05-9.75)	**8.80** (6.85-11.4)	**10.1** (7.56-13.4)	**11.4** (8.21-15.5)	**13.2** (9.17-18.5)	**14.6** (9.90-20.8)
24-hr	**4.29** (3.56-5.21)	**5.90** (4.89-7.19)	**7.24** (5.97-8.86)	**9.17** (7.37-11.8)	**10.8** (8.43-13.9)	**12.4** (9.42-16.5)	**14.2** (10.4-19.4)	**16.7** (11.7-23.4)	**18.8** (12.8-26.5)
2-day	**5.02** (4.19-6.06)	**6.81** (5.67-8.25)	**8.31** (6.88-10.1)	**10.5** (8.47-13.3)	**12.3** (9.66-15.8)	**14.2** (10.8-18.6)	**16.2** (11.9-21.9)	**19.0** (13.4-26.4)	**21.3** (14.6-29.9)
3-day	**5.56** (4.66-6.69)	**7.40** (6.18-8.92)	**8.92** (7.41-10.8)	**11.1** (9.02-14.1)	**12.9** (10.2-16.6)	**14.9** (11.4-19.5)	**16.9** (12.4-22.8)	**19.8** (14.0-27.4)	**22.1** (15.2-30.9)
4-day	**6.02** (5.06-7.22)	**7.85** (6.58-9.44)	**9.38** (7.81-11.3)	**11.6** (9.40-14.6)	**13.4** (10.6-17.1)	**15.3** (11.7-20.0)	**17.3** (12.8-23.3)	**20.2** (14.3-27.9)	**22.5** (15.5-31.3)
7-day	**7.17** (6.05-8.56)	**8.99** (7.56-10.7)	**10.5** (8.77-12.6)	**12.6** (10.3-15.8)	**14.4** (11.5-18.3)	**16.3** (12.6-21.1)	**18.3** (13.5-24.4)	**21.1** (15.1-28.9)	**23.3** (16.2-32.3)
10-day	**8.21** (6.94-9.76)	**10.1** (8.51-12.0)	**11.6** (9.77-13.9)	**13.9** (11.3-17.2)	**15.6** (12.5-19.7)	**17.5** (13.6-22.7)	**19.5** (14.5-26.0)	**22.4** (16.0-30.5)	**24.6** (17.1-34.0)
20-day	**11.3** (9.58-13.3)	**13.7** (11.6-16.2)	**15.6** (13.2-18.6)	**18.3** (15.0-22.4)	**20.3** (16.3-25.4)	**22.5** (17.4-28.7)	**24.7** (18.4-32.4)	**27.7** (19.9-37.4)	**30.1** (21.1-41.2)
30-day	**13.9** (11.8-16.3)	**16.9** (14.4-19.9)	**19.2** (16.2-22.7)	**22.3** (18.3-27.2)	**24.7** (19.8-30.5)	**27.0** (21.0-34.3)	**29.4** (22.0-38.4)	**32.7** (23.6-43.9)	**35.1** (24.7-48.0)
45-day	**17.2** (14.7-20.2)	**21.0** (17.9-24.6)	**23.8** (20.2-28.1)	**27.5** (22.5-33.2)	**30.2** (24.3-37.1)	**32.9** (25.6-41.4)	**35.5** (26.6-46.1)	**39.0** (28.2-52.0)	**41.5** (29.3-56.5)
60-day	**20.1** (17.3-23.5)	**24.5** (21.0-28.7)	**27.7** (23.6-32.6)	**31.9** (26.1-38.3)	**34.9** (28.1-42.7)	**37.8** (29.5-47.4)	**40.6** (30.5-52.4)	**44.2** (32.0-58.7)	**46.8** (33.2-63.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of annual maxima series (AMS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and annual exceedance probability) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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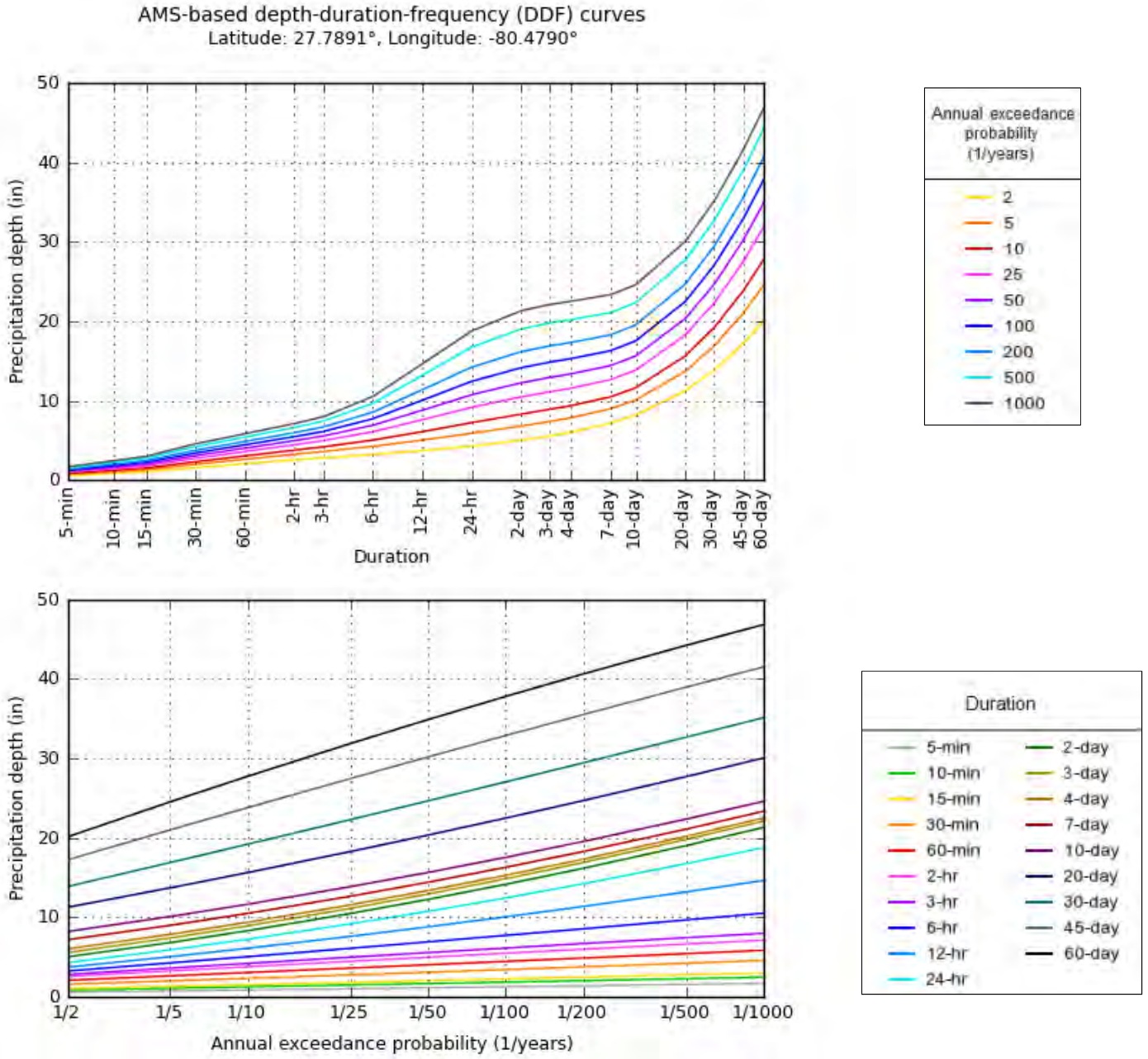
PF graphical



NOAA Atlas 14, Volume 9, Version 2

Created (GMT): Mon Feb 28 19:25:08 2022

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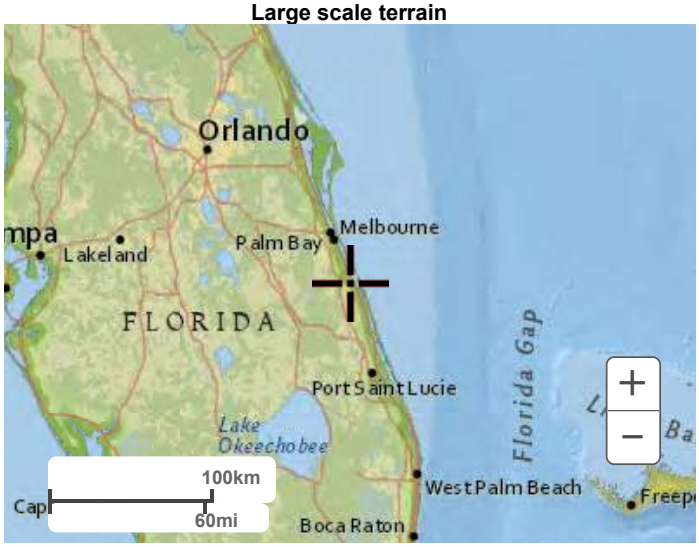
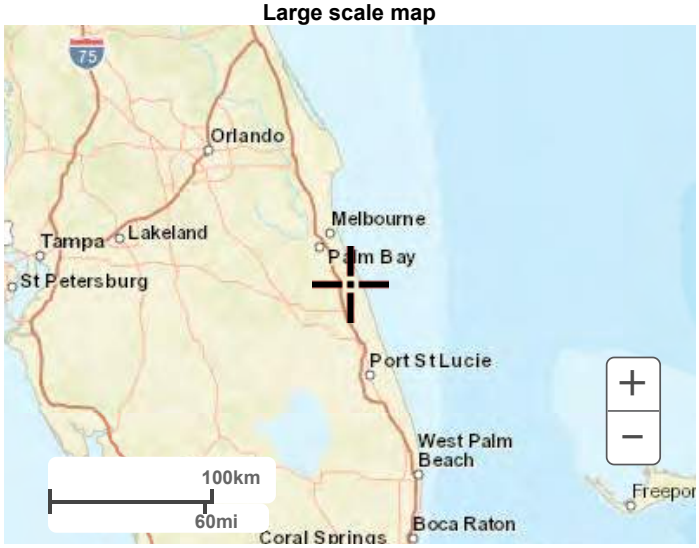
Maps & aerials

Small scale terrain

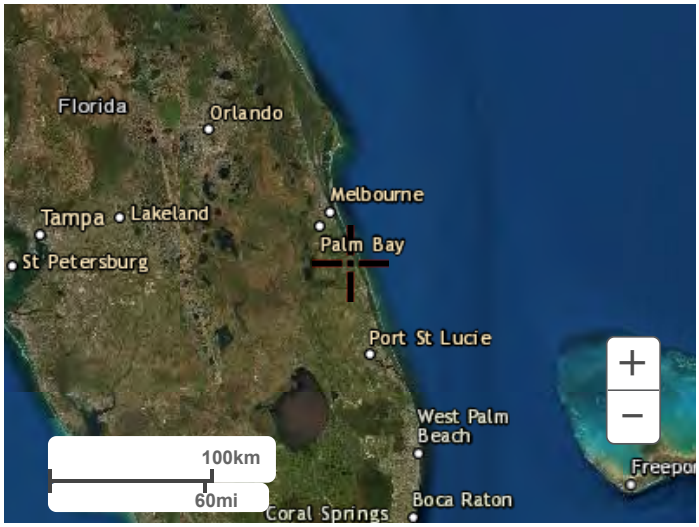
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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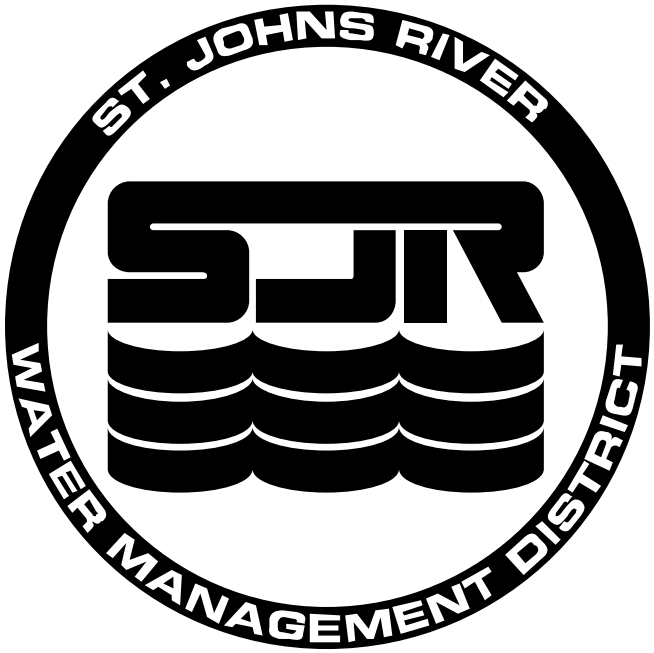

June 1, 2018

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
4049 Reid Street
Palatka, FL 32177-2529
(386) 329-4500

ABOUT THIS MANUAL

This manual is a compilation of information that will be useful to anyone interested in the St. Johns River Water Management District's (SJRWMD) environmental resource permitting (ERP) program. It was developed as a result of the enactment of section 373.4131 of the Florida Statutes which directed the Department of Environmental Protection (DEP) and the water management districts to adopt statewide ERP rules. In SJRWMD, the relevant rules are contained in chapters 62-330, 40C-1, 40C-4, 40C-8, 40C-41, and 40C-44, F.A.C., and for mitigation banks include chapter 62-342, F.A.C. In addition, applicants are required to demonstrate compliance with the provisions of SJRWMD's Environmental Resource Permit Applicant's Handbook, which has been incorporated by reference. The SJRWMD's Handbook consists of two volumes:

- Volume I (which applies statewide and is available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09390 http://www.flrules.org/Gateway/reference.asp?No=Ref-09391 and from the District), and

- SJRWMD Volume II (included as Part A in this manual and available on the District's website at www.sjrwmd.com and at http://www.flrules.org/Gateway/reference.asp?No=Ref-09405.)

Part A of the manual contains SJRWMD Volume II which is based on, and merges many provisions of, the District's previous three applicant's handbooks: Applicant's Handbook: Management and Storage of Surface Waters (December 27, 2010), Applicant's Handbook: Regulation of Stormwater Management Systems, Chapter 40C-42, F.A.C. (December 27, 2010), and Applicant's Handbook: Agricultural Surface Water Management Systems (December 27, 2010). The October 1, 2013 version of Part A was revised on June 1, 2018.

Part B of the manual contains surface water management design aids and examples, and methodologies, that are all intended to assist applicants in designing projects (surface water management systems) that will meet their needs as well as the requisite water quality and water quantity requirements. The examples are designed to illustrate how the District's rules and aids may be used in the design of a particular project to meet these permitting requirements.

Part C of the manual contains guidance documents from DEP to the water management districts that may also be useful to applicants as they design projects for consideration by the District.

Part D contains copies of the applicable rules in chapters 62-330, 40C-1, 40C-4, 40C-8, 40C-41, and 40C-44, F.A.C., and the mitigation banking rules in chapter 62-342, F.A.C.

Part E contains copies of forms that the District has incorporated by reference in title 40C, F.A.C.

The design aids and examples and methodologies and the guidance documents in the manual are intended to provide general information only. Specific projects may involve additional or different design considerations in order to address site-specific issues. These parts of the manual do not constitute additional rule criteria.

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A. ENVIRONMENTAL RESOURCE PERMIT APPLICANT'S HANDBOOK, VOLUME II: FOR USE WITHIN THE GEOGRAPHIC LIMITS OF THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

June 1, 2018

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
4049 Reid Street
Palatka, FL 32177-2529
(386) 329-4500

PART I
INTRODUCTION, ORGANIZATION, DEFINITIONS AND APPLICABILITY

1.0 Introduction *Revised 6/1/18*

This is Volume II of a two-volume Applicant's Handbook that is designed to assist persons in understanding the rules, procedures, standards and criteria of the environmental resource permit (ERP) program under part IV of chapter 373 of the Florida Statutes (F.S.). Within the St. Johns River Water Management District, the ERP program is governed by chapters 373, 403 and 120, F.S. and chapters 62-330, 40C-1, 40C-4, 40C-41, and 40C-44, F.A.C. This handbook volume accompanies Applicant's Handbook – Volume I (General and Environmental). Volume II and portions of Volume I are incorporated by reference in chapter 62-330, F.A.C., and are, therefore rules of the Department of Environmental Protection (DEP). In accordance with paragraph 373.4131(2)(a), F.S. (2012), they are also rules of the District.

This Volume includes:

- Design and performance standards and criteria for water quality and quantity for stormwater management systems, including alternative criteria for those systems
- Explanations of standards and criteria pertaining to water flows and levels, flood protection and the design of dams
- Design and performance standards for agricultural surface water management (Chapter 40C-44, F.A.C.)
- Descriptions of drainage basins and regional watersheds
- Explanations of basin criteria (Chapter 40C-41, F.A.C.)
- Descriptions of District-specific thresholds and exemptions referenced in chapter 62-330, F.A.C.

This Volume should be used in conjunction with Volume I, which provides general background information on the ERP program including points of contact, a summary of the statutes and rules used to authorize and implement the ERP program, and forms used to notice or apply to the District for an ERP authorization, except those forms related to agricultural systems which are incorporated by reference in rules 40C-44.061 and 40C-44.101, F.A.C. Volume I also provides discussion of:

- Activities that are regulated by the ERP program
- Types of permits, permit thresholds, and exemptions
- Procedures used in the review of ERPs

- Conditions for issuance of an ERP, including a detailed discussion of the environmental criteria that are used for activities located in wetlands and other surface waters
- Erosion and sediment control practices to prevent water quality violations
- Operation and maintenance requirements and copies of maps used in implementing the provisions of the ERP program

The term "District" or "SJRWMD" where used in this Volume shall apply to the Department of Environmental Protection, the St. Johns River Water Management District or a delegated local government as applicable in accordance with the division of responsibility specified by the operating agreement incorporated by reference in subsection 62-330.010(3), F.A.C., except where a specific agency is otherwise identified. In cases where conflicting or ambiguous interpretations of the information in this Volume result in uncertainty, the final determination of appropriate procedures to be followed will be made by reference to chapters 120 and 373, and chapters 40C-1, 40C-4, 40C-41, 40C-44 and 62-330, F.A.C.

References to a section or subsection shall include all parts of the section or subsection unless otherwise specified.

1.1 Organization *Revised 6/1/18*

This Volume is divided into eight parts:

Part I – Introduction, Organization, Definitions and Applicability
Part II – General Criteria
Part III – Stormwater Quantity/Flood Control
Part IV – Stormwater Quality
Part V – Best Management Practices
Part VI – Basin Criteria
Part VII - Agricultural Surface Water Management Systems
Part VIII – Appendices

1.2 District-Specific Thresholds

1.2.1 Background

Rule 62-330.020 sets forth the thresholds for when an environmental resource permit must be obtained under part IV of chapter 373. Subsection (2) of this Rule requires a person to obtain an environmental resource permit before constructing, altering, operating, maintaining, removing, or abandoning any new project that, by itself or in combination with an activity conducted after October 1, 2013, cumulatively results in "[a]ny project exceeding the thresholds in section 1.2 (District-specific thresholds) of the applicable Volume II" unless the

proposed project is governed by subsection 62-330.020(1), F.A.C. [62-330.020(2)(i), F.A.C.]

Subsections 1.2.2 and 1.2.3 of this Volume set forth the District-specific thresholds for activities within the St. Johns River Water Management District.

The District encourages applicants to consult section 2.0 of Volume I which contains definitions of important terms such as "project" and "activity".

1.2.2 Activities in the Wekiva Riparian Habitat Protection Zone

A permit under chapter 62-330 is required for any activity that is located wholly or partially within the Wekiva River Hydrologic Basin's Riparian Habitat Protection Zone (RHPZ) described in paragraph 40C-41.063(3)(e), F.A.C. When an activity requires a permit pursuant to this subsection, the review for determining compliance with all relevant permitting requirements will be conducted in accordance with rule 62-330.054.

1.2.3 Agricultural Surface Water Management Systems *Revised 6/1/18*

A permit under chapter 62-330, F.A.C., is required for the alteration, maintenance and operation of certain existing agricultural surface water management systems and for the construction, maintenance and operation of certain new agricultural surface water management systems, in accordance with chapter 40C-44, F.A.C. (Environmental Resource Permits: Regulation of Agricultural Surface Water Management Systems). These systems are described in rule 40C-44.041, but are also described in this subsection and in Part VII of this Volume.

Agricultural operations that are required to obtain a permit shall satisfy the requirements of the District in terms of the quality of water discharged from the system, by implementing the performance standards and water quality practices described in Part VII of this Volume.

A permit for an agricultural system is required under this subsection and chapter 40C-44, F.A.C., if the activity exceeds any of the following thresholds:

(a) The activity incorporates pumped discharges from an existing agricultural surface water management system, when:

(1) the pumps are stationary or portable facilities, and

(2) the pump(s) have a capacity, either individually or cumulatively, of 10,000 GPM or greater. [40C-44.041(1)(a), F.A.C.]

(b) The activity causes or contributes to a violation of state water quality standards in waters of the state, when:

(1) the discharge is pumped or gravity drained, and

(2) the District has considered the following information on a case-by-case basis:

a. water quality monitoring data collected by the District or other agency,

b. the size of the agricultural operation and the amount of stormwater and associated wastewater reaching waters of the state, relative to the size and nature of the immediate drainage basin,

c. the means of conveyance of stormwater and associated wastewater to waters of the state,

d. characteristics of the site including the slope, vegetation, rainfall and other factors related to the likelihood or frequency of discharge of stormwater and associated wastewater to waters of the state,

e. the status, results and recommendations of available basin-specific studies, including those conducted as part of a Surface Water Improvement and Management Plan or pursuant to chapter 62-40, F.A.C., and

f. the existence of mixing zones, variances or site specific alternative criteria granted by DEP pursuant to chapters 62-4 and 62-302, F.A.C. [40C-44.041(1)(b), F.A.C.]

(c) An applicant proposes construction, maintenance and operation of new agricultural surface water management systems, or alteration of existing systems, which:

(1) drain an agricultural area greater than 2 acres;

(2) are below thresholds described in paragraphs 62-330.020(2)(a) and (e), F.A.C.;

(3) serve a project with a total land area less than 40 acres; and

(4) do not provide for the placement of 12 or more acres of impervious surface which constitutes 40 or more percent of the total land area. [40C-44.041(2), F.A.C.]

When construction or alteration of an agricultural surface water management system that requires a permit pursuant to this subsection also requires a permit because it exceeds one or more thresholds listed in paragraphs 62-330.020(2)(a),(b), (c), (e),(f),(g),(h), or (j), F.A.C., or in subsection 1.2.2 of this Volume, the review for determining compliance with all relevant permitting requirements will be conducted in accordance with rule 62-330.054.

When construction or alteration of an agricultural surface water management system requires a permit solely pursuant to this subsection or paragraph 62-330.020(2)(d), F.A.C., the permit application for such activity shall be filed, and shall be reviewed and acted upon, in accordance with chapter 40C-44, F.A.C., and Part VII of this Volume. The District encourages applicants to contact the District's Agricultural Assistance Team to assist them in completing such permit applications.

1.3 District-Specific Exemptions

1.3.1 Background

Rule 62-330.051(1) exempts from permitting under chapter 62-330, F.A.C., activities that are conducted in conformance with the District-specific exemptions in Section 1.3 of Volume II applicable to the location of the activity. However, if an activity is not exempt and requires an individual ERP under chapter 62-330, F.A.C., rule 62-330.054 requires the application for the individual ERP to be prepared, submitted, reviewed and acted upon in accordance with subparagraphs 62-330.054(2)(a), (b) and (c), F.A.C., *except as otherwise provided by the ERP rules*.

Consistent with these rules, the District has established one District-specific exemption from permitting and one District-specific exemption from certain provisions of chapter 62-330, F.A.C. More specifically, subsection 1.3.2 of this Volume sets forth a District-specific exemption from permitting within the St. Johns River Water Management District while subsection 1.3.3 exempts certain agricultural systems from certain requirements in chapter 62-330, F.A.C.

1.3.2 Existing Systems

The District's rules in chapters 40C-4, 40C-40, and 40C-41, F.A.C. became effective on December 7, 1983. Before December 7, 1983, rules authorized under part IV, chapter 373, F.S. were implemented in the Upper St. Johns River and the Ocklawaha River basins as shown in Figure 1.3-1. The rules adopted on December 7, 1983 superseded all previous rules. The date of implementation is important in determining whether a

permit is required and the effective dates for the District's permitting programs are described in rule 40C-4.031. Certain systems are not required to be permitted until they are to be altered, removed, or abandoned. These systems are identified in the paragraph below.

Specifically exempted from permitting under chapter 62-330 for the purpose of construction, operation, and maintenance are:

(a) Each system or phase of a phased system which is located in the areas described in the Upper St. Johns River Basin or the Ocklawaha River Basin as depicted in Figure 1.3-1, except agricultural operations, which:

(1) Was constructed and operating under the provisions of a valid District permit on December 7, 1983; or

(2) Was not required to obtain a permit prior to December 7, 1983, and was:

a. Constructed and operating prior to December 7, 1983; or

b. Being constructed on December 7, 1983, and was completed and operating by June 7, 1984; or

c. Under construction on December 7, 1983, and which had complied with the regulations of the Florida Department of Environmental Regulation and the appropriate local governmental agency.

(3) Was constructed and operating as of March 2, 1974 for the Upper St. Johns River Basin as described in Figure 1.3-1; or

(4) Was constructed and operating as of January 1, 1975 for the portion of the Oklawaha River Basin as described in Figure 1.3-1.

(b) Each system or phase of a phased system which is located in the Lower St. Johns River Basin as described in Figure 1.3-1 and section 373.069(2)(c), F.S. (Supp. 1976), except agricultural operations, and which was:

(1) Constructed and operating prior to December 7, 1983; or

(2) Being constructed on December 7, 1983, and was

completed and operating on June 7, 1984; or

(3) Under construction on December 7, 1983, and which had complied with the regulations of the Florida Department of Environmental Regulation and the appropriate local governmental agency and was completed December 7, 1984.

(c) The exemptions listed in paragraphs (a) and (b) above apply only to those systems or phases of a phased system as such systems are set forth in its plans, specifications and performance criteria prepared and existing as of December 7, 1983 and to the extent:

(1) Construction of such system is completed, within the applicable time frames, in accordance with such plans, specifications and performance criteria; and

(2) Such system is maintained and operated in a manner consistent with such plans, specifications and performance criteria.

(d) The exemptions listed in paragraphs (a), (b) and (c) above shall not apply to those systems or phases of a phased system which on December 7, 1983 have been abandoned or removed or have ceased to operate as set forth in such system's plans, specifications and performance criteria.

(e) Those systems or phases of a phased system exempted by paragraphs (a), (b) and (c) above shall not be required to obtain a permit for construction, operation or maintenance.

(1) Any alteration of such system, or a portion thereof (including the rebuilding of such system if it has ceased to operate as set forth in such system's plans, specifications and performance criteria), shall require that a permit be obtained for such alteration, which permit shall include an authorization to alter as well as an authorization to operate and maintain such alteration. For purposes of this subsection, the following are not considered to be alterations, and consequently are not required to be permitted:

a. The relocation of pumps, provided that the pump is not moved out of the immediate vicinity of its existing location, not to another drainage basin or subbasin, and operation of the pump at the new location will not result in increased adverse impacts

to the water resource.

b. The installation of driveway and road inlets and pipes with a diameter of less than 60 inches or equivalent size within an existing surface water management system, provided that the pipe or inlet will not increase the volume of water discharged, and causes no upstream or downstream flooding.

c. The change of the location of a drainage system's secondary or tertiary drainage ditches provided that the total linear length and cross-sectional dimensions of the ditches are not changed.

d. Roadways not located in wetlands may be widened provided that fill material is not obtained by excavating ditches next to the roadway, and provided that the roadway is otherwise constructed in accordance with accepted engineering practices. Roadways not located in wetlands may be increased in height provided that the elevation of the existing centerline road grade is above the 10-year flood elevation, and provided that no increase in upstream flooding is caused.

(2) Any abandonment or removal of such system or portion thereof, shall require that a permit be obtained for such abandonment or removal.

(3) The activities in subparagraphs (e)(1)a. through d. are also exempt from permitting when conducted by agricultural operations.

(f) The amendments to subsections 10.7.2, 10.7.4, 10.7.5., 16.1.3 and 16.1.5, Applicant's Handbook: Management and Storage of Surface Waters, effective September 25, 1991, shall not apply to each system for which the District has issued an individual or general permit pursuant to Chapter 40C-4 or 40C-40, F.A.C., prior to September 25, 1991. This subsection applies only to the project area and plan approved in the referenced permit; however, where the referenced permit authorizes construction of a master system for drainage and flood control, this subsection shall apply to the project area served by the master system and to the plan approved in the referenced permit.

(g) The amendments to subsections 10.7.2, 10.7.4, 10.7.5, 16.1.3 and

16.1.5, Applicant's Handbook: Management and Storage of Surface Waters, effective September 25, 1991 shall not apply to each system for which the District has issued, pursuant to Chapter 40C-4, F.A.C., and prior to September 25, 1991, both a conceptual approval permit and at least one permit authorizing construction consistent with the conceptual approval permit. This subsection applies only to the project area and plan approved in the referenced conceptual approval permit.

(h) The permitting threshold set forth in subparagraph 40C-4.041(2)(b)8., F.A.C., as it existed on September 25, 1991, incorporated by reference in 40C-4.091(1)(a), F.A.C., and contained in Appendix D of this Volume, regarding isolated wetlands and the amendments to subsections 10.7.2, 10.7.4, 10.7.5, 16.1.3 and 16.1.5, Applicant's Handbook: Management and Storage of Surface Waters, effective September 25, 1991 shall not apply to each system for which the District has issued a permit pursuant to Chapter 40C-42, F.A.C., prior to September 25, 1991. This subsection applies only to a system which did not require a permit pursuant to Chapter 40C-4 or 40C-40, F.A.C., prior to September 25, 1991 and only to the project area and the plan approved in the referenced permit.

(i) The amendments to section 10.3.2 of the Applicant's Handbook: Management and Storage of Surface Waters effective February 27, 1994, shall not apply to any general or individual permit application pursuant to Chapter 40C-4 or 40C-40, F.A.C., which is complete prior to February 27, 1994.

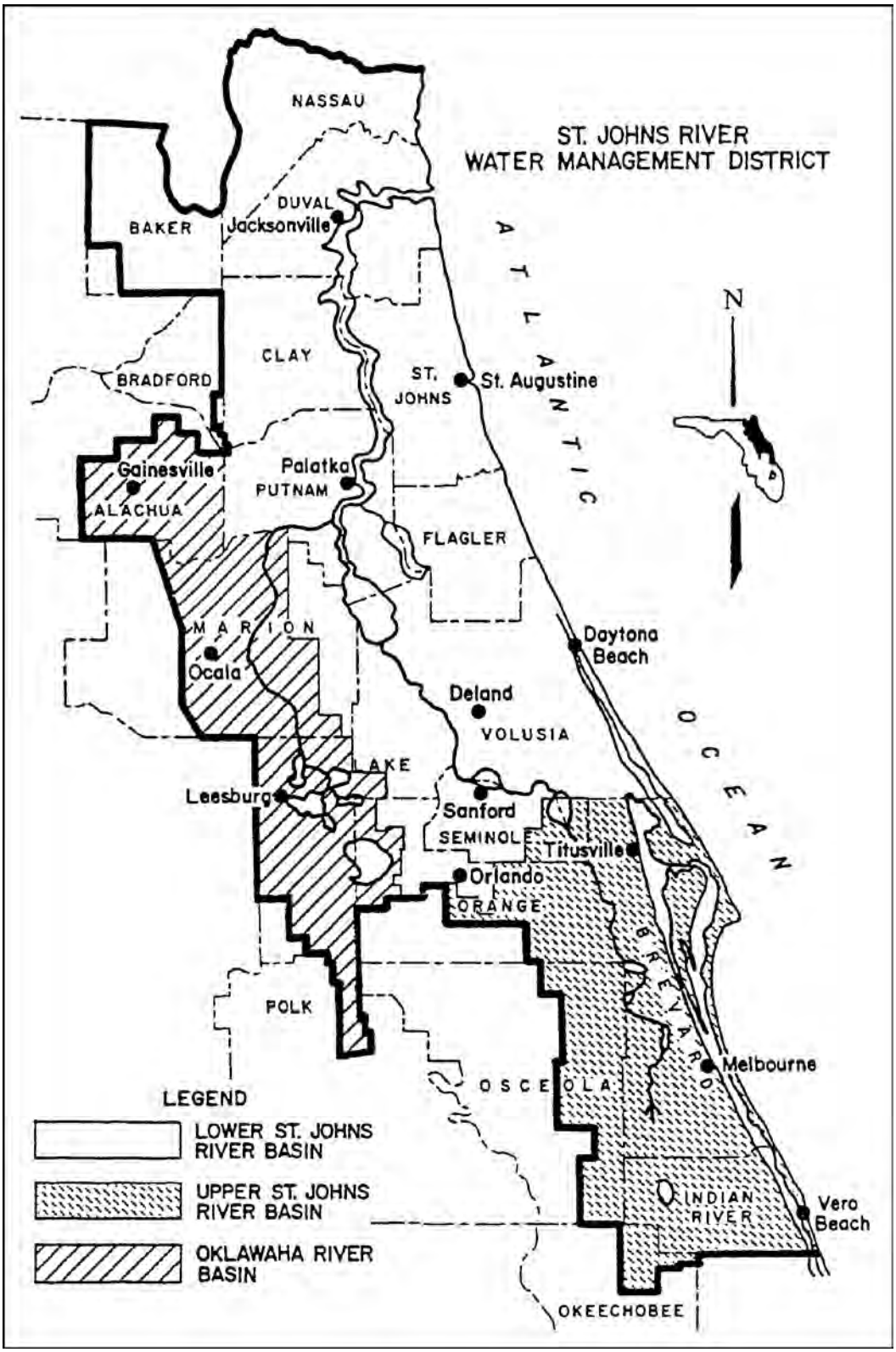


Figure 1.3-1 Areas within the District Having Differing Effective Dates for Implementation of Management and Storage of Surface Water Rules

1.3.3 Agricultural Surface Water Management Systems *Revised 6/1/18*

Each system that requires an individual permit solely pursuant to section 1.2.3 of this Volume or paragraph 62-330.020(2)(d), F.A.C., shall be exempt from the requirements in rules 62-330.060, 62-330.062, 62-330.090(1),(4) and (6), 62-330.301, 62-330.302, 62-330.310, 62-330.311, 62-330.315, 62-330.320, 62-330.340, and 62-330.350. Permit applications for such systems shall be filed, reviewed and acted upon in accordance with chapter 40C-44, F.A.C., and Part VII of this Volume. Once authorized, such systems shall be constructed, operated and maintained in accordance with 40C-44, F.A.C., and Part VII of this Volume.

PART II – GENERAL CRITERIA

2.0 Criteria for Evaluation – Reasonable Assurance *Revised 6/1/18*

Except as provided in section 1.2.3 of this Volume, an applicant for an individual permit must provide reasonable assurance that the proposed activities will meet the criteria in rules 62-330.301 and 62-330.302, F.A.C. More specifically, under 62-330.301, F.A.C., an applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a project within SJRWMD:

(a) Will not cause adverse water quantity impacts to receiving waters and adjacent lands (62-330.301(1)(a), F.A.C.);

(b) Will not cause adverse flooding to on-site or off-site property (62-330.301(1)(b), F.A.C.);

(c) Will not cause adverse impacts to existing surface water storage and conveyance capabilities (62-330.301(1)(c), F.A.C.);

(d) Will not adversely impact the value of functions provided to fish and wildlife and listed species by wetlands and other surface waters (62-330.301(1)(d), F.A.C.);

(e) Will not adversely affect the quality of receiving waters such that the water quality standards set forth in Chapters 62-4, 62-302, 62-520, and 62-550, F.A.C., (incorporated by reference in 40C-4.091(1)(c)) including the antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), F.A.C., subsections 62-4.242(2) and (3), F.A.C., and Rule 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in subsections 62-4.242(2) and (3), F.A.C., will be violated (62-330.301(1)(e), F.A.C.);

(f) Will not cause adverse secondary impacts to the water resources (62-330.301(1)(f), F.A.C.);

(g) Will not adversely impact the maintenance of surface or ground water levels or surface water flows established pursuant to section 373.042, F.S., (62-330.301(1)(g), F.A.C.);

(h) Will not cause adverse impacts to a Work of the District established pursuant to Section 373.086, F.S. (62-330.301(1)(h), F.A.C.);

(i) Will be capable, based on generally accepted engineering and scientific principles, of being performed and of functioning as proposed (62-330.301(1)(i), F.A.C.);

(j) Will be conducted by a person with the financial, legal and administrative capability of ensuring that the activity will be undertaken in accordance with the terms and conditions of the permit, if issued (62-330.301(1)(j), F.A.C.); and

(k) Will comply with the applicable special basin or geographic area criteria in Chapter 40C-41, F.A.C. (62-330.301(1)(k), F.A.C.);

The provisions in this Volume and in Volume I explain how applicants may provide the requisite reasonable assurance to demonstrate compliance with these criteria within SJRWMD. In certain instances, an applicant for an individual permit that involves an agricultural surface water management system will be governed solely by Chapter 40C-44, F.A.C. and Part VII of this Volume. (See subsection 62-330.054(2), F.A.C. and subsections 1.2.3 and 1.3.3 of this Volume) Therefore, the District recommends that applicants whose projects involve an agricultural surface water management system that only exceeds the thresholds set forth in section 1.2.3 of this Volume initially consult Part VII of this handbook.

2.1 Definitions *Revised 6/1/18*

The following definitions are used by the District to clarify its intent in implementing its permitting programs pursuant to part IV, chapter 373, F.S.

(a) “Compensating treatment” means treatment for water quality in an offsite location when physical conditions do not allow for treatment on-site equivalent to that otherwise required by Chapter 62-330, F.A.C., and this Volume.

(b) "Control Device" or "Bleed-down Device" means that element of a discharge structure which allows the gradual release of water under controlled conditions.

(c) "Control Elevation" means the lowest elevation at which water can be released through the control device or withdrawn by a stormwater harvesting system.

(d) "Detention with filtration" or "Filtration" means the selective removal of pollutants from stormwater by the collection and temporary storage of stormwater and the subsequent gradual release of the stormwater into surface waters in the state through at least 2 feet of suitable fine textured granular media such as porous soil, uniformly graded sand, or other natural or artificial fine aggregate, which may be used in conjunction with filter fabric and/or perforated pipe.

(e) "Detention" or "To Detain" means the collection and temporary storage of stormwater with subsequent gradual release of the stormwater.

(f) "Direct Discharge" means, for purposes of this Volume, either a point or nonpoint discharge which enters Class I, Class II, Outstanding Florida Waters (OFWs), or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting without an adequate opportunity for mixing and dilution to prevent significant degradation. Examples of direct discharge include the following:

(1) Discharge without entering any other water body or conveyance prior to release to the Class I, Class II, Outstanding Florida Water, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting.

(2) Discharge into an intermittent watercourse which is a tributary of a Class I, Class II, Outstanding Florida Water, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting.

(3) Discharge into a perennial watercourse which is a tributary of a Class I, Class II, Outstanding Florida Water, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting when there is not an adequate opportunity for mixing and dilution to prevent significant degradation.

(g) "Dry Detention" means a system designed to collect and temporarily store stormwater in a normally dry basin with subsequent gradual release of the stormwater.

(h) "Effective Grain Size" means the diameter of filter sand or other aggregate that corresponds to the 10 percentile finer by dry weight on the grain size distribution curve.

(i) “Floodway” means the permanent channel of a stream or other watercourse, plus any adjacent floodplain areas that must be kept free of any encroachment in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than a designated amount (not to exceed one foot except as otherwise established by the District or established

by a Flood Insurance Rate Study conducted by the Federal Emergency Management Agency (FEMA)).

(j) “Hydrologically Sensitive Area” means wetlands and those geographical areas which are specifically designated as hydrologically sensitive areas by the Board because of the importance of the hydrology and hydraulics of the area in meeting the Legislative policy contained in section 373.016, F.S.

(k) "Intermittent Watercourse" means a stream or waterway that flows only at certain times of the year, flows in a direct response to rainfall, and is normally an influent stream except when the ground water table rises above the normal wet season level.

(l) “Littoral Zone” means in reference to stormwater management systems that portion of a wet detention pond which is designed to contain rooted aquatic plants.

(m) "Off-line" means the storage of a specified portion of the stormwater in such a manner so that subsequent runoff in excess of the specified volume of stormwater does not flow into the area storing the initial stormwater.

(n) "Perennial Watercourse" means a stream or waterway which is not an intermittent watercourse.

(o) “Permanent Pool” means that portion of a wet detention pond which normally holds water (e.g., between the normal water level and the pond bottom).

(p) "Reconstruction" means rebuilding or construction in an area upon which construction has previously occurred.

(q) "Retention" means a system designed to prevent the discharge of a given volume of stormwater runoff into surface waters in the state by complete on-site storage. Examples may include excavated or natural depression storage areas, pervious pavement with subgrade, or above ground storage areas.

(r) "Seasonal high ground water table elevation" means the highest level of the saturated zone in the soil in a year with normal rainfall.

(s) "Stormwater Discharge Facility" means a stormwater management system which discharges stormwater into surface waters of the state.

(t) "Stormwater Harvesting" means to prevent the discharge of a given volume of stormwater into surface waters of the state by deliberate application of stormwater for irrigation (such as irrigation of golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries,

agricultural lands, and residential and commercial properties) or industrial uses (such as cooling water, process water, and wash water).

(u) "Swale" means a manmade trench which:

(1) Has a top width to depth ratio of the cross-section equal to or greater than 6:1, or side slopes equal to or greater than 3 feet horizontal to 1 foot vertical.

(2) Contains contiguous areas of standing or flowing water only following a rainfall event.

(3) Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.

(4) Is designed to take into account the soil erodibility, soil percolation, slope, slope length, and drainage area so as to prevent erosion and reduce pollutant concentration of any discharge.

(v) “Traversing Work” means any artificial structure or construction that is placed in or across a stream, or other watercourse, or an impoundment.

(w) "Underdrain" means a drainage system installed beneath a stormwater holding area to improve the infiltration and percolation characteristics of the natural soil when permeability is restricted due to periodic high water table conditions or the presence of layers of fine textured soil below the bottom of the holding area. These systems usually consist of a system of interconnected below-ground conduits such as perforated pipe, which simultaneously limit the water table elevation and intercept, collect, and convey stormwater which has percolated through the soil.

(x) "Underground Exfiltration Trench" or "Exfiltration Trench" means a below-ground system consisting of a conduit such as perforated pipe surrounded by natural or artificial aggregate which is utilized to percolate stormwater into the ground.

(y) "Uniformity Coefficient" means the number representing the degree of homogeneity in the distribution of particle sizes of filter sand or other granular material. The coefficient is calculated by determining the D60/D10 ratio where D10 and D60 refer to the particle diameter corresponding to the 10 and 60 percentile of the material which is finer by dry weight.

(z) “Wet Detention” means the collection and temporary storage of stormwater in a permanently wet impoundment in such a manner as to provide for

treatment through physical, chemical, and biological processes with subsequent gradual release of the stormwater.

(aa) "Wetlands Stormwater Management System" means a stormwater management system which incorporates those wetlands described in section 10.2 of this Volume, into the stormwater management system to provide stormwater treatment.

2.2 Existing Ambient Water Quality

In instances where an applicant is unable to meet water quality standards because existing ambient water quality does not meet standards and the system will contribute to this existing condition, mitigation for water quality impacts can consist of water quality enhancement. In these cases, the applicant must implement mitigation measures that will cause net improvement of the water quality in the receiving waters for those parameters which do not meet standards. (see paragraph 373.414(1)(b), F.S. and section 8.2.3 of Volume I)

2.3 Professional Certification

All construction plans and supporting calculations submitted to the District must be signed, sealed, and dated by the appropriate registered professional (e.g., engineer, geologist, or landscape architect) as required by the relevant statutory provisions (i.e., chapters 471, 472, 481, or 492, F.S.) when the design of the project requires the services of a registered professional.

2.4 Maintenance Access

Regular maintenance is crucial to the long term effectiveness of stormwater management systems. The systems must be designed to permit personnel and equipment access and to accommodate regular maintenance activities. For example, high maintenance features such as inlets, outlets, and pumps should be easily accessible to maintenance equipment and personnel.

Legal authorization, such as an easement, deed restrictions, or other instrument must be provided establishing a right-of-way or access for maintenance of the stormwater management system unless the operation and maintenance entity wholly owns or retains ownership of the property. The following are requirements for specific types of maintenance access easements:

(a) Easements must cover at least the primary and high maintenance components of the system (i.e., inlets, outlets, littoral zones, filters, pumps, etc.).

(b) Easements for waterbodies, open conveyance systems, stormwater basins and storage areas must meet the following requirements:

1. Include the area of the water surface measured at the control elevation

2. Be a minimum of 20 feet from the edge of water at the control elevation or top of bank and include side slopes no steeper than 4H:1V

(c) Easements adjacent to water control structures must be 20 feet wide.

(d) Easements for piped stormwater conveyance must be a minimum of the width of the pipe plus 4 times the depth of the pipe invert.

(e) Access easements must be 20 feet wide from a public road or public right-of-way to the stormwater management system.

(f) As an alternative, the applicant may propose other authorization for maintenance access provided the applicant affirmatively demonstrates that equipment can enter and perform the necessary maintenance on the system.

A copy of the legal authorization must be submitted with the permit application.

2.5 Legal Authorization

Applicants which propose to utilize offsite areas not under their control to satisfy the criteria for evaluation listed in section 2.0 must obtain sufficient legal authorization prior to permit issuance to use the area. For example, an applicant who proposes to locate the outfall pipe from the stormwater basin to the receiving water on an adjacent property owner's land must obtain a drainage easement or other appropriate legal authorization from the adjacent owner. A copy of the legal authorization must be submitted with the permit application.

2.6 Public Safety

2.6.1 Basin Side Slopes

Normally dry basins designed to impound more than two feet of water or permanently wet basins must contain side slopes that are no steeper than 4H:1V out to a depth of two feet below the control elevation. As an alternative, the basins can be fenced or otherwise restricted from public access if the slopes must be steeper due to space or other constraints.

2.6.2 Basin Side Slope Stabilization

All stormwater basin side slopes shall be stabilized by either vegetation or other material to minimize erosion of the basin.

Stabilization of side slopes is necessary in order to prevent erosion due to flow velocity and runoff from the banks. Good engineering practices, taking into consideration soil characteristics, flow and drainage characteristics, shall be employed. Again, the retardation of overland runoff and soil stabilization using naturally occurring vegetation coverage shall be considered before paving, riprap, lining, energy dissipation and other structural measures are employed.

2.6.3 Control Structures

Control structures that are designed to contain more than two feet of water within the structure under the design storm and have openings of greater than one foot minimum dimension must be restricted from public access.

2.7 Tailwater Considerations

"Tailwater" refers to the water elevation (or pressure) at the final discharge part of the stormwater management system. Tailwater is an important component of the design and operation of nearly all stormwater management systems and can affect any of the following management objectives of the system:

(a) Peak discharge from the stormwater management system

(b) Peak stage in the stormwater management system

(c) Level of flood protection in the project

(d) Recovery of peak attenuation and stormwater treatment volumes

(e) Control elevations, normal water elevation regulation schedules, and ground water management

2.7.1 Tailwater for Water Quality Design *Revised 6/1/18*

For recovery of the stormwater treatment volume, stormwater management systems (except retention and exfiltration systems) must provide a gravity or pumped discharge that effectively operates (i.e., meets applicable criteria) under one of the following tailwater conditions:

(a) Maximum stage in the receiving water resulting from the mean annual 24-hour storm. This storm depth is shown on the isopluvial map in Figure

2.7.1-1. Generally, applicants utilizing this option would model the receiving waters utilizing standard hydrologic and hydraulic methods for the mean annual 24-hour storm to determine peak stages at various points of interest. Lower stages may be utilized if the applicant demonstrates that flow from the project will reach the receiving water prior to the time of maximum stage in the receiving water.

(b) Mean annual high tide for tidal areas. This elevation is the average of all the high tides for each year. This elevation may be determined from tide charts or other similar information.

(c) Mean annual seasonal high water elevation. This elevation may be determined by water lines on vegetation or structures, historical data, adventitious roots or other hydrological or biological indicators, design of man-made systems, or estimated by a registered professional using standard hydrological methods based on the site and receiving water characteristics.

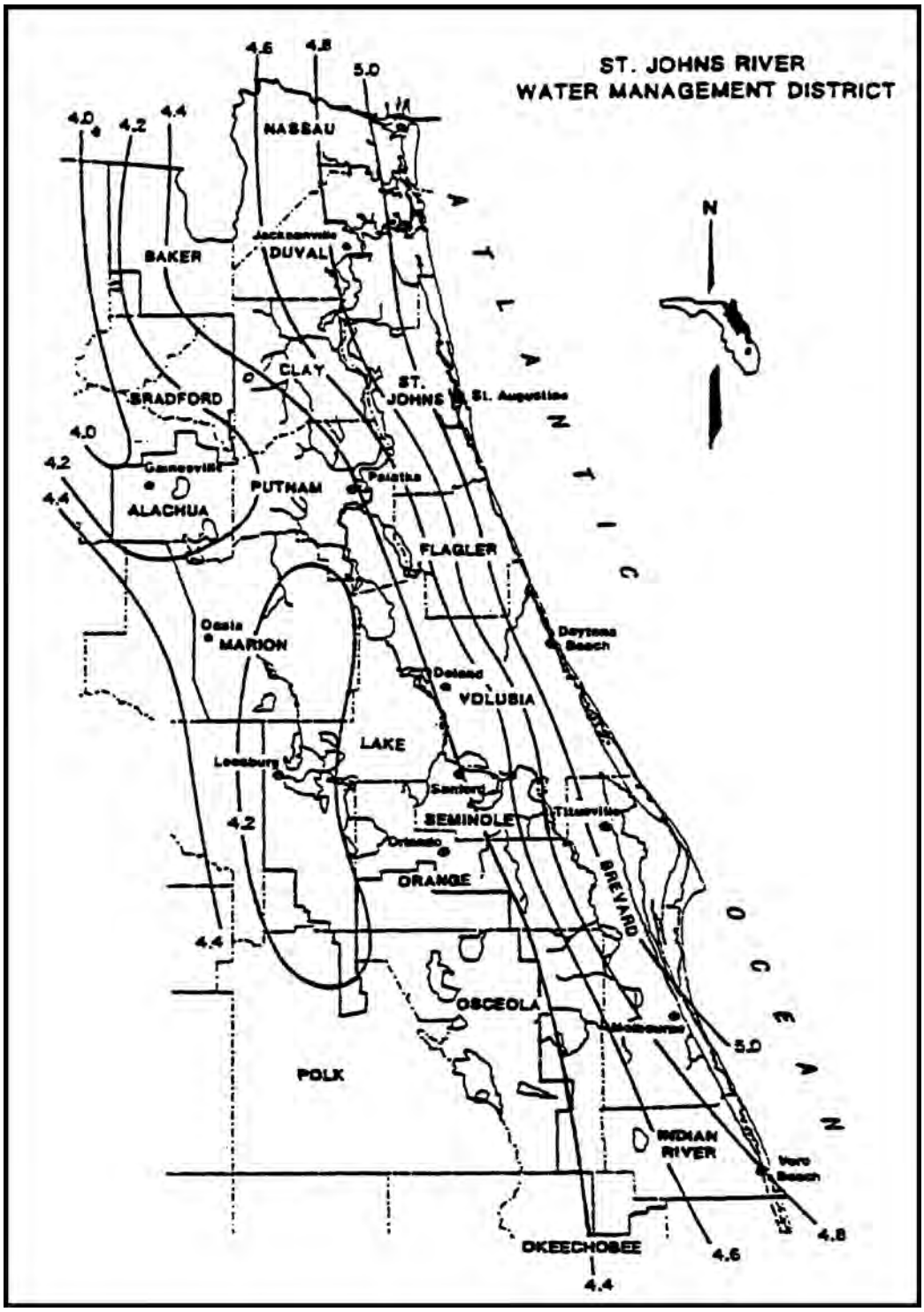


Figure 2.7.1-1 Mean Annual 24-Hour Maximum Rainfall, inches (Source: Rao, 1991)

2.7.2 Tailwater for Water Quantity Design

Receiving water stage can affect the amount of flow which will discharge from the project to the receiving water. This stage may be such that tailwater exists in portions of the project system, reducing the effective flow or storage area. Typical examples of this are illustrated in Figures 2.7.2-1 (gravity) and 2.7.2-2 (pumped).

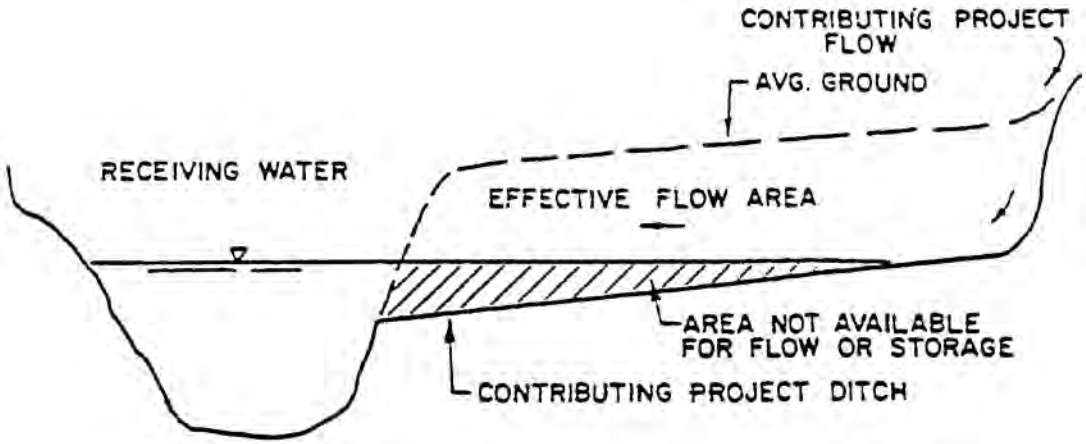


Figure 2.7.2-1

The stage in the receiving water should be considered to be the maximum stage which would exist in the receiving water from a storm equal to the project design storm. Lower stages may be used if the applicant can show that the flow from his project will reach the receiving water prior to the time of maximum stage in the receiving water.

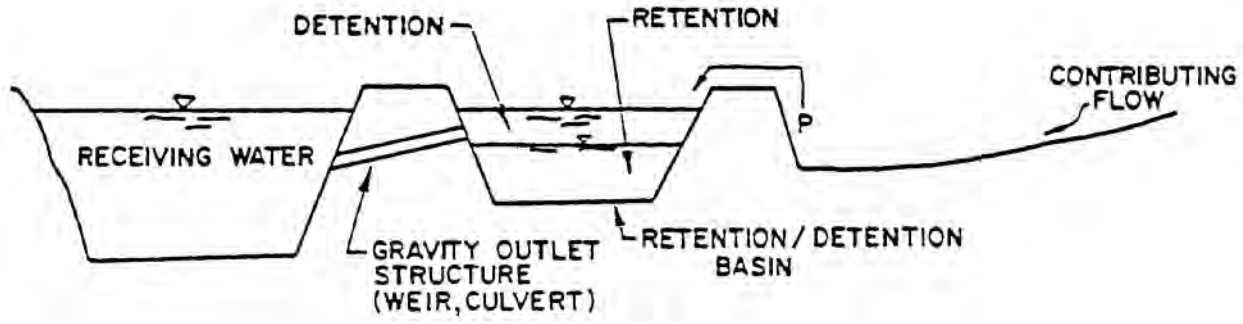


Figure 2.7.2-2

2.8 Applicant Responsibility

Except as provided in Part VII of this Volume, the applicant:

(a) must provide for an operation and maintenance entity as required in Part V of Applicant's Handbook Volume I.

(b) is responsible for converting the permit from the construction phase to the operation and maintenance phase, as required in Rule 62-330.310 and section 6.1.4 of Applicant's Handbook Volume I.

(c) is responsible for notifying the Agency of any transfer of permit, ownership, or sale, including applying to the Agency for transfer of ownership using Form 62-330.340(1) within 30 days of such transfer (Rule 62-330.340, F.A.C.)

2.9 Operation and Maintenance

Except as provided in Part VII of this Volume, all systems under this Volume must be transferred to an operation and maintenance entity as provided in Rule 62-330.340, F.A.C. and Part V of Applicant's Volume I.

2.10 Retrofits of Existing Surface Water Management Systems

(a) A stormwater retrofit project is typically proposed by a county, municipality, state agency, or water management district to provide new or additional treatment or attenuation capacity, or improved flood control to an existing stormwater management system or systems. Stormwater retrofit projects shall not be proposed or implemented for the purpose of providing the water quality treatment or flood control needed to serve new development or redevelopment.

Example components of stormwater retrofit projects are:

(1) Construction or alteration that will add additional treatment or attenuation capacity and capability to an existing stormwater management system;

(2) Modification, reconstruction, or relocation of an existing stormwater management system or stormwater discharge facility;

(3) Stabilization of eroding banks through measures such as adding attenuation capacity to reduce flow velocities, planting of sod or other vegetation, and installation of rip rap boulders;

(4) Excavation or dredging of sediments or other pollutants that have accumulated as a result of stormwater runoff and stormwater discharges.

(b) Stormwater Quality Retrofits

(1) The applicant for a stormwater quality retrofit project must provide reasonable assurance that the retrofit project itself will, at a minimum provide additional water quality treatment such that there is a net reduction of the stormwater pollutant loading into receiving waters. Examples are:

a. Addition of treatment capacity to an existing stormwater management system such that it reduces stormwater pollutant loadings to receiving waters;

b. Adding treatment or attenuation capability to an existing developed area when either the existing stormwater management system or the developed area has substandard stormwater treatment and attenuation capabilities, compared to what would be required for a new system requiring a permit under Part IV of Chapter 373, F.S.; or

c. Removing pollutants generated by, or resulting from, previous stormwater discharges.

(2) If the applicant has conducted, and the Agency has approved, an analysis that provides reasonable assurance that the proposed stormwater quality retrofit will provide the intended pollutant load reduction from the existing system or systems, the project will be presumed to comply with the requirements in **sections 4.0 through 4.5** of this Volume.

(3) The pollutants of concern will be determined on a case-by-case basis during the permit application review based upon factors such as the type and intensity of land use, existing water quality data within the area subject to the retrofit, and the degree of impairment or water quality violations in the receiving waters.

(c) Stormwater Quantity (Flood Control) Retrofits

The applicant for a stormwater quantity retrofit project must provide reasonable assurance that the retrofit project will reduce existing flooding problems in such a way that it does not cause any of the following:

(1) A net reduction in water quality treatment provided by the existing stormwater management system or systems;

(2) Increased discharges of untreated stormwater entering adjacent or receiving waters;

If the applicant has conducted, and the Agency has approved, an analysis that provides reasonable assurance that the stormwater quantity retrofit project will comply with the above, the project will be presumed to comply with the requirements in **sections 3.1 through 3.3** of this Volume.

(d) The applicant for any stormwater retrofit project must design, implement, and operate the project so that it:

(1) Will not cause or contribute to a water quality violation;

(2) Does not reduce stormwater treatment capacity or increase discharges of untreated stormwater. Where existing ambient water quality does not meet water quality standards the applicant must demonstrate that the proposed activities will not cause or contribute to a water quality violation. If the proposed activities will contribute to the existing violation, measures shall be proposed that will provide a net improvement of the water quality in the receiving waters for those parameters that do not meet standards.

(3) Does not cause any adverse water quality impacts in receiving waters; or

(4) Will not cause or contribute to increased flooding of adjacent lands or cause new adverse water quantity impacts to receiving waters.

2.11 Flexibility for State Transportation Projects and Facilities

With regard to state linear transportation projects and facilities, the District shall be governed by subsection 373.413(6), F.S. (2012).

PART III – STORMWATER QUANTITY/FLOOD CONTROL

3.0 General Flood Control Performance Criteria

Urbanization increases total runoff volume, peak discharge rates, and the magnitude and frequency of flood events. With an increase in the number of flood events a stream is subjected to, the potential for accelerated erosion of both the stream banks and channel bottom is enhanced. Proper design of detention systems to limit post-development peak discharge rates to predevelopment rates can minimize some of the stormwater effects of urbanization.

3.1 Projects That Must Meet Water Quantity Criteria

Projects that do not exceed the thresholds listed in paragraphs 3.1 (a)–(h) below shall have a rebuttable presumption that they meet the criteria for issuance in paragraphs 2.0 (a)–(c) if they are designed to meet the standards listed in subsections 3.2.1 (a) and 3.3.1. Projects that exceed any of the thresholds listed in paragraphs 3.1 (a)–(h) shall have a rebuttable presumption that they meet the criteria for issuance in paragraphs 2.0 (a)–(c) if they are designed to meet the standards in subsections 3.2.1, 3.3.1, 3.3.2, 3.4.1, 3.5.1 and 3.5.2.

(a) Is capable of impounding a volume of water of 40 or more acre-feet;

(b) Serves a project with a total land area equal to, or exceeding 40 acres;

(c) Provides for the placement of 12 or more acres of impervious surface which constitutes 40 or more percent of the total land area;

(d) Is wholly or partially located in, on, or over any wetland or other surface water.

(e) Serves a project with a total land area equal to or exceeding ten acres, when any part of the project is located within the Wekiva River Hydrologic Basin north of State Road 436, within the Econlockhatchee River Hydrologic Basin, within the Tomoka River Hydrologic Basin, or within the Spruce Creek Hydrologic Basin;

(f) Provides for the placement of one-half acre or more of impervious surface, when any of the impervious surface is located within the Wekiva River Hydrologic Basin north of State Road 436;

(g) Provides for the placement of two acres or more of impervious surface, when any of the impervious surface is located within the

Econlockhatchee River Hydrologic Basin, within the Tomoka River Hydrologic Basin, or within the Spruce Creek Hydrologic Basin; or

(h) Is wholly or partially located within the Wekiva River Hydrologic Basin's Riparian Habitat Protection Zone as described in Paragraph 40C-41.063(3)(e).

3.2 Design Standards for Flood Protection

3.2.1 Water Quantity *Revised 6/1/18*

(a) The post-development peak discharge rate must not exceed the pre-development peak rate of discharge for the mean annual 24-hour storm for systems serving both of the following:

(1) New construction area greater than 50% impervious (excluding waterbodies)

(2) Projects for the construction of new developments that exceed the thresholds in paragraphs 62-330.020(2)(b) or (c), F.A.C.

Note: Both of these conditions must be met before a project is required to comply with the peak discharge criterion. Also, projects which modify existing systems are exempt from this criterion pursuant to condition 2., above. Pervious concrete and turf blocks are not considered impervious surface for this purpose, however, compacted soils and limerock are considered impervious for purposes of this subsection.

(b) The post-development peak rate of discharge must not exceed the pre-development peak rate of discharge for the 25-year frequency, 24-hour duration storm for all areas of the District except:

(1) For those systems which discharge directly into the St. Johns River north of Lake George, the man-made portions of the Intracoastal Waterway, the Intracoastal Waterway north of the Matanzas Inlet, or the Atlantic Ocean.

(2) Where separate basin criteria have been adopted (see section 13.0 of this Volume). Projects located in areas for which separate basin criteria have been developed must meet the flood protection design standards specified by the basin criteria.

(c) The post-development volume of direct runoff must not exceed the pre-development volume of direct runoff for the 25-year

frequency, 96-hour duration storm for systems discharging to land-locked lakes which are adjacent to properties of more than one ownership. These systems shall not cause an increase in the total pre-development flood stage. This can be accomplished through retention with percolation or, if the soil conditions are not sufficient for percolation, then through detention for a duration sufficient to mitigate adverse impacts on flood stages.

(d) Systems which are within areas for which separate basin criteria have been adopted pursuant to Chapter 40C-41, F.A.C., must meet the applicable volume and rate requirements found in section 13.0 of this Volume.

3.2.2 Alternative Peak Discharge Criteria

The applicant has two options for providing reasonable assurances that the standards referenced in subsection 3.2.1 (a) and (b) are met. The applicant may make such demonstration through compliance with the criteria specified in subsection 3.2.1 (a) and (b) or applicants may propose to utilize the applicable storm event duration, or criteria specified by a local government, state agency (including FDOT), or stormwater utility with jurisdiction over the project or by use of alternative methods as may be appropriate for the specific system. However, the District must review and approve the use of the alternative criteria. Applicants proposing to use alternative criteria are encouraged to have a preapplication conference with District staff.

3.2.3 Methodologies

(a) A peak discharge analysis typically consists of generating pre-development and post-development runoff hydrographs, routing the post-development hydrograph through a detention basin, and sizing an overflow structure to control post-development discharges at or below predevelopment rates.

Peak discharge computations should consider the duration, frequency, and intensity of rainfall, the antecedent moisture conditions, upper soil zone and surface storage, time of concentration, tailwater conditions, changes in land use or land cover, and any other changes in topographic and hydrologic characteristics. Large systems should be divided into subbasins according to artificial or natural drainage divides to allow for more accurate hydrologic simulations.

The Natural Resources Conservation Service (NRCS) Curve Number Method is an example of an accepted methodology (see SJ No. 85-5: A Guide to SCS Runoff Procedures (1985) and incorporated by reference in 40C-4.091(1)(e)).

(b) The modified rational method (see Appendix C of this Volume, incorporated by reference in 40C-4.091(1)(a)) is a popular method for estimating peak runoff rates for small urban areas. The rational method gives peak discharge rates rather than a runoff hydrograph. The modified rational formula can be modified to generate a runoff hydrograph by utilizing the rainfall intensity for various increments of a design storm. Similar to the rational method, use of the modified rational hydrograph method should be limited to small drainage basins with short times of concentration. Therefore, the modified rational method shall only be used for systems meeting the following criteria:

(1) The drainage area is less than 40 acres.

(2) The predevelopment time of concentration for the system is less than 60 minutes.

(3) The post-development time of concentration for the system is less than 30 minutes.

The modified rational hydrograph method shall only be utilized for the mean annual return frequency, 24-hour duration storm.

3.2.4 Computer Programs Accepted by the District

Numerous computer programs have been written to solve the runoff hydrograph and detention basin routing calculations required in a peak discharge analysis. If the model is sound from a theoretical standpoint and the results compare favorably with those of a benchmark standard model (such as HEC-1), the program is accepted for use.

3.2.5 Aggregate Discharge

Depending on the location and design of large systems where multiple off-site discharges are designed to occur, the District may allow the total post-development peak discharge not to exceed the pre-development peak discharge for the combined discharges rather than for each individual discharge. Such a consideration shall be made only if the combined discharges meet all other requirements of chapter 62-330, F.A.C., and discharge to the same receiving water body.

3.2.6 Rainfall Intensity

In determining peak discharge rates, intensity of rainfall values shall be obtained through a statistical analysis of historical long term rainfall data or from sources or methods generally accepted as good engineering practice.

(a) Examples of acceptable sources include:

(1) USDA Soil Conservation Service, "Rainfall Frequency Atlas of Alabama, Florida, Georgia, and South Carolina for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" January 1978; Gainesville, Florida.

(2) U.S. Weather Bureau Technical Paper No. 49.

(3) U.S. Weather Bureau Technical Paper No. 40.

(4) U.S. Department of Interior, Bureau of Reclamation, "Design of Small Dams", 2nd Edition.

(b) For a drainage basin greater than 10 square miles, the areal rainfall can be calculated from point rainfall using a method that has been well documented. The converting factor as described in U.S. Weather Bureau Technical Paper No. 49 may be used.

3.2.7 System Recovery

Where basins are designed for reducing post-development peak rate discharge and volume, the outlet and regulation schedule should be designed to provide necessary design detention and retention storage within 14 days following any storm event.

3.2.8 Upper Soil Zone Storage and Surface Storage

In most instances, the upper soil zone storage and surface storage capacities will have an effect on the pre-development and post-development peak discharges and should be considered in these computations. Any generally accepted and well documented method may be used to develop the upper soil zone storage and surface storage values.

(a) The soil zone storage at the beginning of a storm should be estimated by using reasonable and appropriate parameters to reflect drainage practices, average wet season water table elevation, the antecedent moisture condition (AMC II) and any underlying soil characteristics which would limit or prevent percolation of storm water into the entire soil column. In no case should the soil storage used in the computation exceed the difference between the maximum soil water capacity and the field capacity (i.e.,

gravitational water) for the soil columns above any impervious layer or seasonal ground water table.

(b) Surface storage, including that available in wetlands and low lying areas, shall be considered as depression storage. Depression storage shall be analyzed for its effect on peak discharge and the time of concentration. Depression storage can also be considered in post-development storage routing which would require development of stage-storage relationships; if depression storage is considered, then both pre-development and post-development storage routing must be considered.

3.3 Storage and Conveyance

3.3.1 Conveyance *Revised 6/1/18*

Projects which alter existing conveyance systems (e.g., rerouting an existing ditch) must not adversely affect existing conveyance capabilities. It is presumed a system will meet this criterion if one of the following are met:

(a) The existing hydraulic capacity is maintained in the new system. This can be accomplished by maintaining existing headwater and tailwater conditions.

(b) The applicant demonstrates that changes in flood elevation and velocities will not adversely impact upstream or downstream off-site property. For example, this criterion may be satisfied by demonstrating that there is no increase in damages to existing off-site property (e.g., roads, buildings) resulting from changes in the existing flood elevations. Also, the applicant should demonstrate that proposed velocities are non-erosive or that erosion control measures (e.g., rip-rap, concrete lined channels, etc.) are sufficient to safely convey the flow.

(c) The criterion in paragraph 3.3.2(b) is met.

3.3.2 Floodways and Floodplain Storage

Floodways and floodplains, and levels of flood flows or velocities of adjacent streams, impoundments or other water courses must not be altered so as to adversely impact the off-site storage and conveyance capabilities of the water resource. It is presumed a system will meet this criterion if the following are met:

(a) A system may not cause a net reduction in flood storage within a 10- year floodplain except for structures elevated on pilings or traversing works.

Traversing works, works or other structures shall cause no more than a one-foot increase in the 100-year flood elevation immediately upstream and no more than one tenth of a foot increase in the 100-year flood elevation 500 feet upstream. A system will not cause a net reduction in flood storage within a 10-year floodplain if compensating storage is provided outside the 10-year floodplain.

(b) A system may not cause a reduction in the flood conveyance capabilities provided by a floodway except for structure elevated on pilings or traversing works. Such works, or other structures shall cause no more than a one-foot increase in the 100-year flood elevation immediately upstream and no more than one-tenth of a foot increase in the 100-year flood elevation 500 feet upstream.

(c) An applicant may only be permitted to contravene the requirements of (a) or (b) if the applicant gives reasonable assurance that were all other persons who could impact the surface water of any impoundment, stream, or other watercourse by floodplain encroachment to exceed (a) and (b) above to the same degree as the applicant proposes, the cumulative impacts would not contravene subparagraphs 62-330.301(1)(a)-(c), F.A.C.

3.3.3 Level of Service *Revised 6/1/18*

As part of providing reasonable assurance that the criteria in paragraphs 2.0(a)-(c) will be met, the applicant must demonstrate that the elevation of any proposed streets and roadways and the first floor of any proposed building will be set at or above the elevation associated with the peak stage of the applicable design storm pursuant to section 3.1 of this Volume.

3.3.4 Floodway and Floodplain Elevation Determination

(a) The floodway and floodplain criteria contained in subsection 3.3.2 are applicable only to locations downstream of the point on a stream or watercourse where the drainage area is five square miles.

(b) The District has detailed information regarding floodplain and floodway elevations for many of the streams and water courses in its jurisdiction. The applicant is encouraged to consult with the District prior to making calculations. Other sources of information include the most recently published data from flood insurance rate studies or relevant engineering reports. If data are not available from the District, the flood insurance rate studies, or published reports, the applicant will be responsible for making determination of floodplain elevations or floodway limits using the

procedure of "Normal Depth Analysis", extrapolation of existing data, or any other acceptable technique.

3.3.5 Flow Velocity

Good engineering practices shall be employed to minimize the flow velocity to avoid transport of soil particles and other suspended solids from one location and deposition in another location. Many different measures, structural or non-structural, may be used to reduce erosion from the bottom and side slopes of a conveyance system or around the control structures. However, velocity reduction measures and re-vegetation with naturally occurring species of the area should be considered before using other methods of bottom and side slope consolidation.

3.4 Dams and Impoundments

3.4.1 Dams greater than six feet in height or which have a storage capacity of greater than 15 acre-feet of water which could be released in the event of dam failure shall have a spillway system with a capacity to pass the flow resulting from the design storm indicated in Table 3.4.1-1, without overtopping the dam unless the applicant provides analyses to show that the design flood can be stored, passed through, or passed over the dam without failure occurring.

TABLE 3.4.1-1

Hazard Classification	Storage Capacity (acre-feet)	Height (feet)	Design Storm
A	> 15	> 6	25-yr.
B	< 1000	< 40	25-yr
		40-100	1/2 PMP
		> 100	PMP
	1000-50,000	$\leq$ 100	1/2 PMP
		> 100	PMP
	50,000	> 6	PMP
C	< 1000	< 40	1/2 PMP
		$\geq$ 40	PMP
	$\geq$ 1000	> 6	PMP

3.4.2 Dams greater than six feet in height or which have a storage capacity of greater than 15 acre-feet of water which could be released in the event of dam failure shall have a spillway system capable of removing from the reservoir at least 80% of the water detained in the reservoir above the principal spillway within ten days after passage of the design storm.

3.5 Low Flow and Base Flow Maintenance

Flows of adjacent streams, impoundments or other water courses must not be decreased so as to cause adverse impacts.

3.5.1 Low Flow

(a) Only systems with both of the following conditions meet the low flow performance criteria in (b) and (c).

(1) Systems which impound water for purposes in addition to temporary detention storage. Water impounded longer than a 14-day bleed down period is considered conservation storage for benefits other than detention storage (i.e., recreation, irrigation, etc.).

(2) Systems that impound a stream or other water course which, under pre-development conditions, discharged surface water off-site to receiving water during 5-year, 30-day drought frequency conditions.

(b) Any system meeting the conditions of (a) above shall be designed with an outlet structure to maintain a low flow discharge of available conservation storage. When the conservation storage is at the average dry season design stage, the low flow discharge should equal the average pre-development surface water discharge which occurred from the project site to receiving waters during the 5-year, 30-day drought.

(c) The system shall be operated to provide a low flow discharge whenever water is impounded. However, discharge may be discontinued, if desired, during the wet season (considered as June through October) unless a water shortage condition is declared by the District. The actual discharge will vary according to the water stage in the impoundment. When conservation storage is at the average dry season design stage, the discharge will be the average 5 year, 30-day low flow. When storage is below the average dry season design stage, the discharge may be less than the average 5-year, 30-day low flow.

3.5.2 **Base Flow** *Revised 6/1/18*

It is presumed that an adverse impact will result if the system causes the ground water table to be lowered:

(a) more than an average three feet lower over the project area than the average dry season low water table; or

(b) at any location, more than five feet lower than the average dry season low water table; or

(c) to a level that would decrease flows or levels below any minimum level or flow established pursuant to section 373.042, F.S.

PART IV – STORMWATER QUALITY

4.0 Criterion

Under 62-330.301, F.A.C., an applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a project will not adversely affect the quality of receiving waters such that the water quality standards set forth in Chapters 62-4, 62-302, 62-520, and 62-550, F.A.C., will be violated.

4.1 State Water Quality Standards

State water quality standards are established by DEP and are set forth in chapters 62-4, 62-302, 62-520 and 62-550, F.A.C. Surface and ground water discharges from stormwater management systems, works, and other projects may not cause or contribute to a violation of state water quality standards.

4.1.1 Surface Water Quality Standards

State water quality standards for surface waters are contained in chapters 62-4 and 62-302, F.A.C. The standards apply at the point of mixing of discharge from the system with waters of the state.

4.1.2 Ground Water Quality Standards

State water quality standards for ground water are set forth in chapter 62-520, F.A.C. In addition to the minimum criteria, Class G-I and G-II ground water must meet primary and secondary drinking water quality standards for public water systems established pursuant to the Florida Safe Drinking Water Act, which are listed in sections 62-550.310 and 62-550.320, F.A.C., (incorporated by reference in 40C-4.091(1)(c)).

Only the minimum criteria apply within a zone of discharge, as determined in section 62-520.400, F.A.C., (incorporated by reference in 40C-4.091(1)(c)). A zone of discharge is defined as a volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which an opportunity for the treatment, mixture or dispersion of wastes into receiving ground water is afforded. Generally, stormwater systems have a zone of discharge 100 feet from the system boundary or to the project's property boundary, whichever is less.

4.1.3 How Standards May be Met

A showing by the applicant that a project complies with the applicable criteria in Parts II, IV, V and subsection 13.3.1 and sections 13.6 through 13.7 of this Volume and in Part IV of Volume I shall create a rebuttable presumption that the applicant has provided reasonable assurance that the proposed project meets the requirements in subsection 2.0(e) and 62-330.301(1)(e), F.A.C.

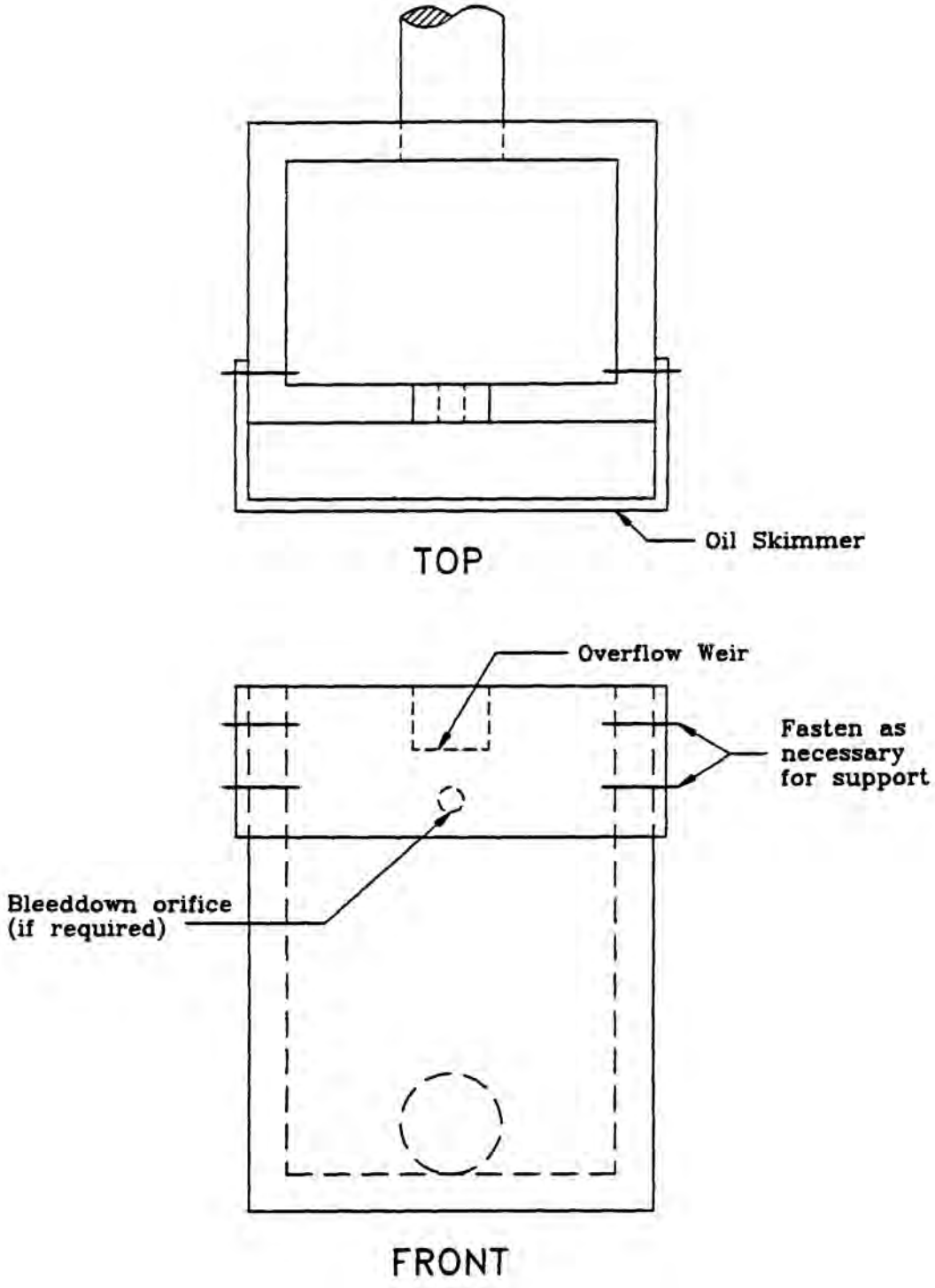
4.2 Erosion and Sediment Control Criteria for Stormwater Management Systems, Works and other Projects

Land clearing actions, including the construction of stormwater management systems or works, shall be designed, constructed, and maintained at all times so that erosion and sedimentation from the system, including the areas served by the system, do not cause or contribute to violations of applicable water quality standards in receiving waters. Further, because sedimentation of off-site lands can lead to public safety concerns, erosion and sediment controls shall be designed and implemented to retain sediment on-site. In particular, the erosion and sediment control requirements described in Part IV of Applicant's Handbook Volume I shall be followed during construction of the system.

4.3 Oil and Grease Control

Systems which receive stormwater from areas with a greater than 50 percent impervious area (excluding water bodies) or which are a potential source of oil and grease (e.g., gasoline station) must include a baffle, skimmer, grease trap or other mechanism suitable for preventing oil and grease from leaving the stormwater system in concentrations that would cause a violation of water quality standards. A typical illustration of a skimmer on an outlet structure is shown in Figure 4-1.

Figure 4-1. Oil skimmer detail for a typical outfall structure (N.T.S.)



4.4 On-Line and Off-line Stormwater Systems *Revised 6/1/18*

Pollutants in stormwater runoff from urbanized areas generally exhibit the "first flush" effect. This is the phenomenon where the concentrations of pollutants in stormwater runoff are highest during the early part of the storm with concentrations declining as the runoff continues. Substantial reductions in pollutant loads will occur when this first flush is captured and treated. Therefore, each Best Management Practice (BMP) specifies a required volume of stormwater runoff to be captured and treated (i.e., treatment volume) prior to release to surface or ground water.

There are two basic types of configurations for capturing the treatment volume: on-line and off-line systems. On-line systems (Figure 4-2) consist of a storage area which provides storage of the required treatment volume for smaller storm events and, if required, temporary detention storage for peak discharge control during larger storm events. Runoff volumes in excess of the treatment volume mix with the treatment volume in the basin and transport a portion of the pollutant mass load over the basin control structure.

Off-line treatment systems (Figure 4-3) divert the treatment volume into a basin which is designed for storage and treatment of the applicable treatment volume. Runoff volumes in excess of the treatment volume by-pass the off-line basin and are discharged to the receiving water or routed to a detention basin if peak discharge attenuation is required. A diversion box (Figure 4-4) may be utilized to divert the treatment volume to the off-line basin and route subsequent flows away from the off-line basin.

Off-line systems are generally more effective at removing pollutants than on-line systems because accumulated pollutants cannot be "flushed out" during storm events that produce runoff volumes exceeding the treatment storage volume. Consequently, on-line systems must treat a greater volume of runoff than off-line systems to reduce the likelihood of flushing accumulated pollutants out of the system and achieve the pollutant removal goals required by the Water Resource Implementation Rule (chapter 62-40, F.A.C.). Treatment volumes for each of the stormwater treatment practices described in this Volume are discussed in sections 5.0 through 12.9 of Part V of this Volume.

The treatment storage provided in an off-line system can be considered in the stage/storage calculations for peak discharge attenuation. Off-line systems should be designed to bypass essentially all additional stormwater runoff volumes greater than the treatment volume to a discharge point or other detention storage area. Of course, there will be some incremental additional storage in the off-line system associated with the hydraulic grade line at the weir structure in the typical diversion structure. This will depend on the size of the weir, but the weir should be sized to pass the design flow with minimal headwater.

Proposed off-line systems which will also serve to provide significant detention storage above the off-line treatment volume storage will be considered to function as on-line systems.

4.5 Hazardous or Toxic Substances

Systems serving a use that produces or stores hazardous or toxic substances shall be designed to have no stormwater discharge that contains such substances.

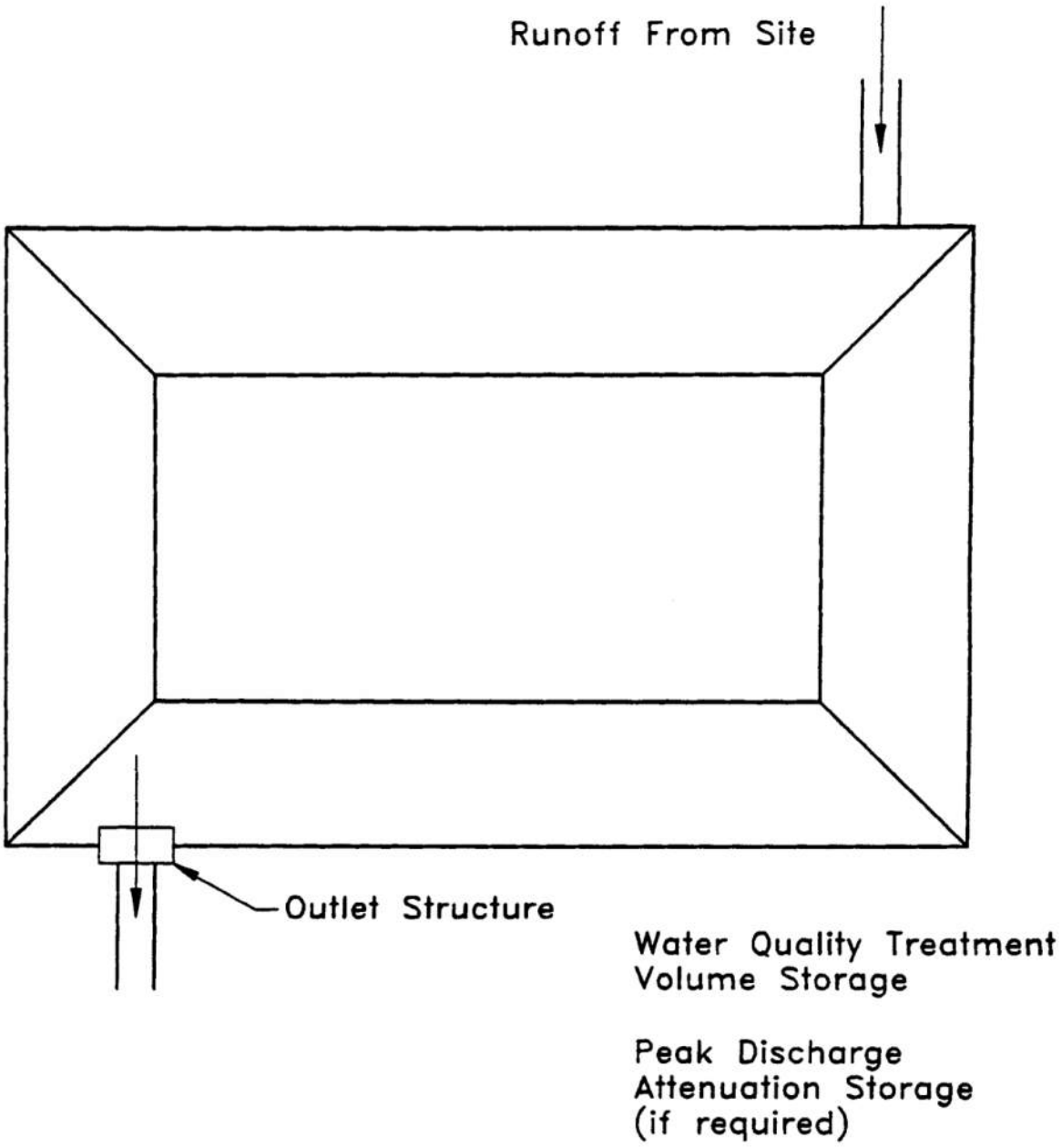


Figure 4-2. On-line treatment system

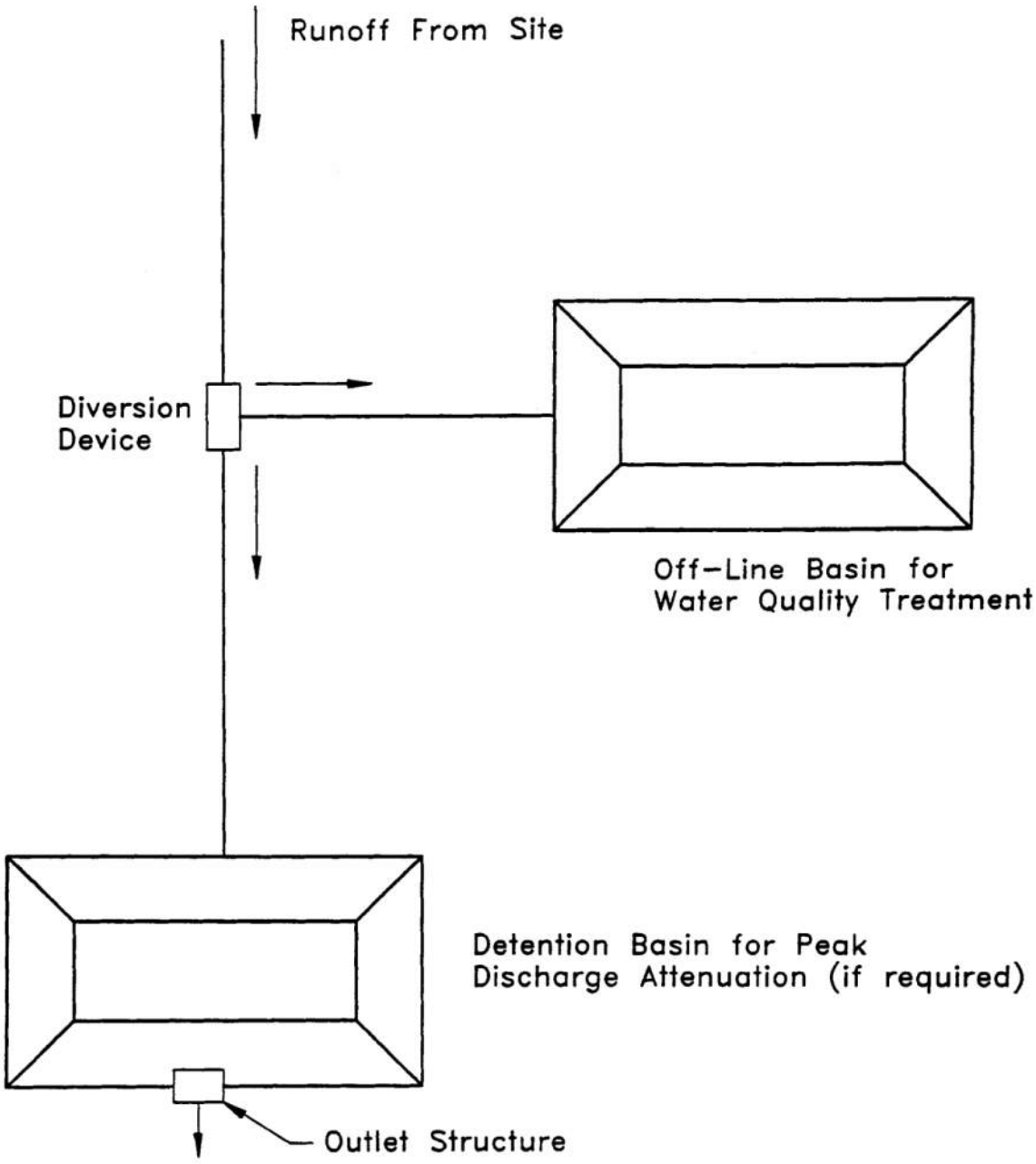


Figure 4-3. Off-line treatment system

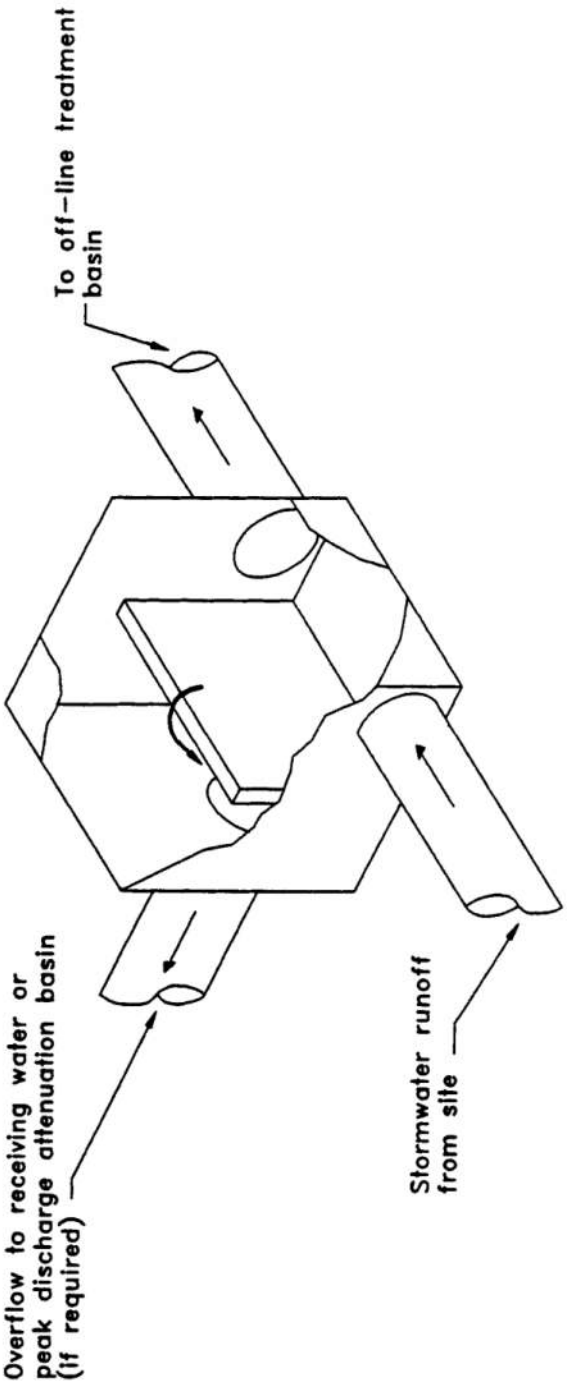


Figure 4-4. Diversion box (N.T.S.)

PART V – BEST MANAGEMENT PRACTICES

5.0 Retention System Design and Performance Criteria

5.1 Description *Revised 6/1/18*

Retention system is defined as a storage area designed to store a defined quantity of runoff, allowing it to percolate through permeable soils into the shallow ground water aquifer. Stormwater retention works best using a variety of retention systems throughout the project site. Examples of retention systems include:

- Man-made or natural depressional areas where the floor is graded as flat as possible and turf is established to promote infiltration and stabilize the basin slopes (see Figure 5-1)
- Shallow landscaped areas designed to store stormwater
- Vegetated swales with swale blocks or raised inlets
- Pervious concrete with continuous curb

Soil permeability and water table conditions must be such that the retention system can percolate the desired runoff volume within a specified time following a storm event. After drawdown has been completed, the basin does not hold any water, thus the system is normally "dry." Unlike detention basins, the treatment volume for retention systems is not discharged to surface waters.

Retention systems should not be located in close proximity to drinking water supply wells. Chapter 62-555, F.A.C., requires stormwater treatment facilities to be at least 100 feet from any public supply well. Chapter 62-532, F.A.C., identifies stormwater detention or retention basins as a “potentially moderate sanitary hazard” and includes additional setback requirements for certain wells from such basins. Chapter 40C-41, F.A.C., provides additional design features for systems constructed in Sensitive Karst Areas of the District where the drinking water aquifer is close to the land surface (see section 13.6).

Besides pollution control, retention systems can be utilized to promote the recharge of ground water to prevent saltwater intrusion in coastal areas or to maintain groundwater levels in aquifer recharge areas. Chapter 40C-41, F.A.C., contains recharge criteria for the Wekiva Recharge Protection Basin and the Tomoka River and Spruce Creek Hydrologic Basins (see sections 13.3.1 and 13.5.1).
Retention systems can also be used to meet the runoff volume criteria for projects which discharge to land-locked lakes (see section 3.2 of this Volume).

There are several design and performance criteria specific to retention systems which are described below.

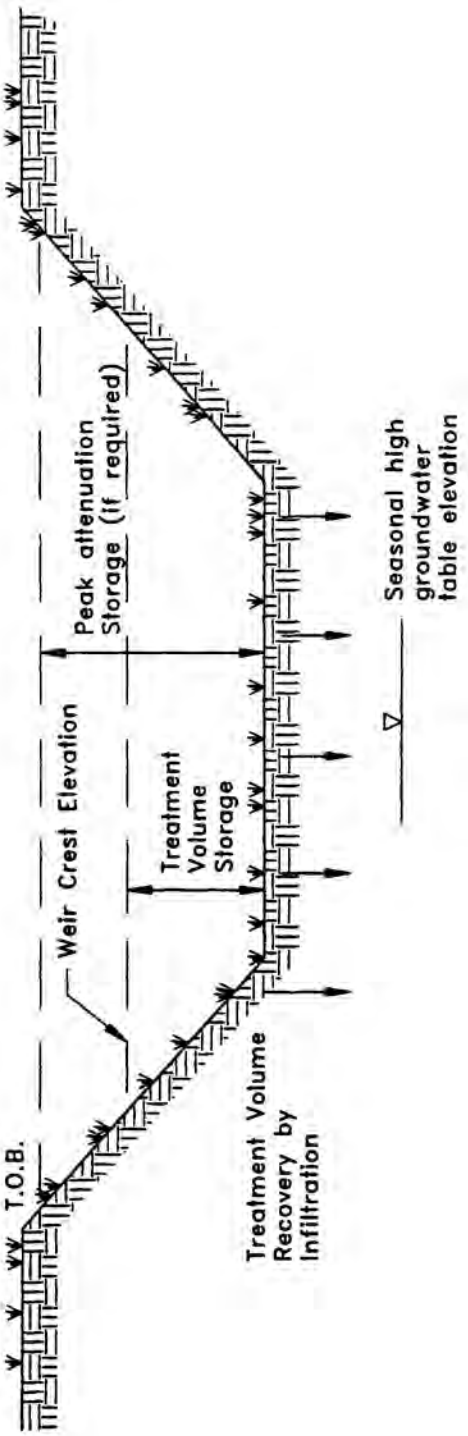


Figure 5-1. Retention (N.T.S.)

5.2 Treatment Volume

5.2.1

The first flush of runoff should be routed to the retention basin and percolated into the ground. Retention systems that discharge to Class III receiving water bodies shall provide for one of the following:

(a) *Off-line* retention of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater.

(b) *On-line* retention of an additional one half inch of runoff from the drainage area over that volume specified for off-line treatment.

(c) *On-line* retention that provides for percolation of the runoff from the three year, one-hour storm.

(d) *On-line* retention of the runoff from one inch of rainfall or 1.25 inches of runoff from the impervious area, whichever is greater, for systems which serve an area with less than 40 percent impervious surface and that contain only U.S. Department of Agriculture Natural Resources Conservation Service (SCS) hydrologic group "A" soils.

5.2.2

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting the applicant shall provide retention for one of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line retention in (a), above. *Off-line* retention must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

(b) *On-line* retention of an additional fifty percent of the treatment volume specified in (b), above.

(c) *On-line* retention of the runoff from the three-year, one-hour storm.

(d) *On-line* retention that provides at least an additional 50 percent of the runoff volume specified in (d), above, for systems which serve an area with less that 40 percent impervious surface and that contain only U.S. Department of

Agriculture Natural Resources Conservation Service (SCS) hydrologic group "A" soils.

5.3 Recovery Time

The retention system must provide the capacity for the appropriate treatment volume of stormwater specified in section 5.2 within 72 hours following a storm event assuming average antecedent moisture conditions. In retention systems, the stormwater is drawn down by natural soil infiltration and dissipation into the ground water table, evaporation, or evapotranspiration, as opposed to underdrain systems which rely on artificial methods like drainage pipes.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to saturated depending on the amount of rainfall received prior to a given point in time. Therefore, "average AMC" means the soil is neither dry or saturated, but at an average moisture condition at the beginning of a storm event when calculating recovery time for retention systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

5.4 Basin Stabilization

The retention basin should be stabilized with pervious material or permanent vegetative cover. To provide proper treatment of the runoff in very permeable soils, permanent vegetative cover must be utilized when U.S. Department of Agriculture Natural Resources Conservation Service (SCS) hydrologic group "A" soils underlie the retention basin, except for pervious pavement systems.

5.5 Retention Basin Construction

5.5.1 Overview

Retention basin construction procedures and the overall sequence of site construction are two key factors that can control the effectiveness of retention basins. Sub-standard construction methods or construction sequence can render the basin inoperable prior to completion of site development.

5.5.2 Construction Requirements

The following construction procedures are recommended to avoid degradation of retention basin infiltration capacity due to construction practices (Andreyev and Wiseman 1989):

(a) Initially construct the retention basin to rough grade by under-excavating the basin bottom and sides by approximately 12 inches.

(b) After the drainage area contributing to the basin has been fully stabilized, the interior side slopes and basin bottom should be excavated to final design specifications. The excess soil and undesirable material should be carefully excavated and removed from the pond so that all accumulated silts, clays, organics, and other fine sediment material has been removed from the pond area. The excavated material should be disposed of beyond the limits of the drainage area of the basin.

(c) Once the basin has been excavated to final grade, the entire basin bottom should be deep raked and loosened for optimal infiltration.

(d) Finally, the basin should be stabilized according to section 5.4, above.

5.6 References

Andreyev, N.E., and L.P. Wiseman. 1989. *Stormwater Retention Pond Infiltration Analysis in Unconfined Aquifers*. Prepared for Southwest Florida Water Management District, Brooksville, Florida.

6.0 Underdrain Design and Performance Criteria

6.1 Description

Stormwater underdrain systems consist of a dry basin underlain with perforated drainage pipe which collects and conveys stormwater following percolation from the basin through suitable soil. Underdrain systems are generally used where high water table conditions dictate that recovery of the stormwater treatment volume cannot be achieved by natural percolation (i.e, retention systems) and suitable outfall conditions exist to convey flows from the underdrain system to receiving waters. Schematics of a typical underdrain system are shown in Figures 6-1 and 6-2.

Underdrain systems are intended to control both the water table elevation over the entire area of the treatment basin and provide for the drawdown of the treatment volume. Underdrains are utilized where the soil permeability is adequate to recover the treatment volume since the on-site soils overlay the perforated drainage pipes.

There are several design and performance criteria which must be met in order for a underdrain system to meet the rule requirements. The underdrain rule criteria are described below.

6.2 Treatment Volume

The first flush of runoff should be detained in a dry detention basin and percolated through the soil. Dry detention systems that discharge to Class III receiving water bodies, shall provide for either of the following treatment volumes:

(a) *Off-line* retention of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, or

(b) *On-line* retention of an additional one half inch of runoff from the drainage area over that volume specified for off-line treatment.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting the applicant shall provide retention for either of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line retention in (a), above. *Off-line* retention must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

(b) *On-line* retention of the runoff from the three-year, one-hour storm or an additional fifty percent of the treatment volume specified in (b), above, whichever is greater.

6.3 Recovery Time

The system should be designed to provide for the drawdown of the appropriate treatment volume specified in section 6.2 within 72 hours following a storm event. The treatment volume is recovered by percolation through the soil with subsequent transport through the underdrain pipes. The system should only contain standing water within 72 hours of a storm event.

The pipe system configuration (e.g., pipe size, depth, pipe spacing, and pipe inflow capacity) of the underdrain system must be designed to achieve the recovery time requirement.

6.4 Safety Factor

The underdrain system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions. Examples of how to apply this factor include but are not limited to the following:

(a) Reducing the design percolation rate by half

(b) Designing for the required drawdown within 36 hours instead of 72 hours.

6.5 Underdrain Media

To provide proper treatment of the runoff, at least two feet of indigenous soil must be between the bottom of the basin storing the treatment volume and the outside of the underdrain pipes (or gravel envelope as applicable).

6.6 Filter Fabric

Underdrain systems shall utilize filter fabric or other means to prevent the soil from moving into and clogging perforated pipe.

6.7 Inspection and Cleanout Ports

To facilitate maintenance of the underdrain system, capped and sealed inspection and cleanout ports which extend to the surface of the ground should be provided, at a minimum, at the following locations for each drainage pipe:

(a) The terminus

(b) At every 400 feet or every bend of 45 or more degrees, whichever is shorter.

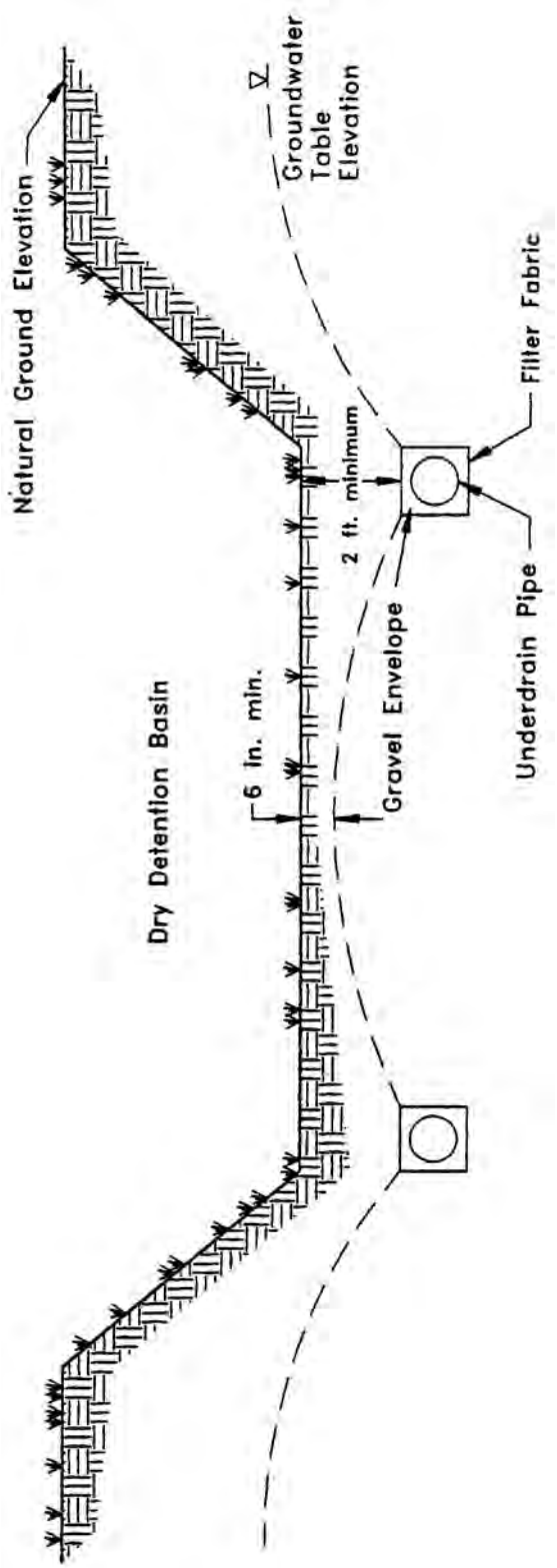


Figure 6-1. Cross-section of underdrain system (N.T.S.)

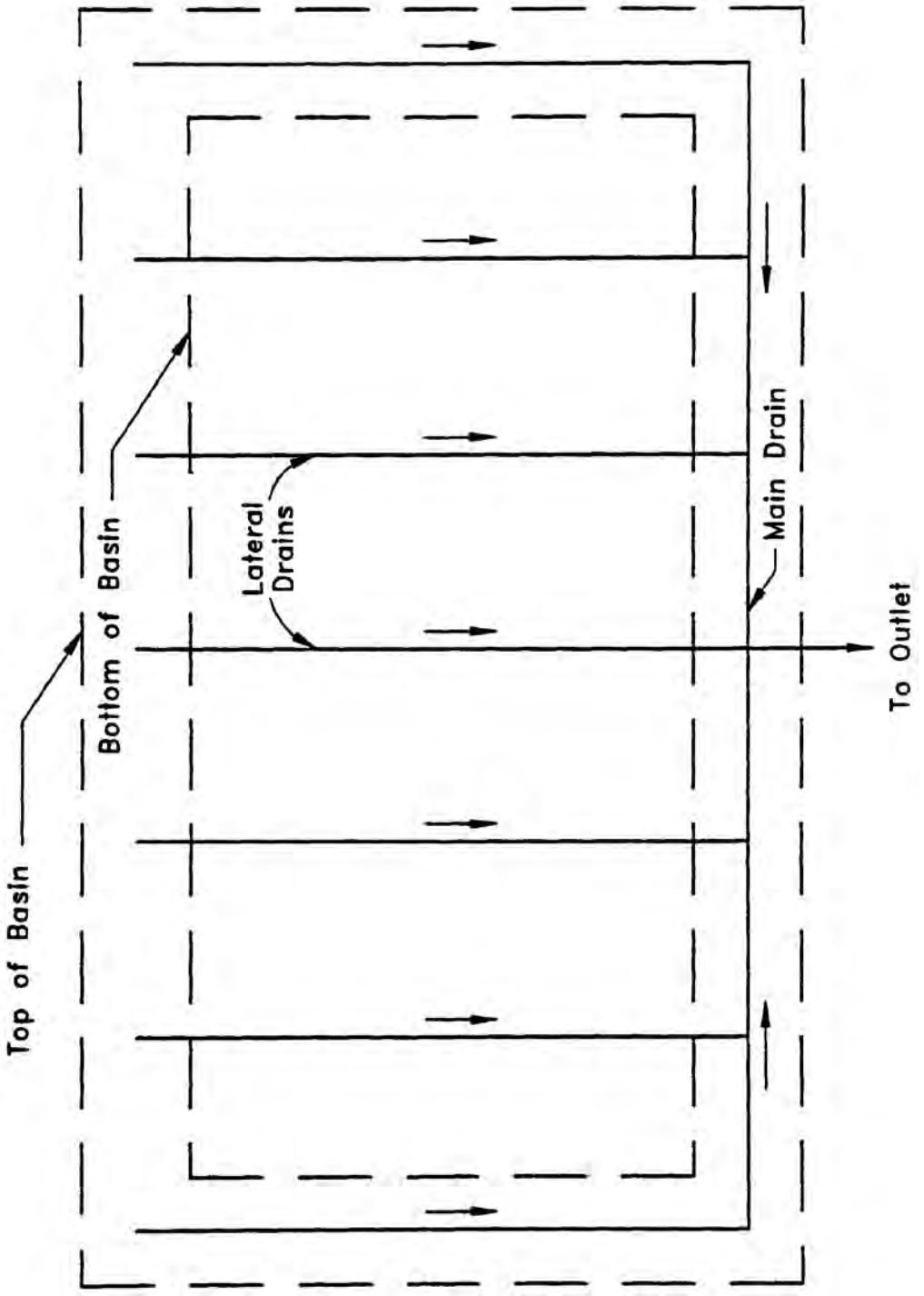


Figure 6-2. Top view of underdrain system (N.T.S.)

6.8 Basin Stabilization

The underdrain basin shall be stabilized with permanent vegetative cover and should contain standing water only immediately following a rainfall event.

6.9 References

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

7.0 Exfiltration Trench Design and Performance Criteria

7.1 Description *Revised 6/1/18*

Exfiltration trench is a subsurface system consisting of a conduit such as perforated pipe surrounded by natural or artificial aggregate which temporarily stores and infiltrates stormwater runoff (Figure 7-1). Stormwater passes through the perforated pipe and infiltrates through the trench walls and bottom into the shallow groundwater aquifer. The perforated pipe increases the storage available in the trench and helps promote infiltration by making delivery of the runoff more effective and evenly distributed over the length of the system (Livingston et al. 1988). Generally, exfiltration trench systems are utilized where space is limited and/or land costs are high (i.e., downtown urban areas).

Soil permeability and water table conditions must be such that the trench system can percolate the required stormwater runoff treatment volume within a specified time following a storm event. The trench system is returned to a normally "dry" condition when drawdown of the treatment volume is completed. Like retention basins, the treatment volume in exfiltration trench systems is not discharged to surface waters. Thus, exfiltration is considered a type of retention system.

Exfiltration trench systems should not be located in close proximity to drinking water supply wells. Chapter 62-555, F.A.C., requires stormwater treatment systems to be at least 100 feet from any public supply well. Chapter 62-532, F.A.C., identifies stormwater detention or retention basins as a “potentially moderate sanitary hazard” and includes additional setback requirements for certain wells from such basins. Chapter 40C-41, F.A.C., provides additional design features for systems constructed in Sensitive Karst Areas of the District where the drinking water aquifer is close to the land surface (see section 13.6).

Besides pollution control, exfiltration trench systems can be utilized to promote the recharge of ground water and to prevent saltwater intrusion in coastal areas, or to maintain groundwater levels in aquifer recharge areas. Chapter 40C-41, F.A.C., contains recharge criteria for the Wekiva Recharge Protection Basin and the Tomoka River and Spruce Creek Hydrologic Basins (see sections 13.3.1 and 13.5.1). Exfiltration trench systems can also be used to meet the runoff volume criteria for projects which discharge to land-locked lakes (see section 3.2.1 of this Volume).

The operational life of an exfiltration trench is believed to be short (possibly 5 to 10 years) for most exfiltration systems. Sediment accumulation and clogging by fines can reduce the life of an exfiltration trench (Wanielista et al. 1991). Total replacement of the trench may be the only possible means of restoring the treatment capacity and recovery of the system. Periodic replacement of the trench should be considered routine operational maintenance when selecting this management practice.

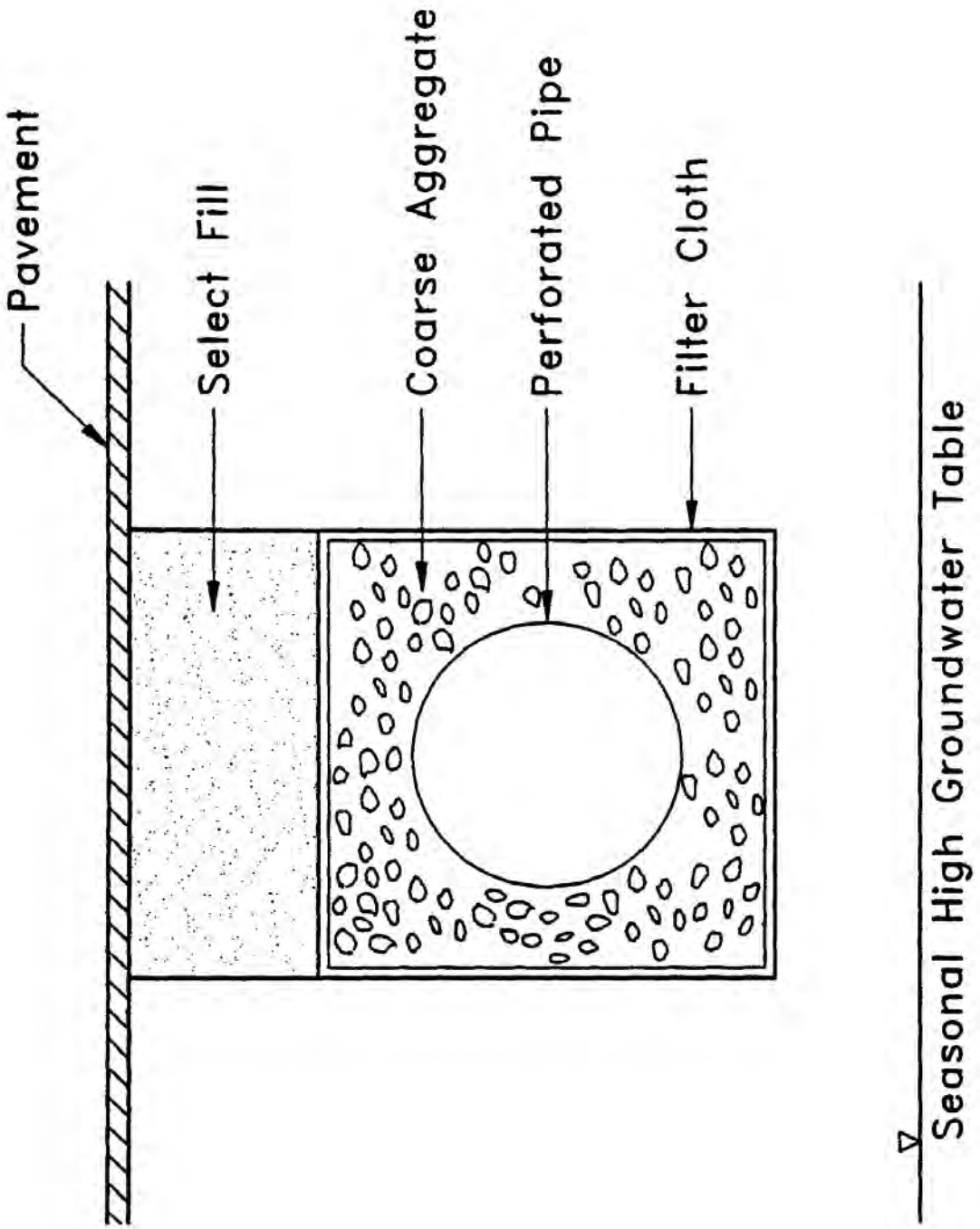


Figure 7-1. Cross-section of typical underground exfiltration trench (N.T.S.)

There are several design and performance criteria which must be met in order for an exfiltration trench system to meet the District's requirements. A description of each criterion is presented below.

7.2 Treatment Volume

The first flush of runoff should be collected in the exfiltration trench and infiltrated into the surrounding soil. For systems which discharge to Class III receiving water bodies, the exfiltration trench shall provide either of the following:

(a) *Off-line* storage of the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater.

(b) *On-line* storage of an additional one-half inch of runoff from the drainage area over that volume specified for off-line treatment.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting the applicant shall provide storage for either of the following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line storage in (a), above. *Off-line* storage must be provided for at least the first one-half inch of runoff or 1.25 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

(b) *On-line* storage of the runoff from the three-year, one-hour storm or an additional fifty percent of the treatment volume specified in (b), above, whichever is greater.

Exfiltration trench systems must be designed to have the capacity to retain the required treatment volume without considering discharges to ground or surface waters.

7.3 Recovery Time

The system must be designed to provide for the appropriate treatment volume of stormwater runoff specified in section 7.2 within 72 hours following a storm event assuming average antecedent moisture conditions. The stormwater is drawn down by infiltration into the soil.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to

saturated depending on the amount of rainfall received prior to a given point in time. Therefore, "average AMC" means the soil is neither dry or saturated, but at an average moisture condition at the beginning of a storm event when calculating recovery time for exfiltration systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

7.4 Safety Factor

The exfiltration trench system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions. For example, two possible ways to apply this factor are:

(a) Reducing the design percolation rate by half

(b) Designing for the required drawdown within 36 hours instead of 72 hours

7.5 Minimum Dimensions

The perforated pipe shall be designed with a 12-inch minimum pipe diameter and a three (3)-foot minimum trench width. The perforated pipe should be located within the trench section to minimize the accumulation of sediment in the aggregate void storage and maximize the preservation of this storage for stormwater treatment. To meet this goal, it is recommended that the perforated pipe be located at or within 6 inches of the trench bottom. The maximum trench width will be limited by the rate at which stormwater can effectively fill the void storage within the trench.

7.6 Filter Fabric

Exfiltration trench systems shall be designed so that aggregate in the trench is enclosed in filter fabric. This serves to prevent migration of fine materials from the surrounding soil that could result in clogging of the trench. Wanielista et al. (1991) reports that woven fabric (Mirafi 700XG) performed better in mixed sand and silty soil than non-woven fabric (Mirafi 140N). On the other hand, the 140N had higher exfiltration rates in sandy soils than the woven fabric.

Filter fabric may also be utilized directly surrounding the perforated pipe. In this instance, sedimentation of particulates will occur in the perforated pipe. Consequently, the pipe is more prone to clogging and reductions in capacity will occur more often than usual. Livingston et al. (1988) points out that while this may seem unacceptable, the pipe may be cleaned relatively easily using high pressure hoses, vacuum systems, etc. On the other hand, designs without the fabric directly surrounding the perforated pipe require complete replacement when clogging occurs.

7.7 Inspection and Cleanout Structures

Inspection and cleanout structures which extend to the surface of the ground must be provided, at a minimum, at the inlet and terminus of each exfiltration pipe. Inlet structures should include sediment sumps. These inspection and cleanout structures provide three primary functions:

(a) Observation of how quickly the trench recovers following a storm

(b) Observation of how quickly the trench fills with sediment

(c) Maintenance access to the perforated pipe

(d) Sediment control (sumps)

Standard precast concrete inlets and manholes are widely used to furnish the inspection and cleanout access.

7.8 Ground Water Table

The exfiltration trench system must be designed so that the invert elevation of the trench is at least two feet above the seasonal high ground water table elevation unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that an alternative design is appropriate for the specific site conditions.

7.9 Construction

During construction, measures should be implemented to limit the parent soil and debris from entering the trench. Wanielista (1991) reports complete failure (no exfiltration) when a 1" to 2" thickness of parent soil and stormwater solids were added to an exfiltration trench. Applicants and system designers should consult Part IV of Volume I for information on erosion and sediment control. Any method used to reduce the amount of fines entering the exfiltration trench during construction will extend the life of the system (Wanielista et al. 1991). The use of an aggregate with minimal fines is also recommended (Wanielista et al. 1991).

7.10 Alternative Designs

Wanielista et al. (1991) describes an alternative procedure for designing exfiltration trenches based on long term mass balance of an exfiltration system utilizing local rainfall conditions. Fifteen years of hourly precipitation data from six regions in Florida were used as input for the mass balance. From these simulations, design curves for exfiltration systems were developed. These curves relate the rate at which stored runoff is removed from the trench to the volume of storage within the trench. These curves can be used to design an exfiltration trench based on diversion efficiencies of 50%, 60%, 70%, 80%, 85%, 90%, and 95%. In lieu of the requirements of section 7.2, the District accepts this methodology for those areas of the District (i.e., Jacksonville and Orlando) for which the curves have been developed. Applicants designing systems which discharge to Class III receiving waters shall use the 80% curve and those that direct discharge to Class I, Class II, and Outstanding Florida Waters shall utilize the 95% curve.

7.11 References

Livingston, E.H., E. McCarron, J. Cox, and P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Wanielista, M.P., M.J. Gauthier, and D.L. Evans. 1991. *Design and Performance of Exfiltration Systems*. Department of Civil and Environmental Engineering, University of Central Florida, Orlando, Florida.

8.0 Wet Detention Design and Performance Criteria

8.1 Description

These systems are permanently wet ponds which are designed to slowly release collected stormwater runoff through an outlet structure. A schematic of a typical wet detention system is shown in Figure 8-1.

There are several components in a wet detention system which must be properly designed to achieve the required level of stormwater treatment. A description of each design feature and its importance to the treatment process is presented below. The design and performance criteria for wet detention systems are discussed below.

8.2 Treatment Volume

For wet detention systems, the design treatment volume is the greater of the following:

(a) one inch of runoff over the drainage area

(b) 2.5 inches times the impervious area (excluding water bodies)

Additional treatment volume is required for systems which discharge directly to Class I, Class II, Outstanding Florida Waters, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting (see section 8.13 of this Volume).

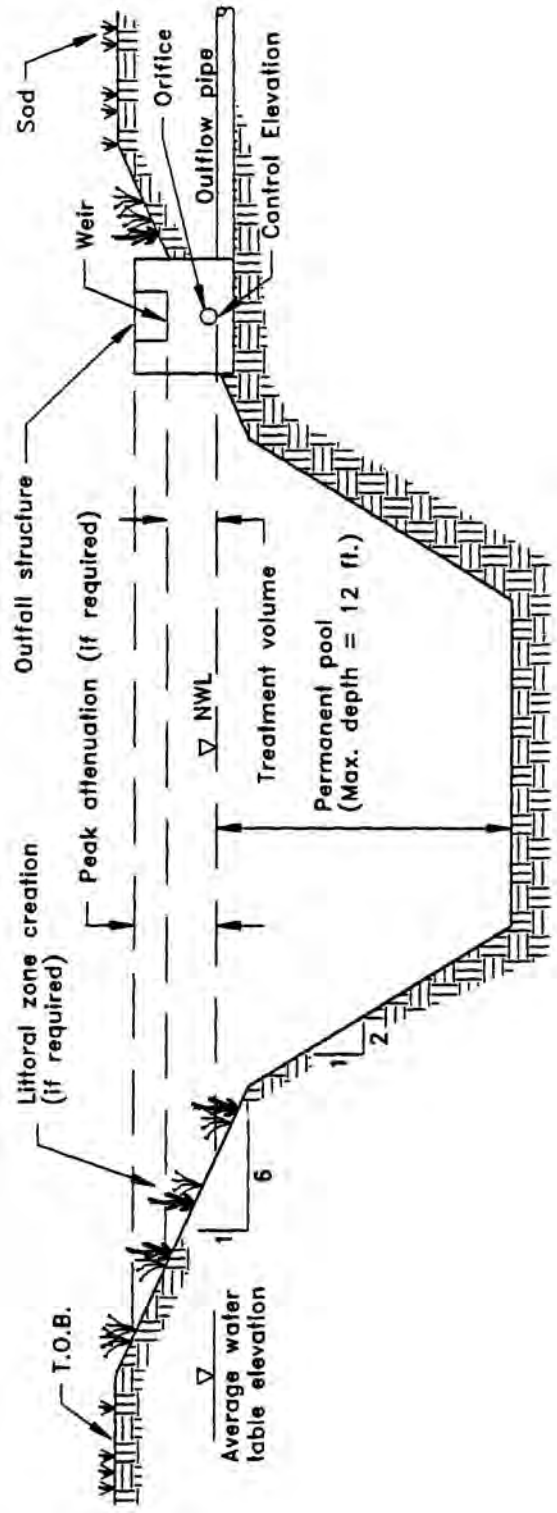


Figure 8-1. Wet detention (N.T.S.)

8.3 Recovery Time

The outfall structure shall be designed to drawdown one-half the required treatment volume within 24 and 30 hours following a storm event, but no more than one-half of this volume will be discharged within the first 24 hours.

8.4 Outlet Structure *Revised 6/1/18*

The outlet structure generally includes a drawdown device (such as an orifice, "V" or square notch weir) set to establish a normal water control elevation and slowly release the treatment volume (see Figures 8-2 and 8-3 for schematics). The design of the outfall structure must also accommodate the passage of ground water baseflows and flows from upstream stormwater management systems (see Figure 8-4).

The control elevation shall be set at or above the design tailwater elevation so the pond can effectively recover the treatment storage. Drawdown devices shall have a cross-sectional area of at least six (6) square inches and be at least two (2) inches wide. If the device is a “V” notch, the notch shall be at least twenty (20) degrees. Drawdown devices less than 6 inches wide or less than 45 degrees for "V" notches shall include a device to minimize clogging. Examples of such devices include baffles, grates, screens, and pipe elbows.

8.5 Permanent Pool

The permanent pool shall be sized to provide at least a 14-day average residence time during the wet season (June - October).

Additional permanent pool volume may be required for wet detention systems which directly discharge to Class I, Class II, or Outstanding Florida Waters (see section 8.13 of this Volume).

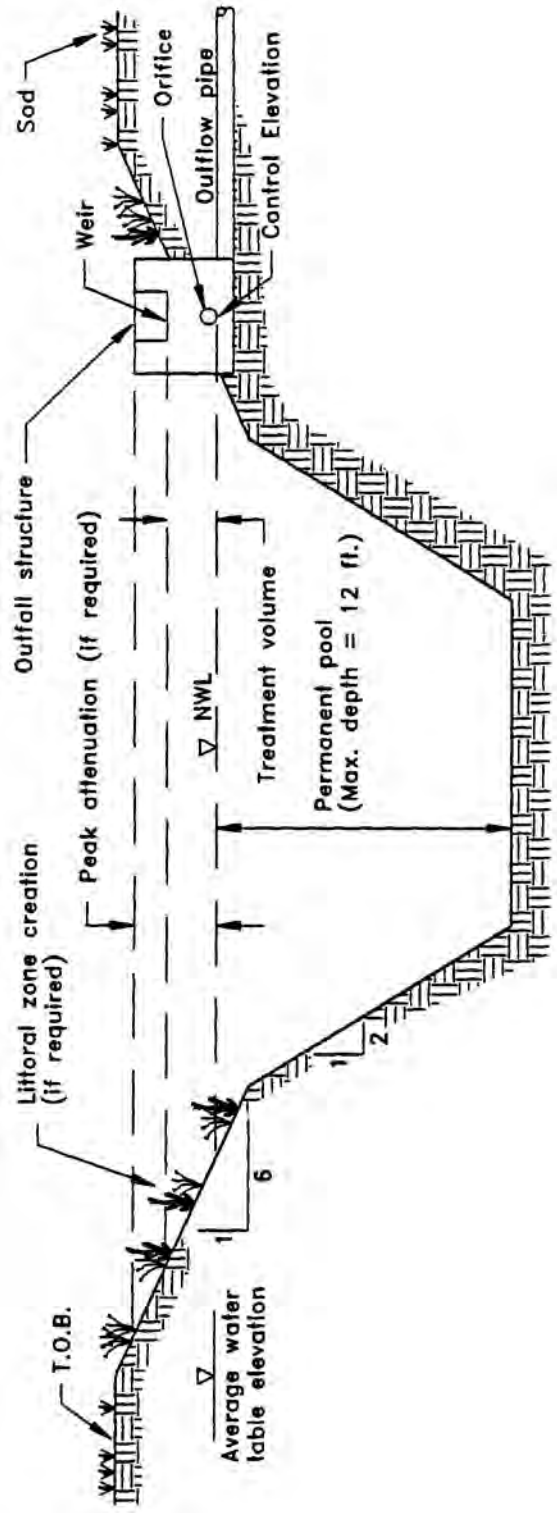


Figure 8-1. Wet detention (N.T.S.)

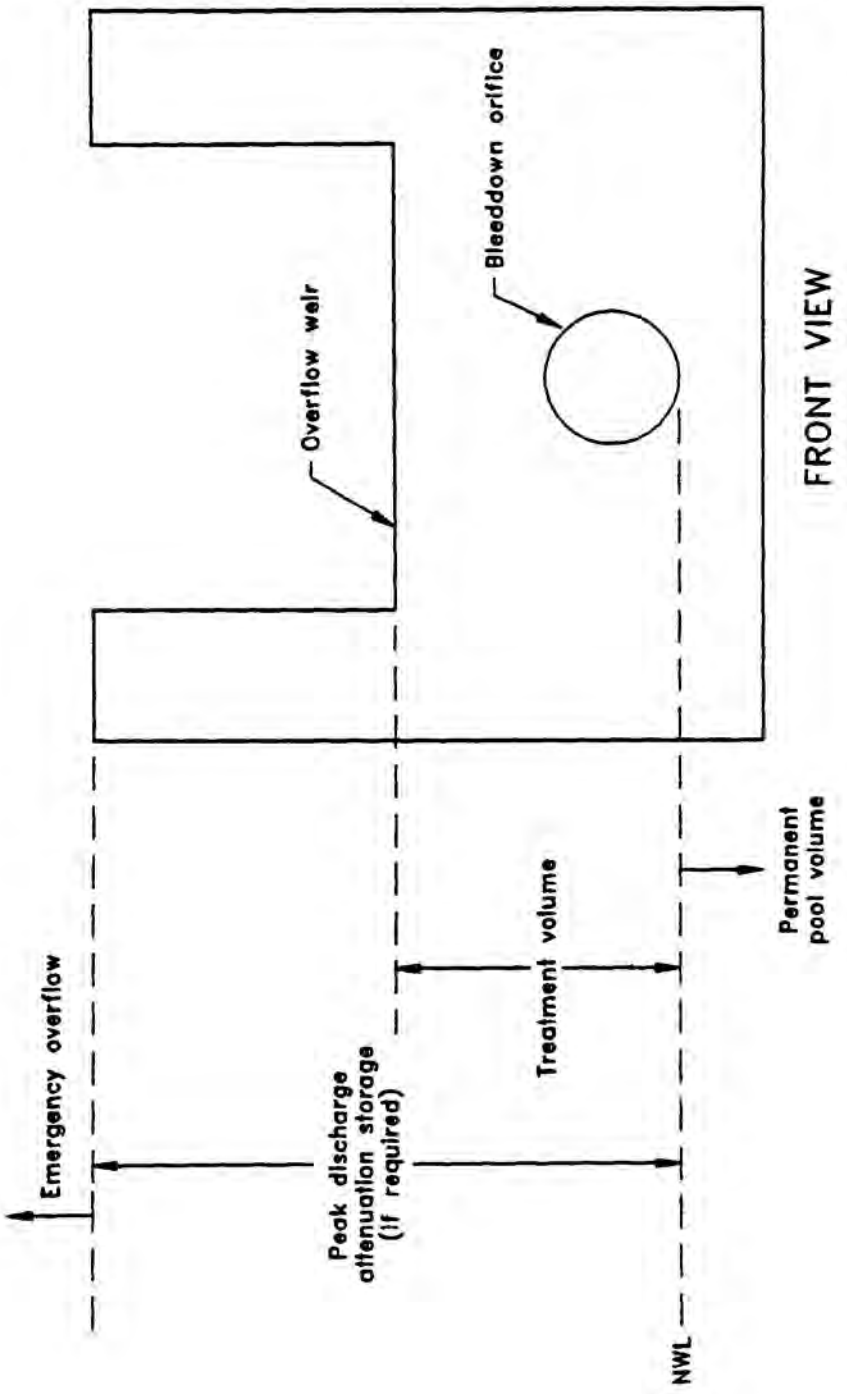


Figure 8-2. Typical wet detention outfall structure (N.T.S.)

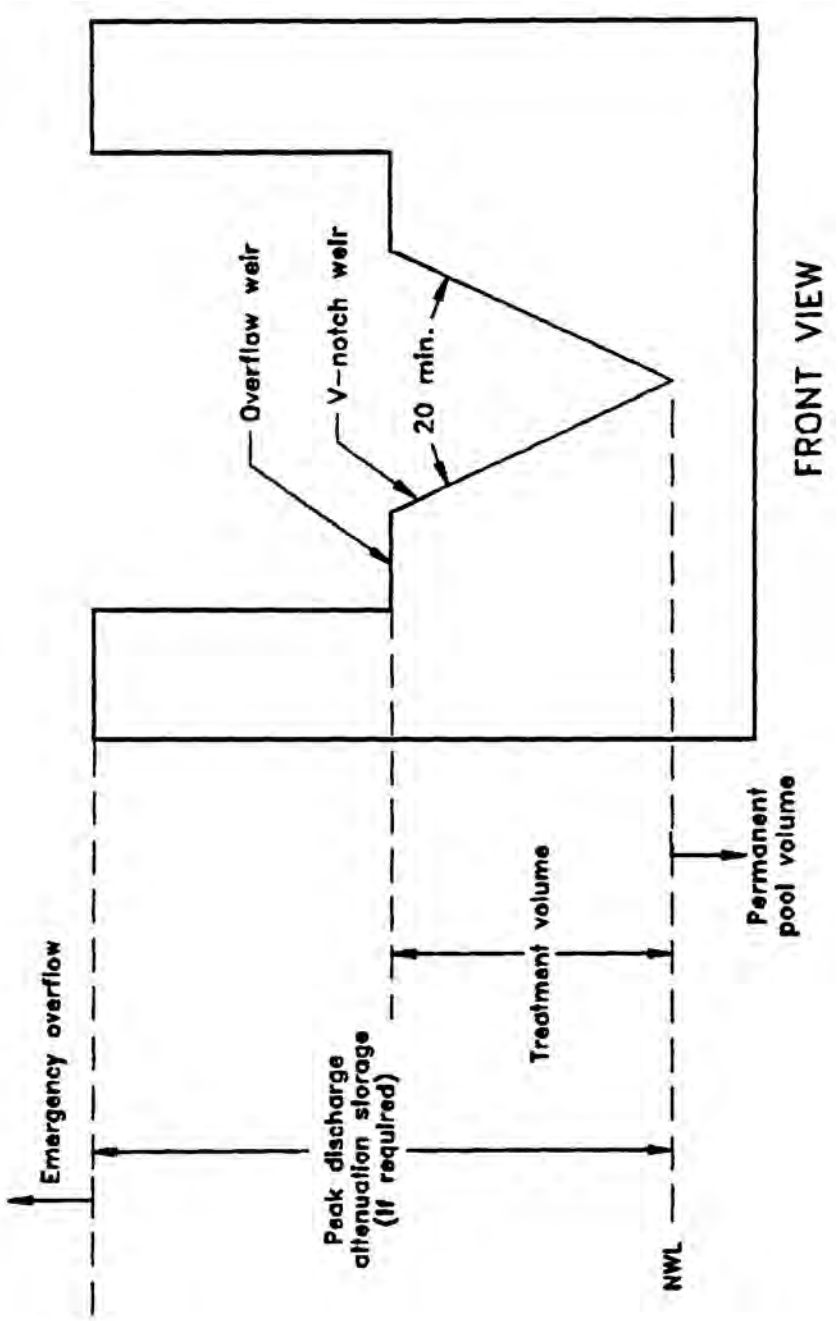


Figure 8-3. Typical wet detention outfall structure with "V"-notch weir (N.T.S.)

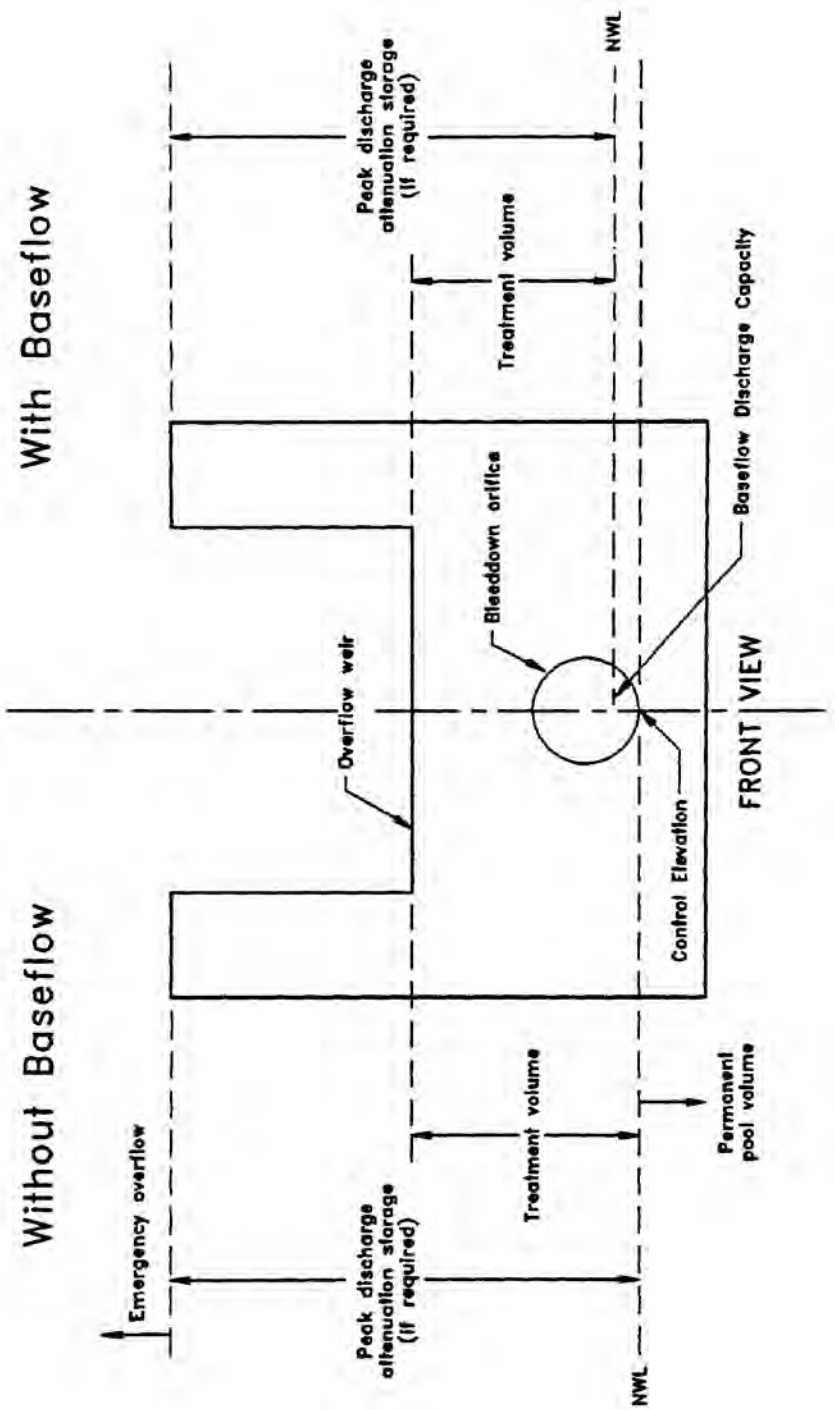


Figure 8-4. Typical wet detention outfall structure with and without baseflow conditions (N.T.S.)

8.6 Littoral Zone

The littoral zone is that portion of a wet detention pond which is designed to contain rooted aquatic plants. The littoral area is usually provided by extending and gently sloping the sides of the pond down to a depth of 2-3 feet below the normal water level or control elevation. Also, the littoral zone can be provided in other areas of the pond that have suitable depths (i.e., a shallow shelf in the middle of the lake).

The littoral zone is established with native aquatic plants by planting and/or the placement of wetland soils containing seeds of native aquatic plants. A specific vegetation establishment plan must be prepared for the littoral zone. The plan must consider the hydroperiod of the pond and the type of plants to be established. Livingston et al. (1988) has published a list of recommended native plant species suitable for littoral zone planting. In addition, a layer of muck can be incorporated into the littoral area to promote the establishment of the wetland vegetation. When placing muck, special precautions must be taken to prevent erosion and turbidity problems in the pond and at its discharge point while vegetation is becoming established in the littoral zone.

The following is a list of the design criteria for wet detention littoral zones:

(a) The littoral zone shall be gently sloped (6H:1V or flatter). At least 30 percent of the wet detention pond surface area shall consist of a littoral zone. The percentage of littoral zone is based on the ratio of vegetated littoral zone to surface area of the pond at the control elevation.

(b) The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless the applicant affirmatively demonstrates that the littoral zone vegetation can survive at greater depths.

(c) Within 24 months of completion of the system or as specified by permit condition, 80 percent coverage of the littoral zone by suitable aquatic plants is required.

(d) Planting of the littoral zone is recommended to meet the 80% coverage requirement. As an alternative to planting, portions of the littoral zone may be established by placement of wetland top soils (at least a four inch depth) containing a seed source of desirable native plants. When utilizing this alternative, the littoral zone must be stabilized by mulching or other means and at least the portion of the littoral zone within 25 feet of the inlet and outlet structures must be planted.

8.7 Littoral Zone Alternatives

As an option to establishing and maintaining vegetative littoral zones as described in section 8.6, the applicant can provide either:

(a) An additional 50% of the appropriate permanent pool volume as required in section 8.5 or 8.13, or

(b) Pre-treatment of the stormwater prior to the stormwater entering the wet detention pond. The level of pre-treatment must be at least that required for retention, underdrain, exfiltration, or swale systems. See section 8.11 of this Volume for additional information on pre-treatment.

8.8 Pond Depth

Wet detention systems shall provide for a maximum pond depth of 12 feet and a mean depth (pond volume divided by the pond area at the control elevation) between 2 and 8 feet.

8.9 Pond Configuration

The average length to width ratio of the pond must be at least 2:1.

If short flow paths are unavoidable, the effective flow path can be increased by adding diversion barriers such as islands, peninsulas, or baffles to the pond. Inlet structures should be designed to dissipate the energy of water entering the pond. Examples of good and poor pond configurations are given in Figure 8-5.

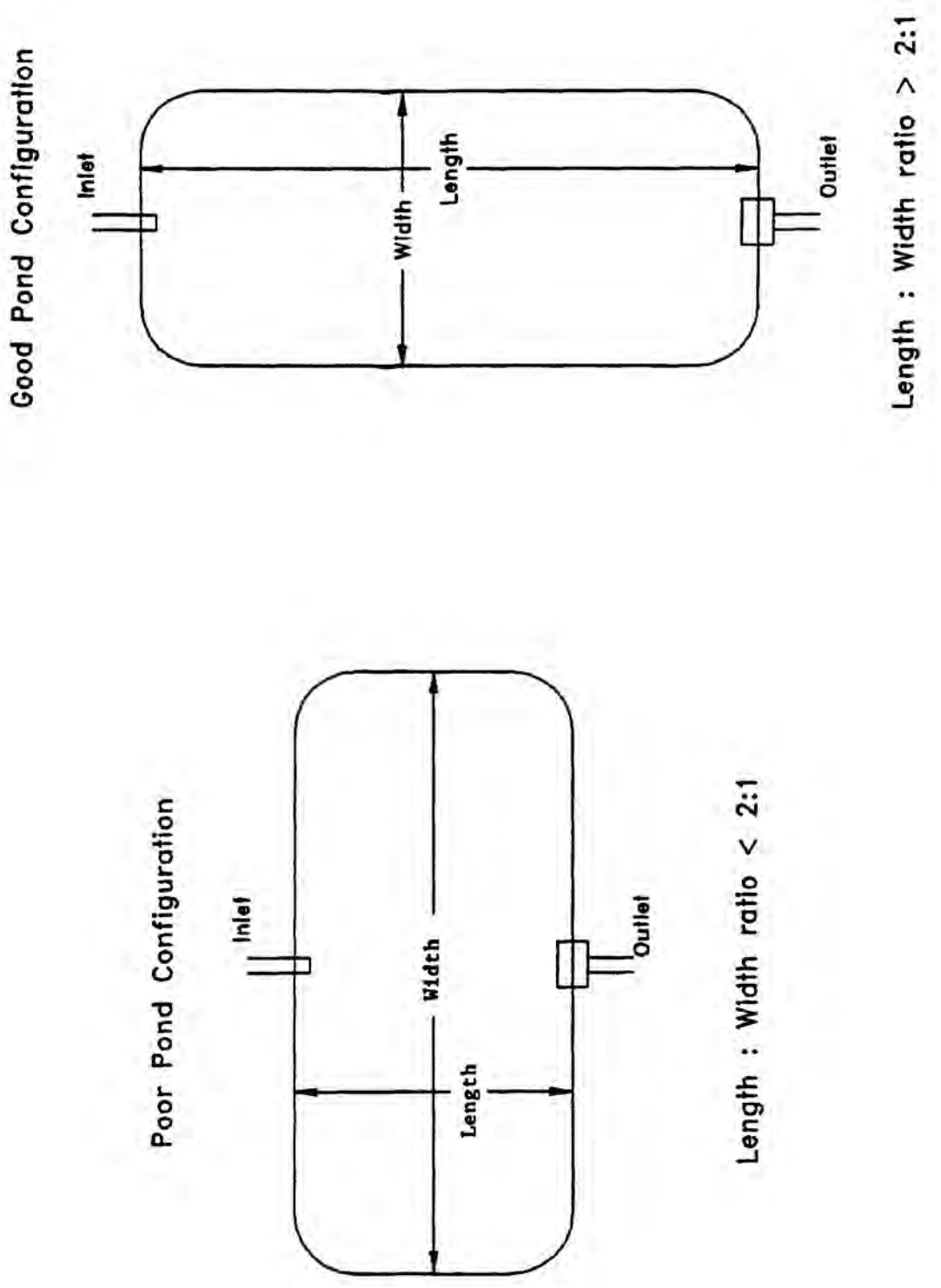


Figure 8-5. Examples of good and poor wet detention pond configurations (N.T.S.)

8.10 Ground Water Table

To minimize ground water contributions which may lower treatment efficiencies, the control elevation shall be set at or above the normal on-site ground water table elevation (Yousef et al. 1990). This elevation may be determined by calculating the average of the seasonal high and seasonal low ground water table elevations.

Ground water inflow (baseflow) must be considered when the control elevation is set below the normal ground water table elevation or the project utilizes underdrains (i.e., road underdrains) to control ground water conditions on-site. The design of the outfall structure must provide for the discharge of baseflow at the design normal water level in the pond. Baseflow rates must be included in the drawdown calculations for the outfall structure. Baseflow shall also be considered in the permanent pool residence time design. Establishment of the normal water level in the pond will also be influenced by baseflow conditions (see Figure 8-4).

8.11 Pre-treatment

"Pre-treatment" is defined as the treatment of a portion of the runoff prior to its entering the wet detention pond. Pre-treatment increases the pollutant removal efficiency of the overall stormwater system by reducing the pollutant loading to the wet detention pond. Pre-treatment may be used to enhance the appearance of the wet detention pond or meet the additional treatment criteria for discharges to receiving water which are classified as Class I, Class II, Outstanding Florida Waters (OFWs), or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting.

For developments where the appearance of the lake is important, pre-treatment can reduce the chances of algal blooms and slow the eutrophication process. Some types of pre-treatment practices include utilizing vegetative swales for conveyance instead of curb and gutter, perimeter swales or berms around the lake, oil and grease skimmers on inlet structures, retention storage in swales with raised inlets, or shallow landscaped retention areas (when soils and water table conditions will allow for adequate percolation).

For systems in which pre-treatment is utilized to meet the additional design criteria requirements for systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, pre-treatment practices must meet the appropriate design and performance criteria for that BMP. Acceptable types of pre-treatment include the following:

(a) Retention systems which meet the design and performance criteria in section 5,

(b) Underdrain systems which meet the design and performance criteria in section 6,

(c) Exfiltration trench section 7, or

(d) Swales systems which meet the design and performance criteria in section 9.

Alternative pre-treatment methods will be evaluated on a case-by-case basis by the District. Applicants or system designers are encouraged to meet with District staff in a pre-application conference if alternative methods are proposed.

8.12 Pond Side Slopes

The pond must be designed so that the average pond side slope measured between the control elevation and two feet below the control elevation is no steeper than 3:1 (horizontal:vertical).

8.13 Direct Discharges to Class I, Class II, OFWs, or Shellfishing Waters

Wet detention systems which discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, must provide either:

(a) An additional fifty percent of both the required treatment and permanent pool volumes

(b) Pre-treatment of the stormwater prior to the stormwater entering the wet detention pond. The level of pre-treatment must be at least that required for retention, underdrain, exfiltration, or swale systems (see section 8.11 of this Volume).

8.14 References

Camp Dresser & McKee Inc (CDM). 1985. *An Assessment of Stormwater Management Programs.* Prepared for Florida Department of Environmental Regulation, Tallahassee, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Yousef, Y.A., M.P. Wanielista, L.Y. Lin, and M. Brabham. 1990. *Efficiency Optimization of Wet Detention Ponds for Urban Stormwater Management (Phase I and II).* University of Central Florida, Orlando, Florida

9.0 Swale Systems Design and Performance Criteria

9.1 Description *Revised 6/1/18*

Swales are a man-made or natural system shaped or graded to required dimensions and designed for the conveyance and rapid infiltration of stormwater runoff. Swales are designed to infiltrate a defined quantity of runoff through the permeable soils of the swale floor and side slopes into the shallow ground water aquifer (Figure 9-1). Turf is established to promote infiltration and stabilize the side slopes. Soil permeability and water table conditions must be such that the swale can percolate the desired runoff volume from the 3-year, 1-hour storm event. The swale holds water only during and immediately after a storm event, thus the system is normally "dry." Unlike retention basins, swales are "open" conveyance systems. This means there are no physical barriers such as berms or check-dams to impound the runoff in the swale prior to discharge to the receiving water.

Swale systems should not be located in close proximity to drinking water supply wells. As required by chapter 62-555, F.A.C., stormwater treatment facilities must be at least 100 feet from any public supply well. Chapter 62-532, F.A.C., identifies stormwater detention or retention basins as a “potentially moderate sanitary hazard” and includes additional setback requirements for certain wells from such basins. Additional design criteria are established for swale systems constructed in Karst Sensitive Areas of the District where the drinking water aquifer is close to the land surface (see section 13.6).

Besides pollution control, swale systems can be utilized to promote the recharge of groundwater to prevent saltwater intrusion in coastal areas, and to maintain ground water levels in aquifer recharge areas. Swales can be incorporated into the design of a stormwater management system to meet the recharge criteria for the Wekiva Recharge Protection Basin and the Tomoka River and Spruce Creek Hydrologic Basins.

Swales can also be utilized to provide pre-treatment of runoff prior to its release to another treatment BMP such as wet detention (see section 8.11) or wetlands stormwater management systems (see section 10.4). Pre-treatment reduces the pollutant loading to the downstream treatment system, increases the pollutant efficiency of the overall stormwater management system, and reduces maintenance. In some cases, pre-treatment may be used to meet the additional treatment criteria for discharges to sensitive receiving waters (Class I, Class II, and OFWs). For developments where the appearance of the downstream system (i.e, wet detention lake) is important, pre-treatment can reduce the probability of algal blooms occurring and slows the eutrophication process.

The design and performance criteria specific to swale systems are described in the following sections.

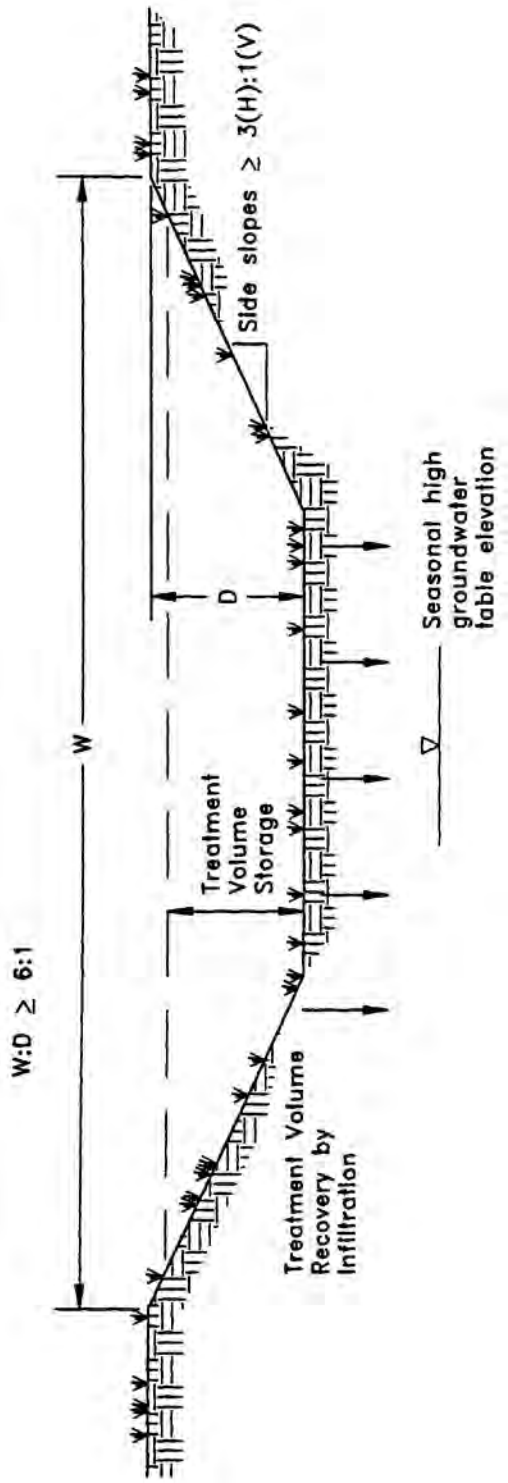


Figure 9-1. Cross-section of swale system (N.T.S.)

9.2 Treatment Volume

The runoff from the site should be routed to the swale system for conveyance and percolation into the ground. For systems which discharge to Class III receiving water bodies, the swales shall be designed to percolate 80% of the runoff from the 3-year, 1- hour storm. The remaining 20% of the runoff from the 3-year, 1-hour storm event may be discharged offsite by the swale system.

Swale systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, shall be designed to percolate all of the runoff from the 3-year, 1-hour storm.

9.3 Recovery Time

Swale systems must provide the capacity for the specified treatment volume of stormwater and contain no contiguous areas of standing or flowing water within 72 hours following the storm event referenced in section 9.2 assuming average antecedent moisture conditions. The treatment volume must be provided by percolation through the soil, evaporation, or evapotranspiration.

Antecedent moisture condition (AMC) refers to the amount of moisture and storage in the soil profile prior to a storm event. Antecedent soil moisture is an indicator of wetness and availability of soil to infiltrate water. The AMC can vary from dry to saturated depending on the amount of rainfall received prior to a given point in time. Therefore, "average AMC" means the soil is neither dry or saturated, but at an average moisture condition at the beginning of a storm event when calculating recovery time for swale systems.

The antecedent condition has a significant effect on runoff rate, runoff volume, infiltration rate, and infiltration volume. The infiltration volume is also known as the upper soil zone storage. Both the infiltration rate and upper soil zone storage are used to calculate the recovery time of retention systems and should be estimated using any generally accepted and well documented method with appropriate parameters to reflect drainage practices, seasonal high water table elevation, the AMC, and any underlying soil characteristics which would limit or prevent percolation of storm water into the soil column.

9.4 Dimensional Requirements

Swales must have a top width to depth ratio of the cross-section equal to or greater than 6:1 or side slopes equal to or greater than 3:1 (horizontal to vertical).

9.5 Stabilization

Swales should be stabilized with vegetative cover suitable for soil stabilization, stormwater treatment, and nutrient uptake. Also, the swale should be designed to take into account the soil errodibility, soil percolation, slope, slope length, and drainage area so as to prevent erosion and reduce pollutant concentrations.

10.0 Wetlands Stormwater Management Systems Design and Performance Criteria

10.1 Description

For wetlands stormwater management systems the District must ensure that a proposed wetlands stormwater management system is compatible with the existing ecological characteristics of the wetlands proposed to be utilized for stormwater treatment. The District must also ensure that water quality standards will not be violated by discharges from wetlands stormwater management system. To achieve these goals, specific performance criteria are set forth and described below for systems which incorporate wetlands for stormwater treatment.

10.2 Types of Wetlands that may be Utilized for Stormwater Treatment

The only wetlands which may be considered for use to provide stormwater treatment are those which are:

(a) Isolated wetlands; and

(b) Those which would be isolated wetlands, but for a hydrologic connection to other wetlands or surface waters via another watercourse that was excavated through uplands.

10.3 Treatment Volume

The system shall be part of a comprehensive stormwater management system that utilizes wetlands in combination with other best management practices to provide treatment of the runoff from the project. For systems discharging to Class III waters, treatment of the runoff from the greater of the following shall be provided:

(a) First one inch of runoff, or

(b) 2.5 inches times the impervious area.

Those systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, shall provide an additional fifty percent of the applicable treatment volume specified above.

If the wetland alone cannot provide the treatment volume, then other best management practices shall be incorporated upstream and outside of the wetland to store the proper level of runoff. Utilization of other BMPs must not adversely affect the ability of the wetlands stormwater management system from meeting the requirements of this section.

10.4 Recovery Time

The system shall be designed to bleed down one-half the applicable treatment volume specified above between 60 and 72 hours following a storm event.

10.5 Inlet Structures

Inlet structures shall be designed to dissipate the energy of runoff entering the wetland and minimize the channelized flow of stormwater. Methods include, but are not limited to, sprinklers, pipe energy dissipators, overland flow or spreader swales.

10.6 Wetland Function

The use of wetlands for stormwater treatment must meet the criteria in section 10.0, Environmental Considerations, of the Environmental Resource Permit Applicant's Handbook, Volume I. Pre-treatment can reduce the impact of untreated stormwater upon the wetland. In addition, pre-treatment can be utilized to attenuate stormwater volumes and peak discharge rates so that the wetland's hydroperiod is not adversely altered (Livingston 1989). Swale conveyances and lakes adjacent to the wetland are typical pre-treatment practices.

10.7 Residence Time

The design features of the system should maximize residence time of the stormwater within the wetland to enhance the opportunity for the stormwater to come into contact with the wetland sediment, vegetation, and micro-organisms (Livingston 1989). This can be accomplished by several means. The inlets and outlets should be located to maximize the flow path through the wetland. Energy dissipators and spreader swales can promote overland flow and reduce the possibility of channelized flow occurring. In some instances, berms in wetlands can act as baffles to increase the flow path of surface flow through the wetland.

10.8 Monitoring

In order to establish a reliable, scientifically valid data base upon which to evaluate the performance criteria and the performance of the wetlands stormwater management system, a monitoring program may be required. Monitoring programs shall provide the District with comparable data for different types of wetlands and drainage designs. Data to be collected may include but not be limited to:

(a) Sedimentation rate

(b) Sediment trace metal concentrations

(c) Sediment nitrogen and phosphorus concentrations

(d) Changes in the frequency, abundance and distribution of vegetation

(e) Inflow and outflow water quality for nutrients, metals, turbidity, oils and greases, bacteria and other parameters related to the specific site conditions

Inflow and outflow water quality parameters will be monitored on such storm event occurrences as established by the District based on a site specific basis. The District shall eliminate the requirement to continue the monitoring program upon its determination that no further data is necessary to evaluate the performance criteria or ensure compliance with the performance criteria and applicable water quality standards.

10.9 Dredge and Fill

If the applicant proposes to dredge or fill in the wetlands used for stormwater treatment, the District in its review of the permit application shall evaluate the adverse effects of the dredging or filling on the treatment capability of the wetland.

10.10 Alternative Criteria *Revised 6/1/18*

If the applicant is unable to show compliance with the performance criteria sections 10.3 – 10.9, above, the applicant may qualify for an environmental resource permit to use a wetlands stormwater management system using alternative design and performance criteria if the applicant affirmatively demonstrates that the use of the wetlands meets the criteria in section 10.0, Environmental Resource Permit Applicant's Handbook, Volume I (General and Environmental) and the applicant complies with the requirements for issuance in section 2.0.

10.11 References

Livingston, E.H. 1989. The Use of Wetlands for Urban Stormwater Management. In *Design of Urban Runoff Quality Controls*, ed. L.A. Roesner, B. Urbonas, and M.B. Sonnen, pages 467-490. American Society of Civil Engineers. New York.

11.0 [Reserved]

12.0 Dry Detention Design and Performance Criteria

12.1 Description *Revised 6/1/18*

Dry detention systems are normally dry storage areas which are designed to store a defined quantity of runoff and slowly release the collected runoff through an outlet structure to adjacent surface waters. After drawdown of the stored runoff is completed, the storage basin does not hold any water, thus the system is normally "dry." A schematic of a typical dry detention system is presented in Figure 12-1.

Dry detention basins are similar to retention systems in that the basins are normally dry. However, the main difference between the two systems is that retention systems are designed to percolate the stored runoff into the ground while dry detention systems are designed to discharge the runoff through an outlet structure to adjacent surface waters.

Sedimentation is the primary pollutant removal process which occurs in dry detention systems. Unfortunately, only pollutants which are primarily in particulate form are removed by sedimentation. Therefore, the pollutant removal efficiency of dry detention systems is not as great as systems such as retention and wet detention which remove both dissolved and particulate pollutants. Because of the limited pollutant removal efficiency of dry detention, this BMP must only be utilized where no other BMP is technically feasible. For example, use of dry detention must be restricted to the following situations:

(a) Where high ground water table or soil conditions limit the feasibility of other BMPs such as retention, and

(b) Small drainage basins (less than 5 acres). For larger projects (greater than 5 acres) other BMPs like wet detention shall be utilized instead of dry detention.

There are several design and performance criteria which must be met in order for a dry detention system to meet the District's requirements. A description of each design criterion is presented below.

12.2 Treatment Volume

For discharges to Class III receiving water bodies, the dry detention system shall provide *off-line* detention of the first one inch of runoff or 2.5 inches of runoff from the impervious area, whichever is greater.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, the applicant shall provide dry detention for at least an additional fifty percent of the applicable treatment volume specified for off-line dry detention in (a),

above. Off-line detention must be provided for at least the first one inch of runoff or 2.5 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

Dry detention removes less pollutants on a per unit basis than other traditional best management practices. Therefore, dry detention systems must treat a greater volume of stormwater than the other treatment practices specified in this Volume to achieve an equivalent level of pollutant removal.

12.3 Recovery Time

The outfall structure shall be designed to drawdown one-half the required treatment volume specified above between 24 and 30 hours following a storm event.

12.4 Outlet Structure

The outlet structure shall include a drawdown device (such as an orifice, "V" or square notch weir) set to slowly release the treatment volume (see Figures 12-2 and 12-3 for conceptual schematics). In addition, the structure must include a device to prevent the discharge of accumulated sediment, minimize exit velocities, and prevent clogging. Examples of such devices include perforated risers enclosed in a gravel jacket and perforated pipes enclosed in sand or gravel (see Figure 12-5).

In addition, the control elevation shall be set at or above the design tailwater elevation so the basin can effectively recover the treatment storage.

12.5 Ground Water Table, Basin Floor, and Control Elevation

To minimize ground water contributions and ensure the basin floor is normally dry, the control elevation and basin floor shall be set at least one foot above the seasonal high ground water table elevation. Sumps may be placed up to one foot below the control elevation. The basin floor shall be level or uniformly sloped toward the control structure. The system may only contain standing water within 3 days of a storm event. Continuous standing water in the basin may also reduce the aesthetic value of the system and may promote mosquito production.

12.6 Basin Stabilization

The dry detention basin shall be stabilized with permanent vegetative cover.

12.7 Basin Configuration

The average length to width ratio of the dry detention basin must be at least 2:1. Under these design conditions, short circuiting is minimized and pollutant removal efficiency is maximized.

If short flow paths are unavoidable, the effective flow path can be increased by adding diversion barriers such as peninsulas or baffles to the basin. Examples of good and poor basin configurations are given in Figure 12-4.

12.8 Inlet Structures

Inlet structures shall be designed to dissipate the energy of water entering the basin.

12.9 Maintenance

Dry detention systems must include provisions for removal of sediment and debris from the basin and mowing and removal of grass clippings.

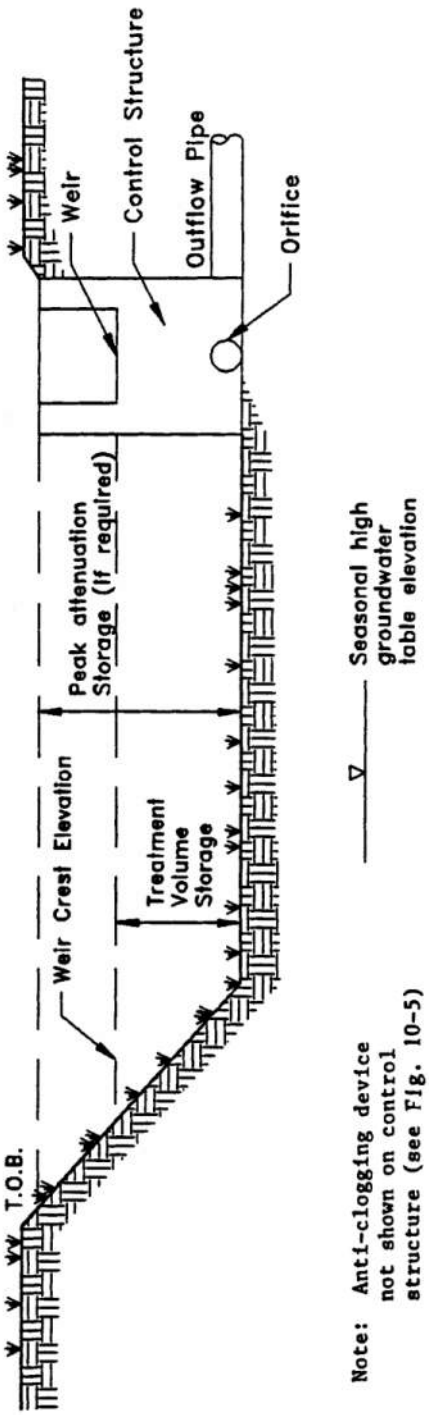


Figure 12-1 Dry detention (N.T.S.)

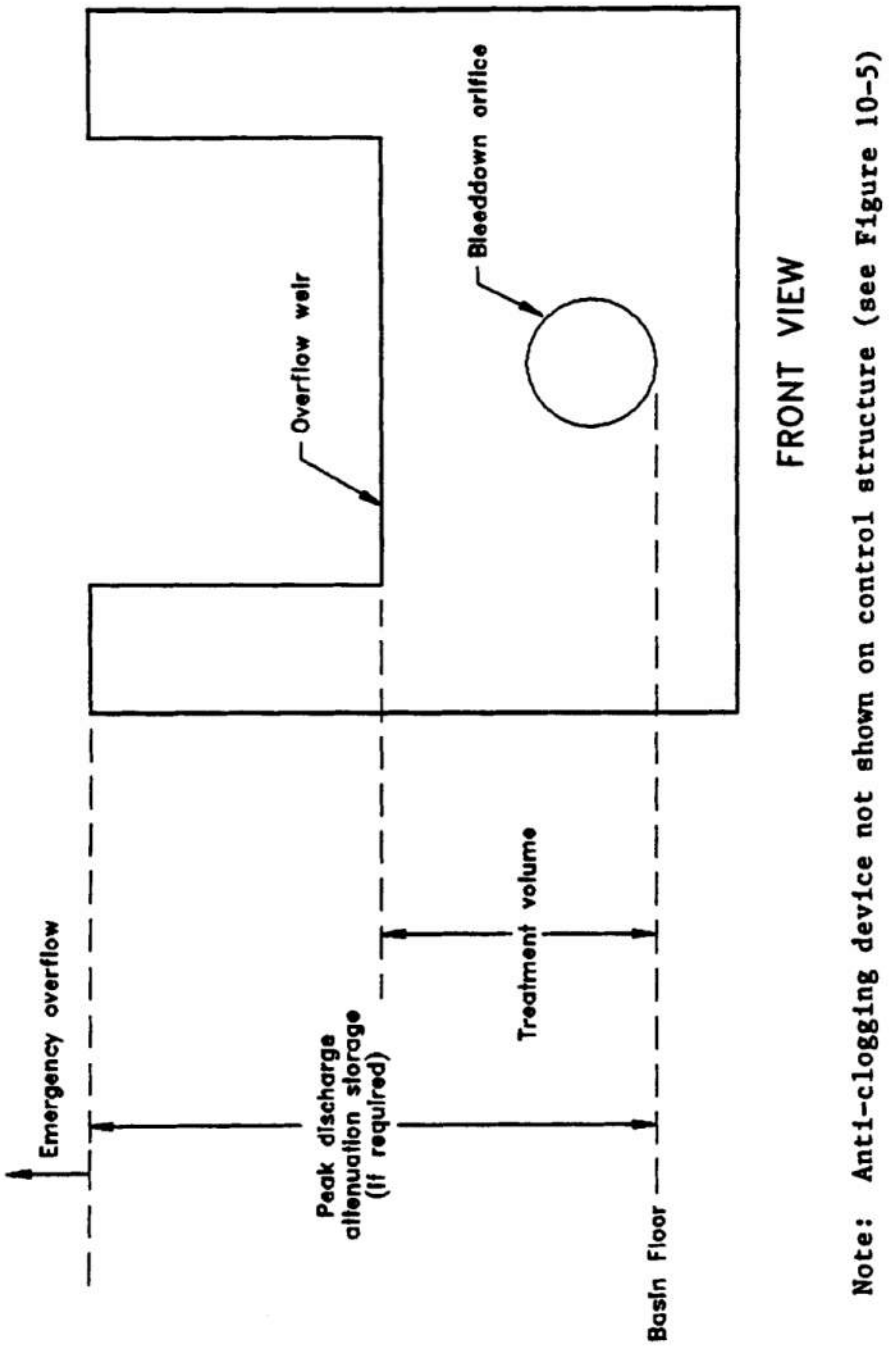


Figure 12-2. Typical dry detention outfall structure with orifice (N.T.S.)

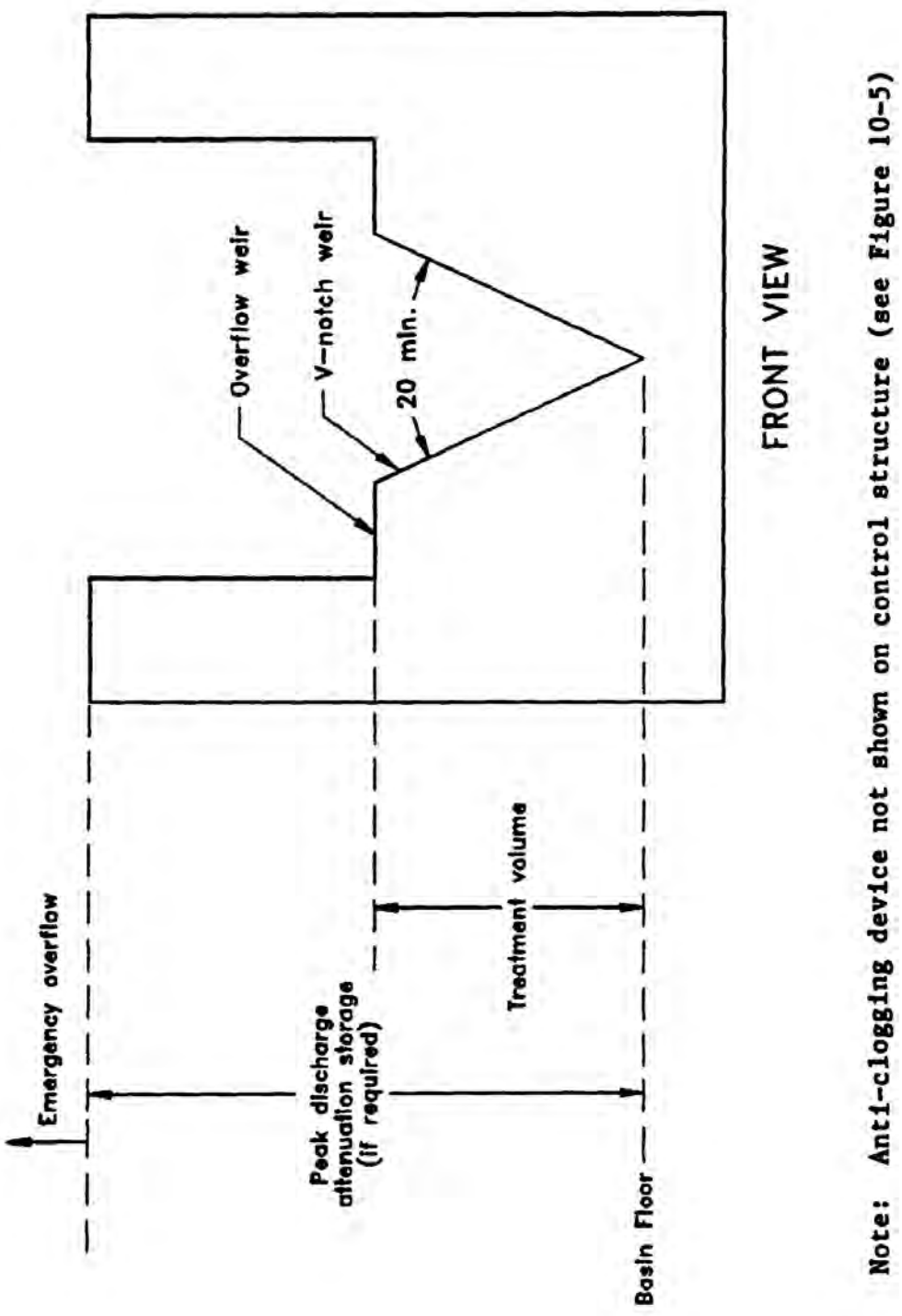


Figure 12-3. Typical dry detention outfall structure with "V"-notch weir (N.T.S.)

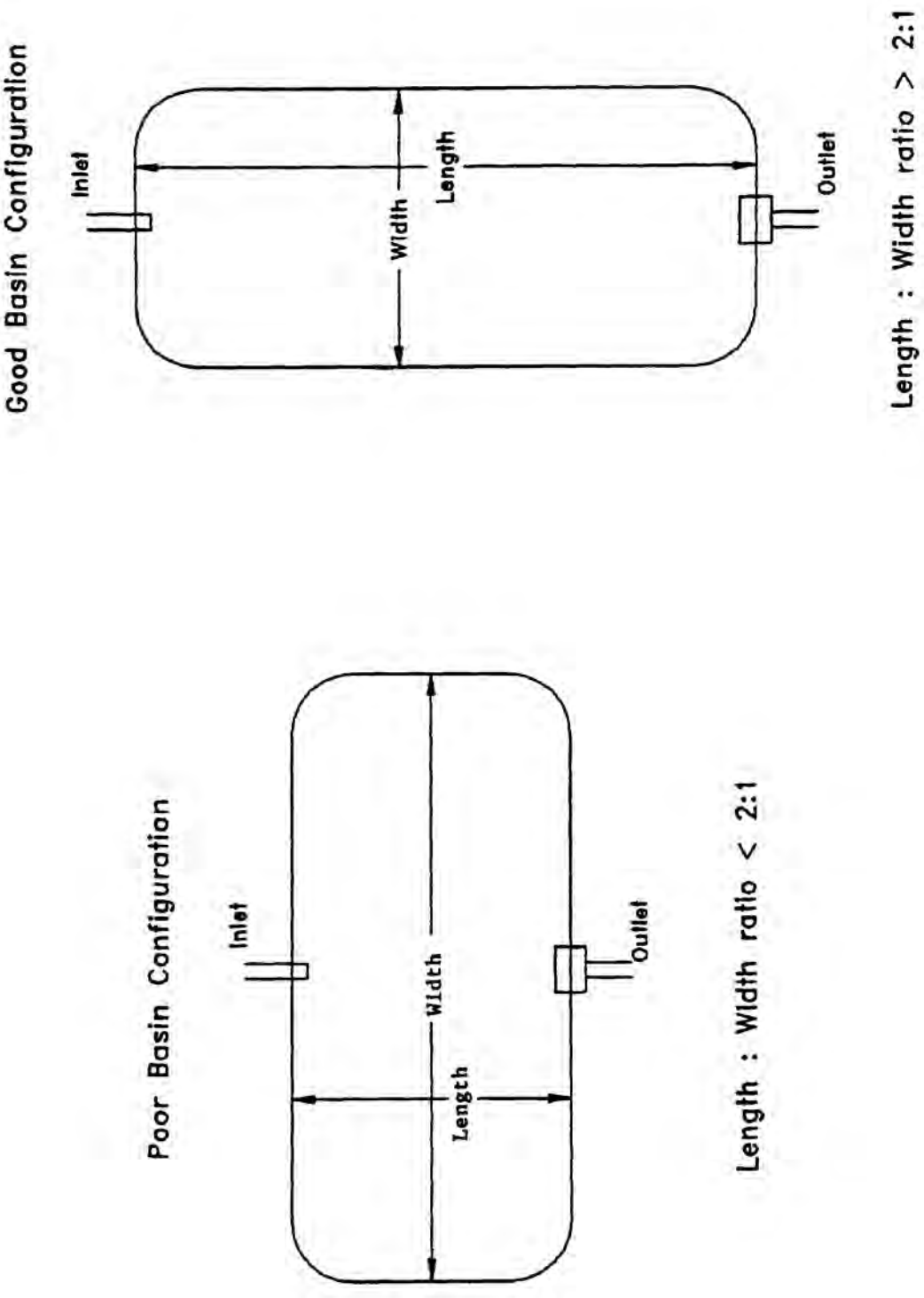


Figure 12-4. Examples of good and poor dry detention pond configurations (N.T.S.)

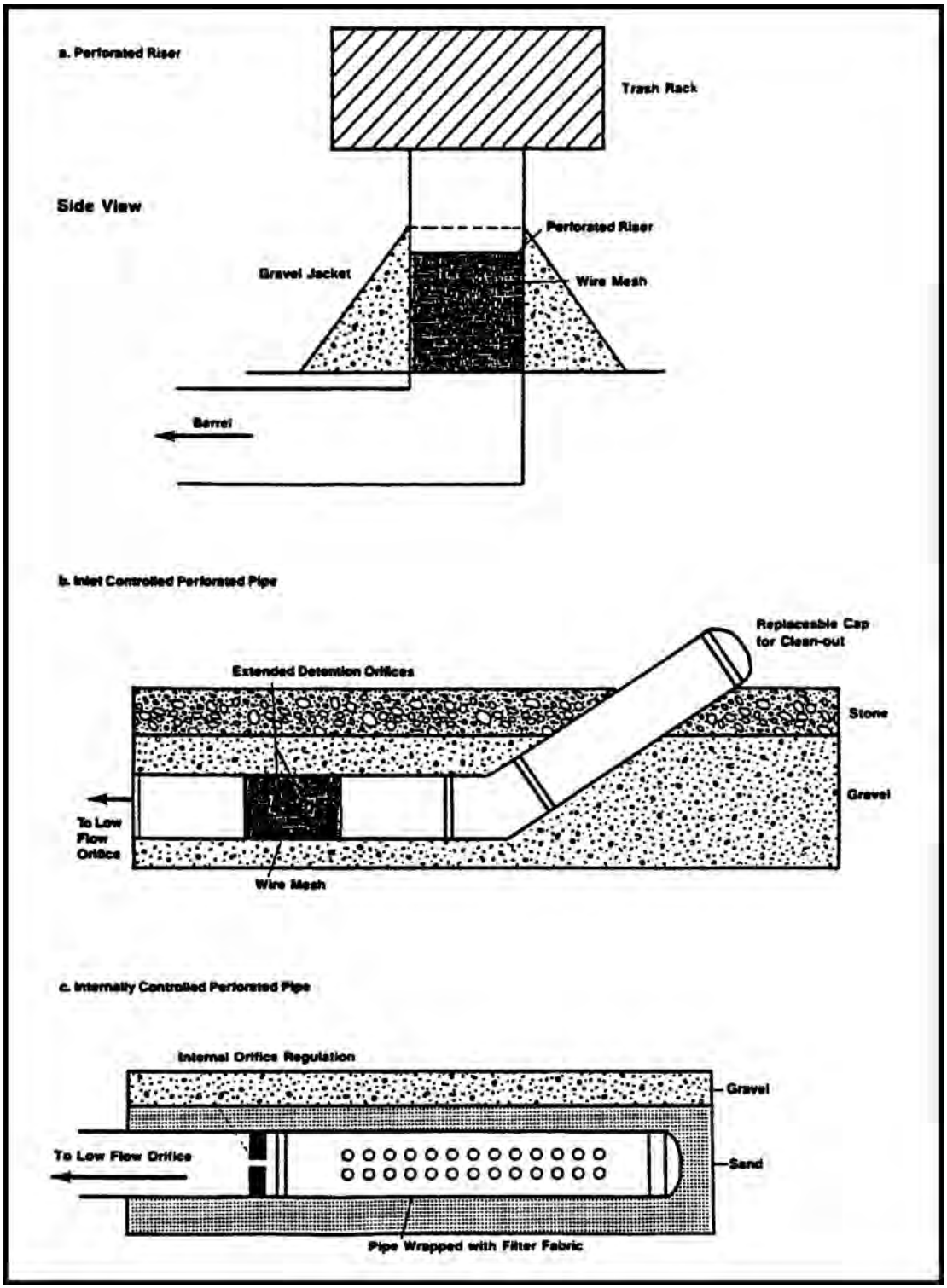


Figure 12-5. Devices to prevent clogging in dry detention control structures (Source: Schueler, T.R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's. Metropolitan Washington Council of Governments, Washington, D.C.)

PART VI – BASIN CRITERIA

13.0 Basin Criteria *Revised 6/1/18*

Chapter 40C-41, F.A.C., and this section establish additional criteria which are to be used in reviewing applications for permits in certain hydrologic basins. These basins are:

(a) Upper St. Johns River Hydrologic Basin

(b) Ocklawaha River Hydrologic Basin

(c) Wekiva River Hydrologic Basin

(d) Wekiva Recharge Protection Basin

(e) Econlockhatchee River Hydrologic Basin

(f) Tomoka River Hydrologic Basin

(g) Spruce Creek Hydrologic Basin

(h) Sensitive Karst Areas Basin

(i) Lake Apopka Hydrologic Basin

See Figure 13.0-1 for a description of the areas contained within the Upper St. Johns River Hydrologic Basin, the Ocklawaha River Hydrologic Basin, the Wekiva River Hydrologic Basin, the Econlockhatchee River Hydrologic Basin, the Tomoka River Hydrologic Basin and the Spruce Creek Hydrologic Basin. See Figures 13.0-2, 13.0-3, and 13.0-4 for a description of the areas contained within the Sensitive Karst Areas Basin. See Figure 13.0-5 for a description of the areas contained within the Lake Apopka Hydrologic Basin. A legal description of the Hydrologic Basin boundaries is available in Appendix B.

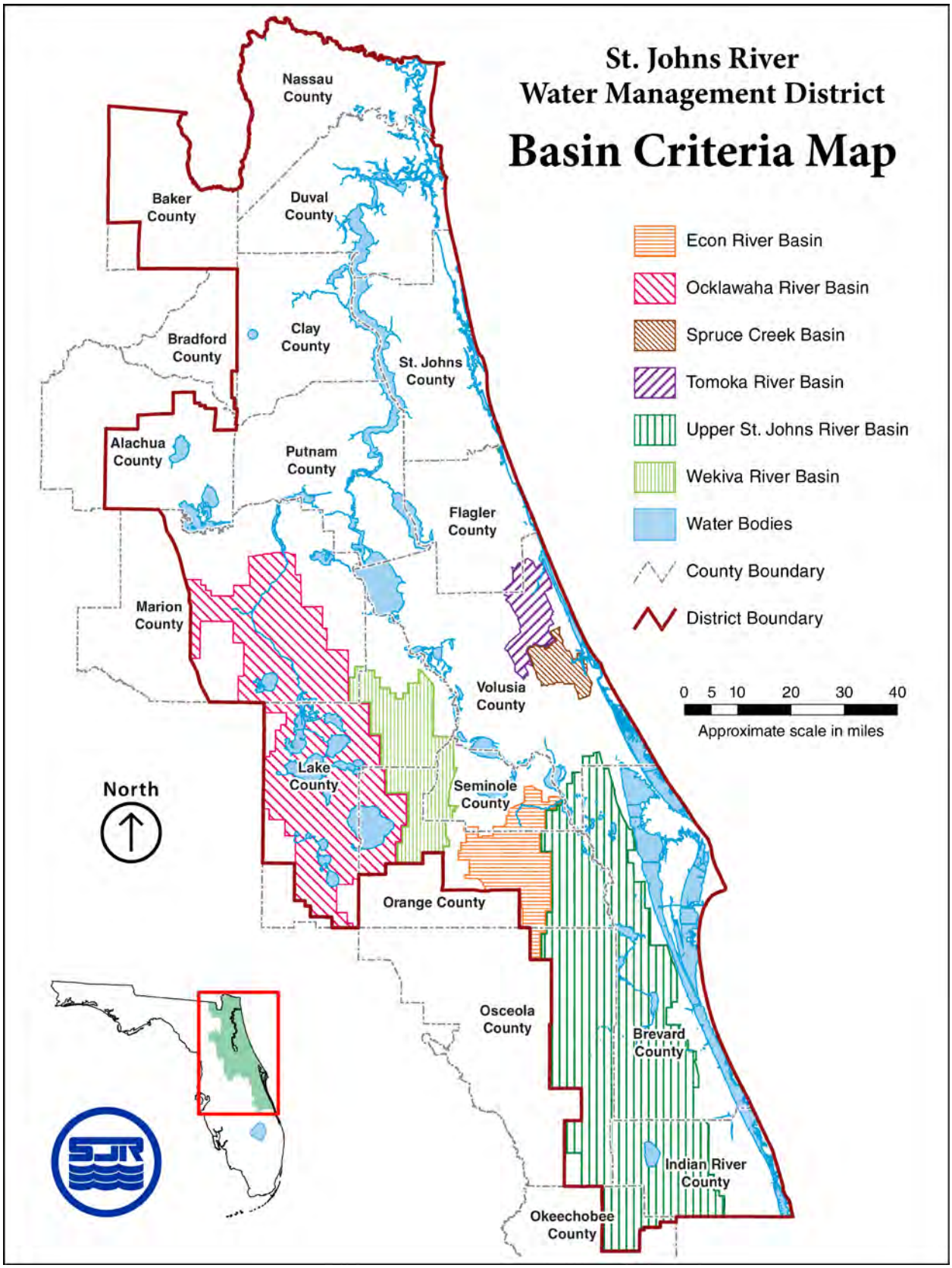


Figure 13.0-1 Basin Criteria Map

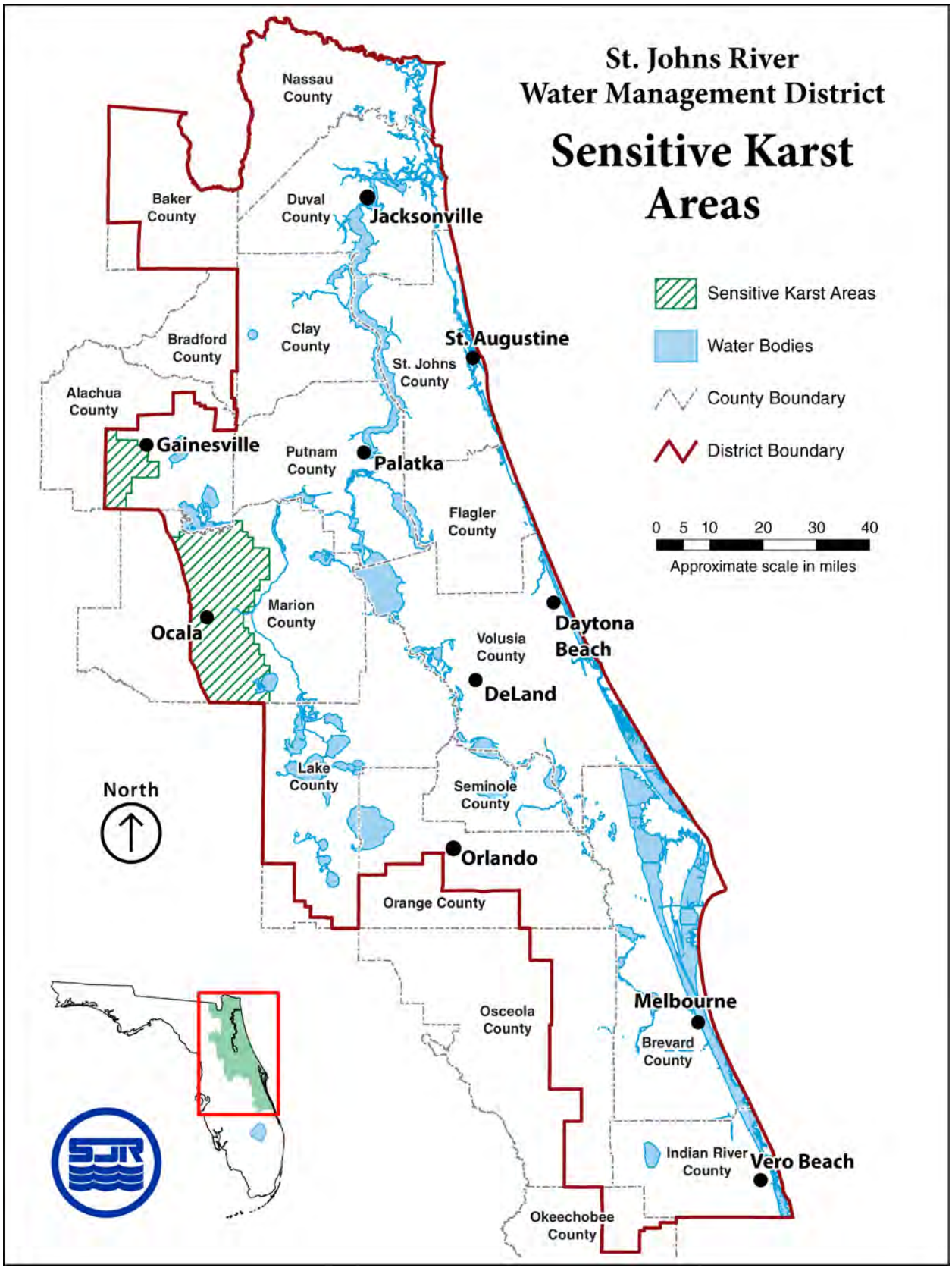


Figure 13.0-2 Sensitive Karst Areas in the St. Johns River Water Management District

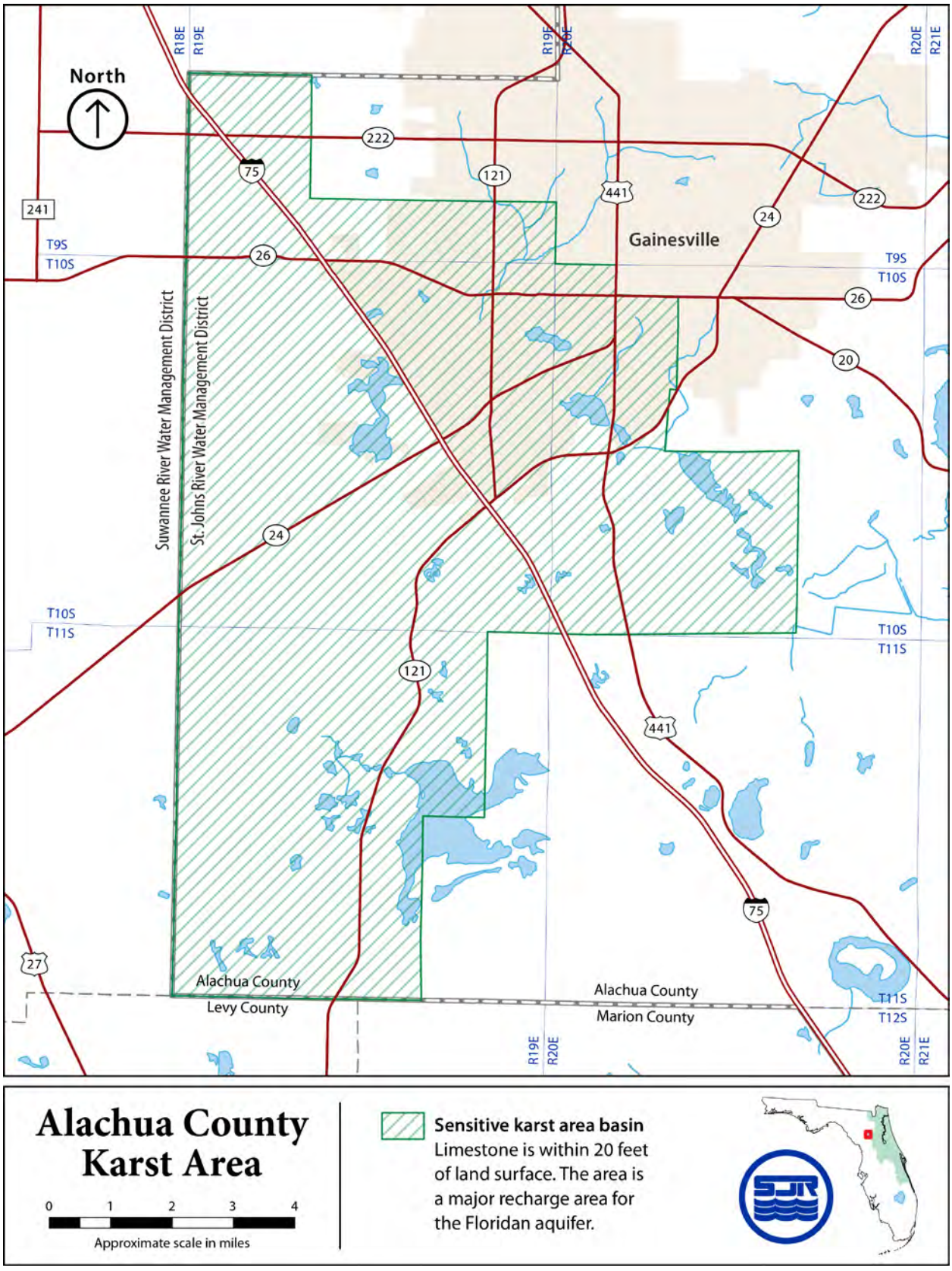


Figure 13.0-3 Alachua County Karst Area

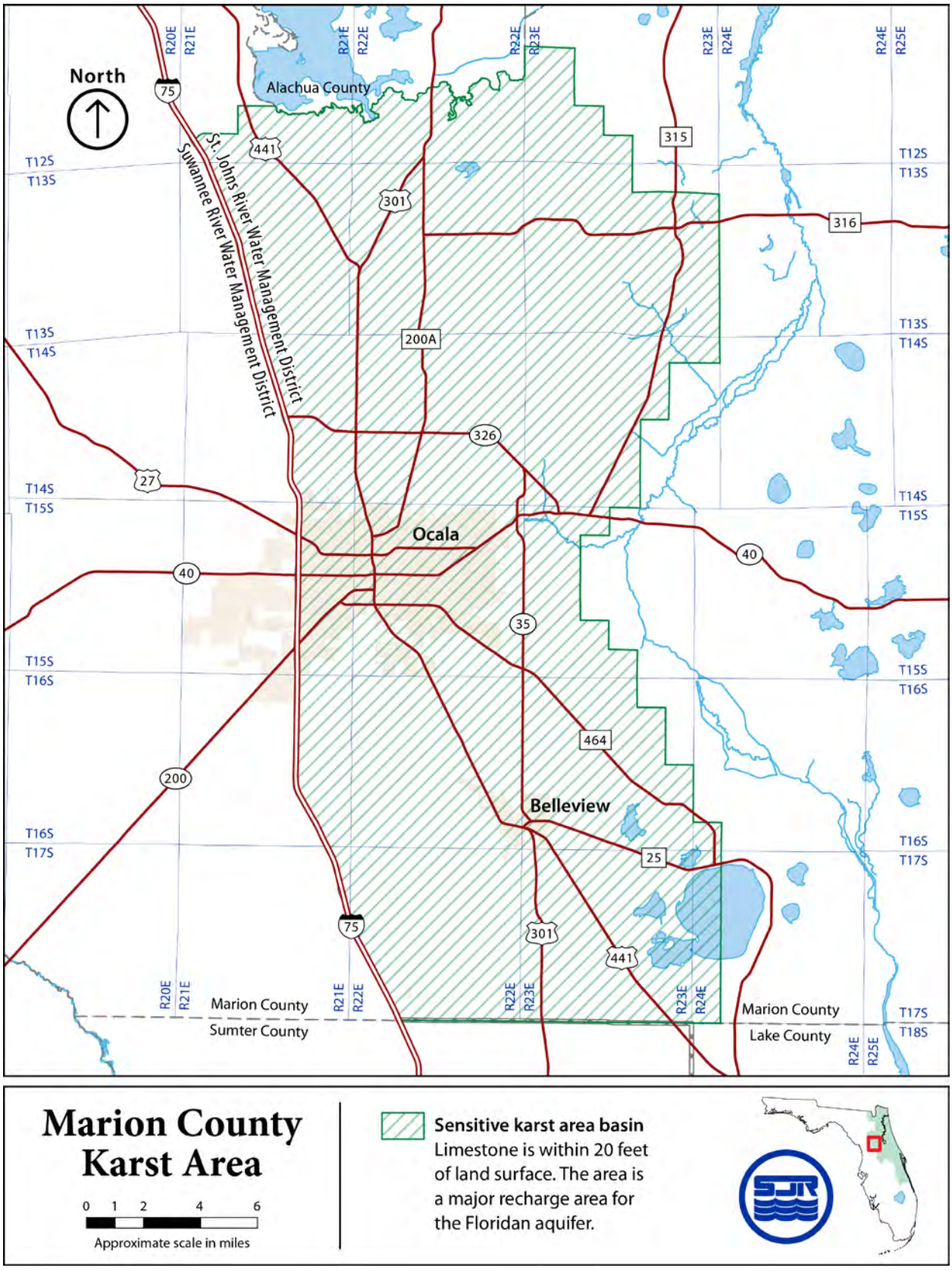


Figure 13.0-4 Marion County Karst Area

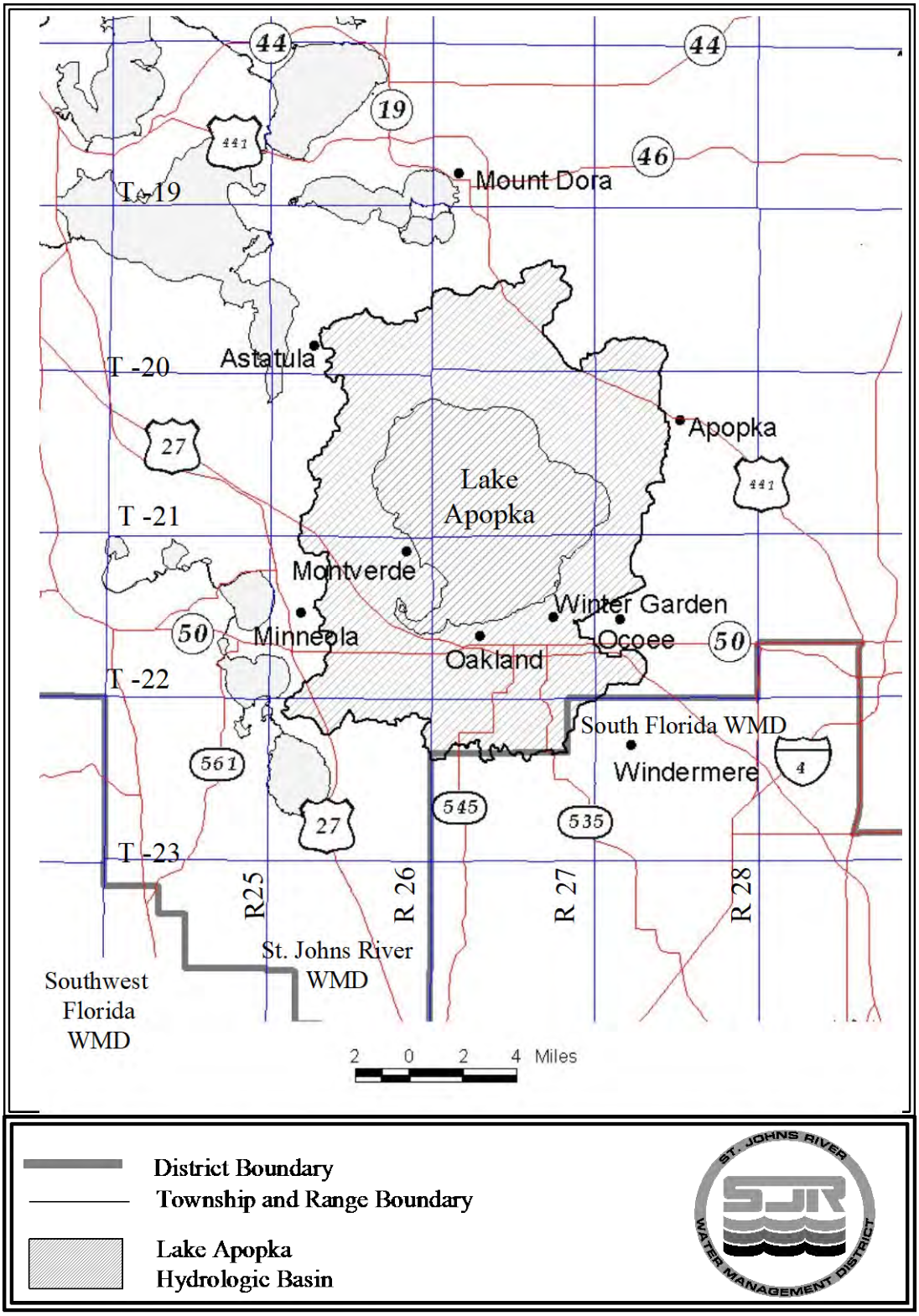


Figure 13.0-5 Lake Apopka Drainage Basin

13.1 Upper St. Johns River Hydrologic Basin

As part of the design criteria described in sections 62-330.301 and 62-330.302, F.A.C., above, systems in the Upper St. Johns River Basin must meet the following criteria:

13.1.1 Storm Frequency

The system shall meet applicable discharge criteria for 10-year and 25-year frequency storms. On-site storage and outlet capacity should be designed for the 25-year storm. Outlet capacity design should be checked and further refined, if necessary, for the 10-year storm.

13.1.2 Runoff Volume

For systems utilizing pumped discharges, the post-development discharge volume during the four day period beginning the third day of the four-day duration storm may not exceed the pre-development discharge during the same period.

13.1.3 Interbasin Diversion

(a) A system may not result in an increase in the amount of water being diverted from the Upper St. Johns River Hydrologic Basin into coastal receiving waters.

(b) It is an objective of the District to, where practical, curtail diversions of water from the Upper St. Johns River Hydrologic Basin into coastal receiving waters.

13.2 Ocklawaha River Hydrologic Basin

As part of the design criteria described in sections 62-330.301 and 62-330.302, F.A.C., above, systems in the Ocklawaha River Hydrologic Basin must meet the following criteria:

13.2.1 Storm Frequency

The system shall meet applicable discharge criteria for 10-year and 25-year frequency storms. On-site storage and outlet capacity should be designed for the 25-year storm. Outlet capacity design should be checked and further refined, if necessary, for the 10-year storm.

13.2.2 Runoff Volume

For systems utilizing pumped discharges, the post-development discharge volume during the four-day period beginning the third day of the four-day duration storm may not exceed the pre-development discharge during the same period.

13.3 Wekiva River Hydrologic Basin and Wekiva Recharge Protection Basin

As part of the standards and design criteria described in sections 62-330.301 and 62-330.302, F.A.C., above, systems in the Wekiva River Hydrologic Basin or the Wekiva Recharge Protection Basin (which are both shown in Figure 13.3-2) must meet the following standards and criteria as described below:

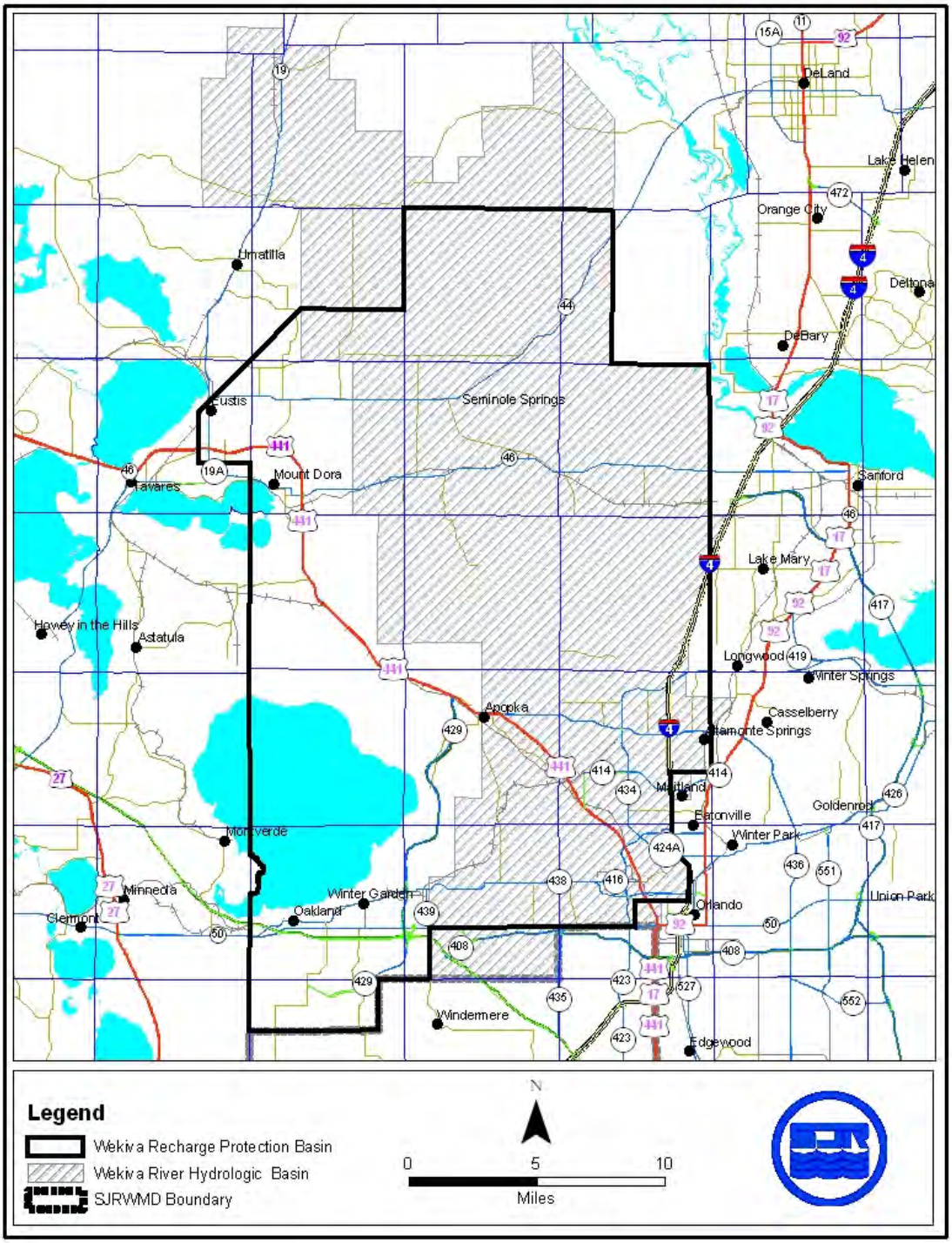
13.3.1 Recharge Standard

Applicants required to obtain a permit pursuant to Chapters 62-330 or 40C-44, F.A.C., for a surface water management system located within the Wekiva Recharge Protection Basin shall demonstrate that the system provides for retention storage of three inches of runoff from all impervious areas proposed to be constructed on soils defined as a Type "A" Soils as defined by the Natural Resources Conservation Service (NRCS) Soil Survey in the following NRCS publications: Soil Survey of Lake County Area, Florida (1975); Soil Survey of Orange County Area, Florida (1989); and Soil Survey of Seminole County Area, Florida (1990), which are incorporated by reference in rule 40C-4.091(1)(d), F.A.C. For purposes of this rule, areas with Type "A" Soils shall be considered "Most Effective Recharge Areas." The system shall be capable of infiltrating this storage volume through natural percolation into the surrounding soils within 72 hours. Off-site areas or regional systems may be utilized to satisfy this requirement. As an alternative, applicants may demonstrate that the post-development recharge capacity is equal to or greater than the pre-development recharge capacity. Pre-development recharge shall be based upon the land uses in place as of 12-3-06. Applicants may utilize existing permitted municipal master stormwater systems, in lieu of onsite retention, to demonstrate that post-development recharge is equal to or greater than pre-development recharge. Also, applicants may submit additional geotechnical information to establish whether or not a site contains Type "A" soils.

13.3.2 Storage Standard

Within the Wekiva River Hydrologic Basin, a system may not cause a net reduction in flood storage within the 100-year floodplain of a stream or other watercourse which has a drainage area upstream of more than one square mile and which has a direct hydrologic connection to the Wekiva or Little Wekiva Rivers or Black Water Creek.

Figure 13.3-2 Wekiva River Hydrologic Basin and Wekiva Recharge Protection Basin



13.3.3 Standards for Erosion and Sediment Control and Water Quality *Revised 6/1/18*

Construction and alteration of systems can result in erosion and downstream turbidity and sedimentation of waters. Erosion is the process by which the land surface is worn away by action of wind, water, and gravity. During construction and alteration, the potential for erosion increases dramatically. The result of erosion is discharges of turbid water and subsequent sedimentation (settling out) of soil particles in downstream receiving waters. Turbidity, suspended solids, and sedimentation result in adverse biological effects in aquatic and wetland environments, water quality degradation, and loss of flood storage and conveyance. The potential for erosion can be severe in the Wekiva River Hydrologic Basin as a result of steep slopes and erosive soils.

(a) Although erosion and sediment control measures are required throughout the St. Johns River Water Management District (see section 11.0 of Volume I), the District has determined that the problems associated with erosion in the Wekiva River Hydrologic Basin are sufficiently serious to warrant requiring those applicants proposing certain systems to provide detailed plans when permit applications are submitted.

A Water Quality Protection Zone shall extend one half mile from the Wekiva River, Little Wekiva River north of State Road 436, Black Water Creek, Rock Springs Run, Seminole Creek, and Sulphur Run, and shall also extend one quarter mile from any wetland abutting an Outstanding Florida Water.

An erosion and sediment control plan must be submitted as part of the surface water management permit application for a surface water management system which:

1. Serves a project which is located wholly or partially within this zone; or

2. Serves a project with a total land area equal to or exceeding 120 acres.

The applicant proposing such a system must give reasonable assurance in the erosion and sediment control plan that during construction or alteration of the system (including revegetation and stabilization), erosion will be minimized and sediment will be retained on-site. The plan must be in conformance with the erosion and sediment control principles set forth in section 13.8.2, and must contain the information set forth in section 13.8.3.

(b) For a project which will be located wholly or partially within 100 feet of an Outstanding Florida Water or within 100 feet of any wetland abutting such a water, an applicant must provide reasonable assurance that the construction or alteration of the system will not cause sedimentation within these wetlands or waters and that filtration of runoff will occur prior to discharge into these wetlands and waters.

It is presumed that this standard will be met if, in addition to implementation of the plan required in paragraph (a), any one of the following criteria is met:

1. A minimum 100-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. During construction or alteration, runoff (including turbid discharges from dewatering activities) must be allowed to sheetflow across this undisturbed vegetation as the natural topography allows. Concentrated or channelized runoff from construction or alteration areas must be dispersed before flowing across this undisturbed vegetation. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

2. Construction of the following perimeter controls at all outfall points to the Outstanding Florida Water or its abutting wetlands must be completed prior to the start of any construction or alteration of the remainder of the system:

   a. Stormwater discharge facility meeting the requirements of Part V of this Volume;

   b. Sedimentation trap or basin located immediately upstream of the stormwater discharge facility referred to above; and

   c. Spreader swale to reduce the velocity of discharge from the stormwater facility to non-erosive rates before discharge to wetlands abutting the Outstanding Florida Water.

   These perimeter controls must be maintained routinely and operated throughout construction or alteration of the entire system. A minimum 25-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

3. During construction or alteration, no direct discharge to the Outstanding Florida Water or its abutting wetland may occur during the 10-year 24-hour storm event or due to discharge from dewatering activities. Any on-site storage required to satisfy this criteria must be available (recovered) within 14 days following the rainfall event. A minimum 25-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

   In determining whether construction or alteration is of "limited scope necessary", pursuant to any of the three presumptive criteria above, the District shall require that the area of disturbance be minimized and that the length of time between initial disturbance and stabilization of the area also be minimized.

13.3.4 Standard for Limiting Drawdown

Lowering the ground water table adjacent to wetlands can change the wetland hydroperiod such that the functions provided by the wetland are adversely affected.

Within the Wekiva River Hydrologic Basin, a Water Quantity Protection Zone shall extend 300 feet landward of the landward extent of Black Water Swamp and the wetlands abutting the Wekiva River, Little Wekiva River, Rock Springs Run, Black Water Creek, Sulphur Run, Seminole Creek, Lake Norris, and Lake Dorr. As part of providing reasonable assurance that the standard set forth in paragraph 62-330.301(1)(d) is met, where any part of a system located within this zone will cause a drawdown, the applicant must provide reasonable assurance that construction, alteration, operation, or maintenance of the system will not cause ground water table drawdowns which would adversely affect the functions provided by the referenced wetlands.

The applicant shall provide an analysis which includes a determination of the magnitude and areal extent of any drawdowns, based on site-specific hydrogeologic data collected by the applicant, as well as a description of the referenced wetlands, the functions provided by these wetlands, and the predicted impacts to these functions.

It is presumed that the part of this standard regarding drawdown effects will be met if the following criteria is met:

A ground water table drawdown must not occur within the Water Quantity Protection Zone.

13.3.5 Standard for Riparian Wildlife Habitat

Within the Wekiva River Hydrologic Basin, the wetlands abutting the Wekiva River, Little Wekiva River downstream of Maitland Boulevard, Rock Springs Run, Black Water Creek, Sulphur Run and Seminole Creek support an abundance and diversity of aquatic and wetland dependent wildlife. Uplands abutting these wetlands protect the wetlands from climatic extremes and also provide important habitat for some aquatic and wetland dependent species. Construction and alteration of surface water management systems within these wetlands and uplands can result in adverse changes in the habitat, abundance, and food sources of aquatic and wetland dependent species.

(a) The applicant must provide reasonable assurance that the construction or alteration of a system will not adversely affect the abundance, food sources, or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species provided by the following designated Riparian Habitat Protection Zone:

1. The wetlands abutting the Wekiva River, Little Wekiva River downstream of Maitland Boulevard, Rock Springs Run, Black Water Creek, Sulphur Run, or Seminole Creek;

2. The uplands which are within 50 feet landward of the landward extent of the wetlands above.

3. The uplands which are within 550 feet landward of the stream's edge as defined, for the purpose of this subsection, as the waterward extent of the forested wetlands abutting the Wekiva River, Little Wekiva River downstream of the northernmost crossing of the Little Wekiva River with S.R. 434, Rock Springs Run, Black Water Creek, Sulphur Run or Seminole Creek. In the absence of forested wetlands abutting these streams, the stream's edge shall be defined, for the purpose of this subsection, as the mean annual surface water elevation of the stream; however, if hydrologic records are unavailable, the landward extent of the herbaceous emergent wetland vegetation growing in these streams shall be considered to be the stream's edge.

(b) Any of the following activities within the Riparian Habitat Protection Zone is presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and any land clearing which results in the creation of any system. (Activities not listed above do not receive a presumption of no adverse effect.)

(c) The presumption in paragraph (b) shall not apply to any activity which promotes a more endemic state, where the land in the zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with the endemic land cover.

13.3.6 Local Government Notification for Wekiva River Protection Area *Revised 6/1/18*

The District shall not issue a conceptual approval or individual permit for a proposed surface water management system located wholly or partially within the Wekiva River Protection Area, as defined in Section 369.303(9), F.S., until the appropriate local government has provided written notification that the proposed activity is consistent with the local comprehensive plan and is in compliance with land development regulations in effect in the area where development will take place. The applicant proposing such a system must submit to the District form no. 40C-41.063(4), entitled "Local Government Notification", (incorporated by reference in 40C-41.063(4)), after it has been completed and executed by the local government. This form is available upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529. Permit applications for systems within the Wekiva River Protection Area shall be processed by the District staff pursuant to the time frames established in Section 120.60, F.S., and any District rule regarding permit processing, except that any agency action to approve or approve with conditions shall not occur until the Local Government Notification has been received by the District.

13.4 Econlockhatchee River Hydrologic Basin

As part of the standards and design criteria described in 62-330.301 and 62-330.302, F.A.C., above, systems in the Econlockhatchee River Hydrologic Basin must meet the following standards and criteria:

13.4.1 Design Storm Criteria

Systems must meet the peak discharge requirement for the following 24-hour duration design storm events:

(a) Mean annual storm (2.3-year return period) with a total 24-hour rainfall depth of 4.5 inches.

(b) 25-year return period.

System outlet control structures can be designed to meet the control peak discharge rates for both design storms by use of a two-stage weir, v-notch weir, multiple orifices, or other similar structures.

13.4.2 Floodplain Storage Criteria *Revised 6/1/18*

A system must not cause a net reduction in flood storage within the 100-year floodplain of the Econlockhatchee River or any of its tributaries, at a location with an upstream drainage area of 1 square mile or greater, except for structures elevated on pilings or traversing works that comply with the conveyance requirements in subsection 3.3.2.

13.4.3 Riparian Wildlife Habitat Standard

The wetlands abutting the Econlockhatchee River and its tributaries support an abundance and diversity of aquatic and wetland dependent wildlife. Uplands abutting these wetlands protect the wetlands and provide important habitat for aquatic and wetland dependent species. Construction, alteration, operation, maintenance, removal or abandonment of surface water management systems within these wetlands and uplands can result in adverse changes in the habitat, diversity, abundance and food sources of aquatic and wetland dependent species. Implementation of these regulations should be done in a manner which encourages development of functional resource protection plans.

(a) The applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a system within the following designated Riparian Habitat Protection Zone will not adversely affect the abundance, diversity, food sources or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species:

1. The wetlands contiguous with the Econlockhatchee River and the following tributaries: Little Econlockhatchee River north of University Boulevard, Mills Creek, Silcox Branch (branch of Mills Creek), Mills Branch (branch of Mills Creek), Long Branch, Hart Branch, Cowpen Branch, Green Branch, Turkey Creek, Little Creek, and Fourmile Creek;

2. The uplands which are within 50 feet landward of the landward extent of the wetlands above; and

3. The uplands which are within 550 feet landward of the stream's edge as defined, for the purpose of this subsection, as the waterward extent of the forested wetlands abutting the Econlockhatchee River and the above named tributaries. In the absence of forested wetlands abutting these streams, the stream's edge shall be defined, for the purpose of this subsection, as the mean annual surface water elevation of the stream; however, if hydrologic records are unavailable, the landward extent of the herbaceous emergent wetland

vegetation growing in these streams shall be considered to be the stream's edge.

4. The following portions of streams typically lack a defined water's edge, and subparagraph 3. shall not apply:

   a. Mills Creek upstream of the intersection of the creek with the Fort Christmas Road in Section 2, Township 22 South, Range 32 East;

   b. Long Branch upstream of the intersections of the creek with SR 520;

   c. Hart Branch upstream of the intersection of the creek and the Old Railroad Grade in Section 18, Township 23 South, Range 32 East;

   d. Cowpen Branch upstream of the southernmost bifurcation of the creek in Section 20, Township 23 South, Range 32 East;

   e. Green Branch upstream of the intersection of the creek with the north-south section line between Section 29 and 30, Township 23 South, Range 32 East;

   f. Turkey Creek including Turkey Creek Bay upstream of the intersection of the creek with the Weewahootee Road in Section 5, Township 24 South, Range 32 East;

   g. Little Creek upstream of the intersection of the creek with the north-south section line between Sections 22 and 23, Township 24 South, Range 32 East;

   h. Fourmile Creek including Bee Tree Swamp upstream of a point along the creek exactly halfway between section lines at the south end of Section 21 and the north end of Section 33 within Section 28, Township 24 South, Range 32 East; and

   i. All of the Econlockhatchee River Swamp (a portion of the Econlockhatchee River).

(b) Any of the following activities within the Riparian Habitat Protection Zone are presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and

any land clearing which results in the creation of any system. (Activities not listed above do not receive a presumption of no adverse effect.)

(c) The presumption in paragraph (b) shall not apply to any activity which promotes a more endemic state, where the land in the zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with endemic land cover.

(d) Applicants seeking to develop within the Riparian Habitat Protection Zone shall be given the opportunity to demonstrate that the particular development for which permitting is being sought will not have an adverse effect on the functions provided by the zone to aquatic or wetland dependent species. The functions provided by the zone are dependent on many factors. When assessing the value of the zone to aquatic and wetland dependent species, factors which the District will consider include: vegetative land cover, hydrologic regime, topography, soils, and land uses, existing within and adjacent to the zone; and range, habitat, and food source needs of aquatic and wetland dependent species, as well as sightings, tracks, or other such empirical evidence of use.

(e) The standard of paragraph 13.4.3(a) may be met by demonstrating that the overall merits of the proposed plan of development, including the preservation, creation or enhancement of viable wildlife habitat, provide a degree of resource protection to these types of fish and wildlife which offsets adverse effects that the system may have on the abundance, diversity, food sources, or habitat of aquatic or wetland dependent species provided by the zone. Mitigation plans will be considered on a case-by-case basis upon detailed site specific analyses. The goal of this analysis shall be the determination of the value of the proposed mitigation plan to aquatic and wetland dependent species with particular attention to threatened or endangered species. Mitigation plans should include: the information set forth in section 10.3.3 Applicant's Handbook Volume I for the uplands and wetlands within the zone and within other areas to be preserved, created or enhanced as mitigation for impacts within the zone; as well as other pertinent information, including land use, and the proximity of the site to publicly owned land dedicated to conservation. Implementation of this section contemplates that the proximity of development to the river and tributaries named herein and activities permitted in the zone may vary from place to place in support of a functional resource protection plan. Furthermore, some reasonable use of the land within the protection zone can be allowed under subsection 13.4.4.

(f) Roads or other traversing works which cross the zone have the potential to fragment the zone and adversely affect the habitat value of the zone to aquatic and wetland dependent species. To minimize adverse effects to the

zone, applicants for permits to construct traversing works in the zone must first demonstrate the need for the traversing works to provide for regional transportation, regional utility services, or reasonable property access, in addition to meeting the requirement of paragraph 13.4.3(a), above. Traversing works must also be designed to meet all requirements of the district rules related to water quality and quantity. Permittees responsible for traversing works shall be required to be responsible for maintaining the traversing works clean and free from trash and debris to the greatest extent practical.

13.4.4 Off-site Land Preservation as Mitigation in the Econlockhatchee River Hydrologic Basin. *Revised 6/1/18*

Mitigation in the Econlockhatchee River Hydrologic Basin must offset any adverse impacts of the system to the functions provided by the Econlockhatchee River Riparian Habitat Protection Zone and wetlands outside this zone, to aquatic and wetland dependent species. The lands proposed for preservation must be regionally significant or provide unique fish and wildlife habitat. For the purposes of this section the land to be preserved must be located entirely within the Econlockhatchee River Basin as designated in section 40C-41.023, F.A.C., and the applicant must propose to convey the land in fee simple to the St. Johns River Water Management District or a mutually acceptable designee. Alternatively, a perpetual conservation easement or other acceptable legal instrument may be conveyed to the District or a mutually acceptable designee in accordance with section 704.06, F.S. All of the following requirements will apply to off-site land preservation proposals within the Econlockhatchee River Basin:

(a) Prior to proposing off-site land preservation, the applicant must demonstrate that alternatives for avoiding adverse impacts to the functions provided by the Riparian Habitat Protection Zone and wetlands outside the zone have been evaluated, and that to the maximum extent practicable, adverse impacts to these functions have been avoided.

(b) As a part of an off-site land preservation proposal, the applicant must demonstrate that the proposal meets the standard described in paragraph 13.4.3(a) by providing a functional analysis, as described in paragraph 13.4.3(c), of the proposed impacts within the Riparian Habitat Protection Zone and the benefits of the proposed preservation area. If adverse impacts occur to wetlands, then as part of an off-site land preservation proposal, the applicant must demonstrate that the proposal meets the criteria described in section 10.3.3, Applicant's Handbook Volume I.

(c) The functional gain afforded by the preservation will depend upon the functional analysis of impacts and benefits. The suitability of this mitigation option will be determined on a case-by-case basis based on site-specific information.

13.5 Tomoka River and Spruce Creek Hydrologic Basins

As part of the standards and design criteria described in 62-330.301 and 62-330.302, F.A.C., systems within the Tomoka River Hydrologic Basin or the Spruce Creek Hydrologic Basin must meet the following standards and criteria:

13.5.1 Recharge Standard

Projects, or portions of projects, in the Most Effective Recharge Areas must retain three (3) inches of runoff from the directly connected impervious area within the Most Effective Recharge Area of the project area. As an alternative, applicants may demonstrate that the post-development recharge capacity will be equal to or greater than the pre-development recharge capacity.

Most Effective Recharge Areas, as used in this section, are areas which have 10-20 inches of recharge per year. Most Effective Recharge Areas can be more accurately defined by soils types. Those areas with Type "A" Hydrologic Soil Group shall be considered to be Most Effective Recharge Areas. Figures 13.5-1 and Figure 13.5-2 show the approximate location of the Most Effective Recharge Area in the Tomoka River and Spruce Creek Hydrologic Basins.

Section 13.8.1 contains a list of Type "A" soils for Flagler and Volusia counties. This list will be used to determine whether a proposed project, or portion of a project, is in the Most Effective Recharge Area. Also, applicants may submit additional geotechnical information to establish whether or not a site contains Type "A" soils and is within the Most Effective Recharge Area.

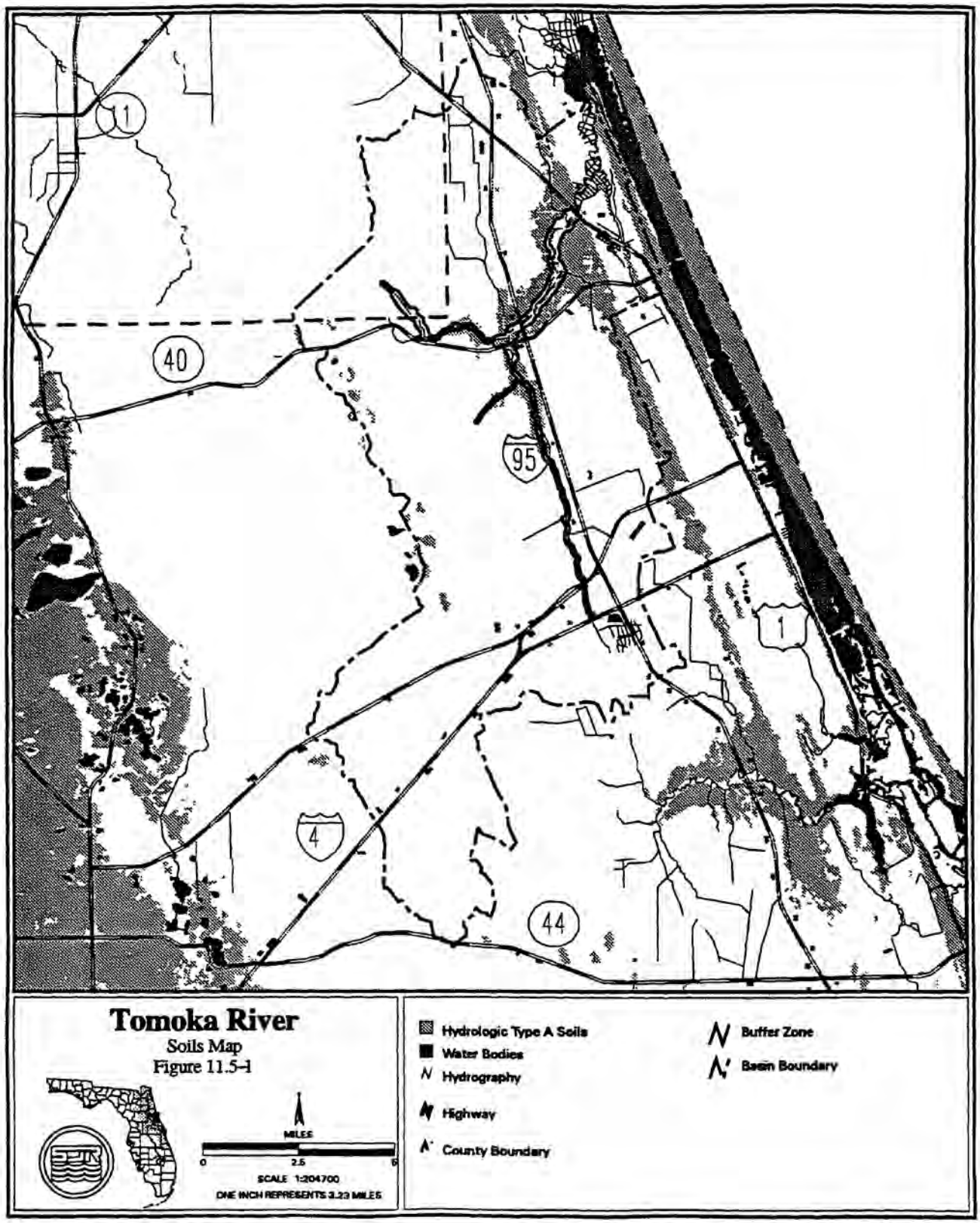


Figure 13.5-1 Tomoka River Soils Map

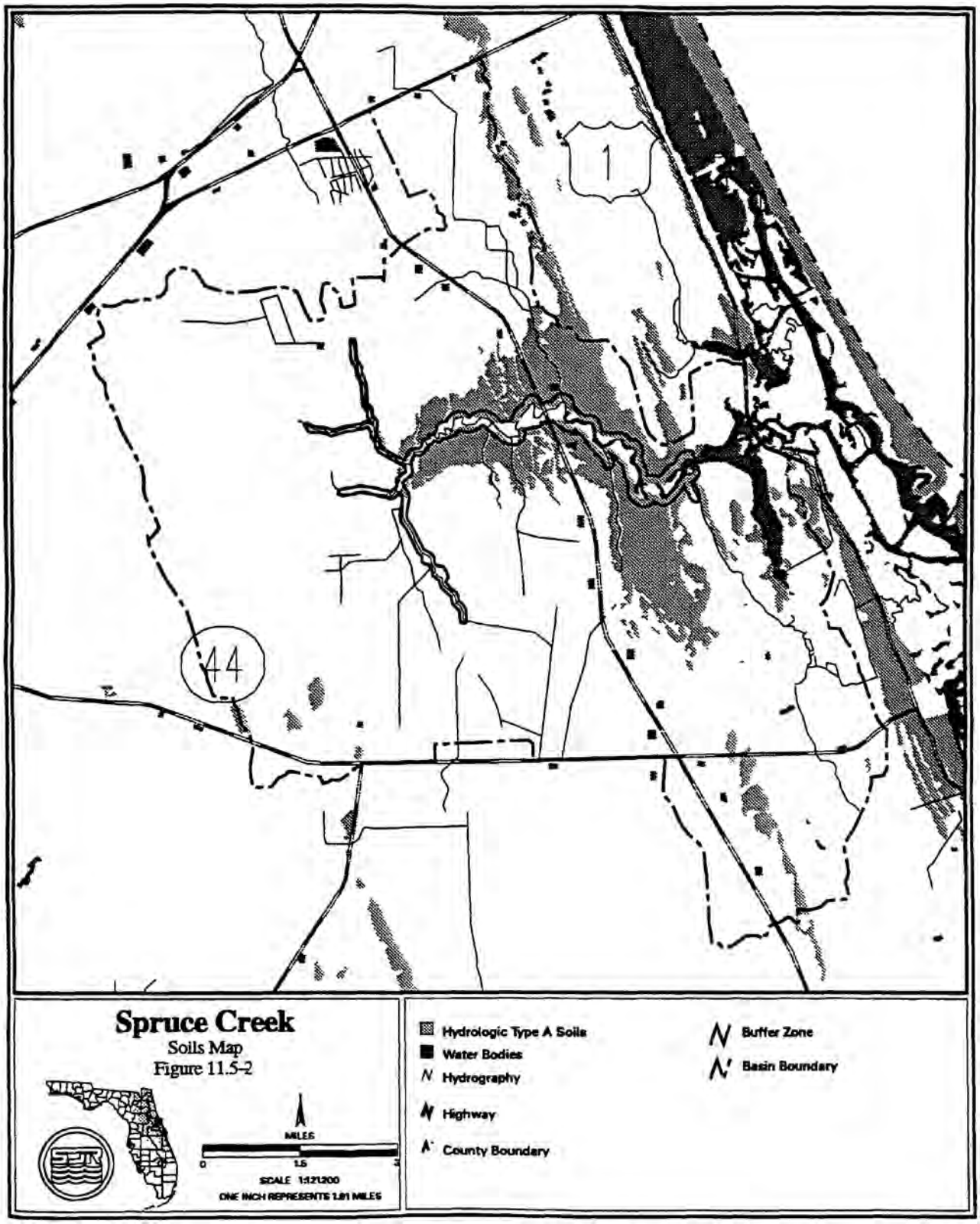


Figure 13.5-2 Spruce Creek Soils Map

Directly connected impervious areas are those impervious areas, which are connected to the surface water management system by a drainage improvement, such as a ditch, storm sewer, paved channel, or other man-made conveyance. Stormwater that is retained must be infiltrated into the soil or evaporated such that the storage volume is recovered within 14 days following the storm event.

13.5.2 Floodplain Storage Criteria

Systems constructed in the 100-year floodplain have the potential to increase flood stages on adjacent property. A system must not cause a net reduction in flood storage within the 100-year floodplain of the Tomoka River or Spruce Creek or any of their tributaries except for structures elevated on pilings or traversing works that comply with conveyance requirements in subsection 3.3.2.

13.5.3 Stormwater Management Standard

Construction of new stormwater management systems must be in accordance with the design and performance standards of Part V of this Volume. However, systems which serve drainage areas in excess of 10 acres cannot use detention with filtration treatment as the sole stormwater treatment methodology. Additionally, when retention systems are not feasible due to limited percolation capacity, wet detention treatment or other treatment demonstrated to be equivalent to retention or wet detention, in accordance with Part V of this Volume, must be used.

13.5.4 Riparian Wildlife Habitat Standard

The wetlands abutting the Tomoka River and Spruce Creek and their tributaries support an abundance and diversity of aquatic and wetland dependent wildlife. Uplands abutting these wetlands protect the wetlands and provide important habitat for aquatic and wetland dependent species. Construction, alteration, operation, maintenance, removal or abandonment of surface water management systems within these wetlands and uplands can result in adverse changes in the habitat, diversity, abundance and food sources of aquatic and wetland dependent species. Implementation of these regulations should be done in a manner which encourages development of functional resource protection plans.

(a) The applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a system within the following designated Riparian Habitat Protection Zone will not adversely affect the abundance, diversity, food sources or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species:

1. The wetlands and uplands which are within 50 feet landward of the landward extent of the wetlands which abut Spruce Creek north of

Pioneer Trail to the FEC railroad, and the Tomoka River north of I-4 to US 1 and the following tributaries:

a. Spruce Creek east of the western section line of Section 35, Township 16 South, Range 32 East, Volusia County, Florida.

b. Spruce Creek east of the power line easement in Section 27, Township 16 South, Range 32 East, Volusia County, Florida.

c. Spruce Creek west of SR 415 and south of the northern section line of Section 23, Township 16 South, Range 32 East, Volusia County, Florida.

d. The Little Tomoka River north of SR 40 in Volusia County and south of the western section line of Section 22, Range 31 East, Township 14 South, Flagler County.

e. Priest Branch east of the power line easement in Section 6, Township 15 South, Range 32 East, Volusia County, Florida.

2. The uplands which are within 550 feet landward of the stream's edge of the following portions of the streams. The stream's edge is defined, for the purpose of this subsection, as the waterward extent of the wetlands abutting the stream:

a. Spruce Creek north of the southern section line of Section 25, Range 32 East, Township 16 South, Volusia County, Florida;

b. Tomoka River north of the confluence of the Tomoka River and Priest Branch; and

3. The uplands which are within 320 feet landward of the stream's edge of the following stream. The stream's edge is defined, for the purpose of this subsection, as the waterward extent of the wetlands abutting the stream:

a. Spruce Creek east of I-95 and west of the FEC railroad; and

4. The uplands that are within 275 feet landward of the edge of the following streams:

a. Spruce Creek south of the southern section line of Section 25, Range 32 East, Township 16 South, Volusia County, Florida;

b. Spruce Creek east of the western section line of Section 35, Township 16 South, Range 32 East, Volusia County, Florida.

c. Spruce Creek east of the power line easement in Section 27, Township 16 South, Range 32 East, Volusia County, Florida.

d. Spruce Creek west of SR 415 and south of the northern section line of Section 23, Township 16 South, Range 32 East, Volusia County, Florida.

e. The Tomoka River south of the confluence of the Tomoka River and Priest Branch in section 36, Range 31 East, Township 14 South, Volusia County, Florida;

f. The Little Tomoka River north of SR 40, Volusia County, and south of the western section line of Section 22, Range 31 East, Township 14 South, Flagler County, Florida.

g. Priest Branch east of the power line easement in Section 6, Township 15 South, Range 32 East, Volusia County, Florida.

(b) Any of the following activities within the Riparian Habitat Protection Zone are presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the Zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and any land clearing which results in the creation of any system (activities not listed above do not receive a presumption of no adverse effect.)

(c) The presumption in paragraph (b) shall not apply to any activity which promotes a more endemic state, where the land in the Zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with endemic land cover.

(d) The standard of subsection 13.5.4(a) may be met by demonstrating that the overall merits of the proposed plan of development, including mitigation as described in section 10.3, Applicant's Handbook Volume I provide a degree of resource protection to these types of fish and wildlife which offsets adverse effects of the proposed system on the uplands and wetlands within the Zone. Some reasonable use of the land within the Zone can be allowed under subsection 13.5.4.

(e) Roads or other traversing works which cross the Zone have the potential to fragment the Zone and adversely affect the habitat value of the Zone to aquatic and wetland dependent species. To minimize adverse effects to the Zone, applicants for permits to construct traversing works in the Zone must

first demonstrate the need for the traversing works to provide for regional transportation, regional utility services, or reasonable property access, in addition to meeting the requirement of subsection 13.5.4(a), above. Traversing works must also be designed to meet all requirements of the district rules related to water quality and quantity.

13.6 Sensitive Karst Areas Basin Design Criteria

Chapter 40C-41, F.A.C., establishes additional surface water management criteria which are used in reviewing applications for permits in designated hydrologic basins. The Sensitive Karst Areas Basin covers those portions of western Alachua and western Marion counties within the District's boundaries (Figures 13.0-3 and 13.0-4). The design criteria for the Sensitive Karst Areas Basin are found in subsection 40C-41.063(6), F.A.C., and are discussed below.

13.6.1 Background of the Sensitive Karst Areas Design Criteria

The Floridan aquifer is the drinking water source for most of the population in the District. In parts of Alachua and Marion counties, the limestones that make up or comprise this aquifer are at or very near the land surface and potential sources of pollution. Potential contamination of the Floridan aquifer from surface pollutant sources in these areas is greater than within the rest of the District due to the hydrogeology and geology of these "sensitive karst areas." "Karst" is a geologic term used to describe areas where sinkhole formation is common and landscapes are formed by the solution of limestone.

13.6.2 Hydrogeology of the Sensitive Karst Areas Basin

Throughout the majority of the District the highly porous limestone which contains the Floridan aquifer is overlain by tens to hundreds of feet of sands, clays, and other material. This material acts as a buffer, isolating the Floridan aquifer from surface pollutants. Surface water seeps through this material slowly which allows for filtration, adsorption, and biological removal of contaminants.

However, in the Sensitive Karst Areas (SKA) the limestone which contains the Floridan aquifer exists at, or virtually at, land surface (Figure 13.6-1). The absence of cover material allows rapid movement of surface water into the aquifer with little treatment. The SKA are areas of high recharge for the Floridan aquifer. Floridan aquifer ground water levels vary from land surface to approximately 60 feet below land surface in the SKA.

A factor which makes the SKA particularly prone to stormwater contamination is the formation of solution pipe sinkholes. Solution pipe sinkholes are common in these areas and form due to the collapse of surficial material into vertical cavities that have been dissolved in the upper portion of the limestone (Figure 13.6-1). They are also formed by the movement of surface material into the porous limestone of

the SKA. In most cases, the solution pipes are capped by a natural plug of sands and clays (Figures 13.6-1 and 13.6-2). If the cap is washed out, the resulting solution pipe sinkhole (Figure 13.6-3) can act as a direct avenue for the movement of inadequately treated stormwater into the Floridan aquifer.

Solution pipe sinkholes often form in the bottom of stormwater retention basins. The capping plug may be reduced by excavation of the pond. Stormwater in the basin may increase the hydraulic head on the remaining plug. Both of these factors can wash the plug down the solution pipe. Solution pipes act as natural drainage wells and can drain stormwater basins.

The irregular weathering of the limestone surface in the SKA causes uncertainty and errors in determining the depth from land surface to limestone. For example, in Figure 13.6-1, boring A would show limestone much deeper than it would actually be encountered during excavation, shown at boring B. This potential for error must be considered for site investigations when evaluating site borings.

The SKA has been delineated within the District using two criteria:

(a) The area is a major recharge area, defined by the United States Geological Survey (USGS) as 10 to 20 inches annual recharge, for the Floridan aquifer.

(b) The porous limestone of the Floridan aquifer occurs within 20 feet of the land surface.

Delineations were made using the best available data, including boring and geologic data from the District, the Florida Geologic Survey, and the USGS. As additional data becomes available, the delineation of these areas can be further refined if needed. A generalized map of the SKA is shown in Figure 13.0-2; detailed maps are provided in Figures 13.0-3 and 13.0-4. If needed, maps of the SKA on USGS Quad Sheets are available for viewing in the Palatka and Maitland offices.

13.6.3 Design Criteria for Sensitive Karst Areas *Revised 6/1/18*

The stormwater system should be designed to assure adequate treatment of the water before it enters the Floridan aquifer. The system design should prevent the formation of solution pipe sinkholes in the basins. To protect the Floridan aquifer, the District requires the following minimum design features for all projects in the SKA:

(a) A minimum of three feet of unconsolidated soil material between the surface of the limestone bedrock and the bottom and sides of the stormwater basin. Excavation and backfill of suitable material may be made to meet this criteria. This provides reasonable assurance of adequate treatment of stormwater before it enters the Floridan aquifer.

(b) Stormwater storage areas should be as shallow as possible with a horizontal bottom (no deep spots). In general, the size of a stormwater storage basin can be minimized by providing retention throughout the project site by using shallow landscaped areas and swales.

(c) Maximum basin depth of 10 feet. (Items (b) and (c) reduce the potential for solution pipe sinkhole formation caused by a large hydraulic head.)

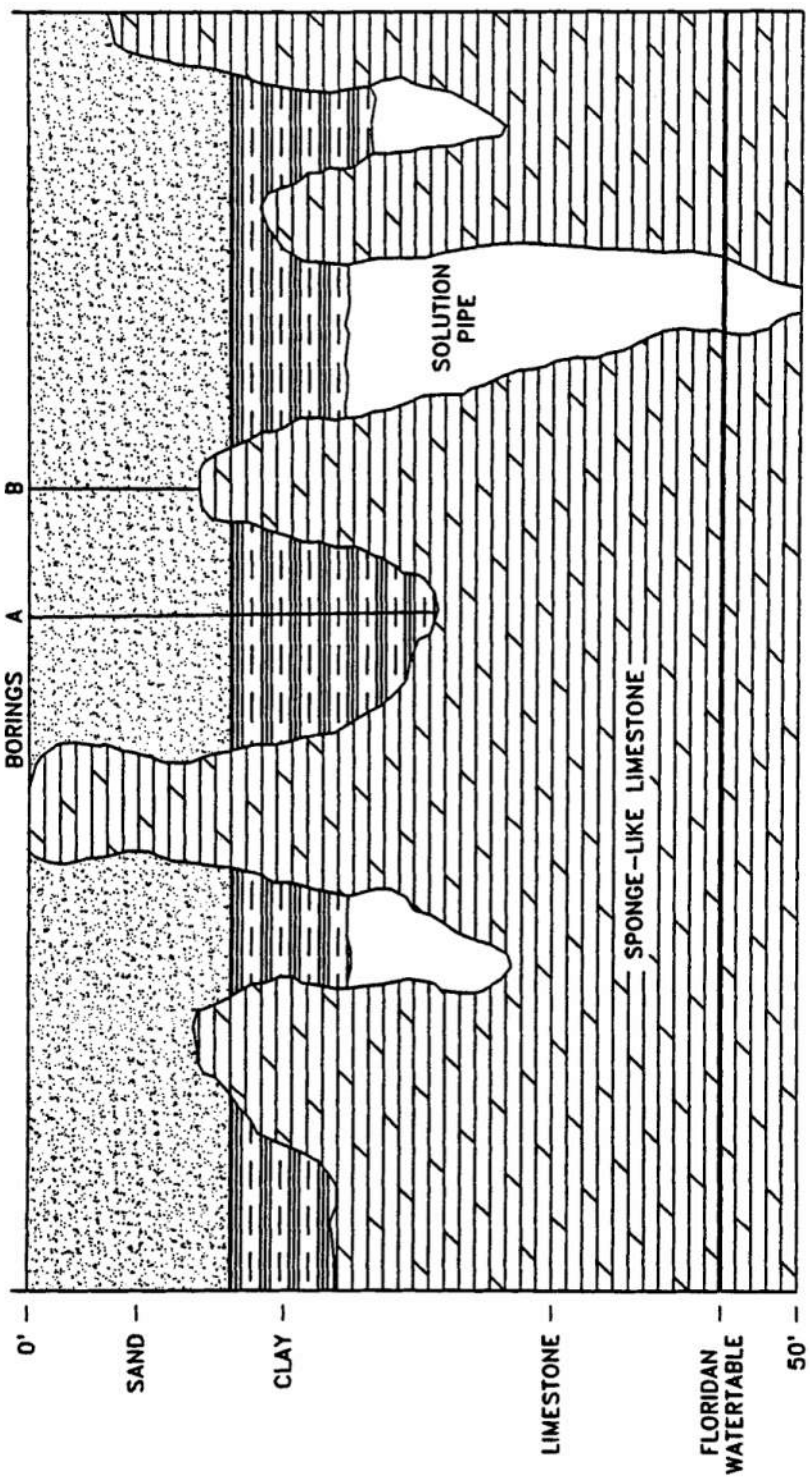


Figure 13.6-1 Generalized geologic section in karst sensitive area

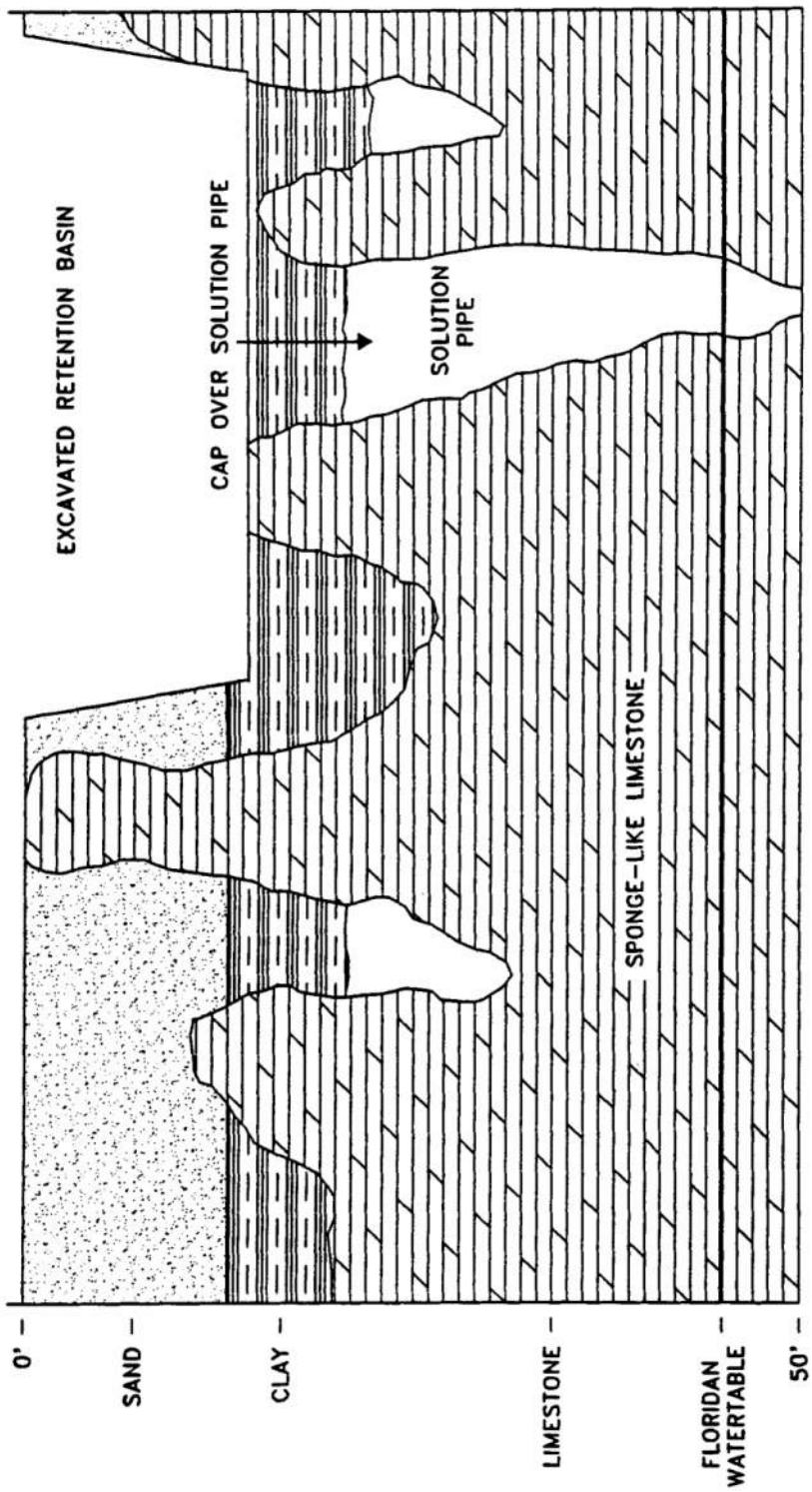
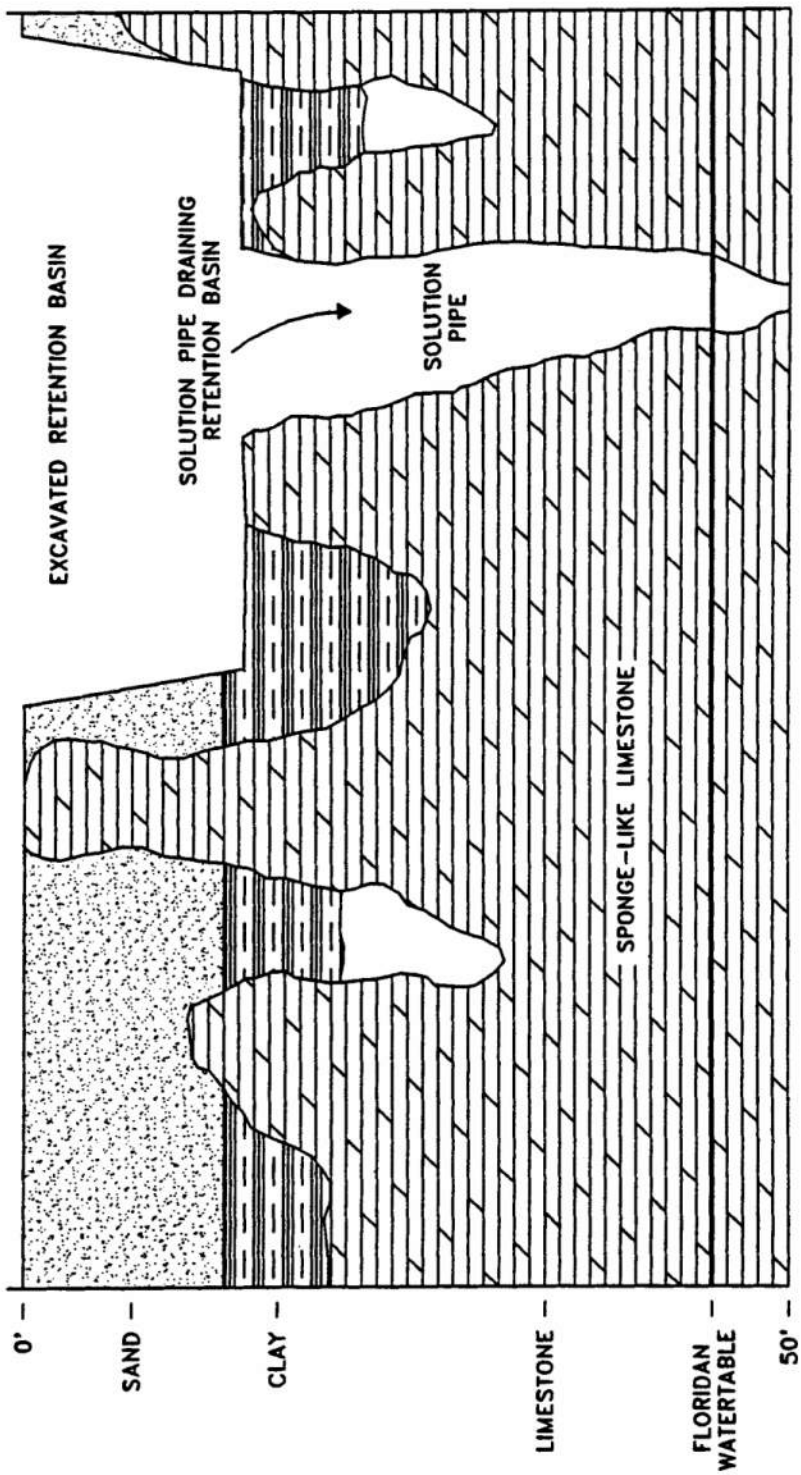


Figure 13.6-2 Generalized geologic section in karst sensitive area with excavated retention basin

Figure 13.6-3. Generalized geologic section in karst sensitive area with excavated retention basin



(d) Fully vegetated basin side slopes and bottom. Vegetation plays a critical role in the removal of contaminants from stormwater and stabilization of side slopes. In the SKA, droughty, highly alkaline soils are common and prevent successful establishment of commonly used grasses such as bahia. Typically poor survival of vegetation in stormwater basins in the SKA has demonstrated the need for mat-forming vegetation which can tolerate these conditions.

Two species of grasses are best suited for use in retention basins in the SKA. These grasses are discussed below:

St. Augustine: This grass can tolerate high alkalinity and brief inundation. However, irrigation is required to foster a healthy cover during dry periods.

Bermuda: This grass can grow in alkaline conditions, is drought resistant, and can stand brief inundation. It is also a low maintenance species which provides excellent cover and soil stabilization. Bermuda grass grows in a thick mat, eventually covering all exposed soil. It recovers quickly after even extended drought. Mowing is rarely required because bermuda creeps laterally rather than growing vertically. Seed is available commercially and is inexpensive.

The above conditions represent the minimum design requirements for systems in the SKA. Depending on the potential for contamination to the Floridan aquifer, more stringent criteria may apply. Industrial and some commercial sites will normally require more stringent design features. Some of the more stringent site-specific design requirements which may be necessary include:

(a) More than 3 feet of material between the limestone bedrock surface and the bottoms and sides of retention basins

(b) Basin liners (Clay or geotextile)

(c) Sediment trapping structures at stormwater inlets

(d) Off-line treatment

(e) Special stormwater system design

(f) Ground water monitoring

(g) Paint/solvent and water separators

If the design of the proposed stormwater management systems does not include the minimum design criteria discussed in this section, an analysis must be submitted to the District that provides reasonable assurance that the ground water quality standards as set forth in chapter 62-520, F.A.C., (incorporated by reference in 40C-4.091(1)(c), F.A.C.) are met.

13.7 Lake Apopka Hydrologic Basin *Revised 6/1/18*

(a) Pursuant to section 373.461(3)(a), F.S., the total phosphorus criterion for Lake Apopka is 55 parts per billion. To meet this total phosphorus criterion, the applicant must provide reasonable assurance of compliance with the following total phosphorus discharge limitations and comply with the relevant monitoring requirements in section 13.7(b) and relevant inspection requirements of section 13.7(c):

(1) Sites Within Lake Apopka Hydrologic Basin

Applicants required to obtain a permit pursuant to chapters 62-330 or 40C-44, F.A.C., for a surface water management system located within the Lake Apopka Hydrologic Basin shall demonstrate: (i) that the system provides stormwater treatment equivalent to or greater than any of the applicable stormwater treatment options contained in Table 13.7-1 for the removal of total phosphorus; (ii) that the post-development total phosphorus load discharged from the project area will not exceed the pre-development total phosphorus load discharged from the project area; or (iii) that the system, under the soil moisture conditions described in section 3.2.8(a), will not discharge water to Lake Apopka or its tributaries for the 100-year, 24-hour storm event. Systems described under section 13.7(a)(1)(iii) shall be considered to discharge to a land-locked lake that must meet the criteria in section 3.2. Any alteration of a system originally permitted pursuant to section 13.7(a)(1)(iii) which results in an increase in discharge of water to Lake Apopka or its tributaries shall be considered an interbasin diversion that must meet the criteria in sections 13.7(a)(2) and 13.7(b)(4).

(2) Interbasin Diversion of Water to Lake Apopka Hydrologic Basin

Applicants required to obtain a permit pursuant to chapters 62-330 or 40C-44, F.A.C., for a surface water management system that will cause the importation of water from another hydrologic basin into the Lake Apopka Hydrologic Basin shall not discharge any phosphorus from the project area to Lake Apopka or its tributaries, unless the applicant implements measures to reduce the existing total phosphorus load to Lake Apopka or its tributaries from another existing source by at least an equivalent amount of total

phosphorus. The imported water shall consist only of stormwater runoff. The imported water shall not be discharged to Lake Apopka or its tributaries when the water level of Lake Apopka is in Zone A of the Lake Apopka Regulation Schedule set forth in Figure 13.7-2. All measures to reduce existing phosphorous loads to Lake Apopka or its tributaries must be constructed and operating in compliance with the environmental resource permit prior to any importation of water into the Lake Apopka Hydrologic Basin. Measures that reduce existing phosphorous loads to Lake Apopka or its tributaries shall not include those measures taken on the District's land.

(3) Methodology for Determining Total Phosphorus Loads.

Determination of Pre-Development Total Phosphorus Loads.

Pre-development total phosphorus loads shall be based upon the land uses in place as of March 7, 2003. For systems which have been constructed in accordance with a permit issued pursuant to chapters 62-330 or 40C-44, F.A.C., at the permit applicant's option, the pre-development total phosphorus loads shall be based upon the land uses in place at the time the prior permit was issued. Pre-development total phosphorus loads shall be determined by: monitoring the total phosphorus loads from the project area for a period of one year prior to construction, alteration, abandonment, or removal of the proposed or existing system; calculating total phosphorus loads using the appropriate mean annual total phosphorus loadings in Table 13.7-3, or calculating total phosphorus loads for pre-development land uses not listed in Table 13.7-3 using mean annual total phosphorus loadings from the scientific literature. When the pre-development total phosphorus loads are determined by monitoring, the calculation of pre-development total phosphorus loads shall be adjusted by interpolation or extrapolation to reflect mean annual rainfall conditions.

Determination of Post-Development Total Phosphorus Loads.

Post-development total phosphorus loads shall be based upon the land uses proposed in the permit application and shall be determined by: calculating total phosphorus loads using the appropriate mean annual total phosphorus loadings in Table 13.7-3 and then reducing the total phosphorus load according to the appropriate total phosphorus removal efficiency values for systems listed in Tables 13.7-4 through 13.7-33. For purposes of Tables 13.7-4 and 13.7-6 through 13.7-33, the term "retention" includes stormwater harvesting and underdrain and underground exfiltration trench systems as those terms are defined in section 2.1 of this Volume. The calculation of total phosphorus loads for post-development land uses not listed in Table 13.7-3 or total phosphorus removal efficiency values for

systems not listed in Tables 13.7-4 through 13.7-33 may be calculated using mean annual total phosphorus loadings and total phosphorus removal efficiency values from the scientific literature.

(b) Monitoring

(1) Monitoring for Retention Systems.

A surface water management system to be permitted under section 13.7(a)(1)(i) which utilizes only retention, shall be monitored as set forth in this paragraph. Water elevations in such a system shall be monitored from the date that construction of the system is completed or any part of the system is used for its intended purpose, whichever is sooner. The monitoring shall continue for three years following completion of construction of the entire system, including all associated residential, commercial, transportation, or agricultural improvements. If the results of the monitoring indicate that the system is not recovering the treatment volume in accordance with the permitted design, then the permittee shall either perform maintenance on the system, or obtain a modification to the permit and implement measures, to bring the system into compliance, and in either event the monitoring shall continue for three years after the date the system is brought into compliance.

(2) Monitoring for Systems Permitted Under Section 13.7(a)(1)(iii).

A surface water management system to be permitted under section 13.7(a)(1)(iii), shall be monitored as set forth in this paragraph. Water elevations in such a system shall be monitored from the date that construction of the system is completed or any part of the system is used for its intended purpose, whichever is sooner. The monitoring in such a system shall continue for ten years following completion of construction of the entire system, including all associated residential, commercial, transportation, or agricultural improvements. If the results of the monitoring indicate that either the system is not recovering storage in accordance with the permitted design or causes water to be discharged to Lake Apopka or its tributaries for events less than the 100-year, 24-hour storm event, then the permittee shall either perform maintenance that brings the system into compliance or obtain a modification to the permit and implement measures to bring the system into compliance, and in either event the monitoring shall continue for three years after the date the system is brought into compliance.

(3) Monitoring for Other Systems

A surface water management system to be permitted, other than a system described in sections 13.7(b)(1), 13.7(b)(2) or 13.7(b)(4), shall be

monitored as set forth in this paragraph. Except as provided below, the total phosphorus load from the project area shall be monitored from the date that construction of such a system is completed or any part of the system is used for its intended purpose, whichever is sooner. The monitoring shall continue for three years following completion of construction of the entire system, including all associated residential, commercial, transportation, or agricultural improvements. If the results of the monitoring indicate that post-development total phosphorus loads exceed pre-development total phosphorus loads, then the permittee shall either perform maintenance on the system, or obtain a modification to the permit and implement measures, to reduce the total phosphorus loads to no more than pre-development levels, and, in either event, the monitoring shall continue for three years after the date the system is maintained or modified as described herein.

No monitoring shall be required under section 13.7(b)(3) when an applicant demonstrates that the system provides stormwater treatment equivalent to or greater than any of the applicable stormwater treatment options contained in Table 13.7-1 for the removal of total phosphorus. Alternatively, no monitoring shall be required under section 13.7(b)(3) when an applicant demonstrates that the post-development total phosphorus load discharged from the project area will not exceed the pre-development total phosphorus load discharged from the project area when determined using the appropriate mean annual total phosphorus loadings and total phosphorus removal efficiency values from Tables 13.7-3 through 13.7-33.

(4) Monitoring for Interbasin Diversion of Water to Lake Apopka Hydrologic Basin

A surface water management system to be permitted under section 13.7(a)(2) shall be monitored as set forth in this paragraph. The total phosphorus load shall be monitored from: (i) any system designed to reduce the existing total phosphorus load to Lake Apopka or its tributaries, and (ii) the system that is importing water to the Lake Apopka Hydrologic Basin. Monitoring of the system that is importing water to the Lake Apopka Hydrologic Basin shall commence from the date that construction of such system is completed or any part of the system is used for its intended purpose, whichever is sooner. Monitoring of systems designed to reduce the existing total phosphorus load to Lake Apopka or its tributaries shall commence from the date that construction of such system is completed. Monitoring shall continue for as long as water is imported from the system to the Lake Apopka Hydrologic Basin. If monitoring results indicate that the reductions in total phosphorus load are less than that in the imported water, then the permittee shall either perform

maintenance or obtain a permit modification to bring the system(s) into compliance.

(c) Inspecting Systems

Systems subject to the inspection requirements in section 62-330.311, F.A.C., and which are also subject to the phosphorus discharge limitations in section 13.7(a), shall be inspected by the operation and maintenance entity within one year after completion of construction and every year thereafter.

TABLE 13.7-1

STORMWATER TREATMENT CRITERIA TO ACHIEVE NO NET INCREASE IN POST-DEVELOPMENT LOADINGS WITHIN THE LAKE APOPKA HYDROLOGIC BASIN

LAND USE CATEGORY	HYDROLOGIC SOIL GROUP	RETENTION[1] ONLY[2]	RETENTION[1]/ WET DETENTION OPTION[3]
Low-Density Residential (max. 15% impervious)	A	2.75"	1.00"/14 days
	B	1.75"	0.50"/14 days
	C	1.25"	0.50"/14 days
	D	1.00"	0.25"/14 days
Single-Family Residential (max. 25% impervious)	A	2.75"	1.00"/14 days
	B	2.00"	0.75"/14 days
	C	1.75"	0.75"/14 days
	D	1.50"	0.50"/14 days
Single-Family Residential (max. 40% impervious)	A	3.75”	1.25"/14 days
	B	3.00"	1.00"/14 days
	C	2.00"	0.75"/14 days
	D	1.50"	0.50"/14 days
Multi-Family Residential (max. 65% impervious)	A	4.00”	2.50"/14 days
	B	3.75"	2.00"/14 days
	C	3.25"	1.75"/14 days
	D	2.75"	1.50"/14 days
Commercial (max. 80%impervious)	A	4.00”	2.75"/14 days
	B	3.75"	2.25"/14 days
	C	2.75"	1.50"/14 days
	D	2.25"	1.25"/14 days
Highway (max. 50% impervious)	A	4.00"	2.00"/14 days
	B	3.00"	1.50"/14 days
	C	2.50"	1.25"/14 days
	D	2.25"	1.00"/14 days
Highway (max. 75% impervious)	A	4.00”	2.75"/14 days
	B	3.75"	2.25"/14 days
	C	2.75"	1.75"/14 days
	D	2.25"	1.25"/14 days

1. For purposes of this Table, the term “retention” includes stormwater harvesting ~~reuse~~ and underdrain and underground exfiltration trench systems as those terms are defined in section 2.1 of this Volume .

2. Required dry retention volume (inches of runoff over project area)

3. Required dry retention volume (inches of runoff over project area) followed by wet detention with listed minimum residence time.

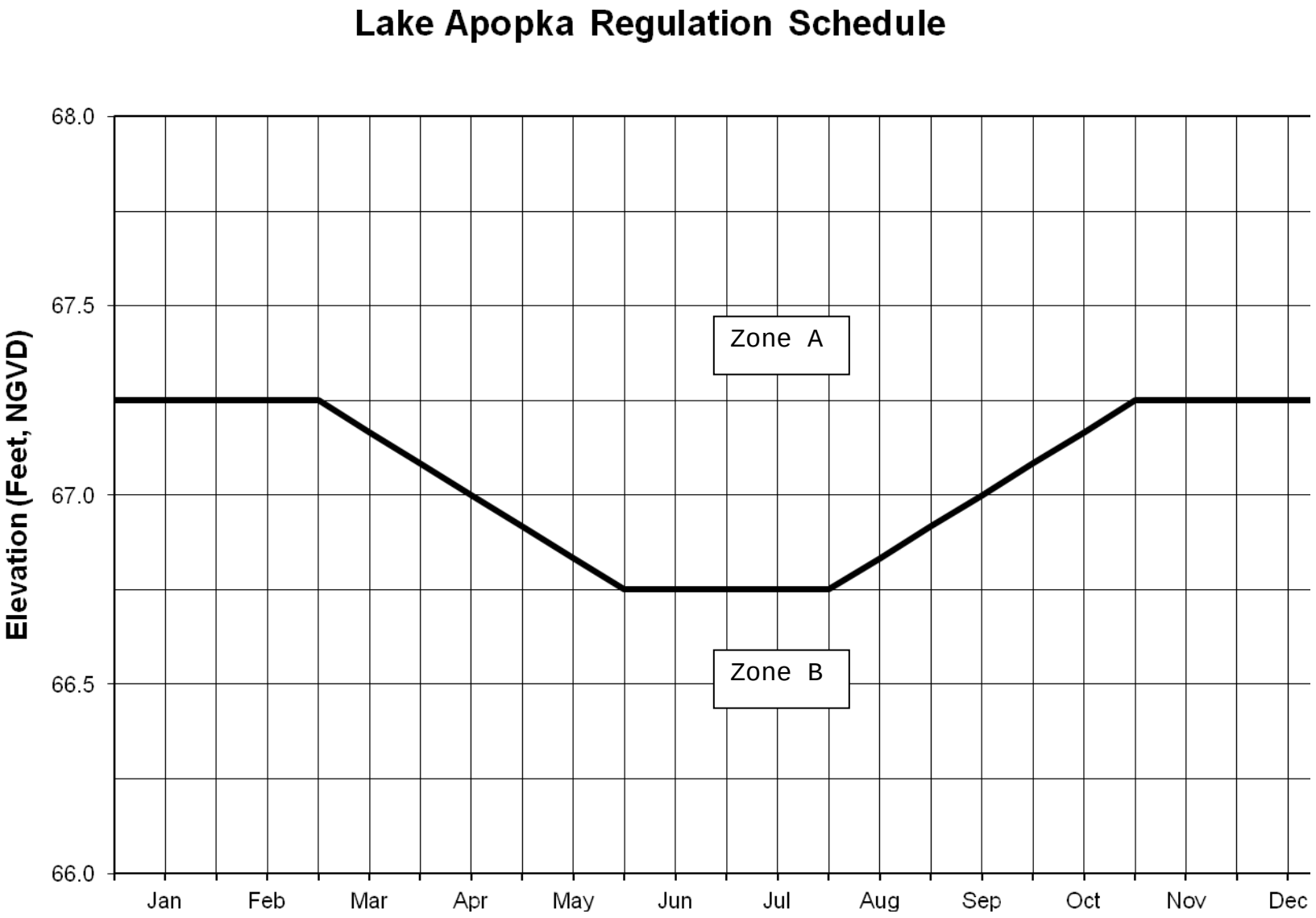

Lake Apopka Regulation Schedule
Elevation (Feet, NGVD)
68.0
67.5
67.0
66.5
66.0
Zone A
Zone B
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 13.7-2

TABLE 13.7-3

MEAN ANNUAL LOADINGS OF TOTAL PHOSPHORUS FOR LAND USE TYPES IN THE LAKE APOPKA HYDROLOGIC BASIN

LAND USE CATEGORY	MEAN ANNUAL TOTAL PHOSPHORUS LOAD (kg/ac-yr)			
	HSG A	HSG B	HSG C	HSG D
Low-Density Residential (max. 15% impervious)	0.069	0.135	0.215	0.284
Single-Family Residential (max. 25% impervious)	0.227	0.286	0.383	0.465
Single-Family Residential (max. 40% impervious)	0.250	0.333	0.446	0.536
Multi-Family Residential (max. 65% impervious)	1.082	1.156	1.257	1.336
Commercial (max. 80% impervious)	0.899	0.916	0.943	0.964
Highway – max. 50% impervious	0.710	0.756	0.817	0.871
Highway – max. 75% impervious	1.053	1.076	1.106	1.133
Agriculture – Pasture	0.026	0.118	0.239	0.347
Agriculture – Crops, Ornamentals, Nurseries	0.040	0.180	0.366	0.531
Agriculture – Groves	0.007	0.036	0.079	0.123
Open Land/Recreational/Fallow Groves and Cropland	0.004	0.017	0.035	0.051
Forests/Abandoned Tree Crops	0.004	0.021	0.045	0.070

HSG = Hydrologic Soil Group

TABLE 13.7-4

REMOVAL EFFICIENCIES FOR TOTAL PHOSPHORUS IN DRY RETENTION SYSTEMS THAT MEET THE DESIGN AND PERFORMANCE CRITERIA IN PART V, "ENVIRONMENTAL RESOURCE PERMIT APPLICANT'S HANDBOOK VOLUME II: FOR USE WITHIN THE GEOGRAPHIC LIMITS OF THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT"

LAND USE	HSG A		HSG B		HSG C		HSG D	
	STANDARD	OFW	STANDARD	OFW	STANDARD	OFW	STANDARD	OFW
Low-Density Residential (max. 15% impervious)	78%	82%	67%	74%	63%	72%	60%	71%
Single-Family Residential (max. 25% impervious)	90%	92%	78%	83%	69%	77%	65%	74%
Single-Family Residential (max. 40% impervious)	84%	88%	72%	80%	65%	75%	63%	73%
Multi-Family Residential (max. 65% impervious)	74%	83%	69%	79%	64%	75%	62%	74%
Commercial (max. 80% impervious)	65%	76%	63%	74%	62%	72%	61%	71%
Highway (max. 50% impervious)	75%	85%	70%	80%	65%	76%	63%	74%
Highway (max. 75% impervious)	65%	76%	63%	74%	62%	72%	61%	71%

Standard - Meets design and performance criteria in Part V, Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District, for discharges to Class III waters

OFW - Meets design and performance criteria in Part V, Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District, for discharges to Class I, Class II, or Outstanding Florida Waters

TABLE 13.7-5

REMOVAL EFFICIENCIES FOR TOTAL PHOSPHORUS IN WET DETENTION SYSTEMS THAT MEET THE DESIGN AND PERFORMANCE CRITERIA IN PART V, ENVIRONMENTAL RESOURCE PERMIT APPLICANT'S HANDBOOK, VOLUME II: FOR USE WITHIN THE GEOGRAPHIC LIMITS OF THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Residence Time (days)	Phosphorus Removal Efficiency (%)
14	61.5
21	64.5

Table 13.7-6

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Low-Density Residential (max. 15% impervious) For Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	70	86	88	89
0.50	78	90	92	92
0.75	82	92	93	94
1.00	85	93	94	95
1.25	88	94	95	96
1.50	90	95	96	96
1.75	91	96	96	97
2.00	92	96	97	97
2.25	93	97	97	97
2.50	93	97	97	98
2.75	94	97	98	98
3.00	95	98	98	98
3.25	96	98	98	99
3.50	97	98	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-7

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Low-Density Residential (max. 15% impervious) For Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	53	78	82	83
0.50	67	85	87	88
0.75	74	88	90	91
1.00	79	91	92	93
1.25	83	92	93	94
1.50	85	93	94	95
1.75	88	94	95	96
2.00	89	95	96	96
2.25	90	96	96	97
2.50	92	96	97	97
2.75	93	97	97	97
3.00	93	97	97	98
3.25	94	97	98	98
3.50	94	97	98	98
3.75	95	98	98	98
4.00	95	98	98	98

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-8

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Low-Density Residential (max. 15% impervious) For Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	46	75	79	81
0.50	63	83	86	87
0.75	72	87	89	90
1.00	78	90	91	92
1.25	82	92	93	94
1.50	85	93	94	95
1.75	87	94	95	96
2.00	89	95	96	96
2.25	91	96	96	97
2.50	92	96	97	97
2.75	93	97	97	97
3.00	94	97	97	98
3.25	94	97	98	98
3.50	95	98	98	98
3.75	95	98	98	98
4.00	96	98	98	98

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-9

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Low-Density Residential (max. 15% impervious) For Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	42	74	78	79
0.50	60	82	85	86
0.75	71	87	89	90
1.00	78	90	91	92
1.25	82	92	93	94
1.50	85	93	94	95
1.75	88	94	95	96
2.00	90	95	96	96
2.25	91	96	97	97
2.50	92	96	97	97
2.75	93	97	97	98
3.00	94	97	98	98
3.25	95	98	98	98
3.50	95	98	98	98
3.75	96	98	98	98
4.00	96	98	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-10

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 25% impervious) For Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	82	92	93	94
0.50	90	95	96	96
0.75	92	96	97	97
1.00	94	97	98	98
1.25	95	98	98	98
1.50	96	98	98	98
1.75	96	98	99	99
2.00	97	98	99	99
2.25	97	99	99	99
2.50	98	99	99	99
2.75	98	99	99	99
3.00	98	99	99	99
3.25	99	99	99	99
3.50	99	99	100	100
3.75	99	100	100	100
4.00	99	100	100	100

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-11

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 25% impervious) For Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	65	84	87	88
0.50	78	90	91	92
0.75	83	92	94	94
1.00	87	94	95	95
1.25	89	95	96	96
1.50	91	96	96	97
1.75	92	96	97	97
2.00	93	97	97	98
2.25	94	97	98	98
2.50	95	98	98	98
2.75	95	98	98	98
3.00	96	98	98	98
3.25	96	98	99	99
3.50	96	98	99	99
3.75	97	99	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-12

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 25% impervious) For Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	54	79	82	84
0.50	69	86	88	89
0.75	77	90	91	92
1.00	82	92	93	94
1.25	85	93	94	95
1.50	88	95	95	96
1.75	90	95	96	96
2.00	91	96	97	97
2.25	92	97	97	97
2.50	93	97	97	98
2.75	94	97	98	98
3.00	95	98	98	98
3.25	96	98	98	98
3.50	96	98	98	99
3.75	96	98	99	99
4.00	97	98	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-13

Estimated Total P Removal Efficiencies for Various Treatment Options in Single-Family Residential (max. 25% impervious) For Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	48	76	80	81
0.50	65	84	86	87
0.75	74	88	90	91
1.00	81	91	93	93
1.25	84	93	94	94
1.50	87	94	95	95
1.75	89	95	96	96
2.00	91	96	96	97
2.25	92	96	97	97
2.50	93	97	97	98
2.75	94	97	98	98
3.00	95	98	98	98
3.25	95	98	98	98
3.50	96	98	98	98
3.75	96	98	99	99
4.00	97	98	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-14

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 40% impervious) for Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	71	90	93	94
0.50	86	95	96	97
0.75	90	97	98	98
1.00	93	97	98	99
1.25	94	98	99	99
1.50	95	98	99	99
1.75	96	99	99	99
2.00	97	99	99	99
2.25	97	99	99	99
2.50	97	99	99	99
2.75	98	99	99	100
3.00	98	99	99	100
3.25	98	99	100	100
3.50	98	99	100	100
3.75	99	100	100	100
4.00	99	100	100	100

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-15

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 40% impervious) for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	61	86	90	92
0.50	77	92	94	95
0.75	83	94	95	97
1.00	87	95	97	97
1.25	89	96	97	98
1.50	91	97	98	98
1.75	93	97	98	99
2.00	94	98	98	99
2.25	94	98	99	99
2.50	95	98	99	99
2.75	95	99	99	99
3.00	96	99	99	99
3.25	97	99	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-16

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 40% impervious) for Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	51	82	87	90
0.50	68	88	91	93
0.75	77	92	94	95
1.00	83	94	95	96
1.25	86	95	96	97
1.50	89	96	97	97
1.75	91	96	97	98
2.00	92	97	98	98
2.25	93	97	98	98
2.50	94	97	98	98
2.75	95	98	98	98
3.00	95	98	98	99
3.25	96	98	98	99
3.50	96	98	99	99
3.75	97	98	99	99
4.00	97	98	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-17

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Single-Family Residential (max. 40% impervious) for Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	48	82	87	90
0.50	65	88	91	93
0.75	75	91	94	95
1.00	81	93	95	96
1.25	85	95	96	97
1.50	88	96	97	98
1.75	90	96	97	98
2.00	92	97	98	98
2.25	93	97	98	99
2.50	94	98	98	99
2.75	94	98	99	99
3.00	95	98	99	99
3.25	96	98	99	99
3.50	96	99	99	99
3.75	97	99	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-18

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Multi-Family Residential (max. 65% impervious) for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	53	78	82	83
0.50	74	88	90	91
0.75	83	92	94	94
1.00	88	95	96	96
1.25	91	96	97	97
1.50	93	97	97	98
1.75	95	98	98	98
2.00	95	98	98	98
2.25	96	98	98	99
2.50	97	98	99	99
2.75	97	99	99	99
3.00	97	99	99	99
3.25	98	99	99	99
3.50	98	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-19

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Multi-Family Residential (max. 65% impervious) for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	49	77	81	82
0.50	69	86	88	89
0.75	79	90	92	92
1.00	85	93	94	95
1.25	89	95	96	96
1.50	91	96	96	97
1.75	92	97	97	97
2.00	94	97	98	98
2.25	95	98	98	98
2.50	95	98	98	98
2.75	96	98	98	99
3.00	96	98	99	99
3.25	97	99	99	99
3.50	97	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-20

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Multi-Family Residential (max. 65% impervious) for Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	45	75	79	81
0.50	64	84	86	87
0.75	75	89	90	91
1.00	82	92	93	94
1.25	86	94	95	95
1.50	89	95	96	96
1.75	91	96	97	97
2.00	93	97	97	97
2.25	94	97	98	98
2.50	95	98	98	98
2.75	95	98	98	98
3.00	96	98	98	99
3.25	96	98	99	99
3.50	97	98	99	99
3.75	97	98	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-21

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Multi-Family Residential (max. 65% impervious) for Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	43	74	78	80
0.50	62	83	85	86
0.75	74	88	90	91
1.00	80	91	92	93
1.25	85	93	94	95
1.50	88	95	95	96
1.75	90	96	96	97
2.00	92	96	97	97
2.25	93	97	97	98
2.50	94	97	98	98
2.75	95	98	98	98
3.00	96	98	98	98
3.25	96	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-22

Removal Efficiencies for Total Phosphorus Using Various

Treatment Options in Commercial (max. 80% impervious)

for Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	41	73	77	79
0.50	65	84	86	87
0.75	76	89	91	91
1.00	83	92	93	94
1.25	88	95	95	96
1.50	91	96	96	97
1.75	93	97	97	97
2.00	94	97	98	98
2.25	95	98	98	98
2.50	96	98	98	99
2.75	97	98	99	99
3.00	97	99	99	99
3.25	97	99	99	99
3.50	98	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-23

Removal Efficiencies for Total Phosphorus Using Various

Treatment Options in Commercial (max. 80% impervious)

for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	41	73	77	79
0.50	63	83	86	87
0.75	74	88	90	91
1.00	81	92	93	93
1.25	87	94	95	95
1.50	89	95	96	96
1.75	92	96	97	97
2.00	93	97	97	98
2.25	94	97	98	98
2.50	95	98	98	98
2.75	96	98	98	99
3.00	97	98	99	99
3.25	97	99	99	99
3.50	97	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-24

Removal Efficiencies for Total Phosphorus Using Various

Treatment Options in Commercial (max. 80% impervious)

for Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	39	72	77	78
0.50	62	83	85	86
0.75	72	87	89	90
1.00	80	91	92	93
1.25	85	93	94	95
1.50	88	95	96	96
1.75	91	96	97	97
2.00	92	97	97	97
2.25	94	97	98	98
2.50	95	98	98	98
2.75	96	98	98	98
3.00	96	98	99	99
3.25	97	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-25

Removal Efficiencies for Total Phosphorus Using Various

Treatment Options in Commercial (max. 80% impervious)

for Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	39	72	76	78
0.50	61	82	85	86
0.75	71	87	89	90
1.00	79	90	92	93
1.25	84	93	94	94
1.50	88	94	95	96
1.75	90	96	96	97
2.00	92	96	97	97
2.25	94	97	98	98
2.50	94	97	98	98
2.75	95	98	98	98
3.00	96	98	98	99
3.25	97	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-26

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 50% impervious) for Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	54	79	82	83
0.50	75	88	90	91
0.75	85	93	94	95
1.00	90	95	96	96
1.25	92	97	97	97
1.50	94	97	98	98
1.75	95	98	98	98
2.00	96	98	99	99
2.25	97	99	99	99
2.50	97	99	99	99
2.75	98	99	99	99
3.00	98	99	99	99
3.25	98	99	99	99
3.50	98	99	99	99
3.75	98	99	99	99
4.00	99	99	99	100

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-27
Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 50% impervious) for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	50	77	81	82
0.50	70	86	89	89
0.75	80	91	92	93
1.00	86	93	94	95
1.25	89	95	96	96
1.50	91	96	97	97
1.75	93	97	97	97
2.00	94	97	98	98
2.25	95	98	98	98
2.50	96	98	98	98
2.75	96	98	99	99
3.00	97	98	99	99
3.25	97	99	99	99
3.50	97	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-28

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 50% impervious) for Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	47	76	79	81
0.50	65	84	87	88
0.75	76	89	91	91
1.00	83	92	93	94
1.25	87	94	95	95
1.50	89	95	96	96
1.75	91	96	97	97
2.00	93	97	97	97
2.25	94	97	98	98
2.50	95	98	98	98
2.75	96	98	98	98
3.00	96	98	98	99
3.25	97	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-29

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 50% impervious) for Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	44	74	78	80
0.50	63	83	86	87
0.75	74	88	90	91
1.00	81	91	93	93
1.25	85	93	94	95
1.50	89	95	96	96
1.75	91	96	96	97
2.00	92	96	97	97
2.25	93	97	97	98
2.50	94	97	98	98
2.75	95	98	98	98
3.00	96	98	98	99
3.25	96	98	99	99
3.50	97	98	99	99
3.75	97	99	99	99
4.00	97	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-30

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 75% impervious) for Hydrologic Soil Group A

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	41	73	77	79
0.50	65	84	86	87
0.75	76	89	91	91
1.00	83	92	93	94
1.25	88	95	95	96
1.50	91	96	96	97
1.75	93	97	97	97
2.00	94	97	98	98
2.25	95	98	98	98
2.50	96	98	98	99
2.75	97	98	99	99
3.00	97	99	99	99
3.25	97	99	99	99
3.50	98	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-31

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 75% impervious) for Hydrologic Soil Group B

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	41	73	77	79
0.50	63	83	86	87
0.75	74	88	90	91
1.00	81	91	93	93
1.25	87	94	95	95
1.50	89	95	96	96
1.75	92	96	97	97
2.00	93	97	97	98
2.25	94	97	98	98
2.50	95	98	98	98
2.75	96	98	98	99
3.00	97	98	99	99
3.25	97	99	99	99
3.50	97	99	99	99
3.75	98	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-32

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 75% impervious) for Hydrologic Soil Group C

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	39	72	77	78
0.50	62	82	85	86
0.75	72	87	89	90
1.00	80	91	92	93
1.25	85	93	94	95
1.50	88	95	95	96
1.75	91	96	97	97
2.00	92	97	97	97
2.25	94	97	98	98
2.50	95	98	98	98
2.75	96	98	98	98
3.00	96	98	99	99
3.25	97	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

Table 13.7-33

Removal Efficiencies for Total Phosphorus Using Various Treatment Options in Highway (max. 75% impervious) for Hydrologic Soil Group D

Retention Depth (inches)	Annual Total P Removal (%)			
	Dry Retention[1]	Retention / Wet Detention[2]		
		t_d=7 days	t_d=14 days	t_d=21 days
0.25	38	72	76	78
0.50	61	82	85	86
0.75	71	87	89	90
1.00	79	90	92	93
1.25	84	93	94	94
1.50	88	94	95	96
1.75	90	96	96	97
2.00	92	96	97	97
2.25	94	97	98	98
2.50	94	97	98	98
2.75	95	98	98	98
3.00	96	98	98	99
3.25	97	98	99	99
3.50	97	99	99	99
3.75	97	99	99	99
4.00	98	99	99	99

1. Dry retention alone.
2. Dry retention followed by wet detention with various residence times.

13.8 Additional Basin Criteria

13.8.1 Soil Types *Revised 6/1/18*

Type “A” Soils as defined by the Natural Resources Conservation Service (NRCS) Soil Survey in the following NRCS publications: Soil Survey of Flagler County Area, Florida (1997); Soil Survey of Lake County Area, Florida (1975); Soil Survey of Orange County Area, Florida (1989); Soil Survey of Seminole County Area, Florida (1990); and Soil Survey of Volusia County Area, Florida (1980), (incorporated by reference in 40C-4.091(1)(d), F.A.C).

Flagler County
Orsino
Astatula
Tavares
Palm Beach Sand
Welaka
Cocoa
Bulow
Paola

Lake County
Apopka
Apopka Urban Land
Astaula
Chandler
Chandler Urban Land
Kendrick
Lake
Lake Urban Land
Orlando
Orsino
Paola
Paola Urban Land
St. Lucie
St. Lucie Urban Land
Tavares
Tavares Urban Land

Orange County
Archbold
Apopka
Candler
Candler Urban Land
Florahome
Florahome Urban Land
Lake
Millhopper
Millhopper Urban Land
St. Lucie
St. Lucie Urban Land
Tavares
Tavares Urban Land

Seminole County
Apopka
Astatula

Millhopper
Paola
St. Lucie
Tavares

Volusia County
Apopka
Arents
Astatula
Astatula Urban Land
Bulow
Cocoa
Cocoa Urban
Deland
Orsino
Palm Beach
Palm Beach Urban Land
Paola
Paola Urban Land
St. Lucie
Tavares

13.8.2 Erosion and Sediment Control Principles

Factors which influence erosion potential include soil characteristics, vegetative cover, topography, and climatic conditions. The following principles must be considered in planning and undertaking construction and alteration of surface water management systems:

(a) Plan the development to fit topography, soils, and drainage patterns;

(b) Minimize the extent of area exposed at one time and the duration of exposure;

(c) Schedule areas with greatest erosion potential for dry, rather than wet, season exposure;

(d) Apply erosion control practices to minimize erosion from disturbed areas;

(e) Apply perimeter controls to protect disturbed area from off-site runoff and to trap eroded material on-site to prevent sedimentation in downstream areas;

(f) Keep runoff velocities low and retain runoff on-site;

(g) Stabilize disturbed areas immediately after final grade has been attained or during interim periods of inactivity resulting from construction delays; and

(h) Implement a thorough maintenance and follow-up program.

13.8.3 Erosion and Sediment Control Plan

A plan must be prepared prior to construction and alteration for certain systems and submitted with the permit application to minimize erosion and retain sediment on-site. The details and scope of the plan will depend on the potential for erosion. Projects with larger exposed areas, long duration of construction, steep slopes, erosive soils, or close proximity to streams and other watercourses will require more detailed and comprehensive plans. The plan must include consideration of the site specific erosion potential, including slopes, soil erodability, vegetative cover, and runoff characteristics. The following is a listing of the minimum information, which must be included in the plan, to be shown on construction or alteration plans, detail sheets, or other appropriate documents:

(a) The existing and proposed topography;

(b) A general description of the predominant soil types on the site, and the corresponding erodability potential as described by the appropriate soil survey information or on-site investigation;

(c) Schedule and general description of each construction phase of the project. At a minimum, the following applicable phases must be addressed: clearing, excavation earthwork, embankment earthwork, site utilities, roads, site grading and stabilization. The schedule must include estimated starting date and duration. Description must include limits of area impacted by each phase; and

(d) For each construction phase, a description of the following:

1. Storm drainage characteristics, including flow patterns and the peak velocity and discharge from the 1-in-2 year 24 hour storm, at all locations where control measures are proposed and at points of off-site discharge; and

2. Individual control measures (to be shown on construction plans or detail sheets):

a. Estimated date of installation and removal,

b. Location,

c. Purpose of measure and area served,

d. Detailed construction drawings and specifications,

e. Operation and maintenance schedule, and

f. All supporting calculations and documentation including referenced design standards and specifications.

PART VII – AGRICULTURAL SURFACE WATER MANAGEMENT SYSTEMS

(CHAPTER 40C-44)

A. POLICY AND PROCEDURES

14.0 Introduction

14.1 Policy

The District's policy is to assist those affected by the Agricultural Surface Water Management System rule (chapter 40C-44, F.A.C.) to understand the program and complete the application. Chapter 40C-44, F.A.C., is incorporated by reference in rule 62-330.010, F.A.C.

14.2 Purpose

The purpose of this part is to provide applicants, potential applicants, and others who are interested, with information and guidance regarding the Agricultural Surface Water Management System permitting program. The final determination of appropriate procedures to be followed will be made by reference to chapters 120 and 373, F.S., and chapters 62-330, 40C-1, and 40C-44, F.A.C. Specific rule citations are given, when appropriate, for further reference.

14.3 Organization of Part VII *Revised 6/1/18*

This part contains information regarding the programs, policy and procedures and criteria used in permit evaluation of agricultural systems.

If an applicant or potential applicant has any questions about these procedures or wishes to have District staff assistance in interpreting them or in completing an application, he is encouraged to contact the District's Agricultural Assistance Team:

Division of Regulatory Services
St. Johns River Water Management District
4049 Reid Street
Palatka, FL 32177-2529
(386) 329-4500

14.4 Applicable Statutes and Rules

The Agricultural Surface Water Management System permit application process is governed by chapters 373 and 120, F.S., and chapters 62-330, 40C-1, and 40C-44, F.A.C., and is affected by chapters 62-302, 62-4, and 62-40, F.A.C.

14.5 General Description of Rule *Revised 6/1/18*

The rule requires an individual environmental resource agricultural system permit for existing systems with pumped discharges, if the capacity, either individually or cumulatively, is 10,000 GPM or greater. These pumps typically drain large citrus groves, improved pasture, or muck farms, which produce sod or vegetables on organic soils. The pumps may be significant sources of pollution, due to their erosive velocities and ability to drain water faster and to a greater depth than gravity drained agricultural operations.

The rule also authorizes the District to require an individual permit for (1) existing pumped or gravity drained agricultural operations, on a case by case basis, if the discharge causes or contributes to a violation of state water quality standards and (2) certain new agricultural stormwater management systems that fall below some of the thresholds in subsection 62-330.020(2), F.A.C.

The rule establishes performance standards for agricultural discharges which are required to obtain a permit.

The rule contains water quality practices, which are presumed to provide reasonable assurance that the performance standards will be met when implemented as described in the rule. The water quality practices are more appropriate for agriculture than those which are currently used for urban projects and frequently applied to agriculture. The water quality practices include reduction of discharge volume by improved water table control and on-site recycling, implementation of a comprehensive Conservation Plan including nutrient and pesticide management plans, and installation of a treatment system using wet detention reservoirs or other equivalent alternatives.

Under this rule, permits for operation and maintenance are permanent. However, the rule allows modification or revocation of the permit if the permittee does not comply with the permit requirements or if monitoring indicates that the system does not comply with the performance standards.

Agricultural operations which are required to obtain a permit under subsection 62-330.020(2), F.A.C., must comply with the performance standards and water quality practices contained in this rule, in order to meet the District's water quality criteria.

14.6 Explanation of Thresholds, Exemptions, and Individual Permits

Permits are required for activities which exceed certain "thresholds" (see section 14.8). Activities below these thresholds are considered to have a minor impact on water resources and are not regulated.

Although certain activities may exceed a threshold, the District may elect to "exempt" them in the rule from a requirement to obtain a permit, usually because the activity is regulated by another agency or permit process (see section 14.10). Other exemptions are established by the Florida Legislature (see section 14.10.1).

14.7 Definitions

The following definitions are used by the District to clarify its intent in implementing chapter 40C-44, F.A.C., the Agricultural Surface Water Management System rule. Many of the definitions are derived directly from chapter 40C-44, F.A.C., and are reproduced here for the convenience of applicants.

(a) "Agriculture," for the purposes of this chapter, means the commercial production of crops, animals or animal products, or farm commodities including but not limited to vegetables, citrus and other fruits, grain, forage, sod, livestock, poultry, and foliage plants. For the purposes of this chapter, agriculture also includes horticulture and floriculture.

(b) "Agricultural Operation" means a contiguous farm, grove, ranch, nursery or similar entity owned or controlled by one or more persons, engaged in, or proposing to engage in, the practice of agriculture.

(c) "Associated Wastewater" means the flow of water which directly results from agricultural activities such as irrigation, soil flooding for pest control or soil preservation, freeze protection or pre-storm event drainage and is mixed or conveyed with stormwater in the surface water management system.

(d) "Closed System" means any reservoir or works located entirely within agricultural lands owned or controlled by the user and which requires water only for the filling, replenishing, and maintaining the water level thereof.

(e) "Conservation Plan" means a document, which describes a system of management practices to control and reduce soil erosion and sediment loss, and improve the quality of discharged water for a specific parcel of property, and which has been either:

(1) prepared by the U.S. Department of Agriculture Soil Conservation Service (SCS) in conjunction with a local Soil and Water Conservation District Board, organized pursuant to chapter 582, F.S., and which includes and applies the appropriate management practices consistent with the SCS Field Office Technical Guide - Section IV, and the Best Management Practices Selector,

incorporated by reference in section 40C-44.091, F.A.C., and which includes the following elements when appropriate for the proposed land use, as reference in the SCS Field Office Technical Guide - Section IV:

a. Reduction of the volume of water discharged off-site;

b. Water Table Control in Open Channels;

c. Irrigation Land Leveling;

d. Irrigation Water Management;

e. Nutrient Management Plan;

f. Pesticide Management Plan;

g. Reuse of the runoff from the agricultural site, using reservoir or canal storage already existing, proposed as part of the plan or otherwise required by permit, for uses such as freeze protection, soil flooding for pest control or soil preservation, or irrigation needs; and

h. Control of soil erosion.

(2) prepared by a private consultant, who has professional expertise in the fields of hydrology, water pollution control, irrigation design and soil conservation, according to SCS standards, specifications and guidelines. The plan must include and apply the appropriate management practices consistent with the SCS Field Office Technical Guide - Section IV and the Best Management Practices Selector, incorporated by reference in section 40C-44.091, F.A.C., and include the following elements when appropriate for the proposed land use, as referenced in the SCS Field Office Technical Guide - Section IV:

a. Reduction of the volume of water discharged off-site;

b. Water Table Control in Open Channels;

c. Irrigation Land Leveling;

d. Irrigation Water Management;

e. Nutrient Management Plan;

f. Pesticide Management Plan;

g. Appropriate reuse of the annual stormwater runoff from the agricultural site for uses such as freeze protection, soil flooding for pest control or soil preservation, or irrigation needs;

h. Control of soil erosion; and

i. Reduction of suspended solids loading at points of discharge off-site.

(f) "Engineer" means a Professional Engineer registered in Florida, or other person exempted pursuant to the provisions of chapter 471, F.S., who is competent in the fields of hydrology and water pollution control.

(g) "Existing agricultural surface water management system" means a system which was constructed or implemented on or before the effective date of this chapter.

(h) "Hayland" means a tract of land used for forage production, which has been planted with desirable forage plant species.

(i) "Improved Pasture" means a tract of land used for livestock grazing, which has been planted with desirable forage plant species.

(j) "Littoral zone" means, in reference to stormwater management systems, that portion of a wet detention pond which is designed to contain rooted aquatic plants.

(k) “NAVD” means North Atlantic Vertical Datum.

(l) "NGVD" means national geodetic vertical datum.

(m) "Permanent Pool" means that portion of a wet detention pond, which normally holds water, between the pond bottom and control elevation, excluding any water volume claimed as treatment volume.

(n) "Treatment" means any method, technique, process or management practice which changes the physical, chemical, or biological character of water and thereby reduces its potential for polluting waters of the state.

14.8 Activities Requiring a Permit

14.8.1 Date of Implementation

Chapter 40C-44, F.A.C., became effective on August 11, 1991. The rule was amended on October 20, 1992, October 3, 1995, and October 1, 2013.

Pumped agricultural operations, which have a valid Industrial Waste permit or consent order issued by DEP or the District, can continue to operate according to the terms of the permit or consent order until it expires. Ninety days prior to the expiration date of the permit or consent order, the agricultural operation must apply for a chapter 40C-44 permit or, if they also have a MSSW permit issued prior to June 1, 1988, must apply to modify the MSSW permit. [40C-44.031(1)(a)(b)(c), F.A.C.]

14.8.2 Permits Required

An individual environmental resource permit for an agricultural system is required prior to the undertaking of any activity described in section 14.9, if the activity exceeds the following thresholds:

(a) incorporates pumped discharges from an existing agricultural surface water management system, when:

(1) the pumps are stationary or portable facilities, and

(2) the pump(s) have a capacity, either individually or cumulatively, of 10,000 GPM or greater. [40C-44.041(1)(a), F.A.C.]

(b) causes or contributes to a violation of state water quality standards in waters of the state, when:

(1) the discharge is pumped or gravity drained, and

(2) the District has considered the following information on a case-by-case basis:

a. water quality monitoring data collected by the District or other agency,

b. the size of the agricultural operation and the amount of stormwater and associated wastewater reaching waters of the state, relative to the size and nature of the immediate drainage basin,

c. the means of conveyance of stormwater and associated wastewater to waters of the state,

d. characteristics of the site including the slope, vegetation, rainfall and other factors related to the likelihood or

frequency of discharge of stormwater and associated wastewater to waters of the state,

e. the status, results and recommendations of available basin-specific studies, including those conducted as part of a Surface Water Improvement and Management Plan or pursuant to chapter 62-40, F.A.C., and

f. the existence of mixing zones, variances or site specific alternative criteria granted by DEP pursuant to chapters 62-4 and 62-302, F.A.C. [40C-44.041(1)(b), F.A.C.]

(c) proposes construction, maintenance and operation of new agricultural surface water management systems, or alteration of existing systems, which:

(1) drain an agricultural area greater than 2 acres;

(2) are below thresholds described in paragraphs 62-330.020(2)(a) and (e), F.A.C.;

(3) serve a project with a total land area less than 40 acres; and

(4) do not provide for the placement of 12 or more acres of impervious surface which constitutes 40 or more percent of the total land area. [40C-44.041(2), F.A.C.]

When an activity that requires a permit pursuant to paragraph 62-330.020(2)(i), F.A.C., and section 1.2.3 of this Volume (i.e., chapter 40C-44, F.A.C.), also requires a permit pursuant to paragraph 62-330.020(2)(a), (b), (c), (d), (e), (f), (g), (h) or (j), F.A.C., or section 1.2.2 of this Volume, the review for determining compliance with all relevant permitting requirements will be included as part of one environmental resource permit.

14.8.3 The District will not issue separate permits for parts of a system, except for a system which is to be constructed in phases.

14.9 Activities Authorized by Permit

An individual environmental resource agricultural system permit must be obtained pursuant to paragraph 62-330.020(2)(i), F.A.C., for any surface water management system which exceeds the thresholds listed in subsection 14.8.2 of this Volume. Such permit is to be obtained as:

(a) Authorization to maintain and operate an existing system.

(b) Authorization to construct prior to the construction of a proposed system.

(c) Authorization to alter prior to the alteration of an existing system.

(d) Authorization to operate the entire system prior to the construction or operation of a proposed system or alteration of an existing system.

(e) Authorization to maintain prior to the maintenance or repair of a proposed system, or alteration of an existing system, except for routine custodial maintenance.

(f) Authorization to abandon prior to the abandonment of an existing system.

(g) Authorization to remove prior to the removal of an existing system.

14.10 Exemptions

14.10.1 Section 373.406 of the Florida Statutes specifically exempts certain activities from the requirements of chapter 62-330, F.A.C. Please refer to this statute and section 3.2 of Volume I for details regarding these exemptions.

14.10.2 In addition to the statutory exemptions, chapter 40C-44, F.A.C., provides for the exemptions listed below:

(a) Concentrated Animal Feeding Operations with a valid permit issued by the DEP pursuant to chapter 62-670, F.A.C., provided that:

(1) For dairy farms, the permitted design incorporates a high intensity use area, from which the stormwater runoff is centrally collected for storage and disposal by land application, or is treated prior to discharge.

(2) For egg production facilities, the permitted design prevents the discharge of process wastewater and stormwater runoff to surface waters, except in the event of a storm greater than a 25-year, 24-hour event.

(3) For any concentrated animal feeding operation which does not incorporate a high intensity use area, the permitted design includes provisions to treat stormwater and associated wastewater from adjacent animal loafing and feeding areas; manure pits; animal watering systems; washing, cleaning or flushing pens; or other pollutant sources, so that discharges through the surface water management system from the operation will not cause or

contribute to a violation of water quality standards in waters of the state. [40C-44.051(1), F.A.C.]

(b) Animal Feeding Operations, which do not discharge except in the event of a storm greater than a 25-year, 24-hour event and therefore are not Concentrated Animal Feeding Operations, pursuant to chapter 62-670, F.A.C. [40C-44.051(2), F.A.C.]

The exemptions for certain animal feeding operations, whose activities have been reviewed by DEP, and which provide treatment of their pollutant sources, are placed in the rule to minimize overlap between the District and the DEP. Only those areas of a Concentrated Animal Feeding Operation for which treatment has been provided, according to a DEP permit, are exempt. Likewise, only those areas of an Animal Feeding Operation which have facilities to retain the 25-year, 24-hour storm event are exempt. For areas which may be a pollutant source and for which treatment or retention is not provided, such as adjacent pastures or haylands, the District may require an individual permit on a case-by-case basis, as stated in section 14.8 of this Volume.

(c) Privately owned or operated agricultural surface water management systems lying within the boundaries of an active water control district that has obtained a chapter 40C-44 permit. [40C-44.051(3), F.A.C.]

The following is a list of active water control districts within the St. Johns River Water Management District:

1. Delta Farms Water Control District
2. Elkton Water Control District
3. Fellsmere Water Control District
4. Florahome Water Control District
5. Hastings Water Control District
6. Indian River Farms Water Control District
7. Ranger Water Control District
8. Sebastian River Improvement District
9. Sixteen Mile Creek Water Control District
10. Melbourne-Tillman Water Control District
11. St. Johns Improvement District
12. Zellwood Drainage and Water Control District

(d) Agricultural surface water management systems which are implementing one or more of the following practices under the District's Best Management Practices Cost-Sharing Program: SJ1 (Backflow Prevention), SJ5 (Pump Platform Fuel and Oil Containment) or SJ6 (Pesticide Mixing and Storage Area Containment). [40C-44.051(4), F.A.C.]

(e) Minor alterations, as described in section 14.11, of new or existing agricultural surface water management systems which have a permit under chapters 62-330, 40C-4, 40C-40, or 40C-44, F.A.C. [40C-44.051(5), F.A.C.]

This exemption applies to agricultural operations which propose minor alterations and which have obtained permits under the referenced rule chapters for their activities, and is intended to prevent repetitive permit modifications. For example, if the permit requires implementation of a Conservation Plan, but the Conservation Plan recommends installation of small water control structures which were not included in the original permit, no modification of the permit is necessary if the proposed activity is a minor alteration.

(f) Agricultural surface water management systems, which are required to obtain a permit as described in section 14.8.2, provided they have a Consumptive Use Permit which requires that they obtain, implement and maintain a Conservation Plan. [40C-44.051(6), F.A.C.]

This exemption is intended to minimize duplicative permitting for small agricultural operations such as ferneries or nurseries. It applies to agricultural operations with a project area less than <40 acres which propose no work in, on, or over wetlands or other surface waters that would require a permit pursuant to 62-330.020(2)(a), F.A.C., and which propose to construct or modify a surface water management system. If they have a valid Consumptive Use Permit, which requires that they obtain, implement and maintain a Conservation Plan, as defined in Section 14.7(e), then they do not have to obtain a permit under Chapter 40C-44, F.A.C. Under this exemption, the permit requirements described in Section 14.2.2.(a) have been transferred to a Consumptive Use permit condition.

14.11 Minor Alterations

14.11.1 Minor alterations are those alterations of existing agricultural surface water management systems which do not increase the peak discharge rate and total discharge volume (when applicable), alter off-site storage and conveyance capabilities of the water resource, adversely affect hydrologically related environmental functions, or increase the off-site pollutant loading. [40C-44.071(2), F.A.C.]

14.11.2 The following activities are presumed to be minor alterations:

(a) regrading or contouring of ditches and other conveyance systems necessary to implement a management practice recommended by a Conservation Plan.

(b) installation of new internal ditches or other conveyance systems necessary to implement a management practice recommended by a Conservation Plan.

(c) installation of internal water control structures necessary to implement a management practice recommended by a Conservation Plan.

(d) modification or expansion of existing detention ponds within previously diked areas, provided that public safety concerns related to levee failure are addressed, no floodplain encroachment occurs, and impacts to wetlands or other surface waters do not require a permit pursuant to paragraph 62-330.020(2)(a), F.A.C.

(e) construction of new detention ponds within previously diked areas, provided that public safety concerns related to levee failure are addressed, no floodplain encroachment occurs, and impacts to wetlands or other surface waters do not require a permit pursuant to paragraph 62-330.020(2)(a), F.A.C. [40C-44.071(3), F.A.C.]

14.11.3 The District's determination that the conceptual plans are consistent with chapter 373, F.S., and chapters 62-330, and 40C-41, F.A.C., will provide the applicant with an assurance that the concepts upon which his designs are based can provide for systems which will not be harmful to the water resources of the District and will not be inconsistent with the overall objectives of the District.

15.0 Application Preparation

15.1 Pre-application Conference

15.1.1 The District encourages applicants to participate in a pre-application conference with District staff. At the applicant's request, District staff will arrange for and participate in a pre-application conference. At a pre-application conference, the staff will be prepared to discuss with the applicant such information as:

(a) application completion, processing and evaluation procedures;

(b) information which will be required for evaluation of the application;

(c) the criteria which will be used in evaluation of the application;

(d) other hydrological, environmental or water quality data.

15.1.2 To schedule a pre-application conference, potential applicants should contact:

Division of Regulatory Services
St. Johns River Water Management District
4049 Reid Street
Palatka, FL 32177-2529
(386) 329-4500

15.2 Forms and Instructions

15.2.1 Applicants should complete Section A of form 62-330.060(1) (Joint Application for Individual and Conceptual Environmental Resource Permit/Authorization to Use State-Owned Submerged Lands/Federal Dredge and Fill Permit) (*6/1/18*) and incorporated by reference in rule 62-330.060(1), F.A.C., and form 40C-44.101(2) (Supplemental Information for Agricultural Systems), which has been incorporated by reference in 40C-44.101(2). These forms must be used in the application for an individual permit for construction, operation, maintenance, alteration, removal, or abandonment of new or existing systems. *Revised 6/1/18*

15.3 Permit Processing Fee

15.3.1 A non-refundable permit processing fee as specified by chapter 40C-1, F.A.C., is required for the processing of each application for individual permits or for a permit modification, and must be submitted concurrently with the filing of an application. An application submitted without the fee will not be considered complete. The required processing fees are listed in section 40C-1.603.

15.4 Procedure for Processing Applications *Revised 6/1/18*

Applications will be processed in accordance with the procedures described in subsections 5.5.3.3 and 5.5.3.5 through 5.5.3.7 of Volume I and subsection 373.4141(1), F.S. Thus:

(a) Within 30 days after receipt of an application for a permit under this part, the District shall review the application and shall request submittal of all additional information the department or the water management district is permitted by law to require. If the applicant believes any request for additional information is not authorized by law or rule, the applicant may request a hearing pursuant to s. 120.57. Within 30 days after receipt of such additional information, the department or water management district shall review it and may request only that information needed to clarify such additional information or to answer new questions raised by or directly related to such additional information. If the applicant believes the request of the department or water management district for such additional information is not authorized by law or rule, the department or water management district, at the applicant's request, shall proceed to process the permit application. [373.4141(1), F.S.]

(b) The District will inform the applicant within 30 days of receipt of the application, or within 30 days of receipt of additionally received information, whether the proposed activities are exempt from permitting or qualify for a general permit. Any processing fees received in excess of those required under Rule 62-330.071, F.A.C., will be refunded. [5.5.3.3, A.H., Volume I]

(c) The applicant shall have 90 days from the date the District makes a timely request for additional information to submit that information to the District. If an applicant requires more than 90 days to respond, it must notify the District in writing of the circumstances, at which time the application shall remain in active status for one additional period of up to 90 days. Additional extensions shall be granted for good cause shown by the applicant. A showing that the applicant is making a diligent effort to obtain the requested additional information, and that the additional time period is both reasonable and necessary to supply the information, shall constitute good cause. In such case, a specified amount of additional time shall be granted at the mutual consent of the District and the applicant. If the applicant chooses not to, or is unable to, respond to the request for additional information within the above time frames, the application shall be administratively denied without prejudice. Such denial is not a determination of the merits of an application and does not preclude the applicant from reapplying at a later time. However, the applicant will not

receive a refund of processing fees submitted, and the District will not apply those processing fees to a subsequently submitted permit application or notice. An applicant who cannot provide requested information within the above time frames is encouraged to withdraw their application before the District takes action to deny it. [5.5.3.5, A.H., Volume I]

(d) The applicant may submit a written request for an application to be deemed complete at any time. Upon receipt of such request, the District will begin processing the application and will take agency action to issue or deny the application within 60 days of that date, or within such additional time as may be provided if the applicant voluntarily waives that time clock. [5.5.3.6 A.H., Volume I]

(e) The applicant may voluntarily request the application be withdrawn prior to agency action if it does not or cannot provide the requested information or required processing fees within the above time frames. The applicant will not receive a refund of processing fees, but the District will apply processing fees submitted for such withdrawn application to the processing fee required for a new application or notice received from the same applicant, for an activity on all or a part of the same parcel within 365 days of the date the District received the request to withdraw the previous application. [5.5.3.7 A.H., Volume I]

16.0 Permits

16.1 Operation and Maintenance Unique to Agricultural Systems

16.1.1 Responsibility for Operation and Maintenance

The entity responsible for operation of the system (owner, lessee, public body, etc.) must be identified. If the responsible entity is not the owner, the following will be required:

(a) If the operation entity is to be a public body, such as a water control district, a preliminary letter of acceptance from the public body shall be submitted. A final letter of acceptance by the governing body is required before an operation or maintenance permit can become effective.

(b) If the entity is a lessee, the lessee must provide a copy of the lease agreement, and a separate document stating that the lessee will be responsible for maintenance and operation.

16.1.2 Operation and Maintenance Requirements

(a) The permittee is required to provide for periodic inspections of the surface water management system to insure that the system is functioning as designed and permitted.

(b) The following operational maintenance activities shall be performed on all permitted systems on a regular basis or as needed:

(1) Removal of trash and debris from the surface water management system,

(2) Inspection of culverts, culvert risers, pipes and screwgates for damage, blockage, excessive leakage or deterioration,

(3) Inspection of pipes for evidence of lateral seepage,

(4) Inspection of flapgates for excessive backflow or deterioration,

(5) Removal of sediments when the storage volume or conveyance capacity of the surface water management system is below design levels,

(6) Stabilization and restoration of eroded areas,

(7) Inspection of pump stations for structural integrity and leakage of fuel or oil to the ground or surface water, and

(8) Inspection of monitoring equipment, including pump hour meters and staff gauges, for damage and operational status.

(c) The permittee shall maintain and operate the Conservation Practices contained in the Conservation Plan, consistent with current SCS standards, specifications and guidelines.

(d) In addition to the practices listed in subsection (b) above, specific operational maintenance activities are required, depending on the type of permitted system, as follows:

(1) Overland flow systems shall include provisions for:

a. Mowing and removal of clippings, and

b. Maintenance of spreader swales and overland flow areas to prevent channelization.

(2) Spray irrigation systems for reuse/disposal shall include provisions for:

a. Inspection of the dispersal system, including the sprayheads or perforated pipe for damage or clogging, and

b. Maintenance of the sprayfield to prevent channelization.

(3) Treatment systems which incorporate isolated wetlands shall include provisions for:

a. Stabilization and restoration of channelized areas, and

b. Removal of sediments which interfere with the function of the wetland or treatment system.

(4) Systems in Class I waters shall include provisions for inspection and maintenance of valves for wells which discharge from an aquifer which contains greater than 250 mg/l of chloride.

(e) If the system is not functioning as designed and permitted, operational maintenance must be performed immediately to restore the system. If the operational maintenance measures are insufficient to enable the system to meet the performance standards of this chapter, the permittee must either

replace the system or construct an alternative design. A permittee must apply for and obtain a modification prior to constructing such alternative design. [40C-44.069, F.A.C.]

16.2 Transfers

16.2.1 The District must be notified in writing, within 30 days of any sale, conveyance, or other transfer of a permitted system or facility or within 30 days of any transfer of ownership or control of the real property at which the permitted system is located. Transfers of ownership or transfers of a permit obtained solely pursuant to 62-330.020(2)(i), F.A.C., and section 1.2.3 of this Volume are subject to the requirements of chapter 40C-1, F.A.C. All other transfers are subject to the requirements of chapter 62-330, F.A.C.

16.3 Related Permits

16.3.1 Application to construct, alter, or maintain a system must include application for any related permit required to operate a system.

16.3.2 Agricultural operations which are also required to obtain a permit pursuant to 62-330.020(2)(a), (b), (c), (d), (e), (f), (g), (h) or (j), F.A.C., or section 1.2.2 of this Volume, must comply with the performance standards and water quality practices contained in chapter 40C-44, F.A.C., in order to meet the District's water quality criteria. Additional special conditions, which will be applied in this case, are listed in section 40C-44.061, F.A.C. *Revised 6/1/18*

16.3.3 For permits which include construction, the permit for operation and maintenance will be granted with a condition that the operation and maintenance permit becomes valid upon satisfactory completion of the permitted construction or alteration (as demonstrated by the submission of certified as-built plans) and compliance with all conditions of the permit.

16.4 Duration

16.4.1 The permit which is granted will include a specified period for which the permit is valid. Unless revoked or modified, such period is:

(a) generally five years for permits to construct, alter, or remove a system; and

(b) permanent for permits to operate, maintain, or abandon a system.

16.4.2 The designed duration for permits to construct, alter, abandon, or remove, will be dependent upon the facts and circumstances of each situation. These include:

(a) size of a proposed system; and

(b) anticipated amount of time required to complete the proposed activity.

16.4.3 Permits expire at 11:59 pm on the date indicated on the permit conditions unless an application is made pursuant to chapter 40C-1, F.A.C., for an extension on or before the date of expiration. Application for an extension should be made by writing to:

Division of Regulatory Services
St. Johns River Water Management District
4049 Reid Street
Palatka, FL 32177-2529

16.4.4 If an application for re-issuance is made prior to expiration, the permit remains in effect until the District takes action on the application.

16.4.5 The District may revoke or modify a permit in accordance with the provisions of section 373.429, F.S., and chapter 40C-1, F.A.C. The following constitutes grounds for modification or revocation:

(a) Consistent noncompliance with permit conditions.

(b) Consistent noncompliance with state water quality standards.

(c) Noncompliance with approved wasteload allocations, developed pursuant to a Surface Water Improvement and Management Plan or other state or District program, when adopted by District rule, such that the operation has become inconsistent with the objectives of the District, as set forth in section 18.0 of Part VII of this Volume, or

(d) Noncompliance with a pollutant load reduction goal when adopted by District rule, such that the operation has become inconsistent with the objectives of the District, as set forth in section 18.0 of Part VII of this Volume.

For the purposes of this section of the rule only, the District will consider "consistent noncompliance with state water quality standards" to be violations of state water quality standards for 2 consecutive quarters of 3 or more parameters or violations of state water quality standards for 4 consecutive quarters of 1 or more parameters.

16.5 Enforcement and Inspection

16.5.1 Chapter 373, F.S. provides for the enforcement of District rules by administrative

and civil complaint. In addition to the authority of the District to enforce, the District has the authority to obtain the assistance of county and city officials in the enforcement of the rules (see sections 373.603 and 373.609, F.S.) A person who violates District rules or refuses to comply with a District order may be subject to criminal prosecution as set forth in section 373.403, F.S.

16.5.2 One condition of each permit will be that District authorized staff, upon proper identification, will have permission to enter, inspect and observe the system to insure compliance with the approved plans and specifications included in the permit.

16.6 Compliance

16.6.1 Permit conditions routinely require installation of monitoring equipment and reporting of monitoring data. Other conditions, as directed by the District, may be placed on permits. Noncompliance by performing activities which have not been authorized by permit and are not exempt, or by failure to adhere to permit conditions is subject to the appropriate legal action (see section 16.5.1).

16.6.2 Forms *Revised 6/1/18*

Compliance forms, used to report monitoring data, are incorporated by reference in 40C-44.061, F.A.C., and are available from the District.

16.6.3 Water Quality Monitoring *Revised 6/1/18*

Water quality monitoring is typically required by individual permits. Permittees are required to analyze samples for the parameters listed in Table 1 incorporated by reference in 40C-44.061, F.A.C., and may be required to perform additional analyses based on site specific conditions.

Samples must be analyzed by a laboratory certified by the Florida Department of Health (DOH).

16.6.4 Pump Hour Monitoring

Pump hour monitoring is typically required by individual permits. Pump hours are monitored by the installation of pump hour meters on each drainage pump, and submission of quarterly reports unless otherwise specified by permit condition.

16.6.5 Pond Stage Monitoring

Monitoring of pond stages is typically required by individual permits. A surveyed staff gauge (referenced to National Geodetic Vertical Datum (NGVD) or North American Vertical Datum (NAVD)) must be installed and maintained in each pond.

Staff gauges are made of metal or plastic with graduated lines. They can be purchased from survey equipment suppliers or field equipment supply catalogs, such as Forestry Suppliers or Ben Meadows. The USDA Natural Resources Conservation Service may be able to provide assistance in the installation and surveying of staff gauges.

Water levels must be recorded a minimum of 3 non-consecutive days per week, or as an alternative, once a week and daily during pump operation. More frequent monitoring may be required, depending on pump capacity, amount of freeboard, etc. Reports of water levels must be submitted to the District quarterly unless otherwise specified by permit condition.

B. CRITERIA FOR EVALUATION

17.0 Criteria for Evaluation

17.1 Purpose

The criteria which are explained in this part are those which have been approved by the Governing Board for use by District staff in evaluating permit applications for agricultural systems. The criteria are used in evaluating applications for individual permits. The staff recommendation on permit approval for any permit will be based upon a determination of whether the system meets the criteria for evaluation.

17.2 Source of Criteria *Revised 6/1/18*

The criteria for evaluation have been developed from guidelines established in chapter 373, F.S. (Water Resources Act of 1972); chapter 403, F.S., (Environmental Control); chapter 62-40, F.A.C. (State Water Policy); chapter 40C-4, F.A.C., (Environmental Resource Permits: Surface Water Management Systems), chapters 62-4 and 62-302, F.A.C. (Water Quality Standards), incorporated by reference in 40C-4.091(1)(c), F.A.C, this handbook, and through permitting decisions of the District. These criteria have been incorporated by reference in chapter 62-330, F.A.C.

17.3 Statutory Criteria

17.3.1 In order to obtain a permit, an applicant must give reasonable assurance that:

(a) The construction or alteration of any dam, impoundment, reservoir, appurtenant work or works will not be harmful to the water resources of the District.

(b) The operation or maintenance of any dam, impoundment, reservoir, appurtenant work or works will not be inconsistent with the overall objectives of the District and will not be harmful to the water resources of the District.

(c) The abandonment or removal of any dam, impoundment, reservoir, appurtenant work or works will not be inconsistent with the overall objectives of the District.

17.4 State Water Quality Standards *Revised 6/1/18*

State water quality standards are contained in chapters 62-4, 62-302, 62-520, and 62-550, F.A.C., (incorporated by reference in 40C-4.091(1)(c), F.A.C.). The standards are set by DEP, not by the District. Discharges from the agricultural surface water management systems can not cause or contribute to a violation of state water quality standards in waters of the state, as set forth in chapters 62-4, 62-302, 62-520, and 62-550 F.A.C., including any antidegradation provisions of sections 62-4.242(1)(a) and (b), 62-4.242(2) and (3), and 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in sections 62-4.242(2) and (3), F.A.C.

17.4.1 Surface Water Quality Standards

State water quality standards for surface waters are contained in chapters 62-4 and 62-302, F.A.C. The standards apply at the point of mixing with waters of the state. For the purposes of this rule, violations must be projected, based on monitoring results at the pump inlet or pond outfall and sound scientific rationale, or observed at the edge of the "boil" caused by the pump or weir discharge.

17.4.2 Groundwater Quality Standards

State water quality standards for groundwater are contained in chapter 62-520, F.A.C. Section 62-520.400, F.A.C., specifies minimum criteria for groundwater. In addition to the minimum criteria, Class G-I and G-II groundwater must meet primary and secondary drinking water quality standards for public water systems established pursuant to the Florida Safe Drinking Water Act, which are listed in sections 62-550.310 and .320, F.A.C.

Only the minimum criteria apply within a zone of discharge, as determined in section 62-520.400, F.A.C. A zone of discharge is defined as a volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which an opportunity for the treatment, mixture or dispersion of wastes into receiving ground water is afforded. Stormwater facilities generally have a zone of discharge 100 feet from the site boundary or to the installation's property boundary, whichever is less.

18.0 Overall Objectives of the District

18.1 Objectives

18.1.1 To obtain a permit for operation, maintenance, removal or abandonment of a system, each applicant must give reasonable assurance that such activity will not:

(a) Endanger life, health, or property;

(b) Be inconsistent with the maintenance of minimum flows and levels established pursuant to section 373.042, F.S.;

(c) Adversely affect the availability of water for reasonable beneficial purposes;

(d) Be incapable of being effectively operated;

(e) Adversely affect the operation of a Work of the District established pursuant to section 373.086, F.S.

(f) Adversely affect existing agricultural, commercial, industrial, or residential developments;

(g) Cause adverse impacts to the quality of receiving waters;

(h) Adversely affect natural resources, fish and wildlife;

(i) Increase the potential for damages to off-site property or the public caused by:

(1) Floodplain development, encroachment or other alteration;

(2) Retardance, acceleration, displacement or diversion of surface water;

(3) Reduction of natural water storage areas;

(4) Facility failure;

(j) Increase the potential for flood damages to residences, public buildings, or proposed and existing streets and roadways; and

(k) Otherwise be inconsistent with the overall objectives of the District. *Revised 6/1/18*

18.1.2 Because a system may result in both beneficial and harmful effects in terms of various individual objectives, in determining whether the applicant has provided evidence of reasonable assurance of compliance with subparagraph 40C-44.301(l)(a), the District shall consider a balancing of specific effects to show the system is not inconsistent with the overall objectives of the District.

19.0 Harm to the Water Resources of the District

19.1 Harm to the Water Resources Standards

19.1.1 The Governing Board has delineated the following performance standard which must be met to demonstrate that the proposed activity will not be harmful to the water resources of the District and will not cause adverse impacts to the quality of the receiving waters:

Discharges from the agricultural surface water management system shall not cause or contribute to a violation of water quality standards in waters of the state, as set forth in chapters 62-4, 62-302, 62-520, and 62-550, F.A.C. (incorporated by reference in 40C-4.091(1)(c)), including any antidegradation provisions of sections 62-4.242(1)(a) and (b), 62-4.242(2) and (3), and 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in sections 62-4.242(2) and (3), F.A.C.
Revised 6/1/18

19.1.2 To obtain an individual permit for construction, alteration, operation, or maintenance of a system, each applicant must give reasonable assurance that such activity is not harmful to the water resources by meeting the following standards:

(a) Adverse water quantity impacts will not be caused to receiving waters and adjacent lands;

(b) Surface and ground water levels and surface water flow will not be adversely affected;

(c) Existing surface water storage and conveyance capabilities will not be adversely affected;

(d) The system must be capable of being effectively operated;

(e) The activity must not result in adverse impacts to the operation of Works of the District established pursuant to section 373.086, F.S.; and

(f) Hydrologically-related environmental functions will not be adversely affected;

19.2 Harm to the Water Resources Criteria

19.2.1 It is presumed that a system meets the standards listed in subsection 19.1.2 if the system meets the criteria in sections 62-330.301 and 62-330.302, F.A.C.

19.2.2 Individual Permits *Revised 6/1/18*

(a) For the following types of systems qualifying for an individual permit pursuant to paragraph 40C-44.061(2), F.A.C., it is presumed that compliance with the criteria specified in section 19.1.2 will provide reasonable assurance that the system will comply with the performance standards described in section 19.1.1:

(1) Small agricultural operations (greater than 2 acres, but less than 40 acres) that do not propose any work in wetlands or other surface waters that would require a permit pursuant to paragraph 62-330.020(2)(a), F.A.C., if they have obtained a Conservation Plan, implemented the Conservation Plan within 180 days of permit issuance, and maintained the Conservation Plan. [40C-44.055(1), F.A.C.]

(2) Existing agricultural operations which are applying for a chapter 40C-44, F.A.C., permit prior to the expiration of a valid Industrial Waste permit or consent order (section 14.8.1), provided they:

a. Continue to maintain and operate the surface water management system, and associated treatment system, as previously permitted or authorized by consent order, and

b. Demonstrate compliance with the performance standards described in subsection 40C-44.065(1), F.A.C., based upon data collected in compliance with monitoring conditions. If the District staff determines that the compliance monitoring data does not demonstrate compliance with the performance standards, staff will notify the applicant, in writing, of the specific pollutant or pollutants for which treatment will be required in order to obtain an individual permit. [40C-44.055(2), F.A.C.]

(3) Minor alterations, described in section 14.1, provided the applicant provides reasonable assurance, through plans, test results or other information, that the activity is a minor alteration [40C-44.055(3), F.A.C.]

(4) Surface water management systems which drain an agricultural operation of less than 120 acres, which do not contain a concentrated animal feeding operation, which

implement a Conservation Plan within 180 days of permit issuance, and which maintain the Conservation Plan, provided the permittee satisfies the following monitoring conditions:

a. The permittee must maintain hour meters, in operating order, on each drainage pump. If the hour meters are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Reports of pump operating hours for each pump must be submitted to the District quarterly, using forms provided in the handbook.

b. The permittee must maintain a surveyed staff gauge, (referenced to NGVD or NAVD), in each detention pond. If the staff gauges are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Water levels must be recorded a minimum of 3 nonconsecutive days per week, or as an alternative, once a week and daily during pump operation. Reports of water levels for each pond must be submitted quarterly to the District using forms incorporated by reference and provided in 40C-44.061, F.A.C., and available from the District.

c. The permittee must monitor the water quality on a quarterly basis at each discharge point from pumps or pond outfalls to waters of the state. If no discharge has occurred during a particular quarter, no sampling is required. Water samples must be analyzed for the parameters listed in Table 1 (see 40C-44.061, F.A.C.). Samples must be analyzed by a laboratory certified by the Florida Department of Health.

d. If, after five years of water quality monitoring, the permittee demonstrates that the data collected represents steady state conditions and is adequate to project future compliance with state water quality standards, the District shall amend the monitoring conditions by reducing the frequency of monitoring or the number of parameters monitored, or eliminating such requirements.

e. If, after five years of water quality monitoring, the District notifies the permittee in writing that

discharges from the surface water management system have not complied with the performance standards described in subsection 40C-44.065(1), F.A.C., then the permittee must apply for an individual permit in accordance with subsection 40C-44.061(3), F.A.C.

(5) Surface water management systems which drain an agricultural operation which do not contain a concentrated animal feeding operation, which have obtained a Conservation Plan, implemented the Conservation Plan within 180 days of permit issuance, maintain the Conservation Plan, and which have not been issued an Industrial Waste permit or consent Order, provided the permittee satisfies the monitoring conditions described below:

a. The permittee must maintain hour meters, in operating Order, on each drainage pump. If the hour meters are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Reports of pump operating hours for each pump must be submitted to the District quarterly, using forms incorporated by reference and provided in 40C-44.061, F.A.C., and available from the District.

b. The permittee must maintain a surveyed staff gauge, (referenced to NGVD or NAVD), in each detention pond. If the staff gauges are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Water levels must be recorded a minimum of 3 nonconsecutive days per week, or as an alternative, once a week and daily during pump operation. Reports of water levels for each pond must be submitted quarterly to the District using forms incorporated by reference and provided in 40C-44.061, F.A.C., and available from the District.

c. The permittee must monitor the water quality on a quarterly basis at each discharge point from pumps or pond outfalls to waters of the state following implementation of the Conservation Plan or within 180 days of permit issuance, whichever occurs sooner. If no discharge has occurred during a

particular quarter, no sampling is required. Water samples must be analyzed for the parameters listed in Table 1 (see 40C-44.061, F.A.C.). Samples must be analyzed by a laboratory certified by the Florida Department of Health.

d. If, after five years of water quality monitoring, the permittee demonstrates that the data collected represents steady state conditions and is adequate to project future compliance with state water quality standards, the District shall amend the monitoring conditions by reducing the frequency of monitoring or the number of parameters monitored, or eliminating such requirements.

e. If, after one year of water quality monitoring, the District notifies the permittee in writing that discharges from the surface water management system have not complied with the performance standards described in section 40C- 44.065(1), F.A.C., then the permittee must apply for an individual permit in accordance with subsection 40C-44.061(3), F.A.C.

(b) For all other systems which are required to obtain an individual permit under section 40C-44.061, F.A.C., it is presumed that implementation of the water quality practices listed in section 19.2.4 will provide reasonable assurance that the system will comply with the performance standards described in section 19.1.1. The water quality practices or other alternatives shall be implemented to the extent necessary to comply with the performance standards described in section 19.1.1. In some cases, the implementation of these practices may not result in compliance with the performance standards for issuance of an individual permit. In those cases, the applicant shall provide for implementation of such additional water quality practices and/or treatment methodologies as necessary to provide reasonable assurance that the discharge will comply with the performance standards described in section 19.1.1.

19.2.3 Discharge to Class I, Class II, or Outstanding Florida Waters

New and existing systems which discharge to Class I, Class II or Outstanding Florida Waters shall be required to provide an additional level of treatment to provide reasonable assurance of compliance with section 19.1.1. Direct discharges to

Outstanding Florida Waters shall provide an additional 50% of the applicable treatment volume.

19.2.4 Water Quality Practices *Revised 6/1/18*

(a) Reduce the volume of stormwater and associated wastewater discharged to waters of the state by:

(1) Implementing management practices designed to reduce the volume of water discharged off-site, including Water Table Control in Open Channels, Irrigation Land Leveling and Irrigation Water Management, and

(2) Maximizing on-site recycling to satisfy irrigation, freeze protection and pest control needs. The applicant may demonstrate maximum stormwater harvesting by using all the practically available water from reservoir storage prior to using groundwater.

(b) Implement and maintain a Conservation Plan, which includes a Nutrient Management Plan and Pesticide Management Plan.

(c) Provide treatment of the pollutants generated by the agricultural operation. The treatment method required depends on the intensity of land use and associated pollutants.

(1) Wet detention ponds, designed and operated in accordance with section 8.0 of this Volume, are presumed to satisfy the requirements of paragraphs (a)(2) and (c) for those portions of an agricultural operation described below:

a. Citrus, row crop, sod, hayland or improved pasture which discharge to Class I, Class II, or Outstanding Florida Waters, or

b. Citrus, row crop, sod, hayland or improved pasture on predominantly organic soils. For the purposes of this handbook, organic soils are listed as mucks, peats or mucky fine sands in the NRCS county Soil Surveys.

(2) Other water quality practices in lieu of wet detention, such as overland flow, vegetative filters and detention in isolated wetlands, are presumed to satisfy the requirements in paragraph (c) for low intensity agricultural operations such as rough or semi-improved pasture, when the practice(s) is designed, operated and maintained using accepted engineering principles.

(3) Agricultural surface water management systems may incorporate overland flow, vegetative filters and detention in isolated wetlands as water quality practices. Existing canals and conveyance systems may be incorporated into a wet detention treatment system, when appropriate. The applicant must provide reasonable assurance, through plans, test results or other information, that the practice will provide an adequate level of treatment to meet the performance standards in section 19.1.1.

(d) Applicants who propose to satisfy the performance standards in section 19.1.1 by employing a treatment methodology or device other than those described in sections 19.2.4(a)-(c), may seek approval for an equivalent alternative through the District's permit process.

19.2.5 Agricultural surface water management systems requiring a permit which will be located in the Lake Apopka Hydrologic Basin or which will discharge water to Lake Apopka or its tributaries, must comply with the requirements of subsection 40C-41.063(8), F.A.C., and Section 13.7 of this Volume.

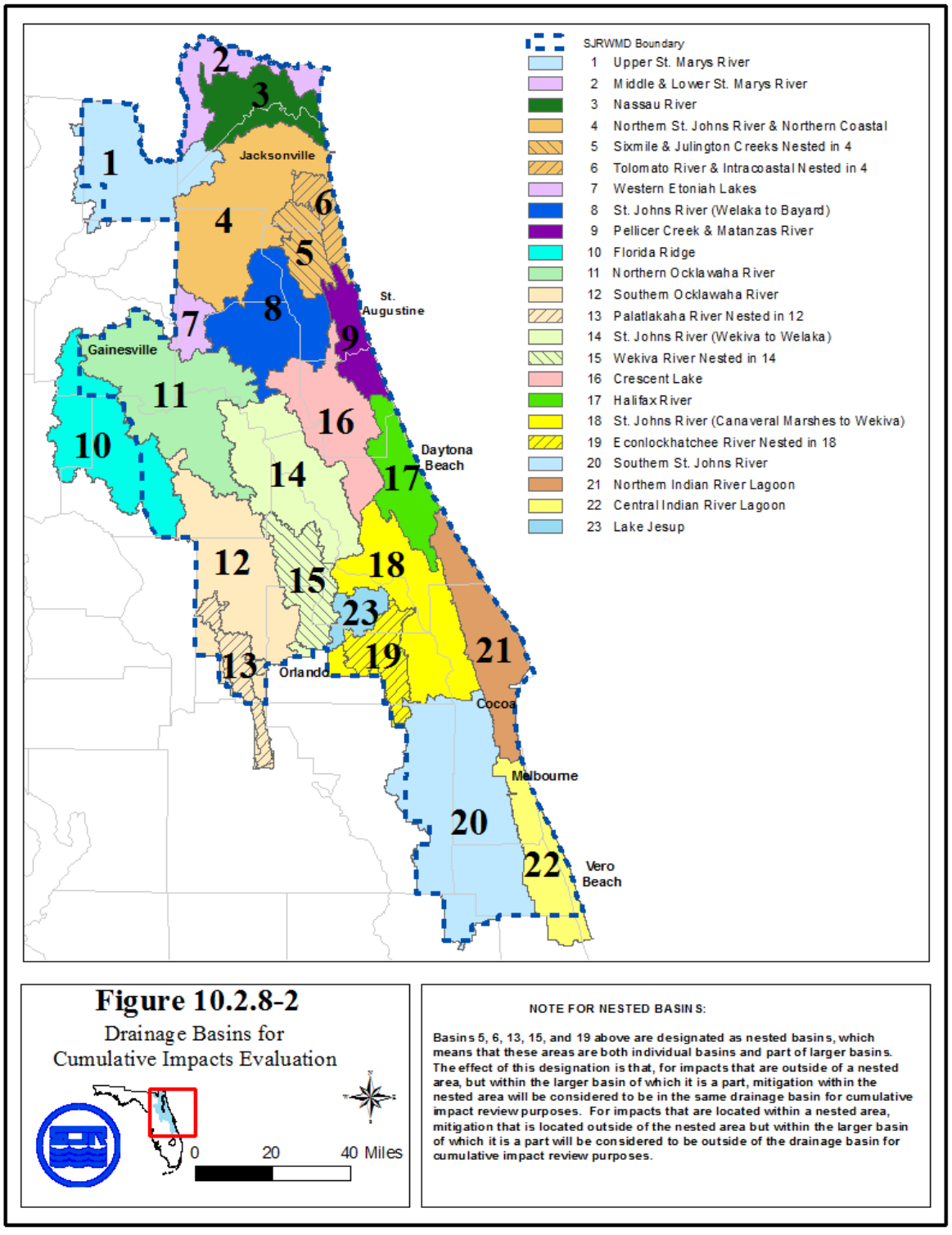
19.2.6 Agricultural surface water management systems requiring a permit that will be located within the Wekiva Recharge Protection Basin must comply with the requirements of paragraph 40C-41.063(3)(a), F.A.C., and Section 13.3 of this Volume.

APPENDICES

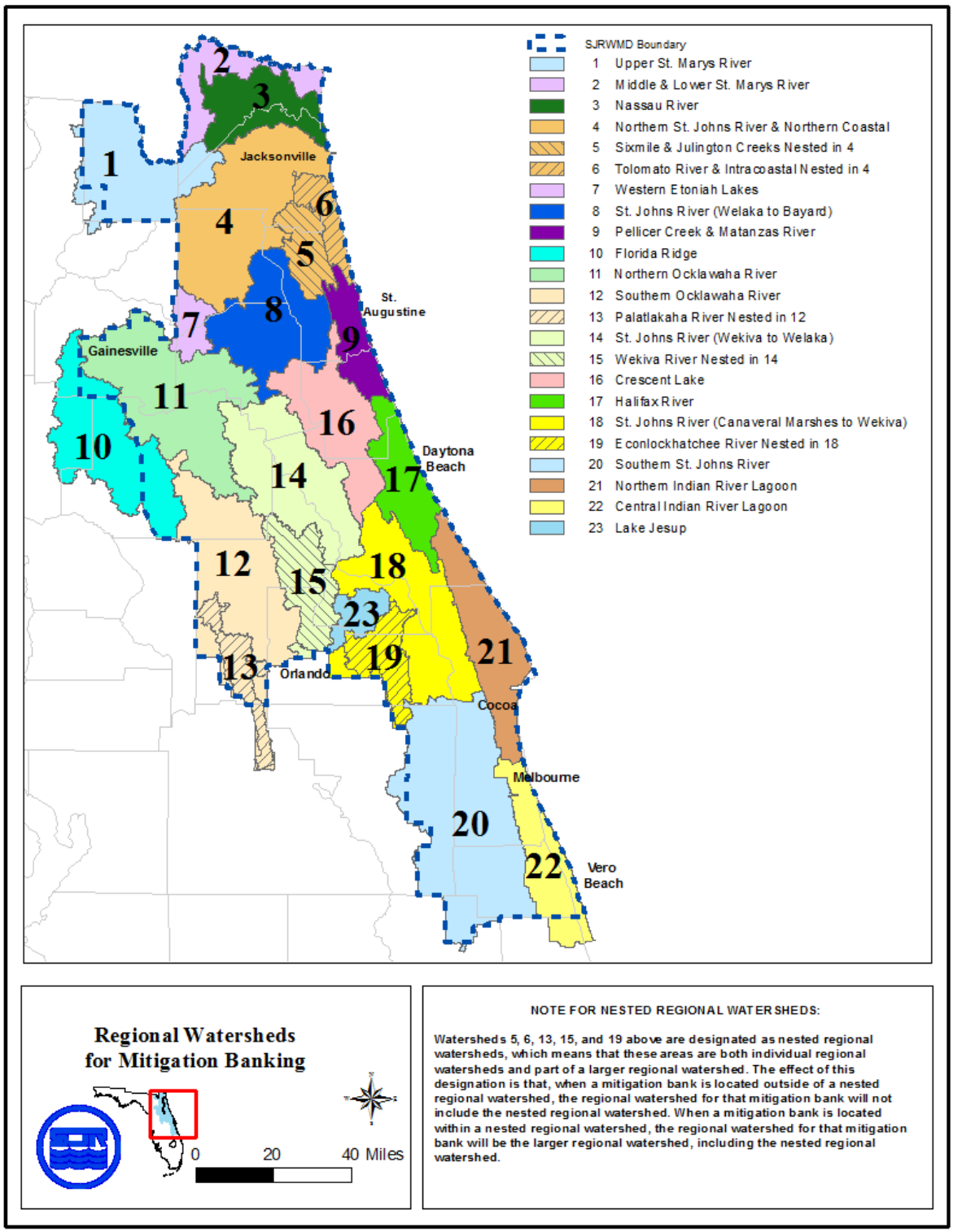
APPENDIX A

SJRWMD Drainage Basins for Cumulative Impacts Evaluation and Regional Watersheds for Mitigation Banking

SJRWMD Drainage Basins and Regional Watersheds



This figure constitutes Figure 10.2.8-2 in Applicant's Handbook, Volume I (General and Environmental) effective *10-1-13*



Revised 10/1/13

APPENDIX B

Basin Boundaries

LEGAL DESCRIPTION

UPPER ST. JOHNS RIVER HYDROLOGIC BASIN

Begin at the southeast corner of Section 33, Township 33 South, Range 38 East; thence west along the township section line between Township 33 and 34 South to the northwest corner of Section 6, Township 34 South, Range 37 East; thence south along the range line between Ranges 36 and 37 East to the southeast corner of Section 1, Township 34 South, Range 36 East; thence west along the section line to the northwest corner of Section 10, Township 34 South, Range 36 East; thence south along the section line to the southeast corner of Section 9, Township 34 South, Range 36 East; thence west along the section lines to the northwest corner of Section 18, Township 34 South, Range 36 East; thence south along the range line between Ranges 35 and 36 East to the southeast corner of Section 12, Township 34 South, Range 35 East; thence west along the section line to the northwest corner of Section 13, Township 34 South, Range 35 East; thence south along the section lines to the southwest corner of Section 35, Township 34 South, Range 35 East; thence west along the township line between Townships 34 and 35 South to the southwest corner of Section 35, Township 34 South, Range 34 East; thence north along the section lines to the Okeechobee and Osceola County line; thence west along the Okeechobee and Osceola County line to the southwest corner of Section 31, Township 32 South, Range 34 East; thence north along the section lines to the northeast corner of Section 1, Township 32 South, Range 33 East; thence west along the section lines to the southwest corner of Section 34, Township 31 South, Range 33 East; thence north along the section lines to the northwest corner of Section 3, Township 31 South, Range 33 East; thence east along the township line between Township 30 and Township 31 South to the southeast corner of Section 36, Township 30 South, Range 33 East; thence north along the range line between Ranges 33 and 34 East to the northeast corner of Section 1, Township 30 South, Range 33 East; thence west along the township line between Townships 29 and 30 South to the southwest corner of Section 31, Township 29 South, Range 33 East; thence north along the range line between Ranges 32 and 33 East to the northwest corner of Section 6, Township 28 South, Range 33 East; thence east along the township line between Townships 27 and 28 South to the southeast corner of Section 36, Township 27 South, Range 32

East; thence north along the range line between Ranges 32 and 33 East to the northeast corner of Section 1, Township 26 South, Range 32 East; thence west along the township line between Townships 25 and 26 South to the southwest corner of Section 35, Township 25 South, Range 32 East; thence north along the section lines to the northwest corner of Section 11, Township 25 South, Range 32 East; thence east along the section line to the southeast corner of Section 2, Township 25 South, Range 32 East; thence north along the section lines to the northwest corner of Section 24, Township 24 South, Range 32 East; thence east along the section line to the southeast corner of Section 13, Township 24 South, Range 32 East; thence north along the range line between Ranges 32 and 33 East to the northeast corner of Section 25, Township 22 South, Range 32 East; thence west along the section lines to the southwest corner of Section 23, Township 22 South, Range 32 East; thence north along the section lines to the northwest corner of Section 2, Township 22 South, Range 32 East; thence east along the township line between Townships 21 and 22 South to the southeast corner of Section 35, Township 21 South, Range 32 East; thence north along the section lines to the northwest corner of Section 13, Township 21 South, Range 32 East; thence east along the section lines to the southeast corner of Section 7, Township 21 South, Range 33 East; thence north along the section line to the northwest corner of Section 8, Township 21 South, Range 33 East, thence east along the section line to the southeast corner of Section 5, Township 21 South, Range 33 East; thence north along the section line to the northwest corner, Section 4, Township 21 South, Range 33 East; thence east along the township line between Township 20 and 21 South to the southeast corner of Section 33, Township 20 South, Range 33 East; thence north along the section lines to the northwest corner of Section 22, Township 20 South, Range 33 East; thence east along the section line to the southeast corner of Section 15, Township 20 South, Range 33 East; thence east along the section lines to the south east corner of Section 1, Township 20 South, Range 33 East; thence north along the range line between Ranges 33 and 34 East to the northwest corner of Section 30, Township 19 South, Range 34 East; thence east along the section lines to the northeast corner of Section 28, Township 19 South, Range 34 East; thence northerly along the boundary line between Section 21, Township 19 South, Range 34 East, and John H. McIntosh Grant to the northeast corner of Section 21, Township 19 South, Range 34; thence easterly along the boundary line between John Low Grant and John H. McIntosh Grant to the westerly right-

of-way line of Interstate Highway 95; thence southerly along the westerly right-of-way line of Interstate Highway 95 to the Brevard-Volusia County line; thence east along the Brevard-Volusia County line to the westerly right-of-way line of U.S. Route No. 1; thence southerly along the westerly right-of-way line of U.S. Route No. 1 to the northerly right-of-way line of State Route No. 50; thence west along the northerly right-of-way line of State Route No. 50 to the northwest corner of Section 27, Township 22 South, Range 35 East; thence south along the section lines to the southwest corner of Section 34, Township 22 South, Range 35 East; thence east along the township line between Townships 22 and 23 South to the northeast corner of Section 3, Township 23 South, Range 35 East; thence south along the section lines to the southwest corner of Section 14, Township 23 South, Range 35 East; thence east along the section lines to the northeast corner of Section 24, Township 23 South, Range 35 East; thence south along the range line between Ranges 35 and 36 East to the southwest corner of Section 7, Township 24 South, Range 36 East; thence east along the section line to the northeast corner of Section 18, Township 24 South, Range 36 East; thence south along the section lines to the southwest corner of Section 17, Township 25 South, Range 36 East; thence east along the section lines to the westerly right-of-way line of U.S. Route No. 1, thence southerly along the westerly right-of-way line of U.S. Route No. 1 to the range line between Ranges 36 and 37 East; thence south along the range line between Ranges 36 and 37 East to the northeast corner of Section 13, Township 27 South, Range 36 and 37 East to the northeast corner of Section 13, Township 27 South, Range 36 East; thence west along the section line to the northwest corner of Section 13, Township 27 South, Range 36 East; thence south along the section line to the southeast corner of Section 14, Township 27 South, Range 36 East; thence west to the easterly right-of-way line of Interstate Highway 95; thence south along the easterly right-of-way line of Interstate Highway 95 to the township line between Townships 27 and 28 South; thence east along the township line between Townships 27 and 28 South to the north quarter corner of Section 6, Township 28 South, Range 37 East; thence south to the center of Section 7, Township 28 South, Range 37 East; thence east to the east quarter corner of said section; thence south along the section line to the southwest corner of Section 8, Township 28 South, Range 37 East; thence east along the section line to the north quarter corner of Section 17, Township 28 South, Range 37 East; thence south to the south quarter corner of said section; thence east

along the section line to the northeast corner of Section 20, Township 28 South, Range 37 East; thence south along the section lines to the southwest corner of Section 28, Township 28 South, Range 37 East; thence east along the section lines to north quarter corner of Section 34, Township 28 South, Range 37 East; thence south to the south quarter corner of Section 3, Township 29 South, Range 37 East; thence west along the section line to the easterly right-of-way line of Interstate Highway 95; thence southerly along the easterly right-of-way line of Interstate Highway 95 to the section line between Sections 22 and 23, Township 29 South, Range 37 East; thence south along the section lines to the township line between Townships 29 and 30 South; thence west along the township line between Townships 29 and 30 South to the northwest corner of Section 3, Township 30 South, Range 37 East; thence south along the section lines to the southwest corner of Section 34, Township 30 South, Range 37 East; thence east along the township line between Townships 30 and 31 South to the southwest boundary of the Fleming Grant; thence southeast along the southwest boundary of the Fleming Grant to the range line between Ranges 37 and 38 East; thence south along the range line between Ranges 37 and 38 East to the southwest corner of Section 19, Township 32 South, Range 38 East; thence east along the section line to the northeast corner of Section 30, Township 32 South, Range 38 East; thence south along the section lines to the southwest corner of Section 5, Township 33 South, Range 38 East; thence east along the section line to the northeast corner of Section 8, Township 33 South, Range 38 East; thence south along the section line to the southwest corner of Section 9, Township 33 South, Range 38 East; thence east along the section line to the northeast corner of Section 16, Township 33 South, Range 38 East; thence south along the section line to the southeast corner of Section 33, Township 33 South, Range 38 East.

NOTE: This description based on Florida Department of Transportation County Maps.

LEGAL DESCRIPTION

OKLAWAHA RIVER HYDROLOGIC BASIN *Revised 6/1/18*

Begin at the northeast corner of Section 13, Township 25 South, Range 26 East; thence south along the range line between Ranges 26 and 27 East to the southwest corner of Section 18, Township 26 South, Range 27 East; thence east along the section line to the northeast corner of Section 19, Township 26 South, Range 27 East; thence south along the section lines to the southwest corner of Section 32, Township 26 South, Range 27 East; thence east along the township line between Townships 26 and 27 South to the northeast corner of Section 5, Township 27 South, Range 27 East; thence south along the section lines to the southerly right-of-way line of State Road 600; thence westerly along the southerly right-of-way line of said State Road 600 to the west boundary of Section 27, Township 27 South, Range 26 East; thence north along the section lines to the northeast corner of Section 16, Township 25 South, Range 26 East; thence west along the section line to the southwest corner of Section 9, Township 25 South, Range 26 East; thence north along the section lines to the Lake and Polk County line; thence west along the county line to the southwest corner of Section 32, Township 24 South, Range 26 East; thence into Lake County, north along the section lines to the northeast corner of Section 30, Township 24 South, Range 26 East; thence west along the section lines to the northeast corner of Section 28, Township 24 South, Range 25 East; thence north along the section lines to the northeast corner of Section 16, Township 24 South, Range 25 East; thence west along the section line to the northwest corner of Section 16, Township 24 South, Range 25 East; thence north along the section line to the northeast corner of Section 8, Township 24 South, Range East; thence west along the section lines to the range line between Ranges 24 and 25; thence north along the range line to the northeast corner of Section 12, Township 22 South, Range 24 East; thence west along the section lines to the southwest corner of Section 2, Township 22 South, Range 24 East; thence north along the section lines to the northeast corner of Section 27, Township 21 South, Range 24 East; thence west along the section lines to the southwest corner of Section 20, Township 21 South, Range 24 East; thence north along the section lines to the northeast corner of Section 18, Township 21 South, Range 24 East; thence west along the section line to the northwest corner of Section 18, Township 21 South, Range 24 East; also being the Sumter and Lake County line; thence north along the Sumter and

Lake County line, also being the range line between Ranges 23 and 24 East to the northwest corner of Section 30, Township 19 South, Range 24 East; thence east along the section line to the northeast corner of Section 30, Township 19 South, Range 24 East; thence north along the section line to the northwest corner of Section 20, Township 19 South, Range 24 East; thence east along the section line to the northeast corner of Section 20, Township 19 South, Range 24 East; thence north along the section lines to the northwest corner of Section 33, Township 18 South, Range 24 East; thence east along the section line to the northeast corner of Section 33, Township 18 South, Range 24 East; thence north along the section line to the northwest corner of Section 27, Township 18 South, Range 24 East; thence east along the section line to the southeast corner of Section 22, Township 18 South, Range 24 East; thence north along the section lines to the northeast corner of Section 15, Township 18 South, Range 24 East; thence west along the section lines to the northwest corner of Section 18, Township 18 South, Range 24 East also being the Sumter and Lake County line; thence north along the Sumter and Lake County line to the northeast corner of Section 1, Township 18 South, Range 23 East and the Marion County line; thence west along the Sumter and Marion County line, also being the township line between Township 17 and 18 South, to the southwest corner of Section 32, Township 17 South, Range 23 East; thence north along the section lines to the northwest corner of Section 8, Township 17 South, Range 23 East; thence east along the section line to the southeast corner of Section 5, Township 17 South, Range 23 East; thence north along the section lines to the northeast corner of Section 8, Township 16 South, Range 23 East; thence west along the section lines to the southwest corner of Section 6, Township 16 South, Range 23 East; thence north along the range lines between Range 22 and 23 East to the northeast corner of Section 24, Township 15 South, Range 22 East; thence west along the section lines to the northwest corner of Section 19, Township 15 South, Range 22 East; thence south along the range lines between Ranges 21 and 22 East to the Southeast corner of Section 24, Township 16 South, Range 21 East; thence west along the section lines to the westerly right-of-way line of Interstate Highway 75; thence northerly along the westerly right-of-way line of Interstate Highway 75 to the north boundary of Section 9, Township 14 South, Range 21 East; thence east along the section lines to the northeast corner of Section 12, Township 14 South, Range 21 East; thence south along the range line between Ranges 21 and 22 to the southwest corner of

Section 7, Township 14 South, Range 22 East; thence east along the section line to the northeast corner of Section 18, Township 14 South, Range 22 East; thence south along the section line to the southwest corner of Section 17, Township 14 South, Range 22 East; thence east along the section line the northeast corner of Section 20, Township 14 South, Range 22 East; thence south along the section line to the southwest corner of Section 21, Township 14 South, Range 22 East; thence east along the section lines to the southeast corner of Section 24, Township 14 South, Range 22 East; thence north along the range line between Ranges 22 and 23 East to the northwest corner of Section 18, Township 14 South, Range 23 East to the northwest corner of Section 18, Township 14 South, Range 23 East; thence east along the section lines to the southeast corner of Section 9, Township 14 South, Range 23 East' thence north along the section lines to the northeast corner of Section 4, Township 14 South, Range 23 East; thence west along the township line between Townships 13 and 14 South of the southwest corner of Section 33, Township 13 South, Range 23 East; thence north along the section lines to the southerly right-of-way line or Florida Highway 316; thence easterly along the southerly right-of-way line of Florida Highway 316 to the east line of Section 14, Township 13 South, Range 24 East; thence south along the section lines to the southwest corner of Section 36, Township 13 South, Range 24 East; thence east along the township line between Township 13 and 14 South to the northeast corner of Section 1, Township 14 South, Range 24 East; thence south along the range line between Ranges 24 and 25 East to the southwest corner of Section 31, Township 14 South, Range 25 East; thence along the township line between Townships 14 and 15 South to the northeast corner of Section 2, Township 15 South, Range 25 East; thence south along the section lines to the southwest corner of Section 24, Township 15 South, Range 25 East; thence east along the section line to the northeast corner of section 25, Township 15 South, Range 25 East; thence south along the range line between Ranges 25 and 25 1/2 South to the township line between Townships 15 and 16 South; thence south along the range line between Ranges 25 and 26 East to the southwest corner of Section 7, Township 17 South, Range 26 East; thence east along the section lines to the northeast corner of Section 15, Township 17 South, Range 26 East; thence south along the section lines to the southwest corner of Section 35, Township 17 South, Range 26 East; thence east along the section lines to the northeast corner of Section 5, Township 18 South, Range 27 East; thence south along the section lines

to the southwest corner of Section 33, Township 18 South, Range 27 East; thence east along the township line between Townships 18 and 19 South to the northeast corner of Section 3, Township 19 South, Range 27 East; thence south along the section lines to the southwest corner of section 35, Township 19 South, Range 27 East; thence east along the township line between Townships 19 and 20 South to the northeast corner of Section 2, Township 20 South, Range 26 East; thence south along the section lines to the southwest corner of Section 25, Township 20 South, Range 27 East; thence east along the section lines to the northeast corner of Section 33, Township 20 South, Range 28 East; thence south along the section lines to the southeast corner of Section 28, Township 21 South, Range 28 East; thence west along the section line to the northwest corner of Section 33, Township 21 South, Range 28 East; thence south along the section lines to the southeast corner of Section 8, Township 22 South, Range 28 East; thence west along the section line to the northeast corner of Section 18, Township 22 South, Range 28 East; thence south along the section lines to the southeast corner of Section 31, Township 22 South, Range 28 East; thence west along the township line between Townships 22 and 23 South to the northwest corner of Section 1, Township 23 South, Range 27 East; thence south along the section lines to the southeast corner of Section 11, Township 23 South, Range 27 East; thence west along the section lines to the northwest corner of Section 18, Township 23 South, Range 27 East; thence south along the range line between Ranges 26 and 27 East to the northeast corner of Section 24, Township 23 South, Range 26 East; thence west along the section line to the northwest corner of Section 24, Township 23 South, Range 26 East; thence south along the section line to the southeast corner of Section 23, Township 23 South, Range 26 East; thence west along the section lines to the northwest corner of Section 28, Township 23 South, Range 26 East; thence south along the section lines to the southwest corner of Section 16, Township 24 South, Range 26 East; thence east along the section lines to the northeast corner of Section 22, Township 24 South, Range 26 East; thence south along the section lines to the southwest corner of Section 16, Township 24 South, Range 26 East; thence east along the section lines to the northeast corner of Section 22, Township 24 South, Range 26 East; thence south along the section lines to southeast corner of Section 26, Township 24 South, Range 26 East; thence east along the section line to the northeast corner of Section 35, Township 24 South, Range 26 East; thence south along the section lines to the southwest corner of Section 12, Township

25 South, Range 26 East; thence east along the section line to the northeast corner of Section 13, Township 25 South, Range 26 East.

LESS AND EXCEPT any portion lying within Polk County (transferred to the Southwest Florida Water Management District, effective at 12:01 a.m. on July 1, 2003, per subsection 373.0691(2), Florida Statutes (2014)).

NOTE: This description based on Florida Department of County Maps.

LEGAL DESCRIPTION

WEKIVA RIVER HYDROLOGIC BASIN

Begin at the southeast corner of Section 31, Township 22 South, Range 28 East; thence east along the Township line between Townships 22 and 23 South to the center line of the State Highway 435, Township 22 South, Range 28 East; thence northerly along the center line of State Highway 435 to the center line of State Highway 50; thence east along the center line of State Highway 50 to the southeast corner of Section 22, Township 22 South, Range 29 East; thence north along the section line to the northeast corner of Section 22, Township 22 South, Range 29 East; thence east along the section line to center line of Interstate 4; thence northerly along the center line of Interstate 4 to the Seminole and Orange County line; thence east along the Seminole and Orange County line to the center line of State Highway 427, thence north along the center line of State Highway 427 to the center line of State Highway 436, thence east along the center line of State Highway 436 to the center line of State Highway 427; thence northeasterly along the center line of State Highway 427 to the southeast corner of Section 6, Township 21 South, Range 30 East; thence west along the section lines to the southeast corner of Section 2, Township 21 South, Range 29 East; thence north along the section lines to the center line of Interstate 4; thence north along the center line of Interstate 4 to the center line of State Highway 46A; thence west along the center line of State Highway 46A to the southwest corner of Section 31, Township 19 South, Range 30 East; thence north along the section lines also being the range line between Ranges 29 and 30 East to the Township line between Townships 18 and 19 South; thence west along the Township line between Townships 18 and 19 South to the Lake and Seminole County line, thence west along the Township line between Townships 18 and 19 South to the southwest corner of Section 33, Township 18 South, Range 29 East; thence north along the section lines to the north corner of Section 16, Townships 17 South, Range 29 East; thence northwesterly along section line to the northwest corner of Section 39 Township 17 South, Range 28 East (also being the Domingo Fernandez Grant line): thence west along Township line between Townships 16 and 17 South to the northeast corner of Section 2, Township 17 South, Range 28 East; thence south along the section lines to the southeast corner of Section 11, Township 17

South, Range 28 East; thence west along the section lines to the southwest corner of Section 10, Township 17 South, Range 28 East; thence south along the section lines to the southeast corner of Section 21, Township 17 South, Range 28 East; thence west along the section line to the southwest corner of Section 21, Township 17 South, Range 28 East; thence south along the section line to the southeast corner of Section 29, Township 17 South, Range 28 East; thence west along the section line to the southwest corner of Section 29, Township 17 South, Range 28 East; thence north along the section line to the northeast corner of Section 30, Township 17 South, Range 28 East; thence west along the section line to the northwest corner of Section 30, Township 17 South, Range 28 East; thence north along the section line to the northeast corner of Section 24, Township 17 South, Range 27 East; thence west along the section lines to the northwest corner of Section 23, Township 17 South, Range 27 East; thence north along the section lines to the northeast corner of Section 10, Township 17 South, Range 27 East; thence west along the section line to the northwest corner of Section 10, Township 17 South, Range 27 East; thence north along the section line to the northwest corner of Section 4, Township 17 South, Range 27 East; also being the Township line between Townships 16 and 17 South; thence west along the section line to the southwest corner of Section 31, Township 16 South, Range 27 East; thence north along the section line to the northwest corner of Section 31, Township 16 South, Range 27 East; also being the Lake and Marion County line; thence west along the section line to the northwest corner of Section 36, Township 16 South, Range 26 East; thence south along the section lines to the southwest corner of Section 1, Township 17 South, Range 26 East; thence west along the section line to the northwest corner of Section 11, Township 17 South, Range 26 East; thence south along the section lines to the southwest corner of Section 35, Township 17 South, Range 26 East; also being the Marion and Lake County line; thence east along the section lines to the northwest corner of Section 5, Township 18 South, Range 27 East; thence south along the section lines to the southwest corner of Section 33, Township 18 South, Range 27 East; thence east along the Township line between Townships 18 and 19 South to the northeast corner of Section 3, Township 19 South, Range 27 East; thence south along the section lines to the southwest corner of Section 35, Township 19 South, Range 27 East; thence east along the Township line between Townships 19 and 20 South to the northeast corner of Section 2, Township 20 South, Range 27 East; thence south along the section lines to the

southwest corner of Section 25, Township 20 South, Range 27 East; thence east along the section lines to the northeast corner of Section 33, Township 20 South, Range 28 East; thence south along the section lines to the southeast corner of Section 28, Township 21 South, Range 28 East; thence west along the section line to the northwest corner of Section 33, Township 21 South, Range 28 East; thence south along the section lines to the southeast corner of Section 8, Township 22 South, Range 28 East; thence west along the section line to the northeast corner of Section 18, Township 22 South, Range 28 East; thence south along the section lines to the southeast corner of Section 31, Township 22 South, Range 28 East, which is also the point of beginning.

LEGAL DESCRIPTION

WEKIVA RECHARGE PROTECTION BASIN[1]

Begin at the northwest corner of Section 6, Township 18 South, Range 28 East, Lake County, Florida, said corner lying on the north line of Township 18 South; thence Easterly along said north line of Township 18 South to the northeast corner of Section 5, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 5 to the northeast corner of Section 8, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 8 to the northeast corner of Section 17, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 17 to the northeast corner of Section 20, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 20 to the northeast corner of Section 29, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 29 to the northeast corner of Section 32, Township 18 South, Range 29 East; thence Southerly along the east line of said Section 32 to the southeast corner thereof, said corner lying on the south line of Township 18 South; thence Easterly along the south line of said Township 18 South to an intersection with the east line of Range 29 East; thence Southerly along the east line of said Range 29 East to the southeast corner of Section 24, Township 21 South, Range 29 East; thence Westerly along the south line of said Section 24 to the southeast corner of Section 23, Township 21 South, Range 29 East; thence Westerly along the south line of said Section 23, to an intersection with the centerline of Interstate Highway No. 4; thence generally Southerly along the centerline of Interstate Highway No. 4 to an intersection with the south line of Section 13, Township 22 South, Range 29 East; thence Westerly along the south line of said Section 13 to the southeast corner of Section 14, Township 22 South, Range 29 East; thence Westerly along the south line of said Section 14 to the southeast corner of Section 15, Township 22 South, Range 29 East; thence Westerly along the south line of said Section 15 to the northeast corner of Section 21, Township 22 South, Range 29 East; thence Southerly along the east line of said Section 21 to an intersection with the centerline of State Road No. 50; thence Westerly along

[1]This legal description is for the same area defined as the “Wekiva Study Area” in Section 369.316, Florida Statutes.

the centerline of said State Road No. 50 to the northeast corner of Section 30, Township 22 South, Range 28 East; thence Southerly along the east line of said Section 30 to the northeast corner of Section 31, Township 22 South, Range 28 East; thence Southerly along the east line of said Section 31 to the southeast corner thereof, said corner lying on the south line of Township 22 South; thence Westerly along said south line of Township 22 South to the northeast corner of Section 2, Township 23 South, Range 27 East; thence Southerly along the east line of said Section 2 to the northeast corner of Section 11, Township 23 South, Range 27 East; thence Southerly along the east line of said Section 11 to the southeast corner thereof; thence Westerly along the south line of said Section 11 to the southeast corner of Section 10, Township 23 South, Range 27 East; thence Westerly along the south line of said Section 10 to the southeast corner of Section 9, Township 23 South, Range 27 East; thence Westerly along the south line of said Section 9 to the Southeast corner of Section 8, Township 23 South, Range 27 East; thence Westerly along the south line of said Section 8 to the southeast corner of Section 7, Township 23 South, Range 27 East; thence Westerly along the south line of said Section 7 to the southwest corner thereof, said corner lying on the line of demarcation between Orange County and Lake County; thence generally Northerly and along said county line to the northeast corner of Section 12, Township 20 South, Range 26 East, said corner lying on the east line of Range 26 East; thence generally Northerly and along said east line of Range 26 East to the southeast corner of Section 24, Township 19 South, Range 26 East; thence Westerly along the south line of said Section 24 to the southeast corner of Section 23, Township 19 South, Range 26 East; thence Westerly along the south line of said Section 23 to the southwest corner thereof; thence Northerly along the west line of said Section 23 to the southwest corner of Section 14, Township 19 South, Range 26 East; thence Northerly along the west line of said Section 14 to the southwest corner of Section 11, Township 19 South, Range 26 East; thence generally Northeasterly to the southwest corner of Section 1, Township 19 South, Range 26 East; thence generally Northeasterly to the southwest corner of Section 31, Township 18 South, Range 27 East; thence generally Northeasterly to the southwest corner of Section 29, Township 18 South, Range 27 East; thence generally Northeasterly to the northwest corner of Section 28, Township 18 South, Range 27 East; thence Easterly along the north line

of said Section 28 to the northwest corner of Section 27, Township 18 South, Range 27 East; thence Easterly along the north line of said Section 27 to the northwest corner of Section 26, Township 18 South, Range 27 East; thence Easterly along the north line of said Section 26 to the northwest corner of Section 25, Township 18 South, Range 27 East; thence Easterly along the north line of said Section 25 to an intersection with the west line of Range 28 East; thence Northerly along the west line of said Range 28 East, to the northwest corner of Section 6, Township 18 South, Range 28 East, and the Point of Beginning.

LEGAL DESCRIPTION

ECONLOCKHATCHEE RIVER HYDROLOGIC BASIN

Begin at the Northeast corner of Section 1, Township 26 South, Range 32 East; thence West along the Township line between Township 25 South and Township 26 South to the Southwest corner of Section 33, Township 25 South, Range 32 East; thence North along the Section lines to the Osceola and Orange County line; thence West along the Osceola and Orange County line to the South quarter corner of Section 31, Township 4 South, Range 32 East; thence North along the quarter section lines to the center of Section 18, Township 24 South, Range 32 East; thence West along the quarter section line to the Northwest corner of the Northeast quarter of the Southwest quarter of Section 18, Township 24 South, Range 32 East; thence North along the quarter quarter section lines to the Northeast corner of the Southwest quarter of the Southwest quarter of Section 7, Township 24 South, Range 32 East; thence West along the North line of the Southwest quarter of the Southwest quarter of Section 7, Township 24 South, Range 32 East to the range line between Range 31 East and Range 32 East; thence North along the range line between Range 31 East and Range 32 East to the Northerly Right-of-Way line of State Road 528, also known as the Bee Line Expressway; thence Westerly along the Northerly Right-of-Way line of State Road 528 to the Southwest Right-of-Way line of State Road 15; thence Northwesterly, Westerly and Northerly along the Southwest Right-of-Way line of State Road 15 to the South line of Section 8, Township 23 South, Range 30 East; thence East along the Section lines to the South quarter corner of Section 9, Township 23 South, Range 30 East; thence North along the quarter section lines to the center of Section 33, Township 22 South, Range 30 East; thence West along the quarter section lines to the center of Section 31, Township 22 South, Range 30 East; thence North along the quarter Section lines to the center of Section 19, Township 22 South, Range 30 East; thence East to the East quarter corner of Section 19, Township 22 South, Range 30 East; thence North along the Section lines to the Southwest corner of Section 8, Township 22 South, Range 30 East; thence East along the Section line to the Southeast corner of Section 8, Township 22 South, Range 30 East; thence North along the Section lines to the Northeast corner of Section 5, Township 22 South, Range 30 East; thence West along the Section line to the South quarter corner of Section 32, Township 21 South, Range 30 East; thence North to the North quarter

corner of Section 32, Township 21 South, Range 30 East; thence East along the Section lines to the North quarter corner of Section 35, Township 21 South, Range 30 East; thence South along the quarter section lines to the South quarter corner of Section 2, Township 22 South, Range 30 East; thence East along the Section line to the Southwest corner of Section 1, Township 22 South, Range 30 East; thence North along the Section line to the Northwest corner of the South 1/2 of the South 1/2 of Section 1, Township 22 South, Range 30 East; thence East to the Northwest corner of the South 1/2 of the South 1/2 of Section 6, Township 22 South, Range 31 East; thence East to the Northeast corner of the South 1/2 of the South 1/2 of Section 6, Township 22 South, Range 31 East; thence North along the Section lines to the Northwest corner of Section 32, Township 21 South, Range 31 East; thence East along the Section lines to the West Right-of-Way line of State Road 520; thence North along the West Right-of-Way line of State Road 520 to the East West quarter section line of Section 27, Township 21 South Range 31 East; thence East to the center of Section 27, Township 21 South, Range 31 East; thence North along the quarter section lines to the North quarter corner of Section 22, Township 21 South, Range 31 East; thence East to the Southeast corner of Section 15, Township 21 South, Range 31 East; thence North along the Section lines to the North Right-of-Way line of State Road 426; thence East and Northeasterly along the North Right-of-Way line of State Road 426 to the West Section line of Section 5, Township 21 South, Range 32 East; thence North along the Section lines to the West quarter corner of Section 20, Township 20 South, Range 32 East; thence East to the East quarter corner of Section 20, Township 20 South, Range 32 East; thence East to the center of Section 21, Township 20 South, Range 32 East; thence North along the North-South quarter line of Section 21, Township 20 South, Range 32 East to the North Right-of-Way line of State Road 46; thence Southeasterly along the North Right-of-Way line of State Road 46 to the North-South quarter line of Section 26, Township 20 South, Range 32 East; thence South along the quarter section lines to the center of Section 2, Township 21 South, Range 32 East; thence East along the quarter Section lines to the center of Section 1, Township 21 South, Range 32 East; thence North along the quarter Section lines to the center of Section 36, Township 20 South, Range 32 East; thence East along the quarter section lines to the center of Section 33, Township 20 South, Range 33 East; thence South along the quarter section lines to the South quarter corner of Section 4, Township 21

South, Range 33 East; thence West along the Section lines to the Northeast corner of Section 7, Township 21 South, Range 33 East; thence South along the Section line to the Southeast corner of Section 7, Township 21 South, Range 33 East; thence West along the section line to the Southwest corner of Section 7, Township 21 South, Range 33 East; thence South along the Range line between Range 32 East and Range 33 East to the Southeast corner of Section 13, Township 21 South, Range 32 East; thence West along the Section line to the Northeast Corner of Section 23, Township 21 South, Range 32 East; thence South along the section lines to the Southeast corner of Section 2, Township 22 South, Range 32 East; thence West along the section line to the South quarter corner of Section 2, Townships 22 South, Range 32 East; thence South along the quarter section lines to the South quarter corner of Section 23, Township 22 South, Range 32 East; thence East along the Section lines to the Northeast corner of Section 30, Township 22 South, Range 33 East; thence South along the Section lines to the South Right-of-Way line of State Road 50; thence West along the South Right-of-Way line of State Road 50 to the North-South quarter Section line of Section 31, Township 22 South, Range 33 East; thence South along the quarter Section lines to the South quarter corner of Section 7, Township 23 South, Range 33 East; thence West to the Southwest corner of Section 7, Township 23 South, Range 33 East; thence South along the Range line between Range 32 East and Range 33 East to the Southwest corner of Section 19, Township 23 South, Range 33 East; thence East along the section line to the North quarter corner of Section 30, Township 23 South, Range 33 East; thence South along the quarter section lines to the South quarter corner of Section 6, Township 24 South, Range 33 East; thence East along the section line to the Southeast corner of Section 6, Township 24 South, Range 33 East; thence South along the section lines to the East quarter corner of Section 31, Township 24 South, Range 33 East; thence West along the quarter section lines to the West quarter corner of Section 36, Township 24 South, Range 32 East; thence South along the Section lines to the West quarter corner of Section 1, Township 25 South, Range 32 East; thence East along the quarter section lines to the East quarter corner of Section 6, Township 25 South, Range 33 East; thence South along the Section lines to the Southeast corner of Section 19, Township 25 South, Range 33 East; thence West along the section line to the Southwest corner of Section 19, Township 25

South, Range 33 East; thence South along the range line between Range 32 East and Range 33 East to the Northeast corner of Section 1, Township 26 South, Range 32 East which is also the Point of Beginning.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series quadrant maps and Florida Department of Transportation County Maps.

LEGAL DESCRIPTION

MARION COUNTY KARST AREA

BEGIN at the intersection of the westerly right-of-way line of Interstate Highway 75 with the Sumter-Marion County line; thence northerly along the westerly right-of-way line of Interstate Highway 75 to the intersection of said westerly right-of-way line with the northerly right-of-way line of State Road 318; thence northeasterly and easterly along the northerly right-of-way line of State Road 318 to the intersection of said right-of-way line with the westerly line of Section 28, Township 12 South, Range 21 East;l thence north along the section line to the northwest corner of Section 28, Township 12 South, Range 21 East; thence east along he section lines to the Alachua-Marion County line; thence easterly along the Alachua-Marion County line (following the meanderings thereof) to the range line between Range 22 and Range 23 East, the same being the Alachua-Marion County line; thence north along the Alachua-Marion County line and the range line between Range 22 and Range 23 East to the northwest corner of Section 18, Township 12 South, Range 23 East; thence east along the section line to the northeast corner of Section 18, Township 12 South, Range 23 East; thence south along the section lines to the southwest corner of Section 20, Township 12 South, Range 23 East; thence east along the section line to the southeast corner of Section 20, Township 12 South, Range 23 East; thence south along the section line to the northwest corner of Section 33, Township 12 South, Range 23 East; thence east along the section line to the northeast corner of Section 33, Township 12 South, Range 23 East, thence south along the section lines to the southwest corner of Section 3, Township 13 South, Range 23 East; thence east along the section lines to the southeast corner of Section 1, Township 13 South, Range 23 East; thence south along the range line between Range 23 and Range 24 East to the southeast corner of Section 1, Township 14 South, Range 23 East; thence west along the section line to the southeast corner of Section 2, Township 14 South, Range 23 East; thence south along the section lines to the southeast corner of Section 14, Township 14 South, Range 23 East; thence west along the section line to the southwest corner of Section 14, Township 14 South, Range 23 East; thence south along the section lines to the southeast corner of Section 34, Township line between Townships 14 and 15 South to the northeast corner of Section 4, Township 15 South, Range 23 East; thence south along the section line to the southeast corner of Section 4, Township 15 South, Range 23

East; thence west along the section line to the southwest corner of Section 4, Township 15 South, Range 23 East; thence south along the section lines to the southwest corner of Section 21, Township 15 South, Range 23 East; thence east along the section line to the southeast corner of Section 21, Township 15 South, Range 23 East; thence south along the section line to the northwest corner of Section 34, Township 15 South, Range 23 East; thence east along the section line to the northeast corner of Section 34, Township 15 South, Range 23 East; thence south along the section lines to the northwest corner of Section 11, Township 16 South; Range 23 East; thence east along the section line to the northeast corner of Section 11, Township 16 South, Range 23 East; thence south along the section lines to the northwest corner of Section 24, Township 16 South, Range 23 East; thence east along the section line to the northeast corner of Section 24, Township 16 South, Range 23 East; thence south along the range line between Range 23 and Range 24 East to the northwest corner of Section 31, Township 16 South, Range 24 East; thence east along the section line to the northeast corner of Section 31, Township 16 South, Range 24 East; thence south along the section lines to the intersection of the division line between Sections 5 and 6, Township 17 South, Range 24 East with the waters of Lake Weir; thence south crossing the water of Lake Weir to the intersection of the division line between Sections 19 and 20, Township 17 South, Range 24 East with the waters of Lake Weir; thence south along the section lines to the southeast corner of Section 31, Township 17 South, Range 24 East, and the Marion-Lake County line, also being the township line between Townships 17 and 18 South; thence west along the Marion-Lake County line and west along the Sumter-Marion County line, also being the township line between Townships 17 and 18 South, to the POINT OF BEGINNING.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series quadrangle maps and Florida Department of Transportation County Maps.

LEGAL DESCRIPTION

ALACHUA COUNTY KARST AREA

BEGIN at the southeast corner of Section 36, Township 11 South, Range 18 East on the Alachua-Levy County line; thence north along the range line between Range 18 and Range 19 East to the northwest corner of Section 19, Township 9 South, Range 19 East; thence east along the section lines to the northeast corner of Section 20, Township 9 South, Range 19 East; thence south along the section lines to the southeast corner of Section 29, Township 9 South, Range 19 East; thence east along the section lines to the northeast corner of Section 36, Township 9 South, Range 19 east; thence south along the range line between Range 19 and Range 20 East to the southeast corner of Section 36, Township 9 South, Range 19 East; thence east along the township line between Township 9 and Township 10 South to the intersection of said township line with the easterly right-of-way line of State Road No. 25 (U.S. Route No. 441); thence south along the easterly right-of-way line of State Road No. 25 (U.S. Route No. 441) to the intersection of said easterly right-of-way line with the northerly right-of-way line of State Road No. 26; thence east along said northerly right-of-way line to the intersection of said northerly right-of-way line with the division line between Section 4 and Section 5, Township 10 South, Range 20 East; thence south along the section lines to the southwest corner of Section 9, Township 10 South, Range 20 East; thence south to the northwest corner of Section 21 Township 10 South, Range 20 East; thence east along the section lines to the northeast corner of Section 22, Township 10 South, Range 20 East; thence south along the section lines and along a southerly prolongation of the east line of Section 27, Township 10 South, Range 20 East, to the intersection of said southerly prolongation with an easterly prolongation of the north line of Section 6, Township 11 South, Range 20 East; thence west along said easterly prolongation to the northeast corner of Section 6, Township 11 South, Range 20 East; thence west along the township line between Township 10 and Township 11 South, to the northwest corner of Section 1, Township 11 South, Range 19 East; thence south along the section lines to the southeast corner of Section 14, Township 11 South, Range 19 East; thence west along the section line to the southwest corner of Section 14, Township 11 South, Range 19 East; thence south along the section lines to the southeast corner of Section 34, Township 11 South, Range 19 East, and the Alachua Marion County line, also being the township

line between Township 11 and Township 12 South; thence west along the Alachua-Marion County line and west along the Alachua-Levy County line to the POINT OF BEGINNING.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series Quadrangle maps and Florida Department of Transportation County Maps.

LEGAL DESCRIPTION

LAKE APOPKA HYDROLOGIC BASIN

Begin at the Northeast corner of Section 29, Township 22 South, Range 28 East; thence South along the Section lines to the Southeast corner of the Northeast quarter of Section 32, Township 22 South, Range 28 East; thence west along the quarter section line to the Southeast corner of the Northwest quarter of Section 31, Township 22 South, Range 28 East; thence South along the quarter section line to the Southeast corner of the Southwest quarter of Section 31, Township 22 South, Range 28 East; thence West along the Section lines to the Southwest corner of the Southeast quarter of Section 36, Township 22 South, Range 27 East; thence South along the quarter section line to the Southeast corner of the Southwest quarter of Section 1, Township 23 South, Range 27 East; thence West along the Section line to the Southeast corner of Section 2, Township 23 South, Range 27 East; thence South along the Section line to the Southeast corner of Section 11, Township 23 South, Range 27 East; thence West along the Section lines to the Southeast corner of the Southwest quarter of Section 7, Township 23 South, Range 27 East; thence South along the quarter section line to the Southeast corner of the Northeast quarter of the Northwest quarter of Section 18, Township 23 South, Range 27 East; thence West along the south line of the Northeast quarter of the Northwest quarter and along the south line of the Northwest quarter of the Northwest quarter, to the Southwest corner of the Northwest quarter of the Northwest quarter of Section 18, Township 23 South, Range 27 East; thence North along the Section line to the Southwest corner of Section 7, Township 23 South, Range 27 East: thence West along the Section line to the Southwest corner of the Southeast quarter of Section 12, Township 23 South, Range 26 East; thence North along the quarter section line to the Southeast corner of the Southwest quarter of Section 1, Township 23 South, Range 26 East; thence West along the Section lines to the Southwest corner of the Southeast quarter of Section 6, Township 23 South, Range 26 East; thence North along the quarter section line to the Northwest corner of the Northeast quarter of Section 6, Township 23 South, Range 26 East; thence East along the Section line to the Southwest corner of Section 32, Township 22 South, Range 26 East; thence North along the Section line to the Northwest corner of Section 32, Township 22 South, Range 26 East; thence East along the Section line to the Southwest corner of Section 28, Township 22 South, Range 26 East; thence North along the Section line to the Southeast corner of the Northeast Quarter of Section 5, Township 22 South, Range 26 East; thence West along the quarter section line to the Southwest corner of the Northwest Quarter of Section 5, Township 22 South, Range 26 East; thence North along the Section lines to the Northwest corner of

Section 32, Township 21 South, Range 26 East; thence East along the Section line to the Northeast corner of the Northwest quarter of Section 32, Township 21 South, Range 26 East; thence North along the quarter section lines to the Northwest corner of the Northeast quarter of Section 20, Township 21 South, Range 26 East; thence East along the Section line to the Southwest corner of Section 16, Township 21 South, Range 26 East; thence North along the Section line to the Northwest corner of Section 16, Township 21 South, Range 26 East; thence East along the Section line to the Southwest corner of the Southeast quarter of Section 9, Township 21 South, Range 26 East; thence North along the quarter section line to the Northwest corner of the Southeast quarter of Section 4, Township 21 South, Range 26 East; thence West along the quarter section line to the Southwest corner of the Northwest quarter of Section 4, Township 21 South, Range 26 East; thence North along the Section line to the Northwest corner of Section 4, Township 21 South, Range 26 East and the South line of Section 33, Township 20 South, Range 26 East; thence West along said South line to the Southwest corner of said Section 33, Township 20 South, Range 26 East; thence North along the section lines to the Northwest corner of Section 28, Township 20 South, Range 26 East; thence East along the section lines to the Southwest corner of the Southeast quarter of Section 24, Township 20 South, Range 26 East; thence North along the quarter section line to the Northwest corner of the Southeast quarter of Section 24, Township 20 South, Range 26 East; thence East along the quarter section line to the Northeast corner of the Southeast quarter of Section 24, Township 20 South, Range 26 East; thence North along the Section line to the Northwest corner of Section 19, Township 20 South, Range 27 East; thence East along the Section lines to the Northwest corner of Section 21, Township 20 South, Range 27 East; thence North along the Section line to the Northwest corner of the Southwest quarter of Section 16, Township 20 South, Range 27 East; thence East along the quarter section line to the Northeast corner of the Southeast quarter of Section 16, Township 20 South, Range 27 East; thence North along the Section line to the Northwest corner of Section 15, Township 20 South, Range 27 East; thence East along the Section line to the Northeast corner of Section 14, Township 20 South, Range 27 East; thence South along the Section lines to the Southeast corner of Section 23, Township 20 South, Range 27 East; thence West along the Section line to the Southwest corner of the Southeast quarter of Section 23, Township 20 South, Range 27 East; thence South along the quarter section line to the Northwest corner of the Northeast quarter of Section 35, Township 20 South, Range 27 East; thence East along the Section line to the Northeast corner of Section 35, Township 20 South, Range 27 East; thence South along the Section line to the Southeast corner of Section 35, Township 20 South,

Range 27 East; thence East along the Section line to the Southwest corner of the Southeast quarter of Section 36, Township 20 South, Range 27 East; thence North along the quarter section line to the Northwest corner of the Southeast quarter of Section 36, Township 20 South, Range 27 East; thence East along the quarter section line to the Northeast corner of the Southeast quarter of Section 36, Township 20 South, Range 27 East; thence North along the Section line to the Northwest corner of Section 31, Township 20 South, Range 28 East; thence East along the Section lines to the Northeast corner of the Northwest quarter of Section 33, Township 20 South, Range 28 East; thence South along the quarter section lines to the Southeast corner of the Southwest quarter of Section 9, Township 21 South, Range 28 East; thence East along the Section line to the Northwest corner of the Northeast quarter of the Northeast quarter of Section 16, Township 21 South, Range 28 East; thence South along the quarter-quarter Section lines to the Southwest corner of the Southeast quarter of the Southeast quarter of Section 16, Township 21 South, Range 28 East; thence West along the Section line to the Southwest corner of the Southeast quarter of Section 16, Township 21 South, Range 28 East; thence South along the quarter section line to the Southeast corner of the Southwest quarter of Section 21, Township 21 South, Range 28 East; thence West along the Section line to the Southeast corner of Section 20, Township 21 South, Range 28 East; thence South along the Section line to the Southeast corner of Section 32, Township 21 South, Range 28 East; thence West along the Section line to the Southwest corner of the Southeast quarter of Section 32, Township 21 South, Range 28 East; thence South along the quarter section line to the Southwest corner of the Northeast quarter of Section 8, Township 22 South, Range 28 East; thence East along the quarter section line to the Southeast corner of the Northeast quarter of Section 8, Township 22 South, Range 28 East; thence South along the Section line to the Southeast corner of Section 8, Township 22 South, Range 28 East; thence West along the Section line to the Southeast corner of Section 7, Township 22 South, Range 28 East; thence South along the Section line to the Southeast corner of the Northeast quarter of Section 18, Township 22 South, Range 28 East; thence West along the quarter section line to the Northeast corner of the Southeast quarter of Section 13, Township 22 South, Range 27 East; thence South along the Section line to the Southeast corner of Section 13, Township 22 South, Range 27 East; thence West along the Section line to the Southwest corner of the Southeast quarter of Section 13, Township 22 South, Range 27 East; thence South along the quarter section line to the Northwest corner of the Northeast quarter of Section 25, Township 22 South, Range 27 East; thence East along the Section lines to the Northeast corner of Section 29, Township 22 South, Range 28 East, and the Point of Beginning.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series quadrangle maps and St. Johns River Water Management District Hydrologic Basin maps.

LEGAL DESCRIPTION

TOMOKA RIVER HYDROLOGIC BASIN

Begin at the intersection of the West line of the Northeast 1/4 of Section 35, Township 15 South, Range 32 East, and the southerly right-of-way line of State Road 400. Thence Northerly along said West line of said Northeast 1/4, to the Northwest corner of said Northeast corner of said Section 35; Thence Northerly to the Southmost corner of Section 39, Township15 South, Range 32 East; Thence Northeasterly along the Southeast line of said Section 39, a distance of 5400 feet to a point; Thence Northwesterly to a point on the Northwest line of said Section 39, said point lying 4600 feet northeast of the Westmost corner of said Section as measured along the Northwesterly line thereof; Thence Northeasterly to the Northmost corner of Section 13, Township 15 South, Range 32 East; Thence Northeasterly and perpendicular to the Southwest line of Section 38, Township 15 South, Range 32 East, a distance of 2000 feet; Thence Northwesterly and parallel to the Southwest line of said Section 38, a distance of 2000 feet; Thence Northeasterly and perpendicular to the Southwest line of said Section 38, a distance of 2000 feet; Thence Northwesterly to the Southwest corner of Section 1, Township 15 South, Range 32 East; Thence Northerly along the West line of said Section 1, to an intersection with the Southwest line of Section 37, Township 15 South, Range 32 East; Thence Northwesterly along the Southwest line of said Section 37 and the Southwest line of Section 42, Township 14 South , Range 32 East, to the Northwest corner of said Section 42; Thence Northeasterly along the Northwest line of said Section 42, to an intersection with the east right-of-way of U.S. Highway No. 1; Thence Northwesterly along said east right-of-way line, to an intersection with the south right-of-way of State Road No. 40; Thence Northeasterly along said south right-of-way, a distance of 1200 feet, more or less, to a point 1300 feet southwest of the southwesterly edge of water of the Halifax River, as depicted on USGS Quadrangle Map “Ormond Beach, FLA”, photorevised 1980; Thence Northwesterly and parallel to said southwesterly edge of water, a distance of 26,000 feet; Thence Southwesterly a distance of 9200 feet to an intersection with a point on the Southwest line of Section 40, Township 13 South, Range 32 East, said point lying 4000 feet southeast of

the Northwest corner of said Section 40 as measured along said Southwest line; Thence Northwesterly along the Southwest line of said Section 40 and Section 39, Township 13 South, Range 32 East, a distance of 6100 feet; Thence Northwesterly a distance of 6800 feet more or less to the intersection of the west right-of-way line of Interstate Highway No. 95, and the west line of Section 24, Township 13 South, Range 31 East; Thence Northwesterly along said west right-of-way line of Interstate Highway No. 95, a distance of 2600 feet; Thence Southwesterly to the Southeast corner of the Southwest 1/4 of the Southwest 1/4 of Section 23, Township 13 South, Range 31 East; Thence Southerly to the intersection of the southwest right-of-way line of U.S. Highway No. 1 and the south line of the North 1/2 of Section 26, Township 13 South, Range 31 East; Thence Easterly along said south line of the North 1/2 of Section 26, to the Northwest corner of the Southwest 1/4 of said Section 26; Thence Easterly to the Northwest corner of the Northeast 1/4 of the Southwest 1/4 of Section 27, Township 13 South, Range 31 East; Thence Southwesterly to the Southwest corner of the Northeast 1/4 of Section 33, Township 13 South, Range 31 East; Thence Easterly to the Southwest corner of the Northeast 1/4 of the Northeast 1/4 of Section 32, Township 13 South, Range 31 East; Thence Southeasterly to the Southeast corner of said Section 32; Thence Southerly to the Southeast corner of Section 8, Township 14 South, Range 31 East; Thence Southwesterly to the Northwest corner of the Southwest 1/4 of the Southwest 1/4 of Section 19, Township 14 South, Range 31 East; Thence Southerly to the Southwest corner of said Section 19; Thence Southeasterly to the intersection of the North line of the South 1/4 of Section 30, Township 14 South, Range 31 East, and the south right-of-way line of State Road No. 40; Thence Easterly along said south right-of-way line of State Road No. 40 to a point 500 feet west of the East line of said Section 30, as measured along said south right-of-way line; Thence Southerly to a point on the south line of said Section 30, said point lying 700 feet west of the Southeast corner of said Section 30; Thence Southwesterly to the Southwest corner of the Northeast 1/4 of Section 31, Township 14 South, Range 31 East; Thence Southeasterly to a point on the East line of said Section 31, said point lying 600 feet north of the Southeast corner of said Section 31; Thence Southeasterly to the Northwest corner of Section 3, Township 15 South, Range 31 East; Thence Southeasterly to the Southwest corner of the Southeast 1/4

of said Section 3; Thence Southeasterly to the Southeast corner of Section 10, Township 15 South, Range 31 East; Thence Southeasterly to the Northwest corner of the Northeast 1/4 of the Southwest 1/4 of Section 14, Township 15 South, Range 31 East; Thence Easterly to the Northeast corner of the Southwest 1/4 of said Section 14; Thence Southerly to the Southeast corner of the Southwest 1/4 of said Section 14; Thence Southeasterly to a point on the South line of Section 23, Township 15 South, Range 31 East, said point lying 750 feet west of the Southeast corner of said Section 23; Thence Southeasterly to the Southeast corner of the Northeast 1/4 of Section 26, Township 15 South, Range 31 East; Thence Southwesterly to the Southwest corner of the Southeast 1/4 of the Southeast 1/4 of said Section 26; Thence Southeasterly to the Southeast corner of the Northeast 1/4 of Section 35, Township 15 South, Range 31 East; Thence Southwesterly to the Southwest corner of the Northeast 1/4 of the Northeast 1/4 of Section 9, Township 16 South, Range 31 East; Thence Southwesterly to the Southeast corner of the Northeast 1/4 of the Southwest 1/4 of said Section 9; Thence Westerly to the Southwest corner of the Northeast 1/4 of the Southwest 1/4 of said Section 9; Thence Southerly to the Southwest corner of the Southeast 1/4 of the Southwest 1/4 of said Section 9; Thence Southwesterly to the Northwest corner of the Southwest 1/4 of Section 16, Township 16 South, Range 31 East; Thence Southerly to the Southwest corner of the Northwest 1/4 of the Southwest 1/4 of said Section 16; Thence Southeasterly to the Northwest corner of the Northeast 1/4 of Section 21, Township 16 South, Range 31 East; Thence Southeasterly to the Southeast corner of said Section 21; Thence Southeasterly to a point on the South line of the North 1/2 of Section 34, Township 16 South, Range 31 East, said point lying 600 feet west of the East line of said Section 34, as measured along said South line of said North 1/2 of Section 34; Thence Southerly and parallel to the East line of Section 34, Township 16 South, Range 31 East, and Section 3, Township 17 South, Range 31 East, a distance of 7100 feet; Thence Southeasterly to the Southeast corner of the Northeast 1/4 of the Southeast 1/4 of Section 11, Township 17 South, Range 31 East; Thence Southeasterly to the Southeast corner of the Northwest 1/4 of Section 13, Township 17 South, Range 31 East; Thence Northeasterly to the Northeast corner of said Section 13; Thence Northerly to the Northwest corner of the Southwest 1/4 of the Southwest 1/4 of Section 7, Township 17

South, Range 32 East; Thence Easterly to the Southeast corner of the Northeast 1/4 of the Southwest 1/4 of said Section 7; Thence Northerly to the Northwest corner of the Northeast 1/4 of said Section 7; Thence Northwesterly to the Northwest corner of Section 6, Township 17 South, Range 32 East; Thence Northeasterly to the Northwest corner of the Northeast 1/4 of the Southwest 1/4 of Section 31, Township 16 South, Range 32 East; Thence Southeasterly to the Southeast corner of the Southwest 1/4 of the Southwest 1/4 of Section 32, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of said Southwest 1/4 of said Southwest 1/4 of Section 32; Thence northwesterly to a point on the South line of Section 29, Township 16 South, Range 32 East, said point lying 600 feet easterly of the Southwest corner of said Section 29 as measured along the South line thereof; Thence northwesterly to the Northwest corner of the Southwest 1/4 of the Southwest 1/4 of said Section 29; Thence northwesterly to the Northwest corner of the Northeast 1/4 of the Northeast 1/4 of Section 30, Township 16 South, Range 32 East; Thence northwesterly to the Northeast corner of the Northwest 1/4 of the Northwest 1/4 of Section 19, Township 16 South, Range 32 East; Thence northeasterly to the Northeast corner of the Southeast 1/4 of the Southwest 1/4 of Section 18, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of the Southwest 1/4 of said Section 18; Thence northeasterly to the Southeast corner of the Northeast 1/4 of the Northeast 1/4 of said Section 18; Thence easterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 17, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of the Northwest 1/4 of Section 17; Thence northeasterly to the Northeast corner of the Southwest 1/4 of the Southeast 1/4 of Section 8, Township 16 South, Range 32 East; Thence southeasterly to the Southeast corner of said Section 8; Thence southeasterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 16, Township 16 South, Range 32 East; Thence easterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 15, Township 16 South, Range 32 East; Thence southeasterly to the Northwest corner of the Southeast 1/4 of the Southeast 1/4 of said Section 15; Thence northeasterly to a point on the East line of said Section 15, lying 600 feet south of the Northeast corner of said Section as measured along the East line thereof; Thence southeasterly to the Southeast corner of the Southwest 1/4 of the Northwest 1/4 of Section 14,

Township 16 South, Range 32 East; Thence northeasterly to a point on the North line of said Section 14, lying 1800 feet east of the Northwest corner of said Section as measured along the North line thereof; Thence easterly to the Southwest corner of the Southeast 1/4 of the Southeast 1/4 of Section 11, Township 16 South, Range 32 East; Thence northerly to the Northwest corner of said Southeast 1/4 of said Southeast 1/4 of said Section 11; Thence northeasterly to a point on the East line of said Section 11, lying 2000 feet north of the Southeast corner of said Section as measured along the East line thereof; Thence northeasterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 12, Township 16 South, Range 32 East; Thence easterly to the Southeast corner of the Northwest 1/4 of the Northeast 1/4 of said Section 12; Thence northwesterly to the Northeast corner of the Southeast 1/4 of the Southwest 1/4 of Section 1, Township 16 South, Range 32 East; Thence westerly to the Northwest corner of said Southeast 1/4 of said Southwest 1/4 of Section 1; Thence northwesterly to the point of intersection of the West line of the Northeast 1/4 of Section 35, Township 15 South, Range 32 East and the south right-of-way line of State Road 400, and the Point of Beginning.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series quadrant maps and St. Johns River Water Management District Hydrologic Basin maps.

LEGAL DESCRIPTION

SPRUCE CREEK HYDROLOGIC BASIN

Begin at the intersection of the West line of the Northeast 1/4 of Section 35, Township 15 South, Range 32 East, and the southerly right-of-way line of State Road 400. Thence northeasterly along said southerly right of way line of State Road 400, to an intersection with the North line of the South 1/2 of Section 30, Township 15 South, Range 33 East; Thence southerly along the East line of the Southwest 1/4 of said Section 30, to the Northeast corner of the Northwest 1/4 of Section 31, Township 15 South, Range 33 East; Thence southerly along the East line of the West 1/2 of said Section 31, to the Northeast corner of the Northwest 1/4 of Section 6, Township 16 South, Range 33 East; Thence southeasterly to a point on the East line of said Section 6, lying 500 feet north of the Southeast corner of said Section as measured along the East line thereof; Thence southeasterly to a point on the North line of Section 8, Township 16 South, Range 33 East, said point lying 500 feet east of the Northwest corner of said Section as measured along the North line thereof; Thence southerly to a point on the South line of said Section 8, said point lying 500 feet east of the Southwest corner of said Section as measured along the South line thereof; Thence southeasterly to the Southwest corner of the Southeast 1/4 of the Southeast 1/4 of Section 17, Township 16 South, Range 33 East; Thence easterly to the Northeast corner of the Northwest 1/4 of the Northwest 1/4 of Section 21, Township 16 South, Range 33 East; Thence southeasterly to the Southwest corner of the Southeast 1/4 of the Southeast 1/4 of said Section 21; Thence southeasterly to the west-most corner of Section 38, Township 16 South, Range 33 East; Thence easterly to an intersection with a southerly projection of the East line of the West 1/2 of Section 22, Township 16 South, Range 33 East; Thence northerly to the Northeast corner of the Southwest 1/4 of said Section 22; Thence easterly along the South line of the North 1/2 of said Section 22 and the easterly prolongation thereof, to an intersection with the West right-of-way line of U.S. Highway No. 1; Thence southerly and southeasterly along said West right-of-way line, to an intersection with a northerly projection of the West line of Section 36, Township 16 South, Range 33 East; Thence southerly to the Southwest corner of the Northwest 1/4 of said Section 36; Thence easterly to the Southeast corner of the Northwest 1/4 of said Section 36; Thence

southeasterly to an intersection with a point on the Southeast line of Section 40, Township 17 South, Range 33 East, said point lying 9400 feet northeasterly of the southmost corner of said Section 40 as measured along the Southeast line thereof; Thence southerly to the Northeast corner of the Southwest 1/4 of Section 12, Township 17 South, Range 33 East; Thence southeasterly to an intersection with a point on the southeasterly right-of-way line of State Road 44, said point also lying on the East line of the West 1/2 of Section 19, Township 17 South, Range 34 East; Thence southerly to the westmost corner of Section 48, Township 17 South, Range 34 East; Thence southwesterly along the southwesterly prolongation of the Northwest line of said Section 48, a distance of 1000 feet to a point; Thence southwesterly to an intersection with a point on the South line of Section 44, Township 17 South, Range 33 East, said point lying 2300 feet easterly of the Southwest corner of said Section 44 as measured along the South line thereof; Thence southerly for 3800 feet to a point in the Ambrose Hull Grant Section 52, Township 17 South, Range 34 East, said point lying 1800 feet northwest of the Southeasterly line of said Section 52, and 1400 feet northeast of the Southwesterly line of said Section 52; Thence southwesterly to a point on the West line of the East 1/2 of Section 1, Township 18 South, Range 33 East, said point lying 2200 feet south of the North line of said Section 1 as measured along the West line of the East 1/2 thereof; Thence northerly to the Southwest corner of the Southeast 1/4 of Section 27, Township 17 South, Range 33 East; Thence northwesterly to the Northwest corner of said Section 27; Thence northerly along the line dividing Sections 21 and 22, Township 17 South, Range 33 East, to the north right-of-way line of State Road No. 44; Thence westerly along said north right-of-way line to the West line of Section 20, Township 17 South, Range 33 East; Thence northerly along the West line of said Section 20 to a point 1000 feet south of the Northwest corner thereof; Thence westerly and parallel to the North lines of Section 19, Township 17 South, Range 33 East, and Section 24, Township 17 South, Range 32 East, to an intersection with the West line of the East 1/2 of said Section 24; Thence southerly along said West line of said East 1/2, to an intersection with the north right-of-way line of State Road No. 44; Thence westerly along said north right-of-way line to an intersection with the west right-of-way line of State Road No. 415; Thence southwesterly to the Northwest corner of the Southwest 1/4 of the

Southwest 1/4 of Section 23, Township 17 South, Range 32 East; Thence westerly to the Northeast corner of the Northwest 1/4 of the Southwest 1/4 of Section 22, Township 17 South, Range 32 East; Thence southwesterly to the Northwest corner of the Southwest 1/4 of the Southwest 1/4 of said Section 22; Thence westerly to the Northwest corner of the Southeast 1/4 of the Southeast 1/4 of Section 21, Township 17 South, Range 32 East; Thence northerly to the Northwest corner of the Northeast 1/4 of the Northeast 1/4 of said Section 21; Thence northwesterly to the Northwest corner of the Southeast 1/4 of Section 16, Township 17 South, Range 32 East; Thence westerly to the Northwest corner of the Northeast 1/4 of the Southwest 1/4 of said Section 16; Thence northwesterly to the Northwest corner of said Section 16; Thence northwesterly to the Northwest corner of the Northeast 1/4 of the Northeast 1/4 of Section 8, Township 17 South, Range 32 East; Thence northwesterly to the Southeast corner of the Southwest 1/4 of the Southwest 1/4 of Section 32, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of said Southwest 1/4 of said Southwest 1/4 of Section 32; Thence northwesterly to a point on the South line of Section 29, Township 16 South, Range 32 East, said point lying 600 feet easterly of the Southwest corner of said Section 29 as measured along the South line thereof; Thence northwesterly to the Northwest corner of the Southwest 1/4 of the Southwest 1/4 of said Section 29; Thence northwesterly to the Northwest corner of the Northeast 1/4 of the Northeast 1/4 of Section 30, Township 16 South, Range 32 East; Thence northwesterly to the Northeast corner of the Northwest 1/4 of the Northwest 1/4 of Section 19, Township 16 South, Range 32 East; Thence northeasterly to the Northeast corner of the Southeast 1/4 of the Southwest 1/4 of Section 18, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of the Southwest 1/4 of said Section 18; Thence northeasterly to the Southeast corner of the Northeast 1/4 of the Northeast 1/4 of said Section 18; Thence easterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 17, Township 16 South, Range 32 East; Thence northerly to the Northeast corner of the Northwest 1/4 of Section 17; Thence northeasterly to the Northeast corner of the Southwest 1/4 of the Southeast 1/4 of Section 8, Township 16 South, Range 32 East; Thence southeasterly to the Southeast corner of said Section 8; Thence southeasterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 16,

Township 16 South, Range 32 East; Thence easterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 15, Township 16 South, Range 32 East; Thence southeasterly to the Northwest corner of the Southeast 1/4 of the Southeast 1/4 of said Section 15; Thence northeasterly to a point on the East line of said Section 15, lying 600 feet south of the Northeast corner of said Section as measured along the East line thereof; Thence southeasterly to the Southeast corner of the Southwest 1/4 of the Northwest 1/4 of Section 14, Township 16 South, Range 32 East; Thence northeasterly to a point on the North line of said Section 14, lying 1800 feet east of the Northwest corner of said Section as measured along the North line thereof; Thence easterly to the Southwest corner of the Southeast 1/4 of the Southeast 1/4 of Section 11, Township 16 South, Range 32 East; Thence northerly to the Northwest corner of said Southeast 1/4 of said Southeast 1/4 of said Section 11; Thence northeasterly to a point on the East line of said Section 11, lying 2000 feet north of the Southeast corner of said Section as measured along the East line thereof; Thence northeasterly to the Southeast corner of the Northeast 1/4 of the Northwest 1/4 of Section 12, Township 16 South, Range 32 East; Thence easterly to the Southeast corner of the Northwest 1/4 of the Northeast 1/4 of said Section 12; Thence northwesterly to the Northeast corner of the Southeast 1/4 of the Southwest 1/4 of Section 1, Township 16 South, Range 32 East; Thence westerly to the Northwest corner of said Southeast 1/4 of said Southwest 1/4 of Section 1; Thence northwesterly to the point of intersection of the West line of the Northeast 1/4 of Section 35, Township 15 South, Range 32 East and the south right-of-way line of State Road 400, and the Point of Beginning.

NOTE: This description is based on U.S. Geological Survey 7.5 minute series quadrant maps and St. Johns River Water Management District Hydrologic Basin maps.

APPENDIX C

Methodology and Design Example for the Modified Rational Hydrograph Method

Methodology and Design Example for the Modified Rational Hydrograph Method

C.1 Description

The rational method is a popular method for estimating peak runoff rates for small urban areas. The rational formula is expressed as:

$$Q_P = C\,I\,A \qquad \text{(C.1-1)}$$

where: Q_P = Peak runoff rate (*cfs*)
C = Runoff coefficient
I = Rainfall intensity (*in/hr*)
A = Drainage area (*acres*)

Values for the runoff coefficient (C) are contained in Table G1-1. The intensity (I) is determined from intensity-duration-frequency (IDF) curves such as those published by the FDOT (1987a). The rational method gives peak discharge rates rather than a runoff hydrograph.

Table C 1.1 Runoff Coefficients (*C*) for a Design Storm Return Period of Ten Years or Less[1]

		Sandy Soils		Clay Soils	
Slope	Land Use	Min.	Max.	Min.	Max.
Flat (0-2%)	Lawns	0.05	0.10	0.13	0.17
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[2]	0.75	0.95	0.90	0.95
	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass, and farmland[3]	0.15	0.20	0.20	0.25
	Residential				
	SFR: 1/2 acre lots and larger	0.30	0.35	0.35	0.45
	SFR: smaller lots and duplexes	0.35	0.45	0.40	0.50
	MFR: apartments, condominiums	0.45	0.60	0.50	0.70
	Commercial and Industrial	0.50	0.95	0.50	0.95
Rolling (2-7%)	Lawns	0.10	0.15	0.18	0.22
	Rooftops and pavements	0.95	0.95	0.95	0.95
	Pervious pavements[2]	0.80	0.95	0.90	0.95
	Woodlands	0.15	0.20	0.20	0.25

	Pasture, grass, and farmland[3]	0.20	0.25	0.25	0.30
	Residential				
	SFR: 1/2 acre lots and larger	0.35	0.50	0.40	0.55
	SFR: smaller lots and duplexes	0.40	0.55	0.45	0.60
	MFR: apartments, condominiums	0.50	0.70	0.60	0.80
	Commercial and Industrial	0.50	0.95	0.60	0.95
Steep (>7%)	Lawns	0.15	0.20	0.25	0.35
	Rooftops and pavements	0.95	0.95	0.95	0.95
	Pervious pavements[2]	0.85	0.95	0.90	0.95
	Woodlands	0.20	0.25	0.25	0.30
	Pasture, grass, and farmland[3]	0.25	0.35	0.30	0.40
	Residential				
	SFR: 1/2 acre lots and larger	0.40	0.55	0.50	0.65
	SFR: smaller lots and duplexes	0.45	0.60	0.55	0.70
	MFR: apartments, condominiums	0.60	0.75	0.65	0.85
	Commercial and Industrial	0.60	0.95	0.65	0.95

Sources: Florida Department of Transportation, 1987; Wanielista, 1990

[1]For 25- to 100-yr recurrence intervals, multiply coefficient by 1.1 and 1.25, respectively, and the product cannot exceed 1.0.
[2]Coefficients assume good ground cover and conservation treatment.
[3]Depends on depth and degree of permeability of underlying strata.
Note: SFR = Single Family Residential;
MFR = Multi-Family Residential

However, the Suwannee River Water Management District (1990) reports that the traditional rational formula can be modified to generate a runoff hydrograph by utilizing the rainfall intensity for various increments of the storm. The rate of discharge at any point in time during a storm can be calculated by combining the rainfall intensity for that time increment with the traditional rational formula. The modified rational hydrograph equation is as follows:

$$Q = C\,(I/P_{Total})\,(P_{Total})\,A \qquad \text{(C.1-2)}$$

where: Q = Discharge for a given time increment (cfs)
C = Runoff coefficient
I/P_{Total} = Intensity for a given time increment (in/hr-in)

P_{Total} = Total rainfall depth (in)
A = Drainage area (acres)

The Suwannee River Water Management District (SRWMD) modified rational method, which was also adopted by the Florida Department of Transportation (FDOT) for their Drainage Connection permits (FDOT 1987b), utilizes rainfall data from the SRWMD and FDOT to determine values of I/P_{Total} and P_{Total} respectively. The SRWMD requires applicants to analyze the system for several storm frequencies over various durations to determine the "critical" storm (i.e., the storm event which requires the most storage for peak discharge attenuation).

To transfer this methodology to the St. Johns River Water Management District (SJRWMD), staff derived values of I/P_{Total} at 15 minute increments (see Table G~~24~~-2) from long term historic rainfall records within the SJRWMD for the mean annual, 24-hour storm as reported by Rao (1991). The applicant is only required to analyze the system for this rainfall distribution because it includes rainfall depths corresponding to the mean annual storm for durations up to and including 24 hours. Values of P_{Total} within the SJRWMD for the mean annual, 24-hour storm are found in Figure 2.7.1-1 of this Volume.

Similar to the rational method, use of the modified rational hydrograph method should be limited to small drainage basins with short times of concentration (SRWMD 1990). Therefore, the District's rules restrict use of the modified rational method for systems meeting the following criteria:

(a) The drainage area is less than 40 acres.

(b) The predevelopment time of concentration for the system is less than 60 minutes.

(c) The postdevelopment time of concentration for the system is less than 30 minutes.

Note: The District does not accept the modified rational hydrograph method for use in 25-year peak discharge design storms (see section 3.2.3 of this Volume). If a project requires a peak discharge analysis for multiple design storms to comply with chapter 62-330, F.A.C., and section 3.2.3, the District recommends that the system be analyzed for both design storm events using a methodology as described in section 3.2.3 of this Volume. As an alternative, the applicant may utilize the modified rational method only for the mean annual storm provided the above criteria are met.

Table C.1.2. SJRWMD Mean Annual, 24-Hour Storm Distribution for the Modified Rational Hydrograph Method

Time (hrs)	I/P_{Total} (in/hr-in)	Time (hrs)	$TimeI/P_{Total}$ (hrs)(in/hr-in)
0.00	0.000	12.25	0.256
0.25	0.008	12.50	0.204
0.50	0.008	12.75	0.116
0.75	0.004	13.00	0.092
1.00	0.008	13.25	0.080
1.25	0.008	13.50	0.068
1.50	0.008	13.75	0.044
1.75	0.008	14.00	0.040
2.00	0.008	14.25	0.036
2.25	0.008	14.50	0.036
2.50	0.008	14.75	0.032
2.75	0.012	15.00	0.028
3.00	0.008	15.25	0.020
3.25	0.008	15.50	0.020
3.50	0.008	15.75	0.020
3.75	0.012	16.00	0.016
4.00	0.008	16.25	0.016
4.25	0.012	16.50	0.016
4.50	0.008	16.75	0.016
4.75	0.012	17.00	0.016
5.00	0.012	17.25	0.012
5.25	0.008	17.50	0.016
5.50	0.012	17.75	0.012
5.75	0.012	18.00	0.012
6.00	0.012	18.25	0.012
6.25	0.016	18.50	0.012
6.50	0.012	18.75	0.012

6.75	0.012	19.00	0.012
7.00	0.016	19.25	0.012
7.25	0.016	19.50	0.008
7.50	0.016	19.75	0.012
7.75	0.016	20.00	0.008
8.00	0.016	20.25	0.012
8.25	0.020	20.50	0.008
8.50	0.020	20.75	0.008
8.75	0.020	21.00	0.008
9.00	0.020	21.25	0.012
9.25	0.032	21.50	0.008
9.50	0.032	21.75	0.008
9.75	0.032	22.00	0.008
10.00	0.040	22.25	0.008
10.25	0.044	22.50	0.008
10.50	0.048	22.75	0.008
10.75	0.072	23.00	0.008
11.00	0.084	23.25	0.008
11.25	0.104	23.50	0.008
11.50	0.132	23.75	0.008
11.75	0.436	24.00	0.004
12.00	1.080	24.00	0.004

C.1.2 Example Problem for the Modified Rational Hydrograph Method

Given: A = 3 acres Project Location = Titusville

C_{pre} = 0.35 C_{post} = 0.85

Determine: Utilizing the modified rational method determine the predevelopment and postdevelopment runoff hydrographs for the mean annual, 24-hour storm.

Step 1. Determine P_{Total} for the project location.

From Figure 2.7.1-1, the rainfall depth (P_{Total}) for the mean annual, 24-hour storm for Titusville is 5.0 inches.

Step 2. Set up the modified rational equations for both pre-development and post-development conditions utilizing equation 1-2.

$$Q_{pre} = (3\ ac)\ (0.35)\ (5.0\ in)\ (I/P_{Total}) = (5.25)(I/P_{Total})$$

$$Q_{post} = (3\ ac)\ (0.85)\ (5.0\ in)\ (I/P_{Total}) = (12.75)(I/P_{Total})$$

Step 3. Utilizing the values of I/P_{Total} in Table C.1-2, calculate the predevelopment and post-development runoff hydrographs at 15-minute increments for the mean annual, 24-hour storm. See Table C.1-3 for the Q_{pre} and Q_{post} hydrographs.

Step 4. From Table C.1-3, the post-development peak discharge rate is greater than the pre-development rate. Therefore, the postdevelopment runoff hydrograph should be routed through a detention basin and discharge structure with a suitable stage-storage-discharge relationship such that the peak discharge rate from the basin is less than or equal to the predevelopment peak rate of 5.67 cfs.

C.1.3 References

Florida Department of Transportation. 1987a. *Drainage Manual, Volume 2A - Procedures*. Tallahassee, Florida.

Florida Department of Transportation. 1987b. *Handbook for Drainage Connection Permit*. Tallahassee, Florida.

Rao, D.V. 1991. *24-Hour Rainfall Distributions for Surface Water Basins Within the St. Johns River Water Management District, Northeast Florida*. St. Johns River Water Management District Technical Publication No. 91-3, Palatka, Florida.

Suwannee River Water Managment District. 1990. *MSSW Handbook*. Live Oak, Florida.

Table C.1-3 Pre- and Post-Development Hydrographs for the Modified Rational Example Problem

Time (hrs)	I/P_{Total}	Q_{pre} (cfs)	Q_{post} (cfs)
0.00	0.000	0.000	0.000
0.50	0.008	0.044	0.104
0.75	0.004	0.020	0.052
1.00	0.008	0.044	0.104
1.25	0.008	0.044	0.104
1.50	0.008	0.044	0.104
1.75	0.008	0.044	0.104
2.00	0.008	0.044	0.104
2.25	0.008	0.044	0.104
2.50	0.008	0.044	0.104
2.75	0.012	0.064	0.152
3.00	0.008	0.044	0.104
3.25	0.008	0.044	0.104
3.50	0.008	0.044	0.104
3.75	0.012	0.064	0.152
4.00	0.008	0.044	0.104
4.25	0.012	0.064	0.152
4.50	0.008	0.044	0.104
4.75	0.012	0.064	0.152
5.00	0.012	0.064	0.152
5.25	0.008	0.044	0.104
5.50	0.012	0.064	0.152
5.75	0.012	0.064	0.152
6.00	0.012	0.064	0.152
6.25	0.016	0.084	0.204
6.50	0.012	0.064	0.152
6.75	0.012	0.064	0.152

7.00	0.016	0.084	0.204
7.25	0.016	0.084	0.204
7.50	0.016	0.084	0.204
7.75	0.016	0.084	0.204
8.00	0.016	0.084	0.204
8.25	0.020	0.104	0.256
8.50	0.020	0.104	0.256
8.75	0.020	0.104	0.256
9.00	0.020	0.104	0.256
9.25	0.032	0.168	0.408
9.50	0.032	0.168	0.408
9.75	0.032	0.168	0.408
10.00	0.040	0.212	0.508
10.25	0.044	0.232	0.560
10.50	0.048	0.252	0.612
10.75	0.072	0.380	0.920
11.00	0.084	0.440	1.072
11.25	0.104	0.548	1.328
11.50	0.132	0.692	1.684
11.75	0.436	2.288	5.560
12.00	1.080	5.672	13.772
12.25	0.256	1.344	3.264
12.50	0.204	1.072	2.600
12.75	0.116	0.608	1.480
13.00	0.092	0.484	1.172
13.25	0.080	0.420	1.020
13.50	0.068	0.356	0.868
13.75	0.044	0.232	0.560
14.00	0.040	0.212	0.508
14.25	0.036	0.188	0.460

14.50	0.036	0.188	0.460
14.75	0.032	0.168	0.408
15.00	0.028	0.148	0.356
15.25	0.020	0.104	0.256
15.50	0.020	0.104	0.256
15.75	0.020	0.104	0.256
16.00	0.016	0.084	0.204
16.25	0.016	0.084	0.204
16.50	0.016	0.084	0.204
16.75	0.016	0.084	0.204
17.00	0.016	0.084	0.204
17.25	0.012	0.064	0.152
17.50	0.016	0.084	0.204
17.75	0.012	0.064	0.152
18.00	0.012	0.064	0.152
18.25	0.012	0.064	0.152
18.50	0.012	0.064	0.152
18.75	0.012	0.064	0.152
19.00	0.012	0.064	0.152
19.25	0.012	0.064	0.152
19.50	0.008	0.044	0.104
19.75	0.012	0.064	0.152
20.00	0.008	0.044	0.104
20.25	0.012	0.064	0.152
20.50	0.008	0.044	0.104
20.75	0.008	0.044	0.104
21.00	0.008	0.044	0.104
21.25	0.012	0.064	0.152
21.50	0.008	0.044	0.104
21.75	0.008	0.044	0.104

22.00	0.008	0.044	0.104
22.25	0.008	0.044	0.104
22.50	0.008	0.044	0.104
22.75	0.008	0.044	0.104
23.00	0.008	0.044	0.104
23.25	0.008	0.044	0.104
23.50	0.008	0.044	0.104
23.75	0.008	0.044	0.104
24.00	0.004	0.020	0.052
24.25	0.000	0.000	0.000

APPENDIX D

Subparagraph 40C-4.041(2)(b)8 as it existed on September 25, 1991

ANNOTATIONS

Validity

Challenge of rule's validity failed, where petitioner argued that agency had neglected to describe in sufficient detail territory where permits were required; since precise boundaries of territory could be determined from information contained in rule and from maps available to public, no practical reason existed to require promulgation by rule of such metes and bounds. Sartori v. St. Johns River Water Management District (DOAH 81-2393R), 3 FALR 2456-A (1981).

Determination that challenged rule constituted incomplete exercise of legislative authority did not render such exercise invalid, where petitioner complained that neighboring property remained free from regulation due to agency procrastination; petitioner had suffered no injury as result of this delay. Sartori v. St. Johns River Water Management District (DOAH 81-2393R), 3 FALR 2456-A (1981).

40C-4.034 Revocation and Modification of Permits.

Specific Authority 373.044, 373.113, 373.171 FS. Law Implemented 373.429 FS. History—New 2-20-77. Amended 12-26-77. Formerly 16I-4.34, Transferred to 40C-4.341, Amended 2-3-81. Formerly 40C-4.34.

40C-4.041 Permit Required.

(1) Unless expressly exempt by statute or rule, a surface water management permit must be obtained from the District prior to the construction, alteration, operation, maintenance, removal or abandonment of any dam, impoundment, reservoir, appurtenant work or works and for the maintenance and operation of existing agricultural surface water management systems or the construction of new agricultural surface water management systems.

(2) The District issues three types of surface water management permits: conceptual approval permits, individual permits and general permits.

(a) A conceptual approval permit may be issued for projects that are to be developed in phases. A letter of conceptual approval does not authorize any construction.

(b) An individual or general permit is required prior to the construction, alteration, operation, maintenance, abandonment or removal of a surface water management system which:

1. Is capable of impounding a volume of water of forty or more acre feet; or

2. Serves a project with a total land area equal to or exceeding forty acres; or

3. Serves a project with a total land area equal to or exceeding ten acres, when any part of the project is located within the Wekiva River Hydrologic Basin north of State Road 436, or within the Econlockhatchee River Hydrologic Basin; or

4. Provides for the placement of twelve or more acres of impervious surface which constitutes 40 or more percent of the total land area; or

5. Provides for the placement of one half acre or more of impervious surface, when any of the impervious surface is located within the Wekiva River Hydrologic Basin north of State Road 436; or

6. Provides for the placement of two acres or more of impervious surface, when any of the impervious surface is located within the Econlockhatchee River Hydrologic Basin; or

7. Contains a traversing work which traverses:

a. A stream or other watercourse with a dralnage area of five or more square miles upstream from the traversing work; or

b. An impoundment with more than ten acres of surface area; or

8. Contains a surface water management system which serves an area of five or more contiguous acres of wetlands with a direct hydrologic connection to:

a. A stream or other watercourse with a drainage area of five or more square miles; or

b. An impoundment with no outfall, which is not wholly owned by the applicant and which is ten acres or greater in size; or

c. A wetland not wholly owned by the applicant.

9. Is wholly or partially located within the Wekiva River Hydrologic Basin's Riparian Habitat Protection Zone as described in Paragraph 40C-41.063(3)(e); or

10. Consists of or includes filling in, excavation in, or drainage of a wetland which is not isolated when any of the filling, excavation, or drainage is located within the Econlockhatchee River Hydrologic Basin; or

11. Is wholly or partially located within any isolated wetland.

(c) A general permit will be issued for specific classes of surface water management systems which satisfy the thresholds and conditions of Chapter 40C-40, F. A. C. A general permit may authorize the construction, alteration, operation, maintenance, abandonment, or removal of a system.

(d) An individual permit may be issued for projects which do not qualify for general permits under the provisions of Chapter 40C-40, F. A. C. An individual permit may authorize the construction, alteration, operation, maintenance, abandonment or removal of a system.

(e) An individual or general permit may be issued for the maintenance and operation of existing agricultural surface water management systems or the construction of new agricultural surface water management systems which satisfy the water quality practices and performance standards of chapter 40C-44, F.A.C.

(3)(a) The Governing Board may designate specific geographic areas within which individual or general permits shall be required for the construction, alteration, operation, maintenance, removal, or abandonment of any systems with threshold volumes and areas different from those specified in subsection (2)(b) above.

(b) Such designation shall be adopted by rule pursuant to Chapters 120 and 373, Florida Statutes, and Chapter 40C-1, F. A. C.

(c) Prior to the adoption of such rule, the Governing Board shall hold at least one public meeting in the vicinity of the area for which such designation is proposed. The purpose of the meeting shall be to hear testimony regarding the

justification and anticipated impacts of the designation.

Specific Authority 373.044, 373.113, 373.171 FS. Law Implemented 373.409, 373.413, 373.416, 373.426, 373.429 FS. History—New 1-31-77, Formerly 16I-4.04, 40C-4.04, Amended 2-3-81, 12-7-83, Formerly 40C-4.041, 40C-4.0041, Amended 8-28-88, 8-1-89, 4-3-91, 8-11-91, 9-25-91.

40C-4.042 Formal Wetland Determination.

(1) Pursuant to section 373.421, F.S., a real property owner, an entity that has the power of eminent domain, or any other person who has a legal or equitable interest in real property may petition the District for a formal wetland determination for that property. A formal wetland determination means the District will verify the locations on the property of the landward boundaries of wetlands as defined by the District.

(2) To petition for a formal wetland determination, the petitioner must submit to the District the following:

(a) seven copies of completed form 40C-1.181(12), including copies of all items required by that form, and

(b) a wetland determination fee as prescribed in section 40C-1.603, F.A.C.

(3)(a) Within 30 days of receipt of a petition for a formal wetland determination, the District shall notify the petitioner of any additional information which may be necessary in order to complete review of the petition. The District shall complete the determination and shall issue a notice of intended agency action within 30 days after the petition is deemed complete. The District will publish the notice of intended agency action on the petition in a newspaper of general circulation in the county or counties where the property is located.

(b) The provisions of sections 120.57 and 120.59, F.S., apply to formal wetland determinations made pursuant to this section. Any person whose substantial interests will be affected by the District's proposed action on the petition may request an administrative hearing on the proposed action pursuant to section 40C-1.511, F.A.C. If no request for an administrative hearing is filed, the District will then take final action on the petition for the formal wetland determination.

(4) The petitioner or his agent shall clearly delineate the landward boundary of wetlands on the property. A District representative will verify the location of the boundary line. The petitioner must then have the boundary line surveyed, and must return four certified copies of that survey to the District. In order for the petition to be deemed complete, the District must receive four certified copies of the survey.

(5) The executive director is delegated the authority to take final action on petitions for formal wetland determinations under this section. The executive director shall issue a formal wetland determination only if the petitioner has satisfied all the requirements of this section.

(6) A formal wetland determination shall be binding for the time period issued provided physical conditions on the property do not change so as to alter the wetland boundaries during that period. A formal wetland determination shall be issued for five years.

(7) Any person eligible to petition for a wetland determination may petition to renew a formal wetland determination prior to the expiration date. A petition to renew an expired wetland determination shall be processed in the same manner as a petition for an original formal wetland determination. Persons petitioning the District to renew an expired formal wetland determination must submit the information and renewal fee required by subsections 40C-4.042(2) through (4), F.A.C.

(8) The Governing Board may revoke the formal wetland determination upon a finding that the petitioner has submitted inaccurate information to the District.

(9) A formal wetland determination issued pursuant to this section is final agency action and is in lieu of a declaratory statement of jurisdiction obtainable pursuant to section 120.565, F.S.

(10) The District may issue informal nonbinding preapplication wetland determinations or otherwise institute nonbinding wetland determinations on its own initiative as provided by law.

Specific Authority 373.044, 373.113, 373.421 FS. Law Implemented 373.421 FS. History—New 11-12-91.

40C-4.051 Exemptions.

(1) Exemptions are as found in:

(a) Section 373.406, Florida Statutes.

(b) Section 403.813(2), Florida Statutes.

(2) Specifically exempted from permitting under this chapter for the purpose of construction, operation, and maintenance are:

(a) Each system or phase of a phased system which is located in the areas described in Rule 40C-4.031 (1)(a) and (b), F.A.C., except agricultural operations, which:

1. Was constructed and operating under the provisions of a valid District permit on December 7, 1983; or

2. Was not required to obtain a permit prior to December 7, 1983, and was:

a. Constructed and operating prior to December 7, 1983; or

b. Being constructed on December 7, 1983, and was completed and operating by June 7, 1984; or

c. Under construction on December 7, 1983, and which had complied with the regulations of the Florida Department of Environmental Regulation and the appropriate local governmental agency.

3. Was constructed and operating as of March 2, 1974 for the Upper St. Johns Basin as described in Rule 40C-4.031(1)(a), F.A.C.; or

4. Was constructed and operating as of January 1, 1975 for the portion of the Oklawaha River Basin as described in Rule 40C-4.031(1)(b), F.A.C.

(b) Each system or phase of a phased system which is located in the area as described in Rule 40C-4.031(1)(c), F.A.C., except agricultural operations, and which was:

B. SURFACE WATER MANAGEMENT DESIGN AIDS

June 1, 2018

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

4049 Reid Street

Palatka, FL 32177-1429

(386) 329-4500

PART IX
ALTERNATIVE TREATMENT SYSTEMS

20.0 Compensating Stormwater Treatment

Occasionally, applicants find that it is impractical to construct a stormwater management system to capture the runoff from a portion of the project site due to extreme physical site conditions or right-of-way problems. Two methods have been developed to compensate for the lack of treatment for a portion of a project. The first method is to treat the runoff that is captured to a greater extent than required by District rules (i.e., "overtreatment"). The second method is to provide treatment for an off-site area which currently is not being treated (i.e., "off-site compensation"). Each method is designed to furnish the same level of treatment as if the runoff from the entire project site was captured and treated according to the District's rules.

Either of these methods should only be utilized as a last resort and the applicant is strongly encouraged to schedule a pre-application conference with District staff to discuss the project if these alternatives are being considered. Other rule criteria, such as peak discharge attenuation, will have to be met if the applicant utilizes these methods. Each alternative is described in more detail in the following sections.

20.1 Overtreatment

Overtreatment means to treat the runoff from the project area that does flow to a treatment system to a higher level than District rules require to make up for the lack of treatment for a portion of the project. The average treatment efficiency of the areas treated and the areas not treated must meet the pollutant removal goals of chapter 62-40, F.A.C., (i.e., 80% removal for discharges to Class III waters and 95% removal for systems which discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting). To meet these goals, the area not being treated generally must be small (less than 10%) in relation to the area which is captured and treated. Staff can aid in determining the proper level of overtreatment for a particular situation.

20.2 Off-site Compensation

Off-site compensation means to provide treatment to an existing developed area which currently is not being treated to compensate for the lack of treatment for portions of the proposed project due to space constraints. The following conditions must be met when utilizing off-site compensation:

(a) The off-site treatment system must serve an existing developed area for which no treatment is presently provided, required, or permitted.

(b) The off-site land area being treated must serve a similar or more intensive land use than the on-site area being compensated for.

(c) The proposed off-site treatment system must meet the applicable criteria of Environmental Resource Permit Applicant's Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District (see Part A. of this Manual), including legal authorization to utilize the off-site area for stormwater treatment and provisions for operation and maintenance of the system.

(d) The off-site area must be in the same watershed as the proposed project.

21.0 Stormwater Harvesting Systems Design Criteria

21.1 Description

Stormwater harvesting uses treated stormwater for beneficial purposes before it is discharged to surface waters, thereby reducing the stormwater volume and mass of pollutants discharged. On the average, within the St. Johns River Water Management District, landscape irrigation can account for more than 50% of the total water use at residential locations. Stormwater harvesting systems are designed to prevent the discharge of a given volume of stormwater into surface waters of the state by deliberate application of stormwater runoff for irrigation or other supplemental water uses. Examples of areas that can be irrigated include golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries, agricultural lands, and residential and commercial properties. Supplemental uses include hydration of wetlands, low flow augmentation, cooling water, processing water, and wash water.

A stormwater harvesting pond is similar to a wet detention system described in section 8 except for the drawdown of the treatment volume storage. For typical wet detention ponds, the treatment volume is released at a controlled rate by a drawdown orifice or bleeder. However, in a stormwater harvesting system the drawdown structure is replaced by a mechanical reuse system which recovers the treatment volume storage by withdrawing water from the pond. In a stormwater harvesting pond the treatment volume is termed "harvested volume" and the "control elevation" is the lowest elevation at which water can be withdrawn from the pond by the stormwater harvesting system. Like wet detention, stormwater harvesting systems are a recommended BMP for sites with moderate to high ground water table conditions. A schematic of a typical stormwater harvesting pond is shown in Figure 21-1.

The District encourages the use of stormwater harvesting systems because of the following benefits they provide:

(a) Reduction of runoff volume discharged to the receiving waters

(b) Reduction of pollutants discharged to the receiving waters

(c) Substitution of stormwater for irrigation of turf grass instead of using potable water

(d) Potential economic savings from paying reduced or no utility fees due to the reduced use of potable water for irrigation of turf grass.

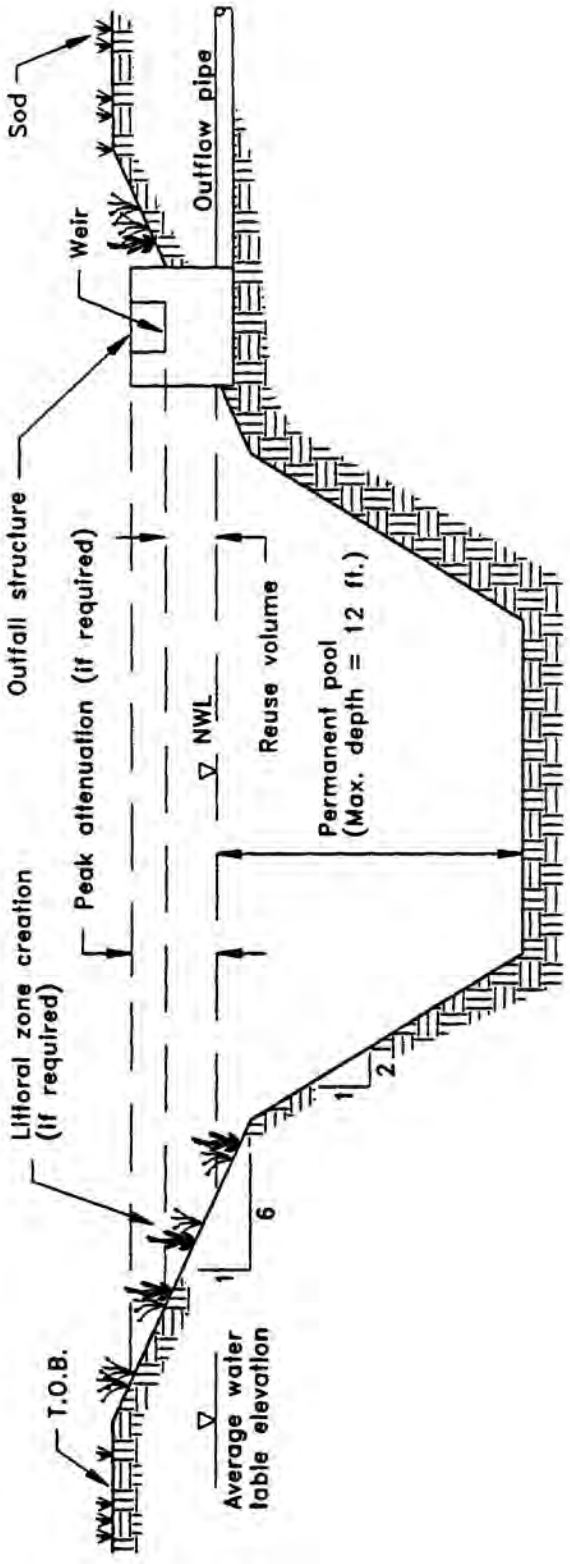


Figure 21-1. Stormwater harvesting system (N.T.S.)

Stormwater harvesting systems significantly remove dissolved and suspended pollutants by taking advantage of physical, chemical, and biological processes associated with wet detention systems and the recycling of constituents back to the landscape by systems that irrigate with stormwater (Wanielista et al. 1991). Stormwater harvesting systems can be utilized to meet the District's runoff volume criteria (see section 3.2 of this Manual).

In addition, stormwater harvesting ponds provide flood detention. As stormwater treatment systems, these ponds should not be designed to promote in-water recreation (i.e., swimming, skiing, fishing, and boating).

There are several components in a stormwater harvesting system which must be properly designed to achieve the required level of stormwater treatment. A description of each design feature and its importance to the treatment process is presented below. These criteria are intended to promote the harvesting of stormwater from properly designed stormwater management systems, such as wet detention. Several of these criteria are the same as those for wet detention systems as described in section 8 of this Manual.

21.2 "Harvested Volume"

A portion of the runoff from the site must be stored in the pond and subsequently withdrawn through the stormwater harvesting system. Systems which discharge to Class III receiving water bodies shall harvest at least 50 percent of the average annual runoff.

Stormwater harvesting systems which directly discharge to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, must harvest at least 90 percent of the average annual runoff discharging to the pond. A methodology for designing stormwater harvesting systems to meet the above criteria is presented in section 29 of this Manual.

21.3 Permanent Pool

The permanent pool is that portion of a pond designed to constantly contain water (i.e., below the control elevation). The permanent pool should be sized to provide at least a 14-day residence time during the wet season (June - October). A description of the pollutant removal processes which occur in the permanent pool is given in section 8.5 of this Manual and a methodology for calculating the residence time is given in section 26 of this Manual.

21.4 Littoral Zone

The littoral zone is that portion of a stormwater harvesting pond designed to contain rooted aquatic plants. The littoral zone is usually created by extending and gently sloping the sides of the pond down to a depth of 2-3 feet below the normal water level or control elevation. Also, the littoral zone can be provided in other areas of the pond that have suitable depths (i.e., a shallow shelf in the middle of the lake).

The littoral zone is established with native aquatic vegetation by planting and/or placing wetland soils containing seeds of native aquatic plants. A specific planting plan must be prepared for the littoral zone. The plan must consider the pond hydroperiod and the type of plants to be established. Livingston et al. (1988) has published a list of recommended native plant species suitable for littoral zone planting. In addition, a layer of muck can be incorporated into the littoral zone to promote the establishment of the native aquatic vegetation. When placing muck, special precautions must be taken to prevent erosion and turbidity problems in the pond and at its discharge point while vegetation is becoming established in the littoral zone.

The following is a list of the design criteria for stormwater harvesting ponds designed with a littoral zone:

(a) The littoral zone shall be gently sloped (6H:1V or flatter). At least 30 percent of the stormwater harvesting pond surface area shall consist of a littoral zone. The percentage of littoral zone is based on the ratio of vegetated littoral zone to surface area of the pond at the control elevation.

(b) The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless the applicant affirmatively demonstrates that the littoral zone vegetation can survive at greater depths.

(c) Within 24 months of completion of the system, 80 percent coverage of the littoral zone by suitable native aquatic vegetation is required.

(d) Planting of the littoral zone is recommended to meet the 80 percent coverage requirement. As an alternative to planting, portions of the littoral zone may be established by placement of muck soils (at least a four-inch depth) containing a seed source of desirable aquatic native vegetation. When utilizing this alternative, the littoral zone must be stabilized by mulching or other means and at least the portion of the littoral zone within 25 feet of the inlet and outlet structures must be planted.

21.5 Littoral Zone Alternatives

In lieu of establishing and maintaining vegetative littoral zones as described in section 21.4, the applicant can provide either:

(a) An additional 50 percent of the permanent pool volume as required in section 21.3, or

(b) Pre-treatment of the stormwater prior to the stormwater entering the stormwater harvesting pond. The level of pre-treatment must be at least that required for retention, underdrain, exfiltration, or swale systems. See section 8.11 of this Manual for additional information on pre-treatment.

Providing a larger permanent pool or pre-treatment volume will compensate for the pollutant removal benefits associated with an established littoral zone. However, even under the above alternatives, a portion of the stormwater harvesting pond may be colonized with nuisance species that will need to be controlled. This should be considered routine operational maintenance.

21.6 Pond Depth

The District requires a maximum pond depth of 12 feet and a mean depth (pond volume divided by the pond area at the control elevation) between 2 and 8 feet, unless demonstrated through a water quality analysis to support a deeper pond depth and mean depth. This criterion is needed because many of the nutrients and metals removed from the water column accumulate in the top few inches of the pond bottom sediments (Yousef et al. 1990). If a pond is deep enough, it has a tendency to stratify, creating the potential for anaerobic conditions developing at the bottom of the pond (CDM 1985). An aerobic environment should be maintained throughout the water column in wet ponds to minimize the release of nutrients and metals from the bottom sediments (Yousef et al. 1990). The maximum depth criterion minimizes the potential for significant thermal stratification which will help maintain aerobic conditions in the water column that should maximize sediment uptake and minimize sediment release of pollutants. On the other hand, the minimum mean depth criterion is required because aquatic plant growth may become excessive if the pond is too shallow.

21.7 Pond Configuration

The average length to width ratio of the pond should be at least 2:1. If short flow paths are unavoidable, the effective flow path can be increased by adding diversion barriers such as islands, peninsulas, or baffles to the pond. Inlet structures should be designed to dissipate the energy of water entering the pond.

21.8 Ground Water Table

To minimize ground water contributions which may lower treatment efficiencies, the control elevation should be set at or above the normal on-site groundwater table elevation (Yousef et al. 1990). This elevation may be determined by calculating the average of the seasonal high and seasonal low groundwater table elevations. In areas where the seasonal low water table is not determinable, the applicant may propose using the seasonal high water table elevation minus one foot. Regardless of which method is used, the system cannot cause adverse hydrologic impacts to adjacent wetlands or other surface waters.

If the control elevation is proposed to be set lower than the average elevation, ground water inflow must be considered in the calculation of the wet season residence time, estimated normal water level in the pond, and pollution removal efficiency of the system.

21.9 References

Camp Dresser & McKee Inc (CDM). 1985. *An Assessment of Stormwater Management Programs.* Prepared for Florida Department of Environmental Regulation, Tallahassee, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Yousef, Y.A., M.P. Wanielista, L.Y. Lin, and M. Brabham. 1990. *Efficiency Optimization of Wet Detention Ponds for Urban Stormwater Management (Phase I and II)*. University of Central Florida, Orlando, Florida.

Wanielista, M.P., Y.A. Yousef, G.M. Harper, T.R. Lineback, L. Dansereau. 1991. *Precipitation, Inter-Event Dry Periods, and Reuse Design Curves for Selected Areas of Florida*. University of Central Florida, Orlando, Florida.

22.0 Filtration Design and Performance Criteria

22.1 Description

Stormwater filtration systems consist of a perforated pipe which collects and conveys stormwater following infiltration and percolation through suitable soil, sand, or aggregate filter. Filters are generally used where space, soil permeability, and/or high water table conditions dictate that recovery of the stormwater treatment volume cannot be achieved by natural percolation (i.e, retention systems) or sedimentation (i.e., wet detention systems). The filter trench is normally backfilled to the surface with aggregate material that is more permeable than the surrounding soil. Pollutant removal occurs as the prescribed volume of stormwater passes through the filter media surrounding the conduit.

Filters are normally installed in the bottom or along the banks of detention basins and may be utilized in either dry or wet basins. The most common wet systems utilize either side-bank or "shelf" filters (Figures 22-1 and 22-2, respectively). Shelf filters (Figure 22-2) are the preferred alternative from a hydraulic performance and maintenance standpoint. In normally dry basins, the filters can be located in the bottom of the basin or along the side of the bank (Figures 22-3 and 22-4, respectively). Again, locating the filter beneath the basin (Figure 22-4) is preferable to side bank filters.

A filtration system may also function to lower the water table in its immediate vicinity to some limited extent. However, unlike underdrain systems, filter systems are not necessarily designed with this objective. The District generally requires the placement of filter systems above the ground water table (see section 22.8).

Filters are a maintenance-intensive BMP because of the likelihood that they will become clogged over time. Filters must routinely be cleaned by pressure back washing or replaced. In most cases, partial or total replacement of the sand filter is required after it becomes clogged. Periodic replacement of the filter should be considered when selecting this BMP.

The pollutant removal capabilities of filtration systems have been documented to be limited (Harper and Herr 1993). Only pollutants which are primarily in particulate form are trapped by the filter media. Therefore, the pollutant removal efficiency of filters systems is not as great as systems such as retention and wet detention which remove both dissolved and particulate pollutants. Because of the limited pollutant removal efficiency of dry detention, this BMP must only be utilized where no other general permit BMP is feasible. Filters in wet basins (Figures 22-1 and 22-2) are preferable to filters in dry basins (Figures 22-3 and 22-4) because of the added pollutant removal capabilities of the permanent pool of the wet basin (Harper and Herr 1993).

Filters appear to be best suited for small drainage areas such as small, highly impervious commercial/industrial sites that are well stabilized with little potential for eroded soils. For larger projects (greater than 5 acres) other BMPs like wet detention should be utilized instead of filters.

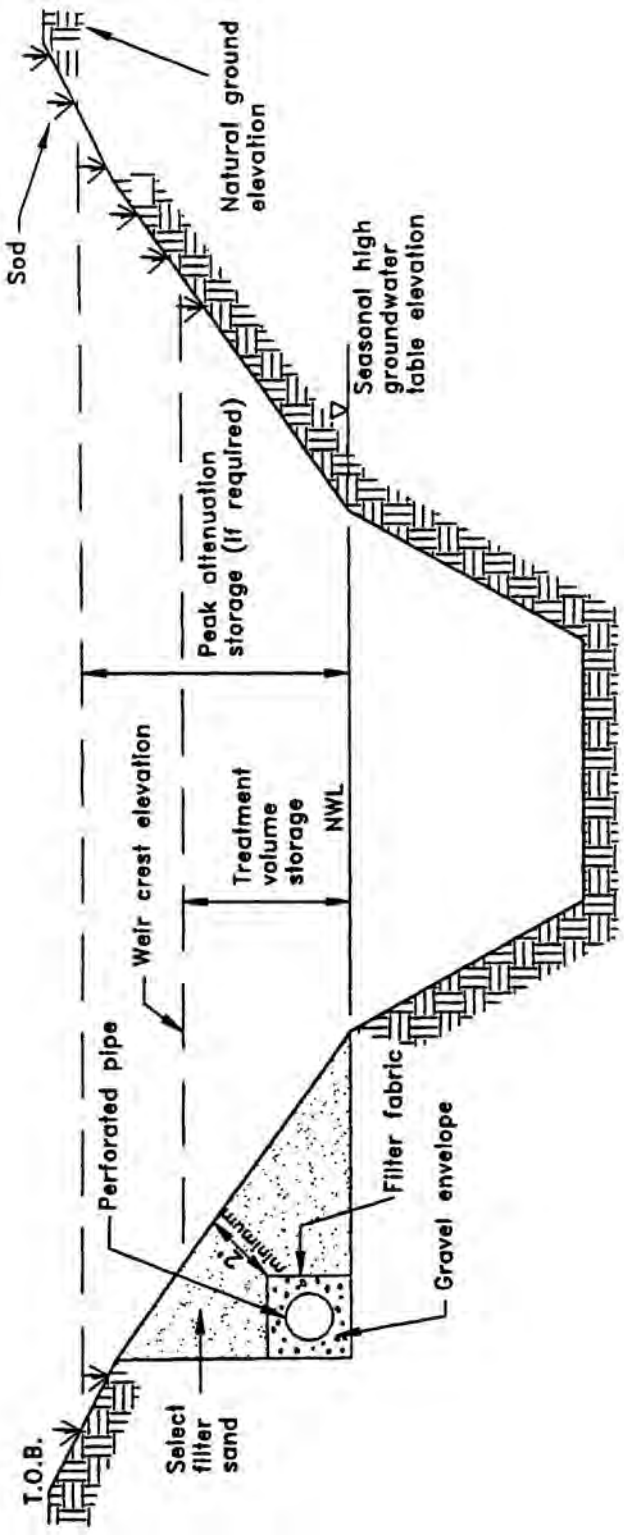


Figure 22-1. Side-bank filters in a wet basin (N.T.S.)

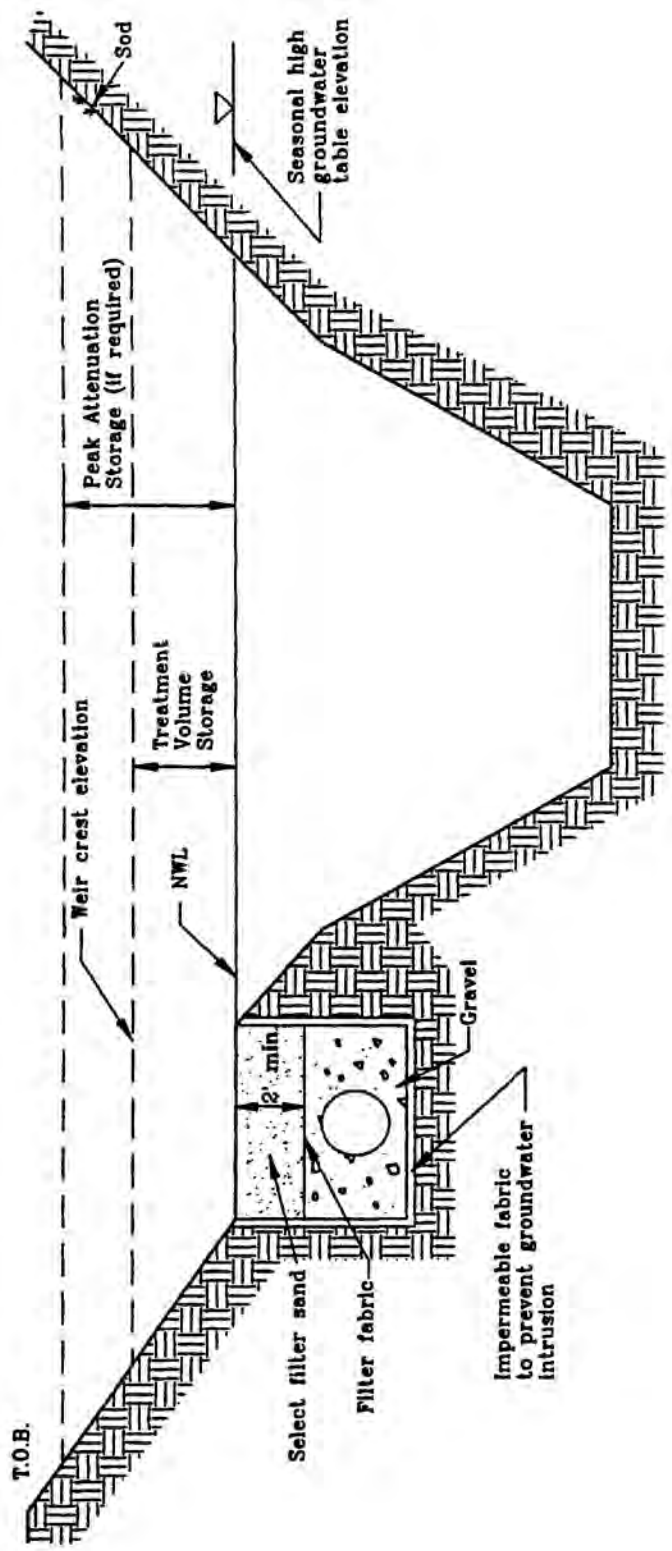


Figure 22-2. Filter shelf in a wet basin (N.T.S.)

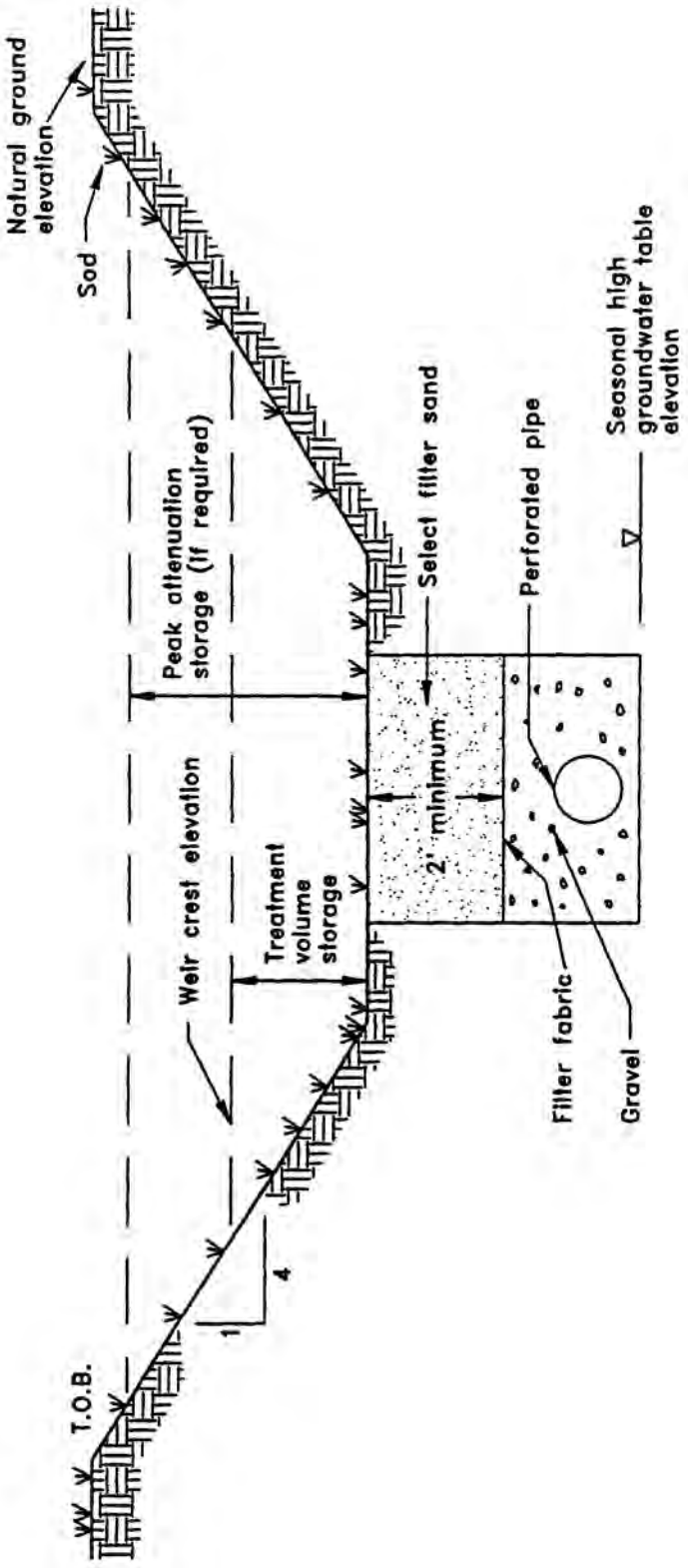


Figure 22-3. Dry detention with filtration (N.T.S)

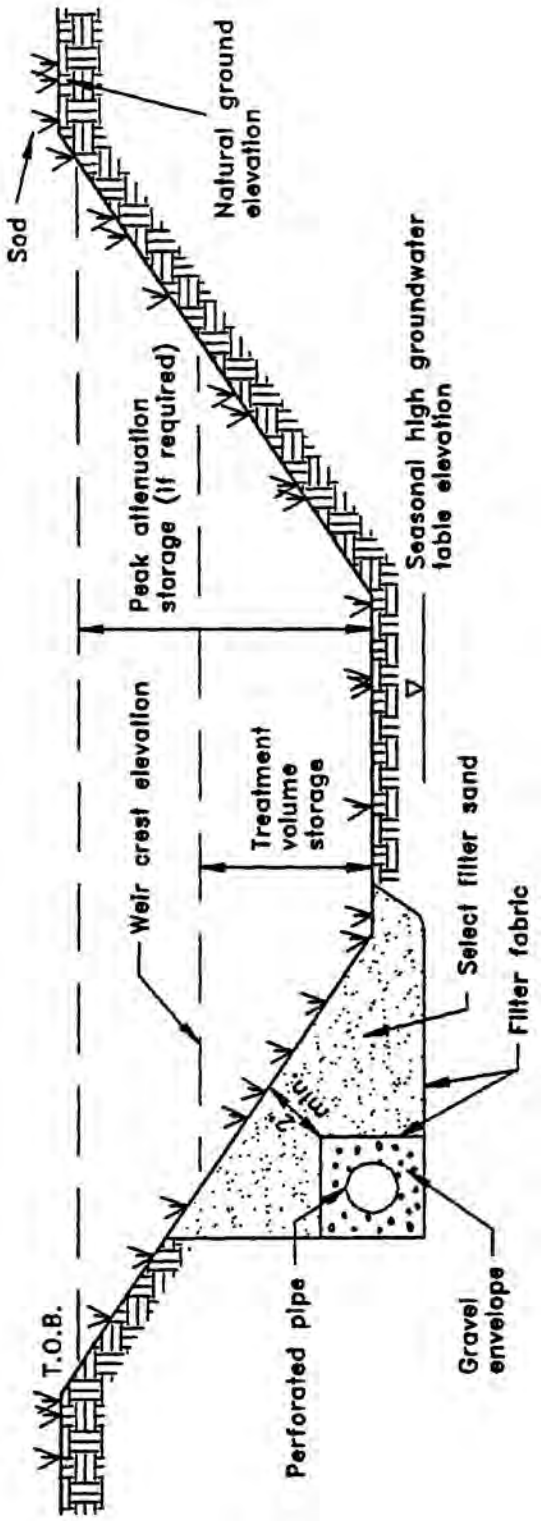


Figure 22-4. Dry detention with side-bank filters (N.T.S.)

Filters are not recommended for use in subdivisions where natural soil can erode and wash into the filter and where homeowners associations are commonly responsible for maintenance of the system.

The design and performance criteria specific to filtration systems are presented below.

22.2 Treatment Volume

The first flush of runoff should be detained in a wet or dry detention basin and filtered through the porous filter media. For discharges to Class III receiving water bodies, the system shall provide either of the following:

(a) *Off-line* detention with filtration of the first one-inch of runoff or 2.5 inches of runoff from the impervious area, whichever is greater

(b) *On-line* detention with filtration of an additional one half inch of runoff from the drainage basin area over the volume specified for off-line treatment.

For direct discharges to Class I, Class II, OFWs, or Class III waters which are approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting, the applicant should provide detention with filtration for either of following:

(a) At least an additional fifty percent of the applicable treatment volume specified for off-line filtration in (a), above. *Off-line* detention with filtration must be provided for at least the first one inch of runoff or 2.5 inches of runoff from the impervious area, whichever is greater, of the total amount of runoff required to be treated.

(b) *On-line* detention with filtration of the runoff from the three-year, one-hour storm or an additional fifty percent of the treatment volume specified in (b), above, whichever is greater.

22.3 Recovery Time

The system should be designed to provide for the appropriate treatment volume of stormwater specified in section 22.2 within 72 hours following a storm event. A suitable configuration (e.g., trench area, depth, pipe diameter, hydraulic conductivity of filter media, and openings in the perforated pipe) of the filter system must be designed to achieve the recovery time requirement.

Additional capacity must be provided in the filter system if inflows from the surrounding ground water table, upstream underdrain systems (i.e., road underdrain systems), or treatment volumes from upstream stormwater systems are routed to the filter system. Underdesign of the system will result in reduced hydraulic capacity.

This, in turn, will result in a reduction in storage between subsequent rainfall events and an associated decrease in the annual average volume of stormwater treated resulting in a reduction of pollutant removal (Livingston et al. 1988). Such circumstances may also reduce the aesthetic value of the system and may promote mosquito production.

A detailed methodology with design examples for calculating retention basin recovery is presented in section 30.

22.4 Safety Factor

The filter system must be designed with a safety factor of at least two unless the applicant affirmatively demonstrates based on plans, test results, calculations or other information that a lower safety factor is appropriate for the specific site conditions. Examples of how to apply this factor include but are not limited to the following:

(a) Reducing the design percolation rate by half

(b) Doubling the length of the filtration system

(c) Designing for the required drawdown within 36 hours instead of 72 hours.

22.5 Filter Media

The filter media should have pore spaces large enough to provide sufficient flow capacity so that the permeability of the filter is equal to or greater than the surrounding soil. The design shall ensure that the particles within the filter do not move. When sand or other fine textured aggregate other than natural soil is used for filtration, the filter material should be of quality sufficient to satisfy the following requirements:

(a) Washed (less than 1 percent silt, clay and organic matter) unless filter cloth is used which is suitable to retain the silt, clay and organic matter within the filter. Calcium carbonate aggregate is not an acceptable filter media.

(b) Uniformity coefficient of 1.5 or greater but not more than 4.0.

(c) Effective grain size of 0.20 to 0.55 millimeters in diameter.

These criteria are not intended to preclude the use of multilayered filters nor the use of materials to increase ion exchange, precipitation or the pollutant absorption capacity of the filter.

22.6 Filter Fabric

Filtration systems should utilize filter fabric or other means to prevent the filter material from moving into and clogging the perforated pipe.

22.7 Ground Water Table

The filter system should be designed so that the invert elevation of the perforated pipe is above the seasonal high ground water table (SHGWT) elevation. If the pipe is proposed to be set below this elevation, contributions from the surrounding ground water may reduce the ability of the system to recover the treatment volume in the required time. Filter systems placed below the SHGWT elevation should be separated by structural means from the hydraulic contribution of the surrounding water table or ground water inflow must be considered in sizing the system to meet the required recovery time.

22.8 Inspection and Cleanout Ports

To facilitate maintenance of the filter system, capped and sealed inspection and cleanout ports which extend to the surface of the ground should be provided, at a minimum, at the following locations for each drainage pipe:

(a) The terminus

(b) Every 400 feet or every bend of 45 or more degrees, whichever is less.

22.9 Operation and Maintenance Entity

Filtration systems are not recommended when the operation and maintenance entity is a homeowners association.

22.10 References

Harper, H.H. and J.L. Herr. 1993. Treatment Efficiency of Detention with Filtration Systems. St. Johns River Water Management District Special Publication SJ93-SP12, Palatka, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

PART X
METHODOLOGIES AND DESIGN EXAMPLES

23.0 Methodology and Design Examples for Retention Systems

The most common type of retention system consists of man-made or natural depression areas where the floor is graded as flat as possible and turf is established to promote infiltration and stabilize basin side slopes. Soil permeability and water table conditions must be such that the retention system can percolate the desired runoff volume within a specified time following a storm event.

23.1 Infiltration Processes

When runoff enters the retention basin, standing water in the basin begins to infiltrate. Water in the retention basin exits the basin in two distinct stages, either vertically (Stage One) thorough the basin bottom (unsaturated flow) or laterally (Stage Two) through the side slopes (saturated flow). One flow direction or the other will predominate depending on the height of the water table in relation to the bottom of the basin. The following paragraph briefly describes the two stages of infiltration and subsequent subsections present accepted methodologies for calculating infiltration rates and recovery times for unsaturated vertical (Stage One) and saturated lateral (Stage Two) flow.

Initially, the subsurface conditions are assumed to be the seasonal high ground water table (SHGWT) below the basin bottom, and the soil above the SHGWT is unsaturated. When the water begins to infiltrate, it is driven downward in unsaturated flow by the combined forces of gravity and capillary action. The water penetrates deeper and deeper into the ground and fills the voids in the soil. Once the unsaturated soil below the basin becomes saturated, the water table "mounds" beneath the basin (Figure 23-1). At this time, saturation below the basin prevents further vertical movement and water exiting the basin begins to flow laterally (Mongeau 1991). For successful design of retention basins, both the unsaturated and saturated infiltration must be accounted for and incorporated into the analysis (Andreyev and Wiseman 1989).

23.2 Water Management District-Sponsored Research on Retention Systems

The District has noticed difficulties pertaining to the design, construction, and operation of retention basins located where soil infiltration is limited. To improve the effectiveness of retention systems, the District conducted full-scale hydrologic monitoring of retention basins. This field data was used to evaluate and to recommend hydrogeologic characterization techniques and design methodologies for computing the time of percolation of impounded stormwater runoff. Although all of the retention basins selected for instrumentation were located within the Indian River Lagoon Basin of the SJRWMD where soil infiltration potential is, for the most part, limited, the results of the study and the design recommendations have district-

wide applicability for similar areas where water table and soil conditions limit percolation. Funding for the study was provided through the Indian River Lagoon Basin Surface Water Improvement and Management (SWIM) program. Copies of the report may be obtained from the District librarian in Palatka headquarters (see Appendix A, "Environmental Resource Permit Applicant's Handbook, Volume I (General and Environmental)" for address and phone number). The reader should request District Special Publication SJ93-SP10. The document is also available on the District's website under Special Publications.

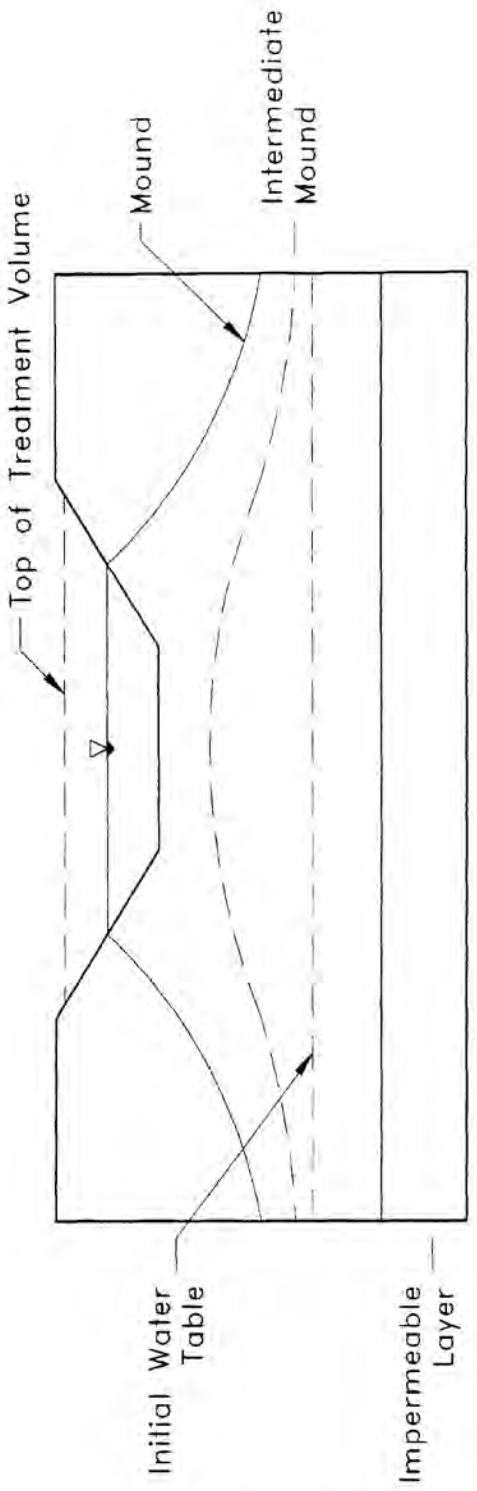


Figure 23-1. Groundwater Mounding Beneath a Retention System. (Source: Andreyev and Wiseman, 1989).

The study included design recommendations on field and laboratory methods of aquifer characterization and methodologies for computing recovery time. Acceptable methodologies for calculating retention basin recovery are presented in section 23.3 and recommended field and laboratory aquifer characterization testing methods are presented in section 23.4, below. These recommendations are based, in part, on the results in District Special Publication SJ93-SP10.

23.3 Accepted Methodologies and Design Procedures for Retention Basin Recovery

23.3.1 Accepted Methodologies

Acceptable methodologies for calculating retention basin recovery are presented below in Table 23-1. Vertical unsaturated flow methodologies are described in more detail in section 23.3.3 and lateral saturated flow methodologies are presented in section 23.3.4.

Table 23-1. Accepted Methodologies for Retention Basin Recovery

Vertical Unsaturated Flow	Lateral Saturated Flow
Green and Ampt Equation	Simplified Analytical Method
Hantush Equation	PONDFLOW
Horton Equation	Modified MODRET
Darcy Equation	
Holton Equation	

Several of these methodologies are available commercially in computer programs which the District has screened.

If applicants wish to calculate retention basin recovery by hand, acceptable methodologies for vertical unsaturated and lateral saturated flow are described in sections 23.3.3 and 23.3.5, respectively. A design example for each flow condition is presented below in section 23.5.

23.3.2 Design Procedures

It is recommended that, unless the normal seasonal high water table is over 6 inches below the basin bottom, unsaturated flow prior to saturated lateral mounding be conservatively ignored in recovery analysis. In other words, there should be no credit for soil storage immediately beneath the basin if the seasonal high water table is within 6 inches of the basin bottom. This is not an unrealistic assumption since the height of capillary fringe in fine sand is on the order of 6 inches and a partially

mounded water table condition may be remnant from a previous storm event, especially during the wet season.

It is also recommended that the filling of the pond with the treatment volume be simulated as a "slug" loading (i.e., treatment volume fills the pond within an hour).

23.3.3 Accepted Methodology for Estimating Vertical Unsaturated Flow

Vertical unsaturated flow consists of primarily downward movement of water stored in the basin into an unsaturated portion of the soil profile existing beneath the basin (Mongeau 1991). Vertical unsaturated flow only applies when the groundwater table or mound is below the retention basin bottom. Acceptable methodologies for calculating unsaturated vertical infiltration are included in Table 23-1. Each of the equations, however, are based on design assumptions that may not always be appropriate. In general the Green and Ampt equation is the most appropriate for conditions that typically occur in retention basin design. Andreyev and Wiseman (1989) utilized the following methodology in the MODRET computer program to estimate recovery in retention basins during unsaturated vertical flow. This methodology, which can easily be solved by hand, utilizes the modified Green and Ampt infiltration equation:

$$I_d = \frac{K_{vu}}{FS} \tag{23-1}$$

where: I_d = Design infiltration rate
K_{vu} = Unsaturated vertical hydraulic conductivity
FS = Factor of safety (recommend $FS = 2.0$)

The time to saturate (t_{sat}) the soil mass below the basin is:

$$t_{sat} = \frac{f\ h_b}{I_d} \tag{23-2}$$

where: t_{sat} = Time to saturate soil below the basin
h_b = Height of basin bottom above the groundwater table
f = Fillable porosity (generally 0.2 to 0.3)

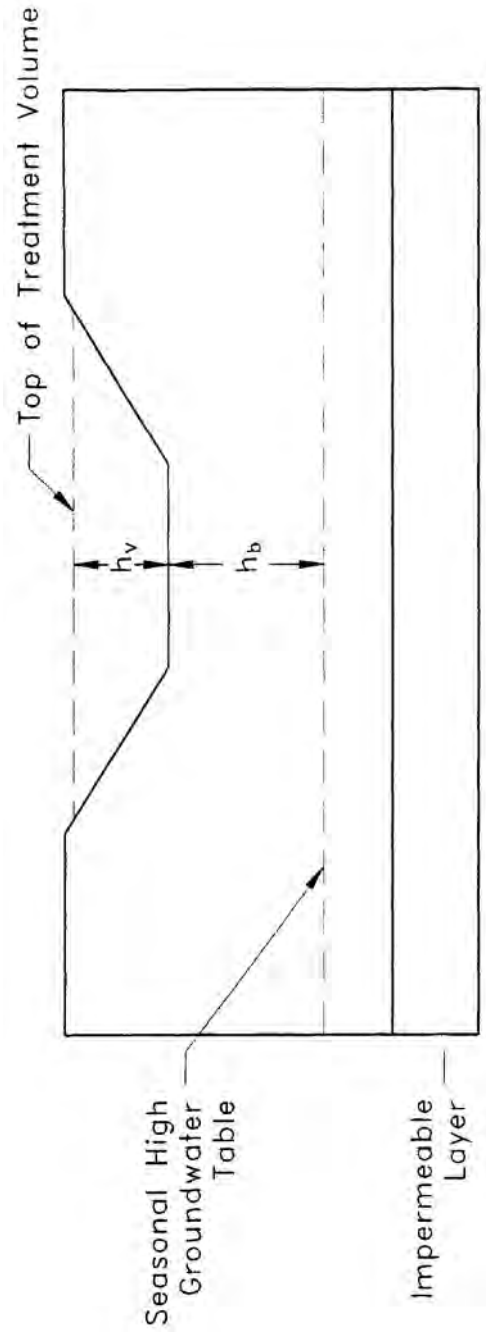


Figure 23-2. Design Parameters for Analysis of Stage One (Vertical) Flow (Source: Andreyev and Wiseman, 1989).

See Figure 23-2 for a schematic of the retention basin with the appropriate design parameters illustrated for vertical unsaturated flow conditions.

The total volume of water required to saturate the soil below the basin bottom (V_u) can be calculated as follows:

$$V_u = A_b \; h_b \, f \tag{23-3}$$

where: A_b = Area of basin bottom

Likewise, the height of water required to saturate the soil below the basin bottom (h_u) can be calculated using:

$$h_u = f \; h_b \tag{23-4}$$

Recovery of the treatment storage will occur entirely under vertical unsaturated flow conditions when:

(a) Treatment volume $\leq V_u$; or

(b) Height of the treatment volume (h_v) in the basin $\leq h_u$

If recovery of the treatment storage occurs entirely under vertical unsaturated conditions, analysis of the system for saturated lateral flow conditions will not be necessary.

This simplified approach is conservative because it does not consider the horizontal movement of water from the ground water mound that forms during this stage. In cases where the horizontal permeability is great, a more accurate estimate of the total vertical unsaturated flow can be obtained by using the Hantush equation. However, horizontal permeability of the unsaturated zone must be determined using an appropriate field or laboratory test.

The factor of safety (*FS*) is recommended to account for flow losses due to basin bottom siltation and clogging. For most sandy soils the fillable porosity (*f*) is approximately 0.2 to 0.3. The unsaturated vertical hydraulic conductivity (K_{vu}) can be measured using the field testing procedures or laboratory methods recommended in section 23.4.

A design example for utilizing the above methodology is presented below in section 23.5.

23.3.4 Accepted Methodologies for Lateral Saturated Flow

If the ground water mound is at or above the basin bottom, the rate of water level decline in the basin is directly proportional to the rate of mound recession in the saturated aquifer. The Simplified Analytical Method, PONDFLOW, and Modified MODRET methodologies are generally acceptable for retention basin recovery analysis under lateral saturated flow conditions. These models are all similar in that the receiving aquifer system is idealized as a laterally infinite, single-layered, homogenous, isotropic water table aquifer of uniform thickness, with a horizontal water table prior to hydraulic loading. If these assumptions are not reasonable, these models may not be applicable and a more appropriate model will be required.

All of the accepted models require input values for the pond dimensions, retained stormwater runoff volume, and the following set of aquifer parameters:

- Thickness or elevation of base of mobilized (or effective) aquifer
- Weighted horizontal hydraulic conductivity of mobilized aquifer
- Fillable porosity of mobilized aquifer
- Ambient water table elevation which, for design purposes is usually the normal seasonal high water table

In addition, to these one-layered, uniform aquifer idealization models accepted above, more complicated fully three dimensional models with multiple layers (such as MODFLOW) may be used. In order to use such three dimensional models, however, much more field data is necessary to characterize the three dimensional nature of the aquifer.

A brief description of each of the models recommended in Special Publication SJ93-SP10 is provided below. The reader is encouraged to consult the Special Publication for a more detailed description.

MODRET

MODRET is a methodology developed by Andreyev and Wiseman (1989) for the Southwest Florida Water Management. The saturated analysis module of MODRET is essentially a pre- and post-processor for the USGS three-dimensional ground water flow model MODFLOW. The MODRET model also has the capability to calculate unsaturated vertical flow from retention basins using the Green and Ampt equation. Unsaturated flow takes place prior to the ground water mound intersecting the basin bottom.

The input parameters in the MODRET pre-processor are use to create MODFLOW input files. After the MODFLOW program is executed, the MODRET post-processor extracts and prints the relevant information from the MODFLOW output files. MODRET allows the user to input time-varying recharge (such as a

hydrograph from a storm event) and calculate saturated flow out of the basin during recharge (i.e., a storm event).

During the study presented in Special Publication SJ93-SP10, it was discovered that the MODRET model was producing unstable MODFLOW solutions when modeling the recovery of some of the sites. This problem generally occurs when one or a combination of the following is true:

- The pond dimensions are relatively large (greater than 100 feet)
- The aquifer is relatively thin (less than 5 feet)
- The horizontal hydraulic conductivity is relatively low (less than 5 ft/day)

Upon further review, the MODRET model was modified in the study to correct this instability problem by changing the head change criterion for convergence to 0.001 ft from 0.01 ft. The original MODRET model with this modification is therefore referred to as "Modified MODRET."

PONDFLOW

PONDFLOW is a retention recovery computer model developed by Kuhns (1990). It is similar to MODRET in that is uses a finite difference numerical technique to approximate the time varying ground water profile adjacent to the basin. Also, like MODRET it can accommodate a time-varying recharge to the pond, account for seepage during the storm, and also calculates vertical unsaturated flow using Darcy's Equation.

Simplified Analytical Method (SAM)
The Simplified Analytical Method is a product of the study presented in District Special Publication SJ93-SP10. Figure 23-9 depicts the basic elements of the SAM. The integral for recovery time may be solved numerically or using commercially available software.

The SAM is somewhat conservative since it assumes that, for a prescribed runoff volume, the rise in the pond stage occurs instantaneously and there is no credit for seepage during the storm event.

23.3.5 Methodology for Analyzing Recovery by Lateral Saturated Flow by Hand

One methodology for analyzing lateral saturated flow from retention basins by hand is presented by Andreyev and Wiseman (1989) as part of their MODRET report. During the District's retention basin study presented in Special Publication SJ93-SP10, it was discovered that the MODRET model was producing unstable MODFLOW solutions when modeling the recovery of some of the retention basins monitored. This problem generally occurs when one or a combination of the following is true:

- The pond dimensions are relatively large (greater than 100 feet)
- The aquifer is relatively thin (less than 5 feet)
- The horizontal hydraulic conductivity is relatively low (less than 5 ft/day)

Therefore, the above parameters should be checked prior to utilizing the MODRET lateral saturated flow analysis presented below.

Andreyev and Wiseman (1989) used the MODFLOW groundwater flow computer model developed by the U.S. Geological Survey to generate a series of dimensionless curves to predict retention basin recovery under lateral saturated flow (Stage Two) conditions. The dimensionless parameters can be expressed as:

$$F_x = \sqrt{\frac{W^2}{4\ K_H\ D\ t}} \tag{23-5}$$

$$F_y = \frac{h_c}{H_T} \tag{23-6}$$

where: F_x = Dimensionless parameter representing physical and hydraulic characteristics of the retention basin and effective aquifer system (x-axis)

F_y = Dimensionless parameter representing percent of water level decline below a maximum level (y-axis)

W = Average width of the retention basin, midway between basin bottom and water level at time t (*ft*)

K_H = Average horizontal hydraulic conductivity (*ft/day*)

D = Average saturated thickness of the aquifer (*ft*)

t = Cumulative time since saturated lateral (Stage Two) flow started (*days*)

h_c = Height of water in the basin above the initial ground water table at time t (*ft*)

H_T = Height of water in the basin above the initial ground water table at the start of saturated lateral (Stage Two) flow (*ft*)

The average saturated thickness of the aquifer (D) can be expressed as:

$$D = H + \frac{h_c}{2} \tag{23-7}$$

where: H = Initial saturated thickness of the aquifer (*ft*)

The height of water in the basin above the initial groundwater table at the start of saturated lateral (Stage Two) flow (H_T) is:

$$H_T = h_b + h_2 \quad (23\text{-}8)$$

where: h_2 = Height of water in the basin above the basin bottom at the start of saturated lateral (Stage Two) flow (*ft*)

Figure 23-3 contains an illustration of the design parameters for analysis of saturated lateral (Stage Two) flow conditions. The design parameters for a retention system utilizing both unsaturated vertical (Stage One) and saturated lateral (Stage Two) flow is represented in Figure 23-4.

The equation for F_x can be rearranged to solve for the time (t) to recover the remaining treatment volume under saturated lateral (Stage Two) flow:

$$t = \frac{W^2}{4\ K_H\ D\ F_x^2} \quad (23\text{-}9)$$

Andreyev and Wiseman (1989) developed four families of dimensionless curves for fillable porosity (f) = 0.1, 0.2, 0.3, and 0.4. Five individual curves, for length to width ratios of 1, 2, 4, 10, and 100 were developed for each family. The resulting dimensionless curves are presented on Figures 23-5 through 23-8. These curves can be used to calculate the recovery time given the hydraulic parameters of the aquifer, the recharge rate, and the physical configuration of the basin. An example design problem utilizing both unsaturated vertical (Stage One) and saturated lateral (Stage Two) flows to estimate the recovery time is given below in section 23.5.

23.4 Recommended Field and Laboratory Tests for Aquifer Characterization

The following field and laboratory investigation and testing guidelines are recommended for aquifer characterization and are described in more detail in Special Publication SJ93-SP10.

23.4.1 Definition of Aquifer Thickness

Standard Penetration Test (SPT) borings (ASTM D-1586) or auger borings (ASTM D 1452) should be used to define the thickness of the mobilized aquifer (i.e., depth to "hardpan" or restrictive layer) especially where the ground water table is high. This type of boring provides a continuous measure of the relative density/consistency of the soil (as manifested by the SPT "N" values) which is important for detecting the top of cemented or very dense "hardpan" type layers. Such layers restrict the vertical movement of ground water and are found over much of the District. If carefully utilized, manual "bucket" auger borings can also be used to define the thickness of the aquifer. Power flight auger borings may also be used with caution since this method may result in some mixing of soil from a given level with soils from strata above, thus masking the true thickness of the aquifer. To avoid this problem, technical guidelines for continuous flight auger borings are included in Appendix C of the District Special Publication SJ93-SP10.

Preferably, the SPT borings should be continuously sampled at least 2 feet into the top of the hydraulically restrictive layer. If a restrictive layer is not encountered, the boring should be extended to at least 10 feet below the bottom of the pond. As a minimum, the depth of the exploratory borings should extend to the base elevation of the aquifer assumed in analysis, unless nearby deeper borings or well logs are available.

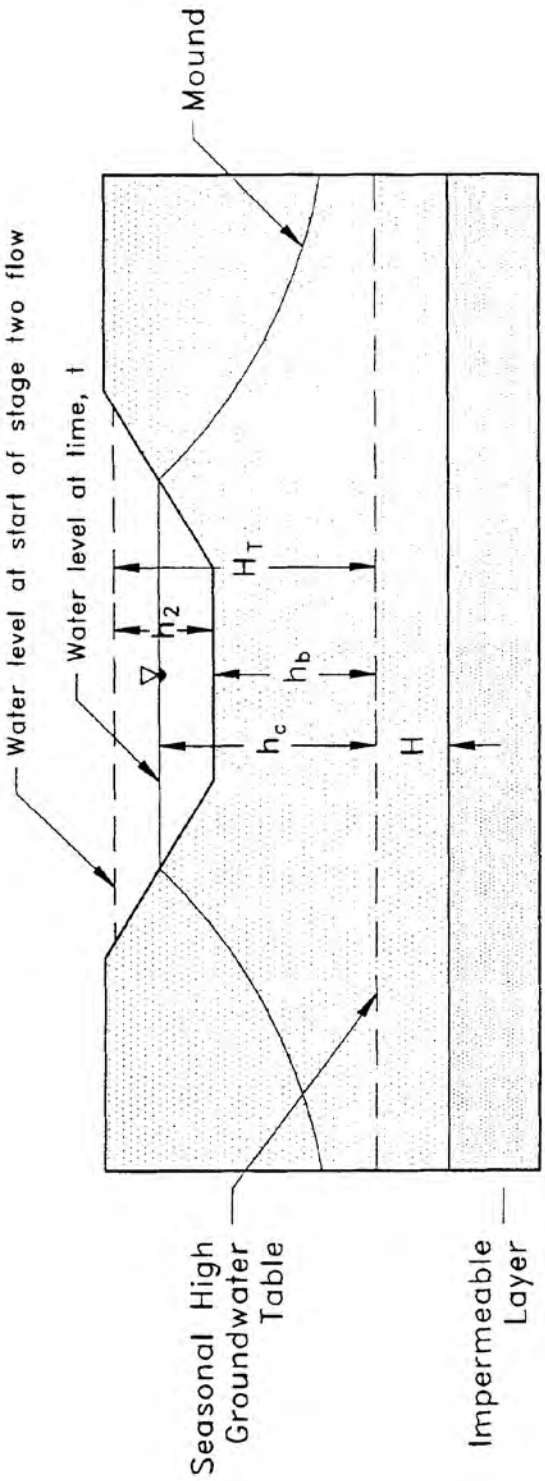


Figure 23-3. Design Parameters for Groundwater Mounding Analysis for Stage Two (Lateral) Flow (Source: Andreyev and Wiseman, 1989)

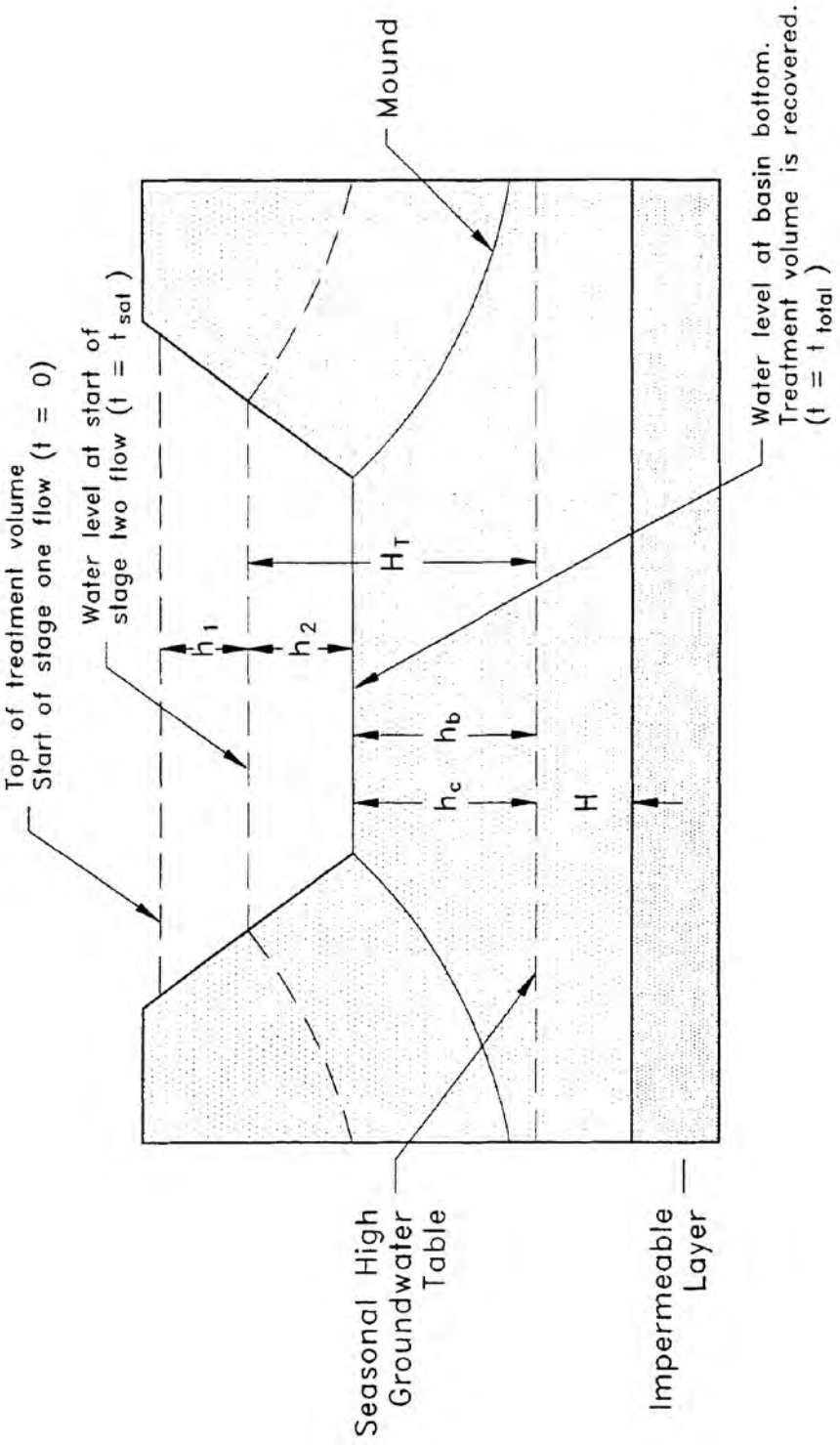


Figure 23-4. Design Parameters for Groundwater Mounding Analysis for Stage One and Stage Two Flow (Source: Andreyev and Wiseman, 1989).

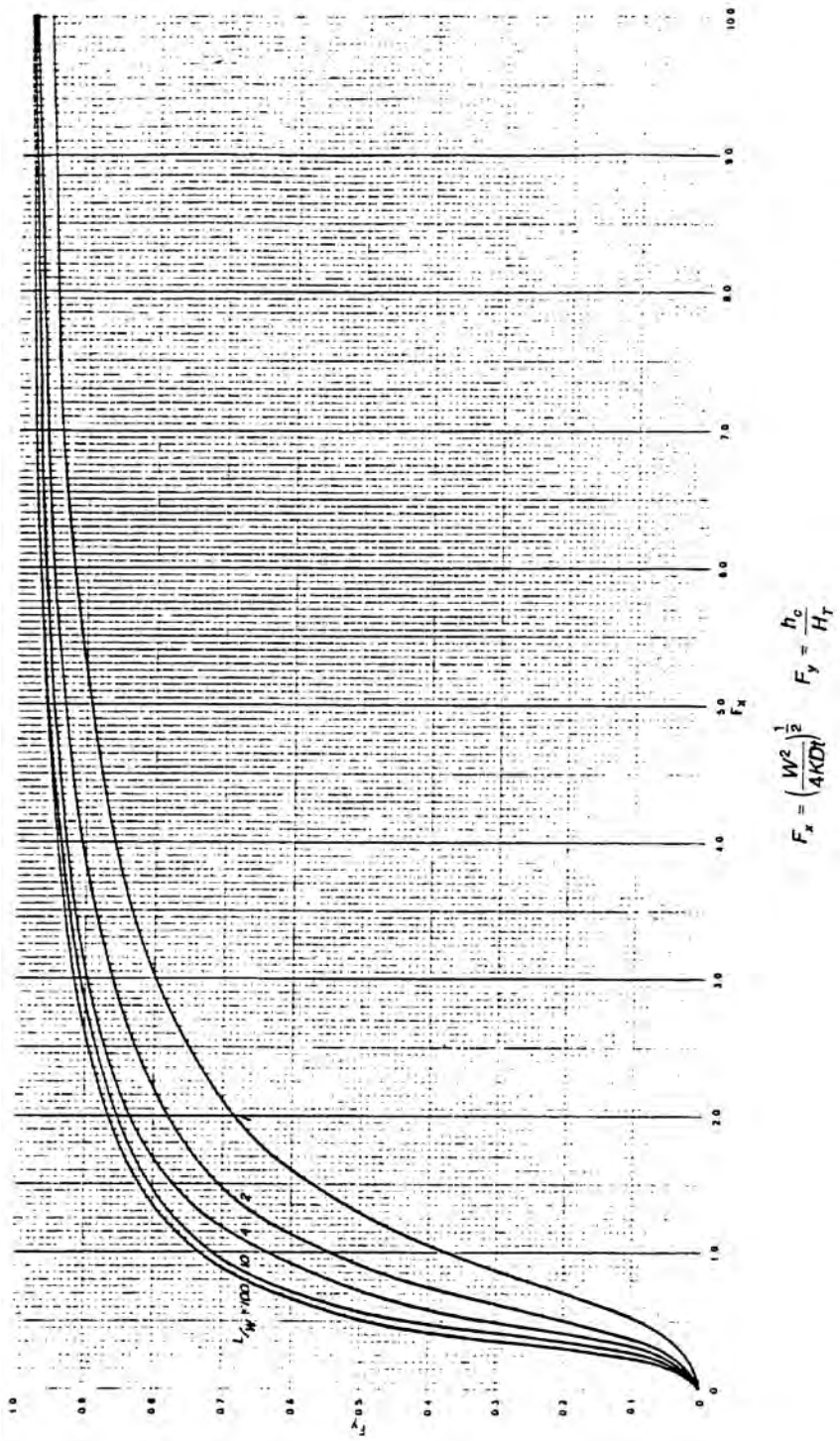


Figure 23-5. Dimensionless Curves Relating Basin Design Parameters to Basin Water Level in a Rectangular Retention Basin Over an Unconfined Aquifer (f = 0.1) (Source: Andreyev and Wiseman, 1989).

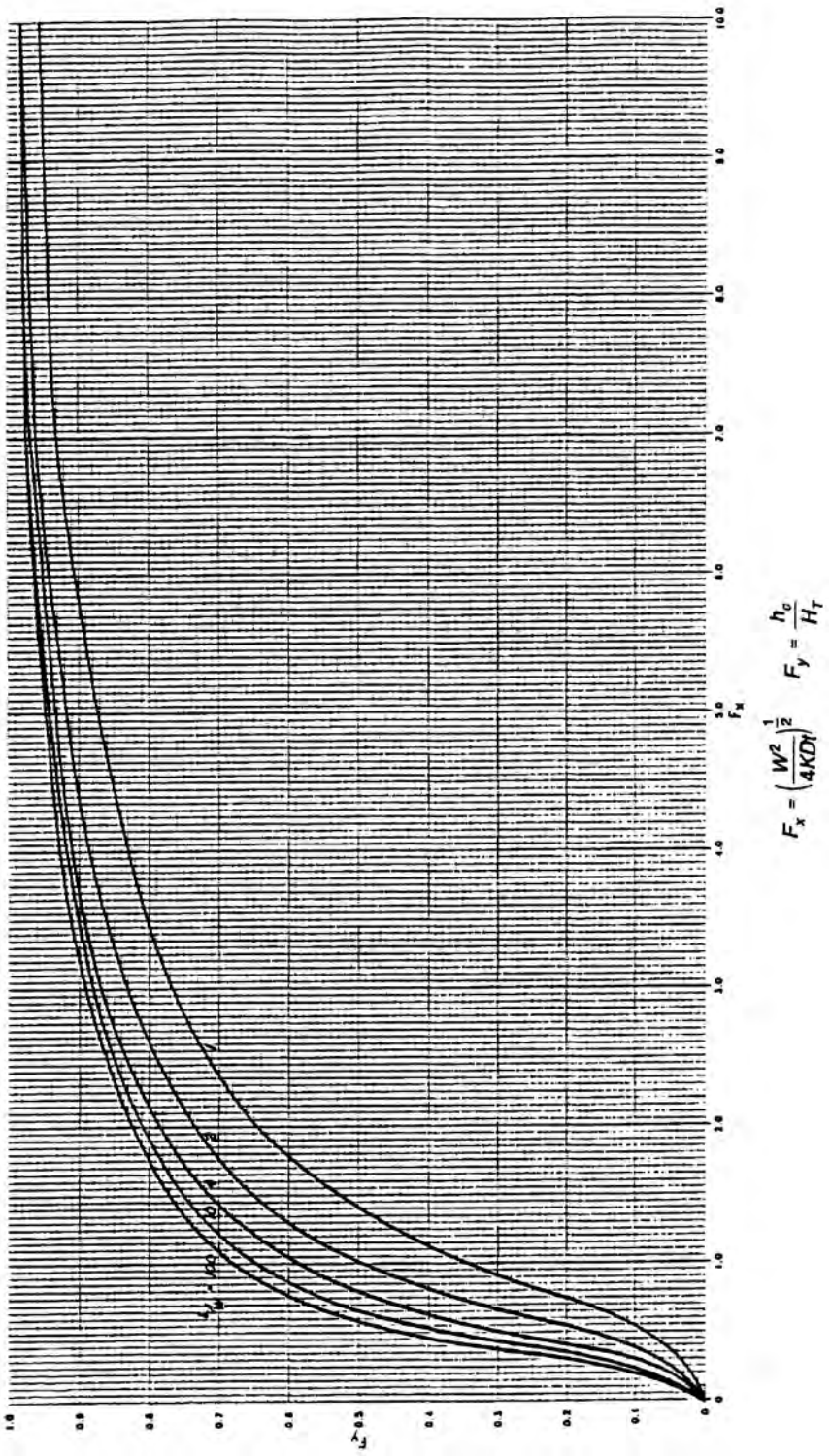


Figure 23-6. Dimensionless Curves Relating Basin Design Parameters to Basin Water Level in a Rectangular Retention Basin Over an Unconfined Aquifer (f = 0.2) (Source: Andreyev and Wiseman, 1989).

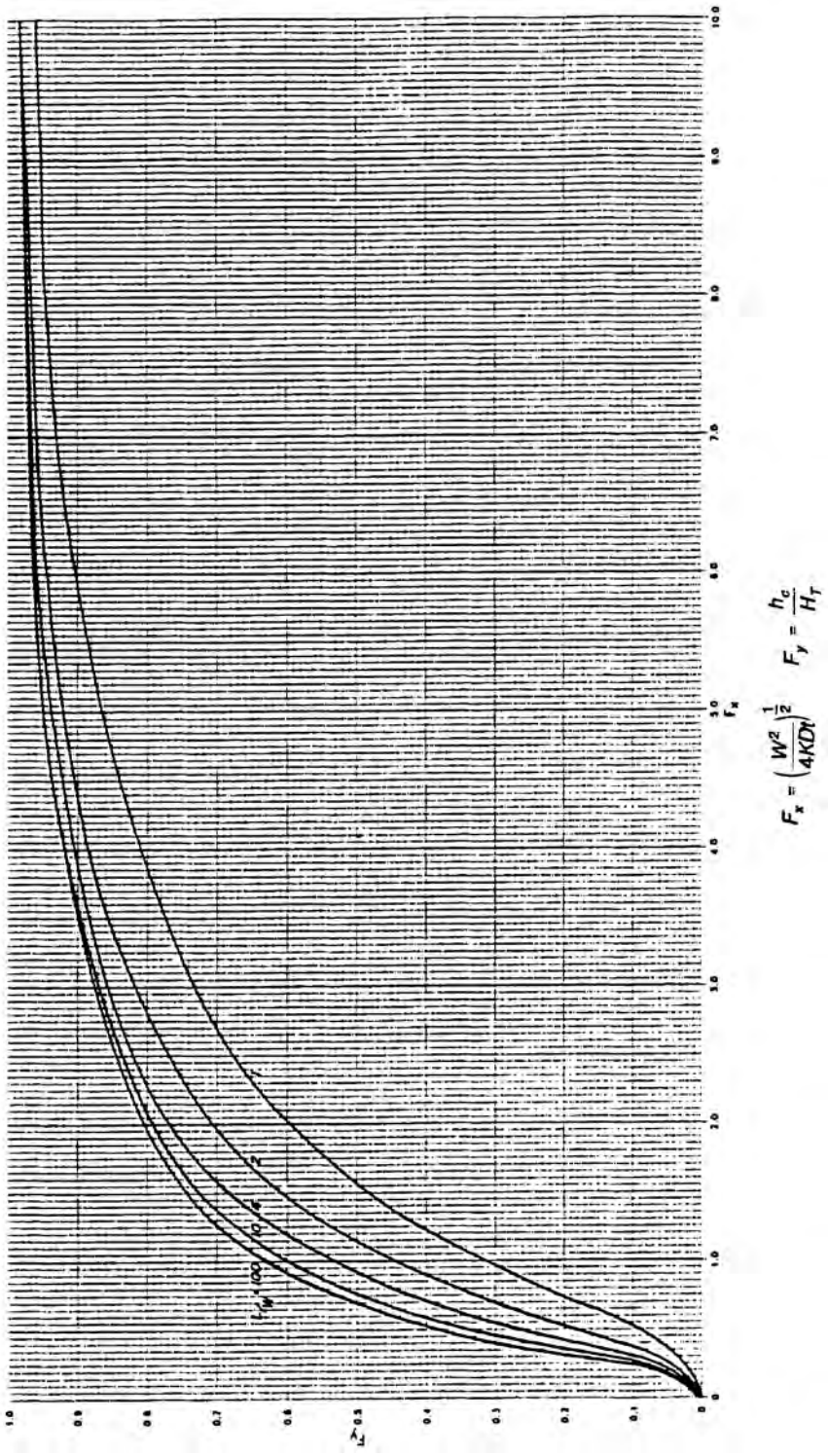


Figure 23-7. Dimensionless Curves Relating Basin Design Parameters to Basin Water Level in a Rectangular Retention Basin Over an Unconfined Aquifer ($f = 0.3$) (Source: Andreyev and Wiseman, 1989).

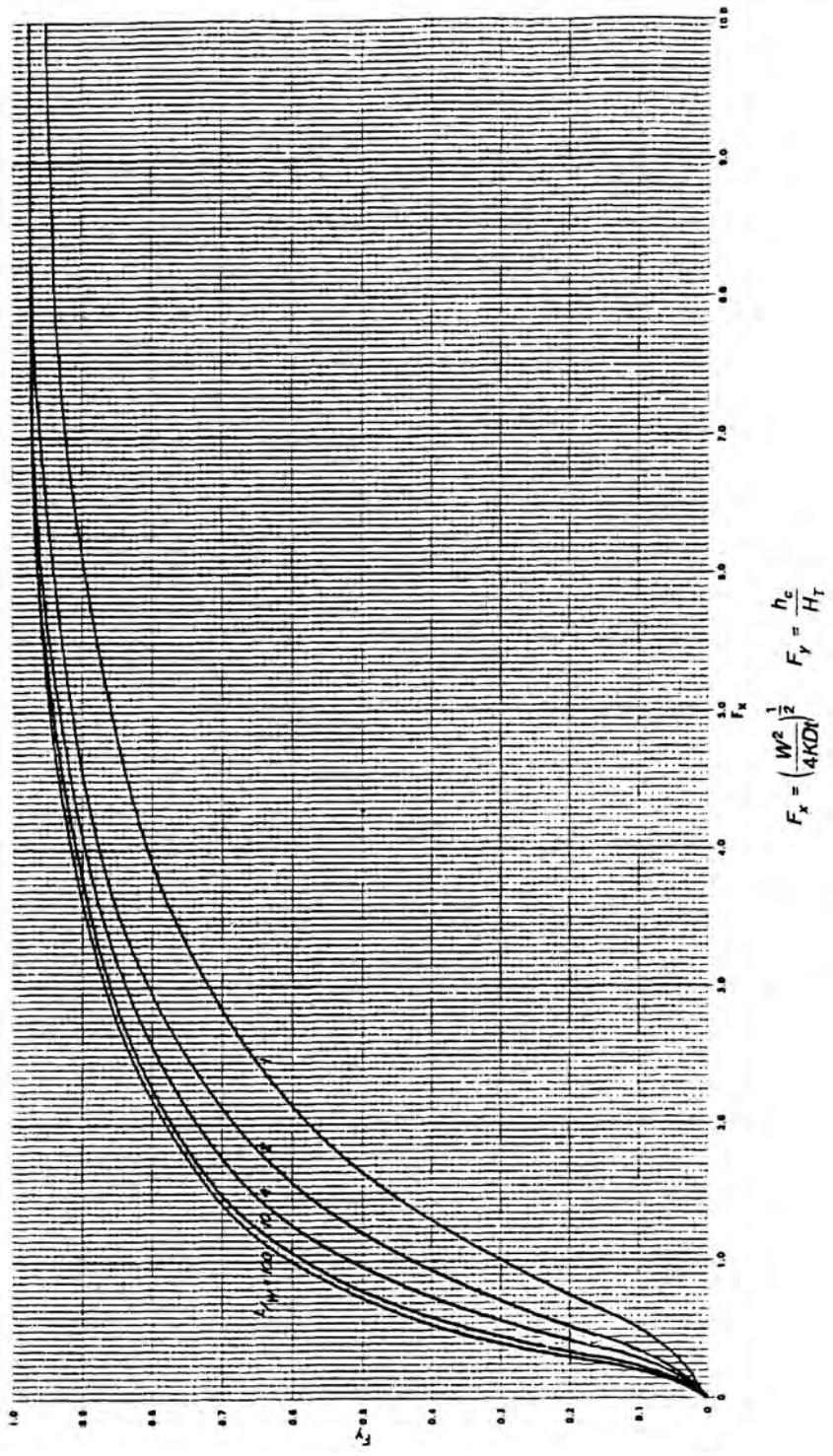
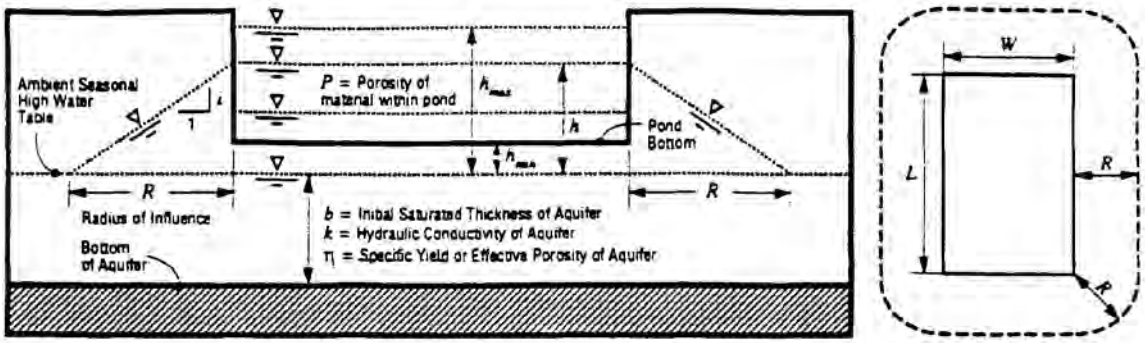


Figure 23-8. Dimensionless Curves Relating Basin Design Parameters to Basin Water Level in a Rectangular Retention Basin Over an Unconfined Aquifer ($f = 0.4$) (Source: Andreyev and Wiseman, 1989).



Required to find: Time for recovery from h_{max} to h_{min}

Solution: Assumes the volume that infiltrates the aquifer fills a triangular wedge above the water table, adjacent to the pond perimeter. For volume balance, therefore:

Volume Recovered from Pond = Volume in saturated triangular prism adjacent to pond and conical fans around edges

$$PLW\,(h_{max} - h) = \eta\, h \left\{ R\,(L + W) + \frac{\pi}{3} R^2 \right\} \tag{1}$$

Solving equation (1) for radius of influence:

$$R = \frac{\left\{ (L + W)^2 + \frac{4\pi}{3} \frac{PWL}{\eta} \frac{(h_{max} - h)}{h} \right\}^{1/2} - (L + W)}{\frac{2\pi}{3}} \tag{2}$$

$$\text{Therefore gradient } i = \frac{h}{R} = \frac{\frac{2\pi}{3} h}{\left\{ (L + W)^2 + \frac{4\pi}{3} \frac{PWL}{\eta} \frac{(h_{max} - h)}{h} \right\}^{1/2} - (L + W)} \tag{3}$$

$$\text{Seepage Face Area } A = (h + b)(2L + 2W) \tag{4}$$

$$\text{From Darcy's Law: Infiltration Rate } q = k\,i\,A = \frac{\frac{4\pi}{3} k\,(L + W)\,h\,(h + b)}{\left\{ (L + W)^2 + \frac{4\pi}{3} \frac{PWL}{\eta} \frac{(h_{max} - h)}{h} \right\}^{1/2} - (L + W)} \tag{5}$$

Incremental recovered volume
$PWL\,dh = q\,dt$;

$$dt = \frac{PWL}{q}\,dh$$

$$\text{Recovery Time } t = \int_{h_{min}}^{h_{max}} PWL \frac{\left[\left\{ (L + W)^2 + \frac{4\pi}{3} \frac{PLW}{\eta} \frac{(h_{max} - h)}{h} \right\}^{1/2} - (L + W) \right]}{\frac{4\pi}{3} k\,h\,(L + W)\,(h + b)}\,dh \tag{6}$$

Figure 23-9. Simplified Analytical Method (Source: SJRWMD Special Publication SJ93-SP10)

The number of borings required to characterize the receiving aquifer of a retention basin depends on the anticipated areal and vertical variability of the aquifer. The local experience of the geotechnical engineer also plays an important role in the selection of the number of borings. As a guide, Andreyev and Wiseman (1989) suggest the following empirical equation to estimate the number of exploratory borings required:

$$B = 1 + \sqrt{2A} + \frac{L}{2\pi W} \qquad (23\text{-}10)$$

where: B = Number of borings required
A = Average area of basin (*acres*)
L = Length of basin (*ft*)
W = Width of basin (*ft*)

Ground surface elevations at the boring locations should be surveyed if there is significant relief in the locality of the borings.

23.4.2 Estimated Normal Seasonal High Ground Water Table

In estimating the normal seasonal high ground water table (SHGWT), the contemporaneous measurements of the water table are adjusted upward or downward taking into consideration numerous factors, including: antecedent rainfall, redoximorphic features (i.e., soil mottling), stratigraphy (including presence of hydraulically restrictive layers), vegetative indicators, effects of development, and hydrogeologic setting. The application of these adjustments requires considerable experience.

In general, the measurement of the depth to the ground water table is less accurate in SPT borings when drilling fluids are used to maintain an open borehole. Therefore, when SPT borings are drilled, it may be necessary to drill an auger boring adjacent to the SPT to obtain a more precise stabilized water table reading. In poorly drained soils, the auger boring should be left open long enough (at least 24 hours) for the water table to stabilize in the open hole.

23.4.3 Estimation of Horizontal Hydraulic Conductivity of Aquifer

The following hydraulic conductivity tests are recommended for retention systems:

a) Laboratory hydraulic conductivity test on undisturbed sample (Figure 23-10)

b) Uncased or fully screened auger hole using the equation on Figure 23-11

c) Cased hole with uncased or screened extension with the base of the extension at least one foot above the confining layer (Figure 23-12)

d) Pump test or slug test, when accuracy is important and hydrostratigraphy is conductive to such a test method.

Of the above methods, the most cost effective is the laboratory permeameter test on an undisturbed horizontal sample. However, it becomes difficult and expensive to obtain undisturbed hydraulic conductivity tube samples under the water table or at depths greater than 5 feet below ground surface. In such cases -- where the sample depth is over 5 feet below ground surface or below the water table -- it is more appropriate to use the insitu uncased or fully screened auger hole method (Figure 23-11) or the cased hole with uncased or screened extension (Figure 23-12).

The main limitation of the laboratory permeameter test on a tube sample is that it represents the hydraulic conductivity at a point in the soil profile which may or may not be representative of the entire thickness of the mobilized aquifer. In most cases, the sample is retrieved at a depth of 2 to 3 feet below ground surface where the soil is most permeable, while the mobilized aquifer depth may be 5 to 6 feet. It is therefore important to use some judgement and experience in reviewing the soil profile to estimate the weighted hydraulic conductivity of the mobilized aquifer. It is not practical or economical to obtain and test permeability tubes at each point in the soil profile where there is a change in density, degree of cementation, or texture. Some judgement and experience must therefore be used to estimate representative hydraulic conductivities of the less permeable zones of the mobilized aquifer. In such an evaluation, geotechnical engineers usually consider, among other factors, particle size distribution (particularly the percent of roots, sample orientation (i.e., horizontal or vertical), remolding, and compaction. Valuable insight into the variation of saturated hydraulic conductivity with depth in typical Florida soils can be gleaned from the comprehensive series of soil characterization reports published by the Soil Science Department at the University of Florida. As an additional guide, Figure 23-13 presents an approximate correlation between hydraulic conductivity of poorly graded fine sands in Florida versus the percent by dry weight passing the U.S. No. 200 sieve.

The uncased or fully screened auger hole or cased hole with uncased or screened extension hydraulic conductivity test methods are suitable for use where the mobilized aquifer is stratified and there is a high water table. Ideally, these tests should be screened over the entire thickness of the mobilized aquifer to obtain a representative value of the weighted horizontal hydraulic conductivity. Tests performed below the water table avoid the need to saturate the soil prior to testing. If the mobilized aquifer is thick with substandard saturated and unsaturated zones, it is worthwhile to consider performing a laboratory permeameter test on an undisturbed sample from the upper unsaturated profile and also performing one the institute tests to characterize the portion of the aquifer below the water table.

Pump tests are appropriate for thick aquifers (greater than 10 feet) without intermediate hydraulically restrictive layers of hardpan, etc. Pump tests are the most expensive of the recommended hydraulic conductivity test methods. Therefore, it is recommended that pump tests be used in cases where the mobilized aquifer is relatively thick (greater than 10 feet)

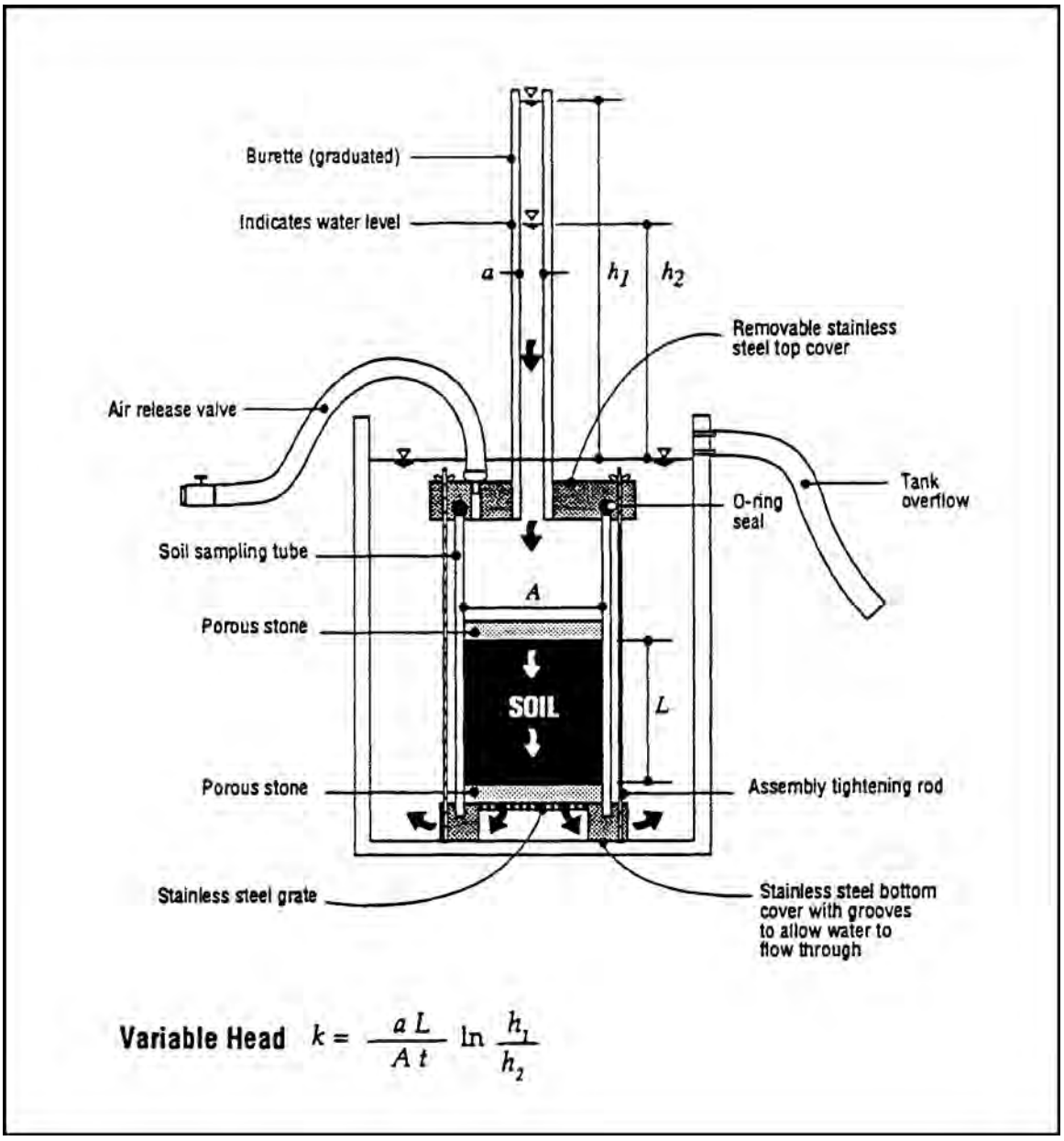
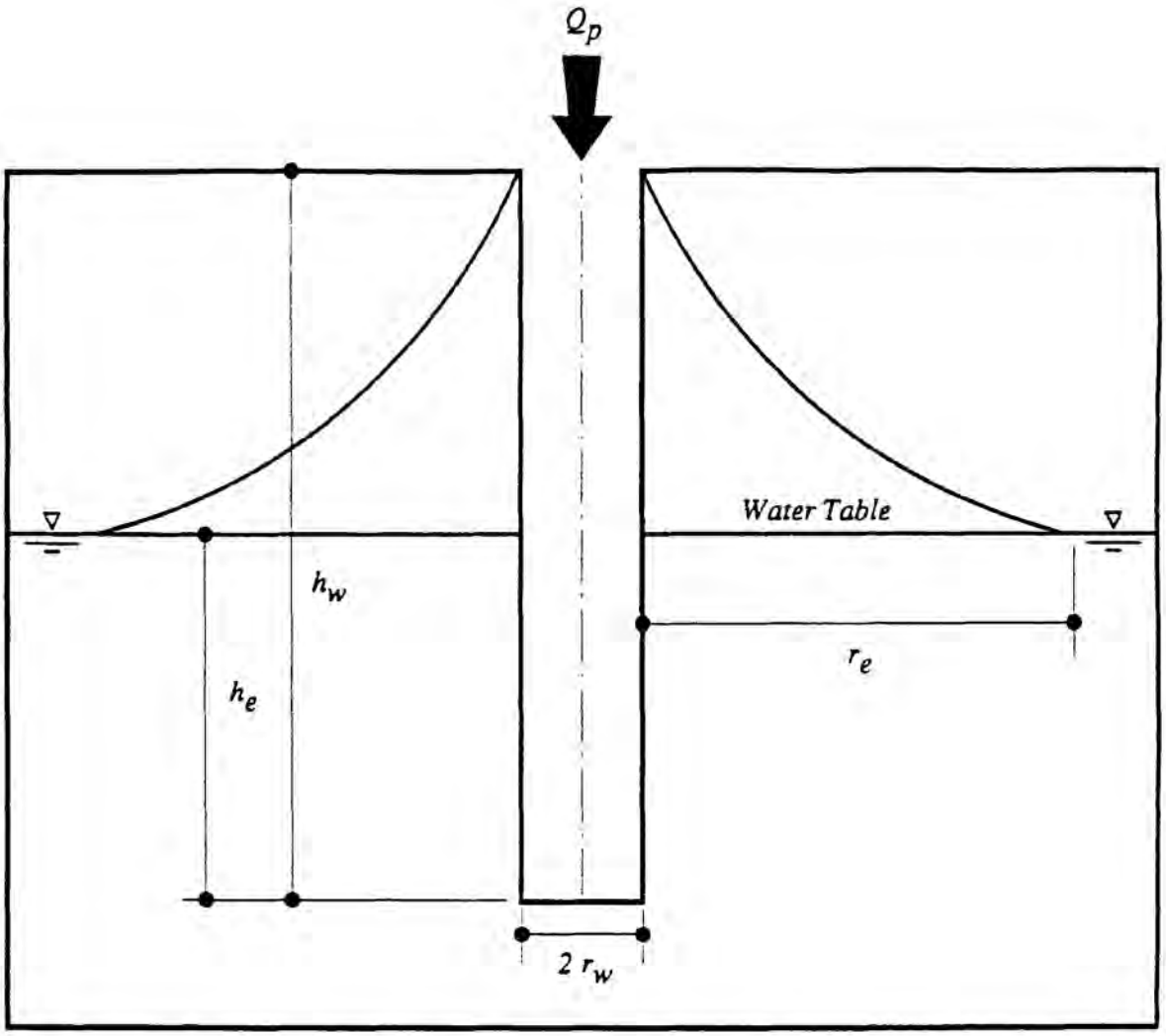


Figure 23-10. Laboratory Permeameter Test (PSI/Jammal & Associates Test Equipment) (Source: SJRWMD Special Publication SJ93-SP10)



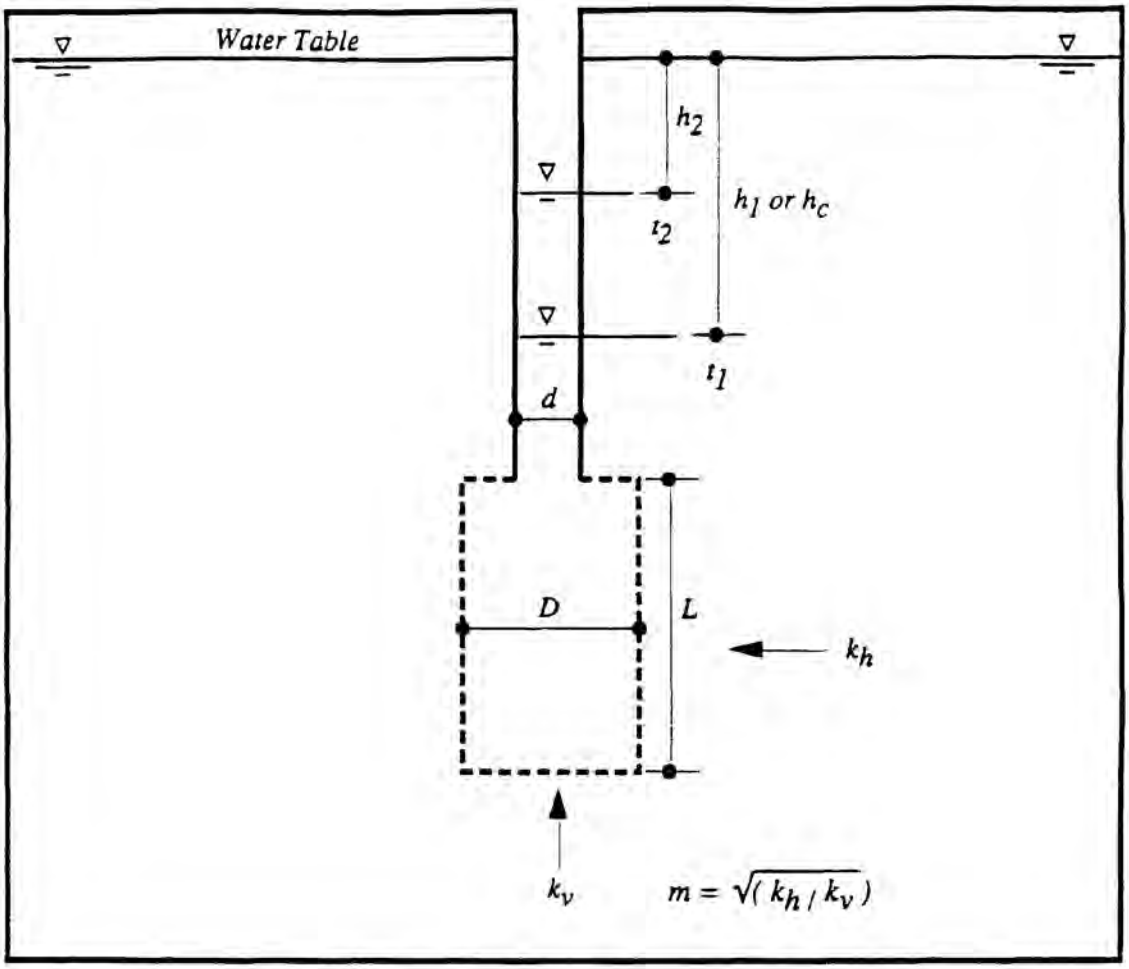
NOTE

Use r_e = 20 to 25 ft.

$$K = \frac{Q_p \, ln \left(\frac{r_e}{r_w}\right)}{\pi (h_w^2 - h_e^2)}$$

Q_p = Steady inflow rate to borehole (cfs)
K = Hydraulic conductivity (ft/sec)
r_e = Radius of influence of borehole (ft)
r_w = Radius of borehole (ft)
h_e = Depth of borehole below water table (ft)
h_w = Total depth of borehole (ft)

Figure 23-11. Field Hydraulic Conductivity Test: Uncased or Fully Screened Auger Hole, Constant Head (Source: SJRWMD Special Publication SJ93-SP10)



Constant Head $k_h = \dfrac{q \ln \left[\dfrac{mL}{D} + \sqrt{1 + \left(\dfrac{mL}{D}\right)^2}\right]}{2 \pi L h_c}$

Variable Head $k_h = \dfrac{d^2 \ln \left[\dfrac{mL}{D} + \sqrt{1 + \left(\dfrac{mL}{D}\right)^2}\right]}{8 L (t_2 - t_1)} \ln \dfrac{h_1}{h_2}$ $\qquad k_h = \dfrac{d^2 \ln \left(\dfrac{2mL}{D}\right)}{8 L (t_2 - t_1)} \ln \dfrac{h_1}{h_2}$ for $\dfrac{mL}{D} > 4$

ASSUMPTIONS

Soil at intake, infinite depth and directional isotropy (k_v and k_h constant); no disturbance, segregation, swelling or consolidation of soil; no sedimentation or leakage; no air or gas in soil, well point, or pipe; hydraulic losses in pipes, well point or filter negligible. (After Hvorslev, U. S. Corps of Engineers, W.E.S., 1951)

Figure 23-12. Field Hydraulic Conductivity Test: Cased Hole with Uncased or Screened Extension (Source: SJRWMD Special Publication SJ93-SP10)

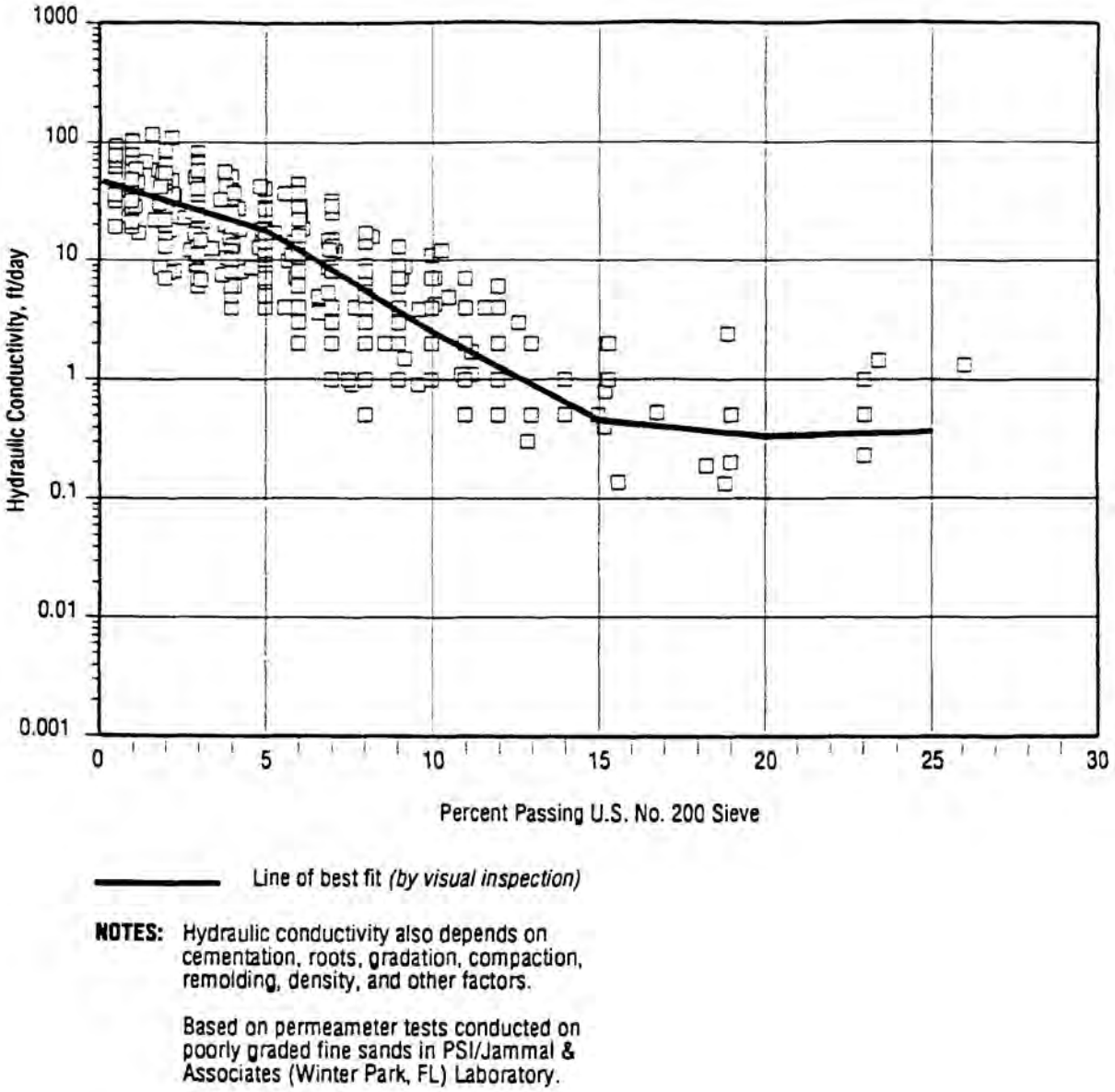


Figure 23-13. Correlation of Hydraulic Conductivity with Fraction by Weight Passing the U. S. No. 200 Sieve (Poorly Graded Fine Sands in Florida) (Source: SJRWMD Special Publication SJ93-SP10)

and where the environmental, performance, or size implications of the system justifies the extra costs of such a test.

For design purposes, a hydraulic conductivity value of over 40 ft/day should not be used for fine-grained sands and 60 ft/day for medium-grained sands.

The selection of the number of hydraulic conductivity tests for a specific project depends of the local experience and judgement of the geotechnical engineer. Andreyev and Wiseman (1989) recommends one hydraulic conductivity test plus one more test for every four soil borings.

23.4.4 Vertical Hydraulic Conductivity

The unsaturated vertical infiltration rate (K_{vu}) can be measured using a double ring infiltrometer test. The field test should be conducted at the same elevation as the proposed basin bottom or lower, if possible. The surface at the test site should be compacted to simulate pond bottom conditions after construction. Field measurements of K_{vu} at depths of more than 1 to 2 feet may not be possible, however, correlation of shallow strata test results with deeper strata may be possible. If field measurements of K_{vu} are not possible, measure the saturated vertical hydraulic conductivity (K_{vs}) by obtaining undisturbed tube sample in the vertical direction. Conduct laboratory permeameter test and then estimate K_{vu} using an empirical correlation of K_{vu} versus K_{vs} (Andreyev and Wiseman 1989):

$$K_{vu} = \frac{2}{3} K_{vs} \qquad (23\text{-}11)$$

23.4.5 Estimation of Fillable Porosity

In Florida, the receiving aquifer system for retention basins predominantly comprises poorly graded (i.e., relatively uniform particle size) fine sands. In these materials, the water content decreases rather abruptly with the distance above the water table and they therefore have a well-defined capillary fringe.

Unlike the hydraulic conductivity parameter, the fillable porosity value of the poorly graded fine sand aquifers in Florida are in a much narrower range (20 to 30 percent), and can therefore be estimated with much more reliability. For fine sand aquifers, it is therefore recommended that a fillable porosity in the range 20 to 30 percent be used in infiltration calculations. The higher values of fillable porosity will apply to the well- to excessively-drained, hydrologic group "A" fine sands, which are generally deep, contain less than 5 percent by weight passing the U.S. No. 200 (0.074 mm) sieve, and have a natural moisture content of less than 5 percent. No specific field or laboratory testing requirements is recommended to estimate this parameter.

23.5 Design Example for Retention Basin Recovery

The following design example is for estimating retention basin recovery by hand utilizing the methodologies in sections 23.3.3 and 23.3.5.

Given: Commercial project discharging to Class III waters
Drainage area = 1.5 acres
Percent impervious = 60%
Off-site drainage area = 0 acres
On-line treatment
f = 0.30; K_{vs} = 2 ft/day; K_H = 10 ft/day; FS = 2.0
Basin bottom elevation = 20.0 feet
Seasonal high groundwater table elevation = 17.0 feet
Impervious layer elevation = 14.0 feet
Rectangular retention basin with bottom dimensions of length = 100 ft and width = 50 ft

The proposed detention basin has the following stage-storage relationship:

Stage (ft)	Storage (ft^3)
20.00	0
20.25	1278
20.50	2615
20.75	4011
21.00	5468
21.25	6988

Objective: Calculate the time to recover the treatment volume.

Design Calculations:

Part I. Calculate the Treatment Volume and
the Height of the Treatment Volume in the Basin

Step 1. Calculate the required treatment volume. For on-line retention, the rule requires retention of 0.5 inches of runoff or 1.25 inches times the impervious area, whichever is greater, plus an additional 0.5 inch.

$$0.5\text{" volume} = \frac{(1.5\ ac)\ (0.5\ in)\ (43560\ ft^2/ac)}{12\ in/ft} = 2723\ ft^3$$

$$1.25'' \text{ x imp. area} = 1.5\ ac\ (0.6)\ (1.25\ in)\ (43560\ ft^2/ac) = 4084\ ft^3$$
$$12\ in/ft$$

$$\text{Total treatment volume} = 2723 + 4084 = 6807\ ft^3$$

Step 2. Calculate the height of the treatment volume in the basin. Using the stage/storage data, we see that 6807 ft^3 is between elevation 21.0 and 21.25 ft. Interpolating:

$$\text{Treatment vol. elev.} = (21.25 - 21.0\ ft)\ \text{x}\ \frac{(6807\ ft^3 - 5468\ ft^3)}{(6988\ ft^3 - 5468\ ft^3)} + 21.0\ ft = 21.22\ ft$$

Part II. Unsaturated Vertical Flow Analysis

Step 3. Determine if saturated lateral (Stage Two) flow will occur.

$$\text{Treatment volume depth } (h_v) = 21.22 - 20.00\ ft = 1.22\ ft$$

From Equation 23~~26~~-4, the height of water to saturate the soil (h_u) is:

$$h_u = f(h_b) = 0.3\ (3\ ft) = .90\ ft$$

Saturated lateral flow will occur since $h_v > h_u$

Step 4. Calculate the volume of water infiltrated in unsaturated vertical (Stage One) flow and the time to infiltrate this volume. The area of basin bottom (A_b) is:

$$A_b = 50\ ft\ \text{x}\ 100\ ft = 5000\ ft^2$$

Utilizing Equation 23-3, the volume infiltrated during Stage One (V_u) is:

$$V_u = 5000\ ft^2\ (3\ ft)\ 0.35) = 5250\ ft^3$$

The unsaturated vertical hydraulic conductivity (K_{vu}) is determined from Equation 23-11:

$$K_{vu} = \frac{2\ (2\ ft/day)}{3} = 1.33\ ft/day$$

The design infiltration rate (I_d) is found from Equation 23-1:

$$I_d = \frac{1.33\ ft/day}{2} = 0.67\ ft/day$$

From Equation 23-2, the time to saturate soil beneath the basin (t_{sat}) is:

$$t_{sat} = \frac{(3\,ft)(0.35)}{0.67\,ft/day} = 1.57\,days$$

Part III. Saturated Lateral Flow Analysis

Step 5. Calculate the remaining treatment volume to be recovered under saturated lateral (Stage Two) flow conditions.

$$\textit{Remaining volume to be infiltrated under saturated lateral flow} = 6807 - 5250 = 1557\,ft^3$$

Calculate the elevation of treatment volume at the start of saturated lateral flow by interpolating:

$$\textit{Treatment volume elev. at start of saturated lateral flow} = (20.50 - 20.25\,ft) \times \frac{(1557\,ft^3 - 1278\,ft^3)}{(2615\,ft^3 - 1278\,ft^3)} + 20.25\,ft = 20.30\,ft$$

Step 6. Calculate F_y and F_x

When the treatment volume is recovered (time $t = t_{Total}$) the water level is at the basin bottom. Hence, the height of the water level above the initial groundwater table (h_c) will be equal to h_b.

$$h_c = h_b = 3\,ft \quad (\text{at } t = t_{Total})$$

The height of water in the basin at the start of saturated lateral flow (h_2) is:

$$h_2 = 20.3 - 20.0 = 0.3\,ft$$

From Equation 23-8:

$$H_T = h_b + h_2 = 3.0 + 0.3 = 3.3\,ft$$

F_y is determined from Equation 23-6:

$$F_y = \frac{3\,ft}{3.3\,ft} = 0.91$$

When the water level is at the basin bottom (time $t = t_{Total}$) the basin length (L) = 100 ft and the basin width (W) = 50 ft.

$$\textit{Basin length to width ratio (L/W)} = \frac{100\,ft}{50\,ft} = 2$$

Determine F_x.

From Figure 23-7; $F_x = 4.65$ (for $f = 0.3$, $L/W = 2$, and $F_y = 0.91$)

Step 7. Calculate the time to recover the remaining treatment volume under saturated lateral flow.

$$H = 17.0 - 14.0 = 3.0\,ft$$

The average saturated thickness (D) can be found from Equation 23-7:

$$D = H + \frac{hc}{2} = 3.0 + \frac{3.0}{2} = 4.5\,ft$$

The time (t) to recover the remaining treatment volume under lateral saturated flow conditions is determined from Equation 15-9:

$$t = \frac{(50\,ft)^2}{(4)\,(10\,ft/day)\,(4.5\,ft)\,(4.75)^2} = 0.62\ days$$

Part IV. Calculate Total Recovery Time

Step 8. Total time to recover the treatment volume (t_{Total}) equals the time to recover during unsaturated vertical flow plus the time to recover under lateral saturated conditions.

$$\textit{Total recovery time } (t_{Total}) = 1.57\ days + 0.62\ days = 2.19\ days \text{ or } 53\ hours$$

Therefore, the design meets the 72-hour recovery time criteria.

23.6 References

Andreyev, N.E., and L.P. Wiseman. 1989. *Stormwater Retention Pond Infiltration Analysis in Unconfined Aquifers*. Prepared for Southwest Florida Water Management District, Brooksville, Florida.

Kuhns, G.L. 1990. *PONDFLOW II - Stormwater Recovery Analysis Program*. User Manual (unpublished).

Mongeau, M.L. 1991. Groundwater Considerations. In *Stormwater Management: A Designer's Course*. Florida Engineering Society, Orlando, Florida.

Professional Service Industries, Inc. (PSI), Jammal & Associates Division. 1993. *Full-Scale Hydrologic Monitoring of Stormwater Retention Ponds and Recommended Hydro-Geotechnical Design Methodologies.* Prepared for St. Johns River Water Management District, Palatka, Florida. Special Publication SJ93-SP10.

24.0 Methodology and Design Example for Underdrain Systems

24.1 Spacing Underdrain Laterals

Optimum drain spacing for drainage laterals is influenced by soil permeability, drain depth, water table elevation desired after installation of the system, and site characteristics. The following procedure used to design underdrain systems are largely based on techniques used to design agricultural subsurface drainage systems. The procedures in this section are adapted from Livingston et al. (1988).

Underdrain spacing can be determined by the "ellipse equation" which is expressed as (SCS 1973):

$$S = \sqrt{\frac{4\,K\,(m^2 + 2\,a\,m)}{q}} \qquad (24\text{-}1)$$

where: S = Drain spacing (*ft*)
K = Permeability rate of the soil (*ft*/*hr*)
M = Height of water table above drain (after drawdown) measured at the midpoint between laterals (*ft*)
A = Height of drain above impermeable layer (*ft*)
Q = Drainage coefficient (*ft/hr*)

Refer to Figure 24-1 for an illustration of the variables used in the ellipse equation.

The drainage coefficient (q) is the rate of water removal to obtain the required 72-hour recovery of the treatment volume and to lower the free water surface a specified depth below the basin bottom. In the ellipse equation, the drainage coefficient (q) is expressed in the same units as the permeability (K). The drainage coefficient (q) can be expressed as (Livingston et al. 1988):

$$q = \frac{c}{t} \qquad (24\text{-}2)$$

where: c = Depth from the ground surface to water table (after drawdown) (*ft*)
t = Recovery time (*hr*)

Based on Figure 24-1, the height of the water table above the drain (m) is given by:

$$m = d - c \qquad (24\text{-}3)$$

where: d Depth to drainage pipe from the natural ground surface elevation (*ft*)

The height of the drain above the impermeable barrier (a) is:

$$a = D - d \qquad (24\text{-}4)$$

where: D = Depth to impermeable layer from the natural ground surface elevation (*ft*)

When there is no impermeable barrier present, the depth to the impermeable layer (D) should be assumed at a depth equal to twice the drain depth (d).

The ellipse equation is based on steady state conditions and the assumption that ground water inflow from outside the area is slight. For this reason the use of the ellipse equation should be limited to conditions in which:

(a) The hydraulic gradient of the undisturbed water table is one percent (0.01 feet per foot) or less. Under these conditions there is likely to be very little ground water flow or movement from outside the system.

(b) The site is underlain by a impermeable barrier at relatively shallow depths (twice the depth of the drain (d) or less) which restricts vertical flow and forces the percolating water to flow horizontally toward the drain.

(c) A gravel envelope surrounds the perforated drainage pipes so that flow restrictions into the drain are minimized.

(d) The height of drain above impermeable layer (a) is less than or equal to the depth to the drainage pipe (d).

24.2 Length of Underdrain Required and Basin Dimensions

It is desirable to keep both the bottom and sides of the detention area dry. To maintain a dry basin bottom, the District recommends the distance between the basin bottom and water table after drawdown be at least 6 inches (see Figure 24-1). Maintaining $r \geq 6$ inches will ensure that the floor of the basin is above the ground water table capillary zone.

If the side slope and shape of the detention basin are known, it is possible to determine the dimensions of the basin and the exact length of drain pipe needed. The area (A_L) served by each lateral in a rectangular basin is given by (see Figure 24-2):

$$A_L = S\,(L + S) \qquad (24\text{-}5)$$

where: A_L = Area served by each lateral (ft^2)
L = Length of lateral (*ft*)

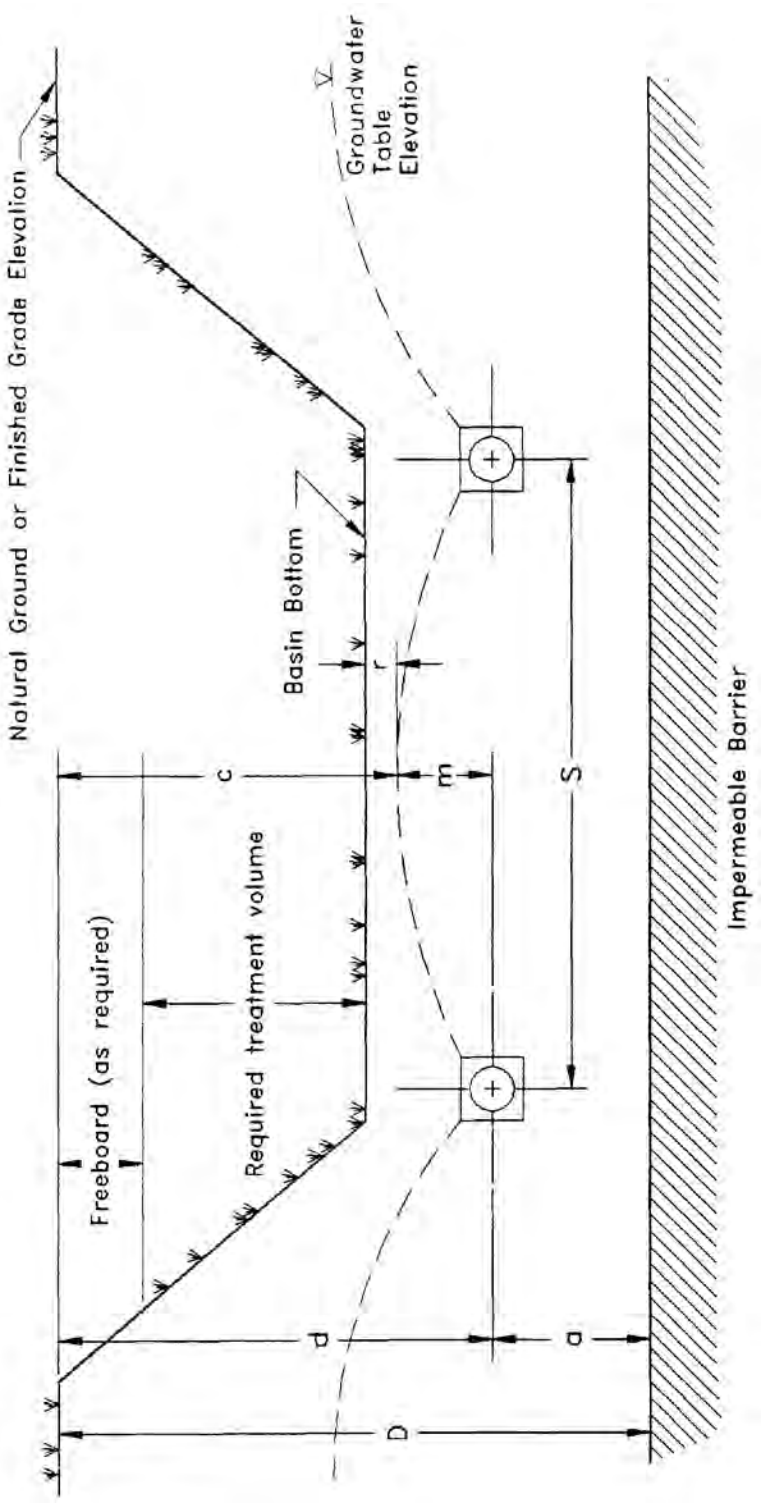


Figure 24-1. Cross-section of underdrain system illustrating variables used in the ellipse equation (N.T.S.)

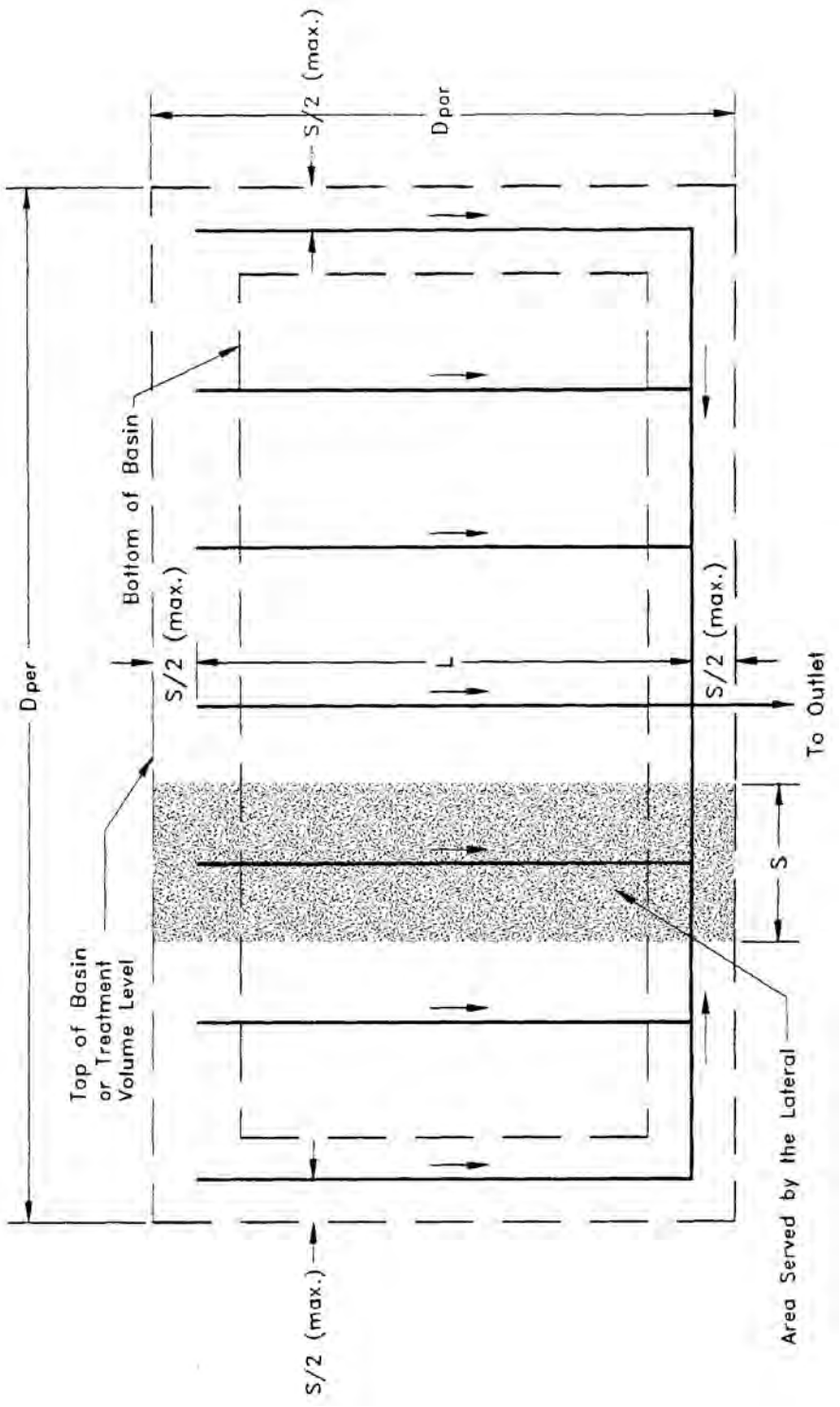


Figure 24-2. Top view of underdrain system illustrating variables used in the ellipse equation (N.T.S.)

The total area served by all the laterals (A_{TL}) is:

$$A_{TL} = A_L N \tag{24-6}$$

where: N = Number of laterals

The top area of the detention basin (A_{BT}) can be expressed as:

$$ABT = DPAR \ DPER \tag{24-7}$$

where: A_{BT} = Top area of the detention basin (ft^2)
D_{PAR} = Distance of top of basin in the direction parallel to the laterals (ft)
D_{PER} = Distance of top of basin in the direction perpendicular to the laterals (ft)

Setting the total area served by the laterals (A_{TL}) so that it is equal to the area of the detention basin as measured from the top of bank dimensions (A_{BT}), will ensure that both the bottom and sides of the basin remain dry between storm events. In this case the criteria for the lateral spacings and the top dimensions of the basin are determined as follows:

$$\textit{Lateral Length :} \quad L + S \geq D_{PAR} \tag{24-8}$$

$$\textit{Lateral Spacing :} \quad S\,(N) \geq D_{PER} \tag{24-9}$$

$$\textit{Lateral Side Offset Distance :} \quad Offset \leq \frac{S}{2} \tag{24-10}$$

$$\textit{Top Area:} \quad D_{PAR}\ (D_{PER}) \leq A_{TL} \tag{24-11}$$

Given the lateral spacing (S) and two of the three variables L, D_{PAR}, or D_{PER}, the designer can solve for the unknown variable using the equations in this section. An example problem for designing an underdrain system is given in section 24.5.

24.3 Drain Size

The discharge from a drain may be found by the following formula (SCS 1973):

$$Q_r = \frac{q\,S\left(L + \frac{S}{2}\right)}{CF} \tag{24-12}$$

where: Q_r = Relief drain discharge (cfs)
S = Drain spacing (ft)

L = Drain length (*ft*)
q = Drainage coefficient (*in/hr*)
CF = Conversion factor = 43200

Subsurface drains ordinarily are not designed to flow under pressure. The hydraulic gradient is considered to be parallel with the grade line of the underdrain. The flow in the drain is considered to be open-channel flow. The size conduit required for a given capacity is dependent on the hydraulic gradient and the roughness coefficient (n) of the drain. Commonly used materials have n values ranging from about 0.011 for good quality smooth plastic pipe to about 0.025 for corrugated metal. When determining the size of drain required for a particular situation the n value of the product to be used must be known. This information will normally be available from the manufacturer. The diameter pipe required for a given capacity, hydraulic gradient, and four different n values may be determined from Figures 24-3, 24-4, 24-5, and 24-6.

The area to the right of the broken line in the charts indicates conditions where the velocity of flow is expected to be less than 2.0 ft/sec. Lower velocities may present a problem with siltation in areas of fine soils.

24.4 Sizing of Drains Within the System

The previous discussion on drain size deals with the problem of selecting the proper size for a drain at a specific point in the stormwater system. In drainage systems with laterals and mains, the variation of flow within a single line may be great enough to warrant changing size in the line. This is often the case in long drains or system with numerous laterals. The example problem in section 24.5 illustrates a method for such a design.

24.5 Example Design Calculations for Underdrain Systems

Given: Desired depth of the treatment volume in the basin = 3 feet
Desired basin freeboard = 1 ft
4" minimum pipe diameter
3" gravel envelope on each side of the drainage pipes
Minimum distance between basin bottom and top of the gravel envelope = 2 feet = $m + r$
Depth from natural ground to impermeable barrier = 7.5 feet
Area of basin (measured from top of treatment volume) = 7260 ft^2
Maximum top dimension of basin perpendicular to drainage laterals = 30 feet
K = 1.0 ft/hr
Slope of laterals = 0.2%
n = 0.015
Safety factor = 2.0
"T" shaped drainage network (similar to Figure 24-2)

Objective: Design an underdrain system to lower the water level to a level 6" below the basin bottom within 72 hours.

Design Calculations:

Step 1. Calculate the required drain spacing.

First determine the depth to the drain line from natural ground surface (*d*) from the following relationship:

Depth to the drain line from natural ground surface (d) = Depth of treatment volume in the basin + depth of freeboard + depth of soil between basin floor and envelope + depth of gravel envelope + drain radius

$$d = 3\,ft + 1\text{ ft} + 2\,ft + \frac{3\,in}{12\,in/ft} + \frac{2\,in}{12\,in/ft} = 6.42\,ft$$

Determine the height of the drain above the impermeable layer (*a*) by utilizing Equation 24-4:

$$a = D - d = 7.5 - 6.42 = 1.08\,ft$$

Depth to water table after drawdown (*c*) = *treatment volume depth + freeboard depth + r*

$$c = 3\,ft + 1\,ft + \frac{6\,in}{12\,in/ft} = 4.5\,ft$$

From Equation 24-3:

$$m = d - c = 6.42\,ft - 4.5\,ft = 1.92\,ft$$

Determine the drainage coefficient (q) from Equation 24-2 with t = 36 hrs to incorporate a safety factor of 2 (i.e., 72/2 = 36):

$$q = \frac{c}{t} = \frac{4.5\text{ ft}}{36\text{ hr}} = 0.125\text{ ft/hr} = 1.5\text{ in/hr}$$

The spacing (S) is determined from Equation 24-1:

$$S = \sqrt{\frac{4(1.0\,ft/hr)\left[(1.92\,ft)^2 + 2(1.08\,ft)(1.92\,ft)\right]}{0.125\,ft/hr}} = 15.8\,ft$$

Determine the number of laterals (*N*) utilizing Equation 24-9:

$$N \geq \frac{30\,ft}{15.8\,ft} \geq 1.5$$

Since the laterals should be located no farther than *S*/2 from the top of the basin, use two laterals spaced 15 ft apart and located 5 ft inside the top of basin. The two laterals will be connected to a main line with an outlet pipe intersecting at the midpoint of the main line.

Step 2. Calculate the length of the laterals.

Use Equation 24-11 with $A_{BT} = A_{TL}$:

$$D_{PAR} = \frac{7260\ ft^2}{30\ ft} = 242\ ft$$

Find the length of each lateral (L) from Equation 24-8:

$$L = 242\ ft - 15\ ft = 227\ ft$$

Step 3. Size the drainage laterals. The flow per lateral (Q_r) is found from Equation 24-12:

$$Q_r = (1.5\ inch/hr)\ 15\ ft \left(227\ ft + \frac{15}{2}\ ft \right) \frac{1}{43200} = 0.122\ cfs$$

From Figure 24-5 with slope = 0.002 and n = 0.015, the capacity of a 4" pipe is 0.074 cfs. Since this is less than the flow rate that each lateral must convey, a 4" drain will not be sufficient for the entire length of the lateral and the size will have to be increased. Start the design process at the upper end of the drain using a minimum size of 4 inches. First, compute the distance that the drain would carry the flow on the assumed grade. The accretion per 100 would be:

$$\frac{0.122\ cfs}{227\ ft / 100\ ft} = 0.054\ cfs$$

The distance (in 100-foot sections) down gradient that a 4" drain would be adequate is:

$$\frac{0.074\ cfs}{0.054\ cfs} = 1.38\ (100 - \text{foot sections of 4" pipe})$$

The 4" drain pipe is adequate for 135 feet of line. Continue these calculations for the next size pipe (5-inch) which has a maximum capacity of 0.13 cfs (from Figure 24-5).

$$\frac{0.13\ cfs}{0.055\ cfs} = 2.42\ (100 - \text{foot sections of 5" pipe})$$

The 5" drain would be adequate for 242 feet. Of this 242 feet, 138 would be 4" drain; and the remaining 104 feet would be 5" pipe. Since the total length required for each lateral is 227 feet, the amount of 5" drain needed is:

$$227\,ft \;-\; 138\,ft \;=\; 89 ft \;\; of \;\; 5" \; drain \; per \; lateral$$

In summary, each lateral should contain 138 ft of 4" drain and 89 ft of 5" drain, although practical applications might consider 5" drain for the entire 227 ft.

Step 4. Size the main and outlet lines.

Assume the outlet intersects the main line at the midpoint. With only two laterals in the system, the main will not intersect any other laterals before reaching the outlet. Therefore, a 5" drain 10 feet in length on either side of the outlet will be sufficient for the main line.

$$Flow \; in \; the \; outlet \;=\; 0.122 \; cfs \; per \; lateral \;\times\; 2 \; laterals \;=\; 0.244 \; cfs$$

From Figure 24-5, with slope = 0.002 and n = 0.015; a flow of 0.244 cfs is greater than the capacity of a 6" but less than the capacity of a 8" drain. Therefore, use 8" drain for the outlet.

24.6 References

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management.* Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Natural Resources Conservation Service (SCS). 1973. *Drainage of Agricultural Lands*. Water Information Center, Port Washington, New York.

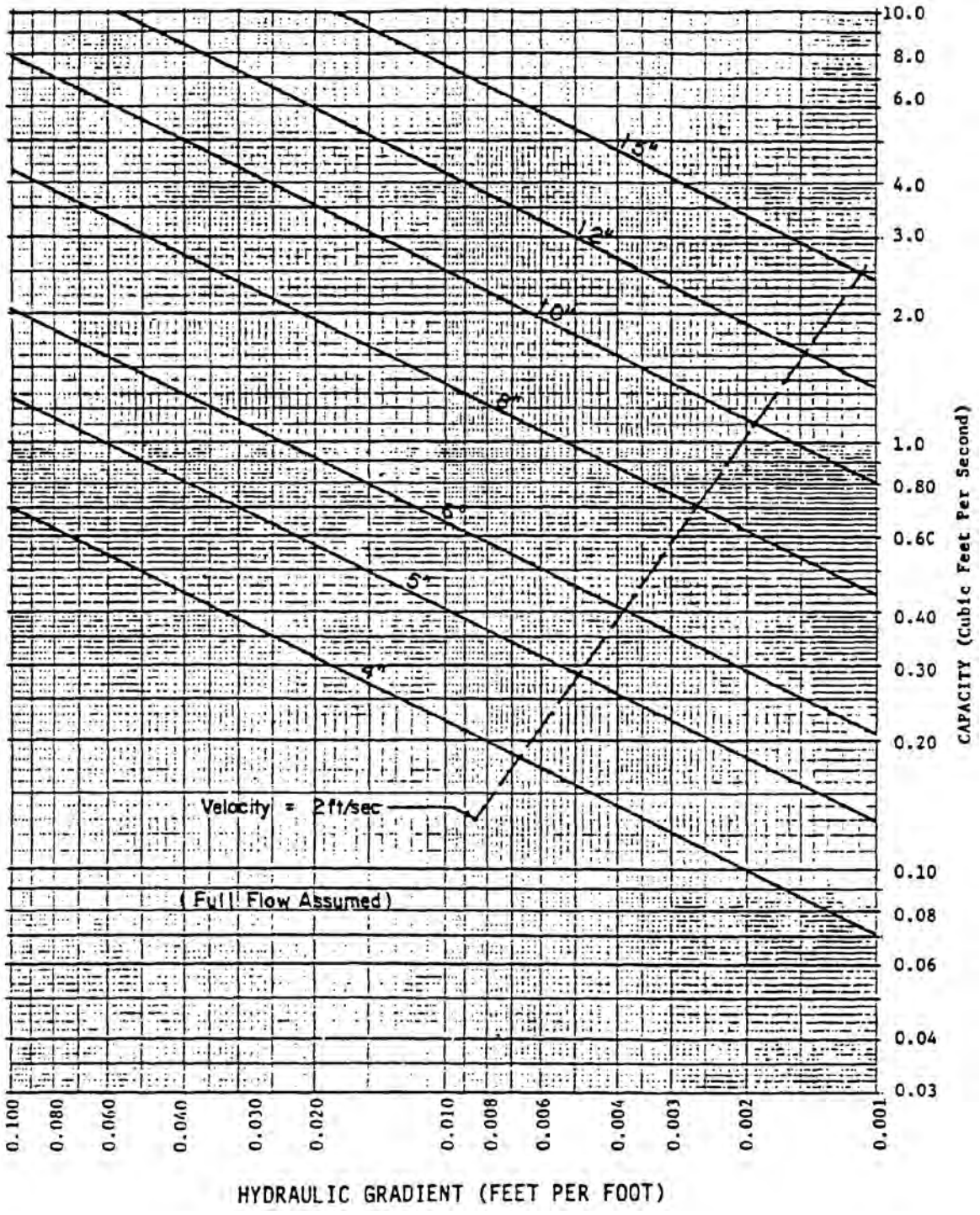


Figure 24-3. Subsurface Drain Capacity Chart - "n" = 0.011 (Source USDA-SCS)
Source: Livingston et al., 1988

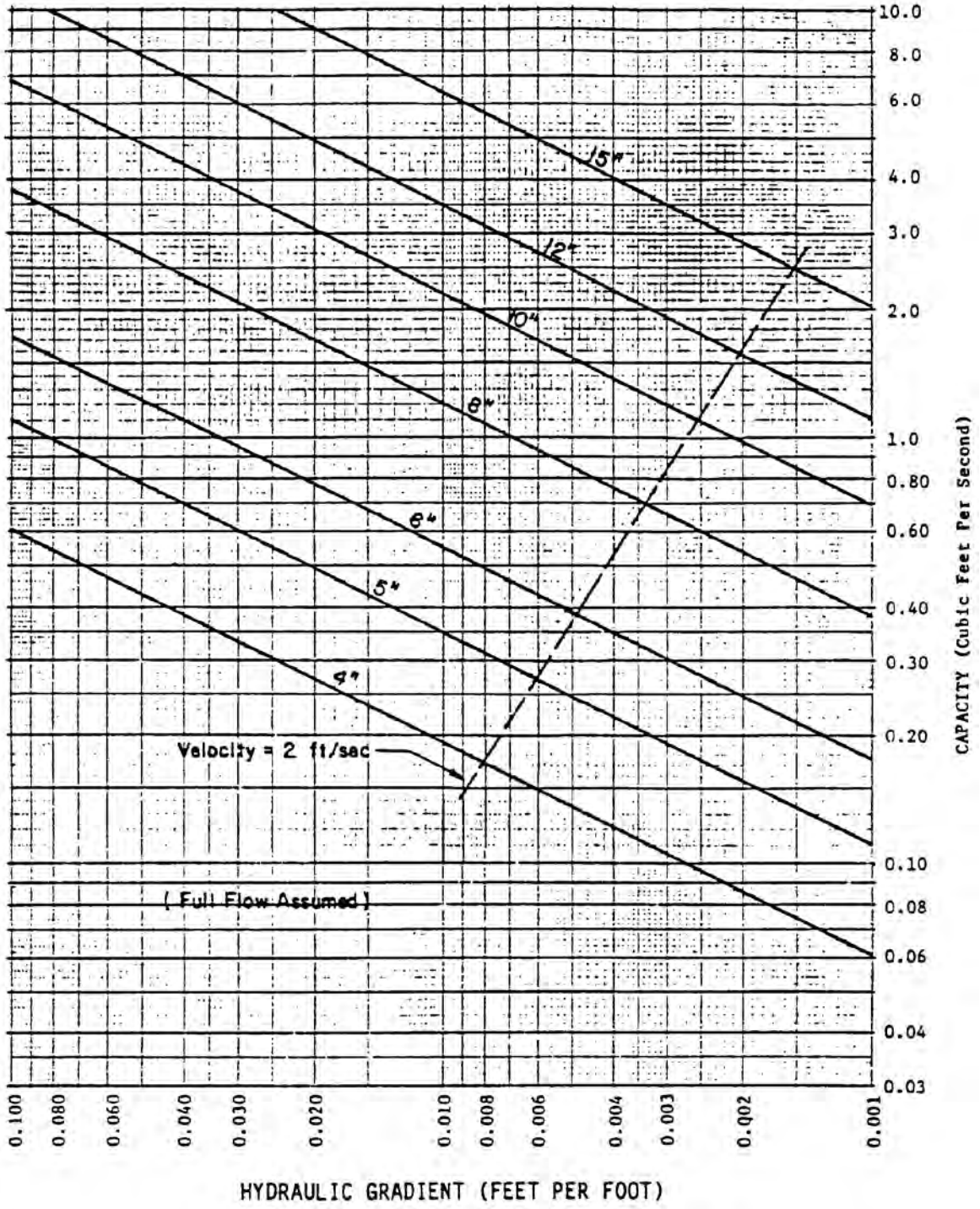


Figure 24-4. Subsurface Drain Capacity Chart - "n" = 0.013 (Source USDA-SCS)
Source: Livingston et al., 1988

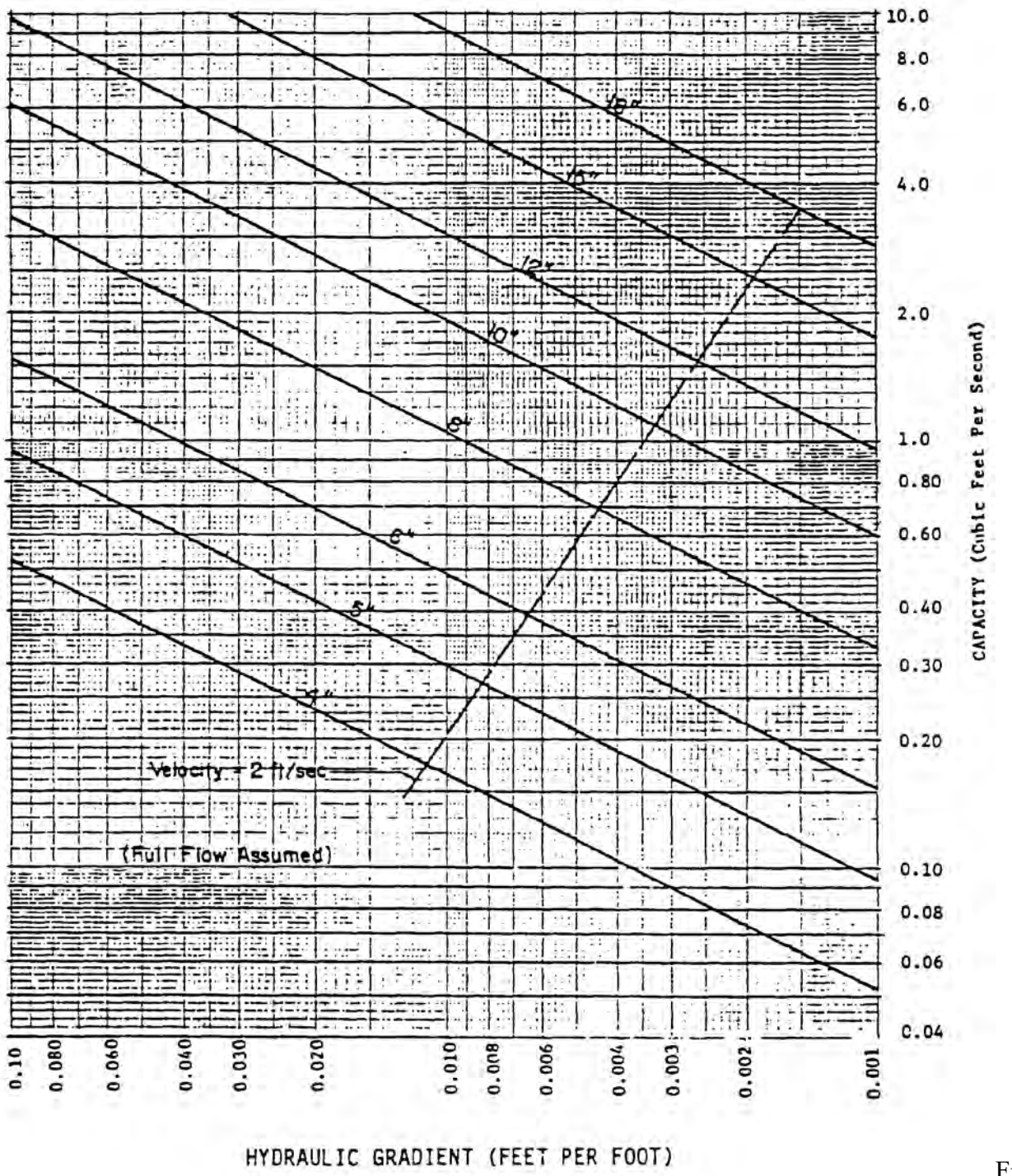


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Figure 24-5. Subsurface Drain Capacity Chart - "n" = 0.015 (Source USDA-SCS)
Source: Livingston et al., 1988

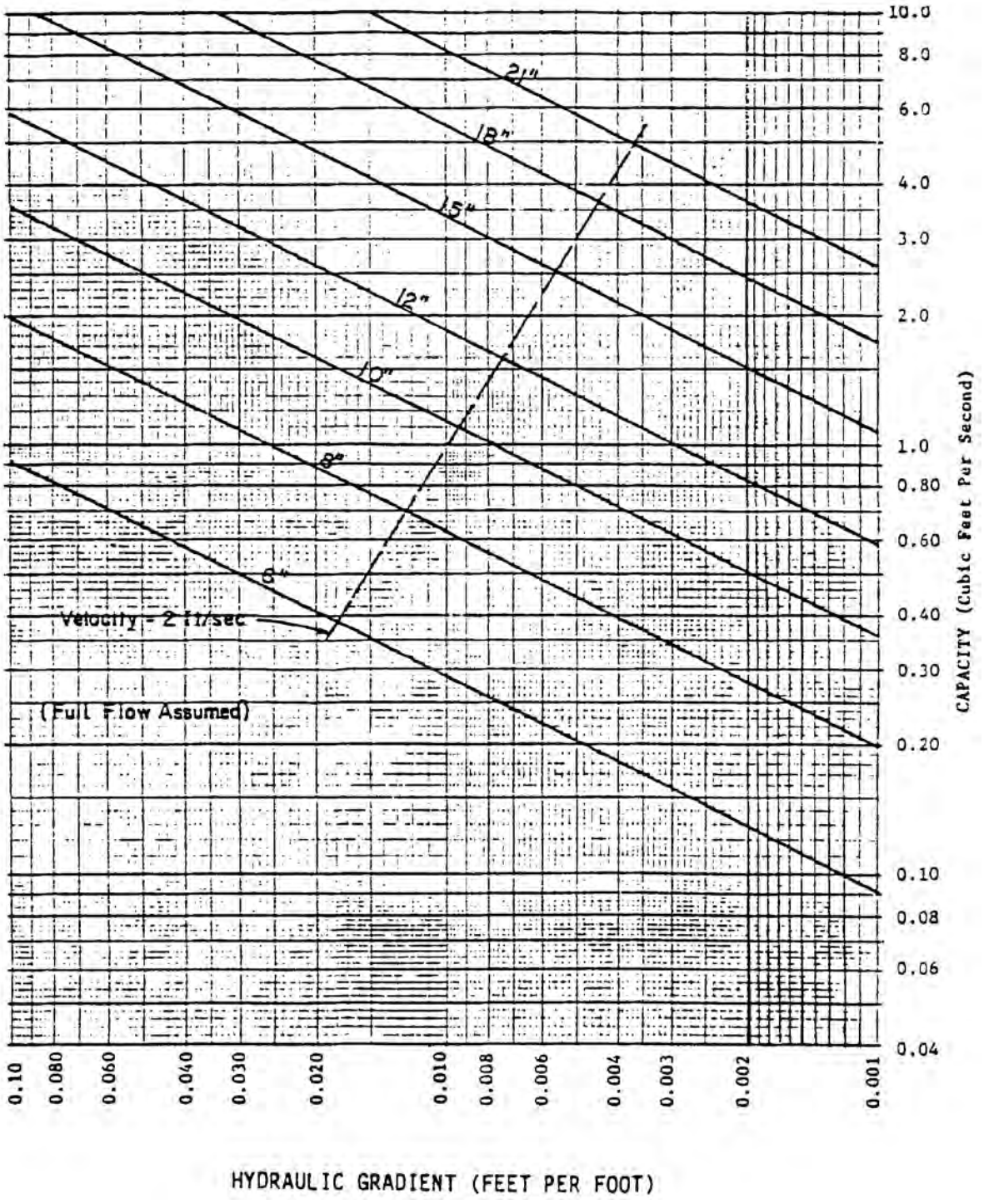

Figure 24-6. Subsurface Drain Capacity Chart - "n" = 0.025 (Source USDA-SCS)
Source: Livingston et al., 1988

25.0 Methodology and Design Example for Exfiltration Trench Systems

25.1 Calculating Storage Capacity of an Exfiltration Trench

The storage volume of a trench (V_{TR}) can be expressed as:

$$V_{TR} = V_P + V_S \tag{25-1}$$

where: V_{TR} = Total storage volume of the trench
V_P = Volume of the pipe
V_S = Volume of the void spaces in the trench aggregate

The volume in a pipe (V_P) is:

$$V_P = A_P\, L \tag{25-2}$$

where: A_P = Pipe area
L = Length of pipe = length of trench

The area of a pipe (A_P) is:

$$A_P = \frac{\pi\, d^2}{4} \tag{25-3}$$

where: d = Pipe diameter

Substituting Equation 25-3 into Equation 25-2 gives:

$$V_P = \frac{\pi\, d^2\, L}{4} \tag{25-4}$$

The volume of the void spaces in the trench aggregate (V_S) can be expressed as:

$$V_S = \left(A_T - A_P\right) f\, L \tag{25-5}$$

where: A_T = Trench area
f = Fillable porosity of the aggregate

The area of a trench (A_T) with rectangular cross-section is:

$$A_T = W\, H \tag{25-6}$$

where: W = Trench width
H = Trench height

The capacity of a trench (V_{TR}) with rectangular cross-section can now be expressed by substituting Equations 25-2 through 25-6 into Equation 25-1:

$$V_{TR} = \frac{\pi d^2 L}{4} + (WH - \frac{\pi d^2}{4}) f L \quad (25\text{-}7)$$

Equation 25-7 can be simplified to:

$$V_{TR} = L\left[\frac{\pi d^2}{4}(1 - f) + WHf\right] \quad (25\text{-}8)$$

25.2 Estimating Recovery Time

The infiltration design methodologies and geotechnical tests recommended in section 23 for retention systems are applicable to exfiltration trenches. It is recommended that, unless the normal seasonal high water table is over 6 inches below the trench bottom, unsaturated flow prior to saturated lateral mounding be conservatively ignored in recovery analysis. In other words, there should be no credit for soil storage immediately beneath the trench if the seasonal high water table is within 6 inches of the trench bottom. This is not an unrealistic assumption since the height of capillary fringe in fine sand is on the order of 6 inches and a partially mounded water table condition may be remnant from a previous storm event, especially during the wet season.

It is also recommended that the filling of the trench with the treatment volume be simulated as a "slug" loading (i.e., treatment volume fills the trench within an hour).

25.2.1 Limiting Exfiltration Rates

Wanielista et al. (1991) reports that because of sediment buildup on the fabric, the rate at which water can exfiltrate through the filter fabric will decline over time and approach a value substantially lower than initial rates and then generally remain constant at this level. This value is designated as the limiting exfiltration rate for the trench. The limiting exfiltration rate is the lowest sustained rate at which the water can be expected to flow through the fabric, after long term loading. Wanielista et al. (1991) found the limiting exfiltration rate to be 0.5 in/hr through the fabric.

Wanielista et al. (1991) reports that woven fabric (Mirafi 700XG) performed better in mixed sand and silty soil than non-woven fabric (Mirafi 140N). On the other hand, the non-woven fabric had higher exfiltration rates in sandy soils than the woven fabric. If the filter fabric is "matched" to the soil type, the limiting exfiltration rate can be increased to 1.0 in/hr.

The above limiting exfiltration rates through the fabric should be compared to the permeability of the parent soil and for conservative designs, the lesser of the two values should be used in the recovery time calculations.

25.3 Design Example for Sizing an Exfiltration Trench

Given: Treatment Volume = 500 ft^3
f(soil) = 0.3; f(aggregate) = 0.5; K_{vs} = 2 ft/day; K_H = 5 ft/day; FS = 2.0
Seasonal high groundwater table elevation = 17.0 feet
Impervious layer elevation = 14.0 feet
Trench bottom elevation = 21.0 ft
Pipe invert elevation = 22.0 ft

Objective: Size an exfiltration trench to store the treatment volume and recover within 72 hours.

Design Calculations:

Step 1. Select the trench dimensions.
Pipe diameter (d) = 24 in
Rectangular trench cross-section with:
Trench width (W) = 6 ft
Trench height (H) = 4 ft

Step 2. Calculate the length of trench (L) required to store the treatment volume.
From Equation 25-8:

$$1000\ ft^3 = L\left[\frac{\pi (2\,ft)^2\ (1\ -\ 0.5)}{4} + (4\,ft)\ (6\,ft)\ (0.5)\right]$$

$$L = 73.7\,ft$$

Since pipe lengths are usually sold in twenty foot lengths, round up to $L = 80\,ft$

Step 3. Check for lateral saturated infiltration (see section 23 for a complete description of infiltration processes). Determine the volume infiltrated during unsaturated vertical flow (V_u) from Equation 23-3:

$$V_u = A_b\ f\ h_b$$

$$\textit{Area of trench bottom } (A_b) = 80\,ft \text{ x } 6\,ft = 480\,ft^2$$

$$\textit{Height of trench bottom above the ground water table } (h_b) = 21.0\,ft - 17.0\,ft = 4.0\,ft$$

$$V_u = (480\,ft^2)\ (4\,ft)\ (0.3) = 576\,ft^3$$

Lateral saturated infiltration will not occur since the volume infiltrated during vertical unsaturated flow (V_u) is greater than the treatment volume of 500 ft^3.

Step 4. Calculate the time to saturate the soil beneath the trench *(t_{sat})*. From Equation 23-11, the unsaturated vertical hydraulic conductivity (K_{vu}) is:

$$K_{VU} = \frac{2(2\ ft/day)}{3} = 1.33\ ft/day$$

The design infiltration rate (I_d) is determined using Equation 23-1:

$$I_d = \frac{1.33\ ft/day}{2} = 0.67\ ft/day$$

$$I_d = 0.67\ ft/day\ (12\ in/ft)(1\ day/24\ hrs) = 0.34\ in/hr$$

Since I_d is less than the limiting exfiltration rate through the filter fabric (0.5 in/hr) use the value of I_d calculated above in the design analysis.

The time elapsed to saturate soil beneath the trench (t_{sat}) is found from Equation 23-2:

$$t_{sat} = \frac{(4\ ft)(0.3\ ft)}{0.67\ ft/day} = 1.79\ days$$

Therefore, the design meets the 72 hour recovery time criterion.

25.4 Alternative Design Procedures

Wanielista (1991) has developed an alternative procedure for designing off-line exfiltration trenches based on the long term mass balance of an exfiltration system utilizing local rainfall conditions. Fifteen years of hourly precipitation data from six regions in Florida were used as input for the mass balance. From these simulations, design curves for exfiltration systems were developed. These curves relate the rate at which stored runoff is removed from the trench to the volume of storage within the trench. These curves can be used to design an exfiltration trench based on diversion efficiencies of 50%, 60%, 70%, 80%, 85%, 90%, and 95%.

The District accepts this methodology for those areas of the District (i.e., Jacksonville and Orlando) for which the curves have been developed. Applicants designing systems which discharge to Class III receiving waters should use the 80% curve and those that direct discharge to Class I, Class II, and Outstanding Florida Waters should utilize the 95% curve.

25.5 References

Wanielista, M.P., M.J. Gauthier, and D.L. Evans. 1991. *Design and Performance of Exfiltration Systems*. Department of Civil and Environmental Engineering, University of Central Florida, Orlando, Florida.

26.0 Methodology and Design Example for Wet Detention

26.1 Calculating Permanent Pool Volumes

The residence time of a pond is defined as the average time required to renew the water volume (permanent pool volume) in the pond and can be expressed as:

$$RT = \frac{PPV}{FR} \tag{26-1}$$

where: RT = Residence time (*days*)
PPV = Permanent Pool Volume (*ac-ft*)
FR = Average Flow Rate (*ac-ft/day*)

Solving Equation 26-1 for the permanent pool volume (PPV) gives:

$$PPV = (RT)\ (FR) \tag{26-2}$$

The average flow rate (FR) during the wet season (June - October) can be expressed by:

$$FR = \frac{DA\ C\ R}{WS} \tag{26-3}$$

where: DA = Drainage area to pond (*ac*)
C = Runoff coefficient (see Table 24-1 for a list of recommended values for C)
R = Wet season rainfall depth (*in*)
WS = Length of wet season (*days*) (June - October = 153 *days*)

The depth of the wet season rainfall (R) for areas of the District is shown in Figure 26-1. The rainfall depth at a particular location may be established by interpolating between the nearest isopluvial lines.

Substituting Equation 26-3 into Equation 26-2 gives:

$$PPV = \frac{DA\ C\ R\ RT}{WS\ CF} \tag{26-4}$$

where: CF = Conversion factor = 12 *in/ft*

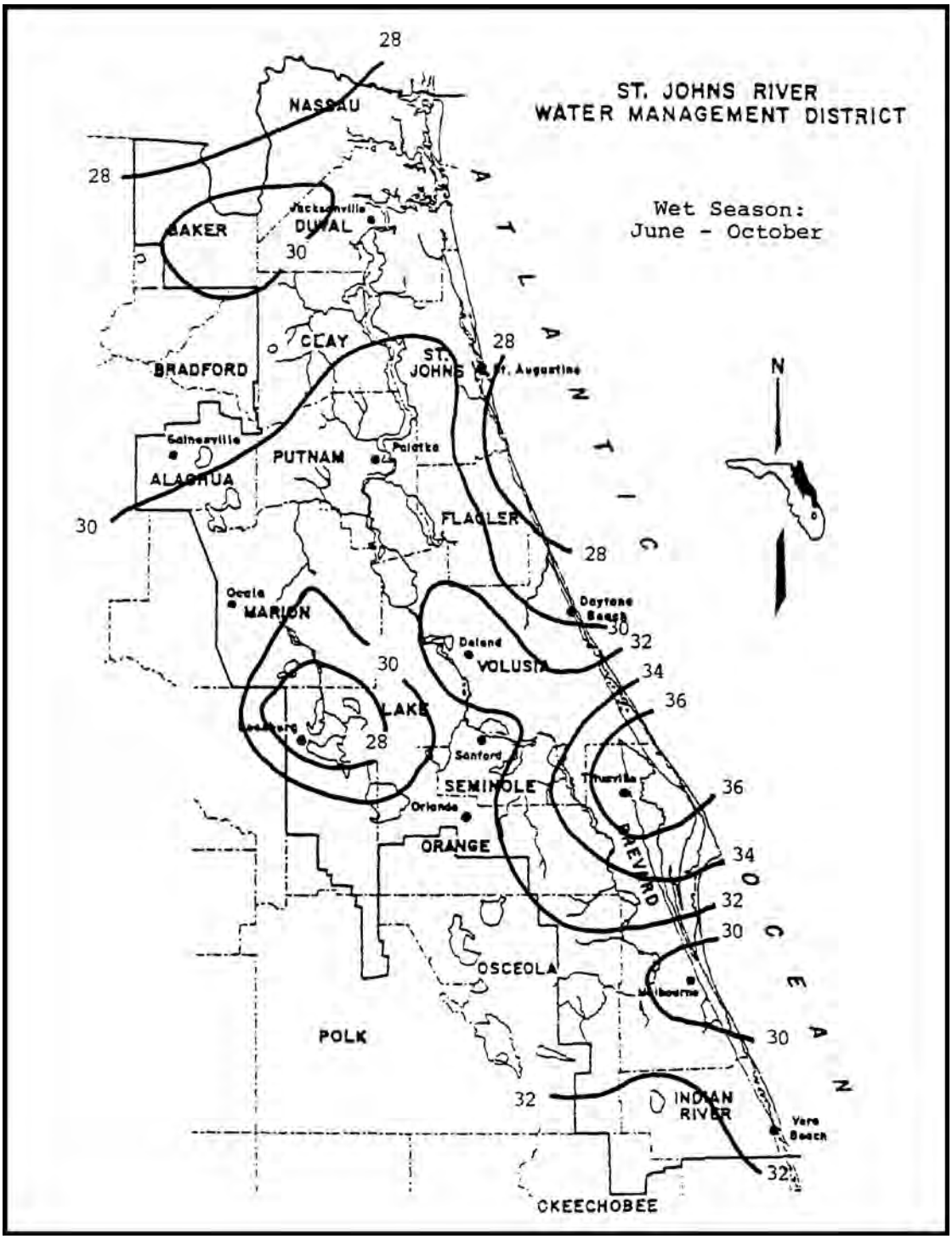

Figure 26-1. Wet Season Normal Rainfall, inches (Source: Rao, et al., 1990)

26.2 Sizing the Drawdown Structure

The rule requires that no more than half the treatment volume should be discharged in the first 24 to 30 hours after the storm event. A popular means of meeting this requirement is to use an orifice or a weir. The following subsections show procedures for sizing an orifice and V-notch weir to meet the drawdown requirements.

26.2.1 Sizing an Orifice

The orifice equation is given by:

$$Q = C A \sqrt{2 g h} \tag{26-5}$$

where: Q = Rate of discharge (*cfs*)
A = Orifice area (ft^2)
G = Gravitational constant = (32.2 ft/sec^2)
H = Depth of water above the flow line (center) of the orifice (*ft*)
C = Orifice coefficient (usually assumed = 0.6)

The average discharge rate (Q) required to drawdown half the treatment volume (TV) in a desired amount of time (t) is:

$$Q = \frac{TV}{2 t CF} \tag{26-6}$$

where: TV = Treatment Volume (ft^3)
t = Recovery time (*hrs*)
CF = Conversion Factor = 3600 *sec/hr*

The depth of water (h) should be set to the average depth above the flow line between the top of the treatment volume and the stage at which half the treatment volume has been released:

$$h = \frac{(h_1 + h_2)}{2} \tag{26-7}$$

where: h_1 = Depth of water between the top of the treatment volume and the flow line (*ft*)
h_2 = Depth of water between the stage when half the treatment volume has been released and the flow line of the orifice (*ft*)

Equation 26-5 can be rearranged to solve for the area (A):

$$A = \frac{Q}{C \sqrt{2 g h}} \tag{26-8}$$

The diameter (D) of an orifice is calculated by:

$$D = \sqrt{\frac{4A}{\pi}} \tag{26-9}$$

where: D = Diameter of the orifice (*ft*)

26.2.2 Sizing a V-notch Weir

Discharge (Q) through a V-notch opening in a weir can be estimated by:

$$Q = 2.5 \tan\left(\frac{\theta}{2}\right) h^{2.5} \tag{26-10}$$

where: Q = Discharge (*cfs*)
Θ = Angle of V-notch (*degrees*)
h = Head on vertex of notch (*ft*)

The average discharge rate (Q) required to draw down half the treatment volume (TV) in a desired amount of time (t) is:

$$Q = \frac{TV}{2\,t\,CF} \tag{26-11}$$

where: TV = Treatment Volume (ft^3)
t = Recovery time (*hrs*)
CF = Conversion Factor = 3600 *sec/hr*

The depth of water (h) should be set to the average depth above the vertex of the notch between the top of the treatment volume and the stage at which half the treatment volume has been released:

$$h = \frac{(h_1 + h_2)}{2} \tag{26-12}$$

where: h_1 = Depth of water between the top of the treatment volume and the vertex of the notch (*ft*)
h_2 = Depth of water between the stage when half the treatment volume has been released and the vertex of the notch (*ft*)

Equation 26-10 can be rearranged to solve for the V-notch angle (□):

$$\theta = 2 \tan^{-1}\left(\frac{Q}{2.5\, h^{2.5}}\right) \quad (26\text{-}13)$$

Substituting Equation 26-11 into Equation 18-13 and simplifying gives:

$$\theta = 2 \tan^{-1}\left(\frac{TV}{5\, t\, CF\, h^{2.5}}\right) \quad (26\text{-}14)$$

26.3 Mean Depth of the Pond

The mean depth (*MD*) of a pond can be calculated from:

$$MD = \frac{PPV}{A_P} \quad (26\text{-}15)$$

where: MD = Mean depth of the pond (*ft*)
A_P = Area of pond measured at the control elevation (ft^2)

26.4 Design Example

Given:

Residential development in Melbourne
Class III receiving waters
Project area = 100 acres; Project runoff coefficient = 0.4
Project percent impervious (not including pond area) = 30%
Off-site drainage area = 10 acres; Off-site percent impervious = 0%
Off-site runoff coefficient = 0.2
Seasonal high groundwater elevation at the proposed lake = 20.0 ft
Design tailwater elevation = 19.5 ft
Pond area at elevation 20.0 ft = 5.0 acres
Non-littoral zone option

The proposed wet detention lake has the following stage-storage relationship:

Stage (ft)	Storage (ac-ft)
9.0	0.0
20.0	17.0
25.0	35.5

Design Calculations:

Step 1. Calculate the required treatment volume. The District requires a treatment volume of either 1 inch of runoff or 2.5 inches times the impervious area, whichever is greater.

$$\text{Treatment volume required (one inch of runoff)} = \frac{(110\ ac.)(1\ inch)}{12\ in/ft} = 9.17\ ac\text{-}ft$$

$$\text{(2.5" times \% imp.) (excludes pond area)} = \frac{[(100 - 5.0\ ac)(0.3) + (10\ ac)(0)]\ (2.5\ in.)}{12\ in/ft} = 5.94\ ac\text{-}ft$$

$$\text{Treatment volume} = 9.17\ ac\text{-}ft$$

Step 2. Set the elevation of the control structure.

Set the orifice invert at or above the normal water table and design tailwater elevation. Therefore, set the orifice invert elevation at 20.0 ft.

Set an overflow weir at the top of the treatment volume storage to discharge runoff volumes greater than the treatment volumes. Utilizing the stage-area-storage relationship, interpolate between 20.0 and 25.0 ft.

$$Weir\ elev. = (25\ ft - 20\ ft) \times \frac{9.17\ ac - ft}{35.5\ ac - ft - 17.0\ ac - ft} + 20\ ft = 22.48\ feet$$

Step 3. Calculate the minimum permanent pool volume that will provide the required residence time. Since the non-littoral zone option is being utilized, the permanent pool must be sized to provide a residence time of at least 21 days (i.e., 14 days plus an additional 50%) during the wet season (June - October).

The length of the wet season (WS) = 153 *days*

From Figure 26-1, the wet season rainfall depth (R) for Melbourne = 30 *inches*

For a non-littoral zone option, the minimum residence time (RT) = 21 *days*

The runoff coefficient (C) for the drainage area to the wet detention pond is:

$$C = \frac{(100\ ac)(0.4) + (10\ ac)(0.2)}{110\ ac} = 0.38$$

Utilizing Equation 26-4:

$$Permanent\ pool\ volume = \frac{(110\ ac)(0.38)(30\ in)(21\ days)}{(153\ days)12\ in\ /\ ft} = 14.3\ ac - ft$$

The pond volume below elevation 20.0 feet is 17.0 ac-ft. Therefore, adequate storage is provided to satisfy the permanent pool criteria.

Step 4. Size a circular orifice to recover one-half the treatment volume in 48 hours. Since the size of the orifice has yet to be determined, use the invert elevation of the orifice as an approximation of the flow line (center) of the orifice. After calculating the orifice size, adjust the flow line elevation and calculate the orifice size again.

$$\textit{Treatment volume depth } (h_1) = 22.48\,ft - 20.00\,ft = 2.48\,ft$$

$$\textit{Stage at half the treatment volume} = \frac{9.17\,ac-ft \times 0.5}{(35.5\,ac-ft - 17.0\,ac-ft)} \times (25.0\,ft - 20.0\,ft) + 20.0\,ft = 21.24\,ft$$

$$h_2 = 21.24\,ft - 20.00\,ft = 1.24\,ft$$

From Equation 26-7:

$$h = \frac{(2.48\,ft + 1.24\,ft)}{2} = 1.86\,feet$$

The average flow rate (Q) required to drawdown one-half the treatment volume is found from Equation 26-6:

$$Q = \frac{9.17\,ac-ft \times 43560\,ft^2/ac}{2} \times \frac{1}{48\,hrs} \times \frac{1}{3600\,\text{sec}} = 1.1558\,cfs$$

Find the area (A) of the orifice utilizing Equation 26-8:

Given: $C =$ 0.6
$G =$ 32.2 *ft/sec*^{2}

$$A = \frac{1.1558\ ft^3/\text{sec}}{0.6\sqrt{2\ (32.2\ ft/\text{sec}^2)\ 1.86\ ft}} = 0.176\ ft^2$$

From Equation 26-9, the orifice diameter (D) is:

$$D = \sqrt{\frac{4\ (0.176\ ft^2)}{3.1416}} = 0.473\,ft = 5.7\ inches$$

Adjust h_1, h_2, and the orifice diameter (D) to the flow line of the orifice.

$$\textit{Flow line elevation} = 20.00\,ft + \frac{0.437\,ft}{2} = 20.24\,ft$$

$$h_1 = 22.48\,ft - 20.24\,ft = 2.24\,ft$$

$$h_2 = 21.24\,ft - 20.24\,ft = 1.00\,ft$$

$$h = \frac{2.24\ ft + 1.00\ ft}{2} = 1.62\ ft$$

$$A = \frac{1.1558\ ft^3/\text{sec}}{0.6\sqrt{2\ (32.2\ ft/\text{sec}^2)\ 1.62\ ft}} = 0.189\ ft^2$$

$$D = \sqrt{\frac{4\ (0.189\ ft^2)}{3.1416}} = 0.491\ ft = 5.9\ inches$$

$$Flow\ line\ elev. = 20.00\ ft + \frac{0.491\ ft}{2} = 20.25\ ft$$

$20.25\ ft$ vs $20.24\ ft$ = $0.01\ ft$ difference which is acceptable

Step 5. Check the mean depth of the pond. The mean depth of the permanent pool must be between 2 and 8 feet. From Equation 26-15:

$$mean\ depth = \frac{17.0\ ac\text{-}ft}{5.0\ ac} = 3.4\ ft$$ which is consistent with the mean depth criteria.

Additional Steps.

In a typical design, the applicant would have to design the following:

(a) Pond shape to provide at least 2:1 length to width ratio
(b) Alignment of inlets and outlets to promote mixing and maximize flow path
(c) Overflow weir to safely pass the design storm event(s) at pre-development peak discharge rates.

26.5 References

Rao, D.V., S.A. Jenab, and D.A. Clapp. 1990. *Rainfall Analysis for Northeast Florida, Part V: Frequency Analysis of Wet Season and Dry Season Rainfall.* St. Johns River Water Management District, Technical Publication No. 90-3, Palatka, Florida.

27.0 Methodology and Design Example for Swales

Infiltration from swale systems follows the same processes discussed in section 23.1 for retention systems. However, unlike retention systems, swales are an "open" conveyance facility which must infiltrate a specified portion of runoff from the three-year, one-hour storm without the aid of berms, check dams, etc. Also, the swale must be sized to convey a design storm without being subjected to erosive velocities. The following methodology, which is adapted from Livingston et al. (1988), is recommended for designing swales to percolate the desired portion of runoff and to convey the design flow rate with acceptable velocities.

27.1 Runoff Hydrograph and Volume

The rational method can be utilized to estimate peak runoff rates for small urban areas. The traditional rational formula is expressed as:

$$Q = C\,I\,A \tag{27-1}$$

where: Q = Peak runoff rate (*cfs*)
C = Runoff coefficient
I = Rainfall intensity (*in./hr*)
A = Drainage area (*acres*)

Values for the runoff coefficient (C) are contained in Table 31-1. The intensity (I) is determined from intensity-duration-frequency (IDF) curves such as those published by the Florida Department of Transportation (1987).

A simplified runoff hydrograph for a specific design storm with given duration (D) can be constructed given the time of concentration (Tc) of the drainage area. As seen in Figure 27-1, this modified simplified runoff hydrograph is a modification of the traditional rational formula. The implied assumption behind Figure 27-1 is that the drainage basin time of concentration (Tc) is less than the duration (D) of the design storm event.

The peak runoff rate from this simplified hydrograph method is not the "traditional" rational peak discharge rate at the basin time of concentration but a sustained and lower peak runoff rate (Q_P) resulting from the rainfall intensity as determined for the desired duration of the storm. The sustained peak runoff rate is expressed as:

$$Q_P = C\,I_D\,A \tag{27-2}$$

where: Q_P = Peak runoff rate from the 3-year, 1-hour rainfall intensity (*cfs*)
I_D = Average rainfall intensity for a one hour duration (*in./hr*)

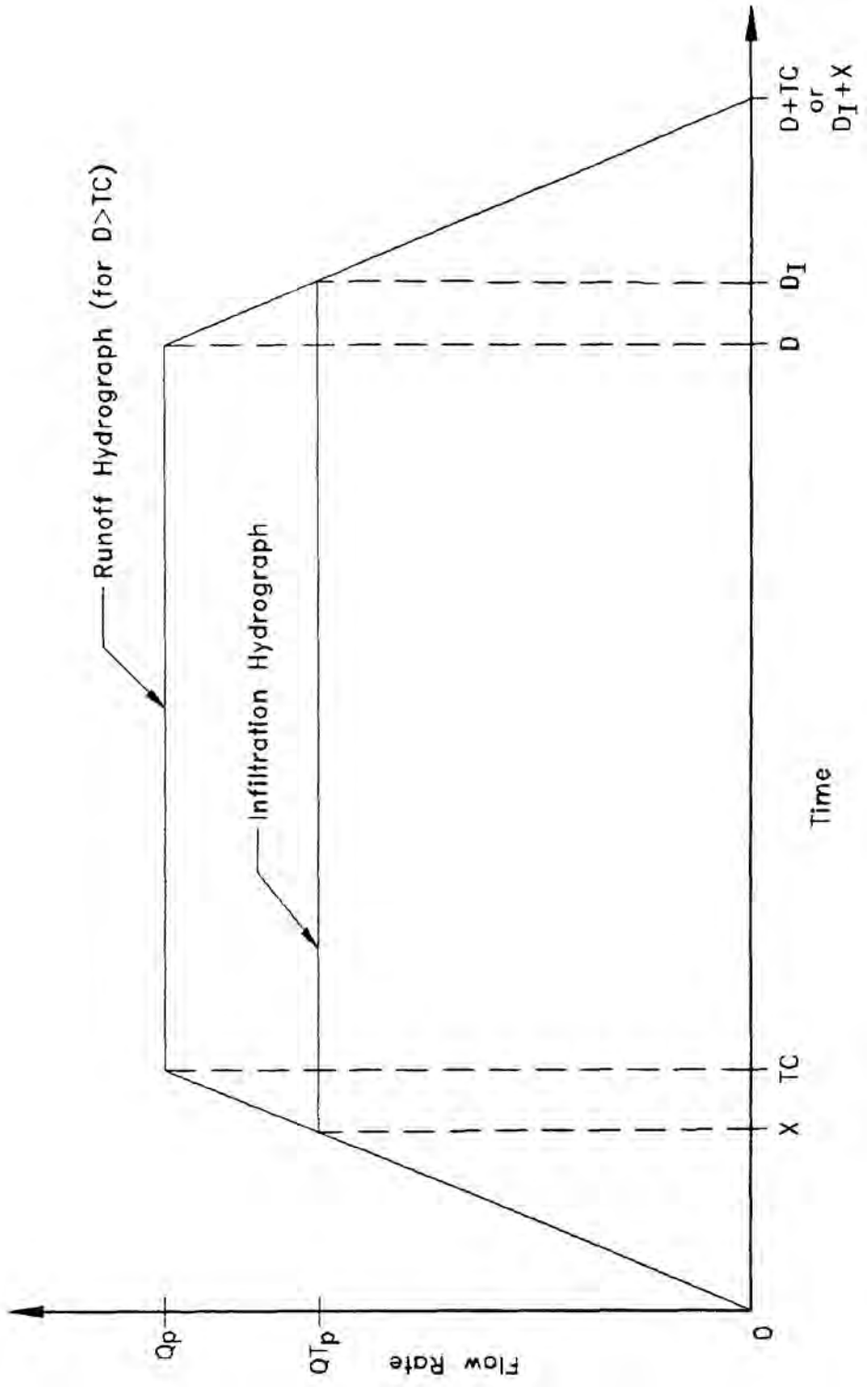

Figure 27-1. Simplified Runoff and Infiltration Hydrographs

The volume of runoff (V_R) is equal to the area under the runoff hydrograph curve in Figure 27-1 and can be expressed as:

$$V_R = \frac{1}{2} Q_P Tc + Q_P (D - Tc) + \frac{1}{2} Q_P (D + Tc - D) \quad (27\text{-}3)$$

$$V_R = Q_P D \quad (27\text{-}4)$$

where: V_R = Volume of runoff (ft^3)
Tc = Time of concentration (hr)
D = Rainfall duration (hr)

27.2 Infiltration Hydrograph and Volume

The peak infiltration rate and volume should be calculated using one of the acceptable methodologies listed in section 23.3.4 for vertical unsaturated infiltration. Utilizing the modified Green and Ampt Equation (described in section 23.3.4) the peak infiltration rate is the design infiltration rate (I_d) and is expressed as:

$$I_d = \frac{K_{vu}}{FS} \quad (27\text{-}5)$$

where: I_d = Design infiltration rate (ft/hr)
K_{vu} = Unsaturated vertical hydraulic conductivity (ft/hr)
FS = Factor of safety (recommend $FS = 2.0$)

The area of swale bottom and side slopes (A_b) in which infiltration will occur is:

$$A_b = L P \quad (27\text{-}6)$$

where: A_b = Area of swale bottom and side slopes in which infiltration will occur (ft^2)
L = Length of swale (ft)
P = Wetted perimeter (ft)

The peak infiltration flow rate (Qi_P) is:

$$Qi_P = I_d A_b = I_d L P \quad (27\text{-}7)$$

where: Qi_P = Peak infiltration flow rate (ft^3/hr)

The wetted perimeter (P) is dependent on the geometry of the swale. Equations for the wetted perimeter for three common swale shapes are given in Figure 27-2.
A simple infiltration hydrograph can be constructed as in Figure 27-1. The volume infiltrated is the area under the infiltration hydrograph curve and can be expressed as:

$$V_I = \frac{1}{2} Qi_P X + Qi_P (D_I - X) + \frac{1}{2} Qi_P (D_I + X - D_I) \quad (27\text{-}8)$$

and simplified to:

$$V_I = Qi_P D_I \quad (27\text{-}9)$$

where: V_I = Volume of runoff infiltrated (ft^3)
D_I = Time from the beginning of the storm to the end of the peak infiltration flow rate (hr)
X = Time from D_I to the end of the runoff hydrograph (hr)

Based on Figure 27-1, D_I can be expressed as:

$$D_I = D + Tc - X \quad (27\text{-}10)$$

and X can be expressed as:

$$X = \frac{Tc\ Qi_P}{Q_P} \quad (27\text{-}11)$$

Substituting equations 27-10 and 27-11 into 27-9 gives:

$$V_I = Qi_P \left(D + Tc - \frac{Tc\ Qi_P}{Q_P} \right) \quad (27\text{-}12)$$

If the volume infiltrated (V_I) is greater than or equal to the required portion (i.e, 80%) of the runoff volume (V_R) then the design is adequate for treatment purposes. In addition, the design should be checked to ensure that the swale can convey the design storm runoff without reaching erosive velocities.

27.3 Velocity

The velocity of flow in an open channel can be found from Manning's Equation:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} \quad (27\text{-}13)$$

where: V = Average velocity in the channel (ft/sec)
n = Manning's roughness coefficient, based on the lining of the channel
R = Hydraulic radius (ft)
S = Slope of the channel (ft/ft)

The maximum permissible velocity for various channel slopes and types of vegetative cover is given in Table 27-1. The velocity of flow in the swale

(calculated using the Manning's equation) will be non-erosive if it is less than the maximum permissible velocity given in Table 27-1.

The hydraulic radius (R) is dependent on the geometry of the swale. Equations for the hydraulic radius for three common swale shapes are given in Figure 27-2.

Manning's roughness coefficient (n) can be determined from Table 27-2 and Figure 27-3. In utilizing Table 27-2, mowed conditions are recommended for analysis of the swale infiltration capacity. The retardance class under mowed conditions result in lower n values, shallower flow depths, and less wetted perimeter for infiltration. Unmowed conditions may be more appropriate for swale analysis under flood flow conditions. The retardance class under unmowed conditions result in higher n values. This will yield more conservative flow depths which may be more appropriate for establishing floodwater elevations in the swale.

Table 27-1. Permissible Velocities for Grass-Lined Channels

Channel Slope	Lining	(	Permissible Velocity ft/sec)
0 – 5%	Bermuda grass		6.0
	Bahia		5.0
	Bluestem (broomsedges)		5.0
	Grass-legume mixture		4.0
	Sericea lespedeza		2.5
	Annual lespedeza		2.5
	Small grains (temporary)		2.5
5 – 10%	Bermuda grass		5.0
	Bahia		4.0
	Bluestem (broomsedges)		4.0
	Grass-legume mixture		4.0

Source: Livingston et al. 1988

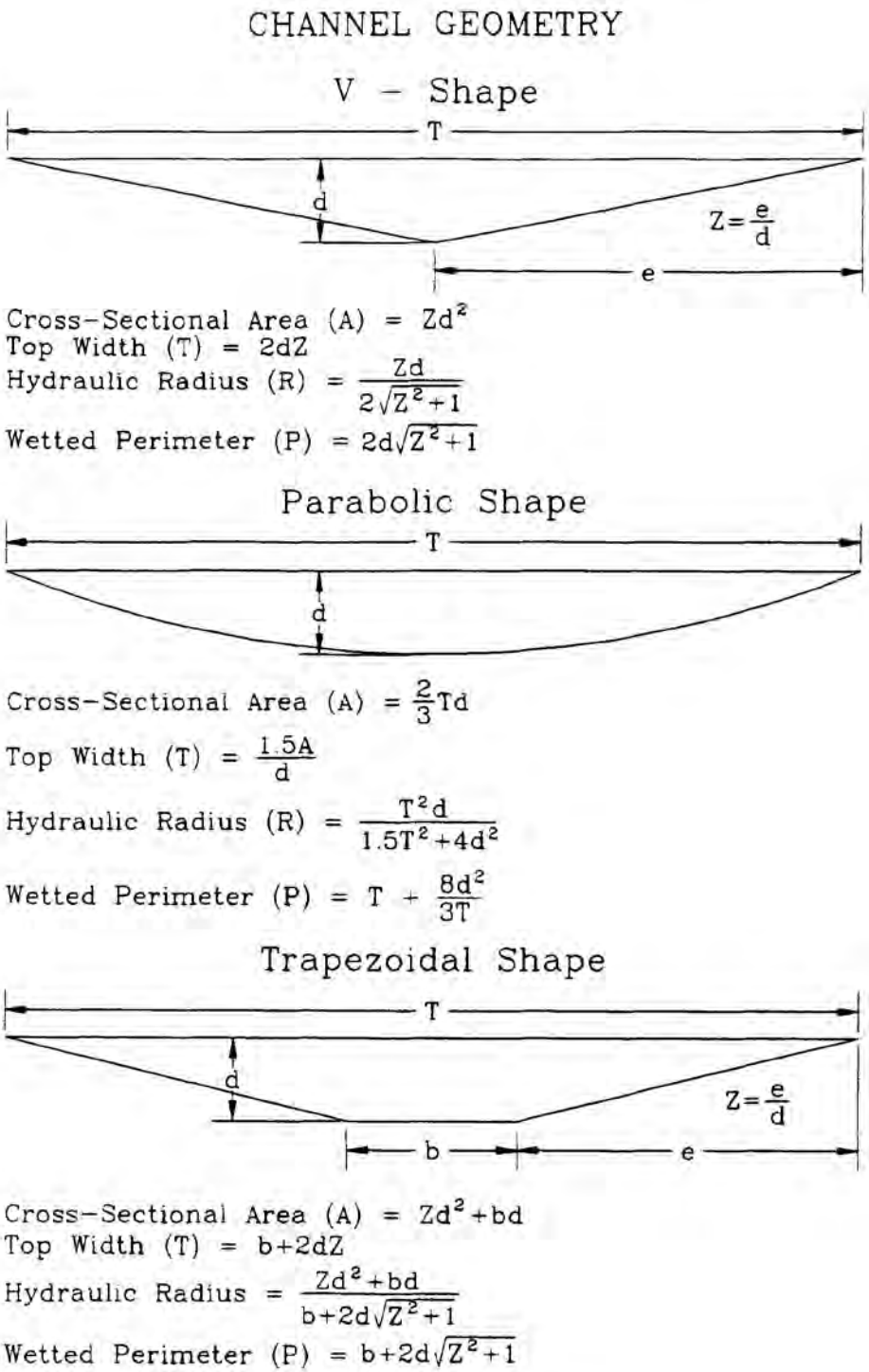

Figure 27-2. Typical Waterway Shapes and Mathematical Expressions for Calculating Cross-sectional Area, Top Width, Hydraulic Radius and Wetted Perimeter
Source: Livingston et al. 1988

Table 27-2. Classification of Vegetation Cover as to Degree of Retardance

Retardance Class	Cover	Condition
A	Bluestem (broomsedges)	Excellent stand, tall (average 36")
B	Bermuda or Bahia	Good stand, tall (average 12")
	Native Grass mixture (bluestem, vasey grass, and other long and short wet prairie grasses)	Good stand, unmowed
	Lespedeza sericea	Good stand, not woody tall (average 19')
C	Bahia	Good stand, uncut (6-8")
	Bermuda grass	Good stand, mowed (average 6")
	Centipede grass or St. Augustine	Very dense (average 6")
D	Bermuda or Bahia	Good stand, cut to 2.5" height Cut to 2" height
	Lespedeza sericea	Very good stand before cutting
E	Centipede grass or St. Augustine	Good stand, cut to 1.5" height

Source: Livingston et al. 1988

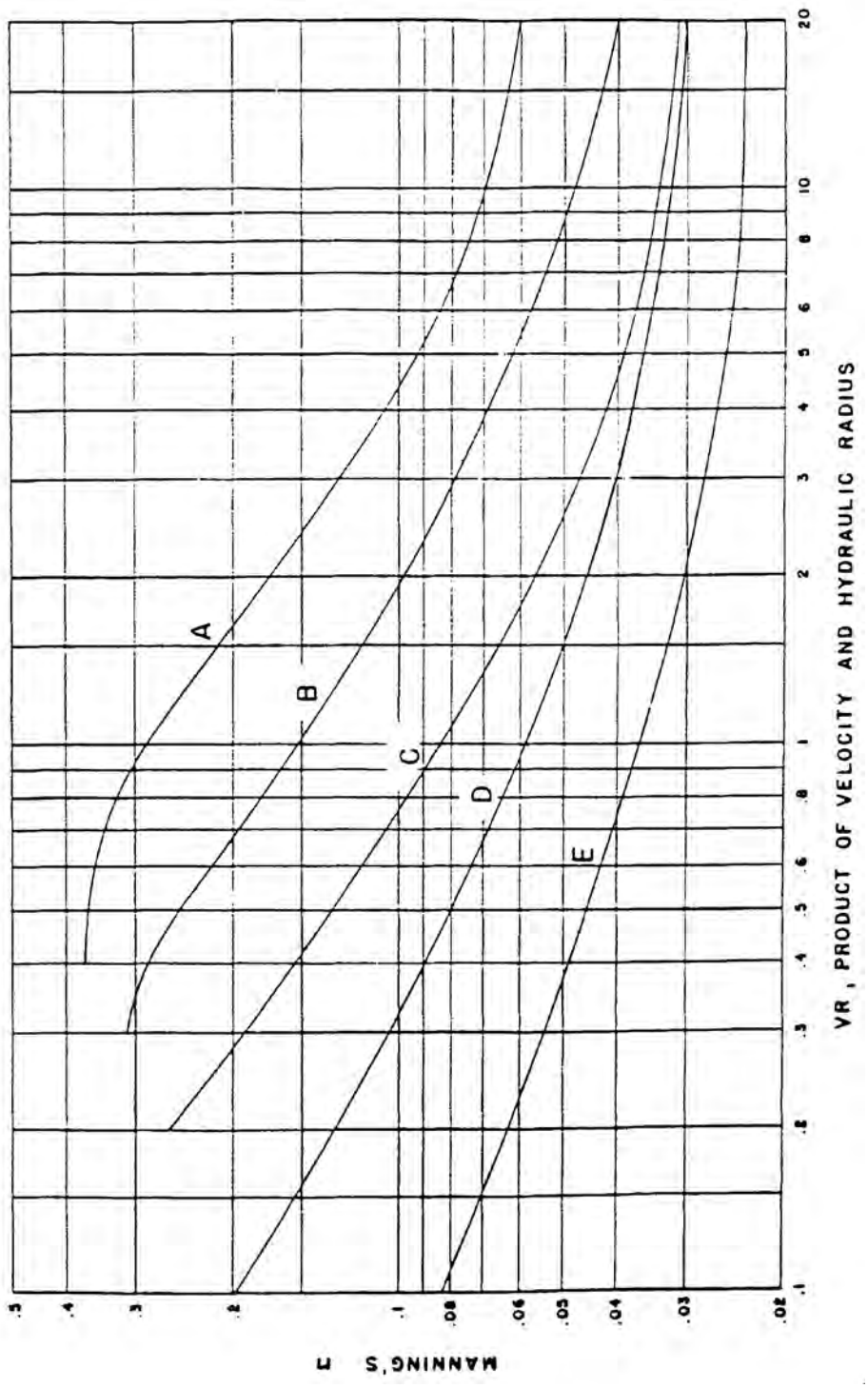

Figure 27-3. Manning's "n" Related to Velocity, Hydraulic Radius and Vegetal Retardance
Source: Livingston et al. 1988

27.4 Capacity

Manning's Equation (Equation 27-13) and the Continuity Equation ($Q = V A$) can be combined to determine flow capacity of an open channel:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A \qquad (27\text{-}14)$$

where: Q = Flow in the channel (ft^3/sec)
A = Cross-section area of the channel (ft^2)

The cross-sectional area (A) is dependent on the channel shape and equations for the cross-sectional area for three common swale shapes are given in Figure 27-2.

In addition to the treatment capacity of the swale, the design of the swale must be adequate to provide flood protection in accordance with the requirements of local agencies.

27.5 Vertical Unsaturated and Lateral Saturated Infiltration

The design of the swale system should be checked using one of the accepted methodologies in section 23 to insure that lateral saturated infiltration does not occur. Lateral saturated infiltration occurs when the ground water table "mounds" beneath the swale and intercepts the swale bottom. See section 23 for a complete description of infiltration processes.

Utilizing the methodology described in section 23.3.4, the volume infiltrated under vertical unsaturated flow (V_u) is determined from Equation 23-3:

$$V_u = A_b f h_b$$

where: V_u = Volume of water required to saturate the soil below the swale
h_b = Height of swale bottom above the ground water table
f = Fillable porosity (generally 0.2 to 0.3)

If $V_u > V_R$ infiltration will occur entirely under vertical unsaturated flow conditions.

27.6 Example Design Calculations for Swale Systems

Given: Residential project in Palatka discharging to Class III waters
Drainage area = 10 acres
Post-development runoff coefficient = 0.4
Tc = 20 minutes; S = 3%
f = 0.3; K_{vs} = 36 in/hr; FS = 2.0; h_b = 10 ft
Rectangular project site with dimensions of length = 660 ft and width = 660 ft

Three streets each 600 ft long with swales on both sides

Objective: Design a swale system to percolate the required treatment volume and check the capacity and velocity of the swales.

Design Calculations:

Step 1. Determine Q_P and V_R.

For swales discharging to Class III waters, the rule requires percolation of 80% of the runoff from the 3-year, 1-hour storm.

From the Florida Department of Transportation IDF Curve (FDOT 1987) for Zone 5 (Palatka) the average intensity (i) for the 3-year, 1-hour storm is 2.6 in./hr.

The sustained peak runoff rate (Q_p) is determined from Equation 27-2:

$$Q_P = (0.4)\ 2.6\ in./hr\ (10\ ac) = 10.4\ cfs$$

The volume of runoff (V_R) is found by utilizing Equation 27~~30~~-4:

$$V_R = (10.4\ cfs)\ (60\ min)\ (60\ sec/min) = 37440\ ft^3$$

Since each swale serves approximately an equal drainage area and project land use, the peak runoff rate (Q_P) per swale represents a more realistic flow for design of the treatment function for the swale. The peak runoff flow rate (Q_P) per swale is:

$$Q_P\ per\ swale = \frac{10.4\ cfs}{(3\ streets)\left(2\ \frac{swales}{street}\right)} = 1.73\ \frac{cfs}{swale}$$

Step 2. Select swale dimensions and determine flow depth and infiltration area. Assume a "V - shaped" swale. For maintenance and public safety reasons, limit the side slopes to no steeper than 4:1. Try swales with 6:1 side slopes. From Figure 27-2:

$$Z = \frac{e}{d} = 6 \qquad (27\text{-}15)$$
$$A = Z\ d^2 = 6\ d^2$$

$$R = \frac{Z\ d}{2\sqrt{Z^2 + 1}} = \frac{6d}{2\sqrt{6^2 + 1}} = 0.49\ d \qquad (27\text{-}16)$$

where: d = Normal depth of flow in the channel (ft)

Use Figures 27-3 and Table 27-2 to determine Manning's roughness coefficient (n). From Table 27-2 for Bahia grass, assume the grass as a good stand and mowed. Therefore, the retardance class = class D and $n = 0.04$ for design of the swale treatment capacity. A more overgrown condition (retardance class = B and $n = 0.077$) should be considered for conveyance and level of service flood protection design.

To solve for the normal depth (d), first rearrange Equation 27-14 to give:

$$R^{2/3} A = \frac{Q n}{1.49 S^{1/2}}$$

Substituting the above values of Q, n, and S:

$$R^{2/3} A = \frac{1.73 \text{ cfs } (0.04)}{1.49 (0.03 \text{ ft / ft})^{1/2}} = 0.27$$

Trial #1: Assume $d = 0.50$ ft. From Equation 27-15 the cross-sectional area (A) is:

$$A = 6 (0.50 ft)^2 = 1.5 ft^2$$

Determine the hydraulic radius (R) from Equation 27-16:

$$R = 0.49 (0.5 ft) = 0.245 ft$$

Therefore

$$R^{2/3} A = (0.245)^{2/3} 1.5 = 0.59$$

Since $0.59 \neq 0.27$, try another value for d.
Trial #2: Assume $d = 0.37$ ft

From Equation 27-15:

$$A = 6 (0.37 ft)^2 = 0.82 ft^2$$

From Equation 27-16:

$$R = 0.49 (0.37 ft) = 0.18 ft$$

and:

$$R^{2/3} A = (0.18)^{2/3} 1.5 = 0.26$$

Since $0.26 \approx 0.27$, the value of $d = 0.37$ ft is acceptable.

Also from Figure 27-2, the wetted perimeter (P) is:

$$P = 2\,d\sqrt{1 + Z^2} = 2\,(0.37ft)\sqrt{1 + 6^2} = 4.50\,ft$$

The total length of swales, $L = (3\ streets)\ (2\ swales/street)\ (600\ ft/swale) = 3600\ ft$

From Equation 27-6, the total infiltration area (A_b) can be determined:

$$A_b = L\,P = (3600\,ft)\ 4.5\,ft = 16200\,ft^2$$

The infiltration area (A_b) per swale is:

$$A_b \text{ per swale} = (600\,ft)\ 4.5\,ft = 2700\,ft^2 \text{ per swale}$$

Step 3. Check for lateral saturated infiltration (see section 23 for a complete description of infiltration processes).

Volume infiltrated under vertical unsaturated flow (V_u) is determined from Equation 23-3:

$$V_u = A_b f\,h_b = 16200\,ft^2\ (0.3)\ 10\,ft = 48600\,ft^3$$

Since $V_u > V_R$ infiltration will occur entirely under vertical unsaturated flow conditions. Therefore, analysis of lateral saturated infiltration will not be required for this example.

Step 4. Calculate the peak infiltration flow rate (Qi_P).

The unsaturated vertical hydraulic conductivity (K_{vu}) is found by Equation 23-11:

$$K_{vu} = \frac{2(36\,in./hr)}{3} = 24\,in./hr$$

From Equation 27-5, the design infiltration rate (I_d) is:

$$I_d = \frac{24\,in./hr}{2} = \cdots 12\,in./hr$$

The peak infiltration rate (Qi_P) per swale is determined by Equation 27-7 with the infiltration area (A_b) per swale = 2700 ft^2:

$$Qi_P \text{ per swale} = 12\ in./hr\ (2700\,ft^2 \text{ per swale})\ (1\ ft / 12\ in.)\ (1\ hr / 60\ min)$$

$$Qi_P \text{ per swale} = 45.0\,ft^3/min = 0.75\,ft^3/sec \text{ per swale}$$

Step 5. Calculate the volume of water infiltrated (V_I) per swale and compare to the required infiltration volume. From Equation 27-12 with $T_c = 20\ min$; $D = 60\ min$; $Qi_P = 45.0\,ft^3/min$; and $Q_P = 1.73\,ft^3/sec$:

$$V_I \text{ per swale} = 45.0 \text{ ft}^3/\text{min} \left(60 \text{ min} + 20 \text{ min} - \frac{20 \text{ min } (45.0 \text{ ft}^3/\text{min})}{1.73 \text{ ft}^3/\text{sec } (60 \text{ sec}/\text{min})} \right)$$

$$V_I \text{ per swale} = 3210 \text{ ft}^3 \text{ per swale}$$

$$\text{Total } V_I = 3210 \text{ ft}^3 \text{ per swale} \times 6 \text{ swales} = 19259 \text{ ft}^3$$

Required infiltration volume for discharges to Class III receiving waters is 80% of the runoff volume (V_R):

$$\text{The required infiltration volume} = 0.8 V_R = 0.8 (37440 \text{ ft}^3) = 29952 \text{ ft}^3$$

Since the volume of runoff infiltrated (V_I) < required infiltration volume (80% of V_R) the design is inadequate.

Step 6. Revise the swale section to provide more infiltration surface area. Try a trapezoidal section with an 8 ft bottom width (b) and 4:1 side slopes. From Figure 27-2:

$$Z = \frac{e}{d} = 4.0$$

$$A = bd + Zd^2 = 8d + 4d^2 \qquad (27\text{-}17)$$

$$R = \frac{bd + Zd^2}{b + 2d\sqrt{Z^2 + 1}} = \frac{8d + 4d^2}{8 + 8.25d} \qquad (27\text{-}18)$$

$$P = b + 2d\sqrt{Z^2 + 1} = 8 + 2d\sqrt{4^2 + 1} = 8 + 8.25d \qquad (27\text{-}19)$$

where: b = Bottom width of a trapezoidal channel (ft)

Assume a value for d and then compare $AR^{2/3}$ for the trapezoidal channel with the value of $AR^{2/3}$ determined in Step 2., above. From Step 2.: $A R^{2/3} = 0.27$

Assume $d = 0.13$ ft. From Equation 27-17, the cross-sectional area (A) is:

$$A = 8 (0.13) + 4 (0.13)^2 = 1.11 \text{ ft}^2$$

The hydraulic radius (R) is determined from Equation 27-18:

$$R = \frac{8\text{ft}(0.13\text{ft}) + 4(0.13\text{ft})^2}{8\text{ft} + 8.25(0.13\text{ft})} = 0.12\text{ft}$$

$$A R^{2/3} = (1.11 \text{ ft}^2) (0.12)^{2/3} = 0.27$$

Since 0.27 = 0.27, the value of d = 0.13 ft is acceptable.

The wetted perimeter (P) is found from Equation 27-19:

$$P = 8 + 8.25\,(0.13\,ft) = 9.07\,ft$$

The infiltration area (A_b) per swale is determined from Equation 27-6:

$$A_b \text{ per swale} = L\,P = (600\,ft)\ 9.07\,ft = 5442\,ft^2 \text{ per swale}$$

Utilizing Equation 27-7, the peak infiltration rate (Qi_P) per swale is:

$$Qi_P \text{ per swale} = 12\ in./hr\ (5442\,ft^2)\ (1\,ft / 12\,in.)\ (1\,hr / 60\,min)$$

$$Qi_P \text{ per swale} = 90.7\,ft^3/min = 1.51\,ft^3/sec$$

From Equation 27-12, the volume infiltrated (V_I) per swale is:

$$V_I \text{ per swale} = 90.7\ ft^3/\text{min}\ \left(60\ \text{min} + 20\ \text{min} - \frac{20\ \text{min}\ (90.7\ ft^3/\text{min})}{1.73\ ft^3/\text{sec}\ (60\ \text{sec}/\text{min})}\right)$$

$$V_I \text{ per swale} = 5668.8\,ft^3 \text{ per swale}$$

$$\text{Total volume of runoff infiltrated } (V_I) = 6\ swales\ (5668.8\,ft^3\ per\ swale) = 34013\,ft^3$$

$$\text{Required infiltration volume} = 0.8\,V_R = 0.8\,(37440\,ft^3) = 29952\,ft^3$$

Since the volume of runoff infiltrated (V_I) > required infiltration volume the design is adequate.

Step 7. Calculate the velocity in the swale and compare with permissible values. From Table 27-1, for Bahia grass the maximum permissible velocity (V_{max}) is 5.0 ft/sec.

Calculate the velocity of the swales from Equation 27-13:

$$V = \frac{1.49}{0.04}\ (0.12)^{2/3}\ (0.03)^{1/2} = 1.57\,ft/\text{sec}$$

The calculated velocity of flow in the swale (1.57 ft/sec) will be non-erosive since it is less than the maximum permissible velocity (5 ft/sec) given in Table 27-1.

27.7 References

Florida Department of Transportation. 1987. *Drainage Manual, Volume 2A - Procedures*. Tallahassee, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management*. Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

28.0 Methodology and Design Example for Dry Detention

28.1 Designing the Drawdown Structure

The District's rules generally require that no more than half the treatment volume should be discharged in the first 24 - 30 hours after the storm event. A popular means of meeting this requirement is to use an orifice or a weir. The following subsections show procedures for sizing an orifice and V-notch weir to meet the drawdown requirements.

28.1.1 Designing an Orifice

Discharge (Q) through an orifice is given by:

$$Q = CA\sqrt{2gh} \tag{28-1}$$

where: Q = Rate of discharge (*cfs*)
A = Orifice area (ft^2)
G = Gravitational constant = (32.2 ft/sec^2)
H = Depth of water above the flow line (center) of the orifice (*ft*)
C = Orifice coefficient (usually assumed = 0.6)

The average discharge rate (Q) required to drawdown half the treatment volume (TV) in a desired amount of time (t) is:

$$Q \quad \frac{TV}{2tCF} \tag{28-2}$$

where: TV = Treatment Volume (ft^3)
t = Recovery time (*hrs*)
CF = Conversion Factor = 3600 *sec/hr*

The depth of water (h) should be set to the average depth above the flow line between the top of the treatment volume and the stage at which half the treatment volume has been released:

$$h = \frac{(h_1 + h_2)}{2} \tag{28-3}$$

where: h_1 = Depth of water between the top of the treatment volume and the flow line of the orifice (*ft*)
h_2 = Depth of water between the stage when half the treatment volume has been released and the flow line of the orifice (*ft*)

Equation 28 -1 can be rearranged to solve for the area (A):

$$A = \frac{Q}{C\sqrt{2gh}} \tag{28-4}$$

The diameter (D) of an orifice is calculated by:

$$D = \sqrt{\frac{4A}{\pi}} \tag{28-5}$$

where: D = Diameter of the orifice (*ft*)

28.1.2 Designing a V-notch Weir

Discharge (Q) through a V-notch opening in a weir can be estimated by:

$$Q = 2.5 \tan\left(\frac{\theta}{2}\right) h_v^{2.5} \tag{28-6}$$

where: Q = Discharge (*cfs*)
θ = Angle of V-notch (*degrees*)
h_v = Head on vertex (invert) of notch (*ft*)

The average discharge rate (Q) required to draw down half the treatment volume (TV) in a desired amount of time (t) is:

$$Q = \frac{TV}{2\,t\,CF} \tag{28-7}$$

where: TV = Treatment Volume (ft^3)
t = Recovery time (*hrs*)
CF = Conversion Factor = 3600 *sec/hr*

The depth of water (h_v) should be set to the average depth above the vertex of the notch between the top of the treatment volume and the stage at which half the treatment volume has been released:

$$h = \frac{(h_1 + h_2)}{2} \tag{28-8}$$

where: h_{v1} = Depth of water between the top of the treatment volume and the vertex of the notch (*ft*)
h_{v2} = Depth of water between the stage when half the treatment volume has been released and the vertex of the notch (*ft*)

Equation 28-6 can be rearranged to solve for the V-notch angle (θ):

$$\theta = 2 \tan^{-1}\left(\frac{Q}{2.5\ h_v^{2.5}}\right) \quad (28\text{-}9)$$

Substituting Equation 28-7 into Equation 28-9 and simplifying gives:

$$\theta = 2 \tan^{-1}\left(\frac{TV}{5\ t\ CF\ h_v^{2.5}}\right) \quad (28\text{-}10)$$

28.2 Example Design Calculations for Dry Detention Systems

Given:

Commercial development
Class III receiving waters
Project area = 0.66 acres
Project percent impervious (not including pond area) = 37%
Off-site drainage area = 0 acres
Seasonal high groundwater elevation at the proposed basin = 6.2 ft
Design tailwater elevation = 6.1 ft
Off-line treatment

The proposed detention basin has the following stage-storage relationship:

Stage (ft)	Storage (ac-ft)	Storage (ft^3)
6.3	0.000	0
6.4	0.010	36
6.5	0.022	958
6.6	0.034	1481
6.7	0.047	2047
6.8	0.064	2788

Design Calculations:

Step 1. Calculate the required treatment volume.

For off-line treatment by dry detention, the rule requires a treatment volume of 1 inch of runoff or 2.5 inches times the impervious area, whichever is greater.

$$\textit{Treatment volume required (one inch of runoff)} = \frac{(0.66\ ac)(1\ inch)}{12\ in/ft} = 0.055\ ac\text{-}ft$$

$$\textit{(2.5 inches times \% imp.)} = \frac{(0.66\ ac)(2.5\ in)(0.37)}{12\ in/ft} = 0.051\ ac\text{-}ft$$

Therefore, *treatment volume* = 0.055 *ac-ft*

Step 2. Set the elevation of the basin floor and the control structure.

Set the detention basin floor and control structure above the design tailwater elevation and at least one foot above the seasonal high water table elevation. Therefore, set the floor elevation at 6.3 ft.

Set an overflow weir at the top of the treatment volume storage to discharge runoff volumes greater than the treatment volumes. Utilizing the stage-storage relationship, 0.055 ac-ft of storage is between 6.7 and 6.8 feet. Interpolate between 6.7 and 6.8 ft to find the weir elevation:

$$\textit{Weir elevation} = (6.8 - 6.7\ ft) \times \frac{(0.055\ ac\text{-}ft - 0.047\ ac\text{-}ft)}{(0.064\ ac\text{-}ft - 0.047\ ac\text{-}ft)} + 6.7\ ft = 6.75\ ft$$

Step 3. Size the outfall structure to recover one-half the treatment volume in 24 hours. For this example, we will design both a circular orifice and V-notch weir to recover the treatment volume.

Option A) Orifice Design

Size a circular orifice to recover one-half the treatment volume in 24 hours. Since the size of the orifice has yet to be determined, use the invert elevation of the orifice as an approximation of the flow line (center) of the orifice. After calculating the orifice size, adjust the flow line elevation and calculate the orifice size again. If the difference in flow line elevations in negligible, the orifice design is adequate.

Trial #1

Treatment volume depth (h_1) = 6.75 *ft* - 6.30 *ft* = 0.45 *ft*

One-half the treatment volume = 0.055 *ac-ft* x 0.5 = 0.0275 *ac-ft*

Interpolate between 6.6 and 6.5 ft to find the elevation at one-half the treatment volume:

$$\textit{elevation at one-half treatment volume} = (6.6 - 6.5\ ft) \times \frac{(0.0275\ ac\text{-}ft - 0.022\ ac\text{-}ft)}{(0.034\ ac\text{-}ft - 0.022\ ac\text{-}ft)} + 6.5\ ft = 6.55\ ft$$

$$h_2 = 6.55\ ft - 6.3\ ft = 0.25\ ft$$

From Equation 28-3:

$$h = \frac{(0.45\ ft + 0.25\ ft)}{2} = 0.35\ feet$$

The average flow rate (Q) required to drawdown one-half the treatment volume in 24 hours is found from Equation 28-2:

$$Q = 0.055\ ac\text{-}ft \times \frac{1}{2} \times 43560\ ft^2/ac \times \frac{1}{24\ hrs} \times \frac{1\ hr}{3600\ sec} = 0.0139\ cfs$$

Find the area (A) of the orifice utilizing Equation 28-4:

Given: $C = 0.6$
$G = 32.2\ ft/sec^2$

$$A = \frac{0.0139\ ft^3/\text{sec}}{0.6\sqrt{2\ (32.2\ ft/\text{sec}^2)\ 0.35\ ft}} = 0.0049\ ft^2$$

From Equation 28-5, the orifice diameter (D) is:

$$D = \sqrt{\frac{4\ (0.0049\ ft^2)}{3.1416}} = 0.079\ ft = 0.95\ inches$$

Trial #2

Adjust h_1, h_2, and the orifice diameter (D) to the flow line of the orifice.

$$Flow\ line\ elevation = 6.30\ ft + \frac{0.079\ ft}{2} = 6.34\ ft$$

$$h_1 = 6.75\ ft - 6.34\ ft = 0.41\ ft$$

$$h_2 = 6.55\ ft - 6.34\ ft = 0.21\ ft$$

$$h = \frac{0.41\ ft + 0.21\ ft}{2} = 0.31\ ft$$

$$A = \frac{0.0139\ ft^3/\text{sec}}{0.6\sqrt{2\ (32.2\ ft/\text{sec}^2)\ 0.31\ ft}} = 0.0052\ ft^2$$

$$D = \sqrt{\frac{4\ (0.0052\ ft^2)}{3.1416}} = 0.0813\ ft = 0.98\ inches$$

$$Adjusted\ flow\ line\ elev. = 6.30\ ft + \frac{0.0813\ ft}{2} = 6.34\ ft$$

This trial is acceptable because there is no difference between the flow line elevations. Therefore, a 0.98 inch diameter circular orifice at invert elevation 6.3 will meet the recovery time criteria. The diameter may be rounded up to 1.0 inch for construction purposes.

Some mechanism, such as a gravel jacket or perforated pipe wrapped with filter fabric, must be provided to minimize clogging (see section 12.4 of this Manual). The designer should check that the discharge rate is not limited by the selected anti-clogging device.

Option B) V-notch weir

Size a V-notch weir to recover one-half the treatment volume in 24 hours. The vertex (invert) of the notch will be set at the detention basin floor elevation (6.30 ft). Next, calculate the depth of water between the top of the treatment volume and the vertex of the notch (h_{v1}):

$$\textit{Treatment volume depth } (h_{v1}) = 6.75\,ft - 6.30\,ft = 0.45\,ft$$

Find the depth of water between the stage when half the treatment volume has been released and vertex of the notch (h_{v2}):

$$\textit{One-half the treatment volume} = 0.055\ ac\text{-}ft \times 0.5 = 0.0275\ ac\text{-}ft$$

Interpolate between 6.6 and 6.5 ft to find the elevation at one-half the treatment volume:

$$\textit{elevation at one-half treatment volume} = (6.6 - 6.5\,ft) \times \frac{(0.0275\ ac\text{-}ft - 0.022\ ac\text{-}ft)}{(0.034\ ac\text{-}ft - 0.022\ ac\text{-}ft)} + 6.5\,ft = 6.55\,ft$$

$$h_{v2} = 6.55\,ft - 6.3\,ft = 0.25\,ft$$

The average depth of water above the notch (h_v) is determined from Equation 28-8:

$$h_v = \frac{(0.45\,ft + 0.25\,ft)}{2} = 0.35\,feet$$

From Equation 28-10, calculate the angle of the V-notch (θ):

$$\theta = 2\ \tan^{-1}\left(\frac{0.055ac\text{-}ft \times 43560\ ft^2/ac}{5\ (24hrs)3600\,\text{sec}/hr\ (0.35ft)^{2.5}}\right) = 8.8degrees$$

Therefore, a 8.8 degree V-notch weir with top elevation at 6.75 *ft* and vertex elevation at 6.30 *ft* will meet the recovery time criteria.

Some mechanism, such as a gravel jacket or perforated pipe wrapped with filter fabric, must be provided to minimize clogging (see section 12.4 of this Manual). The designer should check that the discharge rate is not limited by the selected anti-clogging device.

29.0 Methodology and Design Examples for Stormwater Harvesting Systems

29.1 Overview

Water budgets are utilized to design stormwater harvesting systems. A water budget is an accounting of water movement onto, within, and off an area. The purpose of developing a water budget for stormwater harvesting systems is to quantify the reduction in offsite discharge that can be harvested for a given time period. Individual components of water supply, storage, use, and movement must be accounted for in the water budget. Calculation of these components require knowledge of the watershed characteristics, harvesting area (if irrigation is to be used), desired percentage of runoff to be harvested, harvested volume, harvesting rate, rainfall data, and evaporation data.

Using the above parameters, Wanielista et al. (1991) simulated the long-term behavior of stormwater harvesting ponds over time for various locations in Florida. The results of the simulations are presented in Rate-Efficiency-Volume (REV) curves. The REV curves can be used to design stormwater harvesting systems to meet the performance criteria described in section 21 of this Manual.

Important assumptions that must be kept in mind when using the REV curves include:

(a) Net ground water movement into or out of the pond is assumed to be zero.

(b) The harvesting rate is constant over time.

(c) The mean annual evaporation from the pond equals the mean annual rainfall on the pond.

(d) The results are long term averages based on historical rainfall records. The results will not give an indication of conditions during a wet or dry year.

To design a stormwater harvesting system which does not meet one of the above assumptions, the applicant can develop a site-specific water budget analysis to meet the performance criteria described in section 21 of this Manual.

The following sections and design examples summarize the REV curve methodology presented by Wanielista et al. (1991) for the design of stormwater harvesting systems.

29.2 Equivalent Impervious Area

When designing stormwater harvesting systems, the runoff characteristics of the watershed must be determined. The overall runoff coefficient (C) for an area composed of different surfaces can be determined by weighting runoff coefficients with respect to the total areas they encompass:

$$C = \frac{C_1 A_1 + C_2 A_2 + \ldots + C_N A_N}{A_1 + A_2 + \ldots + A_N} \quad (29\text{-}1)$$

where: C_N = Runoff coefficient for surface N (see Table 31~~24~~-1 for values of C)
A_N = Area of surface N

This weighted runoff coefficient (C) is termed the effective runoff coefficient and is representative of the entire watershed.

The equivalent impervious area (EIA) is equal to the product of the total area of the watershed (A) and the effective, or weighted, runoff coefficient (C) for the watershed:

$$EIA = C A \quad (29\text{-}2)$$

where: EIA = Equivalent impervious area (acres)
C = Effective runoff coefficient for the watershed
A = Area of watershed (acres)

The EIA is defined as the area of a completely impervious watershed that would produce the same volume of runoff as the actual watershed. For example, a 20-acre watershed with an effective runoff coefficient (C) of 0.5 would have an EIA of 10 acres (20 ac x 0.5). If one inch of rain fell on this 10-acre impervious area, the runoff volume would be 10 ac-in (10 ac x 1 in). If the same amount of rain fell on the actual watershed, the runoff volume would not change:

$$20\ ac\ (1\ in)\ (0.5) = 10\ ac\text{-}in$$

The EIA will be expressed in acres throughout this methodology. The use of the EIA serves to generalize the model so that it can be applied to a watershed of any size and runoff characteristics.

The EIA for a watershed should include the area of the pond when using this methodology.

29.3 Harvested Volume

The harvested volume (V) is the amount of runoff stored in the stormwater pond between the top of the permanent pool and the invert of the overflow structure (see Figure 21-1). This volume is akin to the treatment volume in wet detention systems. The major difference between a stormwater harvesting pond and a wet detention pond is the operation of this storage volume. For wet detention systems, the treatment volume is designed to be discharged downstream to receiving waters via an overflow structure. On the other hand, in a stormwater harvesting pond the harvested volume (V) is reused instead of being discharged downstream.

Harvested volumes are expressed in units of inches over the *EIA*. The values can be converted using simple formulas or equations (see the example problems at the end of this section).

29.4 Harvesting Rate

Harvesting rate (*R*) is the rate at which stormwater runoff is harvested. On the REV curves, the units used for harvesting rate are inches per day over the *EIA*. The values can be converted using simple formulas or equations (see the design example in section 29-7 of this Manual).

Many stormwater harvesting applications involve an area to be irrigated. For instance, an apartment complex may irrigate grass and other landscaped common areas. Recommended irrigation rates for turf grasses in Florida is usually less than one inch per week on the average over a year.

Use of a constant harvesting rate for irrigation applications tends to over estimate the efficiency of the system due to the lack of reuse demands during periods of heavy rainfall. Therefore, the District recommends that the harvesting efficiency (*E*), defined as the percentage of runoff that is harvested, be increased by 5% to compensate for use of a constant reuse rate. For example, if the required harvesting efficiency (*E*) is 50% and a constant harvesting rate (*R*) is utilized, then the system should be designed for $E = 55\%$.

The designer should consult a landscape irrigation specialist for the design of the irrigation system and the recommended irrigation rates.

29.5 Rate-Efficiency-Volume (REV) Curves

Wanielista et al. (1991) used long term rainfall records for 25 Florida rainfall stations in a model that simulated the behavior of a stormwater harvesting pond over time. Both the rate of harvesting from the pond and the harvested volume were varied. The harvesting efficiency (*E*), defined as the percentage of runoff that is harvested, was calculated as the harvested volume and harvesting rate were varied. The results of the simulations are presented in Rate-Efficiency-Volume (REV) curves. The REV curves relate the harvesting rate (*R*), the efficiency (*E*), and the harvested volume (*V*) of the pond.

The REV curves are generalized for application to watersheds of any size or runoff coefficient via the *EIA*. Both the harvesting rate and harvested volume are based on the *EIA*.

Wanielista et al. (1991) developed a REV chart for each of the 25 rainfall station locations used in the simulations. Individual REV charts are specific to geographical regions with similar meteorological characteristics. The designer should use the one closest to the site for design. The REV charts for stations within the SJRWMD are presented in Figures 29-1 through 29-8 and are listed in Table 29-1 below.

Table 29-1. REV Charts for Stations within the SJRWMD

STATION NAME	FIGURE NUMBER
Jacksonville	29-1
Marineland	29-2
Gainesville	29-3
Daytona Beach	29-4
Orange City	29-5
Orlando	29-6
Lisbon	29-7
Melbourne	29-8

On every REV chart, there is a curve for each of the following efficiency levels (in percentage): 50, 60, 70, 80, 90, and 95. The range of the curves are restricted by practical applicability.

The following design examples illustrate the use of the REV charts, reuse rate, reuse volume, and *EIA* in the design of stormwater reuse systems.

29.6 Design Examples for Stormwater Harvesting Systems

The following design example cover the design of the harvesting rate, harvested volume, and the harvesting efficiency. In a typical design, the applicant would have to consider the following:

(a) Irrigation system or areas that will be irrigated
(b) Permanent pool size and depth
(c) Pond shape to provide at least 2:1 length to width ratio
(d) Alignment of inlets and outlets to promote mixing, settling, and maximize the flow path
(e) Overflow weir to safely pass the design storm event(s) at pre-development conditions
(f) Littoral zone (if required)

Example Problem #1 (Determine *R*; Given *E* and *V*)

Given: 10-acre watershed in Orlando that is 70% impervious
Runoff coefficient for the pervious area = 0.2
Harvested volume available in a pond = 109,000 ft^3
Area available for irrigation = 2.5 acres
Harvesting efficiency = 50%

Objective: Determine the harvesting rate (*R*)

Design Calculations:

Step 1. Determine the *EIA*. From Equation 29-1, the runoff coefficient (*C*) is:

$$C = \frac{7\ ac\ (1.0) + 3\ ac\ (0.2)}{10\ ac} = 0.76$$

The effective impervious area (*EIA*) is found from Equation 29-2:

$$EIA = 0.76\ (10\ ac) = 7.6\ ac$$

Step 2. Convert the harvested volume (*V*) units to inches over the *EIA*.

$$V = 109{,}000\ ft^3 \times \frac{1}{7.6\ ac} \times \frac{1\ ac}{43560\ ft^2} \times \frac{12\ inches}{1\ ft} = 3.95\ inches$$

Step 3. Find the harvesting rate (*R*). From the Orlando REV chart (Figure 29-6),

$$R = f(50\%, 3.95\ \text{inches}) = 0.068\ \text{inches per day over the } EIA$$

Step 4. Convert the harvesting rate units to inches per week over the irrigated area.

$$R = 0.068\ \frac{inch}{day} \times 7.6\ ac \times \frac{43560\ ft^2}{1\ ac} \times \frac{1\ ft}{12\ inches} = 1876\ \frac{ft^3}{day}$$

$$R = 1876\ \frac{ft^3}{day} \times \frac{7\ days}{1\ week} \times \frac{1}{2.5\ ac} \times \frac{1\ ac}{43560\ ft^2} \times \frac{12\ inches}{1\ ft} = 1.45\ \frac{inches}{week}$$

Therefore, irrigation of 1.45 inches per week over the 2.5-acre irrigation area will achieve 50% efficiency with the given harvested volume.

Example Problem #2 (Determine *V*; given *E* and *R*)

Given: 20-acre watershed in Melbourne that is 50% impervious
Pervious $C = 0.3$
6 acres are available for irrigation at a rate of 2 inches per week
Required efficiency is 90%

Objective: Determine the harvested volume (*V*)

Design Calculations:

Step 1. Determine the *EIA*. From Equation 29-1, the runoff coefficient (*C*) is:

$$C = \frac{10\ ac\ (1.0) + 10\ ac\ (0.3)}{20\ ac} = 0.65$$

The effective impervious area (*EIA*) is found from Equation 29-2:

$$EIA = 0.65\ (20\ ac) = 13\ ac$$

Step 2. Convert the harvesting rate units to inches per week over the *EIA*.

$$R = 6\ ac\ x\ \frac{2\ inches}{1\ week}\ x\ \frac{1}{13\ ac}\ x\ \frac{1\ week}{7\ days} = 0.13\ \frac{inches}{day}\ on\ the\ EIA$$

Step 3. Find the harvested volume (*V*). From the Melbourne REV chart (Figure 29-7),

$V = f$(90%; 0.13 inches/day over the *EIA*) = 6.5 inches over the *EIA*

Step 4. Convert the harvested volume (*V*) units to ft^3

$$V = 6.5\ inches\ x\ 13\ ac\ \frac{1\ ft}{12\ inches}\ x\ \frac{43560\ ft^2}{1\ ac} = 306735\ ft^3$$

Therefore, 306735 ft^3 of harvested volume is needed in the pond.

Example Problem #3 (Determine *E*; Given *R* and *V*)

Given: 3.5-acre watershed in Orlando that is 100% impervious
Harvested volume (*V*) = 0.875 ac-ft
2.87 acres are available for irrigation at a rate of 1.75 inches per week

Objective: Determine the harvesting efficiency (*E*)

Design Calculations:

Step 1. Determine the *EIA*. Since the site is 100% impervious, the *EIA* = 3.5-acres

Step 2. Convert the harvested volume (*V*) units to inches over the *EIA*.

$$V = 0.875\ ac\text{-}ft\ x\ \frac{1}{3.5\ ac}\ x\ \frac{12\ inches}{1\ ft} = 3\ inches\ on\ the\ EIA$$

Step 3. Convert the harvesting rate units to inches per week over the *EIA*.

$$R = 2.87\ ac\ x\ \frac{1.75\ inches}{1\ week}\ x\ \frac{1}{3.5\ ac}\ x\ \frac{1\ week}{7\ days} = 0.205\ \frac{inches}{day}\ on\ the\ EIA$$

Step 4. Determine the efficiency from the Orlando REV chart (Figure 29-6).

$$E = f(0.205 \text{ inches/day}; 3.0 \text{ inches}) = 90\%$$

29.7 References

Wanielista, M.P., Y.A. Yousef, G.M. Harper, T.R. Lineback, L. Dansereau. 1991. *Precipitation, Inter-Event Dry Periods, and Reuse Design Curves for Selected Areas of Florida*. University of Central Florida, Orlando, Florida.

Wanielista, M.P. 1992. Private Communication. University of Central Florida, Orlando, Florida.

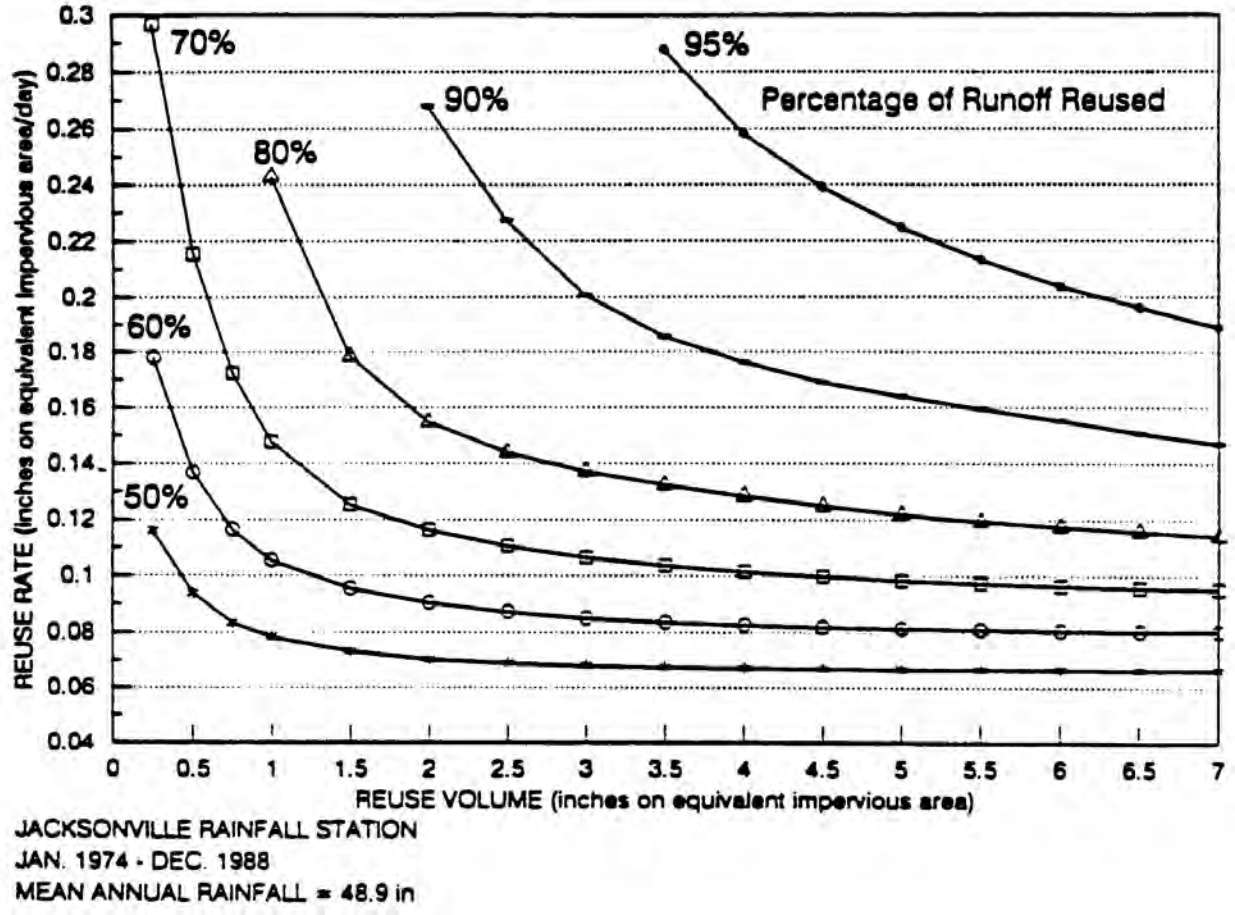

Figure 29-1. REV Chart for Jacksonville

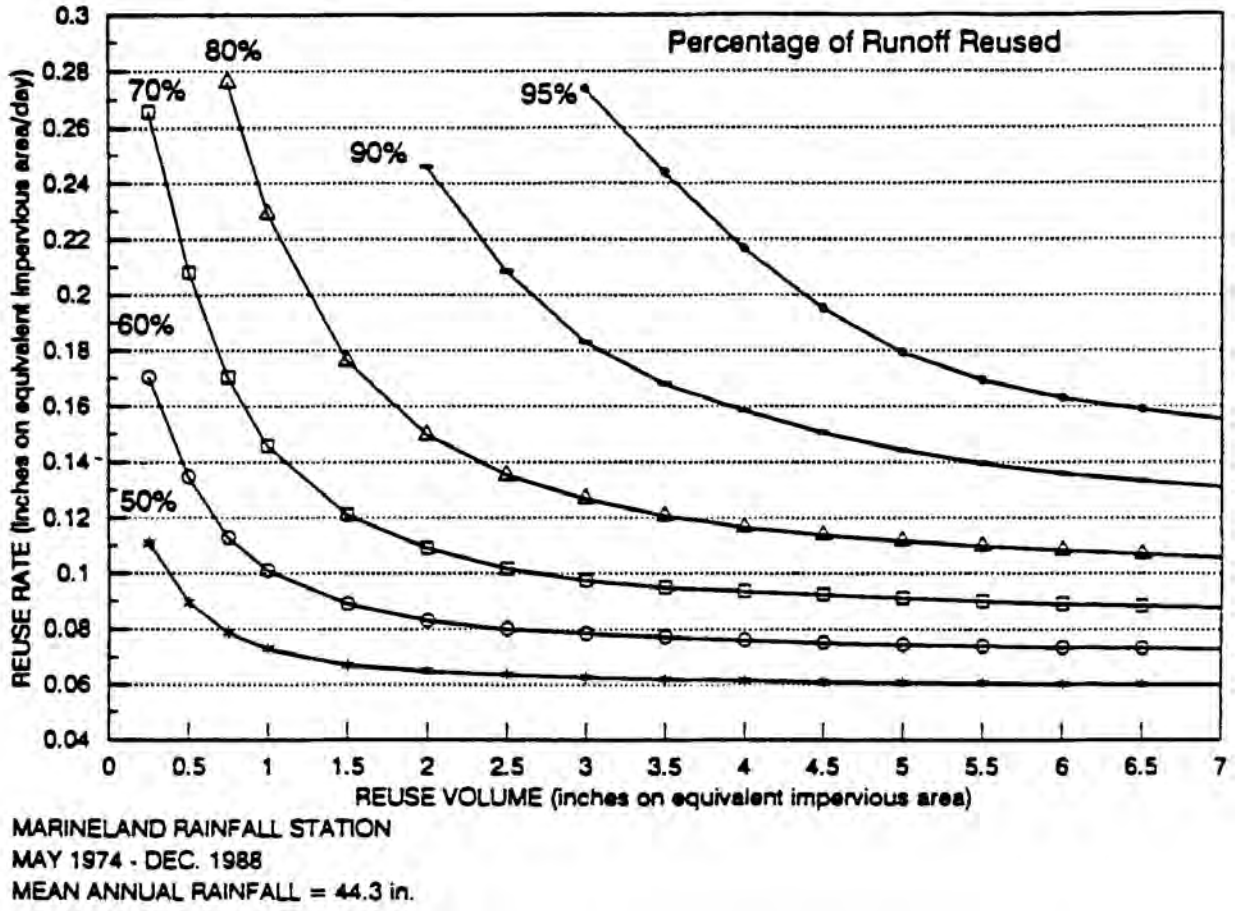

Figure 29-2. REV Chart for Marineland

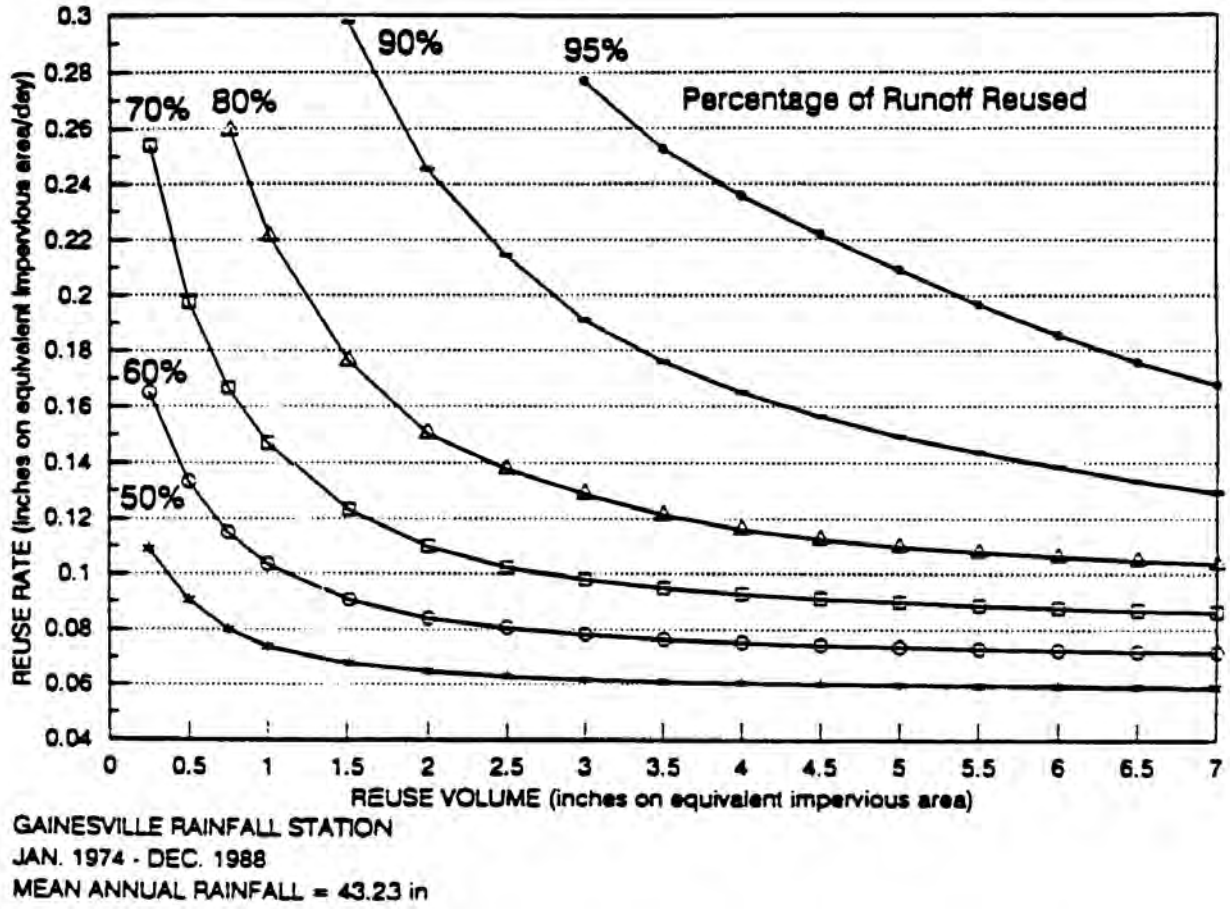

Figure 29-3. REV Chart for Gainesville

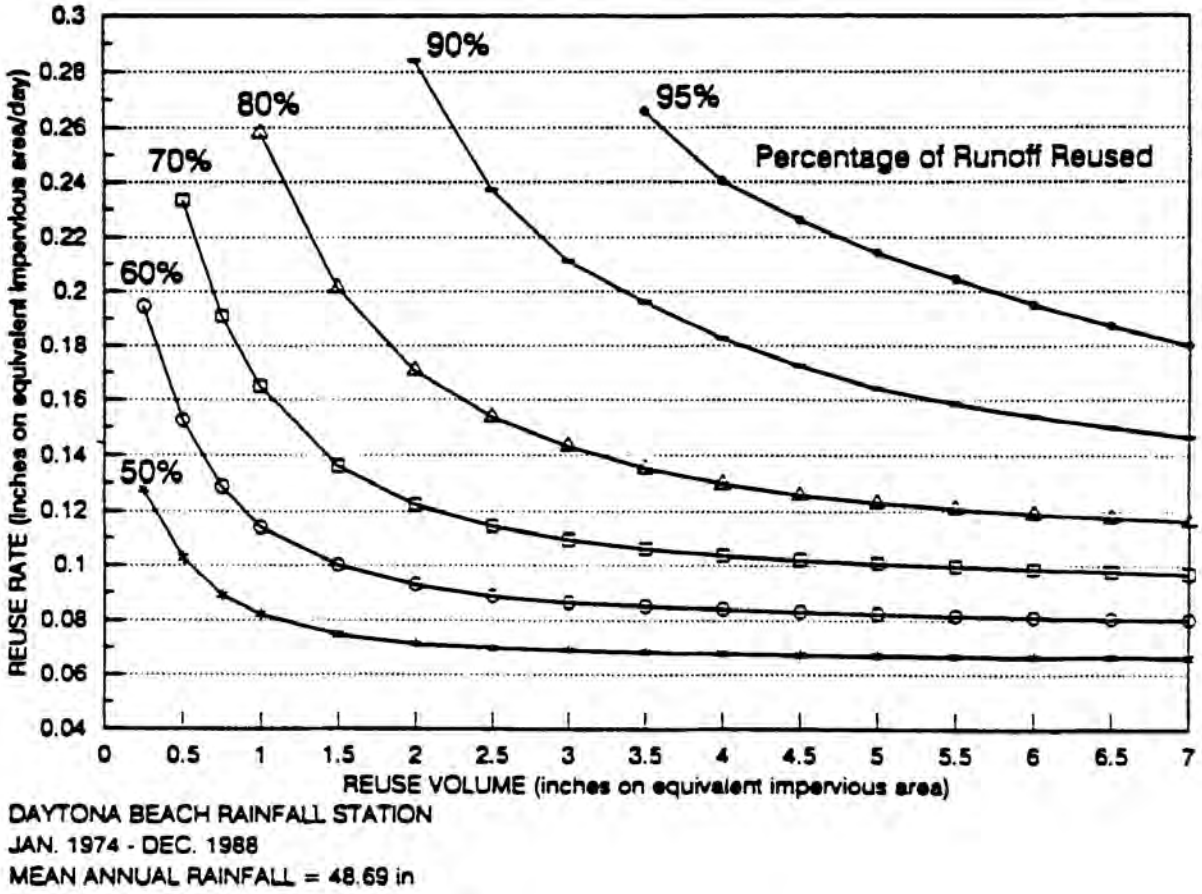

Figure 29-4. REV Chart for Daytona Beach

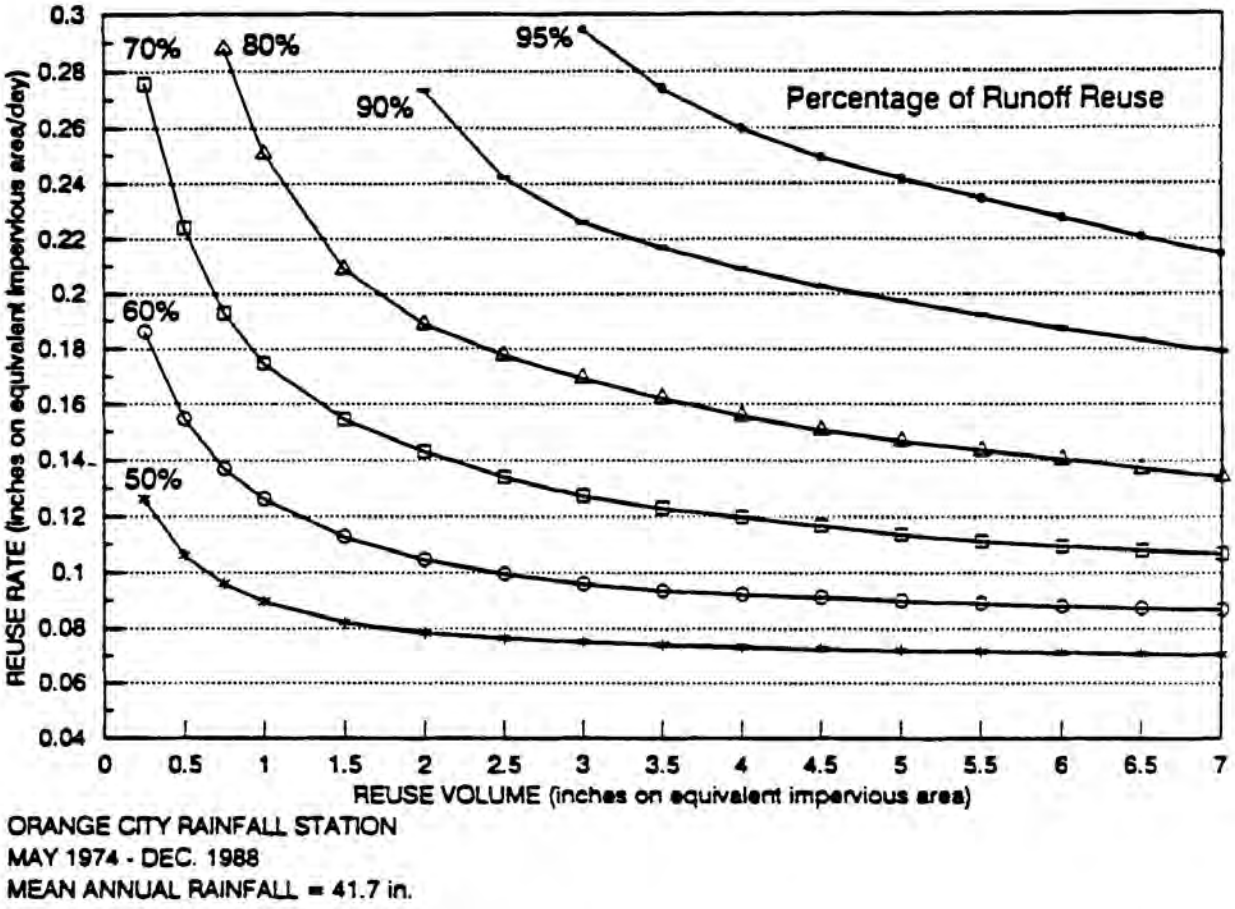

Figure 29-5. REV Chart for Orange City

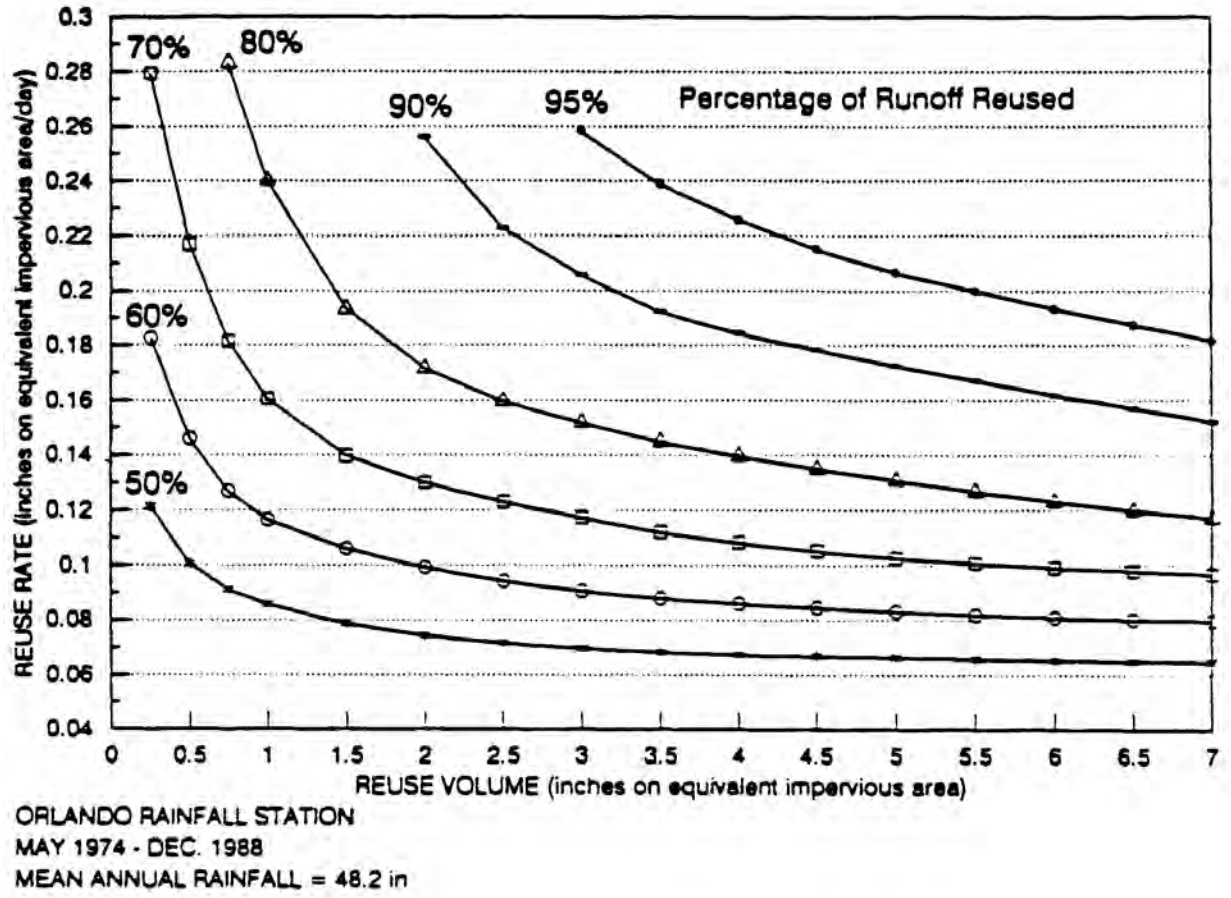

Figure 29-6. REV Chart for Orlando

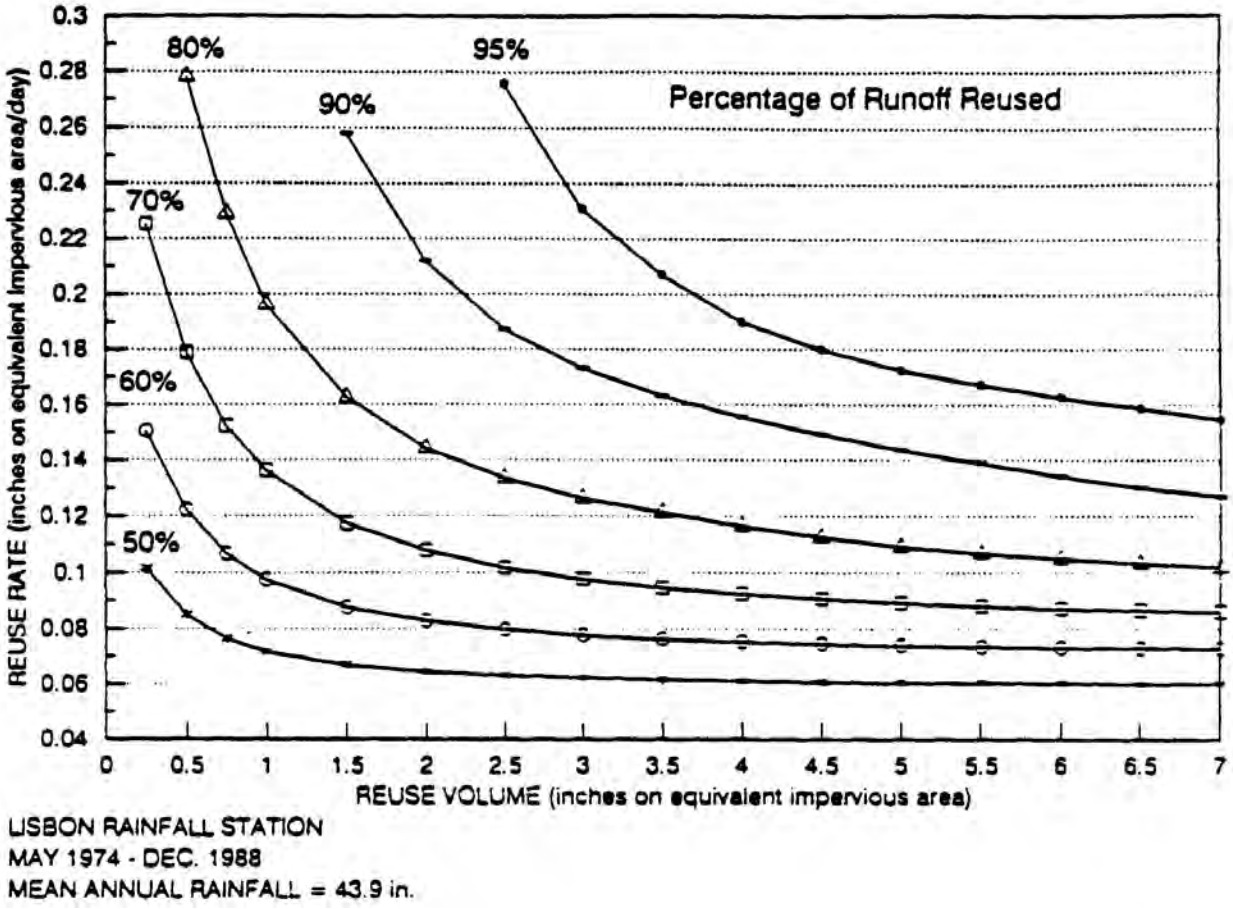

Figure 29-7. REV Chart for Lisbon

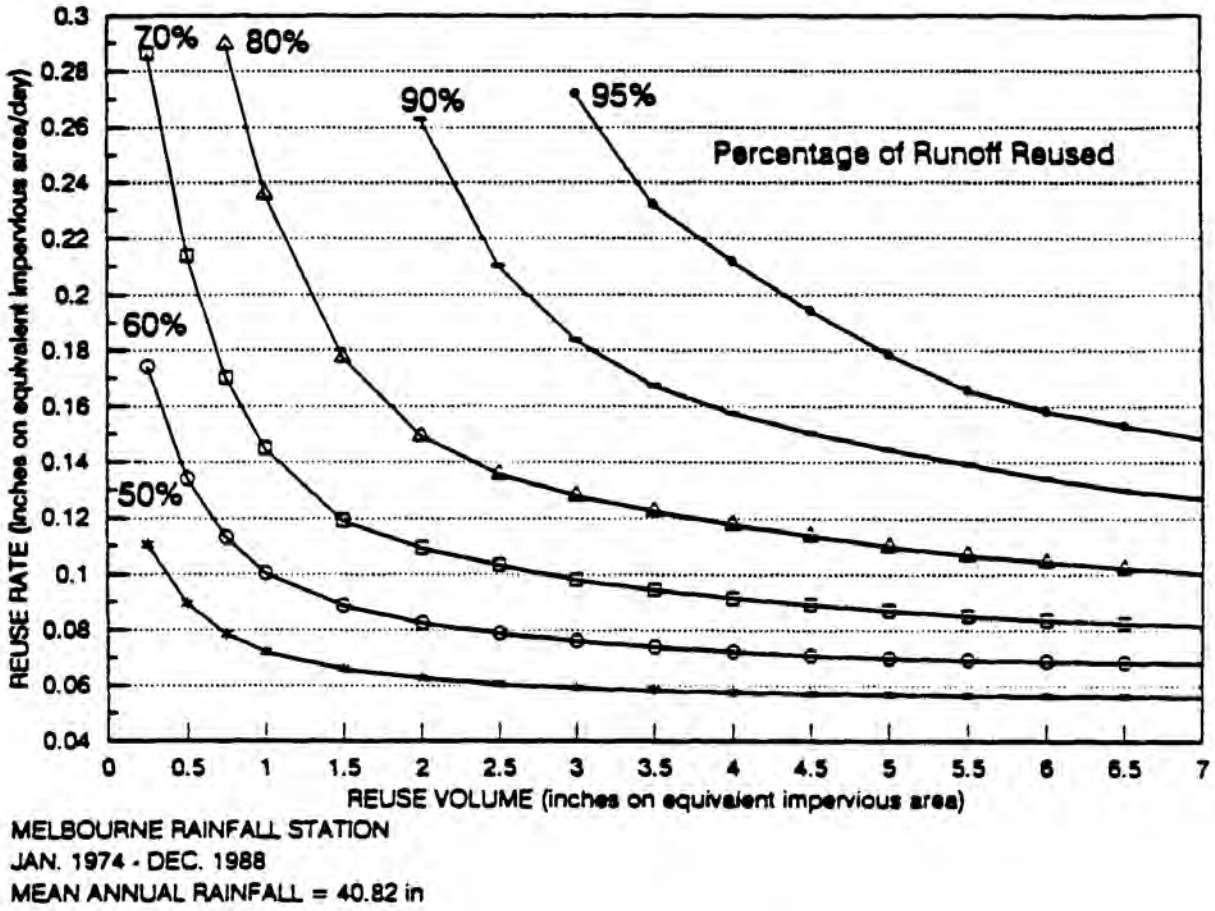

Figure 29-8. REV Chart for Melbourne

30.0 Methodology and Design Examples for Filtration

30.1 Calculating Recovery Time Utilizing Darcy's Equation

The Darcy's equation can be utilized to calculate recovery times for filtration systems. The Darcy Equation for saturated flow through porous media is written:

$$V = K\,i \tag{30-1}$$

where: V = Velocity of flow through the porous media (*ft/hr*)
K = Permeability rate of filter media (*ft*/*hr*)
i = Hydraulic gradient (*ft/ft*)

The rate of flow (Q) passing a given cross-sectional area of saturated soil (A) is:

$$Q = V\,A \tag{30-2}$$

where: Q = Rate of flow (ft^3/*hr*)
A = Area of flow (ft^2)

Combining equations 30-1 and 30-2:

$$Q = K\,i\,A \tag{30-3}$$

Equation 30-3 can be applied in a number of acceptable ways to design filtration systems. These methodologies include incremental drawdown analysis, flow nets, and analytical adaption of the falling head equation. The method selected should take into account the fact that the flow rate varies over time as the filter system recovers the treatment volume.

In the incremental drawdown analysis, the flow through the filter system is evaluated incrementally with respect to pond stage elevation to determine the recovery time. The instantaneous rate of discharge (Q) is calculated at various stages of drawdown or storage elevations in the basin. The time necessary to draw down each increment of storage is summed and compared to the desired recovery time. The design (eg., length) of the filter system is usually finalized by trial and error until the desired recovery time is achieved. See section 30.7 for detailed design examples.

The methodology in the following sections describes the incremental drawdown analysis and the associated variables used in the analysis. Applicants proposing to utilize other methods are encouraged to consult with District staff prior to application submittal.

30.2 Hydraulic Gradient

The hydraulic gradient (i) between two points is equal to the difference in hydraulic head at each point divided by the distance between the points as measured along the flow path. The hydraulic gradient (i) may be expressed as:

$$i = \frac{\Delta H}{D} \tag{30-4}$$

where: i = Hydraulic gradient
ΔH = Difference in hydraulic head between the free water surface in the basin and a horizontal reference plane (usually chosen passing through the flow line of the filter pipe) (*ft*)
D = Distance of the path of flow through the porous media (*ft*)

The hydraulic gradient (i) can be readily obtained from scaled drawings of the filtration system (see Figures 30-1 and 30-2). The details within the construction plans should provide sufficient information to reproduce a scaled drawing to measure flow lengths.

For side-bank filters, the flow path varies with the drop in water surface elevation (Figure 30-1). The flow path for each increment can be assumed to be the average of the flow paths below the top elevation of the given increment. For example, for increment #2 of Figure 30-1, the average flow path can be assumed to be:

$$\text{Average Flow Path for Increment \#2} = \frac{D2 + D3 + D4 + D5}{4} \tag{30-5}$$

For increment #4 in Figure 30-1, the average flow path can be assumed to be:

$$\text{Average Flow Path for Increment \#4} = \frac{D4 + D5}{2} \tag{30-6}$$

For vertical filters the flow path distance (D) is constant for each increment of the analysis (Figure 30-2).

30.3 Permeability

The permeability (K) should be selected with respect to surrounding soils. Once the system is constructed, soils will migrate into the filter and reduce the conductivity. Therefore, design permeabilities of the filter which are far greater than the permeability of the surrounding soils should be avoided. In Table 30-1, below, recommended permeability (K) values are given for each soil type.

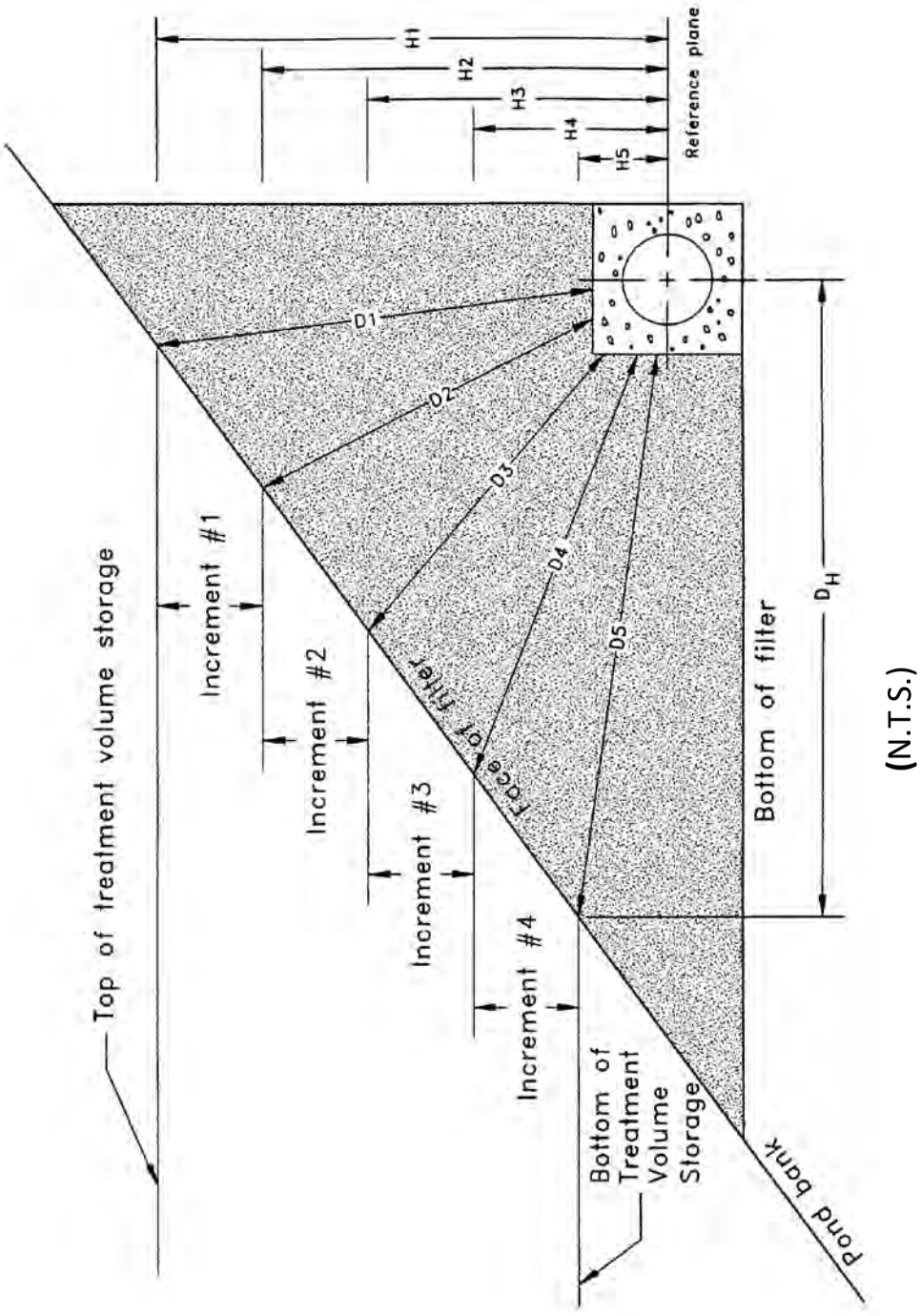

Figure 30-1. Cross-section of Side-bank Filter Illustrating the Parameters Used in Calculating Hydraulic Gradient (i) for Lateral Flow Conditions (adapted from Livingston et al 1988)

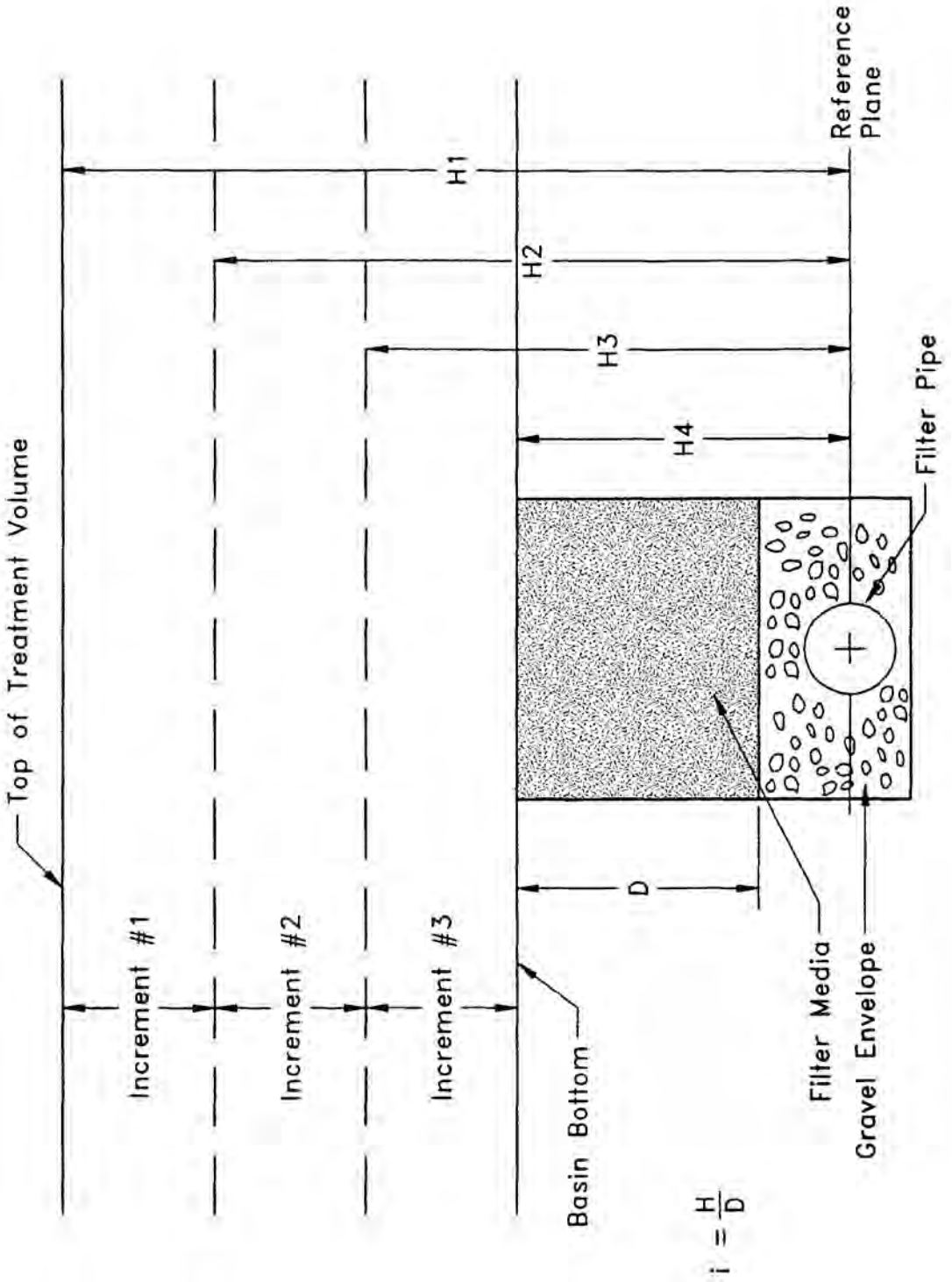

Figure 30-2. Cross-section of Basin-bottom Filter Illustrating the Parameters Used in Calculating Hydraulic Gradient (i) for Vertical Flow Conditions

For "wet" filter systems, a permeability (*K*) for Soil Type "A" may be utilized since most soil particles will settle out in the wet pond prior to reaching the filter media. Permeability values should be reduced by 25% when sod is proposed to be laid over the filter media. On the other hand, *K* values may be increased by 25% when a gravel envelope is placed around the perforated pipe (Harper and Herr, 1993).

Table 30-1. Recommended Permeability (*K*) Values

Soil Type	K (*ft/hr*)
A	2.5
B	2.0
C	1.0
D	0.5
A/D	2.5
B/D	1.5
C/D	0.5

30.4 Flow Area

The flow area (*A*) for use in equation 30-3 is the cross-sectional flow area of the filter media and is calculated as:

$$A = W\ L \tag{30-7}$$

where: W = Width of saturated filter media perpendicular to the direction of flow (*ft*)
L = Length of filter media (*ft*)

For vertical filters, the width of filter media (*W*) remains constant with the drop in water surface elevation. See example problem #2 in section 30-7 for example calculation for vertical filters.

However, for sidebank filters, the width of saturated filter media (*W*) can vary along the flow path (*D*) as flow converges toward the perforated drain pipe and with the falling water surface elevation. The design filter width (*W*) for sidebank filters should be taken as the average of the converging saturated filter width. One method of estimating the design filter width (*W*) is to take the average of the saturated filter width at the filter surface and the width of the saturated filter media at the drain pipe (or gravel envelope as appropriate). Another method is to utilize the saturated filter width at the midpoint of the flow path through the filter media as the design filter width (*W*).

30.5 Incremental Drawdown Analysis

The discharge rate (Q) can be calculated at the various increments of drawdown or stages in the basin by substituting Equation 30-4 into equation 30-3:

$$Q = K \frac{\Delta H}{\Delta D} A \qquad (30\text{-}8)$$

To calculate the recovery time of the system, the flow rate (Q) can be expressed as a function of time ($Q = V/t$), substituted in Equation 33-8 and rearranged to solve for time (t) as follows:

$$t = \frac{V}{K \frac{\Delta H}{\Delta D} A} \qquad (30\text{-}9)$$

where: t = Time (*hrs*)
V = Volume to be discharged (ft^3).

Equation 30-9 can be solved for each increment of treatment volume and the time calculated to drawdown each increment summed to give the total recovery time for the filter design. Example formats for calculating the recovery time utilizing the incremental Darcy's method for side-bank and vertical filters is presented in Figures30-4 and 30-5, respectively. Example problems utilizing this methodology is given below in section 30.7.

The increment of analysis, although not a direct parameter of Darcy's equation, is an important parameter which effects the length of filter required to meet the rule criteria. To produce the most accurate result, the increment should not be larger than 0.1 feet. Smaller increments may be appropriate when the depth in the detention basin of the required treatment volume is shallow (e.g., if the treatment volume is only 0.2 feet deep).

30.5.1 Alternative Methodologies

Besides the incremental analysis presented above, other acceptable methodologies exists for designing filtration systems. The incremental method presented on page 6-274 of *The Florida Land Development Manual* (Livingston et al 1988) is acceptable for designing side bank filters (Harper and Herr 1993). The only difference between this methodology and that presented above is the calculation of the flow path distance (D) variable used in determining the hydraulic gradient (i) (equation 303-3) for side bank filters. For vertical filters, the flow path distance (D) is the same between the two methodologies.

The Falling Head equation presented on page 6-268 of *The Florida Land Development Manual* (Livingston et al 1988) is acceptable for designing vertical filters (Harper and Herr 1993).

30.6 Safety Factor

A safety of 2 is recommended when designing filtration systems (see section 22.4). The methodologies and permeability values recommended above for designing filter systems are conservative so designers utilizing these procedures are not required to provide a safety factor. The only exception is when the incremental method is utilized for designing vertical filters. In this case, a safety factor of 2 is recommended since Harper and Herr (1993) report that this procedure overpredicts recovery times by about a factor of 2.

30.7 Pipe Capacity

The capacity of the pipe must be always checked to ensure that the pipe can convey the design flow rates. This can be readily calculated using a modified form of the Manning's Equation:

$$d_i = \left(\frac{1630\ Q_p\ n}{\sqrt{S}} \right)^{3/8} \qquad (30\text{-}10)$$

where: d_i = Inside pipe diameter (*in*)
n = Manning's coefficient of roughness
Q_p = Peak design discharge rate (*cfs*)
S = Slope of the pipe (*ft/ft*)

If the pipe cannot convey the peak flow rate, additional head losses must be considered in the recovery time or a larger size pipe must be used.

30.8 Example Design Calculations for Filter Systems

Example Problem #1. Side Bank Filter

Given:

Commercial development
Class III receiving waters
Project area = 0.66 acres
Project percent impervious (not including pond area) = 37%
Off-site drainage area = 0 acres
Seasonal high groundwater elevation at the proposed basin = 5.7 ft
Design tailwater elevation = 5.6 ft
Off-line treatment
Type B soils
4:1 side slopes

Side-bank filter with square cross-section gravel envelope around the perforated pipe (gravel envelope width = 3")
Pipe n = 0.016; Pipe S = 0.0012

The proposed detention basin has the following stage-storage relationship:

Stage (ft)	Storage (ac-ft)	Storage (ft^3)
6.3	0.000	0
6.4	0.010	436
6.5	0.022	958
6.6	0.034	1481
6.7	0.047	2047
6.8	0.064	2788

Objective: Design a side bank filter using the incremental method

Design Calculations:

Step 1. Calculate the required treatment volume.

For off-line treatment by filtration, the rule requires a treatment volume of 1 inch of runoff or 2.5 inches times the impervious area, whichever is greater.

$$\textit{Treatment volume required (one inch of runoff)} = \frac{(0.66\ ac.)(1\ inch)}{12\ in/ft} = 0.055\ ac\text{-}ft$$

$$\textit{(2.5 inches times \% imp.)} = \frac{(0.66\ ac)(2.5\ in.)(0.37)}{12\ in/ft} = 0.051\ ac\text{-}ft$$

Therefore, *treatment volume* = 0.055 *ac-ft* or 2396 ft^3

Step 2. Set the elevation of the filter pipe and control structure.

Set the filter pipe invert at or above the seasonal high water table and design tailwater elevation. Therefore, set the filter pipe invert elevation at 5.7 ft.

Set an overflow weir at the top of the treatment volume storage to discharge runoff volumes greater than the treatment volumes. Utilizing the stage-storage relationship, 0.055 ac-ft of storage is between 6.7 and 6.8 feet. Interpolate between 6.7 and 6.8 ft. to find the weir elevation:

$$\textit{Weir elevation} = (6.8 - 6.7\,\textit{ft}) \times \frac{(0.055\,\textit{ac-ft} - 0.047\,\textit{ac-ft})}{(0.064\,\textit{ac-ft} - 0.047\,\textit{ac-ft})} + 6.7\,\textit{ft} = 6.75\,\textit{ft}$$

$$\textit{Treatment volume depth} = 6.75 - 6.3\,\textit{ft} = 0.45\,\textit{ft}$$

Step 3. Determine the *K* value

From Table 30-1, the permeability (*K*) = 2.0 *ft/hr* for Type B soils

Add 25% to the *K* value since a gravel envelope is utilized.

$$\text{Design } K = 2.0\,\textit{ft/hr} \times 1.25 = 2.5\,\textit{ft/hr}$$

Step 4. Size the filter to draw down the treatment volume in at least 72 hours.

For a selected pipe diameter, length, and slope, utilize the incremental Darcy's equation to determine the recovery time for a side-bank filter with a gravel envelope. If the drawdown time is greater than 72 hours or the pipe diameter is inadequate to convey the flows, the pipe variables must be adjusted and the drawdown time recalculated until the desired results are obtained.

Trial 1: Pipe diameter = 6 in.
Pipe length = 200 feet

The calculations for trial #1 are shown in Figure 30-5. For this trial, the drawdown is greater than the required 72 hours. Therefore, increase the pipe length for trial #2.

Trial 2: Pipe diameter = 6 in.
Pipe length = 280 feet

From this trial (Figure 30-6), the time to recover the required treatment volume is less than 72 hours. Also, the selected pipe diameter is adequate to convey the peak flow rate. Therefore, the design for trial #2 is adequate.

Additional Steps.

In a typical design, the applicant would also design the following:

(a) Filter media to meet the required specifications
(b) Cleanout and inspection ports
(c) Filter fabric to prevent the filter media from migrating into the gravel envelope and perforated pipe.

Example Problem #2

Given:

Treatment Volume = 3710 ft^3
K = 2.5 ft/hr
Basin side slopes = 3:1
Basin floor elevation = 20.7 ft
Vertical filter with a square cross-section gravel envelope around the perforated pipe (gravel envelope width = 3")
Pipe *n* = 0.016

The proposed detention basin has the following stage-storage relationship:

Stage (ft)	Storage (ft^3)
22.0	15445
21.9	11827
21.8	8478
21.7	5394
21.6	2569
21.5	0

Objective: Design a vertical filter using the incremental method

Design Calculations:

Step 1. Determine the *K* value. From section 30.6, a safety factor of 2 will be required since the incremental method is being used to design the filter system.

Design *K* (with safety factor of 2) = 2.5/2 = 1.25 *ft/hr*

Add 25% to the K value to account for the gravel envelope around the filter pipe.

Design *K* = 1.25 *ft/hr* x 1.25 = 1.56 *ft/hr*

Step 2. Determine the pipe invert elevation and calculate the recovery time.

Trial #1: Pipe inside diameter = 6.00 inches
Pipe length = 50 feet

Pipe invert elevation = Bottom of basin elev. - depth of filter media - gravel envelope width - pipe diameter

$$\text{Pipe invert} = 21.5\text{ ft} - 2\text{ ft} - \frac{3\text{ in}}{12\text{ in/ft}} - \frac{6\text{ in}}{2\text{ in/ft}} = 18.75\text{ ft}$$

This trial (Figure 30-7) shows that, the time to recover the required treatment volume is less than 72 hours. The pipe diameter is also adequate to convey the peak flow rate. Therefore, the design for trial #1 is adequate.

30.9 References

Harper, H.H. and J.L. Herr. 1993. *Treatment Efficiency of Detention with Filtration Systems.* St. Johns River Water Management District, Special Publication SJ93-SP12, Palatka, Florida.

Livingston, E.H., E. McCarron, J. Cox, P. Sanzone. 1988. *The Florida Land Development Manual: A Guide to Sound Land and Water Management.* Florida Department of Environmental Regulation, Nonpoint Source Management Section, Tallahassee, Florida.

Incremental Method for Calculating Drawdown Time for Side-bank Filter Systems Using Darcy's Equation

Project Name :

Date:

Project No.

Basin Information

Filter Permeability (k)	=
Basin side slope (h/v)	=
Top of treatment volume: Elevation	=
Bottom of treatment volume: Elevation	=
Number of increments	=

Filter Pipe Information

Length of pipe (L)	=
Pipe diameter (d)	=
Pipe invert elevation	=
Horizontal distance to edge	=
Envelope height above pipe (b)	=
Average envelope width	=
Manning's n	=
Slope (ft per ft)	=

Elevation (ft.)	Storage (cf)	Storage Increment (V) (cf)	Flow Distance (D) (ft.)	Change in Elevation (H) (ft.)	Hydraulic Gradient (i)	Average Filter Flow Area (A) (sf)	Instant-aneous Discharge (Q) (cfh)	Average Discharge Per Increm. (Qave) (cfh)	Drawdown Time Per Increm. (t) (hrs.)

t = V / Qave

Total Drawdown Time = Sum of drawdown times for each increment

D = (D1 + D2 + ... +Dn) / n

i = H / D

Q = k i A

Horizontal distance to edge = Distance from the center of the pipe to the edge of the pond bottom

Average envelope width = distance between pipe and edge of envelope measured along the flow distances (D)

Total Drawdown Time =

Pipe capacity (inside dia) =

Figure 30-3. Example Format for Calculating Drawdown Time for Side-bank Filter Systems

Incremental Method for Calculating Drawdown Time for Vertical Filter Systems Using Darcy's Equation

Project Name :

Date:

Project No. :

Basin Information

Filter permeability (k)	=
Top of treatment volume: Elevation	=
Bottom of treatment volume: Elevation	=
Number of increments	=

Filter Pipe Information

Length of pipe (L)	=
Pipe diameter (d)	=
Pipe invert elevation	=
Depth of filter media (D)	=
Width of filter media (W)	=
Manning's n	=
Slope (ft per ft)	=

Elevation (ft.)	Storage (cf)	Storage Increment (V) (cf)	Change in Elevation (H) (ft.)	Hydraulic Gradient (i)	Average Filter Flow Area (A) (sf)	Instant-aneous Discharge (Q) (cfh)	Average Discharge Per Increm. (Qave) (cfh)	Drawdown Time Per Increm. (t) (hrs.)

$i = H / D$

$Q = k\,i\,A$ $\qquad t = V / Qave$

Total Drawdown Time = Sum of drawdown times for each increment

Total Drawdown Time =

Pipe capacity (inside dia) =

Figure 30-4. Example Format for Calculating Drawdown Time for Vertical Filter Systems

Incremental Method for Calculating Drawdown Time for Side-bank Filter Systems Using Darcy's Equation

Project Name : Example #1
Project No. : Trial #1

Basin Information

Filter permeability (k)	=	2.50 ft/hr
Basin side slope (h/v)	=	4
Top of treatment volume: Elev.	=	6.75 ft
Bottom of treatment volume: Elev.	=	6.30 ft
Number of increments	=	5

Filter Pipe Information

Length of pipe (L)	=	200 ft.
Pipe diameter (d)	=	6.0 in.
Pipe invert elevation	=	5.70 ft.
Horizontal distance (Dh)	=	3.90 ft.
Envelope height above pipe	=	3.00 in.
Average envelope width	=	3.00 in.
Manning's n	=	0.016
Slope (ft per ft)	=	0.0012

Elevation (ft.)	Storage (cf)	Storage Increment (V) (cf)	Average Flow Distance (D) (ft.)	Change in Elevation (H) (ft.)	Hydraulic Gradient (i)	Average Filter Flow Area (A) (sf)	Instant-aneous Discharge (Q) (cfh)	Average Discharge Per Increm. (Qave) (cfh)	Drawdown Time Per Increm. (t) (hrs.)
6.75	2396		2.51	0.80	0.32	185.5	148.1		
		349						132.2	2.64
6.70	2047		2.66	0.75	0.28	164.9	116.3		
		566						93.5	6.05
6.60	1481		2.84	0.65	0.23	123.7	70.7		
		523						54.1	9.67
6.50	958		3.03	0.55	0.18	82.5	37.4		
		522						25.9	20.15
6.40	436		3.22	0.45	0.14	41.2	14.4		
		436						7.2	60.58
6.30	0		3.42	0.35	0.10	0	0.0		

Total Drawdown Time	=	99.1 hrs
Pipe capacity (inside dia)	=	3.62 in.

Figure 30-5. Calculations for Example Problem #1; Trial #1

Incremental Method for Calculating Drawdown Time for Side-bank Filter Systems Using Darcy's Equation

Project Name : Example #1
Project No. : Trial #2

Basin Information

Filter permeability (k)	=	2.50 ft/hr
Basin side slope (h/v)	=	4
Top of treatment volume: Elev.	=	6.75 ft
Bottom of treatment volume: Elev.	=	6.30 ft
Number of increments	=	5

Filter Pipe Information

Length of pipe (L)	=	280 ft.
Pipe diameter (d)	=	6.0 in.
Pipe invert elevation	=	5.70 ft.
Horizontal distance (Dh)	=	3.90 ft.
Envelope height above pipe	=	3.00 in.
Average envelope width	=	3.00 in.
Manning's n	=	0.016
Slope (ft per ft)	=	0.0012

Elevation (ft.)	Storage (cf)	Storage Increment (V) (cf)	Average Flow Distance (D) (ft.)	Change in Elevation (H) (ft.)	Hydraulic Gradient (i)	Average Filter Flow Area (A) (sf)	Instant-aneous Discharge (Q) (cfh)	Average Discharge Per Increm. (Qave) (cfh)	Drawdown Time Per Increm. (t) (hrs.)
6.75	2396		2.51	0.80	0.32	259.8	207.3		
		349						185.1	1.89
6.70	2047		2.66	0.75	0.28	230.9	162.9		
		566						130.9	4.32
6.60	1481		2.84	0.65	0.23	173.2	99.0		
		523						75.7	6.91
6.50	958		3.03	0.55	0.18	115.4	52.4		
		522						36.3	14.39
6.40	436		3.22	0.45	0.14	57.7	20.2		
		436						10.1	43.27
6.30	0		3.42	0.35	0.10	0	0.0		

Total Drawdown Time	=	70.8 hrs
Pipe capacity (inside dia)	=	4.11 in.

Figure 30-6. Calculations for Example Problem #1; Trial #2

Incremental Method for Calculating Drawdown Time for Vertical Filter Systems Using Darcy's Equation

Project Name : Example #2
Project No. :

Basin Information

Filter permeability (k)	=	1.56 ft/hr
Top of treatment volume: Elev.	=	22.00 ft
Bottom of treatment volume: Elev.	=	21.50 ft
Number of increments	=	5

Filter Pipe Information

Length of pipe (L)	=	50 ft.
Pipe diameter (d)	=	6.0 in.
Pipe invert elevation	=	18.75 ft.
Depth of Filter Media (D)	=	2.00 ft.
Width of Filter Media (W)	=	3.00 ft.
Manning's n	=	0.016
Slope (ft per ft)	=	0.0012

Elevation (ft.)	Storage (cf)	Storage Increment (V) (cf)	Change in Elevation (H) (ft.)	Hydraulic Gradient (i)	Average Filter Flow Area (A) (sf)	Instant-aneous Discharge (Q) (cfh)	Average Discharge Per Increm. (Qave) (cfh)	Drawdown Time Per Increm. (t) (hrs.)
22.00	15445		3.00	1.50	150.0	351.0		
		3618					345.2	10.48
21.90	11827		2.90	1.45	150.0	339.3		
		3349					333.5	10.04
21.80	8478		2.80	1.40	150.0	327.6		
		3084					321.8	9.58
21.70	5394		2.70	1.35	150.0	315.9		
		2825					310.1	9.11
21.60	2569		2.60	1.30	150.0	304.2		
		2569					298.4	8.61
21.50	0		2.50	1.25	150.0	292.5		

Total Drawdown Time	=	47.8 hrs
Required pipe capacity (inside dia)	=	5.01 in.

Figure 30-7. Calculations for Example Problem #2

31.0 [Reserved]

PART XI
METHODOLOGIES FOR CALCULATING WATER BUDGETS

32.0 Methodologies for Calculating Water Budgets

32.1 Description of Water Budgets

A water budget is an accounting of water movement onto, within, and off of an area. Developing a water budget provides an overall view of sources with excess water and sources with water needs. A management plan can be devised to link excess water to water needs. On-site storage in canals and reservoirs allows this link to span over time.

On-site harvesting runoff reduces the offsite loading of nutrients and is considered a treatment practice. Water use efficiency is increased by reuse, resulting in less offsite water needed to meet onsite water demands.

All agricultural operations must implement a Conservation Plan which addresses harvesting runoff. Individual permittees are required to maximize on-site harvesting runoff to satisfy irrigation, freeze protection and pest control needs. (subsection 19.2.4 of this Manual)

The purpose of developing a water budget is to quantify the reduction in offsite discharge by harvesting runoff for a typical year. Individual components of supply, storage, use, and movement must be estimated on a monthly basis for an average year. Each component value should be representative of the unique situation of the soil, crop, operation, and management.

The following parameters are used to calculate water budgets. Examples of a water budget using these parameters are included at the end of section 33 of this Manual.

32.2 Reservoir and Canal Storage

Canals and reservoirs provide storage of excess water until the water is needed. For both types of water bodies, any volume above the downstream control elevation is assumed to be discharged downstream.

For the water budget, only the volume which can be moved from storage to a point of need should be considered to be harvested. The harvested runoff volume is dependent on the most limiting feature of the flow path, e.g. pump inlet, reservoir bottom, culvert inverts, field topography.
Secondary canals and field ditches can normally be omitted without affecting the accuracy of the water budget.

32.3 Rainfall

Average monthly rainfall depths can be found in the District's Technical Publication SJ 86-4, "Rainfall Analysis for Northeastern Florida; Part II: Summary of Monthly and Annual Rainfall Data" and Weather Bureau publications entitled "Climatic Summary of the United States", and the "Annual Summaries of Climatological Data". The District's Technical Memorandum; "30 Year Mean; Blaney - Criddle; Supplemental Irrigation Requirement" provides average monthly rainfall depths for at least one location in each county. Average rainfall depths should represent a minimum of 30 years of rain gage data collected by NOAA stations or other reliable sources.

32.4 Effective Rainfall

Effective rainfall (R_e) is the precipitation retained by the soil to meet evapotranspiration requirements. It does not include precipitation lost to deep percolation below the root zone nor to surface runoff.

Since there are no records of effective rainfall available, the effective portion of the precipitation must be estimated from the total precipitation.

SCS (now NRCS) analyzed 50 years of rainfall data at each of 22 stations to develop a method to estimate the monthly effective rainfall. Based on their findings, the monthly effective rainfall can be calculated by:

$$R_e = (0.70917\ R^{0.82416} - 0.11556)(10^{0.02426u})\ (F)$$

where: R = average effective monthly rainfall, in.;
R_e = average total monthly rainfall, inches;
u = monthly evapotranspiration, inches;
F = soil water storage factor.

The soil water storage factor is estimated by:

$$F = (0.531747 + 0.295164D - 0.057697D^2 + 0.003804D^3\ )$$

where D is the net application depth or the usable soil water storage in inches. Typical net application depths for Florida soils range from 1.5 inches for sandy soils, soils with naturally shallow water tables, or soils planted with shallow rooted crops to 4.0 inches for well drained loamy soils used to grow deep rooted crops.

In situations where the rooting depth is limited by shallow water tables, the effective rainfall must be adjusted to account for the upflux of water from the water table to the root zone. The net application depth should be based on the average rooting depth (i.e., average water table depth plus the depth of water which is capable of moving up into the root zone by capillary action.)

The average monthly effective rainfall, R_e , cannot exceed the average monthly rainfall, R, or average monthly evapotranspiration, u. If the estimated R_e exceeds either, then R must be reduced to the smaller of the two. USDA-NRCS publication Irrigation Water Requirements; Technical Release No. 21 discusses this procedure in greater detail.

32.5 Evapotranspiration (Potential and Actual)

Potential Evapotranspiration (PET) is the depth of water evaporated from the soil plus the transpiration from plants assuming the transpiration is not limited by soil water availability. PET may be calculated by any well documented method.

32.6 Evaporation from the Reservoir

M.A. Kohler (1959) reported the average annual lake evaporation ranges from 45 inches per year near the District's northern border to 48 inches per year near the District's southern border. Average monthly lake evaporation data may be available for a few sites, but is unavailable for the majority of the District. A record length of at least 20 years should be used calculate average monthly evaporation.

If lake evaporation data is not available for a lake near the project site, the average annual evaporation can be estimated from Figure 32-1. Average Annual Lake Evaporation (inches), from “Evaporation Maps for the United States”. Monthly lake evaporation can be estimated by proportioning the annual evaporation similarly to the distribution of monthly pan evaporation for a nearby location. Pan evaporation is published in "Climatological Data: Florida" by the NOAA Climatic Data Center, Asheville, North Carolina. Summary of the pan evaporation data for northeast Florida locations is given in Table 32-1.

In the monthly water budget, surface evaporation from the reservoir must be completely satisfied for prior to allocating reservoir water for irrigation.

32.7 Net Irrigation Required

The net irrigation required (NIR) is the depth of supplemental water above precipitation, stored soil moisture, or groundwater, that is required to allow plants to transpire without limitation due to the lack of available water. This volume must be determined for each field with a different crop or fields under different planting dates. Monthly NIR values for a typical year are computed by:

$$NIR = (PET - R_e) \times A$$

where:

NIR = monthly net irrigation volume, ac-in.;
PET = monthly potential evapotranspiration, inches;

R_e = monthly effective rainfall, inches;
A = field acreage.

If R_e is greater than the PET, then NIR is equal to zero since all of the water required to meet PET is supplied by precipitation.

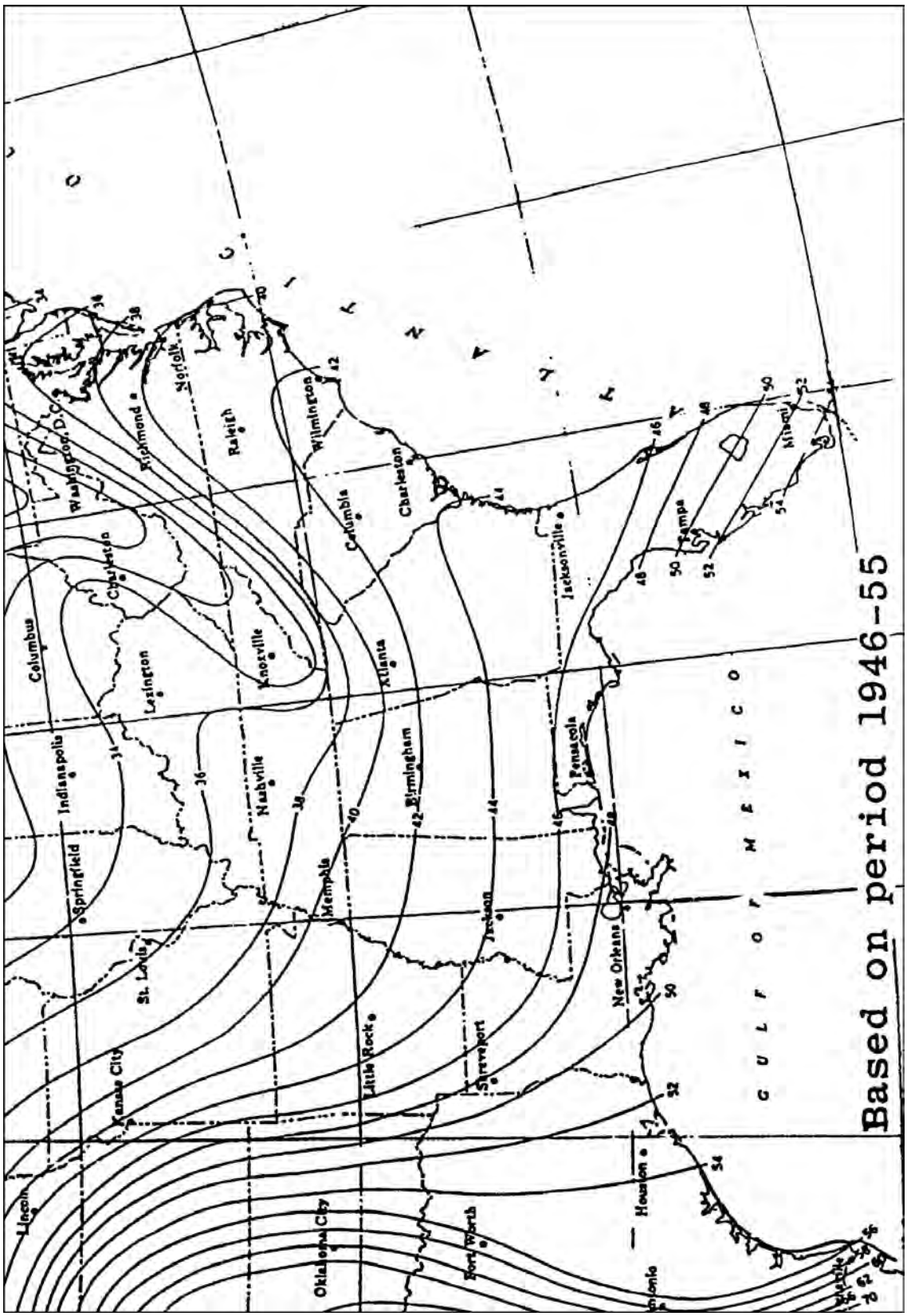

Table 32-1. Mean monthly pan evaporation and percent of annual pan evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
						Gainesville (1953–1990)							
Mean	2.93	3.64	5.52	6.94	7.92	7.51	7.10	6.57	5.66	4.92	3.49	2.74	64.94
%	4.51	5.61	8.50	10.69	12.20	11.56	10.93	10.12	8.1	7.58	7.37	42..	100.00
						Lake Alfred (1965–1990)							
Mean	3.54	4.30	6.42	7.69	8.70	7.80	7.76	7.39	6.56	5.69	4.12	3.29	73.26
%	4.83	5.87	8.76	10.50	11.87	10.65	10.60	10.09	8.95	7.77	5.62	4.49	100.0
						Lake City (1965-1990)							
Mean	3.04	3.65	5.04	6.83	7.78	7.57	7.55	6.80	5.90	5.05	3.70	3.04	65.95
%	4.61	5.53	7.64	10.36	11.80	11.48	11.45	10.31	8.94	7.66	5.61	4.61	100.0
						Lisbon (1960–1990)							
Mean	2.47	3.16	5.07	6.55	7.40	6.81	6.78	6.24	5.21	4.38	2.83	2.37	59.27
%	4.16	5.33	8.55	11.05	12.49	11.49	11.44	10.53	8.79	7.39	4.78	4.00	100.0
						Vero Beach (1952–1990)							
Mean	3.40	4.09	5.79	6.88	7.63	7.25	7.17	6.83	6.04	5.44	3.89	3.22	67.63
%	5.03	6.05	8.56	10.17	11.28	10.72	10.60	10.10	8.93	8.05	5.75	4.76	100.0

Taken from "Climatological Data: Florida" by the NOAA Climatic Data Center, Asheville, North Carolina.

32.8 Gross Irrigation Required

The gross irrigation required (GIR) is the depth of water that must be supplied to provide the NIR. Losses due to evaporation, deep seepage, and leaks in the irrigation distribution system plus the non-uniformity of applied water reduces the efficiency of the irrigation system.

Less efficient irrigation systems require more water to be distributed to meet the NIR. The total water volume required, which must be supplied by the surface water or groundwater source, is:

$$GIR = NIR / I_e$$

where:

GIR = monthly gross irrigation volume, acre-in.;
NIR = monthly net irrigation volume, acre-in.
I_e = irrigation efficiency, as a decimal

Typical application efficiencies for different types of irrigation systems are listed in Table 32-2.

All water supplied by the reservoir to meet the GIR is considered harvested runoff and represents a reduction in the potential offsite discharge volume.

32.9 Other Water Sources (Groundwater and Off-Site Surface Water)

Groundwater and off-site surface water sources need to be identified and the volume from these sources has to quantified. If these other water sources are used to meet NIR, then the additional water would not increase the volume entering into the reservoir or being discharged off-site. If these other contributing water sources are providing water for freeze protection, nematode control, or soil oxidation control, then this volume, adjusted for any evaporation or deep seepage losses, must be routed to the reservoir.

In order to maximize harvesting runoff as required by section 40C-44.066(1)(b), all available water in the reservoir must be used prior to using groundwater or offsite surface water sources unless it is impractical due to specific circumstances.

Table 32-2: Irrigation system irrigation efficiencies+*

Sprinkler Irrigation Systems

System Type	Range	Average
Solid Set Systems	0.70 - 0.80	0.75
For Container Nurseries	0.15 - 0.50	0.20
Guns		
Portable Guns	0.60 - 0.70	0.65
Traveling Guns	0.65 - 0.75	0.70
Center Pivot and Lateral Move Systems	0.70 - 0.85	0.75
Periodic Move Laterals	0.65 - 0.75	0.70

Hand-Move or Portable		
Lateral End-Tow Systems		
Side-Roll Systems		
Side-Move Systems		

System Type	**Range**	**Average**
Micro Irrigation Systems		
Drip or Line Source		
Systems Surface		
Subsurface	0.75 - 0.90	0.85
Spray Systems	0.75 - 0.95	0.85
Bubbler Systems	0.70 - 0.90	0.80
	0.70 - 0.85	0.80

System Type	**Range**	**Average**
Subirrigation (Seepage) Systems		
Open Field Ditch Systems		
Open Field Conveyance Systems		
Flow Through		
Tailwater Recycle	0.20 - 0.70	0.50
Semi-Closed Conveyance Systems	0.30 - 0.80	0.60
Flow Through	0.30 - 0.70	0.50
Tailwater Recycle	0.40 - 0.80	0.60
Subsurface Conduit Systems	0.40 - 0.80	0.60

Surface (Flood) Systems	**Range**	**Average**
Crown Flood Systems	0.25 - 0.75	0.50
Continuous Flood (Paddy) Systems	0.25 - 0.75	0.50

*****Irrigation system application efficiencies for well-designed and well-managed irrigation systems in Florida.
[+]Taken from IFAS Bulletin 247, Efficiencies of Florida Agricultural Irrigation Systems; June 1988, by Smajstrla, A.G., et al.

32.10 Volume of Water Entering the Reservoir

Reservoir storage recharge is a combination of all stormwater runoff (RO) from the fields plus any off-site water entering the project area which is not used to meet the PET. Minimum RO volume from a field is the non-effective rainfall amount minus seepage loss and may be calculated by:

$$RO = (R - R_e) \times A - S_1$$

where:

RO = monthly runoff from rain, acre-inches;
R = monthly rainfall, inches;
R_e = monthly effective rain, inches;
A = field acreage;
S_1 = deep and lateral seepage losses, acre-inches.

Seepage losses must be quantified using standard methods.

32.11 Volume of Water Discharged Off-site

The maximum water stage in the reservoir is assumed to be the lowest control elevation of the discharge structure(s). Any storage volume over this stage will be discharged off-site.

32.12 Seepage to/from the Reservoir/Farm

Seepage between the reservoir and agricultural fields can normally be neglected since the water is still within the system. Typical reservoir designs are not conducive for offsite groundwater to seep into the reservoir. Seepage from the reservoir can normally be neglected unless the surface water elevations or groundwater elevations in the offsite areas adjacent to the reservoir are more than 1.5 feet lower than the reservoir control elevation. If this is the case, the outgoing seepage can be estimated by a form of Darcy's law:

$$Q = (- Kah/L) \times W \times days$$

where:

Q = seepage flow, ft^3/month;
K = effective hydraulic conductivity, ft/day;
a = vertical area of flow per foot of perimeter, ft^2/ft
h = average hydraulic head, feet;

L = average seepage flow length, feet;
W = length of perimeter seepage face, feet;
days = number of days in the month

Darcy's law can also be used to estimate the seepage onto the fields from off-site or the seepage from the fields to off-site areas.

32.13 Reduction in Volume Discharged by Harvested Runoff

The reduction in the off-site discharge is equal to the volume of water returned from the reservoir to the fields to meet NIR or provide freeze protection, nematode control, or soil oxidation control. This relation may be mathematically represent as:

$$RD = [1 – (VD / PVD)] \times 100$$

where:

RD = reduction of offsite discharge, %
VD = estimated volume discharge offsite, ac-ft
PVD = estimated volume discharged offsite if no water was recycled onsite, ac-ft

PART XII
METHODOLOGIES AND DESIGN GUIDELINES FOR AGRICULTURAL SURFACE WATER MANAGEMENT SYSTEMS UTILIZING WET DETENTION SYSTEMS

33.0 Methodologies and Design Guidelines for Agricultural Surface Water Management Systems Utilizing Wet Detention Systems

33.1 Design High Water Level

The design high water level is to be determined for pumped systems in the Upper St. Johns River Hydrologic Basin and the Ocklawaha River Hydrologic Basin by modeling the 25-year 96-hour storm through the pond. All other systems must model the 25-year 24-hour storm through the pond.

As an alternative to modeling the required storm event, the applicant may estimate the design high water level by adding the stage at which the peak discharge out of the pond is equal to the peak discharge into the pond plus the rainfall depth of the design storm event. Maximum peak discharge from the pond based on a stage equal to the design high water level can not exceed pre- development peak discharge.

33.2 Dike Freeboard

To address public safety concerns, a minimum 1.5 foot freeboard should be provided above the maximum high water level. If the farm and pond is surrounded by an existing dike, then the freeboard on the farm side of the pond may be reduced to 1.0 foot.

33.3 Maintenance Access

Detention basins must be designed to accommodate maintenance equipment access and to facilitate regular maintenance, mowing, and vegetation control.

33.4 Water Budget Calculations - Example

Given:

Citrus grove proposed near Titusville (Class III receiving waters) Project area = 240 acres; Proposed land use - 224 acres of citrus grove irrigated by micro-irrigation systems; fair condition; 80 acres on Class B soils (Curve number = 65) and 144 acres on Class C soils (Curve number = 76). A 16 acre wet detention pond will be constructed on Class C soils. Off-site drainage area = 40 acres of fair pasture on Class C soils; Curve number = 79. Design tailwater elevation = 65.0 ft. Wet Season groundwater elevation = 66.0 ft. Reservoir control elevation = 66.0 feet.

The following assumptions were made to provide the most accurate and realistic management of the water:

1. The volume of water entering the pond is totaled for the month prior to any water being distributed.

2. Use of pond water is prioritized as follows: i) evaporation; ii) irrigation; iii) offsite discharge.

3. The volume of water remaining at the end of the month in excess of the permanent pool volume is discharged offsite.

4. None of the treatment volume may be used to meet evaporation or irrigation requirements.

5. Only the permanent pool volume above the return structure invert elevation may be recycled to the farm as irrigation water.

Components of the water budget are described below.

Column A. Month - Start the year with a month in which the reservoir is expected to be full. October is usually a good month to start with since it is the last month of the wet season.

Column B. Reservoir stage at the beginning of the month. It is assumed to be equal to the control elevation for the first month. Based on stage vs storage volume relationship and column C.

Column C. Reservoir volume at the beginning of the month (B.O.M.). For the first month, it is assumed to equal the permanent pool volume and must equal the End of the Month Reservoir Volume (column T) for the last month of the budget. For other months, the B.O.M. volume is equal to the E.O.M volume of the previous month.

Column D. Monthly rainfall volume falling on the pasture. Estimated by multiplying monthly rainfall depth (column AA) by pasture acreage.

Column E. Monthly potential evapotranspiration volume for the pasture. Estimated by multiplying monthly potential evapotranspiration rates (column BB) by pasture acreage. Potential evapotranspiration rates were calculated using the Modified Blaney-Criddle Method.

Column F. Actual evapotranspiration volume from the pasture. Estimated by multiplying monthly effective rainfall (column CC), the only water source for the pasture, by the pasture acreage.

Column G. Runoff volume from the pasture routed to the pond. This volume is calculated by multiplying the pasture acreage by the difference between the rainfall

and effective rainfall (column AA - column CC). Values were divided by 12 to convert acre-inches to acre-feet.

Column H. Monthly rainfall volume falling on the citrus grove. Estimated by multiplying monthly rainfall depth (column AA) by citrus acreage.

Column I. Monthly potential evapotranspiration volume for the citrus. Estimated by multiplying monthly potential evapotranspiration rates (column DD) by citrus acreage. Potential evapotranspiration rates were calculated using the Modified Blaney-Criddle Method.

Column J. Actual evapotranspiration volume from the citrus. Actual evapotranspiration volume cannot exceed the potential evapotranspiration volume (column I) nor may it exceed the sum of effective rainfall multiplied by the citrus acreage plus the Net Irrigation Volume (column L).

Column K. Net Irrigation volume provide to the citrus acreage. This volume may not exceed the Net Irrigation Required for citrus (column EE) times the citrus acreage nor may this volume exceed the pond water available for irrigation multiplied by the expected irrigation efficiency. An irrigation efficiency of 0.75 was selected for the micro-irrigation system of this example (see Table 31-2).

Column L. Gross Irrigation volume provided to the citrus grove from the pond. This volume is calculated by dividing the Net Irrigation volume (column L) by the irrigation efficiency.

Column M. Lost Irrigation is the volume of water which is provided to meet the irrigation demands of the citrus grove, but was lost due to evaporation, deep seepage, lateral seepage, etc. This volume is the difference between column M and column L.

Column N. Runoff volume from the citrus grove routed to the pond. This volume is calculated by multiplying the citrus acreage by the difference between the rainfall and effective rainfall (column AA - column FF). Values were divided by 12 to convert acre-inches to acre-feet.

Column O. Precipitation volume falling on the pond. This volume is calculated by multiplying the pond area by the monthly rainfall (column AA).

Column P. Pond Evaporation volume. This volume is calculated by multiplying the pond area by the evaporation rate from an open water body (column GG). Evaporation must be satisfied prior to any water being used for irrigation or being discharged offsite.

Column Q. Maximum Pond Volume - Pond Evaporation is computed by summing the B.O.M. Pond Volume (column C) and the runoff volumes routed to the pond (columns G & N) minus the pond evaporation (column P).

Column R. Pond Volume - Irrigation is the Maximum Pond Volume (column Q) minus the Gross Irrigation Volume (column L).

Column S. Overflow from Pond is the pond volume (column R) in excess of the permanent pool volume.

Column T. End of the Month Pond Volume is the smaller value of the pond volume (column R) and the pond permanent pool volume.

Column AA. Rainfall depths used should represent the mean value for 20 years or longer. Values used for this example were taken from SJRWMD Technical Memorandum, "30 Year Mean, Blaney - Criddle, Supplemental Irrigation Requirements". SJRWMD's Technical Publication SJ 86-4, Rainfall Analysis for Northeast Florida, Part II, "Summary of Monthly and Annual Rainfall Data" gives long term rainfall average for 43 sites in northeast Florida.

Column BB. Potential Evapotranspiration rate for pasture estimated by the Blaney - Criddle Method using crop growth stage coefficient Figure No. 17.

Column CC. Effective Rainfall for the pasture acreage estimated by the Soil Conservation Service method. A net irrigation depth of 2 inches was used assumed based on type "C" soils. Mean monthly rainfall depths (column AA) were assumed.

Column DD. Potential Evapotranspiration rate for citrus estimated by the Blaney - Criddle Method using crop growth stage coefficient Figure No. 10. The coefficients reported in Figure No. 10 assumes complete field cover. Since it is impractical to have 100% field cover by the trees, the potential evapotranspiration rate was corrected using a factor of 0.84.

Column EE. Net Irrigation Required is the additional depth of water required by the crop to allow the crop to transpire without limitation due to insufficient available water. This depth is equal to the potential evapotranspiration rate (column DD) minus the effective rainfall for the citrus grove (column FF), but can not less than zero.

Column FF. Effective Rainfall for the citrus acreage estimated by the Soil Conservation Service method. A net irrigation depth of 2 inches was used assumed based on type "B" and "C" soils. Mean monthly rainfall depths (column AA) were assumed.

Column GG. Monthly pan evaporation. Values were selected for the closest location site from Table 31-1.

Column HH. Pond Evaporation for individual months were estimated by distributing the annual lake evaporation, estimated as 46 inches from Figure 31-1, based on the fraction of monthly pan evaporation (column GG) to the annual pan evaporation. For example, the pond evaporation for October would be:

(2.47 inches/ 59.27 inches) x 46.0 inches = 1.92 inches.

Column II. The Volume routed to the pond is the sum of runoff from the pasture, sum of column G, and runoff from the groves, sum of column N. A 46 percent reduction of the offsite discharge is expected for the agricultural operation. This reduction results from reuse of the pond water and evaporation from the pond. This reduction is estimated from the ratio of volume discharge to the potential discharge volume, which the volume routed to the pond:

WATER BUDGET EXAMPLE

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Month	B.O.M. Pond Stage (ft)	B.O.M. Pond Vol. (ac-ft)	Rainfall Pasture (ac-in)	P.E.T. Pasture (ac-in)	A.E.T. Pasture (ac-in)	Pasture to Pond (ac-in)	Rainfall Citrus (ac-in)	P.E.T. Citrus (ac-in)	A.E.T. Citrus (ac-in)	Net Irr. Citrus (ac-ft)	Gross Irrig. Citrus (ac-ft)	Lost Irr. (ac-ft)	Citrus to Pond (ac-ft)	Rainfall Pond (ac-in)	Pot. Pond Ev. (ac-in)	Theor. Max. Vol – Evap (ac-ft)	Pond Volume –Irrg (ac-ft)	Overflow from Pond (ac-ft)	E.O.M. Pond Volume (ac-ft)
Oct.	66.0	54.2	214	183	130	7.0	1196	741	741	5.2	7.0	1.7	43.1	85	31	108.9	101.9	-47.7	54.2
Nov.	66.0	54.2	89	109	54	2.9	497	506	506	17.5	23.4	5.8	16.8	36	39	73.6	50.2	0.0	50.2
Dec.	65.7	50.2	81	65	47	2.8	452	358	358	8.0	10.7	2.7	15.9	32	63	66.3	55.6	-1.4	54.2
Jan.	66.0	54.2	78	58	45	2.7	435	352	352	8.2	11.0	2.7	15.1	31	81	67.9	56.9	-2.7	54.2
Feb.	66.0	54.2	122	57	57	5.4	681	305	305	0.0	0.0	0.0	31.4	49	92	87.3	87.3	-33.1	54.2
Mar.	66.0	54.2	128	140	79	4.1	719	605	605	15.3	20.4	5.1	24.8	51	85	80.4	60.0	-5.8	54.2
Apr.	66.0	54.2	81	191	56	2.1	455	737	737	37.3	49.8	12.4	13.8	32	84	65.8	16.0	0.0	16.0
May	63.6	16.0	130	262	94	3.0	728	959	814	29.0	38.7	9.7	21.8	52	77	38.7	0.0	0.0	0.0
June	62.5	0.0	251	292	174	6.4	1404	1057	1057	17.9	23.9	6.0	46.9	100	65	56.3	32.4	0.0	32.4
July	64.6	32.4	305	326	215	7.5	1707	1183	1183	13.1	17.4	4.4	56.7	122	54	102.2	84.8	-30.6	54.2
Aug.	66.0	54.2	280	303	194	7.2	1568	1111	1111	14.6	19.4	4.9	52.6	112	35	120.4	101.0	-46.8	54.2
Sept.	66.0	54.2	300	247	190	9.2	1678	932	932	0.0	0.0	0.0	62.2	120	29	133.1	133.1	-78.9	54.2
		Totals	2057	2234	1334	60.3	11520	8846	8701	166.2	221.6	55.4	401.1	823	736	1000.8	779.2	-247.0	44.3

0 = PASTURE W.B. 0 = CITRUS W.B 0 = POND W.B.

ACRES -> 40 AC OF PASTURE 224 ACRES OF CITRUS 16 AC OF POND

Table 33-1

	AA	BB	CC	DD		EE	FF	GG	HH	II
	Rainfall	P.E.T.	Eff. Rain	P.E.T.		N.I.R.	Eff. Rain	Pan. Evap.	P.E.	
Oct.	5.34	4.57	3.25	3.31	Irr. Coeff. = 0.75	0.29	3.03	2.47	1.92	Volume routed to the Pond (ac-ft) = 461
Nov.	2.22	2.72	1.36	2.26		0.94	1.32	3.16	2.45	
Dec.	2.02	1.62	1.17	1.60		0.43	1.17	5.07	3.93	
Jan.	1.94	1.46	1.12	1.57		0.44	1.13	6.55	5.08	% Reduction of offsite discharge = 46
Feb	3.04	1.43	1.43	1.36		0.00	1.36	7.40	5.74	
Mar	3.21	3.51	1.97	2.70		0.82	1.88	6.81	5.29	
Apr	2.03	4.77	1.40	3.29		2.00	1.29	6.78	5.26	
May	3.25	6.56	2.36	4.28		2.21	2.08	6.24	4.84	
June	6.27	7.30	4.34	4.72		0.96	3.76	5.21	4.04	
July	7.62	8.15	5.37	5.28		0.70	4.58	4.38	3.40	
Aug.	7.00	7.58	4.84	4.96		0.77	4.18	2.83	2.20	
Sept.	7.49	6.17	4.74	4.16		0.00	4.16	2.37	1.84	
Totals	51.43	55.84	33.35	39.49		9.56	29.94	59.27	46.00	= Estimated annual lake evaporation
	(Inches)	Pasture (inches)	Pasture (inches)	Citrus (inches)		Citrus (inches)	Citrus (inches)		Pond (inches)	

33.5 References

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PART XIII
METHODOLOGIES FOR CALCULATING PEAK DISCHARGE

34.0 Methodologies for Calculating Peak Discharge

34.1 Rainfall

(a) Duration: See subsection 3.2.1 of this Manual for duration to be used.

(b) Frequency: See subsection 3.2.1of this Manual for frequency to be used.

(c) Intensity: See section 36.0 of this Manual for discussion of rainfall intensity and distribution.

34.2 Antecedent Moisture Conditions

Use average wet season (AMC II). This average condition is defined by SCS as 1.4 to 2.1 inches of rainfall in the five day period prior to a storm event. Further information on antecedent moisture can be obtained in USDA, Soil Conservation Service, 1972. National Engineering Handbook, section 4, Hydrology.

34.3 Upper Soil Zone Storage

Soil storage is taken into account through use of the SCS curve number (see section 34.8). In areas of sandy soils, the standard SCS method may not accurately predict the available soil storage. A shallow water table or hardpan confining layer may reduce the amount of available soil storage. A deep water table and no confining layer will allow storage of a large amount of water in the soil.

For projects on sandy soils where the depth to the average wet season water table or to a confining layer has been accurately determined, the original curve number may be modified to reflect these conditions.

34.4 Surface Storage

Surface storage in depressional areas may be considered if stage-storage calculations are included. Discharge from these areas during storm events must also be considered and appropriate stage-discharge calculations must also be provided.

34.5 Time of Concentration

Many of the accepted runoff computation methods require determination of the time of concentration. A recommended method for this is described in publications of the Soil Conservation Service (TR 55, Chapter 3 and National Engineering Handbook, Section 4, Chapter 15). It involves dividing the flow into three types: overland, storm sewer, and channel flow.

(a) Overland flow: The travel time for overland flow is the time it takes water to travel from the uppermost part of the watershed to a storm sewer system or defined channel. This type of flow is significant in small watersheds because a higher proportion of the travel time is due to overland flow. If the slope and land use of the overland segment are known, the average flow velocity can be read from Figure 34.5-1. The travel time is then computed by dividing the overland flow length by the average velocity.

(b) Storm sewer flow: The average flow velocity in storm sewers can be determined during Manning's equation with average conduit sizes and slopes. The travel time through the storm sewers is computed by dividing the length of flow by the average velocity.

(c) Channel flow: The average velocity in an open channel can be determined using Manning's equation (see section 36.3). Flow depth to be used can be the design flow or bankfull flow. The travel time in an open channel is computed by dividing the channel length by the average velocity.

34.6 Tailwater Conditions

Receiving water stage can affect the amount of flow which will discharge from the project to the receiving water. This stage may be such that tailwater exists in portions of the project system, reducing the effective flow or storage area. Typical examples of this are illustrated in Figures 34.6-1 (gravity) and 34.6-2 (pumped).

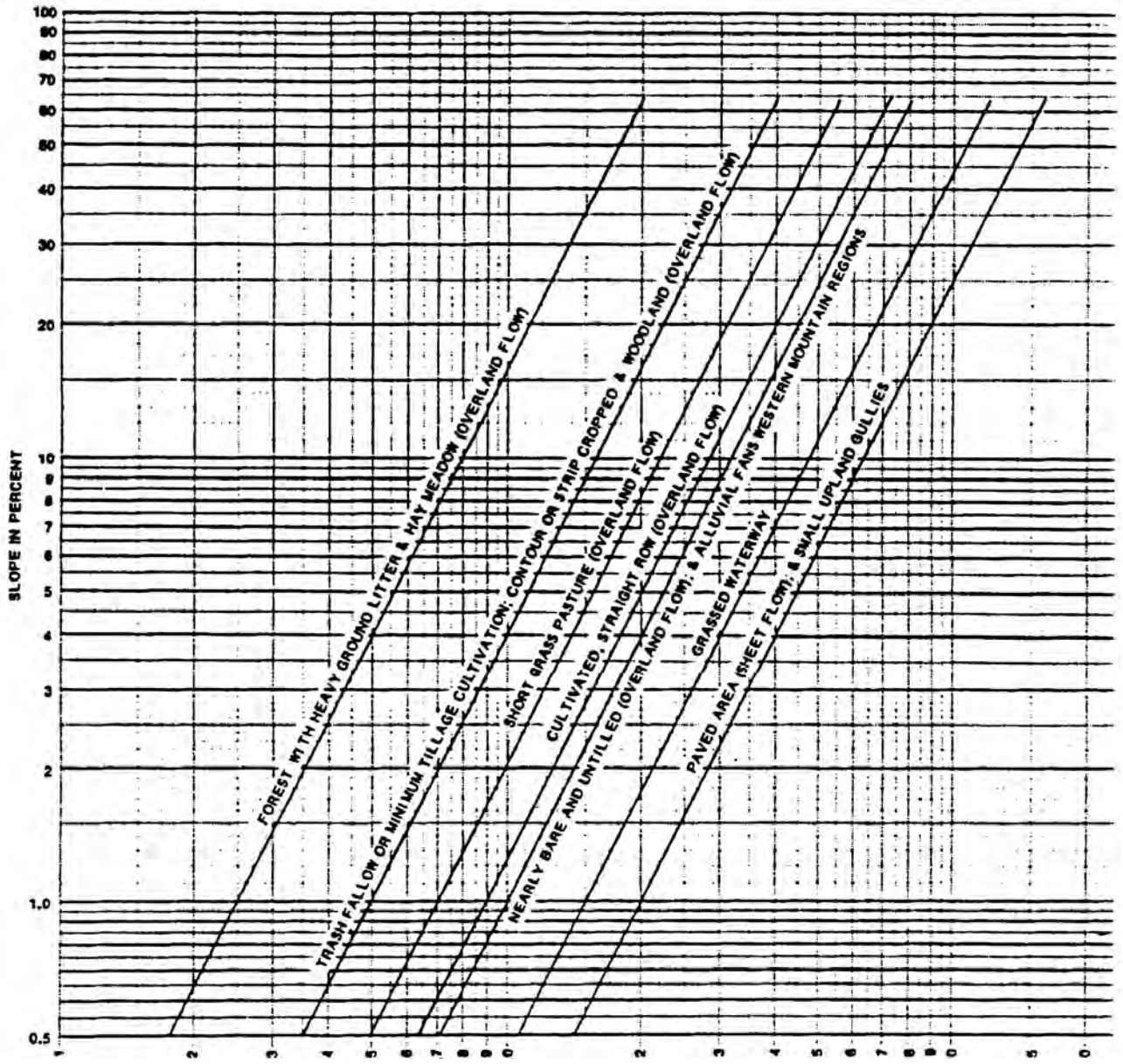


Figure 34.5-1 Velocity in feet per second

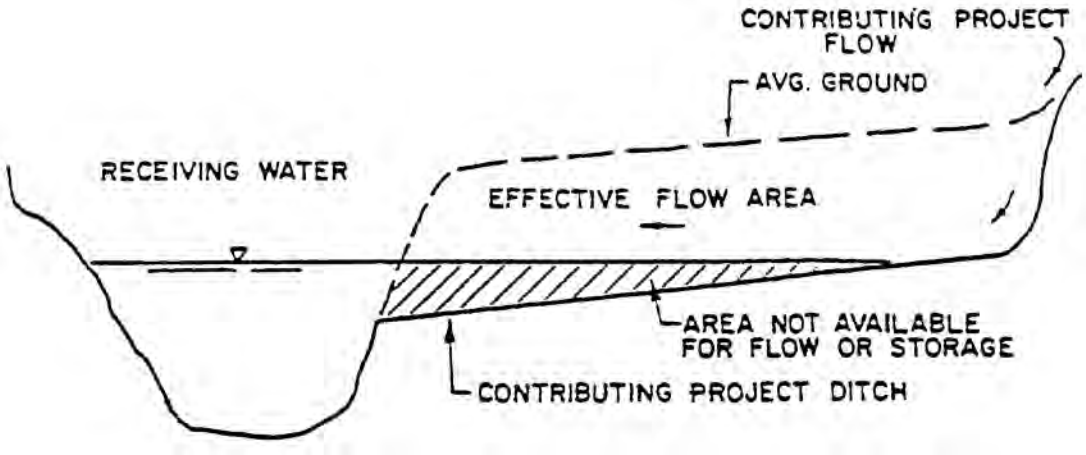
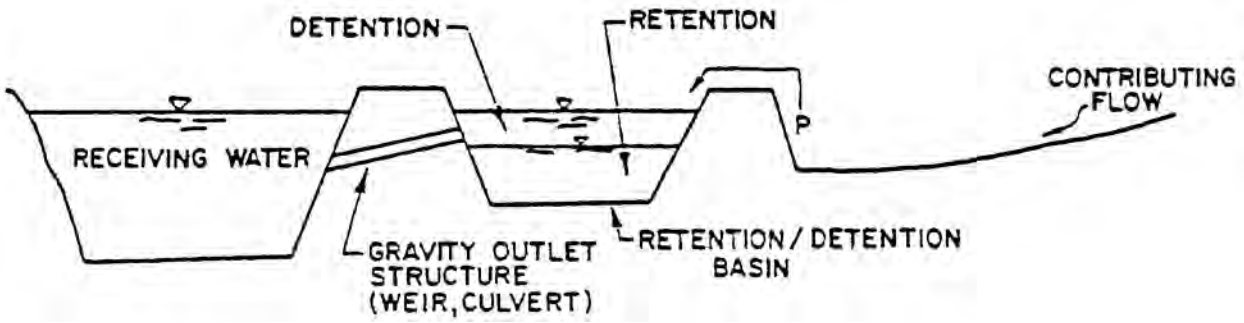


Figure 34.6-1

The stage in the receiving water should be considered to be the maximum stage which would exist in the receiving water from a storm equal to the project design storm. Lower stages may be used if the applicant can show that the flow from his project will reach the receiving water prior to the time of maximum stage in the receiving water.

Figure 34.6-2



34.7 Changes in Land Use

Post-development conditions will generally include changes in land use and land cover from the pre-development conditions. All curve numbers, calculations of time of concentration, etc. should reflect these changes.

34.8 Runoff Estimation

One of the recommended methods for estimation of runoff volume from rainfall information has been developed by the United States Department of Agriculture's Soil Conservation Service (SCS) (now NRCS).

The runoff equation used by SCS was developed by Victor Mockus and others and presented in the Soil Conservation Service's National Engineering Handbook, Section 4, Hydrology. The relationship between accumulated rainfall and accumulated runoff was derived from experimental data for numerous soils, vegetative cover and land treatment measures.

The equation is:

$$R = \frac{(P - Ia)^2}{(P - Ia) + S}$$

where: R = accumulated direct runoff (inches)
P = accumulated rainfall (inches)
Ia = initial abstraction including surface storage, interception, and infiltration prior to runoff (inches)
S = potential maximum retention (inches)

The relationship between Ia and S was developed from experimental watershed data. The empirical relationship used in the SCS runoff equation is:

$$Ia = 0.2S$$

Substituting 0.2S for Ia in the runoff equation, above, yields:

$$R = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

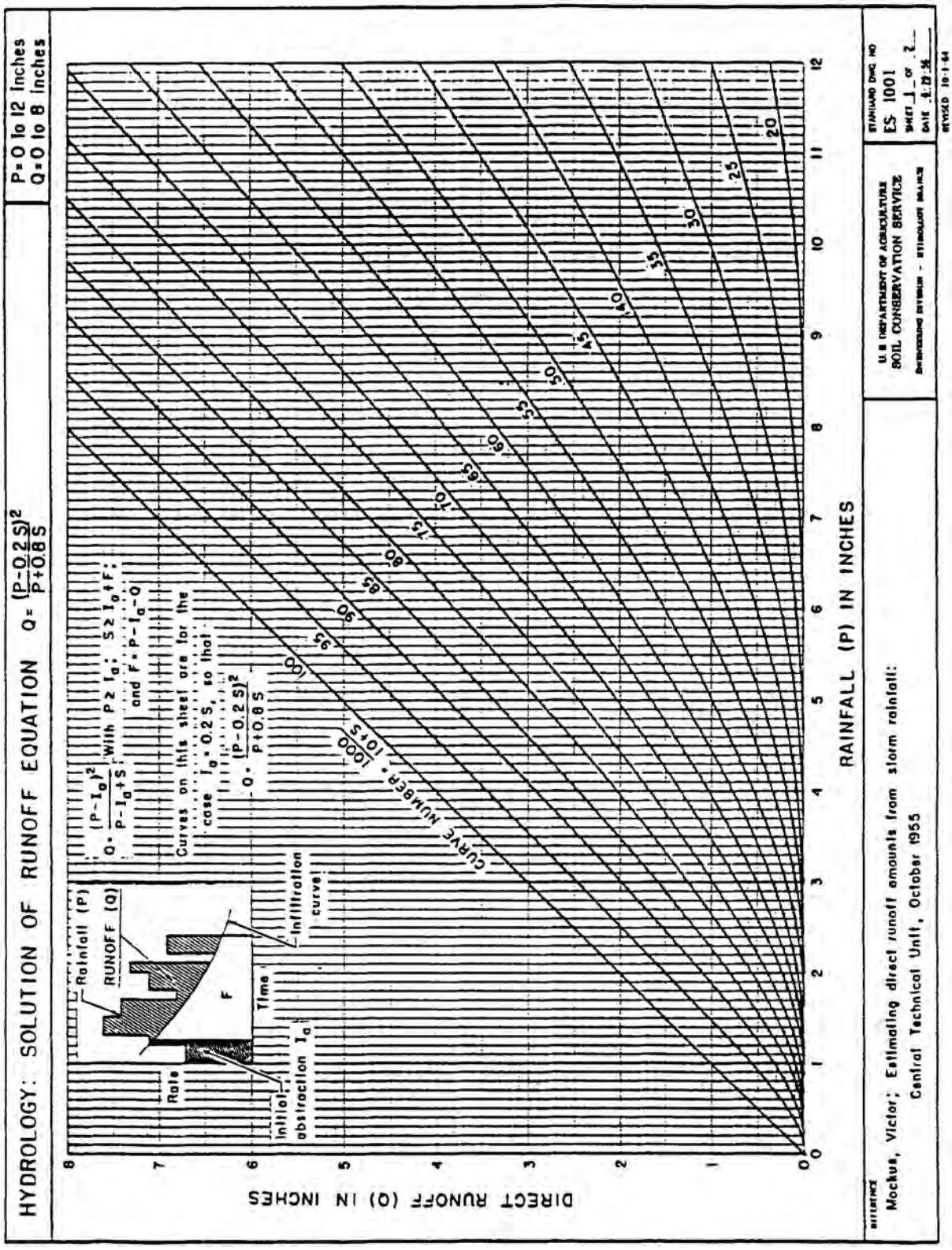

HYDROLOGY: SOLUTION OF RUNOFF EQUATION $Q = \frac{(P-0.2S)^2}{P+0.8S}$
P=0 to 12 inches
Q=0 to 8 inches
DIRECT RUNOFF (Q) IN INCHES
RAINFALL (P) IN INCHES
CURVE NUMBER = 1000/(10+S)
Rainfall (P)
RUNOFF (Q)
F
Time
Infiltration curve
Rate
Initial abstraction I_a
$Q = \frac{(P-I_a)^2}{P-I_a+S}$ With $P \geq I_a$; $S \geq I_a + F$; and $F = P - I_a - Q$
Curves on this sheet are for the case $I_a = 0.2S$, so that $Q = \frac{(P-0.2S)^2}{P+0.8S}$
Mockus, Victor; Estimating direct runoff amounts from storm rainfall: Central Technical Unit, October 1955
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
STANDARD DWG NO
ES- 1001
SHEET 1 OF 2
REVISED 10-1-64

Figure 34.8-1

Table 34.8-1
Peak Discharge / Inch Runoff For Florida
(cfs / inch)

		Drainage Area in Acres											
Slope	CN (Curve Numbers)	2	4	6	8	10	20	40	60	80	100	200	400
Flat	60	1	3	3	4	5	8	14	18	22	25	39	61
	65	2	3	4	5	5	9	15	19	24	27	43	67
	70	2	3	4	5	6	10	16	21	26	30	48	74
	75	2	3	4	5	6	10	17	23	28	33	53	83
	80	2	3	4	6	7	11	19	25	31	36	58	92
	85	2	3	5	6	8	12	21	28	34	40	65	104
	90	2	3	5	6	8	13	23	31	38	45	74	118
	95	2	4	5	7	8	15	26	35	43	51	85	138
Moderate	60	2	3	5	6	7	12	21	28	34	40	64	102
	65	2	3	5	6	7	13	22	30	37	43	70	112
	70	2	3	5	6	8	14	23	32	40	47	76	123
	75	2	4	5	7	8	14	25	34	43	50	83	135
	80	2	4	5	7	8	15	27	37	46	54	91	148
	85	2	4	5	7	9	16	29	40	50	59	100	164
	90	2	4	6	7	9	17	31	43	54	64	110	184
	95	2	4	6	8	9	18	33	47	59	71	123	208
Steep	60	2	4	5	7	9	16	28	39	49	59	98	162
	65	2	4	6	7	9	17	30	42	52	62	106	175
	70	2	4	6	7	9	17	31	44	55	66	113	189
	75	2	4	6	8	9	18	33	46	58	70	121	204
	80	2	4	6	8	9	18	34	48	61	74	129	221
	85	2	4	6	8	9	19	35	50	65	78	139	240
	90	2	4	6	8	9	19	36	53	68	83	149	261
	95	2	4	6	8	9	19	37	55	72	88	161	287

Source: USDA, SCS "Interim Runoff Procedure for Florida," Florida Bulletin 210-1-2

A graphical solution of this equation is shown in Figure 34.8-1. The S values are transformed into curve numbers (CN) by the following equation:

$$CN = \frac{1000}{S + 10}$$

Peak discharges can be determined from the runoff volume using Table 34.8-1. Peak discharge (cfs) per inch of runoff volume are given for various drainage areas, slopes and curve numbers. This table should be used for watersheds of less than 600 acres. Larger or non-homogeneous watersheds should be subdivided into hydrologic sub-areas and their peak discharges determined by any of the flood-routing methods listed in subparagraphs 3.2.3(a)(1)-(4) of this Manual.

These peak discharges can be further modified to account for parameters such as actual land slope, watershed shape and depressional surface storage. Further information concerning the use of these modifications is given in the sample problems at the end of this section and in reference number six.

34.9 Detention Basin Design

One of the most common procedures for assuring that post- development peak discharge rates do not exceed pre-development rates is the use of detention basins. These basins store the runoff and release it off-site through a control structure at the required rate. Detention is defined as the collection and temporary storage of stormwater with subsequent gradual release at a specified rate. In addition, the purpose of detention basins can be expanded to include partial treatment to improve water quality by removal of pollutants. Retention and filtration, if properly designed, are the primary techniques used to accomplish these means. Retention is defined as the prevention of discharge of a given volume of stormwater runoff by complete on-site storage. Removal of the water is caused only by percolation, evaporation, or evapotranspiration. Filtration is the selective removal of suspended matter from stormwater by passing it through fine textured granular media such as porous soil, sand and gravel, or other aggregate, which may be used in conjunction with filter fabric and/or underdrain pipe.

The following discussion relates to detention only and the water quantity considerations involved in design. For water quantity control, detention basins require some type of spillway outlet structure. This may be a culvert, weir, or vegetated overflow. These control structures must be designed to discharge at a rate not to exceed the pre-development rate for the required design storm. Discharge rates are a function of the headwater in the basin and the tailwater outside the basin. Tailwater conditions outside the basin should be considered to be the maximum stage which would exist in the receiving water from a storm equal to the project design storm. Lower stages may be used if the applicant can show that the flow from his project will reach the receiving water prior to the time of maximum stage in the receiving water. The headwater in the basin is a function of the inflow, available

storage, and outflow. Modeling of the relationships between these variables can be accomplished using any conventional flood routing technique. Stage-storage and stage-discharge curves for the basin and outlet structure are required. When constructing a stage-discharge curve, it must be determined what portion of the outlet structure will control the flow rate for various headwater conditions. For example, a culvert with a flashboard riser will initially be controlled by the capacity of the riser (weir control). As headwater increases the control will shift to the hydraulic capacity of the culvert (pipe control). Culvert flow may be controlled by the entrance conditions (inlet control) or the tailwater conditions (outlet control). In all the above situations, whichever control allows the smallest discharge must be used.

Basin criteria require that when designing an outlet structure to control discharge for a large storm event (25-year frequency) the structure's performance during less severe storm events (10-year frequency) must also be checked. If an outlet is sized to meet the pre- and post-development peak discharge criteria for a 25-year storm event, during a 10-year event the headwater/tailwater condition may be such that the structure will discharge substantially more than the pre-development peak rate. This is illustrated in the following example:

On-site storage is to be provided to meet the pre-and post-development peak discharge criteria for the 10- and 25-year frequency storms (see Figure 34.9-1). The 25-year pre-development discharge is 100 cfs and the 10-year is 50 cfs. The 25-year tailwater elevation in the receiving water is 10.0 ft. and the 10-year is 5.0 ft. The detention basin has a 48" CMP outlet and is sized so that the 25-year stage is elevation 12.5 ft. and the 10-year is 9.0 ft. This gives a 25-year outflow of 100 cfs for 2.5 feet of head and outlet control. Checking the outflow for the 10-year storm gives a discharge of 65 cfs for 4 feet of head and inlet control, an increase over the 50 cfs pre-development flow.

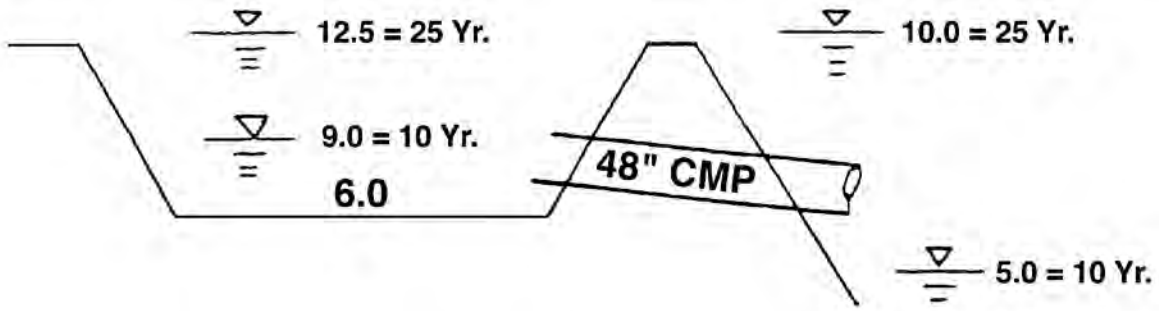


Figure 34.9-1

In a situation such as this it may be necessary to use a smaller pipe or revise the outlet structure design to incorporate additional features such as a two-stage outlet. This will insure that pre-development discharge does not exceed post-development discharge for both the 10-year and 25-year storm events.

Another requirement for detention basins is to be able to draw down the water level to restore storage capacity within a maximum of 14 days following a storm event. If this cannot be accomplished with the primary outlet structure, a small bleed-down pipe equipped with gate valve may be required.

Other recommended design considerations include:

(a) anti-vortex devices on riser culverts;

(b) basin side slopes of 4:1 or flatter;

(c) maximum depths of four to six feet over 80% of the basin area;

(d) seeding and mulching, if necessary, of all exposed earth surfaces;

(e) erosion control measures at the spillway inlet and outlet;

(f) layouts which avoid rectangular shapes and blend in with the natural contours;

(g) provisions should be made for prompt maintenance including mowing of vegetation and visual inspection of the outlet structure for possible problems; and

(h) trash racks on the outlet structure if the possibility exists for debris to accumulate and block the opening.

34.10 References

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PART XIV
METHODOLOGIES FOR CALCULATING RAINFALL DATA

35.0 Methodologies for Calculating Rainfall Data

35.1 24-Hour Storms

35.1.1 Rainfall depth: Rainfall depths for 24-hour duration events can be found in any of the sources listed in paragraph 3.2.6(a) of this Manual.

35.1.2 Rainfall Distributions: For 24-hour rainfall events, recommended methods for distribution of this rainfall throughout the 24 hours are:

(a) A statistical analysis of the historical hourly rainfall data.

(b) The SCS-Type II distribution: This method has been described in the SCS TP-149 publication (see Reference 11). See Table 35.1-1 for a breakdown of this distribution. The accumulative distribution is shown in Figure 35.1-1.

(c) The SCS Interim Runoff Procedure for Florida (Modified NRCS-Type II Distribution): This method is described in an SCS report by Roger Cronshey, Hydraulic Engineer (May 1980). This distribution was developed on the same lines as the SCS type II rainfall, but uses the data from HYDRO-35. A generalized depth-duration curve was derived for the State of Florida in the form of ratios of t-hour depth to 24-hour depth. The ratios are given by:

$$\text{Ratio} = 0.5\ t^{0.74} \quad 0 < t < .65 \text{ hrs.}$$

$$\text{Ratio} = 0.411\ t\ 0.28 \quad 0.65 \text{ hr.} < t < 24 \text{ hrs.}$$

in which t = duration in hours. Incremental depths (for the required time step) are calculated on the basis of the foregoing relations and rearranged so that the largest depth occurs prior to 12 hours in the distribution. The second largest is placed after the first and the third placed before the first. Alternating the remaining rainfall amounts continued in the same manner until the entire 24-hour distribution has been established. See Table 35.1-1 for a breakdown of this distribution.

Table 35.1-1. Rainfall Ratios (Accumulated Total/24 Hour Total)

Time (hr.)	NRCS Type II	NRCS Type II FL. Modified
0.0	.000	.000
0.5	.005	.006
1.0	.011	.012
1.5	.017	.019
2.0	.022	.025
2.5	.029	.032
3.0	.035	.039
3.5	.042	.047
4.0	.048	.054
4.5	.056	.062
5.0	.064	.071
5.5	.072	.080
6.0	.080	.089
6.5	.090	.099
7.0	.100	.110
7.5	.110	.122
8.0	.120	.134
8.5	.134	.148
9.0	.147	.164
9.5	.163	.181
10.0	.181	.201
10.5	.204	.226
11.0	.235	.258
11.5	.283	.308

12.0	.663	.607
12.5	.735	.719
13.0	.772	.757
13.5	.799	.785
14.0	.820	.807
14.5	.835	.826
15.0	.850	.842
15.5	.865	.857
16.0	.880	.870
16.5	.889	.882
17.0	.898	.893
17.5	.907	.904
18.0	.916	.913
18.5	.925	.923
19.0	.934	.931
19.5	.943	.940
20.0	.952	.948
20.5	.958	.955
21.0	.964	.962
21.5	.970	.969
22.0	.976	.976
22.5	.982	.983
23.0	.988	.989
23.5	.994	.995
24.0	1.000	1.000

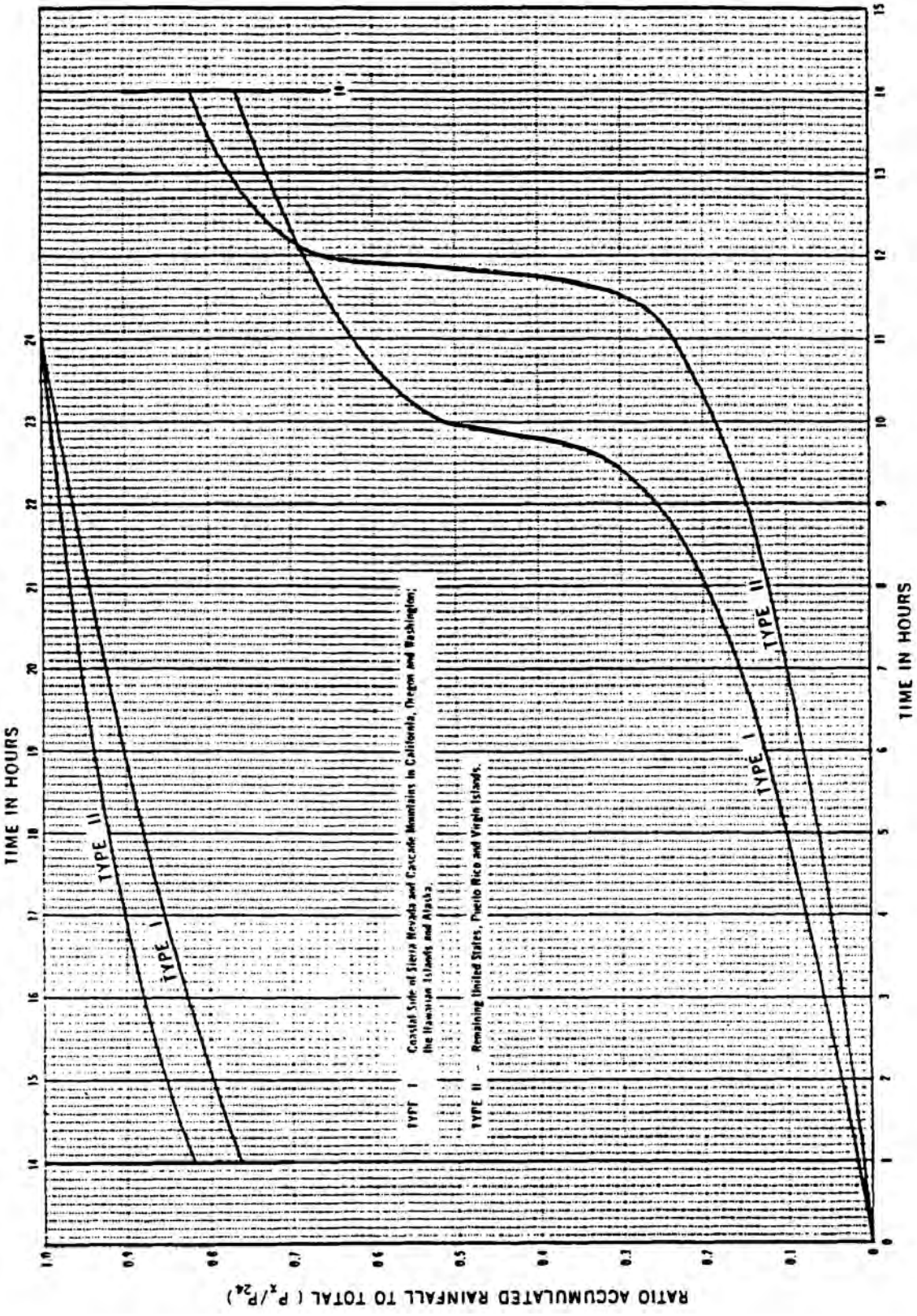
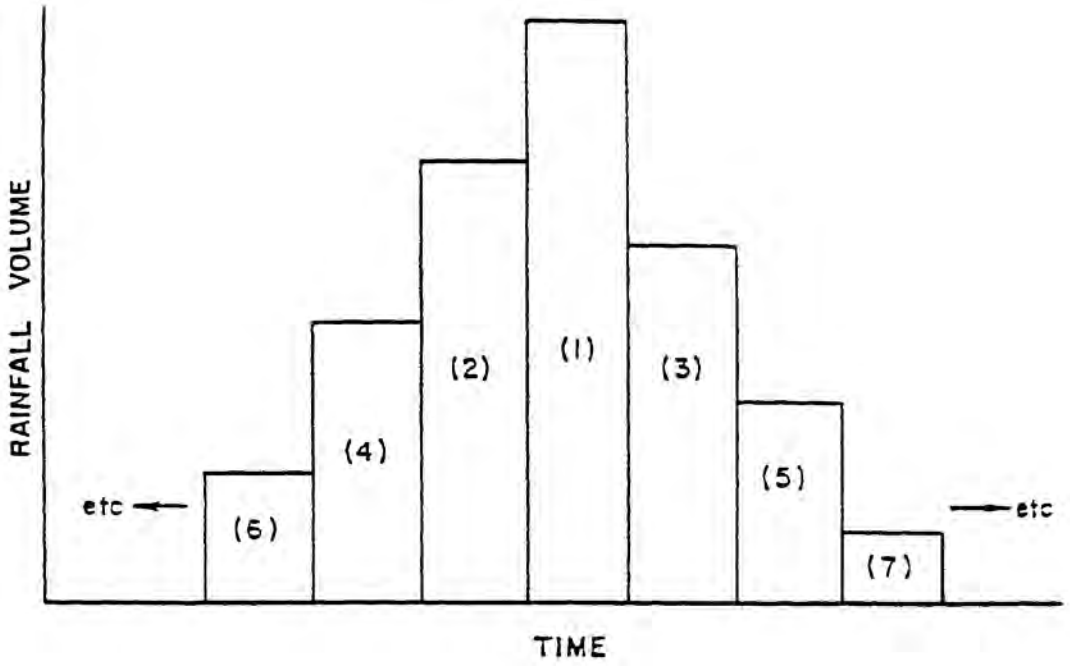


Figure 35.1-1 Twenty-four Hour Rainfall Distribution (SCS)

Figure 35.1-2 Arrangement of Incremental Depths in a Synthetic Storm (HEC-1)



(d) Derivation from depth-duration curve (HEC-1 Type): When depth-duration data are available, HEC-1 manual recommends the following procedure:

1. Compute incremental precipitation depths at the desired time steps, and

2. Rearrange incremental depths so that the second largest value precedes the largest value, the third largest value follows the largest value, the fourth largest precedes the second largest, etc. This arrangement is shown in Figure 35.1-2. Numbers (1), (2), etc. in Figure 35.1-2 represent the order of incremental depths with (1) for the largest.

(e) HEC-1 PMP (Probable Maximum Precipitation) type distribution: The HEC-1 Manual describes the following procedure for distributing PMP.

1. Divide each 24-hour period into four 6-hour periods and distribute 24-hour rainfall according to the following ratios among 6-hour periods:

First 6 hour period: $\frac{0.4(R24 - R12)}{R24}$

Second 6-hour period: $\frac{(R12 - R6)}{R24}$

Third 6-hour period: $\frac{R6}{R24}$

Fourth 6-hour period: $\frac{0.6(R24 - R12)}{R24}$

in which R6, R12, and R24 are the maximum 6-hour, 12-hour, and 24-hour rainfall amounts, respectively.

2. Assume uniform distribution in each 6-hour period except during the peak 6-hour period.

3. For distributing the peak 6-hour rainfall, the HEC-1 manual provides default values. These default values may be used only if other satisfactory distribution is not available.

(f) Any other generally accepted and well documented method.

35.2 Four Day Storms

35.2.1 Rainfall Depth: The District has developed a dimensionless four day rainfall distribution in terms of the peak 24-hour rainfall. This is presented in subsection 35.2.3. The applicant may use this distribution or may develop his own as described in the following sections.

Rainfall depths for a given return period can be obtained either from the generalized charts published by the National Weather Service or by detailed statistical analysis of station data. The NWS publications HYDRO-35 (1977), TP-40 (1961), and TP-49 (1964) generalized charts published by the National Weather Service or by detailed statistical analysis of station data. The NWS publications HYDRO-35 (1977), TP-40 (1961), and TP-49 (1964) provide the necessary generalized data. HYDRO-35 provides 5-, 10-, 15-, 30-, and 60-minute rainfall values; TP-40 provides 2-, 3-, 6-, 12-, and 24-hour values, while TP-49 provides 2-, 4-, 7-, and 10-day values. TP-40 also includes 30-minute and 1-hour values, but these should be ignored since HYDRO-35 contains updated data.

Considerable additional data have been added since the publication of TP-40 and TP-49 for rain gage stations throughout the District. Thus, the estimates of rainfall

depths based on present data may be regarded as more accurate. However, while the determination of rainfall depths by statistical analysis is encouraged, the designer should exercise care in judiciously selecting the necessary techniques since these are not standardized. The following example illustrates some of the available procedures.

Example: Determine 100-year rainfall depths for different durations for the City of Palatka.

(a) Rainfall depths from the NWS charts.

The following rainfall depths are read from the NWS publications:

Table 35.2-1

Duration	100-Year Rainfall Depth (inches)	Source
5 minutes	0.85	HYDRO-35
10 minutes	1.53	HYDRO-35
15 minutes	2.00	HYDRO-35
30 minutes	3.18	HYDRO-35
60 minutes	4.40	HYDRO-35
2 hours	5.2 (5.4)	TP-40
3 hours	6.0	TP-40
6 hours	7.1	TP-40
12 hours	8.9 (8.5)	TP-40
24 hours	10.4 (10.2)	TP-40
2 days	12.2	TP-49
4 days	14.5	TP-49

Plot a rainfall depth-duration curve with the above data on a log-log graph paper and smoothen the values for consistency. The depth-duration curve for the above data (Table 35.2-1) shows that the 2-hour, 12-hour, and 24-hour values should be slightly adjusted; the adjusted values are shown in parentheses in the above table.

(b) Rainfall Depths by Statistical Analysis

This method consists of deriving annual series of maximum precipitation for each duration from the observed data and conducting frequency analysis on the annual series of data. However, most stations in the District, including Palatka, have only non-recording rain gages which provide "observational-day" amounts. Thus, data for less than 24 hours are not available for most stations. Even for 24-hour and greater durations, the observational-day amounts need to be adjusted to obtain n-hour precipitation because the actual storms do not exactly confine to observational-days. For example, the 24-hour maximum rainfall of a given year may commence to occur at any clock hour of an observational-day and extend into the next observational-day. As a result, this rainfall amount will be reported on two observational-days. If no other rainfall is associated, all of the rainfall reported on the two consecutive days comes from this 24-hour event; this is an extreme case. In practice, the observational-day amounts are converted into n-hour values either by multiplying the former by a factor or by adding a portion of the adjacent day rainfall to the former. In the present example (Palatka data), 1-, 2-, 3-, and 4-(observational) day maximum rainfall amounts were converted into 24-, 48-, 72-, and 96-hour precipitation by adding one half of the larger adjacent day precipitation as recommended by Hershfield (1963). Results of frequency analysis by log Pearson type 3 distribution (Rao, 1980) are shown below:

Table 35.2-2. Rainfall Frequency Analysis for Palatka (1949-1980)

Duration	Rainfall Depth for Return Period			Maximum Values	
	10 yr	25 yr.	100 yr.	Observed	N-Hour
(1)	(2)	(3)	(4)	(5)	(6)
24-hr	7.0 (7.0)	8.9 (8.2)	12.2 (10.4)	8.6	11.3
48-hr	7.7 (8.1)	9.8 (9.9)	13.5 (12.2)	14.1	14.5
72-hr	8.7	11.1	15.4	14.9	16.5
96-hr	9.6 (9.5)	12.3 (11.8)	17.1 (14.5)	18.1	18.2

The NWS values are shown in parentheses (Cols. 2-4) for a comparison. A comparison of 100-year rainfall estimates with maximum observed values (Col. 5) indicates that the NWS values are underestimates. For obtaining consistency of results, the NWS suggests to plot the values obtained by frequency analysis as a depth duration curve on a log-log graph paper and smoothen the curve if necessary. This is shown for 100-year values in Figure 35.2-1 (dashed line). The 24-hour value falls away from the line, thus this value needs adjustment. The (dashed) line is extended backwards until it smoothly joined the NWS curve in the less-than-24-hour portion. The

accepted curve consists of the dashed portion, and the NWS curve for other durations. The values read from the accepted curve are as follows:

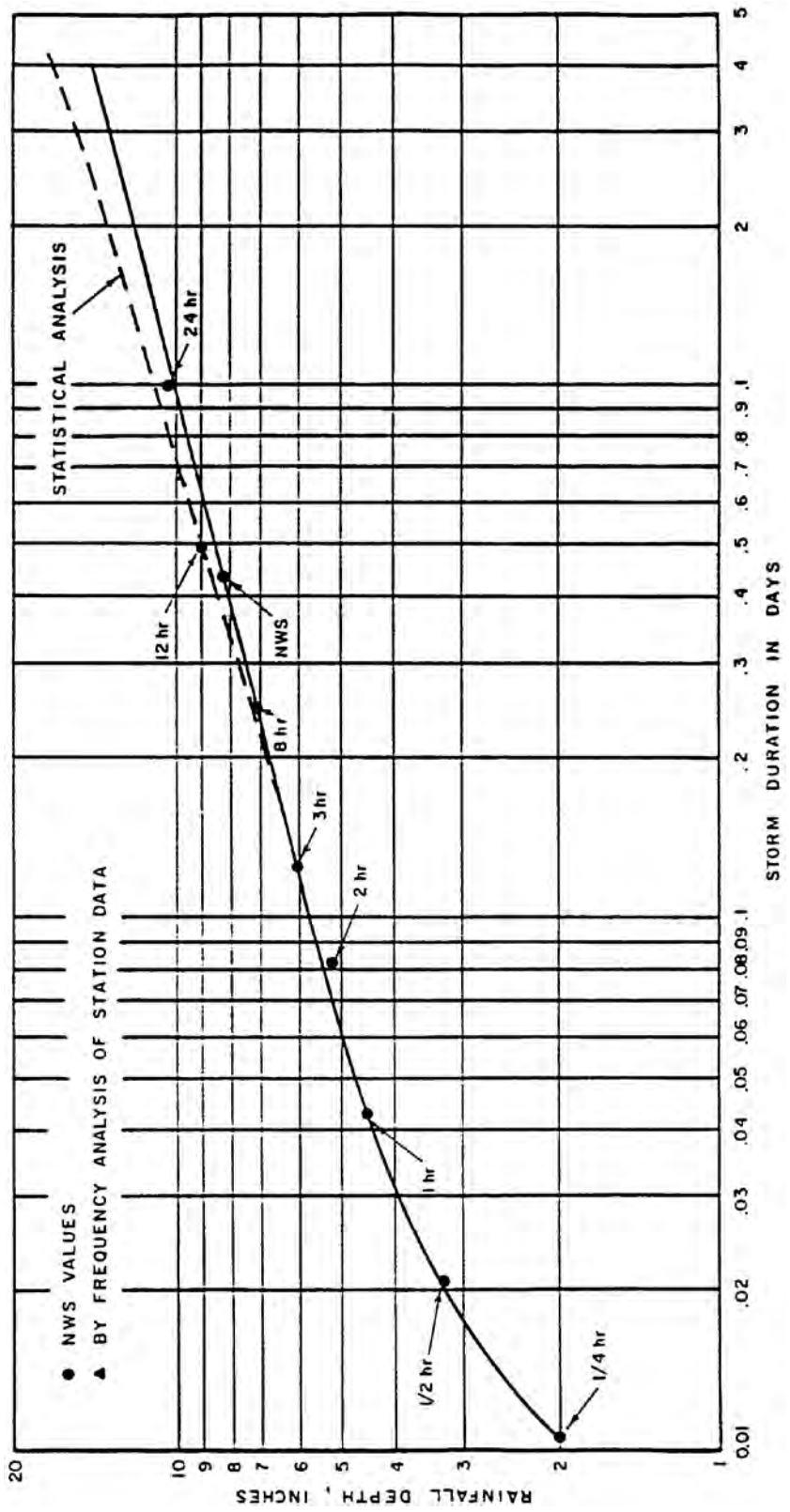


Figure 35.2-1 Rainfall Depth Duration Curve for Palatka (T=100 Yr.)

TABLE 35.2-3

Duration	100-Yr. Rainfall (Inches)
5 minutes	0.85 (Accepted from HYDRO-35)
10 minutes	1.53 (Accepted from HYDRO-35)
15 minutes	2.0 (Accepted from HYDRO-35)
30 minutes	3.2 (Accepted from HYDRO-35)
60 minutes	4.4 (Accepted from HYDRO-35)
2 hours	5.4
3 hours	6.0
6 hours	7.3
12 hours	8.9
24 hours	11.1
48 hours	13.5
72 hours	15.4
96 hours	17.1

35.2.2 Rainfall Distribution

The 4-day duration rainfall distribution shall be calculated assuming:

(a) The maximum 24-hour rainfall occurs on day three of the 4-day duration storm;

(b) Difference between the 2-day rainfall and the 24-hour rainfall occurs on day two, and;

(c) The difference between the 3-day rainfall and the 2-day rainfall occurs on day four;

(d) The difference between the 4-day rainfall and the 3-day rainfall occurs on the first day.

Example: For the City of Palatka, for the values determined by frequency analysis the 24-hour, 100-year depths are as follows:

Time (hrs)	Rainfall Depth (in.)	Incremental Depth (in.)
24	11.1	11.1
48	13.5	2.4
72	15.4	1.9
96	17.1	1.7

The four day distribution as suggested above is shown in Figure 35.2-2.

The distribution for each day of the four day period shall be calculated:

(a) For day three (maximum 24-hour rainfall) use any one of the methods described in Subsection 35.1.2 for a 24-hour duration.

(b) For other days use the above or a uniform distribution for each day.

35.2.3 Four Day Dimensionless Rainfall Distribution

This distribution has been developed by the District using NWS rainfall amounts and a distribution as described in Subsection 35.2.2. The distribution is in terms of accumulated rainfall as a percentage of the peak 24-hour rainfall. It uses an NRCS Type II distribution on the third day and a uniform distribution for the remaining days. Table 35.2-4 shows this distribution.

Figure 35.2-2 Four Day Rainfall Distribution (Basis COE HEC-1)

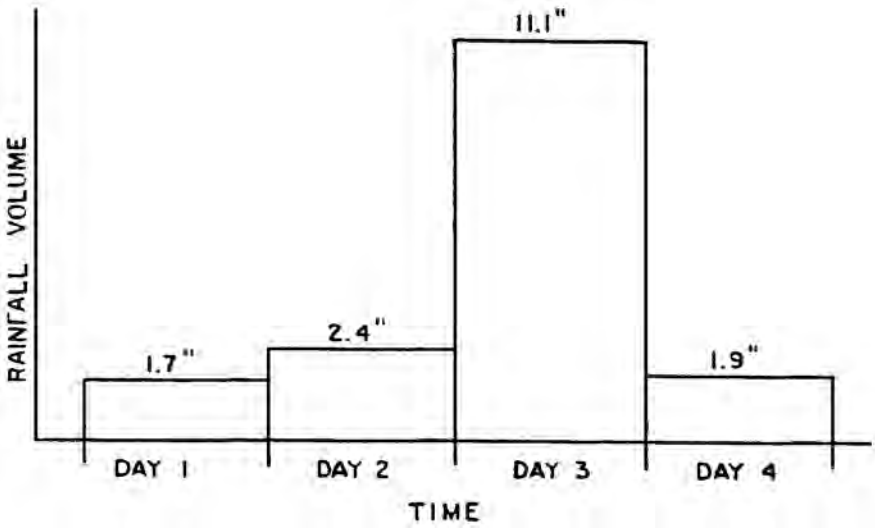

RAINFALL VOLUME
1.7"
2.4"
11.1"
1.9"
DAY 1
DAY 2
DAY 3
DAY 4
TIME

Table 35.2-4

Time (hours)	Accumulated Total/Peak 24 Hour Total (%)
0	0
4	1.4
8	2.8
12	4.2
16	5.6
20	7.0
24	8.4
28	11.7
32	15.1
36	18.4
40	21.7
44	25.1
48	28.4
50	30.6
52	33.2
54	36.4
56	40.4
58	46.5
59	51.9
59.5	56.7
60	94.7
60.5	101.9
61	105.6
62	110.4

64	116.4
66	120.0
68	123.6
70	126.0
72	128.4
76	130.9
80	133.4
84	135.9
88	138.4
92	140.9
96	143.4

35.3 References

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PART XV
PROCEDURES FOR DETERMINATION OF FLOODPLAIN ELEVATIONS AND FLOODWAY ENCROACHMENT LIMITS USING NORMAL DEPTH ANALYSIS

36.0 Procedure for Determination of Floodplain Elevations and Floodway Encroachment Limits Using Normal Depth Analysis

36.1 Introduction

This section provides guidelines for the determination of floodplain elevations and floodway encroachment limits along watercourses where such determinations are not currently available. The procedure recommended is based on a direct application of Manning's equation and is commonly referred to as Normal Depth Analysis.

In order to assess the impact of a proposed project on the water resources (as discussed in section 3.3), the following must be determined: The flood stage elevations and the extent of the floodplain during storms with 10 and 100 year frequencies, and the floodway. The floodway is the channel of a watercourse, plus any adjacent floodplain areas that must be kept free from encroachment in order to convey the 100 year flood without substantial increases in floodstages. A District-wide minimum standard limits the increase in floodstage to a one foot maximum increase.

NOTE: The one foot increase cited above is used in the initial determination of the floodway itself and is not meant to allow subsequent heightening of the 100 year flood elevation, once the limits of the floodway have been so set. That is, in order to determine that portion of the floodplain which will be designated as the floodway, one begins at the outer limits of the floodplain and assumes full development inward, toward the river or stream channel, on both sides of the flood hazard area, until the point is reached where development will cause the 100 year flood elevation to rise by one foot. The area remaining between this boundary and the channel is the floodway, and because any further development here would necessarily increase the 100 year flood elevation by more than one foot, no such development can be permitted.

Normal depth analysis provides a reasonable estimate of flood stages. It is a relatively simple procedure requiring a minimal amount of data. It assumes a uniform flow condition wherein the discharge, waterway cross section, mean velocity, and depth remain essentially constant through a reach of stream. While these circumstances rarely exist under natural conditions, normal depth analysis provides a reasonable close approximation in most cases. The exception is where there is a downstream control such as a bridge or a dam, which obstructs the flow and causes a backwater effect or when non-uniform flow is evident in the stream reach. In those cases, a detailed analysis of the backwater effect and non-uniform flow conditions must be provided by the applicant when establishing the floodplain

and floodway. The use of the Corps of Engineers HEC-2 model for such an analysis is discussed in reference (1) and (2). Any other acceptable method may also be used.

36.2 Data Required for Analysis

The following information is required for the use of normal depth analysis in determining the floodplain elevations during the 10-year and 100-year storms and floodway encroachment limits:

(a) The 10-year and 100-year flood flows: These flood discharges should be determined from a frequency analysis where streamflow data are available. When streamflow data are available, the flood flows can be determined by using regression equation or any other acceptable procedure. The District will, if requested by the applicant, determine the 10-year and 100-year peak discharge.

(b) One or more representative channel cross sections (including channel and overbank flow areas) at the area of interest. The cross section should be taken perpendicular to the direction of the flood flow. The cross section should be representative of the reach of stream in the vicinity of the area of concern. If the stream reach adjacent to the area of interest is more than 300 feet in length, more than one cross section should be taken.

(c) Slope of water surface determined from known flood profiles or average channel bed slope in the reach by field survey. Figure 36.2-1 depicts a typical situation and illustrates some of the data requirements.

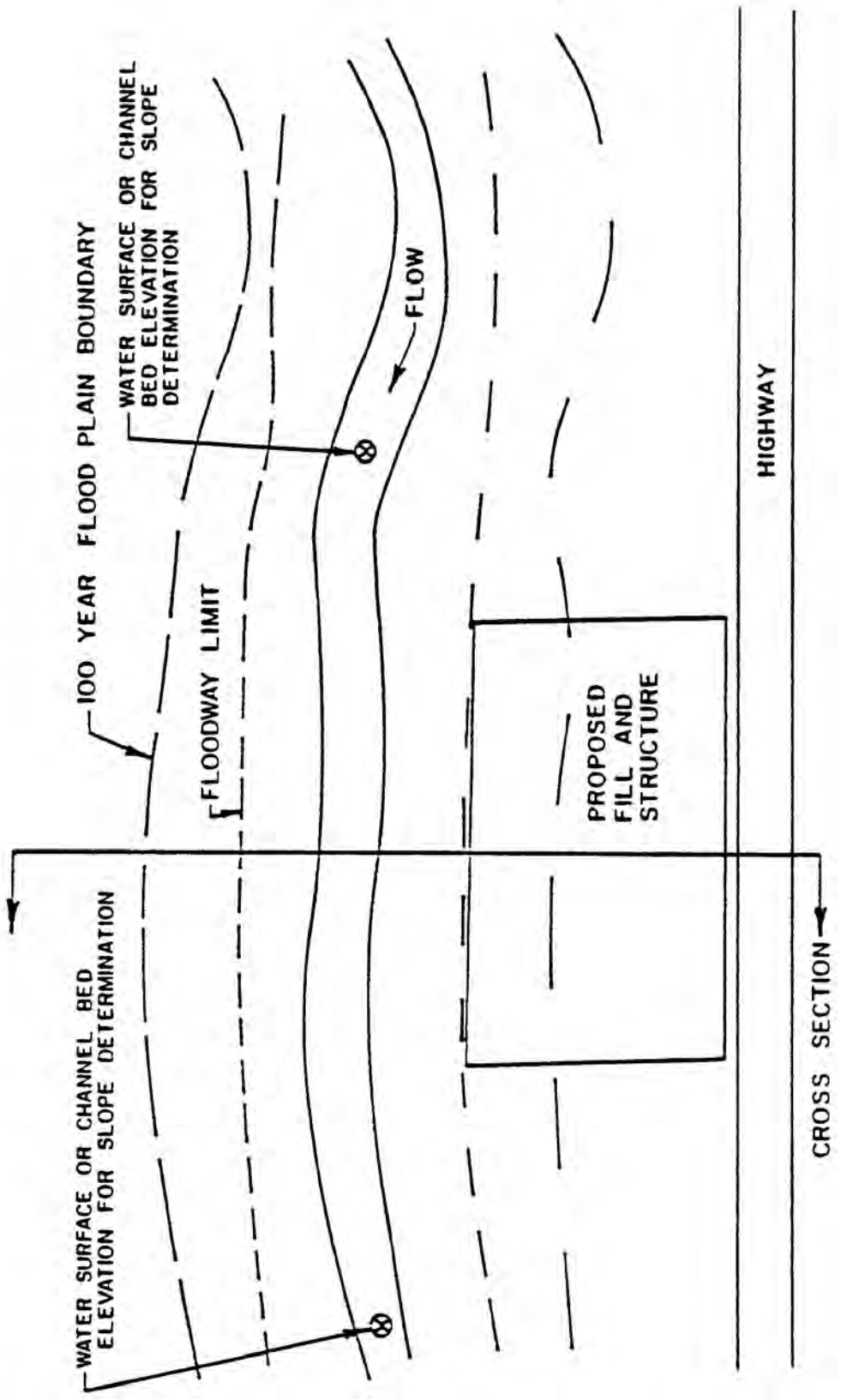

Figure 36.2-1 Typical Floodplain Encroachment

36.3 Manning's Equation

The basic formula in determining flood stage and floodway encroachment limits is Manning's equation:

$$Q = KS^{1/2} = \frac{1.49}{n} AR^{2/3} S^{1/2} \qquad 36\text{-}1$$

in which:

Q = Discharge in cubic feet per second,

K = Conveyance of the channel section = $\frac{1.49}{n} AR^{2/3}$

n = Manning's roughness coefficient,
R = Hydraulic radius in feet = A/P,
A = Cross sectional area through which flow occurs in square feet
P = Wetted perimeter in feet,
S = Slope of the energy gradient of streamflow in feet per foot.

The roughness coefficient "n" in eq. 36-1is to be evaluated from field investigation by an experienced engineer. For further discussion and assistance in the selection of an appropriate "n" value, see Barnes (1967) or Chow (1959).

During uniform flow, the slopes of the energy gradient of streamflow, the water surface profile, and the river bed are equal. As a result, the slope of the energy gradient, S, can be approximated as either the channel bed slope or the water surface slope.

36.4 Procedure for the Determination of Flood Stage

(a) Divide the channel section into several Subsections or segments each having a reasonably uniform roughness coefficient, A_1, A_2, A_3, --A_n as is shown in Figure 36.4-1.

(b) Determine "n" value for each individual Subsection.

(c) Select a flood stage, y_1 as a first estimate.

(d) Determine cross section area, hydraulic radius and compute conveyance, K, for each Subsection based on floodstage y_1.

(e) Calculate the total discharge Q1 that corresponds to the stage y_1; as described in Table 36~~15~~.4-1.

(f) If Q_{100}>Q1, increase flood stage y_2 by small increment.
If Q_{100}<Q1, decrease flood stage y_2 by small increment.
Follow steps (d) and (e) to determine Q_2.

(g) Repeat step (f) until several Q values above and below Q_{100} are established.

(h) Plot a stage vs. discharge curve from which a stage corresponding to Q_{100} can be determined.

Example 1: A representative cross section for a reach of stream adjacent to a newly proposed development is shown in Figure 36.4-1. The roughness coefficients for each segment of the cross section are also shown in the figure. The slope of channel bed in this stream reach is about 0.36%. Determine the 100-year flood elevation for Q_{100}=7,900 cfs.

Solution: Detailed calculation is shown in Table 36~~15~~.4-1 for $y_1$and y_2.

At stage y_1 = 121.0 ft., Q = 7,154 cfs.

At stage y_2 = 122.0 ft., Q = 8,639 cfs.

At stage y_3 = 121.5 ft., Q = 7,875 cfs.

A stage - discharge curve for y_1, y_2, and y_3 is used to estimate the flood stage for Q_{100} as 121.52 ft. (Figure 36.4-2)

TABLE 36.4-1. NORMAL DEPTH ANALYSIS

Stage	Sub-sect no.	A	P	R	$R^{2/3}$	n	k
121.0(y_1)	1	118	44	2.68	1.93	0.07	4,846
	2	120	20	6.0	3.30	0.07	8,427
	3	237	25	9.48	4.47	0.07	22,544
	4	230	24	9.58	4.50	0.035	44,060
	5	160	20	8.0	4.0	0.09	10,592
	6	90	15	6.0	3.30	0.09	4,915
	7	280	40	7.0	3.65	0.09	16,914
	8	144	29	4.97	2.91	0.09	6,935
							119,233

$Q_1 = KS^{1/2} = 119{,}233 \times 0.06 = 7{,}154$ cfs

122.0(y_2)	1	163	47	3.47	2.30	0.07	7,978
	2	140	20	7.0	3.65	0.07	10,874
	3	262	25	10.48	4.8	0.07	26,762
	4	245	24	10.20	4.7	0.035	49,019
	5	180	20	9.0	4.33	0.09	12,899
	6	105	15	7.0	3.65	0.09	6,343
	7	320	40	8.0	4.0	0.09	21,184
	8	174	32	5.44	3.10	0.09	8,927
							143,986

$Q_2 = KS^{1/2} = 145{,}217 \times 0.06 = 8{,}639$ cfs

36.5 Determination of Floodway Limits

To determine floodway encroachment limits, it is first necessary to estimate the total conveyance capacity that can be lost due to encroachment without increasing the 100-year flood stage by more than one foot. Floodway limits are then determined based on the assumption that the entire conveyance capacity outside of the floodway will eventually be lost. Whenever possible, the floodway limits should be set so that an equal degree of encroachment (loss of conveyance) can occur on both sides of the stream course. In some cases, equal encroachment on both sides may not be possible

because the conveyance of the overbank flow area on one side of the channel is relatively small in comparison with that of the other side. In this situation, the floodway limits should be further adjusted so that each limit will lie at a minimum distance away from the permanent channel. The minimum distance is one channel width. The floodway limits can be determined using the following procedure. The 100-year floodplain and flood stage must already be determined from existing reports, or if necessary, the Normal Depth Analysis used in Example 1. The summarized steps are outlined as follows:

(a) Add allowable increment in stage (one foot) to the 100 year flood stage to obtain a new flood stage.

(b) Calculate new conveyance K' and discharge Q' for the entire cross section under new flood stage and determine the increases in conveyance, K = K' - K, and discharge, Q = Q' - Q.

(c) Adjust the floodway limits by trial and error, so that the decrease in conveyance within the floodplain on each side of the channel due to assumed filling equals K2/2 as computed in step (b).

(d) If necessary, further adjust floodway encroachment limits so that each limit is at least one channel width away from the permanent channel.

Example 2: Define the floodway limits for the problem in Example 1.

Solution:

Regulatory flood discharge, Q = 7,900 cfs

Regulatory (100 year) flood stage = 121.5 feet

Permissible flood stage after assumed filling = 121.5 ft. + 1.0ft. = 122.5 ft.

Conveyance of the stream at stage y = 121.5 ft., $K = Q/(S^{1/2}) = 7{,}900/0.06 = 131{,}700$

Calculation of conveyance at stage y = 122.5 is shown in Table 36.4-2.

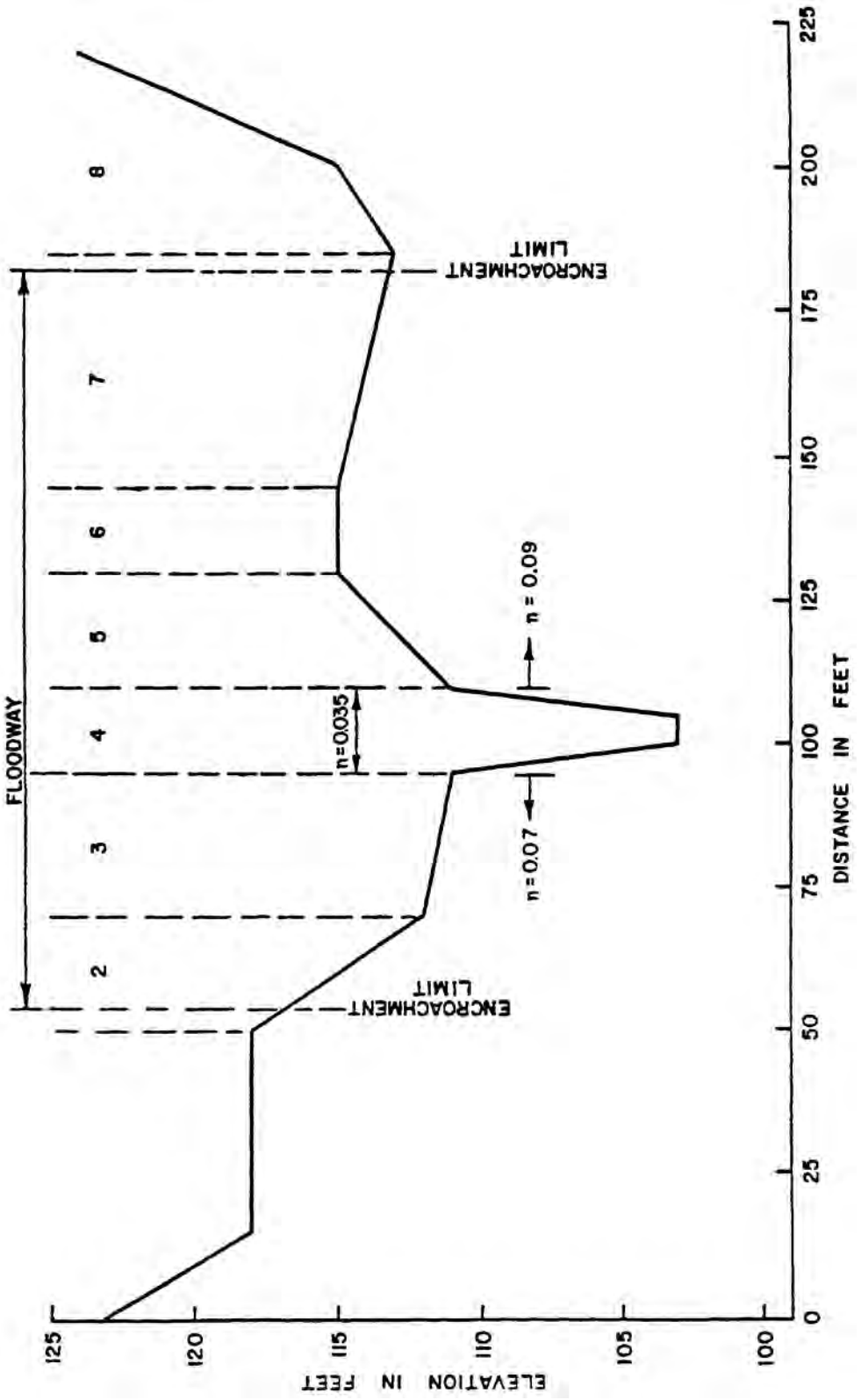

Figure 36.4-1 Typical Channel Cross section

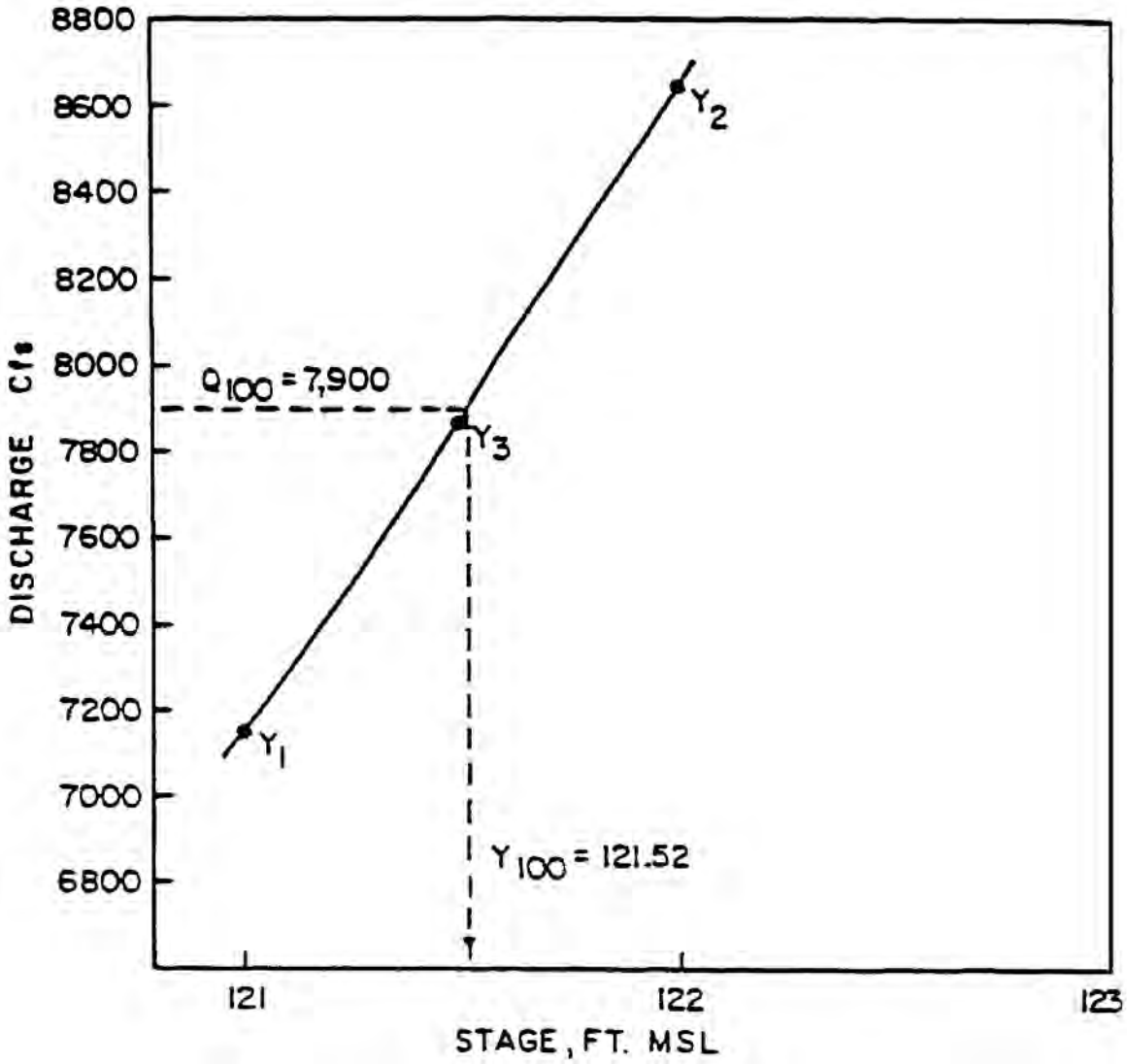

Figure 36.4-2 Stage-Discharge Relationship

Table 36.4-2

Stage	Sub-sect No.	A	P	R	$R^{2/3}$	n	k
122.5	1	187	49	3.82	2.44	07	9,714
	2	150	20	7.5	3.82	07	12,199
	3	274.5	25	11	4.95	07	28,982
	4	252.5	24	10.5	4.8	035	51,595
	5	190	20	9.5	4.5	.09	14,159
	6	112.5	15	7.5	3.82	09	7,117
	7	340	40	8.5	4.16	.09	23,422
	8	188	34	5.53	3.12	09	9,127
							156,315

Increase in conveyance by allowing one foot increase in stage above regulatory flood stage, K = 156,315 - 131,700 = 24,615.

The permitted decrease in conveyance due to encroachment in either side of the channel is K/2 = 12,308.

From Table 36.4-2, one can anticipate the lines of floodway limit to be within Subsections 2 and 7, which are shown in Figure 36.2-1. The exact location of the floodway limits is determined by trial and error.

36.6 References

Bonner, Vernon R., Floodway Determinations Using Computer Program HEC-2. U.S. Army Corps of Engineers Training Documents 5, May 1974.

U.S. Army Corps of Engineers, HEC-2 Water Surface Profiles Users Manual (with supplement)., November, 1976, Exhibit 9A: Users Manual Supplement for Floodway Determinations.

Barns, Harry H., "Roughness Characteristics of Natural Channels," U.S. Geological Survey Water Supply Paper No. 1849, 1967.

Chow, Ven Te, "Open-Channel Hydraulics," McGraw-Hill Book Company, Inc., 1959, Chapter 5.

PART XVI
STANDARDS FOR DAMS AND IMPOUNDMENTS

37.0 Standards for Dams and Impoundments

37.1 Hazard Classification

Every structure will be given hazard potential classification to reflect the damage which might occur in the event of a structural or operational failure. The damage potential will take into account a number of factors including, but not limited to: physical characteristics and degree of development of the site and area downstream; relationship of the site to industrial and residential areas; use of downstream properties throughout the reach of the potential damage; geological considerations; public and private uses of the impoundment or reservoir; probable future downstream development, and natural resources in the site area.

The following broad categories are established to permit the association of criteria with the damage that might result from a failure:

Class A. Structures located in rural or agricultural areas where failure may damage farm buildings, agricultural land or other agricultural resources. No loss of human life would be expected.

Class B. Structures located in predominantly rural or agricultural areas where failure would damage private or public property but such damage would be relatively minor and of short duration. Loss of human life would be possible but unlikely.

Class C. Structures located where failure will likely cause any of the following: Loss of human life or serious damage to homes, industrial and commercial buildings, important public utilities, primary highways or major railroads.

37.2 Storage Capacity

The storage capacity is defined as the volume of water impounded by the structure below the emergency spillway crest; or if no emergency spillway is used, the volume of water impounded below the top of the structure, less any freeboard.

37.3 Height

The height of the structure is defined as the vertical distance as measured from the lowest elevation of the structure crest to the lowest point of natural ground, including any stream channel, along the downstream toe of the structure.

37.4 Probable Maximum Precipitation (PMP)

In some situations where substantial risk of loss of life exists, it is appropriate to evaluate a structure against what appears to be the worst possible condition. The probable maximum precipitation is accepted as the standard for this type of evaluation. The PMP is almost always beyond the possibility of control with conventional flood protection measures. If it were to occur, flooding would be extensive and damage would be severe. Consideration of the PMP in design serves only to eliminate the possibility of the addition of a sudden structural failure to already serious flood conditions.

The 24-hour PMP value to be used for projects in the SJRWMD is 31.0 inches. This value is for drainage areas of 200 square miles. Apply the following adjustment factors for other drainage areas:

Drainage Area (mi2)	% of 200 mi² PMP
500	92
100	105
50	111
20	118
10	123

The 24-hour rainfall distribution is to be determined as explained in section 35.0.

37.5 References

Linsley, Kohler and Paulhus, 1975. Hydrology for Engineers. McGraw Hill Book Company, New York. 460 pp.

U.S. Department of Interior, Bureau of Reclamation, Design of Small Dams, 1974.

U.S. Weather Bureau, Hydrometeorological Report 33, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian...," 1956.

PART XVII
DESIGN AND OPERATION OF MULTI-PURPOSE IMPOUNDMENTS TO PROVIDE LOW FLOW BENEFITS

38.0 Design and Operation of Multi-Purpose Impoundments to Provide Low Flow Benefits

38.1 Determination of 5-Year 30-Day Low Flow

The objective is to determine the 5-year 30-day low flow from the project under pre-development conditions. The 5-year 30- day low flow is the average flow during the most critical 30- day period of a drought with 5-year return frequency. If substantial streamflow records exist at the project site, the 5-year 30-day flow can be determined using statistical analysis. In most cases, however, such data does not exist and one of the following procedures may be used by the applicant.

Method 1: Use average 5-year, 30-day flow contribution based on location of project.

1. Determine the total land area (both project acreage and other off-site land) contributing water to stream at the location of the impoundment (square miles).

2. From Figure 38.1-1, determine the average 5-year, 30-day low flow per square mile in the region of the project, q (cfs/sq.mi.).

3. Q(cfs) = Area Contributing to Impoundment X q.

Method 2: Use nearest streamflow data.

1. Determine the total land area (both project and other lands draining into project) contributing water to the stream at the location of the impoundment.

2. Obtain the following information from the District:

   a. The 5-year, 30-day low flow in the receiving water at the nearest stream gage location to the project site.

   b. The total area contributing streamflow to the receiving water at the stream gage location.

3. Determine the pre-development 5-year low flow from the project site as:

$$Q = \frac{\text{Area Contributing to Impoundment}}{\text{Area Contributing to Stream Gage}} \times \text{5-year, 30 day low flow at stream gage}$$

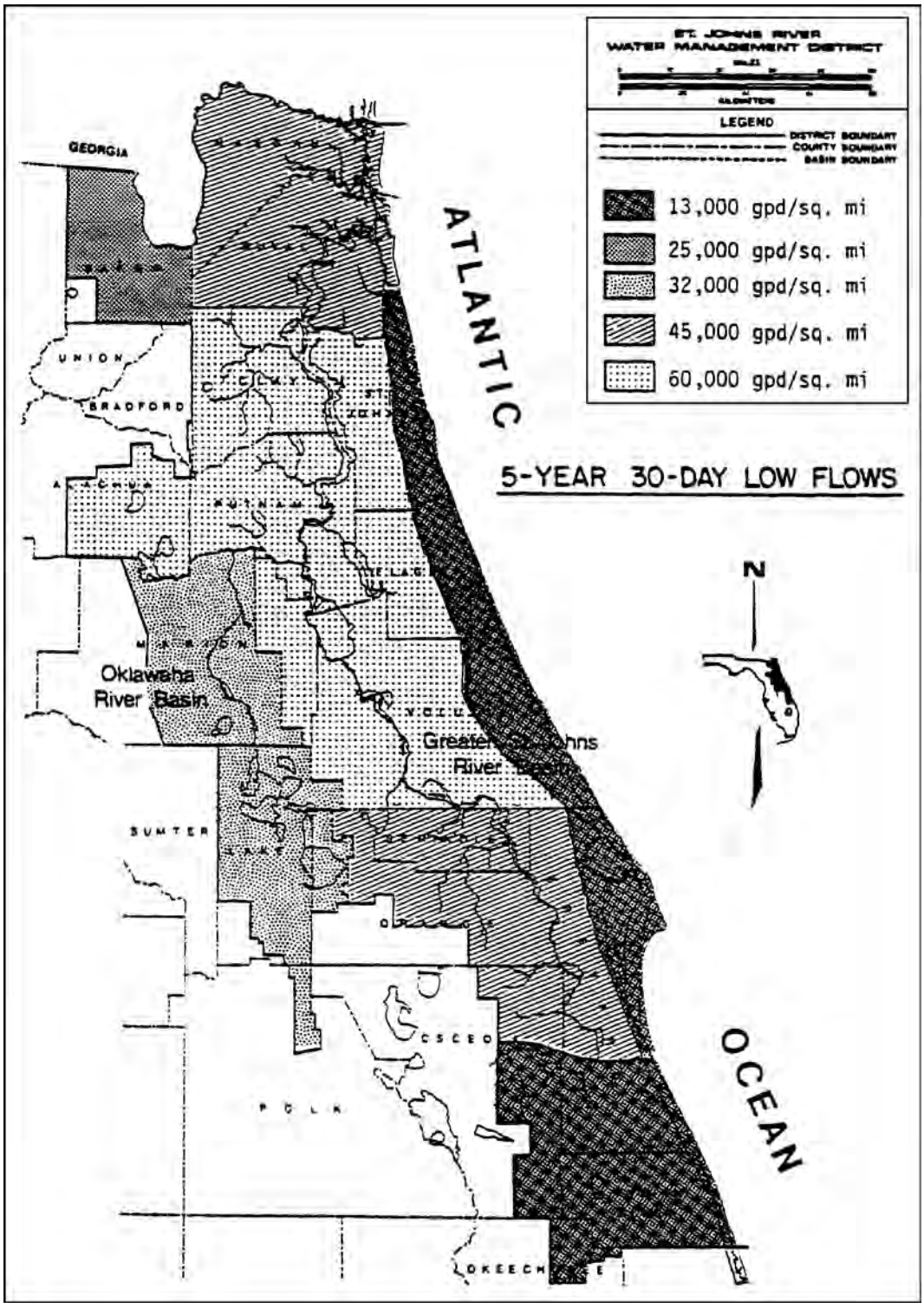

Figure 38.1-1 Average 5-Year, 30-Day Low Flow Contribution Per Square Mile

An example: A 6.2 square mile agricultural project is proposed in eastern Osceola County as shown in Figure 38.1-2. An impoundment of a stream (with streamflow during the 5-year, 30- day drought frequency) is proposed for stormwater management and irrigation benefits. The pre-development 5-year, 30-day low flow at the outlet of the impoundment is calculated below:

Using Method 1: (see Figure 38.1-1)

$$Q = 8.4 \text{ sq. mi. X } 0.07 \text{ cfs/sq. mi.} = 0.6 \text{ cfs}$$

Using Method 2:

$$\text{At stream gage, 5-year, 30-day low flow} = 1.4 \text{ cfs}$$

$$Q = \frac{8.4}{17.4} \times 1.4 = 0.7 \, cfs$$

38.2 Design Guidelines

The criteria in subsection 3.5.1 specifies that the structure must be designed so as to provide a minimum low flow discharge as determined in the previous section. The following guidelines should be considered in the design: 1) the outlet structure should provide the capability of discharging the 5- year, 30-day low flow (as calculated in the previous section) when the water storage is at the average dry season design stage (the stage corresponding to the average conservation storage during the dry season); 2) the outlet structure should provide for the discharge of all available impounded water.

A typical design of an impoundment according to these guidelines is shown in Figure 38.2-1. A gated culvert is at the bottom of the impoundment to provide for discharge of available water to maintain historical low flows. The culvert would be sized to discharge the 5-year, 30-day low flow discharge when the impoundment is at the average dry season design stage (the stage corresponding to the permanent storage during the dry season).

38.3 Operation of Impoundment to Provide Necessary Low Flow

In order to assist in the preservation of existing low flow conditions in the receiving water, the minimum low flow discharge should occur whenever water is available in the impoundment. However, low flow discharge may be discontinued, if desired, during periods when low streamflow conditions are not critical. This period will be presumed to be during the months of June through October unless a water shortage condition is declared by the District.

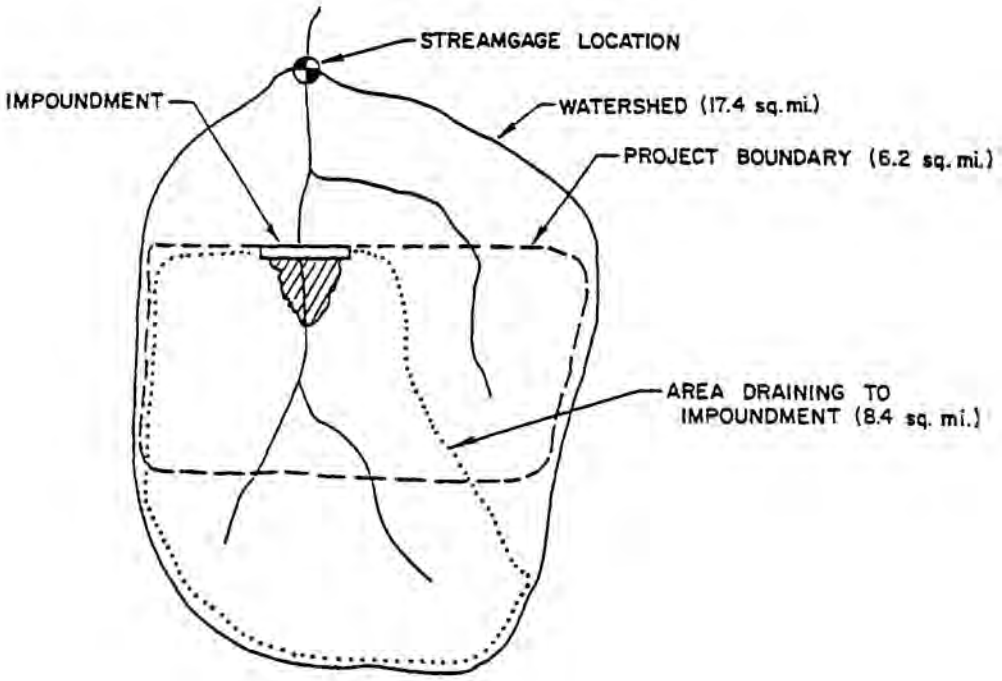

Figure 38.1-2 Example 6.2 Square Mile Agricultural Project

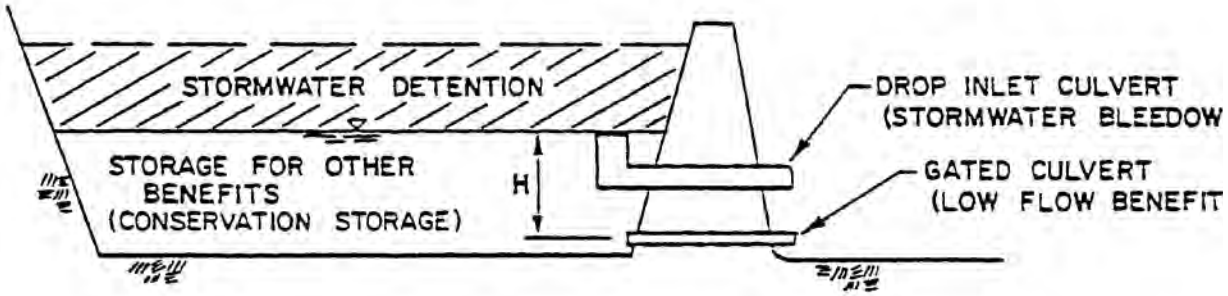

Figure 38.2-1 Typical Design Elements in Multi-Purpose Impoundment

The actual low flow discharge made from the impoundment will depend on the current water stage in the impoundment. When water storage in the impoundment is below the average dry season design stage, actual discharge may be less than the 5-year, 30-day low flow discharge. The discharge will be made according to the stage-discharge relationship (provided by the applicant) for the particular outlet structure.

PART XVIII
FLEXIBILITY FOR STATE TRANSPORTATION PROJECTS AND FACILITIES

39.0 Flexibility for State Transportation Projects and Facilities

State linear transportation projects and facilities (collectively referred to as "projects" in this section) often have unique design limitations. In recognition of this, subsection 373.413(6), F.S. requires the Agency to consider and balance the expenditure of public funds for stormwater treatment with the benefits to the public in providing the most cost-efficient and effective method of achieving the treatment objectives of stormwater management systems when reviewing such projects. To accomplish this, alternatives to on-site treatment for water quality will be considered including regional stormwater treatment systems, off-site compensating treatment, and incorporation of off-site runoff into the treatment system for the project.

The incorporation of comingling of off-site runoff into the treatment system for the project is often a more cost effective design when compared to routing off-site runoff around the system. In most cases the comingling of off-site stormwater runoff into the system will also provide for increased pollutant removal when compared to the design option of routing it around the treatment system even if the treatment system is designed to only meet the design and performance standards of Volume II for the runoff from just the on-site project area. However, for undeveloped or unimproved offsite areas co-mingling into an onsite FDOT retention type treatment system, the design capacity of the on-site system may need to be evaluated in order to ensure that there is no harm to the existing conditions. Such instances should be evaluated on a case by case basis.

C. DEP GUIDANCE DOCUMENTS

October 1, 2013

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

4049 Reid Street

Palatka, FL 32177-1429

(386) 329-4500

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

MARJORY STONEMAN DOUGLAS BUILDING
3900 COMMONWEALTH BOULEVARD
TALLAHASSEE, FLORIDA 32399-3000

RICK SCOTT
GOVERNOR

HERSCHEL T. VINYARD JR.
SECRETARY

TO: George Roberts, Chair, NWFWMD
Jon P. Steverson, Executive Director, NWFWMD
Donald J. Quincy, Chair, SRWMD
Ann Shortelle, Executive Director, SRWMD
Lad Daniels, Chair, SJRWMD
Hans G. Tanzler III, Executive Director, SJRWMD
Carlos Beruff, Chair, SWFWMD
Blake Guillory, Executive Director, SWFWMD
Daniel O'Keefe, Chair, SFWMD
Ernie Barnett, Interim Executive Director, SFWMD

THROUGH: Herschel T. Vinyard Jr.
Secretary

FROM: Greg Munson
Deputy Secretary, Water Policy and Ecosystem Restoration

SUBJECT: Guidance on Proposed Implementation of Statutory Provision for Treatment of Offsite Flows to New or Altered Linear Transportation Projects

DATE: August 13, 2013

Treatment of stormwater run-off from state roads and other locations has long been critical to protecting our state's water. A variety of treatment strategies has been, and will continue to be, an important tool in that treatment. HB 599 (2012) provides the Florida Department of Environmental Protection (FDEP) and the Florida Department of Transportation (FDOT) the opportunity to provide greater environmental benefit within the existing stormwater projects, and this guidance memorandum is intended to achieve those benefits.

This guidance also recognizes the importance of coordination between the FDEP, the FDOT, and each water management district in providing the most cost-efficient and effective method for water quality treatment in FDOT's stormwater management systems. This coordination also will result in an overall benefit to the environment.

Background

HB 599 (2012), enacted as Chapter 2012-174, Laws of Florida, amended Chapter 373, F.S. to create the following provision as Section 373.413(6):

> *It is the intent of the Legislature that the governing board or department exercise flexibility in the permitting of stormwater management systems associated with the construction or*

alteration of systems serving state transportation projects and facilities. Because of the unique limitations of linear facilities, the governing board or department shall balance the expenditure of public funds for stormwater treatment for state transportation projects and facilities with the benefits to the public in providing the most cost-efficient and effective method of achieving the treatment objectives. In consideration thereof, the governing board or department shall allow alternatives to onsite treatment, including, but not limited to, regional stormwater treatment systems. ***The Department of Transportation is responsible for treating stormwater generated from state transportation projects but is not responsible for the abatement of pollutants and flows entering its stormwater management systems from offsite sources; however, this subsection does not prohibit the Department of Transportation from receiving and managing such pollutants and flows when cost effective and prudent.*** *Further, in association with right-of-way acquisition for state transportation projects, the Department of Transportation is responsible for providing stormwater treatment and attenuation for the acquired right-of-way but is not responsible for modifying permits for adjacent lands affected by right-of-way acquisition when it is not the permittee. The governing board or department may establish, by rule, specific criteria to implement the management and treatment alternatives and activities under this subsection.*

This memo proposes an implementation strategy for that portion of the statute, which addresses offsite flows (see bolded section). This statutory provision recognizes that, similar to any other type of new construction or development project, FDOT must treat the stormwater flows generated from a transportation project. It is expected that such treatment will satisfy the requirements of the ERP rules, including the presumptive and other technical criteria found in the various Applicant's Handbook as implemented by the water management districts (WMDs). FDEP supports adherence to these requirements.

This provision also states that FDOT is not responsible for treating offsite flows ("abatement of pollutants and flows") which enter its project area from properties outside of its right-of-way that would otherwise normally discharge to, or in the direction of, the FDOT project area. FDOT generally has four options in dealing with offsite flows that would be intercepted by a linear transportation project:

1) Bypass offsite flows around the project's treatment system;
2) Accept offsite flows and direct them to a treatment system that is designed to treat the transportation project and the entire offsite flow;
3) Accept offsite flows and direct them to a treatment system that is designed to treat only the project; or
4) Accept offsite flows and direct them to a treatment system that is designed to treat the project and partially treat the off-site property.

We believe this statute intends to allow any of the four options at FDOT's discretion based on their analysis of "cost effective and prudent" as long as the minimum treatment required for the project, i.e. "*treating stormwater generated from state transportation project,*" is provided.

Empirical nutrient loading model results (Harper methodology) show that, in all cases involving wet detention treatment, even when the treatment facility is designed for only the project area, there is an overall environmental benefit achieved by comingling (i.e. the net pollutant reduction is greater).

The same modeling shows that for retention type treatment systems, when the offsite lands provide equal or greater nutrient loading when compared to the FDOT project, there is also an overall environmental benefit achieved by comingling even when the treatment facility is designed for only the project area. Thus, in these cases, the water quality at downstream points of discharge from the comingled system will be equal to or better than those systems that by-pass offsite flows. Based upon these results, FDEP supports allowing comingling in these cases without requiring further analysis as long as the proposed treatment pond meets the ERP design requirements for the run-off from the project area and results in an overall environmental benefit.

The same empirical nutrient loading model results (Harper methodology) show that where undeveloped or unimproved offsite lands flow into onsite FDOT dry retention ponds, the water quality at downstream points of discharge from the comingled system may, in some cases, be worse than those systems that by-pass offsite flows. As such, these designs should be evaluated on a case by case basis to ensure that environmental protection is not diminished. FDOT estimates that this situation occurs in a small portion of its projects (estimated 6 to 10 projects in a year) and has agreed to work with FDEP for at least a one year period to have each of these "case by case" projects reviewed by a coordination team composed of the FDEP Stormwater Engineer, FDOT Central Office Drainage Engineer, FDOT District Drainage Engineer, WMD reviewer, and project engineer. The goal of the group is to maintain a consistent application across the state with the FDEP representative and the FDOT Central Office representative being a constant and to provide data that may allow us to update this guidance in the future.

Additionally, FDEP has encouraged project "planning and update meetings" to share information between FDOT Districts, the WMDs and FDEP District Offices, and these meetings are frequently occurring. The planning and update meetings will help to address and alleviate concerns about offsite impacts to water quality during the permitting of these projects.

Proposed Implementation

There have been many discussions between FDEP and WMD staff, as well as with FDOT staff, related to implementing s. 373.413(6), F.S., including consideration of drafting rule language under Statewide ERP. The current draft of the proposed Statewide ERP rule only makes a reference to the statutory language. Since rulemaking is discretionary under the statute, it is proposed that a "design aid" be added to the Applicant Handbook in lieu of specific rule language. The current recommended design aid is as follows:

> *State linear transportation projects and facilities (collectively referred to as "projects" in this section) often have unique design limitations. In recognition of this, subsection 373.413(6), F.S. requires the Agency to consider and balance the expenditure of public funds for stormwater treatment with the benefits to the public in providing the most cost-efficient and effective method of achieving the treatment objectives of stormwater management systems when reviewing such projects. To accomplish this, alternatives to on-site treatment for water quality will be considered including regional stormwater treatment systems, off-site compensating treatment, and incorporation of off-site runoff into the treatment system for the project.*

The incorporation or comingling of off-site runoff into the treatment system for the project is often a more cost effective design when compared to routing off-site runoff around the system. In most cases the comingling of off-site stormwater runoff into the system will also provide for increased pollutant removal when compared to the design option of routing it around the treatment system even if the treatment system is designed to only meet the design and performance standards of Volume II for the runoff from just the on-site project area. However, for undeveloped or unimproved offsite areas co-mingling into an onsite FDOT retention type treatment system, the design capacity of the on-site system may need to be evaluated in order to ensure that there is no harm to the existing conditions. Such instances should be evaluated on a case by case basis.

This design aid language is proposed as an addendum to the rule package and not a specific rule as part of Chapter 62-330, FAC (including the Applicant's Handbooks).

cc: Ananth Prasad, Secretary, FDOT
Jeff Littlejohn, P.E., Deputy Secretary, Regulatory Programs, FDEP
Tom Beck, Ph.D., AICP, Director, Office of Water Policy, FDEP
Mark P. Thomasson, P.E., Director, Water Resources Management, FDEP
Rick Renna, P.E., State Hydraulics Engineer, FDOT

2. [Placeholder for Guidance related to Dredge Disposal Sites]

D. FORMS

October 1, 2013

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

4049 Reid Street

Palatka, FL 32177-1429

(386) 329-4500

District Form 40C-41.063(4)

Local Government Notification

LOCAL GOVERNMENT NOTIFICATION

_____ hereby provides notification that the
(name of local governmental entity)

development proposal, submitted to the St. Johns River Water Management District, known as _____
(project name)

being proposed by _____
(applicant name)

which is located in Section _____ Township _____ Range _____ and which Consists of _____ acres has been reviewed by the local government. After such review, all necessary final action has been taken by the government entity to determine, and such determination has been made, that the proposed activity is consistent with the local comprehensive plan and is in compliance with any local development regulation in effect in the area where the development will take place.

_____
Name and title of officer or employee of Local Government authorized to execute notification

_____
Signature of above officer or employee

_____
Date

40C-44.061(2)(d)1.

Form EN-14M

St. Johns River Water Management District
Division of Regulatory Services

Condition Compliance

Permit Issued to: _____ Permit Number: _____ Date: _____
Month Year

Operations Logs/Day of Month/Please show day of month and time pump(s) is turned on and day of month and time pump(s) is turned off.

Pump No.	Indicate am or pm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total Hours
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Form EN-14M *(10/1/13)*
Incorporated by reference in 40C-44.061(2)(d)1., F.A.C.

Form 40C-44.061(2)(d)2.

Form EN-52

St. Johns River Water Management District
Division of Regulatory Services

Condition Compliance

Permit Issued to: _____ Permit Number: _____ Date: _____
Month Year

Operations Logs/Day of Month/Please show day of month and water level

Pond Number Or Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Form 40C-44.101(2)

SUPPLEMENTAL INFORMATION FOR AGRICULURAL SYSTEMS

SUPPLEMENTAL INFORMATION FOR AGRICULTURAL SYSTEMS

Instructions: This form is a supplement for agricultural systems that meet the requirements of 40C-44 (F.A.C.). The information required by this supplement is in addition to the information required by Section A of the ERP application (Form 62-330.060(1)). ***Existing agricultural systems should complete Part 1 of this supplement. New agricultural projects should complete Part 2 of this supplement.*** Both existing and proposed agricultural projects should complete Tables 1 and 2 as applicable. If the project exceeds one or more of the thresholds identified in paragraphs (a) through (h) or paragraph (j) of subsection 62-330.020(2), F.A.C., or in subsection 1.2.2 of Volume II, additional sections of the ERP application (Form 62-330.060(1)) must also be completed, as applicable.

PART 1: EXISTING AGRICULTURAL OPERATIONS

A. Does this agricultural operation have a consent order? If yes, please provide the permit or consent order number ( ) and, for consent orders, the expiration date: .

B. Provide a map, or maps, delineating:

1. ☐ A general location map (USGS 7 ½' Quadrangle) delineating the agricultural operation and nearby highways and water bodies.
2. ☐ Property boundaries of the agricultural operation on an aerial photo
3. ☐ The existing topography, drainage patterns and basin boundaries within the agricultural operation. Identify and quantify the area of any lands outside the agricultural operation which contribute runoff to the agricultural operation.
4. ☐ The existing land use (crop) or land cover.
5. ☐ The location of existing surface water works (ditches, canals, levees, pumps, ponds, irrigation gates, etc.).
6. ☐ Rights-of-way and easements for the existing drainage system, if any.
7. ☐ Soil types used to determine hydrologic soil group.
8. ☐ For agricultural operations proposing minor alteration, wetlands delineated on a land cover map.

C. ☐ Provide drawings depicting existing surface water works (ditches, canals, levees, pumps, ponds, outfall structures, irrigation gates, etc.). Provide approximate levee cross-sections and top elevations, ditch and canal side slopes and bottom elevations, pump intake inverts, irrigation gate inverts, discharge structure control elevations, etc., with supporting documentation. If this information has been supplied to the District previously as an As-Built drawing and no subsequent changes have been made, reference to the appropriate permit number is sufficient.

D. ☐ Provide all available pump hour records or maintenance records to document the level and frequency of pump use. Provide pump curves, flow measurements or other information to document pump capacity. For data that has previously been supplied to the District, in compliance with a permit or Consent Order, reference to the appropriate permit number is sufficient.

E. ☐ Provide available records of pond stages. For data that has previously been supplied to the District, in compliance with a permit or Consent Order, reference the appropriate permit number is sufficient.

F. ☐ Describe any existing treatment facilities (ponds, grassed waterways, overland flow areas, wetland filtration, etc.) for the agricultural operation.

G. ☐ Provide copies of all available water quality data which characterizes discharge off-site (to surface or groundwater). For data which has been supplied to the District previously in compliance with a permit condition or Consent Order, reference to the appropriate permit number is sufficient.

H. ☐ Is the agricultural operation used for disposal or reuse of domestic wastewater or sludge? If yes, provide copies of relevant documents or contracts.

I. ☐ Provide the name(s) of the water body which receives discharge from the system.

J. ☐ Develop a monthly water budget for the agricultural operation for an average rainfall year. The water budget should be a composite of water budgets developed for each land use. Include all sources of incoming water, the proportion of rain that is effective and the portion that would run off, and all mechanisms by which water is removed.

1. ☐ Parameters which must be considered for land areas are:

   a. ☐ Rainfall
   b. ☐ Effective rainfall
   c. ☐ Surface runoff entering from other sites
   d. ☐ Incoming groundwater seepage
   e. ☐ Irrigation volume (gross and net) from surface sources
   f. ☐ Irrigation volume (gross and net) from groundwater sources
   g. ☐ Irrigation efficiency, based on irrigation method
   h. ☐ Potential evapotranspiration
   i. ☐ Actual evapotranspiration
   j. ☐ Excess water leaving the fields/groves

2. ☐ Parameters which must be considered for water bodies (ponds):

   a. ☐ Rainfall
   b. ☐ Evaporation
   c. ☐ Water volume returned to fields Water stage
   d. ☐ Stored volume

3. ☐ For each parameter, give the reference or methodology used to determine its value. Clearly state acreage for each land use and water body. Select the first month of the water budget such that the assumed initial volume of the on-site water bodies is equal to their final volume. Show computational checks on the overall water budget and the individual water budgets for each field or water body.

4. ☐ Compute the decrease in off-site discharge credited to any detention ponds.

K. Does the agricultural operation have a currently valid Conservation Plan? ☐ Yes ☐ No. To what extent has the Conservation Plan been implemented? Attach a copy of the Conservation Plan, if available.

L. If applicable, describe minor alterations needed to implement a management practice recommended by a Conservation Plan or listed in Section 40C-44.066, F.A.C. If the applicant is not the property owner (e.g., property lessee), provide lease agreement or other document which authorizes the proposed alterations.

M. Complete Table 1 and 2, as applicable.

PART 2: PROPOSED AGRICULTURAL OPERATIONS (construction or major alterations)

A. Indicate any previous consent orders for this project area. Include issuance and expiration dates.

B. Provide pre-development site information, including:

1. ☐ A map, or maps of the same scale, of the project area and vicinity (at a scale no smaller than one inch equals 800' and on a sheet(s) no larger than 24" x 36") delineating:

   a. ☐ Existing land use or land cover
   b. ☐ Existing topography, drainage patterns and basin boundaries within the agricultural operation
   c. ☐ The area of any lands outside the agricultural operation which contribute runoff to the agricultural operation
   d. ☐ The existing surface water works (ditches, canals, levees, pumps, ponds, irrigation gates, etc.)
   e. ☐ Rights-of-way and easements for the existing drainage system, if any
   f. ☐ Wetlands delineated on a land cover map at the same scale as the site plan
   g. ☐ Soil types used to determine hydrologic soil group
   h. ☐ Normal and wet season water table elevations
   i. ☐ Ten year and, if applicable, 100 year flood elevation and floodplain boundary of any lake, stream or other watercourse located on or adjacent to the site
   j. ☐ Limits of waters of the state

2. ☐ Provide a recent aerial photograph at the same scale as the site plan, with project boundaries delineated on the photograph.

C. Provide a description of the on-site wetlands, including:

1. The acreage of wetlands existing on the site:

2. A discussion of the proposed alterations or disturbances to the wetland areas:

3. A discussion of the wetlands that will be preserved in their natural or existing state:

D. Provide post-development site information, including construction plans and specifications (on sheets no larger than 24" x 36"). Include:

1. ☐ Proposed land use and land cover.

2. ☐ Proposed construction schedule, including sequence of any major phases, an estimated start and completion date.

3. ☐ Location, size and design capacity of all surface water works (ditches, canals, levees, pumps, ponds, outfall structures, irrigation gates, etc.).

4. ☐ Location and details of all water control structures, control elevations of the control structures, and any seasonal water level regulation schedules.

5. ☐ Post-development drainage basin boundaries showing the direction of flows, taking into account any off-site runoff being directed through or around the system.

6. ☐ Location of all water bodies, with details of size, side slopes and depths.

7. ☐ Provide pump specifications and operating curves for a range of possible operating conditions.

8. ☐ Rights-of-way and easements for the system, including all on-site and off-site areas to be reserved for water management purposes.

9. ☐ Any temporary construction which might affect the surface water management system prior to completion of the system.

10. ☐ All erosion and sediment control measures to be implemented during each phase of construction prior to completion of the system, intended to prevent violations of state water quality standards.

11. ☐ Proposed maintenance practices and schedules

12. ☐ If applicable, proposed wetland mitigation plans and details

E. Provide design analysis, including:

1. ☐ Pre-development and post-development drainage calculations as follows:

   a. ☐ Runoff characteristics, including area, runoff curve number or runoff coefficient, SCS hydrologic soil group and time of concentration for each drainage hydrologic unit

   b. ☐ Water table elevations (normal and average wet season) including aerial extent and magnitude of any proposed water table drawdown.

   c. ☐ Receiving water elevations (normal, wet season, design storm).

   d. ☐ Design storms used including duration, frequency, and time distribution.

   e. ☐ Runoff hydrograph(s) for each drainage basin for all required storm events.

   f. ☐ State-storage computations for any storage area, such as a reservoir, detention area or channel storage, used in storage routing.

   g. ☐ Stage-discharge computations for any storage areas at a selected control point, such as structure control or natural restriction.

   h. ☐ Flood routings through on-site conveyance and storage areas.

   i. ☐ Water storage profiles and elevations in the primary surface water management system for the required design storm event(s).

j. ☐ Runoff peak rates and volumes discharged from the system for the design storm event(s).

2. ☐ Calculations to demonstrate water quality treatment in compliance with Section 40C-44.026.

3. ☐ Engineering analysis of floodplain storage and conveyance, if applicable, including:

a. ☐ Hydraulic calculations for all proposed traversing works.

b. ☐ Backwater water surface profiles showing upstream impact of traversing works.

c. ☐ Location and volume of encroachment with 10 year floodplain.

d. ☐ Plan for compensating storage.

e. ☐ Provide a description of the engineering methodology, assumptions and references and a copy of all such computations, engineering plans and specifications used to analyze the system. If a computer program is used for the analysis, provide the name and a description of the program.

F. ☐ Develop a monthly water budget for the agricultural operation for an average rainfall year. The water budget should be a composite of water budgets developed for each land use. Include all sources of incoming water, the proportion of rain that is effective and the portion that would run off, and all mechanisms by which water is removed.

1. ☐ Parameters which must be considered for land areas are:

a. ☐ Rainfall
b. ☐ Effective rainfall
c. ☐ Surface runoff entering from other sites
d. ☐ Incoming groundwater seepage
e. ☐ Irrigation volume (gross and net) from surface sources
f. ☐ Irrigation volume (gross and net) from groundwater sources
g. ☐ Irrigation efficiency, based on irrigation method
h. ☐ Potential evapotranspiration
i. ☐ Actual evapotranspiration
j. ☐ Excess water leaving the fields/groves

2. ☐ Parameters which must be considered for water bodies (ponds):

a. ☐ Rainfall
b. ☐ Evaporation
c. ☐ Water volume returned to fields
d. ☐ Water stage
e. ☐ Stored volume

3. ☐ For each parameter, give the reference or methodology used to determine its value. Clearly state acreage for each land use and water body. Select the first month of the water budget such that the assumed initial volume of the on-site water bodies is equal to their final

volume. Show computational checks on the overall water budget and the individual water budgets for each field or water body.

4. ☐ Compute the decrease in off-site discharge credited to any detention ponds.

G. ☐ Provide Special Basin Information, including:

1. ☐ Wekiva Recharge Protection Basin – For projects within the Wekiva Recharge Protection Basin (basin boundary defined in Chapter 40C-41, F.A.C.), provide design analysis to demonstrate compliance with Wekiva Recharge Protection criteria, including: pre- and post-development recharge from the project area.

2. ☐ Lake Apopka Hydrologic Basin – For projects within the Lake Apopka Hydrologic Basin (basin boundary defined in Chapter 40C-41, F.A.C.) or that will discharge water to Lake Apopka or its tributaries, provide design analysis to demonstrate compliance with the Lake Apopka Hydrologic Basin criteria, including: pre-development total phosphorus and post-development total phosphorus discharged from the project area.

H. Complete Table 1 and 2, as applicable.

TABLE 1 - SUMMARY OF LAND USE AND AGRICULTURAL PRACTICES - ROW CROPS AND CITRUS - Typical Year

Parcel #: Acreage:

	Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
Crops For the Year planting dates harvesting dates												
Seed Bedding and Cultivation dates times type depth												
Fertilizer dates types rates												
Pesticides dates types rates												
Desired Water Table Depths during cropping during fallow												
Irrigation dates amount irrigation method water source												

Note: Parcel = land under the same crops and cultivation practices during the year.
Identify each parcel on a map.

TABLE 2 - SUMMARY OF LAND USE AND AGRICULTURAL PRACTICES – PASTURE -Typical Year

Parcel #: Acreage:

	Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
Pasture Rotation and Animal Density Months Cow/calf unit per acre												
Type of Vegetation And Condition												
Schedule of Pasture Management Practices (mowing, seeding, etc.)												
Fertilizer dates types rates												
Pesticides dates types rates												
Desired Water Table Depths during cropping during fallow												
Irrigation dates amount irrigation method water source water source												

Note: Parcel = land under the same crops and cultivation practices during the year.
Identify each parcel on a map.

E. RULES

June 1, 2018

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

4049 Reid Street

Palatka, FL 32177-1429

(386) 329-4500

CHAPTER 62-330
ENVIRONMENTAL RESOURCE PERMITTING

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62-330.443	General Permit to the Florida Department of Transportation, Counties, and Municipalities for Minor Bridge Alteration, Placement, Replacement, Removal, Maintenance, and Operation
62-330.447	General Permit to the Florida Department of Transportation, Counties, and Municipalities for Minor Activities within Existing Rights-of-Way or Easements
62-330.448	General Permit to Counties and Municipalities to Pave Existing County or Municipally Owned and Maintained Roads, Including the Repair and Replacement of Bridges That Are Part of the Roadway
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62-330.451	General Permit to Counties, Municipalities, and other Agencies to Conduct Stormwater Retrofit Activities
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62-330.463	General Permit for Breaching Mosquito Control Impoundments and for the Construction and Operation of Culverts and Associated Water Control Structures in Mosquito Control Impoundments by Governmental Mosquito Control Agencies
62-330.467	General Permit for Breaching Mosquito Control Impoundments by Governmental Mosquito Control Agencies (Repealed)
62-330.474	General Permit for Certain Minor Activities
62-330.475	General Permit for Single-family Residential Activities in Isolated Wetlands
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62-330.483	General Permit to the Department and Water Management Districts to Conduct Minor Activities
62-330.485	General Permit to the Department and Water Management Districts for Environmental Restoration or Enhancement
62-330.487	General Permit to the Department and Water Management Districts to Change Operating Schedules for Water Control Structures
62-330.488	General Permit to Governmental Entities for Certain Public Use Facilities at Public Natural Areas
62-330.490	General Permit for the Reclamation of Eligible Phosphate Lands Mined Before July 1, 1975
62-330.491	Noticed General Permit for Raising the Height of Existing Earthen Embankments for Impoundments at Facilities for Mining Sand and Limestone (Repealed)
62-330.492	General Permit for Prospecting for Limestone, Sand, and Peat
62-330.493	General Permit to Perform Prospecting Activities for Phosphate Minerals
62-330.494	General Permit for Temporary Dragline Crossings of Waterways for Mining Activities
62-330.495	General Permit for Low Water Crossings for Mining Activities
62-330.496	General Permit for Dry Borrow Pits of Less than Five Acres (Repealed)
62-330.500	General Permit for Construction, Operation, Maintenance, Alteration, Abandonment or Removal of Minor Silvicultural Surface Water Management Systems (Repealed)
62-330.501	General Permit for Temporary Agricultural Activities within the South Florida Water Management District

62-330.505	General Permit to the U.S. Forest Service for Minor Works within National Forests
62-330.550	General Permit for Construction, Operation and Maintenance of Nonproduction-related Agricultural Facilities
62-330.600	General Permit for the Construction of Artificial Reefs
62-330.602	General Permit for Installation and Maintenance of Intake and Discharge Pipes Associated with Marine Bivalve Facilities (Repealed)
62-330.630	General Permit to U.S. Army Corps of Engineers for Environmental Restoration or Enhancement Activities
62-330.631	General Permit to Governmental Entities for Limited Environmental Restoration or Enhancement Activities
62-330.632	General Permit for the Restoration, Establishment and Enhancement of Low Profile Oyster Habitat
62-330.635	General Permit for Soil Remediation
62-330.901	Noticed General Permit Forms (Repealed)

62-330.010 Purpose and Implementation.

(1) This chapter, together with the rules and all documents it incorporates by reference, implements the comprehensive, statewide environmental resource permit (ERP) program under section 373.4131, F.S.

(2) The ERP program governs the following: construction, alteration, operation, maintenance, repair, abandonment, and removal of stormwater management systems, dams, impoundments, reservoirs, appurtenant works, and works (including docks, piers, structures, dredging, and filling located in, on or over wetlands or other surface waters, as defined and delineated in chapter 62-340, F.A.C.) (any one or a combination of these may be collectively referred to throughout this chapter as "projects" or "systems").

(3) The responsibilities for implementing this chapter are described in Operating and Delegation Agreements between the Department of Environmental Protection ("Department"), the water management districts ("Districts"), and local governments ("delegated local governments"). The Agreements are incorporated by reference in rule 62-113.100, F.A.C. The term "Agency" applies to the Department, a District, or a delegated local government, as applicable, throughout this chapter.

(4) This chapter is used in conjunction with an Applicant's Handbook, in two volumes, as follows:

(a) Applicant's Handbook Volume I, "General and Environmental" (hereinafter "Volume I") applies statewide to all activities regulated under chapter 62-330, F.A.C. It includes explanations, procedures, guidance, standards, and criteria on what is regulated by this chapter, the types of permits available, how to submit an application or notice for a regulated activity to the Agencies, how applications and notices are reviewed, the standards and criteria for issuance, and permit duration and modification. Volume I, including Appendices G, H, and I only, is incorporated by reference herein, (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09390 and http://www.flrules.org/Gateway/reference.asp?No=Ref-09391).

(b) An Applicant's Handbook Volume II (hereinafter "Volume II"), has been adopted for use within each District. Each District's Volume II is incorporated by reference herein and in the rules listed below, which also are incorporated by reference herein. These rules and Handbook Volumes are available as provided in subsection (5), below.

1. Northwest Florida Water Management District – "Department of Environmental Protection and Northwest Florida Water Management District Environmental Resource Permit Applicant's Handbook – Volume II (Design and Performance Standards Including Basin Design and Criteria)," including all appendices, is incorporated by reference herein (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09392 and http://www.flrules.org/Gateway/reference.asp?No=Ref-03173) or from the Agency as provided in subsection (5).

2. Suwannee River Water Management District, Applicant's Handbook Volume II, is incorporated by reference herein, (August, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09398), and in subsection 40B-400.091(2), F.A.C., (October 14, 2013) (https://www.flrules.org/Gateway/reference.asp?No=Ref-02523).

3. St. Johns River Water Management District, Applicant's Handbook Volume II, is incorporated by reference herein, (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09405), and in subsections 40C-4.091(1) (June 1, 2018) (https://www.flrules.org/Gateway/reference.asp?No=Ref-09411), and 40C-44.091(1), F.A.C., (June 1, 2018) (https://www.flrules.org/Gateway/reference.asp?No=Ref-09410).

4. Southwest Florida Water Management District, Applicant's Handbook Volume II, is incorporated by reference herein, (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-03176), and in rule 40D-4.091, F.A.C., (October 1, 2013) (https://www.flrules.org/Gateway/reference.asp?No=Ref-02527).

5. South Florida Water Management District, Applicant's Handbook Volume II, including Appendices A through D, is incorporated by reference herein, (October 1, 2013) (https://www.flrules.org/Gateway/reference.asp?No=Ref-02528) and in paragraph 40E-4.091(1)(a), F.A.C., (May 22, 2016) (https://www.flrules.org/Gateway/reference.asp?No=Ref-02529).
A copy of the incorporated material identified above may be obtained from the Agency Internet site, https://floridadep.gov/water/water/content/water-resource-management-rules#ERP, or as described in subsection 62-330.010(5), F.A.C.

(5) A copy of Volumes I and II and the other Agreements, rules, forms, and other documents incorporated by reference in this chapter also may be obtained from the Agency Internet site or by contacting staff in an Agency office identified in Appendix A of Volume I.

(6) This chapter explains how to submit notices and applications for activities regulated under part IV of chapter 373, F.S., and provides the standards for Agency review and action, which must not be harmful to the water resources and not be inconsistent with the overall objectives of the Agency. This chapter also includes procedures for petitions for a formal determination of the landward extent of wetlands and surface waters under chapter 62-340, F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.418, 373.4131, 373.4145, 403.805(1) FS. Law Implemented 373.409, 373.413, 373.4131, 373.414(9), 373.4141, 373.4142, 373.4145, 373.416, 373.423, 373.426, 373.428, 373.429, 373.441 FS. History–New 10-1-13, Amended 6-1-18.

62-330.020 Regulated Activities.

(1) A permit under this chapter is not required for activities that qualify for:

(a) Operation and routine custodial maintenance of projects legally in existence under chapter 403 or part IV of chapter 373, F.S., provided the terms and conditions of the permit, exemption, or other authorization for such projects continue to be met, and provided the activity is conducted in a manner that does not cause violations of state water quality standards. However, this exemption shall not apply to any project that is altered, modified, expanded, abandoned, or removed;

(b) An exemption listed in rule 62-330.051 or 62-330.0511, F.A.C., or in section 1.3 (District-specific exemptions) of the applicable Volume II;

(c) The "grandfathering" provisions of section 373.4131(4), 373.414(11), (12)(a), (13), (14), (15), or (16), F.S.; or

(d) The "10/2" general permit for upland stormwater systems authorized in section 403.814(12), F.S.

(2) Unless the activity qualifies under subsection (1), above, a permit is required prior to the construction, alteration, operation, maintenance, removal, or abandonment of any project that, by itself or in combination with an activity conducted after October 1, 2013, cumulatively results in any of the following:

(a) Any project in, on, or over wetlands or other surface waters;

(b) A total of more than 4,000 square feet of impervious and semi-impervious surface areas subject to vehicular traffic;

(c) A total of more than 9,000 square feet of impervious and semi-impervious surface area;

(d) A total project area of more than five acres;

(e) A capability of impounding more than 40 acre-feet of water;

(f) Any dam having a height of more than 10 feet, as measured from the lowest elevation of the downstream toe to the dam crest;

(g) Any project that is part of a larger common plan of development or sale;

(h) Any dry storage facility storing 10 or more vessels that is functionally associated with a boat launching area;

(i) Any project exceeding the thresholds in section 1.2 (District-specific thresholds) of the applicable Volume II, or

(j) Any modification or alteration of a project previously permitted under part IV of chapter 373, F.S.

(3) Construction and operation of projects under subsection (2), above, are subject to the additional limitations in paragraph 3.1.4(f) of Volume I.

(4) The following types of permits are available:

(a) A general permit, as provided in rule 62-330.052, F.A.C., and rules 62-330.410 through 62-330.635, F.A.C.;

(b) An individual permit, as provided in rule 62-330.054, F.A.C.; and,

(c) A conceptual approval permit, as provided in rule 62-330.055 or 62-330.056, F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.117, 373.118, 373.409, 373.413, 373.4131, 373.4132, 373.4145, 373.416, 373.426, 403.0877 FS. History–New 10-1-13, Amended 6-1-18.

62-330.021 Definitions.

Terms used in this chapter are defined in section 2.0 of Volume I and section 2.1 of Volume II.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9),373.4141, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4141, 373.4145, 373.416, 373.418, 373.426 FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.021, Amended 10-1-13.

62-330.050 Procedures for Review and Agency Action on Exemption Requests.

(1) A notice to the Agency is not required to conduct an activity that is exempt under rule 62-330.051, F.A.C., except where required in a specific exemption. Persons are encouraged, but not required, to use any available electronic self-certification service of the Agency to confirm that the activity meets the exemption.

(2) If a person desires Agency verification of qualification to conduct an exempt activity (other than for silviculture, for which the procedures in rule 62-330.0511, F.A.C., apply), and a self-certification is not available or the person chooses not to use a self-certification, they may submit a written or electronic Form 62-330.050(1) – "Request for Verification of an Exemption," (June 1, 2018), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-09360), or a letter that clearly requests an exemption verification. A copy of the form may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. Such request must include:

(a) The processing fee prescribed in rule 62-330.071, F.A.C. Only one exemption verification processing fee shall be assessed if the request contains multiple exempt activity types on a single parcel;

(b) A location map(s) of sufficient detail to allow someone who is unfamiliar with the area to locate the site of the activity;

(c) Drawings, calculations, and other supporting information to clearly depict and describe the proposed activities;

(d) The tax parcel identification number from the local government tax rolls;

(e) Contact information for the person requesting the verification; and,

(f) Authorization signed by the property owner allowing Agency staff to inspect the location of the proposed activities.

(3) Additional information on completing and submitting a request for verification of an exemption is contained in sections 3.2, 4.2, 4.2.1, 4.3, and 4.4 of Volume I.

(4) The Agency shall take reasonable efforts to determine within 30 days of receipt of a request whether the submitted materials demonstrate the activity qualifies for an exemption or, if they do not, what information would enable the Agency to make such a determination. If those materials are not received within 60 days of the Agency's request, the Agency shall advise the person that it cannot verify that the activity qualifies for an exemption. The materials submitted and responses received shall not be considered an application for a general, conceptual approval, or individual permit unless requested in writing.

(5) If, after receipt of an application for a permit, the Agency determines the proposed activity qualifies in whole for an exemption under this chapter, the Agency shall make such determination within 30 days of receipt of the application and refund any processing fees received in excess of those required under rule 62-330.071, F.A.C.

(6) The Agency will consider exempt activities included in an application to conduct other activities as part of an entire application requiring a permit, and will review and act upon the entire application at one time. However, an applicant may request the Agency separately determine whether specific activities that are part of the application qualify for an exemption. In such a case, the applicant shall pay an additional processing fee for the exemption verification, but only one additional exemption verification processing fee will be required even if more than one kind of exempt activity is included. In accordance with section 10.27(d) of Volume I, the Agency with consider the secondary impacts arising from activities described in section 403.813(1), F.S., that are very closely linked and causally related to the activities proposed in the application.

(7) The Agency's determination of qualification for an exemption is subject to chapter 120, F.S. Self-certification is not an Agency action subject to chapter 120, F.S., unless the Agency determines the self-certification does not meet all of its applicable terms and conditions.

(8) Activities conducted in accordance with an exemption under this chapter remain subject to other applicable permitting, authorization, and performance requirements (including, but not limited to, those governing the "take" of listed species) of the Agencies, the Board of Trustees, and other federal, state, and local government entities.

(9) The following apply when specified in an exemption in rule 62-330.051, F.A.C.:

(a) Activities shall not exceed a permitting threshold in section 1.2 of the applicable Volume II;

(b) Construction, alteration, and operation shall not:

1. Adversely impound or obstruct existing water flow, cause adverse impacts to existing surface water storage and conveyance capabilities, or otherwise cause adverse water quantity or flooding impacts to receiving water and adjacent lands;

2. Cause an adverse impact to the minimum flows and levels established pursuant to section 373.042, F.S.;

3. Cause adverse impacts to a Work of the District established pursuant to section 373.086, F.S.;

4. Adversely impede navigation or create a navigational hazard;

5. Cause or contribute to a violation of state water quality standards. Turbidity, sedimentation, and erosion shall be controlled during and after construction to prevent violations of state water quality standards, including any antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), subsections 62-4.242(2) and (3) and rule 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters due to construction-related activities. Erosion and sediment control best management practices shall be installed and maintained in accordance with the guidelines and specifications described in the *State of Florida Erosion and Sediment Control Designer and Reviewer Manual* (Florida Department of Transportation and Florida Department of Environmental Protection, June 2007*)*, incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02530), and the *Florida Stormwater Erosion and Sedimentation Control Inspector's Manual* (Florida Department of Environmental Protection, Nonpoint Source Management Section, Tallahassee, Florida, July 2008), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02531); nor

6. Allow excavated or dredged material to be placed in a location other than a self-contained upland disposal site, except as expressly allowed in an exemption in rule 62-330.051, F.A.C.

(c) When performed in waters accessible to federally- or state-listed aquatic species, such as manatees, marine turtles, smalltooth sawfish, and Gulf sturgeon, all in-water work shall comply with the following:

1. All vessels associated with the project shall operate at "Idle Speed/No Wake" at all times while in the work area and where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

2. All deployed siltation or turbidity barriers shall be properly secured, monitored, and maintained to prevent entanglement or entrapment of listed species.

3. All in-water activities, including vessel operation, must be shut down if a listed species comes within 50 feet of the work area. Activities shall not resume until the animal(s) has moved beyond a 50-foot radius of the in-water work, or until 30 minutes elapses since the last sighting within 50 feet. Animals must not be herded away or harassed into leaving. All onsite project personnel are responsible for observing water-related activities for the presence of listed species.

4. Any listed species that is killed or injured by work associated with activities performed shall be reported immediately to the Florida Fish and Wildlife Conservation Commission (FWC) Hotline at 1(888)404-3922 and ImperiledSpecies@myFWC.com.

Copies of incorporated materials identified above may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 403.805(1) FS. Law Implemented 373.109, 373.406, 373.4131, 373.4145, 403.813(1), 668.003, 668.004, 668.50 FS. History–New 10-1-13, Amended 6-1-18.

62-330.051 Exempt Activities.

The activities meeting the limitations and restrictions below are exempt from permitting. However, if located in, on, or over state-owned submerged lands, they are subject to a separate authorization under chapters 253 and 258, F.S., as applicable.

(1) Activities conducted in conformance with the District-specific exemptions in section 1.3 of Volume II applicable to the location of the activity.

(2) Activities conducted in conformance with the exemptions in section 373.406, or 403.813(1), F.S.

(3) Aquatic Plant and Organic Detrital Control and Removal –

(a) Disking and tilling of exposed lake bottoms in accordance with a permit issued by the Florida Fish and Wildlife Conservation Commission or an exemption under chapter 369, F.S.

(b) Organic detrital material removal in accordance with section 403.813(1)(r) or (u), F.S.

(c) Aquatic plant control where the activity qualifies for an exemption authorized under section 369.20, F.S., or in a permit from the Florida Fish and Wildlife Conservation Commission under section 369.20 or 369.22, F.S.; and the harvested plant material is not disposed of in wetlands or other surface waters, or in a manner that adversely affects water quality or flood control.

(d) The mechanical harvesting or shredding of aquatic plants and incidentally associated sediments, including subsequent side

casting of the harvested or shredded material, provided:

1. The activity is authorized and conducted by the Florida Fish and Wildlife Conservation Commission, under section 369.20 or 369.22, F.S.;

2. The work involves no dredging and is the minimum amount necessary for maintaining existing navigation corridors and preventing flooding, and in no case shall exceed five total acres of harvesting, shredding, and sidecasting;

3. The work is performed in a manner that does not adversely affect water quality or flood control; and

4. Notice of intent to use this exemption is provided to the Agency five days before performing any work.

(4) Bridges, Driveways, and Roadways –

(a) The replacement and repair of existing open-trestle foot bridges and vehicular bridges in accordance with Section 403.813(1)(l), F.S.

(b) Construction, alteration, or maintenance, and operation, of culverted driveway or roadway crossings and bridges of wholly artificial, non-navigable drainage conveyances, provided:

1. The construction project area does not exceed one acre and is for a discrete project that is not part of a larger plan of development that requires permitting under this chapter. However, these limitations shall not preclude use of this exemption to provide access to activities that qualify for the general permit in section 403.814(12), F.S.;

2. The culvert or bridge shall be sized and installed to pass normal high water stages without causing adverse impacts to upstream or downstream property;

3. Culverts shall not be larger than one, 24-inch diameter pipe, or its hydraulic equivalent, and must not reduce the upstream hydraulic discharge capacity;

4. The crossing shall not:

a. Be longer than 30 feet from top-of-bank to top-of-bank;

b. Have a top width of more than 20 feet or a toe-to-toe width of more than 40 feet; and,

c. Have side slopes steeper than three feet horizontal to one foot vertical;

5. There are no more than two crossings on any total land area, with a minimum distance of 500 feet between crossings;

6. If dewatering is performed, all temporary work and discharges must not cause flooding or impoundment, downstream siltation, erosion, or turbid discharges that violate state water quality standards;

7. Any temporary work shall be completely removed and all upstream and downstream areas that were disturbed shall be restored to pre-work grades, elevations and conditions; and,

8. All work shall comply with subsection 62-330.050(9), F.A.C.

(c) Minor roadway safety construction, alteration, maintenance, and operation, provided:

1. There is no work in, on, or over wetlands other than those in drainage ditches constructed in uplands;

2. There is no reduction in the capacity of existing swales, ditches, or other systems legally in existence under chapter 403 or Part IV of chapter 373, F.S.;

3. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.; and

4. The work is limited to:

a. Sidewalks having a width of six feet or less;

b. Turn lanes less than 0.25 mile in length, and other safety-related intersection improvements; and

c. Road widening and shoulder paving that does not create additional traffic lanes and is necessary to meet current, generally accepted roadway design and safety standards.

(d) Resurfacing and repair of existing paved roads, and grading of existing unpaved roads, provided:

1. Travel lanes are not paved that are not already paved;

2. No substantive changes occur to existing road surface elevations, grades, or profiles; and

3. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(e) Repair, stabilization, paving, or repaving of existing roads, and the repair or replacement of vehicular bridges that are part of the road, where:

1. They were in existence on or before January 1, 2002, and have:

a. Been publicly-used and under county or municipal ownership and maintenance thereafter, including when they have been presumed to be dedicated in accordance with section 95.361, F.S.;

b. Subsequently become county or municipally-owned and maintained; or

c. Subsequently become perpetually maintained by the county or municipality through such means as being accepted by the county or municipality as part of a Municipal Service Taxing Unit or Municipal Service Benefit Unit; and

2. The work does not realign the road or expand the number of traffic lanes of the existing road, but may include safety shoulders, clearing vegetation, and other work reasonably necessary to repair, stabilize, pave, or repave the road, provided that the work is constructed using generally accepted roadway design standards;

3. Existing bridges are not widened more than is reasonably necessary to properly connect the bridge with the road to match the width of the roadway travel lanes and safely accommodate the traffic expected;

4. No debris from the original bridge shall be allowed to remain in wetlands or other surface waters;

5. Roadside swales or other effective means of stormwater treatment are incorporated as part of the work;

6. No more dredging or filling of wetlands or water of the state is performed than is reasonably necessary to perform the work in accordance with generally accepted roadway design standards;

7. Notice of intent to use this exemption is provided to the Agency 30 days before performing any work; and

8. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(f) The repair of existing concrete bridge pilings by the Florida Department of Transportation, counties, and municipalities, through the construction of pile jackets, provided the permanent outer form is composed of inert materials and the quantity of material shall not exceed 300 cubic yards of dredging or 300 cubic yards of filling per project. The following conditions shall also apply:

1. Although the bottom sediments within the forms may be removed by jetting or pumping, and may not be recoverable, erosion and sediment control best management practices, including turbidity curtains or similar devices, shall be used in accordance with the *State of Florida Erosion and Sediment Control Designer and Reviewer Manual* to prevent violations of state water quality standards.

2. Immediately following completion of any work that involves disturbance of the shoreline or banks of wetlands or other surface waters, the shoreline and banks shall be stabilized with native vegetation or riprap to prevent erosion; in areas where native wetland vegetation was disturbed, the stabilization shall consist of the same species planted in a manner to achieve stability and coverage of a similar wetland community as previously existed. Temporary erosion controls for all exposed soils within wetlands and other surface waters shall be completed within seven calendar days of the most recent construction activity. Prevention of erosion of exposed earth into wetlands and other surface waters is a construction priority and completed slopes shall not remain unstabilized while other construction continues.

3. Pilings shall not be installed or replaced to add additional traffic lanes.

4. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(5) Dock, Pier, Boat Ramp and Other Boating-related Work –

(a) Installation or repair of pilings and dolphins associated with private docking facilities or piers that are exempt under section 403.813(1)(b), F.S.;

(b) Installation of private docks, piers, and recreational docking facilities, and installation of local governmental piers and recreational docking facilities, in accordance with section 403.813(1)(b), F.S. This includes associated structures such as boat shelters, boat lifts, and roofs, provided:

1. The cumulative square footage of the dock or pier and all associated structures located over wetlands and other surface waters does not exceed the limitations in section 403.813(1)(b), F.S.;

2. No structure is enclosed on more than three sides with walls and doors;

3. Structures are not used for residential habitation or commercial purposes, or storage of materials other than those associated with water dependent recreational use; and

4. Any dock and associated structure shall be the sole dock as measured along the shoreline for a minimum distance of 65 feet, unless the parcel of land or individual lot as platted is less than 65 feet in length along the shoreline, in which case there may be one exempt dock allowed per parcel or lot.

(c) Construction of private docks or piers of 1,000 square feet or less of over-water surface area in artificial waters in accordance with section 403.813(1)(i), F.S., and within residential canal systems legally in existence under chapter 403 or part IV of chapter 373, F.S. This includes associated structures such as roofs and boat lifts, provided the cumulative square footage of the dock or pier and all associated structures located over wetlands and other surface waters does not exceed 1,000 square feet.

(d) Replacement or repair of existing docks and piers, including mooring piles, in accordance with section 403.813(1)(d), F.S., provided the existing structure is still functional or has been rendered non-functional within the last year by a discrete event, such as

a storm, flood, accident, or fire.

(e) The construction and maintenance to design specifications of boat ramps in accordance with section 403.813(1)(c), F.S., where navigational access to the proposed ramp currently exists:

1. In artificial waters and residential canal systems; or

2. In any wetland or other surface waters when the ramps are open to the public; and

3. The installation of docks associated with and adjoining boat ramps constructed as part of the above ramps is limited to an area of 500 square feet or less over wetlands and other surface waters.

(f) The construction, installation, operation, or maintenance of floating vessel platforms or floating boat lifts in accordance with section 403.813(1)(s), F.S.

(g) The removal of derelict vessels, as defined in section 823.11(1), F.S., by federal, state, and local agencies, provided:

1. The derelict vessel case has been completed as specified in section 705.103, F.S., and has been entered into the Statewide Derelict Vessel Database maintained by the Florida Fish and Wildlife Conservation Commission;

2. All work is done in a manner that, to the greatest extent practicable, avoids additional dredging or filling, grounding or dragging of vessels, and damage to submerged resources such as seagrass beds, oyster beds, coral communities, mangroves, other wetlands, and live bottom; and

3. An absorbent blanket or boom shall be immediately deployed on the surface of the water around the derelict vessel if fuel, oil, or other free-floating pollutants are observed during the work.

(h) The installation of a pile-supported boat lift within an existing mooring area at a docking facility that is legally in existence, provided:

1. Such installation does not conflict with a condition of a permit issued thereunder;

2. The boat lift does not include additional structures, such as platforms, cat walks, and roofs.

(6) Construction, alteration, maintenance, operation, and removal of freshwater fish attractors by the Florida Fish and Wildlife Conservation Commission, U.S. Forest Service, and county and municipal governments, provided:

(a) The material is limited to clean concrete, rock, brush, logs, or trees;

(b) The material is firmly anchored to the bottom of the waterbody;

(c) The size of an individual fish attractor shall be limited to one quarter of an acre in area;

(d) The top of the fish attractor shall be at least three feet below the water surface at expected average low water depth, as determined based on best available information for the waterbody at the specific location of the attractor;

(e) The attractor shall be outside any posted navigational channels and shall not cause a navigational hazard;

(f) No material is placed on or in areas vegetated by native aquatic vegetation; and

(g) The provisions of paragraph 62-330.050(9)(c), F.A.C., also shall apply to protect listed species during the work.

(7) Maintenance and Restoration –

(a) Maintenance dredging under section 403.813(1)(f), F.S.

(b) Maintenance of insect control structures, dikes, and irrigation and drainage ditches under section 403.813(1)(g), F.S.

(c) The restoration of existing insect control impoundment dikes, and the connection of such impoundments to tidally influenced waters under section 403.813(1)(p), F.S., provided:

1. The restored section of dike is limited to 100 feet in length;

2. The connection shall provide sufficient cross-sectional area to allow beneficial tidal influence;

3. Dredging and filling are limited to that needed to restore the dike to original design specifications; and

4. The final elevation of the dredge area shall be within two feet of immediately adjacent bottom elevations.

(d) Alteration and maintenance of treatment or disposal systems under rule 62-340.700, F.A.C.

(e) Construction and maintenance of swales in accordance with section 403.813(1)(j), F.S.

(f) Placement of wooden, composite, metal, or other non-earthen construction mats to provide temporary access to maintain or repair projects within wetlands, provided:

1. There is no cutting or clearing of wetland trees having a diameter four inches (circumference of 12 inches) or greater at breast height;

2. The maximum width of the construction access area shall be 15 feet;

3. Mats shall be removed as soon as practicable after equipment has completed passage through, or work has been completed at, each location along the alignment of the project, but in no case longer than seven days after equipment has completed work or

passage through that location; and

4. Areas disturbed for access shall be restored to natural grades immediately after the work is complete.

(g) Port dredging under section 403.813(3), F.S.

(h) The following activities undertaken by the National Oceanic and Atmospheric Administration's (NOAA) Florida Keys National Marine Sanctuary:

1. Seagrass restoration following the procedures of the Final Programmatic Environmental Impact Statement for Seagrass Restoration in the Florida Keys National Marine Sanctuary (NOAA 2004), which is incorporated by reference herein (June 1, 2018) (https://www.flrules.org/Gateway/reference.asp?No=Ref-09440) and available as provided in subsection 62-330.010(5), F.A.C.; and

2. Coral restoration following the procedures of the Final Programmatic Environmental Impact Statement for Coral Restoration in the Florida Keys and Flower Garden Banks National Marine Sanctuaries (NOAA 2010), which is incorporated by reference herein (June 1, 2018) (https://www.flrules.org/Gateway/reference.asp?No=Ref-009441) and available as provided in subsection 62-330.010(5), F.A.C.

(8) The installation of aids to navigation, including bridge fender piles, "No Wake" and similar regulatory signs, and buoys associated with such aids, in accordance with section 403.813(1)(k), F.S.

(9) Pipes or Culverts –

(a) Repair or replacement, provided:

1. The pipes or culverts have equivalent hydraulic capacity to those being repaired or replaced;

2. The invert elevation shall not be changed; and

3. The pipes or culverts function to discharge or convey stormwater, and are not associated with the repair, replacement, or alteration of a dam, spillway, or appurtenant works.

(b) Construction, alteration, operation, maintenance, and removal of outfall pipes, together with associated headwalls, and energy dissipation baffles, rocks, and other scour-reduction devices at the outfall locations, provided:

1. The pipes extend less than 20 feet in, on, or over wetlands or other surface waters;

2. The outfall is part of an activity that is exempt under part IV of chapter 373, F.S., or qualifies for the general permit in section 403.814(12), F.S.;

3. The outfall is designed to prevent erosion and scour;

4. Work in natural waterbodies, wetlands, and Outstanding Florida Waters is limited to 0.03 acre;

5. No activities occur in seagrasses;

6. Within waters accessible to manatees, submerged or partially submerged outfall pipes having a diameter larger than eight inches shall have grating such that no opening is larger than eight inches; and

7. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(c) The extension of existing culverts and crossing approaches, and the installation of scour protection structures at such locations, when done to accommodate an activity that does not require a permit under this chapter, provided:

1. Work in wetlands or other surface waters is limited to a total of 100 cubic yards of dredging and filling, and no more than 0.10 acre at any culvert extension or crossing approach location; and

2. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(10) The construction, alteration, maintenance, removal or abandonment of recreational paths for pedestrians, bicycles, and golf carts, provided:

(a) There is no work in, on, or over wetlands or other surface waters other than those in drainage ditches constructed in uplands;

(b) There is no reduction in the capacity of existing swales, ditches, or other stormwater management systems legally in existence under chapter 403 or part IV of chapter 373, F.S.;

(c) The paths have a width of eight feet or less for pedestrian paths, and 14 feet or less for multi-use recreational paths;

(d) The paths are not intended for use by motorized vehicles powered by internal combustion engines or electric-powered roadway vehicles, except when needed for maintenance or emergency purposes; and

(e) The paths comply with the limitations and restrictions in subsection 62-330.050(9), F.A.C.

(11) Sampling and Testing –

(a) Collection of seagrass, macroalgae, and macrobenthos in accordance with the terms and conditions of a permit or license issued by the Florida Fish and Wildlife Conservation Commission.

(b) Construction, operation, maintenance, and removal of scientific sampling, measurement, and monitoring devices, provided:

1. The device's purpose is solely to collect scientific or technical data, such as staff gages, tide and current gages, meteorological stations, water recording, biological observation and sampling, and water quality testing and improvement. Parshall flumes and other small weirs installed primarily to record water quantity and velocity are authorized, provided the amount of fill is limited to 25 cubic yards;

2. The device and any associated structures or fill, such as foundations, anchors, buoys, and lines, is removed to the maximum extent practicable at the end of the data collection or sampling;

3. The site is restored to pre-construction conditions within 48 hours of completion of use of the device; and

4. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(c) An exemption for geotechnical, geophysical, and cultural resource data surveys, mapping, sounding, sampling, and coring associated with beach restoration and nourishment projects and inlet management activities as provided in section 403.813(1)(v), F.S.

(d) Geotechnical investigations, including soil test borings, standard penetration tests, and other work involving boring, auguring, or drilling for the purposes of collecting geotechnical data, together with clearing for temporary access corridors to perform these investigations, subject to the following:

1. Excavation at each soil boring, auguring, or coring location is limited to no more than one foot in diameter. The total area of work authorized in wetlands and other surface waters is limited to 0.5 acre, including all excavations and clearing for temporary access corridors.

2. No drilling fluid or dredged material shall be left above grade in a wetland or other surface water.

3. Boreholes suspected to have penetrated a confining layer shall be grouted from the bottom up by means of a tremie pipe and the severed materials shall be removed from the wetland or other surface waters.

4. This exemption shall not apply to borings used to place seismographic charges for oil and gas exploration.

5. This exemption does not supersede the exemption in section 403.813(1)(v), F.S., for geotechnical, geophysical, and cultural resource data surveys, mapping, sounding, sampling, and coring associated with beach restoration and nourishment projects and inlet management activities.

6. Turbidity, sedimentation, and erosion shall be controlled during and after investigations to prevent violations of state water quality standards due to construction related activities.

7. Drilling activities associated with construction of wells must comply with chapter 62-532, F.A.C.

8. Temporary vehicular access within wetlands during construction shall be performed using vehicles generating minimum ground pressure to minimize rutting and other environmental impacts. Within forested wetlands, the permittee shall choose alignments that minimize the destruction of mature wetland trees to the greatest extent practicable. When needed to prevent rutting or soil compaction, access vehicles shall be operated on wooden, composite, metal, or other non-earthen construction mats. In all cases, access in wetlands shall comply with the following:

a. Access within forested wetlands shall not include the cutting or clearing of any native wetland tree having a diameter four inches or greater at breast height;

b. The maximum width of the construction access area shall be limited to 15 feet;

c. All mats shall be removed as soon as practicable after equipment has completed passage through, or work has been completed, at any location along the alignment of the project, but in no case longer than seven days after equipment has completed work or passage through that location; and

d. Areas disturbed for access shall be restored to natural grades immediately after the maintenance or repair is completed.

(12) Construction, Replacement, Restoration, Enhancement, and Repair of Seawall, Riprap, and Other Shoreline Stabilization –

(a) Construction, replacement, and repair of seawalls or riprap in artificially created waterways under section 403.813(1)(i), F.S., and within residential canal systems legally in existence under chapter 403 or part IV of chapter 373, F.S, including only that backfilling needed to level the land behind seawalls or riprap.

(b) The restoration of a seawall or riprap under section 403.813(1)(e), F.S., where:

1. The seawall or riprap has been damaged or destroyed within the last year by a discrete event, such as a storm, flood, accident, or fire or where the seawall or riprap restoration or repair involves only minimal backfilling to level the land directly associated with the restoration or repair and does not involve land reclamation as the primary project purpose. See section 3.2.4 of Volume I for factors used to determine qualification under this provision;

2. Restoration shall be no more than 18 inches waterward of its previous location, as measured from the waterward face of the

existing seawall to the face of the restored seawall, or from the waterward slope of the existing riprap to the waterward slope of the restored riprap; and

3. Applicable permits under chapter 161, F.S., are obtained.

(c) The construction of seawalls or riprap in wetlands or other surface waters between and adjoining existing seawalls or riprap at both ends in accordance with section 403.813(1)(o), F.S. For purposes of this exemption, riprap is subject to the same length and orientation limitations as a seawall.

(d) Installation of batter piles, king piles, or a seawall cap, used exclusively to stabilize and repair seawalls, provided they do not impede navigation.

(e) Restoration of an eroding shoreline with native wetland vegetative enhancement plantings, provided:

1. The length of shoreline is 500 linear feet or less;

2. Plantings are native wetland plants appropriate for the site obtained from commercially-grown stock;

3. Plantings extend no farther than 10 feet waterward of the approximate mean high water line (MHWL) or ordinary high water line (OHWL);

4. All invasive and exotic vegetative species along the shoreline is removed in conjunction with the planting to the extent practicable;

5. Biodegradable natural fiber logs or mats that are secured in place, such as with the use of wooden stakes, may be used if necessary to support the vegetative plantings; and

6. No fill is placed other than that needed to support the vegetative plantings, except that a breakwater is authorized to be installed concurrent with the planting if permanent wave attenuation is required to maintain the shoreline vegetation, provided:

a. The waterward toe of the breakwater extends no more than 10 feet waterward of the approximate MHWL or OHWL, with a top height of no more than the mean or ordinary high water elevation;

b. The breakwater is composed predominantly of natural oyster shell cultch (clean and fossilized oyster shell) or other stable, non-degradable materials such as oyster reef, reef balls, boulders, clean concrete rubble, riprap, rock sills, or triangular concrete forms. Oyster shell cultch, if used, shall be enclosed in mesh bags having openings of no more than three inches, or securely fixed to matting prior to placement in the water. Oyster bags and mats must be anchored to prevent movement of shell from the project area;

c. The breakwater shall not be placed over, or within three feet (in any direction) of any submerged grassbed or existing emergent marsh vegetation;

d. The breakwater shall be placed in units so that there is at least one opening measuring at least five feet in width located every 75 linear feet along the breakwater, with a minimum of one opening, to allow the flow of water and the passage of fish and aquatic wildlife;

e. All equipment used during construction shall be operated from, and be stored in uplands; and

f. All work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(13) Single-Family Residences and Associated Residential Improvements –

(a) The construction, alteration, maintenance, removal, and abandonment of one individual single-family dwelling unit, duplex, triplex, or quadruplex, and associated residential improvements, that:

1. Do not involve any work in wetlands or other surface waters;

2. Are not part of a larger common plan of development or sale requiring a permit or modification of a permit under part IV of chapter 373, F.S.; and

3. Comply with the limitations and restrictions in subsection 62-330.050(9), F.A.C.

(b) The construction, alteration, maintenance, removal, and abandonment of one individual single-family dwelling unit, duplex, triplex, or quadruplex, and associated residential improvements if it will be located:

1. Within the boundaries of a valid permit issued under part IV of chapter 373, F.S., and it was accounted for under the permit; or

2. Within the boundaries of a development that predates the applicable effective date for the permitting program established under part IV of chapter 373, F.S., provided the activity does not involve any work in wetlands or other surface waters.

(c) Construction, operation, or maintenance of a stormwater management facility designed to serve single-family residential projects in conformance with section 403.813(1)(q), F.S.

(14) Utilities –

(a) Installation of overhead transmission lines in accordance with section 403.813(1)(a), F.S.

(b) Installation of subaqueous transmission and distribution lines in accordance with section 403.813(1)(m), F.S.

(c) Replacement or repair of subaqueous transmission and distribution lines in accordance with section 403.813(1)(n), F.S.

(d) Activities necessary to preserve, restore, repair, remove, or replace an existing communication or utility pole or aerial transmission or distribution line, provided there is no dredging or filling in wetlands or other surface waters except to remove poles and replace them with new poles, and temporary mats needed to access the site in accordance with paragraph 62-330.051(7)(f), F.A.C. The activity must not increase the voltage of existing power lines or relocate existing poles or lines more than 10 feet in any direction from their original location.

(e) Installation, removal, and replacement of utility poles that support telecommunication lines or cables, or electric distribution lines of 35kV or less, together with the bases and anchoring devices to support those poles. “Anchoring device” shall mean steel guy wires fastened to the ground, without the need for dredging, and “base” shall mean a concrete or steel foundation not exceeding four feet in radius, used to support a utility pole. Work must comply with the following:

1. No more than 15 utility poles shall be installed, removed, or replaced in wetlands;

2. There shall be no permanent placement of fill other than utility poles and anchoring devices;

3. Work shall not occur in forested wetlands located within 550 feet from the mean or ordinary high water line of an Aquatic Preserve or a named waterbody designated as an Outstanding Florida Water or an Outstanding National Resource Water;

4. Vehicle usage in wetlands shall be conducted so as to minimize tire rutting and erosion impacts;

5. There shall be no dredging or filling to create fill pads or access roads, except to place temporary mats for access within the utility right-of-way in wetlands. All temporary mats shall be removed as soon as practicable, but in no case longer than seven days after equipment has completed passage through, or work has been completed, at any location along the alignment of the project;

6. Temporary disturbance to wetlands shall be limited to a length of 0.5 mile, a width of 30 feet, and a total area of 0.5 acre;

7. Maintenance of the utility right-of-way in wetlands shall be limited to a cleared corridor of up to 15 feet wide and a total area of 0.25 acre;

8. Except for the authorized permanent structures, pre-work ground elevations and contours shall be restored within 30 days of completion of the work;

9. Water jets shall not be used unless they are a pre-engineered part of the pole and the water for the jets is either recirculated on site or is discharged in a self-contained upland disposal site;

10. The installation of the utility poles and associated bases and anchoring devices shall not interfere with navigation or impede water flow in wetlands; and

11. Work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(f) Excavation or dredging of temporary trenches to install utilities such as communication cables, water lines, and electrical lines, provided:

1. Material is not deposited within wetlands or other surface waters other than that needed to backfill the trench to restore ground to pre-work grades;

2. Backfilling is performed to restore pre-work grades within 24 hours of disturbance; and

3. Work is conducted in compliance with subsection 62-330.050(9), F.A.C.

(g) Construction, alteration, maintenance, removal, or abandonment of communication tower sites with 0.5 acre or less of impervious or semi-impervious surface such as access roads, buildings, and equipment pads. The design of above-grade access roads shall not adversely affect the conveyance of surface water flows. No activities, including access to the site, shall be located in wetlands or other surface waters or within a 100-year floodplain.

(h) Construction, alteration, maintenance, removal, or abandonment of electrical distribution substation and electrical switching station sites with one acre or less of impervious or semi-impervious surface such as access roads, buildings, and equipment pads. The design of above-grade access roads shall not adversely affect the conveyance of surface water flows. The site must be surrounded by swales, as defined in section 403.803(14), F.S., or other type of equivalent treatment, and must not have a direct discharge to an Outstanding Florida Water. No activities, including access to the site, may be located in wetlands or other surface waters, or within a 100-year floodplain.

(i) Installation and repair of water intake lawn irrigation waterlines and closed-loop air conditioning cooling lines laid on the bottoms of waters of the state for an individual private single-family or multi-family residence, provided that the intake diameter is less than six inches, or its hydraulic equivalent.

(15) Modification or reconstruction of an existing conveyance system constructed prior to the need to obtain a permit under part

IV of chapter 373, F.S., provided:

(a) The work is conducted by a city, county, state agency, or District;

(b) The system alteration is not intended to serve new development; and

(c) The system does not:

1. Discharge directly to Outstanding Florida Waters;

2. Increase pollution loading;

3. Change points of discharge in a manner that would adversely affect the designated uses of wetlands or other surface waters;

4. Result in new adverse water quantity impacts to receiving waters and adjacent lands;

5. Pipe and fill wetlands and other surface waters, including irrigation or drainage ditches; and

6. Replace a functional treatment swale that was authorized under chapter 62-25, F.A.C., or part IV of chapter 373, F.S.

(16) The construction, alteration, maintenance, or filling of wholly-owned, artificial surface waters that:

(a) Were or are created entirely from uplands;

(b) Are isolated such that they do not connect to any other wetlands or other surface waters;

(c) Are not excavated within three feet above any aquitard or karst materials;

(d) Involve no more than a total of 0.5 acre of work in wetlands within the artificial waterbody;

(e) Do not impound water above any surrounding natural grade elevation, or have the capability of impounding more than 40 acre-feet of water;

(f) Were or are not created to provide mitigation under part IV of chapter 373, F.S.;

(g) Excavated materials shall not be used off-site for commercial, industrial, or construction use;

(h) Were not permitted for stormwater treatment or management under chapter 62-25, F.A.C., or part IV of chapter 373, F.S.;

(i) All excavated material shall be deposited and fully contained within uplands;

(j) Are not a farm pond as defined in section 403.927, F.S.; and

(k) Work is conducted in accordance with paragraph 62-330.050(9)(b), F.A.C.;

(17) The construction, alteration, operation, maintenance, repair, reclamation, or abandonment of a dry borrow pit for excavation of sand and other soil materials, provided that all of the following conditions are met:

(a) Notice of intent to use this exemption is provided to the Agency 30 days before performing any work.

(b) The area of excavation for the borrow pit shall be less than five acres, when measured at the natural land surface grade of the pit.

(c) The borrow pit shall be constructed entirely in uplands for the purpose of using the borrow materials as appropriately permitted, authorized, or as exempted. If excavated materials will be used off-site for commercial, industrial, or construction use, the borrow pit is subject to the mine reclamation requirements under part III of chapter 378, F.S.

(d) Borrow pits under this exemption must meet the following conditions:

1. Does not include construction or maintainance of any embankment above the natural land surface grade as a part of the work to construct the pit and remove the soil materials.

2. No above-grade roads are constructed as access to the pit area.

3. Shall not impact wetlands.

4. Shall not be excavated deeper than three feet above seasonal high water level, any surficial aquifer, aquitard, or karst materials.

5. The pit area shall be protected at all times by adequate fencing and gating structures to limit access and provide for safety.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 403.805(1) FS. Law Implemented 373.406, 373.4131, 373.4145, 373.415, 403.813(1) FS. History–New 10-1-13, Amended 6-1-18.

62-330.0511 No-fee Noticed Exemptions for Construction, Operation, Maintenance, Alteration, Abandonment, or Removal of Minor Silvicultural Surface Water Management Systems.

(1) Silviculture activities conducted and noticed in conformance with the best management practices and procedures below shall qualify for this no-fee noticed exemption. The Agencies shall not be compelled to verify qualification for these exemptions following receipt of the notice required in subsection (2), below. However, if a person desires written Agency verification of compliance with this rule, they shall follow the noticing and fee requirements of rule 62-330.050, F.A.C. These exemptions apply to:

(a) Any person constructing, operating, maintaining (including repairing or replacing), altering, abandoning, or removing

silvicultural roads, and other minor activities designed to place the property into silvicultural use or to perpetuate the maintenance of the property in silvicultural use; and

(b) The U.S. Forest Service to construct, operate, maintain, alter, abandon, or remove surface water management systems.

(2) The construction, operation, maintenance, alteration, abandonment, or removal of the minor silvicultural surface water management system described below shall be initiated only after a completed "Notice of Intent to Construct a Minor Silvicultural System," Form 62-330.0511(1), (October 1, 2013), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02510), is received by the Agency, or is properly addressed and stamped and deposited in the United States mail, in which case the postmark date shall be the date of receipt. Persons may also submit annual schedules of proposed silvicultural surface water management systems that meet the requirements of this section, including completed notices for each activity. A copy of the above form may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(3) Activities required to implement the following projects qualify for the exemption under this rule:

(a) A permanent culverted fill road with a road surface of 28 feet or less in width placed in or crossing a stream or other watercourse of less than 10 cubic feet per second average discharge at the location of the work or with a drainage area upstream of the work of less than 10 square miles. The design of the work must allow for conveyance of normal flows and for overtopping during large storm events, and any fill placed in wetlands associated with the stream or other watercourse must be less than 0.5 acre in area. Under this paragraph, the fill material shall be no more than 24 inches above culvert structures. The fill material on the road approaches shall be no more than 24 inches above grade except within an area of 100 feet of either side of a culvert. The road must be designed with culvert inlets positioned at or below natural grade of the bed of the stream or other watercourse to prevent the permanent impoundment of water, and to provide an overflow area or areas which will prevent erosion and adverse effects to water levels upstream and downstream of the road.

(b) A temporary culverted fill road or a temporary bridge up to 50 feet long, with a road surface of 28 feet or less in width placed in or crossing a stream or other watercourse of less than 10 cubic feet per second average discharge at the location of the work or a drainage area upstream of the work of less than 10 square miles. The design of the work must allow for conveyance of existing flow during the period of installation and use and any fill placed in wetlands associated with the stream or other watercourse must be less than 0.5 acre in area. The work must be designed only to facilitate the temporary movement of equipment and must be removed immediately after the operation for which the crossing was needed is complete or within 30 months of the filing of the notice in subsection (2), above, whichever is sooner.

(c) A permanent bridge up to 100 feet in length and 28 feet or less in width supported on pilings or trestles, placed in or crossing a stream or other watercourse of less than 10 cubic feet per second average discharge at the location of the work or with a drainage area upstream of the work of less than 10 square miles. The design of the work and associated approach roads, if any, must allow for conveyance of normal flows and for overtopping during large storm events and any fill placed in wetlands associated with the stream or other watercourse must be less than 0.5 acre in area. The height limitation for fill on the bridge approach roads shall be a maximum of 24 inches above natural grade.

(d) A permanent culverted fill road or bridge with a road surface of 28 feet or less in width, placed in or crossing a wetland or other impoundment, excluding reservoirs created by dams, where the road surface area over the wetland or other impoundment is less than 0.5 acre. Such crossings must be located in a manner which minimizes the area of wetlands being filled. Fill material for crossings of isolated wetlands or other isolated impoundments may be excavated from the wetland being crossed, provided that all excavation takes place immediately adjacent to the road surface and that the excavated area consists only of narrow trenches which are not connected to ditches constructed or maintained for drainage purposes. In addition, such excavations shall not result in drainage from the wetland.

(e) Temporary stream channel diversions necessary to complete the works described in paragraph (3)(a), (b), or (c), above, provided that the area used for the temporary diversion is restored to its previous contours and elevations.

(f) Clearing and snagging in a stream or other watercourse within 50 feet of the center line of a culverted fill road or a bridge described in paragraph (3)(a), (b), or (c), above, necessary to construct said work.

(g) A permanent low water, hard surfaced crossing in a stream, other watercourse, wetland or other impoundment consisting of the placement of rock or similar material no more than 12 inches higher than the bed of the stream, other watercourse or impoundment. Such crossings must be designed only to facilitate the movement of equipment by creating a stable foundation in shallow streams, other watercourse, wetlands or other impoundments. Temporary low water, hard surfaced crossings may be

constructed using logs, but must be removed immediately following the completion of the silvicultural operation or within 30 months of the filing of the Notice of Intent in subsection (2), whichever is sooner.

(h) Upland field ditches of a temporary nature to facilitate only harvesting, site preparation, and planting, with a maximum cross-sectional area of 18 square feet spaced no closer than 660 feet from any other parallel ditch. After seedling establishment, the ditches shall be allowed to revegetate naturally. The person will not be required to fill field ditches after seedling establishment.

(i) Above grade, unpaved, upland silvicultural roads with an average road surface width of 28 feet within a construction corridor up to 50 feet in width. These roads must also incorporate sufficient culverts at grade to prevent alteration of natural sheet flow and may have associated borrow ditches. Road ditches shall be constructed only to obtain road material for the associated road and to provide only enough storage to maintain a dry road surface. Such road ditches must not provide drainage to the tract adjoining the road, other than to provide drainage of the road surface and minor, incidental drainage of abutting lands. These road ditches may be connected to other roadside ditches that were constructed pursuant to an Agency permit or that were exempt from permitting under part IV of chapter 373, F.S., but must not connect directly or indirectly to any works onsite or off-site which are designed or constructed to provide drainage or conveyance or which would result in drainage or conveyance. Road ditches must be separated from wetlands and other surface waters by a buffer strip of indigenous ground cover and a water turnout prior to said buffer strip. However, road ditches may discharge directly to a wetland when the slope of the uplands within 1,000 feet of the edge of the wetland is equal to or less than two percent, provided the ditch does not result in drainage of the wetland and provided that the ditch does not create a hydrologic connection between two or more wetlands. The width of the buffer strip shall be no less than 35 feet, or 50 feet when located adjacent to an Outstanding Florida Water, an Outstanding National Resource Water, or Class I waters.

(j) Upland borrow areas needed to obtain fill material for crossings of streams, other watercourses, wetlands, and other impoundments authorized by this exemption. These upland borrow areas must not provide drainage and must not be hydrologically connected to roadside ditches or field ditches.

(4) The systems identified in subsection (3), above, must meet the following performance standards:

(a) Except for those areas to be filled for crossings as provided in this section, the activities must not convert wetlands or other surface waters to uplands.

(b) A road or bridge must be designed to convey normal water flow while being adequately stabilized to allow for overtopping during storm events without washing out.

(c) A permanent road or bridge placed in or crossing a stream, other watercourse, wetland or other impoundment may be placed no closer than 0.5 mile from any traversing work which traverses the same stream, other watercourse, wetland or impoundment. A low water crossing or temporary road or bridge placed in or crossing a stream, other watercourse, wetland or other impoundment may be placed no closer than 0.25 mile from any traversing work which traverses the same stream, other watercourse, wetland, or other impoundment. The spacing limitation shall be measured along the stream, other water course, wetland or other impoundment. Notwithstanding the spacing limitation in this paragraph, at least one low water crossing, road or bridge crossing of any stream, other watercourse, wetland or other impoundment may be constructed to each upland area being managed for silviculture that would not otherwise be accessible if these spacing limitations were met.

(d) A low water crossing, road, or bridge placed in or crossing a stream, other watercourse or impoundment must not cause increased velocities downstream of the work that would cause scour outside of the area of clearing and snagging described in paragraph (3)(f), above.

(e) A low water crossing, road, or bridge placed in or crossing a stream, other watercourse or impoundment must not cause increased flooding on property not owned by the person.

(f) Erosion control measures must be undertaken to limit the transfer of suspended solids into the receiving waterbody during and after construction of the proposed work. After removing any temporary crossing, disturbed portions of the stream bank and stream channel shall be restored to approximate their original shape and flow capacity. Erodible ground area associated with the crossing shall be stabilized with riprap, mulch or seeded for appropriate ground cover vegetation within 72 hours after removal.

(g) Upland field ditches may connect only to works that are permitted by the Agency, or exempt from permitting under part IV of chapter 373, F.S., and only if the connection will not cause the work to exceed its conveyance capacity or to increase flooding on property not owned by the person; however, this section does not authorize connection to works without the consent of the owner of the work. Field ditches will be presumed to meet the erosion control requirements of paragraph (4)(f), above, when they are separated from streams, other watercourses, wetlands or other impoundments by a buffer strip of undisturbed vegetation and provided the integrity of this buffer is maintained. The width of the buffer strip shall be the width of the total Special Management

Zone (primary zone and secondary zone) as described in the *Silviculture Best Management Practices Manual* (2008), published by the Division of Forestry, Florida Department of Agriculture and Consumer Services, incorporated by reference herein
(#1 http://www.flrules.org/Gateway/reference.asp?No=Ref-03131,
#2 http://www.flrules.org/Gateway/reference.asp?No=Ref-03132,
#3 http://www.flrules.org/Gateway/reference.asp?No=Ref-03133,
#4 http://www.flrules.org/Gateway/reference.asp?No=Ref-03134,
#5 http://www.flrules.org/Gateway/reference.asp?No=Ref-03135,
#6 http://www.flrules.org/Gateway/reference.asp?No=Ref-03136,
#7 http://www.flrules.org/Gateway/reference.asp?No=Ref-03137,
#8 http://www.flrules.org/Gateway/reference.asp?No=Ref-03138,
#9 http://www.flrules.org/Gateway/reference.asp?No=Ref-03139,
#10 http://www.flrules.org/Gateway/reference.asp?No=Ref-03140, and
#11 http://www.flrules.org/Gateway/reference.asp?No=Ref-03141), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. However, field ditches may discharge directly to a wetland when the slope of the uplands within 1,000 feet of the edge of the wetland is equal to or less than two percent, provided the ditch does not result in drainage of the wetland and provided that the ditch does not create a hydrologic connection between two or more wetlands.

(h) In addition to the performance standards in paragraphs (4)(a) through (g), above, the person undertaking the activities must use the best management practices set forth in the *Silviculture Best Management Practices Manual* referenced in paragraph (4)(g), above.

(i) If climatic or flow conditions prevent the removal of a temporary crossing within the time frame specified in this section, the applicant may re-submit the application identified in subsection (2), above, to extend the time period for removal and restoration of the temporary crossing. The person must provide a written explanation and evidence supporting the need to reauthorize the crossing and must specify the additional time needed to remove the crossing, which may not exceed one year.

(5) Activities are authorized by the exemptions above for the following durations:

(a) One year to complete construction, alteration, abandonment, or removal of the silvicultural surface water management system; and

(b) Permanent for operation and maintenance of the silvicultural surface water management system.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 403.805(1) FS. Law Implemented 373.406(2), 373.4131, 373.4145, 373.415, 403.813(1) FS. History–New 10-1-13, Amended 6-1-18.

62-330.052 General Permits – General.

Rules 62-330.401 through 62-330.635, F.A.C., contain the procedures to submit a notice to use a general permit, the procedures for their review, the general conditions that apply to them, and the terms and specific conditions of each general permit. Those provisions do not apply to activities that qualify for the general permit in section 403.814(12), F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 373.426 FS. History–New 10-1-13.

62-330.054 Individual Permits.

(1) An individual permit is required for activities that require a permit if they:

(a) Do not qualify for a general permit in rules 62-330.410 through 62-330.635, F.A.C.; and

(b) Are not proposed for conceptual approval under rule 62-330.055 or 62-330.056, F.A.C.

(2) Except as otherwise provided in subsection (4), below, an application for an individual permit shall be:

(a) Prepared using the form and procedures in rule 62-330.060, F.A.C.;

(b) Submitted in accordance with sections 4.2.3, 4.3, and 4.4 of Volume 1; and

(c) Reviewed and acted on in accordance with rules 62-330.062, 62-330.071, 62-330.075, 62-330.090, 62-330.301, and 62-330.302, F.A.C., and the Applicants Handbook.

(3) An application for a mitigation bank permit shall be processed as a type of individual permit, but also is subject to the requirements in chapter 62-342, F.A.C. If there is a conflict between this chapter and chapter 62-342, F.A.C., chapter 62-342, F.A.C., will control.

(4) An individual permit required solely pursuant to both paragraph 62-330.020(2)(i), F.A.C., and chapter 40C-44, F.A.C., shall be reviewed and acted upon in accordance with chapter 40C-44, F.A.C., (October 1, 2013), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02533), and application for such permit shall be made in accordance with that chapter. A copy of chapter 40C-44, F.A.C., may be obtained as provided in subsection 62-330.010(5), F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.4136, 373.414(9), 373.4145, 373.416, 373.418, 373.426 FS. History–New 10-1-13, Amended 6-1-18.

62-330.055 Conceptual Approval Permits for Urban Infill or Redevelopment.

A county or municipality may request a conceptual approval permit for activities occurring within urban infill and redevelopment areas or community redevelopment areas created under chapter 163, F.S. Following approval of the conceptual permit, any construction, alteration, operation, maintenance or removal consistent with the conceptual permit may be authorized under a notice of intent to use the general permit for urban infill and redevelopment in rule 62-330.450, F.A.C.

(1) An urban infill or redevelopment conceptual approval permit shall be reviewed as provided below and in rule 62-330.056, F.A.C., but does not have to meet all of the stormwater quality and quantity design and performance criteria of Volume II, provided the county or municipality submits a stormwater management master plan for the urban infill or redevelopment area that includes the following:

(a) Identification of the proposed urban infill or redevelopment area and the total contributing drainage area, including any major drainage basins and sub-basins;

(b) Identification of the receiving waters associated with the proposed urban infill or redevelopment area; and

(c) Calculation and assignment of the predevelopment annual loading of pollutants of concern as determined during the permit application review, on a drainage basin or sub-basin basis, for all areas to be included within the conceptual approval permit. Loadings must be specific to the types of land use and must be expressed as a "mass per area" basis. The basin or sub-basin loading assignments will serve as the pollutant goal for future urban infill or redevelopment in each of those areas (target pollutant load). Future development that meets the predevelopment pollutant load assignment will be presumed to meet the net improvement requirements of paragraph (2)(a), below.

(2) An application for a conceptual approval permit for urban redevelopment and infill activities shall also include the following:

(a) A demonstration that the redevelopment will achieve a net improvement of the quality of stormwater in accordance with section 373.4131(1)(b)2., F.S.

(b) Documentation of the rate and volume of stormwater discharges existing as of the date of the application, and information sufficient to estimate the maximum rate and volume of stormwater discharges that will exist as of the date of issuance of the conceptual approval permit.

(c) A commitment that activities within the redevelopment area will use stormwater best management practices (BMPs) to the maximum extent practicable.

(d) Provisions demonstrating that the individual or regional stormwater management systems within the urban infill or redevelopment area will be operated and maintained in perpetuity, consistent with the terms and conditions of the conceptual approval permit.

(e) An identification of proposed construction and no-construction areas.

(f) An estimate of the maximum extent of impacts to wetlands and other surface waters and details of any proposed mitigation for those impacts.

(g) An estimate of the maximum amount of anticipated impervious surface and description of the stormwater treatment system for those areas.

(h) An identification of the general location and types of activities proposed on any state-owned submerged lands.

(i) A timetable for redevelopment, including the requested duration of the conceptual approval permit.

(3) Consistent with the approved stormwater management master plan, the conceptual approval permit will:

(a) Provide a ledger that indicates the target pollutant load (mass per area) for each drainage basin or sub-basin. Any general permit for construction that is submitted in association with the conceptual permit must demonstrate that the proposed project does not exceed the target pollutant load for the receiving waters.

(b) Provide the annual pollutant load (mass per area) for each type of land use category, and the pollutant removal efficiency for

the anticipated BMPs to be employed. Activities requested under the general permit in rule 62-330.450, F.A.C., that use the BMPs approved in the stormwater master plan, that reduce impervious surfaces, or that otherwise meet the pollutant loading target in the stormwater master plan, and that also comply with all the terms and conditions of the general permit, will result in a debit to the ledger. Once the entire pollutant load target is reached for the receiving waters, no more development is allowed under the general permit.

(c) Contain specific conditions necessary to ensure that the future applications for permits to construct, alter, operate, maintain, remove, or abandon systems authorized in the conceptual approval permit are consistent with the redevelopment conceptual approval permit and the general permit in rule 62-330.450, F.A.C.

(d) Allow the rate and volume of stormwater discharges for stormwater management systems within the urban infill or redevelopment area to continue up to the maximum rate and volume of stormwater discharges allowed under section 373.4131(1)(b)4., F.S.

(4) If changes are proposed to the design of existing or future phases, or where there have been changes to state water quality standards, special basins, or site characteristics during the duration of the conceptual approval permit, the applicant must modify the conceptual approval permit if it wishes to continue to rely on it as a basis that reasonable assurance exists for the Agency to issue future construction or operation permits under the terms and conditions of this section. If the permittee fails to do this, the conceptual approval permit can no longer be relied upon as a basis, in part or whole, under which permits to construct or operate future phases will be issued, and the Agency will reevaluate the terms and conditions of the conceptual approval permit at the time a permit application is received to construct the next phase of activities included in the original conceptual approval permit, or at the next requested extension of the conceptual approval permit duration in accordance with subsection 62-330.056(11), F.A.C., whichever occurs first.

(5) Issuance of the conceptual approval permit and activities undertaken under the general permit in rule 62-330.450, F.A.C., must comply with the provisions of section 373.4131(1)(b)1., F.S.

(6) An individual permit under this chapter is required for the construction, alteration, operation, maintenance, abandonment, or removal of activities covered by this conceptual approval permit that involve work in wetlands or other surface waters. The following must occur before the Agency can determine that the general permit in rule 62-330.450, F.A.C., can be used to construct roads, parking areas, buildings, and other structures within the project area authorized by that individual permit, or on lands served by a stormwater management system authorized by that individual permit:

(a) The individual permit must be obtained;

(b) Dredging and filling necessary to prepare the land for future construction, including construction of any required stormwater management systems, must be completed in accordance with the individual permit; and

(c) Any mitigation required to offset adverse impacts from the work in wetlands and other surface waters must be initiated in conformance with the individual permit. When the applicant proposed the recording of a conservation easement over land as part of its mitigation, then a conservation easement acceptable to the agency must be recorded over the mitigation land consistent with the permitted mitigation plan. If the applicant proposed credits from a mitigation bank or regional offsite mitigation area as part of its mitigation, then such credits must be purchased consistent with the permitted mitigation plan.

(7) An urban infill or redevelopment conceptual permit shall be issued for 20 years, unless a shorter duration is requested. The permit shall be renewed at the request of the permittee for another 20 years, unless a shorter duration is requested, subject to activities remaining in compliance with this section and the terms and conditions of the general permit in rule 62-330.450, F.A.C.

Rulemaking Authority 373.026, 373.043, 373.044, 373.4131, 373.4145, 373.418, 380.06, 403.805(1) FS. Law Implemented 373.026, 373.409, 373.413, 373.4131, 373.4141, 373.4142, 373.4145, 373.416, 380.06 FS. History–New 10-1-13, Amended 6-1-18.

62-330.056 Other Conceptual Approval Permits.

(1) A conceptual approval permit is available for an applicant who desires approval of design concepts for a master or future plan to construct, alter, operate, maintain, remove, or abandon projects that require an individual permit under this chapter. This includes activities that are to be developed in phases, such as phased development master plans and projects for which an Application for Development Approval has been made pursuant to part I of chapter 380, F.S., and whenever an applicant has not yet developed detailed design or construction plans for a future activity.

(2) A conceptual approval permit does not authorize any construction, alteration, operation, maintenance, removal, or abandonment, or the establishment and operation of a mitigation bank. Issuance of a conceptual approval permit does not relieve the

holder of such a permit of any requirements to obtain a permit to construct, alter, operate, maintain, remove, or abandon projects that require a permit under this chapter, or to establish and operate a mitigation bank.

(3) An application for a conceptual approval permit shall be prepared and submitted using the procedures in rule 62-330.060, F.A.C., and sections 4.2.3, 4.2.3.1, 4.3, and 4.4 of Volume I. An application for conceptual approval for a mitigation bank also shall include the materials required by chapter 62-342, F.A.C.

(4) The application shall be reviewed and acted on in accordance with this section, rules 62-330.062, 62-330.071, 62-330.075, 62-330.090, 62-330.301, and 62-330.302, F.A.C., and the Applicant's Handbook. Agency review and action also shall be in accordance with chapter 62-342, F.A.C., when the conceptual approval application involves a mitigation bank.

(5) An application for a conceptual approval permit may include a request for a permit to construct and operate the first phase of the activities. In such a case, a separate application and processing fee to construct and operate the first phase shall not be required. In all other cases, an individual permit to construct, alter, operate, maintain, remove, or abandon projects authorized by the conceptual approval permit must be obtained prior to initiating such activities.

(6) Any delineation of wetlands or other surface waters submitted as part of the conceptual approval permit application, including supporting documentation, shall not be considered binding unless a specific condition of the permit or a formal determination under rule 62-330.201, F.A.C., provides otherwise.

(7) Issuance of a conceptual approval permit is a determination that the conceptual plans are, within the extent of detail provided in the conceptual approval permit application, consistent with applicable rules at the time of issuance. A conceptual approval permit provides the conceptual approval permit holder with a rebuttable presumption, during the duration of the conceptual approval permit, that the engineering design and scientific principles upon which the conceptual approval permit are based (within the extent of detail provided in the conceptual approval permit) are likely to meet applicable rule criteria for issuance of permits for subsequent phases of the project, provided all of the following are met at the time of receipt of a complete application to construct or operate the future phases:

(a) The application to construct and operate the future phases remains consistent with the designs and conditions of the issued conceptual approval permit. Primary areas for consistency comparisons include the size, location and extent of the activities proposed, the type and nature of the activities, percent imperviousness, allowable discharge and points of discharge, location and extent of wetland and other surface water impacts, mitigation plans implemented or proposed, control elevations, extent of stormwater reuse, detention and retention volumes, and the extent of flood elevations.

If an application for construction of any portion of the land area contained within the conceptual approval permit is based upon designs that are inconsistent with the conceptual approval permit, the application will be reviewed to determine the extent to which the inconsistency will affect the designs and conditions for the remainder of the lands contained in the conceptual approval permit. If the inconsistency will materially affect those designs and conditions, then the applicant must demonstrate that the holder of the conceptual approval permit agrees to that inconsistency. In such a case, the holder of the conceptual approval permit may:

1. Modify the conceptual approval permit to conform to the revised design;

2. Abandon reliance on the conceptual approval permit; or

3. Rely on those portions of the conceptual approval permit for only those areas that were not affected by the inconsistency.

(b) There are no changes to state water quality standards, that would be affected by activities authorized in the conceptual approval permit that have not already been authorized for construction or operation.

(c) There have been no amendments to Florida law governing special basin criteria that would affect future activities authorized by the conceptual approval permit that have not already been authorized for construction.

(d) There are no substantive changes in the site characteristics that would affect whether the design concepts approved in the conceptual approval permit can continue to be reasonably expected to meet the conditions for authorizing construction of future phases. This shall include such things as designation of an affected waterbody as impaired, changes in the designation of listed species, and changes to nesting, denning, and critical designation status of listed species that exist within the lands served by the project area.

(8) If changes are proposed to the design of existing or future phases, or where there have been changes to state water quality standards, special basins, or site characteristics as described in paragraphs (7)(a) through (d), above, during the duration of a conceptual approval permit, the applicant must modify the conceptual approval permit if it wishes to continue to rely on it as a basis that reasonable assurance exists for the Agency to issue future construction or operation permits under the terms and conditions of this section. If the permittee fails to do this, the conceptual approval permit can no longer be relied upon as a basis, in part or whole,

under which permits to construct or operate future phases will be issued, and the Agency will reevaluate the terms and conditions of the conceptual approval permit at the time a permit application is received to construct the next phase of activities included in the original conceptual approval permit, or at the next requested extension of the conceptual approval permit duration in accordance with subsection 62-330.056(11), F.A.C., whichever occurs first.

(9) The duration of a conceptual approval permit, other than for urban infill and redevelopment, is 20 years, provided a permit under this chapter is issued for the initial phase of construction or alteration, the authorized construction or alteration has begun within five years of the date the conceptual approval permit was issued, and the work remains in compliance with the terms and conditions of both the conceptual approval permit and all permits authorizing construction or alteration. The time periods of this subsection will be tolled if the reviewing agency is notified in writing, within five years of issuance of the conceptual approval permit, that administrative review under either of the following is pending:

(a) The project approved by the conceptual approval permit is undergoing Development of Regional Impact review pursuant to section 380.06, F.S., and an administrative appeal of that review has been filed; or

(b) The issuance of the construction permit for the first phase is under administrative review pursuant to section 120.569 or 120.57, F.S.

If notice is given as provided above, the five-year time period for obtaining a permit and commencing construction shall be tolled until the date of final action resolving such administrative appeal or review, including any judicial review.

(10) If a permit for construction or alteration of the initial phase is not obtained from the Agency and construction commenced within five-years of issuance of the conceptual approval permit, the conceptual approval permit will expire five years from its date of issuance.

(11) Prior to expiration of the conceptual approval permit, the permittee may submit a request to modify its duration. However, the application will be reviewed in consideration of the factors in subsections 62-330.056(7) and (8), F.A.C., at the time of submittal of each request to extend the duration and each subsequent permit application to construct another phase of the projects under the conceptual approval permit. Where substantive changes in the design are proposed by the applicant, or are required to address the factors in paragraphs (7)(b) through (d), above, the permittee must submit an application for a major modification of the conceptual approval permit, which must be approved prior to the Agency issuing a permit to construct or alter future phases.

(12) A permit under this chapter shall not be required to construct or alter projects consistent with a conceptual approval permit issued under part IV of chapter 373, F.S., prior to October 1, 2013; such construction or alteration shall continue to be governed by the rules in effect prior to October 1, 2013, unless modifications are proposed that will require a permit under this chapter in accordance with subsection 62-330.315(4), F.A.C.

(13) Conceptual approvals for ports are available under section 373.4133, F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 373.426 FS. History–New 10-1-13, Amended 6-1-18.

62-330.060 Content of Applications for Individual and Conceptual Approval Permits.

Materials to include in an application or notice for a permit are described below. Applicants are encouraged to have a pre-application meeting or discussion with Agency staff prior to submitting the application or notice.

(1) An application for an individual permit or conceptual approval permit shall be made on Form 62-330.060(1), "Application for Individual and Conceptual Approval Environmental Resource Permit and Authorization to Use State-Owned Submerged Lands," including the information required in the applicable Sections A through H (June 1, 2018), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-09361), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C., or by use of the equivalent e-application form of the applicable Agency. Attachments 1, 2, and 3 of the form (containing agency contacts and a summary of the application fees related to applications and notices) are not incorporated by reference, but are available at https://floridadep.gov/water/submerged-lands-environmental-resources-coordination/content/forms-environmental-resource.

(2) The application must include all material requested in the application form; the processing fee in accordance with rule 62-330.071, F.A.C.; and other information needed to provide reasonable assurance that the proposed activities meet the conditions for issuance in rule 62-330.301, F.A.C., the additional conditions for issuance in rule 62-330.302, F.A.C., and the Applicant's Handbook.

(3) The applicant must certify that it has sufficient real property interest over the land upon which the activities subject to the

application will be conducted, as required in Section A of Form 62-330.060(1) and Section 4.2.3(d) of the Applicant's Handbook Volume I. The applicant or the applicant's authorized agent must sign Part 4.A. of the application, and the applicant must sign Part 4.B. If the applicant's authorized agent signs Part 4.A, the applicant also must sign Part 4.C.

(4) An application for an individual permit also constitutes an application to operate and maintain the project. The application must specify the entity that will operate and maintain the project. If the applicant proposes an entity other than the current owner to operate and maintain the proposed project, documentation must be included demonstrating how such entity will meet the requirements of sections 12.3 through 12.3.4 of Volume I. A homeowner's or property owner's association ("HOA" or "POA," respectively) draft association documents designating the HOA or POA as the operating entity, and prepared in conformance with sections 12.3 through 12.3.4 of Volume I, shall satisfy this requirement. This provision of the association documents may not be modified without a permit modification in accordance with rule 62-330.315, F.A.C.

Rulemaking Authority 373.044, 373.113, 373.171, 373.4131 FS. Law Implemented 373.042, 373.413, 373.4131, 373.416, 668.003, 668.004, 668.50 FS. History–New 10-1-13, Amended 6-1-18.

62-330.061 Submittal of Applications and Notices to Agency Offices.

Rulemaking Authority 373.026, 373.043, 373.044, 373.118, 373.4131, 373.4145, 373.418, 403.805(1), 668.003, 668.004, 668.50 FS. Law Implemented 373.026, 373.118, 373.413, 373.4131, 373.4145, 373.416, 373.426, 668.003, 668.004, 668.50 FS. History–New 10-1-13, Repealed 11-26-15.

62-330.062 Water Quality Certification and Coastal Zone Consistency Concurrence.

(1) A State Water Quality Certification under Section 401 of the Clean Water Act, 33 U.S.C. Section 1341, shall be provided as described below.

(a) A complete application for an individual or conceptual approval permit shall constitute an application for certification of compliance with state water quality standards for activities that require an associated Department of the Army permit or license under Section 404 of the Clean Water Act, 33, U.S.C. 1344. Issuance of the individual or conceptual approval permit under this chapter shall constitute certification of compliance with water quality standards, unless water quality certification is waived in accordance with paragraph (1)(c), below.

(b) State water quality certification is granted when an activity meets all the terms and conditions of a general permit under rule 62-330.052, F.A.C., and the applicable rules 62-330.401 through 62-330.635, F.A.C.

(c) State water quality certification is waived for activities:

1. That are not regulated under rule 62-330.020, F.A.C.

2. That are exempt under rule 62-330.051 or 62-330.0511, F.A.C.

3. That require net improvement of water quality under section 373.414(1)(b), F.S., including permits issued under rule 62-330.055, F.A.C.

4. When the individual or conceptual approval permit is not issued or denied within 365 days of the date the application is deemed complete by the Agency.

5. When the permit or authorization expressly waives water quality certification.

(2) A complete application for an individual or conceptual approval permit for activities located in or seaward of coastal counties, and, in whole or in part, in, on, or over wetlands or other surface waters, shall also constitute a request for the State's concurrence that the activities are consistent with the enforceable policies included in the Florida Coastal Management Program (FCMP) under the "Coastal Zone Management Act" (CZMA), 16 U.S.C. Sections 1451-1466, and its implementing regulations, 15 C.F.R. Part 930. In accordance with section 380.23, F.S.:

(a) Qualification for a general permit, or issuance of an individual or conceptual approval permit shall constitute the state's concurrence that the activity is consistent with the enforceable policies included in the FCMP.

(b) Applications for federally permitted or licensed activities that qualify for an exemption under section 373.406 or 403.813(1), F.S., and this chapter, or the "10/2" general permit under section 403.814(12), F.S., are not eligible to be reviewed for federal consistency with part IV of chapter 373, F.S. The U.S. Army Corps of Engineers (Corps) or any designated federal, state or local agency administering general permits on behalf of the Corps under 33 C.F.R. Section 325.2(b)(2) may presume such exempt activities are consistent with the permitting Agency's authorities within the FCMP, provided the activity receives any applicable authorization to use and occupy state-owned submerged lands under chapter 253, F.S., and, as applicable, chapter 258, F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.418, 380.23(4), 403.0877, 403.805(1) FS. Law Implemented 373.026(7), 373.109, 373.117, 373.118, 373.413, 373.4131, 373.4141, 373.4145, 373.416, 373.426, 373.428, 380.23, 403.0877 FS. History–New 10-1-13, Amended 6-1-18.

62-330.071 Fees.

(1) A processing fee is required to be submitted with an application, notice, or petition under this chapter. The amount of the fee is specified in the following rules of the applicable Agency where the application, notice, or petition is submitted. The rules in paragraphs (b) through (e), below, are incorporated by reference herein. A copy of the incorporated material may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(a) Department or Northwest Florida Water Management District – rule 62-4.050, F.A.C.

(b) Suwannee River Water Management District – rule 40B-1.706, F.A.C., (October 1, 2013), (https://www.flrules.org/Gateway/reference.asp?No=Ref-02534)

(c) St. Johns River Water Management District – rule 40C-1.603, F.A.C., (October 1, 2013), (https://www.flrules.org/Gateway/reference.asp?No=Ref-02535)

(d) Southwest Florida Water Management District – rule 40D-1.607, F.A.C., (October 1, 2013), (https://www.flrules.org/Gateway/reference.asp?No=Ref-02536)

(e) South Florida Water Management District Rule – rule 40E-1.607, F.A.C., (October 1, 2013), (https://www.flrules.org/Gateway/reference.asp?No=Ref-02537).

(f) The processing fee for applications, notices, or petitions that are the responsibility of a local government delegated to implement this chapter under section 373.441, F.S., shall be established by the local government in accordance with the Delegation Agreement between the Department and the local government incorporated by reference in chapter 62-113, F.A.C.

(2) Processing fees submitted in the form of a check shall be made payable to the Agency. Electronic payment will be in accordance with the procedures established by the applicable Agency.

(3) If an applicant withdraws an application for individual or conceptual approval permit prior to Agency action, any processing fee submitted with that application shall be applied to the processing fee for a new application or notice received from the same applicant if done within 365 days from when the original application was withdrawn, provided the activity is located within all or part of the same project area. In such a case, additional processing fees will be required only to collect the balance due for the activities proposed in the revised application or notice. Processing fees previously paid for an application or notice that was denied by the Agency shall not be applied to a new or revised application or notice.

(4) A processing fee shall not be assessed for applications and notices under this chapter submitted by the Army, Navy, Air Force, Coast Guard, Marine Corps, or National Guard branches of the U.S. Department of Defense.

Rulemaking Authority 373.026(7), 373.043, 373.109, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 218.075, 373.109, 373.4131, 373.4145, 373.418, 373.421 FS. History–New 10-1-13, Amended 6-1-18.

62-330.075 Additional Requirements and Procedures for Concurrent Review of Related Applications.

(1) A single application shall be submitted and reviewed for activities that require both an individual permit under this chapter and a proprietary authorization under chapter 253 or 258, F.S., to use state-owned submerged lands. In such cases, the application shall not be deemed complete, and the timeframes for approval or denial shall not commence, until all information required by applicable provisions of part IV of chapter 373, F.S., and proprietary authorization under chapter 253 or 258, F.S., and rules adopted thereunder for both the environmental resource permit and the proprietary authorization is received.

(2) No application under this section shall be approved until all the requirements of applicable provisions of part IV of chapter 373, F.S., and proprietary authorization under chapter 253 or 258, F.S., and rules adopted thereunder for both the individual permit and the proprietary authorization are met. The approval shall be subject to all conditions of the regulatory permit and proprietary authorization, and any additional conditions imposed by such statutes or rules.

(3) For an application reviewed under this section for which a request for proprietary authorization to use state-owned submerged lands has been delegated to the Agency to take final action without action by the Board of Trustees of the Internal Improvement Trust Fund, the Agency shall issue a consolidated notice of intent to issue or deny the individual permit and the proprietary authorization within 60 days of receiving a complete application under this section. Waiving or tolling the timeframes for final action on the application under this section shall constitute a waiver or tolling of the timeframes for final action on the

individual or conceptual approval permit application.

(4) For an application reviewed under this section for which the request for proprietary authorization to use state-owned submerged lands has not been delegated to the Agency to take final action without action by the Board of Trustees of the Internal Improvement Trust Fund, the application shall be reviewed and final agency action taken in accordance with the procedures in sections 373.427(2)(a) through (c), F.S. The recommended consolidated intent, as required in section 373.427(2)(a), F.S., shall be considered issued when the Agency submits it for publication on the Board of Trustees' agenda, and releases it to the applicant and to any person to whom notice is required under rule 62-330.090, F.A.C.

(5) Upon the issuance of the consolidated notice or recommended consolidated notice of intent to issue or deny pursuant to subsection (4), above, the Agency shall be deemed to be in compliance with the timeframes for approval or denial in section 120.60(1), F.S. Failure to satisfy these timeframes shall not result in approval by default of the application to use state-owned submerged lands. Also, if an administrative proceeding under sections 120.569 and 120.57, F.S., is properly requested on both the individual or conceptual approval permit and the proprietary authorization under this section, the review shall be conducted as a single consolidated administrative proceeding, and final agency action shall not be taken on either authorization until the administrative proceeding is concluded.

(6) Appellate review of any consolidated order under this section is governed by section 373.4275, F.S.

(7) For an activity requiring a permit under section 161.041, F.S., and an individual or conceptual approval permit under this chapter, a joint coastal permit shall be required, as provided in chapter 62B-49, F.A.C., in place of the individual or conceptual approval permit under this chapter.

(8) This section shall be applicable to all applications for individual or conceptual approval permits under this chapter, and proprietary authorizations under chapter 253 or 258, F.S., to use state-owned submerged lands, that are received by the Agency after October 1, 2013. If an applicant requests that its application for an individual or conceptual approval permit under this chapter, and proprietary authorizations under chapter 253 or 258, F.S., to use state-owned submerged lands, received prior to October 1, 2013, be processed under this rule, such request shall be granted if the applications for both are incomplete as of October 1, 2013.

(9) Nothing in this section shall be construed to limit an applicant's ability to make separate applications for stages, phases, or portions of a project separate from an activity requiring both a proprietary authorization under chapter 253 or 258, F.S., and an individual or conceptual approval permit under this chapter.

Rulemaking Authority 161.055, 253.03(7), 253.77, 258.43, 373.026, 373.043, 373.044, 373.4131, 373.418, 373.427, 403.805(1) FS. Law Implemented 120.60, 161.041, 161.055, 253.03, 253.77, 258.42, 258.43, 373.026, 373.413, 373.4131, 373.416, 373.427, 373.4275 FS. History–New 10-1-13, Amended 6-1-18.

62-330.090 Processing of Individual and Conceptual Approval Permit Applications.

(1) The Agency shall review, notice, and issue a request for any required additional information in accordance with section 5.5.3 of Volume I.

(2) Pending applications shall be exempt from changes in the rules adopted after an application has been deemed complete except as otherwise provided by law or in this chapter.

(3) If an applicant submits a processing fee in excess of the required fee, the Agency shall begin processing the application and shall refund to the applicant the amount received in excess of the required fee. If an applicant fails to provide the complete processing fee, the Agency will inform the applicant of the amount of additional fee required, and the application will not be complete until the complete processing fee is received, along with the other materials that have been timely requested in accordance with section 5.5.3 of Volume I. The Agency cannot be compelled to issue a permit in advance of receipt of the required fee or any other material required by the Agency to deem an application complete.

(4) If a substantial revision is submitted to a pending application, other than revisions proposed to reduce adverse impacts identified by the Agency, the applicant shall pay the difference between the processing fees already submitted and any additional fees required for the revised application under rule 62-330.071, F.A.C. In such a case, the time frames in section 5.5.3 of Volume I for processing the application shall be restarted.

(5) In addition to the procedures in this section, processing of the application will be performed in accordance with sections 5.5 through 5.6 of Volume I.

(6) A permit shall only be issued to an entity meeting the requirements of section 4.2.3(d) of Volume I.

(7) The Agency shall cause a "Recorded Notice of Environmental Resource Permit" Form No. 62-330.090(1), (June 1, 2018),

incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-09362), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C., to be recorded in the public records of the county where the property is located unless otherwise noted in the permit. This notice shall not be considered an encumbrance upon the property. Such notice need not be recorded when the entire activity:

(a) Is for an individual, single-family residence, duplex, triplex, or quadruplex that is not part of a larger common plan of development or sale proposed by the permittee, except when the permit specifies that recording is necessary to ensure future owners are advised of long-term operational and maintenance requirements, or conservation provisions;

(b) Is authorized by a general permit under this chapter;

(c) Is temporary (not to exceed one year) in nature;

(d) Has no long term maintenance or operation requirements associated with it;

(e) Is located within lands encumbered by a real property interest held by a federal, state, county, or municipal government entity, including a school, university, or college;

(f) Is a utility within an easement recorded in the official records; or

(g) Is within the permit area of an existing permit for which a Notice has already been recorded, and the permit modification does not change the permit area.

Rulemaking Authority 373.026(7), 373.043, 373.116, 373.118, 373.413, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.109, 373.118, 373.4131, 373.4141, 373.4145 FS. History–New 10-1-13, Amended 6-1-18.

62-330.100 Purpose and Intent.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.414, 373.415, 373.418, 373.4211(22), (25), 373.461, 380.06(9), 403.805(1) FS. Law Implemented 373.019, 373.042, 373.0421, 373.085, 373.086, 373.109, 373.118, 373.119, 373.129, 373.136, 373.403, 373.406, 373.413, 373.4135, 373.4136, 373.414, 373.4141, 373.415, 373.416, 373.417, 373.418, 373.419, 373.421(2)-(6), 373.4211(22), 373.439, 373.461, 380.051, 380.06(9), 403.813(1), 403.414, 403.0877 FS. History–New 12-7-92, Formerly 17-330.100, Amended 10-3-95, Repealed 10-1-13.

62-330.200 Rules Adopted by Reference.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.414, 373.415, 373.418, 373.461, 380.06(9), 403.0877 FS. Law Implemented 373.019, 373.042, 373.0421, 373.085, 373.086, 373.109, 373.118, 373.119, 373.129, 373.136, 373.403, 373.406, 373.413, 373.4135, 373.4136, 373.414, 373.4141, 373.415, 373.416, 373.417, 373.418, 373.419, 373.421(2)-(6), 373.4211(22), (25), 373.422, 373.423, 373.426, 373.427, 373.429, 373.430, 373.433, 373.436, 373.439, 373.461, 380.06(9), 403.0877, 403.813(1) FS. History–New 12-7-92, Formerly 17-330.200, Amended 10-3-95, 6-6-96, 8-21-00, 9-4-05, 12-5-05, 6-5-06, 8-2-06, 8-2-06, 8-1-10, Repealed 10-1-13.

62-330.201 Formal Determinations of the Landward Extent of Wetlands and Other Surface Waters.

(1) A real property owner, an entity having a contract to purchase real property, an entity having the power of eminent domain, or any other person who has legal or equitable interest in real property, may petition the Agency for a formal determination of the landward extent of wetlands and other surface waters for that property pursuant to section 373.421(2), F.S. A formal determination means the Agency will make a binding determination of the landward extent (boundaries) of wetlands and other surface waters as defined by chapter 62-340, F.A.C. A formal determination is binding on the real property for which that determination is sought for as long as the determination is valid, in accordance with sections 373.421(2) and (3), F.S. If the petitioner is not the owner of the land, the petitioner must provide the Agency with information sufficient to contact the current owner, and the Agency shall provide notice of receipt of the petition to the landowner.

(2) Procedures for the submittal, review, noticing, and action on a petition for a formal determination are contained in sections 7.2 through 7.2.7 of Volume I. The petition shall be submitted using Form 62-330.201(1), "Petition for a Formal Determination of the Landward Extent of Wetlands and Other Surface Waters," (June 1, 2018), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-09363). It shall be submitted with the fee prescribed in rule 62-330.071, F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.421(2), 403.0877 FS. Law Implemented 120.54(5)(a), 373.026, 373.4131, 373.421(2), 373.441 FS. History–New 7-4-95, Amended 8-14-96, 8-16-98, 2-19-03, Formerly 62-343.040, Amended 10-1-13, 6-1-18.

62-330.301 Conditions for Issuance of Individual and Conceptual Approval Permits.

(1) To obtain an individual or conceptual approval permit, an applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal, or abandonment of the projects regulated under this chapter:

(a) Will not cause adverse water quantity impacts to receiving waters and adjacent lands;

(b) Will not cause adverse flooding to on-site or off-site property;

(c) Will not cause adverse impacts to existing surface water storage and conveyance capabilities;

(d) Will not adversely impact the value of functions provided to fish and wildlife and listed species by wetlands and other surface waters;

(e) Will not adversely affect the quality of receiving waters such that the state water quality standards set forth in chapters 62-4, 62-302, 62-520, and 62-550, F.A.C., including the antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), F.A.C., subsections 62-4.242(2) and (3), F.A.C., and rule 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in subsections 62-4.242(2) and (3), F.A.C., will be violated;

(f) Will not cause adverse secondary impacts to the water resources. In addition to the criteria in this subsection and in subsection 62-330.301(2), F.A.C., in accordance with section 373.4132, F.S., an applicant proposing the construction, alteration, operation, maintenance, abandonment, or removal of a dry storage facility for 10 or more vessels that is functionally associated with a boat launching area must also provide reasonable assurance that the facility, taking into consideration any secondary impacts, will meet the provisions of paragraph 62-330.302(1)(a), F.A.C., including the potential adverse impacts to manatees;

(g) Will not adversely impact the maintenance of surface or ground water levels or surface water flows established pursuant to section 373.042, F.S.;

(h) Will not cause adverse impacts to a Work of the District established pursuant to section 373.086, F.S.;

(i) Will be capable, based on generally accepted engineering and scientific principles, of performing and functioning as proposed;

(j) Will be conducted by a person with the financial, legal and administrative capability of ensuring that the activity will be undertaken in accordance with the terms and conditions of the permit, if issued; and

(k) Will comply with any applicable special basin or geographic area criteria established as follows:

1. Within the Northwest Florida Water Management District, Sections 13.0 through 13.4 (Special Basin Criteria for Sensitive Karst Areas, including Appendix A) of Volume II.

2. Within the Suwannee River Water Management District, Section 5.9 (Sensitive Karst Areas) of Volume II.

3. Within the St. Johns River Water Management District:

a. Chapter 40C-41, F.A.C., "Surface Water Management Basin Criteria," (October 1, 2013), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02551).

b. Sections 13.0 through 13.8.3 (Part VI, Basin Criteria), of Volume II.

4. Within the South Florida Water Management District:

a. Chapter 40E-41, F.A.C., "Surface Water Management Basin and Related Criteria," (December 1, 2011), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02554).

b. Chapter 40E-63, F.A.C., "Everglades Program," (November 9, 2010), incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02557).

c. For activities within the Outstanding Florida Waters of Monroe County, rules 62-312.400 through 62-312.460, F.A.C.

Copies of incorporated material may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(2) In instances where an applicant is unable to meet state water quality standards because existing ambient water quality does not meet standards and the system will contribute to this existing condition, the applicant must implement mitigation measures that are proposed by, or acceptable to, the applicant that will cause net improvement of the water quality in the receiving waters for those parameters that do not meet standards.

(3) In addition to the criteria in chapter 62-330, F.A.C., applications for a mitigation bank must also meet the criteria of chapter 62-342, F.A.C.

(4) The standards and criteria used to determine whether the reasonable assurances required in this section and rule 62-330.302, F.A.C., have been provided, including the provisions for elimination or reduction of impacts and mitigation to offset adverse impacts, are contained in Volume I, incorporated by reference in subsection 62-330.010(4), F.A.C., and Volume II, incorporated by reference in subsection 62-330.010(4), F.A.C., for the applicable District.

(5) Forms for demonstrating that an applicant has met the financial responsibility requirements of sections 10.3.7 through 10.3.7.9 of Volume I shall be in substantial conformance with the forms incorporated by reference below, a copy of which may be

obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(a) Form 62-330.301(1), "Performance Bond to Demonstrate Financial Assurance for Mitigation," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09364).

(b) Form 62-330.301(2), "Irrevocable Letter of Credit to Demonstrate Financial Assurance for Mitigation," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09365).

(c) Form 62-330.301(3), "Standby Trust Fund Agreement to Demonstrate Financial Assurance for Mitigation," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09367).

(d) Form 62-330.301(4), "Trust Fund Agreement to Demonstrate Financial Assurance for Mitigation," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09368).

(e) Form 62-330.301(5), "Escrow Agreement," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09369).

(f) Form 62-330.301(6), "Guarantee Bond to Demonstrate Financial Assurance for Mitigation," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02488).

(6) Forms for recording of a conservation easement in the public records in favor of the Agency shall be in substantial conformance with the forms incorporated by reference below, a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. The use of these forms shall constitute consistency with section 704.06, F.S. Where the applicant demonstrates that project specific conditions necessitate deviation from language of the accepted forms, alternative language shall be accepted provided that the intent of section 704.06, F.S., and section 10.3.8 of Volume I continue to be met:

(a) Form 62-330.301(8), "Deed of Conservation Easement–Standard," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09370).

(b) Form 62-330.301(9), "Deed of Conservation Easement–Standard, with Third Party Beneficiary Rights," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09371).

(c) Form 62-330.301(10), "Deed of Conservation Easement–Passive Recreational Uses," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09372).

(d) Form 62-330.301(11), "Deed of Conservation Easement–Riparian Uses," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09373).

(e) Form 62-330.301(12), "Deed of Conservation Easement–for Local Governments," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09374).

(f) Form 62-330.301(13), "Deed of Conservation Easement–Third Party Beneficiary Rights to the U.S. Army Corps of Engineers," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09375).

(g) Form 62-330.301(14), "Declaration of Restrictive Covenants," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09376).

(h) Form 62-330.301(15), "Declaration of Restrictive Covenants–Insert," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02496).

(i) Form 62-330.301(16), "Temporary Easement for Construction Access," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02497).

(j) Form 62-330.301(17), "Permanent Access Easement," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02498).

(k) Form 62-330.301(18), "Joint Deed of Conservation Easement–Standard (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09377).

(l) Form 62-330.301(19), "Joint Deed of Conservation Easement–Standard, with Third Party Beneficiary Rights (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09378).

(m) Form 62-330.301(20), "Joint Deed of Conservation Easement–Passive Recreational Uses (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09379).

(n) Form 62-330.301(21), "Joint Deed of Conservation Easement–Riparian Uses (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09380).

(o) Form 62-330.301(22), "Joint Deed of Conservation Easement–Local Governments (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09381).

(p) Form 62-330.301(23), "Joint Deed of Conservation Easement–Third Party Beneficiary Rights to the U.S. Army Corps of Engineers (within Broward County)," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09382).

(q) Form 62-330.301(24), "Deed of Conservation Easement for Mitigation Banks–Third Beneficiary Rights to U.S. Army Corps of Engineers," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09383).

(7) An overwater pier, dock, or similar structure located in a deepwater port listed in section 311.09, F.S., does not require treatment of stormwater runoff from its impervious surfaces subject to the requirements of section 373.406(12), F.S.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.042, 373.409, 373.413, 373.4131, 373.4132, 373.4142, 373.4145, 373.416, 373.426, 373.429, 704.06 FS. History–New 10-1-13, Amended 6-1-18.

62-330.302 Additional Conditions for Issuance of Individual and Conceptual Approval Permits.

(1) In addition to the conditions in rule 62-330.301, F.A.C., to obtain an individual or conceptual approval permit under this chapter, an applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, repair, removal, and abandonment of a project:

(a) Located in, on, or over wetlands or other surface waters will not be contrary to the public interest, or if such activities significantly degrade or are within an Outstanding Florida Water, are clearly in the public interest, as determined by balancing the following criteria as set forth in sections 10.2.3 through 10.2.3.7 of Volume I:

1. Whether the activities will adversely affect the public health, safety, or welfare or the property of others;

2. Whether the activities will adversely affect the conservation of fish and wildlife, including endangered or threatened species, or their habitats;

3. Whether the activities will adversely affect navigation or the flow of water or cause harmful erosion or shoaling;

4. Whether the activities will adversely affect the fishing or recreational values or marine productivity in the vicinity of the activity;

5. Whether the activities will be of a temporary or permanent nature;

6. Whether the activities will adversely affect or will enhance significant historical and archaeological resources under the provisions of section 267.061, F.S.; and

7. The current condition and relative value of functions being performed by areas affected by the proposed activities.

(b) Will not cause unacceptable cumulative impacts upon wetlands and other surface waters as set forth in sections 10.2.8 through 10.2.8.2 of Volume I.

(c) Located in, adjacent to or in close proximity to Class II waters or located in Class II waters or Class III waters classified by the Department of Agriculture and Consumer Services as approved, restricted, conditionally approved, or conditionally restricted for shellfish harvesting will comply with the additional criteria in section 10.2.5 of Volume I.

(d) Involving vertical seawalls in estuaries or lagoons will comply with the additional criteria provided in section 10.2.6 of Volume I.

(2) When determining whether an applicant has provided reasonable assurances that the permitting standards of this chapter will be met, the Agency shall consider the applicant's violation of any rules adopted pursuant to sections 403.91 through 403.929, F.S. (1984 Supp.), as amended, or part IV, chapter 373, F.S., and efforts taken by the applicant to resolve these violations.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.414(9), 403.805(1) FS. Law Implemented 373.042, 373.413, 373.4131, 373.414, 373.416, 373.426, 380.23 FS. History–New 10-1-13, Amended 6-1-18.

62-330.310 Operation and Maintenance.

(1) The permit authorizing construction or alteration must be converted to the operation and maintenance phase once the construction or alteration has been completed. The construction or alteration authorized under an individual permit must be certified to be in compliance with the permit before conversion of the permit to the operation and maintenance phase. Procedures for converting the permit to the operation and maintenance phase, and transferring the permit to the perpetual operation and maintenance entity are described in sections 12.2 and 12.2.1 of Volume I.

(2) If a separate entity is to operate and maintain the project, the entity must have the financial, legal, and administrative capability to perform operation and maintenance, as described in sections 12.1 through 12.3.4 of Volume I. Transfer of the permit to the operation and maintenance entity that was approved as part of the permit does not require a permit modification.

(3) If the permittee desires to change or add operation and maintenance entities after the permit is issued, or to allow for multiple entities to operate portions of the project, a permit modification under rule 62-330.315, F.A.C., must be requested and approved before transfer of the permit to the new entity or entities. Such permit modification request must include a demonstration

that the new entity or entities meet the requirements of subsection (2), above. If an interdependent system will have multiple operation and maintenance entities, that modification request must also demonstrate that each entity that will operate and maintain an interdependent part of the system has the capability to operate and maintain all parts of the system necessary to remain in compliance with all conditions of the permit.

(4)(a) For individual permits NOT associated with an individual, private single-family dwelling unit, duplex, triplex, or quadruplex:

1. Upon completion of construction, and following the general conditions in paragraphs 62-330.350(1)(f) and (g), F.A.C., the permittee shall submit both of the following to the permitting Agency:

a. Form 62-330.310(1), "As-Built Certification and Request for Conversion to Operation Phase," which is incorporated by reference herein (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09384); and

b. Form 62-330.310(2), "Request for Transfer of Environmental Resource Permit to the Perpetual Operation and Maintenance Entity," which is incorporated by reference herein (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09385).

2. The permit will be converted to the operation and maintenance phase upon a certification by the permittee and concurrence by the Agency that the entire project, or an independent portion of the project, has been constructed in compliance with the permit.

3. The permit will be transferred to the operation and maintenance entity once the Agency has verified that the entity meets the requirements of section 12.3 of Volume I, all applicable operation and maintenance documents have been recorded in accordance with section 12.3.4 of Volume I, and the entity has accepted responsibility for operation and maintenance of the project or independent portion of the project. The entity is required to sign Form 62-330.310(2), except when the operation and maintenance entity has been accepted at the time of issuance of the permit for the construction phase, or as part of a permit modification.

(b) For individual permits for an individual, private single family dwelling unit, duplex, triplex, or quadruplex, the permit will automatically convert to the operation and maintenance phase upon completion of construction and the Agency's receipt from the permittee, in accordance with the general conditions in paragraph 62-330.350(1)(f), F.A.C., of a completed Form 62-330.310(3), "Construction Completion and Inspection Certification for Activities Associated with a Private Single-Family Dwelling Unit," (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09386), which is incorporated by reference herein, certifying that the project was constructed in accordance with the permit.

(c) Copies of the above forms may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(5) Projects authorized under a general permit shall, upon completion, be operated and maintained in perpetuity by the permittee and subsequent owners of the land on which the project is located.

(6) The operation and maintenance entity or entities shall remain liable for compliance with the terms of the permit in perpetuity, unless the permit is transferred in accordance with rule 62-330.340, F.A.C., or the permit is modified in accordance with subsection (3), above.

(7)(a) The operation phase of mining activities subject to the land reclamation requirements of chapter 378, F.S., shall terminate, without the need to apply for abandonment of the permit, after the mine, or its subunits as applicable:

1. Has been successfully reclaimed in accordance with chapter 378, F.S., other than lands disturbed by mining operations that are not subject to the requirements of chapter 378, F.S.;

2. Has met all success requirements of the individual permit issued under part IV of chapter 373, F.S.; when the construction phase of the permit includes all phases of construction, abandonment, reclamation, and final success determination over reclaimed lands; and

3. Does not contain components that require long-term operation or maintenance, such as: stormwater management systems; achievement of mitigation success criteria; work in conservation easements requiring a permit under this chapter; state-owned submerged lands authorizations; dams; above-grade impoundments; works; water control structures; erosion and sedimentation controls; or dewatering pits.

(b) If a mine is already operating under an operation and maintenance phase of an individual permit, such operation and maintenance phase shall be allowed to terminate upon successful completion of all phases of reclamation and receipt of final success determinations by the Agency over lands reclaimed in accordance with the rules adopted pursuant to chapter 378, F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.416, 373.418, 403.805(1) FS. Law Implemented 373.118, 373.4131, 373.4141, 373.416, 373.419, 373.426, 373.429 FS. History–New 10-1-13, Amended 6-1-18.

62-330.311 Inspections and Reporting.

(1) The operation and maintenance entity shall provide for the inspection of the permitted project after conversion of the permit to the operation and maintenance phase as provided in section 12.4 of Volume I. Minimum inspection frequencies will be established in Volume II for each District as applicable, but actual inspection and reporting frequencies for the specific project are subject to revision through permit conditions, based on site- and activity-specific operational and maintenance requirements.

(2) Within 30 days of any failure of a stormwater management system or deviation from the permit, a report shall be submitted to the Agency using Form 62-330.311(1), "Operation and Maintenance Inspection Certification," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02502), incorporated by reference herein, describing the remedial actions taken to resolve the failure or deviation.

(3) The operation and maintenance entity of a regional stormwater management facility must notify the Agency on an annual basis, using Form 62-330.311(2), "Regional Stormwater Management System Annual Report," (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02503), incorporated by reference herein, of all new systems and their associated stormwater volumes that have been allowed to discharge stormwater into the regional facility, and must confirm that the maximum allowable treatment volume of stormwater authorized to be accepted by the regional facility has not been exceeded.

(4) A copy of the above forms may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(5) Permits issued prior to the effective date of this section shall continue to be inspected and reported on in accordance with the terms and conditions of the existing permit. However, a permittee may request a modification of the permit to reflect inspection and reporting in accordance with this rule.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.416, 373.418, 403.805(1) FS. Law Implemented 373.118, 373.4131, 373.4141, 373.423, 668.003, 668.004, 668.50 FS. History–New 10-1-13, Amended 6-1-18.

62-330.315 Modification of Permits.

(1) Modifications to an unexpired individual or conceptual approval permit may be requested by the permittee and will be processed as a minor or a major modification, as described below and in section 6.2 of Volume I. Permit modification fees are set forth in rule 62-330.071, F.A.C.

(2) Minor modifications may be requested in accordance with section 6.2 of Volume I. Minor modifications are not subject to the public notification requirements of section 5.5 of Volume I. The following types of requests will be considered as minor modifications:

(a) To extend the duration of the construction phase of an individual permit by up to five years, subject to the provisions of subsection 62-330.320(2), F.A.C.;

(b) To correct errors or typographical mistakes;

(c) To incorporate changes requested by the Agency;

(d) To change due dates for reporting or performance deadlines;

(e) To transfer a permit upon a change in ownership or control;

(f) To make minor technical changes; or

(g) To make other minor changes that do not substantially alter the permit authorization, increase permitted off-site discharge, increase the environmental impact of the project, decrease required retention, decrease required detention, decrease required flood control elevations, or decrease pollution removal efficiency. Factors that will be considered in determining whether a change is minor are described in section 6.2.1 of Volume I.

(3) Any application for modification that does not qualify for a minor modification as described above shall be processed as a major modification. An application for a major modification of a permit shall be submitted and processed in the same manner as a new permit application, and those portions of the project proposed for, or affected by, the modification shall be reviewed using the same criteria as a new application.

(4) Modifications of an unexpired permit issued under one or more of the following rules as they were in effect prior to October 1, 2013: chapter 62-330, 62-343, 62-346, 40B-4, 40B-400, 40C-4, 40C-40, 40C-42, 40C-44, 40C-400, 40D-4, 40D-40, 40D-400, 40E-4, 40E-40, or 40E-400, F.A.C., shall be in accordance with the rules under which the permit was issued, except that such modification shall be processed and reviewed under this chapter (effective after October 1, 2013) if:

(a) The modification is reasonably expected to lead to additional or substantially different water resource impacts;

(b) The permittee chooses to modify the permit under this chapter; or

(c) The modification does not qualify as a minor modification under subsection (2), above.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.026(7), 373.043, 373.109, 373.118, 373.413, 373.4131, 373.4141, 373.4142, 373.4145, 373.416, 373.418, 373.429 FS. History–New 10-1-13, Amended 6-1-18.

62-330.320 Duration of Permits.

Unless revoked, extended or otherwise modified, the duration of a permit under this chapter is:

(1) General permit – Five years to construct, commencing from the date notice is received by the Agency, or the date the Agency verifies compliance with the terms and conditions of the general permit in accordance with rule 62-330.402, F.A.C., whichever is later.

(2) Individual permit – Five years from the date of issuance to construct, except:

(a) Less than five years for activities such as temporary or experimental work, or when a shorter duration is needed; or

(b) More than five years when the applicant specifically requests a longer duration and provides reasonable assurance that:

1. The activity for which the permit is to be granted cannot reasonably be expected to be completed within five years after commencement of construction; and

2. The impacts of the activity, considering its nature, the size of the project, and any required mitigation, can be accurately assessed and offset where appropriate, and the terms of the permit can be met for the duration of the permit requested.

(3) Operation and maintenance – in perpetuity following:

(a) Construction in conformance with the terms and conditions of a general permit; or

(b) Conversion from the construction to the operation phase of an individual permit in accordance with rule 62-330.310, F.A.C.

(4) Conceptual approval permit – As provided in rule 62-330.055 or 62-330.056, F.A.C.

(5) Mitigation bank permit – As provided in rule 62-342.750, F.A.C.

(6) A modification to extend the duration of the construction phase of an individual permit shall be granted if the extension request is received in writing by the Agency before expiration of the construction phase; and:

(a) The activity remains consistent with plans, terms, and conditions of the permit and the Agency's rules in effect when the extension is granted; and

(b) The request can be approved in consideration of subparagraphs (2)(b)1. and 2., above.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118, 373.413, 373.4131, 373.4136, 373.4142, 373.4145, 373.416, 373.426 FS. History–New 10-1-13, Amended 6-1-18.

62-330.340 Transfer of Permit Upon Change in Ownership or Control.

(1) Permits in the Operation and Maintenance Phase – Projects constructed in accordance with the terms and conditions of a general permit are automatically authorized to be operated and maintained by the permittee and subsequent owners. A permittee with a valid individual permit in the operation and maintenance phase under this chapter or chapter 62-342, F.A.C., shall notify the Agency electronically or in writing within 30 days of a change in ownership or control of the entire real property, project, or activity covered by the permit. A processing fee is not required for this notice. The permit shall automatically transfer to the new owner or person in control, except in cases of abandonment, revocation, or modification of a permit as provided in sections 373.426 and 373.429, F.S. If a permittee fails to provide written notice to the Agency within 30 days of the change in ownership or control, or if the change does not include the entire real property or activity covered by the permit, then the transfer shall be governed by subsections (2) through (4), below.

(2) Except as provided in subsection (1), above, and in section 6.3.1 of Volume I, or as otherwise required in an individual or conceptual approval permit, or for activities authorized under a general permit, a permittee shall notify the Agency electronically or in writing within 30 days of any change in ownership or control of any portion of the real property upon which an activity is permitted under this chapter or chapter 62-342, F.A.C. A person who obtains an interest in or control of such real property shall:

(a) Request transfer of the permit to become the new permittee or modification of the permit to become a co-permittee; or

(b) Provide written documentation of the following:

1. Certification that the permittee continues to retain sufficient real property interest over the land upon which the activities subject to the permit will be conducted as described in section 4.2.3(d) of Volume I; and

2. Authorization for Agency staff with proper identification to enter, inspect, sample and test the project or activities to ensure conformity with the plans and specifications authorized in the permit.

(3) The person requesting transfer of the permit shall submit to the Agency a completed Form 62-330.340(1), "Request to

Transfer Environmental Resource Permit," incorporated by reference herein (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09387), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C., together with the permit modification fee prescribed by the Agency as set forth in rule 62-330.071, F.A.C. A proposed new permittee shall demonstrate that it has sufficient real property interest in or control over the land consistent with subsection 62-330.060(3), F.A.C.

(a) The Request to Transfer Environmental Resource Permit shall be processed in the same manner as a minor modification as provided in subsection 62-330.315(2), F.A.C.

(b) The proposed new permittee shall include demonstration or documentation with the request that it meets the requirements for being an acceptable operation and maintenance entity provided in subsections 62-330.310(2) and (3), F.A.C., if applicable.

(4) Upon receipt of the completed Request to Transfer Environmental Resource Permit form and applicable processing fee, the Agency shall approve the permit transfer unless it determines that the proposed permittee or co-permittee has failed to provide reasonable assurances that it qualifies to be a permittee or that it can meet the permit conditions.

(a) If the Agency proposes to deny the transfer, it shall provide both the current permittee and the proposed permittee with notice of proposed agency action of denial, and of the right to request an administrative hearing pursuant to chapter 120, F.S.

(b) Failure of the permittee to notify the Agency in writing within 30 days of a change in ownership or control shall not, by itself, render a permit invalid. When it does not appear the current permittee has met the requirements of subsection (2), above, or has not otherwise approved or been made aware of the request to transfer the permit, upon transfer of the permit to the new permittee, the Agency will provide notice to the former permittee, at its last known address, advising of the permit transfer, together with a notice of rights under chapter 120, F.S.

(5) A permittee from whom the permit is transferred shall:

(a) Be jointly and severally liable with the new owner or permittee for compliance with the permit and for any corrective actions that may be required as a result of violations of the permit or Agency rule on the property prior to permit transfer; and

(b) Remain jointly and severally liable for any corrective actions that are required as a result of any violations of the permit that occurred prior to the change in ownership or control of the property upon which the permitted project or activity is located.

(6) Upon transfer of a permit, the new permittee shall comply with all terms and conditions of the permit.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118, 373.109, 373.413, 373.4131, 373.4142, 373.4145, 373.416, 373.426, 373.429, 668.003, 668.004, 668.50 FS. History–New 10-1-13, Amended 6-1-18.

62-330.350 General Conditions for Individual Permits.

(1) The following general conditions are binding on all individual permits issued under this chapter, except where the conditions are not applicable to the authorized activity, or where the conditions must be modified to accommodate project-specific conditions.

(a) All activities shall be implemented following the plans, specifications and performance criteria approved by this permit. Any deviations must be authorized in a permit modification in accordance with rule 62-330.315, F.A.C. Any deviations that are not so authorized may subject the permittee to enforcement action and revocation of the permit under chapter 373, F.S.

(b) A complete copy of this permit shall be kept at the work site of the permitted activity during the construction phase, and shall be available for review at the work site upon request by the Agency staff. The permittee shall require the contractor to review the complete permit prior to beginning construction.

(c) Activities shall be conducted in a manner that does not cause or contribute to violations of state water quality standards. Performance-based erosion and sediment control best management practices shall be installed immediately prior to, and be maintained during and after construction as needed, to prevent adverse impacts to the water resources and adjacent lands. Such practices shall be in accordance with the *State of Florida Erosion and Sediment Control Designer and Reviewer Manual (Florida Department of Environmental Protection and Florida Department of Transportation, June 2007)*, and the *Florida Stormwater Erosion and Sedimentation Control Inspector's Manual (Florida Department of Environmental Protection, Nonpoint Source Management Section, Tallahassee, Florida, July 2008)*, which are both incorporated by reference in subparagraph 62-330.050(9)(b)5., F.A.C., unless a project-specific erosion and sediment control plan is approved or other water quality control measures are required as part of the permit.

(d) At least 48 hours prior to beginning the authorized activities, the permittee shall submit to the Agency a fully executed Form 62-330.350(1), "Construction Commencement Notice," (October 1, 2013), (http://www.flrules.org/Gateway/reference.asp?No=Ref-02505), incorporated by reference herein, indicating the expected start and completion dates. A copy of this form may be obtained

from the Agency, as described in subsection 62-330.010(5), F.A.C., and shall be submitted electronically or by mail to the Agency. However, for activities involving more than one acre of construction that also require a NPDES stormwater construction general permit, submittal of the Notice of Intent to Use Generic Permit for Stormwater Discharge from Large and Small Construction Activities, DEP Form 62-621.300(4)(b), shall also serve as notice of commencement of construction under this chapter and, in such a case, submittal of Form 62-330.350(1) is not required.

(e) Unless the permit is transferred under rule 62-330.340, F.A.C., or transferred to an operating entity under rule 62-330.310, F.A.C., the permittee is liable to comply with the plans, terms, and conditions of the permit for the life of the project or activity.

(f) Within 30 days after completing construction of the entire project, or any independent portion of the project, the permittee shall provide the following to the Agency, as applicable:

1. For an individual, private single-family residential dwelling unit, duplex, triplex, or quadruplex – "Construction Completion and Inspection Certification for Activities Associated with a Private Single-Family Dwelling Unit" [Form 62-330.310(3)]; or

2. For all other activities – "As-Built Certification and Request for Conversion to Operation Phase" [Form 62-330.310(1)].

3. If available, an Agency website that fulfills this certification requirement may be used in lieu of the form.

(g) If the final operation and maintenance entity is a third party:

1. Prior to sales of any lot or unit served by the activity and within one year of permit issuance, or within 30 days of as-built certification, whichever comes first, the permittee shall submit, as applicable, a copy of the operation and maintenance documents (see sections 12.3 thru 12.3.4 of Volume I) as filed with the Florida Department of State, Division of Corporations, and a copy of any easement, plat, or deed restriction needed to operate or maintain the project, as recorded with the Clerk of the Court in the County in which the activity is located.

2. Within 30 days of submittal of the as-built certification, the permittee shall submit "Request for Transfer of Environmental Resource Permit to the Perpetual Operation and Maintenance Entity" [Form 62-330.310(2)] to transfer the permit to the operation and maintenance entity, along with the documentation requested in the form. If available, an Agency website that fulfills this transfer requirement may be used in lieu of the form.

(h) The permittee shall notify the Agency in writing of changes required by any other regulatory agency that require changes to the permitted activity, and any required modification of this permit must be obtained prior to implementing the changes.

(i) This permit does not:

1. Convey to the permittee any property rights or privileges, or any other rights or privileges other than those specified herein or in chapter 62-330, F.A.C.;

2. Convey to the permittee or create in the permittee any interest in real property;

3. Relieve the permittee from the need to obtain and comply with any other required federal, state, and local authorization, law, rule, or ordinance; or

4. Authorize any entrance upon or work on property that is not owned, held in easement, or controlled by the permittee.

(j) Prior to conducting any activities on state-owned submerged lands or other lands of the state, title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund, the permittee must receive all necessary approvals and authorizations under chapters 253 and 258, F.S. Written authorization that requires formal execution by the Board of Trustees of the Internal Improvement Trust Fund shall not be considered received until it has been fully executed.

(k) The permittee shall hold and save the Agency harmless from any and all damages, claims, or liabilities that may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any project authorized by the permit.

(l) The permittee shall notify the Agency in writing:

1. Immediately if any previously submitted information is discovered to be inaccurate; and

2. Within 30 days of any conveyance or division of ownership or control of the property or the system, other than conveyance via a long-term lease, and the new owner shall request transfer of the permit in accordance with rule 62-330.340, F.A.C. This does not apply to the sale of lots or units in residential or commercial subdivisions or condominiums where the stormwater management system has been completed and converted to the operation phase.

(m) Upon reasonable notice to the permittee, Agency staff with proper identification shall have permission to enter, inspect, sample and test the project or activities to ensure conformity with the plans and specifications authorized in the permit.

(n) If prehistoric or historic artifacts, such as pottery or ceramics, projectile points, stone tools, dugout canoes, metal implements, historic building materials, or any other physical remains that could be associated with Native American, early European, or American settlement are encountered at any time within the project site area, the permitted project shall cease all

activities involving subsurface disturbance in the vicinity of the discovery. The permittee or other designee shall contact the Florida Department of State, Division of Historical Resources, Compliance Review Section (DHR), at (850)245-6333, as well as the appropriate permitting agency office. Project activities shall not resume without verbal or written authorization from the Division of Historical Resources. If unmarked human remains are encountered, all work shall stop immediately and the proper authorities notified in accordance with section 872.05, F.S. For project activities subject to prior consultation with the DHR and as an alternative to the above requirements, the permittee may follow procedures for unanticipated discoveries as set forth within a cultural resources assessment survey determined complete and sufficient by DHR and included as a specific permit condition herein.

(o) Any delineation of the extent of a wetland or other surface water submitted as part of the permit application, including plans or other supporting documentation, shall not be considered binding unless a specific condition of this permit or a formal determination under rule 62-330.201, F.A.C., provides otherwise.

(p) The permittee shall provide routine maintenance of all components of the stormwater management system to remove trapped sediments and debris. Removed materials shall be disposed of in a landfill or other uplands in a manner that does not require a permit under chapter 62-330, F.A.C., or cause violations of state water quality standards.

(q) This permit is issued based on the applicant's submitted information that reasonably demonstrates that adverse water resource-related impacts will not be caused by the completed permit activity. If any adverse impacts result, the Agency will require the permittee to eliminate the cause, obtain any necessary permit modification, and take any necessary corrective actions to resolve the adverse impacts.

(r) A Recorded Notice of Environmental Resource Permit may be recorded in the county public records in accordance with subsection 62-330.090(7), F.A.C. Such notice is not an encumbrance upon the property.

(2) In addition to those general conditions in subsection (1), above, the Agency shall impose any additional project-specific special conditions necessary to assure the permitted activities will not be harmful to the water resources, as set forth in rules 62-330.301 and 62-330.302, F.A.C., Volumes I and II, as applicable, and the rules incorporated by reference in this chapter.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.116, 373.117, 373.409, 373.413, 373.4131, 373.4142, 373.4145, 373.416, 373.418, 373.419, 373.422, 373.423, 373.426, 373.428, 403.0877 FS. History–New 10-1-13, Amended 6-1-18.

62-330.351 General Conditions for Conceptual Approval Permits.

The following general conditions are binding on all conceptual approval permits issued under this chapter, except where the conditions are not applicable to the activity or where the conditions must be modified to accommodate project-specific situations. In addition to these general conditions, the Agency shall impose any additional special conditions necessary to assure the permitted activities will not be harmful to the water resources, as set forth in rules 62-330.301 and 62-330.302, F.A.C., Volumes I and II, as applicable, and the rules incorporated by reference in this chapter.

(1) This permit does not authorize any construction, alteration, maintenance, operation, removal, or abandonment, except where such activities are specifically authorized as the first phase of an individual permit or are authorized to occur in accordance with a general permit or exemption under chapter 62-330, F.A.C.

(2) This permit does not:

(a) Convey to the permittee any property rights or privileges, or any other rights or privileges other than those specified herein or in chapter 62-330, F.A.C.;

(b) Convey to the permittee or create in the permittee any interest in real property;

(c) Relieve the permittee from the need to obtain and comply with any other required federal, state, and local authorization, law, rule, or ordinance; or

(d) Authorize any entrance upon or work on property that is not owned, held in easement, or controlled by the permittee.

(3) The permittee shall notify the Agency in writing:

(a) Immediately if any previously submitted information is discovered to be inaccurate; and

(b) Within 30 days of any conveyance or division of ownership or control of the property or the system, the name and contact information for the new owner.

(4) Upon reasonable notice to the permittee, Agency staff with proper identification shall have permission to enter, inspect, sample, and test the project site to ensure conformity with the permit.

(5) Any delineation of the extent of a wetland or other surface water submitted as part of the permit application, including plans

or other supporting documentation, shall not be considered binding unless a specific condition of this permit or a formal determination under rule 62-330.201, F.A.C., provides otherwise.

(6) This conceptual approval permit only authorizes design concepts for a master or future plan to construct, alter, operate, maintain, remove, or abandon projects that require a permit under part IV of chapter 373, F.S. It does not authorize any construction, alteration, operation, maintenance, removal, or abandonment, or the establishment and operation of a mitigation bank, or relieve the permit holder of any requirements to obtain such permits.

(7) Subsequent applications to construct and operate activities shall be prepared and submitted using the applicable procedures in rules 62-330.052, 62-330.054, 62-330.060, and 62-330.402, F.A.C., and sections 4.2.2, 4.2.3, 4.3, and 4.4 of Volume I. An application for conceptual approval for a mitigation bank shall also include the materials required by chapter 62-342, F.A.C.

(8) Issuance of this conceptual approval permit is a determination, within the level of detail provided in the application, that the activities approved in this permit are consistent with applicable rules at the time of issuance. This permit provides the conceptual approval permit holder with a rebuttable presumption, during the duration of this permit, that the engineering design and scientific principles upon which the conceptual approval permit approved herein are likely to meet applicable rule criteria for issuance of permits for subsequent phases of the project, provided all of the following are met at the time of receipt of a complete application to construct and operate the future phases:

(a) The application to construct and operate the future phases remains consistent with the designs and conditions of this permit. Primary areas for consistency comparisons include the size, location, and extent of the activities proposed, the type and nature of the activities, percent imperviousness, allowable discharge and points of discharge, location and extent of wetland and other surface water impacts, mitigation plans implemented or proposed, control elevations, extent of stormwater reuse, detention and retention volumes, and the extent of flood elevations.

If an application for construction of any portion of the land area covered by this permit is inconsistent with the design concepts and conditions approved herein, the application will be reviewed to determine the extent to which the inconsistency will affect the designs and conditions for the remainder of the lands contained in this permit. If the inconsistency will materially affect those designs and conditions, then the applicant must demonstrate that the holder of this permit agrees to that inconsistency. In such a case, the holder of the conceptual approval permit may:

1. Modify the conceptual approval permit to conform to the revised design;

2. Abandon reliance on the conceptual approval permit; or

3. Rely on those portions of the conceptual approval permit for only those areas that were not affected by the inconsistency.

(b) There are no changes to state water quality standards that would be affected by activities authorized in the conceptual approval permit that have not already been authorized for construction or operation.

(c) There have been no amendments to Florida law governing special basin criteria that would affect future activities authorized by the conceptual approval permit that have not already been authorized for construction.

(d) There are no substantive changes in the site characteristics that would affect whether the design concepts approved in the conceptual approval permit can continue to be reasonably expected to meet the conditions for authorizing construction of future phases. This shall include such things as changes in the designation of listed species, and changes to nesting, denning, and critical designation status of listed species that exist within the lands served by the project area.

(9) If changes are proposed to the design of existing or future phases, or where there have been changes to state water quality standards, special basins, or site characteristics as described in conditions paragraphs (3)(a) through (d), above, during the duration of this permit, the applicant must modify this permit if it wishes to continue to rely on this permit as a basis that reasonable assurance exists for the Agency to issue future construction or operation permits under the terms and conditions of this permit. If the permittee fails to do this, this conceptual approval permit can no longer be relied upon as a basis, in part or whole, under which permits to construct or operate future phases will be issued, and the Agency will reevaluate the terms and conditions of this permit at the time a permit application is received to construct the next phase of activities, or at the next requested extension of this permit's duration in accordance with subsection 62-330.056(11), F.A.C., whichever occurs first.

Rulemaking Authority 373.026(7), 373.118(1), 373.043, 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.116, 373.117, 373.118(1), 373.406(5), 373.409, 373.413, 373.4131, 373.414(9), 373.4142, 373.4145, 373.416, 373.418, 373.419, 373.422, 373.423, 373.426, 373.428, 403.0877 FS. History–New 6-1-18.

62-330.360 Emergency Authorizations and Actions.

When the Agency has determined that immediate action is necessary to abate an emergency condition, the Agency shall use one of the following measures below to authorize the work. “Emergency conditions” are defined as those that pose an imminent or existing serious threat or danger and require immediate action to protect the public health, safety or welfare, or the water resources of the Agency, including the health of aquatic and wetland-dependent species; a public water supply; or recreational, commercial, industrial, agricultural or other reasonable uses. Carelessness or the lack of planning on the part of an applicant for an emergency authorization shall not be sufficient grounds to warrant the granting of an emergency authorization.

(1) Issuance of an emergency order under section 373.119(2), F.S. The order shall recite the factual basis for it in accordance with section 120.569(2)(n), F.S., and include all conditions (including a limitation on the duration of the emergency authorization) required to ensure that the activity authorized or directed does not exceed that necessary to abate the threat. When the activity conducted under the order has an operational or maintenance aspect that continues beyond the emergency, any permits required under this chapter shall be applied for as soon as practicable.

(2) Authorization of construction to begin when the Agency has already received an application for a permit under this chapter, and the applicant has submitted a written request for the work to commence prior to issuance of the permit, together with documentation of the emergency conditions that exist. However, if required upon issuance of the permit, the work initiated shall be modified as necessary to comply with the terms and conditions of the permit.

(3) Issuance of an emergency field authorization when an application is not currently under consideration by the Agency. The entity requesting the emergency field authorization shall complete an “Emergency Field Authorization” Form 62-330.360(1), (June 1, 2018) (http://www.flrules.org/Gateway/reference.asp?No=Ref-09388), which is incorporated by reference herein. A copy of this form may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. The activity authorized by the emergency field authorization may commence upon approval by the Agency’s field representative. The recipient of an emergency field authorization is responsible for compliance with all the terms and conditions of the authorization. Within 90 days of issuance of an emergency field authorization, the recipient shall either restore the site to the conditions existing before the emergency, or apply for an application to perform the work in accordance with the requirements for obtaining verification of an exemption or permit, as applicable, under this chapter.

Rulemaking Authority 373.026(7), 373.043, 373.4131, 373.4145, 373.418, 403.805(1) FS. Law Implemented 120.569(2), 373.026(7), 373.119, 373.413, 373.4131, 373.4145, 373.416, 373.418, 373.426, 373.439 FS. History–New 10-1-13, Amended 6-1-18.

62-330.395 Variances.

(1) In addition to a variance available under section 120.542, F.S., the Agencies are authorized to grant a variance from the provisions of section 373.414, F.S., paragraph 62-330.301(1)(e), F.A.C., and rule 62-330.302, F.A.C., pursuant to section 373.414(17), F.S. A person seeking a variance under section 373.414(17), F.S., must demonstrate that any hardship asserted as a basis of the need for a variance is peculiar to the affected property and not self-imposed, and that the grant of a variance will be consistent with the general intent and purpose of this chapter.

(a) Any person seeking a variance under section 373.414(17), F.S., shall file a petition for a variance containing the following information:

1. The petitioner’s name and signature;

2. The statute or rule from which the variance is sought;

3. Facts showing that a variance should be granted for one of the reasons in section 403.201, F.S.;

4. The time period for which the variance is sought, including the reasons and facts supporting the time period;

5. The requirements the petitioner can meet, including the date or time when the requirements will be met;

6. The steps or measures the petitioner is taking to meet the requirement from which the variance is sought. If the request is pursuant to section 403.201(1)(b), F.S., the petitioner shall include a schedule when compliance will be achieved; and

7. The fee prescribed in rule 62-330.071, F.A.C.

(b) The Agency shall review the application within 30 days after receipt to determine if the petition is complete. If the petition is determined to be incomplete, the petitioner shall be afforded an opportunity to supply additional information before the Agency evaluates the petition.

(c) The Agency shall prepare a notice of intended agency action regarding the petition for a variance, and shall publish it one time in the *Florida Administrative Register*. For variance petitions processed by the Department, the petitioner shall also publish notice of intended agency action one time, at its expense, in a newspaper of general circulation, as defined in section 50.031, F.S., in

the county in which the property for which the variance is sought is located. For variance petitions processed by the District, the District will cause the notice of intended agency action to be published, one time, in a newspaper of general circulation, as defined in section 50.031, F.S., in the county in which the property for which the variance is sought is located.

(2) Renewals of variances shall be applied for in the same manner as the initial variance.

Rulemaking Authority 373.043, 373.044, 373.113, 373.4131, 373.414(9), (17) FS. Law Implemented 373.4131, 373.414(9), (17), 403.201 FS. History–New 10-1-13, Amended 6-1-18.

62-330.401 Policy and Purpose of General Permits.

(1) General permits authorize activities that, if conducted consistent with the permit requirements, will cause minimal individual and cumulative adverse impacts to the water resources of the Agencies. Mitigation is neither necessary nor required to offset those impacts except when provided for in the general permit. Persons using a general permit must comply with the notice requirements of rule 62-330.402, F.A.C., the general conditions in rule 62-330.405, F.A.C., and all of the terms, conditions, and limitations of the specific general permit.

(2) The general permit in section 403.814(12), F.S., is not a general permit under this chapter and does not require submittal of the notice specified in subsection 62-330.402(1), F.A.C.

(3) General permits that apply to municipalities are also for use by agencies of the United States Department of Defense.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Amended 2-19-03, 10-1-07, Formerly 62-341.201, Amended 10-1-13.

62-330.402 Submittal and Processing of General Permits.

(1) A person wishing to construct, operate, maintain, alter, abandon, or remove projects under a general permit shall provide notice using Form 62-330.402(1), "Notice of Intent to Use an Environmental Resource General Permit," (June 1, 2018), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-09389), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. The notice must be received by the applicable Agency at least 30 days prior to initiating the activities authorized by the general permit, or at such other time as specified in the general permit. Notices for general permits that identify the reviewing agency as the Department shall be submitted to the Department instead of a District.

(2) The notice for a general permit must include the processing fee prescribed in rule 62-330.071, F.A.C. If a single notice includes more than one general permit, a separate fee shall be required for each general permit.

(3) The specific procedures of a general permit shall govern if they differ from the procedures in this rule.

(4)(a) Within 30 days of receiving Form 62-330.402(1), the Agency shall determine whether the activity qualifies for a general permit. If the activity does not qualify or the notice does not contain all the required information, the Agency will notify the person as provided in section 5.3.2 of Volume I.

(b) If the notice does not demonstrate that the requested activity qualifies for a general permit due to errors or omissions, the person shall have 60 days to amend the notice as provided in section 5.3.3 of Volume I. An additional processing fee will not be required if the person submits additional information demonstrating compliance with the general permit within that 60 days. Alternatively, the person may request that the submitted information be processed as an application for an individual permit, which must be supplemented with the information required in rule 62-330.060, F.A.C., and sections 4.2.3, 4.3, and 4.4 of Volume I, or the person may withdraw the notice for a general permit.

(c) If the activities do not qualify for a general permit, the processing fee submitted for the general permit shall be applied to the processing fee required for an individual permit, as provided in section 5.3.4 of Volume I. The processing fee will not be returned if the person withdraws the notice or if qualification for the general permit is denied.

(5) The Agency will place notice of the proposed use of a general permit on the Agency website within 10 days of receipt of the request.

(6) At their discretion, persons qualifying for a general permit may publish a notice of qualification to use a general permit in a newspaper of general circulation in the affected area. The Agency will not publish, or require the person to publish, such notice.

Rulemaking Authority 373.044, 373.113, 373.118, 373.413, 373.4131 FS. Law Implemented 373.116(2), 373.118(3), 373.413, 373.4131, 373.416, 373.426, 668.003, 668.004, 668.50 FS. History–New 10-1-13, Amended 6-1-18.

62-330.405 General Conditions for All General Permits.

The following general permit conditions are binding upon the permittee and are enforceable under chapter 373, F.S. These conditions do not apply to the general permit for stormwater management systems under section 403.814(12), F.S.

(1) The general permit is valid only for the specific activity indicated. Any deviation from the specified activity and the conditions for undertaking that activity shall constitute a violation of the permit and may subject the permittee to enforcement action and revocation of the permit under chapter 373, F.S.

(2) The general permit does not eliminate the necessity to obtain any required federal, state, local and special district authorizations prior to the start of any construction, alteration, operation, maintenance, removal or abandonment authorized by this permit; and it does not authorize any violation of any other applicable federal, state, local, or special district laws (including, but not limited to, those governing the "take" of listed species).

(3) The general permit does not convey to the permittee or create in the permittee any property right, or any interest in real property, nor does it authorize any entrance upon or activities on property which is not owned or controlled by the permittee, or convey any rights or privileges other than those specified in the general permit.

(4) The general permit does not relieve the permittee from liability and penalties when the permitted activity causes harm or injury to: human health or welfare; animal, plant or aquatic life; or property. It does not allow the permittee to cause pollution that violates state water quality standards.

(5) Section 253.77, F.S., provides that a person may not commence any excavation, construction, or other activity involving the use of state-owned or other lands of the state, the title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund without obtaining the required consent, lease, easement, or other form of authorization authorizing the proposed use. Therefore, the permittee is responsible for obtaining any necessary authorizations from the Board of Trustees prior to commencing activity on state-owned lands.

(6) The authorization to conduct activities under a general permit may be modified, suspended or revoked in accordance with chapter 120, F.S., and section 373.429, F.S.

(7) The general permit is not transferable to a new third party. To be used by a different permittee, a new notice to use a general permit must be submitted in accordance with rule 62-330.402, F.A.C. Activities constructed in accordance with the terms and conditions of a general permit are automatically authorized to be operated and maintained by the permittee and subsequent owners in accordance with subsection 62-330.340(1), F.A.C. Any person holding the general permit, persons working under the general permit, and owners of land while work is conducted under the general permit shall remain liable for any corrective actions that may be required as a result of any permit violations prior to sale, conveyance, or other transfer of ownership or control of the permitted project, activity, or the real property at which the permitted project or activity is located.

(8) Upon reasonable notice to the permittee, Agency staff with proper identification shall have permission to enter, inspect, sample and test the permitted system to ensure conformity with the plans and specifications approved by the general permit.

(9) The permittee shall maintain any permitted project or activity in accordance with the plans submitted to the Agency and authorized in the general permit.

(10) A permittee's right to conduct a specific activity under the general permit is authorized for a duration of five years.

(11) Activities shall be conducted in a manner that does not cause or contribute to violations of state water quality standards. Performance-based erosion and sediment control best management practices shall be implemented and maintained immediately prior to, during, and after construction as needed to stabilize all disturbed areas, including other measures specified in the permit to prevent adverse impacts to the water resources and adjacent lands. Erosion and sediment control measures shall be installed and maintained in accordance with the *State of Florida Erosion and Sediment Control Designer and Reviewer Manual (Florida Department of Environmental Protection and Florida Department of Transportation, June 2007)*, available at https://www.flrules.org/Gateway/reference.asp?No=Ref-04227, and the *Florida Stormwater Erosion and Sedimentation Control Inspector's Manual (Florida Department of Environmental Protection, Nonpoint Source Management Section, Tallahassee, Florida, July 2008)*, available at http://publicfiles.dep.state.fl.us/DEAR/Stormwater_Training_Docs/erosion-inspectors-manual.pdf.

(12) Unless otherwise specified in the general permit, temporary vehicular access within wetlands during construction shall be performed using vehicles generating minimum ground pressure to minimize rutting and other environmental impacts. Within forested wetlands, the permittee shall choose alignments that minimize the destruction of mature wetland trees to the greatest extent practicable. When needed to prevent rutting or soil compaction, access vehicles shall be operated on wooden, composite, metal, or other non-earthen construction mats. In all cases, access in wetlands shall comply with the following:

(a) Access within forested wetlands shall not include the cutting or clearing of any native wetland tree having a diameter four inches or greater at breast height;

(b) The maximum width of the construction access area shall be limited to 15 feet;

(c) All mats shall be removed as soon as practicable after equipment has completed passage through, or work has been completed, at any location along the alignment of the project, but in no case longer than seven days after equipment has completed work or passage through that location; and

(d) Areas disturbed for access shall be restored to natural grades immediately after the maintenance or repair is completed.

(13) Barges or other work vessels used to conduct in-water activities shall be operated in a manner that prevents unauthorized dredging, water quality violations, and damage to submerged aquatic communities.

(14) The construction, alteration, or use of the authorized project shall not adversely impede navigation or create a navigational hazard in the water body.

(15) Except where specifically authorized in the general permit, activities must not:

(a) Impound or obstruct existing water flow, cause adverse impacts to existing surface water storage and conveyance capabilities, or otherwise cause adverse water quantity or flooding impacts to receiving water and adjacent lands; or

(b) Cause an adverse impact to the maintenance of surface or ground water levels or surface water flows established pursuant to section 373.042, F.S., or a Works of the District established pursuant to section 373.086, F.S.

(16) If prehistoric or historic artifacts, such as pottery or ceramics, projectile points, stone tools, dugout canoes, metal implements, historic building materials, or any other physical remains that could be associated with Native American, early European, or American settlement are encountered at any time within the project site area, the permitted project shall cease all activities involving subsurface disturbance in the vicinity of the discovery. The permittee or other designee shall contact the Florida Department of State, Division of Historical Resources, Compliance Review Section (DHR), at (850)245-6333, as well as the appropriate permitting agency office. Project activities shall not resume without verbal or written authorization from the Division of Historical Resources. If unmarked human remains are encountered, all work shall stop immediately and the proper authorities notified in accordance with section 872.05, F.S.

(17) The activity must be capable, based on generally accepted engineering and scientific principles, of being performed and of functioning as proposed, and must comply with any applicable District special basin and geographic area criteria.

(18) The permittee shall comply with the following when performing work within waters accessible to federally- or state-listed aquatic species, such as manatees, marine turtles, smalltooth sawfish, and Gulf sturgeon:

(a) All vessels associated with the project shall operate at “Idle Speed/No Wake” at all times while in the work area and where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

(b) All deployed siltation or turbidity barriers shall be properly secured, monitored, and maintained to prevent entanglement or entrapment of listed species.

(c) All in-water activities, including vessel operation, must be shut down if a listed species comes within 50 feet of the work area. Activities shall not resume until the animal(s) has moved beyond a 50-foot radius of the in-water work, or until 30 minutes elapses since the last sighting within 50 feet. Animals must not be herded away or harassed into leaving. All onsite project personnel are responsible for observing water-related activities for the presence of listed species.

(d) Any listed species that is killed or injured by work associated with activities performed shall be reported immediately to the Florida Fish and Wildlife Conservation Commission (FWC) Hotline at 1(888)404-3922 and ImperiledSpecies@myFWC.com.

(e) Whenever there is a spill or frac-out of drilling fluid into waters accessible to the above species during a directional drilling operation, the FWC shall be notified at ImperiledSpecies@myfwc.com with details of the event within 24 hours following detection of the spill or frac-out.

(19) The permittee shall hold and save the Agency harmless from any and all damages, claims, or liabilities which may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any activity authorized by the general permit.

(20) The permittee shall immediately notify the Agency in writing of any submitted information that is discovered to be inaccurate.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.044, 373.118(1), 373.129, 373.136, 373.406(5), 373.413, 373.4131, 373.414(9), 373.4145, 373.416, 373.422, 373.423, 373.429, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.215, Amended 10-1-13, 6-1-18.

62-330.407 General Permit for Geotechnical Investigations in Wetlands or other Surface Waters.

Rulemaking Authority 373.044, 373.113, 373.118, 373.171, 373.4131 FS. Law Implemented 253.034(1), 373.118, 373.406(5), 373.4131, 373.414(9), 403.814(1) FS. History–New 10-1-13, Repealed 6-1-18.

62-330.410 General Permit for Dredging by the West Coast Inland Navigation District in Sarasota and Manatee Counties.

(1) A general permit is granted to the West Coast Inland Navigation District ("WCIND") to dredge public navigation channels and canals within the trafficsheds listed in Table 1 "Trafficsheds, Dredge Depth Limits, and Trafficshed Report Identification Numbers for Use in General Permit 62-330.410" effective [October 1, 2013] (http://www.flrules.org/Gateway/reference.asp?No=Ref-03207), and Figure 1, "Trafficshed Locations" effective August 4, 2002 (http://www.flrules.org/Gateway/reference.asp?No=Ref-03208), and as described in the reports identified in paragraphs (1)(a) through (d), below. Table 1, Figure 1, and the reports are incorporated by reference herein; a copy of each may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.:

(a) Antonini, Gustavo A., and Paul Box, September 1996, A Regional Waterway Systems Management Strategy for Southwest Florida, TP-83, Florida Sea Grant College Program, Gainesville, Florida, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03143);

(b) Swett, Robert A., Gustavo A. Antonini and Sharon Schulte, July 1999, Regional Waterway Management System for North Manatee County, TD-2, Florida Sea Grant College Program, Gainesville, Florida, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03125);

(c) Antonini, Gustavo A., David Fann, and Robert A. Swett, November 7, 2000, Miguel Bay, Florida: Inventory of Boats, Depths and Signs; and a Waterway Restriction Analysis, TP-2A, Florida Sea Grant College Program, Gainesville, Florida, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03147);

(d) Antonini, Gustavo A., Robert Swett, Sharon Schulte and David Fann, July 1998, Regional Waterway Management System for South Sarasota County, TD-1, Florida Sea Grant College Program, Gainesville, Florida, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03146).

(2) This general permit is further limited as follows:

(a) The area to be dredged shall not contain any live seagrass beds, oyster beds or bars, coral communities, or attached macro-marine algae communities. However, this shall not prevent dredging of incidental individual specimens or scattered (less than one percent coverage within the area to be dredged) occurrences of seagrasses, oysters, or attached macro-algae. To the extent individual or clumped oysters are to be dredged, they shall be relocated to the maximum extent practicable to locations previously approved by the Department.

(b) Channel alignments shall follow existing channels and previously dredged areas to the maximum extent practicable.

(c) Dredging shall not exceed the maximum depths shown in Table 1.

(d) No more than 6,500 cubic yards of dredged material shall be removed over a five-year period within each trafficshed, beginning with the first project authorized under this general permit within the trafficshed. Within 30 days following the conclusion of each dredging event, a report shall be submitted to the local district office of the Department that includes the volume of material excavated from each channel and canal within the trafficshed, and the cumulative total volume of material excavated for the trafficshed under this general permit. This report shall be included with any subsequent notices to dredge channels or canals within the same trafficshed.

(e) The dredging activity is restricted to Class III waters, or Class II waters that are classified by the Department of Agriculture and Consumer Services under chapter 5L-1, F.A.C., as unclassified, prohibited, restricted, or conditionally restricted for shellfish harvesting.

(f) For purposes of this general permit, the term "public navigation channels and canals" shall include the Intracoastal Waterway and any other waterway as determined by the WCIND Board to make a significant contribution to boat traffic in the four county district, including access channels connecting the inland waterways to residential canal systems.

(3) All work under this general permit shall be conducted in conformance with the following specific conditions:

(a) Prior to submittal of a notice to use this general permit, the WCIND shall conduct at least one pre-application meeting with the Department to discuss project designs, implementation details, and any resource concerns, including approval of any oyster relocation sites in accordance with paragraph 62-330.410(2)(a), F.A.C.

(b) Each dredging event for a trafficshed shall require a separate notice to use this general permit. Multiple channels within a single trafficshed may be included in one notice. Each notice shall be submitted with:

1. Scaled plan and cross-sectional drawings that clearly identify the length, width, and depth (referenced to mean lower low water) of the area or areas to be dredged within each channel and canal, locations of any hydraulic pipelines between the dredge

areas and the dredged material disposal sites, and identification of the channels, canals, and names of the trafficsheds that are to be dredged from Table 1;

2. Identification of the source document described in subsection (1) and reference data that specifically describe the project proposed for dredging within the trafficshed. All document titles, page numbers, figures, and other relevant information to the trafficshed must be identified;

3. The location, dimensions, and estimated volumes of dredged material disposal sites, including the location of any oyster relocation or habitat restoration areas required under paragraph 62-330.410(2)(a), F.A.C. If barges or temporary stockpile areas are to be used for temporary disposal and transport, the type and volume capacity of such barges and stockpile areas, including controls that will be used to prevent dredge material runoff from the barges and stockpile areas also must be described;

4. The estimated volume of each proposed dredging area;

5. The dredging and disposal methods, and proposed duration of each;

6. Identification of any special water classifications for the areas to be dredged, such as the water class (rule 62-302.400, F.A.C.); shellfish classification under chapter 5L-1, F.A.C., (approved, conditionally approved, restricted, conditionally restricted, prohibited, or unclassified); aquatic preserve, state park, or state recreation area designation under chapter 258, F.S.; and Outstanding Florida Water or Outstanding National Resource Water designation under rule 62-302.700, F.A.C.;

7. An updated (prepared between May through September within one year prior to the proposed dredging) resource inventory of the areas to be dredged, including the presence of live seagrasses (distinguishing between beds and scattered seagrass growth), oysters (distinguishing between beds, bars, and scattered occurrences), coral communities, or attached macro-marine algae communities (distinguishing between beds and scattered occurrences). This resource inventory must also include all areas within any requested mixing zones associated with the dredging project (including outfall pipes from the dredge material disposal area), and all areas that will be occupied by dredging equipment (including cables, pipelines, dredges, barges, and stockpiling/disposal of dredged material);

8. If the notice applies to a trafficshed that was subject to previous use of this general permit, such notice also shall clearly identify the extent of all previously authorized dredging within the trafficshed by the WCIND; the date of all such dredging events; the estimated cubic yards excavated from each channel and canal, and for the trafficshed as a whole; and the permit numbers assigned to such prior use of this general permit for the trafficshed,

9. The estimated date the dredging activities are planned to begin and the estimated length of time it will take to complete the project. If the project will be accomplished in phases, the estimated starting and ending date of each phase must also be submitted; and,

10. A plan for monitoring water quality in accordance with the requirements of paragraph (3)(e), below.

(c) All dredged material resulting from the activities authorized by this general permit shall be removed and deposited on a self-contained, upland dredged material disposal site. The only exceptions shall be: oyster relocations required under paragraph 62-330.410(2)(a), F.A.C.; or where dredged materials are to be used as part of a habitat restoration plan authorized by the Agency under part IV of chapter 373, F.S., in which case any discharge of dredged material shall be in compliance with all terms of that authorization. In all cases, the dredging operation, the discharge of dredged material, and the dredged material disposal site shall be designed, located, and operated such that there are no water quality violations in wetlands or other surface waters outside of a mixing zone established under paragraph (3)(d), below.

(d) The permittee shall prevent violations of state water quality standards immediately outside of a mixing zone of no more than 150 meters in radius from the dredge site and from any discharge point associated with a dredge material disposal area. This shall minimally consist of: using and maintaining in a functional condition erosion and sediment control devices and best management practices, including turbidity curtains or similar devices; managing dredge pumping rates and volumes so as to minimize discharges from dredged material disposal sites; and managing dredged material disposal site dikes, berms, and water control structures so as to minimize erosion, breaches, and discharges. Mixing zones shall be designed to avoid live seagrass beds, oyster beds and bars, and attached macro-algae communities to the maximum extent practical.

(e) Water quality monitoring shall occur following the monitoring plan required under subparagraph (3)(b)10., above. This shall minimally consist of monitoring at the dredge site, at the location of any waters receiving outfall from dredged material disposal sites, and at background and down-gradient locations in the water body where dredging is occurring and surrounding the dredged material disposal sites. This monitoring shall be designed to measure turbidity and any metals or other toxic materials that have been identified as having a likelihood of entering the water column. All monitoring for turbidity shall occur at intervals not to exceed four

hours during active dredging operations and when there is a discharge from dredge material disposal sites; monitoring for other parameters shall be at intervals specified in the monitoring plan under subparagraph (3)(b)10., above. Results of this monitoring and a copy of the logs shall be submitted to the local office of the Department in accordance with the reporting plan submitted under subparagraph (3)(b)10., above.

(f) In the event the water quality monitoring required under this general permit detects violations of state water quality standards, dredging shall cease immediately until the source of the violation is resolved and the receiving waters again meet applicable water quality standards.

(g) After dredging, the trafficshed shall be marked with appropriate aids to navigation in order to prevent damage to seagrass beds and to minimize turbidity. The permittee is advised that chapter 327, F.S., governs the placement and marking of such aids to navigation.

(h) In addition to the conditions in subsection 62-330.405(18), F.A.C., the following additional manatee conditions shall apply:

1. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel shall be responsible for observing water-related activities for the presence of manatees.

2. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act of 1978. If the dredging activity results in any manatee being harmed, harassed, or killed as a result of construction activities, the Department will refer the matter to the Florida Fish and Wildlife Conservation Commission for appropriate action.

3. Temporary signs concerning manatees shall be posted prior to and during dredging activities. All signs are to be removed by the permittee upon completion of the project. Temporary signs that have already been approved for this use by the FWC must be used. One sign that reads "Caution: Boaters" must be posted. A second sign measuring at least 8 1/2 inches by 11 inches explaining the requirements for "Idle Speed/No Wake" and the shut-down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities. These signs can be viewed at www.MyFWC.com/manatee. Questions concerning these signs can be sent to ImperiledSpecies@myfwc.com.

(i) Work under this general permit shall not commence until the Department has provided written confirmation to the notice required under paragraph 62-330.410(3)(b), F.A.C., that the applicant qualifies to use the general permit.

(4) For activities located outside of aquatic preserves and outside of state parks, state preserves, and state recreation areas, this general permit constitutes consent of use by the Board of Trustees of the Internal Improvement Trust Fund (BOT) under Chapter 253, F.S., to enter upon and use state-owned submerged lands to the extent necessary to complete the permitted activities. However, specific written authorization from the BOT is required to use or alter state-owned submerged lands within aquatic preserves, state parks, state preserves, and state recreation areas under chapter 258, F.S.

(5) Dredged material removed from state-owned submerged lands under this general permit shall be exempt from the payment of severed dredged material fees in accordance with section 253.77, F.S. However, dredged material with economic value, such as beach quality sand, shall be used for public purposes to the maximum extent practicable.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1), 403.814(1) FS. Law Implemented 253.002, 253.77(4), 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.426, 403.813(1)(f), 403.813(2), 403.814(1) FS. History–New 8-4-02, Formerly 62-341.490, Amended 10-1-13.

62-330.411 General Permit for Public Navigation Channel and Canal Infrastructure by the West Coast Inland Navigation District within Charlotte County.

(1) A general permit is granted to the West Coast Inland Navigation District ("WCIND") to dredge public navigation channels and canals within the trafficsheds and secondary channel systems which have been determined by the WCIND Board to make a significant contribution to public boating traffic, as listed in Robert A. Swett, David A. Fann, and Elizabeth Staugler, Maps of Charlotte County General Permit Trafficshed Channels and Secondary Channels, Florida Sea Grant College Program, Gainesville, Florida (July 2014) (SGEF-209), incorporated by reference herein (12/15) (http://www.flrules.org/Gateway/reference.asp?No=Ref-06200). Copies of SGEF-209 may be obtained from the Department as described in subsection 62-330.010(5), F.A.C.

(2) The following terms are defined for the purpose of this general permit:

(a) "Trafficshed" means an area that contains a concentration of boats that use a common channel, exclusive to the trafficshed,

to gain access to secondary access channels and, ultimately, to deep, open water.

(b) “Secondary channel system” means those channels that provide access to two or more trafficsheds.

(c) “Corals” means true stony corals (order Scleractinia), hydrocorals (order Milleporina), and soft corals and other octocorals (subclass Octocorallia).

(d) “Seagrass” means rooted, vascular plants of the families Potamogetonaceae, Hydrocharitaceae and Cymodoceae.

(e) “Communities” means assemblages of attached benthic organisms with a coverage density of at least one percent, and does not include incidental individual (or clumped) specimens.

(3) In addition to the requirements of rule 62-330.405, F.A.C., this general permit is further limited as follows:

(a) Areas to be dredged shall not contain communities of corals, sponges (Porifera), oysters (Crassostrea spp.) or macroalgae.

(b) To the maximum practicable extent, dredging alignments shall follow existing channels and previously dredged areas, minimize impacts to seagrass communities and avoid adverse impacts to adjacent seagrass, coral, sponge or oyster communities that may reasonably be expected to result from turbidity, deposition of dredged material or sloughing of channel side slopes.

(c) Dredging alignments are limited to a top width of 30 feet and a bottom width of 20 feet, and shall not exceed the depths shown in SGEF-209. Overdredging is not allowed.

(d) Seagrasses and incidental individual (or clumped) oysters, corals or sponges within dredge areas shall be relocated to viable recipient sites, using scientifically accepted methods, to the maximum practicable extent.

(e) This general permit shall not apply to dredging within the limits of an area subject to a valid individual permit issued under part IV of chapter 373, F.S.

(4) Prior to each submittal of notice to use this general permit, WCIND shall conduct a pre-application meeting with the Department to review the specific details of the proposed project. For projects within an aquatic preserve, the meeting shall include the manager (or designated staff) of that aquatic preserve. The Department shall notify FWC prior to the pre-application meeting to provide FWC staff the opportunity to participate in the meeting. At the pre-application meeting, WCIND shall present all information necessary to complete Form 62-330.402(1), F.A.C., specifically including the following:

(a) Scaled plan and cross-sectional drawings that clearly identify:

1. The location, length, width, depth at local mean lower low water (MLLW) and estimated volume of each area to be dredged;

2. The locations of any hydraulic pipelines, barges and dredged material transfer sites;

3. The locations, dimensions and volumetric capacity of all proposed dredged material stockpile and disposal areas, including erosion and sedimentation controls; and,

4. The location and dimensions of all proposed turbidity mixing zones, including work areas to be enclosed within turbidity curtains as described in paragraph (6)(c), below. Such zones shall be of the minimum necessary extent, shall not encompass communities of seagrass, coral, sponge, oysters or macroalgae and shall be evaluated in accordance with rule 62-4.244, F.A.C.

(b) A Benthic Resource Inventory (BRI) consisting of scaled, plan-view depictions of the locations, dimensions and qualitative descriptions of the coverage and density for all seagrasses, oysters, corals, sponges and macroalgae within the areas specified under subparagraph (4)(b)1., below, including incidental specimens to be relocated pursuant to paragraph (3)(d), above. The benthic resource inspections conducted to prepare the BRI shall:

1. Be conducted along at least two transects lying parallel to and five feet within the sides of the dredging alignment, with additional transects conducted every 25 feet throughout all proposed turbidity mixing zones and all areas to receive relocated organisms;

2. Be conducted during May through September within one year prior to submittal; and,

3. Be conducted using scientifically accepted methods by individuals experienced and knowledgeable in benthic resource identification. Additionally, if the project is within an aquatic preserve, the manager (or staff) of that preserve shall be given at least two weeks prior notice and reasonable opportunity to accompany those individuals performing the inspections.

(c) A turbidity monitoring plan that includes the following information:

1. The relative locations of all proposed compliance monitoring stations, which shall be located adjacent to and directly downcurrent of the dredging sites, outfalls from dredged material disposal sites and other areas of active work, including the surrounding floating turbidity barriers and other approved mixing zones, if applicable,

2. The locations of the proposed background monitoring stations, which shall be within the same waterbody as the compliance monitoring stations, representative of ambient conditions for that waterbody and outside the influence of the areas of active work; and,

3. Assurance that monitoring shall be performed in accordance with chapter 62-160, F.A.C., including Department procedure "DEP-SOP-001/01 FT 1600 Field Measurement of Turbidity," which is incorporated in paragraph 62-160.800(1)(a), F.A.C., including the specifications of any non-standard sensors to be used.

(5) Each dredging event for a trafficshed or secondary channel system shall require a separate notice to use this general permit. Multiple areas within a single trafficshed or secondary channel system may be included in one notice.

(6) All work under this general permit shall comply with the following specific conditions:

(a) Relocation of seagrasses, corals, sponges or clumped oysters shall be performed in a manner that avoids adverse impacts to water quality or adjacent submerged resources.

(b) Dredged material resulting from the activities authorized by this general permit shall be removed and deposited on a self-contained, upland disposal site, with the following exceptions:

1. Seagrass, oyster, coral or sponge relocations as required by paragraph (3)(d) of this general permit, or

2. Where such deposition is authorized by a valid permit under part IV of chapter 373, F.S.

(c) Floating turbidity curtains shall be installed and maintained in a manner that effectively contains turbidity within the work area, at all times around areas of active in-water work, including dredging, discharge and spoil transfer. Use of these curtains shall not impede navigation or cause adverse sedimentation or other impacts to benthic communities located outside the work area.

(d) WCIND shall monitor in-situ turbidity in accordance with the Department-approved turbidity monitoring plan, described in paragraph (4)(c), above. Turbidity samples shall be collected at each compliance and background station within four hours prior to commencement of any period of in-water work, and shall continue to be collected every four hours thereafter until in-water work ceases, including at least one additional set of samples within four hours after work ceases. Each station shall be sampled at surface, mid-depth and one foot above bottom, or at mid-depth only, for waters less than five feet deep at the time of sampling. Samples shall be collected with a Kemmerer, Van Dorn or a similar sampler that is designed to collect in-situ water samples. Samples shall be analyzed immediately after collection with a turbidimeter that produces results in Nephelometric measurements. Detailed reports of all monitoring data shall be retained by WCIND and made available to Department staff, upon request. In the event that monitoring detects a violation of state water quality standards, WCIND shall:

1. Cease dredging immediately until the source of the violation is identified;

2. Take corrective measures to avoid future violations;

3. Only resume work once the receiving waters again meet water quality standards; and,

4. Report the violation(s) and corrective measures taken to the Department within 24 hours.

(e) The following conditions apply to in-water activities authorized under this general permit, in the trafficsheds and secondary channels identified as Ainger Creek, Balboa Creek, Canal Waterway, Desoto Canal, Dover Canal, Gottfried Creek-Englewood Secondary Channel, Myakka River Secondary Channel, Oyster Creek, Peace Island East, Punta Gorda Marina, San Marino Canal, San Salvador Canal, Santa Barbara Canal, Santa Clara Canal and Whidden Bay Secondary Channel:

1. Specific personnel shall be designated as manatee observers. The designated observer(s) shall be dedicated only for this task, must be on site during all in-water dredging activities and shall advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. The observer(s) shall wear polarized sunglasses during all dredging to aid in observation and shall work in shifts of no longer than 5 hours each. Observers shall maintain a log detailing manatee sightings, work stoppages and other protected species-related incidents. If approved by the Department after consultation with the FWC, the WCIND shall be allowed to implement alternative measures for observing for the presence of manatees when such measures provide reasonable assurance that manatees will not be adversely affected by the alternative methodology.

2. A report, summarizing all activities noted in the observer logs, the location and name of project and the dates and times of work shall be submitted within 30 days following project completion to the FWC's Imperiled Species Management Section at: 620 South Meridian Street, MS #6A, Tallahassee, Florida 32399-1600, or emailed to fcmpmail@myfwc.com.

3. No nighttime mechanical dredging, such as clamshell, shall occur. Movement of a work barge or other associated vessels shall not be performed, except at idle speed, after sunset when the possibility of spotting manatees is negligible.

(7) Within 90 days after completion of dredging under each notice, WCIND shall:

(a) Mark the dredged waterways in accordance with section 327.40, F.S., in a manner to facilitate safe navigation and protection of submerged natural resources.

(b) Submit a post-construction report, signed and sealed by a Registered Professional, detailing all work performed, including:

1. The depths and widths established by the dredging;

2. The total volume of material excavated from each channel and canal dredged; and,

3. A detailed description of all relocation of organisms performed under paragraph (6)(a), above.

(c) The Department shall grant additional time, as reasonably necessary, to satisfy conditions paragraphs (7)(a) and (b), above, upon demonstration of circumstances beyond the control of WCIND that prevented their timely completion.

(8) The No Internal Combustion Motors Zone (NICMZ) covering an area of approximately 89 acres of submerged lands within the Lemon Bay Aquatic Preserve, as described and depicted in the Map and Description of the Whidden Key No Internal Combustion Motor Zone, incorporated by reference herein (12/15) (http://www.flrules.org/Gateway/reference.asp?No=Ref-06201), is hereby established. A copy of that document may be obtained from the Department as described in subsection 62-330.010(5), F.A.C.

(a) WCIND shall install and maintain uniform waterway regulatory markers demarcating the boundaries of the NICMZ established by this general permit, in accordance with all required permits under section 327.41, F.S. WCIND shall provide documentation to the Department that the boundaries of the NICMZ have been so marked, prior to conducting any work under this general permit within Outstanding Florida Waters.

(b) Within the NICMZ, vessels equipped with internal combustion motors (e.g., gasoline or diesel motors) for propulsion must turn off the internal combustion motor and, if possible to do so, tilt or raise the internal combustion motor out of the water. The use of electric motors is not prohibited.

(c) Prior to installing the NICMZ markers under paragraph (8)(a), above, WCIND shall design and implement a program to monitor seagrasses within the NICMZ using scientifically accepted methods after consultation with FWC and Department staff of the local district office and Lemon Bay Aquatic Preserve. The monitoring shall be designed to establish the baseline coverage of seagrasses by species, the locations and coverage of prop scarring and document any change in coverage over time. At a minimum, the first monitoring shall occur within 90 days after the boundaries of the NICMZ have been marked and every two years thereafter for a total of ten years. The monitoring plan shall include metrics that can be used to quantitatively establish the relative success or failure of seagrass restoration and protection following establishment of the NICMZ.

(9) A Letter of Consent is granted for WCIND to enter upon and use state-owned submerged lands to complete the permitted activities, subject to the provisions of subsection 18-21.004(7), F.A.C. Dredged material with economic value, such as beach quality sand, severed from state-owned submerged lands shall be used for public purposes to the maximum practicable extent.

Rulemaking Authority 373.043, 373.4131, 403.805(1), 403.814(1) FS. Law Implemented 253.002, 253.77, 258.42, 373.4131, 373.414, 403.061(34) FS. History–New 12-28-15.

62-330.412 General Permit for Public Navigation Channel and Canal Infrastructure by the West Coast Inland Navigation District within Lee County.

(1) A general permit is granted to the West Coast Inland Navigation District ("WCIND") to dredge public navigation channels and canals within the trafficsheds and secondary channel systems listed in Table 1 "Trafficsheds, Secondary Channel Systems, Dredge Depth Limits, and Trafficshed Report Identification Numbers," effective 18 February 2010, incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03177), and shown in Figures 1 through 48 of Antonini, Gustavo A., Robert A. Swett, and David Fann, 2008, Maps of Lee County Noticed General Permit Trafficshed Channels and Secondary Channels, SGEF-173, Florida Sea Grant College Program, Gainesville, Florida (30 October 2008), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03148). Copies of Table 1 and SGEF-173 may be obtained from the Department as described in subsection 62-330.010(5), F.A.C. Additional information on the background, methodology, and data used in identifying the trafficsheds and secondary channel systems that are the subject of this general permit is described in the following reports:

(a) Antonini, Gustavo A, and Paul Box, 1996, A Regional Waterway Systems Management Strategy for Southwest Florida, TP-83, Florida Sea Grant College Program, Gainesville, Florida;

(b) Swett, Robert A., David A. Fann, Gustavo A. Antonini and Lana Carlin Alexander, 2000, Regional Waterway Management System for Lee County, Phase I, TD-3, Florida Sea Grant College Program, Gainesville, Florida;

(c) Swett, Robert A., David A. Fann, Gustavo A. Antonini and Lana Carlin Alexander, 2001, Regional Waterway Management System for Lee County, Phase 2, TD-4, Florida Sea Grant College Program, Gainesville, Florida;

(d) Fann, D.A., R.A. Swett, and G.A. Antonini, 2002. Regional Waterway Management System for Lee County, Phase 3. TD-5, University of Florida, Gainesville, FL: 21 Florida Sea Grant.

Copies of these documents may be obtained by contacting environmental resource permit program staff in the Department's South

District Office (Fort Myers) and from the Department's Internet site at http://www.dep.state.fl.us/legal/Rules/rulelistnum.htm. This general permit is not required for maintenance dredging that qualifies for an exemption under section 403.813(1)(f), F.S.

(2) This general permit is further limited as follows:

(a) For purposes of this general permit, the term "public navigation channels and canals" shall consist of the Intracoastal Waterway and those trafficsheds and secondary channel systems identified on the maps in SGEF-173, which have been determined by the WCIND Board to make a significant contribution to public boating traffic.

(b) The area to be dredged shall not contain any living communities of true stony coral (order Scleractinia), hydrocoral (order Milleporina), octocoral (subclass Octocorallia), or soft coral (Alcynoacea, Gorgonacea and Pennatulacea), sponge beds (Porifera), oyster bars (Crassostrea spp.), or macroalgae of the family Caulerpaceae. This shall not prevent dredging of incidental individual specimens of corals, sponges, or oysters. To the extent individual or clumped oysters, corals, or sponges are to be dredged, they shall be relocated to the maximum extent practicable in accordance with paragraph (3)(c), of this general permit. In addition, the dredging alignments shall be located so as to not adversely affect coral and sponge communities and oyster bars as a result of sloughing of channel side slopes. Seagrass within the proposed dredged area shall be relocated in accordance with paragraph (3)(c), of this general permit.

(c) To the maximum extent practicable, dredging alignments shall follow existing channels and previously dredged areas and avoid and minimize impacts to seagrass communities (Potamogetonaceae, Hydrocharitaceae and Cymodoceae sp.). Dredging alignments also shall be located to minimize the potential for erosion to adjacent seagrass communities as a result of sloughing of channel side slopes.

(d)1. The "No Internal Combustion Motor Zones" (NICMZs) shown and described in the attached Exhibit A, effective February 18, 2010, incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03178), which reflect the boundaries approved in Resolution 07-09-49 of the Lee County Board of County Commissioners on September 25, 2007, are hereby established by this general permit. A copy of Exhibit A may be obtained from the Department as described in subsection 62-330.010(5), F.A.C. Within these NICMZs, the use of electric motors is permitted, but operators of all vessels equipped with internal combustion motors (e.g.: gasoline or diesel motors) for propulsion must turn off the internal combustion motor and, if possible to do so, tilt or raise the internal combustion motor out of the water.

2. Prior to any dredging authorized by this general permit within an Aquatic Preserve, WCIND shall demonstrate that the NICMZ(s) within that aquatic preserve have been established and marked in the field. Nothing in this rule shall be construed to relieve WCIND from obtaining sign permits required by the Florida Fish and Wildlife Conservation Commission (FWC). For this purpose, DEP authorizes WCIND to apply to FWC for all required sign permits to mark the boundaries of the NICMZs established by this general permit. WCIND shall be responsible for installing and maintaining all permitted signs.

3. WCIND will design and implement a program to monitor seagrasses within the NICMZs using various scientifically approved methods after consultation with DEP and FWC staff. The monitoring shall be designed to establish the baseline coverage of seagrasses by species, the number and coverage of prop scarring, and document any change in coverage over time. At a minimum, the first monitoring will occur within 90 days after the boundaries of the NICMZs have been marked with signage as provided in the preceding section of this general permit, and thereafter every two years for a total of ten years. The monitoring plan shall include metrics that can be used to quantitatively establish the relative success or failure of seagrass restoration and protection following establishment of the NICMZs.

(e) Dredging alignments shall not exceed the maximum depths shown in Table 1. All dredging alignments shall not exceed a maximum top width of 30 feet and a maximum bottom width of 20 feet. Overdredging to achieve the final authorized depth and width is not allowed. An as-built survey of the dredging alignment shall be submitted to the Department as provided in paragraph (3)(h), below.

(f) No more than 8,500 cubic yards of dredged material shall be cumulatively removed through authorizations by this general permit over a five-year period within each trafficshed or secondary channel system, beginning with the first project authorized under this general permit within the trafficshed or secondary channel system. Within 30 days following the completion of the as-built survey required in paragraphs (2)(e), above, and (3)(h), below, a report shall be submitted to the South District office of the Department that includes the volume of material excavated from each channel and canal within the trafficshed or secondary channel system, and the cumulative total volume of material excavated for the trafficshed or secondary channel system under this general permit within the previous five years. This report shall be included with any subsequent notices to dredge channels or canals within the same trafficshed or secondary channel system.

(g) The dredging activity is restricted to Class III Waters, or Class II Waters that are classified by the Department of Agriculture and Consumer Services under chapter 5L-1, F.A.C., as unclassified, prohibited, restricted, or conditionally approved for shellfish harvesting.

(h) This general permit shall not apply to dredging within the limits of areas subject to currently valid individual permits under part IV of chapter 373, F.S.

(3) All work under this general permit shall be conducted in conformance with the general conditions of rule 62-330.405, F.A.C., and the following specific conditions.

(a) Each dredging event for a trafficshed or secondary channel system shall require a separate notice to use this general permit. Multiple areas within a single trafficshed or secondary channel system may be included in one notice. Each notice shall be submitted with all of the following information.

1. Scaled plan and cross-sectional drawings that clearly identify the length, width, and depth (referenced to mean lower low water) of the area or areas to be dredged within each channel and canal; locations of any hydraulic pipelines between the dredge areas and the dredged material disposal sites; and identification of the channels, canals, and names of the trafficsheds or secondary channel system that are to be dredged from Table 1.

2. Identification of the source document described in subsection (1), and reference data that specifically describe the work proposed for dredging within the trafficshed or secondary channel system. All document titles, page numbers, figures, and other relevant information to the trafficshed or secondary channel system must be identified.

3. The location, dimensions, and estimated volumes of dredged material disposal sites, including the location of any water quality or habitat restoration as described in paragraph (3)(d), of this general permit and any relocation areas required under paragraph (2)(b), above. If dredged material fill will be transported over water by barge, the notice will include assurance that the barge will be designed and sized to prevent discharge of dredged material runoff, prop or hull dredging, and discharge during the loading and unloading of material. If stockpile areas are to be used for temporary disposal and transport, the type and volume capacity of such stockpile areas, including controls that will be used to prevent dredge material runoff also must be described. The notice must provide assurance any temporary stockpile areas will have no impacts to jurisdictional wetlands or surface waters.

4. The estimated volume of each proposed dredging area.

5. Identification of any special water classifications for the areas to be dredged, such as the water class (rule 62-302.400, F.A.C.); shellfish classification under chapter 5L-1, F.A.C.; aquatic preserve, state park, or state recreation area designation under chapter 258, F.S.; and Outstanding Florida Water or Outstanding National Resource Water designation under rule 62-302.700, F.A.C.

6. A resource inventory of the dredging alignments which has been prepared or updated between May through September within one year prior to the proposed dredging. The resource inventory must be conducted by an individual experienced and knowledgeable in benthic communities and seagrass identification. The resource inventory must identify the presence and location of seagrasses, oysters, coral communities, sponge beds, and macroalgae of the family Caulerpaceae. This resource inventory must also include all areas within any requested mixing zones associated with the dredging project (including outfall pipes from the dredge material disposal area), and all areas that will be occupied by dredging equipment (including cables, pipelines, dredges, barges, and stockpiling/disposal of dredged material). The resource inventory assessment within channels will be conducted as follows, although the WCIND may use equivalent assessment methods upon receiving prior written approval from the Department:

a. The assessment will be conducted along a minimum of two transects within the dredging alignment. The transects will be along a line parallel with and 5 feet within the sides of the dredging alignment,

b. The resource inventory assessment within any requested mixing zones shall be conducted along grid transects every 10 feet throughout the length and width of the requested mixing zone; and,

c. The resource inventory shall be qualitative in nature but shall include identification and location of corals, sponges, and oysters to be relocated pursuant to paragraph (2)(b), of this general permit, and include general identification and location of the extent of seagrass areas and a qualitative description of their relative extent of coverage, and density. The resource inventory shall be completed and submitted a minimum of 30 days prior to the pre-application meeting required by paragraph (3)(b), of this general permit.

7. Identification of the extent and location of all previous dredging within the past five years authorized under this general permit within the trafficshed or secondary channel system; the date of all such dredging events; the estimated cubic yards excavated from each distinct portion of the trafficshed or secondary channel system under this general permit; and the permit numbers assigned

to such prior use of this general permit for the trafficshed or secondary channel system.

8. The estimated date the dredging activities are planned to begin and the estimated length of time it will take to complete the project. If the project will be accomplished in phases, the estimated starting and ending date of each phase must also be submitted.

9. A plan for monitoring water quality minimally consisting of monitoring at the dredge site, at the location of any waters receiving outfall from dredged material disposal sites, and at background and down-gradient locations in the water body where dredging is occurring and surrounding the dredged material disposal sites. The monitoring shall be designed primarily to measure in-situ turbidity, but is subject to modification based on the pre-application meeting discussion with the Department to ensure the plan is capable of detecting any potential water quality violations from the project or activities. If the dredge area is in close proximity to a facility or location likely to cause a discharge of toxic materials, the water quality monitoring as well as best management practices proposed shall be designed to retain deleterious substances during dredging. Results of the monitoring and a copy of the logs shall be submitted in accordance with paragraph (3)(f), of this general permit.

10. A description of the resources to be relocated pursuant to paragraphs (2)(b) and (3)(c), of this general permit, the methods to be used for their relocation, and the locations to which they will be relocated.

(b) A minimum of 30 days prior to submittal of a notice to use this general permit, the WCIND and Lee County shall conduct at least one pre-application meeting with the Department's South District Environmental Resources Permitting staff to discuss project designs, implementation details, and any resource concerns, including approval of any resource relocation in accordance with paragraph (2)(b), of this general permit or water quality or habitat restoration sites in accordance with paragraph (3)(d), of this general permit. For a proposed project within an aquatic preserve, this meeting shall include the appropriate aquatic preserve manager or their designee. In the event the pre-application meeting adequately addresses all Department questions or concerns, the Department will inform the WCIND that the notice may be submitted immediately for review.

(c) To the extent seagrass, corals, sponges or clumped oysters are within the dredging footprint, they shall be relocated to the maximum extent practicable. Seagrass, oysters, corals, and sponges must be relocated only into areas previously approved in writing by the Department. Relocation shall be done in a manner that avoids adverse impacts to water quality and adjacent submerged resources. If seagrasses are relocated, the donor site within the dredge area and the location of the seagrass transplant shall be described in the application and in the pre-application meeting required under paragraph (3)(b), of this general permit. Any relocation performed under this paragraph shall be described in a detailed report to the Department's South District office within 60 days of project completion. The report shall describe the methods used, the donor site within the dredge area, and the recipient location of the transplant. The WCIND shall provide copies to the Department's South District office of any follow up monitoring or studies performed on the success of the transplants.

(d) All dredged material resulting from the activities authorized by this general permit shall be removed and deposited on a self-contained, upland dredged material disposal site. The only exceptions to the use of a self-contained, upland dredged material disposal site shall be: seagrass, oyster, coral, or sponge relocations as required by this general permit; or where dredged materials are to be used as part of a water quality or habitat restoration plan authorized by the Department or a water management district under part IV of chapter 373, F.S., in which case any discharge of dredged material shall be in compliance with all terms of that authorization. In all cases, the dredging operation, the discharge of dredged material, and the dredged material disposal site shall be designed, located, and operated such that there are no water quality violations in wetlands or other surface waters outside of a mixing zone established under paragraph (3)(e), of this general permit.

(e) In areas outside of aquatic preserves, violations of state water quality standards shall be prevented immediately outside of a mixing zone of no more than 150 meters in radius from the dredge site and from any discharge point associated with a dredge material disposal area. To the greatest extent practicable, the mixing zone shall be restricted to the limits of the dredging alignment. Within aquatic preserves, violations of water quality standards immediately outside the area of active work shall be prevented. This shall minimally consist of the use of erosion and sediment control devices, turbidity curtains or similar devices, and other best management practices, all of which shall be located immediately surrounding the area of active work and maintained in a functional condition. In addition, dredge pumping rates and volumes shall be managed to minimize discharges from dredged material disposal sites; and the management of dredged material disposal site dikes, berms, and water control structures so as to minimize erosion, breaches, and discharges. In all cases, mixing zones shall be designed to avoid living communities of stony corals [true stony corals (order Scleractinia) hydrocorals (order Milleporina)], and octocorals (subclass Octocorallia), sponge bed communities (Porifera), oyster bars (Crassostrea spp.), macroalgae of the family Caulerpaceae, and seagrass (Potamogetaceae, Hydrocharitaceae and Cymodoceae).

(f) At all times during active dredging, the collection, analysis, and monitoring of the water quality samples required under this general permit must be conducted and performed by individuals who have prior training and experience in collecting and analyzing water quality samples using the Standard Operating Procedures accessible at the Department's Internet site and in accordance with chapter 62-160, F.A.C. Such qualified individual(s) shall be on site at all times necessary to ensure full compliance with the requirements of this general permit. In the event the water quality monitoring required under this general permit detects violations of state water quality standards, dredging shall cease immediately until the source of the violation is identified, measures taken to avoid future violations, and the receiving waters again meet applicable water quality standards. Weekly reports describing the hours of dredging accomplished and the results of the required monitoring will be provided to the South District office of the Department. Any violations of water quality standards and/or other requirements of this general permit shall be immediately reported to the South District office of the Department.

(g) The permittee shall be responsible for ensuring that all contractors and other entities implementing this general permit comply with the following standard manatee and marine turtle conditions.

1. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel shall be responsible for observing water-related activities for the presence of manatees.

2. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act of 1978. If the dredging activity results in any manatee being harmed, harassed, or killed as a result of construction activities, the Department will refer the matter to the Florida Fish and Wildlife Conservation Commission (FWC) for appropriate action.

3. Siltation barriers associated with any project or activity authorized by this general permit shall not block manatee entry to or exit from manatee feeding areas and the following manatee warm water refuge areas:

a. Entrance of the Chiquita Canal (which provides access to the Eight Lakes area) within the Cape Coral Southwest Trafficshed.

b. Defined manatee protection speed zone within the Franklin Locks East Trafficshed and all waters of the Caloosahatchee River within 1/4 mile east of the easternmost end of the Franklin Lock & Dam.

c. Matlacha channel (which provides access to the Matlacha Isles canal system) including the Matlacha Isles canal system in the vicinity of the Boat Lift within the Matlacha Isles/Cape Coral (northwest) Trafficshed.

d. Mouth and remainder of the Orange River within the Orange River Trafficshed.

e. All waters within the Mullock Creek Trafficshed.

4. Temporary signs concerning manatees shall be posted prior to and during dredging activities. All signs are to be removed by the permittee upon completion of the project. Temporary signs that have already been approved for this use by the FWC must be used. One sign that reads "Caution: Boaters" must be posted. A second sign measuring at least 8 1/2 inches by 11 inches explaining the requirements for "Idle Speed/No Wake" and the shut-down of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities. These signs can be viewed at www.MyFWC.com/manatee. Questions concerning these signs can be sent to ImperiledSpecies@myfwc.com.

5. Specific personnel shall be designated as manatee observers. The designated observer(s) shall be dedicated only for this task, must be on site during all in-water dredging activities, and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. The observer(s) shall wear polarized sunglasses during all dredging to aid in observation, and shall work in shifts of no longer than 5 hours each. Observers shall maintain a log detailing manatee sightings, work stoppages, and other protected species-related incidents. If approved by the Department after consultation with the FWC, the WCIND shall be allowed to implement alternative measures for observing for the presence of manatees when such measures provide reasonable assurance that manatees will not be adversely affected by the alternative methodology.

6. A report, summarizing all activities noted in the observer logs, the location and name of project, and the dates and times of work shall be submitted within 30 days following project completion, to the FWC's Imperiled Species Management Section at: 620 South Meridian Street, MS #6A, Tallahassee, Florida 32399-1600, or emailed at fcmpmail@myfwc.com.

7. No nighttime mechanical dredging, such as clamshell, shall occur. Movement of a work barge or other associated vessels shall not be performed after sunset, when the possibility of spotting manatees is negligible.

8. All channels designated as Cape Coral Southwest, Franklin Locks East, Matlacha Isles/Cape Coral (northwest), Mullock Creek, and Orange River shall be prohibited from being dredged between November 15th and March 31st of any year due to the

high numbers of manatees present at these warm water refuges in the wintertime. When these areas are being dredged between April 1st and November 14th, the manatee protection measures outlined above for all other channel dredging shall be followed.

(h) An as-built survey shall be initiated within two weeks and shall be completed within 60 days after completion of dredging to document depths and widths established by the dredging. The Department shall grant additional time as reasonable to complete the survey upon submittal of written documentation of the existence of inclement weather or situations beyond the control of the permittee that prevented the timely completion of the survey, the submittal of a new timeline for completing the survey.

(i) Within 90 days of completion of each authorized dredge event under this general permit, the affected trafficshed or secondary channel system shall be marked along its entire length with aids to navigation. Markers shall be placed in a manner to facilitate safe navigation and protection of submerged natural resources. In channels dredged to less than 4 foot MLLW depth, signage that identifies areas of shallow water shall be installed, using language such as "Controlling Depth 3 feet, Local Knowledge Required," "Use Caution," or "Stay in Channel." Nothing in this rule shall be construed to relieve the WCIND from obtaining permits for markers and signs required by the FWC.

(j) WCIND shall provide an as-built report and survey detailing all work performed under this authorization and its compliance with the conditions and criteria of this general permit.

(k) All reports and information required by this authorization shall be submitted to the South District DEP office.

(l) WCIND will facilitate an update of the *Lee County Boaters Guide* to reflect the NICMZs established by this general permit. The update will also include computer internet links to additional boater information that will enhance water quality and protection of resources within the aquatic preserves that are the subject of this general permit. WCIND will facilitate the distribution of the updated Boaters Guide to local marinas, commercial boat rental operations, and local residents.

(m) Works under this general permit shall not commence until the Department has provided written confirmation within 30 days that the notice required under paragraph (3)(a), meets all the applicable terms and conditions of this general permit.

(4) Consent is granted for the West Coast Inland Navigation District to enter upon and use state-owned submerged lands to the extent necessary to complete the permitted activities, to Lee County and the West Coast Inland Navigation District to establish, mark, and enforce the NICMZs depicted in Exhibit A.

(5) Dredged material removed from state-owned submerged lands under this general permit is exempt from the payment of severed dredged material fees in accordance with section 253.77, F.S. However, dredged material with economic value, such as beach quality sand, shall be used for public purposes to the maximum extent practicable.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1), 403.814(1) FS. Law Implemented 253.002, 253.77(1), 253.77(4), 258.42, 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(1), 373.414(1)(b), 373.414(9), 373.416, 373.426, 403.061(34), 403.813(3), 403.814(1) FS. History–New 2-18-10, Formerly 62-341.494, Formerly 62-330.441, Amended 10-1-13.

62-330.417 General Permit for Construction, Alteration, Operation, and Maintenance of Boat Ramp Facilities.

(1) A general permit is granted, except in waters that are accessible to manatees within Charlotte, Hillsborough, Levy, Manatee, and Pinellas Counties or the St. Johns River and its tributaries in Lake and Seminole Counties, for construction, alteration, maintenance, and operation of a single boat ramp for the following entities or facilities:

(a) An individual, detached single-family dwelling unit or two adjacent detached single-family dwelling units, provided the ramp is located on the shared property line.

(b) A multi-family dwelling unit, which, for the purpose of this rule, shall include attached multi-family dwelling units, regardless of the legal subdivision of the underlying property.

(c) A commercial entity, provided such ramp is open to the general public for the life of the ramp, with or without a fee and without any membership or qualifying requirements.

(d) A governmental entity, such as a federal, state, county, or municipal agency, or a water management or inland navigation district, provided the boat ramp is open to the general public for the life of the facility, with or without a fee. The following associated facilities are also authorized for governmental entities in accordance with the terms and conditions of this general permit, provided the ramp and associated facilities remain open to the general public for the life of the facility, with or without a fee: ingress and egress traffic lanes, boat trailer parking spaces, an access road, and associated accessory docks.

(2) The boat ramp and associated facilities must meet all of the following conditions:

(a) The work is not part of a larger plan of development that requires a permit under part IV of chapter 373, F.S.

(b) A minimum navigational access of two feet below mean low water in tidal waters or the expected average low depth in non-

tidal waters, as determined based on best available information for the water body at the project location, must already exist to the proposed ramp. Depth indicators shall be installed at the ramp to identify the controlling depths of the navigational access.

(c) There shall be no work in, on, or over submerged grassbeds or coral communities.

(d) Dredging shall be limited to no more than 100 cubic yards, and in no case shall be more than is necessary to construct the boat ramp surface or restore the ramp to its original configuration and dimension.

(e) The above-water portion of the boat ramp shall be paved or otherwise stabilized to prevent turbidity.

(f) Work under this general permit shall not commence until the Agency has provided written confirmation that the applicant qualifies to use the general permit.

(g) This general permit is limited to one use per parcel of property and cannot be combined with other general permits or exemptions.

(3) Construction of the boat ramp is limited as follows:

(a) The boat ramp for a single-family or multi-family dwelling unit, under paragraph (1)(a) or (b), above, is limited to a single lane and must not exceed a width of 20 feet, including the side slopes, with the boat ramp surface not to exceed a width of 12 feet.

(b) The boat ramp for a commercial or governmental entity under paragraph (1)(c) or (d), above, is limited to a maximum of two lanes and must not exceed a width of 60 feet, including the side slopes, with the ramp surface not to exceed a width of 36 feet.

(c) Construction or expansion of a multi-family, commercial, or governmental boat ramp under paragraph (1)(b), (c), or (d), above, in waters that are accessible to manatees must meet the following criteria:

1. The proposed boat ramp facility must be consistent with the state approved manatee protection plan in counties required to have a manatee protection plan adopted under section 379.2431(2), F.S., or in counties that have voluntarily completed a state approved manatee protection plan. Documentation of plan consistency must be submitted concurrently with the notice to use the general permit in the form of a letter of consistency concurrence from the Florida Fish and Wildlife Conservation Commission. A review by the Commission can be requested at ImperiledSpecies@myfwc.com.

2. The proposed boat ramp facility must have a kiosk or permanent information display board providing information on manatee protection and applicable manatee zones as adopted in chapter 68C-22, F.A.C., "The Florida Manatee Sanctuary Act" (June 13, 2012) (http://www.flrules.org/Gateway/reference.asp?No=Ref-03179), which is incorporated by reference herein and available as provided in subsection 62-330.010(5), F.A.C., for that county.

(d) A boat ramp for a multi-family residence or for commercial or governmental entities under paragraph (1)(b), (c), or (d), above, can have a maximum of two accessory docks, abutting either one or both sides of the boat ramp, provided that the cumulative square footage of accessory docks over wetlands or other surface waters does not exceed 500 square feet in Outstanding Florida Waters or 1,000 square feet outside Outstanding Florida Waters. In addition, the accessory docks shall not be used for overnight mooring.

(4) The total impervious surface in uplands that is subject to vehicular traffic associated with a boat ramp for a governmental entity under paragraph (1)(d), above, shall not exceed 1.2 acres. Before operating any portion of such a boat ramp facility that contains 4,000 square feet or more impervious surface subject to vehicular traffic, a stormwater management system meeting all of the following requirements must be constructed and fully operational.

(a) Each system must be designed by a registered professional in accordance with chapter 471, 472, 481, or 492, F.S., as applicable, and must be constructed, operated, and maintained to serve the total project area of the boat ramp facility.

(b) No system shall accept or treat runoff from offsite areas not associated with the total project area.

(c) The system must provide treatment for a minimum stormwater retention volume of one-half inch of runoff. Recovery of the specified retention volume must occur within 72 hours by percolation through the sides and bottom of the retention basin.

(d) Impervious traffic lanes and parking areas must be graded such that runoff is directed to the stormwater treatment system.

(e) The system must include a continuous vegetated buffer strip adjacent to the downstream side of impervious areas subject to stormwater treatment. The buffer strip must be at least 25 feet wide and stabilized by well-established natural vegetation.

(f) The permittee must maintain the treatment system and buffer strips at all times for the life of the system.

(g) Upon completing construction of the stormwater management system, the system must be operated and maintained by the permittee in accordance with the terms of this general permit for the life of the system. The permittee shall perform routine inspections of the buffer to check for development of concentrated flow through it, gully erosion, or loss of vegetation, and must repair the buffer as soon as practical to restore shallow overland flow conditions and prevent further concentration of flow and damage to the buffer.

(5) Commercial or governmental entities proposing to construct a boat ramp under paragraph (1)(c) or (d), above, shall record a fully executed binding agreement in the official records of the county in which the boat ramp is located. Commercial entities shall execute and record the "Agreement to Maintain Public Access," incorporated herein as Form 62-330.417(1), (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02508), ensuring the facility will remain open to the general public for the life of the facility. Governmental entities shall execute and record the "Agreement to Maintain Public Access and Operate Stormwater System," incorporated herein as Form 62-330.417(2), (October 1, 2013) (http://www.flrules.org/Gateway/reference.asp?No=Ref-02509), ensuring the facility will remain open to the general public for the life of the facility and to ensure that the stormwater management system associated with the boat ramp will be operated and maintained for the life of the system. Copies of incorporated materials may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), (5), 373.406(5), 373.413, 373.4131, 373.414(1), (9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Amended 12-9-09, Formerly 62-341.417, Amended 10-1-13, 6-1-18.

62-330.420 General Permit to Local Governments for Public Mooring Fields.

(1) A general permit is granted to any local government to construct, operate, and maintain a public mooring field for up to 100 vessels, including a dinghy dock and sewage pumpout dock directly supporting the mooring field.

(2) The Notice of Intent to use this general permit required under subsection 62-330.402(1), F.A.C., shall include the following additional information:

(a) Mooring Field Management Plan (Management Plan) that provides reasonable assurance that the mooring field and supporting land-based facility will comply with all of the requirements of this general permit. The Management Plan shall be binding on the permittee for the life of the mooring field. Any revisions or modifications to the Management Plan require written approval, by the Department, prior to becoming effective.

(b) All drawings and documents in support of the proposed mooring field and associated land-based support facility, including details on the anchoring systems proposed for mooring vessels in the mooring field, and any docks, pumpout facilities, kiosks, and in-water navigational signs and markers proposed.

(c) A scaled bathymetry plan showing water depths throughout the proposed mooring field, including any ingress and egress channels directly associated with the mooring field and water depths at any docks proposed at the land-based support facility.

(d) A benthic resource inventory of the proposed mooring field location as well as the areas for the proposed dinghy and pumpout docks.

(3) To qualify for this general permit, the local government must comply with the following specific conditions, in addition to the general conditions in rule 62-330.405, F.A.C.:

(a) Management Plan:

1. At least 30 days prior to submittal of a notice to use this general permit, the local government shall conduct at least one pre-application meeting with the Department to discuss the adequacy of the Management Plan, existing or proposed land-based support facility, project design, and implementation details.

2. Example Management Plans are included in the "References and Design Aids" for Volume I, available at http://www.dep.state.fl.us/water/rulesprog.htm#erp. Entities using this general permit are not required to follow the examples.

(b) Siting Criteria:

1. Navigational access must already exist between the mooring field and the nearest customarily used access channel or navigable waters for the sizes of vessels for which the mooring field is designed to serve, such that no new dredging is required to create access or adequate mooring depths.

2. The mooring field and mooring areas associated with the dinghy dock and pumpout vessel dock shall be sited in an area with adequate circulation and flushing based on the bathymetry plan required in paragraph (2)(c), above, and the proposed drafts and types of vessels to be moored.

3. The mooring field shall be associated with an existing or permitted land-based support facility that is operational prior to the mooring field being occupied. The land-based support facility shall provide amenities and conveniences for the number of occupants that are using the mooring field (e.g., parking, bathrooms, shower facilities, laundry facilities, etc.). These details shall be included in the Management Plan.

4. The mooring field, dinghy dock, and sewage pumpout dock shall not be located in the following areas.

a. Within any marked or customarily used navigational channel, or within setbacks established by the U.S. Army Corps of Engineers for federal channels.

b. Where they would adversely affect waters classified by the Department of Agriculture and Consumer Services as approved, conditionally approved, restricted, or conditionally restricted for shellfish harvesting as set forth in chapter 5L-1, F.A.C. This can be demonstrated by providing a letter of no objection from the Department of Agriculture and Consumer Services. However, no letter is required if a project will be located in Palm Beach, Broward, or Miami-Dade County.

c. Where they would adversely affect critical habitat designated by the U.S. Fish and Wildlife Service or U.S. National Marine Fisheries Service for any federally-listed threatened or endangered species under the Endangered Species Act of 1973.

d. In predominantly fresh waters as defined in chapter 62-302, F.A.C.

(c) Design criteria:

1. The mooring field shall accommodate no more than 100 vessels (excluding any dinghies that may be attached to parent vessels).

2. Vessel mooring systems and the installation plans must be designed by a Florida registered professional so that the mooring systems with vessels attached withstand, at a minimum, tropical storm force winds and so that the associated tethers, lines, and buoys do not scour or damage the bottom. The mooring system and associated tethers, lines, and buoys shall be maintained for the life of the facility.

3. The mooring field shall be permanently associated with a land-based support facility that provides the following:

a. Pumpout either fixed or portable, or a pumpout vessel under contract for service or owned by the land-based support facility capable of serving all vessels using the mooring field, and a plan for regular pumpouts of vessels when needed.

b. A landing platform or dinghy dock for mooring field users to access the land-based support facility, as well as a dock for a fixed sewage pumpout or mooring for the pumpout vessel if one is requested. Such docks are authorized to be constructed under this general permit, provided neither dock exceeds 500 square feet of structure over wetlands and other surface waters, and sufficient water depth exists at the dock for the sizes of vessels for which the dock is designed to serve.

4. The mooring field shall be marked in accordance with Florida Fish and Wildlife Conservation Commission requirements under chapter 327, F.S., including markings of the outside boundaries of the mooring field.

5. Dredging and filling of wetlands or other surface waters is authorized only for the installation of pilings; mooring buoys; vessel mooring systems; mooring field regulatory; boundary, and information markers; dinghy docks; and sewage pumpout docks.

6. If located in a county with a Manatee Protection Plan (MPP) approved by the Florida Fish and Wildlife Conservation Commission, the mooring field shall be designed and maintained in conformance with the MPP. Documentation of plan consistency must be submitted concurrently with the notice to use the general permit in the form of a letter of consistency from the Commission. A review by the Commission can be requested at ImperiledSpecies@myFWC.com.

(d) Operational Criteria:

1. The local government or its contracted entity shall operate and maintain the mooring field and land-based support facility in accordance with the terms of this general permit, the Management Plan, and sovereign submerged lands lease (if applicable) throughout the life of the mooring field.

2. Occupied vessels with Type III marine sanitation devices shall be required to have their holding tanks pumped out, at a minimum, on a 7-day interval while continuously moored in the mooring field. The Management Plan shall specify a pumpout plan, tracking and inspection times, which generally shall not be less than a minimum 7-day interval. The pumpout plan shall include a flag notification system for facilities that are using a pumpout vessel and a proposed inspection schedule for Type I or II systems.

3. The local government must provide, at the land-based support facility, for the regular collection of solid waste, sewage, and recyclable goods from vessels moored at the mooring field. All collected sewage waste must be discharged at a facility permitted by the Department or the Florida Department of Health.

4. The local government must provide information to users explaining ways to minimize discharges of grey water, including encouragement to use land-based support facilities. This information also shall be included in the Management Plan.

5. The following activities are prohibited in the mooring field and at the dinghy dock and sewage pumpout dock at the land-based support facility, unless specifically authorized in the Management Plan or a separate, valid authorization under part IV of chapter 373, F.S.:

a. Major boat repair and maintenance.

b. Fueling activities. However, this shall not prevent fueling at the land-based support facility.

c. Boat hull scraping or painting.

6. The local government shall identify in the Management Plan whether it will provide brochures, or install and maintain a kiosk or permanent information display board in a clearly visible location at the land-based support facility, providing information on:

a. Operational provisions and restrictions associated with use of the mooring field and land-based support facility,

b. Manatee protection and applicable manatee zones as adopted in chapter 68C-22, F.A.C., which is incorporated by reference in subparagraph 62-330.417(3)(c)2., F.A.C.,

c. Location and availability of sewage pumpout facilities and procedures,

d. Navigational ingress and egress to the mooring field and land-based support facility, including identification of channel markers, shoals, and other significant navigational issues, such as controlling water depths; or by providing charts for sale or a location where they may be purchased,

e. Seagrasses, corals, and other significant resources in the adjacent waters, such as their location, protection, and avoidance of impacts, and their importance to the water resources; and,

f. Prohibitions on discharging trash, sewage, and hazardous wastes into the water, and ways to minimize discharging grey water into the water.

(e) Sovereignty Submerged Lands Lease:

1. All public mooring fields and associated land-based support facilities located on sovereignty submerged lands require a lease from the Board of Trustees of the Internal Improvement Trust Fund in accordance with the application procedures and requirements of chapters 18-18, 18-20, and 18-21, F.A.C., as applicable.

2. The lease boundary shall include the over-water surface area of the mooring field, encompassing all of the swing areas and square footage between the swing areas including internal thoroughfares.

3. The lease boundary shall include the preempted area for the dinghy dock and the sewage pumpout dock that contains a temporary mooring area to access a fixed sewage pumpout and for the mooring of a sewage pumpout vessel, if these structures are proposed and located on sovereignty submerged lands and not part of an existing lease or other forms of authorization by the Board of Trustees of the Internal Improvement Fund.

4. The Management Plan shall be referenced in the lease, when located over sovereignty submerged lands.

Rulemaking Authority 373.043, 373.044, 373.118(4), 373.4131 FS. Law Implemented 373.117, 373.118, 373.413, 373.414, 373.416, 373.422 FS. History–New 11-19-15.

62-330.427 General Permit for Docks, Piers and Associated Structures.

(1) A general permit is granted to any person to construct, extend, or remove a dock or pier and associated structures as described below:

(a) A private, single-family pier or dock with up to two boat lifts that, together with all existing structures on the shoreline of the property, does not exceed a total area of 2,000 square feet over surface waters. Such a structure:

1. Shall not accommodate the mooring of more than two vessels, either in the water or on a boat lift. Solely for purposes of this general permit, up to two personal watercraft as defined in section 327.02(33), F.S., may be moored in lieu of either or both allowable vessels of another type. These limits shall not apply to the mooring, storage or other use of the dock or pier by:

a. Non-motor-powered vessels less than 16 feet in length that are stored on or under the dock or pier, or within an authorized mooring area; or

b. Personal watercraft, dinghies or similar small vessels that are stowed out of the water, upon a larger parent vessel that is moored at the dock in compliance with this general permit.

2. Shall be located such that all areas used for vessel mooring and navigational access already provide a minimum depth of two feet below the mean low water level for tidal waters, or two feet below the expected average low water depth for non-tidal waters as determined based on best available information for the water body at the project location; and

3. May include a roof over the vessel mooring areas, boat lifts, and terminal platform, or any portions thereof, subject to the applicable provisions of chapters 253 and 258, F.S., and the rules adopted thereunder. Portions of such roofs that overhang beyond the edge of decked portions of the pier or dock shall be included in the calculation of the total square footage of over-water structure allowed under paragraph (1)(a), above.

(b) A public fishing pier that does not exceed a total area of 2,000 square feet provided the structure is designed and built to

discourage boat mooring by elevating the fishing pier to a minimum height of five feet above mean high water or ordinary high water, surrounding the pier with handrails, and installing and maintaining signs that state "No Boat Mooring Allowed."

(2) This general permit shall be subject to the following specific conditions:

(a) Construction or extension of the boat lift, boat mooring locations, or terminal platform, shall not occur over submerged grassbeds, coral communities or wetlands. However, the access walkway portion of the pier may traverse these resources provided it is elevated a minimum of five feet above mean high water or ordinary high water, contains handrails that are maintained in such a manner as to prevent use of the access walkways for boat mooring or access, and does not exceed a width of six feet, or a width of four feet in Aquatic Preserves;

(b) There shall be no structures enclosed by walls, screens, or doors on any side;

(c) The dock or pier will not facilitate vessel rentals, charters, or serve any other commercial purpose;

(d) There shall be no fish cleaning facilities, boat repair facilities or equipment, or fueling facilities on the structures authorized by this general permit. In addition, no overboard discharges of trash, human or animal waste, or fuel shall occur from any structures authorized by this general permit;

(e) This general permit shall not authorize the construction or extension of more than one dock or pier per parcel of land or individual lot. For the purposes of this general permit, multi-family living complexes shall be treated as one parcel of property regardless of the legal division of ownership or control of the associated property; and

(f) Notwithstanding any other provisions of this general permit, the design, construction and operation of the dock or pier and associated vessels shall not conflict with any manatee protection plan approved and adopted under section 379.2431(2)(t), F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.427, Amended 10-1-13, 6-1-18.

62-330.428 General Permit for Floating Vessel Platforms and Floating Boat Lifts.

A general permit is granted to the owner of an individual, detached, private single-family residence to construct, alter, operate, maintain, and remove floating vessel platforms or floating boat lifts ("platforms or lifts") at their residence, under the following conditions:

(1) Platforms and lifts are authorized only at a dock or along a seawall associated with an individual, detached, private single-family residence on the contiguous uplands. For purposes of this general permit, an individual, detached, single-family residence does not include duplexes, triplexes or quadruplexes.

(2) The dock or seawall must meet one of the following:

(a) It was built prior to July 1, 1975;

(b) It complies with a permit issued under chapter 403, F.S., or part IV of chapter 373, F.S., or

(c) It was built in accordance with an exemption under section 403.813(1), F.S.

(3) The platforms and lifts:

(a) Shall not be located within an aquatic preserve as designated and described in chapter 258, F.S., or within federally designated critical habitat for Johnson's seagrass (*Halophila johnsonii*);

(b) Shall be limited in size as follows:

1. If built in artificial waters and residential canal systems, the platforms and lifts must not cumulatively exceed 1,000 square feet. "Cumulatively" means either alone or in combination with any other platforms or lifts along the person's shoreline.

2. If built within Outstanding Florida Waters, the platforms or lifts must not cumulatively exceed 300 square feet along the person's shoreline.

3. If built in waters other than those listed above, the platforms and lifts must not cumulatively exceed 675 square feet along the person's shoreline.

(c) Shall not be located over submerged grassbeds, attached macroalgae, coral communities, or wetlands;

(d) Shall be used solely for the purpose of storing a vessel or vessels, such that the vessel or vessels are stored out of the water at all times when not in use;

(e) Shall not be added to structures or located in areas where boat mooring is specifically prohibited under a permit issued under either chapter 403, or part IV of chapter 373, F.S., or an authorization under chapter 253 or 258, F.S.; and,

(4) If located within submerged lands owned by the Board of Trustees of the Internal Improvement Trust Fund, the following

additional conditions must also be met to qualify for consent to use and occupy such lands under chapter 253, F.S.

(a) The platforms and lifts must be installed, operated and maintained in conformance with all the applicable terms and conditions of subsections 18-21.004(3) and (7), F.A.C., (March 12, 2012), and rule 18-21.0041, F.A.C. (March 23, 2012);

(b) The platforms and lifts must not extend more than 25 percent into the width of the waterway, as measured from approximate mean high water to approximate mean high water in tidal waters, or from approximate ordinary high water to approximate ordinary high water in non-tidal waters;

(c) Platforms and lifts located on any lands under the jurisdiction or management of the Department's Division of Recreation and Parks must have prior written approval by the Division of Recreation and Parks, and such approval must be submitted with the notice to use this general permit.

Rulemaking Authority 373.026(7), 373.043, 373.044, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1), 403.813(1), 403.814(1) FS. Law Implemented 253.04, 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.813(1), 403.814(1) FS. History–New 8-4-05, Formerly 62-341.428, Amended 10-1-13.

62-330.431 General Permit for Installation of Riprap.

(1) A general permit is granted to any person to install riprap:

(a) At the toe of an existing vertical seawall, provided the slope of the riprap is no steeper than two horizontal to one vertical and the horizontal distance from the toe of the seawall is no more than 10 feet;

(b) At an individual, private residential single-family property that is not part of a larger plan of common development, provided:

1. The slope of the riprap is no steeper than two horizontal to one vertical, and the toe of the riprap is no more than 10 feet waterward of the existing mean high water line or approximate ordinary high water line;

2. Riprap is not placed along a length of shoreline of more than 100 linear feet, and is not combined as part of any other use of this general permit on the same parcel of land; and

3. Erosion has occurred, or is likely to occur, along the shoreline.

(2) This general permit shall be subject to the following specific conditions:

(a) The riprap consists only of natural boulders or clean concrete rubble one to three feet in diameter in average dimension, and there are no reinforcing rods or other similar protrusions in the concrete rubble;

(b) There is no filling of submerged grassbeds or coral communities;

(c) The amount of wetland area filled shall not exceed 100 square feet; and,

(d) There is no backfilling to obtain useable upland, to straighten an otherwise sinuous shoreline, or to reclaim land lost by avulsion or erosion.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.431, Amended 10-1-13, 6-1-18.

62-330.437 General Permit for Installation of Fences.

A general permit is granted to install, maintain, or remove a fence in wetlands or other surface waters under all of the following conditions:

(1) The fence shall not be located on state-owned submerged lands or in Outstanding Florida Waters, Aquatic Preserves, Outstanding National Resource Waters, Class II waters, or waters approved, conditionally approved, restricted, or conditionally restricted by the Department of Agriculture and Consumer Services for shellfish harvesting.

(2) Fences installed within navigable waters other than isolated waters that are wholly owned by one private entity shall:

(a) Not adversely affect navigation, block any waterway or channel, or cause a navigational hazard;

(b) Be installed such that all fence posts located waterward of the mean or ordinary high water line rise at least two feet above the mean high water or the ordinary high water elevation and are marked and maintained with reflectors visible from all directions; and

(c) Extend no more than 25 feet waterward into the open water, beyond the shoreline, or riparian areas of emergent wetland vegetation, whichever is more waterward.

(3) The fence shall be constructed of horizontal metal wire attached to posts, which may include occasional perpendicular wires

to maintain spacing, but shall not include any chain-link or other mesh components.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.437, Amended 10-1-13, 6-1-18.

62-330.439 General Permit for Construction or Maintenance of Culverted Driveway or Roadway Crossings, and Bridges of Artificial Waterways.

(1) A general permit is granted to any person for the purpose of constructing or maintaining a culverted driveway or roadway crossing, or bridge of an artificial waterway, provided:

(a) This general permit shall apply only to wholly artificial, non-navigable drainage conveyances;

(b) A culvert or culverts shall be placed under the roadway or driveway;

(c) The size and number of the culvert(s) shall be adequate to pass normal high water stages of the artificial water body being crossed. In no instance shall the culvert(s) provide a smaller cross-sectional area or hydraulic capacity than any upstream culvert;

(d) The elevation of the culvert invert shall be at the existing bottom grade of the artificial waterway;

(e) The length of the driveway, roadway or bridge crossing the waterway shall not exceed 50 feet top of bank to top of bank;

(f) The top width of the driveway, roadway, or bridge shall not exceed 75 feet, the toe to toe width shall not exceed 100 feet, and the side slopes shall not be steeper than two horizontal to one vertical; and,

(g) The maintenance of the roadway, driveway or bridge shall continue to provide at least the same volume of discharge through the culvert(s).

(2) If dewatering or channel flow diversion is performed, temporary fill dikes and dewatering discharges shall be installed and constructed so that no upstream flooding or impoundment occurs. Any temporary works shall be completely removed and all areas upstream and downstream from the crossing shall be restored to grades, elevations, and conditions existing before construction.

(3) This general permit shall apply only to a maximum of two crossings on a given parcel of property, with a minimum distance of 500 feet between crossings.

(4) This general permit shall not apply if relocation of all or part of the artificial waterway is required.

(5) This general permit does not authorize any road construction or alteration connecting to a crossing.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 10-3-95, Formerly 62-341.439, Amended 10-1-13.

62-330.441 Noticed General Permit for Public Navigation Channel and Canal Infrastructure by the West Coast Inland Navigation District within Lee County.

(1) A general permit is hereby granted to the West Coast Inland Navigation District ("WCIND") to dredge public navigation channels and canals within the trafficsheds and secondary channel systems listed in Table 1 and shown in Figures 1 through 48 of Antonini, Gustavo A., Robert A. Swett, and David Fann, 2008, Maps of Lee County Noticed General Permit Trafficshed Channels and Secondary Channels, SGEF-173, Florida Sea Grant College Program, Gainesville, Florida (30 October 2008), which is hereby incorporated by reference. Additional information on the background, methodology, and data used in identifying the trafficsheds and secondary channel systems that are the subject of this general permit is described in the following reports:

(a) Antonini, Gustavo A, and Paul Box, 1996, A Regional Waterway Systems Management Strategy for Southwest Florida, TP-83, Florida Sea Grant College Program, Gainesville, Florida;

(b) Swett, Robert A., David A. Fann, Gustavo A. Antonini and Lana Carlin Alexander, 2000, Regional Waterway Management System for Lee County, Phase I, TD-3, Florida Sea Grant College Program, Gainesville, Florida;

(c) Swett, Robert A., David A. Fann, Gustavo A. Antonini and Lana Carlin Alexander, 2001, Regional Waterway Management System for Lee County, Phase 2, TD-4, Florida Sea Grant College Program, Gainesville, Florida;

(d) Fann, D.A., R.A. Swett, and G.A. Antonini, 2002. Regional Waterway Management System for Lee County, Phase 3. TD-5, University of Florida, Gainesville, FL: 21 Florida Sea Grant.

Copies of the above documents may be obtained by contacting environmental resource permit program staff in the Department's South District Office (Fort Myers) and from the Department's Internet site at http://www.dep.state.fl.us/legal/Rules/rulelistnum.htm. This general permit is not required for maintenance dredging that qualifies for an exemption under section 403.813(1)(f), F.S.

(2) This general permit is further limited as follows:

(a) For purposes of this general permit, the term "public navigation channels and canals" shall consist of the Intracoastal Waterway and those trafficsheds and secondary channel systems identified on the maps in SGEF-173, which have been determined by the WCIND Board to make a significant contribution to public boating traffic.

(b) The area to be dredged shall not contain any living communities of true stony coral (order Scleractinia), hydrocoral (order Milleporina), octocoral (subclass Octocorallia), or soft coral (Alcynoacea, Gorgonacea and Pennatulacea), sponge beds (Porifera), oyster bars (Crassostrea spp.), or macroalgae of the family Caulerpaceae. This shall not prevent dredging of incidental individual specimens of corals, sponges, or oysters. To the extent individual or clumped oysters, corals, or sponges are to be dredged, they shall be relocated to the maximum extent practicable in accordance with paragraph (3)(c), of this general permit. In addition, the dredging alignments shall be located so as to not adversely affect coral and sponge communities and oyster bars as a result of sloughing of channel side slopes. Seagrass within the proposed dredged area shall be relocated in accordance with paragraph (3)(c), of this general permit.

(c) To the maximum extent practicable, dredging alignments shall follow existing channels and previously dredged areas and avoid and minimize impacts to seagrass communities (Potamogetonaceae, Hydrocharitaceae and Cymodoceae sp.). Dredging alignments also shall be located to minimize the potential for erosion to adjacent seagrass communities as a result of sloughing of channel side slopes.

(d)1. The "No Internal Combustion Motor Zones" (NICMZs) shown and described in the attached Exhibit A, which reflect the boundaries approved in Resolution 07-09-49 of the Lee County Board of County Commissioners on September 25, 2007, are hereby established by this general permit. Within these NICMZs, the use of electric motors is permitted, but operators of all vessels equipped with internal combustion motors (e.g.: gasoline or diesel motors) for propulsion must turn off the internal combustion motor and, if possible to do so, tilt or raise the internal combustion motor out of the water.

2. Prior to any dredging authorized by this general permit within an Aquatic Preserve, WCIND shall demonstrate that the NICMZ(s) within that aquatic preserve have been established and marked in the field. Nothing in this rule shall be construed to relieve WCIND from obtaining sign permits required by the Florida Fish and Wildlife Conservation Commission (FWC). For this purpose, DEP authorizes WCIND to apply to FWC for all required sign permits to mark the boundaries of the NICMZs established by this general permit. WCIND shall be responsible for installing and maintaining all permitted signs.

3. WCIND will design and implement a program to monitor seagrasses within the NICMZs using various scientifically approved methods after consultation with DEP and FWC staff. The monitoring shall be designed to establish the baseline coverage of seagrasses by species, the number and coverage of prop scarring, and document any change in coverage over time. At a minimum, the first monitoring will occur within 90 days after the boundaries of the NICMZs have been marked with signage as provided in the preceding section of this general permit, and thereafter every two years for a total of ten years. The monitoring plan shall include metrics that can be used to quantitatively establish the relative success or failure of seagrass restoration and protection following establishment of the NICMZs.

(e) Dredging alignments shall not exceed the maximum depths shown in Table 1. All dredging alignments shall not exceed a maximum top width of 30 feet and a maximum bottom width of 20 feet. Overdredging to achieve the final authorized depth and width is not allowed. An as-built survey of the dredging alignment shall be submitted to the Department as provided in paragraph (3)(h), below.

(f) No more than 8,500 cubic yards of dredged material shall be cumulatively removed through authorizations by this general permit over a five-year period within each trafficshed or secondary channel system, beginning with the first project authorized under this general permit within the trafficshed or secondary channel system. Within 30 days following the completion of the as-built survey required in paragraphs (2)(e), above, and (3)(h), below, a report shall be submitted to the South District office of the Department that includes the volume of material excavated from each channel and canal within the trafficshed or secondary channel system, and the cumulative total volume of material excavated for the trafficshed or secondary channel system under this general permit within the previous five years. This report shall be included with any subsequent notices to dredge channels or canals within the same trafficshed or secondary channel system.

(g) The dredging activity is restricted to Class III Waters, or Class II Waters that are classified by the Department of Agriculture and Consumer Services under chapter 62R-7, F.A.C., as unclassified, prohibited, restricted, or conditionally approved for shellfish harvesting.

(h) This general permit shall not apply to dredging within the limits of areas subject to currently valid individual ERP dredging permits.

(3) All work under this general permit shall be conducted in conformance with the general conditions of rule 62-341.215, F.A.C., and the following specific conditions.

(a) Each dredging event for a trafficshed or secondary channel system shall require a separate notice to use this general permit. Multiple areas within a single trafficshed or secondary channel system may be included in one notice. Each notice shall be submitted with the following:

1. Scaled plan and cross-sectional drawings that clearly identify the length, width, and depth (referenced to mean lower low water) of the area or areas to be dredged within each channel and canal; locations of any hydraulic pipelines between the dredge areas and the dredged material disposal sites; and identification of the channels, canals, and names of the trafficsheds or secondary channel system that are to be dredged from Table 1.

2. Identification of the source document described in subsection 1 and reference data that specifically describe the work proposed for dredging within the trafficshed or secondary channel system. All document titles, page numbers, figures, and other relevant information to the trafficshed or secondary channel system must be identified.

3. The location, dimensions, and estimated volumes of dredged material disposal sites, including the location of any water quality or habitat restoration as described in paragraph (3)(d), of this general permit and any relocation areas required under paragraph (2)(b), of this general permit. If dredged material fill will be transported over water by barge, the notice will include assurance that the barge will be designed and sized to prevent discharge of dredged material runoff, prop or hull dredging, and discharge during the loading and unloading of material. If stockpile areas are to be used for temporary disposal and transport, the type and volume capacity of such stockpile areas, including controls that will be used to prevent dredge material runoff also must be described. The notice must provide assurance any temporary stockpile areas will have no impacts to jurisdictional wetlands or surface waters.

4. The estimated volume of each proposed dredging area.

5. Identification of any special water classifications for the areas to be dredged, such as the water class (rule 62-302.400, F.A.C.); shellfish classification under chapter 62R-7, F.A.C.; Aquatic Preserve, state park, or state recreation area designation under chapter 258, F.S.; and Outstanding Florida Water or Outstanding National Resource Water designation under rule 62-302.700, F.A.C.

6. A resource inventory of the dredging alignments which has been prepared or updated between May through September within one year prior to the proposed dredging. The resource inventory must be conducted by an individual experienced and knowledgeable in benthic communities and seagrass identification. The resource inventory must identify the presence and location of seagrasses, oysters, coral communities, sponge beds, and macroalgae of the family Caulerpaceae. This resource inventory must also include all areas within any requested mixing zones associated with the dredging project (including outfall pipes from the dredge material disposal area), and all areas that will be occupied by dredging equipment (including cables, pipelines, dredges, barges, and stockpiling/disposal of dredged material). The resource inventory assessment within channels will be conducted as follows, although the WCIND may use equivalent assessment methods upon receiving prior written approval from the Department:

a. The assessment will be conducted along a minimum of two transects within the dredging alignment. The transects will be along a line parallel with and 5 feet within the sides of the dredging alignment;

b. The resource inventory assessment within any requested mixing zones shall be conducted along grid transects every 10 feet throughout the length and width of the requested mixing zone; and,

c. The resource inventory shall be qualitative in nature but shall include identification and location of corals, sponges, and oysters to be relocated pursuant to paragraph (2)(b), of this general permit, and include general identification and location of the extent of seagrass areas and a qualitative description of their relative extent of coverage, and density. The resource inventory shall be completed and submitted a minimum of 30 days prior to the pre-application meeting required by paragraph (3)(b), of this general permit.

7. Identification of the extent and location of all previous dredging within the past five years authorized pursuant to this noticed general permit within the trafficshed or secondary channel system; the date of all such dredging events; the estimated cubic yards excavated from each distinct portion of the trafficshed or secondary channel system pursuant to this general permit; and the permit numbers assigned to such prior use of this general permit for the trafficshed or secondary channel system.

8. The estimated date the dredging activities are planned to begin and the estimated length of time it will take to complete the project. If the project will be accomplished in phases, the estimated starting and ending date of each phase must also be submitted.

9. A plan for monitoring water quality minimally consisting of monitoring at the dredge site, at the location of any waters receiving outfall from dredged material disposal sites, and at background and down-gradient locations in the water body where dredging is occurring and surrounding the dredged material disposal sites. The monitoring shall be designed primarily to measure in-situ turbidity, but is subject to modification based on the pre-application meeting discussion with the Department to ensure the plan is capable of detecting any potential water quality violations from the work. If the dredge area is in close proximity to a facility or location likely to cause a discharge of toxic materials, the water quality monitoring as well as best management practices proposed shall be designed to contain deleterious substances during dredging. Results of the monitoring and a copy of the logs shall be submitted in accordance with the provisions in paragraph (3)(f), of this general permit.

10. A description of the resources to be relocated pursuant to paragraphs (2)(b) and (3)(c), of this general permit, the methods to be used for their relocation, and the locations to which they will be relocated.

(b) A minimum of 30 days prior to submittal of a notice to use this general permit, the WCIND and Lee County shall conduct at least one pre-application meeting with the South District Department Environmental Resources Permitting staff to discuss project designs, implementation details, and any resource concerns, including approval of any resource relocation in accordance with paragraph (2)(b), of this general permit or water quality or habitat restoration sites in accordance with paragraph (3)(d), of this general permit. For a proposed project within an aquatic preserve, this meeting shall include the appropriate aquatic preserve manager or their designee. In the event the pre-application meeting adequately addresses all Department questions or concerns, the Department will inform the WCIND that the notice may be submitted immediately for review.

(c) To the extent seagrass, corals, sponges or clumped oysters are within the dredging footprint, they shall be relocated to the maximum extent practicable. Seagrass, oysters, corals, and sponges must be relocated only into areas previously approved in writing by the Department. Relocation shall be done in a manner that avoids adverse impacts to water quality and adjacent submerged resources. If seagrasses are relocated, the donor site within the dredge area and the recipient location of the seagrass transplant shall be described in the application and in the pre-application meeting required under paragraph (3)(b), of this general permit. Any relocation performed pursuant to this paragraph shall be described in a detailed report to the South District office of the Department within 60 days of project completion. The report shall describe the methods used, the donor site within the dredge area, and the recipient location of the transplant. The WCIND shall provide copies to the South District office of the Department of any follow up monitoring or studies performed on the success of the transplants.

(d) All dredged material resulting from the activities authorized by this general permit shall be removed and deposited on a self-contained, upland dredged material disposal site. The only exceptions to the use of a self-contained, upland dredged material disposal site shall be: seagrass, oyster, coral, or sponge relocations as required by this general permit; or where dredged materials are to be used as part of a water quality or habitat restoration plan authorized by the Department or a water management district under part IV of chapter 373, F.S., in which case any discharge of dredged material shall be in compliance with all terms of that authorization. In all cases, the dredging operation, the discharge of dredged material, and the dredged material disposal site shall be designed, located, and operated such that there are no water quality violations in wetlands or other surface waters outside of a mixing zone established under paragraph (3)(e), of this general permit.

(e) In areas outside of aquatic preserves, violations of state water quality standards shall be prevented immediately outside of a mixing zone of no more than 150 meters in radius from the dredge site and from any discharge point associated with a dredge material disposal area. To the greatest extent practicable, the mixing zone shall be restricted to the limits of the dredging alignment. Within aquatic preserves, violations of state water quality standards immediately outside the area of active work shall be prevented. This shall minimally consist of the use of erosion and sediment control devices, turbidity curtains or similar devices, and other best management practices, all of which shall be located immediately surrounding the area of active work and maintained in a functional condition. In addition, dredge pumping rates and volumes shall be managed to minimize discharges from dredged material disposal sites; and the management of dredged material disposal site dikes, berms, and water control structures so as to minimize erosion, breaches, and discharges. In all cases, mixing zones shall be designed to avoid living communities of stony corals [true stony corals (order Scleractinia) hydrocorals (order Milleporina)], and octocorals (subclass Octocorallia), sponge bed communities (Porifera), oyster bars (Crassostrea spp.), macroalgae of the family Caulerpaceae, and seagrass (Potamogetaceae, Hydrocharitaceae and Cymodoceae).

(f) At all times during active dredging, the collection, analysis, and monitoring of the water quality samples required under this general permit must be conducted and performed by individuals who have prior training and experience in collecting and analyzing water quality samples using the Standard Operating Procedures accessible at the Department’s Internet site and in accordance with

chapter 62-160, F.A.C. Such qualified individual(s) shall be on site at all times necessary to ensure full compliance with the requirements of this noticed general permit. In the event the water quality monitoring required under this general permit detects violations of state water quality standards, dredging shall cease immediately until the source of the violation is identified, measures taken to avoid future violations, and the receiving waters again meet applicable water quality standards. Weekly reports describing the hours of dredging accomplished and the results of the required monitoring will be provided to the South District office of the Department. Any violations of state water quality standards and/or other requirements of this noticed general permit shall be immediately reported to the South District office of the Department.

(g) The permittee shall be responsible for ensuring that all contractors and other entities implementing this general permit comply with the following standard manatee and marine turtle conditions:

1. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel shall be responsible for observing water-related activities for the presence of manatees.

2. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act of 1978. If the dredging activity results in any manatee being harmed, harassed, or killed as a result of construction activities, the Department will refer the matter to the Florida Fish and Wildlife Conservation Commission (FWC) for appropriate action.

3. Siltation barriers shall be made of material in which manatees and turtles cannot become entangled, shall be properly secured, and shall be monitored regularly to avoid manatee entrapment. Barriers associated with any activities authorized by this general permit shall not block manatee entry to or exit from manatee feeding areas and the following manatee warm water refuge areas:

a. Entrance of the Chiquita Canal (which provides access to the Eight Lakes area) within the Cape Coral Southwest Trafficshed.

b. The defined manatee protection speed zone within the Franklin Locks East Trafficshed and all waters of the Caloosahatchee River within 1/4 mile east of the easternmost end of the Franklin Lock & Dam.

c. Matlacha channel (which provides access to the Matlacha Isles canal system) including the Matlacha Isles canal system in the vicinity of the Boat Lift within the Matlacha Isles/Cape Coral (northwest) Trafficshed.

d. Mouth and remainder of the Orange River within the Orange River Trafficshed.

e. All waters within the Mullock Creek Trafficshed.

4. All vessels associated with the project shall operate at “no wake idle” speeds at all times while in water where the draft of the vessel provides less than four-foot clearance from the bottom, and such vessels shall follow routes of deep water whenever possible.

5. If a manatee is sighted within 100 yards of the project area, precautions shall be implemented by the permittee and the contractor to ensure protection of manatees. These precautions shall include not operating any equipment closer than 50 feet to a manatee, and immediately shutting down equipment if a manatee comes within 50 feet of the equipment. Activities will not resume until the manatees have departed the project area of their own volition.

6. Any collision with or injury to a manatee or marine turtle shall be reported immediately to the FWC at 1(888)404-FWCC (1(888)404-3922)).

7. Temporary signs concerning manatees shall be posted prior to and during dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least three feet by four feet which reads “Caution: Manatee Area” shall be posted in a location prominently visible to water-related construction crews. A second sign shall be posted if vessels are associated with the construction, and shall be placed visible to the vessel operator. The second sign shall be at least 8 inches by 11 inches and read: Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of the operation. A collision with or injury to a manatee shall be reported immediately to the FWC at 1(888)404-FWCC (1(888)404-3922)). Specific information on obtaining these signs may be obtained by contacting the FWC.

8. Specific personnel shall be designated as manatee observers. The designated observer(s) shall be dedicated only for this task, must be on site during all in-water dredging activities, and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. The observer(s) shall wear polarized sunglasses during all dredging to aid in observation, and shall work in shifts of no longer than 5 hours each. Observers shall maintain a log detailing manatee sightings, work stoppages, and other protected species-related incidents. If approved by the Department after consultation with the FWC, the

WCIND shall be allowed to implement alternative measures for observing for the presence of manatees when such measures provide reasonable assurance that manatees will not be adversely affected by the alternative methodology.

9. A report, summarizing all activities noted in the observer logs, the location and name of project, and the dates and times of work shall be submitted within 30 days following project completion, to the FWC's Imperiled Species Management Section at: 620 South Meridian Street, 6A, Tallahassee, Florida 32399-1600, or emailed at fcmpmail@myfwc.com.

10. No nighttime mechanical dredging, such as clamshell, shall occur. Movement of a work barge or other associated vessels shall not be performed after sunset, when the possibility of spotting manatees is negligible.

11. All channels designated as Cape Coral Southwest, Franklin Locks East, Matlacha Isles/Cape Coral (northwest), Mullock Creek, and Orange River shall be prohibited from being dredged between November 15th and March 31st of any year due to the high numbers of manatees present at these warm water refuges in the wintertime. When these areas are being dredged between April 1st and November 14th, the manatee protection measures outlined above for all other channel dredging shall be followed.

(h) An as-built survey shall be initiated within two weeks and shall be completed within 60 days after completion of dredging to document depths and widths established by the dredging. The Department shall grant additional time as reasonable to complete the survey upon submittal of written documentation of the existence of inclement weather or situations beyond the control of the permittee that prevented the timely completion of the survey, the submittal of a new timeline for completing the survey.

(i) Within 90 days of completion of each authorized dredge event under this general permit, the affected trafficshed or secondary channel system shall be marked along its entire length with aids to navigation. Markers shall be placed in a manner to facilitate safe navigation and protection of submerged natural resources. In channels dredged to less than 4 foot MLLW depth, signage that identifies areas of shallow water shall be installed, using language such as "Controlling Depth 3 feet, Local Knowledge Required," "Use Caution," or "Stay in Channel." Nothing in this rule shall be construed to relieve the WCIND from obtaining permits for markers and signs required by the FWC.

(j) WCIND shall provide an as-built report and survey detailing all work performed under this authorization and its compliance with the conditions and criteria of this general permit.

(k) All reports and information required by this authorization shall be submitted to the South District DEP office.

(l) WCIND will facilitate an update of the *Lee County Boaters Guide* to reflect the NICMZs established by this general permit. The update will also include computer internet links to additional boater information that will enhance water quality and protection of resources within the aquatic preserves that are the subject of this general permit. WCIND will facilitate the distribution of the updated Boaters Guide to local marinas, commercial boat rental operations, and local residents.

(m) Works under this general permit shall not commence until the Department has provided written confirmation within 30 days that the notice required under paragraph (3)(a), meets all the applicable terms and conditions of this general permit.

(4) WCIND is advised that, pursuant to Section 556.105, F.S., excavating contractors are required to provide certain information concerning the excavation through the one-call notification system not less than two, nor more than five, business days before beginning any excavation.

(5) A Letter of Consent is granted in accordance with subparagraphs 18-21.005(1)(c)10., 15. and 16., F.A.C., by the Board of Trustees of the Internal Improvement Trust Fund (BOT), for the West Coast Inland Navigation District to enter upon and use state-owned submerged lands to the extent necessary to complete the permitted activities. A Letter of Consent also is granted in accordance with subparagraphs 18-21.005(1)(c)15. and 16., F.A.C., from the BOT to Lee County and the West Coast Inland Navigation District to establish, mark, and enforce the NICMZs depicted in Exhibit A.

(6) In accordance with section 253.77, F.S., dredged material removed from sovereign submerged lands under this general permit is exempt from the payment of severed dredged material fees. However, dredged material with economic value, such as beach quality sand, shall be used for public purposes to the maximum extent practicable.

Table 1. Trafficsheds, Secondary Channel Systems, Dredge Depth Limits, and Trafficshed Report Identification Numbers

Trafficshed or Secondary Channel System Name	NGP Dredge Depth (ft)	All Channels Length (ft)	Public Channel Length (ft)	Anticipated NGP Dredge Length (ft)	Public Channel Length in AP (ft)	Anticipated Dredge Length in AP (ft)	Anticipated Dredge Length Outside AP (ft)	Anticipated Dredge Length in AP Sea Grass (ft)	Anticipated Dredge Length in Any Sea Grass (ft)
Back Channel-South Estero Bay	3	18,252	18,252	178	18,252	178	0	0	
Big Carlos Pass & Vicinity	4.5	9,354	9,354	0	8,082	0	0	0	

Trafficshed or Secondary Channel System Name	NGP Dredge Depth (ft)	All Channels Length (ft)	Public Channel Length (ft)	Anticipated NGP Dredge Length (ft)	Public Channel Length in AP (ft)	Anticipated Dredge Length in AP (ft)	Anticipated Dredge Length Outside AP (ft)	Anticipated Dredge Length in AP Sea Grass (ft)	Anticipated Dredge Length in Any Sea Grass (ft)
Bokeelia (east)	4.5	33,027	8,499	535	6,227	450	86	0	0
Bokeelia (west)	3.5	48,391	13,807	1,982	13,807	1,982	0	68	68
Caloosa Isle Marina	5.0	28,326	8,343	2,539	0	0	2,539	0	
Cape Coral Southwest	6.0	359,431	10,603	1,521	0	0	1,521	0	
Central Estero Bay	2.5	18,437	18,437	385	18,437	385	0	0	
Chantry Canal	4.5	76,137	11,315	458	0	0	458	0	
Compass Rose	4.5	1,172	1,172	0	97	0	0	0	
Deep Lagoon	6.0	37,861	9,242	491	0	0	491	0	
Demere Key	3.5	21,647	19,721	1,052	18,927	896	156	735	735
East Fort Myers	7.0	26,534	2,588	1,622	0	0	1,622	0	
Estero Island-Bayside Channels	4.5	11,955	11,955	853	0	0	853	0	
Everest Canal	5.0	124,094	4,928	2,494	0	0	2,494	0	
Fish Tale Marina	4.0	7,391	1,849	0	305	0	0	0	
Fish Trap Bay 2	2.5	8,893	3,213	520	3,213	520	0	0	
Fort Myers Yacht Basin	7.0	7,941	7,941	4,987	0	0	4,987	0	
Franklin Locks East	5.0	38,843	2,478	1,405	0	0	1,405	0	
Getaway	5.0	2,604	2,604	1,066	0	0	1,066	0	191
Hancock Creek	5.0	57,956	26,613	2,778	0	0	2,778	0	
Hogue	4.0	3,115	3,115	345	3,115	345	0	0	
Hurricane Bay East	4.5	8,602	8,602	917	8,474	917	0	0	
Hurricane Bay West	5.0	8,750	8,750	1,369	0	0	1,369	0	
Imperial River-Lower	3.5	31,336	15,203	661	9,225	661	0	0	
Imperial River-Upper	2.5	37,630	9,913	713	0	0	713	0	
Imperial Shores	2.5	15,526	4,106	1,685	4,106	1,685	0	0	
Marsh Point	3.0	17,783	5,729	1,201	0	0	1,201	0	
Matanzas Harbor	5.5	5,103	5,103	66	0	0	66	0	
Matlacha (northwest)	4.5	26,245	1,457	654	1,457	654	0	0	
Matlacha (southwest 2)	3.5	10,670	2,719	180	2,719	180	0	0	
Matlacha Isles/Cape Coral (northwest)	4.0	265,603	14,057	1,729	8,399	1,550	257	0	
Mullock Creek	2.5	42,168	11,374	2,099	10,161	2,099	0	0	
Normandy Canal	5.0	33,982	11,878	4,068	0	0	4,068	0	
North Matlacha	4.5	62,864	62,864	84	62,864	84	0	0	
Orange River	6.5	46,750	3,595	100	0	0	100	0	
Pelican Landing	2.5	3,992	3,992	1,169	3,992	1,169	0	0	
Plato Canal	5.5	109,235	18,520	5,487	0	0	5,487	0	
Punta Rassa/Connie Mack Island	5.0	28,784	14,869	4,084	0	0	4,084	0	103
Redfish Point	6.0	33,806	13,023	4,436	0	0	4,436	0	
Rookery Trace	3.5	8,496	8,496	1,028	1,621	819	231	0	
Roosevelt Channel-Bayside	3.0	2,249	1,509	0	1,292	0	0	0	
Roosevelt Channel-North	5.0	27,369	17,918	694	17,918	694	0	0	
Saint James City (east)	5.0	23,006	16,137	3,266	0	0	3,266	0	
Saint James City (south 1)	5.0	52,518	18,385	6,531	5,459	502	6,030	252	252

Trafficshed or Secondary Channel System Name	NGP Dredge Depth (ft)	All Channels Length (ft)	Public Channel Length (ft)	Anticipated NGP Dredge Length (ft)	Public Channel Length in AP (ft)	Anticipated Dredge Length in AP (ft)	Anticipated Dredge Length Outside AP (ft)	Anticipated Dredge Length in AP Sea Grass (ft)	Anticipated Dredge Length in Any Sea Grass (ft)
Siesta Isles	5.0	17,962	1,088	713	0	0	713	0	
South Estero Bay	4.0	27,694	27,694	327	27,694	327	0	0	
South Matlacha	3.5	71,465	71,465	889	28,408	381	508	381	381
Sunset Bay	2.5	2,681	2,440	376	2,440	376	0	0	

The Central Estero Bay No Internal Combustion Motor Zone is described from a point of beginning at N26.3989° W81.8664° (generally east of the South Estero Bay Channel marker presently numbered G13) [POB] continuing generally south-southeast to the east of the marked navigation channel approximately 7215 feet to a point at N26.3803° W81.8589° (generally east of the South Estero Bay Channel marker presently numbered G29) [2]; thence continuing north of the marked navigation channel in a northeasterly direction approximately 4000 feet to a point at N26.3873° W81.8495° (generally west of the Southern Passage Channel marker presently numbered G19) [3]; thence generally north approximately 240 feet to N26.3879° W81.8495° [4]; thence generally northwest approximately 1300 feet to N26.3908° W81.8519° [5]; thence generally north-northwest approximately 2080 feet to N26.3962° W81.8540° [6]; thence generally northwest approximately 1950 feet to N26.4002° W81.8579° [7]; thence due west to the shoreline of Davis Key and following said shoreline to the western end at N26.3992° W81.8658° [8]; thence continuing generally south of west approximately 230 feet to the point of beginning.

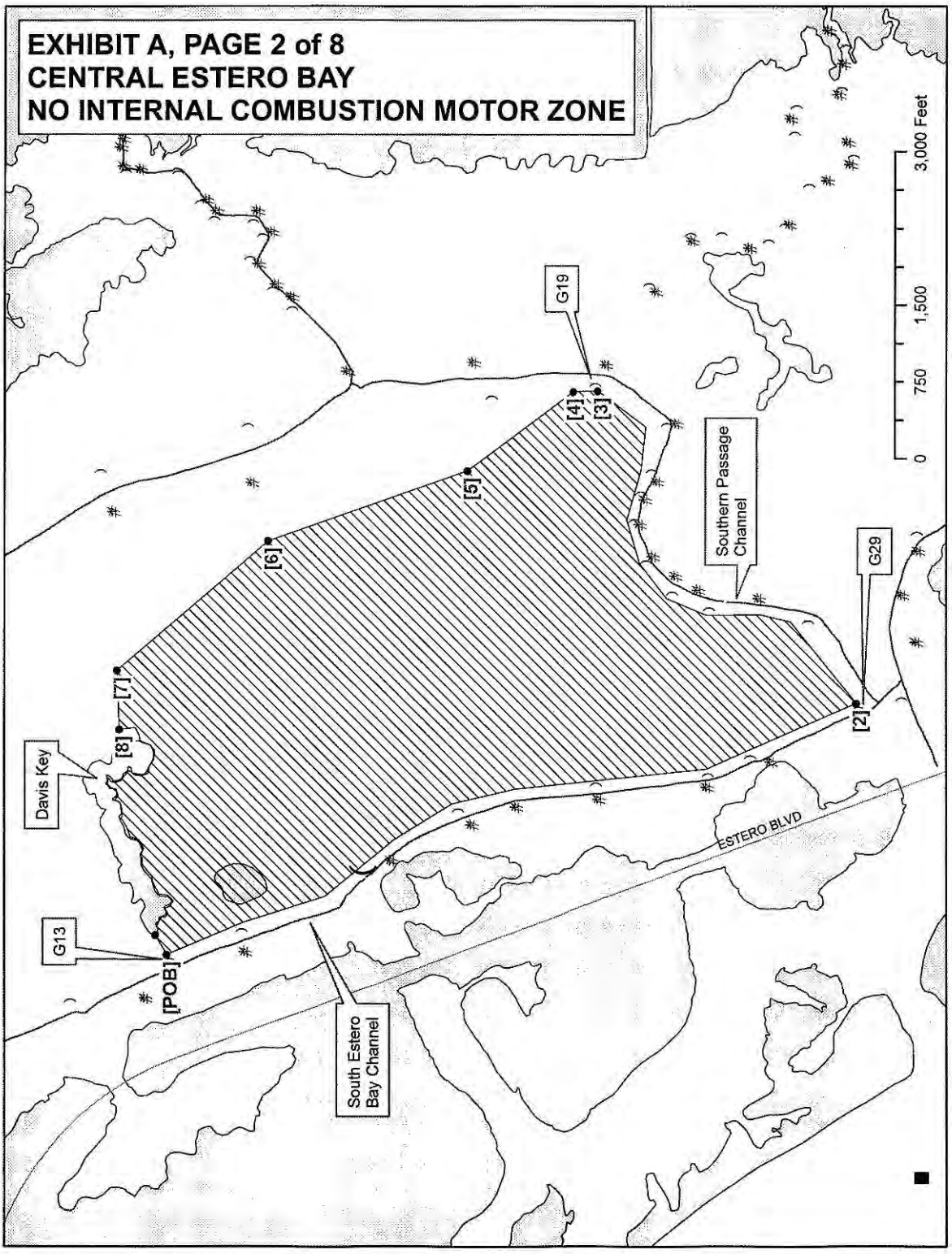


EXHIBIT A, PAGE 2 of 8
CENTRAL ESTERO BAY
NO INTERNAL COMBUSTION MOTOR ZONE
3,000 Feet
1,500
750
0
G19
[4]
[3]
[5]
[6]
[7]
[8]
Southern Passage Channel
G29
[2]
Davis Key
ESTERO BLVD
G13
[POB]
South Estero Bay Channel

The Big Carlos No Internal Combustion Motor Zone is described from a point of beginning at Goombs Point N26.4092° W81.8655° [POB] continuing generally northwest along the mangrove shoreline to a point at N26.4122° W81.8688° [2]; thence continuing generally northwest approximately 120 feet to the shoreline of an unnamed mangrove island at N26.4124° W81.8690° [3]; thence continuing along the shoreline of said island to a point at N26.4158° W81.8721° [4]; thence continuing generally northwest approximately 266 feet to the shoreline of an unnamed mangrove island at N26.4162° W81.8727° [5]; thence continuing along the shoreline of said island to a point at N26.4179° W81.8757° [6]; thence continuing generally southwest approximately 834 feet to a point at N26.4160° W81.8773° [7]; thence continuing generally south approximately 2615 feet to a point at N26.4089° W81.8778° [8]; thence continuing generally east approximately 605 feet to a point at N26.4087° W81.8760° [9]; thence continuing generally south of east approximately 688 feet to a point at N26.4079° W81.8740° [10]; thence continuing generally southeast approximately 570 feet to a point at N26.4070° W81.8726° [11]; thence continuing generally south of east approximately 613 feet to a point at N26.4066° W81.8708° [12]; thence continuing generally east approximately 913 feet to a point at N26.4066° W81.8680° [13]; thence continuing generally north of east approximately 680 feet to a point at N26.4075° W81.8662° [14]; thence continuing generally northeast approximately 390 feet to a point at N26.4084° W81.8655° [15]; thence continuing generally north approximately 314 feet to the point of beginning.

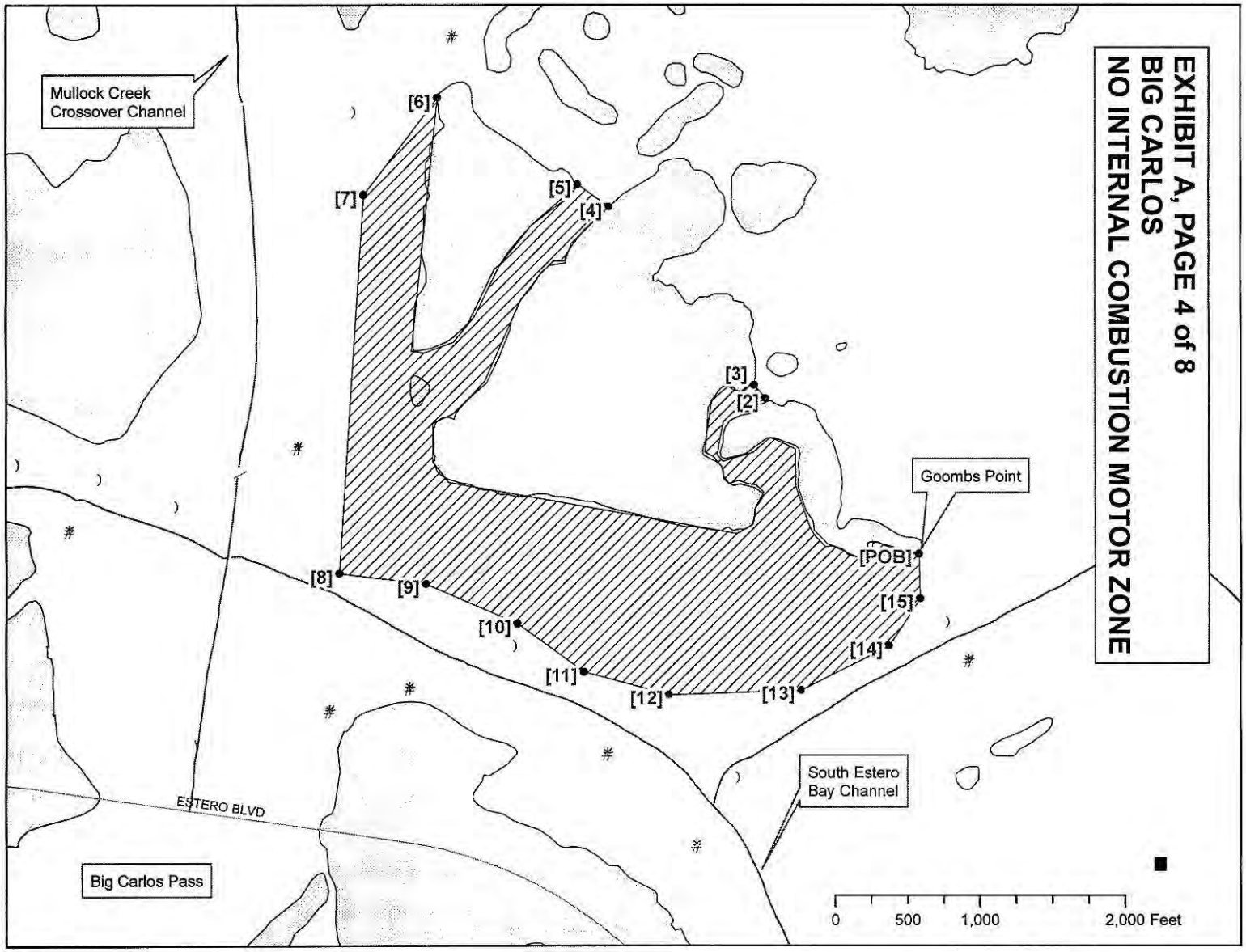
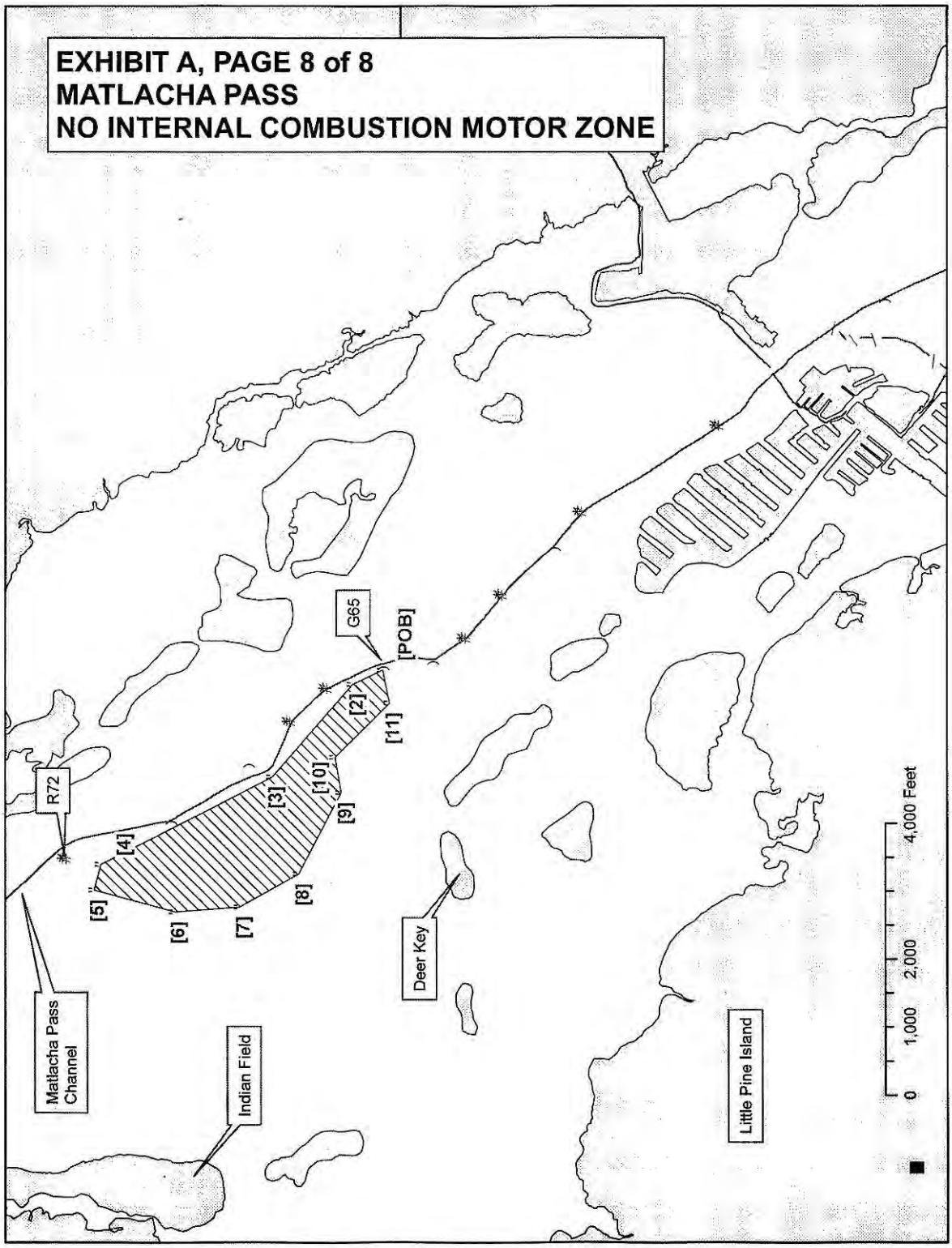


EXHIBIT A, PAGE 4 of 8
BIG CARLOS
NO INTERNAL COMBUSTION MOTOR ZONE
Mullock Creek
Crossover Channel
[6]
[7]
[5]
[4]
[3]
[2]
Goombs Point
[POB]
[8]
[9]
[15]
[10]
[14]
[11]
[12]
[13]
South Estero
Bay Channel
ESTERO BLVD
Big Carlos Pass
0
500
1,000
2,000 Feet

The Jug Creek Shoals No Internal Combustion Motor Zone encompasses a portion of Jug Creek Shoals more specifically described from a point of beginning at N26.7128° W82.1802° (generally southwest of the Jug Creek Shoal Channel marker presently numbered G11) [POB]; thence continuing generally southwest approximately 602 feet to a point at N26.7113° W82.1811° [2]; thence continuing generally southwest approximately 1369 feet to a point at N26.7089° W82.1843° [3]; thence continuing generally southwest approximately 3862 feet to a point at N26.7014° W82.1926° [4]; thence continuing generally southwest approximately 908 feet to a point at N26.6994° W82.1943° [5]; thence continuing generally southwest approximately 1201 feet to a point at N26.6968° W82.1966° [6]; thence continuing generally west- southwest approximately 2144 feet to a point at N26.6952° W82.2029° [7]; thence continuing generally west-northwest approximately 918 feet to a point at N26.6959° W82.2056° [8]; thence continuing generally northwest approximately 571 feet to a point at N26.6971° W82.2067° [9]; thence continuing generally north-northeast approximately 1110 feet to a point at N26.7001° W82.2058° [10]; thence continuing generally northeast approximately 946 feet to a point at N26.7018° W82.2036° [11]; thence continuing generally northeast approximately 876 feet to a point at N26.7030° W82.2013° [12]; thence continuing generally northeast approximately 963 feet to a point at N26.7050° W82.1994° [13]; thence continuing generally northeast approximately 884 feet to a point at N26.7071° W82.1980° [14]; thence continuing generally northeast approximately 893 feet to a point at N26.7089° W82.1962° [15]; thence continuing generally northeast approximately 588 feet to a point at N26.7100° W82.1948° [16]; thence continuing generally northeast approximately 715 feet to a point at N26.7111° W82.1930° [17]; thence continuing generally northeast approximately 1017 feet to a point at N26.7127° W82.1905° [18]; thence continuing generally east approximately 375 feet to a point at N26.7129° W82.1893° [19]; thence continuing generally northeast approximately 553 feet to a point at N26.7136° W82.1879° [20]; thence continuing generally east-northeast approximately 1188 feet to a point at N26.7145° W82.1844° [21]; thence continuing generally east approximately 653 feet to a point at N26.7145° W82.1824° [22]; thence continuing generally east-southeast approximately 741 feet to a point at N26.7139° W82.1802° [23]; thence continuing generally south approximately 393 feet to the point of beginning.

EXHIBIT A, PAGE 6 of 8
JUG CREEK SHOALS
NO INTERNAL COMBUSTION MOTOR ZONE
STRINGFELLOW RD
MAIN ST
Matlacha Pass Channel
G11
[POB]
[23]
[22]
[2]
[3]
[20]
[19]
[17]
[16]
[15]
[14]
[13]
[12]
[11]
[10]
[9]
[8]
[7]
[6]
[5]
[4]
Jug Creek Shoal Channel
Jug Creek Channel
Bocilla Island
Patricio Island
0
1,500
3,000
6,000 Feet

The Matlacha Pass No Internal Combustion Motor Zone encompasses an area specifically described from a point of beginning at N26.6490° W82.0819° (generally west of the Matlacha Pass Channel marker presently numbered G65) [POB]; thence continuing generally north-northwest approximately 492 feet to a point at N26.6502° W82.0826° [2]; thence continuing generally northwest approximately 1809 feet to a point at N26.6535° W82.0868° [3]; thence continuing generally north-northwest approximately 2826 feet to a point at N26.6604° W82.0907° [4]; thence continuing generally north of west approximately 389 feet to a point at N26.6607° W82.0919° [5]; thence continuing generally south-southwest approximately 1223 feet to a point at N26.6574° W82.0928° [6]; thence continuing generally east of south approximately 958 feet to a point at N26.6548° W82.0926° [7]; thence continuing generally southeast approximately 1000 feet to a point at N26.6524° W82.0911° [8]; thence continuing generally east-southeast approximately 1350 feet to a point at N26.6507° W82.0875° [9]; thence continuing generally north of east approximately 532 feet to a point at N26.6509° W82.0859° [10]; thence continuing generally southeast approximately 1127 feet to a point at N26.6487° W82.0834° [11]; thence continuing generally north of east approximately 501 feet to the point of beginning.



Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.414(9), 373.418, 403.805(1), 403.814(1) FS. Law Implemented 253.002, 253.77(1), 253.77(4), 258.42, 373.118(1), 373.406(5), 373.413, 373.414(1), 373.414(1)(b), 373.414(9), 373.416, 373.426, 403.061(34), 403.813(3),

403.814(1) FS. History–New 2-18-10, Formerly 62-341.494, Transferred to 62-330.412.

62-330.443 General Permit to the Florida Department of Transportation, Counties, and Municipalities for Minor Bridge Alteration, Placement, Replacement, Removal, Maintenance, and Operation.

(1) A general permit is granted to the Florida Department of Transportation, counties, and municipalities to conduct the activities described below:

(a) For existing maintained roadways and causeways, the alteration, placement, replacement, removal, modification, or maintenance of bridges or bridge culverts and approaches where the combined total of dredging and filling, both temporary and permanent, in wetlands and other surface waters does not exceed 0.5 acre. The total work conducted under notices of intent to use this general permit shall result in the creation of no more than 0.5 acre of new overwater structure for any bridge crossing, including parallel spans, and no new structure area over waters within federally designated critical habitat of Johnson's seagrass (*Halophila johnsonii*).

(b) Channel clearing and shaping, not to exceed a combined total of 0.5 acre of dredging and filling in wetlands and other surface waters, to facilitate maximum hydraulic efficiency of the structures detailed in paragraph (a), above, where the spoil material is used on an upland portion of the project or is deposited on a self-contained, upland spoil site. Escape of spoil material or water from the spoil deposition area into wetlands or other surface waters is prohibited.

(2) This general permit shall be subject to the following specific conditions:

(a) No dredging of access or work channels is authorized by this general permit;

(b) Temporary fill roads shall not be constructed waterward of mean high water or ordinary high water;

(c) All fill placed in wetlands, other than fill on which a bridge or approach is constructed, shall be regraded to the original wetland elevations and revegetated with native wetland species endemic to adjoining, undisturbed wetlands, within seven days of completion of construction. Within "clear zones," revegetation shall be with native herbaceous species endemic to adjoining, undisturbed wetlands. During the five-year period following the initial planting or restoration of the site, these areas shall be maintained to ensure planted or naturally recruited native wetland species are surviving and growing, and that the areal coverage of exotic and invasive species constitutes less than 10% areal coverage;

(d) Hydraulic openings of bridges shall be sufficient to prevent downstream scour, increased downstream water velocities, and increased flood elevations on the property of others;

(e) Minimum horizontal and vertical navigational clearances on bridges over navigable waters of the United States shall be established in accordance with procedures outlined in Chapter 2 of the U.S. Coast Guard Bridge Administration Manual, COMDTINST M16590.5C, (March 26, 2004), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03150), a copy of which may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C, and in no circumstance shall placement or replacement of a bridge result in a reduction of horizontal and vertical navigational clearances;

(f) Replacement or modification of a bridge that includes changes in the configuration of the bridge and fill areas due to changes in materials, construction techniques, or meeting current construction codes or safety standards are authorized under this permit. Any connecting road expansion or alteration associated with such replacement or modification must be authorized by a separate general or individual permit under chapter 62-330, F.A.C., as applicable, before the start of construction; and

(g) This general permit does not authorize the construction of additional travel lanes for motorized vehicles, except that any single-lane bridge may be widened to two travel lanes, provided the bridge widening does not exceed that reasonably necessary to match the existing travel lane alignment of a two-lane road. This permit does not authorize new corridors or roadway connections where there is no existing structure over wetlands or waterways.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.419, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.443, Amended 10-1-13, 6-1-18.

62-330.447 General Permit to the Florida Department of Transportation, Counties, and Municipalities for Minor Activities within Existing Rights-of-Way or Easements.

(1) A general permit is granted to the Florida Department of Transportation, counties, and municipalities to conduct the activities described below.

(a) The extension of existing culverts and crossing approaches that are authorized under a separate permit or exemption under part IV of chapter 373, F.S., as applicable, to accommodate widening of the roadway where excavation or deposition of material shall not exceed 1,000 cubic yards in wetlands and other surface waters and the area from which material is excavated or to which material is deposited shall not exceed a total of 0.25 acre at any one culverted crossing. The 1,000 cubic yardage limitation shall be separately applied to excavation and deposition of material.

(b) Relocation, recontouring, widening, or reconstruction of existing highway drainage ditches through uplands provided the floor elevation of the ditch is not deepened below the original design elevation and provided that the work does not cause a change in the hydrology of any wetlands which are connected to or which are adjacent to the ditch.

(c) Culvert placement, replacement, and maintenance associated with existing roadways, provided that construction does not cause scour in the downstream waters or increase the velocity of the water downstream, does not reduce existing flood conveyance of the stream for the 100-year flood flow and does not reduce existing flood storage within the 10-year flood plain. The material excavated or deposited as fill shall not exceed 1,000 cubic yards in wetlands and other surface waters. The cross sectional area of the culvert shall not be reduced, unless the reduced cross section provides an equal or greater discharge capability. In the case of a culvert replacement as a wildlife crossing, the cross sectional area shall not be reduced.

(d) Construction of temporary bypass lanes and stream channel diversions necessary to complete projects detailed in paragraph (c), above, provided the area used for the temporary bypass lanes and temporary diversion is restored to its previous contours and elevations.

(e) Channel clearing and shaping, not to exceed a combined total of 0.5 acre of dredging and filling in wetlands and other surface waters, to facilitate maximum hydraulic efficiency of structures authorized by paragraph (c), above, where the spoil material is used on an upland portion of the project or is deposited on a self-contained, upland spoil site. Escape of spoil material and return water from the spoil deposition area into wetlands or other surface waters is prohibited.

(f) Ditch or canal bank and bottom stabilization necessary to repair erosion damage to restore previously existing ditch configurations. Authorized repair methods are placement of riprap, sand cement toe walls, clean fill material, poured concrete, geotechnical textiles and other similar stabilization materials. The placement of riprap or other lining materials shall be limited to a length of 500 feet along the axis of the ditch or canal. This general permit shall not be applicable within one-quarter mile along the length of an area, within the same ditch, which has been stabilized under this general permit within a three-year period.

(g) Roadway safety activities, such as installation of shoulders, sidewalks, guard rails, signs, poles, and mast arms within an existing right-of-way that incur no more dredging or filling than 500 square feet per activity, provided the total impact to wetlands or other surface waters does not involve more than 0.5 acre.

(2) This general permit shall be subject to the following specific conditions:

(a) The permittee shall limit stream channel relocation to streams which have an average discharge of 10 cubic feet per second or less. The length of relocated channels or those significantly altered shall be limited to 200 feet per stream. A stream channel shall be altered only when such a measure will reduce the long term adverse water quality impacts and will maintain or restore the stream's natural hydraulic capability; and

(b) This general permit shall not apply to ditch construction in Class I or Class II surface waters, Outstanding National Resource Waters or waters designated as Outstanding Florida Waters.

(c) Activities under this general permit must not diminish existing stormwater treatment, attenuation, or conveyance capacity.

(d) This general permit does not authorize the construction of additional traffic lanes. Activities that require additional traffic lanes must first obtain an individual environmental resource permit under this chapter, as applicable, before the start of construction.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.419, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.447, Amended 10-1-13, 6-1-18.

62-330.448 General Permit to Counties and Municipalities to Pave Existing County or Municipally Owned and Maintained Roads, including the Repair and Replacement of Bridges that are Part of the Roadway.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.414(9), 373.4145, 373.418, 403.805(1), 403.813(1)(t) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.414(9), 373.4145, 373.416, 373.418, 373.419, 403.813(1)(t) FS. History–New 2-22-07, Amended 10-1-07, Formerly 62-341.448, Repealed 10-1-13.

62-330.449 General Permit for Construction, Operation, Maintenance, Alteration, Abandonment or Removal of Airport Airside Stormwater Management Systems.

(1) A general permit is granted to the owner of a public or private airport or military airbase for the construction, alteration, abandonment, removal, operation, and maintenance of stormwater management systems that serve permanently-paved airside activities, which, for the purposes of this rule, are defined as those components of an airport, airbase, or runway used for aircraft taxiing, landing, takeoff, loading, unloading, service materials storage and service equipment parking.

(2) The stormwater management systems shall be:

(a) Designed such that the stormwater nutrient loading does not exceed the stormwater nutrient loading from natural vegetative communities. The calculation of such loadings shall be done using the methodology and data set forth in the *Statewide Airport Stormwater Best Management Practices Manual*, ("Airside BMP Manual") Florida Department of Transportation-Aviation Office (April 27, 2013), incorporated by reference herein (pages 1-63: http://www.flrules.org/Gateway/reference.asp?No=Ref-03183, pages 64-Appendix L: http://www.flrules.org/Gateway/reference.asp?No=Ref-03184). A copy may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.

(b) Constructed, altered, operated, and maintained such that the runoff from airside activities drains directly to pervious areas that employ one or more of the following applicable structural Best Management Practices (BMPs):

1. Overland flow, as described in Section 605.a. of the Airside BMP Manual.

2. Dry retention basin, as described in Section 605.b. of the Airside BMP Manual.

3. Swales, as described in Section 605.c. of the Airside BMP Manual.

(c) This general permit is only authorized for use where post development site conditions comply with the criteria set forth above.

(3) The projects in subsection (2), above, must also be constructed, operated, and maintained to comply with the following design criteria and performance standards:

(a) There shall be no dredging or filling in wetlands or other surface waters other than those within existing stormwater management systems.

(b) Discharges cannot adversely affect the conveyance capacity of receiving waters, and cannot increase flooding of off-site property or to property not owned by the permittee, based on the design storm specified for the site locale.

(4) Stormwater management systems serving airside areas that consist of underdrains, wet detention systems, other retention methods, and/or alternative treatment systems do not qualify for authorization under this general permit.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.118(6), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), (6), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 10-1-13, Amended 6-1-18.

62-330.450 General Permit for Construction, Alteration, and Operation of Urban Infill and Redevelopment Activities in Conformance with the Conceptual Approval Permit in Rule 62-330.055, F.A.C.

A general permit is issued that authorizes construction, alteration, operation, and maintenance of urban infill and redevelopment projects contemplated by a conceptual approval permit issued under rule 62-330.055, F.A.C., provided all the following conditions are met:

(1) The activities must be within an urban infill and redevelopment area or a community redevelopment area created under chapter 163, F.S., where a conceptual approval permit has been issued under rule 62-330.055, F.A.C.

(2) The notice of intent to use this general permit must include one set of construction plans and calculations prepared by a registered professional that:

(a) Depict all stormwater management features, all existing and proposed impervious areas, all existing and proposed pervious areas, and the land uses within the site of the proposed activities.

(b) Demonstrate a reduction of loading of pollutants, as identified in the conceptual approval permit, under the existing and proposed conditions at the site of the proposed activities.

(c) Constitute a design consistent with the terms and conditions of the conceptual approval permit, including an identification of the owner and operator of the stormwater management systems, and a demonstration of acceptance of such responsibility by that owner or operator.

(d) Identify the specific location within the urban infill and redevelopment or community redevelopment area where activities are proposed, including any areas within or connected to the development area that have been or will be set-aside for preservation, or

where construction otherwise is not to occur.

(3) The Agency shall have 30 days upon receipt of the notice to respond as to whether the plans and calculations are in substantial compliance with the conceptual approval permit. If they are, construction of that portion of the site addressed by those plans may commence. If the Agency determines that the plans and calculations are not in substantial compliance with the conceptual approval permit, the Agency shall, within 30 days of receipt of the notice, inform the applicant of the inconsistencies, the measures needed to address those inconsistencies, and that verification of qualification to use the general permit is denied without prejudice. The applicant may resubmit a notice to use this general permit once those inconsistencies have been addressed. Construction of the projects that are the subject of the original notice shall not commence until the permittee has resubmitted a revised notice and obtained verification that the activities qualify for the general permit.

(4) Construction must be performed in compliance with the terms and conditions of the conceptual approval permit.

(5) As part of reviewing the qualification to use this general permit, the Agency will verify the number of debits that must be made to the ledger of target pollutant loads (mass per acre) if the activities included in the notice are constructed, and will debit that amount from the master ledger approved in the conceptual approval permit.

(6) Within 30 days of completion of construction, the registered professional shall submit certification that construction was completed in substantial conformance with the plans and calculations that were submitted in the verified qualification to use this general permit.

(7) This general permit authorizes construction of the above authorized projects within a duration of five years from verification of qualification; operation and maintenance of the authorized system shall be the responsibility of the owner and operator for the life of the project or activity.

(8) Unless the conditions of subsection 62-330.055(6), F.A.C. have been met, this general permit cannot be used to construct roads, parking areas, buildings, and other structures on areas where work in wetlands and other surface waters requires an individual permit under this chapter, or on lands served by a stormwater management system authorized by the individual permit.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.118(6), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), (6), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 10-1-13, Amended 6-1-18.

62-330.451 General Permit to Counties, Municipalities, and other Agencies to Conduct Stormwater Retrofit Activities.

(1) A general permit is granted to counties, municipalities, state agencies and water management districts to construct, operate, and maintain stormwater retrofit activities as authorized below for improving existing surface water and stormwater systems. This general permit may be used in conjunction with exempt activities.

(2) Types of stormwater retrofit activities authorized under this general permit are:

(a) Construction or alteration that will add additional treatment or attenuation capacity and capability to an existing stormwater management system;

(b) The modification, reconstruction, or relocation of an existing stormwater management system or stormwater discharge facility;

(c) Stabilization of eroding banks, and installation of structures such as gabions to limit bank erosion; or

(d) Excavation or dredging to remove sediments or other pollutants that have accumulated in existing surface waters as a result of stormwater runoff and stormwater discharges, provided the material removed is not deposited in existing wetlands or other surface waters.

(3) Stormwater retrofit activities shall not:

(a) Be proposed or implemented for the purpose of providing the water quality treatment or flood control needed to serve new development or redevelopment; or

(b) Include a dam that has more than 50 acre-feet of storage capacity if the dam is more than five feet high, nor a dam having a height of ten or more feet, regardless of storage capacity. Height is measured from the top of the dam to the natural bed of the stream or watercourse at the downward toe of the dam, or from the lowest elevation of the outside limit of the dam to the maximum elevation of the dam.

(4) There is no limit to the acreage of stormwater retrofit activities in artificial waters. Work in wetlands and non-artificial surface waters shall be limited to no more than 0.5 acre.

(5) A stormwater quality retrofit activity must result in at least one of the following:

(a) Addition of treatment capacity to an existing stormwater management system such that it reduces stormwater pollutant

loadings to receiving waters;

(b) Addition of treatment or attenuation capability to an existing developed area when either the existing stormwater management system or the developed area has substandard stormwater treatment or attenuation capabilities, compared to what would be required for a new system requiring a permit under part IV of chapter 373, F.S.; or

(c) Removal of pollutants generated by, or resulting from, previous stormwater discharges.

(6) A water quantity retrofit project proposed to reduce existing flooding problems must be designed in such a way that the project does not:

(a) Result in a net reduction in water quality treatment provided by the existing stormwater management system; nor

(b) Increase discharges of untreated stormwater entering receiving waters.

(7) The project must be designed, constructed, and implemented as a complete, stand-alone project within the construction phase duration of a general permit, and such that it will not at any time during its construction or operation:

(a) Cause or contribute to any water quality violations;

(b) Contribute to any existing violation if it discharges pollutants into waters where existing ambient water quality does not meet water quality standards for those pollutants. In such a case, the project must include measures that will cause a net improvement in the receiving waters for those pollutants in accordance with section 373.414(1)(b)3., F.S.;

(c) Adversely affect the value of functions provided to fish and wildlife by wetlands or other surface waters;

(d) Adversely affect the hydroperiod of wetlands on adjacent lands or the hydroperiod of other wetlands upstream, downstream, or adjoining to the work area under subsection (4), above;

(e) Cause or contribute to increased flooding of adjacent lands or cause new adverse water quantity impacts to receiving waters;

(f) Add or increase any chemical treatment;

(g) Be operated by pumps or other mechanical or adjustable features; nor

(h) Adversely impact the maintenance of surface or ground water levels or surface water flows established pursuant to section 373.042, F.S.

(8) The entity conducting this general permit must conduct at least one pre-notice meeting with Agency staff having responsibility for the review of the proposed activities. The notice required in rule 62-330.402, F.A.C., shall include materials reflecting the recommendations of the Agency discussed during that meeting, and demonstrating compliance with the above, including a certification by a registered professional that the proposed activity will meet the criteria specified above. Such certification shall include appropriate design analyses, pollutant loading analyses, modeling and other engineering calculations, drawings, specifications and other information to support, describe, verify, and document the registered professional's certification.

(9) Nothing in this general permit will preclude a county or municipality from obtaining and implementing a Basin Management Action Plan with water quality credits for activities performed under this authorization.

(10) Within 30 days after completion of construction, a registered professional shall submit certification that construction was completed in substantial conformance with the plans and calculations that were submitted in the notice to use this general permit.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.118(6), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), (6), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 10-1-13, Amended 6-1-18.

62-330.453 General Permit for Installation, Maintenance, Repair, and Removal of Utility Lines.

(1) A general permit is granted for the installation, maintenance, repair, and removal of underground utility lines, cable, conduit, or pipeline transmitting electricity, communication signals, potable water, raw water, reclaimed water, domestic wastewater, propane gas or natural gas.

(2) For the purposes of this general permit:

(a) "Directional drilling" means the linear or curvilinear excavation of a tunnel or conduit, in any direction, through the use of drilling equipment that can change direction during excavation; this also includes borehole reaming and pulling following primary drilling.

(b) "Jack-and-bore" means the linear, primarily lateral excavation of a tunnel, typically between excavated subgrade pits, through use of drilling equipment and encasement which is advanced under mechanical force, and includes similar methods commonly termed as "microtunneling."

(c) "Frac-out" means any release of drilling fluid or slurry which results in above-grade discharge of drilling fluid or slurry or significant loss of such fluid or slurry into the surrounding parent material.

(3) This general permit is limited as follows:

(a) No work occurs within Outstanding Florida Waters, Aquatic Preserves, or Class I waters.

(b) The installation of conduit or pipeline to drain wetlands or other surface waters is not authorized.

(c) Prior to work, existing pipelines shall be evacuated of substances which, if released, could result in a violation of state water quality standards.

(d) The maximum width of the disturbed corridor in wetlands shall not exceed 30 feet.

(e) The total area of forested wetland disturbance shall not exceed 0.5 acre per ten miles of cable, conduit, or pipeline.

(f) Minor above-grade improvements may be constructed in uplands under this general permit, but shall be limited to vents, valves, meter assemblies, relays, junction boxes, pads or similar structures that are directly connected to the utility line, do not create discharges, and which cumulatively comprise no more than 100 square feet of impervious surfaces per mile of utility line.

(g) Installation, maintenance, repair, and removal activities performed via trenching or methods other than directional drilling or jack-and-bore, are subject to the following special conditions:

1. The maximum width of the excavated trench shall not exceed eight feet, with temporary spoil storage banks not to exceed ten feet in width;

2. For a trench with a top width greater than three feet in herbaceous wetlands, the upper layer of the soil horizon shall initially be scraped and segregated into a spoil bank that is separated from the spoil bank resulting from the excavation of the trench for the utility line. The upper layer of the soil horizon shall be replaced as the last step of restored grades to facilitate natural revegetation;

3. Trenching in surface waters shall be limited to wetlands, artificial waters, and residential canal systems; and

4. Temporary spoil banks shall contain breaches that prevent impoundment or restriction of surface water flows;

(h) Installation, maintenance, repair, and removal conducted using directional drilling or jack-and-bore methods are subject to the following special conditions:

1. The maximum outside diameter of the cable, conduit or pipeline, including encasement, shall not exceed 30 inches.

2. A minimum depth of cover, equal to the greater of either five feet, or five times the maximum encased diameter of the utility line to be installed, shall be maintained between the top of the utility line and casing and the soil surface or submerged bottom of any wetland or waterbody being crossed.

3. All work areas associated with directional drilling or jack-and-bore activities, including entrance and exit pits, drill rigs, tanks, pumps, drilling fluid mixing and settling pits, dewatering systems and staging areas for pipe, cables, and drill string, shall be located within uplands.

4. The use of drilling fluids shall not cause or contribute to a violation of state ground water quality criteria or standards, as defined in chapter 62-520, F.A.C.

5. The permittee shall, at least 48 hours prior to commencement of any directional drilling or jack-and-bore activities, submit to the agency the name, as registered with the Florida Department of State, and all-hours telephone contact information of all contractors responsible for drilling and for containment and cleanup in the event of a drilling fluid frac-out or spill.

6. The contractor shall, at all times during directional drilling activities, maintain appropriate equipment and materials in a readily-accessible location and condition, to effectively contain and clean up a drilling fluid frac-out or spill.

7. The permittee or the permittee's contractor shall, at all times during directional drilling activities, ensure that appropriately-trained personnel monitor downhole equipment position, drilling fluid circulation and pressures, and actively monitor the entire utility line route for surface frac-out of drilling fluids.

8. Drilling activities shall be discontinued and the drilling fluid or slurry shall be contained using appropriate methods as soon as possible, in the event of a drilling fluid frac-out or spill. Removal of drilling fluid or slurry from wetlands and other surface waters shall be initiated and completed in the most expeditious manner practicable. Removed drilling fluid shall be contained or disposed of in an appropriate upland location. Any frac-out or spill of drilling fluid into wetlands or other surface waters shall be reported to Agency staff within 24 hours following detection of the spill or frac-out.

(i) Utilities must be located a minimum of 14 feet below the authorized depth of a federal navigation channel.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.453, Amended 10-1-13, 6-1-18.

62-330.455 General Permit for the Construction of Aerial Pipeline, Cable, and Conduit Crossings of Certain Waters.

(1) A general permit is granted to construct an aerial or piling-supported pipeline, cable, or conduit crossing of a waterbody having a width of no greater than 25 feet, provided:

(a) The crossing is not located in, on, or over Class I waters, Class II waters, or waters approved, conditionally approved, restricted, or conditionally restricted by the Department of Agriculture and Consumer Services for shellfish harvesting if the pipeline or conduit conveys petroleum, domestic wastewater, phosphate matrix slurry, phosphatic clay or sand tailings, recirculated water from beneficiation processes, or other substances which, if leaked, could contaminate drinking water supplies or result in closure of shellfish harvesting waters;

(b) No pipeline, cable, or conduit shall be lower than existing crossings of the waterbody;

(c) Work to install the aerial crossing shall be restricted to a width of no more than thirty feet on each side of the crossing alignment. In cases where multiple pipes, cables or conduits are to be installed along the same alignment the thirty-foot width shall commence from the outermost pipes, cables or conduits. For the purposes of this general permit, no more than three pipes shall be placed along a given alignment, and in no case shall the total disturbance area exceed 75 feet in width; and,

(d) The Agency shall be notified within 24 hours of any leak or failure of any of the pipes associated with the aerial crossing.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.455, Amended 10-1-13.

62-330.457 General Permit for Subaqueous Utility Crossings of Artificial Waterways.

(1) A general permit is granted to any person constructing, repairing or replacing a subaqueous utility crossing of artificial waters and residential canal systems, provided:

(a) The crossing is not located in Class I waters, Class II waters or waters approved, conditionally approved, restricted, or conditionally restricted by the Department of Agriculture and Consumer Services for shellfish harvesting if the utility line conveys petroleum, domestic wastewater, phosphate matrix slurry, phosphatic clay or sand tailings, recirculated water from beneficiation processes, or other substances which, if leaked, could contaminate drinking water supplies or result in closure of shellfish harvesting waters;

(b) The crossing shall be limited to non-navigable watercourses or to those waterways in which navigation can be maintained at all times without the necessity of constructing temporary berms, dikes, or dams, or removing or relocating turbidity control devices to allow boat passage. Customary navigation through the waterway shall be maintained at all times during installation;

(c) No dredging or filling shall be conducted in wetlands or other surface waters, located landward of the top of the banks of the waterway. Dredging and back filling of littoral zones and wetland vegetation growing on the side slopes of the artificial waterway is authorized as necessary to install the subaqueous utility line crossing;

(d) The maximum length of the utility crossing shall not exceed 150 feet from top of bank to top of bank. Excavated trench dimensions shall be limited to a depth of not more than ten feet below existing bottom contours and a trench top width of not more than ten feet;

(e) The maximum width of the area disturbed by equipment during construction shall be no more than 30 feet wide;

(f) Temporary or permanent spoil disposal sites shall be located exclusively on uplands and shall be sited, designed, and managed to have the capacity to retain all dredged material; and

(g) All previously excavated contours are restored with onsite native backfill, coarse sand, or clean, non-toxic rock bedding or cap material, as appropriate, within 72 hours following installation of the utility line.

(2) Installation, maintenance, repair, and removal conducted using directional drilling or jack-and-bore methods under this general permit are subject to the following special conditions:

(a) The maximum outside diameter of the cable, conduit, or pipeline, including encasement, shall not exceed 30 inches.

(b) A minimum depth of cover, equal to the greater of either five feet, or five times the maximum encased diameter of the utility line to be installed, shall be maintained between the top of the utility line and casing and the soil surface or submerged bottom of any wetland or waterbody being crossed.

(c) All work areas associated with directional drilling or jack-and-bore activities, including entrance and exit pits, drill rigs, tanks, pumps, drilling fluid mixing and settling pits, dewatering systems and staging areas for pipe, cables, and drill string, shall be located within uplands.

(d) The use of drilling fluids shall not cause or contribute to a violation of state ground water quality criteria or standards, as defined in chapter 62-520, F.A.C.

(e) At least 48 hours prior to commencement of any directional drilling or jack-and-bore activities, the permittee shall submit to the agency the name, as registered with the Florida Department of State, and all-hours telephone contact information of all contractors responsible for drilling and for containment and cleanup in the event of a drilling fluid frac-out or spill.

(f) The permittee or the contractor shall, at all times during directional drilling activities, maintain appropriate equipment and materials in a readily-accessible location and condition, to effectively contain and clean up a drilling fluid frac-out or spill.

(g) The permittee or the permittee's contractor shall, at all times during directional drilling activities, ensure that appropriately-trained personnel monitor downhole equipment position, drilling fluid circulation and pressures, and actively monitor the entire utility line route for surface frac-out of drilling fluids.

(h) In the event of a drilling fluid frac-out or spill, drilling activities shall be discontinued and the drilling fluid or slurry shall be contained using appropriate methods as soon as possible. Removal of drilling fluid or slurry from wetlands and other surface waters shall be initiated and completed in the most expeditious manner practicable. Removed drilling fluid shall be contained or disposed of in an appropriate upland location. Any frac-out or spill of drilling fluid into wetlands or other surface waters shall be reported to Agency staff within 24 hours following detection of the spill or frac-out.

(3) Utilities must be located a minimum of 14 feet below the authorized depth of a federal navigation channel.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 10-3-95, Formerly 62-341.457, Amended 10-1-13, 6-1-18.

62-330.458 General Permit for the Construction and Maintenance of Electric Power Lines by Electric Utilities.

(1) A general permit is provided in Section 403.814(6), F.S., for the construction of power lines and electrical support structures by electric utilities. Terms used in this general permit shall have the meanings specified below:

(a) "Access areas" shall mean areas which are cleared to allow equipment to reach existing electrical structures or the proposed location of electrical structures;

(b) "Existing facilities" shall mean existing power lines, substations or power plants;

(c) "Impact site" shall mean that portion of a wetland area within the right-of-way either surrounded by uplands within the right-of-way or lying between upland segments of the right-of-way within which clearing of vegetation to the ground is proposed to occur;

(d) "Power line" shall mean the conductors, supporting structures, and related hardware installed or maintained by electric utilities as defined in section 366.02(2), F.S.;

(e) "Project" shall mean the proposed or existing power line for which use of the general permit is proposed;

(f) "Selective clearing" shall mean the cutting or control of vegetation by hand, herbicide, or mechanized equipment that minimizes soil compaction, to a height no lower than the water level at the time of cutting or ground level in areas without standing water. This would include removal of the cut trees from the wetland in cases where leaving the trees would preclude revegetation or impound water flow. This shall not mean the non-selective aerial or broadcast application of herbicides;

(g) "Siting board" means the Governor and Cabinet as provided in section 403.503(8), F.S.;

(h) "Work areas" shall mean areas surrounding the electrical support structures, towers, poles, and guy wires which must be cleared to enable equipment to install and maintain the power line.

(2) Activities conducted under this general permit shall comply with section 403.814(6), F.S., and the following additional conditions.

(a) The shoreline of forested wetlands is interpreted to be the mean or ordinary high water line.

(b) Any mechanized equipment that is used to cut or remove vegetation shall be of a type and be operated so as to minimize soil compaction. Except for Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina* spp.), and punk tree (*Melaleuca quinquinerva*), clearing in the remainder of the project right-of-way within wetlands shall be limited to selective clearing of vegetation which has an expected mature height of 14 feet or more. During construction and while conducting normal maintenance activities, the permittee shall eradicate all Brazilian pepper, Australian pine, and *Melaleuca* from the wetland portion of the right-of-way. During the initial clearing event, and during subsequent maintenance cycles, EPA approved herbicides may be used on the following:

1. Vegetation growing within the area that was formerly cleared to the ground,

2. Vegetation with an expected mature height of over 14 feet growing within the remainder of the right-of-way; and,

3. Exotic vegetation within the right-of-way.

(c) Areas dominated (90 percent or greater aerial coverage) by exotic species shall not be included in the acreage calculation of

clearing to ground of forested wetlands. The ten mile sections shall be measured from the beginning of the project to the terminus of the project, or vice versa, and the sections shall not end in a wetland. In cases where the section does end in a wetland, the closest landward edge of the wetland shall be the section terminus.

(d) Diversion and impoundment of surface waters shall be limited to incidental diversion during construction, and diversion which occurs around support structures, towers, guy wires, and poles.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1), 403.814(6), 403.814(7) FS. History–New 10-3-95, Formerly 62-341.620, Amended 10-1-13.

62-330.459 General Permit for Relocation of Aerial Electric and Communication Lines Associated with Road Improvement Projects.

(1) A general permit is provided for use by electric and communication utilities to relocate aerial transmission and distribution lines, including utility poles and associated bases and anchoring devices within or adjacent to the rights of way of existing roadways.

(2) This general permit applies only to relocation projects necessitated by widening or improvement of existing roads. Documentation of the road widening or improvement that necessitates the relocation shall be submitted at the time the notice to use this general permit is submitted to the Agency.

(3) For the purpose of this general permit, the following definitions shall apply:

(a) “Anchoring device” shall mean steel guy wires fastened to the ground without the need for separate dredging;

(b) “Base” shall mean a man-made, concrete or steel foundation not exceeding four feet in radius, used to support a utility pole; and,

(c) “Utility pole” shall mean a single pole that supports aerial transmission and distribution lines.

(4) This general permit is subject to the following special conditions:

(a) The relocation of the poles shall be either within the existing or proposed road right-of-way or within ten feet adjacent to the existing or proposed road right-of-way;

(b) There shall be no above grade access roads, and no permanent placement of fill in wetlands or other surface waters for access roads or other purposes, other than the utility poles, associated bases, and anchoring devices;

(c) Work shall not impact any living stony coral, soft coral, macro-marine algae community, or submerged grassbeds;

(d) The clearing of wetland vegetation shall be limited to 0.5 acre per 10 miles of transmission or distribution line, unless the clearing of vegetation is addressed in a previously issued permit under part IV, chapter 373, F.S., which authorized the road widening or improvement.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.4137, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.621, Amended 10-1-13.

62-330.463 General Permit for Breaching Mosquito Control Impoundments and for the Construction and Operation of Culverts and Associated Water Control Structures in Mosquito Control Impoundments by Governmental Mosquito Control Agencies.

(1) A general permit is granted to any governmental mosquito control agency to construct and operate culverts and associated water control structures for the control of water levels in mosquito control impoundments, and to breach mosquito control impoundments, provided:

(a) The work is done only to provide improved transport of tidal water and organisms between the impounded wetland and adjacent surface waters or between cells within existing mosquito control impoundments for the purpose of improving water quality and the quality of fish and wildlife values;

(b) The work is not required as mitigation under part IV of chapter 373, F.S.;

(c) Breaches, culverts and associated water control structures shall be installed in locations that restore historic flow patterns, such as at or adjacent to historic locations of tidal creeks, and shall be located and operated such that state water quality standards shall not be violated in the receiving waters outside the impoundment;

(d) Culverts and associated water control structures shall either be left open year-round or shall be only seasonally closed as necessary to control mosquito breeding and to minimize the application of pesticides;

(e) Culverts and water control structures shall not be constructed in the locations of existing breaches of the impoundment dike;

(f) Culverts and water control structures shall be made of a corrosion resistant material;

(g) The diameter and invert elevation of culverts and water control structures shall be sufficient to maintain flow and prevent scouring under expected hydrologic conditions;

(h) Spoil material excavated during construction of the breaches shall be handled and deposited so as to prevent violations of state water quality standards for turbidity, and shall be contained in a self-contained upland disposal site; and,

(i) Wetlands disturbed by construction shall be stabilized with indigenous wetland vegetation or clean riprap, and the uplands disturbed by construction shall be stabilized with vegetation, riprap, or other means.

(2) The Agency shall send a copy of the notice to use this general permit to the Chairman of the Subcommittee on Managed Marshes which is established under section 388.46, F.S.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.463, Amended 10-1-13.

62-330.467 General Permit for Breaching Mosquito Control Impoundments by Governmental Mosquito Control Agencies.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.414(9), 373.416, 373.418 FS. History–New 10-3-95, Formerly 62-341.467, Repealed 10-1-13.

62-330.474 General Permit for Certain Minor Activities.

(1) A general permit is granted to construct, alter, maintain, operate, abandon, and remove the following:

(a) Piling supported structures, other than docks and piers, without walls, screens, or doors, provided that the structure is not used for mooring, and the cumulative square footage of existing and proposed structures over wetlands or other surface waters does not exceed 500 square feet in Outstanding Florida Waters or 1,000 square feet outside of Outstanding Florida Waters;

(b) Up to 100 square feet of dredging or filling in wetlands or other surface waters; or

(c) Maintenance dredging of up to 50 cubic yards of material from wetlands or other surface waters, provided that the dredged material is placed in uplands.

(2) Persons proposing to use this general permit must provide, as part of the notice required in rule 62-330.402, F.A.C., reasonable assurance that the proposed activity:

(a) Does not cause a violation of state water quality standards;

(b) Does not impede the conveyance of a stream, river, or other watercourse in a manner that would increase off-site flooding;

(c) Does not adversely impact aquatic or wetland dependent listed species;

(d) Does not cause the drainage of wetlands; and

(e) Is not located in, on, or over a community of corals, seagrasses, or attached marine macroalgae.

(3) The Agency will provide written notification to the person proposing to use this general permit whether the proposed activity qualifies for this general permit within 30 days of submittal of the written notice. The proposed activity shall not be commenced until the Agency has provided written notice that the applicant qualifies for the general permit.

(4) A determination that an activity qualifies for a general permit for a minor activity applies only to the site specific activity, location, method of construction, or operation of the authorized project, and the other design and operation features of the authorized activity.

(5) This general permit shall not be applicable on any parcel of property which has been the subject of the successive filing of notices under a general permit within a three-year period where the combination of activities to be conducted exceed the thresholds in this rule.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426 FS. History–New 6-1-18.

62-330.475 General Permit for Single-family Residential Activities in Isolated Wetlands.

(1) A general permit is granted to construct, alter, maintain, operate, abandon, and remove a single family residence and associated residential improvements (such as a driveway, garage, and an onsite sewage disposal system), provided:

(a) The land on which the work is to occur is not part of a larger plan of common development;

(b) The notice required in rule 62-330.402, F.A.C., includes documentation that the tract of land was not divided into two or more parcels after July 1, 1994;

(c) Work occurs only in uplands or in isolated wetlands that are not within an Area of Critical State Concern or within the Wekiva River Basin Riparian Habitat Protection Zone as described in subparagraph 40C-41.063(3)(e)1., F.A.C.;

(d) Wetland impacts shall be eliminated except where unrestricted uplands are insufficient to support the residence and associated residential improvements. "Unrestricted uplands" are uplands that are not restricted by easement, deed restriction, local government regulation, setback, or similar restriction which would prevent construction there. Uplands are not considered restricted until all available variance or waiver procedures have been exhausted;

(e) Wherever possible, structures in isolated wetlands should be built on pilings to minimize fill in wetlands; and

(f) No more than 4,000 square feet of isolated wetlands are dredged or filled and no more than 6,000 square feet of isolated wetlands are cleared (this includes the area dredged or filled for the residence and associated residential improvements).

(2) Persons proposing to use this general permit must provide, as part of the notice required in rule 62-330.402, F.A.C., reasonable assurance that the proposed activity:

(a) Does not cause a violation of state water quality standards;

(b) Does not impede the conveyance of a stream, river, or other watercourse in a manner that would increase off-site flooding;

(c) Does not adversely impact aquatic or wetland dependent listed species;

(d) Does not cause the drainage of wetlands.

(3) The Agency will provide written notification to the person proposing to use this general permit whether the proposed activity qualifies for this general permit within 30 days of submittal of the written notice. The proposed activity shall not be commenced until the Agency has provided written notice that the applicant qualifies for the general permit.

(4) This general permit shall not be applicable on any parcel of property which has been the subject of the successive filing of notices under a general permit within a three-year period where the combination of activities to be conducted exceed the thresholds in this rule.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426 FS. History–New 10-3-95, Formerly 62-341.475, Amended 10-1-13, 6-1-18.

62-330.476 General Permit for Private Single-Family Residences within Jupiter Farms, Palm Beach County.

(1) A general permit is granted for the construction, alteration, maintenance, operation, abandonment, and removal of single-family residences and associated on-site residential improvements within the wetlands and other surface waters in Jupiter Farms, Palm Beach County, as identified below. This includes the construction, alteration, maintenance, operation, abandonment, and removal of culverts or bridges over non-navigable drainage or irrigation ditches to provide access to the residence.

(2) This general permit is limited as follows:

(a) The single-family residence is to be located within:

1. Township 40S, Range 41E – Section 33 or 34;

2. Township 41S, Range 41E – Section 1, 2, 3, 4 (east half), 9 (east half), 10, 11, 12, 13, 14, 15, or 16, or

3. Township 41S, Range 42E – Section 7 or 18.

(b) Only one, single-family residence is authorized per parcel or lot. However, this shall not preclude additional living areas, such as "mother-in-law" and guest quarters that are part of the primary residence or other structures authorized under subsection 62-330.476(4), F.A.C.;

(c) The activities are not part of a larger plan of common development proposed by the applicant;

(d) The total area of dredging, filling, construction, land clearing, and other disturbance in wetlands and other surface waters within a parcel or lot shall not exceed 0.75 acre;

(e) The permittee offsets the functions provided by wetlands and other surface waters that will be lost as a result of the above activities through mitigation, as provided in subsection (3), below; and,

(f) The activities undertaken under this general permit:

1. Are associated with a private single-family residence to be used by the current owner; and,

2. Are not intended for, or being proposed by, a corporation, partnership, or other business entity, and otherwise will not be used

for commercial or industrial purposes. However, this does not preclude an owner from conducting commercial activities on the property that are ancillary to a private single-family residence, such as sale of home-made crafts or home-grown produce; and shall not prohibit a trustee, beneficiary, or current resident from qualifying as an applicant when title to such single-family residence and associated on-site residential improvements is held in trust.

(3) To implement mitigation that will offset impacts from the construction of residences within the above-described sections, persons wishing to use this general permit shall pay Palm Beach County, as described below, an amount calculated as "X" times $4,000, where "X" equals the number of acres of wetlands or other surface waters that will be subject to construction, alteration, maintenance, or operation activities authorized herein, rounded to the nearest 0.01 acre (up to 0.75 acre).

(a) Initially these monies shall be applied to the Palm Beach County Department of Environmental Resources Management South Loxahatchee Slough Wetland Restoration Fund to implement the restoration, enhancement and long-term management of 237 acres of impacted wetlands within a 780-acre undeveloped parcel known as the South Loxahatchee Slough Restoration Project (SLSRP), in accordance with the "Memorandum of Understanding between the Florida Department of Environmental Protection, the U.S. Army Corps of Engineers, Jacksonville District, and Palm Beach County Board of County Commissioners through its Department of Environmental Resources Management Regarding Mitigation for Jupiter Farms and Palm Beach Country Estates," dated August 26, 2002, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03149), which is incorporated by reference herein; a copy of this MOU may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. These wetlands are located south of PGA Boulevard, north of the Bee Line Highway, and west of the eastern leg of the C-18 Canal. This site is acknowledged to have the capability of providing 151.9 acre-credits of mitigation for wetland impacts within the above-described sections of Jupiter Farms.

(b) The Department recognizes that all of the wetland impacts within Jupiter Farms cannot be offset within the SLSRP, and that additional mitigation sites will have to be identified, funded, and implemented in the future. Therefore, the SLSRP shall be available under this general permit to offset impacts within the above-described sections of Jupiter Farms until the available credits within that site are exhausted, at which time the money will be directed to other suitable mitigation sites which shall be approved by the Department and identified through amendments to this rule.

(4) For the purposes of this general permit, "associated onsite residential improvements" include projects that are directly associated with a private single-family residence on the property, such as: a driveway, garage, onsite sewage treatment and disposal systems, wells, utility services (water, electricity, telephone, cable, and gas), recreation structures, sheds, barns, stables and animal pens, walkways, boardwalks, lawns, fences, pools, ponds, and gardens. To be authorized under this general permit, such associated on-site residential improvements must be constructed concurrently with construction of an individual single-family residence, or after such residence has been lawfully constructed, and must conform to all the conditions and criteria of this general permit. For purposes of this general permit, associated on-site residential improvements shall not include docks, piers, boat ramps, or other structures designed to provide boating access in, on, or over surface waters, and also shall not include improvements used in whole or part for commercial agriculture or aquaculture operations.

(5) In addition to the general conditions of rule 62-330.405, F.A.C., and the other limiting conditions of this general permit, the following specific conditions shall also apply:

(a) Onsite sewage treatment and disposal systems shall be constructed in uplands unless there is an insufficient unrestricted area of uplands within the contiguous ownership of the applicant on which such treatment and disposal systems can be located. For the purposes of this section, "unrestricted area of uplands" means an area of uplands that is not restricted by easement, deed restriction, local government regulation, or similar restriction that would prevent the on-site sewage treatment and disposal system from being located in those uplands.

(b) Material and debris resulting from any clearing and grading of the property authorized under this general permit shall not be deposited in wetlands or other surface waters outside of the footprint of the residence and associated onsite residential improvements authorized under this general permit.

(c) Culverts or bridges installed in drainage or irrigation ditches to provide access shall be located and sized so as to maintain existing capacity for water flow and volumes.

(d) Any areas excavated under this general permit shall not result in new connections to canals, ditches, swales, or other existing drainage systems within Jupiter Farms.

(6) Persons wishing to conduct activities under this general permit must file a notice with the local office of the Department, which shall include:

(a) A description of the proposed activity on the parcel or lot, including scaled or fully dimensioned plan and cross section views of the proposed dredging, filling, and construction;

(b) A statement that the residence and associated onsite residential improvements comply with the requirements of paragraph (2)(f), of this general permit;

(c) A statement that the parcel or lot is not part of a larger parcel or lot that was subdivided into two or more parcels or lots after 2-19-03;

(d) A statement that the activities are not part of a plan of common development proposed by the applicant;

(e) A location map showing the relationship of the parcel or lot to existing roads and other land features that can allow a person unfamiliar with the area to locate the site. The map shall include property descriptions from the county tax assessor's office;

(f) The area (in square feet) of wetlands or other surface waters proposed to be subject to dredging, filling, and construction;

(g) A description of the efforts made to locate the on-site sewage treatment and disposal systems in the uplands, including a map depicting the location and extent of the proposed onsite sewage treatment and disposal systems in relation to existing wetlands and other surface waters on the property; and,

(h) Proof of the payment as required in subsection 62-330.476(3), F.A.C., in the form of a receipt from Palm Beach County.

(7) This general permit shall not be applicable on any parcel or lot that has been the subject of a prior filing of a notice under this section when the combination of activities to be conducted pursuant to the prior and pending notices exceeds the thresholds of this general permit. However, use of this general permit does not preclude the use of other permits or exemptions that may be applicable on the parcel or lot, except that the general permit under rule 62-330.475, F.A.C., shall not be used with this general permit.

Rulemaking Authority 373.026, 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 2-19-03, Amended 11-3-04, Formerly 62-341.476, Amended 10-1-13.

62-330.477 General Permit for Single Family Residential Lots within the Indian Trail Water Control District.

(1) A general permit is hereby granted for individual single family residential lots within the M-1 and M-2 basins of the Indian Trail Water Control District in Palm Beach County, as described in subsection (3).

(2) This general permit authorizes dredging and filling within wetlands or other surface waters on individual, single family residential lots, for the construction, alteration, maintenance, operation, abandonment, and removal of single family residences, structures associated with the residence, and other works located within the wetlands or other surface waters within the lot, provided:

(a) The individual, single family residential lot is 5 acres or less in size;

(b) The residence is not part of a larger common plan of development proposed by the applicant;

(c) The permittee offsets the adverse individual and cumulative impacts from the authorized activities, by donating $250.00 per lot to the Palm Beach County Pollution Recovery Trust Fund, established pursuant to Palm Beach County Resolution R89-576, which monies shall be applied to the purchase, restoration, or management of a minimum of 200 acres of land, including wetlands and other surface waters within Unit 11 of the Indian Trail Water Control District as described in subsection (4). The permittee must submit proof of this donation, in the form of a receipt from Palm Beach County, with the application to use this general permit;

(d) Associated structures and works authorized by this general permit shall be limited to driveways, culverts, storage sheds, garages, septic tanks and drainfields, pools, fences, gardens, and wells; and,

(e) Dredging is limited to the minimum amount necessary to obtain fill material for the residence and associated structures authorized by this general permit. Such dredged areas shall not connect to canals, ditches, swales, or other existing drainage systems within the Indian Trail Water Control District.

(3) The lands within Indian Trail Water Control District to which this general permit applies are:

(a) M-1 basin of the Indian Trail Water Control District consisting of:

1. Township 42 South Range 40 East – the south one-half (S 1/2) of Sections 13, 14 and 15; the north 135 feet of the south one-half (S 1/2) of Sections 16, 17, and 18 and all of Sections 23, 24, 25, 26, 35 and 36,

2. Township 42 South, Range 41 East – the west one-half (W 1/2) of Section 17; all of Sections 18 and 19; all of Section 20 less the northwest one-quarter (NW 1/4) of the northeast one-quarter (NE 1/4) thereof; all of Sections 21, 22, 27, 28, 29, 30 and 31; the west one-half (W 1/2) and the west one-third (W 1/3) of the east one-half (E 1/2) of Section 32, and all of Sections 33, 34 and 35,

3. Township 43 South, Range 41 East – all of Sections 2, 3, 4, 9, 10 and 11; and,

(b) M-2 basin of the Indian Trail Water Control District, consisting of Township 43 South, Range 40 East – all of Sections 10 and 11; the west three-quarters (W 3/4) of Section 13; all of Sections 14 and 15, and the west three-quarters (W 3/4) of Sections 24 and 25.

(4) Unit 11 of the Indian Trail Water Control District, consisting of Township 41 South, Range 41 East, all of Sections 30 and 31, and the west 1/2 of Sections 29 and 32.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418 FS. History–New 4-3-96, Formerly 62-341.630, Amended 10-1-13.

62-330.483 General Permit to the Department and Water Management Districts to Conduct Minor Activities.

A general permit is granted to the Department and Water Management Districts to conduct the activities described below:

(1) The repair, replacement or alteration of any existing bridge, levee, dam, pump station, lock, culvert, spillway, weir, or any other water control structure with structures of the same design or of a comparable design, provided that the maximum discharge rate capacity and control elevation do not exceed that of the structure to be replaced. Minor deviations in the structure's design are authorized, including those due to changes in materials, construction techniques, or current construction codes or safety standards. Associated construction activities authorized by this permit include temporary fill plugs or cofferdams; upland bypass channels; channel shaping needed to accommodate the repair, replacement or alteration of the structure; and channel and bank stabilization, including riprap within 200 feet of the structure. Replacement may occur at the same site, or adjacent to the original structure. The area of wetlands or other surface waters from which material is to be dredged or filled shall not exceed a total of 0.5 acre for any one structure.

(2) Canal bank and bottom stabilization necessary to repair erosion damage and restore previously existing canal configurations. Authorized repair methods include placement of riprap, sand cement toe walls, clean fill material, poured concrete, geotechnical textiles or other similar stabilization materials. The distance to be restored or repaired shall not exceed 2,000 feet at any one location along canal banks and 500 feet along canal bottoms.

(3) Aerial pipeline crossings (including support piles) of man-made canals consistent with the provisions of rule 62-330.455, F.A.C., except that the width of the crossing may be up to 200 feet.

(4) When the activity under this general permit is to be conducted by the Department, the Department shall provide the notice and any processing fee required to the appropriate District.

(5) When the activity under this general permit is to be conducted by a water management district, the District shall provide the notice and any required fee to the appropriate Department office.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.483, Amended 10-1-13.

62-330.485 General Permit to the Department and Water Management Districts for Environmental Restoration or Enhancement.

(1) A general permit is granted to the Department and Districts for the construction, alteration, operation, maintenance, removal and abandonment of projects to implement Department or District environmental restoration or enhancement projects.

(2) The environmental restoration or enhancement project must comply with any one of the following procedures:

(a) The project is part of a Surface Water Improvement and Management Plan developed pursuant to section 373.453, F.S.; or

(b) The project is approved by the District Governing Board or the Secretary of the Department after conducting at least one public meeting; or

(c) The project is wholly or partially funded through the Land Acquisition Trust Fund pursuant to Article X, Section 28 of the Florida Constitution, or through any successor trust fund.

(3) When the activity is to be conducted by the Department, the Department shall provide the notice and any processing fee required by rule 62-330.071, F.A.C., to the appropriate District.

(4) When the activity is to be conducted by a District, the District shall provide the notice and any required fee to the appropriate Department office.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented

373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.485, Amended 10-1-13, 6-1-18.

62-330.487 General Permit to the Department and Water Management Districts to Change Operating Schedules for Water Control Structures.

(1) A general permit is granted to the Department and Districts to change the operating schedules for existing water control structures that are owned or operated by the Department or District when such changes are for environmental restoration or enhancement.

(2) The Department or the District Governing Board, as applicable, shall hold at least one public meeting concerning the proposed operating schedule prior to its approval.

(3) When the activity under this general permit is to be conducted by the Department, the Department shall provide the notice to the appropriate District.

(4) When the activity under this general permit is to be conducted by a District, the District shall provide the notice to the appropriate Department office.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Amended 10-1-07, Formerly 62-341.487, Amended 10-1-13.

62-330.488 General Permit to Governmental Entities for Certain Public Use Facilities at Public Natural Areas.

(1) A general permit is granted to governmental entities to construct, operate, and maintain public use facilities on public natural areas. For purposes of this rule, "public natural areas" are predominantly undeveloped lands owned by the governmental entity and that are dedicated and managed for the preservation, restoration and maintenance of those lands. The public use facilities authorized by this permit are a parking lot or parking area and an at-grade access road, not to exceed a total size of 2 acres of impervious surface located entirely in uplands; at-grade access trails located entirely in uplands; restroom buildings and open-air shelters located entirely in uplands; pile-supported boardwalks having a maximum width of 6 feet; and pile-supported observation platforms, any of which shall not exceed 120 square feet in size.

(2) The facilities and work must comply with the following:

(a) No fill shall be placed in, on, or over wetlands or other surface waters, except pilings for pile-supported boardwalks and observation platforms. All structures located in, on, or over wetlands and other surface waters shall be sited and constructed to minimize wetland impacts and the removal of trees having a diameter at breast height of 4 inches or greater. To minimize shading of wetland vegetation, all pile-supported boardwalks and observation platforms located in, on, or over wetlands and other surface waters shall be elevated at least two feet above mean high water for tidal waters, at least two feet above seasonal high water for non-tidal waters, or four feet above ground surface, whichever is greater. The total area pile-supported structures over wetlands and other surface waters shall not exceed 10,000 square feet.

(b) All stormwater flow from the impervious surfaces shall sheet flow into uplands. Impervious surfaces shall be no more than one percent of the total acreage of the public natural area, not to exceed a total size of 2 acres of impervious surface. If pervious or semi-impervious surfaces or materials are used, the maximum area of roads, parking lots, parking areas and trails shall not exceed 2 acres, regardless of the total acreage of the public natural area. Water quality treatment shall be provided for the first inch of runoff from the impervious and semi-impervious surfaces.

(c) Impervious surfaces subject to vehicular traffic shall be constructed a minimum of 75 feet from any wetland or other surface water. Buildings and shelters shall be constructed a minimum of 25 feet away from any wetland or other surface water.

(d) Piling supported structures may not be located over coral, seagrasses or other submerged aquatic vegetation.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 403.814(1) FS. History–New 10-1-13.

62-330.490 General Permit for the Reclamation of Eligible Phosphate Lands Mined Before July 1, 1975.

(1) A general permit is granted to all owners of lands mined or disturbed by the severance of phosphate before July 1, 1975, whose reclamation program application has been approved by the Department under chapter 378, part I, F.S., providing the reclamation program:

(a) Is wholly or partially funded by the Department through the Non-mandatory Land Reclamation Trust Fund pursuant to chapter 378, part I, F.S.; and,

(b) Has an approved detailed non-mandatory land reclamation design plan that meets the standards and criteria in chapter 62C-17, F.A.C.

(2) All work shall be in accordance with the approved non-mandatory land reclamation program and all provisions of chapter 62C-17, F.A.C.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.4145, 373.416, 373.418, 378.034, 378.035, 403.814(1) FS. History–New 10-1-13.

62-330.491 Noticed General Permit for Raising the Height of Existing Earthen Embankments for Impoundments at Facilities for Mining Sand and Limestone.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118, 373.406(5), 373.413, 373.414(9), 373.416, 373.418, 373.426 FS. History–New 9-4-05, Formerly 62-341.491, Repealed 10-1-13.

62-330.492 General Permit for Prospecting for Limestone, Sand, and Peat.

A general permit is granted for prospecting for limestone, sand, and peat provided that all of the following conditions are met:

(1) Prospecting is conducted by coring, augering, impact boring or other techniques designed to remove samples from an excavated opening less than one foot in diameter.

(2) No prospecting is conducted below the ordinary or mean high water line of natural water bodies such as natural lakes, ponds, streams, rivers, estuaries or lagoons.

(3) Prospecting in wetlands must meet the following conditions:

(a) No activities shall be conducted in Outstanding Florida Waters, Aquatic Preserves, Class I waters, Class II waters, waters which are classified by the Florida Department of Agriculture and Consumer Services as approved, restricted, conditionally approved or conditionally restricted for shellfish harvesting in rule 5L-1.003, F.A.C., or wetlands used by endangered or threatened species. For purposes of this permit, a wetland is used by endangered or threatened species if reasonable scientific judgment indicates that the wetland provides habitat in which endangered or threatened species engage in activities such as resting, feeding, breeding, nesting or denning.

(b) No above-grade roads shall be constructed. Vehicles used for prospecting in wetlands shall be of a type generating minimum ground pressure to minimize rutting and other environmental impacts. Disturbed areas along each prospecting line shall be restored to original contours upon completion of prospecting activities along that specific alignment.

(c) Disturbances within wetlands shall be no wider than 15 feet along any portion of the prospect line, except at the immediate site of the drill hole. At the immediate site of the drill hole the disturbance shall not exceed 25 feet. No debris or spoil shall be placed outside these limits.

(d) Prospecting lines shall be aligned to minimize wetland impacts and avoid the clearing of wetland trees having 4 inches or greater diameter at breast height to the greatest extent practicable.

(e) All drill tailings shall be returned to the drill hole and the excess removed so that no spoil material is left above grade in a wetland.

(f) If the removal or cutting of vegetation is required, there shall be a minimum interval of 300 feet between individual parallel prospecting lines. The removal of vegetation shall not include grubbing, or the pulling or pushing up of root systems.

(g) Any wetland disturbed by prospecting activities shall be restored by replanting native indigenous vegetation of the same species as were displaced. Exotic species such as Schinus terebinthifolius, Melaleuca quinquenervia, and Casuarina spp., and nuisance species Typha spp., and Ludwigia peruviana shall be controlled at densities not exceeding the densities of these species in undisturbed portions of the wetland.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118, 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 9-4-05, Formerly 62-341.492, Amended 10-1-13.

62-330.493 General Permit to Perform Prospecting Activities for Phosphate Minerals.

(1) A general permit is provided for any person engaged in or proposing to engage in the mining of phosphatic ore to perform prospecting activities for phosphate minerals within wetlands and other surface waters except in Outstanding Florida Waters, Aquatic Preserves, Outstanding National Resource Waters, Class I waters, Class II waters, or waters approved, conditionally approved, restricted, or conditionally restricted by the Department of Agriculture and Consumer Services for shellfish harvesting, provided:

(a) "Prospecting activities" shall be defined as those normal and reasonably necessary to retrieve core samples of subsurface geologic sediments for the specific purpose of locating, mapping and determining the quantities and quality of any phosphorus bearing strata or deposits;

(b) Disturbance along any portion of the prospect line within herbaceous wetlands shall be no wider than 25 feet, no wider than 15 feet within forested wetlands, except at the immediate site of the drill hole, where disturbance shall not exceed 25 feet in width and no activities regulated by the Department associated with prospecting shall occur outside the 15-foot and 25-foot limits, respectively;

(c) An individual prospecting line shall not extend into wetlands or other surface waters more than one-third (1/3) of the width of the landward extent of the wetland or other surface waters involved, unless prospecting is conducted by hand carried drilling devices, in which case full penetration of the wetland or other surface waters shall be allowed, except as restricted by paragraph (1)(e), below. When hand carried drilling devices are used all drilling tailings shall be returned to the drill hole and no spoil shall be left on the surface;

(d) No prospecting activities shall occur in open waters (areas of water bodies not supporting emergent vegetation), such as lakes, ponds, streams, and rivers;

(e) A minimum interval of 300 feet shall exist between individual parallel prospecting lines and minimal distance of 300 feet shall be maintained between the alignment of the prospecting line or lines and opposing sides of wetlands and other surface waters. When hand carried drilling devices are to be used for total penetration of the wetland or other surface waters, the minimal interval of 300 feet between prospecting lines shall apply;

(f) No debris or spoil shall be mechanically placed outside of the 15-foot or 25-foot width allowed, respectively, above; and,

(g) The disturbed area along each prospecting line within herbaceous wetlands shall be replanted with native wetland species that are indigenous to adjoining wetlands unless evidence exists that natural revegetation has covered 33 percent of the disturbed ground area within one growing season. If herbaceous plants are planted, they shall be planted at a density to achieve 33 percent cover by herbaceous wetland species within one growing season. The disturbed area along each prospecting line within forested wetlands shall be replanted with indigenous native wetland tree species at a rate to achieve survival and growth of 400 trees per acre, and the permittee shall institute maintenance activities to ensure the survival of the planted indigenous native wetland trees. The disturbed area along each prospecting line within forested wetlands also shall be replanted with indigenous native wetland herbaceous species in the same manner as for the herbaceous wetlands described above. The restored sites shall be maintained free of any new growth of *Schinus terebinthifolius* (Brazilian pepper), *Melaleuca quinquenervia* (punk tree), and *Casuarina* spp. (Australian pine), and managed so that *Typha* spp. (cattails) does not attain vegetative dominance.

(2) A person wishing to use this general permit shall submit to the Department an annual schedule of proposed prospecting activities within the prospect areas including location maps, aerial photographs showing the proposed prospecting lines, and approximate commencement and completion dates for the activities planned for each prospect area. The annual schedule, or modifications to the annual schedule, must be submitted at least 30 days prior to the commencement of the proposed activity. Where practicable, the annual schedule should be filed with the Department no later than June 1 for the fiscal year July 1 through June 30.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.610, Amended 10-1-13, 6-1-18.

62-330.494 General Permit for Temporary Dragline Crossings of Waterways for Mining Activities.

(1) A general permit is provided for any person engaged in or proposing to engage in the mining of a phosphatic ore for the construction of temporary dragline crossings within certain wetlands and other surface waters, except in Outstanding Florida Waters, Aquatic Preserves, Outstanding National Resource Waters, Class I waters, Class II waters, or waters approved, conditionally approved, restricted, or conditionally restricted by the Department for shellfish harvesting, provided:

(a) The crossing is of a ditch or artificially channelized portion of any wetland or other surface water or at a documented

location of a previously existing dragline crossing within the preceding five years, of any wetland or other surface water, and is not a navigable surface waterbody. The term navigable, for the purpose of this permit, means the surface waterbody is capable of use by small craft;

(b) Only clean sand fill or temporary mats shall be used to construct the crossing;

(c) When demucking or removal of topsoil is necessary for the construction of the crossing, the muck and topsoil shall be retained at a nearby upland location and returned to the crossing site for the restoration activities;

(d) Culverts are installed to maintain the natural and seasonal volume and flow of water;

(e) The top width of the fill shall not exceed 150 feet and the toe to toe width of the fill shall not exceed 200 feet and the side slopes shall be no steeper than three horizontal to one vertical, and the lateral limits of disturbance of the wetlands shall be no more than 20 feet on each side of the fill;

(f) The crossing shall not remain in place for more than one year, unless the crossing is for a one-way access in which case it shall not remain in place for more than six months; and,

(g) The area must be restored to original topographic contours within 60 days of the abandonment of the dragline crossing, which shall be after the dragline has crossed the wetland or other surface water.

(2) This general permit shall be subject to the following specific conditions:

(a) Upon restoration of original topographic contours at a temporary dragline crossing site, the permittee shall at the end of the first growing season provide the opportunity for inspection of the site by staff of the Department office that received notice of the general permit. If satisfactory revegetation of the site has not occurred, the permittee shall initiate, conduct and maintain revegetation and maintenance of the wetland until satisfactory revegetation has been achieved. Revegetation of the site shall be with native wetland species in similar composition to those species which were present at the site or in the contiguous wetland prior to the temporary dragline crossing. For the purpose of this general permit, "satisfactory revegetation" means that the herbaceous wetlands that are disturbed under this general permit shall have achieved not less than 33 percent cover of planted or naturally reestablished herbaceous wetland species within one growing season following disturbance of the site, and the forested wetlands that are disturbed under this general permit shall be achieving a survival and growth of not less than 400 wetland trees per acre within one growing season following disturbance of the site, and a maintenance plan has been developed and is being implemented to ensure the survival of the planted or naturally reestablishing wetland species. The restored sites shall be maintained free of any new growth of *Schinus terebinthifolius* (Brazilian pepper), *Melaleuca quinquenervia* (punk tree), and *Casuarina* spp. (Australian pine). The restored site shall also be managed in a manner which precludes *Typha* spp. (cattails) from manifesting vegetative dominance; and,

(b) A person wishing to use this general permit shall submit to the Department office to which the original notice was given, an annual schedule of proposed temporary dragline crossing areas including location maps, aerial photographs with proposed temporary dragline crossings, typical drawings, and approximate commencement and completion dates for the activities planned. Additionally, the plans shall include proposed restoration procedures for each temporary dragline crossing. The annual schedule, or modifications to the annual schedule, must be submitted, together with the required documentation, at least thirty days prior to the commencement of the proposed activity. Where practicable, the annual schedule and documentation should be filed with the Department no later than June 1 for the fiscal year July 1 through June 30.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.611, Amended 10-1-13.

62-330.495 General Permit for Low Water Crossings for Mining Activities.

(1) A general permit is provided for any person engaged in or proposing to engage in the mining of a mineralized non-metallic ore to move equipment and vehicles, excluding dredges, through and across wetlands or other surface waters during periods of low water, except in Outstanding Florida Waters, Aquatic Preserves, Outstanding National Resource Waters, Class I waters, Class II waters, or waters approved, conditionally approved, restricted, or conditionally restricted by the Department of Agriculture and Consumer Services for shellfish harvesting, provided:

(a) The only dredging or filling performed shall be that caused by the movement of the vehicle or equipment through the water;

(b) The maximum water depth along the crossing shall not exceed two feet during the time the crossing is used;

(c) Vegetative debris shall not be deposited within wetlands and other surface waters;

(d) The lateral width of disturbance shall in no case exceed that necessary to move the vehicles and equipment through and

across wetlands or other surface waters and shall in no case be greater than 50 feet; and,

(e) The distance between crossings of an individual wetland or other surface waters shall be at least 5,000 feet, except at sites where a documented four-wheel vehicular access exists, in which case crossings may be at a spacing of 2,500 feet.

(2) This general permit shall be subject to the specific conditions as follows:

(a) The person wishing to use this general permit shall locate crossings at sites that will cause the least environmental impact. The permittee shall coordinate with the appropriate Department office;

(b) Upon restoration of an individual low water crossing site, the permittee shall at the end of the first growing season provide the opportunity for inspection of the site by the appropriate Department office staff. If satisfactory revegetation for the site has not occurred, the permittee shall initiate, conduct and maintain revegetation of the wetland. For the purpose of this general permit, "satisfactory revegetation" means that the herbaceous wetlands that are disturbed under this general permit shall have achieved not less than 33 percent cover of planted or naturally reestablished herbaceous wetland species within one growing season following disturbance of the site, and the forested wetlands that are disturbed under this general permit shall be achieving a survival and growth of not less than 400 wetland trees per acre within one growing season following disturbance of the site, and a maintenance plan has been developed and is being implemented to ensure the survival of the planted or naturally reestablishing wetland species. The restored sites shall be maintained free of any new growth of *Schinus terebinthifolius* (Brazilian pepper), *Melaleuca quinquenervia* (punk tree), and *Casuarina* spp. (Australian pine). The restored site shall also be managed in a manner which precludes *Typha* spp. (cattails) from manifesting vegetative dominance. Revegetation of the site shall be with native wetland species in similar composition to those species which were present at the site or in the contiguous wetland prior to the low water crossing; and,

(c) A person wishing to use this general permit shall submit to the appropriate Department office, an annual schedule of proposed low water crossing sites including location maps, aerial photographs with proposed low water crossing sites, typical drawings, and approximate commencement and completion dates for the activities planned. Additionally, the plans shall include proposed restoration procedures for each low water crossing. The annual schedule, or modifications to the annual schedule, must be submitted, together with the required documentation, at least 30 days prior to the commencement of the proposed activity. The annual schedule and documentation shall be filed with the Department no later than June 1 for the fiscal year July 1 through June 30.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.612, Amended 10-1-13.

62-330.496 General Permit for Dry Borrow Pits of Less than Five Acres.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426 FS. History–New 10-1-13, Repealed 6-1-18.

62-330.500 General Permit for Construction, Operation, Maintenance, Alteration, Abandonment or Removal of Minor Silvicultural Surface Water Management Systems.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118, 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.426 FS. History–New 9-4-05, Formerly 62-341.500, Repealed 10-1-13.

62-330.501 General Permit for Temporary Agricultural Activities within the South Florida Water Management District.

(1) A general permit is granted to any property owner for temporary agricultural activities within the South Florida Water Management District, provided all the following criteria are met.

(a) Agricultural activities shall be horticultural and limited to seasonal crops. Seasonal crops are harvested in one growing season, which shall not exceed one year.

(b) This permit is valid only for activities in existing improved or semi-improved pastures or fields that have been cultivated within the last five years. For purposes of this section, improved or semi-improved pastures are lands that have been cleared of native plants by mechanical means.

(c) For purposes of this section, the project area and scope is defined as both farmed and detention areas. In order to qualify for a permit under this section, the project area shall not exceed 320 contiguous acres.

(d) The project outfall structure must be located more than 1 mile from Outstanding Florida Waters.

(e) No works or farming activities shall occur within 50 feet of a wetland as defined in section 373.019(27), F.S. If wetlands are located within the project area, a minimum 50-foot undisturbed buffer must be maintained around the wetland.

(f) Pump rates shall not exceed a volume of 2 inches per day at a rate of 37.7 gallons per minute per acre of farmed area. Pump on/off elevations shall be within 2.5 feet of natural ground within the farmed area. All surface water discharges shall be into detention areas.

(g) Water levels in the detention areas shall not exceed a depth of 1.5 feet above natural ground within the detention area.

(h) Water quality and attenuation requirements shall be met by establishing detention areas at a minimum of fifteen percent of the farmed area.

(i) If wetlands are located within a detention area, then the control elevation of the detention area shall be set at the wetland edge elevation. If no wetlands are located within a detention area, then the control elevation shall be set at natural ground elevation.

(j) Control structures shall be sized according to the following list depending on the project size.

Project Size	Control Structure
0-25 acres	6" riser and 12" pipe equivalent
26-65 acres	12" riser and 12" pipe equivalent
66-105 acres	18" riser and 18" pipe equivalent
106-145 acres	24" riser and 24" pipe equivalent
146-185 acres	30" riser and 30" pipe equivalent
186-225 acres	36" riser and 36" pipe equivalent
226-265 acres	42" riser and 42" pipe equivalent
266-305 acres	48" riser and 48" pipe equivalent
306-320 acres	54" riser and 54" pipe equivalent

(k) The minimum setback between the project edge and the property boundary line shall be 50 feet for all projects.

(l) Discharges shall be to the existing pre-project surface water conveyance pathway. Existing sheetflow, if any, shall be maintained through the use of a spreader swale.

(m) Detention area dikes shall be constructed with a top elevation of 3.5 feet above the control elevation with a minimum 5 foot top width and side slopes of two horizontal to one vertical.

(n) Internal farm ditches shall be no deeper than 3 feet below natural ground elevation (excluding sump areas for pump placement which shall not be deeper than 6 feet below natural ground elevation).

(o) External perimeter berms of the farmed areas shall not exceed 2 feet in height.

(p) Farming areas must be laid out in a manner that will not block or impede off-site flows.

(q) Access to the fields shall be accomplished by existing roads. Roads into or on the project are not part of this authorization.

(2) The entity must submit a best management plan that addresses sediment control, soil erosion, nutrients, pesticides, herbicides, suspended solids at points of discharge and other agricultural practices appropriate to crop and site conditions. At a minimum the best management plan must include the following best management practices.

(a) Application equipment shall be properly calibrated and in good repair.

(b) Pesticides and fertilizers shall be stored in a secure, contained location, protected from rainfall. Fertilizers and pesticides shall not be stored together.

(c) All mixing and loading operations shall be conducted away from wells, ditches and wetlands.

(d) Pesticide containers shall be rinsed as soon as they are empty. Containers shall be disposed of in accordance with directions on the label.

(e) Equipment shall be used that directs chemicals only to a designated target area. Overspray or application into ditches and wetland buffer areas shall be avoided.

(f) Spills shall be cleaned up as soon as possible.

(g) Equipment shall be cleaned and rinsed away from ditches and wetland buffers.

(h) A soil or leaf analysis shall be used to determine fertilizer application requirements.

(i) Apply seed and mulch or use other methods to stabilize the disturbed areas outside of the planted area within 14 days from

the completion of planting.

(j) Install silt fences around wetland buffer areas prior to construction.

(k) Install silt fences, hay bales or equivalent downstream of outfall structure during construction.

(3) The duration of this permit shall not exceed three years. No more than two years of the permit duration shall be dedicated to the planting and harvesting of crops. The remainder of the duration of the permit must be dedicated to fallow time. At the end of the growing season specified in the permit, all works shall be removed from the site and the site returned to the condition that existed prior to permit issuance. The site shall remain fallow the following year. Within 30 days of the permit expiration, the permittee shall provide written notification to the South Florida Water Management District that the project has been restored to conditions that existed prior to permit issuance.

Rulemaking Authority 373.044, 373.113, 373.118, 373.4131 FS. Law Implemented 120.60, 373.118, 373.119, 373.413, 373.4131, 373.416, 373.418, 373.423 FS. History–New 10-1-13.

62-330.505 General Permit to the U.S. Forest Service for Minor Works within National Forests.

(1) A general permit is granted to the U.S. Forest Service to conduct the works described below:

(a) Bathing beach restoration at developed recreation sites where maintenance dredging is less than 100 cubic yards per year and less than 100 cubic yards per single occurrence; and,

(b) Dock construction, replacement and maintenance for docks of up to 1,000 square feet of surface area over wetlands and other surface waters in Outstanding Florida Waters and Outstanding National Resource Waters, subject to restrictions listed in sections 403.813(1)(b) and (d), F.S.

(2) The U.S. Forest Service or its contractors shall use turbidity control measures while dredging or filling within wetlands and other surface water to prevent violations of state water quality standards.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.495, Amended 10-1-13.

62-330.550 General Permit for Construction, Operation and Maintenance of Nonproduction-related Agricultural Facilities.

(1) A general permit is granted for the construction, operation, maintenance, alteration, or abandonment of minor systems serving any of the following, provided the activities comply with all of the conditions set forth below.

(a) Seasonal or year-round stands and markets selling exclusively or primarily produce and other farm or nursery products grown onsite.

(b) Farm worker housing and ancillary facilities.

(c) Truck loading and staging areas for transporting farm or nursery products grown onsite.

(d) Nonresidential farm buildings and structures used solely for agricultural purposes and located on a farm or on land that is an integral part of an ongoing farm operation.

(e) Roadway and vehicle parking facilities integral to an activity authorized under this general permit.

(2) This general permit is subject to the following limitations:

(a) Total cumulative building, driveway, parking lot, and other impervious and semi-impervious surfaces will not exceed 20 percent of the total land area, up to four acres. This limitation excludes impervious and semi-impervious areas directly related to agricultural production.

(b) No activities will occur in, on or over wetlands or other surface waters.

(c) The activities will not use new surface water drainage facilities larger than one 24-inch diameter pipe or its hydraulic equivalent.

(d) The activities will not use new drainage pumps or other operable structures for stormwater management.

(e) Finished building floors for residential structures will be above the 100-year flood elevation.

(f) All discharge and project runoff locations, excluding runoff from access driveways, will maintain a minimum 75-foot vegetated buffer. This vegetated buffer must include a 25-foot perpetually undisturbed buffer, upland of any wetlands, other surface waters, and drainage ditches.

(g) Impervious and semi-impervious surfaces, excluding access driveways, will maintain a 25-foot vegetated buffer from property boundaries.

(h) Permitted activities are not conducted within the geographic limits of an existing permit issued under part IV of chapter 373, F.S.

(3) This general permit is not available if the proposed activities, considered separately or in combination with other activities conducted under this permit, exceed or will exceed any of the limitations in subsection (2), above.

(4) The activities undertaken using this permit shall be taken into account in determining the post-development conditions for any subsequent exemption or permitting decision that includes the same project area.

Rulemaking Authority 373.044, 373.113, 373.118, 373.4131 FS. Law Implemented 373.413, 373.4131, 373.414, 373.416, 373.419 FS. History–New 10-1-13, Amended 6-1-18.

62-330.600 General Permit for the Construction of Artificial Reefs.

(1) A general permit is provided for the construction of an artificial reef by any person, provided:

(a) The material to be used shall be clean concrete or rock, clean steel boat hulls, other clean, heavy gauge steel products with a thickness of 1/4 inch or greater, and prefabricated structures that are a mixture of clean concrete and heavy gauge steel;

(b) The material shall be free of soils, oils and greases, debris, litter, putrescible substances or other pollutants;

(c) The material shall be firmly anchored to the bottom and shall not be indiscriminately dumped; and,

(d) The material shall be placed so that the top of the reef does not exceed 1/2 the distance from the bottom to the surface of the water unless a greater distance from the surface is required for safe navigation. At no time shall the distance between the top of the reef and the surface of the water be less than 6 feet.

(2) This general permit shall be subject to the following specific conditions:

(a) The permittee shall conduct a survey of the bottom of the waterbody on which the reef is to be built and shall submit the survey to the Agency with the notice required in rule 62-330.402, F.A.C., demonstrating that the bottom does not have submerged grassbed communities, shellfish or other hardbottom communities, or corals;

(b) There shall be no reefs constructed in bays, lagoons, or estuaries that are less than 12 feet deep;

(c) There shall be no "white goods" (inoperative and discarded refrigerators, freezers, ranges, water heaters, washers, and other similar domestic and commercial appliances), asphalt material, tires, other polluting materials used in construction of the reef;

(d) The site shall be marked with perimeter buoys during construction to ensure that no material is deposited outside of the site;

(e) The size of the boundaries within which the artificial reef is to be deposited shall not exceed 1/4 nautical mile on any side;

(f) The artificial reef site shall not be established within any shipping lanes; and,

(g) The permittee shall notify the National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Rockville, Maryland, and the Florida Fish and Wildlife Conservation Commission (FWC), Division of Marine Fisheries Management, via email at artificialreefdeployments@myfwc.com of the precise location of the reef within 30 days of placement of the reef material.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.600, Amended 10-1-13.

62-330.602 General Permit for Installation and Maintenance of Intake and Discharge Pipes Associated with Marine Bivalve Facilities.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.416, 373.418, 403.814(1) FS. History–New 10-3-95, Formerly 62-341.602, Amended 10-1-13, Repealed 11-26-15.

62-330.630 General Permit to U.S. Army Corps of Engineers for Environmental Restoration or Enhancement Activities.

(1) A general permit is granted to the U.S. Army Corps of Engineers for the construction, alteration, operation, and maintenance of systems to implement environmental restoration or enhancement projects. In order to qualify for this general permit, the decision documents for the environmental restoration or enhancement activity must have been coordinated through the process described in Section III of the *Interagency Coordination Agreement for Civil Works Projects, Florida Department of Environmental Protection, United States Army Corps of Engineers Jacksonville District, United States Army Corps of Engineers Mobile District* (February 28, 2006), incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03128). Copies of incorporated

material may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C. In addition, the environmental restoration or enhancement activity must be funded or conducted by the U.S. Army Corps of Engineers, and be authorized under the following documents, which are incorporated by reference herein:

(a) Section 204 of the Water Resources Development Act (WRDA) of 1992, as amended through January 24, 2002 (Beneficial Uses of Dredged Material), and any subsequent amendment by a WRDA through June 1, 2018, (https://www.flrules.org/Gateway/reference.asp?No=Ref-03224);

(b) Section 206 of the Water Resources Development Act of 1996, as amended through January 24, 2002 (Aquatic Ecosystem Restoration), as amended by a WRDA through June 1, 2018 (https://www.flrules.org/Gateway/reference.asp?No=Ref-03225);

(c) Section 1135 of the Water Resources Development Act of 1986, as amended through January 24, 2002 (Project Modifications for Improvement of the Environment), as amended by a WRDA through June 1, 2018, (https://www.flrules.org/Gateway/reference.asp?No=Ref-03226).

(d) Section 101(8) of WRDA 1992 (Kissimmee River Restoration), as amended by a WRDA through June 1, 2018, (http://www.flrules.org/Gateway/reference.asp?No=Ref-03130); or

(e) The Army Corps Federal portion of any project approved as part of the "Estuaries and Clean Waters Act of 2000" (Title I, PL 106-457) (ERA), Sections 102(3), 104(a), and 110(b) and amended by Section 5017 of WRDA 2007, and any subsequent amendment by a WRDA through June 1, 2018, (https://www.flrules.org/Gateway/reference.asp?No=Ref-02600).

(2) The following shall not be eligible for this general permit; copies of the materials incorporated by reference below may be obtained from the Agency, as described in subsection 62-330.010(5), F.A.C.:

(a) Activities on the sandy beaches of Florida fronting the Atlantic Ocean, the Gulf of Mexico or the Straits of Florida that extend seaward of the mean high water line, including beach restoration, nourishment, disposal of dredged material, beach or inlet structures, or excavation;

(b) Activities proposed to implement mitigation for another activity that requires a permit under part IV of chapter 373, F.S., a water quality certification, or coastal zone consistency concurrence;

(c) Activities that involve replacing a natural biological community type with a different type of biological community, such as filling bay bottom to create a marsh, except:

1. To restore or enhance a community that was previously damaged or destroyed by human activities, such as filling a dredged channel to the elevations and community types that existed before dredging; or

2. To restore or enhance a community type that was previously existing, but has been lost through avulsion when it is determined to be in the public interest; or

3. To reduce or eliminate populations of exotic and nuisance species with the goal of enabling replacement by natural, endemic communities;

(d) Activities that adversely affect animal species that are listed as endangered, threatened or of special concern and endangered or threatened plant species when such plants are located in a wetland or other surface water;

(e) Activities that would adversely affect historic properties listed in or eligible for listing in the National Register of Historic Places under the provisions of section 267.061, F.S.;

(f) Activities requiring a permit under section 373.1502, F.S., or authorized under Section 528 of the Water Resources Development Act of 1996, Public Law 104-303 (Critical Restoration Projects), October 12, 1996, which is incorporated by reference herein (https://www.flrules.org/Gateway/reference.asp?No=Ref-02602);

(g) Activities authorized under Section 101(8) of the Water Resources Development Act of 1992, Public Law 102-580, (October 31, 1992), which is incorporated by reference herein (http://www.flrules.org/Gateway/reference.asp?No=Ref-03127); or

(h) Activities conducted in association with Everglades or Lake Okeechobee restoration.

(3) Prior to submittal of the notice to the agency to use this general permit as required and described in paragraph (5)(a), below, the environmental restoration or enhancement activity must be included in a Feasibility Report, Reevaluation Report, Letter Report or other equivalent federal environmental decision document that has been reviewed by the state of Florida. Documentation that the state has found the environmental restoration or enhancement activity to be consistent with the Florida Coastal Management Program must be submitted with the notice to use this general permit. It is not necessary that the report types cited above be considered final or approved by the Corps.

(4) Activities under this general permit are subject to the following additional provisions and limitations. The activities:

(a) Shall not be available for use as future mitigation credit for a separate activity that requires a permit under part IV of chapter

373, F.S., a water quality certification, or a coastal zone consistency concurrence;

(b) Must be conducted in a manner that will not adversely affect the value of functions provided to fish and wildlife by wetlands or other surface waters;

(c) Must not cause adverse flooding to onsite or off-site property, adverse impacts to existing surface water storage or conveyance capabilities, adverse secondary impacts to the water resources, adverse impacts to the maintenance of surface or ground water levels or surface water flows established pursuant to section 373.042, F.S., adverse impacts to a Works of the District established pursuant to section 373.086, F.S., or adverse effects to properties outside the area to be enhanced or restored;

(d) Must be capable, based on generally accepted engineering and scientific principles, of being performed and of functioning as proposed, and must comply with any applicable special basin and geographic area criteria established in chapter 40C-41 or 40E-41, F.A.C., both of which are incorporated by reference in paragraph 62-330.301(1)(k), F.A.C.; and

(e) Must not be for the primary purpose of providing or enhancing recreation or other public uses of the lands that are enhanced or restored under this general permit, although such areas are not prohibited from being made available for compatible public recreation activities. However, the construction, alteration, operation, removal, maintenance, or abandonment of public recreational facilities, such as parking lots, roads, trails, boardwalks, docks, piers, observation decks, kiosks, and visitor's centers, or any project serving those facilities, are not authorized under this general permit, and must be authorized in accordance with part IV of chapter 373, and chapters 253 and 258, F.S., prior to their construction and use.

(5)(a) The notice required in rule 62-330.402, F.A.C., shall be supplemented with:

1. A copy of the Coastal Zone Consistency Concurrence documentation referenced in subsection (3), above;

2. Documentation of the approved federal authorization under which funding is expected;

3. Copies of the environmental documents that have been developed as part of the early coordination process described in Section III of the *Interagency Coordination Agreement for Civil Works Projects, Florida Department of Environmental Protection, United States Army Corps of Engineers Jacksonville District, United States Army Corps of Engineers Mobile District,* dated February 28, 2006, incorporated by reference in subsection (1), above; and

4. Should the Corps' contractors propose to use flocculating agents such as polymers or alum to consolidate sediments or to otherwise prevent potential water quality violations associated with the project design, the Corps shall coordinate with the Agency in advance of submittal of the notice to use this general permit, and shall submit with the notice reasonable assurance that use of such flocculating agents is not likely to cause chronic or acute toxicity in violation of chapter 62-302, F.A.C., as tested using, at a minimum, elutriate analysis on the specific sediments dredged from or deposited at the project site that require treatment.

5. Should the Corps' contractors identify that a mixing zone for turbidity is required to prevent potential water quality violations associated with the project, the Corps shall coordinate with the Agency in advance of submittal of the notice to use this general permit to discuss the methods proposed that will provide reasonable assurance that there will be no violation of the turbidity standards in chapter 62-302, F.A.C., and, as applicable in rule 62-4.242, F.A.C., outside of the limits established in subsection 62-4.244(5), F.A.C. When the Agency determines that such mixing zone will not cause adverse impacts to the water resources, the Corps will include in the notice to use this general permit a specific request for such a mixing zone and the methods that will be used to comply with its limitations. Projects that require a mixing zone in excess of that allowed under subsection 62-4.244(5), F.A.C., shall not qualify for this general permit.

(b) The Department will provide written notification to the U.S. Army Corps of Engineers whether the proposed activity qualifies for this general permit within 30 days of submittal of the written notice, or 30 days after submittal of any errors or omissions needed to correct the notice, as provided in rule 62-330.402, F.A.C. The proposed activity shall not commence until the Department has provided affirmative, written confirmation that the proposed activity qualifies for this general permit.

Rulemaking Authority 373.026, 373.043, 373.044, 373.118, 373.406, 373.4131, 373.414(9) FS. Law Implemented 373.026, 373.043, 373.046, 373.118, 373.403, 373.413, 373.4131, 373.414(9), 373.416, 373.418, 373.419, 373.422, 373.423, 373.426, 403.814(1) FS. History–New 12-5-06, Formerly 62-341.486, Amended 10-1-13, 6-1-18.

62-330.631 General Permit to Governmental Entities for Limited Environmental Restoration or Enhancement Activities.

(1) A general permit is granted to governmental entities to construct, operate, alter, or maintain projects for environmental restoration or enhancement, subject to the limitations and conditions of this section. For purposes of this rule, "environmental restoration and enhancement" means activities conducted to improve the habitat value of wetlands or surface waters for fish and wildlife by eliminating harmful drainage, improving water quality, preventing erosion, stabilizing eroding shorelines, planting

wetland vegetation, removing spoil, removing exotic and nuisance vegetation, providing structural habitat, and restoring dredged holes to elevations before they were dredged. The following activities are authorized:

(a) Restoration of an eroding shoreline or the enhancement of a disturbed or altered shoreline by planting appropriate native vegetation in accordance with the following:

1. Preparing grades and contours for planting with no net addition or removal of material.

2. Plantings shall consist of native wetland plant species obtained from commercially-grown stock that is native to the geographic area of the project.

3. All invasive and exotic plant species that occur along the shoreline within the project area are removed in conjunction with the planting.

4. If temporary wave attenuation is needed to protect and ensure survivability of the plantings, turbidity curtains shall be installed and maintained immediately waterward of, and parallel to, the planting area, but must be removed within three months after completion of planting.

5. If permanent wave attenuation is required to maintain shoreline vegetation, an oyster reef or riprap breakwater is authorized to be constructed within tidal waters concurrent with the planting, provided that:

a. The breakwater shall not impede navigation or create a navigational hazard. The outer edge of the breakwater shall be located no more than 15 feet waterward of the mean high water line and have a top height of one foot or less above the mean high water elevation.

b. The breakwater shall be composed of riprap or natural oyster shell cultch such as clean oyster shell and fossilized oyster shell, or combination thereof. Oyster shell shall be packaged within biodegradable bags (e.g., coir fiber) or mesh bags, or securely attached to matting prior to placement in the water to prevent movement of shell out of the project area.

c. The breakwater shall be placed in units so that there is at least one opening measuring at least five feet in width located every 75 linear feet along the breakwater, with a minimum of one opening to allow the flow of water, and the passage of fish and aquatic wildlife.

d. If the breakwater and plantings are located in front of an existing seawall or bulkhead, placement of clean fill for the sole purpose of planting wetland vegetation is authorized, provided that stabilizing riprap or an oyster reef breakwater supports the fill at no more than a two horizontal to one vertical slope and the total area of fill is less than one acre.

(b) Placement of riprap or clean oyster shell, underlain with geotextile filter fabric, within 10 feet waterward of the mean or ordinary high water line of an eroding shoreline. Oyster shell shall be packaged within mesh bags, or securely attached to matting prior to placement in the water to prevent movement of shell out of the project area. Where the shoreline is undercut, sandbags or geotubes filled with sand or hardened concrete placed over geotextile fabric are authorized to prepare the slope for placement of the riprap or oyster shell.

(c) Backfilling, plugging, or installation of weirs within existing drainage ditches or swales, without piping, for the purpose of restoring the hydroperiod of wetlands or other surface waters, and/or the groundwater in uplands, within publicly-owned lands, provided the ditches to be filled are not connected to upstream offsite ditches or canals. Any proposed backfilling, plugging or weir installation shall be supported by a determination, signed and sealed by a registered professional, that such activities will not cause adverse flooding to off-site property.

(d) Scrape down of spoil islands to an intertidal elevation or a lower elevation at which light penetration is expected to allow for seagrass or other native submerged aquatic vegetation recruitment, provided the total area does not exceed 10 acres.

(e) Backfilling of existing dredge holes that are at least five feet deeper than surrounding natural grades to an elevation which is expected to allow for seagrass recruitment, with no displacement of highly organic sediments, provided the total area does not exceed 10 acres.

(f) Placement of rock riprap or clean concrete in existing dredge holes that are at least five feet deeper than surrounding natural grades to enhance habitat values, provided that placed rock or concrete does not extend to within one foot of surrounding natural grades, and the total area does not exceed five acres.

(g) Removal of exotic and nuisance species to allow for the activities listed in paragraphs (1)(a) through (d), above.

(h) Restoration of prop scars and blow holes through previously vegetated grassbeds, including use of sand-filled bags to restore historical natural grades and replanting of seagrass collected from upland nursery sources or donor sites previously permitted under part IV of chapter 373, F.S., for this purpose. Bird stakes may be temporarily placed within the restoration area to promote seagrass growth in settings where, based on best available scientific information, the Agency determines that phosphorus is a limiting nutrient

for seagrass growth. Bird stakes, if used, shall be installed no closer than six feet apart and shall be removed within 18 months of initial placement.

(2) To qualify for this general permit, the activity must comply with all the following:

(a) The project shall not be considered as mitigation for any other activity.

(b) The project shall not be located within an Aquatic Preserve.

(c) The project shall not include placement of fill, riprap, or any type of breakwater over or within three feet of an area of greater than one percent coverage by emergent or submerged natural resources, or placement of fill material within smalltooth sawfish critical habitat, as designated by the U.S. National Marine Fisheries Service. For purposes of this general permit, the term "emergent or submerged natural resources" includes freshwater and marine herbaceous and forested wetland vegetation, seagrass, coral, sponge, oyster beds, and other submerged aquatic vegetation.

(d) The governmental entity shall submit scaled and dimensioned project plans, signed and sealed by a registered professional, showing the entire project area and all proposed activities within the project area. In addition, project plan-view drawings shall be submitted showing the locations of all existing emergent and submerged natural resource communities, however, these community-depiction drawings are not required to be signed and sealed by a registered professional.

(e) Emergent or submerged natural resources, and other fresh water or marine ecological communities shall not be adversely affected and the ecology of such communities shall directly benefit from the authorized activity, as affirmatively agreed to by the Agency after review of the submitted notice and project plans. To facilitate this review, a pre-application meeting with the Agency must be held in advance of submitting notice to use this general permit.

(3) This general permit shall be subject to the following specific conditions.

(a) All disturbed areas, including intertidal slopes, shall be stabilized and re-vegetated with appropriate non-invasive, annual ground cover vegetation within 72 hours after completion of construction. Subsequently, the areas shall be planted and maintained as necessary to ensure that there is at least 33 percent cover of planted or naturally re-established native wetland or upland plant species within 18 months of completion of authorized work. The areas shall also be maintained free of exotic invasive species.

(b) Riprap material shall be clean limestone, granite, other native rock, or clean rebar-free concrete rubble measuring one foot to three feet in diameter.

(c) Except as otherwise allowed under this general permit, fill material used to backfill dredge holes or planting areas shall comply with the standard of not more than 10 percent of the material passing through a number 200 standard sieve and containing no more than 10 percent organic content, and be free of contaminants that cause violations of state water quality standards.

(d) Turbidity shall be monitored at least twice daily during construction. Monitoring records shall be maintained and available for inspection by the Agency for the period of in-water construction and an additional 90 days beyond in-water construction.

Rulemaking Authority 373.044, 373.113, 373.118, 373.171, 373.4131 FS. Law Implemented 253.034(1), 373.118, 373.406(5), 373.4131, 373.414(9), 403.814(1) FS. History–New 10-1-13, Amended 6-1-18.

62-330.632 General Permit for the Restoration, Establishment and Enhancement of Low Profile Oyster Habitat.

(1) A general permit is hereby provided for the construction, restoration, and enhancement of low profile oyster habitat (LPOH) within estuaries, lagoons, or other tidal waters, subject to the following:

(a) The total footprint of the LPOH is one quarter acre in size or less;

(b) The work shall be conducted or directly supervised by persons having expertise designing and implementing oyster habitat restoration activities;

(c) The LPOH shall not be inconsistent with any management plan approved by a federal, state, regional and/or local agency that addresses oyster habitat, wetland vegetation, submerged resources, water quality, navigation, or fishing and recreational values of the waterbody, including any Aquatic Preserve management plan adopted under chapter 18-20, F.A.C.;

(d) The LPOH shall not be considered as mitigation to offset impacts for any other project;

(e) The LPOH shall not serve or include any aquaculture activity regulated under chapter 597, F.S.; and

(f) The LPOH shall not adversely affect existing natural resources or resource activities within or adjacent to the footprint of the proposed LPOH footprint.

(2) The notice required in rule 62-330.402, F.A.C., shall include documentation, statements, or demonstrations that the above limitations will be met, together with the following:

(a) An explanation of the overall ecological benefit to be achieved by the LPOH;

(b) Documentation that the person using this general permit has authorization from the owner(s) of the submerged lands, if other than the State of Florida, to conduct the proposed activities;

(c) An environmental resource survey of the bottom of the waterbody throughout the LPOH area, including an additional 50 foot-wide perimeter surrounding the LPOH area demonstrating that:

1. The LPOH area, including the 50 foot-wide perimeter area, does not have any submerged aquatic vegetation or hardbottom resources present;

2. The LPOH will not affect an archaeological, cultural, or historical resource area regulated under chapter 267, F.S.;

3. The LPOH will not have any work conducted within 100 meters of actively nesting wading bird colonies or within 180 meters of actively nesting tern or skimmer colonies;

4. The LPOH will not be constructed within:

a. 100 feet from the outside edge of any designated channel marked in accordance with section 327.40 F.S. or federally maintained channel without written approval from the entity responsible for channel maintenance;

b. Any channel traditionally used for navigation;

c. 100 feet of any dock or overwater structure without notice to the current property owner;

d. Any other designated management zone that requires approval to conduct activities unless written approval is received from the managing agency; or

e. Any previously permitted mitigation areas.

(d) Agreement that the activity will comply with the additional conditions of subsection (3), below.

(3) All work under this general permit shall be conducted in conformance with the following specific conditions:

(a) LPOH materials shall consist of only the following:

1. Clean, sediment free culture materials (cultch) that does not contain deleterious substances that have the potential to leach into surface waters. Cultch shall consist of:

a. Recycled shell that has been quarantined for a minimum of three months;

b. Fossil shell;

c. Limerock consisting of a minimum of 20 percent calcium carbonate by volume, with 90 percent of the limerock being no more than six inches in diameter; or

d. Concrete material in which at least 90 percent of the concrete material is no more than six inches in diameter. Concrete shall not be used for a LPOH located in an Aquatic Preserve.

2. Cultch that was intentionally placed in marine or estuarine waters for a period of time to collect oyster larvae, or seedstock (juvenile shellfish species) that has been cultured and placed in marine or estuarine waters for growout; or

3. Cultch or seedstock that has been generated as a result of shellfish aquaculture activities in accordance with section 597.010, F.S.

(b) LPOH materials shall be firmly fixed on the substrate, bagged, or otherwise contained in such a way as to prevent movement away from the LPOH footprint.

(c) LPOH materials shall not be indiscriminately dumped, placed on substrate with more than five live oysters per square meter, or placed outside of the footprint limits.

(d) The LPOH may consist of placement of LPOH materials in locations where no oyster reef currently exists, restoration of an existing degraded oyster reef to its known historical height, or restoration of an existing degraded oyster reef to the average elevation of existing natural oyster reefs in the immediate vicinity of the LPOH area. Final elevation shall not exceed 18 inches above the existing bottom elevation in locations where no oyster reef currently exists. In no circumstance shall LPOH material be placed at a height above the mean high water elevation.

(e) The LPOH shall not cause harmful erosion or shoaling to adjacent submerged areas and shorelines.

(f) The LPOH shall not cause adverse impacts to the fishing and recreational use of the waterbody, aquatic and wetland dependent species, or submerged resources.

(4) A minimum of 60 days prior to submittal of a notice required in subsection (2), above, the person proposing to use this general permit shall conduct at least one pre-notice meeting with the appropriate Agency staff to discuss the project. If the LPOH is proposed within an Aquatic Preserve, the manager of that preserve or their designee shall be invited to the pre-notice meeting.

(5) The activities authorized in this general permit shall not commence until the Agency has provided written verification of qualification in accordance with section 5.3.2 of Applicant’s Handbook, Volume I.

Rulemaking Authority 373.044, 373.113, 373.118, 373.171, 373.4131 FS. Law Implemented 253.034(1), 373.118, 373.406(5), 373.4131, 373.414(9), 403.814(1) FS. History–New 10-1-13, Amended 6-1-18.

62-330.635 General Permit for Soil Remediation.

(1) A general permit is granted to conduct soil removal activities, including installation of wells and work in wetlands and other surface waters necessary to perform soil remediation as part of a Remedial Action Plan approved by the Department. This includes construction, alteration, operation, and removal of a temporary access road for access to conduct this work, subject to the following conditions.

(a) Removal of contaminated soil is limited to no more than a total of five acres of wetlands.

(b) Temporary fill and materials for equipment access shall be removed immediately following completion of the remediation work.

(c) Any wetland area affected by the work shall be restored to pre-construction wetland elevations within 30 days following completion of the work, using sediments consisting of the same soil textural material as the original pre-construction soil material that is also free of vegetated debris, rebar and any other solid waste materials.

(d) Any muck removed from wetlands for construction of temporary fill roads shall be stockpiled in uplands and used in restoring the affected area to wetland conditions and preconstruction wetland elevations, unless this material is required to be removed as part of the remediation plan.

(e) Within seven days of completion of restoration of pre-construction wetland elevations, all wetland areas shall be re-vegetated with native wetland species endemic to adjoining, undisturbed wetlands or the underlying wetland community type historically occurring at the site. The restored wetland areas shall be maintained and planted as necessary to ensure that at least 33 percent cover of planted or naturally reestablished native wetland plant species is appropriate for the wetland community type within 18 months of completion of authorized work. Exotic invasive species, including but not limited to: *Schinus terebinthifolius*, *Melaleuca quinquenervia*, *Casuarina* spp., *Lygodium* spp., and nuisance species *Typha* spp., and *Ludwigia peruviana* shall be controlled at densities not exceeding the densities of these species in undisturbed portions of the wetland.

(f) In addition to compliance with the notice provisions of rule 62-330.402, F.A.C., within 60 days following completion of construction, the permittee will notify the Agency by letter of the date construction activities were completed.

(g) All contaminated soils removed from the site shall be disposed of in an appropriate disposal facility, in accordance with the Remedial Action Plan approved by the Department.

Rulemaking Authority 373.026(7), 373.043, 373.118(1), 373.406(5), 373.4131, 373.414(9), 373.418, 403.805(1) FS. Law Implemented 373.118(1), 373.406(5), 373.413, 373.4131, 373.414(9), 373.418, 376.3071, 403.814(1) FS. History–New 10-1-13, Amended 6-1-18.

62-330.901 Noticed General Permit Forms.

Rulemaking Authority 373.026(7), 373.043, 373.118, 373.406(5), 373.414(9), 373.4145, 373.418 FS. Law Implemented 373.118, 373.406(5), 373.413, 373.414(9), 373.4145, 373.416, 373.418, 373.426 FS. History–New 9-4-05, Amended 10-1-07, Formerly 62-341.900, Repealed 10-1-13.

CHAPTER 40C-1
(Selected Rules as of 6/1/18)

40C-1.1001 Applicability of the Uniform Rules of Procedure
40C-1.1005 Time for Consideration of Emergency Petition for Variances
40C-1.1007 Point of Entry Into Proceedings
40C-1.1008 Timeframe for Providing Requested Information
40C-1.1009 Emergency Authorization for Activities Regulated Under Part IV of Chapter 373, F.S
40C-1.135 Delegations of Authority
40C-1.602 Licenses or Permits Required
40C-1.603 Permit Fees
40C-1.607 Issuance of a License or Permit
40C-1.608 Denial of a License or Permit
40C-1.612 Transfer of Ownership or Permit

40C-1.1001 Applicability of the Uniform Rules of Procedure.
Except as otherwise provided, the Uniform Rules of Procedure, Chapters 28-101 through 28-110, F.A.C., shall apply to the District.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 120.54(5) FS. History–New 8-4-98.

40C-1.1005 Time for Consideration of Emergency Petition for Variances.
When a petition for an emergency variance or waiver under Section 120.542(3), F.S., and Rule 28-104.005, F.A.C., requires action by the Governing Board, the Board shall grant or deny a petition for emergency variance or waiver within 30 days of its receipt or at the next regularly scheduled meeting for which notice may be properly given.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 120.542 FS. History–New 8-4-98.

40C-1.1007 Point of Entry Into Proceedings.
(1) For all District permitting decisions, the District shall publish, or inform a permit applicant that the applicant has the right or obligation to publish, written notice of a District decision in the Florida Administrative Register or a newspaper of general circulation as set forth in Chapter 50, F.S., in the county or counties affected by such decision or where the activity is proposed. In the case of a permitting decision where the District does not publish notice, the applicant may publish the notice on its own initiative.

(2)(a) "Receipt of written notice of a District decision" as set forth in Rule 28-106.111, F.A.C., means receipt of either written notice that the District intends to take or has taken final agency action, or publication of notice that the District intends to take or has taken final agency action. If the District's Governing Board takes action which substantially differs from a written notice of the District's decision describing intended action, persons who may be substantially affected shall have an additional 21 days, or for consolidated notice of intent under Section 373.427, F.S., an additional 14 days, from the date of receipt of notice of said action to request an administrative hearing, but this request for administrative hearing shall only address the substantial deviation.

(b) Receipt of written notice of a District decision shall be deemed to be either the fifth day after the date on which the written notice is deposited in the United States mail if actual notice is mailed to the petitioner, or the date that notice is published if actual notice is not mailed to the petitioner.

(3) When publication is made of the written notice of a District decision on a permitting matter, the notice, shall be prepared by the District and shall contain at a minimum:

(a) Name of applicant and a brief description of the proposed activity and its location;

(b) Location of the application and its availability;

(c) Statement of the District's intended action;

(d) Scheduled date of Board action, if applicable;

(e) Notification of administrative hearing opportunity; and

(f) Notification of whether mediation under Section 120.573, F.S., is available as an alternative remedy.

(4) When the District requires a permit applicant to publish written notice of a District decision, or the permit applicant elects to do so, the applicant shall provide an affidavit of publication to the District within 7 days of publication.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 120.569, 373.413 FS. History–New 8-4-98.

40C-1.1008 Timeframe for Providing Requested Information.

(1) The applicant shall have 90 days from receipt of a request for additional information regarding a permit or license application, a petition for a formal determination of the landward extent of wetlands and other surface waters, or a petition for a variance or waiver undergoing review by the District to submit that information to the District. If an applicant or petitioner requires more than 90 days in which to complete an application or petition, the applicant or petitioner may notify the District in writing of the circumstances and for good cause shown, the application or petition shall be held in active status for additional periods commensurate with the good cause shown. As used herein, good cause means a demonstration that the applicant or petitioner is diligently acquiring the requested information, and that the additional time period requested is both reasonable and necessary to supply the information. The Executive Director, the Director of the Division of Regulatory Services, the Chief of the Bureau of Environmental Resource Regulation, the Chief of the Bureau of Water Use Regulation, and any Regulatory Coordinator are authorized to make a determination that such good cause has been provided. Any application or petition which has not been completed by the applicant or petitioner within the given time period following a request for additional information by the District shall be administrately denied. The requested information or written request showing good cause for additional time may be submitted to the District at any time prior to the denial of the application or petition. Denial of an application or petition due to failure to submit requested additional information shall be an administrative denial without prejudice to the applicant's or petitioner's right to file a new application or petition. The applicant or petitioner may request a Section 120.569, F.S., hearing pursuant to Chapter 28-106, F.A.C. and Rule 40C-1.1007, F.A.C., to dispute the necessity of the information required.

(2) If requested information is not submitted to the District within the time limits set forth in subsection (1) above, the District shall provide notice to the applicant or petitioner that the District intends to administratively deny the application or petition and that the applicant or petitioner may request referral of the application or petition to the Governing Board for final action. If an applicant or petitioner requests a referral within 21 days of receipt of written notice of a District decision, the application or petition shall be referred to the Governing Board for final action. Applications and petitions not referred to the Governing Board will be denied by staff issuance of a Final Order administratively denying the permit application or petition.

Rulemaking Authority 120.54(5), 120.542, 373.044, 373.113, 373.421(2) FS. Law Implemented 120.54(5), 120.542, 120.60, 373.083(5), 373.118, 373.414(17), 373.421(2) FS. History–New 8-4-98, Amended 1-11-99, 4-10-02, 6-1-18.

40C-1.1009 Emergency Authorization for Activities Regulated Under Part IV of Chapter 373, F.S.

(1) Permission to begin construction, alteration, operation, maintenance, abandonment, or removal of any system requiring a permit under Chapter 40C-44 or 62-330, F.A.C., prior to the issuance of a permit may be applied for, in writing, when emergency conditions can be alleviated by such construction, alteration, operation, maintenance, abandonment, or removal of the system. Emergency conditions are defined as conditions which pose a present or imminent danger and require immediate action to protect: public health, safety or welfare; the health of animals, fish or aquatic life; a public water supply; or recreational, commercial, industrial, agricultural or other reasonable uses. Unless otherwise provided in the emergency authorization, the issuance of an emergency authorization shall not obviate the need for a permit. If a permit is not obtained within a period of one year following execution of the emergency authorization, then such system shall be returned to the condition that existed prior to execution of the emergency authorization. The one year time limit shall be tolled during any challenge or appeal of the permit which delays the issuance of the permit or stays the effect of the permit.

(2) The Governing Board authorizes the Executive Director to issue emergency authorizations. An emergency authorization issued by the Executive Director shall be presented to the Board for concurrence at its next meeting. The failure to receive the Board's concurrence shall invalidate the emergency authorization.

Rulemaking Authority 120.54(5), 373.044, 373.113, 373.418 FS. Law Implemented 120.54(5), 373.119, 373.413, 373.4131, 373.416, 373.418, 373.426, 373.439 FS. History–New 12-7-83, Formerly 40C-4.451, 40C-4.0451, Amended 8-4-98, 10-11-01, 10-1-13.

40C-1.135 Delegations of Authority.

(1) The District is delegated authority by the Department to assume certain responsibilities of Chapters 373 and 403, F.S. This delegation is pursuant to authority contained in Sections 373.016, 373.103 and 403.805(1), F.S., and is described in Rule 62-113.200, F.A.C.

(2) The Board of Trustees of the Internal Improvement Trust Fund, pursuant to Rule 18-21.0051, F.A.C., has delegated to the Governing Board the authority to review and take final agency action on certain applications to use sovereign submerged lands. Rule 18-21.0051, F.A.C., also provides that the Governing Board may further delegate review and decision making authority to District staff. Therefore, the Governing Board delegates this authority to the Executive Director, Director of the Division of Regulatory Services, Chief of the Bureau of Environmental Resource Regulation, and each Regulatory Coordinator, when an application to use sovereign submerged lands involves an activity which is reviewed pursuant to the general permit procedures of Chapter 62-330, F.A.C.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.016, 373.103, 373.113, 373.118, 373.4131 FS. History–New 8-1-89, Amended 1-4-96, 11-11-03, 10-1-13, 6-1-18.

40C-1.602 Licenses or Permits Required.

Unless expressly exempted by law or District rule, permits or licenses must be obtained from the District prior to commencement of the following activities:

(1) A consumptive use permit, pursuant to Chapter 40C-2, F.A.C., must be obtained prior to certain diversions or withdrawals of water as specified in Chapter 40C-2, F.A.C.

(2) A well construction permit, pursuant to Chapter 40C-3, F.A.C., must be obtained prior to construction, repair or abandonment of certain water wells as specified in Chapter 40C-3, F.A.C.

(3) A water well contractor's license, pursuant to Chapters 40C-3 and 62-531, F.A.C., in effect on July 1, 1989, must be obtained by contractors engaged in the business of construction, repair, or abandonment of water wells.

(4) An environmental resource individual or general permit, pursuant to Chapter 62-330, F.A.C., must be obtained prior to construction, alteration, operation, maintenance, removal, modification, or abandonment of certain stormwater management systems, dams, impoundments, reservoirs, appurtenant works or works, including dredging or filling, as specified in Chapter 62-330, F.A.C.

(5) An environmental resource conceptual approval permit, pursuant to Chapter 62-330, F.A.C., may be obtained for proposed surface water management systems as specified in Chapter 62-330, F.A.C.

(6) A permit, pursuant to Chapter 40C-5, F.A.C., prior to construction of any well involving artificial recharge or intentional introduction of water containing sewage wastes into any underground formation.

(7) An environmental resource permit for the operation and maintenance of certain existing agricultural surface water management systems and for the construction of certain new agricultural surface water management systems pursuant to Chapters 62-330 and 40C-44, F.A.C., must be obtained from the District in order to discharge wastewater into waters of the state from such a system.

(8) A mitigation bank permit, pursuant to Chaper 62-342, F.A.C., must be obtained in order to establish a mitigation bank. An application for a mitigation bank permit shall also constitute an application for any permit required under Chapter 62-330, F.A.C., to construct, alter, operate, maintain, abandon, or remove any stormwater management system or works proposed as part of the bank.

(9) A mitigation bank conceptual approval permit, pursuant to Chapter 62-342, F.A.C., may be obtained in order to estimate the legal and financial requirements for establishment of a mitigation bank, the information needed for the mitigation bank application, and the potential mitigation credits for the bank. A mitigation bank conceptual approval permit does not authorize construction or establishment of a bank.

Rulemaking Authority 120.53(1), 373.044, 373.113 FS. Law Implemented 373.085, 373.103, 373.106, 373.118, 373.171, 373.219, 373.308, 373.323, 373.413, 373.4131, 373.416, 373.426, 403.812 FS. History–New 1-22-76, Amended 1-15-80, Formerly 16I-1.04, 40C-1.04, 40C-1.041, Amended 8-1-89, 8-11-91, 9-25-91, 10-3-95, 11-11-03, 10-1-13.

40C-1.603 Permit Fees.

A fee is required and shall be paid to the District when certain applications or petitions are filed pursuant to District rules or permit programs delegated to the District. Effective October 1, 1990, governmental entities shall be required to submit the fees established except as provided in subsections (17), (18) or (19). This fee recovers some of the District's costs of processing applications.

The fee schedule is:

(1) Chapter 40C-2, F.A.C., consumptive use permits:

(a) Applications for consumptive use permits.

1. Consumptive use permits greater than 500,000 gallons of water per day	$1,000
2. Consumptive use permits equal to or less than 500,000 gallons of water per day	$ 400
3. Consumptive use permits less than 100,000 gallons of water per day	$ 100
4. Consumptive use permits where the use does not exceed the thresholds in subsection 40C-2.041(1), F.A.C.	$ 50

(b) Modifications of consumptive use permits.

1. Consumptive use permits where the total allocation requested (existing plus any proposed increase) is greater than 500,000 gallons of water per day	$ 200
2. Consumptive use permits where the total allocation requested (existing plus any proposed increase) is equal to or less than 500,000 gallons of water per day	$ 100
3. Consumptive use permits where the total allocation requested (existing plus any proposed increase) is less than 100,000 gallons of water per day	$ 50
4. Consumptive use permit where the use does not exceed the thresholds in subsection 40C-2.041(1), F.A.C.	$ 25

5. No fee will be charged for early renewal of an existing permit for implementation of a project that provides a water quantity benefit to a water resource.

6. No fee will be charged for modification of an existing permit applied for by letter pursuant to Rule 40C-2.331, F.A.C., regardless of withdrawal amount.

(2) Chapter 40C-3, F.A.C., well construction, repair or abandonment permit.

(a) Public water supply well	$ 250
(b) All other wells	$ 120
(c) Abandonment of a well	$ 0
(d) Variances	$ 100

(3) Chapter 62-330, F.A.C., individual or conceptual environmental resource permits (excluding mitigation bank permits):

(a) New applications (excluding projects described in paragraphs (3)(b) and (3)(c) below) – based on the categories below:

1. Project with no works in, on, or over wetlands and other surface waters, no boat slips, and:	
a. Total project area of less than 10 acres	$ 490
b. Total project area of more than 10 acres but less than 40 acres	$1,190
2. Total project area of less than 10 acres, less than 1 acre of works in, on, or over wetlands and other surface waters, and less than 10 new boat slips	$1,190
3. Project exceeds any of the thresholds in subparagraph (3)(a)2. above, but involves a total project area of less than 40 acres, less than 3 acres of works in, on, or over wetlands and other surface waters, and less than 30 new boat slips	$2,110
4. Project exceeds any of the thresholds in subparagraph (3)(a)3. above, but involves a total project area of less than 100 acres, less than 10 acres of works in, on, or over wetlands and other surface waters, and less than 50 new boat slips	$5,610
5. Project exceeds any of the thresholds in subparagraph (3)(a)4. above, but involves a total project area of less than 640 acres, and less than 50 acres of works in, on, or over wetlands and other surface waters	$5,610
6. Project exceeds any of the thresholds in subparagraph (3)(a)5. above	$9,120

7. When a project requires a Chapter 40C-44, F.A.C., environmental resource agricultural system permit with no works in, on, or over wetlands and other surface waters, the fee will be the same as the fee under subsection (10) below based on the acreage.

(b) New applications for environmental restoration or enhancement activities (not associated with a mitigation bank and not implemented as mitigation). For purposes of this fee category, "environmental restoration or enhancement" means actions designed and implemented solely to convert degraded or altered uplands, wetlands, or other surface waters back to communities typical of those historically present, or to improve the ecological value of wetlands or other surface waters in comparison to their existing condition. $ 250

(c) New applications solely for stormwater retrofit projects $ 250

(d) Major modifications of Chapter 62-330, F.A.C., individual or conceptual environmental resource permits (excluding mitigation bank permits):

1. Major modifications that are consistent with an existing conceptual approval permit	50% of the fee for a new permit under (3)(a) above for the activity proposed in the modification
2. Major modifications to a permit that increase the total project area	Same as fee for a new permit under (3)(a) above for the activity proposed in the modification
3. Other major modifications	50% of the fee for a new permit under (3)(a) above for the activity proposed in the modification

(e) Minor modifications of Chapter 62-330, F.A.C., individual or conceptual environmental resource permits (excluding mitigation bank permits):

1. Transfers or statutory extensions of permits and correction of minor errors that do not require technical review	$0
2. Other extensions	$200 or 25% of the fee for a new permit under (3)(a) above (whichever is less)
3. All other minor modifications	25% of the fee for a new permit under (3)(a) above for the activity proposed in the modification

(4) Mitigation Bank permits and conceptual approvals $11,960

(a) Major modifications of mitigation bank permits and conceptual approvals involving changes to one or more of the following components: service area; credit assessment; success or release criteria; hydrologic structures or alterations; constructions or mitigation design that does not increase the project area; elimination of lands; or monitoring or management plans $1,410

(b) Other major modifications that do not qualify for a modification under paragraph (4)(a), above, or paragraph (4)(e), below $4,230

(c) Minor modifications of mitigation bank permits and conceptual approvals:

1. Transfers or statutory extensions of permits; correction of minor errors that do not require technical review; mitigation bank credit withdrawals and releases $ 0

2. All other minor modifications authorized by subsection 62-330.315(2), F.A.C.	$ 270
(5) Chapter 62-330, F.A.C., general environmental resource permits set forth in Rules 62-330.407 through 62-330.635, F.A.C.	$ 250
(6) Variances or waivers associated with any environmental resource permit application:	
(a) Under Section 120.542, F.S.	$ 0
(b) All other variances or waivers	$ 550 or cost of application, whichever is less
(7) Formal Determinations:	
(a) For property less than 10 acres	$ 860
(b) For property that is at least 10 acres but less than 40 acres	$1,180
(c) For property that is at least 40 acres but less than 100 acres	$2,370
(d) For property that is greater than 100 acres, plus $310 for each additional 100 acres or portion thereof	$2,370
(e) For properties with an existing formal determination that qualify for reissuance in accordance with subsection 373.421(2), F.S.	$ 350
(f) For properties that had a formal determination, when submitted within 2 years after expiration of the formal determination, provided petitioner certifies there are no unpermitted alterations in physical conditions and no change in delineation methodology since issuance of prior formal determination, as confirmed by the District	50% of the fee under (7)(a)-(d) above

(8) Management and storage of surface waters permits under Chapters 40C-4 and 40C-40, F.A.C., as such rules existed prior to the adoption of rules adopted pursuant to Section 373.414(9), F.S., that are submitted pursuant to the grandfathering provisions of Sections 373.414(12) through (16), F.S.

(a) Individual and conceptual permits	$3,530
(b) General permits	$ 980

(c) Permit applications and formal determinations which require wetland delineations pursuant to Section 373.421(7), F.S., will be charged a supplemental application fee of seven hundred dollars ($700), in addition to the application fees above.

(9) Chapter 40C-5, F.A.C., artificial recharge injection well permits	$5,000

(10) Chapter 40C-44, F.A.C., environmental resource agricultural system permits that only require a permit under paragraph 62-330.020(2)(i), F.A.C., and section 1.2.3 of the document entitled “Environmental Resource Permit Applicant’s Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District,” which is incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C.:

(a) Individual Permits for agricultural operations less than 40 acres	$ 420
(b) Individual Permits for agricultural operations greater than 40 acres	$1,050

(11) Modifications of Permits. Unless the fee for modification of a permit is specifically provided above, the fee required with an application for modification shall be that which is established for the applicable type of permit. However, when an applicant for a permit under Chapter 62-330, F.A.C., resubmits within 365 days after withdrawing an application for an activity on part of the same project area for which it already paid the application fee, no fee shall be charged except for any additional fee required due to a change in the project. Additionally, the fee for letter modification of a permit issued pursuant to Chapter 40C-4, 40C-40, or 40C-42, F.A.C., before October 1, 2013 shall continue to be the following applicable fee, unless the permittee elects review in accordance with the rules adopted pursuant to Section 373.4131, F.S.:

(a) Chapter 40C-4, F.A.C., permits	$ 270
(b) Chapter 40C-40, F.A.C., permits	$ 160
(c) Chapter 40C-42, F.A.C., permits	$ 110

(12) Permit applications under Chapter 62-4, 62-312, 40C-4, 40C-40, 40C-42, or 40C-44, F.A.C., submitted and made complete prior to the effective date of the rules adopted pursuant to Section 373.4131, F.S., shall be required to submit the permit application fees in existence prior to October 1, 2013, unless the applicant elects review in accordance with the rules adopted pursuant to Section 373.4131, F.S.

(13) Application fees for authorizations on sovereign submerged lands under Chapters 253 and 258, F.S., are provided in Chapter 18-21, F.A.C.

(14) Informal Wetland Boundary determinations under Part IV of Chapter 373, F.S., for property less than or equal to 1 acre $ 100

(15) Verification that an activity is exempt from regulation:

(a) Under Rules 62-330.050 and 62-330.051, F.A.C. $ 100

(b) Under Rule 62-330.0511, F.A.C. $ 0

(16) The District shall use the Consumer Price Index, for All Urban Consumers (CPI-U), all items, complied by the United States Department of Labor for revising fees under Part IV of Chapter 373, F.S., pursuant to Section 373.109, F.S., and subparagraph 62-113.200(12)(a)8. and paragraph 62-4.050(4)(z), F.A.C.

(17) Pursuant to Section 218.075, F.S., the District shall, for each fiscal year beginning October 1st and ending September 30th, reduce all permit application fees to $100, or, if a permit application fee is less than $100, by 50 percent, for any county, municipality, or third party under contract with a county or municipality, to apply for a permit on the county or municipality's behalf, which qualifies under this subsection. A county, municipality, or third party as described above, may apply to reduce the permit application fees by submitting form 40C-1.603(13) entitled "Request to the St. Johns River Water Management District to Reduce Permit Application Fees," effective 11-11-03, which is hereby incorporated by reference and which can be obtained from St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529, for each fiscal year certifying:

(a) That the county had a population of 50,000 or less on April 1, 1994, and that the county's population has not yet exceeded 75,000, that the municipality has a population of 25,000 or less, or that the county or municipality is not included within a metropolitan statistical area; and

(b) All projects for which the fee reduction or waiver is sought will serve a public purpose; and

(c) The permit application fee cost is a fiscal hardship due to one of the following:

1. Per capita taxable value is less than the statewide average for the current fiscal year.

2. Percentage of assessed property value that is exempt from ad valorem taxation is higher than the statewide average for the current fiscal year.

3. Any condition specified in Section 218.503, F.S., that determines a state of financial emergency.

4. Ad valorem operating millage rate for the current fiscal year is greater than eight mills.

5. A financial condition that is documented in annual financial statements at the end of the current fiscal year and indicates an inability to pay the permit processing fee during that fiscal year.

(18) No fee shall be charged for applications for Chapter 62-330, F.A.C., permits by the following branches of the U.S. Department of Defense: U.S. Army, Navy, Air Force, Coast Guard, and National Guard.

(19) No fee shall be charged for applications for Chapters 40C-2, 40C-3, or 62-330, F.A.C., permits by the Florida Department of Environmental Protection or another water management district.

Rulemaking Authority 373.044, 373.109, 373.113, 373.421(2) FS. Law Implemented 218.075, 373.109, 373.4131, 373.421(2) FS. History–New 10-1-87, Amended 6-1-88, 10-17-88, Formerly 40C-1.202, Amended 8-1-89, 10-19-89, 8-19-90, 7-21-91, 7-23-91, 8-11-91, 9-25-91, 11-12-91, 10-20-92, 11-30-92, 1-6-93, 12-6-93, 1-23-94, 4-12-95, 1-4-96, 4-25-96, 10-2-96, 10-11-01, 4-10-02, 11-11-03, 2-1-05, 2-16-10, 10-1-13, 8-14-14, 11-1-15, 2-1-18, 6-1-18.

40C-1.607 Issuance of a License or Permit.

Where a license or permit requires Governing Board action, issuance of a license or permit is deemed to occur upon the approval by the Board.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.413, 373.4136, 373.416, 373.426 FS. History–New 8-1-89, Amended 8-4-98.

40C-1.608 Denial of a License or Permit.

(1) The District shall set forth in writing the reasons for denial of the license or permit application. For applications

for environmental resource permits, the District will also explain, in general terms, what changes in the permit application, if any, would address such reasons for denial. Such changes shall not be limited to those modifications as described in subsection 10.2.1 of the Applicant's Handbook Volume I (General and Environmental) which is incorporated by reference in subparagraph 40C-41.063(6)(d)4., F.A.C.

(2) When the license or permit is considered by the Board the applicant and other interested persons may appear before the Board to present informal argument for or against the intended District action. Such appearance before the Board shall not provide a basis for appealing the decision of the Board pursuant to Chapter 120, F.S.

(3) The Board may approve, reject or modify the intended District action. The Board's action shall constitute final agency action, except for those instances when a valid petition for an administrative hearing has been timely filed. In such instances, the Board shall defer final consideration of the matter pending completion of the administrative hearing and the submittal of a recommended order, if required, and exceptions thereto.

(4) Applicants and other interested persons should be prepared to explain their positions regarding the license or permit application when it is considered by the Board for final action. If the Board's final action differs substantially from the intended District action, the District shall mail a notice of final action to all persons who received a notice of intended District action. Substantially affected persons who did not request a Section 120.57, F.S., hearing based on the notice of proposed District action shall have the right to request such a hearing within 14 days of receipt of the notice of final action, otherwise such right is deemed waived. Such request for hearing shall be in accordance with subsection (4) above, and may only address those aspects of the final action which substantially deviate from the intended action.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.219, 373.308, 373.413, 373.4131, 373.4136, 373.416, 373.426 FS. History–New 8-1-89, Amended 10-3-95, 8-4-98, 10-1-13.

40C-1.612 Transfer of Ownership or Permit.

(1) Transfer of Ownership or Control. Within 30 days of any transfer of ownership or control of the real property at which any permitted facility, system or activity solely authorized under paragraph 62-330.020(2)(i), F.A.C., and section 1.2.3 of the document entitled "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," which is incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C., for a permit under Chapter 40C-44, F.A.C. (hereafter referred to as a "40C-44 system or activity"), or consumptive use is located or authorized, or transfer of ownership or control of any such facility, system, activity, or well with a permitted consumptive use, the permittee must notify the District in writing of the transfer, giving the name and address of the new owner or person in control and providing a copy of the instrument effectuating the transfer.

(2) Transfer of Permit.

(a) Transfer without Conversion to Operation Phase. To transfer a permit that does not involve a conversion of a construction permit for a 40C-44 system or activity to its operation phase, the permittee must provide the information required in subsection (1) above, together with a written statement from the proposed transferee that it will be bound by all terms and conditions of the permit. Additionally, where applicable, the proposed transferee must demonstrate that it is capable of constructing, operating, and maintaining the permitted facility, 40C-44 system or activity, consumptive use, or well. Once the required information has been provided, the District shall transfer the permit to the proposed transferee in accordance with paragraph (5)(a) below. A permit issued pursuant to Chapter 62-330 or 62-342, F.A.C., other than a permit for a 40C-44 system or activity, shall not be subject to this rule.

(b) Transfer with Conversion to Operation Phase. To transfer a construction permit for a 40C-44 system or activity to its operation phase, a written statement from the proposed transferee is not required when the permit transfer would be to the operation and maintenance entity approved by the permit. Otherwise, all remaining requirements in paragraph (2)(a) above apply to a request under paragraph (2)(b). Once the required information has been provided, the District shall convert the permit to its operation phase and transfer the permit to the proposed transferee in accordance with paragraph (5)(b) below.

(c) Transfer of an Operating Permit for Entire 40C-44 System or Activity. Except as otherwise provided in Sections 373.426 and 373.429, F.S., when a permittee notifies the District in writing within 30 days of a change in ownership or control of an entire 40C-44 system or activity covered by a 40C-44 operating permit, the District shall transfer that operating permit to the new owner or person in control. If the permittee fails to notify the District in writing within 30

days of the change in ownership or control or if a transfer of ownership or control does not include the entire permitted 40C-44 system or activity, then the transfer shall be governed by paragraphs (2)(a) and (5)(a).

(3) The permittee is encouraged to request a permit transfer prior to the sale or legal transfer of the real property at which a permitted facility, 40C-44 system or activity, or consumptive use is located or authorized. However, the permit transfer shall not be effective prior to the sale or legal transfer.

(4) Until the permit transfer has occurred, the permittee and any other person constructing, operating, or maintaining the permitted facility or system shall be liable for compliance with the terms of the permit. The permittee transferring the permit shall remain liable for corrective actions that may be required as a result of any violations occurring prior to the transfer of the permit.

(5) Timeframes for Transfers.

(a) Transfer without Conversion to Operation Phase. Except for those transfers associated with the conversion of a construction permit for a 40C-44 system or activity to its operation phase (which are addressed in paragraph (5)(b) below), the District shall transfer a permit within 5 days of receiving a complete request for transfer pursuant to subsection (1) and paragraph (2)(a) above. However, the District may toll the time for the transfer by notifying the permittee, within 30 days of receipt of the request, that additional information is required to adequately review the transfer request pursuant to subsection (1) and paragraph (2)(a) above, or that deficiencies in the permitted facility, 40C-44 system or activity, consumptive use, or well must be corrected prior to transfer. Within 30 days of receipt of the additional information that meets the requirements of subsection (1) and paragraph (2)(a) above and of verification of the corrected deficiencies, the District shall transfer the permit. If the District therafter fails to transfer the permit within 30 days, the transfer shall be deemed approved. If the permittee fails to provide the requested information within 90 days of receipt of the request for additional information, then the request for transfer shall be subject to administrative denial without prejudice and the provisions of Rule 40C-1.1008, F.A.C., shall apply.

(b) Transfer with Conversion to Operation Phase. Within 60 days of receiving a complete request to convert a construction permit for a 40C-44 system or activity to its operation phase and to transfer the permit to the operation and maintenance entity, pursuant to paragraph (2)(b) above, the District shall convert the permit from its construction phase to its operation phase and transfer the permit to its operation and maintenance entity. However, the District may toll the time by notifying the permittee, within 30 days of receipt of the request, that additional information is required to adequately review the request, pursuant to subsection (1) and paragraph (2)(b) above, or that deficiencies in the permitted system or activity must be corrected prior to conversion and transfer. Within 30 days of receipt of the additional information that meets the requirements of subsection (1) and paragraph (2)(b) above and of verification of the corrected deficiencies, the District shall convert the construction permit to its operation phase and transfer the permit to the operation and maintenance entity. If the District thereafter fails to convert or transfer the permit within 30 days, the conversion and transfer shall be deemed approved. If the permittee fails to provide the requested information within 90 days of receipt of the request for additional information, then the request for transfer shall be subject to administrative denial without prejudice and the provisions of Rule 40C-1.1008, F.A.C., shall apply.

(c) Transfer of an Operating Permit for Entire 40C-44 System or Activity. Except as otherwise provided in Sections 373.426 and 373.429, F.S., the District shall transfer a 40C-44 operating permit for an entire 40C-44 system or activity to the new owner or person in control within 60 days of receiving written notice in accordance with paragraph (2)(c) above.

(6) For any system or activity authorized by a permit issued pursuant to Chapters 40C-4, 40C-40, or 40C-42, F.A.C., before (10-1-13), the provisions in subsections (1) through (5) above shall apply except that any references to 40C-44 systems or activities will be replaced with the rule chapter that authorized the permit (Chapters 40C-4, 40C-40, or 40C-42, F.A.C.).

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.083, 373.171, 373.309, 373.4131, 373.416, 373.426, 373.429, 373.436 FS. History–New 8-1-89, Amended 10-19-89, 7-20-95, 11-6-95, 10-1-13, 6-1-18.

CHAPTER 40C-4
ENVIRONMENTAL RESOURCE PERMITS: SURFACE WATER MANAGEMENT SYSTEMS

40C-4.031 Implementation

40C-4.091 Publications Incorporated by Reference

40C-4.031 Implementation.

(1) The effective dates for the permitting program as established in this chapter pursuant to Part IV of Chapter 373, F.S., are:

(a) January 31, 1977 in that area transferred to the District from the Central and Southern Florida Flood Control District, now the South Florida Water Management District, pursuant to Section 373.069(3), F.S. (Supp. 1976), within the Greater St. Johns River Basin, known as the Upper St. Johns River Basin (see Figure 4-1).

(b) January 31, 1977 in that area transferred to the District from the Southwest Florida Water Management District pursuant to Section 373.069(3), F.S., (Supp. 1976), within the Oklawaha River Basin (see Figure 4-1).

(c) December 7, 1983 in the remaining area of the District not described in paragraph (a) or (b) above and as described in Section 373.069(2)(c), F.S. (see Figure 4-1).

(d) August 11, 1991, for agricultural stormwater management systems.

(2)(a) The program initiated on January 31, 1977, with its limited areas of implementation, is superseded throughout the entire District by the rules that became effective on December 7, 1983.

(b) Each permit issued under the provisions of the program initiated on January 31, 1977 remains valid after December 7, 1983, subject to all limiting conditions attached thereto.

(c) Any permit application received prior to November 15, 1983 will be processed and evaluated under the provisions of the permitting program initiated on January 31, 1977. Any permit application received on or after November 15, 1983 will be processed and evaluated under the provisions of the rules that become effective on December 7, 1983.

Rulemaking Authority 373.044, 373.113, 373.171 FS. Law Implemented 373.413, 373.416, 373.426 FS. History–New 1-31-77, Formerly 16I-4.03, 40C-4.03, Amended 2-3-81, 12-7-83, Formerly 40C-4.031, 40C-4.0031, Amended 8-11-91, 10-3-95, 11-11-03.

40C-4.091 Publications Incorporated by Reference.

(1) The Governing Board hereby adopts by reference:

(a)1. Part I “Introduction, Organization, Definitions and Applicability,” Part II “General Criteria,” Part III “Stormwater Quantity/Flood Control,” Part IV “Stormwater Quality,” and Part V “Best Management Practices,” which are all available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06351];

2. Part VI “Basin Criteria,” available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06352];

3. Appendix A “Drainage Basins for Cumulative Impacts Evaluation and Regional Watersheds for Mitigation Banking,” available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-03008];

4. Appendix B “Legal Description Upper St. Johns River Hydrologic Basin,” “Legal Description Ocklawaha River Hydrologic Basin,” “Legal Description Wekiva River Hydrologic Basin,” “Legal Description Wekiva Recharge Protection Basin,” “Legal Description Econlockhatchee River Hydrologic Basin,” “Legal Description Sensitive Karst Areas Basin, Alachua County,” “Legal Description Tomoka River Hydrologic Basin,” “Legal Description Spruce Creek Hydrologic Basin,” “Legal Description Sensitive Karst Areas Basin, Marion County,” and “Legal Description Lake Apopka Hydrologic Basin,” available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06353];

5. Appendix C (“Methodology and Design Example for the Modified Rational Hydrograph Method”) available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-03009]; and,

6. Appendix D, available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-03010], of the document entitled “Environmental Resource Permit Applicant’s Handbook, Volume II: For Use Within the Geographic Limits of the St.

Johns River Water Management District," effective (6-1-18).

(b) Operating Agreement Concerning Regulation Under Part IV, Chapter 373, F.S., Between St. Johns River Water Management District and Department of Environmental Protection dated July 1, 2007.

(c) Water quality standards of chapter 62-4, F.A.C., (October 1, 2013), available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06354], chapter 62-302, F.A.C., (June 7, 2015), available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06355], chapter 62-520, F.A.C., (July 12, 2009), available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-03005], and chapter 62-550, F.A.C., (July 7, 2015), available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06356].

(d) The following Natural Resources Conservation Service Soil Survey publications: Soil Survey of Flagler County Area, Florida (1997); Soil Survey of Lake County Area, Florida (1975); Soil Survey of Orange County Area, Florida (1989); Soil Survey of Seminole County Area, Florida (1990); and Soil Survey of Volusia County Area, Florida (1980), which are hereby incorporated by reference, effective 12-3-06.

(e) Technical Publication SJ No. 85-5: A Guide to SCS Runoff Procedures (1985) available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-03007].

(2) The documents may be obtained by contacting:

Director, Bureau of Regulatory Support
St. Johns River Water Management District
4049 Reid Street
Palatka, Florida 32177-2529

St. Johns River Water Management District
7775 Baymeadows Way, Suite 102
Jacksonville, Florida 32256

St. Johns River Water Management District
601 South Lake Destiny Road, Suite 200
Maitland, Florida 32751-7262

St. Johns River Water Management District
525 Community College Pkwy., S.E.
Palm Bay, Florida 32909

Rulemaking Authority 369.318, 373.044, 373.046(4), 373.113, 373.117, 373.4131, 373.4136, 373.414, 373.415, 373.416, 373.418, 373.461 FS. Law Implemented 120.60, 369.316, 369.318, 373.016(2), 373.042, 373.0421, 373.046, 373.085, 373.086, 373.103, 373.117, 373.129, 373.413, 373.4131, 373.4135, 373.4136, 373.414, 373.415, 373.416, 373.418,373.419, 373.423, 373.426, 373.461(3), 403.0877, FS. History–New 12-7-83, Amended 10-14-84, Formerly 40C-4.091, Amended 5-17-87, Formerly 40C-4.0091, Amended 8-20-87, 10-1-87, 10-11-87, 11-26-87, 8-30-88, 1-1-89, 8-1-89, 10-19-89, 4-3-91, 9-25-91, 11-12-91, 3-1-92, 7-14-92, 9-8-92, 9-16-92, 11-12-92, 11-30-92, 1-6-93, 1-23-94, 2-27-94, 11-22-94, 10-3-95, 8-20-96, 11-25-98, 12-3-98, 1-7-99, 1-11-99, 8-21-00, 7-8-01, 10-11-01, 4-10-02, 9-26-02, 3-7-03, 11-11-03, 2-1-05, 12-3-06, 7-1-07, 5-13-08, 11-5-08, 10-29-09, 2-16-10, 12-27-10, 10-1-13, 6-1-18.

5-13-08, 11-5-08, 10-29-09, 2-16-10, 12-27-10, 10-1-13.

CHAPTER 40C-8
MINIMUM FLOWS AND LEVELS

40C-8.011 Policy and Purpose
40C-8.021 Definitions
40C-8.031 Minimum Surface Water Levels and Flows and Groundwater Levels

40C-8.011 Policy and Purpose.

(1) This chapter establishes minimum flows and levels for surface watercourses and minimum levels for groundwater at specific locations within the St. Johns River Water Management District.

(2) Where appropriate, minimum flows and levels any reflect seasonal and long term variations and may include a schedule of variations and other measures appropriate for the protection of nonconsumptive uses of a water resource.

(3) In establishing minimum flows and levels the Governing Board shall use the best information and methods available to establish limits which prevent significant harm to the water resources or ecology. The Governing Board will also consider, and at its discretion provide for the protection of nonconsumptive uses, including navigation, recreation, fish and wildlife habitat, and other natural resources.

(4) Where a minimum flow has been established for a specific watercourse or a minimum level has been established for a specific surface water body, the flow or level is expressed as a fluctuation regime which will include a series of minimum flows or levels reflecting a temporal hydrologic regime that will prevent significant harm to water resources or ecology.

(5) Minimum flows and levels prescribed in this chapter are used as a basis for inposing limitations on withdrawals of groundwater and surface water for reviewing proposed surface water management and storage systems and stormwater management systems, and for imposing water shortage restrictions. The limitations and review criteria are prescribed in other rule chapters of the District.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.042, 373.415 FS. History–New 9-16-92, Amended 8-17-94.

40C-8.021 Definitions.

Unless the context indicates otherwise, the following terms shall have the following meanings.

(1) “Black Water Creek” means that watercourse designated Black Water Creek within the Wekiva River Hydrologic Basin as defined by Rule 40C-41.023, F.A.C.

(2) “Determined minimum surface water flow” means a flow, expressed in cubic feet per second combined with a temporal element. The temporal element may be specifically expressed as a duration and return interval or may be generally expressed as a hydroperiod category.

(3) “Determined minimum surface water level” means an elevation in feet NGVD combined with a temporal element. The temporal element, for purposes of this chapter may be specifically expressed as a duration and return interval or may be generally expressed as a hydroperiod category.

(4) “Intermittently exposed” means a hydroperiod category where surface water is present throughout the year except in years of extreme drought. In most lakes this category does not typically support emergent vegetation and would be characterized as open water or floating-leaved deep marsh. Water levels causing inundation are expected to occur more than ninety percent of the time over a long term period of record.

(5) “Intermittently flooded” means a hydroperiod category where the substrate is usually exposed, but surface water is present with variable frequency and duration. Water levels causing inundation are expected to occur on average approximately once every ten years or more. Years may intervene between periods of inundation. On recharge lakes (sandhill type lakes), the dominant vegetation growing at this elevation can change as soil moisture conditions change, from a dominance of upland species to wetland species or the reverse. Duration of inundation is on the order of several months. Water levels are expected to inundate less than two per cent of the time over a long term period of record.

(6) “Long term” or “long term period of record” means at least a 30 year continuous period.

(7) “Minimum frequent high” means a chronically high surface water level or flow with an associated frequency and duration that allows for inundation of the floodplain at a depth and duration sufficient to maintain wetland functions.

(8) “Minimum infrequent high” means an acutely high surface water level or flow with an associated frequency and duration

that is expected to be reached or exceeded during or immediately after periods of high rainfall so as to allow for inundation of a floodplain at a depth and duration sufficient to maintain biota and the exchange of nutrients and detrital material.

(9) “Minimum average” means the surface water level or flow necessary over a long period to maintain the integrity of hydric soils and wetland plant communities.

(10) “Minimum frequent low” means a chronically low surface water level or flow that generally occurs only during periods of reduced rainfall. This level is intended to prevent deleterious effects to the composition and structure of floodplain soils, the species composition and structure of floodplain and instream biotic communities, and the linkage of aquatic and floodplain food webs.

(11) “Minimum infrequent low” means an acutely low surface water level or flow with an associated frequency and duration which may occur during periods of extreme drought below which there will be a significant negative impact on the biota of the surface water which includes associated wetlands.

(12) “NAVD” means North American Vertical Datum of 1988.

(13) “NGVD” means National Geodetic Vertical Datum of 1929.

(14) “Permanently flooded” means a hydroperiod category where water covers the land surface throughout the year in all years. Vegetation, if present, is composed of aquatic macrophytes.

(15) “Phased Restriction” means the level or flow (based on the past 30 consecutive day average level or flow) at which a water use shortage phase (Phase I-IV as defined by Rule 40C-21.251, F.A.C.), is declared and its associated restrictions imposed.

(16) “Seasonally flooded” means a hydroperiod category where surface water is typically present for extended periods (30 days or more) during the growing season, resulting in a predominance of submerged or submerged and transitional wetland species. During extended periods of normal or above normal rainfall, lake levels causing inundation are expected to occur several weeks to several months every one to two years.

(17) “Semi-permanently flooded” means a hydroperiod category where surface water inundation persists in most years. When surface water is absent the water table is usually near the land surface. In many lakes with emergent marshes this water level is near the lower elevation that supports emergent marsh or floating vegetation and peat substrates, or other highly organic hydric substrates. This characterization may not be true for herbaceous wetlands around sandhill type lakes, which often have emergent vegetation that follows declining water levels to below the lower elevation of peat substrate. Water levels causing inundation are expected to occur approximately eighty percent of the time over a long term period of record. Exposure of these ground elevations is expected to re-occur, on average, about every five to ten years for extended periods (several or more months) during moderate droughts.

(18) “Temporarily Flooded” means a hydroperiod category where surface water is present or the substrate is flooded for brief periods (up to several weeks) approximately every five years. Plants of upland and wetland species are characteristic. The composition of the vegetation at this water level is dependant upon whether the flooding predominantly occurs in the growing season, whether seepage from higher elevations is pronounced, and the nature of the soil. Lake water levels are expected to equal or exceed this elevation five per cent of the time or less over a long term period of record.

(19) “Typically saturated” means a hydroperiod category where for extended periods of the year the water level should saturate or inundate. This results in saturated substrates for periods of one-half year or more during non-flooding periods of typical years. Water levels causing inundation are expected to occur fifty to sixty per cent of the time over a long term period of record. This water level is expected to have a recurrence interval, on the average, of one or two years over a long term period of record. Obligate wetland plant species are expected to be predominate near this water level.

(20) “Wekiva River” means that watercourse designated Wekiva River within the Wekiva River Hydrologic Basin as defined by Rule 40C-41.023, F.A.C.

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.042, 373.103, 373.415 FS. History–New 9-16-92, Amended 8-17-94, 6-8-95, 3-19-02, 6-25-14.

40C-8.031 Minimum Surface Water Levels and Flows and Groundwater Levels.

(1) The following minimum groundwater levels and minimum mean annual spring flows are established:

Spring Name	County	Head (ft NGVD)	Discharge (cfs)
Messant Spring	Lake	32	12
Miami Springs	Seminole	27	4

Palm Springs	Seminole	27	7
Rock Springs	Orange	31	53
Sanlando Springs	Seminole	28	15
Seminole Springs	Lake	34	34
Starbuck Springs	Seminole	31	13
Wekiwa Springs	Orange	24	62

(2) The following minimum surface water levels and flows are established:

System Name	County	Minimum Level	Level (ft NGVD)	Flow (cfs)	Hydroperiod Category	Duration (days)	Return Interval (years)
Black Water Creek at The SR 44 Bridge	Lake	Infrequent High	27.0	340	–	7	5
		Frequent High	25.8	145	–	30	2
		Average	24.3	33	–	180	1.7
		Frequent Low	22.8	2.5	–	90	15
		Phase 1 Restriction	22.7	2.0	–	–	–
		Phase 2 Restriction	22.5	1.0	–	–	–
		Phase 3 Restriction	22.4	0.6	–	–	–
		Phase 4 Restriction	22.3	0.3	–	–	–
		Infrequent Low	21.9	0.0	–	7	100
St. Johns River 1.5 miles downstream of Lake Washington weir	Brevard	Frequent High	15.3	1450	Seasonally Flooded	–	–
		Average	12.7	240	Typically Saturated	–	–
		Frequent Low	11.3	28	Semipermanently Flooded	–	–
St. Johns River at SR 44 near DeLand	Volusia	Frequent High	1.9	4600	–	30	3
		Average	0.8	2050	–	180	1.5
		Frequent Low	0.3	1100	–	120	5
Taylor Creek 1.7 miles downstream of structure S-164		Frequent High	–	95	Seasonally Flooded	–	–
		Average	–	17	Typically Saturated	–	–
		Frequent Low	–	0.5	Semipermanently Flooded	–	–
St. Johns River at SR 50 near Christmas	Orange and Brevard	Frequent High	8.1	1950	–	30	2
		Average	5.9	580	–	180	1.5
		Frequent Low	4.2	140	–	120	5
		Infrequent Low	2.7	43	–	60	50
Wekiva River at the SR 46 Bridge	Seminole and Lake	Infrequent High	9.0	880	–	7	5
		Frequent High	8.0	410	–	30	2
		Average	7.6	240	–	180	1.7
		Frequent Low	7.2	200	–	90	3
		Phase 1 Restriction	7.0	190	–	–	–
		Phase 2 Restriction	6.9	180	–	–	–
		Phase 3 Restriction	6.7	160	–	–	–
		Phase 4 Restriction	6.5	150	–	–	–
		Infrequent Low	6.1	120	–	7	100

(3) The following minimum surface water flows are established for Blue Spring in Volusia County:

Time Period	Minimum Long Term Mean Flow
December 3, 2006 through March 31, 2009	133 cfs
April 1, 2009 through March 31, 2014	137 cfs
April 1, 2014 through March 31, 2019	142 cfs
April 1, 2019 through March 31, 2024	148 cfs
After March 31, 2024	157 cfs

(4) The following minimum surface water levels are established:

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(a) Apshawa North	Lake	Frequent High	85.0	83.9	Seasonally Flooded	–	–
		Average	83.3	82.2	Typically Saturated	–	–
		Frequent Low	81.3	80.2	Semipermanently Flooded	–	–
(b) Apshawa South	Lake	Frequent High	86.0	85.7	Seasonally Flooded	–	–
		Average	84.7	83.6	Typically Saturated	–	–
		Frequent Low	83.2	82.1	Semipermanently Flooded	–	–
(c) Argenta	Putnam	Frequent High	50.1	49.0	Seasonally Flooded	–	–
		Average	47.7	46.7	Typically Saturated	–	–
		Frequent Low	46.3	45.3	Semipermanently Flooded	–	–
(d) Ashby	Volusia	Frequent High	12.3	11.3	–	60	2
		Frequent Low	11.1	10.2	–	120	5
(e) Banana	Putnam	Frequent High	37.7	36.8	–	30	3
		Average	36.7	35.8	–	180	1.7
		Frequent Low	33.7	32.8	–	120	5
(f) Bell	Putnam	Frequent High	42.5	44.5	Temporarily Flooded	–	–
		Average	40.5	36.4	Typically Saturated	–	–
		Frequent Low	38.7	37.9	Semipermanently Flooded	–	–
(g) Big	Volusia	Frequent High	26.1	25.1	Seasonally Flooded	–	–
		Average	25.0	24.1	Typically Saturated	–	–
		Frequent Low	23.7	22.7	Semipermanently Flooded	–	–
(h) Bird Pond	Putnam	Frequent High	41.8	40.8	Seasonally Flooded	–	–
		Average	39.5	38.5	Typically Saturated	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
		Frequent Low	38.1	37.1	Semipermanently Flooded	–	–
(i) Blue Pond	Clay	Frequent High	174.1	173.1	Temporarily Flooded	–	–
		Average	173.3	172.3	Typically Saturated	–	–
		Frequent Low	171.7	170.7	Semipermanently Flooded	–	–
(j) Boggy Marsh	Lake	Frequent High	117.3	116.4	Seasonally Flooded	–	–
		Average	115.9	115.0	Typically Saturated	–	–
		Frequent Low	114.5	113.6	Semipermanently Flooded	–	–
(k) Bowers	Marion	Frequent High	57.1	56.1	Temporarily Flooded	–	–
		Average	54.0	53.1	Typically Saturated	–	–
		Frequent Low	52.7	51.7	Semipermanently Flooded	–	–
(l) Brantley	Seminole	Frequent High	46.3	45.3	Seasonally Flooded	–	–
		Average	45.6	44.6	Typically Saturated	–	–
		Frequent Low	44.1	43.1	Semipermanently Flooded	–	–
(m) Brooklyn	Clay	Frequent High	114.6	113.5	Temporarily Flooded	–	–
		Average	108.0	106.9	Typically Saturated	–	–
		Frequent Low	101.0	99.9	Semipermanently Flooded	–	–
(n) Broward	Putnam	Frequent High	40.0	39.1	Temporarily Flooded	–	–
		Average	38.2	35.8	Typically Saturated	–	–
		Frequent Low	36.5	35.6	Semipermanently Flooded	–	–
(o) Burkett	Orange	Frequent High	53.5	52.5	Seasonally Flooded	–	–
		Average	52.6	51.6	Typically Saturated	–	–
		Frequent Low	51.2	50.2	Semipermanently Flooded	–	–
(p) Charles	Marion	Frequent High	40.2	39.3	Seasonally Flooded	–	–
		Average	39.3	38.4	Typically Saturated	–	–
		Frequent Low	37.9	36.9	Semipermanently Flooded	–	–
(q) Cherry	Lake	Frequent High	96.0	94.9	Seasonally Flooded	–	–
		Average	94.9	93.8	Typically Saturated	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
		Frequent Low	93.4	92.4	Semipermanently Flooded	–	–
(r) Clear	Putnam	Frequent High	37.4	36.4	Temporarily Flooded	–	–
		Average	36.4	35.4	Typically Saturated	–	–
		Frequent Low	34.9	34.0	Semipermanently Flooded	–	–
(s) Colby	Volusia	Frequent High	27.6	26.6	–	30	3
		Frequent Low	22.9	21.8	–	120	3
(t) Como	Putnam	Frequent High	37.7	36.8	–	30	3
		Average	36.7	35.8	–	180	1.7
		Frequent Low	33.7	32.8	–	120	5
(u) Como, Little Lake	Putnam	Frequent High	37.7	36.8	–	30	3
		Average	34.6	33.7	–	180	1.7
		Frequent Low	32.6	31.7	–	120	5
(v) Coon Pond	Volusia	Frequent High	35.7	34.8	Seasonally Flooded	–	–
		Average	34.6	33.6	Typically Saturated	–	–
		Frequent Low	33.1	32.2	Semipermanently Flooded	–	–
(w) Cowpen	Putnam	Infrequent High	92.0	90.8		30	25
		Average	85.2	84.0		180	1.7
		Frequent Low	83.5	82.3		120	2.7
(x) Cow Pond	Volusia	Frequent High	40.5	39.5	Seasonally Flooded	–	–
		Average	39.8	38.8	Typically Saturated	–	–
		Frequent Low	37.6	36.6	Semipermanently Flooded	–	–
(y) Crystal/Baker	Putnam	Frequent High	35.5	34.6	Seasonally Flooded	–	–
		Average	33.9	33.0	Typically Saturated	–	–
		Frequent Low	33.0	32.1	Semipermanently Flooded	–	–
(z) Daugharty	Volusia	Frequent High	44.8	43.8	Temporarily Flooded	–	–
		Average	42.6	41.6	Typically Saturated	–	–
		Frequent Low	41.2	40.1	Semipermanently Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(aa) Davis	Volusia	Frequent High	36.2	35.2	Seasonally Flooded	–	–
		Average	35.4	34.4	Typically Saturated	–	–
		Frequent Low	34.0	33.0	Semipermanently Flooded	–	–
(bb) Deep	Putnam	Frequent High	35.0	34.1	Seasonally Flooded	–	–
		Average	33.1	32.2	Typically Saturated	–	–
		Frequent Low	32.2	31.3	Semipermanently Flooded	–	–
(cc) Dias	Volusia	Frequent High	34.6	33.5	Seasonally Flooded	–	–
		Average	33.5	33.0	Typically Saturated	–	–
		Frequent Low	32.2	31.6	Semipermanently Flooded	–	–
(dd) Disston	Flagler	Frequent High	13.8	12.8	Seasonally Flooded	–	–
		Average	13.2	12.3	Typically Saturated	–	–
		Frequent Low	12.5	11.5	Semipermanently Flooded	–	–
(ee) Dorr	Lake	Frequent High	43.5	42.5	Seasonally Flooded	–	–
		Average	43.1	42.1	Typically Saturated	–	–
		Frequent Low	42.1	41.0	Semipermanently Flooded	–	–
(ff) Dream Pond	Putnam	Frequent High	49.0	48.0	Seasonally Flooded	–	–
		Average	47.5	46.5	Typically Saturated	–	–
		Frequent Low	46.0	45.1	Semipermanently Flooded	–	–
(gg) Drudy	Volusia	Frequent High	42.1	41.0	Seasonally Flooded	–	–
		Average	40.6	39.5	Typically Saturated	–	–
		Frequent Low	39.1	38.1	Semipermanently Flooded	–	–
(hh) Echo	Putnam	Frequent High	38.8	37.9	Seasonally Flooded	–	–
		Average	36.7	35.7	Typically Saturated	–	–
		Frequent Low	35.2	34.3	Semipermanently Flooded	–	–
(ii) Emma	Lake	Frequent High	94.1	93.0	Seasonally Flooded	–	–
		Average	92.5	91.4	Typically Saturated	–	–
		Frequent Low	91.1	90.0	Semipermanently Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(jj) Emporia	Volusia	Frequent High	38.9	37.8	Seasonally Flooded	–	–
		Average	35.8	34.7	Typically Saturated	–	–
		Frequent Low	34.3	31.6	Semipermanently Flooded	–	–
(kk) Estella	Putnam	Frequent High	38.6	37.7	Seasonally Flooded	–	–
		Average	37.2	36.3	Typically Saturated	–	–
		Frequent Low	36.5	35.5	Semipermanently Flooded	–	–
(ll) Fox	Brevard	Frequent High	16.7	15.4	Temporarily Flooded	–	–
		Average	15.3	14.0	Typically Saturated	–	–
		Frequent Low	13.8	12.6	Semipermanently Flooded	–	–
(mm) Geneva	Clay	Frequent High	103.0	101.9	Seasonally Flooded	–	–
		Average	101.0	99.9	Typically Saturated	–	–
		Frequent Low	98.5	97.4	Semipermanently Flooded	–	–
(nn) Georges Lake	Putnam	Frequent High	98.4	97.4	Seasonally Flooded	–	–
		Average	97.8	96.9	Typically Saturated	–	–
		Frequent Low	97.0	96.1	Semipermanently Flooded	–	–
(oo) Gertie	Volusia	Frequent High	27.5	26.5	Temporarily Flooded	–	–
		Average	25.6	24.6	Typically Saturated	–	–
		Frequent Low	23.3	22.4	Semipermanently Flooded	–	–
(pp) Gore	Flagler	Frequent High	21.1	20.0	–	30	3
		Average	20.6	19.6	–	180	1.5
		Frequent Low	19.2	18.2	–	120	5
(qq) Grandin	Putnam	Frequent High	81.5	80.7	–	30	2
		Frequent Low	78.6	77.8	–	120	5
(rr) Halfmoon	Marion	Frequent High	49.7	48.6	Seasonally Flooded	–	–
		Average	47.9	46.7	Typically Saturated	–	–
		Frequent Low	46.5	45.3	Semipermanently Flooded	–	–
(ss) Helen	Volusia	Frequent High	46.1	45.0	Temporarily Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
		Average	44.2	43.2	Typically Saturated	–	–
		Frequent Low	43.6	42.6	Semipermanently Flooded	–	–
(tt) Hires	Volusia	Frequent High	41.0	40.0	Seasonally Flooded	–	–
		Average	39.5	38.5	Typically Saturated	–	–
		Frequent Low	38.0	37.0	Semipermanently Flooded	–	–
(uu) Hokey	Volusia	Frequent High	35.4	34.4	Seasonally Flooded	–	–
		Average	33.7	32.7	Typically Saturated	–	–
		Frequent Low	32.3	31.3	Semipermanently Flooded	–	–
(vv) Hopkins Prairie	Marion	Frequent High	25.8	24.5	Seasonally Flooded	–	–
		Average	23.4	22.1	Typically Saturated	–	–
		Frequent Low	22.0	20.7	Semipermanently Flooded	–	–
(ww) Howell	Putnam	Frequent High	34.5	33.5	Seasonally Flooded	–	–
		Average	33.6	32.7	Typically Saturated	–	–
		Frequent Low	31.8	30.9	Semipermanently Flooded	–	–
(xx) Howell	Seminole	Frequent High	53.7	52.7	Seasonally Flooded		
		Average	52.9	51.9	Typically Saturated		
		Frequent Low	51.5	50.5	Semipermanently Flooded		
(yy) Indian	Volusia	Frequent High	36.2	35.2		30	3
		Average	35.0	34.0		180	1.7
		Frequent Low	32.8	31.8		120	5
(zz) Irma	Orange	Frequent High	55.1	54.1	Seasonally Flooded	–	–
		Average	54.8	53.8	Typically Saturated	–	–
		Frequent Low	53.4	52.4	Semipermanently Flooded	–	–
(aaa) Kerr	Marion	Infrequent High	25.6	24.6		30	25
		Frequent High	23.3	22.3		14	2
		Average	21.7	20.7		180	1.7
		Frequent Low	20.4	19.4		120	5

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(bbb) Lizzie	Putnam	Frequent High	43.9	43.0	Seasonally Flooded	–	–
		Average	42.7	41.8	Typically Saturated	–	–
		Frequent Low	41.7	40.8	Semipermanently Flooded	–	–
(ccc) Louisa	Lake	Frequent High	96.5	95.6	Seasonally Flooded	–	–
		Average	95.4	94.5	Typically Saturated	–	–
		Frequent Low	94.0	93.0	Semipermanently Flooded	–	–
(ddd) Lower Lake Louise	Volusia	Frequent High	31.8	30.8	Seasonally Flooded	–	–
		Average	31.2	30.1	Typically Saturated	–	–
		Frequent Low	29.7	28.7	Semipermanently Flooded	–	–
(eee) Lucy	Lake	Frequent High	94.1	93.0	Seasonally Flooded	–	–
		Average	92.5	91.4	Typically Saturated	–	–
		Frequent Low	91.1	90.0	Semipermanently Flooded	–	–
(fff) Magnolia	Clay	Frequent High	124.7	123.6	Seasonally Flooded	–	–
		Average	124.2	123.1	Typically Saturated	–	–
		Frequent Low	121.4	120.3	Semipermanently Flooded	–	–
(ggg) Mall, Little Lake	Putnam	Frequent High	38.7	37.7	Seasonally Flooded	–	–
		Average	36.8	35.8	Typically Saturated	–	–
		Frequent Low	35.2	34.2	Semipermanently Flooded	–	–
(hhh) Margaret	Putnam	Frequent High	35.2	34.2	Seasonally Flooded	–	–
		Average	34.5	33.5	Typically Saturated	–	–
		Frequent Low	32.5	31.5	Semipermanently Flooded	–	–
(iii) Martha	Orange	Frequent High	53.5	52.5	Seasonally Flooded	–	–
		Average	52.6	51.6	Typically Saturated	–	–
		Frequent Low	51.2	50.2	Semipermanently Flooded	–	–
(jjj) Marvin	Putnam	Frequent High	38.6	37.6	Seasonally Flooded	–	–
		Average	37.3	36.4	Typically Saturated	–	–
		Frequent Low	36.3	35.3	Semipermanently Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(kkk) McGrady	Putnam	Frequent High	41.5	40.6	Seasonally Flooded	–	–
		Average	39.9	38.9	Typically Saturated	–	–
		Frequent Low	37.8	36.8	Semipermanently Flooded	–	–
(lll) McKasel	Putnam	Frequent High	36.7	35.7	Seasonally Flooded	–	–
		Average	35.5	34.6	Typically Saturated	–	–
		Frequent Low	34.1	33.1	Semipermanently Flooded	–	–
(mmm) Melrose	Putnam	Frequent High	104.7	103.6		30	3
		Average	104.2	103.1		180	1.7
		Frequent Low	103.7	102.6		120	10
(nnn) Mills	Seminole	Frequent High	42.5	41.1	Seasonally Flooded	–	–
		Average	41.4	40.3	Typically Saturated	–	–
		Frequent Low	39.9	38.9	Semipermanently Flooded	–	–
(ooo) Minneola	Lake	Frequent High	96.0	95.1	Seasonally Flooded	–	–
		Average	95.3	94.4	Typically Saturated	–	–
		Frequent Low	93.9	93.0	Semipermanently Flooded	–	–
(ppp) Monroe	Seminole and Volusia	Frequent High	2.8	1.9	–	30	2
		Average	1.2	0.3	–	180	1.5
		Frequent Low	0.5	-0.4	–	120	5
(qqq) Nettles/English	Putnam	Frequent High	44.3	43.3	Seasonally Flooded	–	–
		Average	42.7	41.9	Typically Saturated	–	–
		Frequent Low	41.7	40.7	Semipermanently Flooded	–	–
(rrr) Nicotoon	Marion	Frequent High	54.7	53.7	Seasonally Flooded	–	–
		Average	53.3	52.3	Typically Saturated	–	–
		Frequent Low	51.9	50.9	Semipermanently Flooded	–	–
(sss) Norris	Lake	Frequent High	29.7	28.7		30	1.7
		Frequent Low	27.7	26.7		120	7.6
						–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(ttt) North Como Park	Putnam	Frequent High	41.3	40.4	Seasonally Flooded	–	–
		Average	39.7	38.8	Typically Saturated	–	–
		Frequent Low	38.5	37.6	Semipermanently Flooded	–	–
(uuu) North Talmadge	Volusia	Frequent High	55.6	54.5	Seasonally Flooded	–	–
		Average	54.4	53.3	Typically Saturated	–	–
		Frequent Low	52.9	51.9	Semipermanently Flooded	–	–
(vvv) Omega	Putnam	Frequent High	57.4	56.3	Temporarily Flooded	–	–
		Average	56.1	55.0	Typically Saturated	–	–
		Frequent Low	54.0	52.9	Semipermanently Flooded	–	–
(www) Orio	Putnam	Frequent High	37.1	35.5	Seasonally Flooded	–	–
		Average	35.6	34.6	Typically Saturated	–	–
		Frequent Low	34.7	33.7	Semipermanently Flooded	–	–
(xxx) Pam	Putnam	Frequent High	39.3	38.2	Seasonally Flooded	–	–
		Average	37.5	36.4	Typically Saturated	–	–
		Frequent Low	36.1	35.0	Semipermanently Flooded	–	–
(yyy) Pearl	Orange	Frequent High	53.5	52.5	Seasonally Flooded	–	–
		Average	52.6	51.6	Typically Saturated	–	–
		Frequent Low	51.2	50.2	Semipermanently Flooded	–	–
(zzz) Pierson	Volusia	Frequent High	34.4	33.3	Seasonally Flooded	–	–
		Average	33.8	32.8	Typically Saturated	–	–
		Frequent Low	32.4	31.3	Semipermanently Flooded	–	–
(aaaa) Pine Island	Lake	Frequent High	107.7	106.6	Seasonally Flooded	–	–
		Average	106.8	105.7	Typically Saturated	–	–
		Frequent Low	105.4	104.3	Semipermanently Flooded	–	–
(bbbb) Prevatt	Orange	Frequent High	56.0	54.9	Seasonally Flooded	–	–
		Average	53.0	52.0	Typically Saturated	–	–
		Frequent Low	50.9	49.9	Semipermanently Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(cccc) Prior	Putnam	Frequent High	42.3	41.3	Seasonally Flooded	–	–
		Average	40.0	39.0	Typically Saturated	–	–
		Frequent Low	39.0	38.0	Semipermanently Flooded	–	–
(dddd) Purdom	Volusia	Frequent High	36.3	35.3		30	2
		Average	35.4	34.3		180	1.7
		Frequent Low	34.4	33.3		120	5
(eeee) Sand	Putnam	Frequent High	40.9	39.4	Seasonally Flooded	–	–
		Average	39.0	38.0	Typically Saturated	–	–
		Frequent Low	36.6	35.7	Semipermanently Flooded	–	–
(ffff) Sand Hill	Clay	Frequent High	132.0	130.9	Seasonally Flooded	–	–
		Average	131.6	130.6	Typically Saturated	–	–
		Frequent Low	129.5	128.4	Semipermanently Flooded	–	–
(gggg) Savannah	Volusia	Frequent High	31.1	30.2	Seasonally Flooded	–	–
		Average	29.5	28.4	Typically Saturated	–	–
		Frequent Low	28.0	27.0	Semipermanently Flooded	–	–
(hhhh) Scoggin	Volusia	Frequent High	35.0	34.0	Seasonally Flooded	–	–
		Average	34.1	33.1	Typically Saturated	–	–
		Frequent Low	32.7	31.7	Semipermanently Flooded	–	–
(iiii) Shaw	Volusia	Frequent High	36.7	35.7	–	30	3
		Average	35.4	34.4	–	180	1.7
		Frequent Low	33.7	32.7	–	120	3
(jjjj) Silver	Putnam	Frequent High	36.8	35.8	Seasonally Flooded	–	–
		Average	35.1	34.1	Typically Saturated	–	–
		Frequent Low	33.7	32.7	Semipermanently Flooded	–	–
(kkkk) Smith	Marion	Frequent High	54.6	53.6	Temporarily Flooded	–	–
		Average	51.4	50.4	Typically Saturated	–	–
		Frequent Low	50.0	49.0	Semipermanently Flooded	–	–

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
(llll) South	Brevard	Frequent High	16.7	15.5	Temporarily Flooded	–	–
		Average	15.3	14.0	Typically Saturated	–	–
		Frequent Low	13.8	12.6	Semipermanently Flooded	–	–
(mmmm) South Como Park	Putnam	Frequent High	38.1	37.2	Seasonally Flooded	–	–
		Average	36.7	35.8	Typically Saturated	–	–
		Frequent Low	35.3	34.4	Semipermanently Flooded	–	–
(nnnn) Star	Putnam	Frequent High	77.5	76.5	Seasonally Flooded	–	–
		Average	75.4	74.4	Typically Saturated	–	–
		Frequent Low	74.0	73.0	Semipermanently Flooded	–	–
(oooo) Stella	Putnam	Frequent High	39.4	38.4	Seasonally Flooded	–	–
		Average	38.6	37.6	Typically Saturated	–	–
		Frequent Low	37.2	36.1	Semipermanently Flooded	–	–
(pppp) Sunset	Lake	Frequent High	85.9	84.9	Temporarily Flooded	–	–
		Average	83.5	82.4	Typically Saturated	–	–
		Frequent Low	81.0	79.9	Semipermanently Flooded	–	–
(qqqq) Swan	Putnam	Frequent High	93.0	91.9	Temporarily Flooded	–	–
		Average	90.3	89.2	Typically Saturated	–	–
(rrrr) Sylvan	Seminole	Frequent High	40.4	39.5	Seasonally Flooded	–	–
		Average	38.9	38.0	Typically Saturated	–	–
		Frequent Low	37.5	36.5	Semipermanently Flooded	–	–
(ssss) Tarhoe	Putnam	Frequent High	36.6	35.7		30	3
		Average	35.1	34.2		180	1.7
		Frequent Low	33.0	32.0		120	5
(tttt) Three Island Lakes	Volusia	Frequent High	23.7	22.7	–	30	5
		Frequent Low	19.4	18.4	–	120	10
(uuuu) Trone	Putnam	Frequent High	37.1	36.2	–	30	3
		Average	35.4	34.5	–	180	1.7

System Name	County	Minimum Level	Level (ft NGVD)	Level (ft NAVD)	Hydroperiod Category	Duration (days)	Return Interval (years)
		Frequent Low	32.8	31.9	–	120	5
(vvvv) Trout	Volusia	Frequent High	23.3	22.3	Seasonally Flooded	–	–
		Average	20.9	20.0	Typically Saturated	–	–
		Frequent Low	17.7	16.8	Semipermanently Flooded	–	–
(wwww) Tuscawilla	Alachua	Frequent High	77.6	76.4	Seasonally Flooded	–	–
		Average	74.6	73.4	Typically Saturated	–	–
		Frequent Low	73.2	72.0	Semipermanently Flooded	–	–
(xxxx) Upper Lake Louise	Volusia	Frequent High	35.3	34.4	Seasonally Flooded	–	–
		Average	34.6	33.6	Typically Saturated	–	–
		Frequent Low	33.2	32.2	Semipermanently Flooded	–	–
(yyyy) Washington	Brevard	Frequent High	15.6	14.2	Seasonally Flooded	–	–
		Average	14.2	12.8	Typically Saturated	–	–
		Frequent Low	12.8	11.4	Semipermanently Flooded	–	–
(zzzz) Wauberg	Alachua	Frequent High	67.4	66.4	Seasonally Flooded	–	–
		Average	67.1	66.1	Typically Saturated	–	–
		Frequent Low	65.6	64.7	Semipermanently Flooded	–	–
(aaaaa) Weir	Marion	Frequent High	57.2	56.2	Seasonally Flooded	–	–
		Average	56.4	55.4	Typically Saturated	–	–
		Frequent Low	54.9	53.9	Semipermanently Flooded	–	–
(bbbbb) Winnemisett	Volusia	Frequent High	59.5	58.5	Seasonally Flooded	–	–
		Average	57.8	56.8	Typically Saturated	–	–
		Frequent Low	56.0	55.0	Semipermanently Flooded	–	–
(ccccc) Winona	Volusia	Frequent High	36.1	35.1	Seasonally Flooded	–	–
		Average	33.5	32.5	Typically Saturated	–	–
		Frequent Low	32.0	31.0	Semipermanently Flooded	–	–

(5)(a) The minimum flow for Alexander Springs in Lake County is 95.7 cubic feet per second (CFS).

(b) The minimum flow for Alexander Springs is a mean annual flow based on the adjusted flow times-series data (1983 – 2014) at USGS gage 00291896. This adjusted flow-time series data from 1983 to 2014, effective 6-29-17, is incorporated by reference and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-08325, and upon request from the St. Johns River Water

Management District, 4049 Reid Street, Palatka, FL 32177-2529.

(6) The following minimum levels are established for Blue Cypress Water Management Area (BCWMA):

(a) The minimum average level, calculated as the long term mean of BCWMA water levels, is 24.0 feet NGVD (22.5 feet NAVD). Water levels shall be at or above this level at least 75% of time over the long term.

(b) The minimum frequent low is 23.0 feet NGVD (21.5 feet NAVD). The daily BCWMA water level shall not fall to this level or below more often than once every 2.5 years over the long term.

(c) The minimum infrequent low is 22.5 feet NGVD (21.0 feet NAVD). The BCWMA water level shall not fall to this level or below for 60 continuous days more frequently than once every 10 years over the long term.

(7)(a) The minimum spring flow for De Leon Springs in Volusia County is 25.6 Cubic feet per second (CFS).

(b) The minimum spring flow for De Leon Springs is a mean annual flow based on the baseline flow-time series data from 1965 to 2015 under the 2010-pumping condition (Baseline Flow), which data is incorporated by reference and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-07783, and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177-2529. The minimum spring flow for De Leon Springs is equal to the Baseline Flow as defined above.

(8)(a) The minimum flow for Gemini Springs in Volusia County is 9.3 cubic feet per second (CFS).

(b) The minimum spring flow for Gemini Springs is a mean annual flow based on the adjusted flow times-series data (1995 – 2015) at USGS gage 00410494. This adjusted flow-time series data from 1995 to 2015, effective 6-29-17, is incorporated by reference and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-08326, and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177-2529.

(9)(a) The minimum flow for Silver Glen Springs in Marion/Lake Counties is 99.6 cubic feet per second (CFS).

(b) The minimum flow for Silver Glen Springs is a mean annual flow based on the adjusted flow times-series data (1984 – 2015) at USGS gage 02236160. This adjusted flow-time series data from 1984 to 2015, effective 6-29-17, is incorporated by reference and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-08327, and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177-2529.

(10) The following minimum surface water flows and levels are established for Silver Springs in Marion County, as measured at the USGS 02239501 gaging station:

Minimum Flows	Flow (cfs)	Level (NAVD)	Duration (days)	Return Interval (years)
Frequent high	828	40.0	30	5
Average	638	38.2	180	1.7
Frequent low	572	37.0	120	3

The minimum surface water flows were developed to ensure that the associated surface water levels will be met. The two factors to be weighed in the status assessment of this MFL are (1) whether the surface water levels have been met; and, (2) the extent to which the surface water flow has been reduced due to groundwater withdrawals.

(11) Ground or surface water withdrawals or surface water works must not cause the infrequent high or frequent high surface water flows and levels to occur less frequently or for at lesser duration than stated. Ground or surface water withdrawals or surface water works must not cause the minimum average, frequent low, or infrequent low surface water levels and flows to occur more frequently or for longer durations than stated.

(12) Determining Ongoing Status – The purpose of this subsection is to provide the approach to determine whether the flow(s) and/or level(s) of a specific MFL water body is/are below or projected to fall below the rule-specified MFL criteria (along with the associated evaluations necessary to make such a determination). This status assessment is independent from and not a determination of consumptive use permit compliance or environmental resource permit compliance. Permit compliance is a regulatory function that is not considered to be within the scope of this subsection.

(a) A screening level analysis, which incorporates change in rainfall trend and uncertainty in MFLs, will be performed approximately every five years to monitor the status of an adopted MFL, as well as when permit applications are considered that may impact an MFL. If the screening level analysis shows that the MFL is being met based on the rainfall-adjusted flows or levels, then no further actions are required beyond continued monitoring. If the analysis shows that the MFL is not being met, or is trending toward not being met based on the rainfall-adjusted flows and levels, the District will conduct a cause and effect analysis to

independently evaluate the potential impacts of various stressors on the MFL water body being assessed. Factors other than consumptive uses of water (e.g., long-term drought) can cause the flow or level of a surface watercourse, aquifer, surface water, or spring to drop below an adopted minimum flow or level. Factors to be considered in the determination of causation include, but are not limited to:

1. Rainfall or other climatic variables,
2. Consumptive use,
3. Land use changes or development,
4. Surface water drainage,
5. Geology/hydromorphology (e.g., sinkhole formation),
6. Water levels/flows in other appropriate water resources (e.g., nearby wells, lakes, streams, wetlands); and,
7. Ecological assessment information.

(b) The types of tools used in the causation analysis include, but are not limited to:

1. Double-mass analyses,
2. Rainfall/flow statistical analysis or flow regression,
3. Stage/duration/frequency analysis,
4. Modeling (regional, groundwater, ecological or water budget models); and,
5. Ecological tools.

Based on the causation analysis, the District will assess existing MFL criteria and any associated recovery and prevention strategies to determine the effectiveness of the strategies in recovering from or preventing significant harm to the water body.

(c) This subsection shall not apply within the Central Florida Water Initiative Area, as defined in paragraph 373.0465(2)(a), F.S. (2016).

Rulemaking Authority 373.044, 373.113 FS. Law Implemented 373.042, 373.0421, 373.103, 373.415 FS. History–New 9-16-92, Amended 8-17-94, 6-8-95, 1-17-96, 8-20-96, 10-20-96, 11-4-98, 6-27-00, 2-13-01, 3-19-02, 5-12-03, 11-10-03, 1-12-04, 2-1-06, 12-3-06, 5-10-07, 5-24-07, 1-11-10, 8-22-13, 4-3-14, 11-25-14, 12-31-14, 1-31-16 (4)(aaa), 1-31-16 (4)(ssss), 2-1-17 (4)(w), 2-1-17 (6), (8), 6-27-17 (7), 6-29-17 (5), (8), (9).

CHAPTER 40C-41
SURFACE WATER MANAGEMENT BASIN CRITERIA

40C-41.023 Basin Boundaries
40C-41.043 Application of Chapter
40C-41.063 Conditions for Issuance of Permits

40C-41.023 Basin Boundaries.

(1) The Upper St. Johns River Hydrologic Basin is that area generally depicted in Figure 41-1 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," (6-1-18), Appendix B which is hereby incorporated by reference available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06353] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, FL 32177-2529.

(2) The Oklawaha River Hydrologic Basin is that area generally depicted in Figure 41-1 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(3) The Wekiva River Hydrologic Basin is that area generally depicted in Figures 41-1 and 41-6 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(4) The Wekiva Recharge Protection Basin is that area generally depicted in Figure 41-6 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(5) The Econlockhatchee River Hydrologic Basin is that area generally depicted in Figure 41-1 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(6) The Tomoka River and Spruce Creek Hydrologic Basins are the areas generally depicted in Figure 41-1 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(7) The Sensitive Karst Areas Basin is that area generally depicted in Figures 41-2, 41-3, and 41-4 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

(8) The Lake Apopka Hydrologic Basin is that area generally depicted in Figure 41-5 and defined in "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," Appendix B.

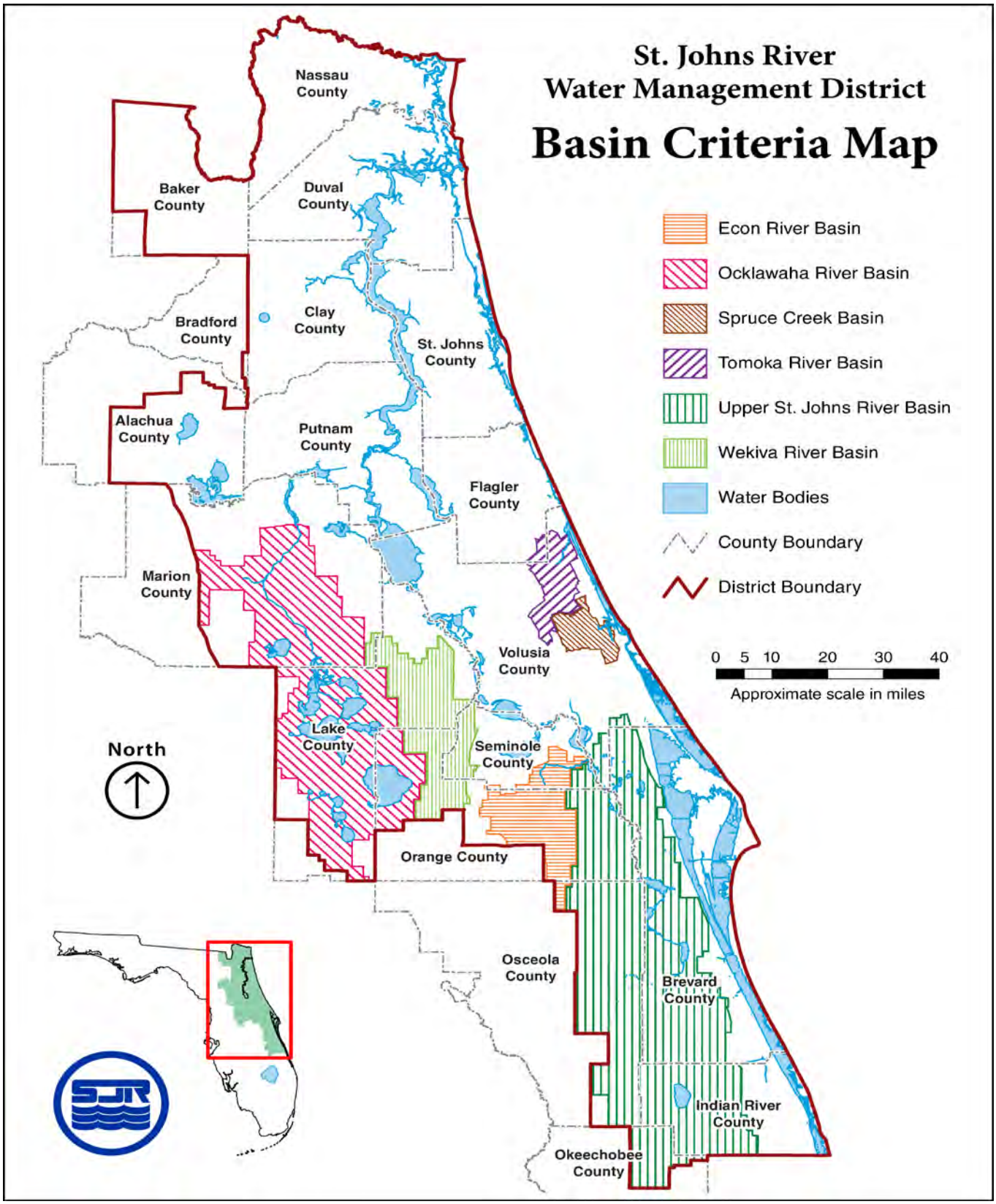


Figure 41-1 Basin Criteria Map

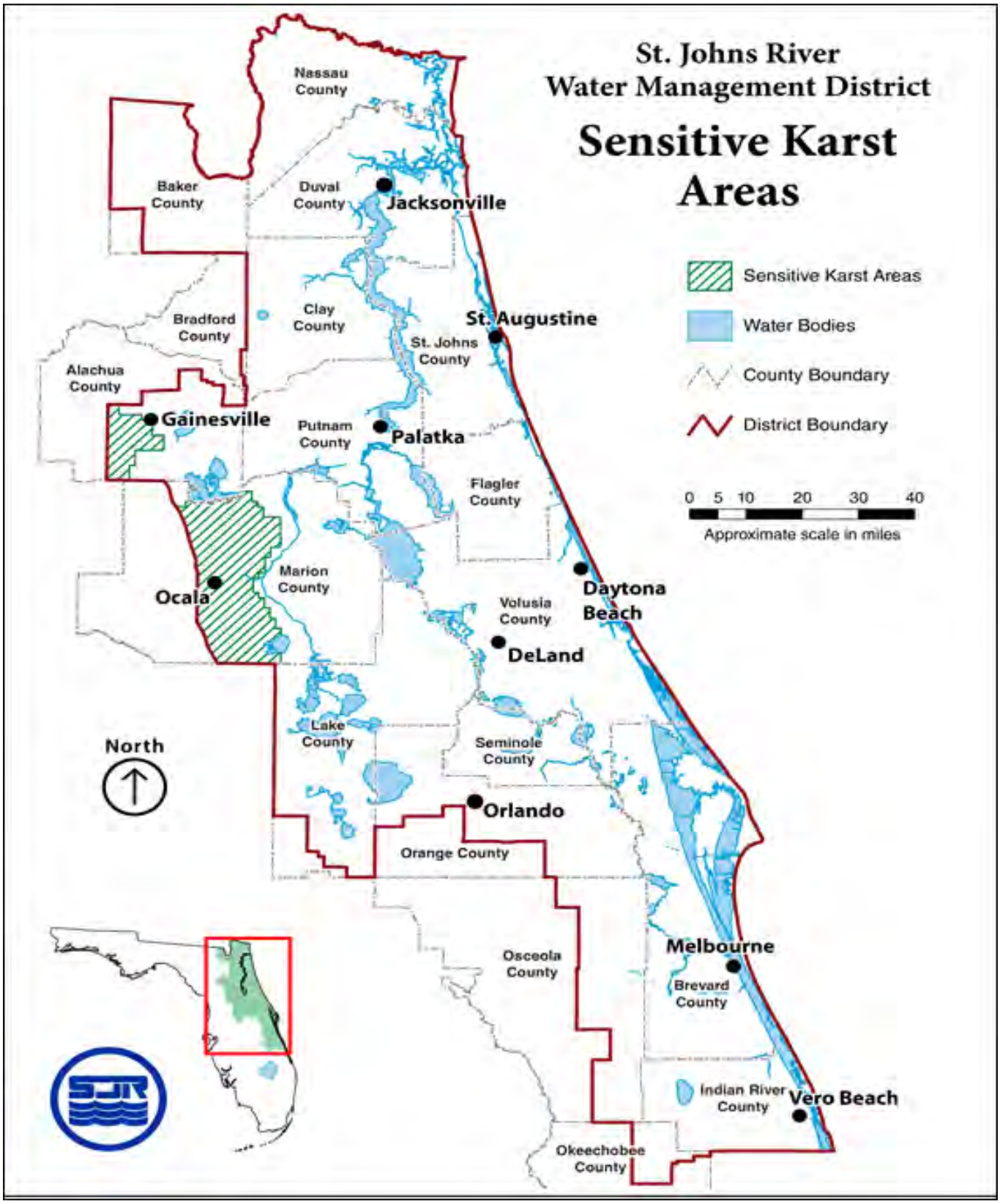


Figure 41-2 Sensitive Karst Areas in the St. Johns River Water Management District

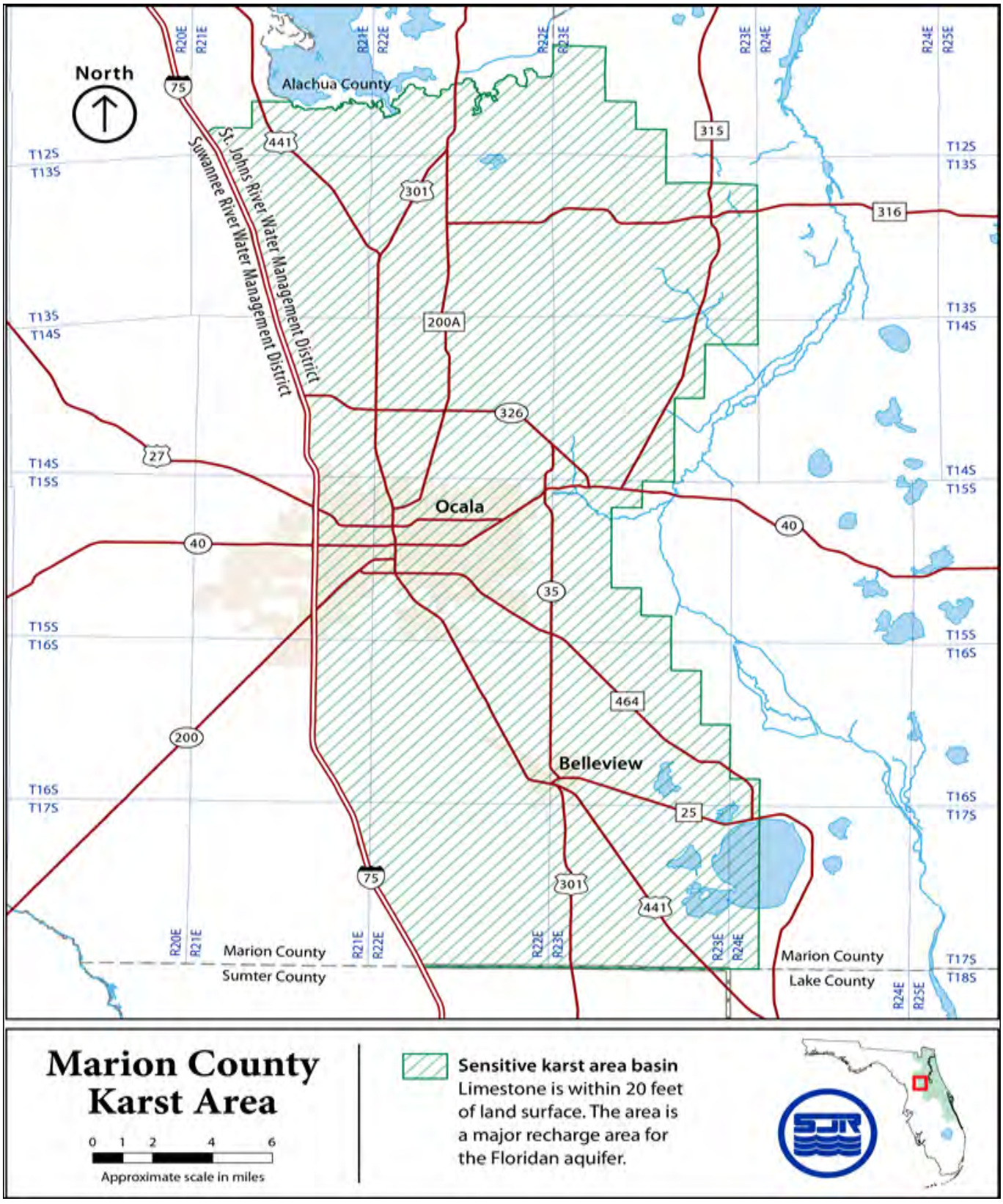


Figure 41-3 Alachua County Karst Area

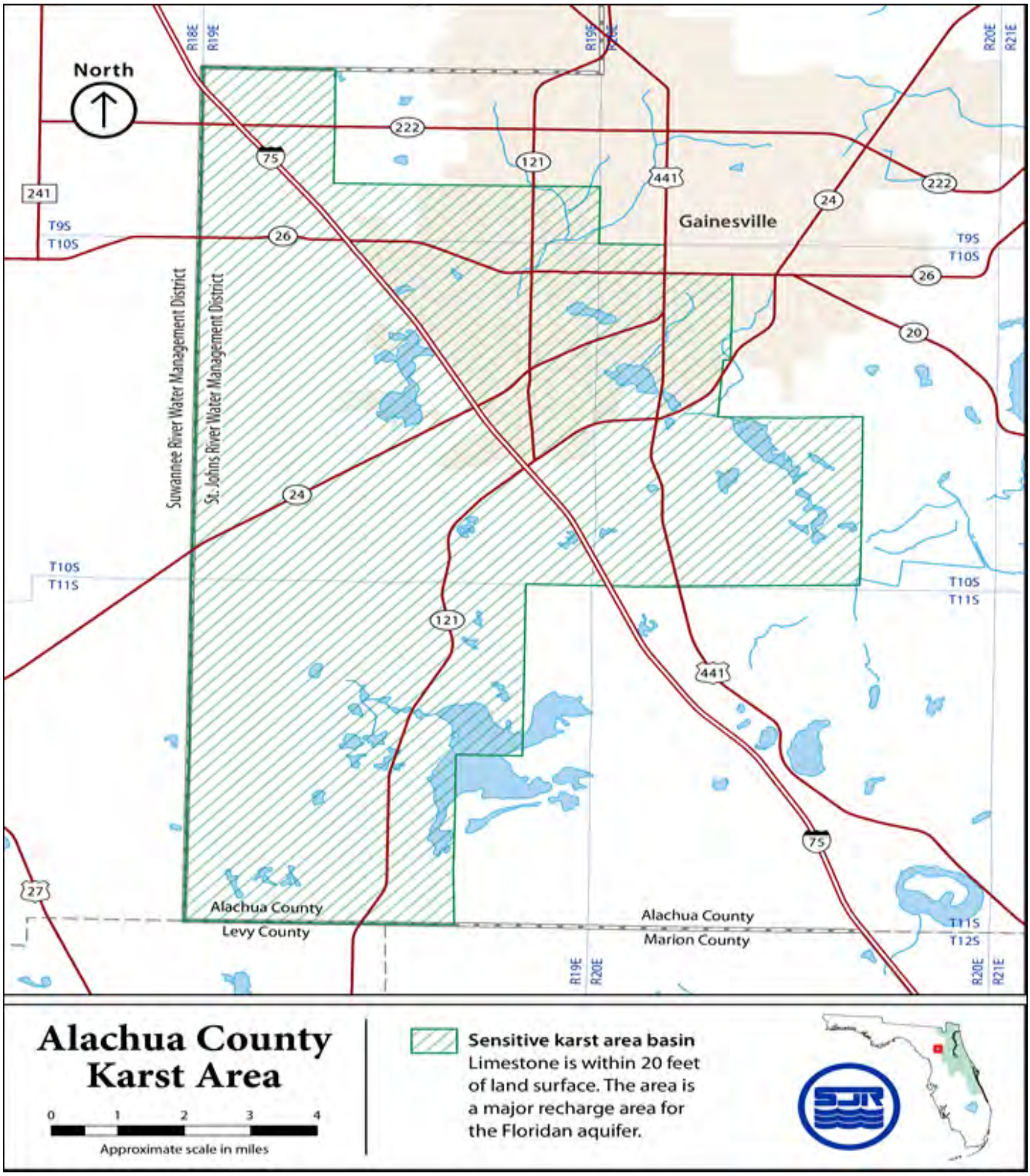


Figure 41-4 Marion County Karst Area

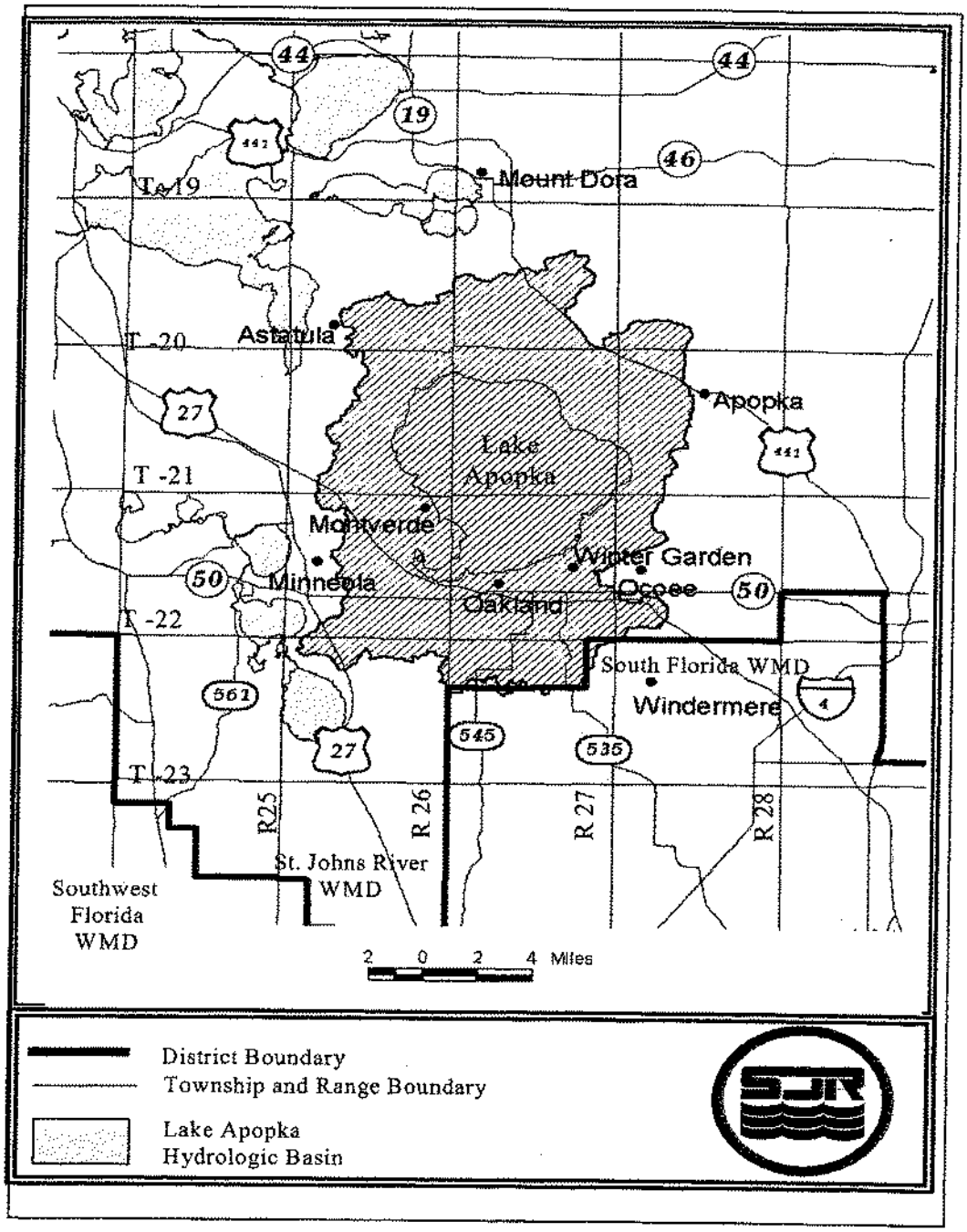
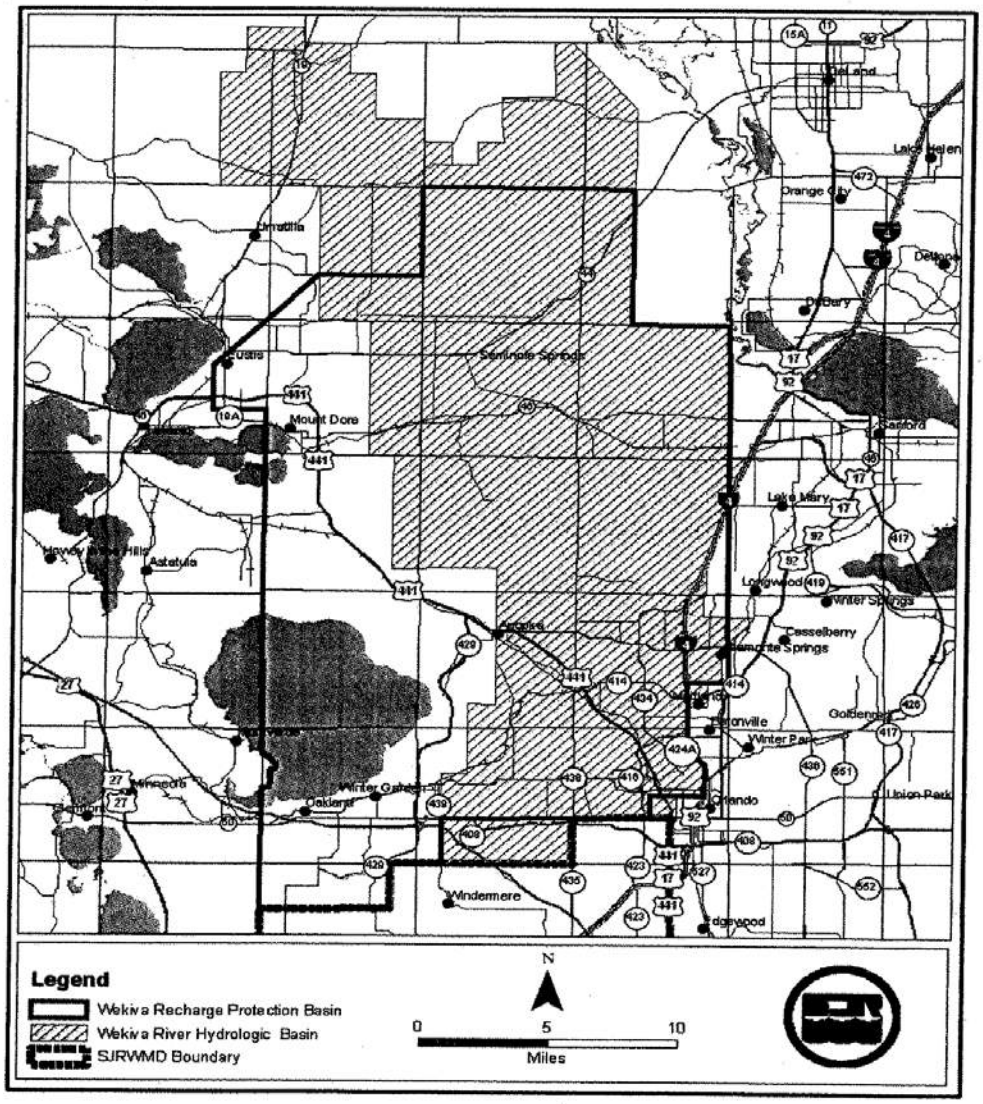


Figure 41-5 Lake Apopka Drainage Basin

Figure 41-6 Wekiva River Hydrologic Basin and Wekiva Recharge Protection Basin



Rulemaking Authority 369.318, 373.044, 373.113, 373.4131, 373.414, 373.415, 373.418 FS. Law Implemented 369.318, 373.413, 373.4131, 373.414, 373.415, 373.416, 373.418, 373.426, 373.461 FS. History–New 12-7-83, Amended 5-17-87, 4-3-91, 9-25-91, 11-25-98, 3-7-03, 12-3-06, 10-1-13, 6-1-18.

40C-41.043 Application of Chapter.

(1) All projects located within the Upper St. Johns River Hydrologic Basin, the Oklawaha River Hydrologic Basin, the Wekiva River Hydrologic Basin, the Wekiva Recharge Protection Basin, the Econlockhatchee River Hydrologic Basin, the Tomoka River Hydrologic Basin, the Spruce Creek Hydrologic Basin, the Sensitive Karst Areas Basin, or the Lake Apopka Hydrologic Basin, requiring permits pursuant to paragraphs 62-330.020(2)(a), (b), (c), (d), (e), (f), (g), (h) or (j) or section 1.2.2, "Environmental Resource Permit Applicant's Handbook Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C., shall be constructed, operated, maintained, altered, abandoned and removed in accordance with the standards and criteria specified in rule 40C-41.063, and rules 62-330.301 and 62-330.302, F.A.C., unless specifically exempted in rule 40C-41.051, F.A.C., or otherwise provided in subsection 40C-41.043(3) or 40C-41.043(4), F.A.C. The most restrictive criteria will be applicable unless the applicant provides reasonable assurance that the purposes and intent of this chapter and chapter 62-330, F.A.C., will be fulfilled using alternate criteria.

(2) Stormwater management systems requiring permits pursuant to rule 62-330.020, F.A.C., that will be located within the Lake Apopka Hydrologic Basin or will discharge water to Lake Apopka or its tributaries, shall be constructed, operated, maintained, altered, abandoned and removed in accordance with the standards and criteria specified in rules 62-330.301 and 62-330.302, F.A.C. and subsection 40C-41.063(8), F.A.C.

(3) Agricultural surface water management systems requiring permits pursuant to Rule 40C-44.041, F.A.C., that will be located within the Lake Apopka Hydrologic Basin or will discharge water to Lake Apopka or its tributaries, shall be constructed, operated, maintained, altered, abandoned and removed in accordance with the standards and criteria specified in Rule 40C-44.301, F.A.C., and subsection 40C-41.063(8), F.A.C.

(4) Agricultural surface water management systems requiring permits pursuant to Rule 40C-44.041, F.A.C., that will be located within the Wekiva Recharge Protection Basin, shall be constructed, operated, maintained, altered, abandoned and removed in accordance with the standards and criteria specified in rule 40C-44.301, F.A.C. and paragraph 40C-41.063(3)(a), F.A.C.

(5) The Governing Board hereby incorporates by reference Part VI (sections 13.0-13.8.3), "Basin Criteria" of the document entitled "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District," (6-1-18), available at [https://www.flrules.org/Gateway/reference.asp?No=Ref-06352], and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka Florida 32177-2529.

Rulemaking Authority 369.318, 373.044, 373.113, 373.4131, 373.414, 373.415, 373.418 FS. Law Implemented 369.318, 373.413, 373.4131, 373.414, 373.415, 373.416, 373.418, 373.426, 373.461 FS. History–New 12-7-83, Amended 5-17-87, 8-30-88, 4-3-91, 9-25-91, 10-3-95, 11-25-98, 3-7-03, 12-3-06, 10-1-13, 6-1-18.

40C-41.063 Conditions for Issuance of Permits.

(1) Within the Upper St. Johns River Hydrologic Basin the following criteria are established:

(a) Storm Frequency – For purposes of design and evaluation of system performance, both the 10-year and the 25-year design storm frequencies must be met.

(b) Runoff Volume – For design purposes, those systems utilizing pumped discharge, the total post-development discharge runoff volumes shall not exceed pre-development discharge runoff volumes for the four-day period beginning the third day of the four-day design storm event.

(c) Interbasin Diversion –

1. A system may not result in an increase in the amount of water being diverted from the Upper St. Johns River Hydrologic Basin into coastal receiving waters.

2. It is an objective of the District to, where practical, curtail diversions of water from the Upper St. Johns River

Hydrologic Basin into coastal receiving waters.

(2) Within the Oklawaha River Hydrologic Basin the following criteria are established:

(a) Storm Frequency – For purposes of design and evaluation of system performance, both the 10-year and the 25-year design storm frequencies must be met.

(b) Runoff Volume – For design purposes, those systems utilizing pumped discharges, the total post-development discharge runoff volumes shall not exceed pre-development discharge runoff volumes for the four-day period beginning the third day of the four-day design storm event.

(3) Within the Wekiva River Hydrologic Basin or the Wekiva Recharge Protection Basin, the following standards and criteria are established:

(a) Recharge Standard – Applicants required to obtain a permit pursuant to chapter 62-330 or 40C-44, F.A.C., for a surface water management system located within the Wekiva Recharge Protection Basin shall demonstrate that the system provides for retention storage of three inches of runoff from all impervious areas proposed to be constructed on soils defined as Type "A" Soils as defined by the Natural Resources Conservation Service (NRCS) Soil Survey in the following NRCS publications: Soil Survey of Lake County Area, Florida (1975); Soil Survey of Orange County Area, Florida (1989) and Soil Survey of Seminole County Area, Florida (1990), which are incorporated by reference in paragraph 40C-4.091(3)(a), F.A.C. For purposes of this rule, areas with Type "A" Soils shall be considered "Most Effective Recharge Areas." Section 13.8.1 "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in subsection 40C-41.043(5), F.A.C., contains a list of Type "A" soils. The system shall be capable of infiltrating this storage volume through natural percolation into the surrounding soils within 72-hours. Off-site areas or regional systems may be utilized to satisfy this requirement. As an alternative, applicants may demonstrate that the post-development recharge capacity is equal to or greater than the pre-development recharge capacity. Pre-development recharge shall be based upon the land uses in place as of 12-3-06. Applicants may utilize existing permitted municipal master stormwater systems, in lieu of onsite retention, to demonstrate that post-development recharge is equal to or greater than pre-development recharge. Also, applicants may submit additional geotechnical information to establish whether or not a site contains Type "A" soils.

(b) Storage Standard – Within the Wekiva River Hydrologic Basin, a system may not cause a net reduction in flood storage within the 100-year floodplain of a stream or other water course which has a drainage area of more than one square mile and which has a direct hydrologic connection to Little Wekiva River, Wekiva River, or Black Water Creek.

(c) Standards for Erosion and Sediment Control and Water Quality – Within the Wekiva River Hydrologic Basin, a Water Quality Protection Zone shall extend one half mile from the Wekiva River, Little Wekiva River north of State Road 436, Black Water Creek, Rock Springs Run, Seminole Creek, and Sulphur Run, and shall also extend one quarter mile from any wetland abutting an Outstanding Florida Water.

1. An erosion and sediment control plan must be submitted as part of the permit application for a surface water management system which:

a. Serves a project which is located wholly or partially within this zone; or

b. Serves a project with a total land area equal to or exceeding 120-acres.

2. The applicant proposing such a system must give reasonable assurance in the erosion and sediment control plan that during construction or alteration of the system (including revegetation and stabilization), erosion will be minimized and sediment will be retained on-site. The plan must be in conformance with the erosion and sediment control principles set forth in Section 13.8.2, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in subsection 40C-41.043(5), F.A.C., and must contain the information set forth in Section 13.8.3, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in subsection 40C-41.043(5), F.A.C.

3. For a project which will be located wholly or partially within 100-feet of an Outstanding Florida Water or within 100 feet of any wetland abutting such a water, an applicant must provide reasonable assurance that the construction or alteration of the system will not cause sedimentation within these wetlands or waters and that filtration of runoff will occur prior to discharge into these wetlands and waters. It is presumed that this standard will be met if, in addition to

implementation of the plan required in subparagraph 1., any one of the following criteria is met:

a. A minimum 100-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. During construction or alteration, runoff (including turbid discharges from dewatering activities) must be allowed to sheetflow across this undisturbed vegetation as the natural topography allows. Concentrated or channelized runoff from construction or alteration areas must be dispersed before flowing across this undisturbed vegetation. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

b. Construction of the following perimeter controls at all outfall points to the Outstanding Florida Water or its abutting wetlands must be completed prior to the start of any construction or alteration of the remainder of the system:

(I) Stormwater discharge facility meeting the requirements of "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), and subsection 40C-42.091(1), F.A.C.

(II) Sedimentation trap or basin located immediately upstream of the stormwater discharge facility referred to above; and,

(III) Spreader swale to reduce the velocity of discharge from the stormwater facility to non-erosive rates before discharge to wetlands abutting the Outstanding Florida Water.

These perimeter controls must be maintained routinely and operated throughout construction or alteration of the entire system. A minimum 25-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

c. During construction or alteration, no direct discharge to the Outstanding Florida Water or its abutting wetland may occur during the 10-year 24-hour storm event or due to discharge from dewatering activities. Any on-site storage required to satisfy this criteria must be available (recovered) within 14 days following the rainfall event. A minimum 25-foot width of undisturbed vegetation must be retained landward of the Outstanding Florida Water or the abutting wetland, whichever is more landward. Construction or alteration of limited scope necessary for outfall structures may occur within this area of undisturbed vegetation.

In determining whether construction or alteration is of "limited scope necessary", pursuant to any of the three presumptive criteria above, the District shall require that the area of disturbance be minimized and that the length of time between initial disturbance and stabilization of the area also be minimized.

(d) Standard for Limiting Drawdown – Within the Wekiva River Hydrologic Basin, a Water Quantity Protection Zone shall extend 300 feet landward of the landward extent of Black Water Swamp and the wetlands abutting the Wekiva River, Little Wekiva River, Rock Springs Run, Black Water Creek, Sulphur Run, Seminole Creek, Lake Norris, and Lake Dorr. As part of providing reasonable assurance that the standard set forth in paragraph 62-330.301(1)(d), F.A.C., is met, where any part of a system located within this zone will cause a drawdown, the applicant must provide reasonable assurance that construction, alteration, operation, or maintenance of the system will not cause ground water table drawdowns which would adversely affect the functions provided by the referenced wetlands.

The applicant shall provide an analysis which includes a determination of the magnitude and areal extent of any drawdowns, based on site-specific hydrogeologic data collected by the applicant, as well as a description of the referenced wetlands, the functions provided by these wetlands, and the predicted impacts to these functions.

It is presumed that the part of this standard regarding drawdown effects will be met if the following criteria is met:

A ground water table drawdown must not occur within the Water Quantity Protection Zone.

(e) Standard for Riparian Wildlife Habitat Within the Wekiva River Hydrologic Basin.

1. The applicant must provide reasonable assurance that the construction or alteration of a system will not adversely affect the abundance, food sources, or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species provided by the following designated Riparian Habitat Protection Zone:

a. The wetlands abutting the Wekiva River, Little Wekiva River downstream of Maitland Boulevard, Rock Springs Run, Black Water Creek, Sulphur Run, or Seminole Creek;

b. The uplands which are within 50-feet landward of the landward extent of the wetlands above.

c. The uplands which are within 550-feet landward of the stream's edge as defined, for the purpose of this

subsection, as the waterward extent of the forested wetlands abutting the Wekiva River, Little Wekiva River downstream of the northernmost crossing of the Little Wekiva River with S.R. 434, Rock Springs Run, Black Water Creek, Sulphur Run or Seminole Creek. In the absence of forested wetlands abutting these streams, the stream's edge shall be defined, for the purpose of this subsection, as the mean annual surface water elevation of the stream; however, if hydrologic records are unavailable, the landward extent of the herbaceous emergent wetland vegetation growing in these streams shall be considered to be the stream's edge.

2. Any of the following activities within the Riparian Habitat Protection Zone is presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and any land clearing which results in the creation of any system. (Activities not listed above do not receive a presumption of no adverse effect.)

3. The presumption in subparagraph 2. shall not apply to any activity which promotes a more endemic state, where the land in the zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with the endemic land cover.

(4) Local Government Notification for Wekiva River Protection Area – The District shall not issue a conceptual approval or individual, permit for a proposed surface water management system located wholly or partially within the Wekiva River Protection Area, as defined in section 369.303(9), F.S., until the appropriate local government has provided written notification that the proposed activity is consistent with the local comprehensive plan and is in compliance with any land development regulation in effect in the area where the development will take place. The applicant proposing such a system must submit to the District form no. 40C-41.063(4), entitled "Local Government Notification" (10-1-13), after it has been completed and executed by the local government. This form is hereby incorporated by reference and is available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-02657] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529. Permit applications for systems within the Wekiva River Protection Area shall be processed by the District staff pursuant to the time frames established in section 120.60, F.S., and any District rule regarding permit processing, except that any agency action to approve or approve with conditions shall not occur until the Local Government Notification has been received by the District.

(5) Within the Econlockhatchee River Hydrologic Basin the following standards and criteria are established:

(a) Design Storm Criteria. A system must meet the peak discharge requirement for the following 24-hour duration design storm events:

1. Mean annual storm (2.3 year return period).

2. 25-year return period. System outlet control structures can be designed to meet the control peak discharge rates for both design storms by use of a two-stage weir, v-notch weir, multiple orifices, or other similar structures.

(b) Floodplain Storage Criteria. A system may not cause a net reduction in flood storage within the 100-year floodplain of the Econlockhatchee River or any of its tributaries, at a location with an upstream drainage area of 1 square mile or greater, except for structures elevated on pilings or traversing works that comply with the conveyance requirements in subsection 3.3.2, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C.

(c) Riparian Wildlife Habitat Standard.

1. The applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a system within the following designated Riparian Habitat Protection Zone will not adversely affect the abundance, diversity, food sources or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species:

a. The wetlands contiguous with the Econlockhatchee River and the following tributaries: Little Econlockhatchee River north of University Boulevard, Mills Creek, Silcox Branch (branch of Mills Creek), Mills Branch (branch of Mills Creek), Long Branch, Hart Branch, Cowpen Branch, Green Branch, Turkey Creek, Little Creek, and Fourmile Creek;

b. The uplands which are within 50-feet landward of the landward extent of the wetlands above; and

c. The uplands which are within 550-feet landward of the stream's edge as defined, for the purpose of this

subsection, as the waterward extent of the forested wetlands abutting the Econlockhatchee River and the above named tributaries. In the absence of forested wetlands abutting these streams, the stream's edge shall be defined, for the purpose of this subsection, as the mean annual surface water elevation of the stream; however, if hydrologic records are unavailable, the landward extent of the herbaceous emergent wetland vegetation growing in these streams shall be considered to be the stream's edge.

d. The following portions of streams typically lack a defined water's edge, and subparagraph c. shall not apply:

(I) Mills Creek upstream of the intersection of the creek with the Fort Christmas Road in Section 2, Township 22 South, Range 32 East;

(II) Long Branch upstream of the intersections of the creek with SR 520;

(III) Hart Branch upstream of the intersection of the creek and the Old Railroad Grade in Section 18, Township 23 South, Range 32 East;

(IV) Cowpen Branch upstream of the southernmost bifurcation of the creek in Section 20, Township 23 South, Range 32 East;

(V) Green Branch upstream of the intersection of the creek with the north-south section line between Section 29 and 30, Township 23 South, Range 32 East;

(VI) Turkey Creek including Turkey Creek Bay upstream of the intersection of the creek with the Weewahootee Road in Section 5, Township 24 South, Range 32 East;

(VII) Little Creek upstream of the intersection of the creek with the north-south section line between Sections 22 and 23, Township 24 South, Range 32 East;

(VIII) Fourmile Creek including Bee Tree Swamp upstream of a point along the creek exactly halfway between section lines at the south end of Section 21 and the north end of Section 33 within Section 28, Township 24 South, Range 32 East; and,

(IX) All of the Econlockhatchee River Swamp (a portion of the Econlockhatchee River).

2. Any of the following activities within the Riparian Habitat Protection Zone are presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and any land clearing which results in the creation of any system. (activities not listed above do not receive a presumption of no adverse effect.)

3. The presumption in subparagraph 2. shall not apply to any activity which promotes a more endemic state, where the land in the zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with the endemic land cover.

4. Applicants seeking to develop within the Riparian Habitat Protection Zone shall be given the opportunity to demonstrate that the particular development for which permitting is being sought will not have an adverse effect on the functions provided by the zone to aquatic or wetland dependent species. The functions provided by the zone are dependent on many factors. When assessing the value of the zone to aquatic and wetland dependent species, factors which the District will consider include: vegetative land cover, hydrologic regime, topography, soils, and land uses, existing within and adjacent to the zone; and range, habitat, and food source needs of aquatic and wetland dependent species, as well as sightings, tracks, or other such empirical evidence of use.

5. The standard of subparagraph 40C-41.063(5)(c)1., F.A.C., may be met by demonstrating that the overall merits of the proposed plan of development, including the preservation, creation or enhancement of viable wildlife habitat, provide a degree of resource protection to these types of fish and wildlife which offsets adverse effects that the system may have on the abundance, diversity, food sources, or habitat of aquatic or wetland dependent species provided by the zone. Mitigation plans will be considered on a case-by-case basis upon detailed site specific analyses. The goal of this analysis shall be the determination of the value of the proposed mitigation plan to aquatic and wetland dependent species with particular attention to threatened or endangered species. Mitigation plans should include: the information set forth in subsection 10.3.3, "Environmental Resource Permit Applicant's Handbook, Volume I (General and Environmental)", implemented pursuant to paragraph 373.4131(2)(a), F.S. (2012), for the uplands and wetlands within the zone and within other areas to be preserved, created or enhanced as mitigation for impacts within the zone; as well as other pertinent information, including land use, and the proximity of the site to publicly owned land dedicated to conservation.

Implementation of this paragraph contemplates that the proximity of development to the river and tributaries named herein and activities permitted in the zone may vary from place to place in support of a functional resource protection plan. Furthermore, some reasonable use of the land within the protection zone can be allowed under paragraph 40C-41.063(5)(c), F.A.C.

6. Roads or other traversing works which cross the zone have the potential to fragment the zone and adversely affect the habitat value of the zone to aquatic and wetland dependent species. To minimize adverse effects to the zone, applicants for permits to construct traversing works in the zone must first demonstrate the need for the traversing works to provide for regional transportation, regional utility services, or reasonable property access, in addition to meeting the requirement of subparagraph 40C-41.063(5)(c)1., F.A.C., above. Traversing works must also be designed to meet all requirements of the district rules related to water quality and quantity. Permittees responsible for traversing works shall be required to be responsible for maintaining the traversing works clean and free from trash and debris to the greatest extent practical.

(6) Within the Tomoka River Hydrologic Basin or the Spruce Creek Hydrologic Basin the following standards and criteria are established:

(a) Recharge Standard. For projects or portions of projects within the Most Effective Recharge Area, three inches of runoff from the directly connected impervious areas in the Most Effective Recharge Areas, as defined in subsection 13.5.1, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in subsection 40C-41.043(5), F.A.C., must be retained within the Most Effective Recharge Area. As an alternative, applicants may demonstrate that the post-development recharge capacity is equal to or greater than the pre-development recharge capacity.

(b) Floodplain Storage Criteria. A system may not cause a net reduction in flood storage within the 100-year floodplain of the Tomoka River, Spruce Creek, or any of their tributaries except for structures elevated on pilings or traversing works that comply with conveyance requirements in subsection 3.3.2, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C.

(c) Stormwater Management Standard. Construction of new stormwater management systems must be in accordance with the design and performance standards of "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C. However, systems which serve drainage areas in excess of 10-acres cannot use detention with filtration treatment as the sole stormwater treatment methodology. Additionally, when retention systems are not feasible due to limited percolation capacity, wet detention treatment or other treatment demonstrated to be equivalent to retention or wet detention, in accordance with "Environmental Resource Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C., must be used.

(d) Riparian Wildlife Habitat Standard.

1. The applicant must provide reasonable assurance that the construction, alteration, operation, maintenance, removal or abandonment of a system within the following designated Riparian Habitat Protection Zone will not adversely affect the abundance, diversity, food sources or habitat (including its use to satisfy nesting, breeding and resting needs) of aquatic or wetland dependent species:

a. The wetlands and uplands which are within 50-feet landward of the landward extent of the wetlands which abut Spruce Creek north of Pioneer Trail to the FEC railroad, and the Tomoka River north of I-4 to US 1 and the following tributaries:

(I) Spruce Creek east of the western section line of Section 35, Township 16 South, Range 32 East, Volusia County, Florida;

(II) Spruce Creek east of the power line easement in Section 27, Township 16 South, Range 32 East, Volusia County, Florida;

(III) Spruce Creek west of SR 415 and south of the northern section line of Section 23, Township 16 South, Range 32 East, Volusia County, Florida;

(IV) The Little Tomoka River north of SR 40 and south of the western section line of Section 22, Range 31 East,

Township 14 South, Flagler County;

(V) Priest Branch east of the power line easement in Section 6, Township 15 South, Range 32 East, Volusia County, Florida; and,

b. The uplands which are within 550-feet landward of the stream's edge of the following portions of the streams. The stream's edge is defined, for the purpose of this subsection, as the waterward extent of the wetlands abutting the stream:

(I) Spruce Creek north of the southern section line of Section 25, Range 32 East, Township 16 South, Volusia County, Florida;

(II) Tomoka River north of the confluence of the Tomoka River and Priest Branch; and,

c. The uplands which are within 320-feet landward of the stream's edge of the following portions of the streams. The stream's edge is defined, for the purpose of this subsection, as the waterward extent of the wetlands abutting the stream:

Spruce Creek east of I-95 and west of the FEC railroad; and,

d. The uplands that are within 275-feet landward of the edge of the following streams:

(I) Spruce Creek south of the southern section line of Section 25, Range 32 East, Township 16 South, Volusia County, Florida

(II) Spruce Creek east of the western section line of Section 35, Township 16 South, Range 32 East, Volusia County, Florida;

(III) Spruce Creek east of the power line easement in Section 27, Township 16 South, Range 32 East, Volusia County, Florida;

(IV) Spruce Creek west of SR 415 and south of the northern section line of Section 23, Township 16 South, Range 32 East, Volusia County, Florida;

(V) The Tomoka River south of the confluence of the Tomoka River and Priest Branch in Section 36, Range 31 East, Township 14 South, Volusia County, Florida;

(VI) The Little Tomoka River north of SR 40 and south of the western section line of Section 22, Range 31 East, Township 14 South, Flagler County, Florida; and,

(VII) Priest Branch east of the power line easement in Section 6, Township 15 South, Range 32 East, Volusia County, Florida.

2. Any of the following activities within the Riparian Habitat Protection Zone are presumed to adversely affect the abundance, food sources, or habitat of aquatic or wetland dependent species provided by the Zone: construction of buildings, golf courses, impoundments, roads, canals, ditches, swales, and any land clearing which results in the creation of any system. (Activities not listed above do not receive a presumption of no adverse effect.)

3. The presumption in subparagraph 2. shall not apply to any activity which promotes a more endemic state, where the land in the Zone has been changed by man. An example of such an activity would be construction undertaken to return lands managed for agriculture or silviculture to a vegetative community that is more compatible with the endemic land cover.

4. The standard of subparagraph 1. may be met by demonstrating that the overall merits of the proposed plan of development, including mitigation as described in section 10.0, "Environmental Resource Permit Applicant's Handbook, Volume I (General and Environmental)", implemented pursuant to Section 373.4131(2)(a), F.S. (2012), provide a degree of resource protection to these types of fish and wildlife which offsets adverse effects of the proposed system on the uplands and wetlands within the Zone. Some reasonable use of the land within the Protection Zone can be allowed under this section.

5. Roads or other traversing works which cross the Zone have the potential to fragment the Zone and adversely affect the habitat value of the Zone to aquatic and wetland dependent species. To minimize adverse effects to the Zone, applicants for permits to construct traversing works in the Zone must first demonstrate the need for the traversing works to provide for regional transportation, regional utility services, or reasonable property access, in addition to meeting the requirement of subparagraph 1., above. Traversing works must also be designed to meet all requirements of the district rules related to water quality and quantity.

(7) Within the Sensitive Karst Areas Basin, stormwater management systems shall be designed to assure adequate

treatment (pursuant to Sections 13.6 through 13.6.3, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in subsection 40C-41.043(5), F.A.C.) of the stormwater before it enters the Floridan Aquifer, and to preclude the formation of solution pipe sinkholes in the stormwater system. Many different stormwater management system designs will achieve these goals, therefore the District does not require any specific system design. However, to assure protection of the Floridan Aquifer, the District does require certain design features. The individual site characteristics may affect what design features will be required. However, for all projects in sensitive karst areas, the following minimum design features are required:

(a) A minimum of three feet of unconsolidated soil material between the surface of the limestone bedrock and the bottom and sides of the stormwater basin. Excavation and backfill of suitable material may be made to meet this criteria;

(b) Stormwater basin depth should be as shallow as possible with a horizontal bottom (no deep spots);

(c) Maximum stormwater basin depth of 10-feet; and,

(d) Fully vegetated basin side slopes and bottoms. The District recommends that Saint Augustine or Bermuda grass be used for this purpose.

(e) The above requirements represent the minimum requirements for stormwater management system design in sensitive karst areas. However, depending on the potential for contamination to the Floridan Aquifer, more stringent requirements may apply for certain projects (e.g., industrial and some commercial sites). Examples for more stringent design features include:

1. More than three feet of material between the limestone bedrock surface and the bottom and sides of the stormwater basin;
2. Basin liners – clay or geotextile;
3. Sediment sumps at stormwater inlets;
4. Off-line treatment;
5. Special stormwater system design;
6. Ground water monitoring, and
7. Paint/solvent and water separators.

(8) Any surface water management system that requires a permit pursuant to Chapters 62-330 or 40C-44, F.A.C., and that will be located within the Lake Apopka Hydrologic Basin or will discharge water to Lake Apopka or its tributaries, must comply with the requirements of Section 13.7, "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in subsection 40C-41.043(5), F.A.C.

Rulemaking Authority 369.318, 373.044, 373.113, 373.4131, 373.414, 373.415, 373.418 FS. Law Implemented 369.318, 373.413, 373.4131, 373.414, 373.415, 373.416, 373.418, 373.426, 373.461 FS. History–New 12-7-83, Amended 5-17-87, 8-30-88, 4-3-91, 9-25-91, 7-14-92, 10-3-95, 11-25-98, 10-11-01, 3-7-03, 2-10-05, 12-3-06, 10-1-13, 6-1-18.

CHAPTER 40C-44
ENVIRONMENTAL RESOURCE PERMITS:
REGULATION OF AGRICULTURAL SURFACE WATER MANAGEMENT SYSTEMS

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40C-44.011 Scope.

(1) An individual environmental resource permit under this chapter will be required for the maintenance and operation of certain existing agricultural surface water management systems as defined herein, and the construction of certain new agricultural surface water management systems.

(2) Agricultural operations which are required to obtain an environmental resource permit pursuant to Chapter 62-330, F.A.C., shall satisfy the requirements of the District in terms of the quality of water discharged from the system, by implementing the performance standards and water quality practices described in this chapter.

Rulemaking Authority 373.044, 373.113, 373.171, 373.4131, 373.418 FS. Law Implemented 373.413, 373.4131, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 10-1-13.

40C-44.021 Definitions.

(1) “Agriculture,” for the purposes of this chapter, means the commercial production of crops, animals or animal products, or farm commodities including but not limited to vegetables, citrus and other fruits, grain, forage, sod, livestock, poultry, and foliage plants. Agriculture also includes horticulture and floriculture.

(2) “Agricultural Operation” means a contiguous farm, grove, ranch, nursery or similar entity owned or controlled by one or more persons, engaged in, or proposing to engage in, the practice of agriculture.

(3) “Associated Wastewater” means the flow of water which directly results from agricultural activities such as irrigation, soil flooding for pest control or soil preservation, freeze protection or pre-storm event drainage and is mixed or conveyed with stormwater in the surface water management system.

(4) “Conservation Plan” means a document, which describes a system of management practices to control and reduce soil erosion and sediment loss, and improve the quality of discharged water for a specific parcel of property, and which has been either:

(a) Prepared by the U.S. Department of Agriculture Soil Conservation Service (SCS) in conjunction with a local Soil and Water Conservation District Board, organized pursuant to chapter 582, F.S., which includes and applies the appropriate management practices consistent with the SCS Field Office Technical Guide – Section IV and the Best Management Practices Selector, incorporated by reference in Rule 40C-44.091, F.A.C., and which includes the following elements when appropriate for the proposed land use:

1. Reduction of the volume of water discharged off-site;

2. Water Table Control in Open Channels;

3. Irrigation Land Leveling;

4. Irrigation Water Management;

5. Nutrient Management Plan;

6. Pesticide Management Plan;

7. Harvesting the runoff from the agricultural site, using reservoir or canal storage already existing, proposed as part of the plan or otherwise required by permit, for uses such as freeze protection, soil flooding for pest control or soil preservation, or irrigation needs; and

8. Control of soil erosion.

(b) Prepared by a private consultant, who has professional expertise in the fields of hydrology, water pollution control, irrigation design and soil conservation, according to standards, specifications and guidelines developed by SCS. The plan must include and apply the appropriate management practices consistent with the SCS Field Office Technical Guide – Section IV and the Best Management Practices Selector, incorporated by reference in rule 40C-44.091, F.A.C., and include the following elements when appropriate for the proposed land use:

1. Reduction of the volume of water discharged off-site;

2. Water Table Control in Open Channels;

3. Irrigation Land Leveling;

4. Irrigation Water Management;

5. Nutrient Management Plan;

6. Pesticide Management Plan;

7. Appropriate harvesting of the annual stormwater runoff from the agricultural site for uses such as freeze protection, soil flooding for pest control or soil preservation, or irrigation needs;

8. Control of soil erosion; and

9. Reduction of suspended solids loading at points of discharge off-site.

(5) “Engineer” means a Professional Engineer registered in Florida, or other person exempted pursuant to the provisions of chapter 471, F.S., who is competent in the fields of hydrology and water pollution control.

(6) “Existing agricultural surface water management system” means a system which was constructed or implemented on or before the effective date of this chapter.

(7) “Hayland” means a tract of land used for forage production, which has been planted with desirable forage plant species.

(8) “Improved Pasture” means a tract of land used for livestock grazing, which has been planted with desirable forage plant species.

(9) “Littoral zone” means, in reference to stormwater management systems, that portion of a wet detention pond which is designed to contain rooted aquatic plants.

(10) “NAVD” means North American vertical datum.

(11) “Permanent Pool” means that portion of a wet detention pond, which normally holds water, between the pond bottom and control elevation, excluding any water volume claimed as treatment volume.

(12) “Stormwater” means the water which results from a rainfall event.

(13) “Surface Water Management System” or “System” means a stormwater management system, dam, impoundment, reservoir, appurtenant work, or works, or any combinations thereof. The terms “surface water management” or “system” include dredged or filled areas.

(14) “Treatment” means any method, technique, process or management practice which changes the physical, chemical, or biological character of water and thereby reduces its potential for polluting waters of the state.

(15) “Wet detention” for the purposes of this chapter, means the collection and temporary storage of water in a normally wet impoundment in such a manner as to provide for treatment through physical, chemical, and biological processes with subsequent gradual release of the water.

Rulemaking Authority 373.044, 373.113, 373.171, 373.418 FS. Law Implemented 373.413, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 7-4-93, 10-3-95, 10-1-13, 6-1-18.

40C-44.031 Implementation.

(1) This chapter shall become effective on 8-11-91.

(2) Permits and consent orders which authorize operation of agricultural operations, issued by the Department of Environmental Regulation, or pending on June 1, 1991, pursuant to the provisions of former chapter 17-6, F.A.C., renumbered as chapters 62-660 and 62-670, F.A.C., shall remain valid after 8-11-91, subject to all limiting conditions contained therein, until final District action on a timely filed permit application made pursuant to this chapter. Ninety days prior to the expiration date of the permit or consent order, an application for the modification of a permit issued pursuant to chapter 40C-4, F.A.C., and prior to June 1, 1988, or for a general or individual permit, as appropriate, pursuant to this chapter, must be submitted to the District.

(3) Permits and consent orders which authorize operation of agricultural operations, issued by the District or executed by all parties to the consent order by 8-11-91, pursuant to the provisions of former chapter 17-6, F.A.C., renumbered as chapters 62-660 and 62-670, F.A.C., and pursuant to subparagraph 62-101.040(12)(a)3., F.A.C., and the Operating Agreement Concerning Stormwater Discharge Regulation and Dredge and Fill Regulation between the St. Johns River Water Management District and Department of Environmental Regulation dated January 4, 1988, shall remain valid after 8-11-91, subject to all limiting conditions therein, until final District action on a timely filed permit application made pursuant to this chapter. Ninety days prior to the expiration date of the permit or consent order, an application for the modification of a permit issued pursuant to chapter 40C-4, F.A.C., and prior to June 1, 1988, for a general or individual permit, as appropriate, pursuant to this chapter must be submitted to the District.

(4) Any permit application received prior to 8-11-91, will be processed and evaluated pursuant to the provisions of the chapters and Operating Agreement referenced in subsection (2) above.

Rulemaking Authority 373.044, 373.113, 373.171, 373.429 FS. Law Implemented 373.416 FS. History–New 8-11-91, Amended 10-20-92, 11-11-03.

40C-44.041 Permits Required.

(1) Unless expressly exempt by section 373.406, F.S. or rule 62-330.051 or 40C-44.051, F.A.C., a permit is required under this chapter for the maintenance and operation of existing agricultural surface water management systems which serve an agricultural operation as described in paragraph (a) or (b), below.

(a) An individual environmental resource permit is required for the maintenance and operation of existing agricultural surface water management systems which incorporate pumped discharges from stationary or portable facilities as part of the surface water management system and which have pumps with a capacity, either individually or cumulatively, of 10,000 gallons per minute (GPM) or greater. The pump operator or person in control of the pump is required to obtain the maintenance and operation permit.

(b) Case by case designation. Notwithstanding any other provision of this section, the District shall require that an agricultural operation, including pumped or gravity-drained systems, obtain an individual environmental resource permit for an agricultural system pursuant to this chapter or modification of a permit issued pursuant to chapter 62-330, F.A.C., if it causes or contributes to a violation of state water quality standards within waters of the state. In determining whether an individual permit is required under these circumstances, the District will consider the following information:

1. Water quality monitoring data collected by the District or other agency;

2. The size of the agricultural operation and the amount of stormwater and associated wastewater reaching waters of the state, relative to the size and nature of the immediate drainage basin;

3. The means of conveyance of stormwater and associated wastewater to waters of the state;

4. Characteristics of the site including the slope, vegetation, rainfall, and other factors relating to the likelihood or frequency of discharge of stormwater and associated wastewater to waters of the state;

5. The status, results and recommendations of available basin-specific studies, including those conducted as part of a Surface Water Improvement and Management Plan or pursuant to chapter 62-40, F.A.C.;

6. The existence of mixing zones, variances or site-specific alternative criteria granted by the Department of Environmental Protection pursuant to chapters 62-4 and 62-302, F.A.C.; and

(2) Unless expressly exempt by section 373.406, F.S. or rule 62-330.051 or 40C-44.051, F.A.C., or authorized under section 403.814(12), F.S., an environmental resource permit must be obtained for the construction, maintenance and operation of new agricultural surface water management systems, or alteration of existing systems, which:

(a) Drain an agricultural area greater than 2 acres;

(b) Are below thresholds described in paragraphs 62-330.020(2)(a) and (e), F.A.C.;

(c) Serve a project with a total land area less than 40 acres; and

(d) Do not provide for the placement of 12 or more acres of impervious surface that constitutes 40 or more percent of the total land area.

Rulemaking Authority 373.044, 373.113, 373.171, 373.406, 373.416, 373.418 FS. Law Implemented 373.409, 373.413, 373.416, 373.418 FS. History–New 8-11-91, Amended 10-20-92, 7-4-93, 10-3-95, 10-1-13.

40C-44.051 Exemptions.

The following types of agricultural surface water management systems are exempt from the permit requirements of this chapter:

(1) Concentrated Animal Feeding Operations with a valid permit issued by the Department of Environmental Protection pursuant to chapter 62-670, F.A.C., provided that:

(a) For dairy farms, the permitted design incorporates a high intensity use area, from which the stormwater runoff is centrally collected for storage and disposal by land application, or is treated prior to discharge.

(b) For egg production facilities, the permitted design prevents the discharge of process wastewater and stormwater runoff to surface waters, except in the event of a storm greater than a 25-year, 24-hour event.

(c) For any concentrated animal feeding operation which does not incorporate a high intensity use area, the permitted design includes provisions to treat stormwater and associated wastewater from adjacent animal loafing and feeding areas; manure pits; animal watering systems; washing, cleaning or flushing pens; or other pollutant sources, so that discharges through the surface water management system from the operation will not cause or contribute to a violation of water quality standards in waters of the state.

(2) Animal Feeding Operations, which do not discharge except in the event of a storm greater than a 25-year, 24-hour event and therefore are not Concentrated Animal Feeding Operations pursuant to chapter 62-670, F.A.C.

(3) Privately owned or operated agricultural surface water management systems lying within the boundaries of an active water control district which has been formed and operated in accordance with chapter 298, F.S., or a special district or improvement district created under Florida law which has the power to construct, operate and maintain agricultural surface water management systems, and which district has obtained or elected to obtain a permit pursuant to the requirements of chapter 40C-44, F.A.C., or has obtained a permit or consent order as stated in rule 40C-44.031, F.A.C. No exemption is implied or expressed here for any permits required by any other rule within title 40C, F.A.C., or the water control district or special district.

(4) Agricultural surface water management systems which are required to obtain a permit pursuant to subsection 40C-44.041(2), F.A.C., to implement one or more of the following practices under the District's Best Management Practices Cost-Sharing Program: SJ1 (Backflow Prevention), SJ5 (Pump Platform Fuel and Oil Containment) or SJ6 (Pesticide Mixing and Storage Area Containment).

(5) Minor alterations, as defined in subsection 40C-44.071(3), F.A.C., of new or existing agricultural surface water management systems permitted under this chapter or chapter 62-330, F.A.C.

(6) Agricultural surface water management systems which are required to obtain a permit pursuant to subsection 40C-44.041(2), F.A.C., provided they have a valid permit issued pursuant to chapter 40C-2, F.A.C., which requires that they obtain a Conservation Plan, as defined in subsection 40C-44.021(4), F.A.C., implement the Conservation Plan within 180 days of permit issuance, and maintain the Conservation Plan.

Rulemaking Authority 373.044, 373.113, 373.171, 373.406, 373.418 FS. Law Implemented 373.413, 373.406, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 10-1-13.

40C-44.055 Standard General Environmental Resource Permits for Agricultural Systems.

Rulemaking Authority 373.044, 373.113, 373.118, 373.171, 373.406, 373.416, 373.418 FS. Law Implemented 373.406, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, Repealed 10-1-13.

***Editorial Note**: Repealed pursuant to paragraph 373.4131(2)(c), F.S.*

40C-44.061 Individual Environmental Resource Agricultural System Permits.

(1) Agricultural surface water management systems which are required to obtain a permit pursuant to rule 40C-44.041, F.A.C., shall obtain an individual environmental resource permit in accordance with this rule.

(2) The following types of agricultural surface water management systems will qualify for an individual environmental resource

permit for an agricultural system, provided they comply with the criteria specified in rule 40C-44.301, F.A.C.:

(a) Agricultural surface water management systems which are required to obtain a permit pursuant to subsection 40C-44.041(1), F.A.C., provided that they have obtained a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C., implement the Conservation Plan within 180 days of permit issuance, and maintain the Conservation Plan.

(b) Agricultural surface water management systems which are required to obtain a permit pursuant to subsection 40C-44.041(1), F.A.C., and which have been authorized pursuant to subsection 40C-44.031(2) or (3), F.A.C., provided they:

1. Continue to maintain and operate the surface water management system, and associated treatment system, as previously permitted or authorized by consent order, and

2. Demonstrate compliance with the performance standards described in rule 40C-44.065, F.A.C., based upon data collected in compliance with monitoring conditions. If the District staff determines that the compliance monitoring data does not demonstrate compliance with the performance standards, staff will notify the applicant, in writing, of the specific pollutant or pollutants for which treatment will be required.

(c) Minor alterations, as defined in subsection 40C-44.071(3), F.A.C., provided the applicant provides reasonable assurance, through plans, test results or other information, that the alteration complies with subsection 40C-44.071(2), F.A.C.

(d) Surface water management systems which drain an agricultural operation of less than 120 acres, which do not contain a concentrated animal feeding operation, which implement a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C., within 180 days of permit issuance and which maintain the Conservation Plan, provided the permittee satisfies the following conditions:

1. The permittee must maintain hour meters, in operating order, on each drainage pump. If the hour meters are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Reports of pump operating hours for each pump must be submitted to the District quarterly, using form 40C-44.061(2)(d)1. (Form EN-14M) which is hereby incorporated by reference as of (10-1-13), available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-02659] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529.

2. The permittee must maintain a surveyed staff gauge, referenced to NGVD or NAVD, in each detention pond. If the staff gauges are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Water levels must be recorded a minimum of 3 nonconsecutive days per week, or as an alternative, once a week and daily during pump operation. Reports of water levels for each pond must be submitted quarterly to the District using form 40C-44.061(2)(d)2. (Form EN-52) which is hereby incorporated by reference as of (10-1-13), available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-02661] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529.

3. The permittee must monitor the water quality on a quarterly basis at each discharge point from pumps or pond outfalls to waters of the state. If no discharge has occurred during a particular quarter, no sampling is required. Water samples must be analyzed for the parameters listed in Table 1 which is hereby incorporated by reference as of (10-1-13), available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-02998] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529. Samples must be analyzed by a laboratory certified by the Florida Department of Health.

4. If, after five years of water quality monitoring, the permittee demonstrates that the data collected represents steady state conditions and is adequate to project future compliance with state water quality standards, the District shall amend the monitoring conditions by reducing the frequency of monitoring or the number of parameters monitored, or eliminating such requirements.

5. If, after five years of water quality monitoring, the District notifies the permittee in writing that discharges from the surface water management system have not complied with the performance standards described in subsections 40C-44.065(1) and (2), F.A.C., then the permittee must apply for an individual permit in accordance with subsection 40C-44.061(3), F.A.C.

(e) Surface water management systems which drain an agricultural operation which do not contain a concentrated animal feeding operation, provided they have obtained a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C., implement the Conservation Plan within 180 days of permit issuance, and maintain the Conservation Plan, and which have not been issued a permit or consent order which authorized operation as described in subsection 40C-44.031(2) or (3), F.A.C., provided the permittee satisfies the monitoring conditions described below:

1. The permittee must maintain hour meters, in operating order, on each drainage pump. If the hour meters are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Reports of pump operating hours for each pump must be submitted to the District quarterly, using Form EN-14M, as incorporated by reference in subparagraph 40C-

44.061(2)(d)1., F.A.C.

2. The permittee must maintain a surveyed staff gauge, referenced to NGVD or NAVD, in each detention pond. If the staff gauges are not installed at the time of permit issuance, they must be installed within 60 days of the issuance of the permit. Water levels must be recorded a minimum of 3 nonconsecutive days per week, or as an alternative, once a week and daily during pump operation. Reports of water levels for each pond must be submitted quarterly to the District using Form EN-52 as incorporated by reference in subparagraph 40C-44.061(2)(d)2., F.A.C.

3. The permittee must monitor the water quality on a quarterly basis at each discharge point from pumps or pond outfalls to waters of the state following implementation of the Conservation Plan or within 180 days of permit issuance, whichever occurs sooner. If no discharge has occurred during a particular quarter, no sampling is required. Water samples must be analyzed for the parameters listed in Table 1 as incorporated by reference in subparagraph 40C-44.061(2)(d)3., F.A.C. Samples must be analyzed by a laboratory certified by the Florida Department of Health.

4. If, after five years of water quality monitoring, the permittee demonstrates that the data collected represents steady state conditions and is adequate to project future compliance with state water quality standards, the District shall amend the monitoring conditions by reducing the frequency of monitoring or the number of parameters monitored, or eliminating such requirements.

5. If, after one year of water quality monitoring, the District notifies the permittee in writing that discharges from the surface water management system have not complied with the performance standards described in subsections 40C-44.065(1) and (2), F.A.C., then the permittee must apply for an individual permit in accordance with subsection 40C-44.061(3), F.A.C.

(3) An individual environmental resource permit for an agricultural system may be issued to the applicant, upon such conditions as the District may direct, only if the applicant affirmatively provides the District with reasonable assurance based on plans, test results or other information, that the construction, expansion, alteration, modification, operation or activity of the surface water management system will comply with the performance standards described in rule 40C-44.065, F.A.C., and the criteria specified in Rule 40C-44.301, F.A.C.

(a) For existing systems, incorporation of the appropriate water quality practices, as described in rule 40C-44.066, F.A.C., shall be presumed to provide reasonable assurance of compliance with the performance standards as described in rule 40C-44.065, F.A.C., provided that provisions have been made for maintenance and operation of the proposed surface water management system and water quality practices pursuant to rule 40C-44.069, F.A.C.

(b) For new systems, incorporation of the appropriate water quality practices, as described in rule 40C-44.066, F.A.C., and installation of a surface water management system designed to provide a level of treatment and pollutant reduction so that pollutant loads discharged to surface waters of the state on an average annual basis, from a particular agricultural operation are 80% less than those from a similar operation which did not incorporate a treatment system or water quality practices, shall be presumed to provide reasonable assurance of compliance with the performance standards as described in rule 40C-44.065, F.A.C., provided that provisions have been made for maintenance and operation of the proposed surface water management system and water quality practices pursuant to rule 40C-44.069, F.A.C.

(c) New and existing systems which discharge to Class I, Class II, or Outstanding Florida Waters shall be required to provide an additional level of treatment to provide reasonable assurance pursuant to subsection (3), above.

Rulemaking Authority 373.044, 373.113, 373.171, 373.406, 373.416, 373.418 FS. Law Implemented 373.413, 373.4131, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 10-1-13.

40C-44.065 Performance Standards.

(1) Discharges from the agricultural surface water management system shall not cause or contribute to a violation of water quality standards in waters of the state, as set forth in chapters 62-3, 62-302, 62-520, 62-522, 62-550 and 62-4, F.A.C., including any antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), subsections 62-4.242(2) and (3), and rule 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in subsections 62-4.242(2) and (3), F.A.C.

(2) Agricultural surface water management systems requiring a permit, which will be located in the Lake Apopka Hydrologic Basin or will discharge water to Lake Apopka or its tributaries, must comply with the requirements of subsection 40C-41.063(8), F.A.C.

(3) Agricultural surface water management systems requiring a permit that will be located in the Wekiva Recharge Protection Basin must comply with the requirements of paragraph 40C-41.063(3)(a), F.A.C., and Sections 13.3 through 13.3.5, “Environmental Resource

Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District", as incorporated by reference in subsection 40C-41.043(5), F.A.C.

Rulemaking Authority 369.318, 373.044, 373.113, 373.171, 373.415, 373.416, 373.418, 373.461 FS. Law Implemented 369.318, 373.016, 373.413, 373.4131, 373.416, 373.418, 373.426, 373.461 FS. History–New 8-11-91, Amended 10-20-92, 7-4-93, 10-3-95, 3-7-03, 12-3-06, 10-1-13, 6-1-18.

40C-44.066 Water Quality Practices.

The practices listed below are set forth in this rule for the purpose of evaluating compliance with this chapter. It is presumed the water quality practices implemented in accordance with this section will provide reasonable assurance that the system will comply with the performance standards described in rule 40C-44.065, F.A.C. The water quality practices or other alternatives shall be implemented to the extent necessary to comply with the performance standards described in rule 40C-44.065, F.A.C. In some cases, the implementation of these practices may not result in compliance with the performance standards for issuance of an individual environmental resource permit for an agricultural system. In those cases, the applicant shall provide for implementation of such additional water quality practices and/or treatment methodologies as necessary to provide reasonable assurance that the discharge will comply with the performance standards described in rule 40C-44.065, F.A.C.

(1) Reduce the volume of stormwater and associated wastewater discharged to waters of the state by:

(a) Implementing management practices designed to reduce the volume of water discharged off-site, including Water Table Control in Open Channels, Irrigation Land Leveling and Irrigation Water Management, and

(b) Maximizing onsite recycling to satisfy irrigation, freeze protection and pest control needs. The applicant may demonstrate maximum stormwater harvesting by using all the practically available water from reservoir storage prior to using groundwater.

(2) Implement and maintain a Conservation Plan, which includes a Nutrient Management Plan and Pesticide Management Plan.

(3) Provide treatment of the pollutants generated by the agricultural operation. The treatment method required depends on the intensity of land use and associated pollutants.

(a) Wet detention ponds, designed and operated in accordance with paragraph (b) or (c) below, are presumed to satisfy the requirements of paragraphs (1)(b) and (3), for those portions of an agricultural operation described below:

1. Citrus, row crop, sod, hayland or improved pasture which discharge to Class I, Class II, or Outstanding Florida Waters, or

2. Citrus, row crop, sod, hayland or improved pasture on predominantly organic soils.

(b) Detention ponds which are part of an existing surface water management system, and which comply with following design and performance criteria are presumed to provide treatment.

1. Wet detention treatment volume is equal to the first inch of runoff.

2. The permanent pool volume provides an average residence time of 21 days during the wet season (June through October). This volume may be determined by estimating 13.82% of the wet season average runoff. The permanent pool volume should be recycled, pursuant to paragraph 40C-44.066(1)(b), F.A.C.

3. No more than half the treatment volume is drawn down in the first 60 hours following a storm event, and the entire treatment volume is drawn down within 168 hours.

4. Pond depths below the water control elevation shall not exceed an average of 5 feet or a maximum of 10 feet, unless the applicant affirmatively demonstrates that the deeper depths will not cause anaerobic conditions in the water column.

5. For ponds where interior borrow canals are likely to result in short-circuiting of flows between the inlet and outlet, the effective flow path shall be increased by adding diversion structures such as canal plugs or baffles.

(c) Detention ponds proposed as part of a new surface water management system which are designed, constructed and operated in accordance with the following design and performance criteria are presumed to provide treatment.

1. Wet detention treatment volume is equal to the first inch of runoff.

2. The permanent pool volume provides an average residence time of 21 days during the wet season (June through October). This volume may be determined by estimating 13.82% of the wet season average runoff. The permanent pool volume should be recycled, pursuant to paragraph 40C-44.066(1)(b), F.A.C.

3. No more than half the treatment volume is discharged in the first 60 hours following a storm event, but at least half of the treatment volume is discharged within 72 hours following a storm event.

4. Pond depths below the water control elevation shall not exceed an average of 4 feet or a maximum of 10 feet, unless the applicant affirmatively demonstrates that the deeper depths will not cause anaerobic conditions in the water column.

5. The treatment volume should not cause the pond level to rise more than 18 inches above the control elevation unless it is

demonstrated that the littoral zone vegetation can survive at greater depths and that the pond area ratio (drainage area/pond area) is still sufficient to provide adequate treatment.

6. The pond design shall incorporate a littoral zone or an alternate method to promote sedimentation. Littoral zones shall be gently sloped (6:1 or flatter) to a point 2-3 feet below the bleed-down or control elevation and extend to the top of the treatment volume. The littoral zone and vegetation should be concentrated at the inflow (adjacent to the sump, if required) and at the outfall.

7. The alignment and location of inlets and outlets shall be designed to maximize flow paths in the pond. The pond shall have a length to width ratio of a minimum of 2:1. If short flow paths are unavoidable, the effective flow path should be increased by adding diversion barriers such as islands, peninsulas or baffles to the pond. Inlet structures should be designed to dissipate the energy of water entering the pond. Pumped inflows must provide a sump to promote sedimentation and reduce water velocities.

8. Pond design must include permanent access for maintenance.

9. The bleed-down orifice invert elevation shall be at or above the estimated wet season water table elevation. If the orifice is proposed to be set below the wet season water table elevation, groundwater inflow must be considered in orifice drawdown calculations, calculation of average residence time, and estimated normal water level. For ponds with pumped inflows, the applicant must demonstrate that the water table of wetlands within the drainage area will not be significantly lowered.

(d) Other water quality practices in lieu of wet detention, such as overland flow, vegetative filters and detention in isolated wetlands, are presumed to satisfy the requirements in subsection (3), for low intensity agricultural operations such as rough or semi-improved pasture, when the practice(s) is designed, operated and maintained using accepted engineering principles.

(e) Agricultural surface water management systems may incorporate overland flow, vegetative filters and detention in isolated wetlands as water quality practices. Existing canals and conveyance systems may be incorporated into a wet detention treatment system, when appropriate. The applicant must provide reasonable assurance, through plans, test results or other information, that the practice will provide an adequate level of treatment to meet the performance standards above.

(4) Applicants who propose to satisfy the performance standards in rule 40C-44.065, F.A.C., by employing a treatment methodology or device other than those described in subsections 40C-44.066(1) through 40C-44.066(3), F.A.C., may seek approval for an equivalent alternative through the District's permit process. The applicant must provide reasonable assurance, through plans, test results or other information, that the alternative will provide an adequate level of treatment to meet the performance standards above.

Rulemaking Authority 373.044, 373.113, 373.171, 373.4131, 373.416, 373.418 FS. Law Implemented 373.016, 373.4131, 373.416 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 10-1-13, 6-1-18.

40C-44.069 Maintenance and Operation Requirements.

(1) The permittee is required to provide for periodic inspections of the surface water management system to insure that the system is functioning as designed and permitted.

(2) The following operational maintenance activities shall be performed on all permitted systems on a regular basis or as needed:

(a) Removal of trash and debris from the surface water management system;

(b) Inspection of culverts, culvert risers, pipes and screwgates for damage, blockage, excessive leakage or deterioration;

(c) Inspection of pipes for evidence of lateral seepage;

(d) Inspection of flapgates for excessive backflow or deterioration;

(e) Removal of sediments when the storage volume or conveyance capacity of the surface water management system is below design levels;

(f) Stabilization and restoration of eroded areas;

(g) Inspection of pump stations for structural integrity and leakage of fuel or oil to the ground or surface water; and

(h) Inspection of monitoring equipment, including pump hour meters and staff gauges, for damage and operational status.

(3) The permittee shall maintain and operate the Conservation Practices contained in the Conservation Plan.

(4) In addition to the practices listed in subsection (2), above, specific operational maintenance activities are required depending on the type of permitted system as follows:

(a) Overland flow systems shall include provisions for:

1. Mowing and removal of clippings; and

2. Maintenance of spreader swales and overland flow areas to prevent channelization.

(b) Spray irrigation systems for reuse/disposal shall include provisions for:

1. Inspection of the dispersal system, including the sprayheads or perforated pipe for damage or clogging; and

2. Maintenance of the sprayfield to prevent channelization.

(c) Treatment systems which incorporate isolated wetlands shall include provisions for:

1. Stabilization and restoration of channelized areas; and

2. Removal of sediments which interfere with the function of the wetland or treatment system.

(d) Systems in Class I waters shall include provisions for inspection and maintenance of valves for wells which discharge from an aquifer which contains greater than 250 mg/l of chloride.

(5) If the system is not functioning as designed and permitted, operational maintenance must be performed immediately to restore the system. If the operational maintenance measures are insufficient to enable the system to meet the performance standards of this chapter, the permittee must either replace the system or construct an alternative design. A permittee must apply for and obtain a modification prior to constructing such alternative design.

Rulemaking Authority 373.044, 373.113, 373.171, 373.416, 373.418 FS. Law Implemented 373.416, 373.418 FS. History–New 10-20-92.

40C-44.071 Relationship to Other Permitting Requirements.

(1) In order to comply with the performance standards in this rule or implement water quality practices outlined in rule 40C-44.066, F.A.C., some existing agricultural surface water management systems may require minor alterations.

(2) Alterations of existing agricultural surface water management systems, which would otherwise require permits pursuant to paragraph 62-330.020(2)(a), F.A.C., will be considered minor alterations and will qualify for an individual environmental resource permit, pursuant to this chapter, provided they do not increase the peak discharge rate and total discharge volume, when applicable ("Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District", Section 3.2), or alter off-site storage and conveyance capabilities of the water resource ("Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District" Section 3.3), or adversely affect wetland functions, ("Environmental Resource Permit Applicant's Handbook, Volume I (General and Environmental)" Section 10.2.2) or increase the off-site pollutant loading ("Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District" Section 4.0), all as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C., or implemented pursuant to paragraph 373.4131(2)(a), F.S. (2012), as applicable.

(3) The following activities, for the purposes of this rule, are presumed to be minor alterations:

(a) Regrading or reconfiguring of ditches and other conveyance systems necessary to implement a management practice recommended by a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C. or listed in rule 40C-44.066, F.A.C.,

(b) Installation of new internal ditches or other conveyance systems necessary to implement a management practice recommended by a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C. or listed in rule 40C-44.066, F.A.C.,

(c) Installation of internal water control structures necessary to implement a management practice recommended by a Conservation Plan, pursuant to subsection 40C-44.021(4), F.A.C. or listed in rule 40C-44.066, F.A.C.,

(d) Modification or expansion of existing detention ponds within previously diked areas, provided that public safety concerns related to levee failure are addressed, no floodplain encroachment occurs, and impacts to wetlands do not require a permit pursuant to paragraph 62-330.020(2)(a), F.A.C.,

(e) Construction of new detention ponds within previously diked areas, provided that public safety concerns related to levee failure are addressed, no floodplain encroachment occurs, and impacts to wetlands do not require a permit pursuant to paragraph 62-330.020(2)(a), F.A.C.

(4) Whenever the alteration, modification or construction of a new or existing agricultural surface water management system requires that an environmental resource permit be secured pursuant to paragraph 62-330.020(2)(a), (b), (c), (d), (e), (f), (g), (h) or (j) or section 1.2.2 "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in paragraph 40C-4.091(1)(a), F.A.C., the performance standards and water quality practices established in this chapter shall be reviewed as part of those permit applications. A separate permit application under this chapter shall not be required. However, the applicant must provide the required technical information as part of those applications to demonstrate compliance with this chapter.

(5) If the District determines that site-specific alternative criteria, as described in rule 62-302.800, F.A.C., may be appropriate

for a water body, based on the results of a basin-specific study or Surface Water Improvement and Management Plan, the District will submit this documentation to the Department of Environmental Protection.

Rulemaking Authority 373.044, 373.113, 373.171, 373.4131, 373.416, 373.418 FS. Law Implemented 373.4131, 373.416, 373.418 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 11-11-03, 10-1-13, 6-1-18.

40C-44.081 Permit Processing Fee.

Rulemaking Authority 373.044, 373.113, 373.171, 373.416, 373.418 FS. Law Implemented 373.416 FS. History–New 8-11-91, Amended 10-20-92, Repealed by Section 5, Chapter 2012-31, Laws of Florida, 5-27-12.

40C-44.091 Publications Incorporated by Reference.

(1) The Governing Board hereby adopts by reference Part VII (sections 14.0-19.2.6), available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-06357] and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529 of the document entitled "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District," effective (June 1, 2018).

(a) The purpose of the document is to provide information regarding the environmental resource permit program for agricultural systems.

(b) The document may be obtained by contacting:
Director, Bureau of Regulatory Support
St. Johns River Water Management District
4049 Reid Street
Palatka, Florida 32177-2529.

(2) The Governing Board hereby adopts by reference the SCS Field Office Technical Guide – Section IV.

(a) The purpose of the document is to provide information regarding SCS standards, specifications and guidelines.

(b) The document may be obtained by contacting:
Director, Bureau of Regulatory Support
St. Johns River Water Management District
4049 Reid Street
Palatka, Florida 32177-2529.

(3) The Governing Board hereby adopts by reference the Institute of Food and Agricultural Sciences, "Best Management Practices Selector."

(a) The purpose of this document is to provide information regarding selecting agricultural water quality practices.

(b) The document may be obtained by contacting:
Director, Bureau of Regulatory Support
St. Johns River Water Management District
4049 Reid Street
Palatka, Florida 32177-2529.

Rulemaking Authority 369.318, 373.044, 373.113, 373.118, 373.171, 373.406, 373.4131, 373.416, 373.418 FS. Law Implemented 369.318, 373.406, 373.413, 373.4131, 373.416, 373.418, 373.426, 373.461, 373.603, 373.609, 373.613 FS. History–New 10-20-92, Amended 7-4-93, 10-3-95, 1-11-99, 4-10-02, 3-7-03, 12-3-06, 12-27-10, 10-1-13, 6-1-18.

40C-44.101 Content of the Application.

(1) All applications for environmental resource permits for agricultural systems shall be processed in accordance with the procedures of Chapters 120 and 373, F.S., and subsection 15.4.1 of the "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within the Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in subsection 40C-44.091(1), F.A.C.

(2) Applicants for an individual environmental resource permit for an agricultural system under this chapter shall complete District form 40C-44.101(2), (Supplemental Information for Agricultural Systems) incorporated herein by reference, as of (10-1-13),

available at [http://www.flrules.org/Gateway/reference.asp?No=Ref-02658], and upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529, and Section A of form 62-330.060(1), Joint Application for Individual and Conceptual Environmental Resource Permit/Authorization to Use State-Owned Submerged Lands/Federal Dredge and Fill Permit" (6-1-18), available upon request from the St. Johns River Water Management District, 4049 Reid Street, Palatka, Florida 32177-2529, and implemented pursuant to paragraph 373.4131(2)(a), F.S. (2012).

Rulemaking Authority 369.318, 373.044, 373.113, 373.171, 373.416, 373.418 FS. Law Implemented 369.318, 373.4131, 373.416, 373.461 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 12-3-06, 10-1-13, 6-1-18.

40C-44.301 Conditions for Issuance of Permits.

(1)(a) To obtain an individual environmental resource permit for operation, maintenance, removal or abandonment of an agricultural system each applicant must give reasonable assurance that such activity will not:

1. Endanger life, health, or property;
2. Be inconsistent with the maintenance of minimum flows and levels established pursuant to chapter 40C-8, F.A.C.
3. Cause significant adverse effects to the availability of water for reasonable beneficial purposes;
4. Be incapable of being effectively operated;
5. Cause significant adverse effects to the operation of a Work of the District established pursuant to section 373.086, F.S.;
6. Cause significant adverse effects to existing agricultural, commercial, industrial, or residential developments;
7. Cause significant adverse impacts to the quality of receiving waters;
8. Cause significant adverse effects to natural resources, fish and wildlife;
9. Increase the potential for damages to off-site property or the public caused by:

a. Floodplain development, encroachment or other alteration;
b. Retardance, acceleration, displacement or diversion of surface water;
c. Reduction of natural water storage areas;
d. Facility failure;

10. Increase the potential for flood damages to residences, public buildings, or proposed and existing streets and roadways; and
11. Otherwise be inconsistent with the overall objectives of the District as set forth in Section 18.0 of the "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District" as incorporated by reference in subsection 40C-44.091(1), F.A.C.

(b) Because a system may result in both beneficial and harmful effects in terms of various individual objectives, in determining whether the applicant has provided evidence of reasonable assurance of compliance with paragraph (1)(a), above, the District shall consider a balancing of specific effects to show the system is not inconsistent with the overall objectives of the District.

(2)(a) To obtain an individual environmental resource permit for construction, alteration, operation, or maintenance of an agricultural system, each applicant must give reasonable assurance that such activity is not harmful to the water resources by meeting the following standards:

1. Significant adverse water quantity impacts will not be caused to receiving waters and adjacent lands;
2. Surface and ground water levels and surface water flow will not be significantly adversely affected;
3. Existing surface water storage and conveyance capabilities will not be significantly adversely affected;
4. The system must be capable of being effectively operated;
5. The activity must not result in significant adverse impacts to the operation of Works of the District established pursuant to section 373.086, F.S.; and
6. Hydrologically-related environmental functions will not be significantly adversely affected;

(b) If the applicant has provided reasonable assurance that the design criteria specified in the "Environmental Resource Permit Applicant's Handbook, Volume II: For Use Within The Geographic Limits of the St. Johns River Water Management District," Part VII, Subpart B "Criteria for Evaluation" adopted by reference in subsection 40C-44.091(1), F.A.C., have been met, then it is presumed that the standards contained in paragraph (2)(a), above, have been satisfied.

(3) Existing systems which are required to obtain a permit pursuant to this chapter are presumed to satisfy the conditions for issuance in subsections (1) and (2) above provided the information requested on the appropriate application form, pursuant to rule 40C-44.101(2), F.A.C., is submitted and the applicant demonstrates compliance with the performance standards of rule 40C-44.065, F.A.C. If available information indicates that the operation and maintenance of the system is inconsistent with the conditions for

issuance in subsections (1) and (2), above, the District shall require additional information which demonstrates that the existing system is in compliance with the performance standards of rule 40C-44.065, F.A.C.

Rulemaking Authority 373.016, 373.044, 373.113, 373.171, 373.406, 373.416, 373.418 FS. Law Implemented 373.016, 373.409, 373.4131, 373.416, 373.418 FS. History–New 8-11-91, Amended 10-20-92, 7-4-93, 10-3-95, 10-1-13, 6-1-18.

40C-44.321 Duration of Permit.

Unless revoked or modified, the duration of a permit is permanent.

Rulemaking Authority 373.113, 373.406, 373.416, 373.418 FS. Law Implemented 373.416 FS. History–New 8-11-91, Amended 10-20-92.

40C-44.341 Revocation or Modification of Permits.

Rulemaking Authority 373.044, 373.113, 373.171, 373.406, 373.416, 373.418 FS. Law Implemented 373.429 FS. History–New 8-11-91, Amended 10-20-92, 7-4-93, 12-27-10, Repealed 11-3-15.

40C-44.900 Forms and Instructions.

Rulemaking Authority 120.53(1), 369.318, 373.044, 373.113, 373.406, 373.416, 373.418 FS. Law Implemented 120.52(16), 120.53(1), 369.318, 373.103, 373.413, 373.416, 373.461 FS. History–New 8-11-91, Amended 10-20-92, 10-3-95, 12-3-06, Repealed 6-1-18.

CHAPTER 62-342
MITIGATION BANKS

62-342.100 Intent
62-342.200 Definitions
62-342.300 Use of a Mitigation Bank (Repealed)
62-342.400 Criteria for Establishing a Mitigation Bank
62-342.450 Mitigation Bank Permit and Mitigation Bank Conceptual Approval Applications
62-342.470 Establishment of Mitigation Credits
62-342.600 Mitigation Service Area
62-342.650 Land Use Restrictions on Mitigation Banks
62-342.700 Financial Responsibility
62-342.750 Mitigation Bank Permit and Mitigation Bank Conceptual Approval
62-342.800 Surrender, Transfer, or Modification of Mitigation Bank Permits
62-342.850 Department or Water Management District Mitigation Banks
62-342.900 Mitigation Banking Forms (Repealed)

62-342.100 Intent.

(1) The Department recognizes that, in certain instances, adverse impacts of activities regulated under part IV of chapter 373, F.S., can be offset through the utilization of mitigation credits from a permitted Mitigation Bank. This rule provides criteria for this mitigation alternative to complement existing mitigation criteria and requirements. This chapter is supplemental to and does not supersede any other criteria and requirements in rules promulgated under part IV of chapter 373, F.S.

(2) The responsibilities for implementing this chapter are described in Operating and Delegation Agreements between the Department of Environmental Protection ("Department") and the water management districts ("Districts"). The Agreements are incorporated by reference in subsection 62-113.100(3), F.A.C. The term "Agency" applies to the Department or a District, as applicable, throughout this chapter.

(3) The Agency intends that Mitigation Banks be used to minimize mitigation uncertainty associated with traditional mitigation practices and provide greater assurance of mitigation success. It is anticipated that the consolidation of multiple mitigation projects into larger contiguous areas will provide greater assurance that the mitigation will yield long-term, sustainable, regional ecological benefits. Mitigation Banks shall be consistent with Agency endorsed watershed management objectives and emphasize restoration and enhancement of degraded ecosystems and the preservation of uplands and wetlands as intact ecosystems rather than alteration of landscapes to create wetlands. This is best accomplished through restoration of ecological communities that were historically present. The establishment and use of Mitigation Banks in or adjacent to areas of national, state, or regional ecological significance is encouraged, provided the area in which the Mitigation Bank is proposed to be located is determined appropriate for a Mitigation Bank and the Mitigation Bank meets all applicable permitting criteria.

(4) Nothing in this chapter shall affect the mitigation requirements set forth in any Mitigation Bank agreement or any permit issued under chapter 84-79, Laws of Florida, or part IV of chapter 373, F.S., prior to February 2, 1994. If a permittee wishes to substantially modify a Mitigation Bank previously established by agreement or permit, the permittee must comply with this chapter. Additionally, some Mitigation Banks may be subject to the version of this section existing prior to July 1, 1996, under sections 373.4136(9) and (10), F.S., and will not be affected by amendments adopted after that date. This chapter does not prohibit an applicant from proposing project-specific, pre-construction on-site or off-site mitigation, without establishing a Mitigation Bank.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.100, Amended 5-21-01, 2-19-15.

62-342.200 Definitions.

Terms used in this chapter shall have the meanings specified below.

(1) "Banker" means an entity that creates, operates, manages, or maintains a Mitigation Bank pursuant to a Mitigation Bank Permit.

(2) "Department" means the Department of Environmental Protection.

(3) “District” means a water management district as established in chapter 373, F.S.

(4) “Ecological Value” means the value of functions performed by uplands, wetlands and other surface waters to the abundance, diversity, and habitats of fish, wildlife, and listed species. These functions include, but are not limited to: providing cover and refuge; breeding, nesting, denning, and nursery areas; corridors for wildlife movement; food chain support; and natural water storage, natural flow attenuation, and water quality improvement, which enhance fish, wildlife and listed species utilization.

(5) “Mitigation Credit” means a standard unit of measure which represents the increase in ecological value resulting from restoration, enhancement, preservation, or creation activities.

(6) “Mitigation Service Area” means the geographic area within which Mitigation Credits from a Mitigation Bank may be used to offset adverse impacts of activities regulated under part IV of chapter 373, F.S.

(7) “Mitigation Bank Permit” means a permit issued to a banker to construct, operate, manage and maintain a Mitigation Bank.

(8) “Mitigation Bank” means a project permitted under section 373.4136, F.S., undertaken to provide for the withdrawal of mitigation credits to offset adverse impacts authorized by a permit under part IV of chapter 373, F.S.

(9) “Regional Watershed” means a watershed as delineated in the following maps. (Figures 1, 2, 3, 4, and 5.)

Figure 1: Northwest Florida Water Management District – “Regional Watersheds of the NWFWMD for Mitigation Banks, 7 Watersheds” (February 19, 2015), which is incorporated by reference herein.

Figure 2: Suwannee River Water Management District – “Watersheds of the SRWMD Mitigation Banks, 7 Watersheds” (February 19, 2015), which is incorporated by reference herein.

Figure 3: St. Johns River Water Management District – “Regional Watersheds for Mitigation Banking” (October 1, 2013), Appendix A, Figure 10.2.8-2, Applicants Handbook Volume II, which is incorporated by reference in subparagraph 62-330.010(4)(b)3., F.A.C., [October 1, 2013] (http://www.flrules.org/Gateway/reference.asp?No=Ref-03181), and in subsections 40C-4.091(1) [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02524), 40C-42.091(1) [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02525), and 40C-44.091(1), F.A.C., [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02526).

Figure 4: Southwest Florida Water Management District – “Drainage Basins and Watersheds within the Southwest Florida Water Management District” (October 1, 2013), Figure 2.6, Applicants Handbook Volume II, is incorporated by reference in subparagraph 62-330.010(4)(b)4., F.A.C., [October 1, 2013] (http://www.flrules.org/Gateway/reference.asp?No=Ref-03176), and in rule 40D-4.091, F.A.C., [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02527).

Figure 5: South Florida Water Management District – Appendix D: “SFWMD Basins for Cumulative Impact Assessments & Mitigation Bank Service Areas” (October 1, 2013), Applicants Handbook Volume II, including Appendices A through D, is incorporated by reference in subparagraph 62-330.010(4)(b)5., F.A.C., [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02528), and in paragraph 40E-4.091(1)(a), F.A.C., [October 1, 2013] (https://www.flrules.org/Gateway/reference.asp?No=Ref-02529).

A copy of the incorporated material identified above also may be obtained from the Agency Internet site or by contacting staff in an Agency office identified in the “References and Design Aids, Volume I,” available at http://www.dep.state.fl.us/water/rulesprog.htm#erp.

Figure 1: Northwest Florida Water Management District – “Regional Watersheds of the NWFWMD for Mitigation Banks, 7 Watersheds” (February 19, 2015)

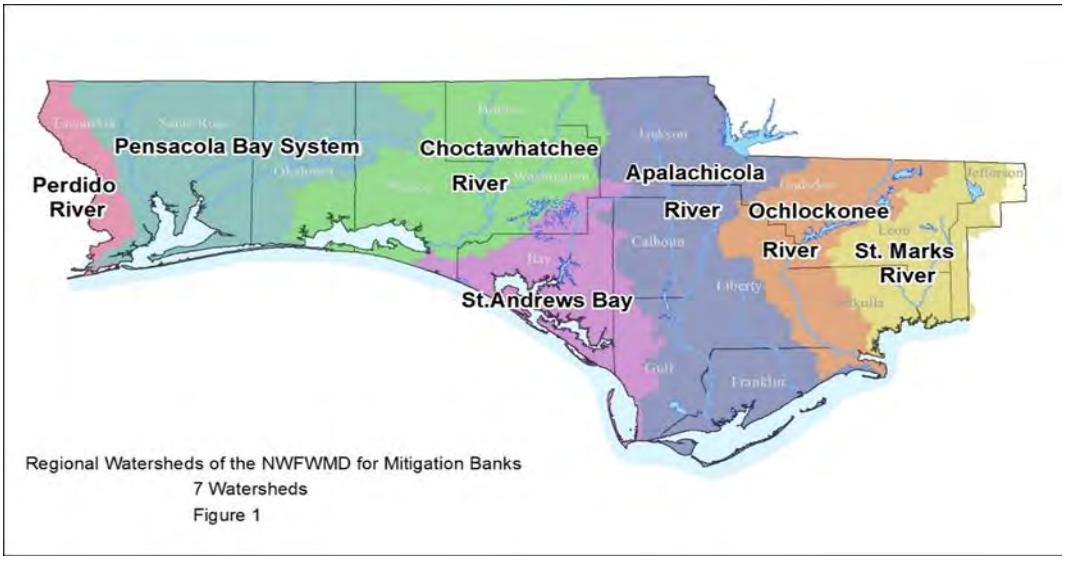


Figure 2: Suwannee River Water Management District – "Watersheds of the SRWMD Mitigation Banks, 7 Watersheds" (February 19, 2015)

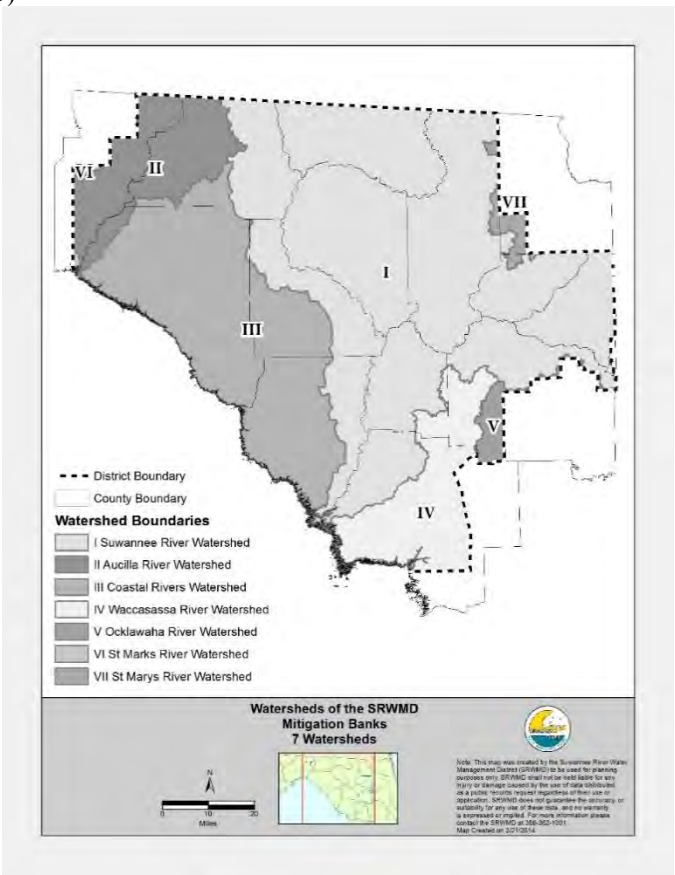


Figure 3: St. Johns River Water Management District – "Regional Watersheds for Mitigation Banking" (October 1, 2013)

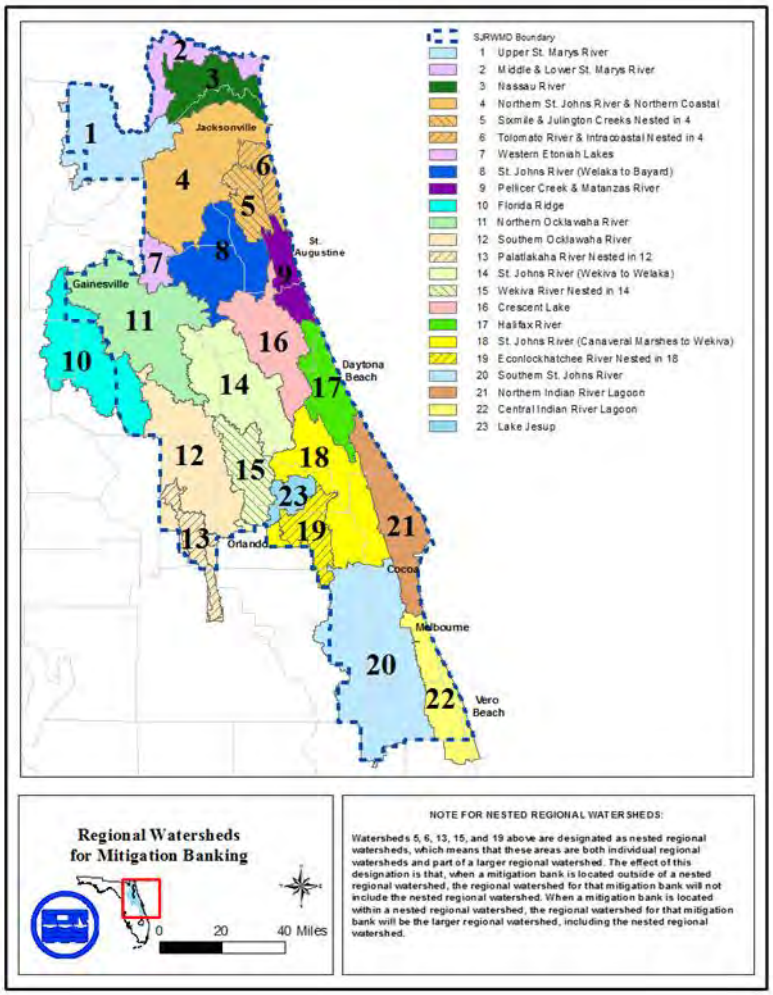


Figure 4: Southwest Florida Water Management District – "Drainage Basins and Watersheds within the Southwest Florida Water Management District" (October 1, 2013)

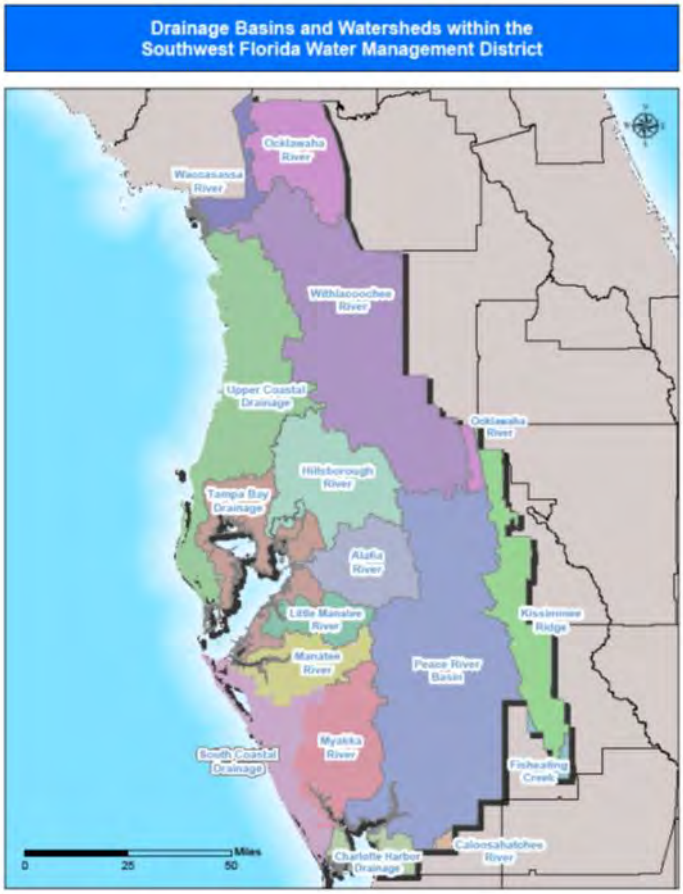
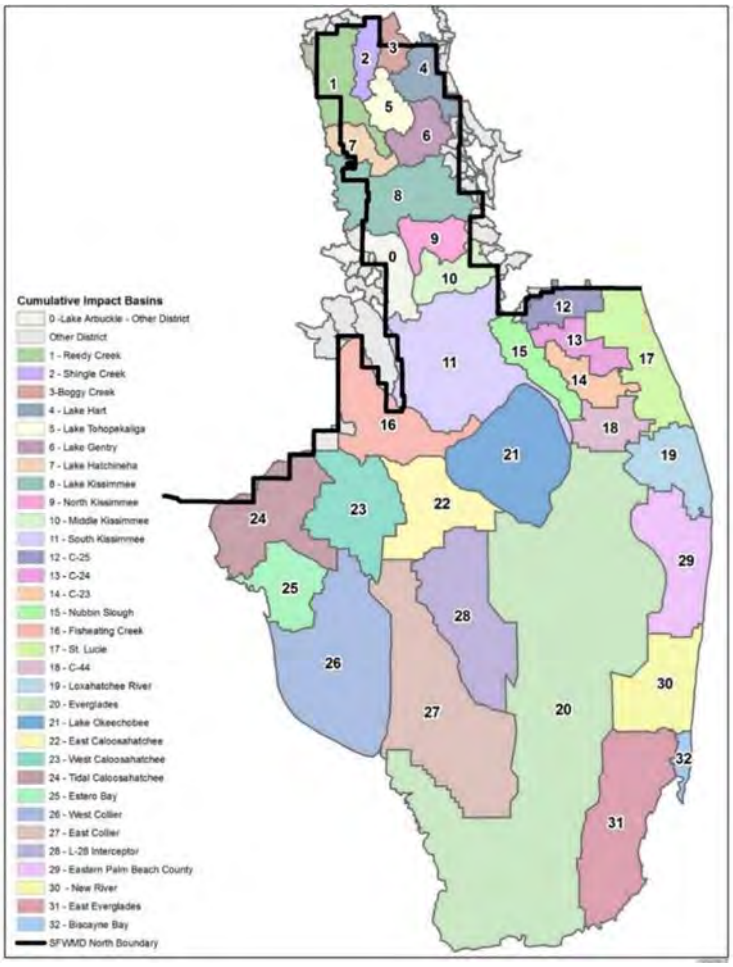


Figure 5: South Florida Water Management District – Appendix D: "SFWMD Basins for Cumulative Impact Assessments & Mitigation Bank Service Areas" (October 1, 2013)



(10) “Success” means when a Mitigation Bank meets the success criteria provided in the Mitigation Bank Permit and in section 10.3.6 of Applicant’s Handbook, Volume I, incorporated by reference in rule 62-330.010, F.A.C.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.200, Amended 12-12-94, 8-21-00, 5-21-01, 2-19-15.

62-342.300 Use of a Mitigation Bank.

Rulemaking Authority 373.4136(11) FS. Law Implemented 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.300, Amended 5-21-01, Repealed 2-16-12.

62-342.400 Criteria for Establishing a Mitigation Bank.

The following criteria shall be met to establish a Mitigation Bank:

(1) The banker shall provide reasonable assurance that the proposed Mitigation Bank will:

(a) Improve ecological conditions of the regional watershed;

(b) Provide viable and sustainable ecological and hydrological functions for the proposed mitigation service area;

(c) Be effectively managed in perpetuity;

(d) Not destroy areas with high ecological value;

(e) Achieve mitigation success; and,

(f) Be adjacent to lands which will not adversely affect the perpetual viability of the Mitigation Bank due to unsuitable land uses or conditions.

(2) The banker shall also provide reasonable assurance that any surface water management system to be constructed, altered, operated, maintained, abandoned, or removed within the Mitigation Bank area will meet conditions of issuance of part IV of chapter 373, F.S., and the rules adopted thereunder.

(3) A Mitigation Bank may be implemented in phases if each phase independently meets the requirements of subsections 62-342.400(1) and (2), above.

(4) The banker shall:

(a) Have sufficient legal or equitable interest in the property to meet the requirements of rule 62-342.650, F.A.C.; and,

(b) Meet the financial responsibility requirements of rule 62-342.700, F.A.C.

Rulemaking Authority 373.4136(11) FS. Law Implemented 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.400, Amended 5-21-01.

62-342.450 Mitigation Bank Permit and Mitigation Bank Conceptual Approval Applications.

Any person or entity proposing to establish a Mitigation Bank must apply for a Mitigation Bank Permit. An application for a Mitigation Bank Permit shall also constitute an application for any required permit authorized under part IV of chapter 373, F.S. Mitigation Bank Permit applications shall be processed according to chapter 120, F.S. The Agency will process and take action on all permit applications under part IV of chapter 373, F.S., necessary for the implementation of any Mitigation Bank for which it has responsibility under the operating agreements between the Department and the Districts incorporated by reference in rule 62-113.100, F.A.C. A person or entity who wishes to obtain an estimation of the legal and financial requirements necessary for a Mitigation Bank, information necessary for evaluation of a Mitigation Bank Permit application, and potential Mitigation Credits to be awarded under a Mitigation Bank Permit, may apply for a Mitigation Bank Conceptual Approval Permit. To provide the Agency with reasonable assurances that the proposed Mitigation Bank will meet the criteria in section 373.4136, F.S., and in this chapter, and that any proposed system will meet the applicable criteria of part IV of chapter 373, F.S., each Mitigation Bank Permit application submitted to the Agency shall include the information required under part IV of chapter 373, F.S., as applicable, and the information specified below as appropriate for the proposed bank:

(1) A description of the location of the proposed Mitigation Bank which shall include:

(a) A map at regional scale showing the project area in relation to the regional watershed and proposed mitigation service area;

(b) A vicinity map showing the project area in relation to adjacent lands and offsite areas of ecologic or hydrologic significance which could affect the perpetual viability or ecological value of the bank;

(c) An aerial photograph identifying boundaries of the project area;

(d) A highway map showing points of access to the Mitigation Bank for site inspection; and,

(e) A legal description of the proposed Mitigation Bank.

(2) A description of the ecological significance of the proposed Mitigation Bank to the regional watershed in which it is located.

(3) A description and assessment of current site conditions which shall include:

(a) A soils map of the project area;

(b) A topographic map of the project area and adjacent hydrologic contributing and receiving areas;

(c) A hydrologic features map of the project area and adjacent hydrologic contributing and receiving areas;

(d) Current hydrologic conditions in the project area;

(e) A vegetation map of the project area;

(f) Ecological benefits currently provided to the regional watershed by the project area;

(g) Adjacent lands, including existing land uses and conditions, projected land uses according to comprehensive plans adopted

pursuant to chapter 163, F.S., by local governments having jurisdiction, and any special designations or classifications associated with adjacent lands or waters; and,

(h) A disclosure by the applicant of any material fact which would affect the contemplated use of the property.

(4) A mitigation plan describing the actions proposed to establish, construct, operate, manage and maintain the Mitigation Bank which shall include:

(a) Construction-level drawings detailing proposed topographic alterations and all structural components associated with proposed activities;

(b) Proposed construction activities, including a detailed schedule for implementation;

(c) The proposed vegetation planting scheme and detailed schedule for implementation;

(d) Measures to be implemented during and after construction to avoid adverse impacts related to proposed activities;

(e) A detailed perpetual management plan comprising all aspects of operation and maintenance, including water management practices, vegetation establishment, exotic and nuisance species control, fire management, and control of access; and,

(f) A proposed monitoring plan to demonstrate mitigation success.

(5) An assessment of improvement or changes in ecological value anticipated as a result of proposed mitigation actions which shall include:

(a) A description of anticipated site conditions in the Mitigation Bank after the mitigation plan is successfully implemented;

(b) A comparison of current fish and wildlife habitat to expected habitat after the mitigation plan is successfully implemented; and,

(c) A description of the expected ecological benefits to the regional watershed.

(6) Evidence of sufficient legal or equitable interest in the property which is to become the Mitigation Bank to meet the requirements of rule 62-342.650, F.A.C.

(7) Draft documentation of financial responsibility meeting the requirements of rule 62-342.700, F.A.C.

(8) Any additional information which the Agency requests in order to evaluate whether the proposed Mitigation Bank meets the criteria of section 373.4136, F.S., and this chapter.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.450, Amended 12-12-94, 5-21-01, 2-19-15.

62-342.470 Establishment of Mitigation Credits.

(1) Based upon the information submitted by the applicant, and an assessment of the proposed Mitigation Bank under the criteria of section 373.4136, F.S., the Agency will assign a number of Mitigation Credits to the proposed Mitigation Bank, or phases thereof.

(2) Mitigation Credits assigned for enhancement, restoration or preservation of wetlands or uplands will be based on the extent of improvement in ecological value resulting from these activities as determined using a functional assessment method relative to that obtained by successfully creating one acre of wetland. In determining the degree of improvement in ecological value, the following factors will be considered. However, no credits shall be released until the requirements of rules 62-342.650 and 62-342.700, F.A.C., are met.

(a) The extent to which target hydrologic regimes can be achieved and maintained.

(b) The extent to which management activities promote natural ecological conditions, such as natural fire patterns.

(c) The proximity of the Mitigation Bank to areas with regionally significant ecological resources or habitats, such as national or state parks, Outstanding National Resource Waters and associated watersheds, Outstanding Florida Waters and associated watersheds, and lands acquired or to be acquired through governmental or non-profit land acquisition programs for environmental conservation; and the extent to which the Mitigation Bank establishes corridors for fish, wildlife or listed species to those resources or habitats.

(d) The quality and quantity of wetland or upland restoration, enhancement, preservation, or creation.

(e) The ecological and hydrological relationship between wetlands and uplands in the Mitigation Bank.

(f) The extent to which the Mitigation Bank provides habitat for fish and wildlife, especially habitat for species listed as threatened, endangered or of special concern, or provides habitats which are unique for that mitigation service area.

(g) The extent to which the lands that are to be preserved are already protected by existing state, local or federal regulations or land use restrictions.

(h) The extent that lands to be preserved would be adversely affected if they were not preserved.

(i) Any special designation or classification of the affected waters and lands.

(3) Some Mitigation Credits may be released for use prior to meeting all of the performance criteria specified in the Mitigation Bank Permit. The release of all mitigation credits awarded will only occur after the bank meets all of the success criteria specified in the permit. The number of credits and schedule for release shall be determined based upon the performance criteria for the Mitigation Bank, the success criteria for each mitigation activity, and a consideration of the factors listed in section 373.4136(5), F.S. However, no credits shall be released until the requirements of rules 62-342.650 and 62.342.700, F.A.C., are met. Additionally, no credits awarded for freshwater creation shall be released until the success criteria included in the Mitigation Bank Permit are met.

(4) If at any time the banker is not in material compliance with the terms of the Mitigation Bank Permit, no Mitigation Credits may be withdrawn. Mitigation Credits shall again be available for withdrawal if the banker comes back into compliance.

(5) The Mitigation Bank Permit shall contain a ledger listing the number and type of Mitigation Credits in the Mitigation Bank. The ledger will provide the maximum number and type of Mitigation Credits which would be available for withdrawal when the Mitigation Bank meets all of the performance criteria in the permit.

(6) Mitigation Credits that have been released may be used to offset adverse impacts from an activity regulated under part IV, chapter 373, F.S. Mitigation credits may be used in whole or in part. However, Mitigation Credits in increments of less than a hundredth of one credit shall not be used.

(7) The Agency shall maintain a ledger of the Mitigation Credits available in each Mitigation Bank. Mitigation Credits shall be withdrawn as a minor modification of the Mitigation Bank Permit. To use Mitigation Credits, the impact permit applicant must submit to the agency permitting the impact, documentation from the banker demonstrating that Mitigation Credits have been reserved, sold or transferred to the permit applicant, and that the banker has requested that the Mitigation Credits be withdrawn from the Mitigation Bank. If the agency permitting the impact determines that use of the Mitigation Credits proposed by the applicant is appropriate to offset the adverse impacts, it shall notify the Agency. Upon receipt of this notice, the Agency shall determine if a sufficient number and type of Mitigation Credits are available, withdraw the Mitigation Credits as a minor modification of the Mitigation Bank Permit, and notify the agency permitting the impact and the banker by letter of the withdrawal of the Mitigation Credits and the remaining balance of Mitigation Credits.

(8) When the Department or a District is the banker, each Agency shall maintain its own ledger. The District or Department shall annually submit a report of the Mitigation Credits sold, transferred, or used from its Mitigation Bank to the permitting Agency.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.470, Amended 5-21-01, 2-19-15.

62-342.600 Mitigation Service Area.

(1) A Mitigation Service Area will be established for each Mitigation Bank in the Mitigation Bank Permit under the criteria of section 373.4136(6), F.S. Except as provided herein, Mitigation Credits may only be withdrawn to offset adverse impacts in the Mitigation Service Area. The boundaries of the Mitigation Service Area shall depend upon the geographic area where the Mitigation Bank could reasonably be expected to offset adverse impacts.

(2) A Mitigation Service Area may be larger than the regional watershed if the Mitigation Bank provides exceptional ecological value such that adverse impacts to wetlands outside the regional watershed could reasonably be expected to be adequately offset by the Mitigation Bank because of local ecological or hydrological conditions. A Mitigation Service Area may be smaller than a regional watershed, if adverse impacts throughout the regional watershed cannot reasonably be expected to be offset by the Mitigation Bank because of local ecological or hydrological conditions.

(3) Mitigation Service Areas may overlap and Mitigation Service Areas for two or more Mitigation Banks may be approved for a regional watershed.

(4) If the requirements in rule 62-342.300, F.A.C., are met, the following projects or activities shall be eligible to use a Mitigation Bank, notwithstanding the fact that they are not completely located within the Mitigation Service Area:

(a) Projects with adverse impacts partially located within the Mitigation Service Area.

(b) Linear projects, such as roadways, transmission lines, distribution lines, pipelines, or railways.

(c) Projects with total adverse impacts of less than one-half acre in size.

(5) When Mitigation Credits are applied to offset adverse impacts within the same regional watershed as the Mitigation Bank, the Mitigation Credit requirement shall be the same as that specified for mitigation on the project site.

(6) When Mitigation Credits are applied to offset adverse impacts outside the regional watershed, the Mitigation Credit requirement shall be higher than that specified for mitigation on the project site if necessary to adequately offset the adverse impacts of the project, except for linear projects, as referenced in paragraph (4)(b), above, when the impact being offset is within the Mitigation Service Area of the Mitigation Bank to be used.

Rulemaking Authority 373.4136(11) FS. Law Implemented 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.600, Amended 12-12-94, 5-21-01.

62-342.650 Land Use Restrictions on Mitigation Banks.

(1) Before Mitigation Credits may be used from a Mitigation Bank or any phase of a Mitigation Bank, the banker shall either:

(a) Cause a fee interest to be conveyed to the Board of Trustees of the Internal Improvement Trust Fund ("Board of Trustees"); or

(b) Cause a conservation easement to be conveyed to both the Department and the District. The grantor of a conservation easement may convey a conservation easement to additional grantees, but such conveyance shall be subordinate to the conservation easement granted to the Department and the District. Mitigation Banks on federal, state, or water management district owned land shall be encumbered in perpetuity by conservation easements, or other mechanisms shall be employed to ensure preservation according to the Mitigation Bank Permit.

(2) If the Mitigation Bank is located within an area identified in an Agency acquisition plan, and the Agency determines that the ecological value of the bank can be increased by incorporating the bank into the Agency's land management programs, the Agency may award additional Mitigation Credits if the fee interest in the bank is conveyed to the Agency as opposed to a conservation easement.

(3) All conservation easements shall be granted in perpetuity without encumbrances, unless such encumbrances do not adversely affect the ecological viability of the Mitigation Bank. All conservation easements shall be of a form and content sufficient to ensure preservation of the Mitigation Bank according to the permit, and shall, at a minimum, meet requirements and restrictions of section 704.06, F.S., except as provided in subsection 62-342.650(9), F.A.C. The conservation easement shall also provide that the banker shall have access to the property and the authority to perform all acts necessary to ensure compliance with the Mitigation Bank Permit (unless the banker is the fee owner of the property), and that the Agency shall have access and the authority to perform these acts if the banker fails to do so.

(4) All real property conveyances of the fee interest shall be in fee simple and by statutory warranty deed, without encumbrances that adversely affect the integrity of the bank and are acceptable to the Board of Trustees. The Board of Trustees will accept a quit claim deed to aid in clearing minor title defects or otherwise resolve a boundary question in the Mitigation Bank.

(5) As part of providing reasonable assurance that the Mitigation Bank site will be preserved in perpetuity, the grantor of the property or conservation easement shall provide the following unless the Agency determines during the permit review process such items are not necessary to ensure preservation of the Mitigation Bank according to the permit:

(a) A boundary survey of the real property interest being conveyed. The survey must be certified, by a land surveyor and mapper, registered in the State of Florida, to meet the requirements of the Agency and the minimum technical standards set forth by the Florida Board of Professional Surveyors and Mappers in rules 5J-17.050 through 5J-17.052, F.A.C., under section 472.027, F.S.

(b) A certified appraisal or other documentation demonstrating the market value of the property or interest to be conveyed to determine the appropriate amount of title insurance.

(c) A marketable title commitment issued to the Agency as beneficiary in an amount at least equal to the fair market value, as established in paragraph 62-342.650(5)(b), F.A.C., of the interest being conveyed. An owner's title insurance policy (ALTA Form B) naming the Agency as beneficiary shall be issued to the Agency within the time frames specified by the permit. The coverage, form and exceptions of the title insurance policy shall ensure that the Mitigation Bank will be preserved according to the Mitigation Bank Permit.

(d) A Phase I environmental audit identifying any environmental problems which may affect the liability of the Agency or Board of Trustees and any additional audits as are necessary to ensure that the Agency or the Board of Trustees is not subject to liability under federal or state laws relating to the treatment or disposal of hazardous substances or ownership of land upon which hazardous substances are located, or to ensure that there are not hazardous substances present on the property which would adversely affect construction, implementation, and perpetual management of the Mitigation Bank.

(6) The Agency shall require additional documentation or actions from the grantor of the conservation easement or fee interest if

such additional documentation or actions are necessary to ensure that the Mitigation Bank will be preserved according to the Mitigation Bank Permit.

(7) The banker shall pay the documentary revenue stamp tax and all other taxes or costs associated with the conveyance, including the cost of recording the deed or conservation easement and any other recordable instruments required by the Agency or Board of Trustees, unless prohibited or exempt by law, as a condition of the receipt of the conveyance.

(8) All real estate taxes and assessments which are or which may become a lien against the property shall be satisfied of record by the banker before recording the conservation easement. If necessary, the banker shall, in accordance with section 196.295, F.S., place funds in escrow with the county tax collector. The mitigation banker shall also provide the Agency with annual documentation demonstrating that such taxes and assessments have been paid.

(9) As a condition of receipt of the conveyance the banker shall remove all abandoned personal property, solid waste, or hazardous substances from the property that: reduces the proposed ecological value of the property; will adversely affect the construction, implementation or management of the bank; will adversely affect the construction, alteration, operation, maintenance, abandonment or removal of any surface water management system to be constructed in the bank; or poses a risk of liability to the Board of Trustees or the Agency.

(10) The banker shall record the conservation easement or property deed required in the Mitigation Bank Permit. The banker shall submit to the Agency the original recorded conservation easement or property deed as soon as such document is returned from the public records office.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.650, Amended 12-12-94, 5-21-01, 2-19-15.

62-342.700 Financial Responsibility.

(1) To provide reasonable assurances that the proposed Mitigation Bank will meet the requirements of section 373.4136, F.S., this rule and the associated permit conditions, non-governmental bankers shall provide proof of financial responsibility for: (a) the construction and implementation of the bank, and (b) the perpetual management of the bank, as required in this section. Governmental entities shall provide proof of financial responsibility under subsection 62-342.700(15), F.A.C. The amount of financial responsibility provided in the mechanisms required in this rule shall be based on the cost estimates determined under subsection 62-342.700(13), F.A.C.

(2) Submitting Financial Responsibility Documentation. The applicant shall provide draft documentation of the cost estimate and required financial responsibility mechanisms described in subsections 62-342.700(5) through (11) and 62-342.700(13), F.A.C., with the permit application, and shall submit to the Agency the executed or finalized documentation within the time frames specified in the permit. The provisions of this section shall also apply to any modifications to the Mitigation Bank Permit.

(3) General Terms for Financial Responsibility Mechanisms. In addition to the specific provisions regarding financial responsibility mechanisms for construction and implementation in subsection 62-342.700(4), F.A.C., and perpetual management in subsection 62-342.700(12), F.A.C., the following terms shall be complied with:

(a) The financial responsibility mechanisms shall be payable at the direction of the Agency to its designee or to a standby trust or standby escrow. The financial responsibility mechanism shall be retained by the Agency if it is of a type which is retained by the beneficiary according to industry standards.

(b) Demonstration of financial responsibility shall be continuous until complete satisfaction of the applicable permit conditions and approved release of financial responsibility by the Agency.

(c) Collectively, the financial responsibility mechanisms must guarantee that the banker will perform all of its obligations under the permit. Within 90 days after receipt by both the banker and the Agency of a notice of cancellation or termination of a financial responsibility mechanism, the banker shall establish a financial responsibility mechanism that meets the criteria of this rule, subject to the Agency's written approval.

(d) A banker may satisfy the requirements of this section by establishing more than one acceptable financial responsibility mechanism per Mitigation Bank. Whenever more than one mechanism is used, the banker shall identify the specific financial responsibility mechanism for each individual activity on the cost estimate as required under subsection 62-342.700(13), F.A.C.

(e) A banker may use a financial responsibility mechanism allowed under this section for more than one Mitigation Bank. The amount of funds available through the mechanism must be no less than the sum of funds that would be required for separate mechanisms for each Mitigation Bank.

(f) A banker must notify the Agency by certified mail within 10 days after the commencement of a voluntary or involuntary proceeding:

1. To dissolve the banker;

2. To place the banker in receivership;

3. For entry of an order for relief against the banker under Title 11 of the United States Code; or

4. A general assignment of its assets for the benefit of creditors under chapter 727, F.S.

A banker will be without the required financial assurance in the event of the suspension or revocation of the authority of any trustee to act as trustee, or in the event of a bankruptcy or receivership of the issuing institution of a financial responsibility mechanism, or the revocation of the authority of such institution to issue such instruments. The banker must notify the Agency within 10 days, and establish other financial assurance within 60 days after such an event.

(4) Financial Responsibility for Construction and Implementation.

(a) No financial responsibility shall be required where the construction and implementation of the Mitigation Bank, or a phase thereof, is completed and successful, as determined by the Agency pursuant to the final success criteria in the Permit, prior to the withdrawal of any credits.

(b) Financial responsibility for the construction and implementation activities of the Mitigation Bank, or each phase thereof, may be established by surety bonds, performance bonds, irrevocable letters of credit, insurance policies, escrow accounts, or trust funds, as described below.

(c) The amount of financial responsibility established shall equal 110 percent of the cost of construction and implementation of the Mitigation Bank, or each phase thereof, in accordance with subsection 62-342.700(13), F.A.C., and as adjusted in accordance with subsection 62-342.700(14), F.A.C., during the course of the project. When the bank has been completely constructed, implemented, and is trending toward success in compliance with the permit, the respective amount of financial responsibility shall be released.

(d) The financial responsibility mechanism shall become effective prior to the release of any mitigation credits.

(5) Surety or Performance Bond.

(a) A banker may satisfy the requirements of subsection 62-342.700(1), F.A.C., by obtaining a surety or performance bond that conforms to the requirements of this subsection. The company issuing the bond must be authorized to do business in Florida. The company must also be among those listed as acceptable sureties in the latest Circular 570 of the U.S. Department of the Treasury (July 1, 2017), which is incorporated by reference herein and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09504, or a Florida-domiciled surety or insurance company with at least an A- rating from the A.M. Best and authorized to write individual bonds up to 10 percent of the policyholder's surplus. The banker shall provide documentation evidencing that the bond company meets these requirements.

(b) The surety or performance bond shall be worded in substantial conformance with Form 62-342.700(5), "Mitigation Bank Performance Bond to Demonstrate Construction and Implementation Financial Assurance" (June 12, 2018), which is incorporated by reference herein and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09498. This form and all the forms incorporated in rule 62-342.700, F.A.C., also are available from the Department of Environmental Protection's Internet site, https://floridadep.gov/water/submerged-lands-environmental-resources-coordination/content/forms-environmental-resource; or by contacting the Division of Water Resource Management, Department of Environmental Protection, 2600 Blair Stone Road, MS #2500, Tallahassee, Florida 32399-2400, (850)245-8336. Deviations from the form shall be identified and submitted to the Agency.

(c) Under the terms of the bond, the surety shall become liable on the bond obligation when the mitigation banker fails to perform under the terms of the Mitigation Bank Permit. In all cases, the surety's liability shall be limited to the sum stated in the bond.

(d) The mitigation banker who uses a surety or performance bond to satisfy the requirements of subsection 62-342.700(4), F.A.C., must establish a standby escrow or standby trust fund when the surety or performance bond is acquired. Under the terms of the bond, all amounts paid by the surety under the bond will be deposited directly into the standby escrow or standby trust fund for distribution by the agent or trustee in accordance with the Agency's instructions. The standby escrow agreement and standby trust fund agreement must meet the requirements specified in subsections 62-342.700(9) and 62-342.700(10), F.A.C., respectively.

(e) The bonding company shall provide notice of cancellation of a bond by certified mail to the banker and to the Agency. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the banker and the Agency, as evidenced by the return receipt.

(f) A bond may be canceled by the banker if the Agency has given prior written consent. The Agency shall provide such consent when either the banker substitutes alternative financial assurance allowed under this rule and such alternate financial assurance is approved by the Agency and is effective or the Agency approves release of financial assurance in accordance with paragraph 62-342.700(4)(c), F.A.C.

(6) Irrevocable Letter of Credit.

(a) A mitigation banker may satisfy the requirements of subsection 62-342.700(1), F.A.C., by obtaining an irrevocable letter of credit that conforms to the requirements of this subsection. The irrevocable letter of credit shall be provided by a federally insured depository that is "well capitalized" or "adequately capitalized" as defined in Section 38 of the Federal Deposit Insurance Act [12 USC 1831o(b)], incorporated by reference herein and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09505. The banker shall submit documentation evidencing that the federally insured depository is appropriately capitalized.

(b) The irrevocable letter of credit shall be worded in substantial conformance with Form 62-342.700(6), "Mitigation Bank Irrevocable Letter of Credit to Demonstrate (Construction and Implementation or Perpetual Management) Financial Assurance" (June 12, 2018) [available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09499, and as described in paragraph (5)(b), above], incorporated by reference herein. Deviations from the form shall be identified and submitted to the Agency.

(c) A mitigation banker who uses an irrevocable letter of credit to satisfy the requirements of subsection 62-342.700(4), F.A.C., must also establish a standby escrow or standby trust fund when the irrevocable letter of credit is acquired. Under the terms of the irrevocable letter of credit, all amounts paid pursuant to a sight draft by the Agency will be deposited by the issuing institution directly into the standby escrow or standby trust fund to be distributed by the agent or trustee in accordance with instructions from the Agency. This standby trust fund must meet the requirements specified in subsections 62-342.700(9) and 62-342.700(10), F.A.C., respectively.

(d) Letters of credit must be irrevocable and issued for a period of at least one year, and the expiration date must be automatically extended for a period of at least one year unless, at least 120 days prior to the expiration date, the issuing institution notifies both the banker and the Agency by certified mail of a decision not to extend the expiration date. The terms of the irrevocable letter of credit must provide that the 120 days begins on the date when both the banker and the Agency have received the notice, as evidenced by the return receipts.

(7) Insurance Policy.

(a) A mitigation banker may satisfy the requirements of subsection 62-342.700(1), F.A.C., for construction and implementation activities by obtaining an insurance policy that conforms to the requirements of this subsection. The insurance policy shall be provided by an insurance company that is authorized to transact insurance in the State of Florida and has at least an A- rating from the A.M. Best. The banker shall provide documentation to the Agency evidencing that the insurance company meets these requirements.

(b) The insurance policy must be worded in substantial conformance to Form 62-342.700(7), "Mitgation Bank Insurance Coverage Form" (June 12, 2018), incorporated by reference herein [available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09500 and as described in paragraph (5)(b), above]. Deviations from the form to meet insurance company documentary requirements must satisfy all criteria listed on the "Mitigation Bank Insurance Coverage Form" and be identified and submitted to the Agency.

(c) The insurance policy must be issued for a period of no less than one year beyond the anticipated completion and success of the mitigation bank, or the last success criterion insured, which ever occurs first based on the construction and implementation schedule in the mitigation bank permit.

(d) The insurance policy must be non-cancellable for the term of the policy. The insurance policy shall include a provision to notify the Agency and banker by certified mail at least 120 days prior to the termination of the policy, nonrenewal of the policy, or a change to the terms and conditions of the policy. The insurance policy must automatically renew for the same terms and conditions of the policy unless the insurance company provides notice of nonrenewal to the banker and the Agency as required in this subsection.

(e) Under the terms of the insurance policy, the Agency must have the authority to file claims when the banker either fails to perform under the terms of the mitigation bank permit, as determined solely by the Agency, or fails to replace the insurance policy with an alternative financial responsibilty mechanism prior to the termination of the insurance policy. The insurance policy must afford the Agency with the sole authority to determine whether the action taken or proposed to be taken by the insurance company is sufficient to satisfy a claim made by the Agency. A claim is satisfied when the amount received by the Agency is greater than or

equal to the most recent approved cost estimate or adjustment in accordance with subsections 62-342.700(13) and 62-342.700(14), F.A.C., respectively, and the bank is in compliance with the terms of the permit.

(f) The mitigation banker who uses an insurance policy to satisfy the requirements of subsection 62-342.700(4), F.A.C., must establish a standby escrow or standby trust fund when the insurance policy is acquired. Under the terms of the insurance policy, all amounts paid by the insurance company in satisfaction of a claim will be deposited directly into the standby escrow or standby trust fund for distribution by the agent or trustee in accordance with the Agency's instructions.

(g) The declaration's page of the insurance policy shall include all of the following items:

1. Insured location – the bank address;
2. Mitigation bank permit number;
3. Insurer's claim's notice address;
4. Regulatory entities and addresses, to include the U.S. Army Corps of Engineers;
5. Surplus line agent – name, address, license number;
6. Producing agent's name, address, and other contact information;
7. Insured's name, address, and other contact information;
8. Policy premium;
9. Limit of liability;
10. Policy inception and expiration dates;
11. Service fee;
12. Premium receipts tax; and
13. Deductible amount.

(8) Escrow.

(a) A mitigation banker may satisfy the requirements of subsection 62-342.700(1), F.A.C., by a deposit of cash into an interest-bearing escrow account with the Florida Department of Financial Services.

(b) The escrow agreement must be worded in substantial conformance to Form 62-342.700(8), "Standby Escrow Agreement" (June 12, 2018), incorporated by reference herein [available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09503 and as described in paragraph (5)(b), above]. Deviations from the form must be identified and submitted to the Agency.

(c) The escrow agreement must be irrevocable until the Agency approves release of financial security in accordance with paragraph 62-342.700(4)(c), F.A.C., and authorizes a final payout.

(9) Standby Escrow.

(a) A mitigation banker using a surety or performance bond, irrevocable letter of credit, or insurance policy shall contemporaneously establish either a standby escrow with the Florida Department of Financial Services meeting the requirements of this subsection or a standby trust fund under subsection 62-342.700(10), F.A.C.

(b) The standby escrow agreement shall be worded in substantial conformance with Form 62-342.700(8), F.A.C., incorporated by reference in paragraph 62-342.700(8)(b), F.A.C., except that the agreement will identify that it is establishing a standby escrow account. Deviations from the form must be identified and submitted to the Agency.

(c) The standby escrow agreement must be irrevocable until the Agency determines that it is no longer required.

(10) Standby Trust Fund.

(a) A mitigation banker using a surety or performance bond, irrevocable letter of credit, or insurance policy shall contemporaneously establish either a standby trust fund meeting the requirements of this subsection or a standby escrow under subsection 62-342.700(9), F.A.C. The trustee of the standby trust shall be an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a federal agency or an agency of the State of Florida. The banker shall provide documentation evidencing such regulation and examination to the Agency.

(b) The standby trust agreement shall be worded in substantial conformance with Form 62-342.700(10), "Mitigation Bank Standby Trust Fund Agreement to Demonstrate (Construction and Implementation or Perpetual Management) Financial Assurance" (June 12, 2018) [available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09502 and as described in paragraph (5)(b), above], incorporated by reference herein. Deviations from the form shall be identified and submitted to the Agency. This form and Form 62-342.700(11), incorporated in subsection 62-342.700(11), F.A.C., references the Investment Company Act of 1940, as amended, 15 U.S.C. 80a-1 et seq. (February 19, 2015), which is incorporated by reference herein and available at http://www.flrules.org/Gateway/reference.asp?No=Ref-05064 and as described in paragraph (5)(b), above. A copy of the Act may

also be obtained by contacting the Division of Water Resource Management, Department of Environmental Protection, 2600 Blair Stone Road, MS #2500, Tallahassee, Florida 32399-2400, (850)245-8336.

(11) Trust Fund.

(a) A mitigation banker may satisfy the requirements of subsection 62-342.700(1), F.A.C., by establishing a trust fund that conforms to the requirements of this section. The trustee of the trust fund shall be an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a federal agency or an agency of the State of Florida. The banker shall provide documentation evidencing proof of such regulation and examination to the Agency.

(b) The trust fund agreement must be worded in substantial conformance to Form 62-342.700(11), "Mitigation Bank Trust Fund Agreement to Demonstrate Construction and Implementation Financial Assurance" (June 12, 2018) [available at http://www.flrules.org/Gateway/reference.asp?No=Ref-09501 and as described in paragraph (5)(b), above], incorporated by reference herein. Deviations from the form shall be identified and submitted to the Agency.

(12) Financial Responsibility for Perpetual Management.

(a) A banker shall establish financial assurance for the perpetual management of the Mitigation Bank, or phase thereof, using the financial responsibility mechanisms described in subsections 62-342.700(5) through 62-342.700(11), F.A.C., except that an insurance policy under subsection 62-342.700(7), F.A.C., may not be used. When an escrow agreement or trust fund is used, the requirements of subsections 62-342.700(8) and 62-342.700(11), F.A.C., respectively, must be met and all references to perpetual management in Forms 62-342.700(8) and 62-342.700(11) shall be selected. When a surety bond, performance bond, guarantee bond, or irrevocable letter of credit is used, a standby trust fund agreement must be established by the banker, and the requirements of subsections 62-342.700(5), 62-342.700(6), 62-342.700(9) and 62-342.700(10), F.A.C., respectively, must be met, and all references to perpetual management in Forms 62-342.700(8) and 62-342.700(11) shall be selected.

(b) The amount of financial responsibility provided shall be sufficient to be reasonably expected to generate annual revenue equal to the annual cost of perpetual management, established under subsection 62-342.700(13), F.A.C., at an assumed average rate of return of six percent per annum, for the bank, or for banks constructed in phases, for all phases for which credits have been released.

(c) The financial responsibility mechanism must be in effect prior to the withdrawal of credits from the Mitigation Bank, or applicable phase thereof.

(13) Cost estimates.

(a) For the purposes of determining the amount of financial responsibility that is required in this section, the banker shall submit a detailed written estimate, in current dollars, of the total cost of construction and implementation and of the cost of perpetual management of the Mitigation Bank. The written cost estimate shall be certified by a licensed professional whose license authority in the State of Florida includes the ability to provide such estimates.

(b) The cost estimate for construction and implementation shall include all costs associated with completing construction and implementation of the Mitigation Bank, or phase thereof, including, as applicable, earthmoving, planting, exotic/nuisance vegetation removal, prescribed fire, land surveying, structure installation, consultant fees, taxes, monitoring activities and reports.

(c) The cost estimate for the perpetual management of the Mitigation Bank shall be based on the costs of maintaining and operating any structures, controlling nuisance or exotic species, fire management, consultant fees, monitoring activities and reports, taxes, and any other costs associated with perpetual management. The amount of financial responsibility shall equal the cost of perpetual management for the bank, or, for banks constructed in phases for all phases for which credits have been released.

(d) The banker shall submit written cost estimates with verifiable basis for the estimates to the Agency along with the financial responsibility mechanism. If more than one financial responsibility mechanism is proposed for the construction and implementation or for perpetual management, the cost estimate shall specify the appropriate mechanism for each itemized cost.

(e) The costs shall be estimated based on a third party performing the work at the fair market value of services. The source of any cost estimates shall be indicated.

(14) Cost adjustments.

(a) Every two years, the banker shall undertake an estimate of the costs of the remaining construction and implementation, and perpetual management. The banker shall submit the estimate to the Agency in writing certified by a person licensed in the State of Florida to provide such estimates, accompanied by supporting documentation. Construction, implementation activity costs, and perpetual management costs shall be listed separately. The Agency shall review the cost adjustment statement and supporting documentation to determine if they reflect all construction, implementation costs and perpetual management costs. If the cost

adjustment statement and supporting documentation accurately reflect a good faith estimate of all construction, implementation costs and perpetual management costs, the Agency shall approve the cost adjustment statement.

(b) At each cost adjustment, the banker shall revise the construction, implementation, and perpetual management cost estimate for inflation and changes in the costs to complete or undertake the current phase of the Mitigation Bank or appropriate phase thereof in accordance with subsection 62-342.700(13), F.A.C.

(c) Revised cost estimates shall be used as the basis for modifying the financial responsibility mechanisms. If the value of any financial responsibility mechanism is less than the total amount of the current construction and implementation and perpetual management cost estimates, the banker shall, upon Agency approval of the cost adjustment statement, increase the value of the financial mechanism to reflect the new estimate within 60 days. If the value of any funding mechanism is greater than the total amount of the current cost estimate, the banker may reduce the value of the funding mechanism to reflect the new estimate upon receiving Agency approval of the cost adjustment statement.

(d) The Agency shall require adjustment of the amount of financial responsibility provided for construction, implementation and perpetual management at times other than the cost adjustment period when the estimated costs associated with compliance with the permit conditions exceed the current amount of financial responsibility and such financial assurances are deemed necessary to ensure compliance with the permit conditions.

(e) The banker may provide revised cost estimates more frequently than every two years. If at any time the banker learns that actual costs exceed estimated costs by more than 25 percent, the banker shall provide a revised cost estimate and adjust the corresponding amount of financial responsibility under this rule.

(15) Financial Responsibility for Governmental, Non-Department and Non-Water Management District, Mitigation Banks.

(a) A governmental entity other than the Department or Districts shall demonstrate reasonable assurances that it can meet the construction and implementation requirements in the Mitigation Bank Permit by any of the mechanisms in subsection 62-342.700(4), F.A.C., above, or by other financial mechanisms which are sufficient to meet the requirements of this section.

(b) Governmental entities other than the Department or Districts shall establish a trust fund for the perpetual management of the Mitigation Bank which meets the requirements of subsection 62-342.700(11), F.A.C., above. The trust fund for perpetual management may be funded as Mitigation Credits are withdrawn, provided that the trust fund is fully funded when all Mitigation Credits are withdrawn. Governmental entities shall comply with the cost adjustment provisions in subsection 62-342.700(14), F.A.C.

Rulemaking Authority 373.4131, 373.4135(1), 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.700, Amended 12-12-94, 9-12-95, 5-21-01, 2-19-15, 6-12-18.

62-342.750 Mitigation Bank Permit and Mitigation Bank Conceptual Approval.

If the Mitigation Bank proposal meets the criteria of section 373.4136, F.S., chapter 62-330, F.A.C., and this chapter, the Agency shall issue a Mitigation Bank Permit to the banker. An authorization under this section may be issued in two forms: a Mitigation Bank Permit or a Mitigation Bank Conceptual Approval.

(1) The Mitigation Bank Permit authorizes the establishment, implementation and operation of the Mitigation Bank, authorizes the construction, alteration, operation, maintenance, abandonment or removal of any surface water management system proposed within the Mitigation Bank, and sets forth the rights and responsibilities of the banker and the Department for the implementation, management, maintenance and operation of the Mitigation Bank. The Mitigation Bank Permit shall include the following:

(a) A description of the Mitigation Service Area.

(b) The maximum number of Mitigation Credits available for use when the Mitigation Bank, or phase thereof, is deemed successful, the type of Mitigation Credits awarded, and the number and schedule of Mitigation Credits available for use prior to success.

(c) The success criteria by which the Mitigation Bank will be evaluated.

(d) The financial responsibility mechanism(s) which must be employed by the banker, and provisions for adjustment of the financial responsibility mechanism.

(e) Requirements for the execution and recording of the conservation easement or conveyance of the fee interest as provided in rule 62-342.650, F.A.C.

(f) A ledger listing Mitigation Credits available in the Mitigation Bank.

(g) A schedule for implementation of the Mitigation Bank, and any phases therein.

(h) The perpetual management requirements for the mitigation bank.

(i) The conditions required under chapter 62-330, F.A.C., for construction, alteration, operation, maintenance, abandonment or removal of any surface water management system proposed within the Mitigation Bank.

(2) A Mitigation Bank Permit shall automatically expire five years from the date of issuance if the banker has not recorded a conservation easement or conveyed fee simple interest, as appropriate, over the real property within the Mitigation Bank, or phase thereof, in accordance with the Mitigation Bank Permit; or, when no property interest is required to be recorded, the Mitigation Bank Permit shall automatically expire if no construction has been commenced pursuant thereto. Except as provided above, a Mitigation Bank Permit shall be perpetual unless revoked or modified.

(3) A Mitigation Bank Conceptual Approval estimates the legal and financial requirements necessary for the Mitigation Bank, information necessary for evaluation of the Mitigation Bank Permit application, and potential Mitigation Credits to be awarded pursuant to the Mitigation Bank Permit. The Mitigation Bank Conceptual Approval does not authorize the use or withdrawal of Mitigation Credits, or any construction within the Mitigation Bank. The level of detail provided in the Mitigation Bank Conceptual Approval will depend on the level of detail submitted with the application. A Mitigation Bank Conceptual Approval shall be valid for a term of five years from the date of issuance.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.750, Amended 5-21-01, 2-19-15.

62-342.800 Surrender, Transfer, or Modification of Mitigation Bank Permits.

(1) If no credits have been used or sold, a banker may apply to surrender a Mitigation Bank Permit, or permitted phase thereof, by submitting a written request to the Agency. The written request must identify which phase of the Mitigation Bank will be surrendered, indicate the extent of mitigation work performed in that phase, and describe the conservation property interest encumbering that phase. The Agency shall authorize release from a Mitigation Bank Permit when no credits have been used, and relinquishment of the phase would not compromise the ecological value of the remaining portions of the Mitigation Bank. A surrender and release of a geographic phase of a Mitigation Bank shall be made by modification of the Mitigation Bank Permit.

(2) If a property interest has been conveyed as provided in rule 62-342.650, F.A.C., for a Mitigation Bank Permit which is surrendered as provided above, the Agency shall convey the property interest back to the grantor of that interest.

(3) If a surface water management system has been constructed or altered within the Mitigation Bank, the banker shall obtain any permits required under part IV of chapter 373, F.S., and chapter 62-330, F.A.C., to operate or abandon the surface water management system.

(4) To transfer a Mitigation Bank Permit, the banker shall meet the requirements of chapter 62-330, F.A.C., and the entity to whom the permit will be transferred must provide reasonable assurances that it can meet the requirements of the permit. If the transfer to the Agency is proposed, the current banker shall provide an updated cost estimate and adjust the final responsibility mechanism, as appropriate, prior to transfer of the permit.

(5) A Mitigation Bank Permit can be issued as a modification of a Mitigation Bank Conceptual Approval.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.800, Amended 12-12-94, 5-21-01, 2-19-15.

62-342.850 Department or Water Management District Mitigation Banks.

The Department or a District may construct, operate, manage, and maintain a Mitigation Bank under this section after obtaining a Mitigation Bank Permit from the appropriate reviewing Agency.

(1) The Department or District may apply to establish a Mitigation Bank by submitting a Mitigation Bank plan, meeting the applicable permitting criteria of this section, in one of the following formats:

(a) A Mitigation Bank plan identifying one or more parcels of lands to be acquired for mitigation site(s).

(b) A Mitigation Bank plan identifying one or more parcels of land in which the Department or District has a legal or equitable interest.

(2) Land Use Restrictions on Department or District Mitigation Banks. The Department or District shall maintain the land within the Regional Mitigation Bank pursuant to the terms of the Mitigation Bank Permit. Any change in the land use shall require a modification of the Mitigation Bank Permit.

(3) Notwithstanding any other provision of this chapter, the Department or District may sell, transfer, or use Mitigation Credits prior to acquiring the proposed mitigation site as set forth in its Mitigation Bank Permit.

(4) Financial Responsibility. A portion of the funds contributed to a Department or District Mitigation Bank from the sale of credits shall be dedicated for the construction and implementation of the Mitigation Bank, and a portion of the funds shall be dedicated for the long-term management of the bank as set forth in the Mitigation Bank Permit. Funds derived from the sale of Mitigation Credits which are not necessary for the construction, implementation, and long-term management of a Department or District Regional Mitigation Bank shall be dedicated for the initiation of other Department or District Mitigation Banks, or expansion of other Department or District land acquisition or restoration projects which improve regional ecological conditions.

(5) Procedures for Establishment of Mitigation Banks. Mitigation Banks established by the Department or Districts shall be permitted, as applicable, under the procedures in the Operating Agreements Concerning Environmental Resource Permitting, Management and Storage of Surface Waters Regulation, and Wetland Resource Regulation, as adopted by the Department paragraphs 62-113.100(3)(f), (m), (s), (x), and (aa), F.A.C.

(6) Each Water Management District is encouraged to establish at least two mitigation banks in the District not later than January 1, 1995, or report to the Secretary as to why such mitigation banks have not been established, any attendant problems to establishing such mitigation banks, and a proposed time frame for establishment of such banks.

Rulemaking Authority 373.4131, 373.4136(11) FS. Law Implemented 373.4131, 373.4135, 373.4136 FS. History–New 2-2-94, Formerly 17-342.850, Amended 12-12-94, 5-21-01, 2-19-15.

62-342.900 Mitigation Banking Forms.

Rulemaking Authority 373.4136(11) FS. Law Implemented 373.4135, 373.4136 FS. History–New 5-21-01, Repealed 2-19-15.

Appendix H

Inspection and Maintenance Standard Operating Procedures

Standard Operating Procedures

The following Standard Operating Procedures (SOPs) are presented as example documents for consideration as templates for selected inspection and maintenance activities. City staff may modify and update these SOPs, and prepare additional SOPs as needed to document all inspection and maintenance activities.

Culvert - Visual Inspection

1 Introduction

This section describes procedures and requirements for visually inspecting culverts for damage, blockage, sediment buildup, and other issues that may impair its operation.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for visual inspections of culverts.

This SOP applies to all inspections performed on the City's culverts. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in this activity:

- Any trained inspector or maintenance personnel.

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Gloves
- Safety glasses
- Safety vest
- Tape Measure
- Measuring Wheel
- Camera
- Trash Bag
- Inspection Vehicle

5 Health and Safety Considerations

- Wear all appropriate safety equipment and follow all proper safety training and procedures.
- DO NOT enter a culvert pipe to perform a visual inspection.

6 Procedure

6.1 Inspection Procedures

6.1.1 Photo Documentation

- Observe the area to ensure no hazardous materials or unsafe conditions are present. Watch for traffic if in a traffic area.
- Take a photo of both ends of the culvert and down the culvert barrel.

6.1.2 Inspection Procedures

- Inspect both ends of the culvert for damage. If the culvert has an endwall or mitered end sections, inspect the concrete for damage, cracking, spalling, or other issues.
- Check the area around each end for sediment or debris buildup.
- Using the tape measure, measure the diameter of the pipe barrel (if circular) or the height and span (if elliptical). Confirm the culvert material, and number of barrels. If possible, confirm the length of the culvert using a measuring wheel.
- Inspect the culvert barrel(s), look for damage on side walls and sediment buildup or debris that may be blocking water flow. If present, estimate the depth of sediment and/or debris buildup.
- Complete the Post Servicing Protocol (Section 6.1.3).

6.1.3 Post Servicing Protocol

After completing inspection, the record of service on page 3 must be completed. The record should include any observations of the following:

- Damage to the culvert ends or barrel(s)
- Sediment and/or debris buildup that may affect the performance of the culvert.

The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance with specified EPA / FDEP requirements.

All records should be made available for inspection upon request at any time.

If required, transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

Inspection Item	Condition	Recommended Interval	Comments
General Area		Quarterly	
Culvert End 1	Damaged Y / N		
Culvert End 2	Damaged Y / N		
Culvert Barrel(s)	Damaged Y / N		

Additional Notes

Culvert - Routine Inspection and Cleaning

1 Introduction

This section describes procedures and requirements for routine inspection and cleaning of culverts for damage, blockage, sediment buildup, and other issues that may impair its operation.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for routine inspection and cleaning of culverts.

This SOP applies to all inspections performed on the City's culverts. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in this activity:

- Maintenance III
- Maintenance II
- Maintenance I

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Gloves
- Safety glasses
- Safety vest
- Tape Measure
- Measuring Wheel
- Camera
- Trash Bag
- Shovels
- Cleaning Equipment (Vactor Truck with jetting tools or Mini-Excavator with culvert cleaner attachment (BTE auger or equivalent))
- Maintenance Vehicles

5 Health and Safety Considerations

- Wear all appropriate safety equipment and follow all proper safety training and procedures.

6 Procedure

6.1 Inspection Procedures

6.1.1 Photo Documentation

- Observe the area to ensure no hazardous materials or unsafe conditions are present. Watch for traffic if in a traffic area.
- Take a photo of both ends of the culvert and down the culvert barrel.

6.1.2 Inspection and Cleaning Procedures

- Inspect both ends of the culvert for damage. If the culvert has an endwall or mitered end sections, inspect the concrete for damage, cracking, spalling, or other issues. If necessary, schedule a follow-up concrete repair.
- Check the area around each end for sediment or debris buildup.
- Using the tape measure, measure the diameter of the pipe barrel (if circular) or the height and span (if elliptical). Confirm the culvert material, and number of barrels. If possible, confirm the length of the culvert using a measuring wheel.
- Inspect the culvert barrel(s), look for damage on side walls and sediment buildup or debris that may be blocking water flow. If present, estimate the depth of sediment and/or debris buildup.
- Use Cleaning Equipment to remove sediment and debris from culvert barrel(s). Estimate the volume of material removed. Dispose of all removed materials properly.
- Complete the Post Servicing Protocol (Section 6.1.3).

6.1.3 Post Servicing Protocol

After completing inspection, the record of service on page 3 must be completed. The record should include any observations of the following:

- Damage to the culvert ends or barrel(s) that may warrant follow-up work.

The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance with specified EPA / FDEP requirements.

All records should be made available for inspection upon request at any time.

If required, transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

Inspection Item	Condition	Recommended Interval	Comments
General Area		Quarterly	
Culvert End 1	Damaged Y / N		
Culvert End 2	Damaged Y / N		
Culvert Barrel(s)	Damaged Y / N		

Additional Notes

Inlet Structure - Visual Inspection

1 Introduction

This section describes procedures and requirements for visually inspecting inlet structures for damage, blockage, sediment buildup, and other issues that may impair the operation of the structure.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for visual inspections of inlet sctructures.

This SOP applies to all inspection performed on the City's inlet structures. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in this activity:

- Any trained inspector or maintenance personnel.

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Gloves
- Safety glasses
- Safety vest
- Steel Grate Hook
- Camera
- Trash Bag
- Inspection Vehicle

5 Health and Safety Considerations

- Wear all appropriate safety equipment and follow all proper safety training and procedures.
- Inlet grates are HEAVY – Use proper lifting techniques and equipment to avoid injury when removing and replacing an inlet grate.

6 Procedure

6.1 Inspection Procedures

6.1.1 Photo Documentation

- Observe the area to ensure no hazardous materials or unsafe conditions are present. Watch for traffic if in a traffic area.
- Take a photo of the inlet structure prior to any work being done.

6.1.2 Inspection Procedures

- Inspect the structure top and grate for damage or deformation. Remove and dispose of any material that may be on or in the grate that could interfere with water flow.
- Carefully remove the grate and set it next to the inlet structure.
- Observe the inlet structure, look for damage on side walls and sediment buildup or debris that may be blocking the pipe(s) at the bottom of the structure. Take a photo looking down at the bottom.
- If present, estimate the depth of sediment and/or debris buildup.
- Carefully replace the grate on the inlet structure.
- Complete the Post Servicing Protocol (Section 6.1.3).

6.1.3 Post Servicing Protocol

After completing inspection, the record of service on page 3 must be completed. The record should include any observations of the following:

- Damage to the inlet, grate, or inflow/outflow pipes
- Partial or complete grate blockage
- Sediment and/or debris buildup that may affect the performance of the inlet.
- Nearby conditions (i.e., new construction with no silt fence in place) that could introduce sediments, debris, or chemicals into the stormwater inlet.

The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance with specified EPA / FDEP requirements.

All records should be made available for inspection upon request at any time.

If required, transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

Inspection Item	Condition	Recommended Interval	Comments
General Area		Quarterly	
Inlet Grate	Damaged Y / N		
Inlet Structure	Damaged Y / N		
Inflow/Outflow Pipe(s)	Damaged Y / N		

Additional Notes

Inlet Structure - Routine Inspection and Cleaning

1 Introduction

This section describes procedures and requirements for visually inspecting inlet structures for damage, blockage, sediment buildup, and other issues that may impair the operation of the structure and conducting a full cleaning of the structure and grate.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for routine inspection and cleaning of inlet structures.

This SOP applies to all inspection performed on the City's inlet structures. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in this activity:

- Maintenance III
- Maintenance I

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Gloves
- Safety glasses
- Safety vest
- Steel Grate Hook
- Camera
- Trash Bag
- Vactor Truck

5 Health and Safety Considerations

- Wear all appropriate safety equipment and follow all proper safety training and procedures.
- Inlet grates are HEAVY – Use proper lifting techniques and equipment to avoid injury when removing and replacing an inlet grate.

- Follow all proper Lift/Push/Pull Safety Training and Procedures
- Follow all proper Confined Space Training and Procedures (if entering structure)
- Follow all safe operating procedures for Vacuum Truck operation

6 Procedure

6.1 Inspection Procedures

6.1.1 Photo Documentation

- Observe the area to ensure no hazardous materials or unsafe conditions are present. Watch for traffic if in a traffic area.
- Take a photo of the inlet structure prior to any work being done.

6.1.2 Inspection and Maintenance Procedures

- Inspect the structure top and grate for damage or deformation. Remove and dispose of any material that may be on or in the grate that could interfere with water flow.
- Carefully remove the grate and set it next to the inlet structure.
- Observe the inlet structure, look for damage on side walls and sediment buildup or debris that may be blocking the pipe(s) at the bottom of the structure. Take a photo looking down at the bottom.
- If present, estimate the depth of sediment and/or debris buildup.
- Remove all debris that cannot be vacuumed from the structure.
- Vacuum any remaining debris and sediment from the structure.
- Carefully replace the grate on the inlet structure.
- Complete the Post Servicing Protocol (Section 6.1.3).

6.1.3 Post Servicing Protocol

After completing inspection, the record of service on page 3 must be completed. The record should include any observations of the following:

- Damage to the inlet, grate, or inflow/outflow pipes
- Partial or complete grate blockage
- Sediment and/or debris buildup that may affect the performance of the inlet.
- Nearby conditions (i.e., new construction with no silt fence in place) that could introduce sediments, debris, or chemicals into the stormwater inlet.

The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance with specified EPA / FDEP requirements.

All records should be made available for inspection upon request at any time.

If required, transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

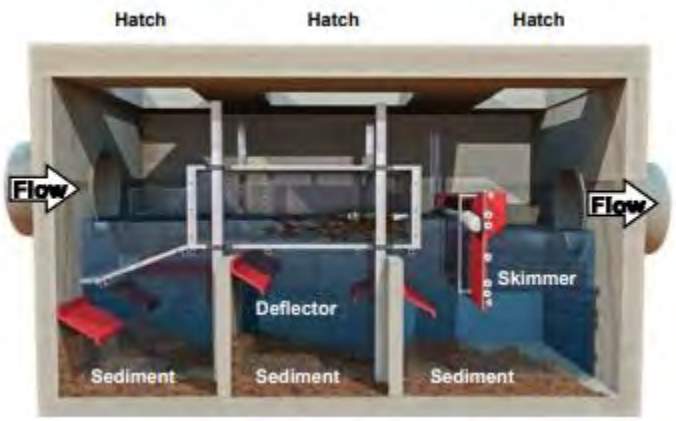
Inspection Item	Condition	Recommended Interval	Comments
General Area		Quarterly	
Inlet Grate	Damaged Y / N		
Inlet Structure	Damaged Y / N		
Inflow/Outflow Pipe(s)	Damaged Y / N		

Additional Notes

Nutrient Separating Baffle Box Routine Inspection and Maintenance

1 Introduction

The Nutrient Separating Baffle Box (NSBB) is a key component of your stormwater management program. To maintain proper operation, maintenance of these units is important. The NSBB is highly effective in capturing total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), organics, trash, litter, oils and grease. NSBB operation is as follows:



- Runoff filters through the screen and skimmer, leaving pollutants behind. Left over runoff evaporates over time.
- Turbulence defectors prevent captured sediment from becoming resuspended.
- Hydrocarbons and other floating debris are trapped upstream of the floating skimmer.

To ensure that the Nutrient Separating Baffle Box obtains optimal pollutant removal efficiencies, subsequent inspections of sediment accumulation should be conducted a minimal of four (4) times per year. In the event the sediment accumulation equals or exceeds 50% of the Minimum Sediment Storage Volume then all accumulated sediment must be removed. All inspections must be documented.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for routine inspection and maintenance of the Nutrient Separating Baffle Box.

This SOP applies to all inspection and maintenance performed on the City's NSBBs. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Maintenance Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in performance of the routine inspection and maintenance of the Nutrient Separating Baffle Box.

- Maintenance III (2)
- Maintenance II (3)
- Maintenance I (2)

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Camera
- Rake
- Disposal Bag
- Pen and Record of Service Form (page 5)
- Gloves
- Flashlight
- Safety glasses
- Safety vest
- Vacuum Truck required for maintenance
- Temporary Pipe Plug for Inlet
- Compressor for Pipe Plug
- Dewatering Pump
- Blower for air circulation
- Air Quality Meter

5 Health and Safety Considerations

- Follow all proper Lift/Push/Pull Safety Training and Procedures
- Follow all proper Confined Space Training and Procedures (if entering baffle box)
- Follow all safe operating procedures for Vacuum Truck operation

6 Procedure

6.1 Inspection and Maintenance Procedures

6.1.1 Photo Documentation

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Inspect the site prior to maintenance effort to assess maintenance needs.
- Write up the BMP system ID, date, and maintenance task, and take a photo of the label.
- Take a photo of the BMP component(s) or specific focus area(s) that will undergo maintenance prior to any work being done.
- Perform maintenance task(s).

- Take a photo of the BMP component(s) or specific focus area(s) that underwent maintenance, matching the photos taken prior to work as best as possible.

Special Considerations:

- The use of cameras with wrist straps is preferred to prevent the possibility of a camera falling into a BMP component.
- Avoid shadows in photos when possible. Use a flashlight when appropriate.
- Be cautious of traffic when taking photos near active roadways and sites.

6.1.2 Inspection Procedures

1. Visually inspect the unit from the surface for broken or missing hinges or handles.
2. Open access points (i.e., Manhole Covers or Hatches) and secure properly.
3. A visual inspection should be made of the basket screen system to determine the capacity of debris, cracks or damages.
4. A visual inspection should be made of the stormboom. Check for missing or broken parts.
5. A visual inspection should be done of the sediment chambers. This may require opening the bottom doors of the screen system (if possible).
6. A visual inspection should be made of the overall condition of the vault. Typically, joint areas as well as inflow and outflow pipe grout areas.
7. Complete the Post Servicing Protocol (Section 7.1.4)

6.1.3 Maintenance Procedures

Maintenance activities including the removal of captured sediment and debris. Maintenance can be performed from outside the NSBB through access points such as manhole covers or hatches installed in the vault surface above the sediment chambers. During maintenance, the screen system may have either sliding top doors or hinged doors. These doors open to gain access to the debris captured by the screen system. The screen system also has bottom doors that open to give access to the sediment collected in the settling chambers. A vacuum truck is required for debris removal. Some situations may arise when the structure needs to be entered.

1. Open the access openings on top of the Baffle Box. These access openings are typically manhole covers, hatches, or grates.
2. Vacuum the debris captured by the screen system to expose the sediment collection chambers.
3. Open the bottom doors to the basket system to expose the sediment collection chambers. These doors are provided with eyebolts to attach a hook to lift open the doors which will hinge off to the side (fig 3.1).
4. Vacuum each of the lower sediment chambers until they are empty.
5. After cleaning the sediment chambers close the bottom screen doors of the screen system. Lower / Slide the top doors and assure they lock correctly.
6. Visually inspect the stormboom in the skimmer system for oil accumulation. Change the stormboom if it is significantly discolored or if it is close to one (1) year of service. The stormboom has ropes attached to each end which are fastened to eyelets adjacent to the access cover. These ropes act as a leash to prevent the bottom from washing away, and to allow the bottom to be easily pulled out of the containment bracket system on the face of the skimmer. Attach a rope on the end of the new boom to a rope on the end of the old boom. As the old boom is pulled out it will pull the new boom

into position. The booms will trade places. Attach the rope ends of the new boom to the eyelets adjacent to the access cover.

7. When all maintenance work is completed, close the access covers or hatches.
8. Complete the Post Servicing Protocol below.

6.1.4 Post Servicing Protocol

After completing inspection or maintenance, the record of service on page 5 must be completed. The record should include maintenance activities performed, amount and description of debris collected and system condition.

- The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance to specified EPA / FDEP requirements.
- All records should be made available for inspection upon request at any time.
- Transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

Inspection Item	Condition	Recommended Interval	Comments
Access points		Quarterly	
Screen System			
Skimmer			
Sediment Chambers			
Vault Condition			

Maintenance Item	Volume Collected	Date	Comments
Screen System			
Skimmer			
Sediment Chambers	Replaced Y / N		

Additional Notes

Open Channel - Visual Inspection

1 Introduction

This section describes procedures and requirements for visually inspecting open channels (i.e., swales and ditches) for damage, blockage, sediment buildup, and other issues that may impair its operation.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for visual inspections of open channels.

This SOP applies to all inspections performed on open channels. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following individuals will be involved in this activity:

- Any trained inspector or maintenance personnel.

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials.

- Gloves
- Safety glasses
- Safety vest
- Tape Measure
- Measuring Wheel
- Camera
- Inspection Vehicle

5 Health and Safety Considerations

- Wear all appropriate safety equipment and follow all proper safety training and procedures.

6 Procedure

6.1 Inspection Procedures

6.1.1 Photo Documentation

- Observe the area to ensure no hazardous materials or unsafe conditions are present. Watch for traffic if in a traffic area.
- Take a photo of the open channel from one end looking toward the other.

6.1.2 Inspection Procedures

- Starting from one end, inspect the end area, bottom area and sideslopes for correct grading, level of vegetation, and sediment or debris buildups. If the channel end has a culvert with an endwall or mitered end sections, inspect the concrete for damage, cracking, spalling, or other issues.
- Observe the shape of the channel, it should be roughly trapezoidal. Using the measuring wheel, measure the bottom width of the channel, from the toe of each sideslope. Measure the length and estimate the slope (V:H) of each side slope.
- Observe the grade of the bottom – it should be a constant longitudinal slope from end to end. If the bottom shows hills and valleys, schedule a regrading soon.
- The channel should be clear of excessive vegetation, trees, rocks, and anything else that may impede water flow.
- Complete the Post Servicing Protocol (Section 6.1.3).

6.1.3 Post Servicing Protocol

After completing inspection, the record of service on page 3 must be completed. The record should include any observations of the following:

- Damage to open channel bottom or sideslopes.
- Sediment and/or debris buildup that may affect the performance of the open channel.

The City will retain the service / inspection record for a minimum of five (5) years from the date of maintenance, or in accordance with specified EPA / FDEP requirements.

All records should be made available for inspection upon request at any time.

If required, transport all debris, trash, litter, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.

7 Record of Service Form

Asset ID No.: _____ **Stormwater Management Zone**: _____

Nearest Address/Street:_____

Date: _____ **Start Time**: _____ **End Time**: _____ **Staff ID**: _____

Staff Count: _____ **Equipment Count**: _____ **CY Removed**: _____

Condition Grade (1-5): _____ **Qualitative Grade (circle one)**: Excellent Good Fair Poor

Inspection Item	Condition	Recommended Interval	Comments
General Area		Quarterly	
Culvert End 1	Damaged Y / N		
Culvert End 2	Damaged Y / N		
Culvert Barrel(s)	Damaged Y / N		

Additional Notes

Zone Activity - Drive-By Visual Inspection

1 Introduction

This section describes procedures and requirements for conducting drive-by visual inspections of entire stormwater management zones and recording proper photo documentation of BMP components. These types of inspections are intended to be conducted twice per year, in May prior to the rainy season and November following the rainy season.

2 Scope and Application

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed for drive-by visual inspections. The following procedures are not all inclusive nor are they applicable in all situations. The major elements of this SOP are:

- Personnel and Equipment
- Inspection Procedures
- Data Management
- Post-Servicing Protocols

3 Personnel Qualifications

The following personnel will be involved in this activity:

- Stormwater Utility Inspector or as designated by the Stormwater Superintendent

4 Equipment Requirements

The following is a list of all (minimum) required equipment and materials:

- Light vehicle
- Vehicle-mounted GPS-enabled camera
- Pen & paper
- Safety vest

5 Health and Safety Considerations

- Follow all proper Safety Training and Procedures
- CAUTION! Use great care while driving, as your attention may be directed toward the condition of roadside swales and culverts that the camera is capturing rather than road traffic. Drive first, take video/pictures second.

6 Procedure

6.1 Inspection and Photo Documentation

- Determine zone driving route in advance to minimize driving distance.
- Ensure camera battery is fully charged and memory card in camera is present and empty.
- At starting location, activate camera and drive slowly (<10 mph) to capture steady video footage or still photos of each property along the route. Observe condition of front yard swales and driveway culverts, noting properties with significant sedimentation or blockage of flow.
- Continue inspections until all properties in zone have been completed.
- Be cautious of traffic when taking photos near active roadways and sites.

6.2 Post Servicing Protocol

- After completing the zone inspection, the Record of Service Form on page 3 must be completed and turned in to the City Engineer or other designated City employee.
- Download the memory card to an appropriate server file as directed by the City Engineer, moving all files and clearing the memory card so it is available for the next inspection. Note the file location on the Record of Service Form.
- The City Engineer or designee will enter the activity record into the CMMS, file the hard copy form and retain the form per City requirements. Photo files will be retained on the City's servers and will be reviewed by the City Engineer or designee and CMMS asset records updated for locations with maintenance issues.
- All records should be made available for inspection upon request at any time.

7 Record of Service Form

Stormwater Management Zone: _____

Date: _____ **Start Time:** _____ **End Time:** _____ **Staff ID:** _____

Staff Count: _____ **Equipment Count:** _____

Picture File Location:_____

Additional Notes

Appendix I

Capital Improvement Plan Detailed Cost Estimates

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2023				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500		$ 115,000			Replacement - John Deere 410K Backhoe
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000		$ 39,667			8-yard Brush Truck and Transport Truck 35 Ton Low Bed Trailer
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199		$ 365,199			potentially include adjustable gates to drain canal prior to large wet weather event
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000		$ 50,000			
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000		$ 25,000			
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309		$ 73,309			
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839				$ 1,684,839	City may be eligible for CDBG-MIT funding due to Hurricane Nichole
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000		$ 50,000			
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000		$ 100,000			
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY23				
		SW Fee	DST	Bond	Grant	
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 933,175**	**$ -**	**$ 1,684,839**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2024				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500					
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000		$ 39,667			
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000		$ 50,000			
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663		$ 824,663			
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY24				
		SW Fee	DST	Bond	Grant	
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 1,029,329**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2025				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500	$ -	$ 242,000			Replacement - CAT M313D Excavator
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000		$ 39,667			
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000		$ 50,000			
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375		$ 174,375			
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512		$ 211,884		$ 70,628	
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY25			
		SW Fee	DST	Bond	Grant
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 832,926**	**$ -**	**$ 70,628**

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2026				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500		$ 218,000			Replacements Bobcat Excavator E42 John Deere Tractor 6130
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182		$ 428,386		$ 142,795	
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					potentially include adjustable gates to drain canal prior to large wet weather event
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000		$ 50,000			
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230		$ 239,230			
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY26				
		SW Fee	DST	Bond	Grant	
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 1,050,616**	**$ -**	**$ 142,795**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2027				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500	$ -				
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000					
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055		$ 779,055			
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY27				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 894,055**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2028				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500	$ -				
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000	$ 15,000				
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000					
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939		$ 755,939			
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY28				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ 15,000**	**$ 855,939**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2029				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500					
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
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16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
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20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040		$ 837,040			
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
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27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY29				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 952,040**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2030				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500		$ 303,500			Replacement - John Deere 825I Gator, CAT 311 Excavator
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
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8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000					
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163					
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY30				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 418,500**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2031				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500					
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
5	Central Collier Waterway Improvements - North Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).	$ 27,130,362					
6	Central Collier Waterway Improvements - South Section	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 5,700 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,770 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).	$ 21,585,297					
7	Schumann Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 12,200 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 12,200 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead). Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.	$ 39,156,096					
8	Schumann Lake Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of lake banks, demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 3,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 5,300 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).	$ 13,195,257					
9	Joy Haven Waterway Improvements	Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition of existing dock structures and fences, installation of temporary sheeting where needed for stability, removal of approximately 2,500 LF of existing seawalls and disposal of transit bulkhead panels, installation of approximately 7,400 LF of vinyl sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap, dredging of approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).	$ 23,774,172					
10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
11	Ocean Cove Drainage Repair	Reconstruction of approximately 2,000 LF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.	$ 571,182					
12	Day Drive Retention Area Restoration	Desilt culvert, clear vegetation over 0.25 ac, excavate 3 feet (approximately 3,200 CY) and regrade approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.	$ 1,570,614					
13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
14	SWMS Pipe Lining	Sliplining of existing culvert pipes rather than open cut replacement to reduce cost and disturbance.	$ 200,000					
15	Stonecrop Ditch - Tulip Culvert Replacement	Existing twin 36" culverts in Stonecrop Ditch at Tulip Dr. (just E of 798 Tulip Dr.) to be changed to a 4' x 7' concrete box culvert to improve capacity (14.1 SF flow area to 28 SF). This will match the culvert capacity at Albatross assuming Project Number 18 and 19 are completed (culverts downstream of Tulip culvert)	$ 239,230					
16	Stonecrop Ditch - Albatross Culvert Replacement	Existing 54" culvert in Stonecrop Ditch at Albatross Terrace (just W of 787 Albatross Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (15.9 SF flow area to 21 SF). This will match the culvert capacity at Bayfront Terrace assuming Project Number 19 is completed (culvert downstream of Albatross culvert)	$ 174,375					
17	Stonecrop Ditch - Bayfront Culvert Replacement	Existing twin 40" culverts in Stonecrop Ditch at Bayfront Terrace (just W of 789 Bayfront Terrace) to be changed to a 4' x 7' concrete box culvert to improve capacity (17.4 SF flow area to 28 SF) which is similar to the proposed Laconia St Con-Span 12ft x 3ft bridge (30sf). This project would also include regrading and armoring of 657ft open channel from Bayfront Terrace to Laconia St.	$ 824,663					
18	Benedictine Area Culvert Improvements	Increase the conveyance capacity of the Benedictine Area Stormwater Network: Replace existing twin 36" culverts at Barber St. crossing S of intersection with Rolling Hill Dr, Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, replace existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.), replace existing 24" culvert at Benedictine Terrace, replace existing twin 24" culverts at Coverbrook Lane.	$ 636,163		$ 636,163			
19	Bryant/Friar Court Retention Pond	Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"	$ 282,512					
20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
23	Coolidge Outfall Improvements	Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of X diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.	$ 73,309					
24	Blossom Ditch Drainage Improvements	Dredge Blossom Ditch and create positive drainage in the ditch and in the connecting pipes from the N alleviating flooding along Lanco Ave and Blossom Dr. 2006 Construction Plans developed but not constructed. Add NSBB to outfall for quality.	$ 1,684,839					
25	Drainage Improvements at Hazel and Lloyd St	Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches	$ 755,939					
26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY31				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 751,163**	**$ -**	**$ -**	

City of Sebastian
Stormwater Master Plan
Capital Improvement Projects

Project No.	Title	Description	Estimated Cost	FISCAL YEAR 2032				
				SW Fee	DST	Bond	Grant	Notes
1	Stormwater Equipment	New and scheduled replacements of equipment and trucks used in the operation and maintenance of the Stormwater System based on their expected useful service lives.	$ 878,500					
2	Stormwater Heavy Equipment	Heavy Equipment replacements for the Stormwater Maintenance Program. Replacements include:	$ 119,000					
3	Roadway Swale Work	Reconstruction of stormwater swales in ROW areas in conjunction with road resurfacing and reconstruction projects.	$ 150,000		$ 15,000			
4	Harbor Point Waterway and Collier Waterway North Improvements	Dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (12' bottom width, 4:1 side slopes), clear & grub, regrade, and sod approximately 211,000 SF of side slope area.	$ 10,987,265					
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10	Collier Waterway South Improvements	Removal of approximately 14,800 LF of existing bulkheads, installation of approximately 14,800 LF of vinyl sheet pile bulkhead (20 ft panel length), dredging and vegetation removal of approximately 7,400 LF of canal.	$ 51,091,662					
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13	Concha Dam Repair	Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheet pile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ weir, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.	$ 365,199					
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20	Hardee Dam Retrofit Gates	Currently has wood panels acting as the gates. These have been leaking beneath the dam and the dam will eventually have to be replaced. The concrete is still in ok condition, stoplogs need replacement. Replacement gate would increase project cost.	$ 25,000					
21	Surrey Terrace Retention Basin	Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 779,055					
22	Rosebush Retention Basin	Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.	$ 837,040					
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26	Stormwater Park Operation	The stormwater pumps are not currently operated using the Float system and therefore do not operate during wet weather events. Repair controls.	$ 50,000					
27	Stonecrop Retention Area	Modify the control structure. Currently the Stonecrop ditch enters the system, 2 60" Pipes, at elevation 7.38 and 7.62. The compound weir dimensions: 2.16ft wide at elevation 6.557ft and 18ft wide at elevation 9.067ft. Add inline tide valves on the two 60" pipes under Stonecrop Dr.	$ 100,000					
28	Canal Dredging	Annual dredging and disposal of canal sediment	$ 1,000,000		$ 100,000			

	Estimated Cost	FY32				
		SW Fee	DST	Bond	Grant	Notes
TOTAL ESTIMATED COST	**$ 198,236,732**	**$ -**	**$ 1,292,961**	**$ -**	**$ 392,654**	

City of Sebastian SWMS Capital Project No. 1

Stormwater Equipment

Item No.	Veh. ID	Model Year	Year/Make/Model	Purchase Price	Replacement Age (Years)	Current Age (Years)	Replacement Hours	Current Hours	Avg. Annual Usage (Hrs)	Replacement Year	Estimated Replacement Cost
1	SW 621	2014	2014 BOBCAT EXCAVATOR E42	$48,200.00	15	9	4,000	2,570	321	2027	$88,000.00
2	SW 622	2020	2020 311 CAT EXCAVATOR	$182,793.00	15	3	4,000	850	425	2030	$283,000.00
3	SW 642	2020	2020 KUBOTA TRACTOR	$23,693.00	15	3	4,000	203	101	2035	$43,000.00
4	SW 643		FRT LOADER MOUNTED TO SW 642	$4,645.00	NA		NA	NA			
5	SW 678	2014	2014 JOHN DEERE 410K BACKHOE	$90,200.00	15	9	4,000	3,831	478	2023	$115,000.00
6	SW 686	2013	2013 CAT M313D EXCAVATOR	$202,173.00	15	10	4,000	3,255	361	2025	$242,000.00
7	SW 690	2015	2015 JOHN DEERE 825I GATOR	$13,725.00	15	8	4,000	900	128	2030	$20,500.00
8	SW 691	2016	2016 JOHN DEERE TRACTOR 6130	$90,026.00	15	7	4,000	2,197	439	2027	$130,000.00
9	SW 692		2016 DIAMOND BOOM MOWER/DITCHER	$72,860.00	15		4,000				$105,000.00
10		Subtotal (1-9)									$1,026,500
11		Contingency (30%)									$307,950
12		**Total Cost (10+11)**									**$1,334,450**

City of Sebastian SWMS Capital Project No. 2

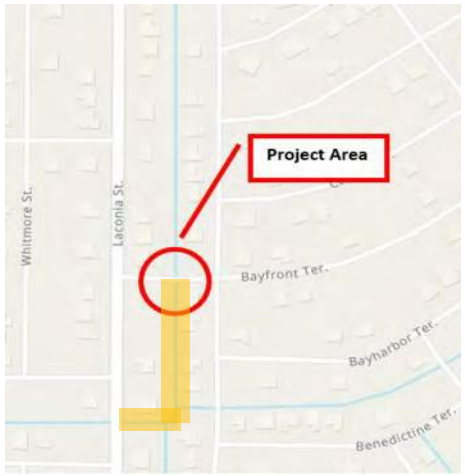
Stormwater Heavy Equipment

Item No.	Veh. ID	Model Year	Year/Make/Model	Purchase Price	Replacement Age (Years)	Current Age (Years)	Replacement Miles	Current Mileage	Avg. Annual Usage (Miles)	Replacement Year	Estimated Replacement Cost
1	SW 601	2016	2016 CHEVROLET 2500 4WD	$30,909.00	15	7	100,000	28,500	4,750	2031	$40,000.00
2	SW 603	2015	2015 FORD F250 4WD	$27,641.00	15	8	100,000	63,000	9,000	2027	$35,000.00
3	SW 604	2018	2018 FREIGHTLINER DUMPTRUCK	$116,754.00	15	5	100,000	16,500	4,125	2033	$180,000.00
4	SW605	2018	2018 FREIGHTLINER DUMPTRUCK	$116,754.00	15	5	100,000	20,400	5,100	2033	$180,000.00
5	SW 606	2005	2005 CHEVROLET 3500 UTILITY TRUCK	$27,780.00	15	18	100,000	99,000	5,823	2020	$50,000.00
6	SW 607	2007	2007 STERLING BRUSH TRUCK	$56,971.00	15	16	100,000	90,000	6,000	2022	$75,000.00
7	SW 608	2015	2015 FORD F550 DUMP TRUCK	$47,851.00	15	8	100,000	27,000	3,857	2030	$71,000.00
8	SW 614	2006	2006 CHEVROLET SIVERADO 4WD	$22,013.00	15	17	100,000	91,000	5,687	2021	$35,000.00
9	SW 616	2001	2001 CHEVROLET 1500	$15,514.00	15	22	100,000	126,500	6,023	2016	$30,000.00
10	SW 620	2016	2016 INT. VAC-TRUCK	$361,586.00	15	7	100,000	21,000	3,500	2031	$550,000.00
11	SW 632	2013	2013 CHEVROLET 3500	$22,399.00	15	10	100,000	63,500	7,055	2028	$50,000.00
12	SW 633	2019	2019 FORD F 150 TRUCK 4WD	$34,394.00	15	4	100,000	4,215	6,600	2034	$71,000.00
13	SW 636	2021	2021 FELLING 70 TON GOOSENECK TRLR	$53,788.00	15	2	100,000	N/A		2036	$97,000.00
14	SW 649	2022	2022 FREIGHTLINER SEMI TRACTOR	$104,674.00	15	1	100,000	1,000	4,000	2037	$217,000.00
15	SW 677	2014	2014 FORD F350	$33,757.00	15	9	100,000	46,000	5,750	2029	$50,000.00
16		Subtotal (1-15)									$696,000
17		Contingency (30%)									$208,800
18		**Total Cost (16+17)**									**$904,800**

City of Sebastian SWMS Capital Project No. 17

Stonecrop Ditch - Bayfront Culvert Replacement

Project Location Map

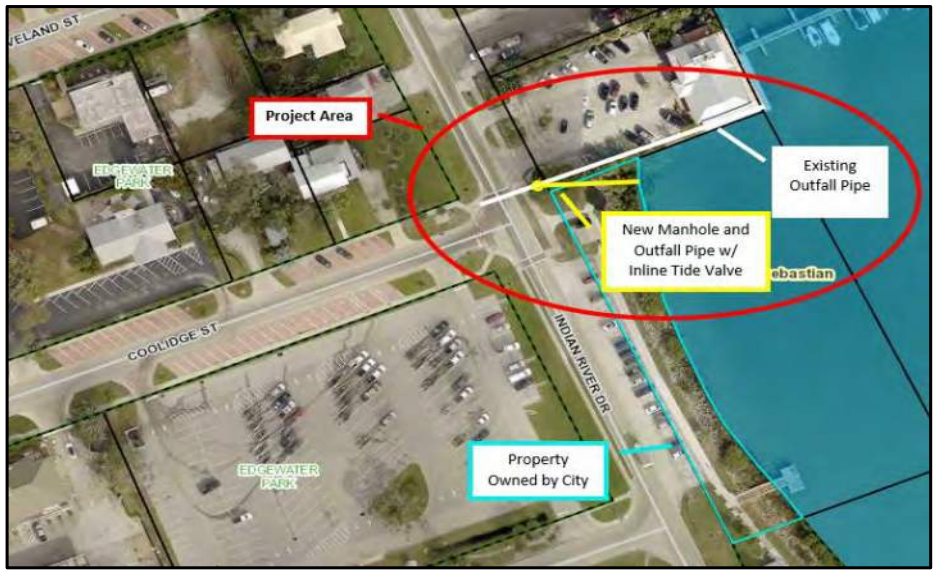


Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$67,967			1	$67,967	Assumed to be 12% of project cost
2	Permitting	LS	$50,000			1	$50,000	ERP permit assumed
3	Bid Documents Prep	LS	$25,000			1	$25,000	Construction drawings, specs
Construction Costs								
4	Mobilization and Demobilization	LS	$23,399			1	$23,399	Assumed to be 5% of other costs.
5	Construction Survey	ES	$1,500			1	$1,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$17			120	$1,982	FDOT 6-month avg cost for sediment barrier and 120 LF floating turbidity barrier
7	Maintenance of Traffic	LS	$608			1	$608	
8	Saw cut and mill existing asphalt pavement	SY	$20	53	0.0%	53	$1,060	Saw cut and mill approximately 24' x 20' of existing roadway pavement, avg 2" depth
9	Remove Existing Pipe Sections	LF	$45	116	0.0%	116	$5,220	Excavation and removal of existing twin 40" culverts, approximately 58 LF each
10	Install 4ft x 7ft Concrete Box Culvert	LF	$775	58	0.0%	58	$44,950	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
11	Roadway Restoration	SY	$60	53	0.0%	53	$3,180	Installation cost includes materials, base installation, compaction, pavement installation, and roadway markings.
12	Channel Excavation	LF	$12	657	0.0%	657	$7,873	Assumed 3:1 slope change to 1.5:1, 36' channel width, 37.5 CF/LF excavated, 1.4 CY/LF.
13	Install Channel Armoring	SF	$15	25,623	0.0%	25,623	$384,345	Assumed 39 SF/LF channel area
14	Fine Grading - Restoration	SY	$3	111	5.0%	117	$350	20' x 50' easement area, 1,000 SF total.
15	Sodding - Easement Restoration	SF	$4	1,000	5.0%	1,050	$4,200	20' x 50' easement area, 1,000 SF total.
16	Waste Disposal - Construction Debris	TON	$34			106	$3,616	Transport and disposal of waste concrete and other demolition/construction materials at the Indian River County LF.
17	Construction Inspections	LS	$9,105			1	$9,105	Assumed to be 2% of other costs.
18	Subtotal (1-17)						$634,356	
19	Contingency (30%)						$190,307	
20	**Total Cost (18+19)**						**$824,663**	

City of Sebastian SWMS Capital Project No. 23

Coolidge Outfall Improvements

Project Location Map



Project Description

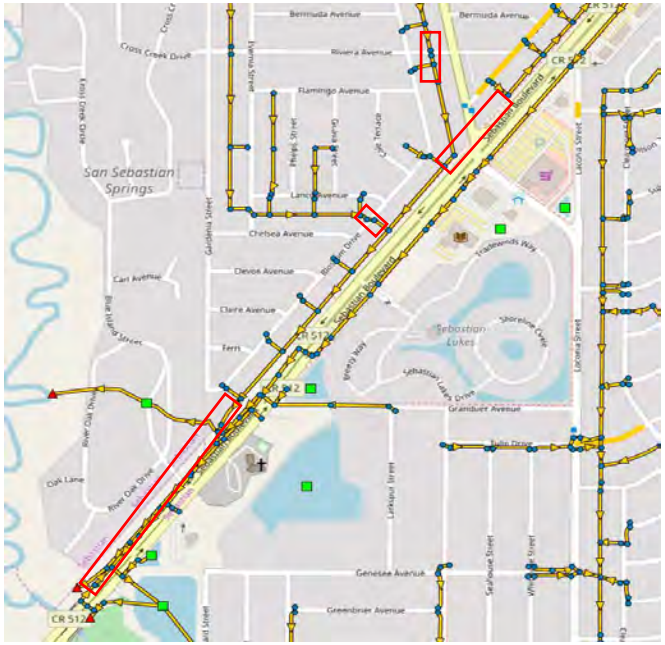
Remove existing outfall pipe sections in manhole area, install new precast concrete 4' diameter manhole, install approximately 80 LF of 24-in diameter A2000 pipe, install inline tide valve and manatee guard on new outfall pipe. Grout fill and abandon in place remaining existing outfall pipe sections under Mulligan's building.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$5,613			1	$5,613	Assumed to be 12% of construction costs
2	Permitting	LS	$2,500			1	$2,500	
3	Bid Documents Prep	LS	$1,500			1	$1,500	
Construction Costs								
4	Mobilization and Demobilization	LS	$2,125			1	$2,125	Assumed to be 5% of other costs.
5	Construction Survey	ES	$5,500			1	$5,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			120	$240	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	0.00	0.0%	0.00	$0	
8	Remove Existing Pipe Sections	LF	$40	16	0.0%	16	$640	Removal of approximately 16 LF of existing outfall pipe
9	Install 4' diameter precast concrete manhole	LS	$8,500			1	$8,500	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
9	Installation of new A2000 outfall pipe	LF	$75	80	0.0%	80	$6,000	Installation cost includes materials, trench excavation, pipe bedding, outfall pipe installation, backfill, and compaction.
10	Installation of inline valve and manatee grate	LS	$12,000			1	$12,000	24 in diameter inline valve and stainless steel manatee grate
11	Plug and grout fill existing outfall pipe	CY	$285			19	$5,415	Assume 160 LF of 24" outfall pipe
13	Sodding - Restoration	SF	$4	1,000	5.0%	1,050	$4,200	Assumed 100' x 10' disturbed area
14	Waste Disposal - Construction Debris	TON	$34			1	$34	Transport and disposal of waste concrete pipe and other demolition/construction materials at the Indian River County LF.
16	Construction Inspections	LS	$2,125			1	$2,125	Assumed to be 5% of other costs.
17	Subtotal (1-16)						$56,392	
18	Contingency (30%)						$16,918	
19	**Total Cost (17+18)**						**$73,309**	

City of Sebastian SWMS Capital Project No. 24

Blossom Ditch Improvements

Project Location Map



		Project Description	Culvert Length, ft	Open Channel Length
24	Blossom Ditch Improvements	Existing 4.5ft diameter pipeline N of Sebastian Blvd to be changed to an open channel	-	1543
		Existing 4.5ft diameter pipe at conflict structure intersecting with 4.5ft diameter pipe S of Gardenia St to be replaced with twin barreled 5.5ft diameter pipes	100	-
		Existing 28" x 36" elliptical pipe at Riviera Avenue to be updated with 2 , create twin 28" x 36" elliptical pipes	82	-
		Add a connecting pipe across Roseland Rd 3' x 7' concrete box culvert	200	-
		Add open channel E and W of the new Roseland culvert, connecting the existing Blossom Ditch and Wentworth Ditch	-	413
		12ft x 24ft Baffle Box to be installed at the downstream end of Blossom Ditch		-
		Existing 30" diameter culvert at Blossom Drive North of Chelsea Ave to be replaced with twin 36" pipes	181.6	-

Historical Flooding documented at Fulton Way East of Roseland Rd
The Proposed solution improves the system connectivity to the South Prong of the San Sebastian River
Proposed solution reduces the flooding in the area - flooding duration for the 25yr storm <1hour and flooded volume for the 25yr storm is reduced significantly

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$138,432			1	$138,432	Assumed to be 12% of construction costs
2	Permitting	LS	$2,500			1	$2,500	
3	Bid Documents Prep	LS	$1,500			1	$1,500	
Construction Costs								
4	Mobilization and Demobilization	LS	$52,435			1	$52,435	Assumed to be 5% of other costs.
5	Construction Survey	ES	$10,000			1	$10,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			120	$240	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	0.00	0.0%	0.00	$0	
8	Remove Existing 30" RCP Pipe	LF	$40	182	0.0%	182	$7,280	Removal of approximately 182 LF of existing pipe
9	Remove Existing 28"x36" ERCP Pipe	LF	$45	82	0.0%	82	$3,690	Removal of approximately 82 LF of existing pipe
10	Remove Existing 54" RCP Pipe	LF	$80	1,643	0.0%	1,643	$131,440	Removal of approximately 1643 LF of existing pipe
11	Channel Excavation	LF	$24	1,956	0.0%	1,956	$46,547	Assumed 3:1 side slopes, 5' depth, 36' channel width, 75 CF/LF excavated, 2.78 CY/LF.
12	Install 3ft x 7ft Concrete Box Culvert	LF	$360	200	0.0%	200	$72,000	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
13	Install 66" RCP Culvert Pipe	LF	$867	200	0.0%	200	$173,400	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
14	Install 36" RCP Culvert Pipe	LF	$244	364	0.0%	364	$88,816	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
15	Install 28"x36" ERCP Culvert Pipe	LF	$331	164	0.0%	164	$54,284	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
16	Install 6'x15' Concrete Wingwall	EA	$12,000			2	$24,000	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
17	Install 6'x6' Box Culvert	LF	$506	8	0.0%	8	$4,048	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
18	Install 12'x24' Baffle Box	LS	$350,000			1	$350,000	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
19	Install 6'x6' Self Regulating Tide Gate	LS	$75,000			1	$75,000	
20	Install Energy Dissipator	LF	$75	50	0.0%	50	$3,750	channel liner, riprap spillway downstream of tide gate
21	Sodding - Restoration	SF	$4	1,000	5.0%	1,050	$4,200	Assumed 100' x 10' disturbed area
22	Waste Disposal - Construction Debris	TON	$34			1	$34	Transport and disposal of waste concrete pipe and other demolition/construction materials at the Indian River County LF.

23	Construction Inspections	LS	$52,435	1	$52,435	Assumed to be 5% of other costs.
24	Subtotal (1-23)				$1,296,030	
25	Contingency (30%)				$388,809	
26	**Total Cost (24+25)**				**$1,684,839**	

City of Sebastian SWMS Capital Project No. 4

Harbor Point Waterway and Collier Waterway North Improvements

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 21,100 LF of canal banks, dredging and disposal of 3 ft (46,900 CY) of sediment from approximately 10,550 LF of trapezoidal open channel (36' bottom width, 4:1 side slopes), regrade and sod approximately 232,100 SF of side slope area.

Total Canal Length = 10,550 ft

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$387,695			1	$387,695	Assumed to be 12% of construction costs
2	Permitting	LS	$232,617			1	$232,617	Assumed to be 3% of construction costs
3	Bid Documents Prep	LS	$77,539			1	$77,539	Assumed to be 1% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$358,976			1	$358,976	Assumed to be 5% of other costs.
5	Construction Survey	ES	$40,000			1	$40,000	Estimated fee staking each contour twice @ 100’ intervals, as-built contour survey included.
6	Pollution Control	LF	$2			21,600	$43,200	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	5.33	0.0%	5.33	$169,200	FDOT 6-month avg cost, assumed side slope area is from elevation 12 to 20, plus 3 feet past TOB, both sides, 22 SF/LF.
8	Dredging	CY	$100	55,915	5.0%	58,711	$5,871,075	Average 3.0’ depth across 48 ft @ el 12, 60’ top width, minimum top elevation 20', 4:1 side slopes, 36' bottom width, 5.3 CY/LF sediment removed.
9	Fine Grading - Side Slopes	SY	$3	25,789	5.0%	27,078	$81,235	Assumed side slope area is from elevation 12 to 20, plus 3 feet past TOB, both sides, 22 SF/LF.
10	Sodding - Side Slopes	SF	$4.00	232,100	5.0%	243,705	$974,820	Assumed side slope area is from elevation 12 to 20, plus 3 feet past TOB, both sides, 22 SF/LF.
11	Construction Inspections	LS	$215,386			1	$215,386	Assumed to be 3% of other costs.
12	Subtotal (1-11)						$8,451,742	
13	Contingency (30%)						$2,535,523	
14	**Total Cost (12+13)**						**$10,987,265**	

City of Sebastian SWMS Capital Project No. 5

Central Collier Waterway Improvements - North Section

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 8,550 LF of canal banks, demolition and reconstruction of existing dock structures and fences, abandon existing bulkheads in place, installation of approximately 8,550 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3' of sediment from approximately 4,270 LF of canal, regrading and resodding of approximately 171,000 SF of canal easement area (20 ft behind bulkhead).

Notes

Total Canal Length = 4,270 ft

Existing dock structures will be replaced only if previously permitted, costs included in contingency funding.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$1,063,936			1	$1,063,936	Assumed to be 12% of construction costs
2	Permitting	LS	$212,787			1	$212,787	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$53,197			1	$53,197	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$949,719			1	$949,719	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			21,600	$43,200	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	7.85	0.0%	7.85	$249,316	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
10	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	171,000	0.0%	171,000	$12,825,000	Installation of approximately 8,550 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
11	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	8,550	0.0%	8,550	$1,710,000	
12	Dredging	CY	$100	23,912	5.0%	25,108	$2,510,760	Average 3.0' depth across 50 ft @ el 12, 80' top width, minimum top elevation 20', 4:1 side slopes, 43' bottom width, 5.6 CY/LF sediment removed.
13	Fine Grading - Easement Restoration	SY	$3	38,000	5.0%	39,900	$119,700	20' easement area on land side of City's drainage ROW line, both sides of canal, 8,550 LF total.
14	Sodding - Easement Restoration	SF	$4	342,000	5.0%	359,100	$1,436,400	20' easement area on land side of City's drainage ROW line, both sides of canal, 8,550 LF total.
15	Waste Disposal - Construction Debris	TON	$34			36,460	$1,239,649	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
17	Construction Inspections	LS	$94,972			1	$94,972	Assumed to be 0.5% of other costs.

18	Subtotal (1-16)	$22,608,635
19	Contingency (20%)	$4,521,727
20	**Total Cost (17+18)**	**$27,130,362**

City of Sebastian SWMS Capital Project No. 6

Central Collier Waterway Improvements - South Section

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 11,350 LF of canal banks , demolition and reconstruction of existing dock structures and fences, installation of approximately 5,770 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3 feet of sediment from approximately 5,770 LF of canal, regrading and resodding of approximately 230,800 SF of canal easement area (20 ft behind bulkhead and slope on Stormwater Park property).

Notes

Total Canal Length = 5,670 ft

Existing dock structures will be replaced only if previously permitted, costs to replace these included in contingency funding.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$846,482			1	$846,482	Assumed to be 12% of construction costs
2	Permitting	LS	$169,296			1	$169,296	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$42,324			1	$42,324	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$726,688			1	$726,688	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			11,900	$23,800	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	10.42	0.0%	10.42	$330,963	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
8	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	114,000	0.0%	114,000	$8,550,000	Installation of approximately 5,700 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
9	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	5,700	0.0%	5,700	$1,140,000	
10	Dredging	CY	$100	31,920	5.0%	33,516	$3,351,600	Average 3.0' depth across 50 ft @ el 12, 80' top width, minimum top elevation 20', 4:1 side slopes, 43' bottom width, 5.6 CY/LF sediment removed.
11	Fine Grading - Easement Restoration	SY	$3	25,333	5.0%	26,600	$79,800	20' easement area on land side of City's drainage ROW line, both sides of canal, 5,700 LF total.
12	Sodding - Easement Restoration	SF	$4	228,000	5.0%	239,400	$957,600	20' easement area on land side of City's drainage ROW line, both sides of canal, 5.700 LF total.
13	Waste Disposal - Construction Debris	TON	$34			46,957	$1,596,524	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$72,669			1	$72,669	Assumed to be 0.5% of other costs.
15	Subtotal (1-14)						$17,987,748	
16	Contingency (20%)						$3,597,550	
17	**Total Cost (15+16)**						**$21,585,297**	

City of Sebastian SWMS Capital Project No. 7

Schumann Waterway Improvements

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 12,200 LF of canal banks , demolition and reconstruction of existing dock structures and fences, installation of approximately 12,200 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3 feet of sediment from approximately 6,100 LF of canal, regrading and resodding of approximately 244,000 SF of canal easement area (20 ft behind bulkhead).

Not included in this project is a new culvert at Empress Avenue at the canal to allow continuous flow between North and South portions, which is going to be completed by a developer as they develop the property on the East.

Notes

Total Canal Length = 6,100 ft

Existing dock structures will be replaced only if previously permitted, costs to replace these included in contingency funding.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$1,535,533			1	$1,535,533	Assumed to be 12% of construction costs
2	Permitting	LS	$307,107			1	$307,107	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$76,777			1	$76,777	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$1,346,479			1	$1,346,479	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			12,700	$25,400	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	5.60	0.0%	5.60	$177,875	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
8	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	244,000	0.0%	244,000	$18,300,000	Installation of approximately 12,200 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
9	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	12,200	0.0%	12,200	$2,440,000	
10	Dredging	CY	$100	45,140	5.0%	47,397	$4,739,700	Average 3.0' depth across 67 ft @ el 12, 100' top width, minimum top elevation 20', 7:1 side slopes, 56' bottom width, 7.4 CY/LF sediment removed.
11	Fine Grading - Easement Restoration	SY	$3	38,667	5.0%	40,600	$121,800	20' easement area on land side of City's drainage ROW line, both sides of canal, 12,200 LF total.
12	Sodding - Easement Restoration	SF	$4	244,000	5.0%	256,200	$1,024,800	20' easement area on land side of City's drainage ROW line, both sides of canal, 12,200 LF total.
13	Waste Disposal - Construction Debris	TON	$34			67,646	$2,299,962	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$134,648			1	$134,648	Assumed to be 0.5% of other costs.
15	Subtotal (1-14)						$32,630,080	
16	Contingency (20%)						$6,526,016	
17	**Total Cost (15+16)**						**$39,156,096**	

City of Sebastian SWMS Capital Project No. 8

Schumann Lake Improvements

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 5,300 LF of canal banks, demolition and reconstruction of existing dock structures and fences, installation of approximately 5,300 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, no dredging of lake, regrading and resodding of approximately 106,000 SF of lake easement area (20 ft behind bulkhead).

Notes

Total Bulkhead Length = 5,250 ft
Existing dock structures will be replaced only if previously permitted, costs to replace these included in contingency funding.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$517,461			1	$517,461	Assumed to be 12% of construction costs
2	Permitting	LS	$103,492			1	$103,492	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$25,873			1	$25,873	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$487,922			1	$487,922	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			5,800	$11,600	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	4.87	0.0%	4.87	$154,547	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
8	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	106,000	0.0%	106,000	$7,950,000	Installation of approximately 5,300 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
9	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	5,300	0.0%	5,300	$1,060,000	
10	Dredging	CY	$100	0	5.0%	0	$0	Assume no dredging of lake
11	Fine Grading - Easement Restoration	SY	$3	11,778	5.0%	12,367	$37,100	20' easement area on land side of City's drainage ROW line, 5,300 LF total.
12	Sodding - Easement Restoration	SF	$4	106,000	5.0%	111,300	$445,200	20' easement area on land side of City's drainage ROW line, 5,300 LF total.
13	Waste Disposal - Construction Debris	TON	$34			1,590	$54,060	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$48,792			1	$48,792	Assumed to be 0.5% of other costs.
15	Subtotal (1-14)						$10,996,048	
16	Contingency (20%)						$2,199,210	
17	**Total Cost (15+16)**						**$13,195,257**	

City of Sebastian SWMS Capital Project No. 9

Joy Haven Waterway Improvements

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 7,400 LF of canal banks , demolition and reconstruction of existing dock structures and fences, installation of approximately 7,400 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3 feet of sediment from approximately 3.700 LF of canal, regrading and resodding of approximately 148,000 SF of canal easement area (20 ft behind bulkhead).

Notes

Total Canal Length = 3,700 ft

Existing dock structures will be replaced only if previously permitted, costs to replace these included in contingency funding

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$932,320			1	$932,320	Assumed to be 12% of construction costs
2	Permitting	LS	$186,464			1	$186,464	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$46,616			1	$46,616	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$817,600			1	$817,600	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			7,900	$15,800	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	3.40	0.0%	3.40	$107,891	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
8	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	148,000	0.0%	148,000	$11,100,000	Installation of approximately 7,400 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
9	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	7,400	0.0%	7,400	$1,480,000	
10	Dredging	CY	$100	27,380	5.0%	28,749	$2,874,900	Average 3.0' depth across 67 ft @ el 12, 100' top width, minimum top elevation 20', 7:1 side slopes, 56' bottom width, 7.4 CY/LF sediment removed.
11	Fine Grading - Easement Restoration	SY	$3	16,444	5.0%	17,267	$51,800	20' easement area on land side of City's drainage ROW line, both sides of canal, 7.400 LF total.
12	Sodding - Easement Restoration	SF	$4	148,000	5.0%	155,400	$621,600	20' easement area on land side of City's drainage ROW line, both sides of canal, 7.400 LF total.
13	Waste Disposal - Construction Debris	TON	$34			41,031	$1,395,059	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$81,760			1	$81,760	Assumed to be 0.5% of other costs.
15	Subtotal (1-14)						$19,811,810	
16	Contingency (20%)						$3,962,362	
17	**Total Cost (15+16)**						**$23,774,172**	

City of Sebastian SWMS Capital Project No. 10

Collier Waterway South Improvements

Project Location Map

Project Description

Clearing and grubbing 20' either side of City drainage ROW lines over approximately 14,800 LF of canal banks, demolition and reconstruction of existing dock structures and fences, installation of approximately 14,800 LF of vinyl sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap on water side of existing bulkhead, dredging 3 feet of sediment from approximately 7,400 LF of canal, regrading and resodding of approximately 296,000 SF of canal easement area (20 ft behind bulkhead).

Notes

Total Canal Length = 7,500 ft

Existing dock structures will be replaced only if previously permitted, costs to replace these included in contingency funding.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$2,003,595			1	$2,003,595	Assumed to be 12% of construction costs
2	Permitting	LS	$400,719			1	$400,719	Assumed to be 1% of construction costs
3	Bid Documents Prep	LS	$100,180			1	$100,180	Assumed to be 0.25% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$1,730,860			1	$1,730,860	Assumed to be 5% of other costs.
5	Construction Survey	ES	$100,000			1	$100,000	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			15,500	$31,000	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	6.89	0.0%	6.89	$218,698	FDOT 6-month avg cost, assumed work area is 20 feet on either side of canal ROW line, both sides, 80 SF/LF.
8	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	300,000	0.0%	300,000	$22,500,000	Installation of approximately 14,800 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
9	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	15,000	0.0%	15,000	$3,000,000	
10	Dredging	CY	$100	70,500	5.0%	74,025	$7,402,500	Average 3.0’ dredging depth across 85 ft @ el 12, 100’ top width, minimum top elevation 20', 5:1 side slopes, 70' bottom width, 9.4 CY/LF sediment removed.
11	Fine Grading - Easement Restoration	SY	$3	33,333	5.0%	35,000	$105,000	20' easement area on land side of City's drainage ROW line, both sides of canal, 15,000 LF total.
12	Sodding - Easement Restoration	SF	$4	300,000	5.0%	315,000	$1,260,000	20' easement area on land side of City's drainage ROW line, both sides of canal, 15,000 LF total.
13	Waste Disposal - Construction Debris	TON	$34			104,434	$3,550,748	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$173,086			1	$173,086	Assumed to be 0.5% of other costs.
15	Subtotal (1-14)						$42,576,385	
16	Contingency (20%)						$8,515,277	
17	**Total Cost (15+16)**						**$51,091,662**	

City of Sebastian SWMS Capital Project No. 11

Ocean Cove Drainage Repair

Project Location Map

Project Description

Clearing and grubbing 40' City drainage ROW over approximately 2,000 LF of ditch, excavation of approximately 0.5 feet of sediment, regrading and resodding approximately 80,000 SF of trapezoidal ditch between Crystal Mist and Carnival Terrace from Clearbrook St to Periwinkle to stabilize side slopes and maintain conveyance capacity.

Total Ditch Length = 2,000 ft

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$18,504			1	$18,504	Assumed to be 12% of construction costs
2	Permitting	LS	$0			1	$0	Assumed to be exempt - maintenance
3	Bid Documents Prep	LS	$7,402			1	$7,402	Assumed to be 2% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$16,822			1	$16,822	Assumed to be 5% of other costs.
5	Construction Survey	ES	$7,500			1	$7,500	Estimated fee staking each contour twice @ 100’ intervals, as-built contour survey included.
6	Pollution Control	LF	$2			4,500	$9,000	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	1.84	0.0%	1.84	$58,320	Assumed clearing a grubbing area is 40 foot wide City drainage ROW over 2,000 LF ditch, 40 SF/LF.
8	Excavation	CY	$65	900	5.0%	945	$61,425	Average 0.5’ depth across 24 ft @ el 18, 40’ top width, minimum top elevation 20', 4:1 side slopes, 24' bottom width, 0.45 CY/LF sediment removed.
9	Fine Grading - Side Slopes	SY	$3	4,889	5.0%	5,133	$15,400	Assumed side slope area is from elevation 18 to 20, plus 3 feet past TOB, both sides, 22 SF/LF.
10	Sodding - Side Slopes	SF	$4.00	44,000	5.0%	46,200	$184,800	Assumed side slope area is from elevation 18 to 20, plus 3 feet past TOB, both sides, 22 SF/LF.
11	Construction Inspections	LS	$16,822			1	$16,822	Assumed to be 5% of other costs.
12	Waste Disposal - Construction Debris	TON	$34			1,276	$43,376	Transport and disposal of waste dredge materials and other demolition/construction materials at the Indian River County LF.
13	Subtotal (1-12)						$439,371	
14	Contingency (30%)						$131,811	
15	**Total Cost (13+14)**						**$571,182**	

City of Sebastian SWMS Capital Project No. 12

Day Drive Retention Area Restoration

Project Location Map

Project Description

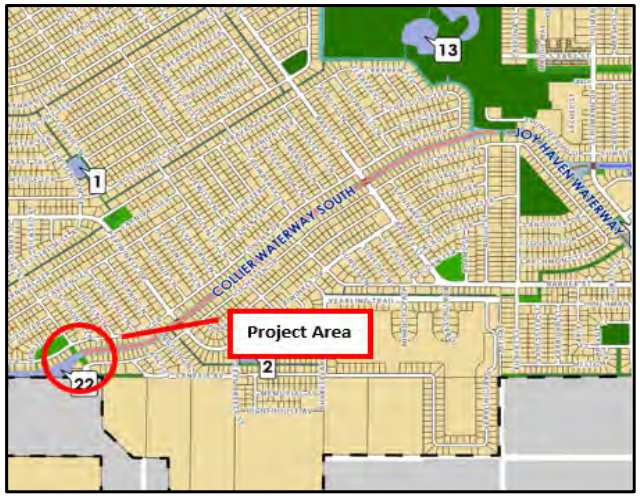
Clearing and grubbing 20' City drainage ROW over approximately 250 LF of ditch, excavation of approximately 0.5 feet of sediment, regrading and resodding approximately 5,000 SF of trapezoidal ditch between Justine Drive and Day Drive to stabilize side slopes and maintain conveyance capacity. Desilt culvert under Day Drive, clearing and grubbing over 0.8 ac retention area, excavate 3 feet (approximately 3,200 CY) and regrade and resod approximately 0.80 ac (175'x425') retention pond and drainage swale to design grades to restore proper retention volume.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$38,327			1	$38,327	Assumed to be 12% of construction costs
2	Permitting	LS	$0			1	$0	Assumed to be exempt - maintenance
3	Bid Documents Prep	LS	$15,331			1	$15,331	Assumed to be 2% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$34,843			1	$34,843	Assumed to be 5% of other costs.
5	Construction Survey	ES	$7,500			1	$7,500	Estimated fee staking each contour twice @ 100' intervals, as-built contour survey included.
6	Pollution Control	LF	$2			1,900	$3,800	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	0.92	0.0%	0.92	$29,215	Assumed clearing and grubbing area is 0.8 retention area and 20 foot wide City drainage ROW over 250 LF ditch, 20 SF/LF.
8	Excavation	CY	$65	8,050	5.0%	8,453	$549,413	Pond: Assumed filled in, 3.0' sediment depth @ bottom el 17 , 175' top width, minimum top elevation 20', 4:1 side slopes, 151' bottom width, 425' length, 18.1 CY/LF sediment removed. Ditch: Average 0.5' sediment depth across 4 ft bottom width @ el 18, 20' top width, minimum top elevation 20', 4:1 side slopes, 1.4 CY/LF sediment removed.
9	Fine Grading - Side Slopes	SY	$3	2,611	5.0%	2,742	$8,225	Pond: Assumed side slope area is from elevation 17 to 20, plus 3 feet past TOB, all sides, 15 SF/LF, 1,200 LF perimeter. Ditch: Assumed side slope area is from elevation 18 to 20, plus 3 feet past TOB, both sides, 22 SF/LF over 250 LF.
10	Sodding - Side Slopes	SF	$4.00	23,500	5.0%	24,675	$98,700	Pond: Assumed side slope area is from elevation 17 to 20, plus 3 feet past TOB, all sides, 15 SF/LF, 1,200 LF perimeter. Ditch: Assumed side slope area is from elevation 18 to 20, plus 3 feet past TOB, both sides, 22 SF/LF over 250 LF.
11	Construction Inspections	LS	$34,843			1	$34,843	Assumed to be 5% of other costs.
12	Waste Disposal - Soil	TON	$34			11,411	$387,970	Transport and disposal of waste dredge materials, vegetation, and other demolition/construction materials at the Indian River County LF.
13	Subtotal (1-11)						$1,208,165	
14	Contingency (30%)						$362,449	
15	**Total Cost (12+13)**						**$1,570,614**	

City of Sebastian SWMS Capital Project No. 13

Concha Dam Repair

Project Location Map



Project Description

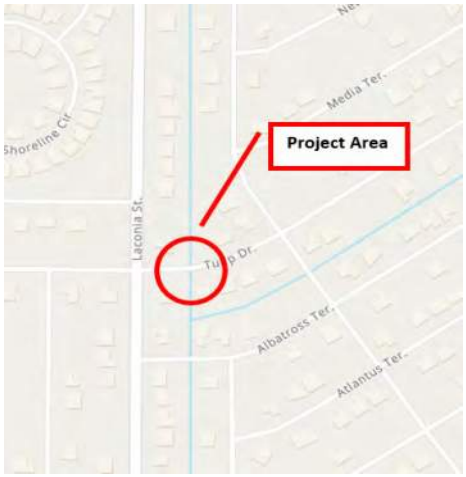
Removal and disposal of approximately 100 LF of existing metal bulkhead and concrete cap, installation of approximately 100 LF of metal sheetpile bulkhead (20 ft panel length) w/ 24x24" concrete cap w/ wier, regrading and resodding of approximately 800 SF of canal easement area (20 ft behind bulkhead). Currently in design.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$28,328			1	$28,328	Assumed to be 12% of construction costs
2	Permitting	LS	$11,803			1	$11,803	Assumed to be 5% of construction costs
3	Bid Documents Prep	LS	$4,721			1	$4,721	Assumed to be 2% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$11,140			1	$11,140	Assumed to be 5% of other costs.
5	Construction Survey	ES	$7,500			1	$7,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$13.79			120	$1,655	FDOT 6-month avg cost for floating turbidity barrier
7	Clearing and Grubbing	AC	$31,755	0.00	0.0%	0.00	$0	FDOT 6-month avg cost.
8	Demolition of Existing Structures	SF	$20	2,000	0.0%	2,000	$40,000	Removal of of approximately 100 LF of existing bulkhead, 20 ft panel length.
9	Installation of Vinyl Sheetpile Bulkhead (20' panel length)	SF	$75	2,000	0.0%	2,000	$150,000	Installation of approximately 14,800 LF of vinyl sheetpile bulkhead (20 ft panel length) and vibration monitoring of structures.
10	Installation of 24x 24" concrete cap for Vinyl Sheetpile Bulkhead	LF	$200	100	0.0%	100	$20,000	
11	Dredging	CY	$100	0	5.0%	0	$0	Average 3.0’ depth across 36 ft @ el 12, 100’ top width, minimum top elevation 20', 4:1 side slopes, 12' bottom width, 4.0 CY/LF sediment removed.
12	Fine Grading - Easement Restoration	SY	$3	89	5.0%	93	$280	20' x 20' easement area on land side of City's drainage ROW line, both sides of canal, 800 SF total.
13	Sodding - Easement Restoration	SF	$4	800	5.0%	840	$3,360	20' x 20' easement area on land side of City's drainage ROW line, both sides of canal, 800 SF total.
14	Waste Disposal - Construction Debris	TON	$34			30	$1,020	Transport and disposal of waste dredge materials, concrete, and other demolition/construction materials at the Indian River County LF.
16	Construction Inspections	LS	$1,114			1	$1,114	Assumed to be 0.5% of other costs.
17	Subtotal (1-16)						$280,922	
18	Contingency (30%)						$84,277	
19	**Total Cost (17+18)**						**$365,199**	

City of Sebastian SWMS Capital Project No. 15

Stonecrop Ditch - Tulip Culvert Replacement

Project Location Map

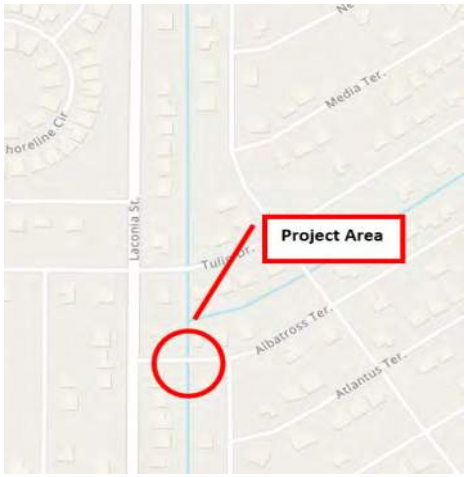


Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$19,717			1	$19,717	Assumed to be 12% of project cost
2	Permitting	LS	$50,000			1	$50,000	ERP permit assumed
3	Bid Documents Prep	LS	$25,000			1	$25,000	Construction drawings, specs
Construction Costs								
4	Mobilization and Demobilization	LS	$4,253			1	$4,253	Assumed to be 5% of other costs.
5	Construction Survey	ES	$1,500			1	$1,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			120	$240	FDOT 6-month avg cost for sediment barrier
7	Maintenance of Traffic	LS	$950			1	$950	
8	Saw cut and mill existing asphalt pavement	SY	$20	53	0.0%	53	$1,060	Saw cut and mill approximately 24' x 20' of existing roadway pavement, avg 2" depth
9	Remove Existing Pipe Sections	LF	$45	81	0.0%	81	$3,645	Excavation and removal of existing twin 36" RCP culverts, approximately 30 LF each
10	Install 4ft x 7ft Concrete Box Culvert	LF	$775	81	0.0%	81	$62,775	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
11	Roadway Restoration	SY	$60	53	0.0%	53	$3,180	Installation cost includes materials, base installation, compaction, pavement installation, and roadway markings.
12	Fine Grading - Restoration	SY	$3	111	5.0%	117	$350	20' x 50' easement area, 1,000 SF total.
13	Sodding - Easement Restoration	SF	$4	1,000	5.0%	1,050	$4,200	20' x 50' easement area, 1,000 SF total.
14	Waste Disposal - Construction Debris	TON	$34			96	$3,259	Transport and disposal of waste concrete and other demolition/construction materials at the Indian River County LF.
15	Construction Inspections	LS	$3,895			1	$3,895	Assumed to be 5% of other costs.
16	Subtotal (1-15)						$184,023	
17	Contingency (30%)						$55,207	
18	**Total Cost (16+17)**						**$239,230**	

City of Sebastian SWMS Capital Project No. 16

Stonecrop Ditch - Albatross Culvert Replacement

Project Location Map

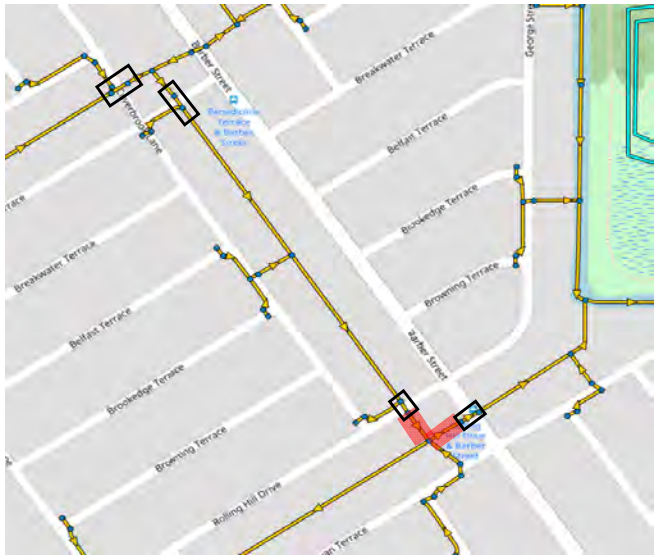


Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$14,372			1	$14,372	Assumed to be 12% of project cost
2	Permitting	LS	$50,000			1	$50,000	ERP permit assumed
3	Bid Documents Prep	LS	$25,000			1	$25,000	Construction drawings, specs
Construction Costs								
4	Mobilization and Demobilization	LS	$2,132			1	$2,132	Assumed to be 5% of other costs.
5	Construction Survey	ES	$1,500			1	$1,500	Estimated fee staking each property line and elevation/alignment checks, as-built survey included.
6	Pollution Control	LF	$3			120	$307	FDOT 12-month average - Market Area 11 sediment barrier
7	Maintenance of Traffic	LS	$608			1	$608	FDOT 12-month average - Market Area 11
8	Saw cut and mill existing asphalt pavement	SY	$20	53	0.0%	53	$1,060	Saw cut and mill approximately 24' x 20' of existing roadway pavement, avg 2" depth
9	Remove Existing 54" Pipe Sections	LF	$45	70	0.0%	70	$3,150	Excavation and removal of existing 54" RCP culvert, approximately 70 LF
10	Install 4ft x 7ft Concrete Box Culvert	LF	$775	30	0.0%	30	$23,250	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
11	Roadway Restoration	SY	$60	53	0.0%	53	$3,180	Installation cost includes materials, base installation, compaction, pavement installation, and roadway markings.
12	Fine Grading - Restoration	SY	$3	111	5.0%	117	$350	20' x 50' easement area, 1,000 SF total.
13	Sodding - Easement Restoration	SF	$4	1,000	5.0%	1,050	$4,200	20' x 50' easement area, 1,000 SF total.
14	Waste Disposal - Construction Debris	TON	$34			93	$3,147	Transport and disposal of waste concrete and other demolition/construction materials at the Indian River County LF.
15	Construction Inspections	LS	$1,880			1	$1,880	Assumed to be 5% of other costs.
16	Subtotal (1-15)						$134,135	
17	Contingency (30%)						$40,240	
18	**Total Cost (16+17)**						**$174,375**	

City of Sebastian SWMS Capital Project No. 18

Benedictine Area Culvert Improvements

Project Location Map



		Project Description	Culvert Length, ft	Open Channel Length
20	Benedictine Area Culvert Improvements	Existing twin 36" culverts in Ditch at Barber St. (just S of intersection with Rolling Hill Dr.) to be changed to a 3' x 10' concrete box culvert to improve capacity (14.1 SF flow area to 30 SF).	78	-
		Dredging and expanding the existing open channel from Barber St crossing and the Rolling Hill Drive crossing, increase the side slopes to 1.5:1	-	278
		Existing 36" culvert at Rolling Hill Drive (just N of 414 Rolling Hill Dr.) to be changed to a 3' x 7' concrete box culvert to improve capacity (7 SF flow area to 21 SF).	55	-
		Existing 24" culvert at Benedictine Terrace to be changed to a 3' x 7' concrete box culvert to improve capacity (7 SF flow area to 21 SF). Note the existing condition 1-24" culvert is suspect - upstream culvert at Coverbrook Lane is 2- 24" culverts, location had high vegetation and logically i would have assumed there would be 2-24" culverts.	57	-
		Existing 2-24" culvert at Coverbrook Lane (just E of 1197 Coverbrook Ln.) to be changed to a 3' x 7' concrete box culvert to improve capacity (14 SF flow area to 21 SF). This will match the culvert capacity at Benedictine Terrace (culvert downstream)	70	-

Historical Flooding documented at Damask Lane (culvert upstream of Coverbrook Lane) and along Rolling Hill Drive. This is a very interconnected location.
The Proposed solution improves the system connectivity to the Canals
Proposed solution reduces the flooding in the area - flooding duration for the 25yr storm <1hour and flooded volume for the 25yr storm is reduced by >50%

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$52,431			1	$52,431	Assumed to be 12% of project cost
2	Permitting	LS	$50,000			1	$50,000	ERP permit assumed
3	Bid Documents Prep	LS	$25,000			1	$25,000	Construction drawings, specs
Construction Costs								
4	Mobilization and Demobilization	LS	$17,235			1	$17,235	Assumed to be 5% of other costs.
5	Construction Survey	ES	$1,500			1	$1,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			120	$240	FDOT 6-month avg cost for sediment barrier
7	Maintenance of Traffic	LS	$1,824			1	$1,824	
8	Saw cut and mill existing asphalt pavement	SY	$20	150	0.0%	150	$3,000	Saw cut and mill approximately 24' x 20' of existing roadway pavement, avg 2" depth
9	Remove Existing 24" Pipe Sections	LF	$40	197	0.0%	197	$7,880	Excavation and removal of three existing 24" culverts, approximately 197 LF total
10	Remove Existing 36" Pipe Sections	LF	$45	211	0.0%	211	$9,495	Excavation and removal of three existing 36" culverts, approximately 211 LF total
11	Install 3ft x 7ft Concrete Box Culvert	LF	$360	182	0.0%	182	$65,520	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
12	Install 3ft x 10ft Concrete Box Culvert	LF	$650	78	0.0%	78	$50,700	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
13	Channel Excavation	LF	$12	278	0.0%	278	$3,332	Assumed 3:1 slope change to 1.5:1, 36' channel width, 37.5 CF/LF excavated, 1.4 CY/LF.
14	Install Channel Armoring	SF	$15	10,842	0.0%	10,842	$162,630	Assumed 39 SF/LF channel area
15	Roadway Restoration	SY	$60	150	0.0%	150	$9,000	Installation cost includes materials, base installation, compaction, pavement installation, and roadway markings.
16	Fine Grading - Restoration	SY	$3	111	5.0%	117	$350	20' x 50' easement area, 1,000 SF total.
17	Sodding - Easement Restoration	SF	$4	1,000	5.0%	1,050	$4,200	20' x 50' easement area, 1,000 SF total.
18	Waste Disposal - Construction Debris	TON	$34			266	$9,037	Transport and disposal of waste concrete and other demolition/construction materials at the Indian River County LF.
19	Construction Inspections	LS	$15,984			1	$15,984	Assumed to be 5% of other costs.
20	Subtotal (1-19)						$489,357	
21	Contingency (30%)						$146,807	
22	**Total Cost (20+21)**						**$636,163**	

City of Sebastian SWMS Capital Project No. 19

Bryant/Friar Court Retention Pond

Project Location Map

Project Description

Construct new approximately 1.0 ac retention pond in the property just N of 105 Friar Ct., appears to be a Park property. Regrade perimeter swales if needed to drain to retention pond. There is some modeled flooding in the area - minor regrading may help to focus the stormwater in the park area, peak flows of ~25cfs for the 25yr storm and the pipes are 15"

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$17,459			1	$17,459	Assumed to be 12% of construction costs
2	Permitting	LS	$50,000			1	$50,000	Assumed ERP required
3	Bid Documents Prep	LS	$4,365			1	$4,365	Assumed to be 3% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$6,833			1	$6,833	Assumed to be 5% of other construction costs.
5	Construction Survey	ES	$5,500			1	$5,500	Estimated fee staking contours, as-built survey included.
6	Pollution Control	LF	$2			1,200	$2,400	FDOT 12-month avg cost for Zone 11
7	Clearing and Grubbing	AC	$28,466	1.10	0.0%	1.10	$31,313	FDOT 12-month avg cost for Zone 11
6	Tree Removal	EA	$580			50	$29,000	FDOT 12-month avg cost for Zone 11
8	Excavate retention area	CY	$10	3,010	0.0%	3,010	$30,100	Excavate 200ft x 220 ft area, two feet deep, 4:1 side slopes. FDOT 12-month avg cost for Zone 11
9	Fine grading	SY	$3			7,260	$21,780	Regrade approximately 1.5 ac
9	Installation of new 6' metal chain link fence	LF	$10			1,000	$10,000	FENCING, TYPE A, 5.1-6.0, STANDARD FDOT 12-month avg cost for Zone 11
10	Installation of new 6' metal chain link gate	EA	$2,375			1	$2,375	FENCE GATE, TYPE A, SINGLE, 0-6.0' OPENING FDOT 12-month avg cost for Zone 11
13	Sodding - Restoration	SF	$4	1,000	5.0%	1,050	$4,200	Assumed 220' x 200' disturbed area
14	Waste Disposal - Construction Debris	TON	$34			20	$680	Transport and disposal of trees and other demolition/construction materials at the Indian River County LF.
16	Construction Inspections	LS	$1,312			1	$1,312	Assumed to be 1% of other construction costs.
17	Subtotal (1-16)						$217,317	
18	Contingency (30%)						$65,195	
19	**Total Cost (17+18)**						**$282,512**	

City of Sebastian SWMS Capital Project No. 21

Surrey Terrace Retention Basin

Project Location Map

Project Description

Approximately 2.3 ac vacant City-owned property S of 737 Surrey Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$57,315			1	$57,315	Assumed to be 12% of construction costs
2	Permitting	LS	$50,000			1	$50,000	Assumed ERP required
3	Bid Documents Prep	LS	$14,329			1	$14,329	Assumed to be 3% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$22,449			1	$22,449	Assumed to be 5% of other construction costs.
5	Construction Survey	ES	$5,500			1	$5,500	Estimated fee staking contours, as-built survey included.
6	Pollution Control	LF	$2			1,200	$2,400	FDOT 12-month avg cost for Zone 11
7	Clearing and Grubbing	AC	$41,119	2.30	0.0%	2.30	$94,574	FDOT 12-month avg cost for Zone 11
8	Excavate retention area	CY	$10	14,900	0.0%	14,900	$149,000	Excavate 250ft x 350 ft area, 5 feet deep, 4:1 side slopes. FDOT 12-month avg cost for Zone 11
9	Fine grading	SY	$3			11,132	$33,396	Regrade approximately 2.3 ac
10	Installation of new 6' metal chain link fence	LF	$10			1,200	$12,000	FENCING, TYPE A, 5.1-6.0, STANDARD FDOT 12-month avg cost for Zone 11
11	Installation of new 6' metal chain link gate	EA	$2,375			2	$4,750	FENCE GATE, TYPE A, SINGLE, 0-6.0' OPENING FDOT 12-month avg cost for Zone 11
12	Sodding - Restoration	SF	$4	35,088	5.0%	36,842	$147,370	Assume 2.3 ac less 210 ft x 310 ft retention bottom area
13	Waste Disposal - Construction Debris	TON	$34			50	$1,700	Transport and disposal of trees and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$4,490			1	$4,490	Assumed to be 1% of other construction costs.
15	Subtotal (1-14)						$599,273	
16	Contingency (30%)						$179,782	
17	**Total Cost (15+16)**						**$779,055**	

City of Sebastian SWMS Capital Project No. 22

Newhall Terrace Retention Basin

Project Location Map

Project Description

Approximately 2.5 ac vacant City-owned property E of 768 Newhall Terrace available to create an additional retention basin to help with flooding in this area. Please let us know if you find something similar is required in the model. Model to determine need.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$61,970			1	$61,970	Assumed to be 12% of construction costs
2	Permitting	LS	$50,000			1	$50,000	Assumed ERP required
3	Bid Documents Prep	LS	$15,492			1	$15,492	Assumed to be 3% of construction costs
Construction Costs								
4	Mobilization and Demobilization	LS	$24,279			1	$24,279	Assumed to be 5% of other construction costs.
5	Construction Survey	ES	$5,500			1	$5,500	Estimated fee staking contours, as-built survey included.
6	Pollution Control	LF	$2			1,200	$2,400	FDOT 12-month avg cost for Zone 11
7	Clearing and Grubbing	AC	$41,119	2.30	0.0%	2.30	$94,574	FDOT 12-month avg cost for Zone 11
8	Excavate retention area	CY	$10	14,900	0.0%	14,900	$149,000	Excavate 250ft x 350 ft area, 5 feet deep, 4:1 side slopes. FDOT 12-month avg cost for Zone 11
9	Fine grading	SY	$3			11,132	$33,396	Regrade approximately 2.3 ac
10	Installation of new 6' metal chain link fence	LF	$10			1,200	$12,000	FENCING, TYPE A, 5.1-6.0, STANDARD FDOT 12-month avg cost for Zone 11
11	Installation of new 6' metal chain link gate	EA	$2,375			2	$4,750	FENCE GATE, TYPE A, SINGLE, 0-6.0' OPENING FDOT 12-month avg cost for Zone 11
12	Sodding - Restoration	SF	$4	43,800	5.0%	45,990	$183,960	Assume 2.5 ac less 210 ft x 310 ft retention bottom area
13	Waste Disposal - Construction Debris	TON	$34			50	$1,700	Transport and disposal of trees and other demolition/construction materials at the Indian River County LF.
14	Construction Inspections	LS	$4,856			1	$4,856	Assumed to be 1% of other construction costs.
15	Subtotal (1-14)						$643,877	
16	Contingency (30%)						$193,163	
17	**Total Cost (15+16)**						**$837,040**	

City of Sebastian SWMS Capital Project No. 25

Drainage Improvements at Hazel and Lloyd St

Project Location Map

Project Description	Culvert Length, ft	Open Channel Length
Dredge and regrade existing open channel from flowing East Hazel and Fordham St, change direction flowir	-	287
Existing 1.5ft diameter pipe East of Fordham St to replaced with 32" x 49" Horizontal Elliptical flowing West.	120	-
Add new 32" x 49" Horizontal Elliptical culvert crossing at Fordham St flowing West.	51	-
Existing 1.5ft diameter pipe West of Fordham St to replaced with 32" x 49" Horizontal Elliptical flowing West.	127	-
Dredge and regrade existing open channel from Fordham St to Stevenson St (widen with 1:1 side slopes)	-	265
Existing 1.5ft diameter culvert at Stevenson Ave to replaced with 32" x 49" Horizontal Elliptical flowing North.	40	-
Dredge and regrade existing open channel from Stevenson St to Main St (widen with 1:1 side slopes)	-	614
Existing 2ft diameter pipe SE of Main St to be replaced with 38" x 60" Horizontal Elliptical pipe	183	-
Existing 1.5ft diameter culvert on Main St to replaced with 38" x 60"Horizontal Elliptical pipe	45	-
Existing twin barreled 2ft diameter culvert at Stevenson Ave to replaced with 38" x 60"Horizontal Elliptical pipe	172	-

Add a culvert crossing at Fordham St to allow flow to travel north to twin ditches, includes regrading open channels and upsizing the downstream culverts from Fordhams St to Twin Ditches
Proposed Solution reduces the duration and extent of flooding East and West of Fordham St.

Item No.	Item Description	Unit	Unit Cost	Takeoff Qty	Waste	Quantity	Total Cost	Notes
Administrative and Engineering Costs								
1	Engineering Survey and Design	LS	$61,874			1	$61,874	Assumed to be 12% of construction costs
2	Permitting	LS	$2,500			1	$2,500	
3	Bid Documents Prep	LS	$1,500			1	$1,500	
Construction Costs								
4	Mobilization and Demobilization	LS	$23,436			1	$23,436	Assumed to be 5% of other costs.
5	Construction Survey	ES	$5,500			1	$5,500	Estimated fee staking each property line and alignment checks, as-built survey included.
6	Pollution Control	LF	$2			120	$240	FDOT 6-month avg cost for sediment barrier
7	Clearing and Grubbing	AC	$31,755	0.48	0.0%	0.48	$15,242	
8	Maintenance of Traffic	LS	$1,824			1	$1,824	
9	Saw cut and mill existing asphalt pavement	SY	$20	150	0.0%	150	$3,000	Saw cut and mill aexisting roadway pavement, avg 2" depth
10	Remove Existing Pipe Sections	LF	$40	607	0.0%	607	$24,280	Removal of approximately 607 LF of existing 18" and 24" RCP pipe
11	Install 3ft x 4ft Concrete Box Culvert	LF	$360	338	0.0%	338	$121,680	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
12	Install 3ft x 5ft Concrete Box Culvert	LF	$482	400	0.0%	400	$192,800	Installation cost includes materials, excavation, bedding, structure installation, backfill, and compaction.
13	Fine grading	SY	$3			2,332	$6,996	Regrade 1,166 LF of trapezoidal swale, 15' top width, 1:1 side slopes, 4ft depth, 18 SF/LF, 2 SY/LF.
14	Roadway Restoration	SY	$60	150	0.0%	150	$9,000	Installation cost includes materials, base installation, compaction, pavement installation, and roadway markings.
15	Sodding - Restoration	SF	$4	20,988	5.0%	22,037	$88,150	Resod 1,166 LF of trapezoidal swale, 15' top width, 1:1 side slopes, 4ft depth, 18 SF/LF, 2 SY/LF.
16	Waste Disposal - Construction Debris	TON	$34			1	$34	Transport and disposal of waste concrete pipe and other demolition/construction materials at the Indian River County LF.
17	Construction Inspections	LS	$23,436			1	$23,436	Assumed to be 5% of other costs.
18	Subtotal (1-17)						$581,491	
19	Contingency (30%)						$174,447	
20	**Total Cost (18+19)**						**$755,939**	

JOB FILE #	SHEET No.
20582/43063	1

CITY OF SEBASTIAN, FLORIDA

THIS CONTRACT PLAN SET INCLUDES:

EXCAVATING/REGRADING PLANS
EROSION CONTROL MEASURES

CITY ENGINEER
DAVID FISHER, P.E.

CITY OF SEBASTIAN
HOME OF PELICAN ISLAND

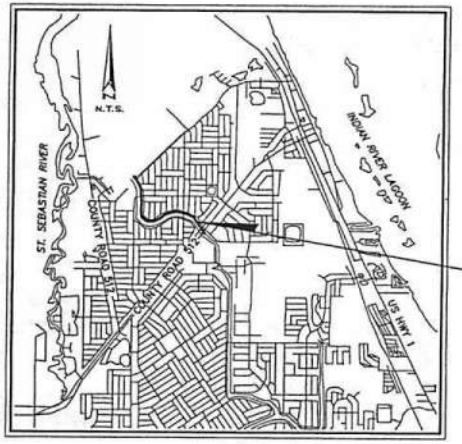
STORMWATER UTILITY ENGINEER
KENNETH JONES

INDEX OF PLANS

SHEET NO.	SHEET DESCRIPTION
1	COVER SHEET
2	INDEX, LEGEND, ABBREVIATIONS, AND GENERAL NOTES
3	TYPICAL SECTIONS
4	SUMMARY OF QUANTITIES
5	KEY PLAN
6–9	HORIZONTAL CONTROL PLAN
10–16	PLAN AND PROFILE
17–30	CROSS SECTIONS
31–34	DRAINAGE STRUCTURES
35–38	EROSION CONTROL PLANS
39–40	STORMWATER POLLUTION PREVENTION PLANS
41	MISCELLANEOUS DETAILS

COLLIER CANAL STORMWATER RETROFIT

THESE PLANS HAVE BEEN PREPARED IN ACCORDANCE WITH AND ARE GOVERNED BY THE STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION DESIGN STANDARDS (BOOKLET DATED JANUARY 2004)



LOCATION MAP

GOVERNING SPECIFICATIONS: STATE OF FLORIDA, DEPARTMENT OF TRANSPORTATION, STANDARD SPECIFICATIONS, DATED 2004 AND SUPPLEMENTS THERETO IF NOTED IN THE SPECIAL TECHNICAL PROVISIONS FOR THIS PROJECT.

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN CHANGED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

PREPARED BY: CAMP DRESSER & MCKEE INC.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 777-231-4332
FL COA NO: EB-0000020

PLANS APPROVED BY _____ DATE
Ana Demelo, P.E. 57420

CONSTRUCTION COMPLETION DATE _____

FIELD VERIFIED BY _____

PERMIT SUBMITTAL
MARCH, 2006

LENGTH OF PROJECT						
			SIDE STREETS		TOTAL	
	LIN.FT.	MILES	LIN.FT.	MILES	LIN.FT.	MILES
DITCH EXCAVATING/REGRADING	–	–	—	—	–	–
	—	—	—	—	—	—
NET LENGTH OF PROJECT	–	–	—	—	–	–
EXCEPTIONS	–	–	—	—	–	–
GROSS LENGTH OF PROJECT	–	–	—	—	–	–

REVISIONS		
BY	DATE	DESCRIPTION

GENERAL NOTES

1. ALL ELEVATIONS ARE REFERRED TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES,STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS, BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES AFFECTING HIS WORK.
3. CONTRACTOR SHALL VERIFY ALL UTILITIES AND NOTIFY THE CITY OF SEBASTIAN, 72 HOURS PRIOR TO DIGGING IN ANY PORTION OF THE SITE.
4. THE CONTRACTOR SHALL REPLACE ANY MONUMENTS, FENCES, ETC. WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED DURING CONSTRUCTION.
5. TOPOGRAPHIC SURVEY WAS PERFORMED BY:
   MASTELLER, MOLER & REED INC.
   2209 14th AVENUE
   VERO BEACH, FL. 32960
   PHONE:(772-564-6050
6. THE CONTRACTOR SHALL CONTACT THE ENGINEER'S OFFICE IMMEDIATELY UPON FINDING ANY CONFLICTS DURING CONSTRUCTION ON ANY IMPROVEMENTS SHOWN ON THE DRAWINGS.
7. EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO BEGINNING ANY DEMOLITION OR CONSTRUCTION. THEY SHALL BE INSTALLED TO THE LIMITS SHOWN IN THE DRAWING, AS REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS (SEE EROSION CONTROL NOTES).
8. EXISTING DRAINAGE STRUCTURES WITHIN CONSTRUCTION LIMITS SHALL BE REMOVED UNLESS OTHERWISE NOTED.
9. ALL STATIONING AND OFFSET REFERS TO CONSTRUCTION BASELINE UNLESS OTHERWISE NOTED ON PLANS.
10. EXISTING UTILITIES AND FACILITIES SHOWN ON THE DRAWINGS WERE LOCATED FROM THE UTILITY OWNERS RECORDS OF UNDERGROUND FACILITIES. GUARANTEE IS NOT MADE THAT ALL EXISTING FACILITIES ARE SHOWN NOR THAT THOSE FACILITIES SHOWN ARE ENTIRELY ACCURATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COORDINATION WITH EXISTING UTILITIES.
11. THE CONTRACTOR SHALL, BY REPAIR OR REPLACEMENT, RETURN TO EQUAL OR BETTER CONDITION ALL PAVEMENT, SIDEWALK, LAWNS, UTILITIES AND OTHER ITEMS DAMAGED BY THIS CONSTRUCTION ACTIVITY.
12. DURING CONSTRUCTION OF THE STORMWATER IMPROVEMENTS, THE CONTRACTOR IS RESPONSIBLE FOR REMOVAL, PROTECTION, AND REPLACEMENT OF ITEMS ON PRIVATE PROPERTY AND PUBLIC RIGHTS OF WAY SUCH AS SPRINKLERS, FENCES, SOD, SHRUBS, TREES, SURVEYING MARKERS, ETC.
13. PRIOR TO EXCAVATING IN THE VICINITY OF A GAS LINE, THE CONTRACTOR SHALL NOTIFY THE GAS UTILITY OWNER IN ACCORDANCE WITH THE REQUIREMENTS OF FLORIDA STATUTES, PROTECTION OF UNDERGROUND PIPELINES F.S. 553.851, OR 17-143.
14. ALL CONSTRUCTION SHALL CONFORM TO CITY OF SEBASTIAN STANDARDS AND SPECIFICATIONS AND TO THE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, MOST RECENT EDITIONS.
15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL UTILITIES THAT MAY EXIST, ABOVE OR BELOW GROUND.
16. ALL BRUSH, STRIPPINGS OR UNSUITABLE MATERIAL SHALL BE DISPOSED OF OFF-SITE AT THE CONTRACTOR'S EXPENSE.
17. A DE-WATERING PERMIT IS REQUIRED BY THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PRIOR TO ANY PUMPING, ETC. AND SHALL BE OBTAINED BY THE CONTRACTOR.
18. MEASURES SHALL BE TAKEN BY THE CONTRACTOR TO ENSURE THAT ADEQUATE EROSION AND SEDIMENT CONTROL ARE MAINTAINED AT ALL TIMES DURING THE PROJECT (SEE EROSION CONTROL NOTES).
19. ALL PRIVATE AND PUBLIC PROPERTY AFFECTED BY THIS WORK SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN THE CONDITION EXISTING PRIOR TO COMMENCING CONSTRUCTION UNLESS SPECIFICALLY EXEMPTED BY THE PLANS. COSTS TO BE INCIDENTAL TO OTHER CONSTRUCTION AND NO EXTRA COMPENSATION TO BE ALLOWED.
20. INSTALLATION OF ALL STORM SEWERS, INLETS, MANHOLES, AND APPURTENANCES SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE APPLICABLE SECTIONS OF THE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS, OR AS INDICATED ON THE DRAWINGS.
21. THE LIMITS OF CONSTRUCTION SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR, ALL PROGRESS, EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF CONSTRUCTION.
22. NO REPRESENTATION IS MADE REGARDING BALANCED EARTHWORK, ANY EXCESS MATERIAL, OR MATERIAL NOT SUITABLE FOR USE AS BACKFILL SHALL BE HAULED AWAY WITH NO ADDITIONAL COMPENSATION.
23. IN AREAS REQUIRING FILL MATERIAL, THE CONTRACTOR WILL STRIP OR OTHERWISE REMOVE ALL VEGETATION SUCH AS MUCK, HEAVY SOILS, HEAVY GROWTH OF GRASS, DECAYED VEGETABLE MATTER, RUBBISH AND ANY OTHER DELETERIOUS MATERIAL BEFORE EMBANKMENT IS STARTED. IMMEDIATELY PRIOR TO THE PLACING OF FILL MATERIALS, THE ENTIRE AREA UPON WHICH FILL IS TO BE PLACED, SHALL BE SCARIFIED.
24. STATION OFFSETS SHOWN ON PLANS ARE FROM CENTERLINE TO CENTERLINE OF STRUCTURE.
25. ALL REINFORCED CONCRETE PIPE (RCP) SHALL BE MINIMUM CLASS III.
26. WATER AND SEWER CROSSINGS:
    A. WHERE WATER MAINS MUST PASS OVER STORM, SANITARY AND/OR EFFLUENT REUSE LINES AND A MINIMUM CLEARANCE OF 18" CANNOT BE MAINTAINED, THE WATER MAIN SHALL BE CONSTRUCTED OF MECHANICAL JOINT DUCTILE IRON PIPE 10' EQUIDISTANT EACH SIDE OF THE CROSSING AND PROVIDE A 6" MINIMUM CLEARANCE BETWEEN THE WATER MAIN AND THE OTHER UTILITY.
    B. A HORIZONTAL SEPARATION OF 10' MUST BE MAINTAINED BETWEEN POTABLE WATER LINES AND NON-POTABLE LINES. WHEN THIS IS NOT POSSIBLE, REPLACE PVC WITH MECHANICAL JOINT DUCTILE IRON PIPE AND LAY IN SEPERATE TRENCH. IN CASE OF RESTRICTED ACCESS REUSE WATER, A 5' MINIMUM HORIZONTAL SEPARATION IS ACCEPTABLE.
27. SITE PREPARATION
    A. REMEDIAL DEWATERING MAY BE NEEDED PRIOR TO ANY EARTHWORK OPERATIONS.
    B. STRIP THE PROPOSED CONSTRUCTION LIMITS OF ALL GRASS, ROOTS, TOPSOIL, CONTRUCTION DEBRIS, AND OTHER DELETERIOUS MATERIALS WITHIN THE PERIMETER OF ALL PAVED AREAS, EXCEPT CLEARING AND GRUBBING OF DEPTHS TO 12 INCHES ESPECIALLY IN THE VICINITY OF THE DITCH. DEEPER CLEARING AND GRUBBING DEPTHS MAY BE REQUIRED.
28. ABSOLUTELY NO WORK WILL BE ALLOWED WITHIN ANY CONSERVATION AREA, BUFFER AREA, MITIGATION AREA, OR DESIGNATED WETLAND AREA UNLESS SO SPECIFICALLY DESCRIBED BY THE PLANS AND GRANTED BY REASON OF PERMIT FROM THE GOVERNMENTAL ENTITY HAVING JURISDICTION OVER SAID AREA.

EROSION CONTROL

IT IS THE CONTRACTORS RESPONSIBILITY TO IMPLEMENT THE EROSION AND TURBIDITY CONTROLS AS SHOWN ON THE EROSION AND TURBIDITY CONTROL PLAN. IT IS ALSO THE CONTRACTORS RESPONSIBILITY TO ENSURE THESE CONTROLS ARE PROPERLY INSTALLED , MAINTAINED AND FUNCTIONING PROPERLY TO PREVENT TURBID OR POLLUTED WATER FROM LEAVING THE PROJECT SITE. THE CONTRACTOR WILL ADJUST THE EROSION AND TURBIDITY CONTROLS SHOWN ON THE EROSION AND TURBIDITY CONTROL PLAN AND ADD ADDITIONAL CONTROL MEASURES, AS REQUIRED,TO ENSURE THE SITE MEETS ALL FEDERAL, STATE AND LOCAL EROSION AND TURBIDITY CONTROL REQUIREMENTS. THE FOLLOWING BEST MANAGEMENT PRACTICES WILL BE IMPLEMENTED BY THE CONTRACTOR AS REQUIRED BY THE EROSION AND TURBIDITY CONTROL PLAN AND AS REQUIRED SITE BY THE REGULATORY AGENCIES.

1. SEDIMENT BASINS AND TRAPS, PERIMETER DITCHES, SEDIMENT BARRIERS AND OTHER MEASURES INTENDED TO TRAP SEDIMENT SHALL BE CONSTRUCTED AS A FIRST STEP BEFORE ANY LAND-DISTURBING TAKES PLACE.
2. ALL SEDIMENT CONTROL MEASURES ARE TO BE ADJUSTED TO MEET FIELD CONDITIONS AT THE TIME OF CONSTRUCTION AND BE CONSTRUCTED PRIOR TO ANY GRADING OR DISTURBANCE OF EXISTING SURFACE MATERIAL ON BALANCE OF SITE. PERIMETER SEDIMENT BARRIERS SHALL BE CONSTRUCTED TO PREVENT SEDIMENT OR TRASH FROM FLOWING OR FLOATING ON TO ADJACENT PROPERTIES.
3. DURING CONSTRUCTION OF THE PROJECT, SOIL STOCK PILES SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. THE CONTRACTOR IS RESPONSIBLE FOR THE TEMPORARY PROTECTIONS AND PERMANENT STABILIZATION OF ALL SOIL STOCKPILES ON SITE AS WELL AS SOIL INTENTIONALLY TRANSPORTED FROM THE PROJECT SITE.
4. AFTER ANY SIGNIFICANT RAINFALL SEDIMENT CONTROL STRUCTURES WILL BE INSPECTED FOR INTEGRITY. ANY DAMAGED DEVICES SHALL BE REPAIRED IMMEDIATELY.
5. CONCENTRATED RUNOFF SHALL NOT FLOW DOWN CUT OR FILL SLOPES UNLESS CONTAINED WITHIN AN ADEQUATE TEMPORARY OR PERMANENT CHANNEL, FLUME OR SLOPE DRAIN STRUCTURE.
6. WHENEVER WATER SEEPS FROM A SLOPE FACE ADEQUATE DRAINAGE OR OTHER PROTECTION SHALL BE PROVIDED.
7. SEDIMENT WILL BE PREVENTED FROM ENTERING ANY STORM DRAIN SYSTEM, DITCH OR CHANNEL. ALL STORM SEWER INLETS THAT ARE MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER CANNOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.
8. BEFORE TEMPORARY OR NEWLY CONSTRUCTED STORMWATER CONVEYANCE CHANNELS ARE MADE OPERATIONAL ADEQUATE OUTLET PROTECTION AND ANY REQUIRED TEMPORARY OR PERMANENT CHANNEL LINING SHALL BE INSTALLED IN BOTH THE CONVEYANCE CHANNEL AND RECEIVING CHANNEL.
9. WHEN WORK IN A LIVE WATERCOURSE IS PERFORMED, PRECAUTIONS SHALL BE TAKEN TO MINIMIZE ENCROACHMENT. CONTROL SEDIMENT TRANSPORT AND STABILIZE THE WORK AREA TO THE GREATEST EXTENT POSSIBLE DURING CONSTRUCTION. NONERODIBLE MATERIAL SHALL BE USED FOR THE CONSTRUCTION OF CAUSEWAYS AND COFFERDAMS. EARTHEN FILL MAY BE USED FOR THESE STRUCTURES IF ARMORED BY NONERODIBLE COVER MATERIALS.
10. STOCKPILING MATERIAL: NO EXCAVATED MATERIAL SHALL BE STOCKPILED IN SUCH A MANNER AS TO DIRECT RUNOFF DIRECTLY OFF THE PROJECT SITE INTO ANY ADJACENT WATER BODY OR STORM WATER COLLECTION FACILITY.
11. EXPOSED AREA LIMITATION: THE SURFACE AREA OF OPEN, RAW ERODIBLE SOIL EXPOSED BY CLEARING AND GRUBBING OPERATIONS OR EXCAVATION AND FILLING OPERATIONS SHALL NOT EXCEED 1 ACRE. IF THE TOTAL AREA TO BE CLEARED IS EQUAL TO, OR EXCEEDS ONE (1) ACRE, THEN THE CONTRACTOR WILL BE RESPONSIBLE FOR PREPARING A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) IN ACCORDANCE WITH EPA'S NPDES REGULATIONS. THE CONTRACTOR WILL BE RESPONSIBLE FOR SUBMITTING A NOTICE ON INTENT (NOI) TO EPA FORTH-EIGHT (48) HOURS PRIOR TO COMMENCING CONSTRUCTION.
12. TEMPORARY SEEDING: AREAS OPENED BY CONSTRUCTION OPERATIONS AND THAT ARE NOT ANTICIPATED TO BE RE-EXCAVATED OR DRESSED AND RECEIVE FINAL GRASSING TREATMENT WITHIN 30 DAYS SHALL BE SEEDED WITH A QUICK GROWING GRASS SPECIES WHICH WILL PROVIDE AN EARLY COVER DURING THE SEASON IN WHICH IT IS PLANTED AND WILL NOT LATER COMPETE WITH THE PERMANENT GRASSING.
13. TEMPORARY SEEDING AND MULCHING: SLOPES STEEPER THAN 8:1 THAT FALL WITHIN THE CATEGORY ESTABLISHED IN PARAGRAPH 12 ABOVE LOOSE MEASURE OF MULCH MATERIAL CUT INTO THE SOIL OF THE SEEDED AREA ADEQUATE TO PREVENT MOVEMENT OF SEED AND MULCH.
14. TEMPORARY GRASSING: THE SEEDED OR SEEDED AND MULCHED AREA(S) SHALL BE ROLLED AND WATERED OR HYDROMULCHED OR OTHER SUITABLE METHODS IF REQUIRED TO ASSURE OPTIMUM GROWING CONDITIONS FOR THE ESTABLISHMENT OF A GOOD GRASS COVER. TEMPORARY GRASSING SHALL BE THE SAME MIX & AMOUNT REQUIRED FOR PERMANENT GRASSING IN THE CONTRACT SPECIFICATIONS.
15. TEMPORARY REGRASSING : IF, AFTER 14 DAYS FROM SEEDING, THE TEMPORARY GRASSED AREAS HAVE NOT ATTAINED A MINIMUM OF 75 PERCENT GOOD GRASS COVER, THE AREA WILL BE REWORKED AND ADDITIONAL SEED APPLIED SUFFICIENT TO ESTABLISH THE DESIRED VEGETATIVE COVER.
16. MAINTENANCE: ALL FEATURES OF THE PROJECT DESIGNED AND CONSTRUCTED TO PREVENT EROSION AND SEDIMENT SHALL BE MAINTAINED DURING THE LIFE OF THE CONSTRUCTION SO AS TO FUNCTION AS THEY WERE ORIGINALLY DESIGNED AND CONSTRUCTED.
17. PERMANENT EROSION CONTROL: THE EROSION CONTROL FACILITIES OF THE PROJECT SHOULD BE DESIGNED TO MINIMIZE THE IMPACT ON THE OFFSITE FACILITIES.
18. PERMANENT SEEDING: ALL AREAS WHICH HAVE BEEN DISTURBED BY CONSTRUCTION WILL, AS A MINIMUM, BE SEEDED. THE SEEDING MIX MUST PROVIDE BOTH LONG-TERM VEGETATION AND RAPID GROWTH SEASONAL VEGETATION. SLOPES STEEPER THAN 4:1 SHALL BE SEEDED AND MULCHED OR SODDED.
19. ALL SLOPES STEEPER THAN 3:1 SHALL BE SODDED.

UTILITY OWNERS & CONTACTS

1. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY COMPANY FORTY-EIGHT (48) HOURS IN ADVANCE OF ANY EXCAVATION INVOLVING ITS UTILITIES SO THAT A COMPANY REPRESENTATIVE CAN BE PRESENT. THE LOCATION OF THE UTILITIES SHOWN IN THE PLANS ARE APPROXIMATE ONLY. THE EXACT LOCATION SHALL BE DETERMINED BY THE CONTRACTOR DURING CONSTRUCTION.

   UTILITY OWNERS:
   -

   BELLSOUTH
   -

   FLORIDA POWER & LIGHT
   -

   TIME WARNER CABLE
   -

2. THE CONTRACTOR SHALL USE THE SERVICES OF SUNSHINE-ONE CALL UTILITY LOCATOR A MINIMUM OF 48 HOURS PRIOR TO THE COMMENCEMENT OF WORK. (SUNSHINE-ONE CALL 1 (800) 423-47701

MAINTENANCE OF TRAFFIC

1. MAINTENANCE OF TRAFFIC PLANS (MOT) IS REQUIRED TO BE SUBMITTED BY THE CONTRACTOR. THIS PLAN SHOULD BE SUBMITTED AND APPROVED BY THE CITY OF S EBASTIANT PUBLIC WORKS OFFICE AT LEAST 14 DAYS PRIOR TO MOBILIZATION.
2. PRIOR TO COMMENCING WORK, THE CONTRACTOR SHALL FURNISH, ERECT AND MAINTAIN ALL BARRICADES, WARNING SIGNS, AND MARKINGS FOR HAZARDS AND THE CONTROL OF TRAFFIC, IN REASONABLE CONFORMITY WITH THE U.S. DEPARTMENT OF TRANSPORTATION MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS, OR AS DIRECTED BY THE OWNER (CITY OF SEBASTIAN), SUCH AS TO EFFECTIVELY PREVENT ACCIDENTS IN ALL PLACES WHERE THE WORK CAUSES OBSTRUCTION TO THE NORMAL TRAFFIC OR CONSTITUTES IN ANY WAY A HAZARD TO THE PUBLIC.
3. ACCESS FOR LOCAL TRAFFIC WITH DESTINATIONS WITHIN THE PROJECT LIMITS SHALL BE MAINTAINED. IF DURING CONSTRUCTION ACCESS FOR LOCAL TRAFFIC IS CHANGED, THEN THE CONTRACTOR SHALL NOTIFY THE OWNER A MINIMUM OF THREE (3) WORKING DAYS IN ADVANCE. IF DURING CONSTRUCTION ROAD CLOSURES ARE REQUIRED, THEN THE CONTRACTOR SHALL NOTIFY THE OWNER A MINIMUM OF FIVE (5) WORKING DAYS IN ADVANCE.

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

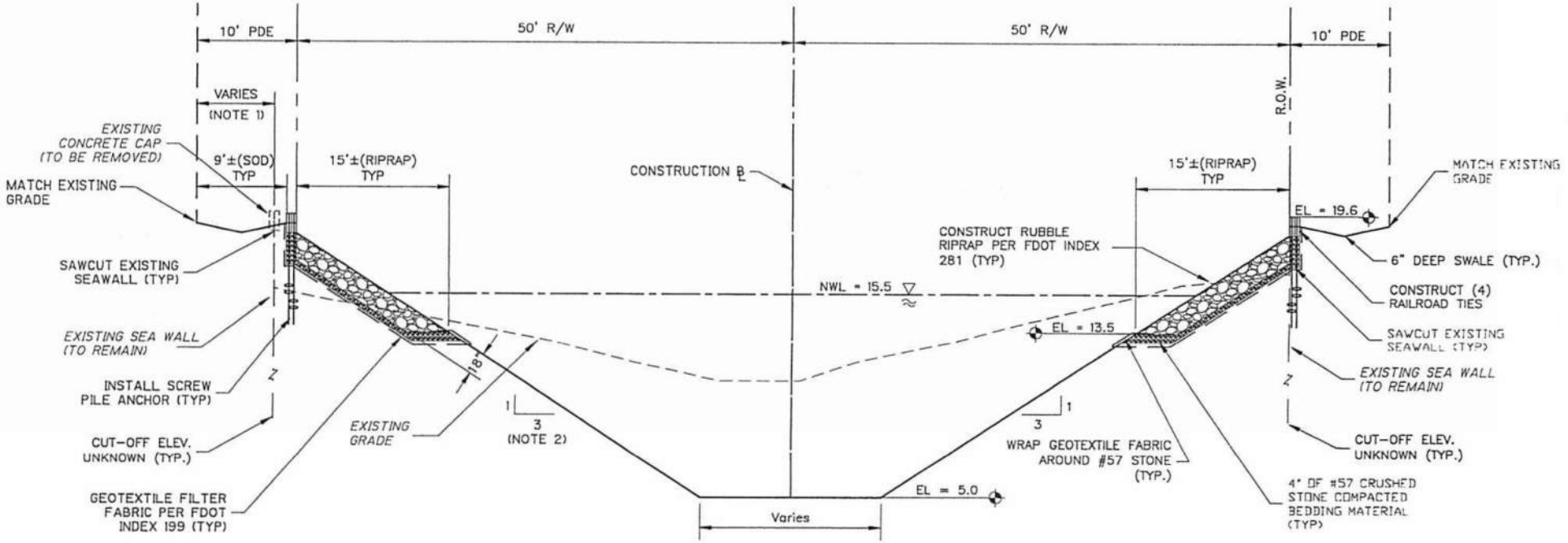
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4320
FL COA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

INDEX, LEGEND, ABBREVIATIONS, AND GENERAL NOTES

PERMIT SUBMITTAL



TYPICAL SECTION

HORIZ 1" = 10'
VERT 1" = 5'

NOTE:
1. EXISTING SHEET PILE LOCATION VARIES FROM 8' MIN TO 24' MAX FROM PERMANENT DRAINAGE EASEMENT (PDE).

2. THE 3:1 SIDE SLOPES MAY BE REVISED TO A FLATTER SLOPE AFTER STABILITY ANALYSIS IS COMPLETED.

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: S. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4333
FL COA NO. 28-0003020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

TYPICAL SECTIONS

PERMIT SUBMITTAL

SUMMARY OF TYPE A FENCING

LOCATION			TYPE A FENCING (LF)	
STATION		SIDE	PLAN	FINAL
FROM	STA. -	- LT	- LF	
TO	STA. -	-LT		
FROM	STA. -	- LT	- LF	
TO	STA. -	- LT		
FROM	STA. -	- LT	- LF	
TO	STA. -	-LT		
FROM	STA. -	-' LT	- LF	
TO	STA. -	-LT		
FROM	STA. -	- LT	- LF	
TO	STA. -	- LT		
FROM	STA. -	- LT	- LF	
TO	STA. -	- LT		
FROM	STA. -	- LT	- LF	
TO	STA. -	-' LT		
-	-	-	-	
-	-	-		
FROM	STA. -	- RT	- LF	
TO	STA. -	-RT		
FROM	STA. -	- RT	- LF	
TO	STA. -	- RT		
FROM	STA. -	-RT	- LF	
TO	STA. -	- RT		
FROM	STA. -	- RT	- LF	
TO	STA. -	-RT		
FROM	STA.-	-RT	- LF	
TO	STA. -	-RT		
FROM	STA. -	- RT	- LF	
TO	STA. -	-RT		
FROM	STA. -	-RT	- LF	
TO	STA. -	-' RT		
FROM	STA. -	- RT	- LF	
TO	STA. -	-RT		
FROM	STA. -	-RT	- LF	
TO	STA. -	- RT		

1. COST OF TEMPORARY CHECK DAM(S) REQUIRED FOR CONSTRUCTION SHALL BE INCLUDED IN MOBILIZATION FDOT INDEX NO. 101-1, NO ADDITIONAL COMPENSATION SHALL BE ALLOWED.
2. REINFORCING STEEL FOR ALL ENDWALLS SHALL BE INCLUDED IN THE COST OF CONCRETE CLASS I PAY ITEM 400-1-2, NO ADDITIONAL COMPENSATION SHALL BE ALLOWED.

SUMMARY OF EARTHWORK

DESCRIPTION	C	F
	CY	CY
FILL, MAINLINE:		- CY
SUB-TOTAL FILL:		- CY
FILL ADJUSTMENT (35%) (3,847 x 0.35):		- CY
SUB-TOTAL WITH FILL ADJUSTMENT		- CY
CUT GENERATED ONSITE:	- CY	
SURPLUS CUT (TO BE HAULED OFFSITE):	- CY	

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LAZNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2008

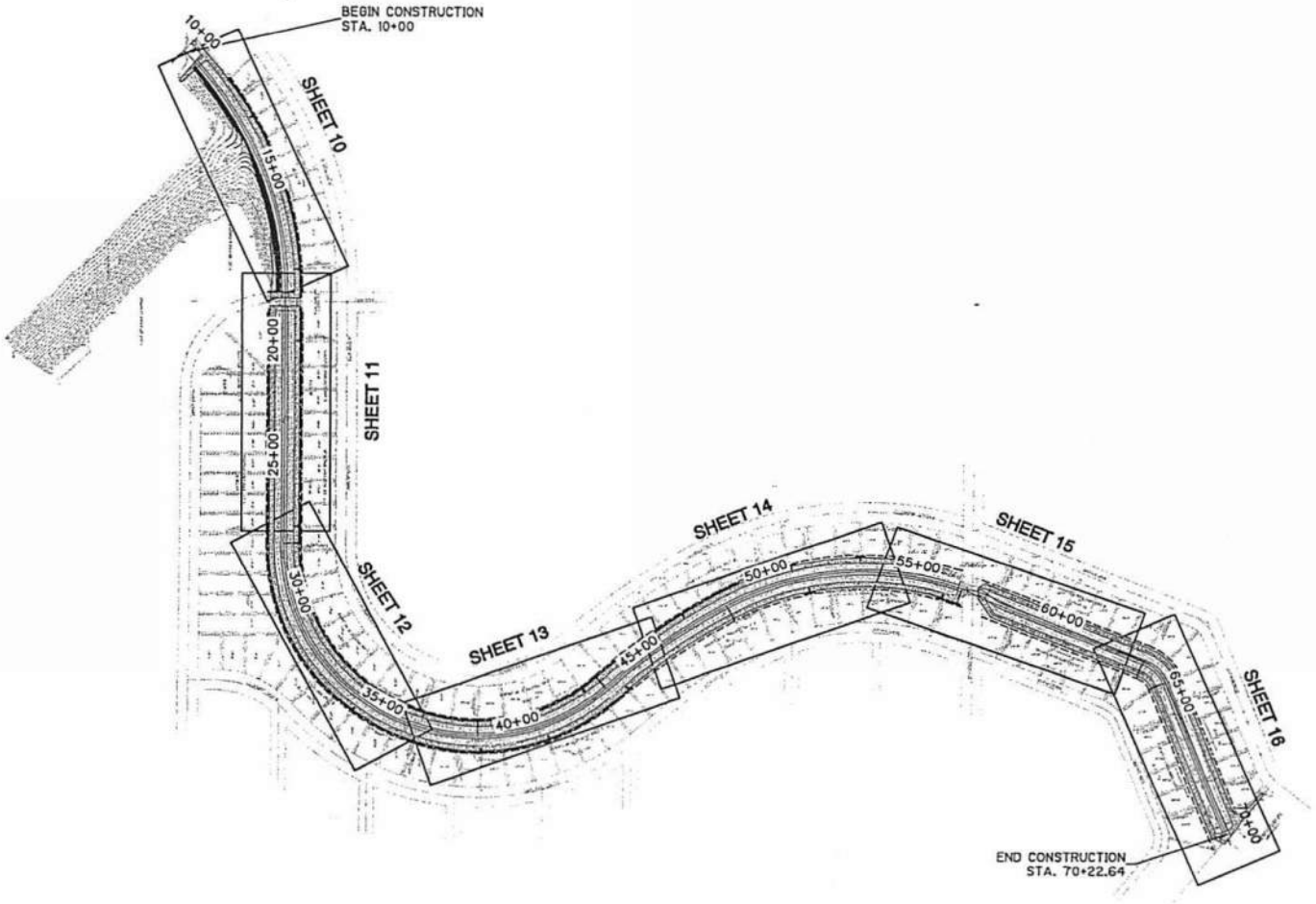
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL CDA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

SUMMARY OF QUANTITIES

PERMIT SUBMITTAL

SHEET No. 5



PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

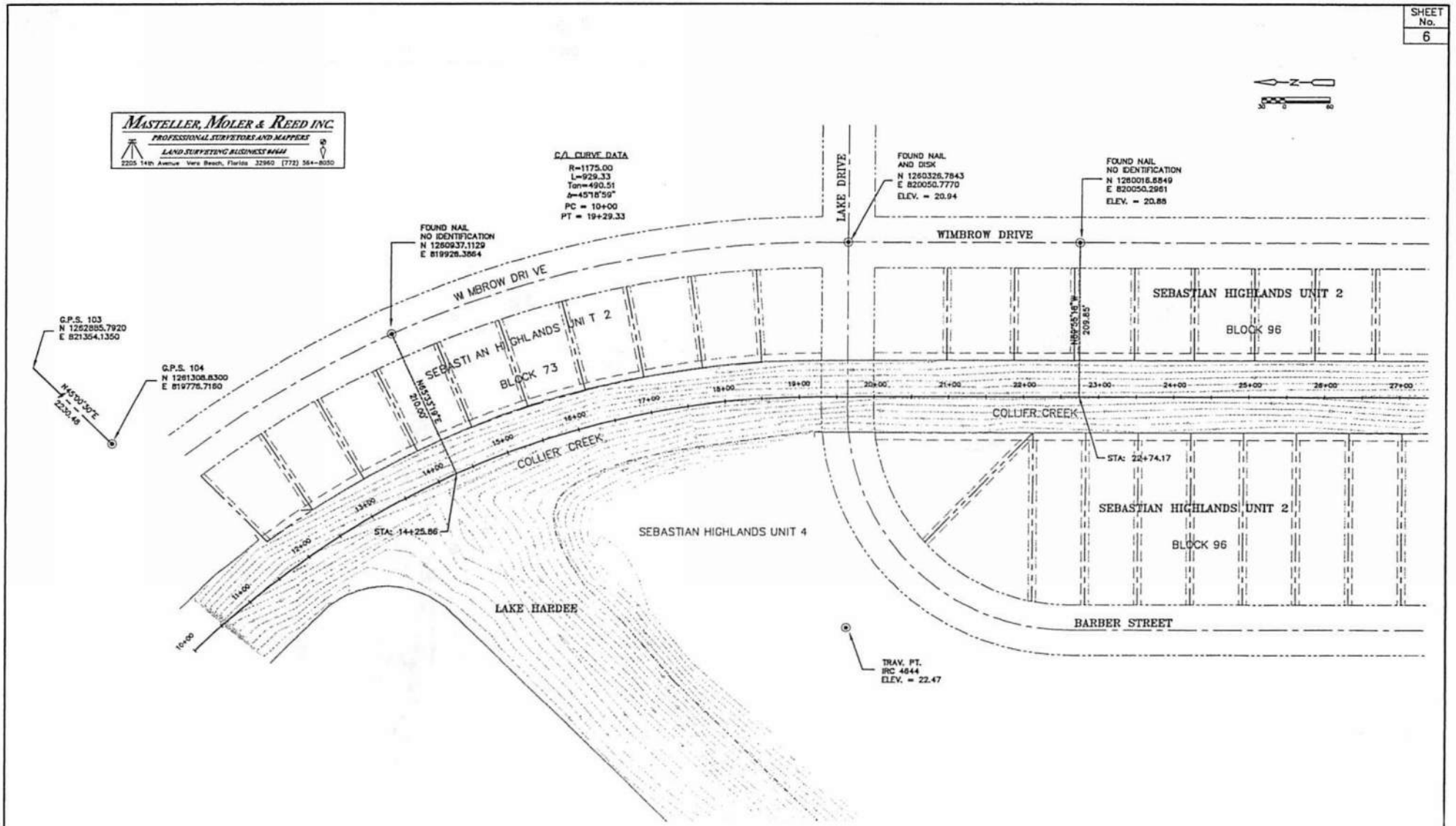
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: EB-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

KEY PLAN

PERMIT SUBMITTAL

SHEET No. 6



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LAGNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

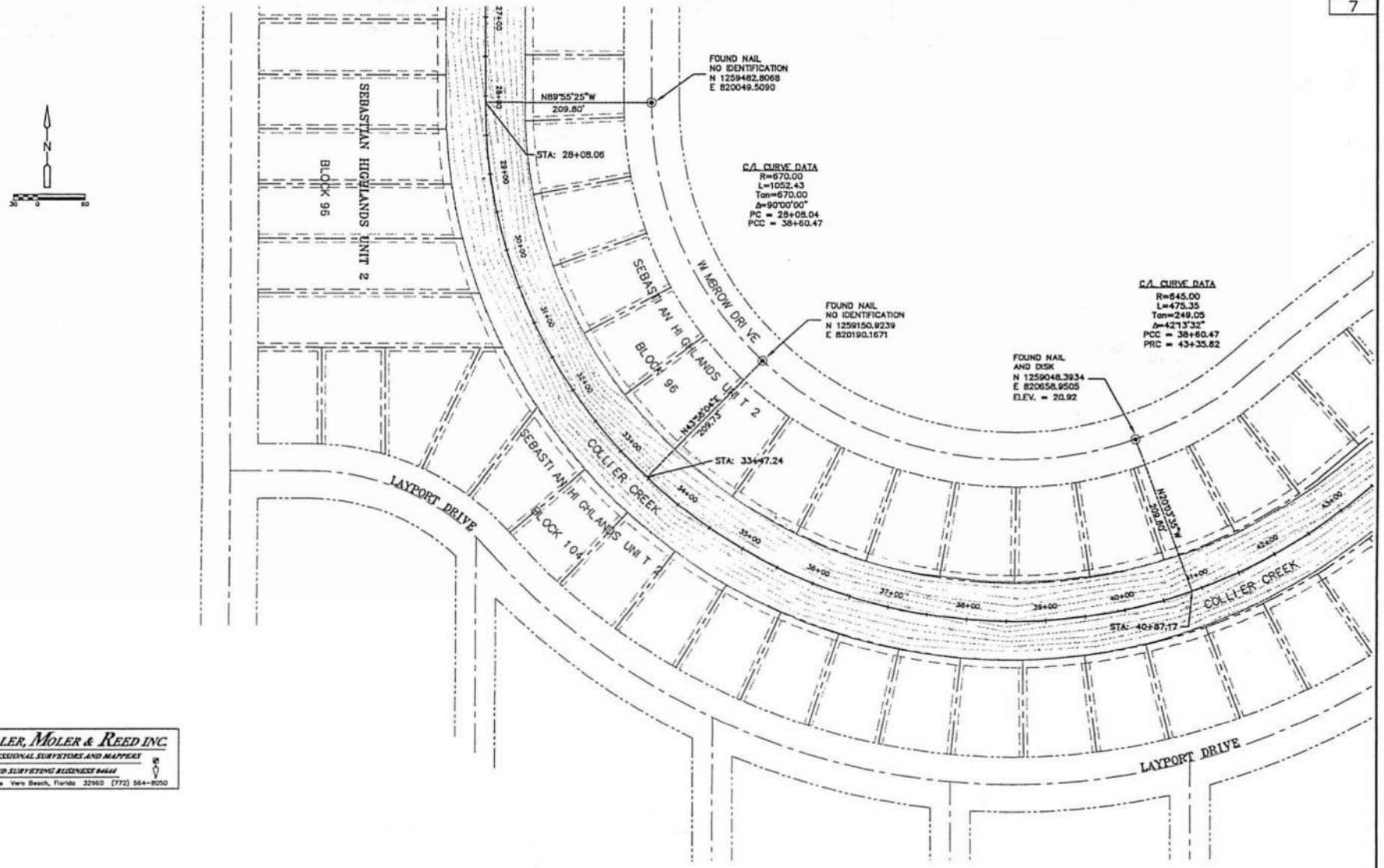
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

HORIZONTAL CONTROL PLAN

PRELIMINARY NOT FOR CONSTRUCTION

SHEET No. 7



MASTELLER, MOLER & REED INC.
PROFESSIONAL SURVEYORS AND MAPPERS
LAND SURVEYING BUSINESS #4648
2205 14th Avenue Vero Beach, Florida 32960 (772) 564-8050

REV. NO.	DATE	DRWN	CHKD	REMARKS

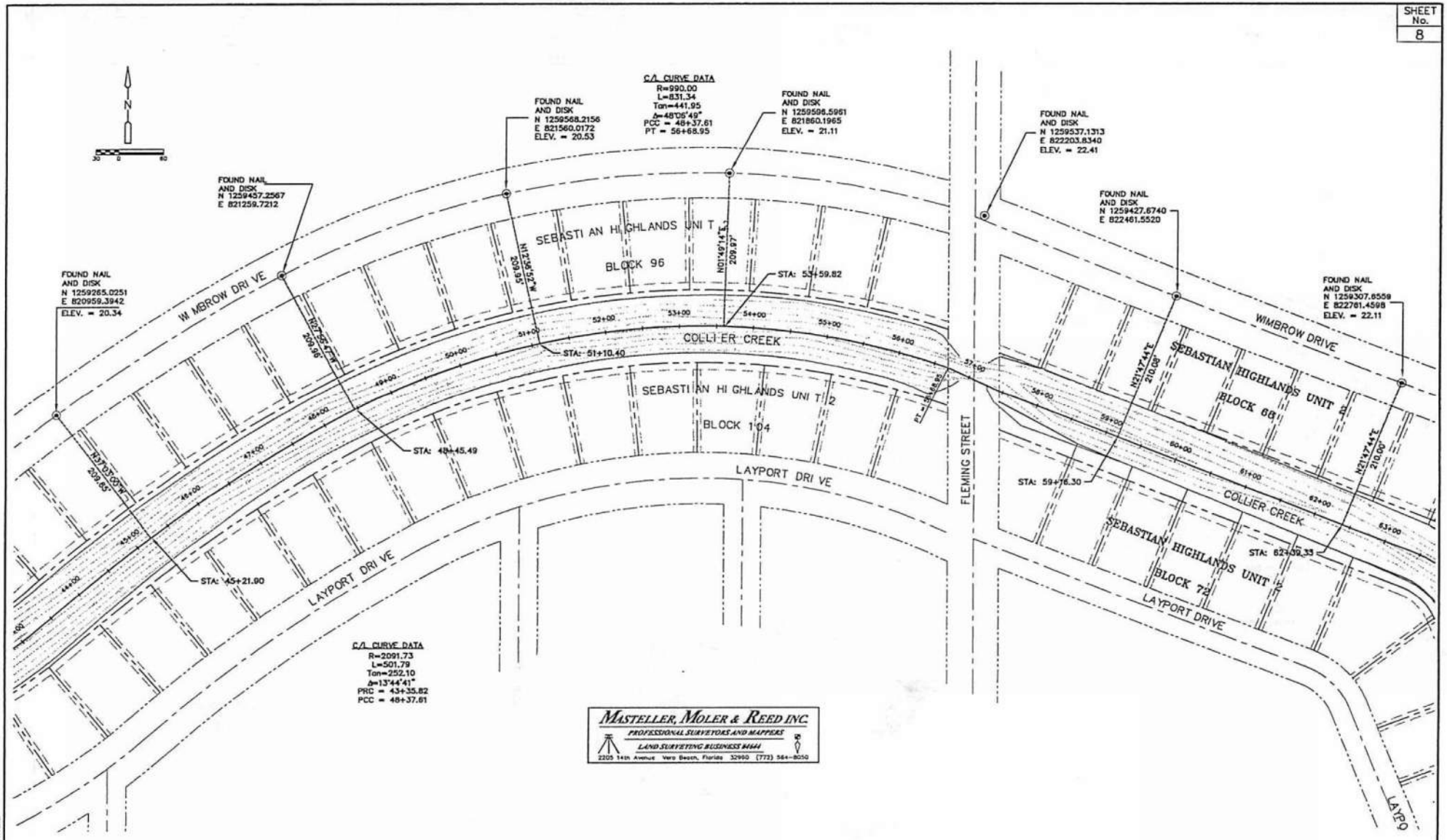
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4333
FL CDA NO: 29-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

HORIZONTAL CONTROL PLAN

PRELIMINARY
NOT FOR CONSTRUCTION



MASTELLER, MOLER & REED INC.
PROFESSIONAL SURVEYORS AND MAPPERS
LAND SURVEYING BUSINESS #644
2205 14th Avenue Vero Beach, Florida 32960 (772) 564-8050

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

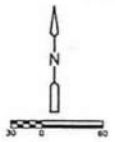
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: 28-0000320

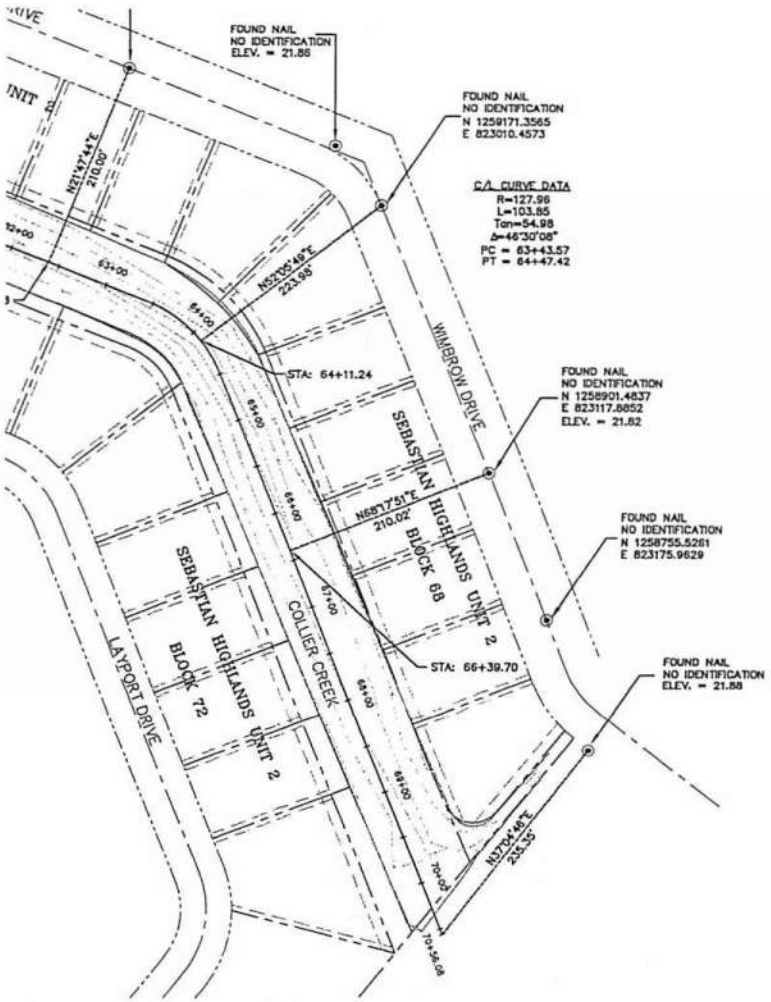
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

HORIZONTAL CONTROL PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

SHEET No. 9





MASTELLER, MOLER & REED INC.
PROFESSIONAL SURVEYORS AND MAPPERS
LAND SURVEYING BUSINESS #4644
2205 14th Avenue Vero Beach, Florida 32960 (772) 564-8050

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: R. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2008

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

HORIZONTAL CONTROL PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

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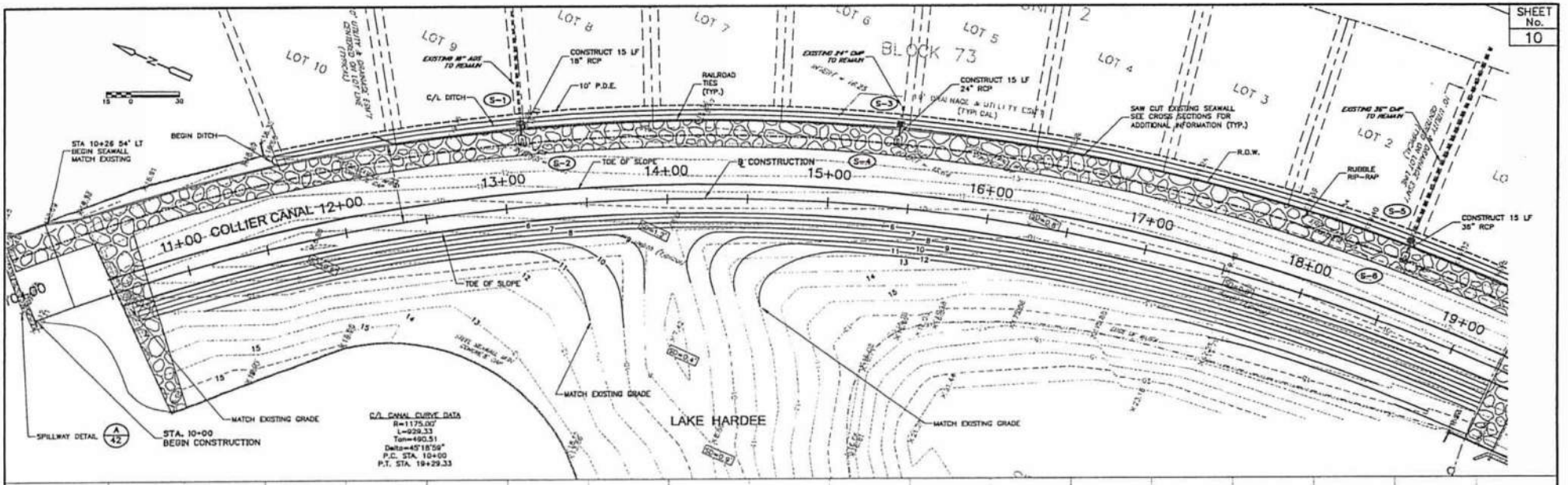
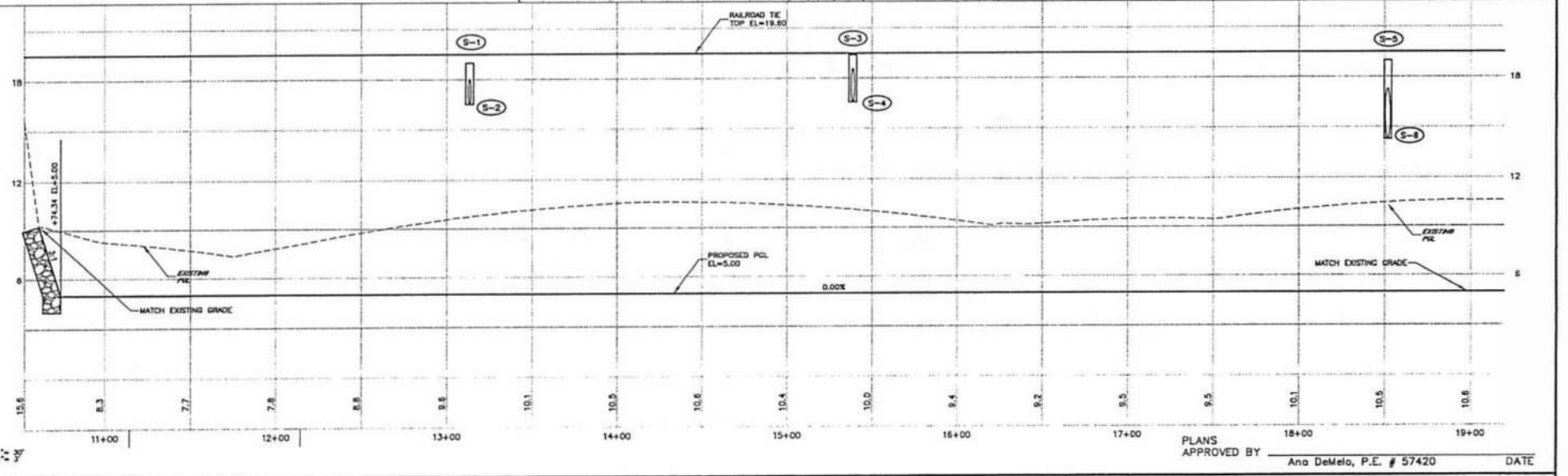




SCALE: HORZ. 1" = 30' VERT. 1" = 3'

PLANS APPROVED BY _____ Ana DeMelo, P.E. # 57420 DATE

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: A. LASHER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

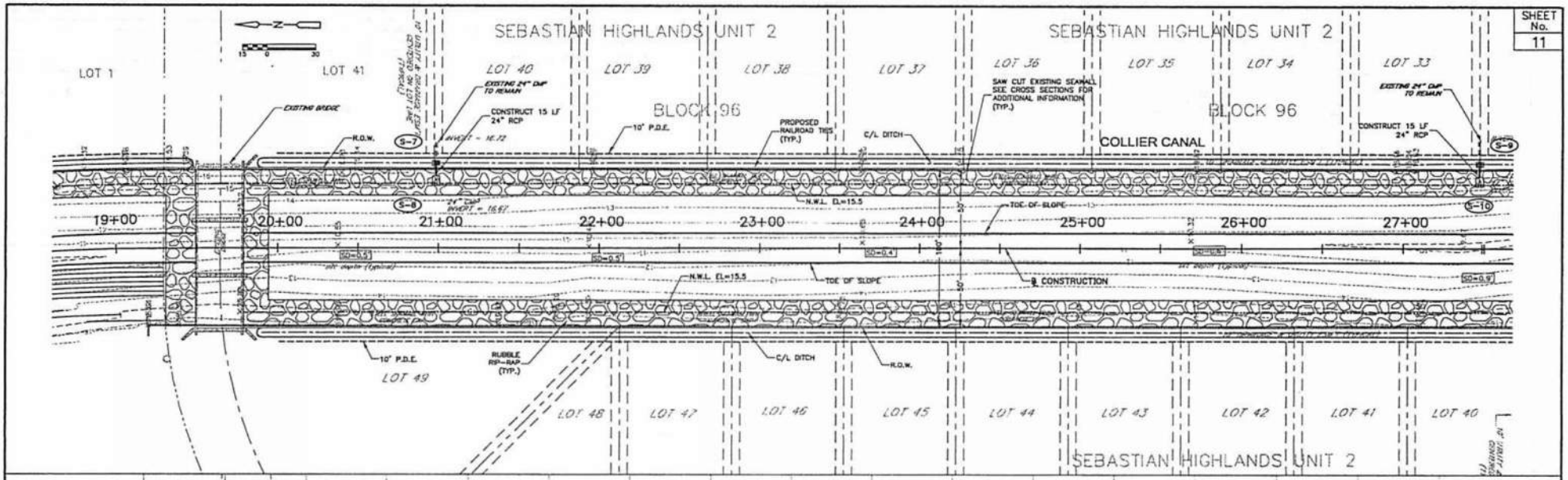
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 99-0000030

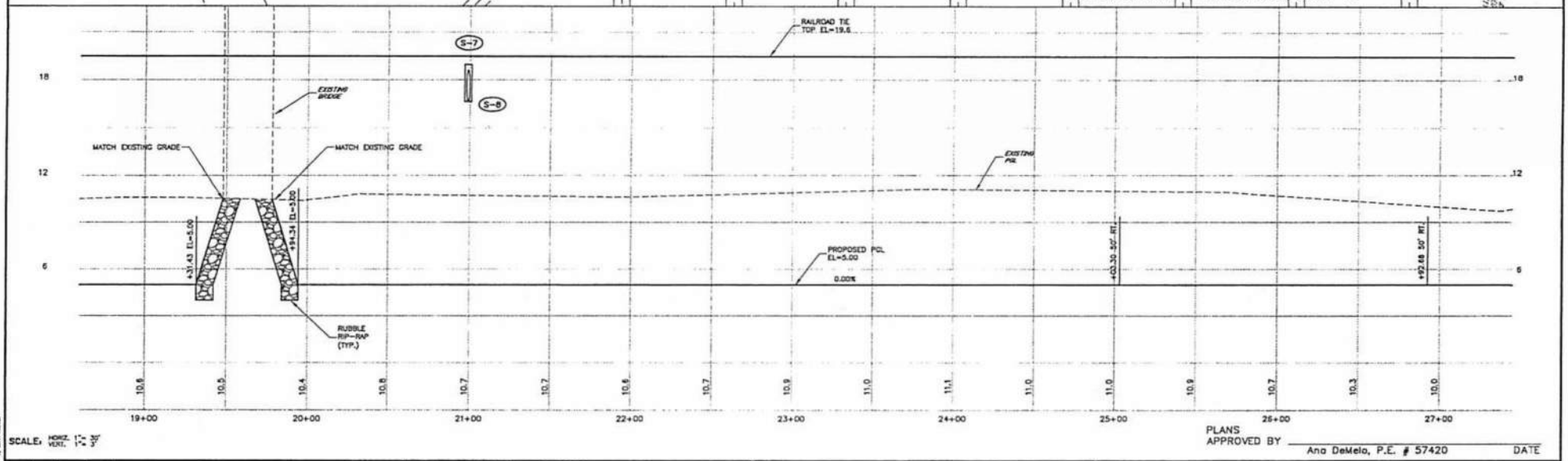
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 10+00 - STA. 19+00

PERMIT SUBMITTAL

SHEET No. 11





SCALE: HORIZ. 1" = 30' VERT. 1" = 3'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: A. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

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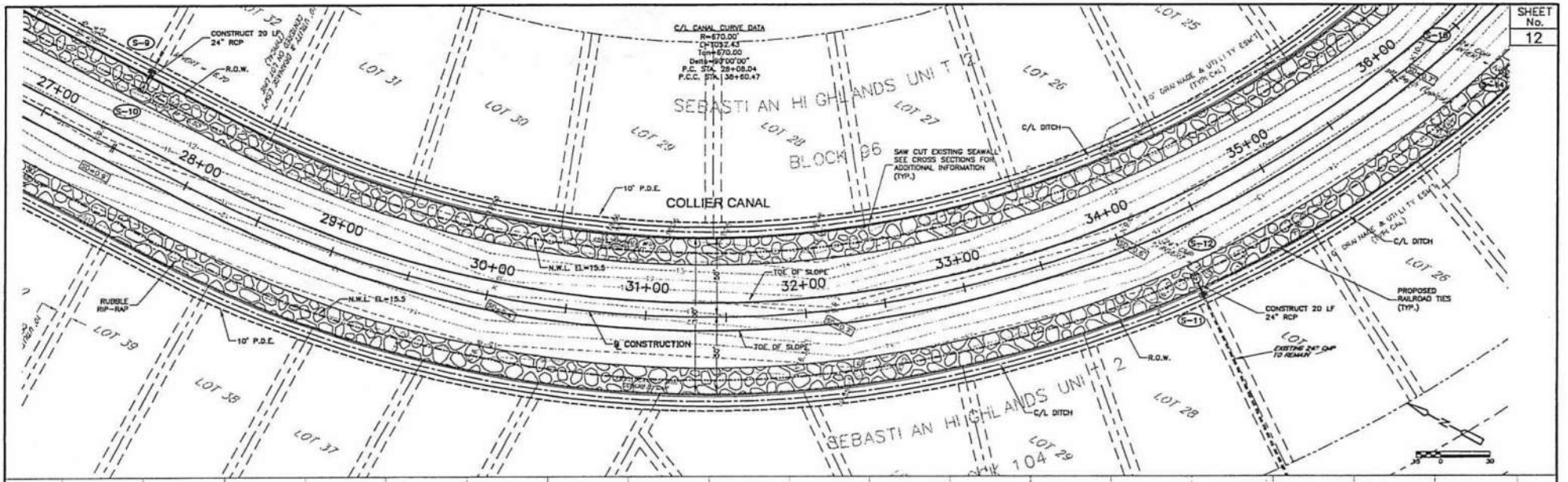
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: EB 0000020

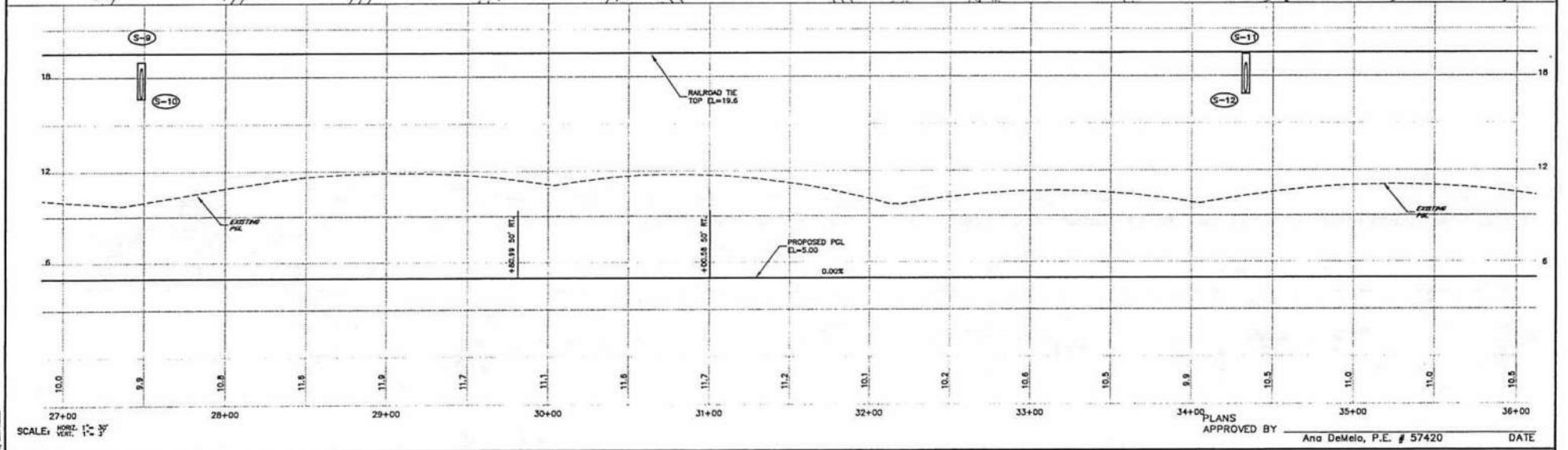
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 19+00 - STA. 27+00

PERMIT SUBMITTAL

SHEET No. 12





SCALE: HORIZ. 1"= 30' VERT. 1"= 3'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
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VERO BEACH, FL 32963
PHONE: 772-231-4301
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FL COA NO: EB-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 27+00 - STA. 36+00

PERMIT SUBMITTAL

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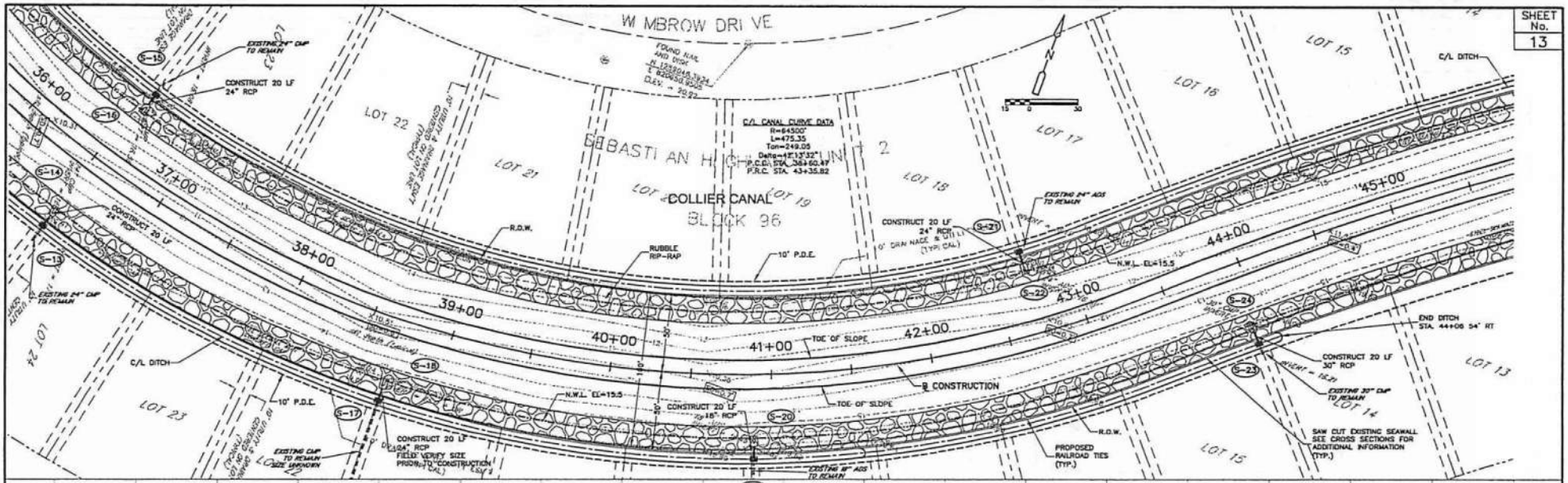
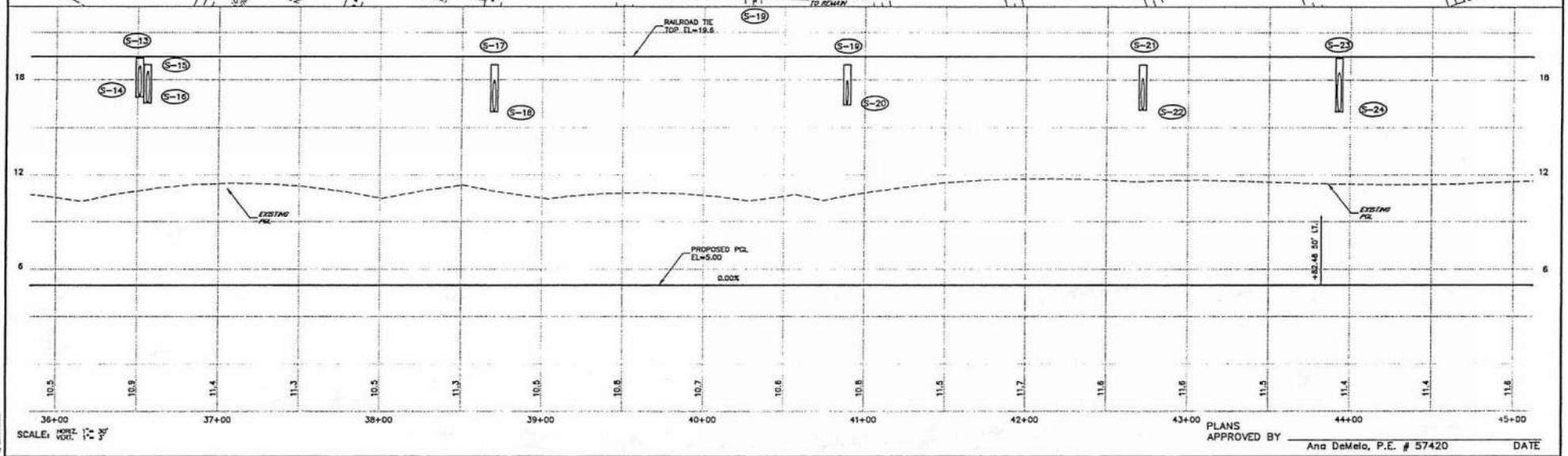




SCALE: HORIZ. 1"= 30' VERT. 1"= 3'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

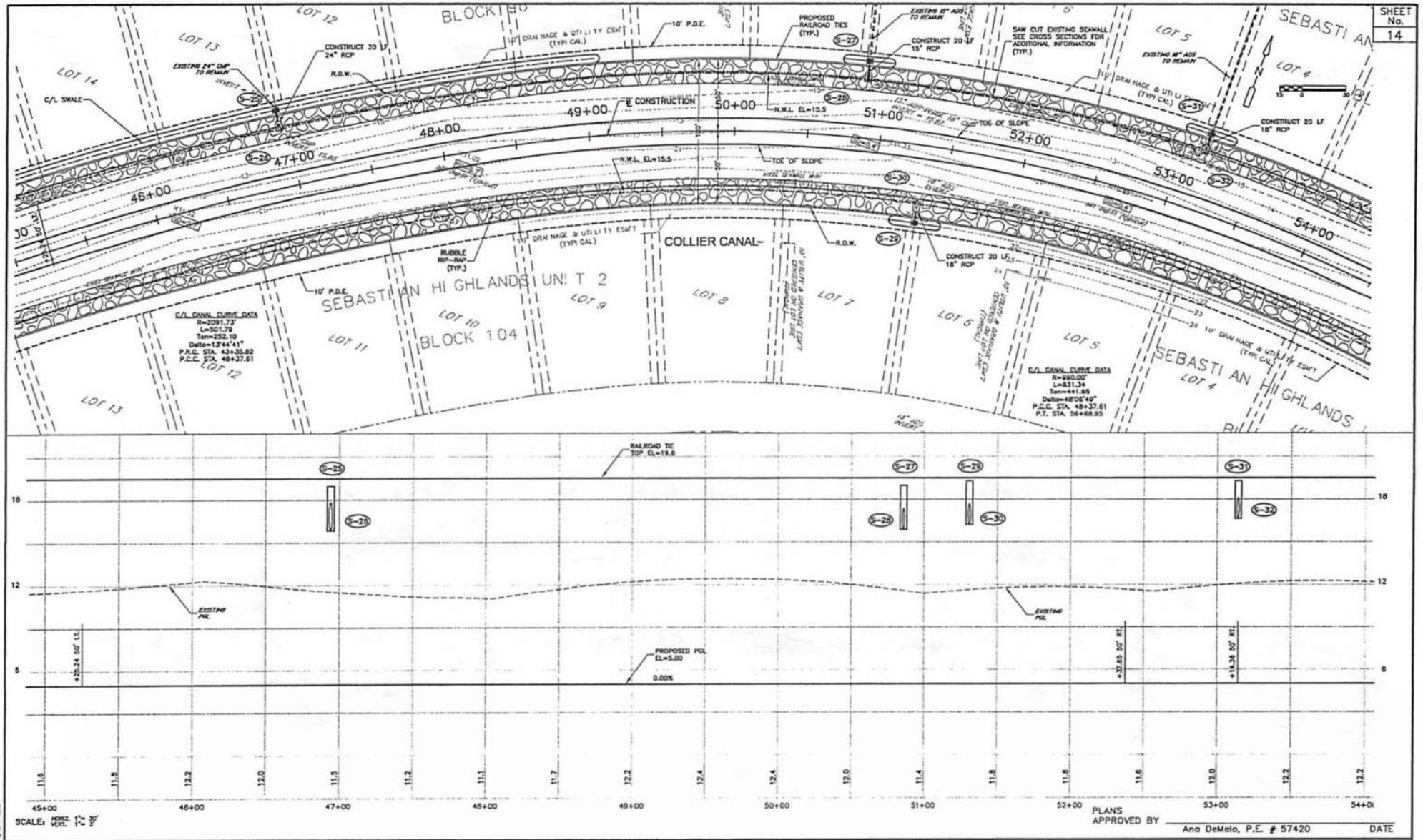
DESIGNED BY: R. STOLTZ
DRAWN BY: G. RUSSELL
SHEET CHK'D BY: J. LASHER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 36+00 - STA. 45+00

PERMIT SUBMITTAL



PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2008

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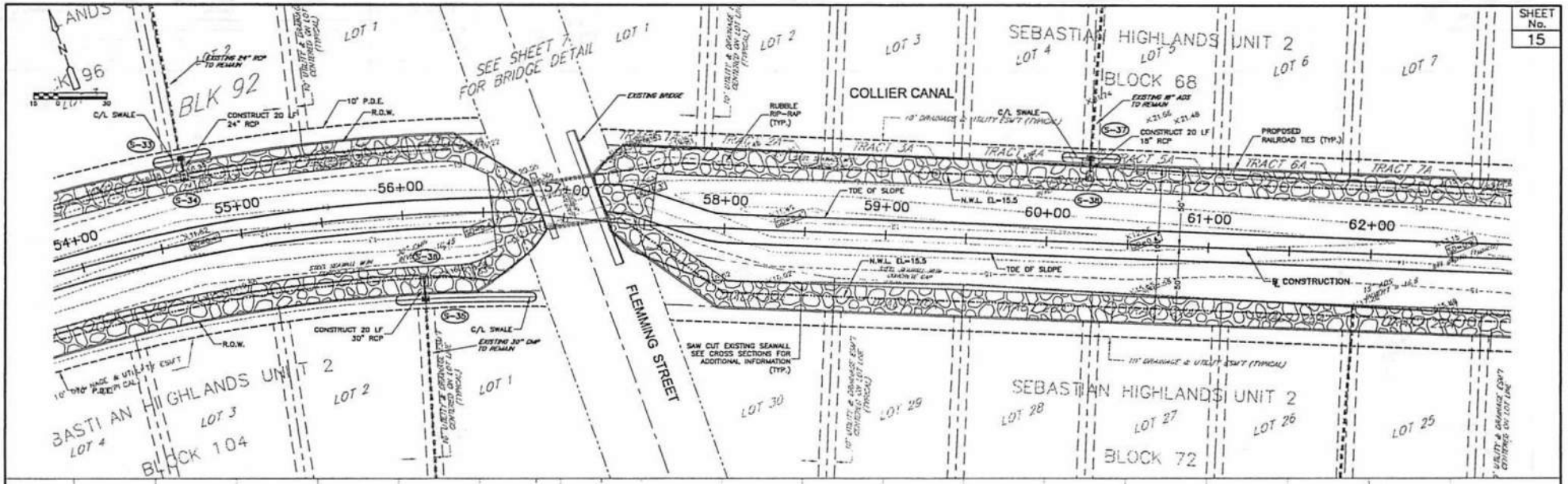
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: 28-0000030

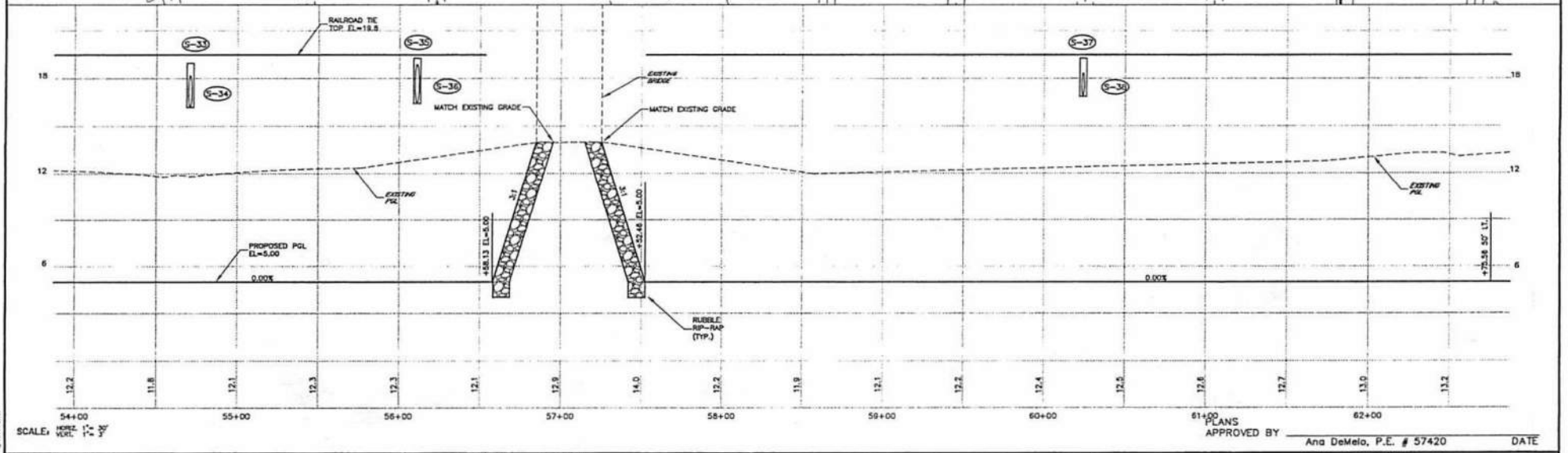
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 45+00 - STA. 54+00

PERMIT SUBMITTAL

SHEET No. 15





SCALE: HORIZ. 1" = 20' VERT. 1" = 3'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

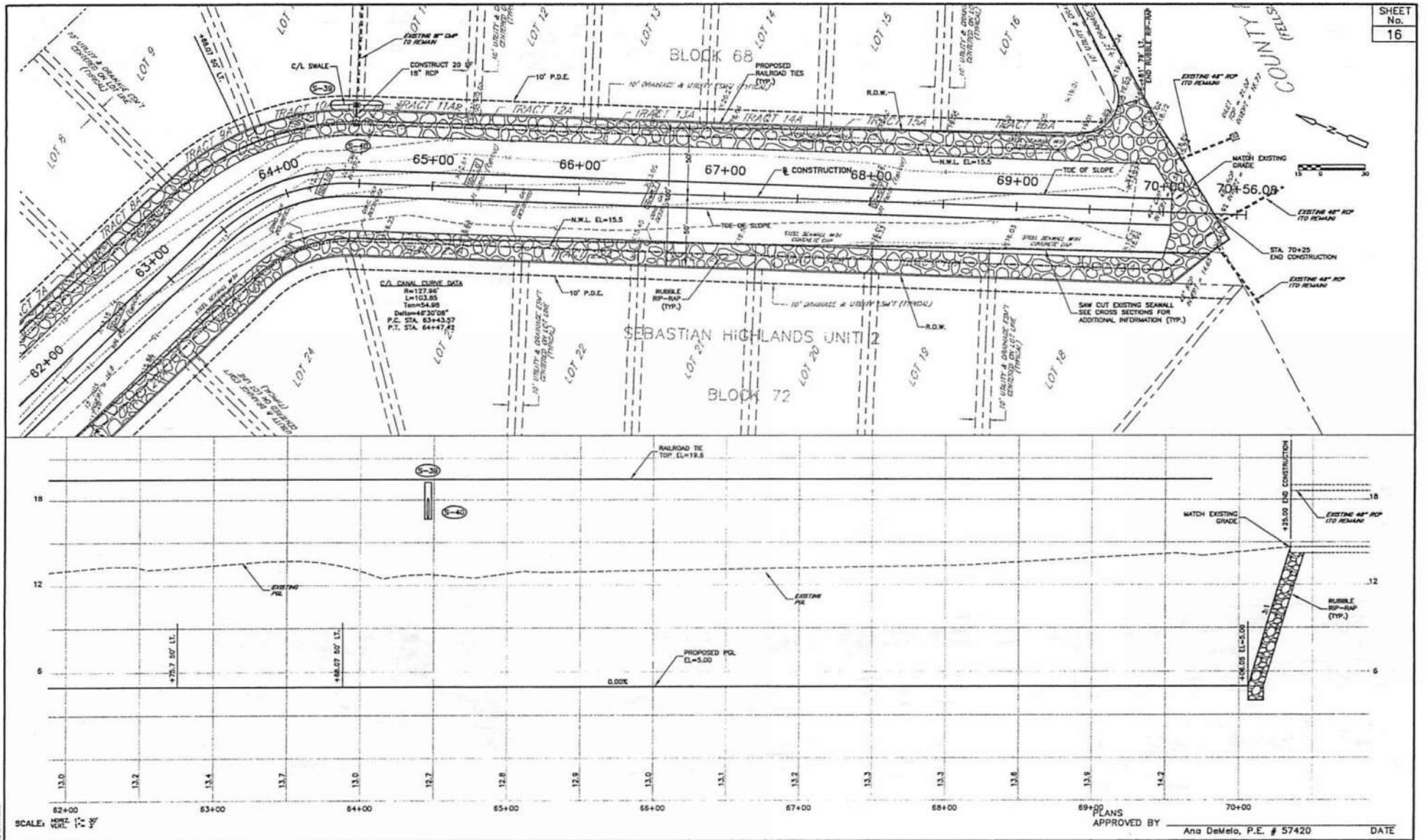
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL COA NO: EB-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 54+00 - STA.62+00

PERMIT SUBMITTAL

SHEET No. 16



SCALE: HORIZ. 1" = 30' VERT. 1" = 3'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

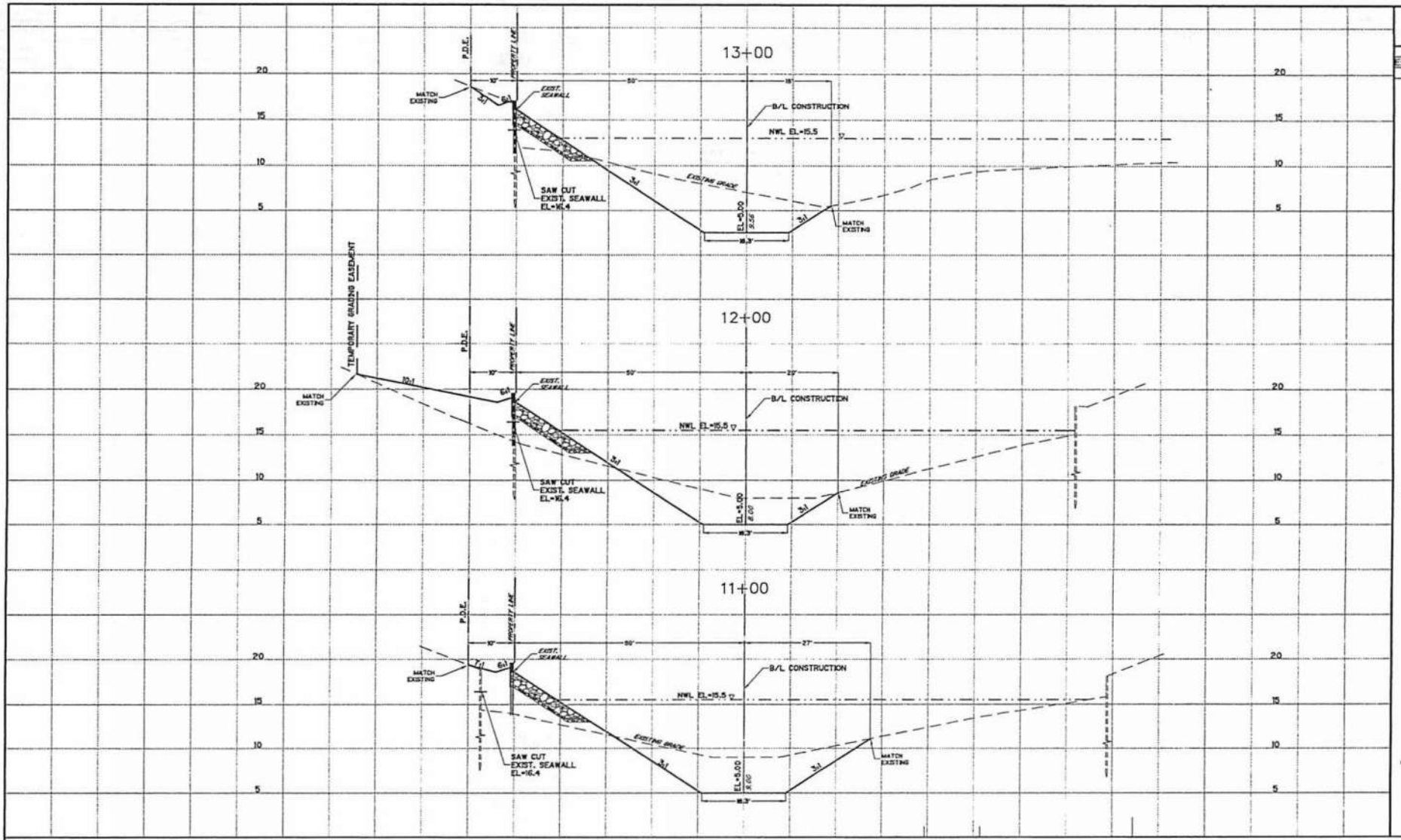
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2005

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

PLAN & PROFILE
STA. 62+00 - STA. 70+56.08

PERMIT SUBMITTAL



SHEET No. 17

MATERIAL			
Excavation		Fill	
A	Y	A	Y
	*		*
	*		*
	*		*
	*		*

SCALE: HORZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

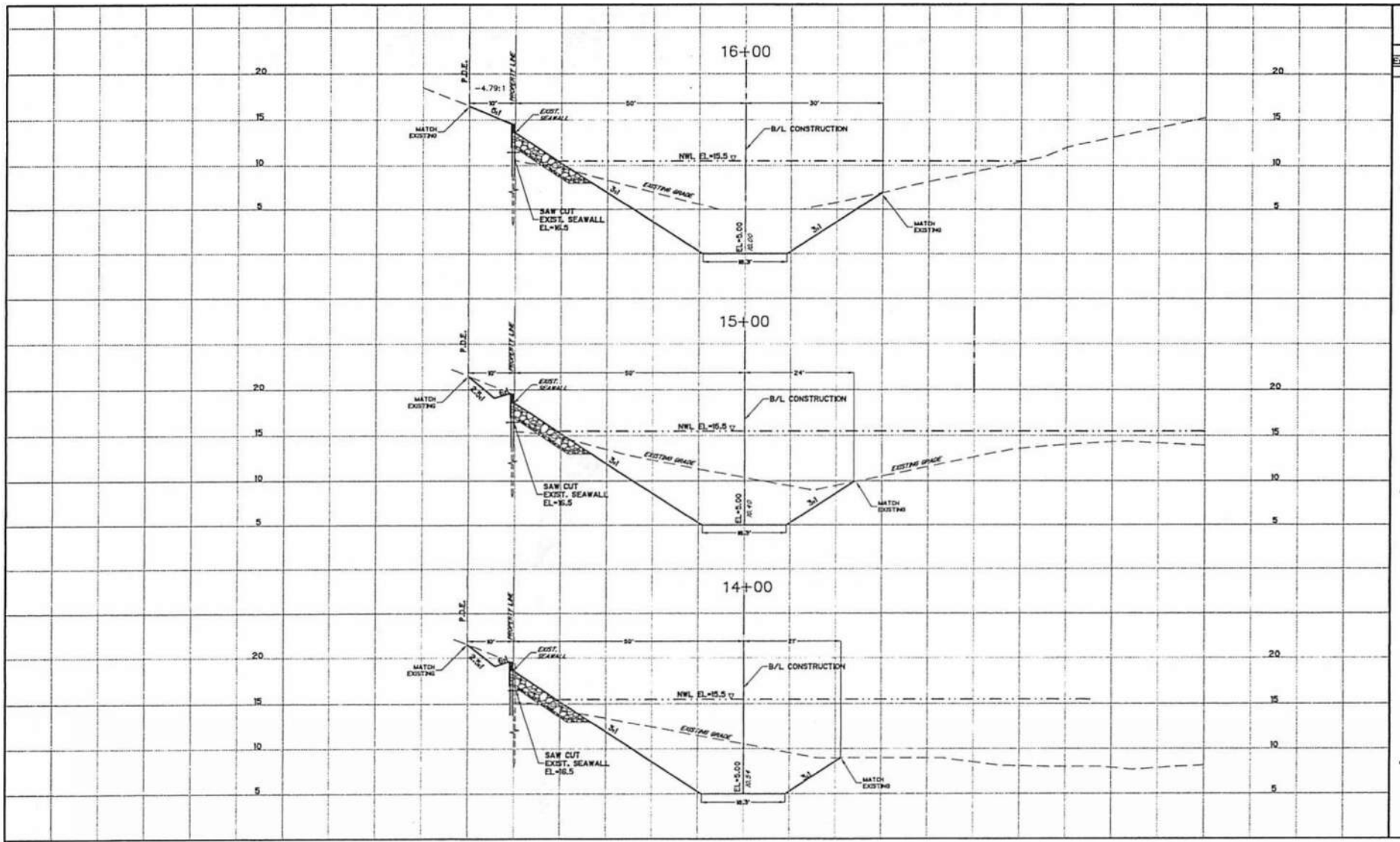
DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL CDA NO: FB-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 18

MATERIAL			
Excavation		Fill	
A	V	A	V
	*		*
*		*	
	*		*
*		*	
	*		*
*		*	

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

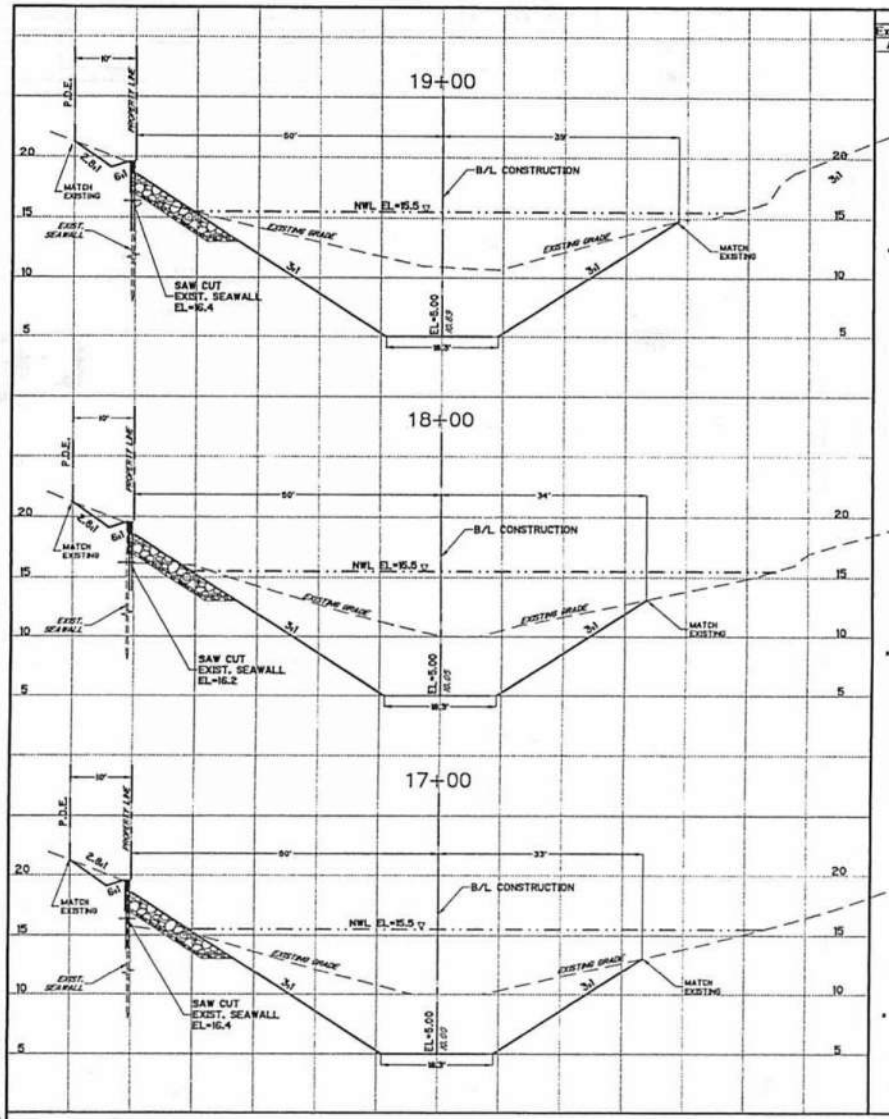
DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: A. LASHER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: EB-0000030

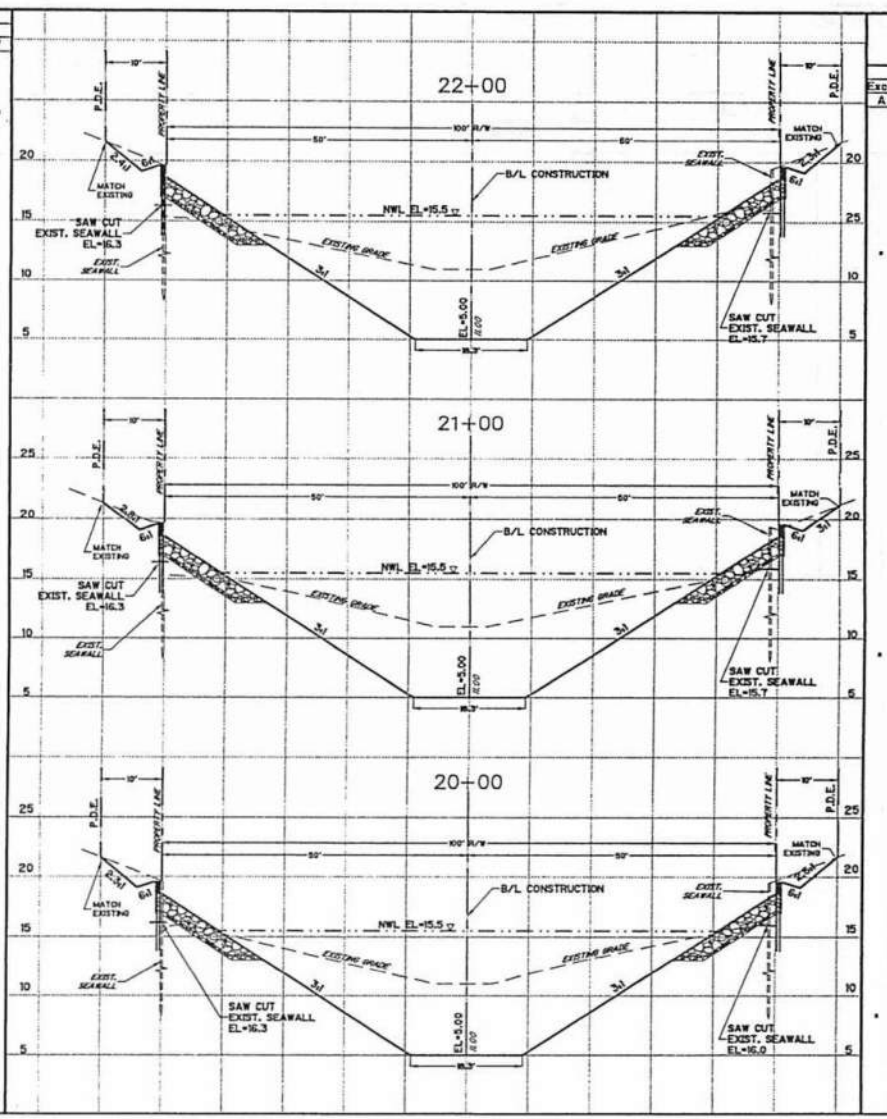
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



MATERIAL			
Excavation		Fill	
A	V	A	V



MATERIAL			
Excavation		Fill	
A	V	A	V

SHEET No. 19

SCALE: HORIZ. 1" = 10'
VERT. 1" = 10'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

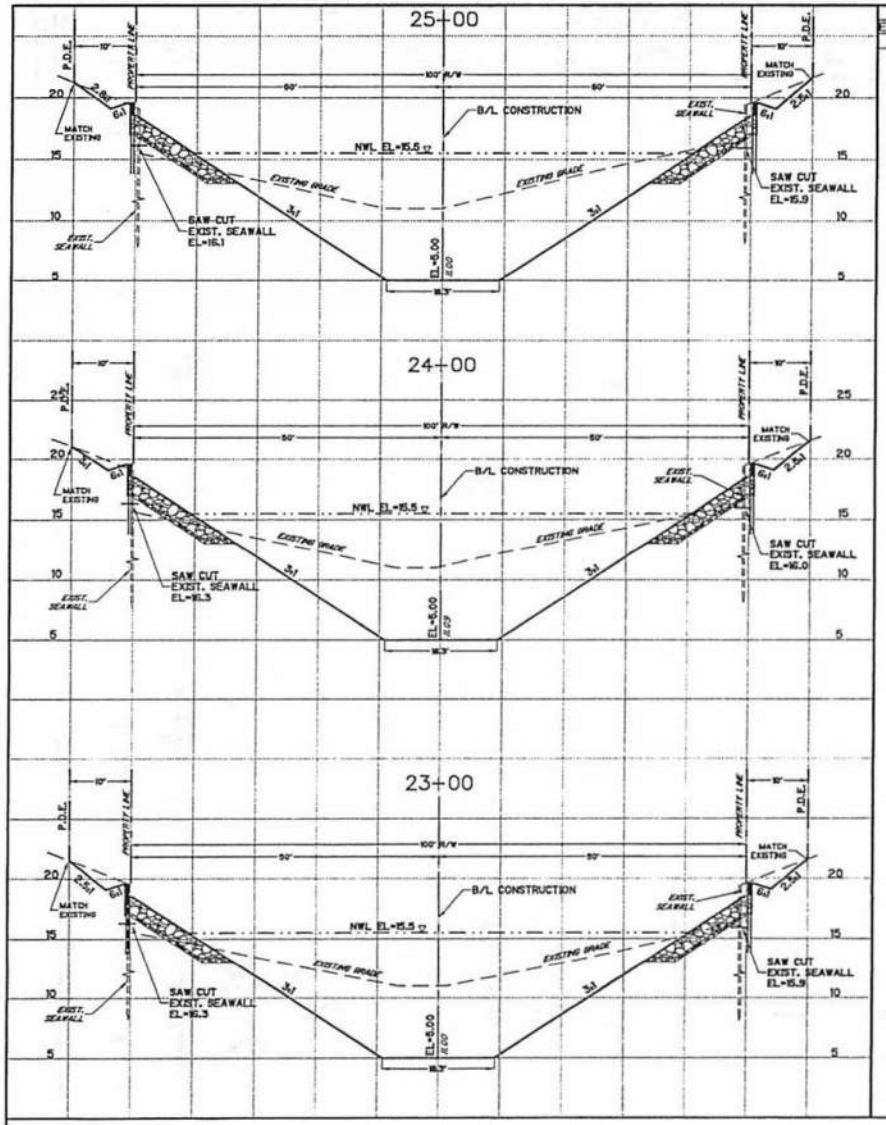
DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2008

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



MATERIAL			
Excavation		Fill	
A	Y	A	Y
	*		*
*			
		*	
*			
	*	*	
			*
*			
	*		
		*	
*			
	*	*	
			*
*			
	*		
		*	
*			
	*	*	

SHEET No.	
	20

MATERIAL			
Excavation		Fill	
A	Y	A	Y
	*		*
*			
		*	
*			
	*	*	
			*
*			
	*		
		*	
*			
	*	*	
			*
*			
	*		
		*	
*			
	*	*	

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

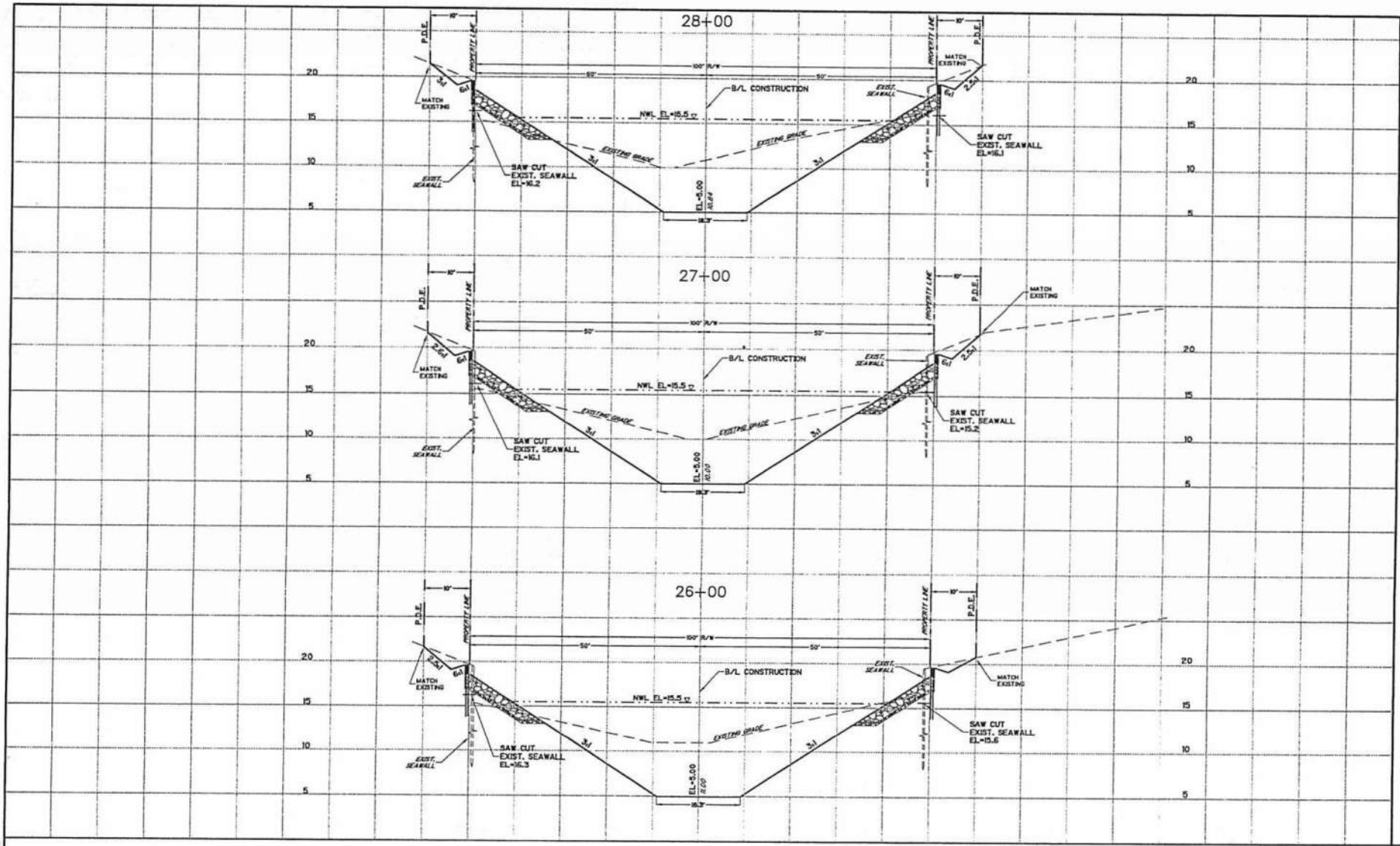
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: A. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 21

MATERIAL			
Excavation		Fill	
A	V	A	V

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

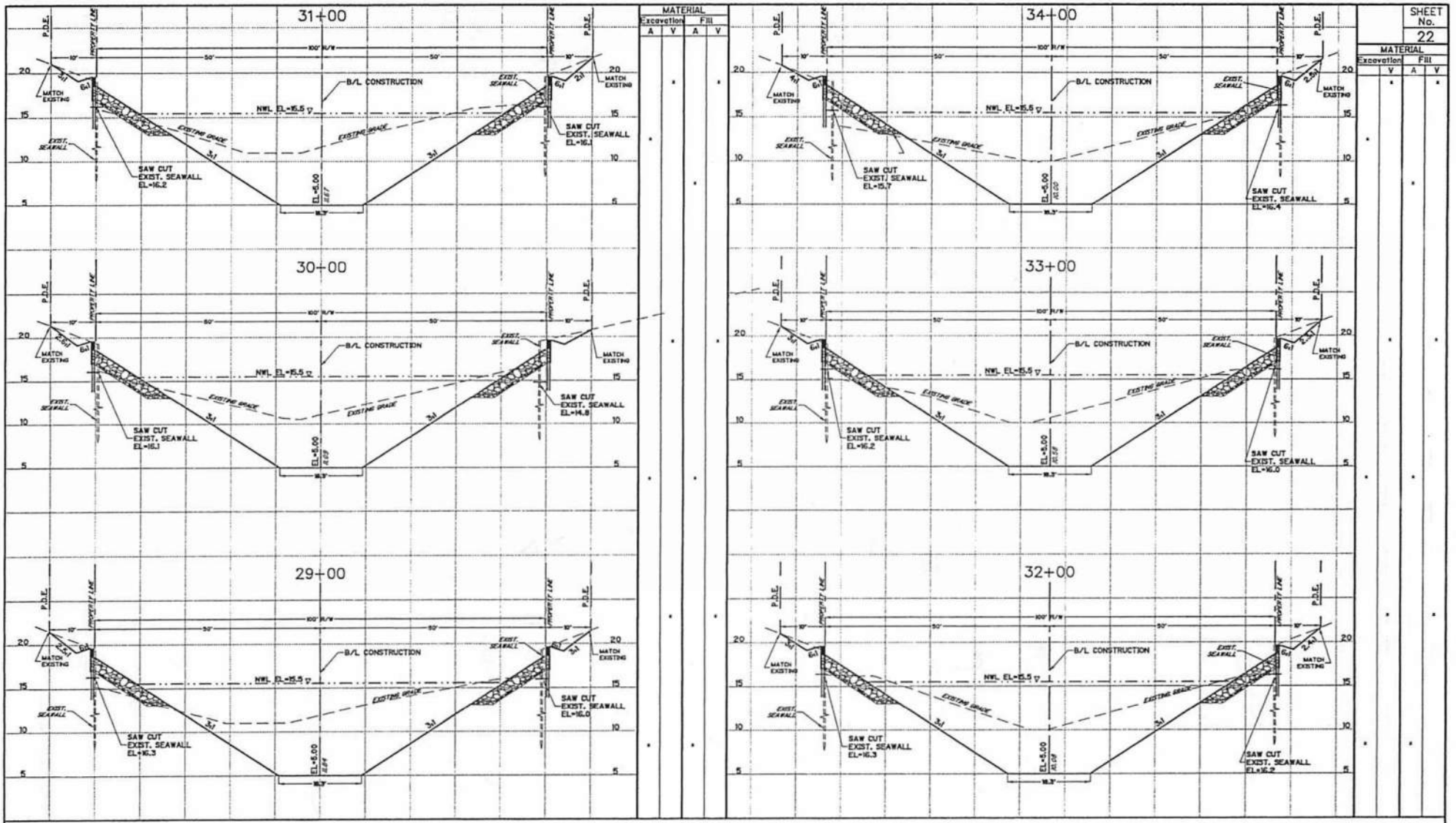
DESIGNED BY: B. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: A. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1731 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL CDM NO: 09-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 22

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

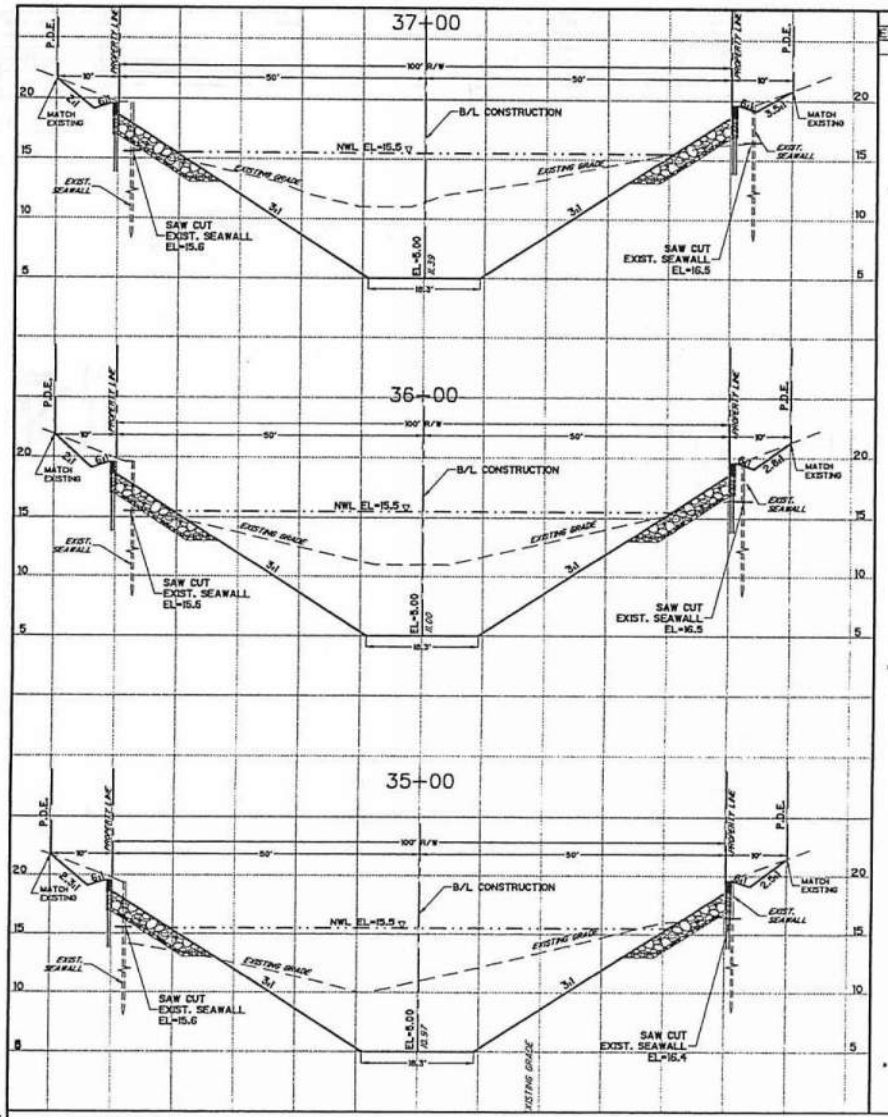
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

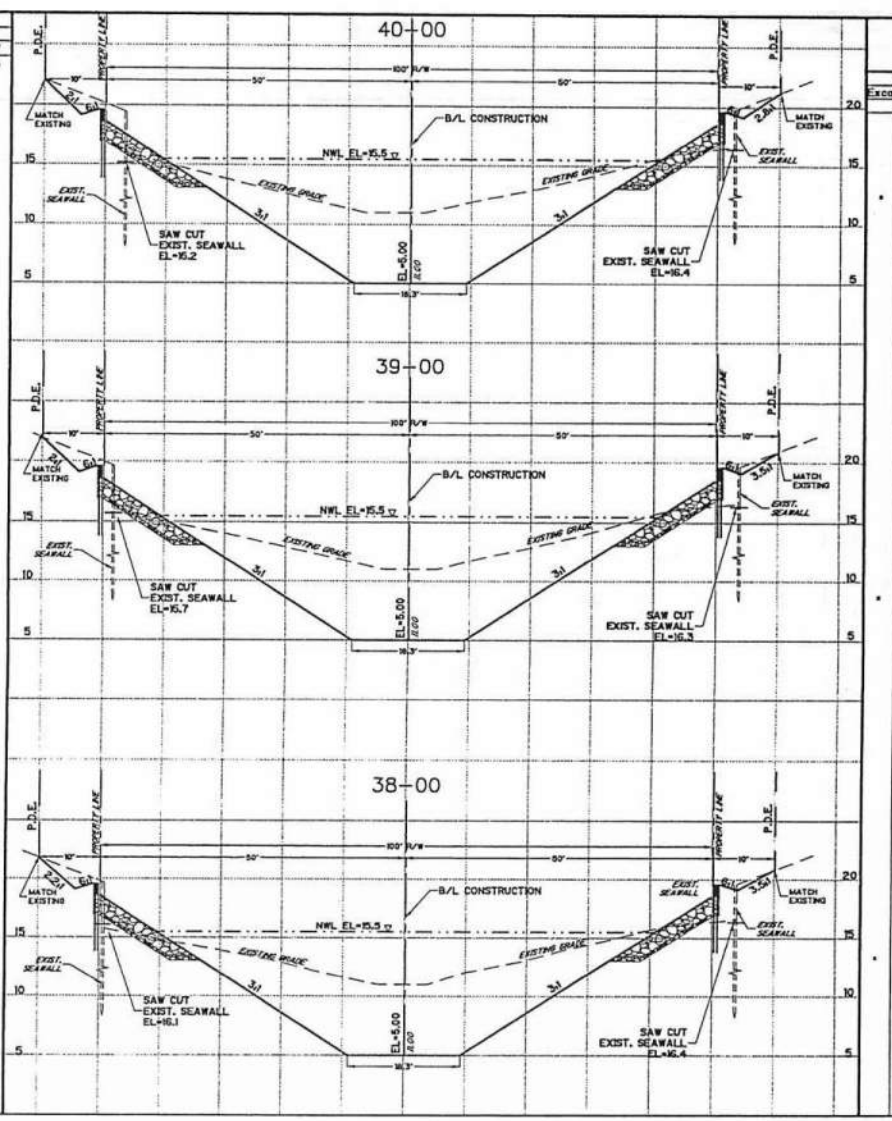
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: EB-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL





MATERIAL				
Excavation		Fill		
A	V	A	V	
	*		*	

SHEET No. 23			
MATERIAL			
Excavation		Fill	
	V	A	V
	*		*

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____
Ana DeMelo, P.E. # 57420 DATE

REV. NO.	DATE	DRWN	CHKD	REMARKS

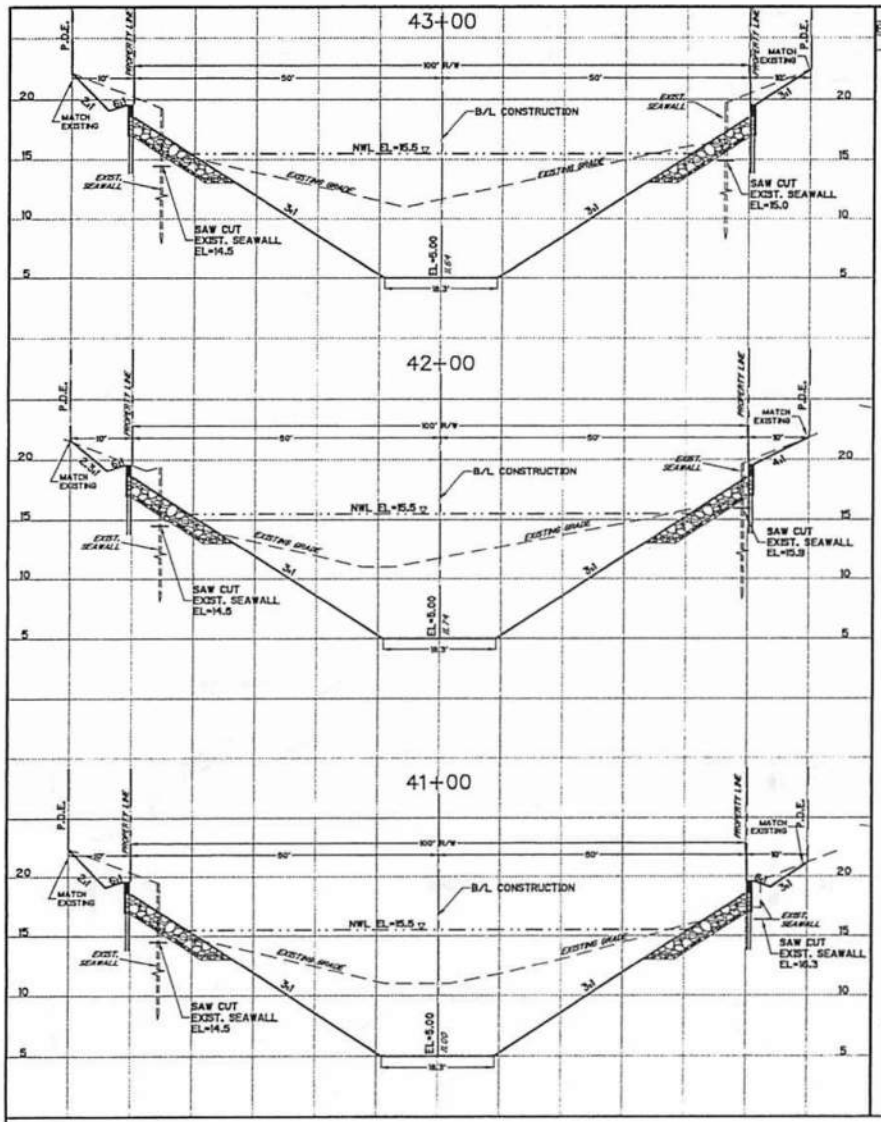
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2008

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL COA NO: 13-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



MATERIAL			
Excavation		Fill	
A	V	A	V

SHEET No. 24			
MATERIAL			
Excavation		Fill	
	V	A	V

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

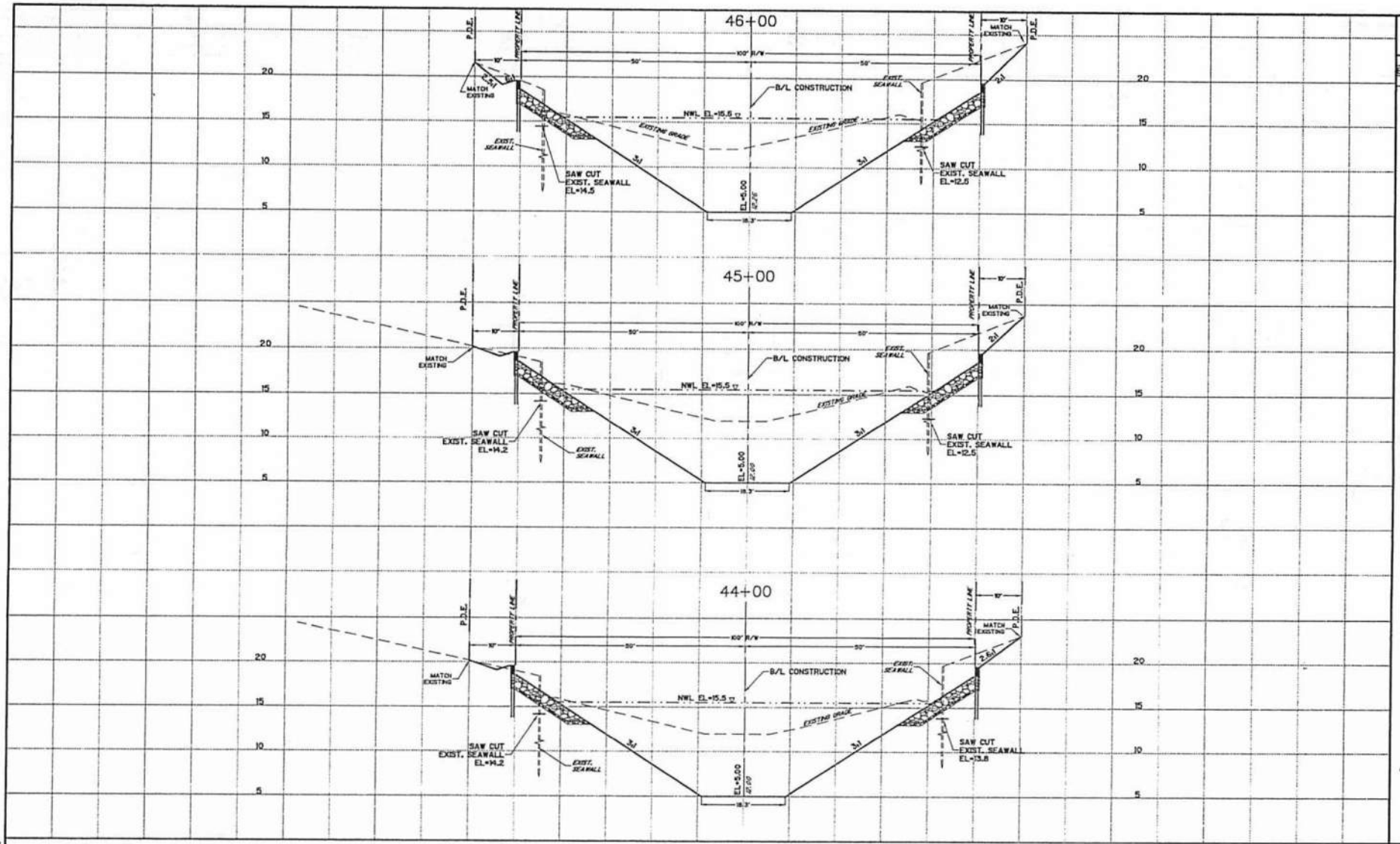
DESIGNED BY: S. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: EB-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 25			
MATERIAL			
Excavation		Fill	
A	V	A	V
	*		*
*			
		*	
	*		*
*		*	

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

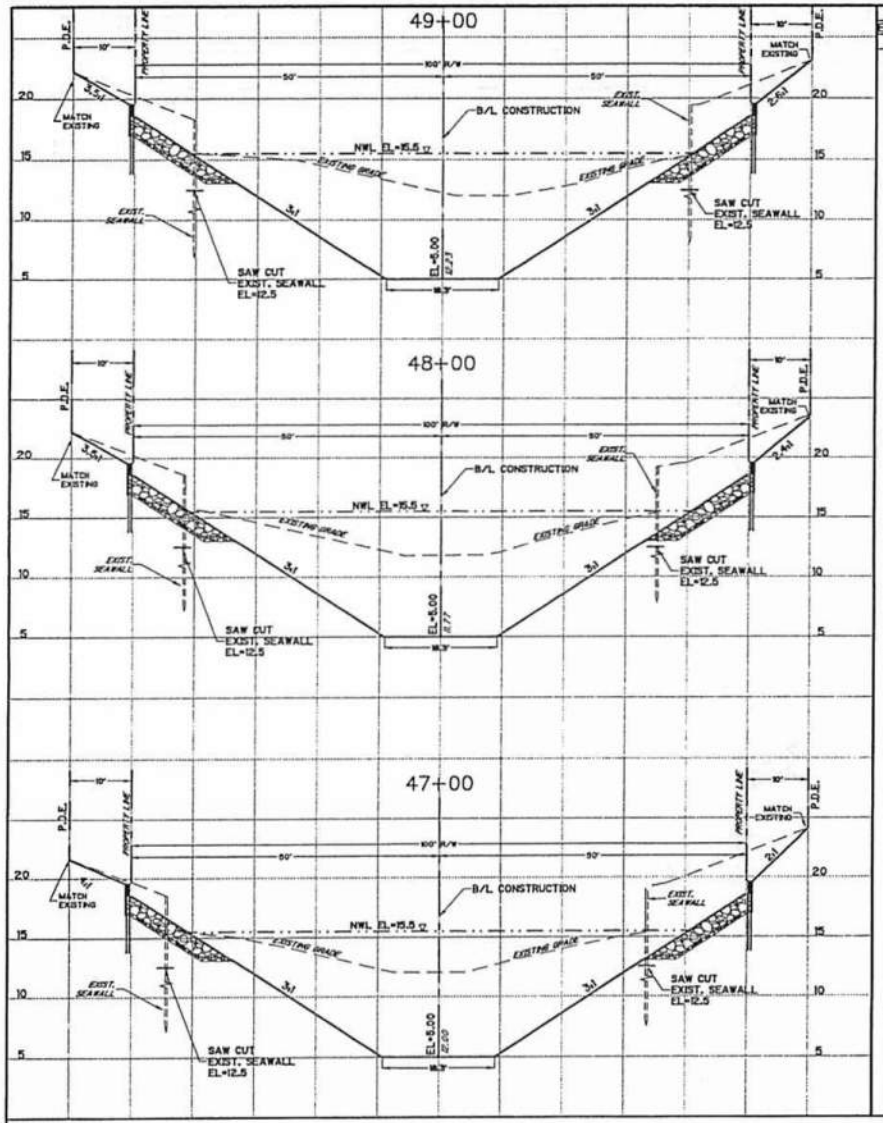
DESIGNED BY: S. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

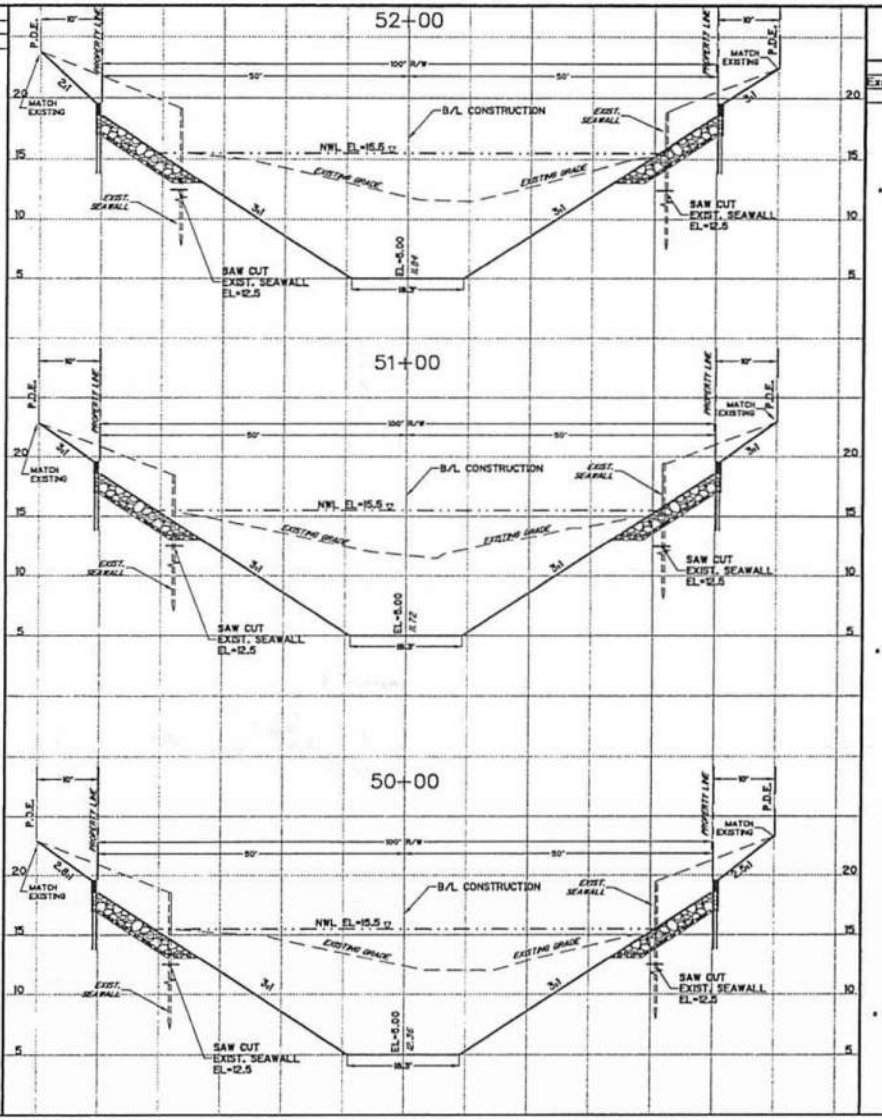
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4302
FL COA NO: 29-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL





MATERIAL			
Excavation		Fill	
A	V	A	V

SHEET No. 26			
MATERIAL			
Excavation		Fill	
	V	A	V

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

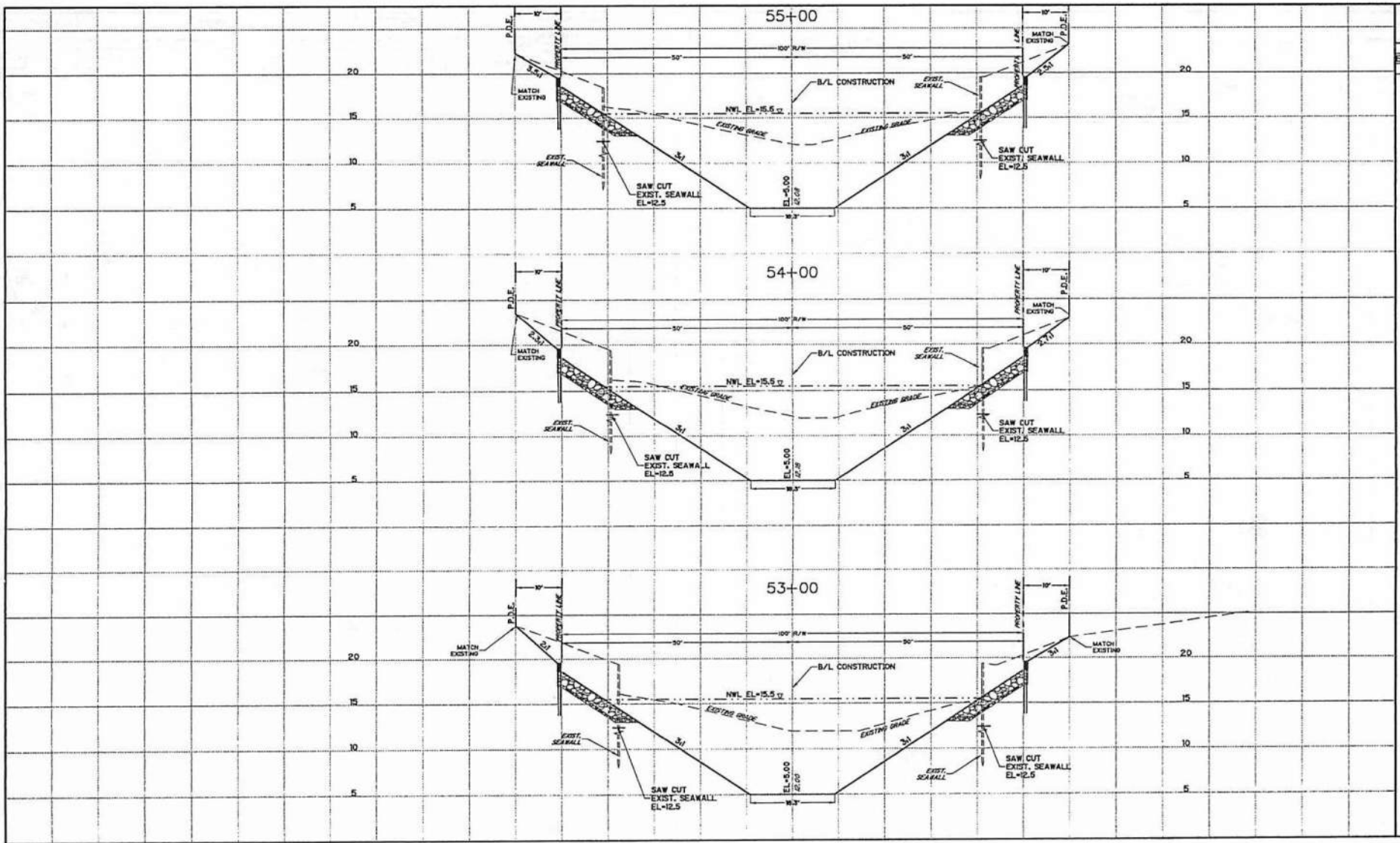
DESIGNED BY: N. STOLTZ
DRAWN BY: A. RUSSELL
SHEET CHK'D BY: A. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 27

MATERIAL			
Excavation		Fill	
	V	A	V
	*		*
*			
		*	
*			
	*		*
		*	
*			
	*		*
		*	

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

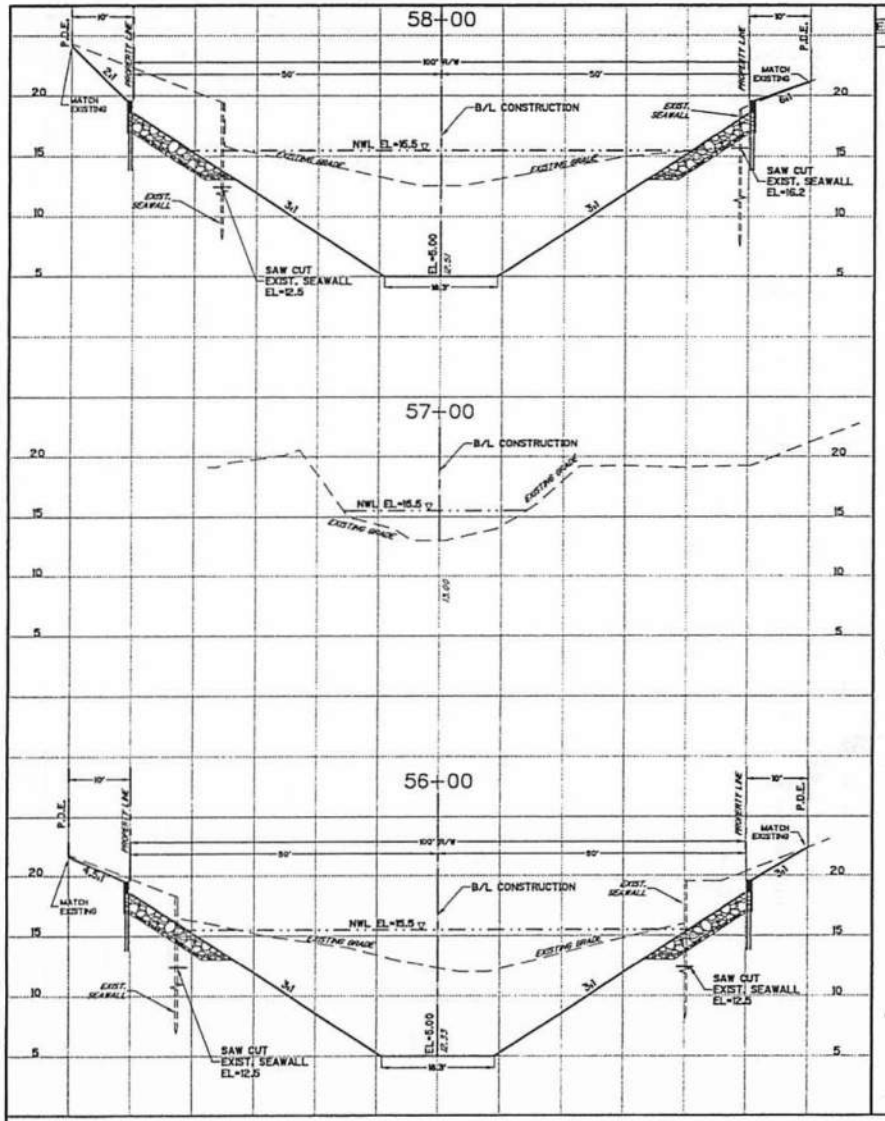
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LAGNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



MATERIAL			
Excavation		Fill	
A	V	A	V

SHEET No. 28

MATERIAL			
Excavation		Fill	
A	V	A	V

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

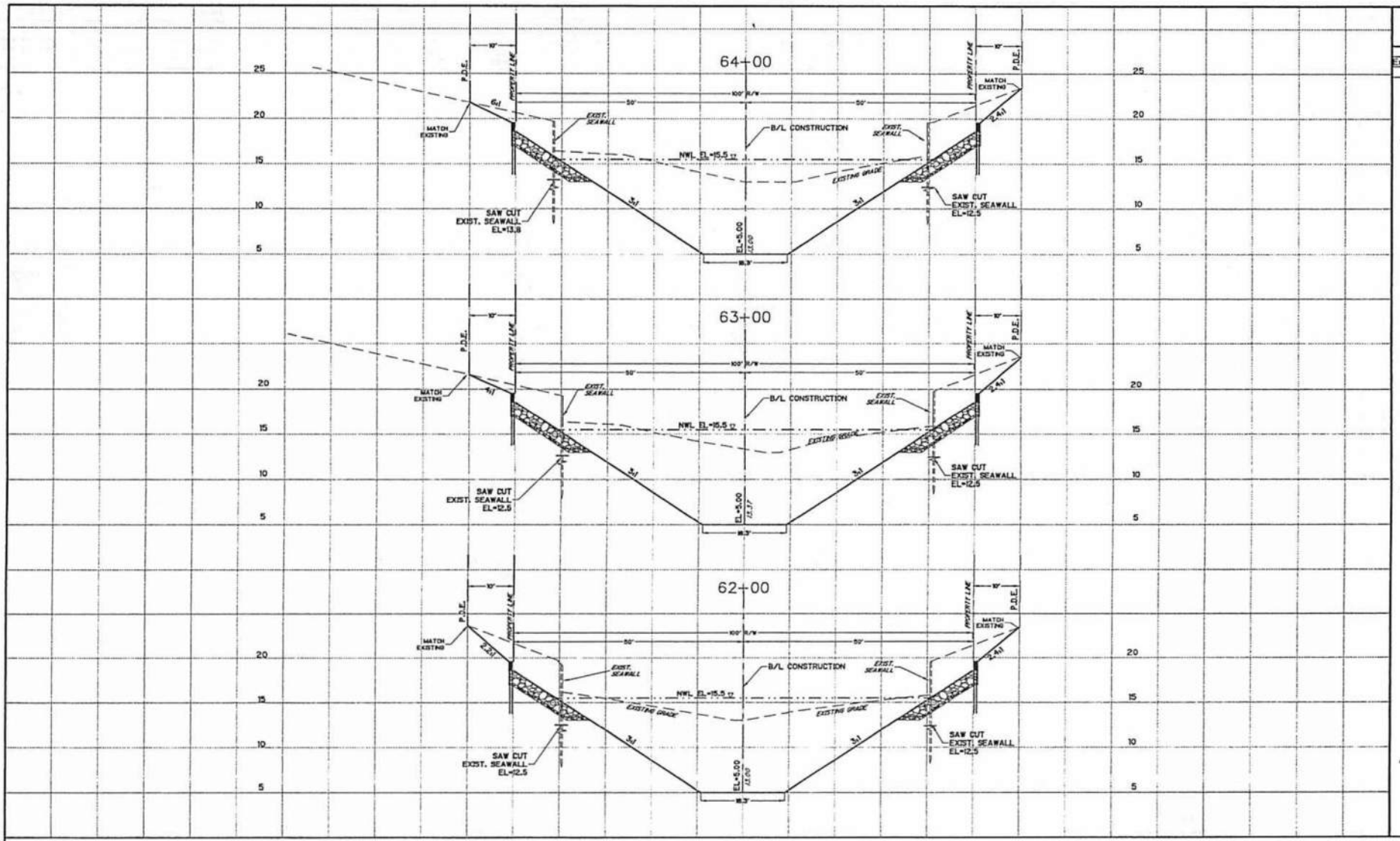
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4322
FL COA NO: FB-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL



SHEET No. 29

MATERIAL			
Excavation		Fill	
A	V	A	V
	*		*
*			
		*	
	*		*
*		*	
	*		*
*		*	

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

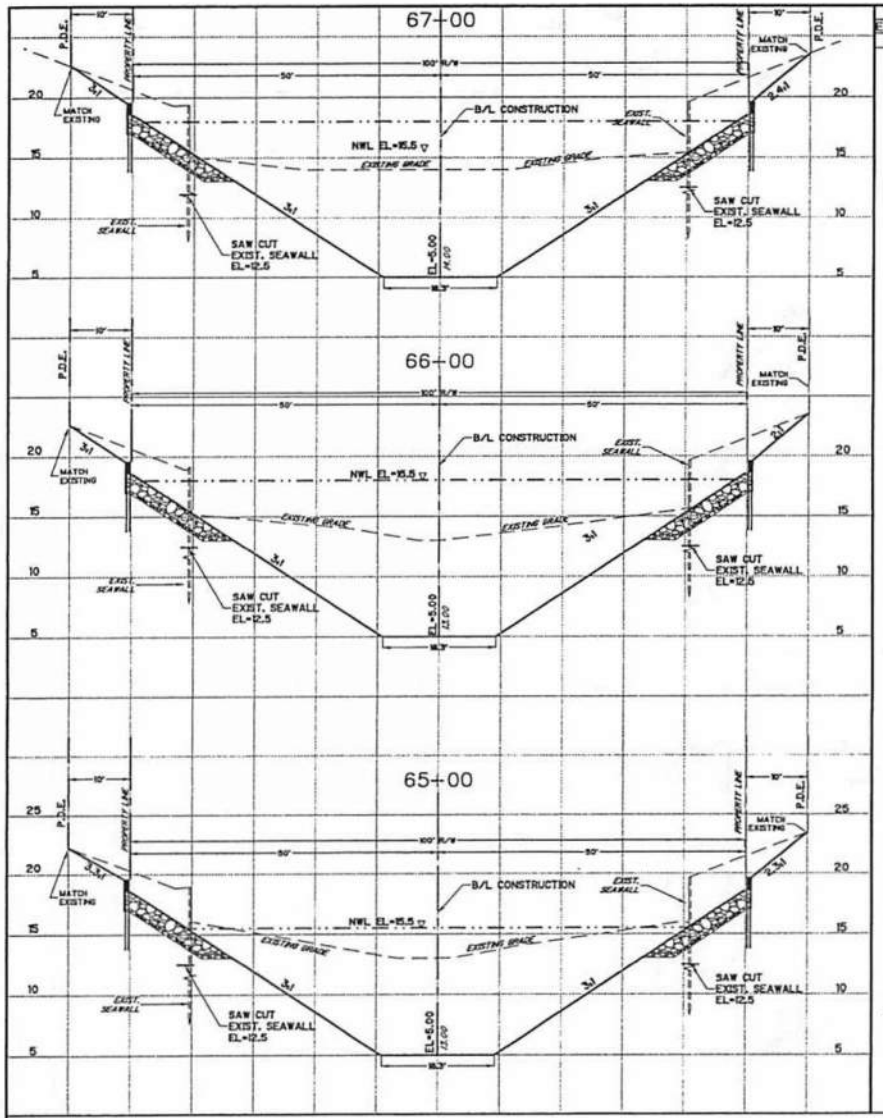
DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

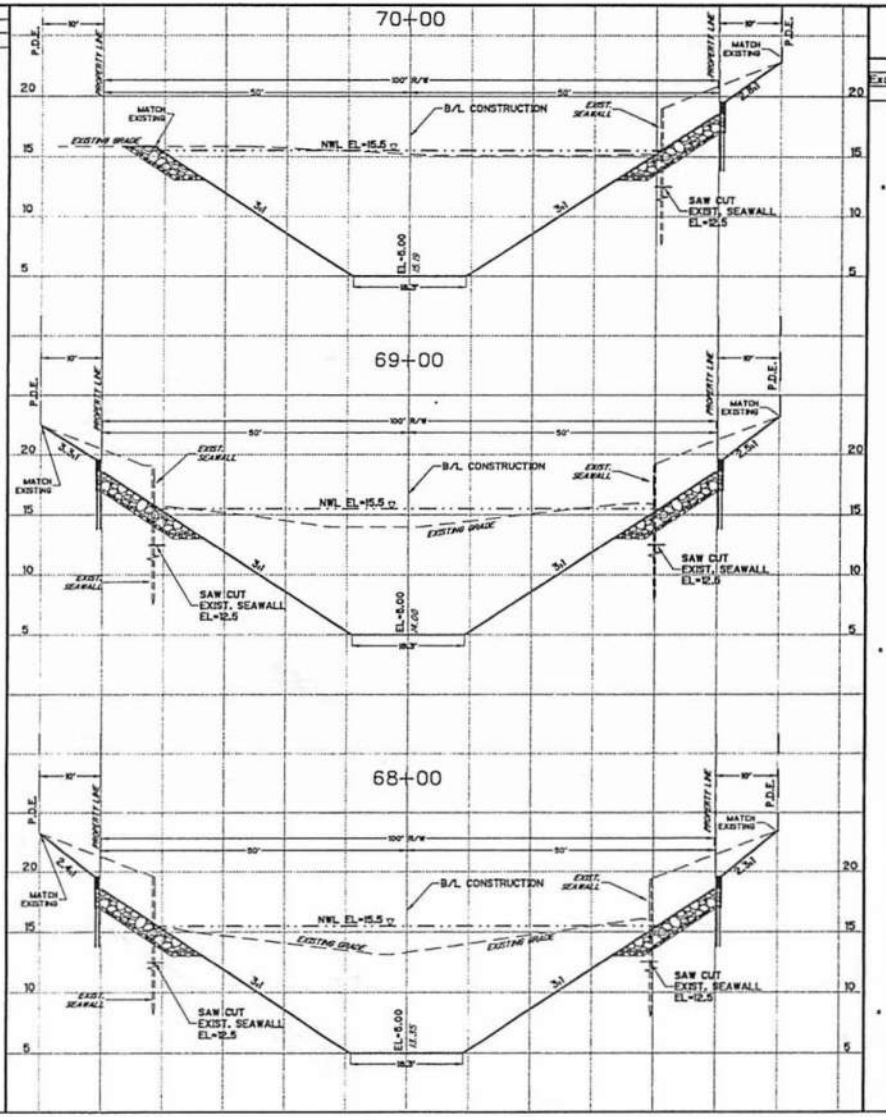
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4333
FL COA NO: 28-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL





MATERIAL

Excavation		Fill	
A	V	A	V

SHEET No. 30

MATERIAL

Excavation		Fill	
	V	A	V

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LADNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

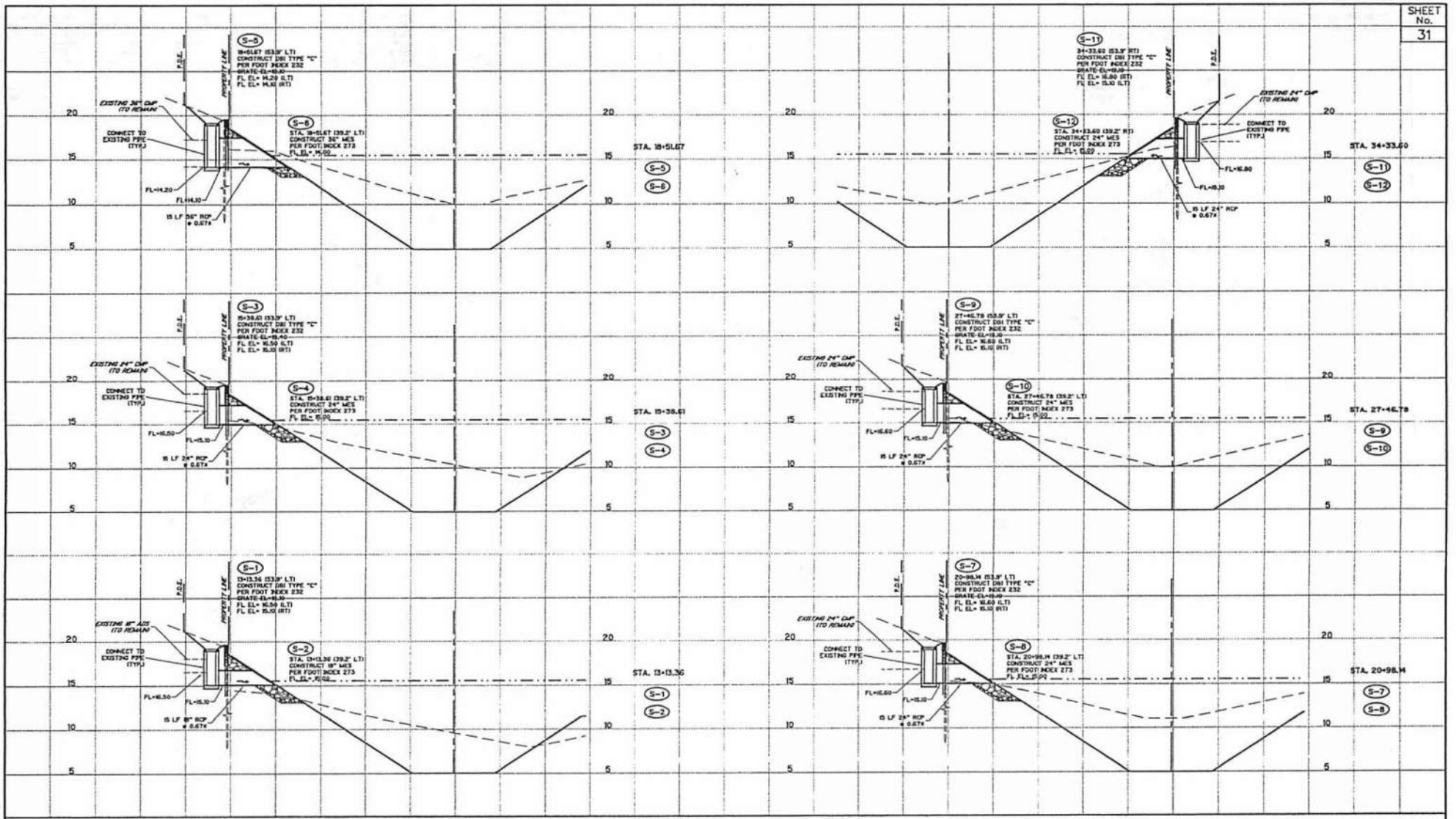
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 201
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: 28-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

CROSS SECTIONS

PERMIT SUBMITTAL

SHEET No. 31



SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

PLANS APPROVED BY _____ DATE _____
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LAZNER
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

CDM Camp Dresser & McKee Inc.
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VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4320
FL COA NO: FB-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

DRAINAGE STRUCTURES

PERMIT SUBMITTAL

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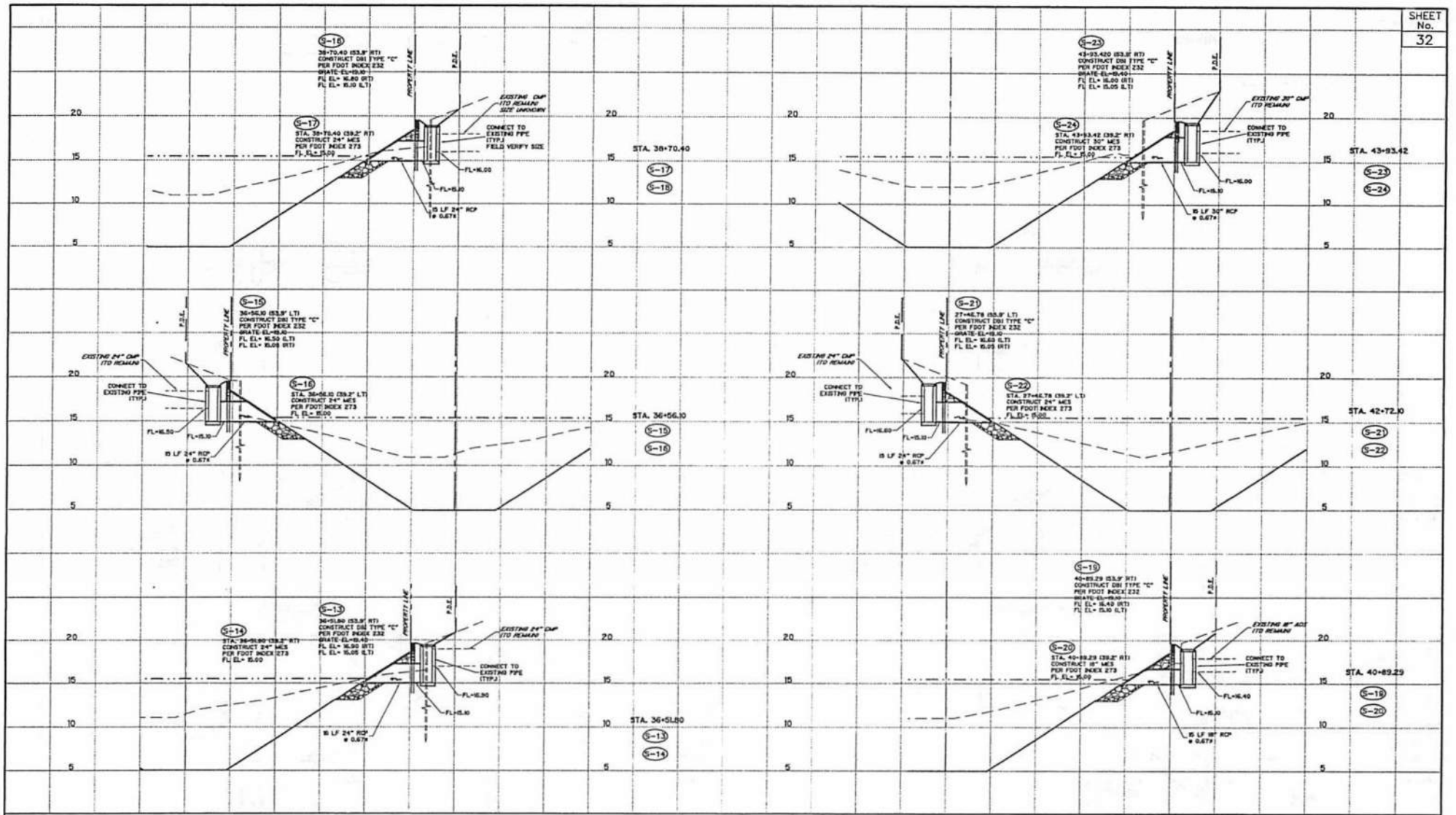
Mar 30, 2006 - 11:06am by John Russell



SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

DRAINAGE STRUCTURES

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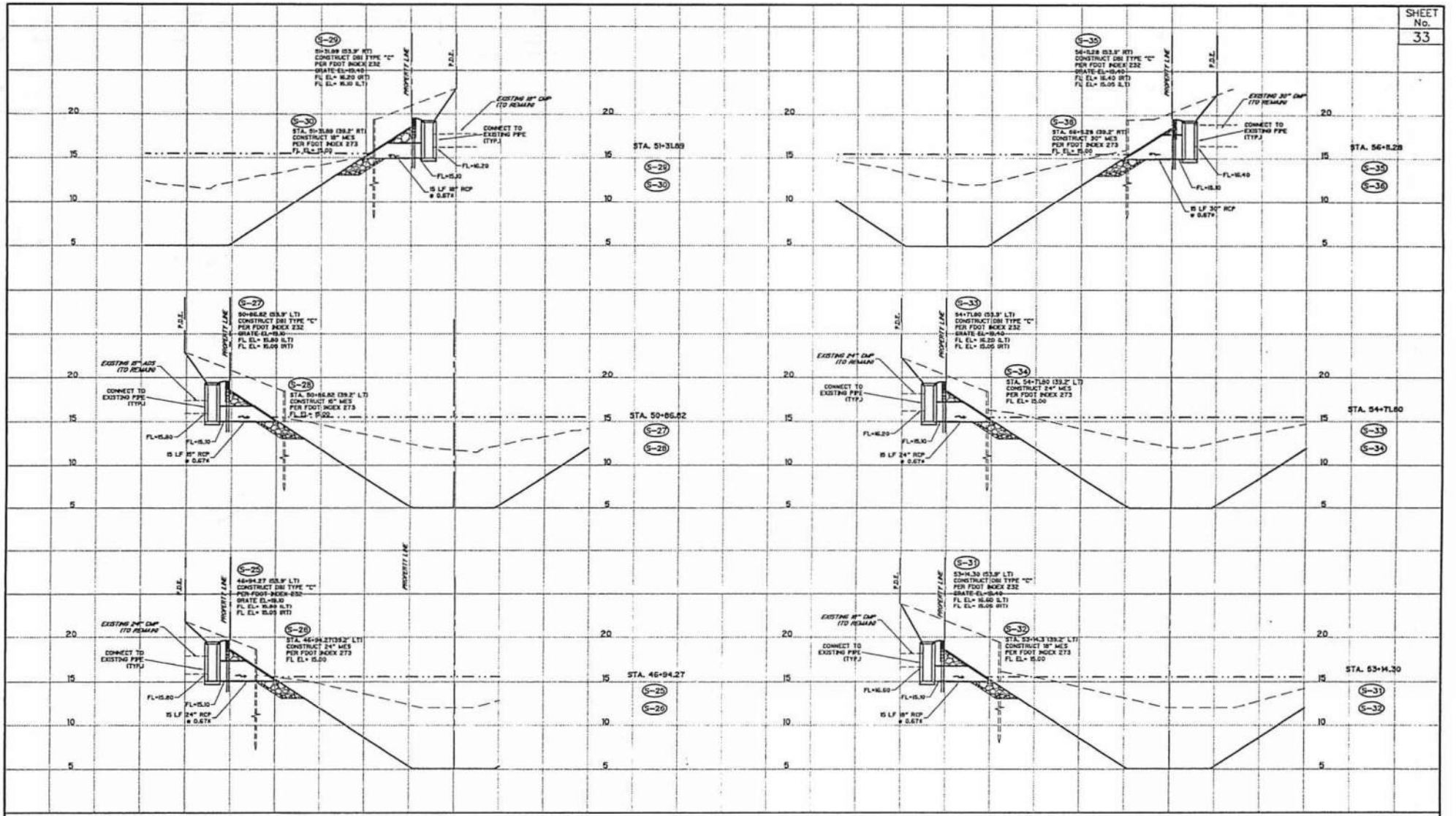

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FL COA NO: 99-0000020

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

DRAINAGE STRUCTURES

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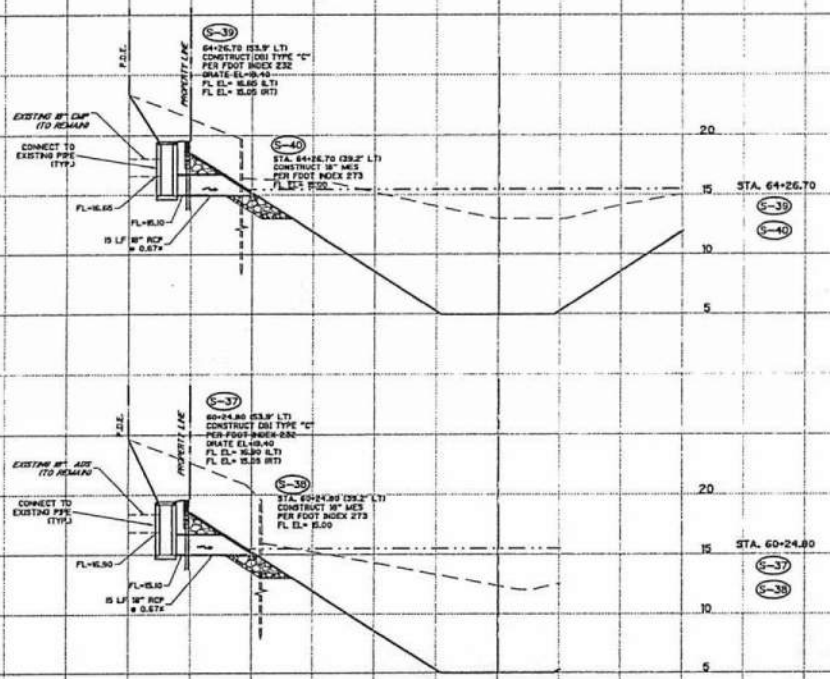

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CITY OF SEBASTIAN, FLORIDA
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DRAINAGE STRUCTURES

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Jul 26, 2006 - 11:58am by John Russell

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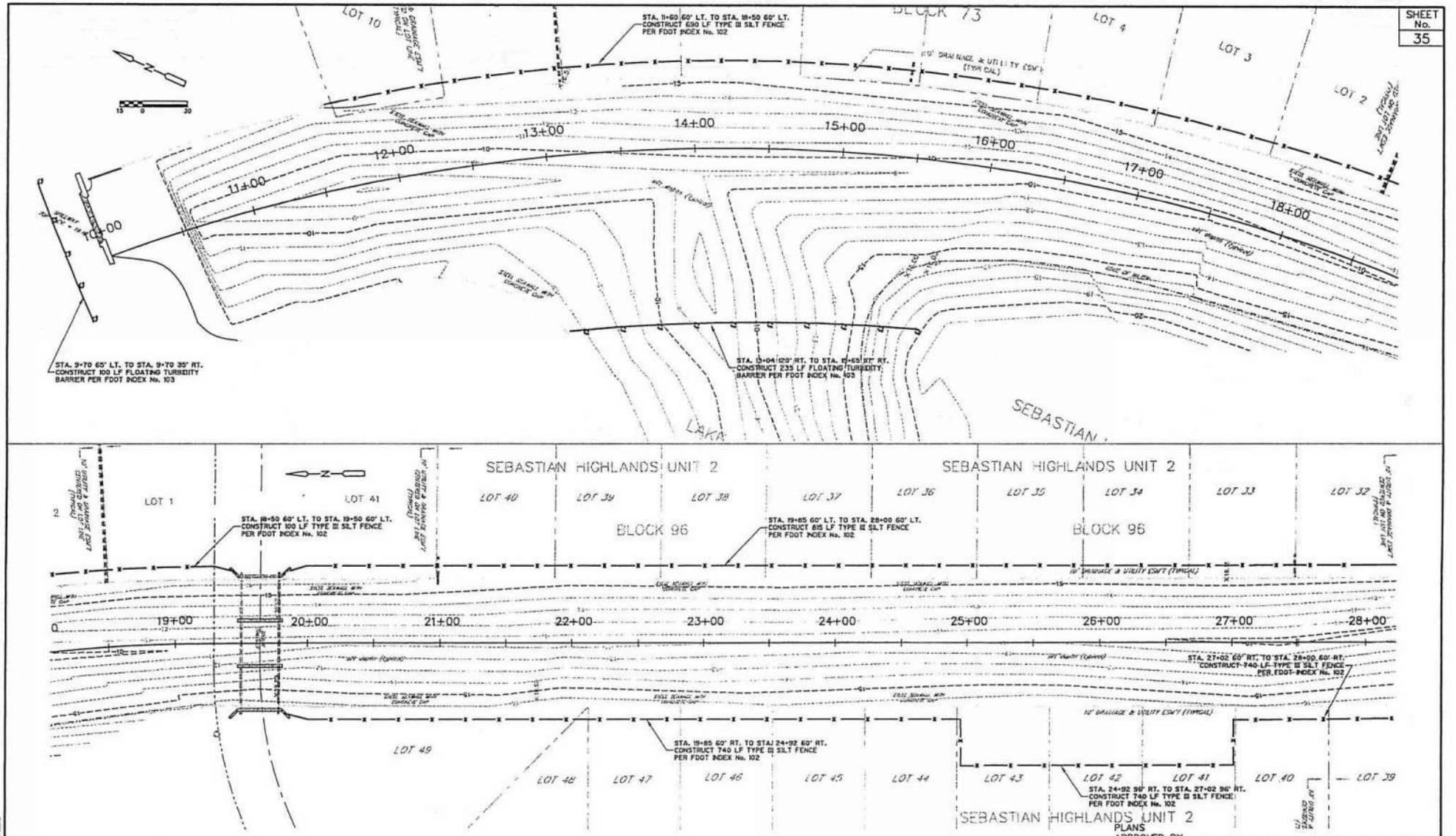

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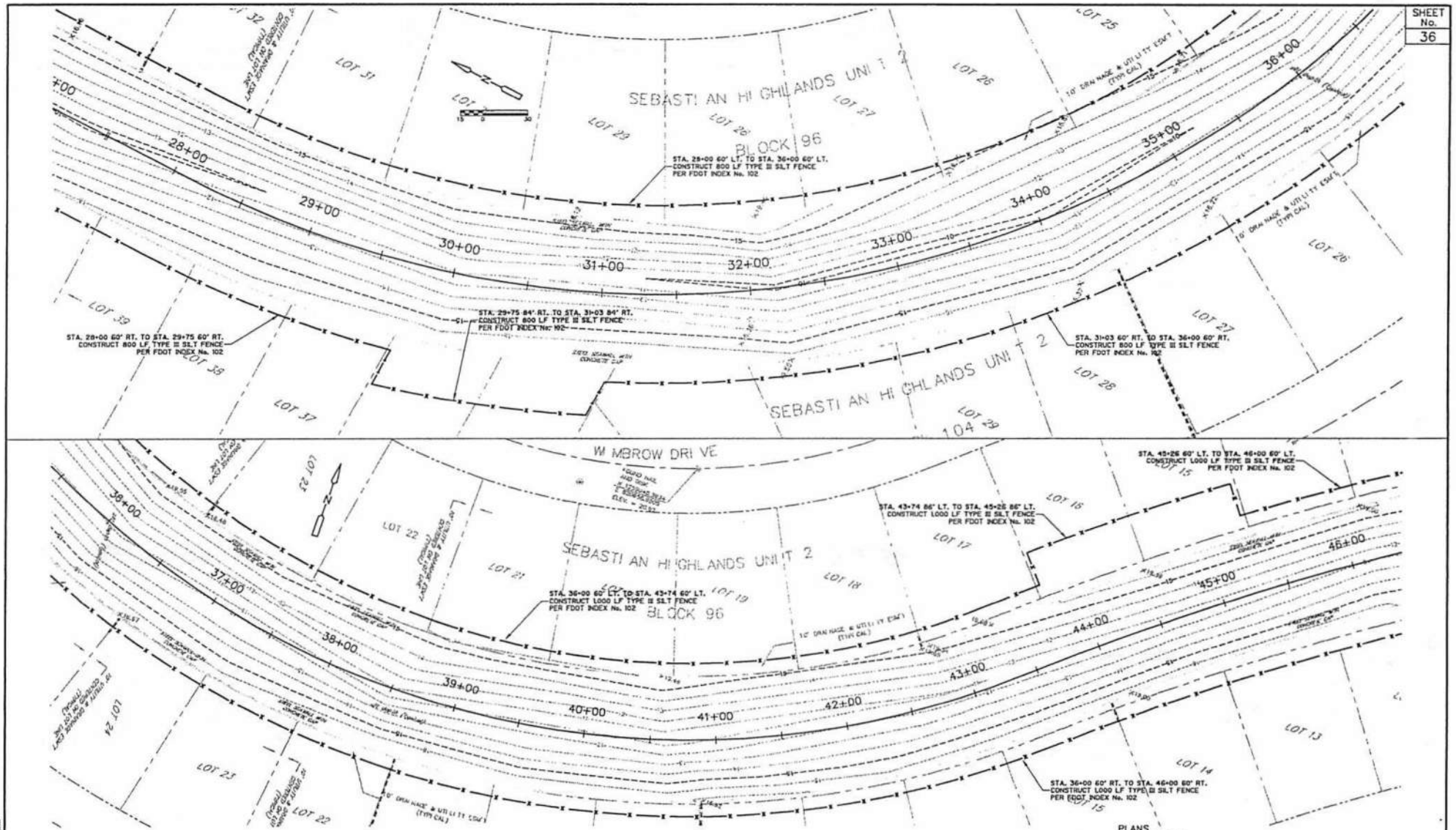
CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

EROSION CONTROL PLAN

PERMIT SUBMITTAL

SHEET No. 36



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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

EROSION CONTROL PLAN

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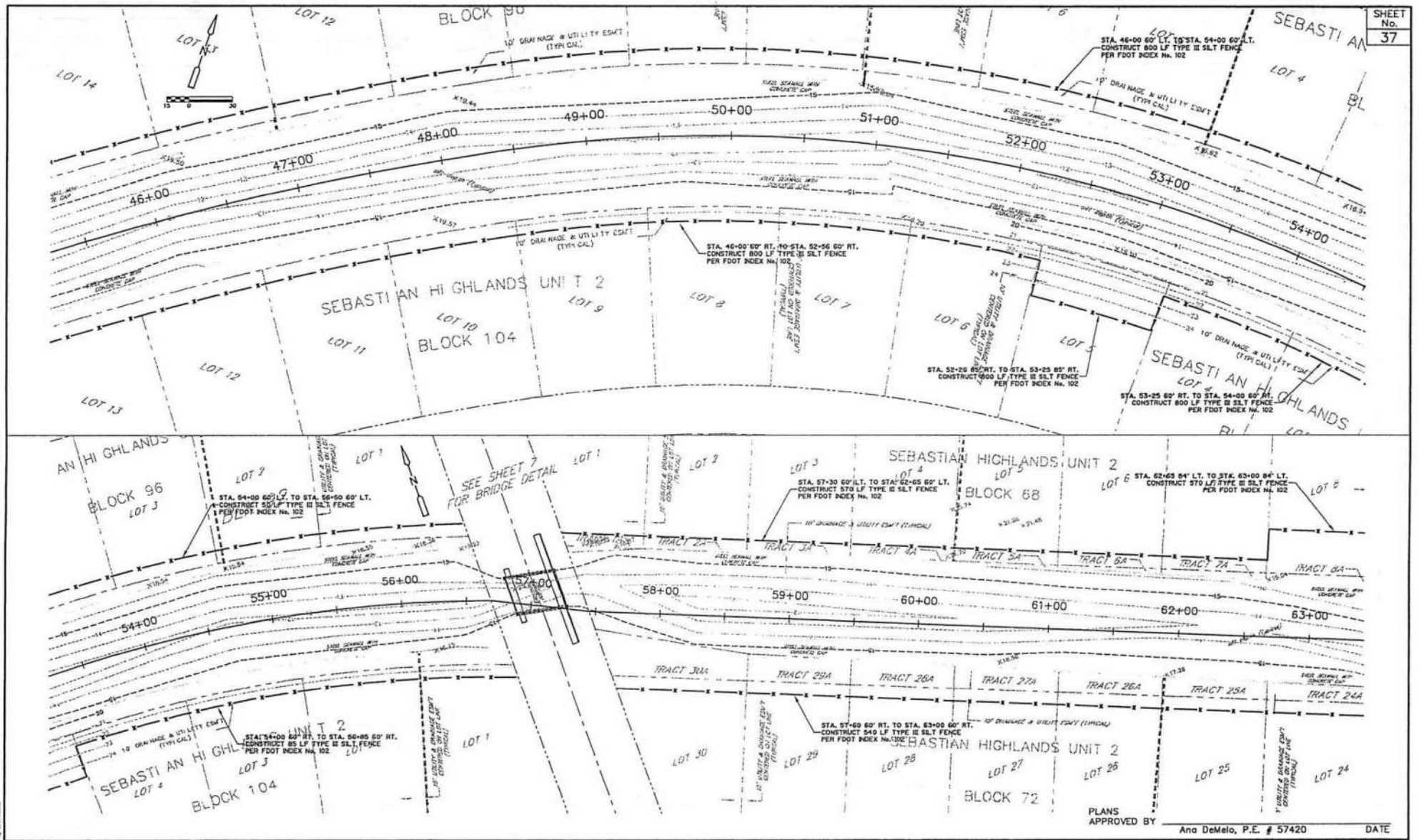

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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

EROSION CONTROL PLAN

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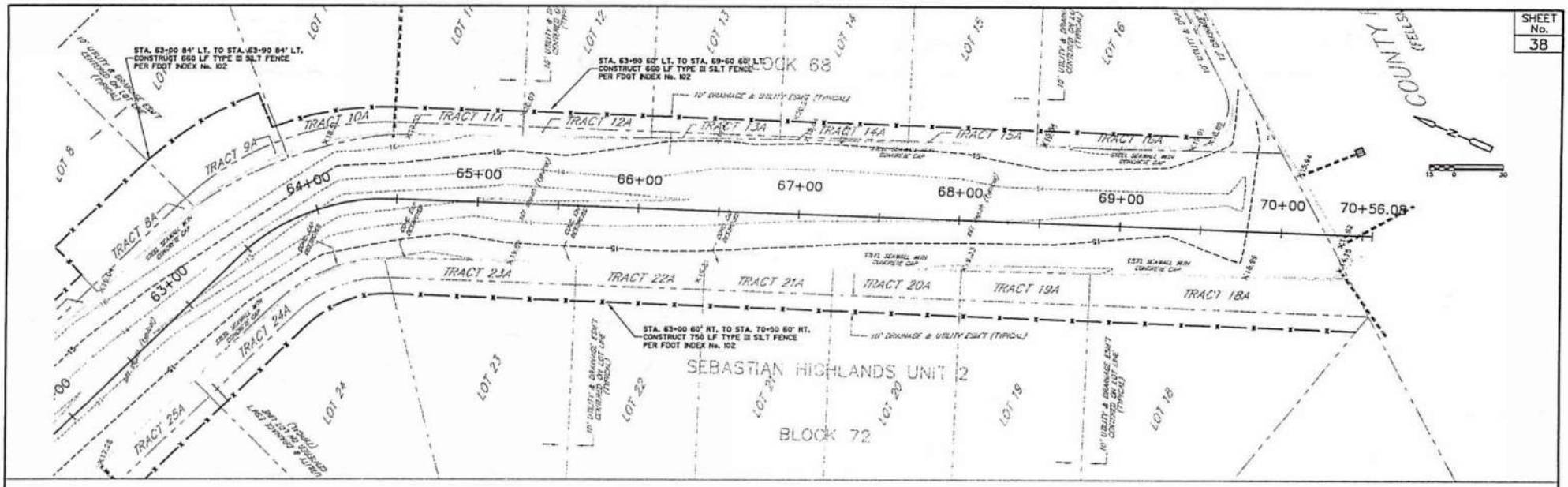

SHEET No. 38

PLANS APPROVED BY _____ Ana DeMelo, P.E. # 57420 DATE

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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

EROSION CONTROL PLAN

PERMIT SUBMITTAL

THE FOLLOWING NARRATIVE OF THE STORMWATER POLLUTION PREVENTION PLAN (SWPPP) CONTAINS REFERENCES TO THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, THE DESIGN STANDARDS, AND OTHER SHEETS OF THESE CONSTRUCTION PLANS. THE FIRST SHEET OF THE CONSTRUCTION PLANS (CALLED THE KEY SHEET) CONTAINS AN INDEX TO THE OTHER SHEETS. THE COMPLETE STORMWATER POLLUTION PREVENTION PLAN INCLUDES SEVERAL ITEMS: THIS NARRATIVE DESCRIPTION, THE DOCUMENTS REFERENCED IN THIS NARRATIVE, THE CONTRACTOR'S APPROVED EROSION CONTROL PLAN REQUIRED BY FDOT SPECIFICATION SECTION No.104, AND REPORTS OF INSPECTIONS MADE DURING CONSTRUCTION.

THE CONTRACTOR MAY MODIFY AND SUBMIT TO THE CITY OF SEBASTIAN THIS STORMWATER POLLUTION PREVENTION PLAN. ANY MODIFICATIONS TO THIS PLAN SHALL BE PREPARED IN ACCORDANCE WITH THE GENERAL REQUIREMENTS AND/OR ANY SPECIAL CONDITIONS OF ALL PERMITS WHICH AUTHORIZE THE CONSTRUCTION OF THE PROJECT. IF THE PERMITS DO NOT CONTAIN SPECIAL CONDITIONS RELATING TO EROSION CONTROL AND WATER POLLUTION, THE SWPPP FOR CONSTRUCTION ACTIVITIES SHALL BE IN ACCORDANCE TO THE FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION GOVERNED BY THIS PROJECT.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING, MONITORING AND MODIFYING THE SWPPP FOR CONSTRUCTION ACTIVITIES TO MEET CHANGING PROJECT SITE CONDITIONS.

PAYMENT FOR ALL WORK AND MATERIALS NECESSARY FOR PREPARATION, MODIFICATION, SUBMITTAL OF THE SWPPP FOR CONSTRUCTION ACTIVITIES AND FOR IMPLEMENTATION DURING CONSTRUCTION SHALL BE INCLUDED IN THE MOBILIZATION PAY ITEM NO 101-1 (LUMP SUM), NO ADDITIONAL COMPENSATION SHALL BE ALLOWED.

1.0 SITE DESCRIPTION:

1.A NATURE OF CONSTRUCTION ACTIVITY:

THE PROJECT CONSISTS OF DREDGING THE CANAL BOTTOM TO ELEVATION 5.0, REGRADING THE SIDE SLOPES AND PLACEMENT OF RIP-RAP. THE PROJECT ALSO CONSISTS OF REMOVAL AND DISPOSAL OF PORTIONS OF THE EXISTING SEAWALL.

1.B SEQUENCE OF MAJOR SOIL DISTURBING ACTIVITIES:

IN THE SECTION 104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL PROVIDE A DETAILED SEQUENCE OF CONSTRUCTION FOR ALL CONSTRUCTION ACTIVITIES. THE CONTRACTOR SHALL FOLLOW THE SEQUENCE OF MAJOR ACTIVITIES DESCRIBED BELOW, UNLESS THE CONTRACTOR PROPOSES A DIFFERENT SEQUENCE THAT IS EQUAL OR BETTER AT CONTROLLING EROSION AND TRAPPING SEDIMENT AND IS APPROVED BY THE ENGINEER.

FOR EACH CONSTRUCTION PHASE, INSTALL PERIMETER CONTROLS AFTER CLEARING AND GRUBBING NECESSARY FOR INSTALLATION OF CONTROLS BUT BEFORE BEGINNING OTHER WORK FOR THE CONSTRUCTION PHASE. REMOVE PERIMETER CONTROLS ONLY AFTER ALL UPSTREAM AREAS ARE STABILIZED.

1. CLEARING AND GRUBBING, EARTHWORK, AND STORM SEWER CONSTRUCTION FOR THE OUTFALL FROM THE PONDS.

2. CLEARING AND GRUBBING, EARTHWORK FOR POND CONSTRUCTION.

3. STORM SEWER AND ROADWAY UNDERDRAIN CONSTRUCTION (IF APPLICABLE). CONSTRUCT THE STORM DRAIN PIPE IN THE UPSTREAM DIRECTION.

4. EARTHWORK ASSOCIATED WITH DRAINAGE STRUCTURES AND CONSTRUCTION OF END WALLS, SUBGRADE, BASE, PAVEMENT, AND DRIVEWAYS.

1.C AREA ESTIMATES:

TOTAL SITE AREA: 17 ACRES.
TOTAL AREA TO BE DISTURBED: 17 ACRES.

1.D RUNOFF DATA:

RUNOFF COEFFICIENTS: BEFORE:
AFTER:

SOILS DATA: THE RESULTS OF THE SOIL BORINGS ARE SHOWN IN THE SUBSURFACE EXPLORATION REPORT DATED JULY 26, 2004 AND THE SUBSURFACE EXPLORATION AND TESTING REPORT DATED JANUARY 21, 2005.

OUTFALL INFORMATION:

STRUCTURE(S) NUMBER(S):
RECEIVING WATER BODIES: SEBASTIAN RIVER

1.E SITE MAP:

THE CONSTRUCTION PLANS ARE BEING USED AS THE SITE MAPS. THE LOCATION OF THE REQUIRED INFORMATION IS DESCRIBED BELOW. THE SHEET NUMBERS FOR THE PLAN SHEETS REFERENCED ARE IDENTIFIED ON THE KEY SHEET OF THESE CONSTRUCTION PLANS.

* DRAINAGE PATTERNS: THE CONTRACTOR SHALL PROVIDE A DRAINAGE MAP SHOWING THE DRAINAGE BASIN DIVIDES AND FLOW DIRECTIONS.

* APPROXIMATE SLOPES: THE SLOPES OF THE SITE CAN BE SEEN IN THE CROSS SECTION SHEETS AND THE PLAN-PROFILE SHEETS. THERE ARE POND CROSS SECTIONS SHEETS.

* AREAS OF SOIL DISTURBANCE: THE AREAS TO BE DISTURBED ARE INDICATED ON THE PLAN-PROFILE SHEETS, THE CROSS SECTION SHEETS, AND THE POND DETAIL SHEETS. ANY AREAS WHERE PERMANENT FEATURES ARE SHOWN TO BE CONSTRUCTED ABOVE OR BELOW GROUND WILL BE DISTURBED.

* AREAS NOT TO BE DISTURBED: ESSENTIALLY THE WHOLE PROJECT WILL BE DISTURBED DURING CONSTRUCTION UNLESS INDICATED OTHERWISE.

* LOCATIONS OF PERMANENT CONTROLS: THE STORMWATER PONDS ARE THE PRIMARY PERMANENT STORMWATER MANAGEMENT CONTROLS. THESE ARE SHOWN ON THE POND DETAIL SHEETS.

* AREAS TO BE STABILIZED: TEMPORARY STABILIZATION PRACTICES ARE SHOWN IN THE SAME LOCATION AS THE TEMPORARY CONTROLS MENTIONED ABOVE. PERMANENT STABILIZATION IS SHOWN ON THE TYPICAL SECTION SHEETS, THE PLAN-PROFILE SHEETS AND THE POND DETAIL SHEETS.

1.F RECEIVING WATERS:

THERE ARE WETLAND AREAS ON THE PROJECT SITE. WETLANDS SHALL BE PROTECTED AT ALL TIMES AS INDICATED ON THE CONSTRUCTION PLANS.

2.0 CONTROLS

2.A EROSION AND SEDIMENT CONTROLS:

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROPOSED STABILIZATION AND STRUCTURAL PRACTICES BASED ON THE CONTRACTOR'S PROPOSED MAINTENANCE OF TRAFFIC PLAN (MOT). WHERE FOLLOWING THE MAINTENANCE OF TRAFFIC (MOT), THE CONTRACTOR MAY CHOOSE TO ACCEPT THE FOLLOWING GUIDELINES OR MODIFY THEM IN THE SECTION 104 EROSION CONTROL PLAN, SUBJECT TO APPROVAL OF THE ENGINEER. AS WORK PROGRESSES, THE CONTRACTOR SHALL MODIFY THE PLAN TO ADAPT TO SEASONAL VARIATION, CHANGES IN CONSTRUCTION ACTIVITIES, AND THE NEED FOR BETTER PRACTICES.

FOR EACH CONSTRUCTION PHASE, INSTALL PERIMETER CONTROLS AFTER CLEARING AND GRUBBING NECESSARY FOR INSTALLATION OF CONTROLS BUT BEFORE BEGINNING OTHER WORK FOR THE CONSTRUCTION PHASE. REMOVE PERIMETER CONTROLS ONLY AFTER ALL UPSTREAM AREAS ARE STABILIZED.

ABSOLUTELY NO WORK WILL BE ALLOWED WITHIN ANY CONSERVATION AREA, BUFFER AREA, MITIGATION AREA OR DESIGNATED WETLAND AREA, UNLESS OTHERWISE SPECIFICALLY DESCRIBED BY THE CONSTRUCTION PLANS AND GRANTED BY PERMIT FROM GOVERNMENTAL AGENCY HAVING JURISDICTION OVER THE PROJECT.

PRIOR TO CLEARING AND GRUBBING, THE LIMITS OF CONSTRUCTION SHALL BE CLEARLY MARKED ALONG THE PROPOSED RIGHT OF WAY LINE TO PROTECT NATURAL AREAS FROM ENCROACHMENT FROM CONSTRUCTION ACTIVITIES.

ALL FILL EMBANKMENT AND GRADED AREAS SHALL BE PROTECTED AGAINST EROSION BY METHODS STATED IN SECTION 104 OF THE FDOT STANDARD SPECIFICATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF EMBANKMENTS AND SHALL REPLACE ANY PORTION, WHICH IN THE OPINION OF THE ENGINEER, HAS BECOME DISPLACED DUE TO EROSION OR DUE TO CARELESSNESS OR NEGLIGENCE ON THE PART OF THE CONTRACTOR.

2.A.1 STABILIZATION PRACTICES:

IN THE SECTION 104 EROSION CONTROL PLAN THE CONTRACTOR SHALL DESCRIBE THE STABILIZATION PRACTICES PROPOSED TO CONTROL EROSION. THE CONTRACTOR SHALL INITIATE ALL STABILIZATION MEASURES AS SOON AS PRACTICAL, BUT IN NO CASE MORE THAN 7 DAYS, IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED. THE STABILIZATION PRACTICES SHALL INCLUDE AT LEAST THE FOLLOWING, UNLESS OTHERWISE APPROVED BY THE ENGINEER.

TEMPORARY:
* ARTIFICIAL COVERINGS IN ACCORDANCE WITH SPECIFICATION SECTION 104.

* SEED AND MULCH, AND SOD IN ACCORDANCE WITH SPECIFICATION SECTION 104.

PERMANENT:
* ASPHALT OR CONCRETE SURFACE.

* SOD IN ACCORDANCE WITH SPECIFICATION SECTION 575.

2.A.2 STRUCTURAL PRACTICES:

IN THE SECTION 104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROPOSED STRUCTURAL PRACTICES TO CONTROL OR TRAP SEDIMENT AND OTHERWISE PREVENT THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE. SEDIMENT CONTROLS SHALL BE IN PLACE BEFORE DISTURBING SOIL UPSTREAM OF THE CONTROL. THE STRUCTURAL PRACTICES SHALL INCLUDE AT LEAST THE FOLLOWING, UNLESS OTHERWISE APPROVED BY THE ENGINEER.

TEMPORARY:
* SILT FENCE IN ACCORDANCE WITH DESIGN STANDARD 102 AND SPECIFICATION SECTION 104.

* BALED HAY OR STRAW IN ACCORDANCE WITH DESIGN STANDARD 102 AND SPECIFICATION SECTION 104.

* SANDBAGS TO CONTROL EROSION AND TRAP SILT.

* INLET PROTECTION IN ACCORDANCE WITH DESIGN STANDARD 102 AND SPECIAL DETAILS SHOW IN THE MOT.

* SEDIMENT BASIN. THE PERMANENT STORMWATER DITCH MAY BE TEMPORARILY USED AS A SEDIMENTATION BASIN.

PERMANENT:
* STORMWATER POND/DITCH.

* SOD.

2.B STORMWATER MANAGEMENT:

THE FACILITIES HAVE BEEN PERMITTED BY THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT AND THE UNITED STATES ARMY CORPS OF ENGINEERS.

2.C OTHER CONTROLS:

2.C.1 WASTE DISPOSAL:

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROPOSED METHODS TO PREVENT THE DISCHARGE OF SOLID MATERIALS, INCLUDING BUILDING MATERIALS, TO WATERS OF THE UNITED STATES. THE PROPOSED METHODS SHALL INCLUDE AT LEAST THE FOLLOWING, UNLESS OTHERWISE APPROVED BY THE ENGINEER.

* PROVIDING LITTER CONTROL AND COLLECTION WITHIN THE PROJECT DURING CONSTRUCTION ACTIVITIES.

* DISPOSING OF ALL FERTILIZER OR OTHER CHEMICAL CONTAINERS ACCORDING TO EPA's STANDARD PRACTICES AS DETAILED BY THE MANUFACTURER.

* DISPOSING OF SOLID MATERIALS INCLUDING BUILDING AND CONSTRUCTION MATERIALS OFF THE PROJECT SITE BUT NOT IN SURFACE WATERS, OR WETLANDS.

2.C.2 OFFSITE VEHICLE TRACKING & DUST CONTROL:

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROPOSED METHODS FOR MINIMIZING OFFSITE VEHICLE TRACKING OF SEDIMENTS AND GENERATING DUST. THE PROPOSED METHODS SHALL INCLUDE AT LEAST THE FOLLOWING, UNLESS OTHERWISE APPROVED BY THE ENGINEER.

* COVERING LOADED HAUL TRUCKS WITH TARPAULINS.

* REMOVING EXCESS DIRT FROM ROADS DAILY.

* STABILIZING CONSTRUCTION ENTRANCES ACCORDING TO DESIGN STANDARD 106.

* USING ROADWAY SWEEPERS DURING DUST GENERATING ACTIVITIES SUCH AS EXCAVATION AND MILLING OPERATIONS, IF APPLICABLE.

2.C.3 STATE AND LOCAL REGULATIONS FOR WASTE DISPOSAL, SANITARY SEWER, OR SEPTIC TANK REGULATIONS:

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROPOSED PROCEDURES TO COMPLY WITH APPLICABLE STATE AND LOCAL REGULATIONS FOR WASTE DISPOSAL, AND SANITARY SEWER OR SEPTIC SYSTEMS.

2.C.4 FERTILIZERS AND PESTICIDES:

IN THE SECTION 104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL DESCRIBE THE PROCEDURES FOR APPLYING FERTILIZERS AND PESTICIDES. THE PROPOSED PROCEDURES SHALL COMPLY WITH APPLICABLE SUBSECTIONS OF SECTION 570 OF THE SPECIFICATIONS.

2.C.5 TOXIC SUBSTANCES:

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL PROVIDE A LIST OF TOXIC SUBSTANCES THAT ARE LIKELY TO BE USED ON THE JOB AND PROVIDE A PLAN ADDRESSING THE GENERATION, APPLICATION, MIGRATION, STORAGE AND DISPOSAL OF THESE SUBSTANCES.

2.C.6 APPROVED STATE AND LOCAL PLANS AND PERMITS:

* ST. JOHNS RIVER WATER MANAGEMENT DISTRICT'S PERMIT #.

* UNITED STATES ARMY CORPS OF ENGINEERS PERMIT #.

* THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN, INSTALLATION, PERMITTING AND OPERATION OF AN ADEQUATE DEWATERING SYSTEM TO DEWATER EXCAVATIONS FOR CONSTRUCTION.

* THE CONTRACTOR SHALL COMPLETE AND FILE A NOTICE OF INTENT (NOI) FORM AT LEAST 48 HOURS PRIOR TO ANY CONSTRUCTION ACTIVITIES ON THE SITE.

* WHEN ALL DISTURBED SOILS HAVE BEEN STABILIZED AND TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES HAVE BEEN REMOVED, THIS CONSTITUTES "ELIMINATION OF STORMWATER DISCHARGES ASSOCIATED WITH THE CONSTRUCTION ACTIVITIES". AT THIS TIME THE CONTRACTOR SHALL COMPLETE AND FILE A NOTICE OF TERMINATION (NOT) TO THE APPROPRIATE PERMITTING AGENCIES AS INDICATED ON SECTION 104-5 OF THE STANDARD SPECIFICATION.

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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

STORMWATER POLLUTION PREVENTION PLAN

PERMIT SUBMITTAL

3.0 MAINTENANCE

IN THE FDOT SPECIFICATION No.104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL PROVIDE A PLAN FOR MAINTAINING ALL EROSION AND SEDIMENT CONTROLS THROUGHOUT CONSTRUCTION. THE MAINTENANCE PLAN SHALL, AT A MINIMUM, COMPLY WITH THE FOLLOWING:

* SILT FENCE: MAINTAIN PER SECTION 104. THE CONTRACTOR SHOULD ANTICIPATE REPLACING SILT FENCE ON 12 MONTH INTERVALS.

* BALED HAY OR STRAW: REMOVE SEDIMENT WHEN IT REACHES 1/2 HEIGHT OF BALES OR WHEN WATER PONDS IN UNACCEPTABLE AMOUNTS OR AREAS. THE CONTRACTOR SHOULD ANTICIPATE REPLACING STRAW BALES ON 3-MONTH INTERVALS.

* POND/DITCH: CAN BE USED AS TEMPORARY SEDIMENT BASINS UNTIL THE AREAS THAT DRAIN TO THEM ARE STABILIZED. SO UNTIL THEN, REMOVE SEDIMENT FROM THE POND/DITCH WHEN IT BECOMES 1.5' DEEP AT ANY POINT.

4.0 INSPECTIONS:

QUALIFIED PERSONNEL SHALL INSPECT THE FOLLOWING ITEMS AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND WITHIN 24 HOURS OF THE END OF A STORM THAT IS 0.25 INCHES OR GREATER. TO COMPLY, THE CONTRACTOR SHALL INSTALL AND MAINTAIN RAIN GAGES AND RECORD THE DAILY RAINFALL. WHERE SITES HAVE BEEN PERMANENTLY STABILIZED, INSPECTIONS SHALL BE CONDUCTED AT LEAST ONCE EVERY MONTH. THE CONTRACTOR SHALL ALSO INSPECT THAT CONTROLS INSTALLED IN THE FIELD AGREE WITH THE LATEST STORMWATER POLLUTION PREVENTION PLAN.

* POINTS OF DISCHARGE TO WATERS OF THE UNITED STATES.

* POINTS OF DISCHARGE TO MUNICIPAL SEPARATE STORM SEWER SYSTEMS.

* DISTURBED AREAS OF THE SITE THAT HAVE NOT BEEN FINALLY STABILIZED.

* AREAS USED FOR STORAGE OF MATERIALS THAT ARE EXPOSED TO PRECIPITATION.

* STRUCTURAL CONTROLS.

* STORMWATER MANAGEMENT SYSTEMS.

* LOCATIONS WHERE VEHICLES ENTER OR EXIT THE SITE.

THE CONTRACTOR SHALL INITIATE REPAIRS WITHIN 24 HOURS OF INSPECTIONS THAT INDICATE ITEMS ARE NOT IN GOOD WORKING ORDER.

IF INSPECTIONS INDICATE THAT THE INSTALLED STABILIZATION AND STRUCTURAL PRACTICES ARE NOT SUFFICIENT TO MINIMIZE EROSION, RETAIN SEDIMENT, AND PREVENT DISCHARGING POLLUTANTS, THE CONTRACTOR SHALL PROVIDE ADDITIONAL MEASURES, AS APPROVED BY THE ENGINEER.

5.0 NON-STORMWATER DISCHARGES:

IN THE FDOT SPECIFICATION No. 104 EROSION CONTROL PLAN, THE CONTRACTOR SHALL IDENTIFY ALL ANTICIPATED NON-STORMWATER DISCHARGES (EXCEPT FLOWS FROM FIRE FIGHTING ACTIVITIES). THE CONTRACTOR SHALL DESCRIBE THE PROPOSED MEASURES TO PREVENT POLLUTION OF THESE NON-STORMWATER DISCHARGES. IF THE CONTRACTOR ENCOUNTERS CONTAMINATED SOIL OR GROUNDWATER NOT INDICATED ON THE CONSTRUCTION DRAWINGS, ALL CONSTRUCTION ACTIVITIES SHALL STOP, AND THE CONTRACTOR SHALL NOTIFY THE COUNTY'S PROJECT MANAGER FOR FURTHER INSTRUCTIONS.

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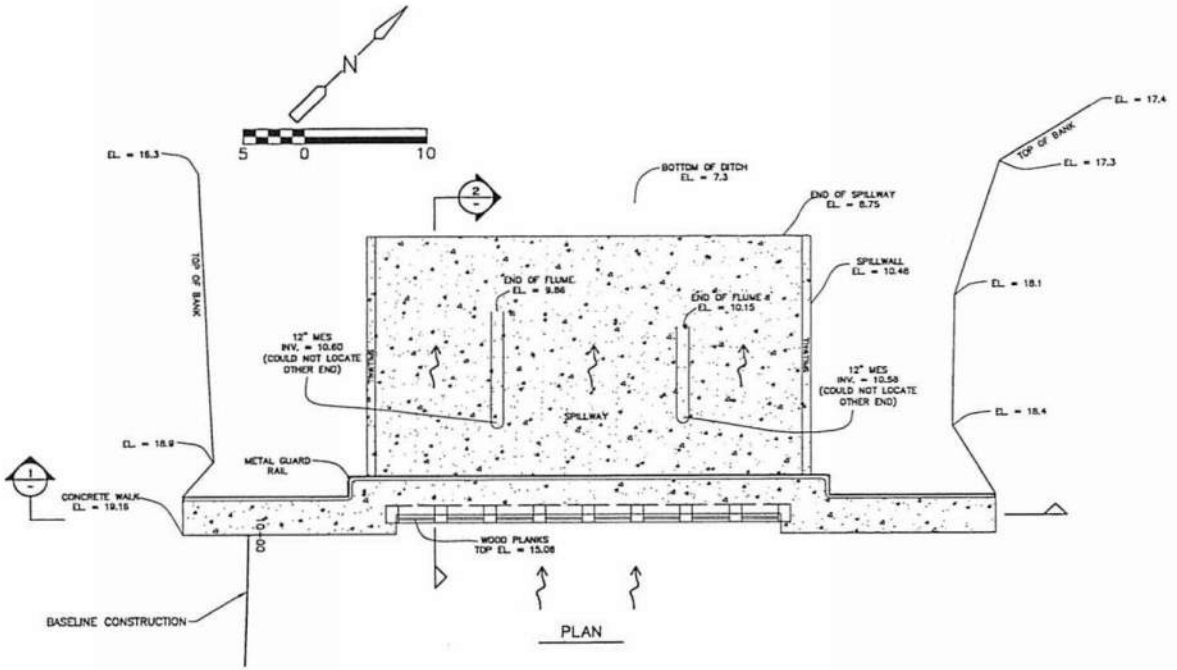
APPROVED BY: A. DEMELO
DATE: MARCH 2006

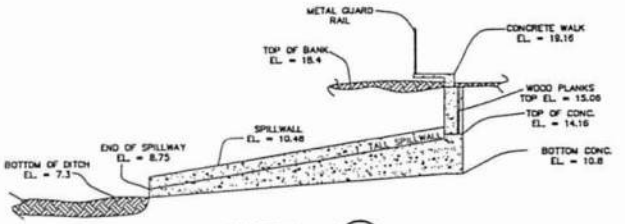
CDM Camp Dresser & McKee Inc.
1701 HIGHWAY A-1-A, SUITE 301
VERO BEACH, FL 32963
PHONE: 772-231-4301
FAX: 772-231-4332
FL COA NO: EB-0000030

CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

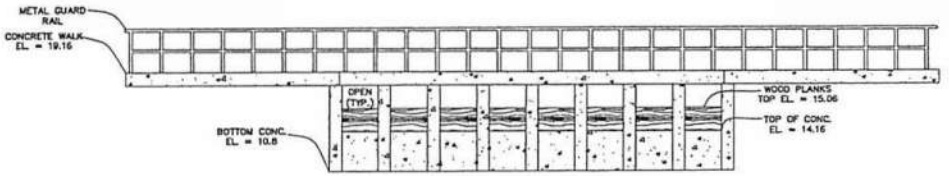
STORMWATER POLLUTION PREVENTION PLAN

PERMIT SUBMITTAL





SECTION 2 N.T.S.



SECTION 1 N.T.S.

DETAIL A N.T.S.

PLANS APPROVED BY _____ DATE
Ana DeMelo, P.E. # 57420

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: J. RUSSELL
SHEET CHK'D BY: J. LAGNEY
CROSS CHK'D BY: A. DEMELO
APPROVED BY: A. DEMELO
DATE: MARCH 2006

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CITY OF SEBASTIAN, FLORIDA
COLLIER CANAL

MISCELLANEOUS DETAILS

PERMIT SUBMITTAL

Appendix J

Stormwater Asset GIS Database

ARCADIS Design & Consultancy for natural and built assets

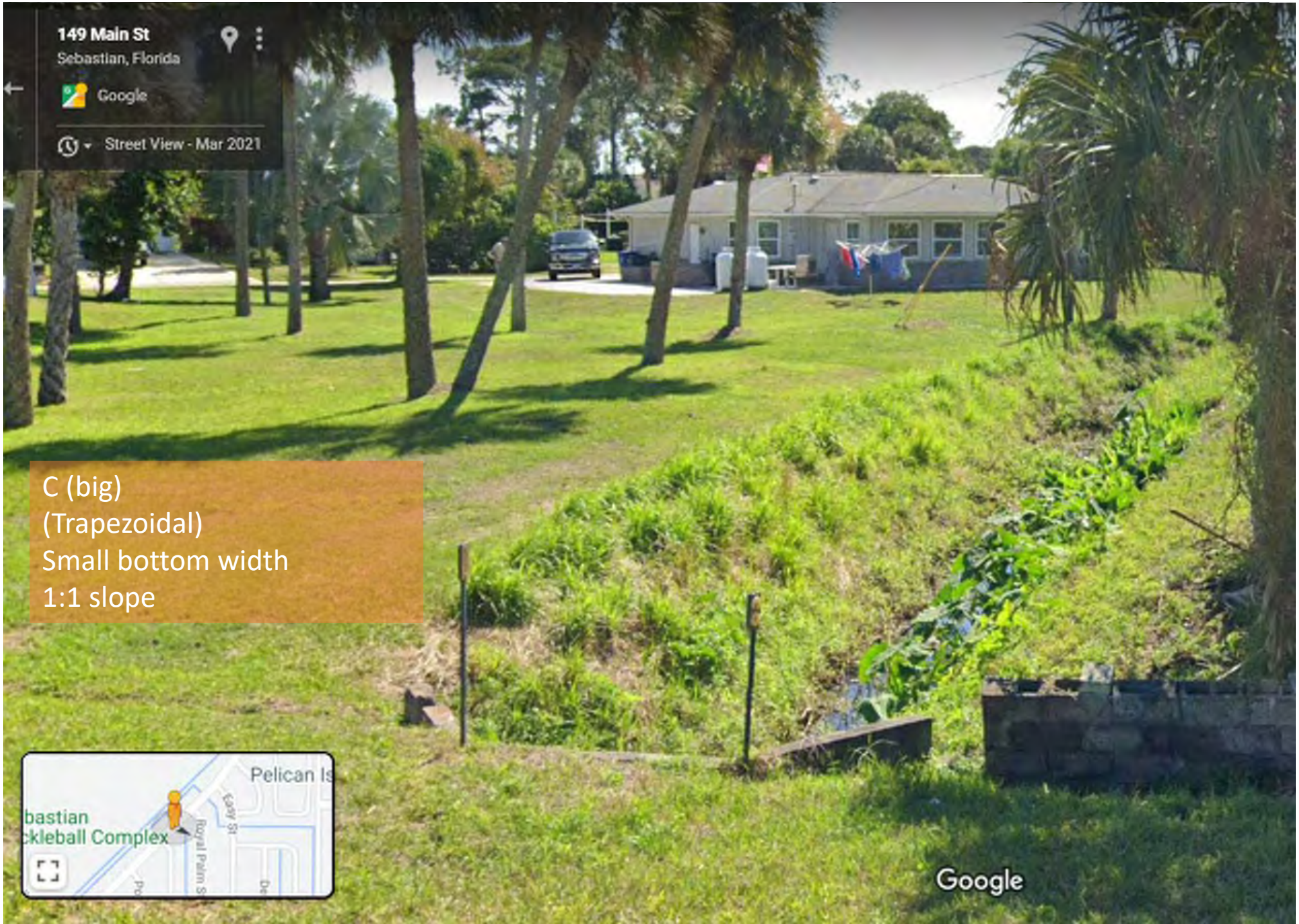
CITY OF SEBASTIAN, FL

ASSET DATABASE FIELD INVESTIGATION CHANNEL TYPE REFERENCE STORMWATER MASTER PLAN

June 2023

392 Bob Cir
Sebastian, Florida
Google
Street View - Mar 2021
A (small)
(Trapezoidal)
Small bottom
width
2:1 slope
1201 Schumann Dr
Sebastian, Florida
Google
Street View - May 2019
Pelican Garden
Google
Pelican Isles
Google

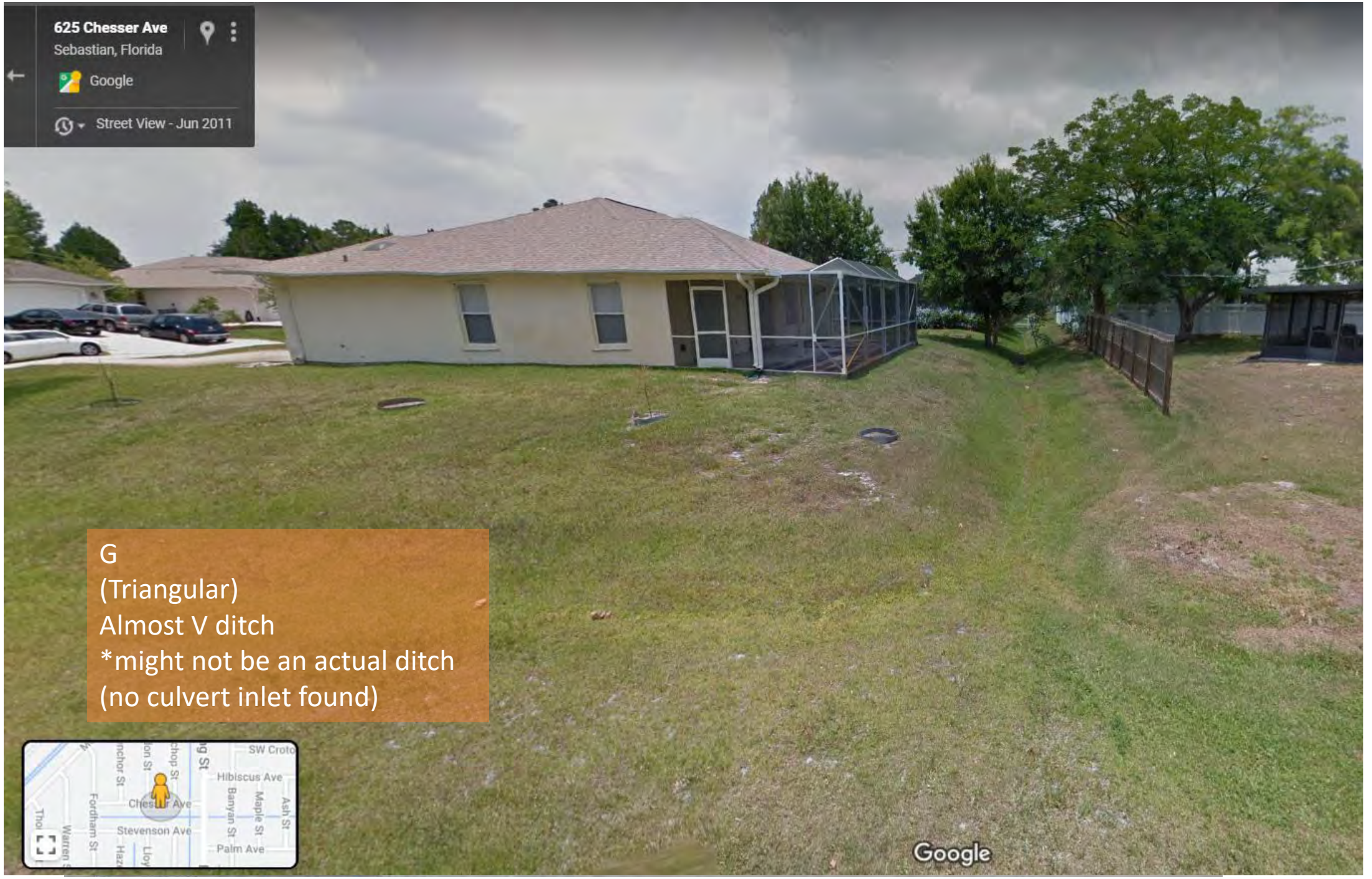
128 Main St
Sebastian, Florida
Google
Street View - Mar 2021
B (big)
(Trapezoidal)
Wider bottom width
2:1 slope
Google


149 Main St
Sebastian, Florida
Google
Street View - Mar 2021
C (big)
(Trapezoidal)
Small bottom width
1:1 slope
Pelican Is
bastian
ckleball Complex
Kay St
Royal Palm S
Google

342 Banyan St
Sebastian, Florida
Google
Street View - Jun 2011
D
Wide bottom width
(Trapeziodal)
2:1 slope
nicipal
Course
Google

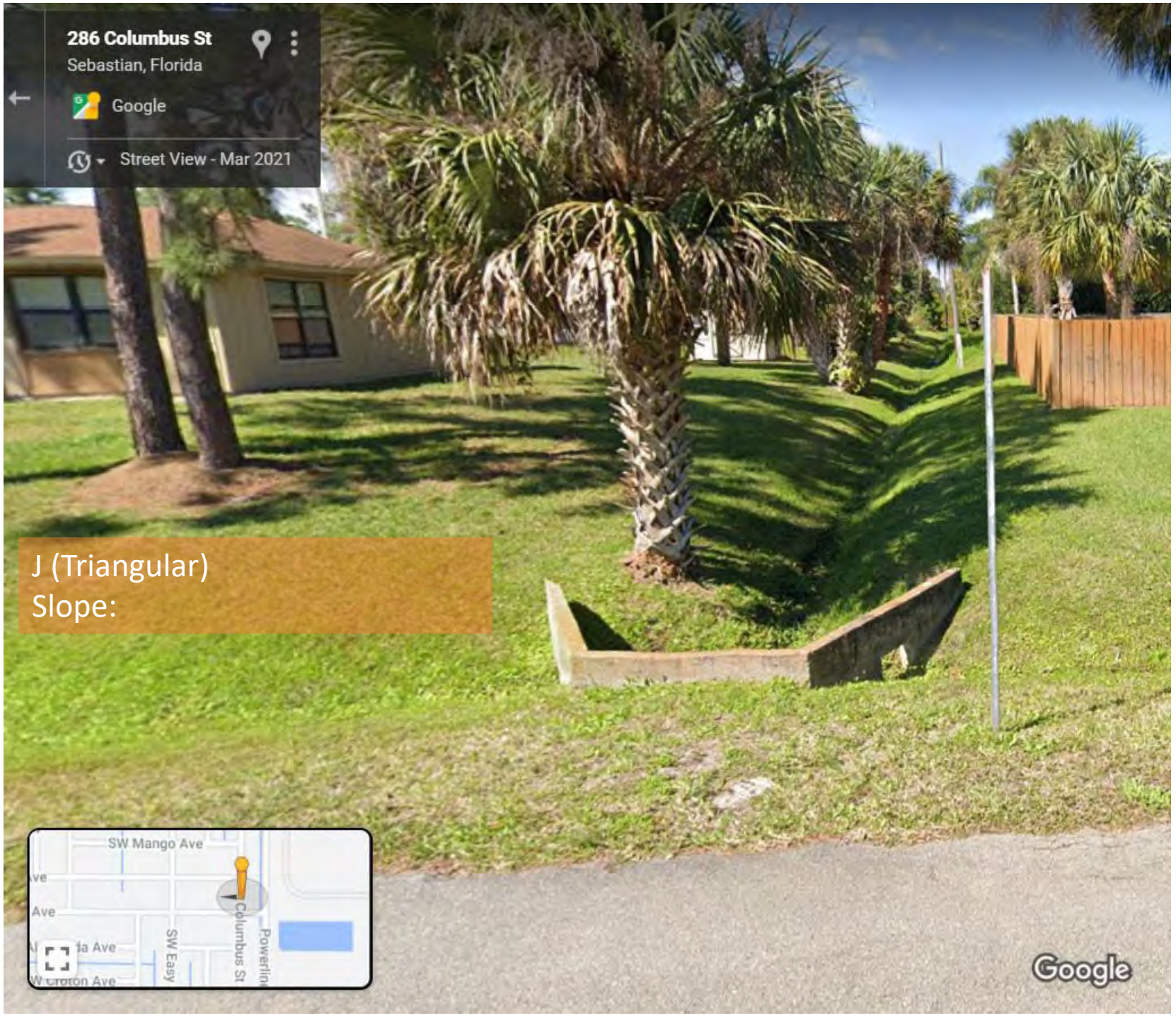
1101 Blossom Dr
Sebastian, Florida
Google
Street View - Jun 2011
E
steep slope (Rectangular)
Wide bottom width
1:1 slope
Devon Ave
Blossom Dr
Google

908 Riviera Ave
Sebastian, Florida
Google
Street View - May 2019
Schumann Dr
Sebastian, Florida
Google
Street View - May 2019
McCormick Home Sales
Google
F
(Trapezoidal)
Like B but shallower slope
2:1 slope
Jamaica Ave
Cumberland Farms
Bermuda Ave
505
PNC Bank
Flamingo Ave
Google


625 Chesser Ave
Sebastian, Florida
Google
Street View - Jun 2011
G
(Triangular)
Almost V ditch
*might not be an actual ditch
(no culvert inlet found)
Hibiscus Ave
Chesser Ave
Stevenson Ave
Palm Ave
Fordham St
Banyan St
Maple St
Ash St
Google

120 Columbus St
Sebastian, Florida
Google
Street View - Mar 2021
701 Benedictine Terrace
Sebastian, Florida
Google
Street View - Jun 2011
Google
H
Rectangular
Almost vertical slope
Complex
Royal Palm St
Kumquat Ave
Delmar St
Google
Image capture: Mar 2021 © 2021 Google

452 SW Mango Ave
Sebastian, Florida
Google
Street View - Jun 2011
I
(Circular)
Almost round/flat ditch
Kumquat Ave
Mango Ave
Citrus Ave
Main St
Fig St
Cedar St
Poinciana St
Delmar St
Google


286 Columbus St
Sebastian, Florida
Google
Street View - Mar 2021
J (Triangular)
Slope:
SW Mango Ave
Columbus St
SW Easy
Google

277 S Wimbrow Dr
Sebastian, Florida
Google
Street View - Jun 2011
K
Slope:
Sebastian Florida Bark Park
Zane Ave
S Wimbrow Dr
Google

S Easy St
Sebastian, Florida
Google
Street View - Jun 2019
L
(Rectangular)
Slope:
Holden Ave
Holden Ct
Google

1986 Barber St
Sebastian, Florida
Google
Street View - May 2019
M (wider than B)
Trapezoidal
Slope:
hurch
Island Pl
Park Place
Tracy Dr
Arcadia Dr
Google

979 Barber St
Sebastian, Florida
Google
Street View - May 2019
N
(Rectangular)
Slope:
Barber St
Clearmont St
Rose Arbor Dr
Google

1033 Seamist Ln
Sebastian, Florida
Google
Street View - Jun 2011
O
(either circular or rectangular)
Slope:
Top Sail Ln
Seamist Ln
Google

Barber St
Sebastian, Florida
Google
Street View - May 2019
P
(Trapezoidal)
Slope:
Giuseppe's Pizzer
& Italian Cuisi
Cumberland Farms
Google

City of Sebastian Stormwater Asset GIS Database Fields

June 2023

= the Field is not aplicable to the type of asset (nodes versus conduits)

Field	Description	Node	Conduit	Example Node Data	Example Link Data
Comments	General comments	x	x	CB captured fr	<Null>
Survey_Comments	Comments from Survey	x	x	<Null>	Could not locate
Inspected	Inspected Y/N	x	x	Yes	Yes
Outfall Name	Outfall name	x		<Null>	
Model	Modeled Y/N	x	x	Yes	Yes
j_status	Join status - provides information related to the location	x	x	Match-Model	Are identical to, Model ID matches GIS ID
Model_desc	model description and comments	x	x	No IE	<Null>
Type	Type of Asset	x	x	Catch Basin	Culvert
Type_Acronymn	Acronymn of Feature Type	x	x	CB	CU
Asset_ID	6 Digit Asset ID SW Zone + unique 5 digit number	x	x	300001	490075
Address	address text	x	x	INDIAN RIVER DR	RIVER OAK DR
StreetNum	address number	x	x	1201	3
SW_Zone	Stormwater Management Zone	x	x	3	4
X	X coordinate of GIS Feature	x		828074.9	
Y	Y Coordinate of GIS Feature	x		1266176.3	
Z	Elevation from 2007 DEM	x		6.1	
F_Rim_Elev	Best Available Rim Elevation NAVD 88	x		7.68	
F_Inv_Elev	Best Available Invert Elevation NAVD 88	x		1.11	
Channel_Type	Channel Type as described in field investigation		x		K
Survey_Type	Asset Type - Public/Private/Other		x		Public
Canal_Name	Canal Name		x		<Null>
Survey_Condition	Surveyed Condition and Vegetation		x		Some Vegetation
Survey_Sediment_Depth	Survey Sediment Depth inches		x		<Null>
Transect	Name of modeled open channel cross-section geometry, associated with locations F_Cross_Section "Irregular"		x		<Null>
Barrels	Best Available number of barrels (closed pipe networks and culverts)		x		
Inlet_AID	Inlet Node Asset ID		x		400072
Outlet_AID	Outlet Node Asset ID		x		400071
F_Cross_Section	Best Available Cross Section Shape		x		CIRCULAR

City of Sebastian Stormwater Asset GIS Database Fields

June 2023

= the Field is not aplicable to the type of asset (nodes versus conduits)

Field	Description	Node	Conduit	Example Node Data	Example Link Data
F_Geom1	Best Available Geom 1, refer to Conduit Geometry Field Descriptions		x		1.25
F_Geom2	Best Available Geom 2, refer to Conduit Geometry Field Descriptions		x		0
F_Geom3	Best Available Geom 3, refer to Conduit Geometry Field Descriptions		x		0
F_Geom4	Best Available Geom 4, refer to Conduit Geometry Field Descriptions		x		0
F_Inlet_IE	Best Available Inlet Elevation NAVD 88		x		13.92
F_Outlet_IE	Best Available Outlet Elevation NAVD 88		x		13.79
F_Length	Best Available Length, feet		x		58.49
Conduit_Material	Material Type based on desktop review and survey		x		<Null>

Asset Type Descriptions and Type Acronymns

Type	Description	Type_Acronymn	Conduit or Node
Backyard Ditch	Ditch behind houses	BD	Conduit
Backyard Pipe	Pipe behind houses	BP	Conduit
Canal	Canal	CA	Conduit
Cross Ditch	Ditch between two houses	CD	Conduit
Cross Pipe	Pipe between two houses	CP	Conduit
Culvert	Culvert - at road crossings	CU	Conduit
Ditch	General Ditch (unspecified)	DI	Conduit
Driveway Culvert	Driveway Culvert	DC1	Conduit
Orifice	Orifice	OR	Conduit
Pipe	General Pipe (unspecified)	PI	Conduit
Pump	Pump	PU	Conduit
Roadside Ditch	Roadside Ditch (not maintained by the City)	RD	Conduit
Weir	Weir	WR	Conduit
Baffle Box	Baffle Box	BB	Node
Catch Basin	(Yard Inlet, storm drain, curb inlet) Pipe to pipe node receiving additional runoff flow	CB	Node
Channel Node	Open Channel to Open Channel	CN	Node
Manhole	Manhole (pipe to pipe node without receiving additional runoff flow)	MH	Node
Model Node	Node Created for modeling purposes not a specific structure	MN	Node
Outfall	Outfall	OF	Node
Pipe End	Pipe/Culvert to Open Channel or Pond inlet/outlet	PE	Node
Storage Node	Storage Node (detention basins, ponds, etc)	SN	Node
Driveway culvert	created for each address point within the SW management Zones	DC2	Node
Roadside Swale	created for each address point within the SW management Zones	RS	Node

Conduit Geometry Field Descriptions

Type of Feature the Cross-Section is associated with	F_Cross_Section	F_Geom1	F_Geom2	F_Geom3	F_Geom4
Pipe	Circular	Diameter, ft			
Pipe	Horiz_Ellipse	Rise, ft	Span, ft		
Open Channel	Irregular				
Open Channel	Parabolic	Depth, ft	Top Width, ft		
Open Channel	Trapezoidal	Depth, ft	Bottom Width, ft	Left Slope (Horiz ft/ Vertical ft)	Right Slope (Horiz ft/ Vertical ft)
Open Channel	Triangular	Depth, ft	Top Width, ft		
Pipe	Vert_Ellipse	Rise, ft	Span, ft		
Weir	V-notch	Height, ft	Top Width, ft		
Weir	Transverse	Height, ft	Top Width, ft		
Weir	Trapezoidal	Height, ft	Bottom Width, ft	Side Slope (Horiz ft/ Vertical ft)	
Orifice	Circular	Diameter, ft			
Orifice	Rect_Closed	Height, ft	Width, ft		

Join Status between the Survey Database and the H&H Model

J_Status Field	Description	Conduit or Node
Are identical to	Spatial join between the features, no	Conduit
Are identical to, Model ID matches GIS ID	Spatial join between the features and ID join with the PCSWMM Model	Conduit
GIS only, not modeled	Feature is in GIS only and not	Conduit
ID match	Spatially not a match but the ID	Conduit
Only modeled, not on GIS	Feature was added in the model but	Conduit
Orifice	Orifice Feature added to Model	Conduit
Pump	Pump Feature added to Model	Conduit
Spatially matched	Spatially joined but the Feature ID	Conduit
Weir	Weir Feature added to Model	Conduit
Combined Node	Node feature added for modeling	Node
GIS only, not modeled	Feature is in GIS only and not	Node
Match and location changed	ID join with model but location adjusted during system review	Node
Match-Model X,Y diff < 1	Spatial join between the features and	Node
Modeled	Feature was added in the model but	Node
Spatially Matched	Spatially joined but the Feature ID	Node

City of Sebastian Stormwater Asset GIS Database Detailed

June 2023

= the Field is not aplicable to the type of asset (nodes versus conduits)

Field	Description	Node	Conduit	Example Node Data	Example Link Data
Shape_Length	Geospatial Length. Modeled length may not match the geospatial length in situations in support of hydraulic model representation		x		58.2
DA_Size	Desktop Analysis Diameter in inches (or elliptical dimensions in inches ex. 44x68) from record drawings		x		12
DA_Material	Desktop Analysis Pipe Material from record drawings		x		HDPE
DA_Comments	Desktop Analysis Comments and drawing references	x	x	MH-1	120
DA_Invert_In	Desktop Analysis Upstream Invert Elevation from record drawings		x		20.15
DA_Invert_Out	Desktop Analysis Downstream Invert Elevation from record drawings		x		20
DA_Rim_Elev	Desktop Analysis Record Drawing Rim Elevation	x		13.35	
DA_Inv_Elev	Desktop analysis Record Drawing Invert Elevation	x		7.6	
DA_Node_Type	Desktop Analysis Record Drawing Node Type	x		Manhole	
Channel_Type	Desktop Analysis Channel Type in support of field investigations		x		NA
Inspected	Inspected Y/N	x	x	Yes	Yes
Survey_Comments	Comments from Survey	x	x	<Null>	2 pipes
Survey_Type	Asset Type - Public/Private/Other		x		Public
Survey_Rim_Elev	Survey Rim Elevation NAVD 88	x		<Null>	
Survey_Inv_Elev	Survey Invert Elevation NAVD88	x		<Null>	
Survey_Node_Type	Survey Node Type	x		<Null>	
Survey_Condition	Surveyed Condition and Vegetation		x		Clear
Survey_Pipe_Material	Surveyed Pipe Material		x		HDPE
Survey_Conduit_Type	Surveyed conduit type ex. Culvert, ditch		x		Culvert
Survey_Channel_Bottom_Width	Surveyed Channel Bottom Width in feet		x		<Null>
Survey_Channel_Top_Width	Surveyed Channel Top Width in feet		x		<Null>
Survey_Channel_Depth	Surveyed Channel Depth in feet		x		<Null>
Survey_Pipe_Size	Survey Pipe Size in feet		x		1
Survey_Sediment_Depth	Survey Sediment Depth feet		x		0.083
Outfall Name	Outfall name	x		<Null>	
j_status	Join status - provides information related to the location	x	x	Match-Model X,Y diff < 1	Are identical to, Model ID matches GIS ID

City of Sebastian Stormwater Asset GIS Database Detailed

June 2023

= the Field is not aplicable to the type of asset (nodes versus conduits)

Field	Description	Node	Conduit	Example Node Data	Example Link Data
Model	Modeled Y/N	x	x	Yes	Yes
Model_desc	model description and comments	x	x		Clear, HDPE
AssetID	6 Digit Asset ID SW Zone + unique 5 digit number	x	x	300025	590658
Type	Conduit/Node Asset Type based on desktop review, survey, and modeling effort	x	x	Manhole	Culvert
Type_Acronymn	Acronymn of Feature Type	x	x	MH	CU
ADDRESS	ADDRESS	x	x	U S HIGHWAY 1	PELICAN ISLAND PL
StreetNum	StreetNum	x	x	1004	138
SW_Zone	SW_Zone	x	x	3	5
Canal_Name	Canal Name		x		<Null>
Transect	Name of modeled open channel cross-section geometry, associated with locations F_Cross_Section "Irregular"		x		
Inlet_AID	Inlet Node Asset ID		x		502182
Outlet_AID	Outlet Node Asset ID		x		502183
F_Cross_Section	Best Available Cross Section Shape		x		CIRCULAR
F_Geom1	Best Available Geom 1, refer to Conduit Geometry Field Descriptions		x		1
F_Geom2	Best Available Geom 2, refer to Conduit Geometry Field Descriptions		x		0
F_Geom3	Best Available Geom 3, refer to Conduit Geometry Field Descriptions		x		0
F_Geom4	Best Available Geom 4, refer to Conduit Geometry Field Descriptions		x		0
Barrels	Best Available number of barrels (closed pipe networks and culverts)		x		2
F_Inlet_IE	Best Available Inlet Elevation		x		20.15
F_Outlet_IE	Best Available Outlet Elevation		x		20
F_Length	Best Available Length, feet		x		58.2
Conduit_Material	Best Available Material Type based on desktop review and survey		x		HDPE
X	X coordinate of GIS Feature	x		828144.5517	
Y	Y Coordinate of GIS Feature	x		1265204.173	
Z	Elevation from 2007 DEM	x		11.48	
F_Rim_Elev	Best Available Rim Elevation NAVD 88	x		13.35	
F_Inv_Elev	Best Available Invert Elevation NAVD 88	x		7.6	

Asset Type Descriptions and Type Acronymns

Type	Description	Type_Acronymn	Conduit or Node
Backyard Ditch	Ditch behind houses	BD	Conduit
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Orifice	Orifice	OR	Conduit
Pipe	General Pipe (unspecified)	PI	Conduit
Pump	Pump	PU	Conduit
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Outfall	Outfall	OF	Node
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Pipe	Horiz_Ellipse	Rise, ft	Span, ft		
Open Channel	Irregular				
Open Channel	Parabolic	Depth, ft	Top Width, ft		
Open Channel	Trapezoidal	Depth, ft	Bottom Width, ft	Left Slope (Horiz ft/ Vertical ft)	Right Slope (Horiz ft/ Vertical ft)
Open Channel	Triangular	Depth, ft	Top Width, ft		
Pipe	Vert_Ellipse	Rise, ft	Span, ft		
Weir	V-notch	Height, ft	Top Width, ft		
Weir	Transverse	Height, ft	Top Width, ft		
Weir	Trapezoidal	Height, ft	Bottom Width, ft	Side Slope (Horiz ft/ Vertical ft)	
Orifice	Circular	Diameter, ft			
Orifice	Rect_Closed	Height, ft	Width, ft		

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J_Status Field	Description	Conduit or Node
Are identical to	Spatial join between the features, no	Conduit
Are identical to, Model ID matches GIS ID	Spatial join between the features and ID join with the PCSWMM Model	Conduit
GIS only, not modeled	Feature is in GIS only and not	Conduit
ID match	Spatially not a match but the ID	Conduit
Only modeled, not on GIS	Feature was added in the model but	Conduit
Orifice	Orifice Feature added to Model	Conduit
Pump	Pump Feature added to Model	Conduit
Spatially matched	Spatially joined but the Feature ID	Conduit
Weir	Weir Feature added to Model	Conduit
Combined Node	Node feature added for modeling	Node
GIS only, not modeled	Feature is in GIS only and not	Node
Match and location changed	ID join with model but location adjusted during system review	Node
Match-Model X,Y diff < 1	Spatial join between the features and	Node
Modeled	Feature was added in the model but	Node
Spatially Matched	Spatially joined but the Feature ID	Node

Appendix K

Stormwater Network Summary Tables

- City of Sebastian SWMP - H&H Model Capacity Limited Conduit Summary_Final.pdf
- City of Sebastian SWMP - H&H Model Negative Pipe Slope Summary.pdf

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
291250	200489	202345	133	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291251	200488	200489	44	CIRCULAR	2	Pipe	Yes	Yes	Yes
291253	202605	200462	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291254	200497	200496	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
291255	200504	200503	44	CIRCULAR	2	Pipe	Yes	Yes	Yes
291260	200501	200500	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291261	202548	202941	137	CIRCULAR	2	Pipe	Yes	Yes	Yes
291265	202722	202727	156	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291266	200422	202729	155	CIRCULAR	2	Pipe	Yes	Yes	Yes
291267	200419	202786	146	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291269	200418	200419	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291271	200438	202722	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290132	200138	200127	254	CIRCULAR	2	Pipe	Yes	Yes	Yes
491273	401811	401810	84	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491274	401812	401813	57	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491276	401815	401814	58	CIRCULAR	3.33ft, 2 Barrels	Pipe	Yes	Yes	Yes
491283	402613	401821	134	Trapezoidal	16.4 Top W, 8 Bottom W, 6.3 H	Open Channel	Yes	Yes	Yes
491287	401826	401827	57	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491289	401829	401828	37	CIRCULAR	2	Pipe	Yes	Yes	Yes
491294	401835	401834	51	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491296	401330	401329	60	CIRCULAR	2.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
491299	401837	402536	503	Trapezoidal	13.3 Top W, 10 Bottom W, 3.8 H	Open Channel	Yes	Yes	Yes
491300	401836	401837	57	CIRCULAR	4	Pipe	Yes	Yes	Yes
491302	401473	401474	63	CIRCULAR	2	Pipe	Yes	Yes	Yes
491305	401842	401843	98	CIRCULAR	1.67	Pipe	Yes	Yes	Yes
491307	401844	401845	58	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491308	401847	401846	57	CIRCULAR	2	Pipe	Yes	Yes	Yes
191309	101638	102326	142	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491311	401848	401866	57	CIRCULAR	3	Pipe	Yes	Yes	Yes
391312	300361	300360	34	CIRCULAR	2ft, 2 Barrels	Pipe	Yes	Yes	Yes
391313	300295	302667	143	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391315	300312	300313	47	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591319	500873	502442	64	CIRCULAR	3	Pipe	Yes	Yes	Yes
391321	300358	302463	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691325	600522	600521	35	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691326	600520	600519	35	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691327	600514	600513	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
691328	600532	600531	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
691329	600540	600539	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
691332	600526	600525	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
491334	401863	401572	69	CIRCULAR	1	Pipe	Yes	Yes	Yes
291335	200446	202721	48	CIRCULAR	2	Pipe	Yes	Yes	Yes
691337	600586	602457	52	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
391338	300396	302491	32	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391339	300397	302489	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391340	300387	300386	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491341	401868	401529	56	CIRCULAR	1	Pipe	Yes	Yes	Yes
491344	401479	402533	157	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591345	501870	501869	79	CIRCULAR	3ft, 2 Barrels	Pipe	Yes	Yes	Yes
491347	401872	401875	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591356	501884	501883	59	CIRCULAR	4	Pipe	Yes	Yes	Yes
491359	401492	402533	148	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491360	402595	401890	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
491361	401415	402371	149	CIRCULAR	2	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
491362	401280	401891	44	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691372	600585	600584	58	CIRCULAR	1	Pipe	Yes	Yes	Yes
691373	600583	600582	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
391375	300408	300409	48	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591376	401169	502598	138	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591377	401159	502597	148	CIRCULAR	2	Pipe	Yes	Yes	Yes
691379	602472	600585	265	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491382	401192	402599	136	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491383	401205	401896	43	CIRCULAR	2	Pipe	Yes	Yes	Yes
491386	401905	401904	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491387	401907	401906	81	CIRCULAR	3ft, 2 Barrels	Pipe	Yes	Yes	Yes
491388	401908	401909	43	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491390	401910	401912	48	CIRCULAR	1	Pipe	Yes	Yes	Yes
591392	501146	502834	135	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591395	501925	501926	39	CIRCULAR	1.67	Pipe	Yes	Yes	Yes
391399	302273	300231	146	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591432	501038	501987	33	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
591433	501065	502619	129	CIRCULAR	2	Pipe	Yes	Yes	Yes
591434	501063	501065	57	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591435	501062	501065	65	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391436	300294	300295	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391437	300262	300263	51	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591439	501027	502385	157	CIRCULAR	2	Pipe	Yes	Yes	Yes
391442	300278	302711	120	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391444	301995	301996	46	CIRCULAR	1	Pipe	Yes	Yes	Yes
591447	500862	502384	163	CIRCULAR	2	Pipe	Yes	Yes	Yes
591451	502000	502001	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
591452	502002	502502	131	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290148	200153	200155	197	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591454	500826	502438	164	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591457	502007	502008	63	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
291470	202021	202549	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291472	200443	200444	36	HORIZ_ELLIPSE	1.5 H x 2.4 W	Pipe	Yes	Yes	Yes
291475	200426	200425	58	CIRCULAR	1	Pipe	Yes	Yes	Yes
391478	302035	302034	34	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391479	302040	302035	154	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391480	302036	302037	88	CIRCULAR	1	Pipe	Yes	Yes	Yes
391484	302041	301713	30	CIRCULAR	4	Pipe	Yes	Yes	Yes
391485	301713	302043	101	CIRCULAR	4	Pipe	Yes	Yes	Yes
591491	500882	502383	134	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290151	200156	200155	33	CIRCULAR	2	Pipe	Yes	Yes	Yes
591492	502056	502057	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591494	502058	500889	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291498	200482	202644	129	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291504	200480	200481	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291505	200481	202645	124	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291506	202341	200471	126	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291507	200471	200472	48	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
290152	200155	200124	410	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
691510	602089	601851	313	Trapezoidal	8 Top W, 3 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
291519	200484	200485	50	CIRCULAR	1	Pipe	Yes	Yes	Yes
391520	302044	301724	100	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
391521	301724	302048	67	CIRCULAR	4	Pipe	Yes	Yes	Yes
691522	600568	600567	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
591523	500909	502439	166	CIRCULAR	2.5	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
591524	502172	500890	86	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
591525	502178	502177	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591526	500795	502428	64	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591527	502181	502180	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
591528	500900	502822	145	CIRCULAR	2	Pipe	Yes	Yes	Yes
591529	502186	502185	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
591530	502187	502188	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591531	500904	502190	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291532	201585	202698	134	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290154	200160	200159	393	CIRCULAR	2	Pipe	Yes	Yes	Yes
591534	502197	502195	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
391535	301725	301724	76	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391536	301721	301722	59	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391537	301722	302775	83	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391539	301717	301718	60	CIRCULAR	1	Pipe	Yes	Yes	Yes
391540	301718	302800	81	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391541	301716	301715	47	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391542	301715	301714	56	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391543	302042	301713	73	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391544	301712	301710	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391545	301710	302793	83	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391548	302069	302042	163	CIRCULAR	2	Pipe	Yes	Yes	Yes
391550	302032	302198	275	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391552	302198	302024	406	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391554	302111	302112	139	HORIZ_ELLIPSE	1.6 H x 2.5 W	Pipe	Yes	Yes	Yes
391556	302112	300593	235	Trapezoidal	16 Top W, 5 Bottom W, 2.4 H	Open Channel	Yes	Yes	Yes
391558	302922	300415	141	CIRCULAR	4	Pipe	Yes	Yes	Yes
391559	300415	201833	181	CIRCULAR	4	Pipe	Yes	Yes	Yes
290157	200165	200164	67	CIRCULAR	4	Pipe	Yes	Yes	Yes
691568	602116	601832	104	CIRCULAR	2	Pipe	Yes	Yes	Yes
691569	602118	602117	139	HORIZ_ELLIPSE	1.6 H x 2.5 W	Pipe	Yes	Yes	Yes
691571	602122	602121	31	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591573	502202	502203	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
691574	602115	602125	112	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291575	202204	200439	46	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491581	402211	402212	119	CIRCULAR	3	Pipe	Yes	Yes	Yes
391611	302071	302221	83	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391627	301966	301967	146	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390190	300166	300167	19	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391630	302886	301970	249	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391631	302234	301936	71	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391649	302256	300008	129	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691650	602259	602392	56	CIRCULAR	1	Pipe	Yes	Yes	Yes
691651	602260	600684	59	CIRCULAR	1	Pipe	Yes	Yes	Yes
391662	302272	301927	12	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
390195	300170	300166	153	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391667	300010	302275	55	CIRCULAR	2	Pipe	Yes	Yes	Yes
391668	302906	300009	534	CIRCULAR	2	Pipe	Yes	Yes	Yes
391672	301737	302272	503	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391674	302277	301737	74	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
390197	300173	300174	124	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691701	600792	600791	30	CIRCULAR	1	Pipe	Yes	Yes	Yes
691707	600793	600794	30	CIRCULAR	3	Pipe	Yes	Yes	Yes
390199	300174	300176	128	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691718	600709	602481	170	CIRCULAR	3	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
391720	300244	300243	90	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391721	300242	300243	58	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
691723	600696	602925	119	CIRCULAR	2	Pipe	Yes	Yes	Yes
291724	201617	202916	99	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291734	200433	200434	77	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
491749	401194	402771	264	CIRCULAR	2	Pipe	Yes	Yes	Yes
491750	401483	401482	102	CIRCULAR	3	Pipe	Yes	Yes	Yes
491751	401482	402535	149	CIRCULAR	3	Pipe	Yes	Yes	Yes
691755	600678	600680	54	CIRCULAR	2	Pipe	Yes	Yes	Yes
691756	600679	600678	84	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691757	600680	600677	143	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
691758	600691	600690	30	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691759	600690	602397	149	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691760	600689	600688	30	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691762	600711	602394	145	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691763	600712	600711	29	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390203	300181	300179	160	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691764	600713	600714	31	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691765	600714	602393	131	CIRCULAR	2	Pipe	Yes	Yes	Yes
691766	600706	602419	162	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691770	600700	602419	150	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691771	600694	600696	17	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691775	600683	600682	28	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691776	600682	602372	200	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691778	600673	602405	196	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691779	600754	600753	30	CIRCULAR	1	Pipe	Yes	Yes	Yes
691780	600753	602255	27	CIRCULAR	1	Pipe	Yes	Yes	Yes
691781	600757	600759	193	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691782	600758	600759	30	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691783	600759	602406	17	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691784	600761	600760	27	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691785	600760	602927	25	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691787	602301	600768	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
691788	600769	600770	29	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691789	600770	602410	204	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691790	600763	600762	28	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691791	600762	602405	198	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691792	600764	600765	30	CIRCULAR	1	Pipe	Yes	Yes	Yes
691793	600765	602413	195	CIRCULAR	1	Pipe	Yes	Yes	Yes
590209	500188	500189	156	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391795	302717	302051	125	CIRCULAR	2	Pipe	Yes	Yes	Yes
391796	302305	302302	63	CIRCULAR	2	Pipe	Yes	Yes	Yes
691797	600788	600794	184	CIRCULAR	1	Pipe	Yes	Yes	Yes
691798	600789	602423	159	CIRCULAR	1	Pipe	Yes	Yes	Yes
691799	600790	600789	30	CIRCULAR	1	Pipe	Yes	Yes	Yes
691800	600787	602421	158	CIRCULAR	1	Pipe	Yes	Yes	Yes
691801	600786	600787	28	CIRCULAR	1	Pipe	Yes	Yes	Yes
691802	600781	600782	27	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691806	600528	600529	44	CIRCULAR	3	Pipe	Yes	Yes	Yes
491807	402313	402312	31	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391808	301723	302048	73	CIRCULAR	2	Pipe	Yes	Yes	Yes
391810	302048	302050	64	CIRCULAR	4	Pipe	Yes	Yes	Yes
391811	302050	302051	483	CIRCULAR	4	Pipe	Yes	Yes	Yes
391812	302051	302788	61	CIRCULAR	2	Pipe	Yes	Yes	Yes
391813	302920	302305	22	CIRCULAR	2	Pipe	Yes	Yes	Yes
391816	302919	302915	25	CIRCULAR	2	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
590211	500189	502439	89	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391818	302306	302055	130	CIRCULAR	2	Pipe	Yes	Yes	Yes
391823	302321	302740	29	CIRCULAR	1	Pipe	Yes	Yes	Yes
590212	502445	502444	63	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
191860	100104	102338	70	Trapezoidal	12 Top W, 10 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
291877	202350	202848	406	Trapezoidal	8 Top W, 7 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
291879	202352	202350	322	Trapezoidal	8 Top W, 7 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
690216	600195	600194	49	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291880	202686	202353	148	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
191882	102354	100103	211	Trapezoidal	10 Top W, 8 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
491889	401259	401250	25	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
491895	402358	401901	26	CIRCULAR	1	Pipe	Yes	Yes	Yes
591897	502361	501870	140	Trapezoidal	14 Top W, 8 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
591900	500810	500808	126	PARABOLIC	0.5 H x 1 W	Pipe	Yes	Yes	Yes
591930	502380	502381	825	Trapezoidal	11 Top W, 8 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
591934	502385	502448	798	Trapezoidal	13.4 Top W, 10 Bottom W, 2.9 H	Open Channel	Yes	Yes	Yes
691938	600514	600532	280	Trapezoidal	26 Top W, 5 Bottom W, 2.5 H	Open Channel	Yes	Yes	Yes
691942	602388	602389	186	CIRCULAR	2	Pipe	Yes	Yes	Yes
691950	602395	602396	94	CIRCULAR	5	Pipe	Yes	Yes	Yes
691955	602402	602401	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
691958	600512	600526	289	CIRCULAR	2	Pipe	Yes	Yes	Yes
691959	600525	600523	291	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691960	600703	602403	23	CIRCULAR	1	Pipe	Yes	Yes	Yes
691963	602408	602409	86	CIRCULAR	3.33	Pipe	Yes	Yes	Yes
690224	600203	600204	53	CIRCULAR	2	Pipe	Yes	Yes	Yes
690225	600204	600205	220	CIRCULAR	2	Pipe	Yes	Yes	Yes
691982	600677	602418	138	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
691984	600699	600698	30	CIRCULAR	3	Pipe	Yes	Yes	Yes
691986	600767	600766	30	CIRCULAR	1	Pipe	Yes	Yes	Yes
691996	600791	602287	26	CIRCULAR	1	Pipe	Yes	Yes	Yes
691997	600766	602425	191	CIRCULAR	1	Pipe	Yes	Yes	Yes
591999	502426	502427	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
392594	302946	202860	185	CIRCULAR	3.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
592009	502432	502431	462	Trapezoidal	20 Top W, 8 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
692011	600708	600707	31	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
692013	600721	600199	229	CIRCULAR	1	Pipe	Yes	Yes	Yes
690229	600206	602481	208	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
592021	502436	502172	102	Trapezoidal	11 Top W, 8 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
592041	502447	502446	35	VERT_ELLIPSE	1.5 H x 0.9 W	Pipe	Yes	Yes	Yes
692044	502428	602429	122	CIRCULAR	1	Pipe	Yes	Yes	Yes
692045	600779	600780	30	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692048	600780	602450	139	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692061	600569	602458	51	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692062	600577	600579	461	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692063	602458	600577	65	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692064	600548	600549	40	CIRCULAR	1	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
692074	600576	600575	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
692078	600566	600565	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
692089	602468	602469	55	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
690236	600214	600215	34	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
692090	602469	602308	211	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel	Yes	Yes	Yes
692091	600563	602468	266	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel	Yes	Yes	Yes
692092	600564	600563	55	CIRCULAR	1	Pipe	Yes	Yes	Yes
692099	600552	600553	51	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
692100	600550	600552	69	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
592102	502478	502479	78	CIRCULAR	1	Pipe	Yes	Yes	Yes
690237	600215	600216	62	CIRCULAR	2	Pipe	Yes	Yes	Yes
592103	502480	500188	332	CIRCULAR	1	Pipe	Yes	Yes	Yes
392117	300263	302484	178	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
692124	600666	600671	486	CIRCULAR	1	Pipe	Yes	Yes	Yes
690238	600216	602372	150	HORIZ_ELLIPSE	1.6 H x 2.5 W	Pipe	Yes	Yes	Yes
692135	602504	502503	65	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
592149	502512	502513	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
492161	402520	401848	335	Trapezoidal	11.3 Top W, 8 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
492183	401412	401414	136	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel	Yes	Yes	Yes
492186	402531	402532	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
492189	402533	402534	356	Trapezoidal	12.8 Top W, 8 Bottom W, 4.2 H	Open Channel	Yes	Yes	Yes
492190	402535	401836	98	Trapezoidal	13.4 Top W, 8 Bottom W, 4.8 H	Open Channel	Yes	Yes	Yes
492191	402536	401838	295	Trapezoidal	10 Top W, 7 Bottom W, 3.5 H	Open Channel	Yes	Yes	Yes
492193	402539	402538	43	CIRCULAR	1	Pipe	Yes	Yes	Yes
492195	402541	402540	55	CIRCULAR	0.5	Pipe	Yes	Yes	Yes
492202	401292	401882	150	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
492215	401767	401426	160	CIRCULAR	1	Pipe	Yes	Yes	Yes
592228	502551	502550	37	CIRCULAR	4	Pipe	Yes	Yes	Yes
492236	402545	402546	42	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
592248	501107	500141	271	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
492253	401285	401284	51	CIRCULAR	2	Pipe	Yes	Yes	Yes
592260	501987	502556	156	CIRCULAR	1	Pipe	Yes	Yes	Yes
592261	501033	502556	165	CIRCULAR	1	Pipe	Yes	Yes	Yes
492279	402561	402562	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
492283	402564	402565	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
492284	402567	402566	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
592285	402566	502867	118	VERT_ELLIPSE	1.6 H x 0.9 W	Pipe	Yes	Yes	Yes
592286	502568	502569	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
592287	502766	501093	281	VERT_ELLIPSE	1.5 H x 0.9 W	Pipe	Yes	Yes	Yes
492288	402571	402570	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
492292	402572	401460	23	CIRCULAR	2	Pipe	Yes	Yes	Yes
492295	402575	402574	54	CIRCULAR	1	Pipe	Yes	Yes	Yes
492297	402576	401804	717	Trapezoidal	11.9 Top W, 8 Bottom W, 4.7 H	Open Channel	Yes	Yes	Yes
592299	502577	502578	42	CIRCULAR	0.5	Pipe	Yes	Yes	Yes
492306	402312	402586	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
492309	401221	402808	107	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
492312	401218	402590	142	CIRCULAR	1.5	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
492313	402589	401824	265	Trapezoidal	17.1 Top W, 8 Bottom W, 6.8 H	Open Channel	Yes	Yes	Yes
690256	602418	602397	546	Trapezoidal	15 Top W, 5 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
492325	401207	401890	148	CIRCULAR	1	Pipe	Yes	Yes	Yes
492331	401160	401892	20	CIRCULAR	2	Pipe	Yes	Yes	Yes
492332	402599	401186	568	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
492336	402602	402603	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
492344	402611	402613	85	Trapezoidal	17.2 Top W, 8 Bottom W, 6.9 H	Open Channel	Yes	Yes	Yes
292345	200493	202783	127	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
692360	600524	600523	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
492361	402625	402624	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
192362	102626	101628	47	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292366	202634	202633	55	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292367	202635	202634	133	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292368	202637	202636	51	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
292369	202347	202638	316	Trapezoidal	8 Top W, 6 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
590261	501988	502386	163	Trapezoidal	8.1 Top W, 5 Bottom W, 2.7 H	Open Channel	Yes	Yes	Yes
492373	402639	402640	42	CIRCULAR	1	Pipe	Yes	Yes	Yes
392385	300258	302651	42	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
392391	300241	302655	182	CIRCULAR	3	Pipe	Yes	Yes	Yes
392393	300293	300292	46	CIRCULAR	2	Pipe	Yes	Yes	Yes
392397	302661	302660	35	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392398	302662	302663	51	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
392399	302663	202786	139	VERT_ELLIPSE	2.5 H x 1.7 W	Pipe	Yes	Yes	Yes
392402	302667	300298	438	Trapezoidal	8.8 Top W, 4 Bottom W, 2.6 H	Open Channel	Yes	Yes	Yes
392404	302671	300269	271	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
492405	402673	401907	402	Trapezoidal	13.4 Top W, 10 Bottom W, 5.1 H	Open Channel	Yes	Yes	Yes
192415	102681	102680	34	VERT_ELLIPSE	1.8 H x 1.1 W	Pipe	Yes	Yes	Yes
292420	202847	202689	145	Trapezoidal	12.8 Top W, 8 Bottom W, 5.8 H	Open Channel	Yes	Yes	Yes
292422	202690	202691	270	Trapezoidal	12.9 Top W, 8 Bottom W, 5.9 H	Open Channel	Yes	Yes	Yes
292430	200450	202704	130	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392434	302708	300312	447	Trapezoidal	7 Top W, 4 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
392440	302463	302713	128	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392442	302713	302714	246	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
392445	301770	302716	130	Trapezoidal	5 Top W, 2 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
392447	302702	302723	53	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391805	300591	302950	67	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
392466	302320	302740	15	CIRCULAR	1	Pipe	Yes	Yes	Yes
392468	302740	302742	403	CIRCULAR	2	Pipe	Yes	Yes	Yes
692488	600527	600528	211	CIRCULAR	1	Pipe	Yes	Yes	Yes
392489	302762	302485	88	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
392492	302764	302765	50	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
192494	102680	102827	143	CIRCULAR	1	Pipe	Yes	Yes	Yes
592499	502768	502779	167	CIRCULAR	1	Pipe	Yes	Yes	Yes
492500	402769	402770	58	CIRCULAR	1	Pipe	Yes	Yes	Yes
492501	402770	402782	153	CIRCULAR	1	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
492502	401199	402771	132	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
492503	402771	402599	240	CIRCULAR	2	Pipe	Yes	Yes	Yes
192505	102678	101636	248	CIRCULAR	1	Pipe	Yes	Yes	Yes
292507	202772	202773	31	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
292508	202773	202942	131	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
492518	402534	402782	474	Trapezoidal	13 Top W, 8 Bottom W, 4.4 H	Open Channel	Yes	Yes	Yes
292524	200441	200443	255	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel	Yes	Yes	Yes
292530	202638	202790	146	CIRCULAR	4	Pipe	Yes	Yes	Yes
392534	301714	301713	30	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292535	202790	202797	47	HORIZ_ELLIPSE	3.2 H x 5 W	Pipe	Yes	Yes	Yes
292536	202797	102795	69	HORIZ_ELLIPSE	3.2 H x 5 W	Pipe	Yes	Yes	Yes
192537	102802	102794	17	CIRCULAR	3	Pipe	Yes	Yes	Yes
192542	102796	102794	28	HORIZ_ELLIPSE	3.2 H x 5 W	Pipe	Yes	Yes	Yes
392544	302801	302775	151	Trapezoidal	14.4 Top W, 8 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
392550	301929	300010	8	CIRCULAR	2	Pipe	Yes	Yes	Yes
392551	300285	302804	130	CIRCULAR	2	Pipe	Yes	Yes	Yes
392552	302804	300283	733	Trapezoidal	8 Top W, 3 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
192556	102795	102802	12	CIRCULAR	3	Pipe	Yes	Yes	Yes
492557	402590	402591	173	Trapezoidal	15.2 Top W, 7 Bottom W, 9 H	Open Channel	Yes	Yes	Yes
492561	401362	402811	141	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
492564	402813	402814	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
392586	300410	302833	129	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
592591	502837	502436	308	Trapezoidal	11 Top W, 8 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
592592	502508	502060	192	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392597	300409	302706	133	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392599	302842	300361	431	Trapezoidal	6 Top W, 1 Bottom W, 2 H	Open Channel	Yes	Yes	Yes
392600	300362	302842	124	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
392612	302844	300385	99	CIRCULAR	4	Pipe	Yes	Yes	Yes
292618	200430	201833	177	CIRCULAR	4	Pipe	Yes	Yes	Yes
292619	200434	202846	47	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292622	202848	202847	107	CIRCULAR	4	Pipe	Yes	Yes	Yes
192630	102338	102853	144	Trapezoidal	12 Top W, 10 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
492632	402854	402855	143	CIRCULAR	2	Pipe	Yes	Yes	Yes
392637	302107	302032	127	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
692654	602932	502858	70	CIRCULAR	1.25ft, 5 Barrels	Pipe	Yes	Yes	Yes
392658	302084	302868	81	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
392659	302073	302084	79	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392660	302221	302868	121	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
392661	302868	302869	172	CIRCULAR	2	Pipe	Yes	Yes	Yes
392662	302869	302069	429	CIRCULAR	2	Pipe	Yes	Yes	Yes
392663	302870	302042	100	CIRCULAR	2	Pipe	Yes	Yes	Yes
692677	602883	601789	218	CIRCULAR	1	Pipe	Yes	Yes	Yes
490289	402782	402535	474	Trapezoidal	13.2 Top W, 8 Bottom W, 4.6 H	Open Channel	Yes	Yes	Yes
392685	302888	302277	216	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
392698	301703	302900	198	CIRCULAR	2	Pipe	Yes	Yes	Yes
392699	302900	301707	140	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
392701	301707	302039	114	CIRCULAR	3	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
392706	302905	302052	57	CIRCULAR	2	Pipe	Yes	Yes	Yes
392707	302917	302907	187	CIRCULAR	2	Pipe	Yes	Yes	Yes
392708	302907	302906	160	CIRCULAR	2	Pipe	Yes	Yes	Yes
692711	600675	600677	139	CIRCULAR	2	Pipe	Yes	Yes	Yes
692712	602875	602481	169	CIRCULAR	1	Pipe	Yes	Yes	Yes
590292	502819	502322	1077	Trapezoidal	44.3 Top W, 5.7 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
490294	401814	402611	438	Trapezoidal	16.3 Top W, 8 Bottom W, 6.2 H	Open Channel	Yes	Yes	Yes
490297	402355	402673	590	Trapezoidal	14 Top W, 10 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
392750	302950	302831	42	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
490301	401902	402360	107	Trapezoidal	14.5 Top W, 10 Bottom W, 4.5 H	Open Channel	Yes	Yes	Yes
490302	401846	402576	725	Trapezoidal	10.9 Top W, 8 Bottom W, 3.5 H	Open Channel	Yes	Yes	Yes
590303	401805	502361	139	Trapezoidal	13.4 Top W, 8 Bottom W, 4.3 H	Open Channel	Yes	Yes	Yes
490304	401820	402589	597	Trapezoidal	16.8 Top W, 8 Bottom W, 6.6 H	Open Channel	Yes	Yes	Yes
490305	401825	402590	533	Trapezoidal	13.4 Top W, 7 Bottom W, 7 H	Open Channel	Yes	Yes	Yes
590309	502550	502810	956	Trapezoidal	8.1 Top W, 5 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
590312	502381	502837	888	Trapezoidal	11 Top W, 8 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
590316	502604	501919	39	CIRCULAR	0.83	Pipe	Yes	Yes	Yes
490319	401329	402521	159	CIRCULAR	3ft, 2 Barrels	Pipe	Yes	Yes	Yes
390332	302973	302922	403	Trapezoidal	14.4 Top W, 8 Bottom W, 7 H	Open Channel	Yes	Yes	Yes
490323	401840	402369	171	Trapezoidal	11.3 Top W, 8 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
490326	402360	401847	133	Trapezoidal	11.4 Top W, 8 Bottom W, 4.1 H	Open Channel	Yes	Yes	Yes
290328	202693	202838	638	Trapezoidal	13.2 Top W, 8 Bottom W, 6.2 H	Open Channel	Yes	Yes	Yes
290331	202846	202840	572	Trapezoidal	13.6 Top W, 8 Bottom W, 6.7 H	Open Channel	Yes	Yes	Yes
390334	300297	302938	288	Trapezoidal	8.2 Top W, 4 Bottom W, 2.3 H	Open Channel	Yes	Yes	Yes
390336	302716	300308	129	Trapezoidal	4 Top W, 4 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
190340	102882	100224	2510	Trapezoidal	13 Top W, 8 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
590343	502810	501180	170	Trapezoidal	11.5 Top W, 8 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
590344	402809	502810	134	CIRCULAR	1	Pipe	Yes	Yes	Yes
590346	501893	501144	450	Trapezoidal	12.4 Top W, 4 Bottom W, 6 H	Open Channel	Yes	Yes	Yes
292620	202838	202969	78	CIRCULAR	4	Pipe	Yes	Yes	Yes
390357	302464	300362	51	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490358	401556	401557	40	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
292749	202969	202845	21	CIRCULAR	4	Pipe	Yes	Yes	Yes
390365	301944	301943	35	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
290369	200238	202859	124	CIRCULAR	2	Pipe	Yes	Yes	Yes
490371	401206	401207	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
490372	401345	401346	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290373	202194	202193	54	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390376	300376	300377	47	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
292736	202689	202962	658	Trapezoidal	12.8 Top W, 8 Bottom W, 5.8 H	Open Channel	Yes	Yes	Yes
590378	501126	501749	75	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590379	501127	501749	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490380	401189	401188	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490381	401420	401421	39	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
490382	401901	401902	70	CIRCULAR	2ft, 2 Barrels	Pipe	Yes	Yes	Yes
590384	501081	501080	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390386	301761	300316	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590387	501108	501107	38	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
292421	202962	202690	730	Trapezoidal	12.8 Top W, 8 Bottom W, 5.8 H	Open Channel	Yes	Yes	Yes
590388	501103	501102	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490389	401501	401500	62	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
490390	401502	401500	73	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
590391	501118	501119	32	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
590393	501100	501101	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490394	401464	401465	35	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590395	501135	501136	42	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
690397	600572	600571	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490398	401402	401401	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590401	500895	502431	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290403	202167	202166	28	HORIZ_ELLIPSE	1.7 H x 2.5 W, 2 Barrels	Pipe	Yes	Yes	Yes
190405	101635	101636	50	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
290407	200470	202108	33	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
490410	401190	401191	42	HORIZ_ELLIPSE	1.3 H x 1.9 W	Pipe	Yes	Yes	Yes
590411	502174	500239	47	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590412	502175	500239	57	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290414	201649	201648	29	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
490415	401747	401746	36	CIRCULAR	2	Pipe	Yes	Yes	Yes
490416	401326	401325	72	HORIZ_ELLIPSE	1.7 H x 2.5 W	Pipe	Yes	Yes	Yes
490418	401325	402520	163	CIRCULAR	2	Pipe	Yes	Yes	Yes
292424	202692	202965	345	Trapezoidal	13.2 Top W, 8 Bottom W, 6.2 H	Open Channel	Yes	Yes	Yes
390438	302812	302889	133	CIRCULAR	1.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
390449	300292	302667	148	CIRCULAR	2	Pipe	Yes	Yes	Yes
390456	301920	302891	132	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390459	300375	300376	254	CIRCULAR	2	Pipe	Yes	Yes	Yes
390461	300377	302894	191	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
390463	302937	300380	131	Trapezoidal	12 Top W, 5 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
390464	300378	300384	248	CIRCULAR	2	Pipe	Yes	Yes	Yes
390468	300306	300303	119	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
390473	300360	300311	265	Trapezoidal	13 Top W, 7 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
390480	302660	302709	128	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390483	300310	302708	142	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
390484	300266	302658	167	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390485	302670	300267	582	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390486	301774	302671	131	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390488	300271	202641	149	CIRCULAR	1.25	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
390495	302705	301950	637	Trapezoidal	6 Top W, 1 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
290503	200472	202672	894	Trapezoidal	10 Top W, 8 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
290504	202522	202343	129	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290510	201595	201594	126	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290511	202614	201588	253	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490514	401303	401302	38	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
590517	501947	501949	34	HORIZ_ELLIPSE	1.3 H x 1.9 W	Pipe	Yes	Yes	Yes
590519	501111	501110	44	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590520	500874	500875	42	HORIZ_ELLIPSE	1.5 H x 1.9 W	Pipe	Yes	Yes	Yes
290522	200462	202682	132	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290527	200486	202783	137	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290537	201610	202688	274	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290538	202777	202776	404	Trapezoidal	6 Top W, 1 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
290539	202776	201609	132	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290542	201599	202684	136	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290544	201600	202683	131	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292752	200487	202781	129	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590042	500043	502604	31	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290547	202622	202348	131	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
190552	101644	102828	139	CIRCULAR	1	Pipe	Yes	Yes	Yes
190560	102173	102328	441	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290568	201622	202352	148	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290575	201586	201587	49	CIRCULAR	1	Pipe	Yes	Yes	Yes
290579	200502	202697	114	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290581	200503	202693	152	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
590044	500044	500045	36	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290586	200508	200507	45	CIRCULAR	2	Pipe	Yes	Yes	Yes
290587	200464	202342	126	CIRCULAR	2	Pipe	Yes	Yes	Yes
290588	202934	200465	128	CIRCULAR	2	Pipe	Yes	Yes	Yes
490591	401246	401245	66	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
590596	501895	501893	58	CIRCULAR	2.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
490600	401248	401247	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590604	500899	500898	48	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390613	300359	302713	405	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390616	302462	302461	253	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390623	300275	302669	129	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390624	302669	300265	183	CIRCULAR	2	Pipe	Yes	Yes	Yes
390626	300268	302659	166	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390627	300407	202729	147	CIRCULAR	2	Pipe	Yes	Yes	Yes
690628	600529	602926	166	CIRCULAR	3	Pipe	Yes	Yes	Yes
690629	600523	600528	253	CIRCULAR	2	Pipe	Yes	Yes	Yes
690630	602387	602389	188	CIRCULAR	2	Pipe	Yes	Yes	Yes
490632	401839	402608	157	HORIZ_ELLIPSE	4.3 H x 6.4 W	Pipe	Yes	Yes	Yes
490633	401461	402580	145	CIRCULAR	2	Pipe	Yes	Yes	Yes
490639	401288	402612	142	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
190060	100065	102879	263	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
390646	300249	301755	35	HORIZ_ELLIPSE	2 H x 3.2 W	Pipe	Yes	Yes	Yes
190061	100067	100065	262	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
390651	300246	302887	142	CIRCULAR	2	Pipe	Yes	Yes	Yes
290654	202616	202916	137	CIRCULAR	2	Pipe	Yes	Yes	Yes
290655	201601	202616	57	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
590658	502182	502183	58	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
490659	401871	401873	62	CIRCULAR	4ft, 3 Barrels	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
490664	401549	401548	36	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
590665	502557	502558	70	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
190062	100069	100067	349	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
390673	301946	301945	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
490674	401446	401445	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490676	401555	401554	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390678	300345	300346	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490679	401517	401518	35	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
190063	100073	100069	353	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
490680	401520	401519	36	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490681	401254	401255	38	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
190682	101634	101633	53	HORIZ_ELLIPSE	1.3 H x 1.9 W	Pipe	Yes	Yes	Yes
590683	501030	501988	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
390684	300339	300340	38	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
290685	202027	202029	35	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290686	201614	201613	35	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290688	200506	200505	39	HORIZ_ELLIPSE	1.7 H x 2.5 W	Pipe	Yes	Yes	Yes
290689	200347	201590	39	CIRCULAR	3	Pipe	Yes	Yes	Yes
190064	100093	100073	295	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
390690	300402	300403	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
390691	300391	302486	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490694	401229	400373	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490697	402323	401913	40	CIRCULAR	2	Pipe	Yes	Yes	Yes
590698	501076	501077	40	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
290699	200420	202027	271	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290704	200427	202840	132	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
290705	200442	200441	61	HORIZ_ELLIPSE	1.3 H x 2.1 W	Pipe	Yes	Yes	Yes
290706	200448	200450	48	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
290707	202636	202347	138	Trapezoidal	6.8 Top W, 3 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
690744	600672	600671	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490066	400070	400068	326	CIRCULAR	4	Pipe	Yes	Yes	Yes
690746	602392	600675	53	CIRCULAR	2	Pipe	Yes	Yes	Yes
590747	500799	502498	63	CIRCULAR	1	Pipe	Yes	Yes	Yes
590748	500800	502498	57	CIRCULAR	1.33	Pipe	Yes	Yes	Yes
590750	502513	502364	135	CIRCULAR	1	Pipe	Yes	Yes	Yes
590751	500805	500804	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590753	500809	500808	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490067	400068	400066	318	CIRCULAR	4	Pipe	Yes	Yes	Yes
590756	502514	500816	53	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590757	500813	502514	70	CIRCULAR	0.83	Pipe	Yes	Yes	Yes
590758	500817	500818	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590759	500821	502437	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
590760	500822	500823	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590761	500824	500826	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
590762	500828	500827	48	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590763	500829	500830	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
590764	500833	500831	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590765	500834	500835	33	CIRCULAR	1	Pipe	Yes	Yes	Yes
590768	500840	500841	44	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590769	500839	500841	59	CIRCULAR	2	Pipe	Yes	Yes	Yes
590770	500844	500843	42	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590771	500848	500847	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
590772	500850	500849	32	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590773	500852	500851	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590775	500855	502459	53	CIRCULAR	1	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
490070	400066	400077	104	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
590776	502459	500857	41	CIRCULAR	1	Pipe	Yes	Yes	Yes
590778	502449	500862	72	CIRCULAR	1.67	Pipe	Yes	Yes	Yes
590781	500866	500865	62	CIRCULAR	1	Pipe	Yes	Yes	Yes
590783	500870	500871	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
590784	500876	500877	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
590785	500878	500879	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
590786	500880	500882	61	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590787	500881	500882	46	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590788	500883	500884	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590789	500886	500885	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590790	500887	500888	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
590794	500897	500896	53	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590795	500901	500900	42	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590799	500910	500909	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590800	500911	500912	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590801	500914	500913	43	CIRCULAR	1.67	Pipe	Yes	Yes	Yes
590803	500917	500918	53	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590804	500920	500919	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
590806	500933	500932	61	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590807	500934	500935	53	CIRCULAR	1	Pipe	Yes	Yes	Yes
590808	500938	500939	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590809	500936	500937	35	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590811	501993	501992	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590814	501031	501032	59	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590815	501034	501033	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590816	501037	501036	45	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
490074	400071	400070	43	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590817	501040	501039	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590818	501041	501042	34	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
590819	501044	501045	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
590820	501046	501047	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590821	501048	501049	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590822	501050	501051	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590824	501054	501741	74	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590825	501057	501741	53	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590826	501058	501059	36	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490075	400072	400071	58	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590827	501060	501061	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590829	501069	502002	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590830	501070	501071	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590832	501079	501078	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590833	501083	501082	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
590834	501085	501084	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590835	501086	501088	71	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
590836	501090	501091	44	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490076	400106	400079	53	CIRCULAR	3	Pipe	Yes	Yes	Yes
590839	501095	501094	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
590840	501096	501097	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590841	501099	501098	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590843	501112	501113	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590844	501115	501114	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590845	501116	501117	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590846	501120	501121	35	CIRCULAR	0.67	Pipe	Yes	Yes	Yes
590847	501122	501123	47	CIRCULAR	1	Pipe	Yes	Yes	Yes
590848	501125	501124	41	CIRCULAR	1	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
590849	501129	501128	49	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590850	501131	501130	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590851	501134	501133	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490853	401140	401141	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
590855	501147	501146	64	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490078	400079	400078	50	CIRCULAR	3	Pipe	Yes	Yes	Yes
590857	501153	501154	28	CIRCULAR	1	Pipe	Yes	Yes	Yes
590858	501156	501155	33	CIRCULAR	1	Pipe	Yes	Yes	Yes
490859	401892	401159	37	CIRCULAR	2	Pipe	Yes	Yes	Yes
490860	401162	401160	703	Trapezoidal	12 Top W, 4 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
490862	401164	401163	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490863	401166	401165	49	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490864	401167	401168	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590866	501177	501176	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490079	400078	400080	258	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
590867	501175	501174	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
590868	501178	501179	43	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490869	401182	401183	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
490871	401186	401187	58	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
490872	401193	401192	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
490873	401195	401194	40	VERT_ELLIPSE	2.1 H x 1.3 W	Pipe	Yes	Yes	Yes
490874	401197	401196	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
490875	401198	401199	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490877	401202	401201	41	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490878	401203	401204	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490879	401208	402595	47	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490880	401210	401211	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
490881	401214	402596	56	CIRCULAR	1	Pipe	Yes	Yes	Yes
490882	402596	402736	60	HORIZ_ELLIPSE	1.2 H x 1.8 W	Pipe	Yes	Yes	Yes
490886	401226	401225	35	CIRCULAR	1	Pipe	Yes	Yes	Yes
190082	100082	100083	18	CIRCULAR	2.83	Pipe	Yes	Yes	Yes
490887	401227	402736	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490888	401231	401230	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490889	401232	402588	67	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490891	401237	401236	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490892	401240	401241	45	CIRCULAR	1	Pipe	Yes	Yes	Yes
490893	401242	401260	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490896	401257	401256	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
190083	100084	100082	116	HORIZ_ELLIPSE	2.8 H x 4.4 W	Pipe	Yes	Yes	Yes
490897	401259	401248	82	CIRCULAR	1	Pipe	Yes	Yes	Yes
190898	101261	101262	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490899	401279	401278	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
490900	401282	401283	31	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490902	401287	401286	43	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490903	401289	401288	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490904	401291	401290	45	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490906	401296	401297	41	CIRCULAR	1	Pipe	Yes	Yes	Yes
490907	402527	401299	58	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490908	401300	402527	50	CIRCULAR	1	Pipe	Yes	Yes	Yes
490909	401305	402530	50	CIRCULAR	1	Pipe	Yes	Yes	Yes
490910	402530	401307	63	CIRCULAR	1.33	Pipe	Yes	Yes	Yes
490911	401310	401309	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
490912	401311	401309	63	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490913	401312	401313	42	CIRCULAR	1	Pipe	Yes	Yes	Yes
490915	401318	401320	41	CIRCULAR	1.67	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
490917	401323	402537	77	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490920	401331	401332	42	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490921	401333	401334	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490922	401335	401336	31	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490924	401339	401340	42	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490925	401342	402560	50	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490926	401343	401344	52	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490927	401347	401348	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391503	302872	302073	389	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490928	401349	401350	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490931	401355	401354	46	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490932	401356	402553	54	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490933	401359	402553	53	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490934	401361	401362	48	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490935	401360	401361	53	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490088	400088	400091	299	CIRCULAR	4	Pipe	Yes	Yes	Yes
490937	401366	401365	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
490938	401367	401368	48	CIRCULAR	1	Pipe	Yes	Yes	Yes
490939	401369	401370	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490941	401371	401373	64	CIRCULAR	2	Pipe	Yes	Yes	Yes
490943	401377	401903	46	CIRCULAR	1	Pipe	Yes	Yes	Yes
490944	401378	401379	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
490945	401380	401381	50	CIRCULAR	1	Pipe	Yes	Yes	Yes
490947	401385	401384	45	CIRCULAR	1	Pipe	Yes	Yes	Yes
490948	401387	401386	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
490949	401388	401389	33	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490952	401395	401394	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
490953	401397	401398	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
490954	401399	401400	38	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490955	401404	401403	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
490956	401407	401406	40	CIRCULAR	1.33	Pipe	Yes	Yes	Yes
490091	400091	400074	255	CIRCULAR	4	Pipe	Yes	Yes	Yes
490957	401410	401409	34	CIRCULAR	1	Pipe	Yes	Yes	Yes
490958	401413	401412	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
490959	401414	401415	42	CIRCULAR	1.33	Pipe	Yes	Yes	Yes
490960	401417	401416	33	CIRCULAR	1	Pipe	Yes	Yes	Yes
490962	401429	401428	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
490963	401432	401430	50	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
190089	100095	100093	151	CIRCULAR	4.5	Pipe	Yes	Yes	Yes
490969	401447	401448	42	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490970	402544	401449	55	CIRCULAR	1	Pipe	Yes	Yes	Yes
490971	401452	402544	47	CIRCULAR	1	Pipe	Yes	Yes	Yes
490972	401453	401435	36	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490974	401454	402356	119	Trapezoidal	5 Top W, 2 Bottom W, 3 H	Open Channel	Yes	Yes	Yes
490975	401456	401457	38	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490976	401458	402559	125	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490977	401459	401458	47	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490978	401462	401463	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
490979	401466	401467	42	CIRCULAR	1	Pipe	Yes	Yes	Yes
490980	401471	401472	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490981	401478	401479	77	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490982	401477	401479	68	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490984	401484	401485	34	CIRCULAR	1	Pipe	Yes	Yes	Yes
490985	401486	401487	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
490987	401491	401488	49	CIRCULAR	1.67	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
490988	401493	401492	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490989	401496	401495	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
490990	401498	401499	55	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490993	401508	401507	49	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490994	401510	401509	54	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490995	401512	401511	34	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490996	401514	401513	44	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490997	401515	401516	35	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490999	401523	401526	45	CIRCULAR	1	Pipe	Yes	Yes	Yes
491000	401524	401526	62	CIRCULAR	1	Pipe	Yes	Yes	Yes
491002	401534	401533	40	CIRCULAR	1	Pipe	Yes	Yes	Yes
491003	401531	401532	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
491004	401536	401535	26	CIRCULAR	1	Pipe	Yes	Yes	Yes
491005	401537	401538	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
491006	401540	401539	49	CIRCULAR	1	Pipe	Yes	Yes	Yes
491007	401542	401541	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
491008	401544	401543	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
491009	401545	401546	39	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
491011	401552	401553	32	CIRCULAR	1	Pipe	Yes	Yes	Yes
491012	402574	401558	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
491014	401560	401561	50	CIRCULAR	1	Pipe	Yes	Yes	Yes
491015	401563	401562	33	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
491016	401565	401564	45	CIRCULAR	1ft, 2 Barrels	Pipe	Yes	Yes	Yes
491017	401566	401567	42	CIRCULAR	1	Pipe	Yes	Yes	Yes
491019	401568	401569	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
491020	401570	401571	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
491022	401575	401576	43	CIRCULAR	1	Pipe	Yes	Yes	Yes
491024	401580	401581	37	CIRCULAR	1	Pipe	Yes	Yes	Yes
291025	201588	201589	44	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291026	201594	202614	44	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
490100	400113	400112	145	HORIZ_ELLIPSE	2 H x 3.2 W	Pipe	Yes	Yes	Yes
291027	201598	201597	50	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291028	201605	201606	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291029	201606	202327	136	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291030	201607	201608	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291034	201613	202349	146	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291037	201621	201622	40	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
190104	100103	100104	41	HORIZ_ELLIPSE	2.3 H x 3 W	Pipe	Yes	Yes	Yes
191042	101632	101631	43	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
191048	101639	101638	36	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
191050	101627	102824	130	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
191053	102170	101643	132	CIRCULAR	1	Pipe	Yes	Yes	Yes
191056	101647	102171	49	VERT_ELLIPSE	1.8 H x 1.1 W	Pipe	Yes	Yes	Yes
191057	101651	102627	38	VERT_ELLIPSE	1.3 H x 1.1 W	Pipe	Yes	Yes	Yes
191058	101653	101652	37	HORIZ_ELLIPSE	1.1 H x 1.8 W	Pipe	Yes	Yes	Yes
191062	101662	101663	39	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
191065	102628	100117	51	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
191068	101668	101669	52	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
191070	101671	102630	45	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
191071	101677	101678	53	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
191072	101680	101681	38	VERT_ELLIPSE	1.3 H x 0.9 W	Pipe	Yes	Yes	Yes
191074	101683	101682	57	HORIZ_ELLIPSE	1 H x 1.5 W	Pipe	Yes	Yes	Yes
191075	101684	101685	47	VERT_ELLIPSE	1.5 H x 0.9 W	Pipe	Yes	Yes	Yes
691078	602420	601706	54	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691079	601706	602434	154	Trapezoidal	6 Top W, 5 Bottom W, 3 H	Open Channel	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
391080	301708	301707	66	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490110	400119	400120	60	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391096	301742	301743	28	CIRCULAR	1	Pipe	Yes	Yes	Yes
391099	300380	300378	54	CIRCULAR	2	Pipe	Yes	Yes	Yes
291101	202683	201601	244	CIRCULAR	2	Pipe	Yes	Yes	Yes
691104	600578	600579	82	CIRCULAR	3	Pipe	Yes	Yes	Yes
291105	200477	202522	44	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
591106	501749	502836	112	CIRCULAR	1	Pipe	Yes	Yes	Yes
391107	301753	301754	62	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391109	302718	300293	134	CIRCULAR	2	Pipe	Yes	Yes	Yes
291113	200473	202647	136	CIRCULAR	2	Pipe	Yes	Yes	Yes
291114	202515	200473	54	HORIZ_ELLIPSE	1.3 H x 2 W	Pipe	Yes	Yes	Yes
491115	401500	401315	250	CIRCULAR	3	Pipe	Yes	Yes	Yes
191116	102685	102629	125	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491122	401766	401767	49	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
491123	401888	402579	143	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391124	300403	202727	149	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391125	300338	301768	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
491126	401277	401161	264	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391128	300346	302706	127	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391129	300247	302719	421	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391130	301755	302454	134	CIRCULAR	2	Pipe	Yes	Yes	Yes
391132	300240	300257	61	CIRCULAR	2	Pipe	Yes	Yes	Yes
391133	302455	300249	127	HORIZ_ELLIPSE	2 H x 3.2 W	Pipe	Yes	Yes	Yes
391136	300316	302456	136	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391137	300318	300317	29	CIRCULAR	2	Pipe	Yes	Yes	Yes
290120	200127	200125	53	CIRCULAR	2	Pipe	Yes	Yes	Yes
391142	302631	301772	74	CIRCULAR	1	Pipe	Yes	Yes	Yes
391143	301772	300359	33	CIRCULAR	1	Pipe	Yes	Yes	Yes
391144	300336	301920	48	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391146	300307	302707	145	CIRCULAR	1	Pipe	Yes	Yes	Yes
391147	300283	300282	37	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391148	301994	300280	31	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391150	300272	300271	36	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391151	301773	302670	134	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391153	300274	302670	128	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391155	300276	300275	49	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391158	302656	302715	118	CIRCULAR	1	Pipe	Yes	Yes	Yes
391160	300291	300294	263	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391161	300290	300291	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
391162	302938	300261	170	CIRCULAR	3	Pipe	Yes	Yes	Yes
391163	300298	300297	40	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
391164	300286	300287	48	CIRCULAR	2	Pipe	Yes	Yes	Yes
391165	300308	300309	47	CIRCULAR	1.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
391166	302492	300407	47	CIRCULAR	2	Pipe	Yes	Yes	Yes
391167	302490	202727	152	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391168	300404	302490	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
391172	300389	300400	599	CIRCULAR	1	Pipe	Yes	Yes	Yes
391173	300388	300389	36	CIRCULAR	1	Pipe	Yes	Yes	Yes
291176	202672	200478	134	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291177	200478	200479	44	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291178	200479	202646	128	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291181	200465	200464	54	CIRCULAR	2	Pipe	Yes	Yes	Yes
191182	102853	102332	591	Trapezoidal	12 Top W, 10 Bottom W, 5 H	Open Channel	Yes	Yes	Yes
191184	101656	102696	131	CIRCULAR	1	Pipe	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
191187	102627	102695	133	CIRCULAR	1	Pipe	Yes	Yes	Yes
291191	200467	200466	36	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291192	200458	200457	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
291194	202344	200458	132	Trapezoidal	6 Top W, 2 Bottom W, 4 H	Open Channel	Yes	Yes	Yes
691196	600574	602460	153	CIRCULAR	2	Pipe	Yes	Yes	Yes
691197	600573	600574	38	CIRCULAR	2	Pipe	Yes	Yes	Yes
691201	601855	601856	59	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691202	600557	602388	74	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
691203	600556	602388	46	CIRCULAR	1	Pipe	Yes	Yes	Yes
691205	600542	600541	39	CIRCULAR	1	Pipe	Yes	Yes	Yes
691206	600546	602387	61	CIRCULAR	1	Pipe	Yes	Yes	Yes
691207	600545	602387	44	CIRCULAR	1	Pipe	Yes	Yes	Yes
691208	600544	600543	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
691209	600533	600534	38	CIRCULAR	1	Pipe	Yes	Yes	Yes
691212	600515	600516	60	CIRCULAR	3	Pipe	Yes	Yes	Yes
691214	600517	600518	50	CIRCULAR	3	Pipe	Yes	Yes	Yes
391215	300414	302705	127	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391216	300413	302832	152	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
691220	601788	601787	104	CIRCULAR	3	Pipe	Yes	Yes	Yes
691222	601789	601790	102	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
691224	600775	602249	33	CIRCULAR	2	Pipe	Yes	Yes	Yes
691225	600771	600772	56	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
691226	601792	601791	108	CIRCULAR	3.33	Pipe	Yes	Yes	Yes
591227	501793	501794	51	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591228	501795	501796	55	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
591230	501797	501798	54	CIRCULAR	2	Pipe	Yes	Yes	Yes
591235	501917	501916	52	CIRCULAR	3	Pipe	Yes	Yes	Yes
591236	501137	502880	155	CIRCULAR	3	Pipe	Yes	Yes	Yes
290129	200129	200128	41	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
591238	501144	501145	62	CIRCULAR	3.5	Pipe	Yes	Yes	Yes
591240	501172	501173	75	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
491241	401804	401805	55	CIRCULAR	3	Pipe	Yes	Yes	Yes
290156	200125	200165	577	CIRCULAR	4	Pipe	Yes	Yes	Yes
291245	201599	201600	37	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291247	201618	201617	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
292769	201619	202790	213	CIRCULAR	1	Pipe	Yes	Yes	Yes
290580	201756	202940	507	Trapezoidal	6.6 Top W, 4 Bottom W, 3.2 H	Open Channel	Yes	Yes	Yes
291244	201808	201809	37	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
392763	302024	302968	155	CIRCULAR	2	Pipe	Yes	Yes	Yes
291248	202606	200491	50	VERT_ELLIPSE	2.5 H x 1.5 W	Pipe	Yes	Yes	Yes
391159	302668	300290	137	CIRCULAR	2	Pipe	Yes	Yes	Yes
392785	302857	302966	42	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292727	202940	200498	474	Trapezoidal	6.6 Top W, 4 Bottom W, 3.2 H	Open Channel	Yes	Yes	Yes
392762	302028	302949	33	CIRCULAR	2	Pipe	Yes	Yes	Yes
392782	302951	302952	67	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
392783	302952	302973	44	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292771	202958	202962	40	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292770	202959	202958	72	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292773	202961	202970	41	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292774	202963	202964	72	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292775	202964	202965	41	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe	Yes	Yes	Yes
292744	202965	202693	68	Trapezoidal	13.2 Top W, 8 Bottom W, 6.2 H	Open Channel	Yes	Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
390016	300009	301929	78	CIRCULAR	2	Pipe	Yes	Yes	Yes
491277	401817	401816	70	CIRCULAR	4.5	Pipe		Yes	Yes
590133	500141	500142	60	CIRCULAR	3	Pipe		Yes	Yes
492756	401824	401825	76	CIRCULAR	5	Pipe		Yes	Yes
391292	302887	302666	316	Trapezoidal	18 Top W, 8 Bottom W, 6 H	Open Channel		Yes	Yes
491298	401476	401475	58	CIRCULAR	4	Pipe		Yes	Yes
590135	500143	500144	35	CIRCULAR	3.5	Pipe		Yes	Yes
391316	300284	300285	39	CIRCULAR	2	Pipe		Yes	Yes
590137	500139	500143	173	CIRCULAR	3.5	Pipe		Yes	Yes
491343	401499	402536	169	CIRCULAR	2	Pipe		Yes	Yes
591355	401882	502542	189	CIRCULAR	2	Pipe		Yes	Yes
391410	301950	301948	50	CIRCULAR	1.5	Pipe		Yes	Yes
391438	300267	300266	56	CIRCULAR	1.5	Pipe		Yes	Yes
290147	200154	200153	36	CIRCULAR	1.5	Pipe		Yes	Yes
391445	302491	202726	139	CIRCULAR	2	Pipe		Yes	Yes
291471	202022	202720	34	CIRCULAR	1.25	Pipe		Yes	Yes
591496	502060	502445	65	CIRCULAR	1.25	Pipe		Yes	Yes
691566	602128	601832	262	CIRCULAR	3.5	Pipe		Yes	Yes
691572	602124	602123	24	CIRCULAR	1.5	Pipe		Yes	Yes
391624	302229	301965	95	CIRCULAR	1	Pipe		Yes	Yes
391628	301967	301969	238	CIRCULAR	1.5ft, 2 Barrels	Pipe		Yes	Yes
391645	300022	300006	40	CIRCULAR	0.5	Pipe		Yes	Yes
691712	600698	602481	129	CIRCULAR	3	Pipe		Yes	Yes
692766	600685	602481	167	CIRCULAR	3ft, 2 Barrels	Pipe		Yes	Yes
391719	300374	300375	43	CIRCULAR	2	Pipe		Yes	Yes
491748	401913	402736	214	CIRCULAR	2	Pipe		Yes	Yes
691768	600704	600703	31	CIRCULAR	2	Pipe		Yes	Yes
390205	300183	300181	231	CIRCULAR	1.5	Pipe		Yes	Yes
691777	600674	600673	29	CIRCULAR	1.25	Pipe		Yes	Yes
191822	101262	102648	412	CIRCULAR	3.33	Pipe		Yes	Yes
391824	302742	302757	397	CIRCULAR	2	Pipe		Yes	Yes
191855	102328	102176	366	TRIANGULAR	1.3 H x 30 W	Pipe		Yes	Yes
690217	600196	600197	61	CIRCULAR	1.5	Pipe		Yes	Yes
690220	600199	600198	62	CIRCULAR	1.5	Pipe		Yes	Yes
591929	502383	502380	928	Trapezoidal	11 Top W, 8 Bottom W, 6 H	Open Channel		Yes	Yes
691947	602292	600710	21	CIRCULAR	3	Pipe		Yes	Yes
691948	600710	600709	28	CIRCULAR	3	Pipe		Yes	Yes
691951	602397	600685	334	Trapezoidal	15 Top W, 5 Bottom W, 4 H	Open Channel		Yes	Yes
690226	600205	600206	59	CIRCULAR	2.5	Pipe		Yes	Yes
690228	602878	600203	65	CIRCULAR	1.5	Pipe		Yes	Yes
592006	502822	502432	1342	Trapezoidal	20 Top W, 8 Bottom W, 5 H	Open Channel		Yes	Yes
692012	600707	602481	152	CIRCULAR	3.5	Pipe		Yes	Yes
692020	600519	602435	184	Trapezoidal	25 Top W, 5 Bottom W, 1.3 H	Open Channel		Yes	Yes
690231	600209	602481	212	CIRCULAR	2	Pipe		Yes	Yes
690232	600212	600210	92	CIRCULAR	1.5	Pipe		Yes	Yes
690234	600211	602481	136	CIRCULAR	2.5	Pipe		Yes	Yes
492250	402555	402554	359	Trapezoidal	11.2 Top W, 10 Bottom W, 3.5 H	Open Channel		Yes	Yes
492304	401290	401289	99	Trapezoidal	26.8 Top W, 5 Bottom W, 2.6 H	Open Channel		Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
390265	302894	302852	1012	Trapezoidal	18 Top W, 6 Bottom W, 7 H	Open Channel		Yes	Yes
492340	401314	402607	160	CIRCULAR	3	Pipe		Yes	Yes
192383	102648	100084	403	CIRCULAR	3.33	Pipe		Yes	Yes
392401	302666	300242	108	Trapezoidal	18 Top W, 8 Bottom W, 6 H	Open Channel		Yes	Yes
392467	302741	302742	33	CIRCULAR	1	Pipe		Yes	Yes
190271	102171	102354	130	CIRCULAR	2.5	Pipe		Yes	Yes
492567	402815	401813	159	CIRCULAR	1.24	Pipe		Yes	Yes
592573	502412	502822	1342	Trapezoidal	20 Top W, 8 Bottom W, 5 H	Open Channel		Yes	Yes
490281	402521	402520	725	Trapezoidal	11.3 Top W, 8 Bottom W, 4 H	Open Channel		Yes	Yes
392680	301969	302886	32	CIRCULAR	1.5	Pipe		Yes	Yes
392681	301968	302886	129	CIRCULAR	1.5	Pipe		Yes	Yes
392694	302489	202728	143	CIRCULAR	2	Pipe		Yes	Yes
392709	301957	302908	151	CIRCULAR	1.25	Pipe		Yes	Yes
590349	502430	502412	485	Trapezoidal	20 Top W, 10 Bottom W, 6 H	Open Channel		Yes	Yes
490356	401439	401438	35	CIRCULAR	1.5	Pipe		Yes	Yes
290364	200495	200237	264	CIRCULAR	1.5	Pipe		Yes	Yes
690375	601860	600527	37	CIRCULAR	1.25	Pipe		Yes	Yes
292743	202691	202970	112	Trapezoidal	12.9 Top W, 8 Bottom W, 5.9 H	Open Channel		Yes	Yes
290399	201688	202686	37	CIRCULAR	1.25	Pipe		Yes	Yes
292423	202970	202692	641	Trapezoidal	12.9 Top W, 8 Bottom W, 5.9 H	Open Channel		Yes	Yes
290526	200492	202784	135	CIRCULAR	1.5	Pipe		Yes	Yes
290584	200505	202692	149	CIRCULAR	2.5	Pipe		Yes	Yes
490607	401914	400273	64	VERT_ELLIPSE	1.8 H x 1.2 W	Pipe		Yes	Yes
490608	401915	400273	48	VERT_ELLIPSE	1.8 H x 1.2 W	Pipe		Yes	Yes
390650	300245	300246	46	CIRCULAR	2	Pipe		Yes	Yes
490675	401275	401277	34	CIRCULAR	1.25	Pipe		Yes	Yes
490687	401419	401888	50	HORIZ_ELLIPSE	1.5 H x 1.9 W	Pipe		Yes	Yes
590766	500836	500838	46	CIRCULAR	2	Pipe		Yes	Yes
590767	500837	500838	53	CIRCULAR	2	Pipe		Yes	Yes
590791	500889	502381	149	Trapezoidal	12 Top W, 8 Bottom W, 3 H	Open Channel		Yes	Yes
590805	500930	500931	36	CIRCULAR	1.25	Pipe		Yes	Yes
590812	501026	501025	40	CIRCULAR	2.4	Pipe		Yes	Yes
590837	501089	501091	78	CIRCULAR	1.67	Pipe		Yes	Yes
490081	400080	400088	337	CIRCULAR	3.5	Pipe		Yes	Yes
490883	401219	401218	60	CIRCULAR	1.5	Pipe		Yes	Yes
490895	401253	401252	61	CIRCULAR	1.25	Pipe		Yes	Yes
490919	401327	401325	35	VERT_ELLIPSE	2.4 H x 1.5 W	Pipe		Yes	Yes
490087	400090	400088	96	CIRCULAR	1.5	Pipe		Yes	Yes
490929	401293	401292	33	CIRCULAR	1.5	Pipe		Yes	Yes
490961	401422	401424	60	CIRCULAR	1.5	Pipe		Yes	Yes
191040	101628	101627	37	CIRCULAR	1.5	Pipe		Yes	Yes
391097	300277_2	300277	41	CIRCULAR	1.5	Pipe		Yes	Yes
491111	401758	401760	34	CIRCULAR	1.25ft, 2 Barrels	Pipe		Yes	Yes
491120	401762	401763	55	CIRCULAR	3ft, 2 Barrels	Pipe		Yes	Yes
290124	200133	200131	248	CIRCULAR	2.5	Pipe		Yes	Yes
290125	200135	200133	51	CIRCULAR	1.5	Pipe		Yes	Yes
691223	602249	602407	171	Trapezoidal	18 Top W, 2 Bottom W, 3 H	Open Channel		Yes	Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
390006	301932	300228	192	CIRCULAR	2.5	Pipe		Yes	Yes
390003	300004	300002	29	CIRCULAR	2	Pipe		Yes	Yes
390007	300005	300004	35	CIRCULAR	2	Pipe		Yes	Yes
292780	202957	200434	136	Trapezoidal	25 Top W, 5 Bottom W, 2 H	Open Channel		Yes	Yes
392786	302923	302971	127	CIRCULAR	4	Pipe		Yes	Yes
491385	401373	402325	153	CIRCULAR	2.5	Pipe	Yes	Yes	Yes
291518	202164	202163	46	CIRCULAR	2	Pipe	Yes	Yes	Yes
490967	401440	401441	40	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
291264	202721	202728	147	CIRCULAR	2.5	Pipe			Yes
291268	202023	200418	261	Trapezoidal	8 Top W, 0.5 Bottom W, 2 H	Open Channel			Yes
491272	401810	402585	112	Trapezoidal	23.2 Top W, 6 Bottom W, 4.7 H	Open Channel			Yes
491282	401460	401461	40	CIRCULAR	2	Pipe			Yes
691291	201833	601832	240	CIRCULAR	4	Pipe			Yes
491293	401834	402366	569	Trapezoidal	10.8 Top W, 6 Bottom W, 4 H	Open Channel			Yes
491301	401838	401839	61	HORIZ_ELLIPSE	3.6 H x 5.7 W, 2 Barrels	Pipe			Yes
691333	601861	601862	59	CIRCULAR	3	Pipe			Yes
491357	401337	402576	145	CIRCULAR	3	Pipe			Yes
491358	401488	402534	139	CIRCULAR	2.5	Pipe			Yes
591396	501926	502621	128	CIRCULAR	2	Pipe			Yes
591406	501091	502619	128	CIRCULAR	3.5	Pipe			Yes
391421	302700	301959	29	CIRCULAR	1	Pipe			Yes
391424	301970	302234	53	CIRCULAR	1.5	Pipe			Yes
391428	301976	301977	80	CIRCULAR	1	Pipe			Yes
391429	301977	301935	59	CIRCULAR	1	Pipe			Yes
391430	301978	301935	43	CIRCULAR	1.25	Pipe			Yes
391443	300279	302712	127	CIRCULAR	1.5	Pipe			Yes
391446	302486	202725	139	CIRCULAR	2	Pipe			Yes
391466	302015	302283	69	CIRCULAR	4	Pipe			Yes
290149	200157_2	200157	35	CIRCULAR	2	Pipe			Yes
391486	302800	302801	202	Trapezoidal	13.6 Top W, 8 Bottom W, 3.5 H	Open Channel			Yes
691516	602099	602098	51	CIRCULAR	1.25	Pipe			Yes
391546	301709	302792	29	CIRCULAR	1	Pipe			Yes
391549	302038	302039	154	CIRCULAR	1.5	Pipe			Yes
491598	402136	402137	139	CIRCULAR	2	Pipe			Yes
391607	302094	301703	163	CIRCULAR	2	Pipe			Yes
290159	200163	202933	138	CIRCULAR	4	Pipe			Yes
391615	302012	301957	151	CIRCULAR	1.25	Pipe			Yes
391617	302225	301959	211	CIRCULAR	1.25	Pipe			Yes
391619	301959	301960	110	CIRCULAR	1.25	Pipe			Yes
691641	602242	602243	60	CIRCULAR	1	Pipe			Yes
391699	300323	302318	33	CIRCULAR	2	Pipe			Yes
391722	300255	300244	163	CIRCULAR	1.25	Pipe			Yes
591730	501042	500043	143	CIRCULAR	3.5	Pipe			Yes
691761	600688	602397	150	CIRCULAR	2	Pipe			Yes
691769	600701	600700	33	CIRCULAR	1.25	Pipe			Yes
591833	502322	502867	366	Trapezoidal	44.3 Top W, 5.7 Bottom W, 3 H	Open Channel			Yes
690213	600192	600191	127	CIRCULAR	2.5	Pipe			Yes
690214	600193	600192	49	CIRCULAR	2.5	Pipe			Yes
690215	600194	600193	197	CIRCULAR	2	Pipe			Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
291872	202166	202347	111	Trapezoidal	8 Top W, 6 Bottom W, 5 H	Open Channel			Yes
690218	600197	600200	61	CIRCULAR	2	Pipe			Yes
691964	602410	602408	199	Trapezoidal	40 Top W, 10 Bottom W, 6 H	Open Channel			Yes
691991	600794	602289	43	CIRCULAR	3	Pipe			Yes
690230	600208	600209	62	CIRCULAR	1.5	Pipe			Yes
692049	600782	602453	140	CIRCULAR	1.5	Pipe			Yes
690233	600210	600211	56	CIRCULAR	2	Pipe			Yes
692054	600537	600538	37	VERT_ELLIPSE	1.5 H x 0.9 W	Pipe			Yes
492174	402524	402483	304	Trapezoidal	14.7 Top W, 8 Bottom W, 8 H	Open Channel			Yes
492184	401554	401549	292	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel			Yes
492188	401475	402533	212	Trapezoidal	12.8 Top W, 8 Bottom W, 4.2 H	Open Channel			Yes
590246	502057	502380	455	Trapezoidal	12 Top W, 8 Bottom W, 3 H	Open Channel			Yes
492324	401890	402594	140	Trapezoidal	6.3 Top W, 3 Bottom W, 5 H	Open Channel			Yes
492326	402612	402613	262	Trapezoidal	7.1 Top W, 3 Bottom W, 6.2 H	Open Channel			Yes
392386	302651	302652	145	CIRCULAR	2.5	Pipe			Yes
392387	302652	302653	421	Trapezoidal	12.5 Top W, 6 Bottom W, 6 H	Open Channel			Yes
392389	302653	302764	46	Trapezoidal	12.5 Top W, 6 Bottom W, 6 H	Open Channel			Yes
192409	102677	102678	30	VERT_ELLIPSE	1.8 H x 1.1 W	Pipe			Yes
692455	600510	600550	1253	Trapezoidal	17.6 Top W, 5 Bottom W, 1.5 H	Open Channel			Yes
392475	302752	302754	61	CIRCULAR	1.5	Pipe			Yes
392532	302791	302792	74	Trapezoidal	11 Top W, 8 Bottom W, 1.9 H	Open Channel			Yes
392554	300386	202805	142	CIRCULAR	2	Pipe			Yes
492569	402821	402818	31	CIRCULAR	1.5	Pipe			Yes
192582	102329	101671	353	Trapezoidal	9.5 Top W, 5 Bottom W, 3 H	Open Channel			Yes
392734	302852	302949	63	Trapezoidal	18 Top W, 6 Bottom W, 7 H	Open Channel			Yes
292596	202840	200430	260	Trapezoidal	13.3 Top W, 8 Bottom W, 6.3 H	Open Channel			Yes
692601	502843	602416	1746	Trapezoidal	45 Top W, 23.4 Bottom W, 3 H	Open Channel			Yes
392624	302025	302030	84	CIRCULAR	1.25	Pipe			Yes
392639	300592	300591	77	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe			Yes
392688	302890	302909	88	Trapezoidal	18 Top W, 6 Bottom W, 7 H	Open Channel			Yes
392689	302910	302891	85	Trapezoidal	18 Top W, 6 Bottom W, 7 H	Open Channel			Yes
392710	302908	302975	135	CIRCULAR	1.25	Pipe			Yes
590308	502361	501884	1001	Trapezoidal	13 Top W, 8 Bottom W, 5 H	Open Channel			Yes
590310	502542	502551	745	Trapezoidal	13 Top W, 8 Bottom W, 5 H	Open Channel			Yes
291562	200432	202972	73	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe			Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
390338	300282	301994	546	Trapezoidal	8 Top W, 3 Bottom W, 4 H	Open Channel			Yes
290339	202163	202934	855	Trapezoidal	12 Top W, 6 Bottom W, 4 H	Open Channel			Yes
292748	202972	200430	43	HORIZ_ELLIPSE	1.2 H x 1.9 W	Pipe			Yes
190341	101640	102826	142	CIRCULAR	1.25	Pipe			Yes
690352	601791	602410	478	Trapezoidal	40 Top W, 10 Bottom W, 6 H	Open Channel			Yes
590355	501074	502361	147	CIRCULAR	2.5	Pipe			Yes
490359	400234	400235	40	CIRCULAR	1.25ft, 2 Barrels	Pipe			Yes
590392	501075	501074	46	CIRCULAR	2	Pipe			Yes
490396	401823	401822	48	CIRCULAR	3ft, 2 Barrels	Pipe			Yes
390436	301921	302890	136	CIRCULAR	1.5	Pipe			Yes
390441	300314	300258	1103	Trapezoidal	8.5 Top W, 3 Bottom W, 4.4 H	Open Channel			Yes
390442	300259	302653	145	CIRCULAR	2.5	Pipe			Yes
390479	302710	302661	138	Trapezoidal	5.5 Top W, 4 Bottom W, 2.3 H	Open Channel			Yes
190549	101682	102337	126	CIRCULAR	1.5	Pipe			Yes
290572	202193	202777	125	Trapezoidal	6 Top W, 3 Bottom W, 3 H	Open Channel			Yes
290576	202698	200508	844	CIRCULAR	2	Pipe			Yes
290582	202704	200504	507	Trapezoidal	9.2 Top W, 8 Bottom W, 4.6 H	Open Channel			Yes
390597	300261	300241	52	CIRCULAR	3	Pipe			Yes
490609	400273	402589	146	CIRCULAR	3	Pipe			Yes
390057	300062	302227	77	CIRCULAR	3.5	Pipe			Yes
390059	302884	300062	480	CIRCULAR	2.5	Pipe			Yes
490631	402525	402368	721	Trapezoidal	11.3 Top W, 10 Bottom W, 2.6 H	Open Channel			Yes
490637	402594	402612	562	Trapezoidal	6.6 Top W, 3 Bottom W, 5.5 H	Open Channel			Yes
690643	502843	602876	2298	Trapezoidal	45 Top W, 23.4 Bottom W, 3 H	Open Channel			Yes
290709	200496	202940	132	Trapezoidal	5.2 Top W, 4 Bottom W, 2.9 H	Open Channel			Yes
590793	500893	500892	38	CIRCULAR	1.25	Pipe			Yes
490072	400075	400077	169	CIRCULAR	1.5	Pipe			Yes
590828	501067	501951	42	CIRCULAR	1.5	Pipe			Yes
490901	401284	402555	230	CIRCULAR	2	Pipe			Yes
490914	401315	401314	55	CIRCULAR	3	Pipe			Yes
490916	401316	401317	40	CIRCULAR	1.5	Pipe			Yes
190086	100083	100089	232	CIRCULAR	4.42	Pipe			Yes
490968	401443	401444	40	CIRCULAR	1.25	Pipe			Yes
490998	401521	401522	33	CIRCULAR	1.5	Pipe			Yes
291032	201609	201610	37	CIRCULAR	1.5	Pipe			Yes
191044	102785	101632	126	Trapezoidal	6 Top W, 4 Bottom W, 5 H	Open Channel			Yes
190106	100117	102331	131	CIRCULAR	2.5	Pipe			Yes
490109	400120	400064	157	CIRCULAR	1.5	Pipe			Yes
391110	301943	302718	132	Trapezoidal	5 Top W, 4 Bottom W, 4 H	Open Channel			Yes
591117	500239	502837	155	CIRCULAR	2	Pipe			Yes
391141	301769	301770	66	CIRCULAR	3	Pipe			Yes
391145	300344	300305	130	CIRCULAR	2	Pipe			Yes
391154	301776	301775	40	CIRCULAR	1.5	Pipe			Yes

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Type	Capacity Limited for the 10yr-24hr Design Storm Event	Capacity Limited for the 25yr-24hr Design Storm Event	Capacity Limited for the 100yr-24hr Design Storm Event
391171	300400	301778	17	Trapezoidal	3 Top W, 0.7 Bottom W, 2 H	Open Channel			Yes
191186	102330	102628	152	CIRCULAR	1.25	Pipe			Yes
691213	600518	602391	184	CIRCULAR	3	Pipe			Yes
290127	200130	200440	203	CIRCULAR	3.5	Pipe			Yes
591233	502510	501801	64	CIRCULAR	3	Pipe			Yes
390015	300011	300009	258	CIRCULAR	2	Pipe			Yes
390005	300002	301932	18	CIRCULAR	2	Pipe			Yes
390004	300021	301932	248	CIRCULAR	2	Pipe			Yes
390020	300023	300024	276	CIRCULAR	3	Pipe			Yes
390019	300024	300021	73	CIRCULAR	3	Pipe			Yes
390032	300026	300029	554	CIRCULAR	1.25	Pipe			Yes
390023	300027	300025	41	CIRCULAR	1.25	Pipe			Yes
390033	300027	300030	541	CIRCULAR	1.25	Pipe			Yes
390022	300028	300027	97	CIRCULAR	1.25	Pipe			Yes
390030	300029	300032	370	CIRCULAR	1.25	Pipe			Yes
390024	302761	300026	88	CIRCULAR	1.25	Pipe			Yes
390002	300003	300004	93	CIRCULAR	2	Pipe			Yes
392731	302856	302966	110	Trapezoidal	18 Top W, 6 Bottom W, 7 H	Open Channel			Yes
390008	300006	300005	83	CIRCULAR	2	Pipe			Yes
390018	300007	300006	149	CIRCULAR	2	Pipe			Yes
390017	300008	300007	75	CIRCULAR	2	Pipe			Yes
492237	401352	401350	91	CIRCULAR	1.5	Pipe	Yes	Yes	Yes
490409	401881	401426	39	CIRCULAR	1.5ft, 2 Barrels	Pipe	Yes	Yes	Yes
490592	402587	401245	74	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
490940	401372	401373	39	CIRCULAR	1.25	Pipe	Yes	Yes	Yes
391152	301774	301773	34	CIRCULAR	1.5	Pipe		Yes	Yes
490894	401250	401249	51	CIRCULAR	1.25ft, 2 Barrels	Pipe	Yes	Yes	Yes
291190	200469	200468	38	CIRCULAR	1	Pipe	Yes	Yes	Yes

Note: The capacity limited conduit summary table only includes conduits included in the Existing Conditions Model.

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Slope (%)
191039	101626	101625	43	CIRCULAR	2	-0.2%
191041	101630	101629	44	CIRCULAR	2.5	-0.2%
191055	101645	101644	43	CIRCULAR	1	-0.5%
191314	101678	102333	128	CIRCULAR	2.5	-0.2%
192504	101629	102823	132	CIRCULAR	2.5	-0.3%
290118	200124	200125	59	CIRCULAR	4	-0.2%
290121	200159	200130	196	CIRCULAR	3.5	-0.2%
290122	200131	200130	48	CIRCULAR	3	-2.5%
290126	200134	200133	44	CIRCULAR	1.5	-0.7%
290130	200137	200138	56	CIRCULAR	1.5	-0.9%
290139	200150	200151	53	CIRCULAR	1.5	-0.5%
290140	200152	200151	56	CIRCULAR	1.5	-1.3%
290144	200145	200146	64	CIRCULAR	1.5	-0.2%
290145	200147	200146	44	CIRCULAR	2	-1.5%
290146	200146	200153	234	CIRCULAR	2.5	-0.2%
290147	200154	200153	36	CIRCULAR	1.5	-0.1%
290149	200157_2	200157	35	CIRCULAR	2	-0.1%
290150	200157	200156	278	CIRCULAR	2	-0.2%
290361	200237	200236	72	CIRCULAR	1.25	-0.1%
290363	200236	201756	39	HORIZ_ELLIPSE	1 H x 1.42 W	-0.3%
290512	201589	200347	723	CIRCULAR	2	-0.01%
290569	202687	202350	142	CIRCULAR	2	-0.03%
290585	200507	202778	132	CIRCULAR	2	-0.6%
291029	201606	202327	136	CIRCULAR	1.5	-0.1%
291036	101620	201619	49	CIRCULAR	1.5	-0.2%
291249	200491	202346	141	CIRCULAR	1.5	-0.1%
291259	202939	200506	156	CIRCULAR	2.5	-0.1%
291467	202017	202016	49	CIRCULAR	1.25	-0.6%
390374	300333	302812	45	CIRCULAR	1.5	-0.4%
390377	300337	301942	42	CIRCULAR	1.5	-1.1%
390428	300257	302650	133	CIRCULAR	2	-0.9%
390450	300340	302759	134	CIRCULAR	1	-0.3%
390465	300383	302852	138	CIRCULAR	2.5	-0.01%
390470	300304	302842	133	CIRCULAR	2	-0.1%
390481	302476	302709	133	CIRCULAR	1.25	-0.04%
390618	300342	302841	128	CIRCULAR	4	-0.2%
390647	300250	300251	36	CIRCULAR	1.25	-0.3%
391142	302631	301772	74	CIRCULAR	1	-0.1%
391149	300280	300281	48	CIRCULAR	2.5	-0.8%
391156	300265	300264	44	CIRCULAR	1.5	-1.6%
391157	300288	302656	40	CIRCULAR	1	-1.3%
391169	300401	202728	149	CIRCULAR	2	-0.1%
391175	302477	302476	44	CIRCULAR	1.25	-0.5%
391317	300311	300310	54	CIRCULAR	2.5	-0.2%
391318	300411	300410	44	CIRCULAR	1.5	-0.2%

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Slope (%)
391336	300354	300355	38	CIRCULAR	2.5	-0.8%
391393	301922	301921	39	CIRCULAR	1.5	-0.5%
391407	300248	301939	34	CIRCULAR	2	-0.6%
391408	300315	300314	39	CIRCULAR	2.5	-0.3%
391440	300269	300268	53	CIRCULAR	1.5	-0.2%
391448	300343	300342	40	CIRCULAR	4	-1.0%
391449	302461	300348	41	CIRCULAR	2.5	-0.5%
391642	301986	302806	28	CIRCULAR	1.25	-3.9%
392386	302651	302652	145	CIRCULAR	2.5	-0.2%
392388	300260	300259	50	CIRCULAR	2.5	-1.2%
392469	302748	302750	35	CIRCULAR	1	-0.8%
392476	302754	302756	63	CIRCULAR	2	-2.5%
392477	302757	301984	99	CIRCULAR	2.5	-0.1%
392481	302744	302760	154	CIRCULAR	1.25	-1.1%
392714	302909	302910	102	CIRCULAR	5	-0.1%
392786	302923	302971	127	CIRCULAR	4	-0.02%
490603	401213	401212	38	CIRCULAR	1.25	-0.3%
490696	400373	400372	120	CIRCULAR	1.5	-0.2%
490861	401161	401162	73	CIRCULAR	2	-0.3%
490865	401171	401169	45	CIRCULAR	1	-0.2%
490870	401184	401185	52	CIRCULAR	1.5	-0.2%
490885	401223	401224	70	CIRCULAR	1.25	-0.3%
490890	402588	401235	53	CIRCULAR	1.25	-0.2%
490901	401284	402555	230	CIRCULAR	2	-0.2%
490905	401295	401294	41	CIRCULAR	1.5	-0.5%
490918	401324	402537	39	CIRCULAR	1.5	-0.8%
490923	401338	401337	36	CIRCULAR	2	-0.3%
490930	401353	401352	41	CIRCULAR	1.5	-1.0%
490936	401364	401363	47	CIRCULAR	1.25	-0.4%
490942	401375	401903	71	CIRCULAR	2	-0.4%
490946	401382	401383	34	CIRCULAR	1	-0.3%
490951	401393	401392	42	CIRCULAR	1.25	-0.7%
490964	401431	401430	64	CIRCULAR	1.5	-0.5%
490965	401434	401433	40	CIRCULAR	1.5	-0.2%
490966	401436	401437	78	CIRCULAR	1.5	-0.3%
490973	401455	401454	52	CIRCULAR	1.5	-0.6%
490983	401480	401481	39	CIRCULAR	1.5	-0.8%
490986	401490	401488	51	CIRCULAR	1.25	-0.4%
490992	401506	401505	44	CIRCULAR	1	-0.2%
491001	401528	401529	57	CIRCULAR	1	-0.2%
491010	401551	402367	35	CIRCULAR	2	-0.9%
491012	402574	401558	44	CIRCULAR	1	-0.5%
491021	401573	401574	39	CIRCULAR	1	-0.3%

Pipe Asset ID	Inlet Node Asset ID	Outlet Node Asset ID	Length (ft)	Pipe Shape	Diameter (ft)	Slope (%)
491023	401577	401578	41	CIRCULAR	1	-0.2%
491243	401807	401806	31	CIRCULAR	1.5	-0.3%
491281	401819	401818	81	CIRCULAR	2.5	-0.7%
491595	402142	402216	109	CIRCULAR	2	-0.1%
491747	401899	401246	193	CIRCULAR	1	-0.4%
492334	402600	402601	38	CIRCULAR	1	-0.2%
492566	402816	402815	38	CIRCULAR	0.5	-0.04%
492753	401821	401820	61	HORIZ_ELLIPSE	3.7 H X 5.7 W	-0.2%
590755	500811	500810	38	CIRCULAR	1	-0.5%
590774	500854	500853	38	CIRCULAR	1.25	-0.3%
590779	500863	500864	57	CIRCULAR	1.25	-0.5%
590782	500869	500868	38	CIRCULAR	1.25	-0.3%
590792	500891	500189	119	CIRCULAR	1	-0.3%
590796	500902	500903	41	CIRCULAR	1	-0.2%
590797	500906	500905	42	CIRCULAR	1.5	-0.7%
590806	500933	500932	61	CIRCULAR	1.25	-0.2%
590813	501029	501028	39	CIRCULAR	1	-0.3%
590823	501052	501053	39	CIRCULAR	1.25	-0.3%
590831	501073	501072	42	CIRCULAR	1	-0.5%
590838	501093	501092	35	CIRCULAR	1.25	-1.7%
590842	501105	501106	39	CIRCULAR	1.25	-0.8%
590856	501149	501150	39	CIRCULAR	1.25	-0.3%
591231	501799	502510	87	CIRCULAR	3	-1.7%
591237	501803	501137	51	CIRCULAR	4.5	-1.6%
591455	502005	502004	82	CIRCULAR	2.5	-0.1%
591533	502192	502191	43	CIRCULAR	1	-0.5%
591567	502200	502201	39	CIRCULAR	1	-0.3%
592050	500845	500846	33	CIRCULAR	1.5	-0.6%
592103	502480	500188	332	CIRCULAR	1	-0.1%
690742	600667	600666	59	CIRCULAR	1	-0.2%
691204	600559	600558	42	CIRCULAR	1	-1.0%
691322	600589	600590	40	CIRCULAR	2	-0.5%
691323	601851	601704	37	CIRCULAR	1.5	-0.5%
691330	600509	600510	34	CIRCULAR	1	-0.3%
691657	602271	602270	58	CIRCULAR	1	-0.2%
691767	600705	600706	30	CIRCULAR	1.25	-1.7%
691772	600695	600694	29	CIRCULAR	1.25	-1.0%
691827	602251	600775	32	CIRCULAR	2	-0.6%
691830	602253	600756	23	CIRCULAR	3	-0.9%
692058	600580	600581	45	CIRCULAR	0.5	-0.2%
692076	600560	600561	43	CIRCULAR	1	-0.2%

Note: The negative pipe slope summary table only includes negatively sloped closed pipes included in the Existing Conditions Model.

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