FINAL

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

SOUTHEAST DISTRICT • ST. LUCIE – LOXAHATCHEE BASIN

TMDL Report

Nutrient and Dissolved Oxygen TMDL for the St. Lucie Basin

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October 2008

Acknowledgments

This study could not have been accomplished without significant support and assistance provided by Florida Department of Environmental Protection-Tallahassee and Southeast District Offices, the South Florida Water Management District, County officials, Environmental Advocacy Groups, consultants, and other stakeholders who volunteered to participate or whose participation was requested.

Editorial assistance provided by Jennifer Gihring, Linda Lord, and Jan Mandrup-Poulsen.

Note: All maps found in this document were prepared by Robert McTear and are for illustrative purposes only. They are a representation of ground conditions and are not intended for delineations or analysis of the features shown.

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http://www.dep.state.fl.us/water/wqssp/classes.htm

Basin Status Reports and Water Quality Assessment Reports

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U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

http://www.epa.gov/region4/water/tmdl/florida/

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http://www.epa.gov/storet/

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http://www.sflorida.er.usgs.gov/ddn_data/text/stl.html

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ACRONYMS AND ABBREVIATIONS

BMAP	Basin Management Action Plan
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CBOD	Carbonaceous Biochemical Oxygen Demand
CFR	Code of Federal Regulations
cfs	cubic feet per second
Chl-a	Chlorophyll a
CWA	Clean Water Act
DCIA	Directly Connected Impervious Area
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
EMC	Event Mean Concentration
EPA	Environmental Protection Agency
ERP	Environmental Resource Permit
FAC	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Affairs
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use and Cover Classification System
FS	Florida Statutes
FWRA	Florida Watershed Restoration Act
GIS	Geographical Information System
GUI	Graphical User Interface
IFAS	Institute of Food and Agricultural Services
IWR	Impaired Waters Rule
LA	Load Allocation
mg/L	Milligrams per liter (also parts per million - ppm)
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NEP	National Estuary Program
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PS	Point Source
SFWMD	South Florida Water Management District
SOD	Sediment Oxygen Demand
STORET	EPA or FDEP STOrage and RETrieval Program
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
µg/L	Micrograms per liter (also parts per billion - ppb)
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WASH	Watershed Model
WBID	Water Body Identification
WLA	Waste Load Allocation
WWW	World Wide Web

EXECUTIVE SUMMARY

1. Impaired Waters Rule (IWR) Listed Waterbody Information

Basin Group: Group II St. Lucie-Loxahatchee

Planning Unit	Waterbody	WBID	Impairment Status & Details	
			Dissolved Oxygen	*Nutrients*
Coastal	St. Lucie River Lower Estuary	3193	Not Impaired	Impaired
North St. Lucie	North Fork St. Lucie River	3194	Impaired; linked to high TP and BOD	Impaired
North St. Lucie	North St. Lucie Estuary	3194B	Impaired; linked to high TN	Impaired
C-24	C-24	3197	Impaired; linked to high TP and BOD	Impaired
C-23	C-23	3200	Impaired; linked to high TP	Impaired
South St. Lucie	South St. Lucie Estuary	3210	Not Impaired	Impaired
South St. Lucie	South Fork St. Lucie River	3210A	Impaired; linked to high TN	Impaired
South St. Lucie	Bessey Creek	3211	Impaired; linked to high TP	Impaired
C-44	C-44	3218	Impaired; linked to high BOD	Not Impaired

2. TMDL Endpoints:

TN Target: 0.72 mg/L; TP Target: 0.081 mg/L; BOD Target: 2.0 mg/L

3. Lead on TMDL:

Florida Department of Environmental Protection

4. TMDL considers point or non-point sources:

Point source (Municipal Separate Sewer Systems)

5. Major NPDES dischargers into surface water:

None

6. TMDL Allocation:

Waterbody	Parameter	Daily TMDL Loading	LA (% Reduction)	MOS
St. Lucie Estuary (3193)	TN	0.72 mg/L	21.4	Implicit
	TP	0.081 mg/L	41.3	Implicit
North Fork St. Lucie River (3194)	TN	384 lbs	25.0	Implicit
	TP	43 lbs	42.2	Implicit
	BOD	2.0 mg/L	74.0	Implicit
North Fork St. Lucie Estuary (3194B)	TN	284 lbs	28.8	Implicit
	TP	32 lbs	58.1	Implicit
C-24 Canal (3197)	TN	956 lbs	51.8	Implicit
	TP	108 lbs	72.2	Implicit
	BOD	2.0 mg/L	33.3	Implicit
C-23 Canal (3200)	TN	664 lbs	51.7	Implicit
	TP	75 lbs	78.6	Implicit
South Fork St. Lucie Estuary (3210)	TN	67 lbs	38.4	Implicit
	TP	8 lbs	57.2	Implicit
South Fork St. Lucie River (3210A)	TN	248 lbs	47.1	Implicit
	TP	28 lbs	61.8	Implicit
Bessey Creek (3211)	TN	82 lbs	23.9	Implicit
	TP	9 lbs	51.2	Implicit
C-44 Canal (3218)	TN	666 lbs	51.2	Implicit
	TP	75 lbs	55.0	Implicit
	BOD	2.0 mg/L	69.7	Implicit

7. Additional Comments

This Total Maximum Daily Loads (TMDL) document provides information on the development of targets for the St. Lucie Basin. The basin is subdivided into **w**ater **b**ody **id**entification units (WBID) as detailed in the document. There are nine impaired WBIDs that this TMDL addresses for dissolved oxygen (DO), nutrients, and biochemical oxygen demand (BOD). Although there are other WBIDs that contribute significant flows to the St. Lucie Estuary, these WBIDs are not considered in this TMDL because they already have TMDLs associated with them, are scheduled for TMDL development in the future, or have significant water improvement projects underway within their boundaries.

The relationships between DO, nutrient concentration, and BOD are complex in any system, and the St. Lucie Estuary is a prime example. Processes that consume oxygen in the water column, such as the microbial breakdown of organic material and sediment oxygen demand (SOD), are fairly constant over the short term. Algal populations, however, can increase rapidly with high nutrient concentrations, and the production of oxygen as a result of photosynthesis during daylight hours and the respiration or consumption from the water column at night can result in large diurnal fluctuations of DO in the water column. As algal populations die, a fraction of algal biomass will become part of the organic material that will be broken down by microbes or settle to the bottom. The reductions proposed in this TMDL are expected to decrease nutrients to the point that the estuarine threshold of 11 µg/L chlorophyll-a will not be exceeded. The reduction in nutrient loads is also expected to improve DO by reducing the diurnal fluctuations in DO and improving DO levels. The TMDL, by law, is designed to address concerns caused by the discharge of pollutants. Other factors that may lower DO, like hydrology or temperature, are not addressed as a part of TMDLs.

The development of a TMDL for a particular WBID is part of an adaptive management process that is reflected in the Florida Department of Environmental Protection (Department) rotating basin evaluations and basin management action plans. While this document provides TMDLs for impaired WBIDs, the TMDLs will be re-evaluated as part of the rotating basin evaluation process and as new data and tools are developed to assess and restore the impaired basins.

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for nutrients and dissolved oxygen (DO) for the St. Lucie basin: WBIDs (**W**ater**B**ody **ID**entification) 3193 (St. Lucie River Lower Estuary), 3194 (North Fork St. Lucie River), 3194B (North St. Lucie Estuary), 3197 (C-24 canal), 3200 (C-23 canal), 3210 (South St. Lucie Estuary), 3210A (South Fork St. Lucie River), 3211 (Bessey Creek), and 3218 (C-44 Canal). Using the methodology described in Rule 62-303, Florida Administrative Code (F.A.C.), Identification of Impaired Surface Waters Rule (IWR) (2001a), which identifies and verifies water quality impairments, the above WBIDs have been determined to be impaired for nutrients and dissolved oxygen except WBIDs 3193 and 3210 which are only impaired for nutrients and WBID and 3218 which is only impaired for DO. The Verified List of impaired waters for the Group 2 St. Lucie – Loxahatchee Basin was adopted by Secretarial Order, December 2004. Portions of the St. Lucie watershed appear on the 1998 303(d) Consent Decree Listing for nutrients and DO. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards, based on the relationship between pollutant sources and instream water quality conditions. In this TMDL, thresholds for causative pollutants were developed through an annual average loading reduction from contributing source areas. Contributing source areas are basins and sub-basins that provide point and non-point source discharge to receiving waterbodies.

1.2 Identification of Waterbody

St. Lucie Basin

In the St. Lucie Basin (**Figure 1.1**), all waterbodies drain directly to either the St. Lucie Estuary (SLE) or the Southern Indian River Lagoon (IRL-S). The SLE watershed comprises approximately 832,500 acres in Martin and St. Lucie Counties. Within the watershed approximately 684,087 acres are agricultural and 117,387 acres are urban (SFWMD, 04-05).

The inland portion of the SLE is composed of the South Fork and the North Fork. The two forks converge at the Roosevelt Bridge to form a single waterbody that extends eastward, where it joins the IRL-S. The watershed contains 15 hydrologic basins, sub-basins, and over 40 named tributaries. Historically, this area included a much smaller natural watershed that directly contributed to the river system, and interior areas of Martin and St. Lucie counties contained large expanses of poorly drained wetlands that did not directly feed into the river and estuary (Gunsalus, 2008). With the construction of drainage improvements in inland areas, the effective drainage area of the SLE and IRL-S expanded to include almost all of Martin and St. Lucie counties.

The C-44 canal serves as a flood control conveyance for Lake Okeechobee and transports water from the lake into the South Fork. The C-44 canal also transports runoff from agricultural areas in its sub-basin. The construction of canals C-23 and C-24 (in addition to C-44) provided connections between their respective sub-basins. C-23 and C-24 canals discharge to the North Fork. The C-25 canal receives agricultural runoff from northern St. Lucie County and areas to the north; it discharges directly into the Central Indian River Lagoon (C-IRL) across from the

Fort Pierce Inlet. However, the C-25 canal is not included in this assessment because it does not discharge directly into the SLE. Rather, it discharges to the IRL and will be accounted for in a separate TMDL.

The St. Lucie Inlet is a man-made inlet that provides ocean access, as well as tidal exchange, between the estuary and the Atlantic Ocean (Sime, 2005). Prior to construction of the St. Lucie Inlet, the SLE was a freshwater lagoon (FDEP, 2003). Due to extensive urban and agricultural drainage projects in the watershed of the SLE, the historic drainage basin area has been greatly expanded to almost 775 square miles (SFWMD, 2003).

The climate in St. Lucie and Martin Counties is subtropical, with annual rainfall averaging approximately 45.67 inches near Lake Okeechobee and 55.51 inches near the coast; however, rainfall amounts can vary greatly from year to year (SFWMD DBHYDRO). The majority of the watershed's annual rainfall comes during the wet season (May through October) from summer thunderstorms and tropical systems. High intensity rain events with short duration thunderstorms are common during the wet season in south Florida (Broward County, 2003). The dry season rainfall (November through April) usually stems from frontal systems that can produce significant rainfall, but occur less frequently than storms during the wet season. At times, this pattern is disrupted by a long-term weather pattern known as El Niño, which causes wetter winters and drier summers (FDEP, 2001). The average summer temperature is 84^{o}F, and the average winter temperature is 64^{o}F (NOAA, 2008).

The topography of the SLE and IRL-S watershed reflects its location within southeastern Florida. Elevations range in the western part of the sub-basin around 10 to 15 feet above sea level and in the eastern part of the sub-basin near the coast around 5 to 10 feet above sea level. The predominant soil types are moderately to well-drained shelly sand and clay and medium fine sand and silt (FDEP, 2008).

In 2007, the Florida Legislature expanded the Lake Okeechobee Protection Act (LOPA, Section 373.4595, F.S.) to strengthen protection for the Northern Everglades watersheds by incorporating restoration efforts for the St. Lucie and Caloosahatchee watersheds, including the estuaries. The Northern Everglades & Estuaries Protection Program (NEEPP):

- Recognizes that Lake Okeechobee and the Caloosahatchee and St. Lucie Watersheds are critical water resources of the state
- Recognizes the TMDL program as a primary means of addressing water quality problems related to phosphorus and other pollutants
- Requires development of Watershed Protection Plans for the St. Lucie and Caloosahatchee watersheds by January 1, 2009
- Expands the use of the Save Our Everglades Trust Fund for Northern Everglades restoration
- Extends the Save Our Everglades Trust Fund through 2020

The NEEPP specifies that the estuary programs shall provide for consideration of all water quality issues needed to meet the TMDL targets, in addition to a number of other substantive requirements. Pollutant load reductions identified in this TMDL and established in accordance with section 403.067 F.S. shall serve as a program objective in the NEEPP process. The South Florida Water Management District (SFWMD), the Department of Agriculture and Consumer Services (DACS), and the Florida Department of Environmental Protection (FDEP) are working closely together to integrate the TMDL and NEEPP processes to meet statutory requirements.

Planning Units and WBIDs of the St. Lucie Basin

To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, FDEP divides basin groups into smaller areas called planning units. Planning units help organize information and management strategies around prominent sub-basin characteristics and drainage features. To the extent possible, planning units were chosen to reflect sub-basins that had previously been defined by SFWMD. The St. Lucie watershed contains six planning units: North St. Lucie, C-23, C-24, C-44, South St. Lucie, and Coastal. Water quality assessments were conducted on individual waterbody segments within each planning unit. Each waterbody segment is assigned a unique WBID number (FDEP, 2003). Refer to **Figure 1.2** for planning units and WBIDs in the St. Lucie basin.

For illustrative purposes, the spatial distribution and acreage of different landuse categories were identified using 2004-05 landuse coverage data (scale 1:60,000) provided by the SFWMD. Landuse categories were lumped into Level 1 and Level 2 **F**lorida **L**and **U**se **C**over and **C**lassification **S**ystem (FLUCCS) categories (Harper and Baker, 2003). Refer to Appendix B for individual WBID landuse figures.

North St. Lucie

The North St. Lucie planning unit encompasses 120,776 acres, with approximately 36,657 acres (30.35%) of agriculture and 49,994 acres (41.39%) of urban. It extends from Ft. Pierce Inlet to the St. Lucie Inlet and westward to the C-24 Canal. Historically, the North Fork St. Lucie River and its main tributaries (Ten Mile and Five Mile Creeks) drained naturally into the St. Lucie Estuary. The planning unit also includes the North St. Lucie Water Control District where drainage is to Ten Mile Creek, C-24, and C-25. It contains WBIDs 3194, 3194A, 3194B, 3194C, and 3194D. For the purpose of this TMDL, WBIDs 3194 and 3194B have been included because they are impaired for nutrients and dissolved oxygen. WBIDs 3194 and 3194B encompass 34,372 acres (28.4%) of the North St. Lucie planning unit. These WBIDs also cover most of Port St. Lucie, the southeastern portion of the St. Lucie County Municipal Separate Storm Sewer System (MS4) area, and the northern portions of Stuart and urban Martin County.

Ten Mile Creek (WBID 3194A) is currently impaired based on data from Run 33 of the IWR because its DO concentration routinely falls below the state standard of 5 mg/L (related to elevated TP). It is also on the consent decree list with a due date of 2010. The Department considered expediting the schedule and including Ten Mile Creek in this TMDL. However, SFWMD has made, and continues to make, progress in the construction, operation, and refinement of the Ten Mile Creek Water Preserve Area. Thus, the Department decided to not include WBID 3194A in this TMDL and will wait for the resulting water quality data before developing TMDL load reduction requirements for Ten Mile Creek. This WBID will be revisited in 2010 and the performance of the stormwater treatment area (STA), along with any changes in water quality, will be taken into consideration. If the Ten Mile project is achieving the expected nutrient reduction benefits, a TMDL may not be needed for this waterbody.

South St. Lucie

The South St. Lucie planning unit encompasses 65,275 acres with approximately 16,948 acres (25.96%) of agriculture and 21,203 acres (32.48%) of urban. This planning unit is located in Martin County and includes most of Stuart (in the southeastern part), plus portions of Palm City, Coral Gardens, Gomez, and Hobe Sound. This planning unit includes the natural drainage of the South Fork St. Lucie River and contains several other drainage areas including Basin 2, Bessey Creek (Basin 4), Basin 5, Danforth Creek (Basin 6), and the Tidal St. Lucie. It also includes the outlet of the C-44 canal. All of these drainage areas converge at the South Fork of the St. Lucie Estuary, except Bessey Creek which empties into the North Fork of the estuary. It contains WBIDs 3210, 3210A, 3210B, 3211, 3211A, 3215, 3217, and 3220. WBIDs 3210, 3210A, and 3211 encompass 18,949 acres (29.0%) of the South St. Lucie planning unit.

Coastal

The Coastal planning unit comprises 175,496 acres. The IRL-S and most of the SLE are included as well as three inlets to the Atlantic Ocean: the Ft. Pierce, St. Lucie, and Loxahatchee Inlets. Historically, the IRL-S had a long and narrow drainage basin. At the turn of the century, extensive drainage systems were constructed that have more than doubled the size of the drainage basin of the lagoon. Smaller drainage systems were also constructed to provide stormwater drainage for individual residential, commercial, and agricultural development projects. These drainage systems discharge large volumes of freshwater from urban and agricultural runoff to the IRL-S (NEP, 1996). This planning unit contains WBIDs 3166, 3190, 3193, 3208, 3208A, 3226, 3226B, 5003A, 8101, 8102, 8103, and 8104. WBID 3193 is almost entirely open water which encompasses 3,226 acres (1.84%) of the Coastal planning unit. WBID 3193 also covers a small portion of the northeastern Stuart MS4 area.

C-23 & C-24 Canals

The C-23 planning unit, WBID 3200, encompasses 106,840 acres. The C-24 planning unit, WBID 3197, encompasses 109,015 acres. C-23 and C-24 canals discharge water into the North Fork of the St. Lucie Estuary. These canals transport loads of nutrients and eroded sediment to the estuary with slugs of freshwater that create fluctuations in estuarine salinity levels. Urban and residential areas continue to expand in the coastal areas with urban stormwater runoff and seepage from septic tanks also contributing to the water quality problems in the streams and canals. As a result of C-23 and C-24 inflows, parts of the St. Lucie Estuary (SLE) are impaired for nutrients and DO. Nutrient loads, salinity fluctuations, and accumulations of sediment stress the estuarine ecology. Other evidence to support impairment status was gathered through a FDEP Southeast District Biological Survey for the SLE segments. Sediment accumulation, decline of seagrasses and oysters, algal blooms, fish kills, and low diversity of benthic macro invertebrates in the SLE comprise this body of evidence (Graves et al., June 2002). Within the C-23 planning unit approximately 80,300 acres (75.16%) are agricultural and 2,753 acres (2.58%) are urban. Within the C-24 planning unit approximately 75,689 acres (69.43%) are agricultural and 12,682 acres (11.63%) are urban.

C-44

The C-44 planning unit, WBID 3218, encompasses 123,078 acres. It includes the C-44 Canal which is part of the navigational route between the east and west coasts of Florida, and directly connects Lake Okeechobee to the St. Lucie River. Agricultural drainage canals connect extensively along the entire length of the canal. Within the planning unit approximately 78,927 acres (64.13%) are agricultural and 3,122 acres (2.54%) are urban. This area also includes a portion of urban Martin County.

MS4 Areas in the St. Lucie Basin

City of Port St. Lucie

The city of Port St. Lucie is approximately 45,740 acres, over 70% of which is urban. According to the U.S. Census Bureau, the population density in the city of Port St. Lucie in 2000 was 1,320 people per square mile. The Bureau reports that the total population for the city was 88,769 residing in 36,908 housing units (U.S. Census Bureau Website, 2008).

City of Stuart

The city of Stuart is approximately 5,648 acres, over half of which is urban. According to the U.S. Census Bureau, the population density in the city of Stuart in 2000 was 2,308 people per square mile. The Bureau reports that the total population for the city was 14,633 residing in 8,879 housing units (U.S. Census Bureau Website, 2008).

Martin County

The Martin County MS4 area was unable to be obtained at the time this document was written. The urban area is approximately 41,063 acres (DEP TIGER, 2003). According to the U.S. Census Bureau, the population density in Martin County in 2000 was 228 people per square mile. The Bureau reports that the total population for the county was 126,731 residing in 65,471 housing units (U.S. Census Bureau Website, 2008).

St. Lucie County

The St. Lucie County MS4 area is approximately 186,157.71 acres, over 65% of which is agriculture. According to the U.S. Census Bureau, the population density in St. Lucie County in 2000 was 337 people per square. The Bureau reports that the total population for the county was 192,695 residing in 91,262 housing units (U.S. Census Bureau Website, 2008).

Figure 1.1 Location of the St. Lucie Basin in St. Lucie and Martin Counties

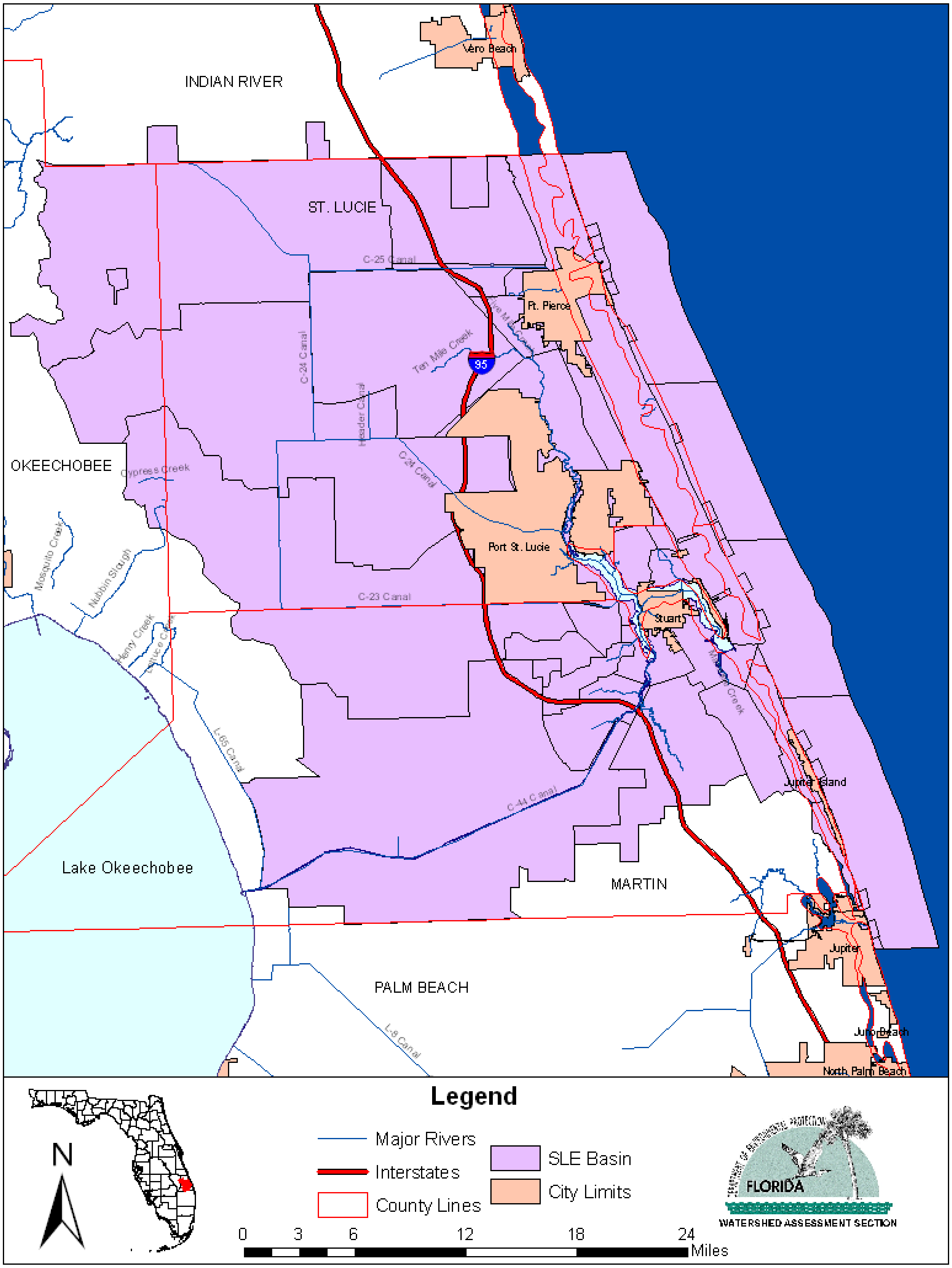


Figure 1.2 Planning Units and WBIDs of the St. Lucie Basin

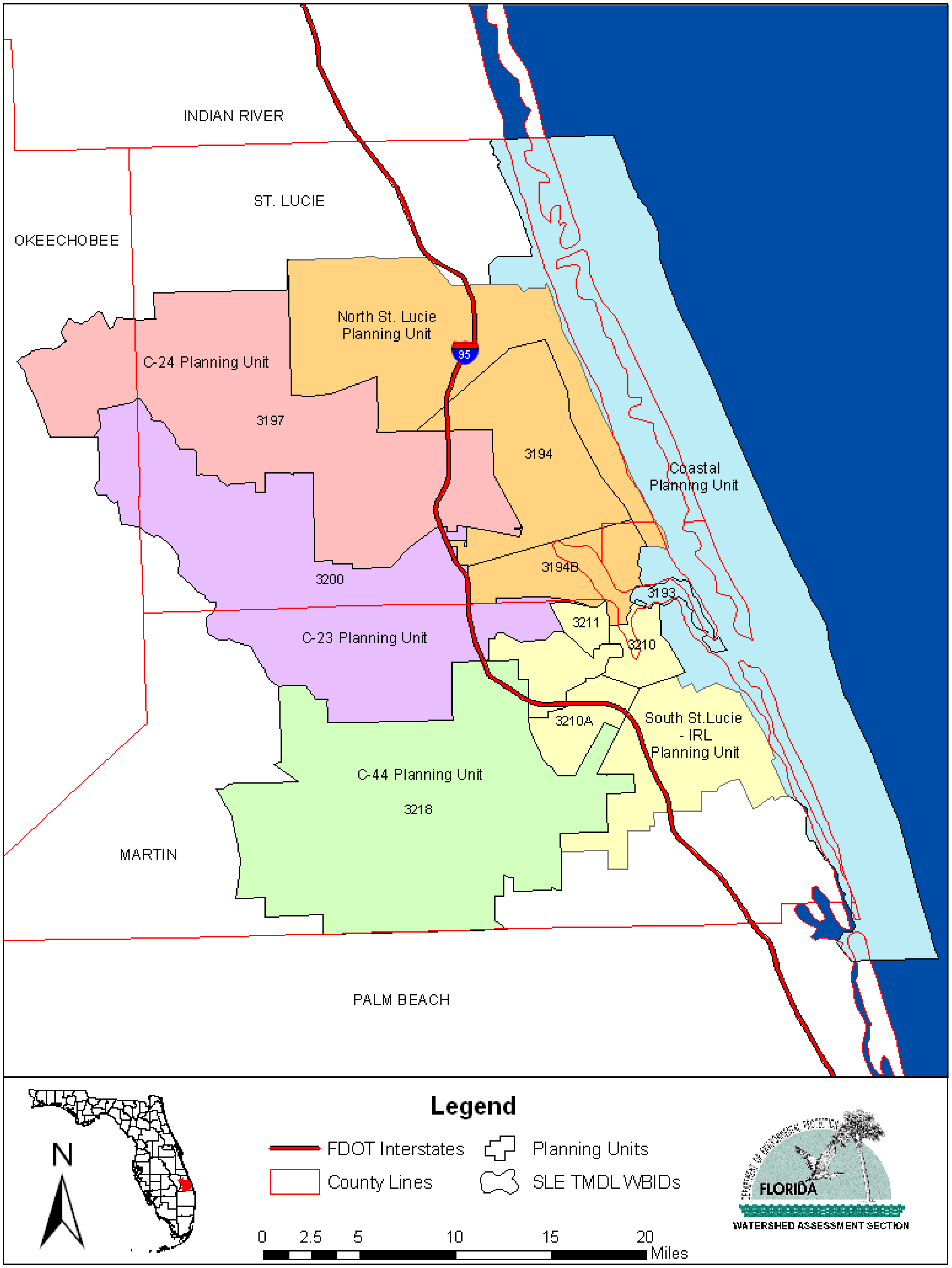
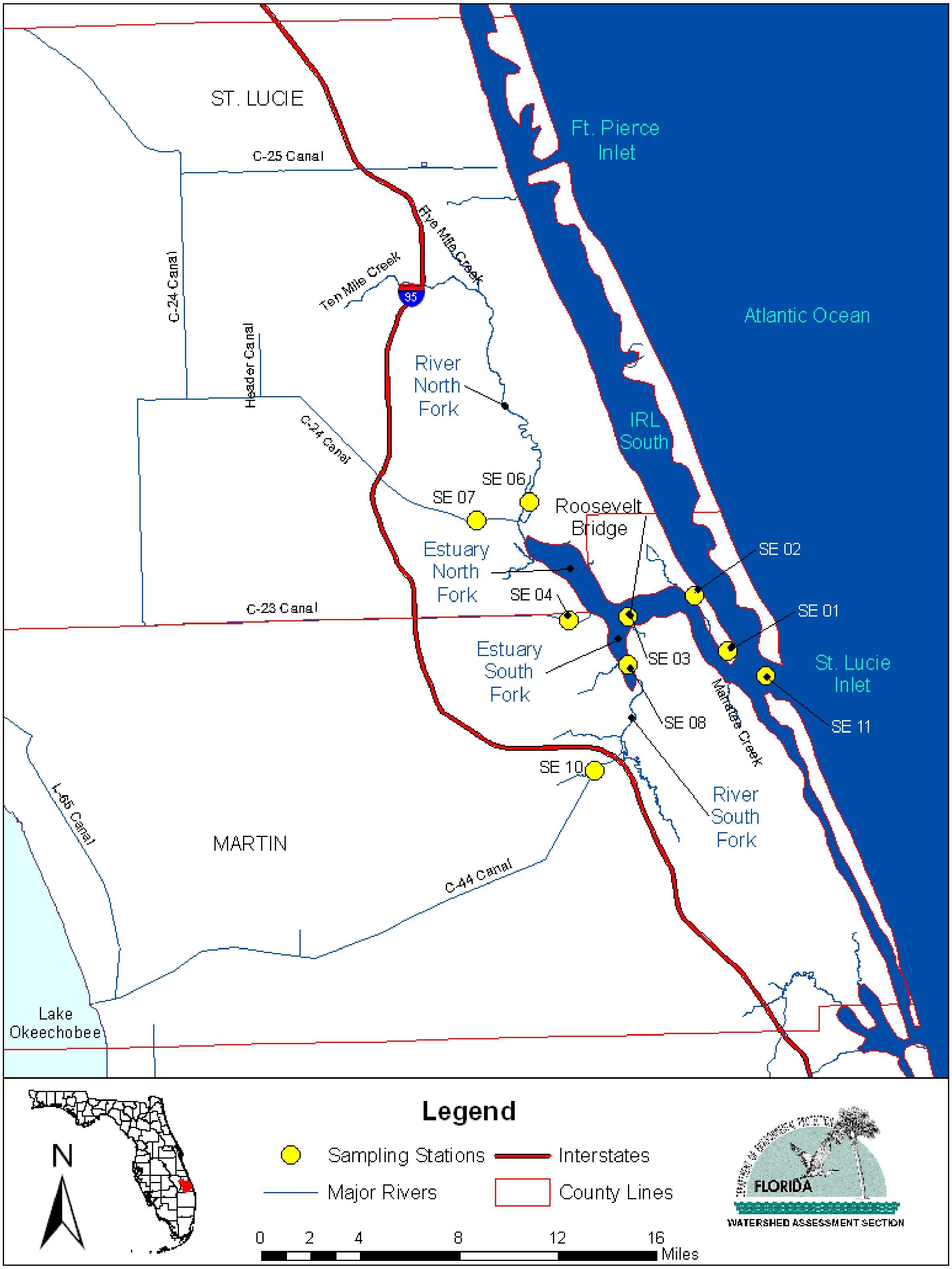


Figure 1.3 Key Watershed Features of the St. Lucie Basin



1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

This TMDL report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, which will be designed to reduce the amount of TN and TP needed to address the nutrient and DO impairments in the St. Lucie watershed. The action plan's activities will depend heavily on the active participation of the SFWMD, Martin County Division of Natural Resources Environmental Section, St. Lucie County Division of Natural Resources Environmental Section, Fish and Wildlife Commission (FWC), University of Florida - Institute of Food and Agriculture Sciences (UF-IFAS), Florida Department of Transportation (FDOT), local businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDL targets.

1.3.1 Development of TMDL

This TMDL was developed in cooperation with the SFWMD, Martin County Division of Natural Resources Environmental Section, St. Lucie County Division of Natural Resources Environmental Section, Fish and Wildlife Commission (FWC), and University of Florida - IFAS. There was also active coordination with a variety of local stakeholders throughout the TMDL development process. This coordination included meetings and teleconference discussions between DEP representatives, County officials, Environmental Advocacy Groups, consultants, and other stakeholders who participated in the process.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the identified impairment of the listed waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]), and the Department is developing basin-specific lists as part of the watershed management cycle.

The 1998 303(d) list included portions of the St. Lucie Basin (FDEP, 1998). However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission (ERC) adopted the new methodology as Rule 62-303, F.A.C. Identification of the IWR, (FDEP, 2001a); the IWR was subsequently modified in 2006 and 2007. The list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

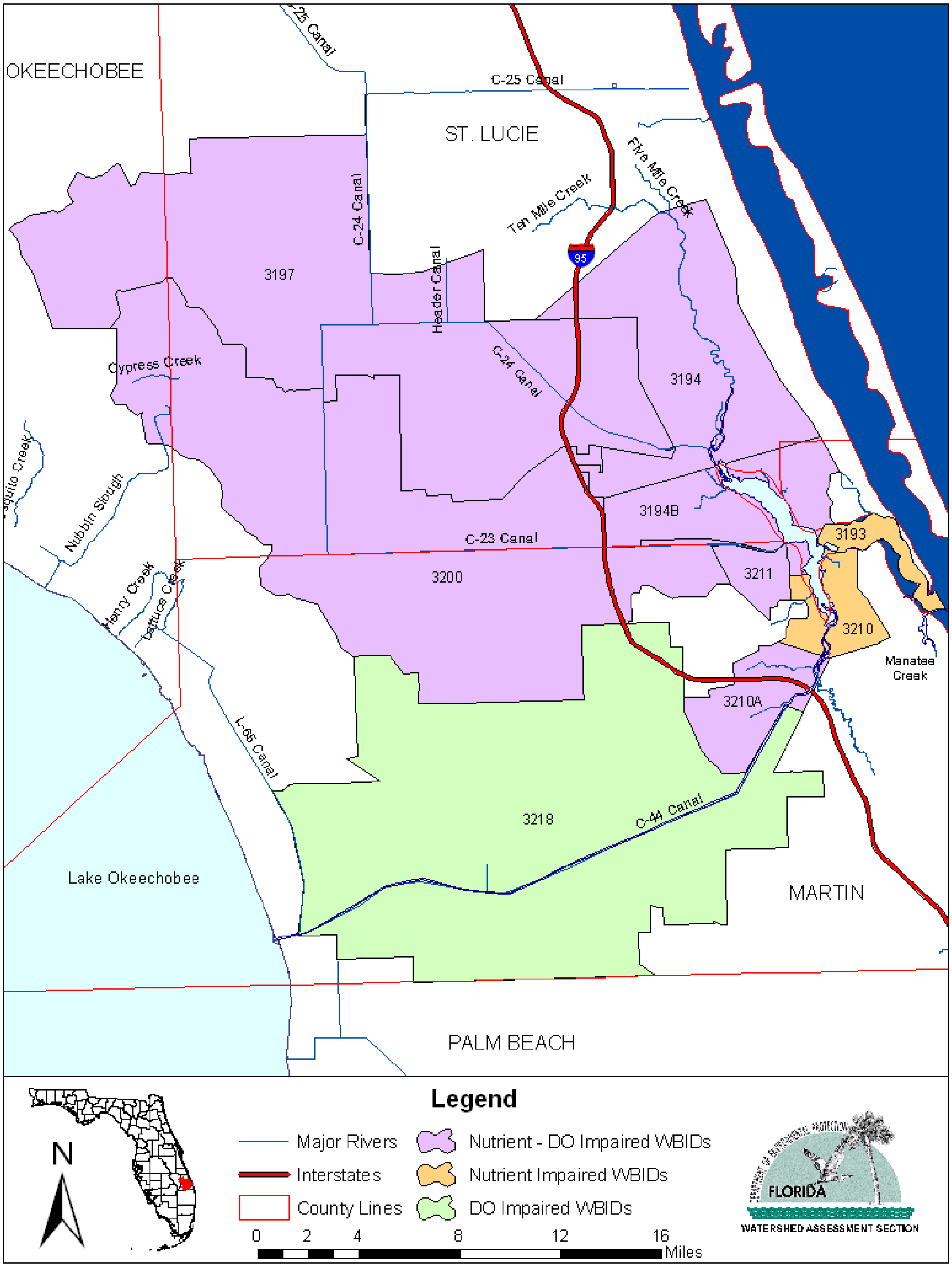
2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments and has verified the impairments for nutrients and low DO in the St. Lucie basin (**Table 2.1 and 2.2**). The basin contains the following impaired WBIDs: 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218. The locations of these WBIDs are shown in **Figure 2.1**. WBIDs were verified as impaired for DO based on data that indicated an exceedance rate greater than or equal to 10 per cent. The Class III freshwater water quality criterion is that DO shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. For Class III marine water bodies, the DO 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. WBIDs were verified as impaired for nutrients based on annual chlorophyll-a data exceeding the nutrient narrative criteria of 20 µg/L for freshwater and 11 µg/L for marine waters (IWR, 62-302). The IWR data were based on samples collected between the 01/1996 – 06/2003. The nutrient and DO data for the St. Lucie basin are available upon request.

Table 2.1. Verified Impaired Listings for Nutrients and Dissolved Oxygen for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)

Planning Unit	Waterbody	WBID	Impairment Status & Details	
			Dissolved Oxygen	*Nutrients*
Coastal	St. Lucie River Lower Estuary	3193	Not Impaired	Impaired
North St. Lucie	North Fork St. Lucie River	3194	Impaired; linked to high TP and BOD	Impaired
North St. Lucie	North St. Lucie Estuary	3194B	Impaired; linked to high TN	Impaired
C-24	C-24	3197	Impaired; linked to high TP and BOD	Impaired
C-23	C-23	3200	Impaired; linked to high TP	Impaired
South St. Lucie	South St. Lucie Estuary	3210	Not Impaired	Impaired
South St. Lucie	South Fork St. Lucie River	3210A	Impaired; linked to high TN	Impaired
South St. Lucie	Bessey Creek	3211	Impaired; linked to high TP	Impaired
C-44	C-44	3218	Impaired; linked to high BOD	Not Impaired

Figure 2.1 Verified Impaired WBIDs for Nutrients and Dissolved Oxygen for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)



Chapter 3: DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

3.2 Applicable Water Quality Standards and Numeric Water Quality Targets

The St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218) is composed of Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the impairment addressed by this TMDL are for DO and the narrative nutrient criteria.

3.2.1 Interpretation of Dissolved Oxygen Criterion

The DO criterion for Class III freshwater waterbodies states that DO shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. For Class III marine water bodies the DO 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.

3.2.2 Interpretation of Biochemical Oxygen Demand Criterion

Florida's BOD criterion is narrative. For any Class III freshwater, the BOD shall not be increased so as to cause DO to be depressed below the applicable DO criterion, and in no case, shall it be great enough to cause nuisance conditions. Natural freshwater systems with low nutrient levels have been observed to have BOD values less than 2.0 mg/L. The existence of elevated BOD (mean and median values > 2.0 mg/L) in several of the watersheds being assessed led to the conclusion that BOD levels were a negative influence on the DO concentrations. The current method detection limit is 2.0 mg/L for most determinations which practically sets a level for determining whether or not BOD contributes to depression of DO levels.

3.2.3 Interpretation of Narrative Nutrient Criterion

Florida's nutrient criterion is narrative; nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. The

Department currently uses chlorophyll-a measurements as a surrogate measure for phytoplankton population. When chlorophyll-a concentrations above 20 µg/L are observed in freshwater systems or 11 µg/L in marine systems, there is an indication that primary producer population is out of balance and nutrient concentrations should be investigated. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for streams and estuaries based on annual average chlorophyll-a levels, these thresholds are not standards. These thresholds were used in the assessment and verification of the WBIDs impaired for nutrients listed in this TMDL.

3.2.4 Factors That Influence Nutrient Concentrations

The St. Lucie Estuary system receives nutrients from natural streams and rivers and structure-controlled canal systems, surface water runoff, groundwater, and tidal influences. Nutrient enrichment in the Estuary has been ongoing for years as the result of both the urbanization of the coastal regions of St. Lucie and Martin Counties and agricultural activities in the western regions of the watershed. Landuse changes have affected the St. Lucie in two primary ways: increasing nutrient loads and hydrologic modifications.

Recent data compiled by Harper & Baker (2007) demonstrated that increasing intensity of landuse generally results in increasing nutrient runoff concentration (Harper & Baker, 2007, Table 4-17) and an increase in runoff volume (Harper & Baker, 2007, Figure 4-4). Both urbanization and increasing intensity of agricultural landuse (e.g. conversion from rangeland to a managed pasture) can result in increased delivery of nutrients to local receiving waters. Specific agricultural activities that can contribute to the declining health of the system include water flow changes due to the creation of secondary and tertiary canal systems for use in irrigation and flood control and the introduction of nutrients via fertilization. Urbanization can result in reduction of pervious areas for infiltration of runoff, which contributes significantly to increased runoff and nutrient load (Harper & Baker, 2007). Other activities associated with urbanization also increase nutrient inputs such as the installation of septic tanks, sewage overflows, fertilizer usage, and the use of irrigation quality water in sprinkler systems in golf courses and new housing developments. The impact of agricultural and urban activities on eutrophication of receiving waters can be decreased through the implementation of best management practices (BMPs).

Natural processes also influence nutrient concentrations in the St. Lucie Watershed. In general, sediment that enters the system settles out of the water column, accumulating behind canal structures and on the bottom of the Estuary. Although data are sparse to quantify this factor, these sediments can contribute to increased SOD, thus lowering DO levels in the water column. Input and re-suspension of sediments also can decrease light penetration, reducing the light intensity with depth, thus reducing viability of submerged aquatic vegetation (SAV) and affecting typical nutrient and oxygen dynamics that would be associated with healthy seagrass systems.

3.2.5 Factors That Influence Dissolved Oxygen

The availability of DO in a marine or freshwater system is highly variable due to several factors. Oxygen is produced in the water column by photosynthesis and is consumed by respiration of plants, animals and aerobic bacteria, and by chemical reactions that occur in brackish waters due to the interaction of sunlight, humic and fulvic materials, as well as oxidation and reduction reactions. The ability of a system to absorb oxygen from the atmosphere is dependent on flow factors such as water depth and turbulence. Elevated nitrogen and phosphorus compounds contribute to excess algae growth. Under high nutrient levels, algae grow rapidly and raise DO concentrations during daylight hours. Respiration (i.e. BOD) by the dense algal populations and other consumers reduce DO concentrations during the night. When phytoplankton cells die, they sink towards the bottom, and are decomposed by bacteria, a process (i.e. SOD) that further reduces DO in the water column.

As mentioned above, factors that may cause significant oxygen depletion include BOD and SOD. BOD, including carbonaceous BOD (CBOD) and nitrogenous BOD (NBOD) may be the product of both naturally occurring oxygen use from the decomposition of organic materials, and the stabilization of waste products associated with nonpoint source runoff. The significance of any of these factors depends on the specific stream conditions. BOD related to microorganisms is called CBOD. The source material for CBOD is organic matter. CBOD results when oxygen is consumed by microorganisms in converting organic material into CO_2, H_20, nutrients, energy, and new cells. Algal cells contain organic chemicals that consume oxygen during decomposition. BOD related to chemical oxidation is called NBOD. The source materials for NBOD include organic matter that decays to ammonia, and ammonia entering the system through stormwater systems or runoff. Nitrification, the process of oxidizing ammonia to nitrates by microorganisms, requires almost 5 mg/L of DO (NBOD) for every mg/L of ammonia that is oxidized.

SOD is the overall demand for DO from the water column that is exerted by the combination of biological, biochemical, and chemical processes at the sediment-water interface. The primary sources of SOD are anaerobic (low-oxygen) chemical compounds in the riverbed sediments and particulate BOD (including algae and other sources of organic matter) that settle out of the water column. SOD is generally composed of biological respiration from benthic organisms and the biochemical (i.e., bacterial) decay processes in the top layer of deposited sediments. In addition to DO depletion, degradation of organic matter in the sediment results in the release of oxygen-demanding (i.e., reduced) nutrients, metals, ammonium, iron, manganese, sulfide, and ammonia (Price et al, 1994). These soluble chemicals are released into the water and exert a relatively rapid (i.e., it occurs on a timescale of hours) oxygen demand as the reduced chemicals are oxidized. Some oxidation processes, such as nitrification of ammonia to nitrate, require bacteria and may be slower (i.e., days). In stratified waters, the sediment and the bottom layer of water are somewhat "trapped" and the oxygen is depleted as a result of decay of organic matter and lack of exchange of oxygenated water from upper layers (EPA, 2007). Estuarine waters are often considered to be stratified

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant or pollutants causing impairment in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act (CWA) redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see Appendix A for background information on the federal and state stormwater programs).

To be consistent with CWA definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL. However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Potential Point Sources of TN, TP, and BOD in the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)

4.2.1 NPDES Wastewater Facilities

According to the FDEP **W**aste **A**pplication **F**acilities **R**eport (WAFR) database, 15 NPDES permitted wastewater facilities exist in the St. Lucie basin (**Table 4.1**). These wastewater facilities are only permitted to discharge to surface water during a 25-year/72-hour storm event making discharge from these facilities very infrequent. Facilities that have permitted discharges above this level are for cooling or dewatering, which are effectively discharging ambient water. Since this report is based on ambient conditions in the watershed, the infrequent discharge from the above mentioned facilities is not included in the overall reduction. If conditions change in the permits for any of the facilities mentioned, that change will be included as part of the restoration effort.

Table 4.1 NPDES Permitted Wastewater Facilities

WBID	Facility Name	Facility ID
3194	St. Lucie County Fairgrounds	FL0434698
3194	Prestige AB Mgmt Co LLC - Ft. Pierce	FLG110569
3194	Rinker Materials of Florida Inc. W. Ft. Pierce Plant	FLG110576
3194	Adonel Ft. Pierce Plant	FLG110638
3197	Florida Rock industry	FL0140406
3200	Gracewood Dairy	FLA187577
3210	Tarmac America - Stuart Plant	FL0126411
3210	Rinker Materials - Stuart Plant	FLG110333
3210	Continental FL Matl - Stuart	FLG110543
3218	Florida Power and Light Plant co- Martin County	FL0030988
3218	Indian Town Cogeneration Plant Emergency Discharge	FL0183750
3218	Payson Park Thoroughbred Training Center	FLA413950
3218	Rinker Materials of Florida Inc. Indiantown	FLG110724
3218	Circle K store # 7403	FLG912597
5003A	Sailfish Point Utilities Corp	FL0037001

4.2.2 Municipal Separate Storm Sewer System Permittees

A municipal separate storm sewer system (MS4) is a publicly owned conveyance or system of conveyances (e.g., ditches, curbs, catch basins, underground pipes, etc.) that is designed or used for collecting or conveying stormwater and that discharges to surface waters of the State. MS4 discharges are regulated by the FDEP under the NPDES Stormwater Program, outlined in Ch. 62-624, F.A.C. There are six permitted MS4s in the St. Lucie Basin: Martin County #FLR04E013, St. Lucie County #FLR04E029, City of Stuart #FLR04E031, City of Port St. Lucie #FLR04E001, Department of Transportation (FDOT) District 4 #FLR04E083, and Florida Turnpike Enterprise #FLR04E049. **Figure 4.2** shows the extent of the MS4 permitted area for each local government. The spatial extent of the DOT and Florida Turnpike Enterprise MS4 permitted area was unavailable at the time of TMDL development.

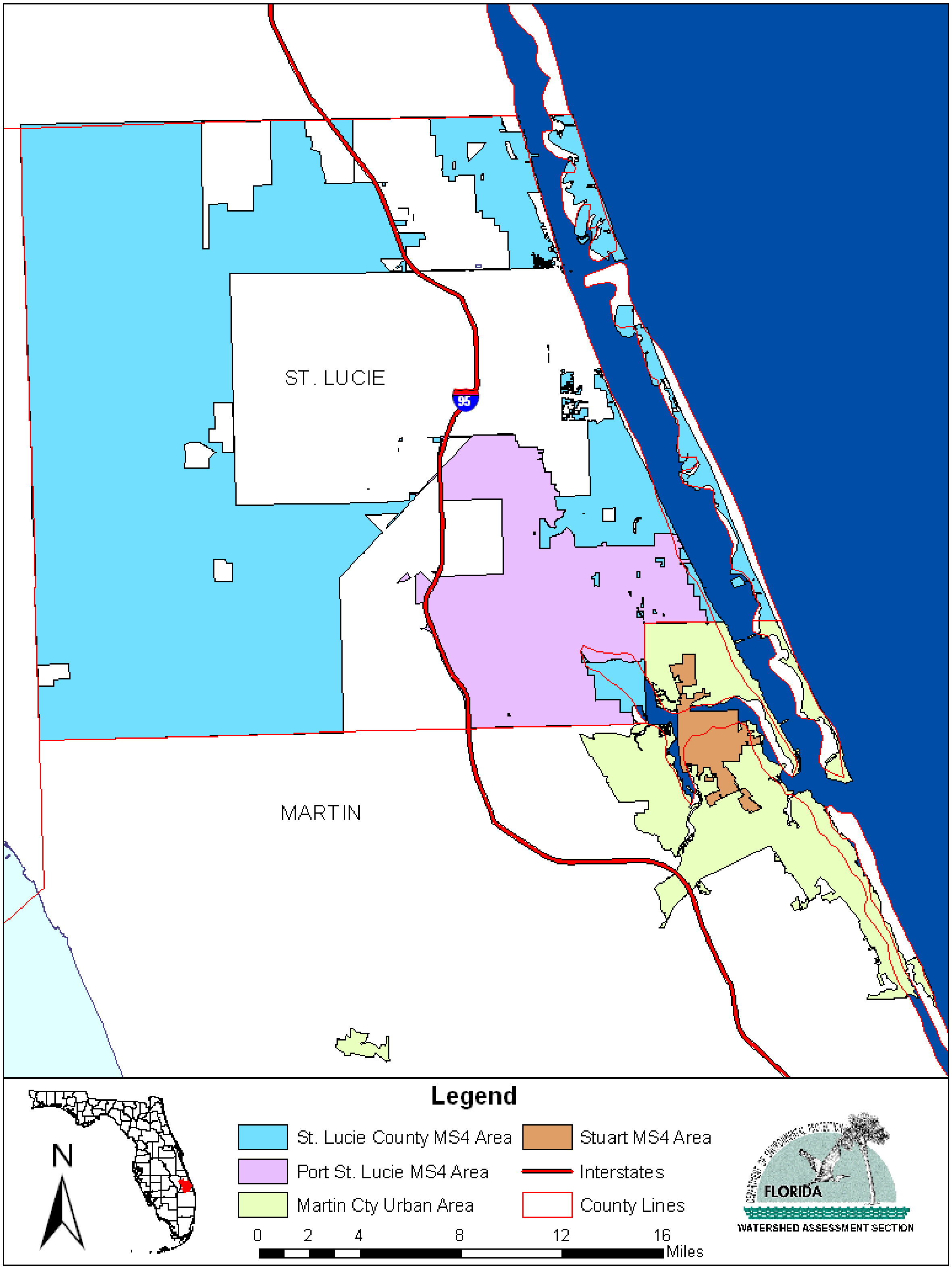
4.2.3 Lake Okeechobee

Lake Okeechobee was connected to the St. Lucie Estuary by the creation of the C-44 Canal as an outlet to manage water levels in the Lake. Through this connection, the Lake is able to discharge freshwater to the C-44 Canal at a very high rate. These releases carry significant nutrient loads which have a known impact on the SLE watershed. Lake Okeechobee currently has a TMDL in place, adopted in May 2001, which calls for an annual load of 140 metric tons of phosphorus to Lake Okeechobee to achieve an in-lake target phosphorus concentration of 40 ppb in the limnetic zone of the lake. It is the Department's stance that any TMDL targets already in place shall be used as inputs into any connecting waterbodies thus, this document will assume that the Lake is meeting its target TP concentration of 40 ppb. Through modeling work done by SFWMD it has been determined that through the reduction of TP levels, TN levels will also decrease to a value of approximately 1.4 mg/L (Tom James, SFWMD, Pers. Comm. 2008).

4.2.4 Groundwater

Groundwater discharge as a potentially significant source of both water and chemicals to coastal areas has presented controversy as to the actual magnitude of groundwater discharge on both local and regional scales. This controversy is fueled by differences in the magnitude of the flux in different locations and the difficulties in quantifying the freshwater and seawater components of groundwater discharge. Groundwater and surface water are unequivocally associated in this region. A quick comparison of the USGS real-time groundwater monitoring website for the St. Lucie area with the SFWMD real-time gate, gauge, and stage web page demonstrate this phenomenon. Since the region is well-drained by an extensive canal network, the water quality at the control structures should be representative of the aquifer which provides seepage to the canal system and eventually the estuary. The hydrologic model which is used in this TMDL considers groundwater flow on a regional basis, including irrigation, seepage, and eventual expression in the canal system. Due to the high solubility of nutrients in water, groundwater is considered to be taken into account when samples are collected at the control structures and water quality sampling stations throughout the waterbodies.

Figure 4.1 Contributing Phase II MS4 Permit Jurisdictions



Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Target Nutrient Reduction Goals

The assimilative capacity of the estuary was established by using target nutrient reduction goals at the Roosevelt Bridge, which were calculated during development of the South Indian River Lagoon Final Integrated Protect Implementation Report and Environmental Impact Statement (IRL-S Plan; SFWMD and U.S. Army Corps of Engineers, 2004). The Department's preferred approach is to use the TP and TN targets from the (IRL-S Plan) as the end point for calculating the TMDLs for the various WBIDs. These targets (81 µg/L TP; 0.72 mg/L TN), applied at the Roosevelt Bridge, are supported by several additional lines of evidence, detailed below, developed through subsequent evaluations by the Department and the SFWMD. The Department realizes that this is a very complex system and that the targets set by this TMDL can be revisited in the future. By revisiting this TMDL we will be able to re-evaluate the targets based on new data as well as any water quality improvements from implemented projects. This iterative TMDL approach allows for a protective yet mutable document that can be updated as knowledge and technology improve.

5.1.1 IRL-S Targets

The Indian River Lagoon Project Implementation Report (IRL-S Plan) was published by the SFWMD, U.S. Army Corps of Engineers, and partner agencies in 2004. Within the IRL-S Plan, water quality targets were identified for the Indian River Lagoon proper and its contributing areas, including the St. Lucie. The primary IRL-S targets (TN and TP) were set at levels considered protective of healthy seagrass beds in the Lagoon. These values were then propagated to the contributing areas, wherein waterbody-specific water quality targets were identified that were considered both protective of the waterbody itself and protective of downstream conditions in the Lagoon. Further detail on these calculations can be found in the IRL-S Plan (USACE/SFWMD, 2004).

The targets identified in the 2004 IRL-S plan for the St. Lucie Estuary (SLE) were calculated by the IRL-S Plan Water Quality Sub-team (See Appendix A of the IRL-S Plan). The TP value was calculated based on an adjusted mean of all Florida estuaries with some estuaries omitted due to geologically induced high phosphorus from substantial phosphate deposits (e.g. Tampa Bay). Modeling conducted during development of the IRL-S Plan indicated that a TP concentration of 81 µg/L TP at Roosevelt Bridge would require that TP loads from the freshwater canals be decreased to 110 metric tons/year TP. This would result in a concentration of 53 µg/L TP in the Lagoon, the IRL-S Plan TP target for the Lagoon proper.

The TN target identified in the IRL-S Plan was based on a paper by Chamberlain and Hayward (1996). The TN target for the St. Lucie identified in the IRL-S Plan was expressed as a 30% reduction in TN. At the time the IRL-S Plan was written, the TN concentration for the estuary was 1.03 mg/L (DBHYDRO SFWMD 1999-2004), and a 30% reduction would yield a concentration of 0.721 mg/L TN. Similar to the link between St. Lucie and Lagoon TP targets, the 0.721 mg/L TN target in the St. Lucie was evaluated and found to be protective of water quality conditions in the Lagoon proper (TN target of 0.67 mg/L) because nitrogen concentrations decrease significantly between Roosevelt Bridge (monitoring station SE03; see

Figure 1.3) and the Lagoon proper (monitoring station SE01; see **Figure 1.3**). Although the IRL-S work was conducted prior to 2004, this pattern in nutrient concentrations between Roosevelt Bridge and the Lagoon persists. Current median TN concentration at Roosevelt Bridge (SE03) is 1.063 mg/L while the Lagoon/Estuary Confluence (SE01) is 0.876 mg/L. Current median TP concentrations at Roosevelt Bridge (164 µg/L) are double those at SE01 (84 µg/L).

Through the work conducted for Plan development, the IRL-S Plan demonstrated that 81 µg/L TP and 0.72 mg/L TN targets in the SLE support water quality restoration in the Estuary and targets established for the broader Lagoon ecosystem. Thus, given the extensive scientific work and support afforded to these targets, the IRL-S TN and TP concentration targets, applied at Roosevelt Bridge, were used as targets in this TMDL.

5.1.2 Updated IRL-S Calculations and Links to Seagrass

Because the IRL-S Plan calculations were conducted in 2004, SFWMD and FDEP recalculated the original IRL-S Lagoon targets to see if there was a significant difference with the inclusion of more recent data. Two methods were used to accomplish this task: 1) using the original IRL-S method (as described above); and 2) using polynomial equations to try to obtain a better fit to the data. The original IRL-S targets for the Lagoon were 53 µg/L TP and 0.67 mg/L TN. The recalculations completed by SFWMD using the same method as the IRL-S Plan resulted in targets of 49 µg/L TP and 0.68 mg/L TN based on median values. Recalculations using the quadratic method resulted in targets of 51 µg/L TP and 0.66 mg/L TN. The result of both of these recalculation efforts are very similar to the Lagoon targets outlined in the original IRL-S Plan. These recalculation efforts support the validity of the original 2004 IRL-S Plan targets for use under current conditions.

5.1.3 Statewide Estuary Descriptive Statistics

Another approach used to evaluate the validity of the IRL-S targets was to calculate TN and TP concentrations for comparable non-impaired estuaries throughout Florida. DEP evaluated TN, TP, and chlorophyll-a data for all estuaries in the state from 2000 - 2007. Estuaries were removed that were known to be high in phosphates and dissimilar in locale and nutrient composition. Median values from the selected estuaries were compared to median values for the St. Lucie Estuary. This analysis showed a median TP value of 65 µg/L and median TN value of 0.86 mg/L for the selected estuaries. The 0.86 mg/L TN value, though slightly higher, is comparable to that identified in the IRL-S Plan for the SLE (0.72 mg/L). The 65 µg/L TP value is slightly lower than that identified in the IRL-S Plan for the SLE (81 µg/L). However, the watershed that drains to the St. Lucie has unique characteristics due to it being a heavily modified, man-made estuary. Lake Okeechobee, via the C-44 Canal, is not a natural connection to the estuary and carries with it a large TP load. The other areas of the watershed that input to the estuary are extensive artificial drainage and irrigation systems unlike anything in relation to most other estuarine systems in Florida. These areas drain mostly agricultural lands which are connected to the estuary through a system of highly managed canals. These differences could result in a higher phosphorus loading regime that does not affect the other selected estuaries. Even with these differences though, the comparability of the TN and TP concentrations support selection of the IRL-S Plan SLE targets for the TMDL.

5.1.4 Comparison of Targets

Table 5.1 Target Method Summary

Method	St. Lucie Estuary Targets		Indian River Lagoon Targets		Period of Record	Method of Analysis
	TN (mg/L)	*TP (µg/L)*	*TN (mg/L)*	*TP (µg/L)*		
SLE Targets from 2004 IRL-S Plan	0.72	81	N/A	N/A	1999 - 2004	Median
SFWMD IRL PLRG	N/A	N/A	0.67	53	1990 - 1999	Median
Seagrass Comparison	N/A	N/A	0.66	55	1995 - 2005	Median
Seagrass Polynomial	N/A	N/A	0.66	51	1995 - 2005	Regression
Statewide Comparison	0.86	65	N/C	N/C	2000 - 2007	Median

N/A: Sufficient data was not available to recalculate these values
N/C: Values not calculated

As shown in **Table 5.1**, three different lines of calculation support the selection of the 2004 IRL-S TN and TP concentrations of 0.72 mg/L and 81 µg/L as the TMDL targets for the St. Lucie Watershed. This weight-of-evidence approach to establishing nutrient targets for the TMDL supports the use of the original IRL-S targets for the St. Lucie Estuary. Additionally, these values are consistent with the best professional judgment of local scientists and stakeholders based on their knowledge of the estuary.

With respect to DO, these targets support what is necessary to control pollutants in such a manner that restores an appropriate balance of flora in the estuary. It is possible that DO is also influenced by factors other than the nutrients and BOD in the system, such as hydrology or existing sediment quality. However, any further depression in DO in the estuary would not be caused by pollutant discharges and thus, not taken into account in this TMDL.

5.2 Data Used in the Determination of the TMDL

Keeping true to the Verified Period for the St. Lucie River basin water quality assessment which started in 1996, no data earlier than 1996 were used to determine verification. WBID 3211 (Bessey Creek), a recently monitored waterbody, has only a five-year period of data (2001 – 2005). All other WBIDs utilize the ten-year period of record (1996 – 2005). **Appendix C** contains the total number of samples and annual TP and TN concentrations utilized for each WBID and **Appendix D** contains the BOD data.

5.3 TMDL Development Process

Ideally, flows and loads impacting a waterbody should be simulated using a model that accurately simulates hydrologic and water quality conditions. Though not a fully complete, calibrated and validated model, the Department has decided to use the WaSh model, in part, as the basis for this TMDL. Due to the insensitivity of the model's response to nutrient levels, the model was not used to estimate nutrient concentration levels. Rather, the hydrology of the basin, which the model predicts well as agreed upon by the technical working group, was used to calculate contributing flows to the Estuary.

The WaSh model is a distributed process-based, coupled hydrologic, hydrodynamic and water quality model originally developed for the unique hydrologic conditions in south Florida. Additionally, the WaSh model was already configured and applied to basins draining to the SLE for previous studies conducted by the South Florida Water Management District. Since its initial development, there have been substantial improvements made to the model, some of which include changes to the phytoplankton – nutrient cycling interaction, the inclusion of atmospheric deposition, and a more detailed look at Aerial Based Mean Concentrations (similar to Event Mean Concentrations) specific to the St. Lucie basin. There are a few shortcomings to the model still, two being the lack of SOD and BOD data to calibrate against. Work is being done to overcome these limitations though and that, along with the updates made to the model will make it better able to simulate realistic conditions. When completed, the WaSh model will aid the BMAP process by providing some foresight into the consequences of potential implementation projects.

The model's hydrologic response has been configured and successfully calibrated and validated for all of the basins influencing the SLE. The flow calibration consisted of comparisons of daily flow measurements over a six-year period (1995 – 2000) and comparisons to monthly salinity data for a three-year period (2003 – 2005). For more detailed information on flow calibration and validation see WaSh Model Documentation Report (URS, 2008).

One of the unique qualities of the St. Lucie Estuary is the combination of ocean, rivers, canals and gated structures that control most surface basin flows to the estuary. Other than the natural tidal influence of the Atlantic Ocean, the North Fork of the St. Lucie River, and several small creeks, most surface flow to the estuary is controlled by structures that can modify the flow from low to high and even stop the flow completely, turning the canals into reservoirs.

The St. Lucie is a highly modified system and many of the WBIDs in the watershed have some sort of structure controlling the flow. Waterbodies 3193, 3194B, 3210, meet at the Roosevelt Bridge and create a confluence with a salinity gradient which decreases as one traverses from 3193 to the North (3194B) or South (3210) Forks of the estuary. A percent reduction was applied to WBID 3193 based on its current mean nutrient concentrations. The nutrient target applied to WBID 3193 was applied to all WBIDS which contribute to the estuary and are listed in **Tables 5.2** and **5.3**. **Figures 5.9** and **5.10** present bar graphs of the current loads and required reductions.

5.3.1 Modeled Flows

Using the WaSh model, flows were estimated for waterbodies in the system. **Figures 5.1** and **5.2** illustrate the fraction of modeled average annual flows from the contributing source areas. It is important to note that while Lake Okeechobee contributes a significant flow to the estuary, a TMDL has been established for the Lake, so its nutrient contributions are not considered in this TMDL except as noted in Chapter 6. WBID Flow data was obtained from the WaSh model in two ways:

1) for those WBIDs with structures at their endpoints, modeled flow data was used from that point and assumed representative of the entire WBID,

2) for those WBIDs without major control structures, the WaSh model has the capability to estimate daily flow values at selected nodes in the routing network. Nodes from each waterbody were selected at or near the intersection of the upstream and downstream boundary of the WBID. Subtracting annual upstream flow from annual downstream flow results in a net annual flow for those waterbodies.

Figure 5.1 Modeled Flows to Estuary with Lake Okeechobee

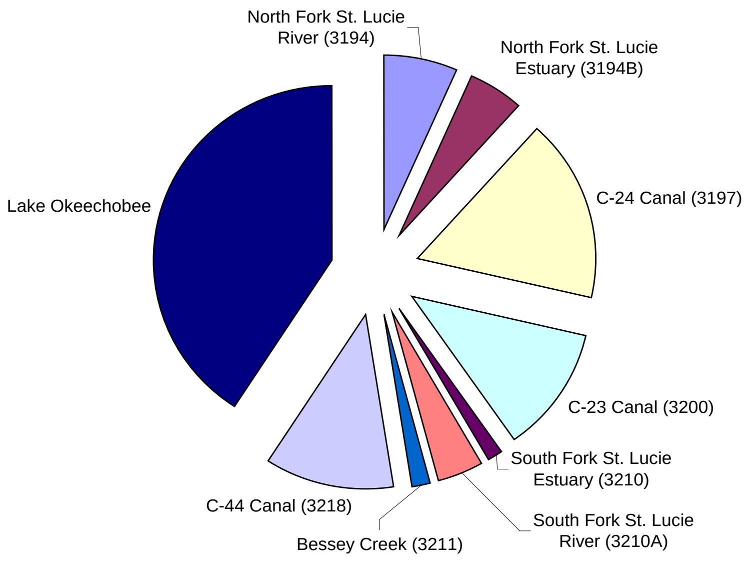
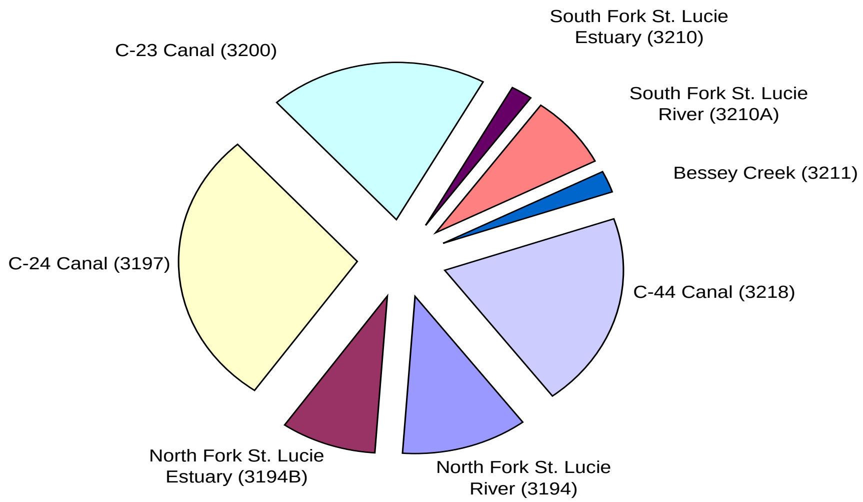


Figure 5.2 Modeled Flows to Estuary without Lake Okeechobee



5.3.2 Measured Nutrient Concentration Data

IWR data from sampling stations within each WBID were used to calculate individual waterbody concentrations based on 10-year measured mean annual nutrient concentrations, as displayed in **Tables 5.2** and **5.3**. **Figures 5.3** and **5.4** illustrate the relative concentrations from each WBID.

Appendix E provides maps of sampling stations and a summary of the descriptive statistics of the nutrient levels associated with each waterbody. An outlier analysis was conducted on the data set from each waterbody to determine if measured values were not representative of the population. The results of the outlier analyses are in **Appendix F**. The only waterbody that had data censored was C23 Canal, WBID 3200. According to the data and additional investigation, the sample site station 21FLWPB28010391 / Site 89 located in a drainage canal at Melear Dairy Farm has been identified as a high nutrient source, which will be addressed during the BMAP process. The data from this station was censored for the nutrient analysis since it is site-specific and not representative of the C-23 basin.

Figure 5.3 Annual Average Total Nitrogen (mg/L) for each WBID

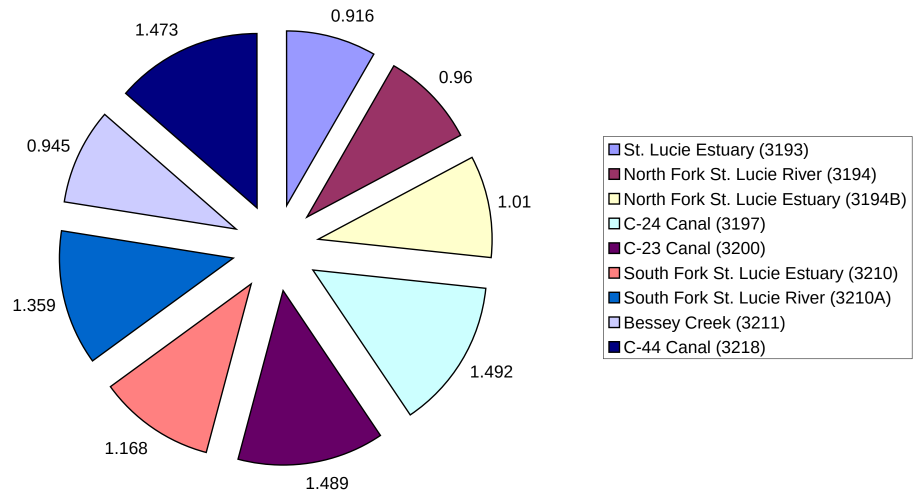
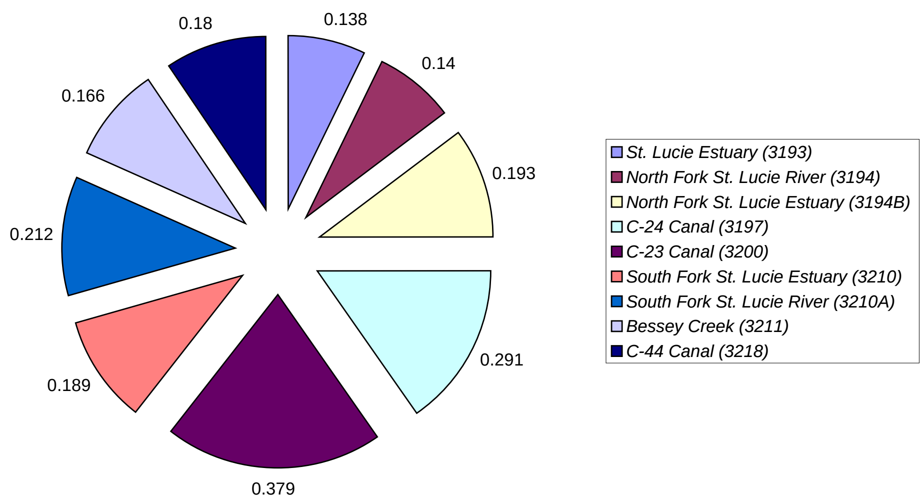


Figure 5.4 Annual Average Total Phosphorus (mg/L) for each WBID



5.3.3 Flow Duration Curves

The TMDL is expressed as a percent reduction in concentration to meet the TMDL concentration target. This approach is supported by examination of flow and load duration curves for the various waterbodies. The majority of flow, and thus loads to the estuary is provided by a system of canals with control structures. For example, **Figure 5.5** and **5.6** present flow duration curves for WBIDs 3200 (C-23) and WBID 3194 (North Fork St. Lucie River). The flow duration curve includes daily flows from the 10-year period of record. The flow duration curves use hydrologic data from the WaSh model to examine the cumulative frequency of historic flow data over the period of record. The daily flow rates are sorted from the highest value to lowest. A duration curve relates flow values to the percent of time those values have been met or exceeded. The use of “percent of time” on the x axis provides a uniform scale ranging between 0 and 100. The full range of flows is considered. Low flows (on the right) are exceeded a majority of the time, whereas floods (on the left) are exceeded infrequently. Duration curve analysis thus identifies intervals, which can be used as a general indicator of hydrologic condition (i.e., wet, dry, seasonal, and to what degree). Generally, dry seasons are represented by low flow conditions, and wet seasons are captured by high flow conditions. Figure 5.5, WBID 3200 (C-23) represents a water body with a control structure. Figure 5.6, WBID 3194 (North Fork St. Lucie River) demonstrates a flow duration curve for a water body with no major control structures.

For WBID 3200, it is interesting to note that there is a significant increase in flows at 60% of days exceeded, and a series of “steps” of constant flow from 20% to 55% of days exceeded from this basin. This is reflective of the operation of the control structures along with associated weather patterns. Other WBIDS with control structures exhibit flow characteristics reflective of gate operation and weather patterns.

For WBID 3194, there are no major control structures and the flow duration curve exhibits the typical sigmoidal pattern for natural systems. A similar flow duration curve pattern is repeated for WBIDs without major control structures.

Figure 5.5 WBID 3200 Flow Duration Curve 1996-2005

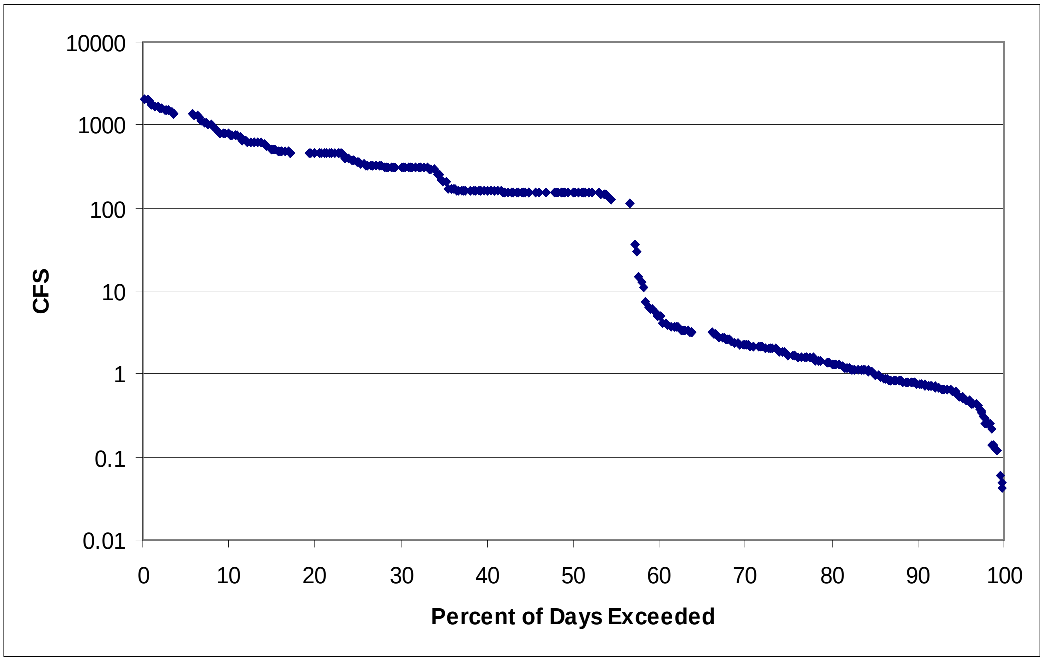
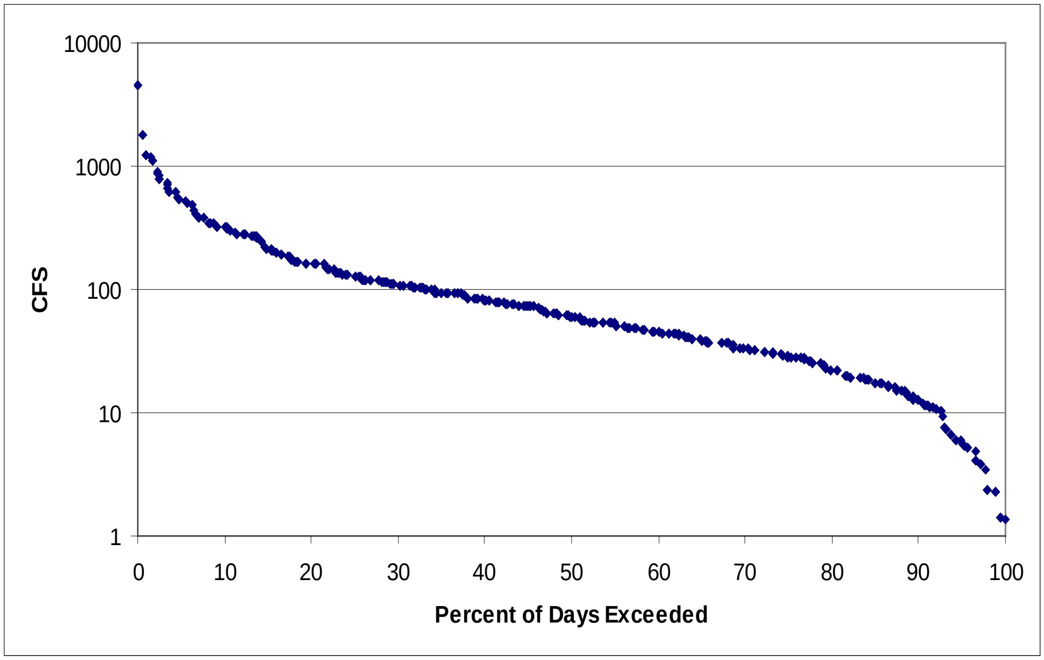


Figure 5.6 WBID 3194 Flow Duration Curve 1996-2005



5.3.4 Load Duration Curves

After flow durations are considered, the next step is to consider the daily load in relation to the target concentration. This is accomplished through the use of a load duration curve. As an example, **Figure 5.7** presents the total phosphorus load duration curves for WBID 3200 (Canal 23).

The load duration curve allows one to compare the target load with the measured load using the estimated flows from the WaSh model for all flow conditions. High loads are on the left side of the figure and low loads are on the right side of the figure. The target load is the series of blue points, and the measured loads are the red points.

WBID 3200 requires a 78.6 percent annual total phosphorus concentration reduction to meet the target daily load given the flows and concentrations for the period of record. The pattern of exceedances for all flow conditions (wet, dry, annual) is repeated for all of the WBIDS and their respective nutrient loads. However, due to variability in flow and load characteristics, the reductions for each WBID are not uniform.

Figure 5.8 exhibits the total nitrogen load duration curve for WBID 3194 which has no major control structure. It is interesting that WBID 3194 currently meets the target load for several days throughout the period of record, and this is reflected in the lower percent reduction for total nitrogen of 25 percent for WBID 3194. WBID 3194 exceeds the target load throughout the period of record over all flow regimes. The exceedances across all flow regimes require a longer-term approach to estimating the percent reductions due to the inherent variability of flow and load estimates. Note that annual average concentration target and the total maximum “daily load” work together. An annual averaging period provides a way to achieve long-term program objectives by averaging short term problems such as high flow storm events.

Figure 5.7 WBID 3200 TP Load Duration Curve 1996-2005

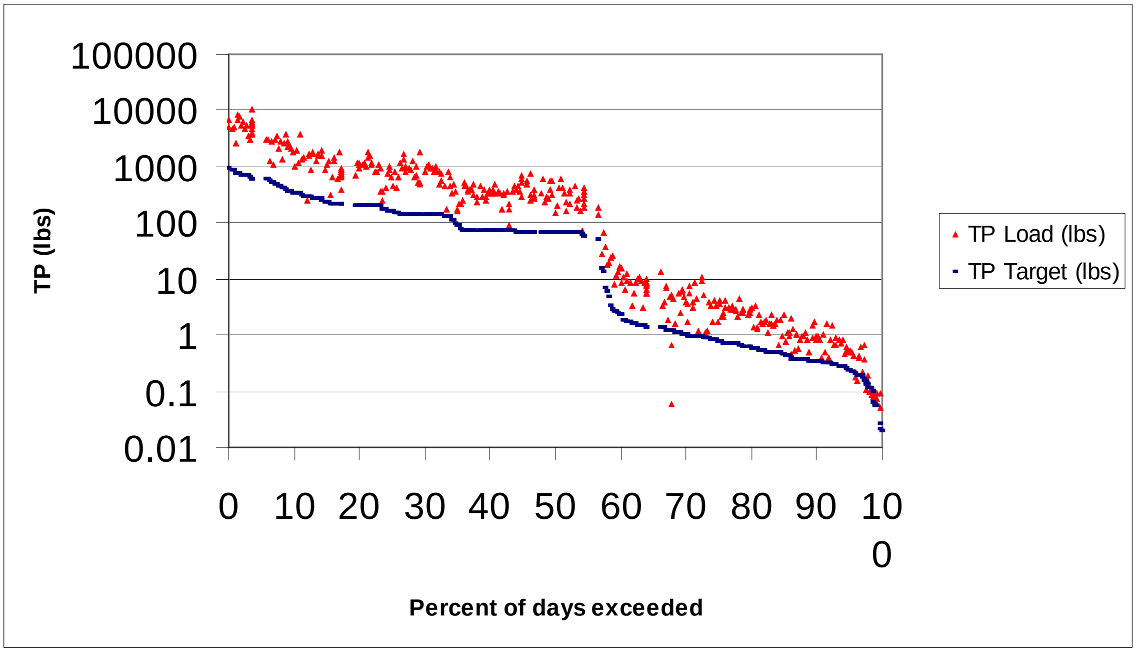
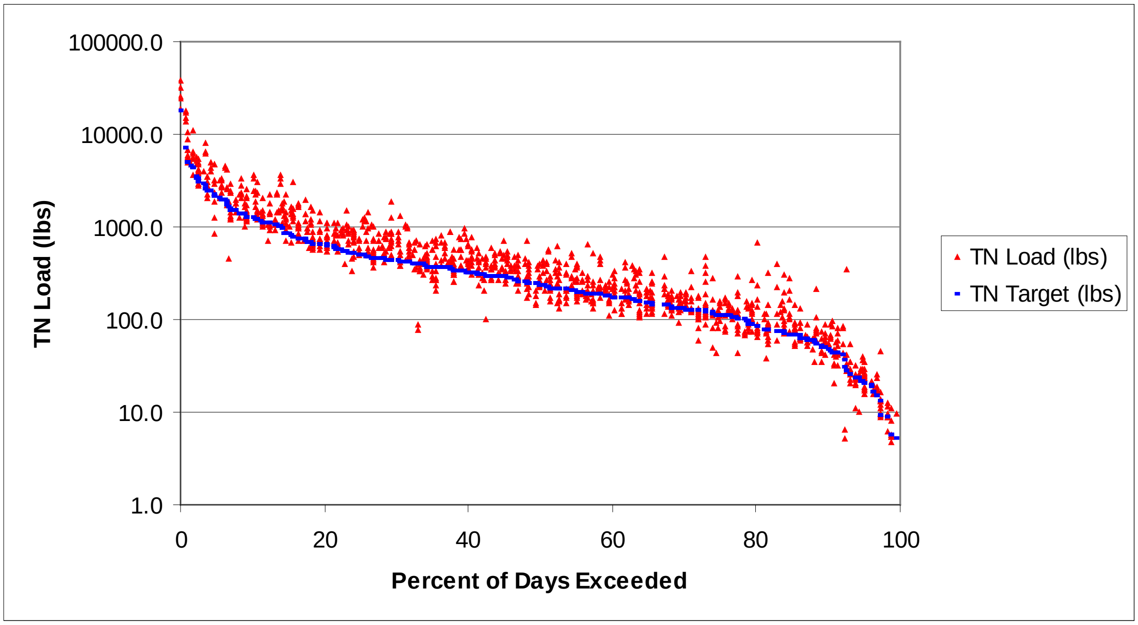


Figure 5.8 WBID 3194 TN Load Duration Curve 1996-2005



5.3.5 Annual Existing and Allowable Loads

After examining the load duration curves for the contributing WBIDS, the general procedure for calculating estimated nutrient loads and reductions was conducted as follows. The load is generated by multiplying concentration times flow and a conversion factor:

$$C \times Q \times f = L$$

Where *C* is the IWR Mean Annual concentration, *Q* is the modeled annual flow for the contributing source area, and *f* is a conversion factor for units. The average value of the 10-year mean annual load is then calculated. WBID 3211 has a 5-year mean annual load since instrumentation of the site has occurred only recently. All other WBIDS have a 10-year period of record for TN and TP. An example TN calculation for WBID 3218 for 1996 is:

$$1.3\frac{mg}{L} \times 142{,}530\ acre-ft \times \frac{325{,}851\ gallons}{acre-ft} \times \frac{3.78\ Liter}{gallon} \times \frac{pounds}{453{,}592.37\ mg} = 503{,}147\ pounds$$

To calculate the target load, the same process is used with a substitution of the target concentration value, C_{target} , for the measured IWR mean annual concentration to yield a target load, L_{target}:

$$C_{target} \times Q \times f = L_{target}$$

The annual load reduction in pounds can then be calculated by subtracting the current load from the target load. Percent reduction is the fraction that must be reduced from the current mean annual load. The annual flows estimated by the WaSh Model and nutrient loads for each impaired waterbody are summarized in **Table 5.2** for total nitrogen and **Table 5.3** for total phosphorus. Annual flow values were multiplied by target concentrations to obtain a target annual load from each waterbody. Mean values were calculated for each WBID resulting in a ten-year mean annual concentration for each waterbody. **Figures 5.5** and **5.6** illustrate the relative current loads and reductions of nutrients in pounds to achieve the target concentrations. It is anticipated that when the nutrient targets are achieved, flora in the system will be in balance in the Estuary.

Table 5.2 WaSh Estimated Flows with Annual Existing and Allowable TN Loads

Waterbody	Modeled Flow (acre-ft/yr)	Annual Average TN [mg/L]	Annual Average TN Load (lbs)	Target Annual TN Load (lbs) or TN [mg/L]	Annual Load Reduction (lbs) or TN [mg/L]	Percent Reduction	Average Daily Load (lbs)	TMDL (lbs)
St. Lucie Estuary (3193)	N/A	0.916	N/A	[0.720]	[0.196]	21.4	N/A	N/A
North Fork St. Lucie River (3194)	71,600	0.960	186,962	140,134	46,828	25.0	512	384
North Fork St. Lucie Estuary (3194B)	53,009	1.010	145,625	103,747	41,878	28.8	399	284
C-24 Canal (3197)	178,296	1.492	723,569	348,957	374,612	51.8	1,982	956
C-23 Canal (3200)	123,751	1.489	501,201	242,202	258,999	51.7	1,373	664
South Fork St. Lucie Estuary (3210)	12,499	1.168	39,710	24,463	15,246	38.4	109	67
South Fork St. Lucie River (3210A)	46,225	1.359	170,870	90,471	80,400	47.1	468	248
Bessey Creek (3211)	15,318	0.945	39,374	29,981	9,394	23.9	108	82
C-44 Canal (3218)	124,122	1.473	497,303	242,929	254,374	51.2	1,362	666

Period of Record: 1996 - 2005
N/A – Not Applicable

Table 5.3 WaSh Estimated Flows with Annual Existing and Allowable TP Loads

Waterbody	Modeled Flow (acre-ft/yr)	Annual Average TP [mg/L]	Annual Average Load (lbs)	Target Annual TP Load (lbs) or TP [mg/L]	Annual Load Reduction (lbs) or TP [mg/L]	Percent Reduction	Average Daily Load (lbs)	TMDL (lbs)
St. Lucie Estuary (3193)	N/A	0.138	N/A	[0.081]	[0.057]	41.3	N/A	N/A
North Fork St. Lucie River (3194)	71,600	0.140	27,265	15,765	11,500	42.2	75	43
North Fork St. Lucie Estuary (3194B)	53,009	0.193	27,827	11,672	16,156	58.1	76	32
C-24 Canal (3197)	178,296	0.291	141,125	39,258	101,867	72.2	387	108
C-23 Canal (3200)	123,751	0.379	127,572	27,248	100,325	78.6	350	75
South Fork St. Lucie Estuary (3210)	12,499	0.189	6,426	2,752	3,673	57.2	18	8
South Fork St. Lucie River (3210A)	46,225	0.212	26,655	10,178	16,477	61.8	73	28
Bessey Creek (3211)	15,318	0.166	6,917	3,373	3,544	51.2	19	9
C-44 Canal (3218)	124,122	0.180	60,770	27,330	33,441	55.0	166	75

Period of Record: 1996 - 2005
N/A – Not Applicable

Table 5.4 Annual Existing and Allowable BOD Concentrations

Waterbody	Modeled Flow (acre-ft/yr)	Annual Average [BOD] mg/L	Target Annual [BOD] mg/L	Annual Reduction [BOD] mg/L	Percent Reduction
North Fork St. Lucie River (3194)	71,600	[7.70]	[2.00]	[5.70]	74.0
C-24 Canal (3197)	178,296	[3.00]	[2.00]	[1.00]	33.3
C-44 Canal (3218)	124,122	[6.60]	[2.00]	[4.60]	69.7

Period of Record: 1996 - 2005

Figure 5.9 Current and Target Average Annual Total Nitrogen Loads

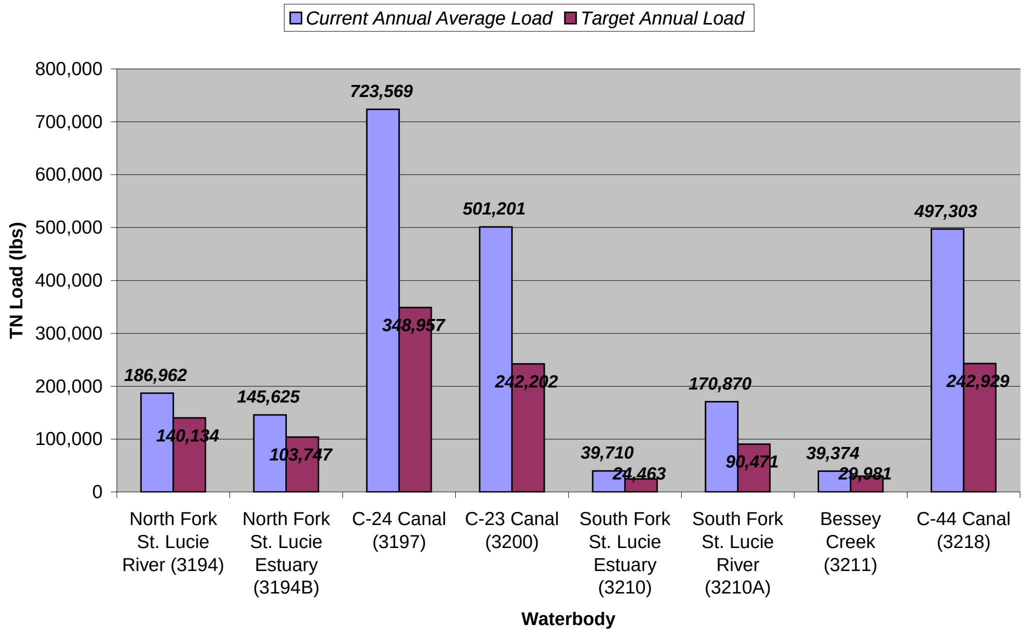
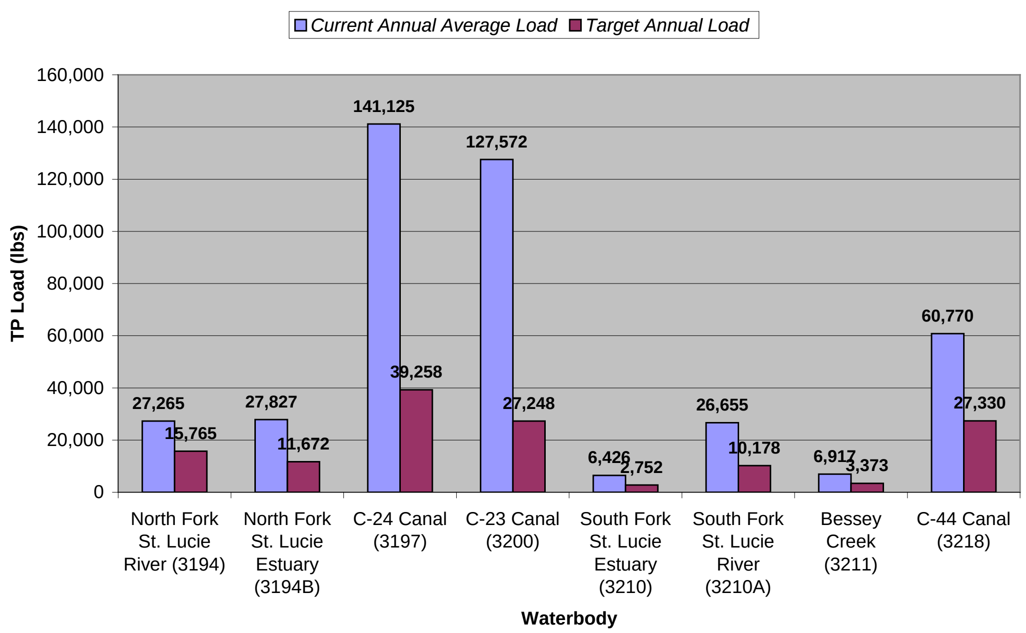


Figure 5.10 Current and Target Average Annual Total Phosphorus Loads



Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. The goal of the TMDL development for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218) is to identify the maximum allowable TN, TP, and BOD loadings to the watershed so that it will meet applicable water quality standards and maintain its function and designated use as Class III water.

A TMDL is typically expressed as the sum of all point source loads (Wasteload Allocations, or WLAs), nonpoint source loads (Load Allocations, or LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\mathbf{TMDL = \sum WLAs + \sum LAs + MOS}$$

Due to the complex nature of the St. Lucie system, large tidal exchange, constant mixing between the North and South forks, etc., flow values for the WBIDs 3193, 3194B, and 3210 were difficult to determine. As such, load reductions will be calculated for those waterbodies that input to the estuary based on concentration reductions applied to the three waterbodies mentioned above that are directly connected to the compliance point of the system, the Roosevelt Bridge.

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities and instead, are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulation 40 CFR § 130.2[I] (EPA, 2003), which states that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure, such as mass per volume. The TMDL for the St. Lucie Estuary is expressed in terms of percent reduction, and represents the reductions in TN, TP, and BOD the estuary systems needs to maintain its designated uses (**Table 6.1**).

Table 6.1 TMDL Components for the St. Lucie Basin

Waterbody	Parameter	Annual TMDL Target lbs or [C]	WLA		LA (% Reduction)	MOS
			NPDES Wastewater (mg/L)	NPDES Stormwater (% Reduction)		
St. Lucie Estuary (3193)	TN	[0.720]	N/A	21.4	21.4	Implicit
	TP	[0.081]	N/A	41.3	41.3	Implicit
North Fork St. Lucie River (3194)	TN	140,134	N/A	25.0	25.0	Implicit
	TP	15,765	N/A	42.2	42.2	Implicit
	BOD	[2.0]	N/A	74.0	74.0	Implicit
North Fork St. Lucie Estuary (3194B)	TN	103,747	N/A	28.8	28.8	Implicit
	TP	11,672	N/A	58.1	58.1	Implicit
C-24 Canal (3197)	TN	348,957	N/A	51.8	51.8	Implicit
	TP	39,258	N/A	72.2	72.2	Implicit
	BOD	[2.0]	N/A	33.3	33.3	Implicit
C-23 Canal (3200)	TN	242,202	N/A	51.7	51.7	Implicit
	TP	27,248	N/A	78.6	78.6	Implicit
South Fork St. Lucie Estuary (3210)	TN	24,463	N/A	38.4	38.4	Implicit
	TP	2,752	N/A	57.2	57.2	Implicit
South Fork St. Lucie River (3210A)	TN	90,471	N/A	47.1	47.1	Implicit
	TP	10,178	N/A	61.8	61.8	Implicit
Bessey Creek (3211)	TN	29,981	N/A	23.9	23.9	Implicit
	TP	3,373	N/A	51.2	51.2	Implicit
C-44 Canal (3218)	TN	242,929	N/A	51.2	51.2	Implicit
	TP	27,330	N/A	55.0	55.0	Implicit
	BOD	[2.0]	N/A	69.7	69.7	Implicit

N/A – Not Applicable, [ ] – concentration in mg/L

6.2 Load Allocation

The load allocation is a percentage of the estimated mean annual load that will result in attainment of target concentration values. Reductions for this TMDL are based strictly on a percent reduction of load allocations (see **Tables 5.2** and **5.3** for actual values). Reductions will be applied to each waterbody that inputs to the Estuary. Though there is a specific point at which each waterbody joins the Estuary, they are considered nonpoint sources and thus, fall in the load allocation section. Specific allocations will be applied during the BMAP process for all contributors to each individual waterbody (e.g. MS4s). For BOD, which is dependent on reduction of algal blooms and other biological processes, the load allocation is a percentage of the mean annual load that will result in attainment of BOD criteria discussed in section 3.2.2 (see **Table 5.4** for actual values).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There are 15 permitted NPDES wastewater facilities (**Table 4.1**) in the St. Lucie basin which are permitted to discharge only during a 25-year/72-hour storm event amounting to minimal and highly irregular impact on nutrient discharges. Facilities that have permitted discharges above this level are for cooling or dewatering, which are effectively discharging ambient water. Since this report is based on ambient conditions in the watershed, the infrequent discharge from the above mentioned facilities is not included in the overall reduction. If conditions change in the permits for any of the facilities mentioned, that change will be included as part of the restoration effort.

6.3.2 NPDES Stormwater Discharges

Chapter 4 listed six Municipal Separate Storm Sewer Systems (MS4s) which may discharge nutrients to water bodies in response to storm events. Although boundaries and locations of MS4s are exhibited in Chapter 4, little information was available to the Department at the time this analysis was conducted regarding the descriptive nature or character (flows and loads) of the NPDES stormwater discharges that would distinguish them from other land uses within the basins. The stormwater TN and TP loadings from MS4 areas were estimated by their inclusion in the comprehensive stormwater modeling of the basin (see WaSh Model Documentation, URS, 2008 for detailed information).

6.4 Margin of Safety

TMDLs must address uncertainty issues by incorporating a margin of safety into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (Clean Water Act, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as in predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty. For the St. Lucie Basin an implicit MOS was employed and the following are two of the critical assumptions that went into the design of this report:

1) Average Annual Flows–

Average annual flows for the10-year period results in a lower TMDL versus a seasonal averaging period and is supported by the flow and concentration data that is available. The estimation using a lower flow value is in accord with the Department's policy to use conservative values for TMDL development.

2) Lake Okeechobee meeting its TMDL target –

It is Department policy that a waterbody with a TMDL in place shall be assumed to be meeting its established target. Lake Okeechobee is an indirect contributor to the Estuary via the C-44 Canal and, as such, all waters being released from the Lake are assumed to be at 40 ppb TP, the target established in the Lake's TMDL. This assumption allows for the partitioning of impairment between the Lake water and the C-44 watershed and does not put the burden of resolving the Lake's impairment issues on the contributors to the C-44 and southern estuary watersheds.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

This TMDL will be implemented primarily through a Basin Management Action Plan (BMAP). Section 373.4595 F.S. requires that the BMAP be initiated no later than 90 days after adoption of this TMDL, and that the BMAP be completed as soon as practicable. In the St. Lucie Watershed, the BMAP process will be closely coordinated with the NEEPP River Watershed Protection Plan. As discussed in Chapter 1, the St. Lucie NEEPP River Watershed Protection Plan is being developed primarily by the SFWMD, with participation from DEP, DACS, and a variety of interested stakeholders. The St. Lucie NEEPP River Watershed Protection Plan is due to the Florida Legislature on January 1, 2009.

Section 373.4595 F.S. calls for expeditious implementation of the River Watershed Protection Plan and states that implementation of the Watershed Plan and any related BMAPs is a reasonable means of achieving TMDLs and compliance with state water quality standards. The SFWMD, FDACS, and FDEP are working closely together to coordinate the NEEPP and BMAP processes, avoid overlap, and ensure that implementation efforts are timely and cost-effective. Prior to initiation of the BMAP, the DEP will closely review the River Watershed Protection Plan and identify components of the Watershed Plan that are directly applicable to the BMAP. Basic BMAP guidelines are outlined in 403.067(7) F.S., including:

- Appropriate load reduction allocations among the affected parties, or to the basin as a whole (403.067(7)(a)2.);
- A description of the appropriate management strategies to be undertaken, including regional treatment systems or other public works, where appropriate;
- An implementation schedule;
- A basis for evaluating the plan’s effectiveness;
- Feasible funding strategies;
- Linkages to affected NPDES permits;
- Mechanisms by which potential future increases in pollutant loading will be addressed;
- A water quality monitoring component sufficient to evaluate progress in pollutant load reductions; and
- An assessment process to occur no less than every five years.

The BMAP will likely include other factors beyond these basic elements. The BMAP development process will occur with the close cooperation of local stakeholders and DEP’s partner NEEPP agencies (SFWMD and FDACS), many of whom were involved in development of this TMDL.

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Appendix A

Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (e.g., performance standards) as set forth in Rule 62-40, F.A.C.

The rule requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG had been developed for Newnans Lake at the time this report was developed.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria.

An important difference between the federal and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges. Additionally, Phase II of the NPDES Program expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 10,000 people. The revised rules required that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

Appendix B

2004-05 Level 1 and Level 2 FLUCCS Landuse Figures for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218,)

Figure B.1 WBID 3193 2004-05 Level 1 and Level 2 FLUCCS Landuse

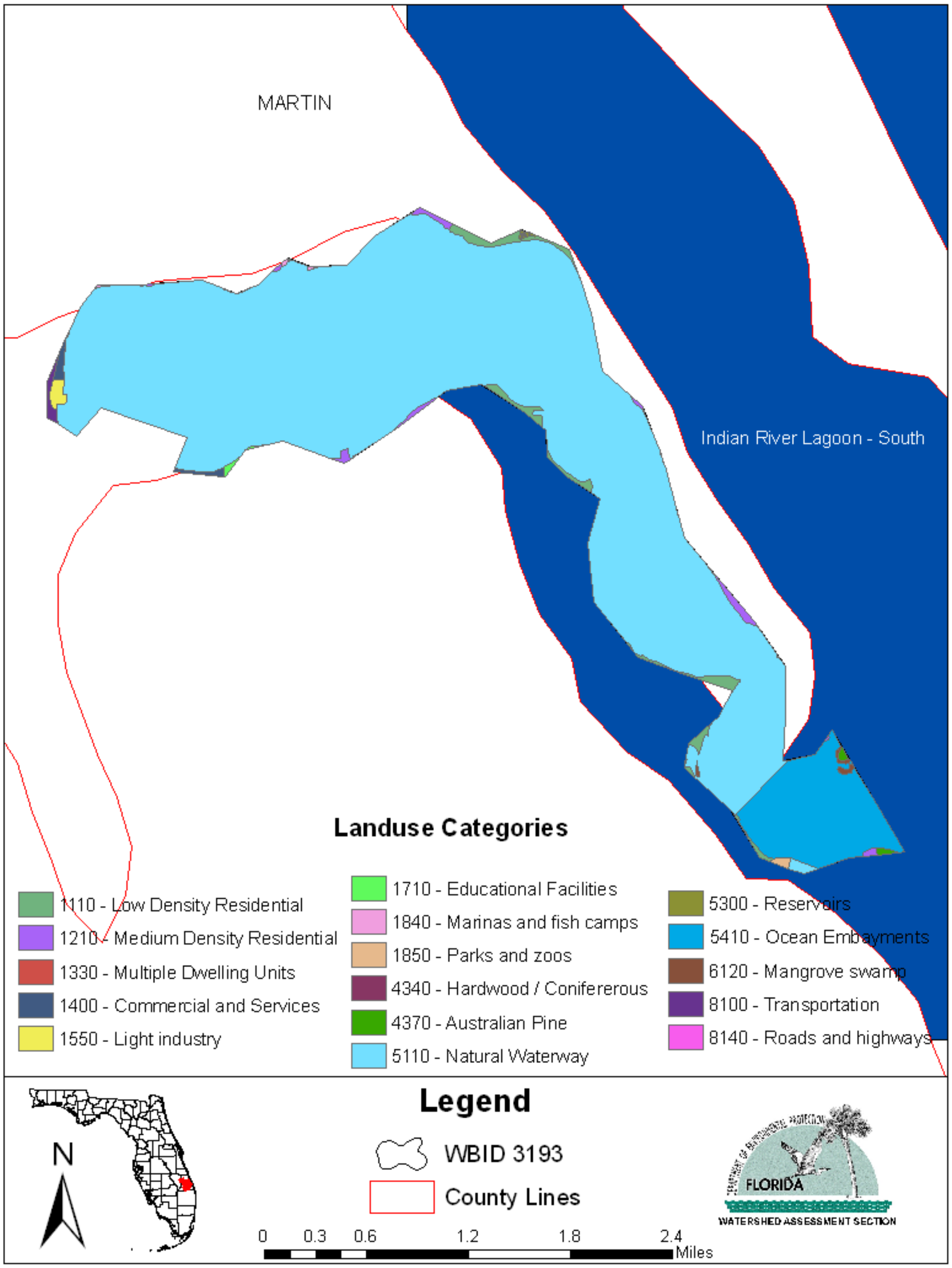


Figure B.2 WBID 3194 2004-05 Level 1 and Level 2 FLUCCS Landuse

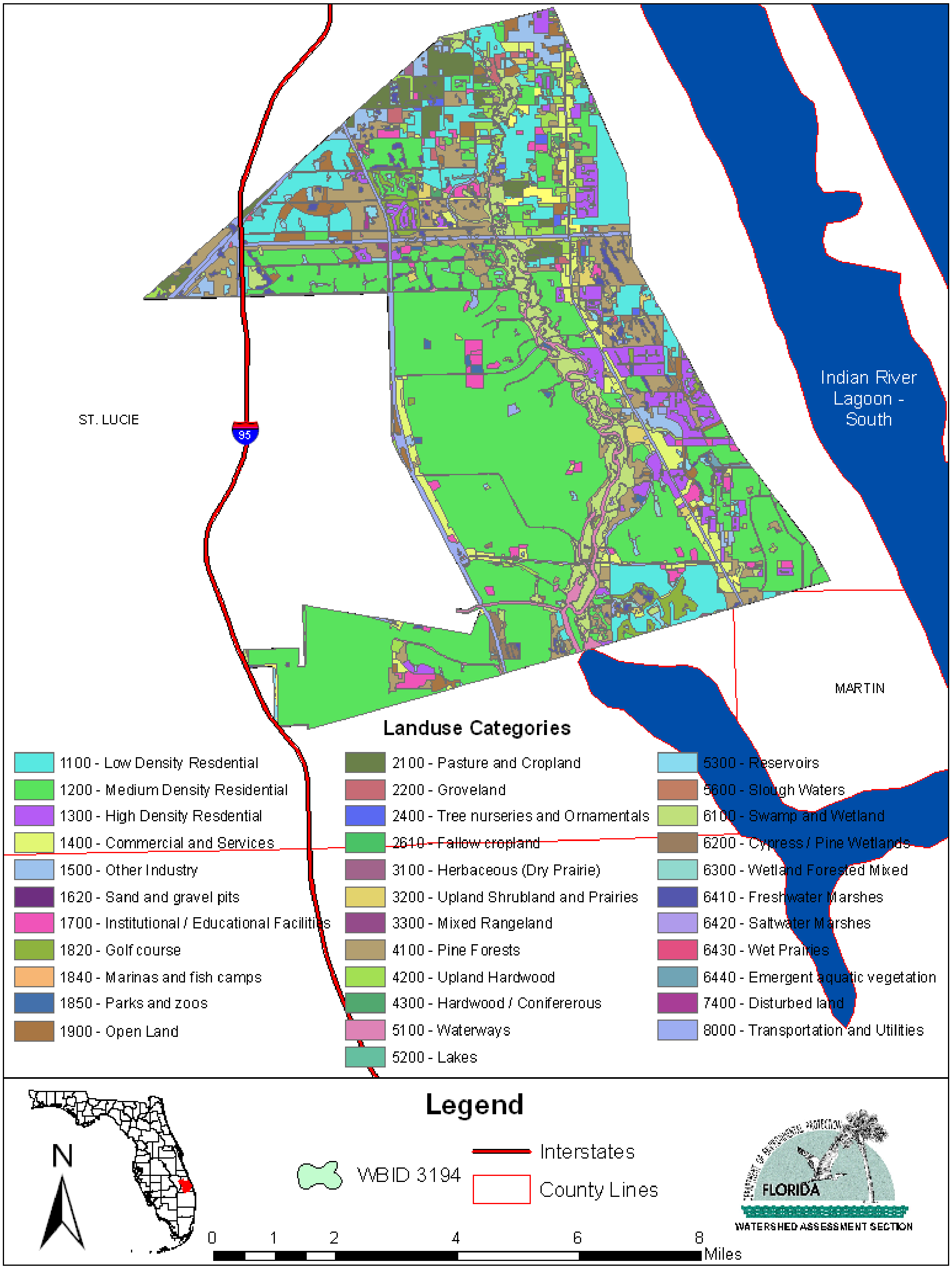


Figure B.3 WBID 3194B 2004-05 Level 1 and Level 2 FLUCCS Landuse

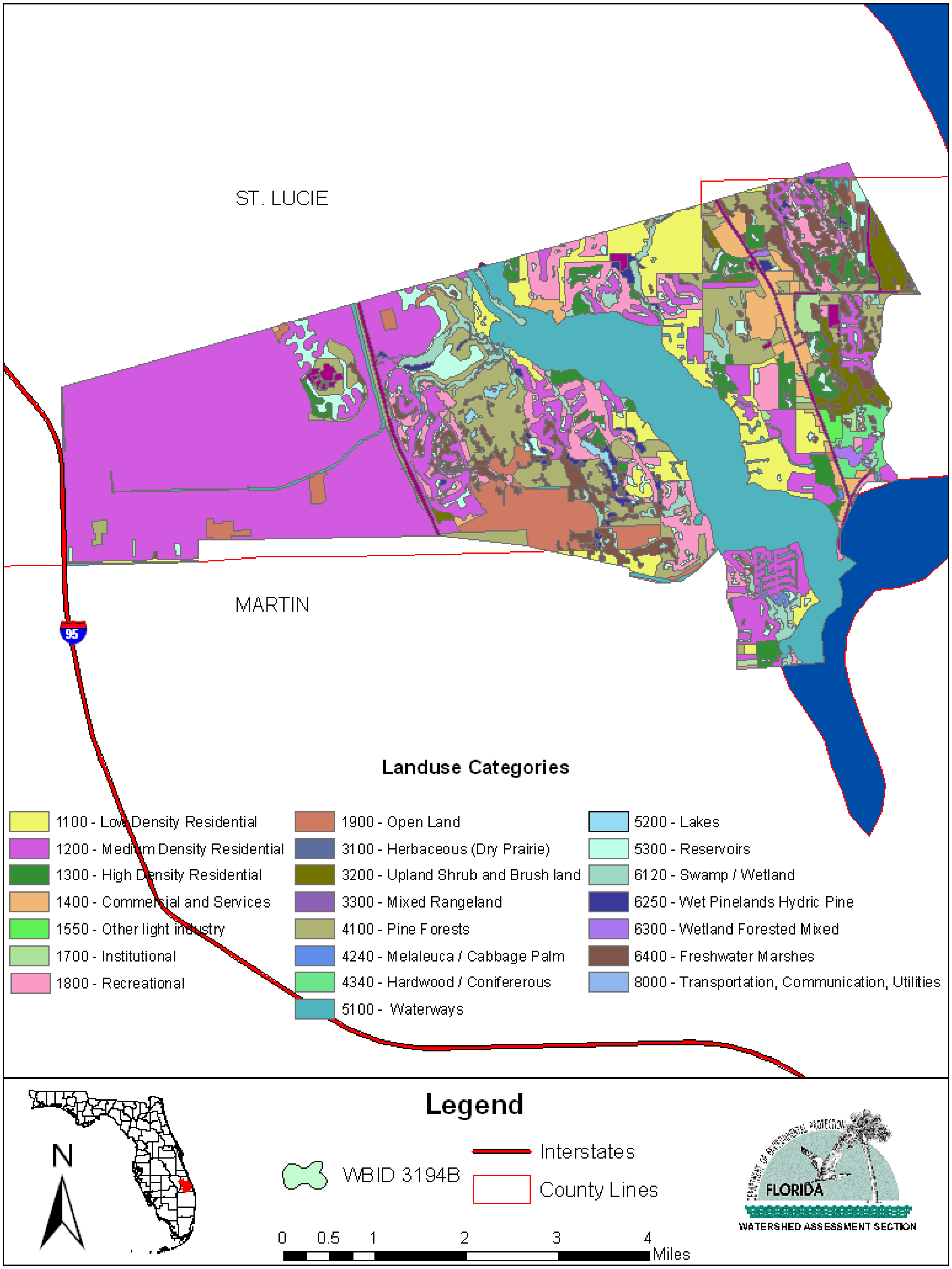


Figure B.4 WBID 3197 2004-05 Level 1 and Level 2 FLUCCS Landuse

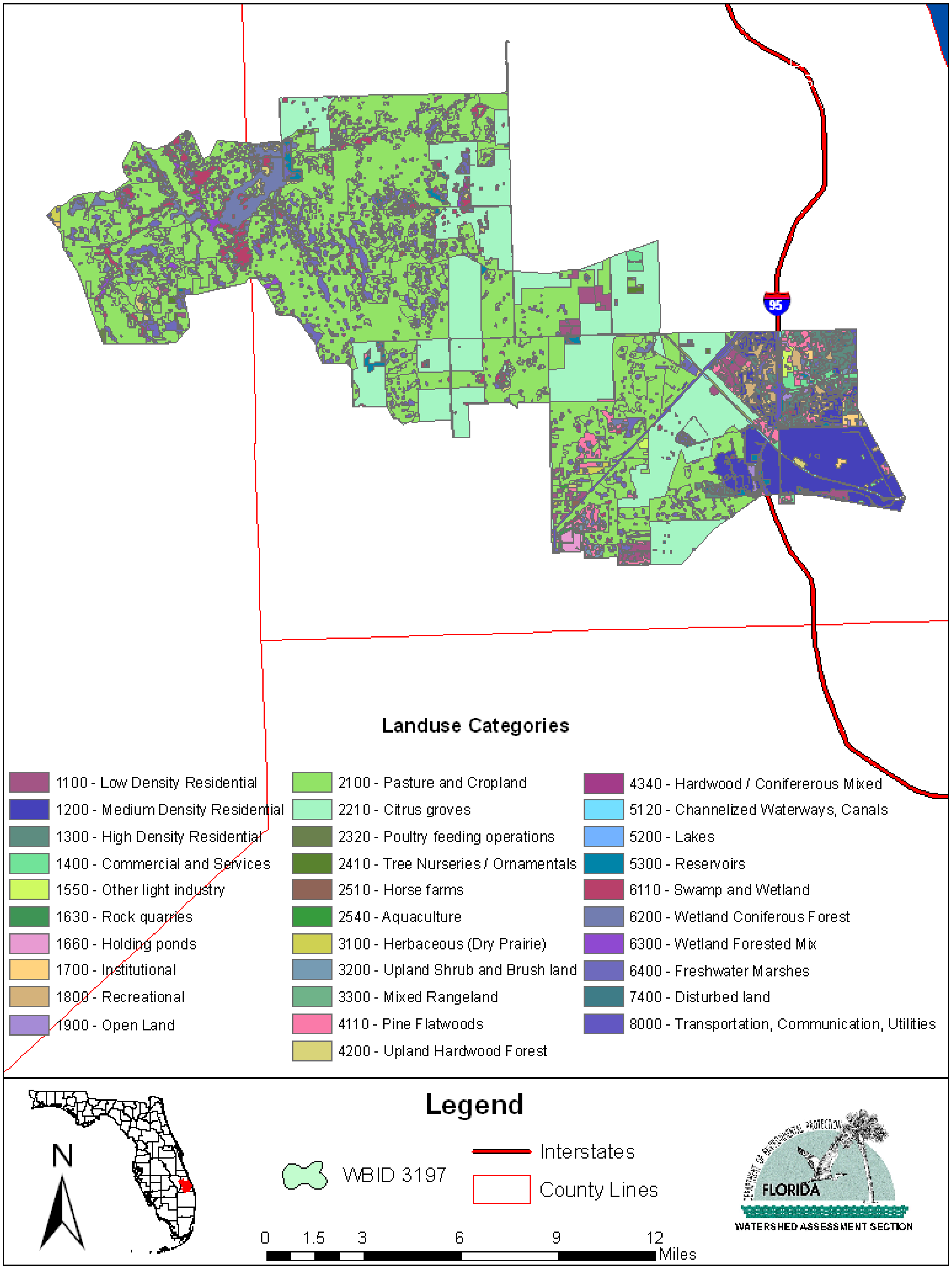


Figure B.5 WBID 3200 2004-05 Level 1 and Level 2 FLUCCS Landuse

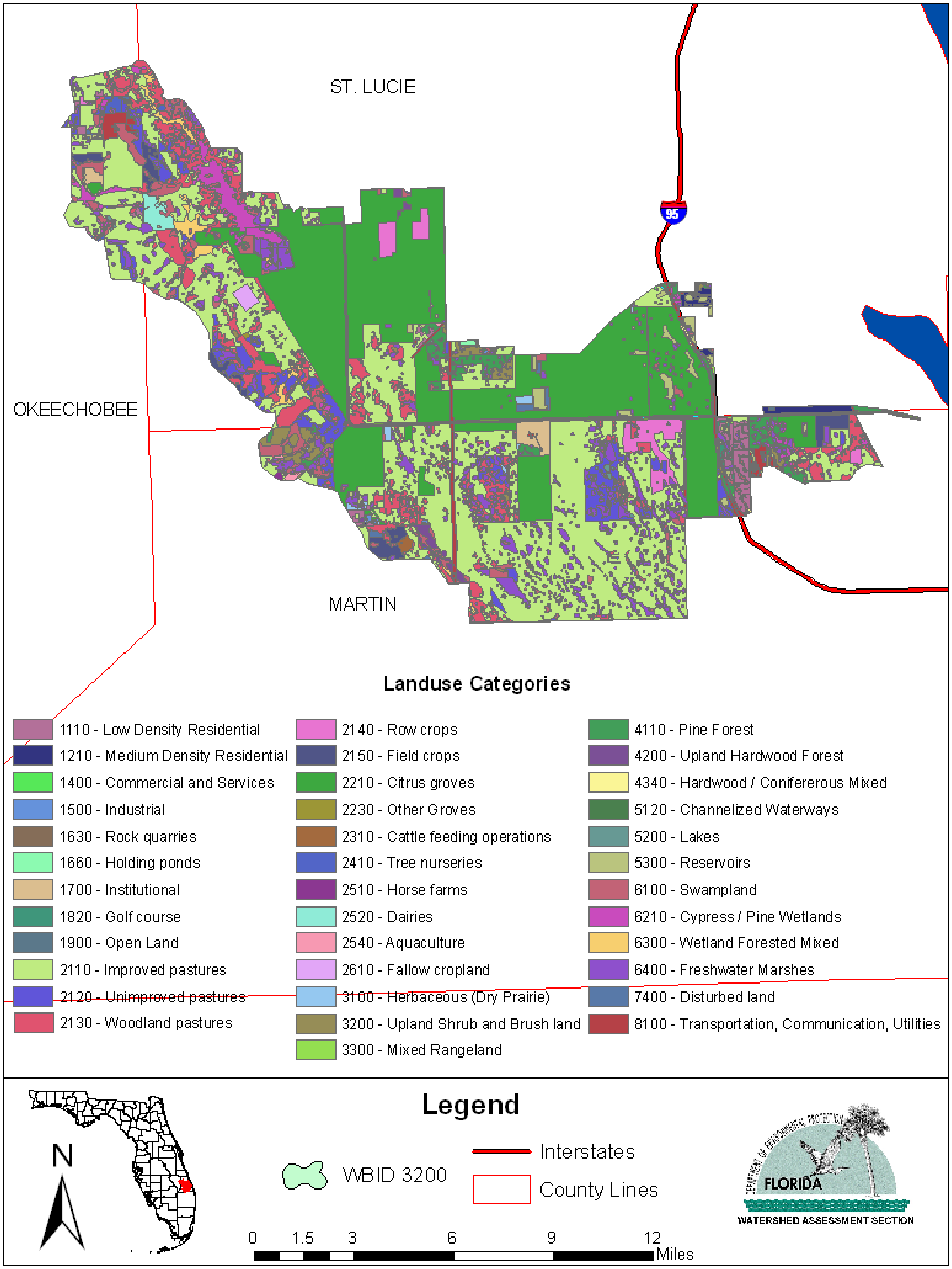


Figure B.6 WBID 3210 2004-05 Level 1 and Level 2 FLUCCS Landuse

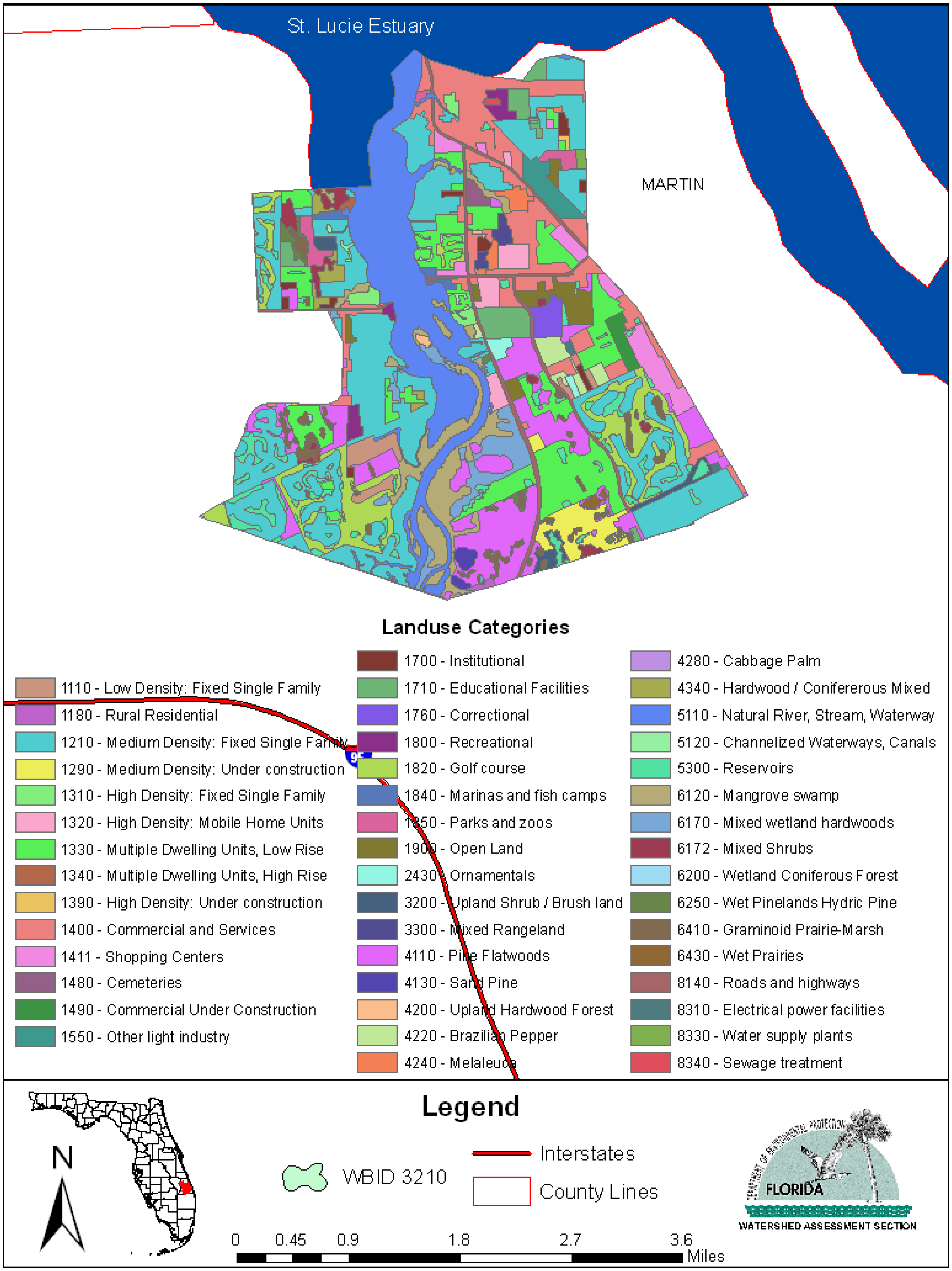


Figure B.7 WBID 3210A 2004-05 Level 1 and Level 2 FLUCCS Landuse

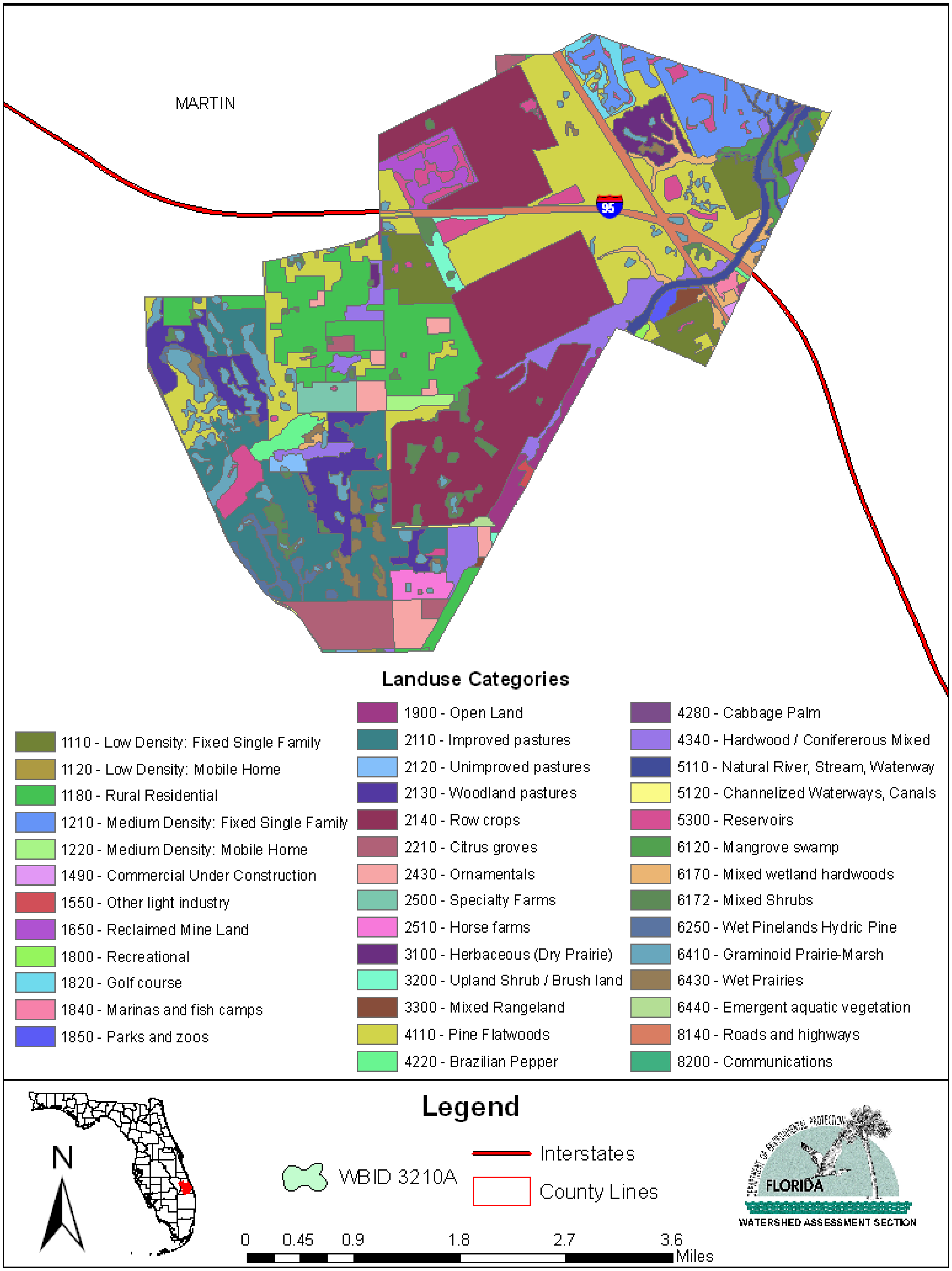


Figure B.8 WBID 3211 2004-05 Level 1 and Level 2 FLUCCS Landuse

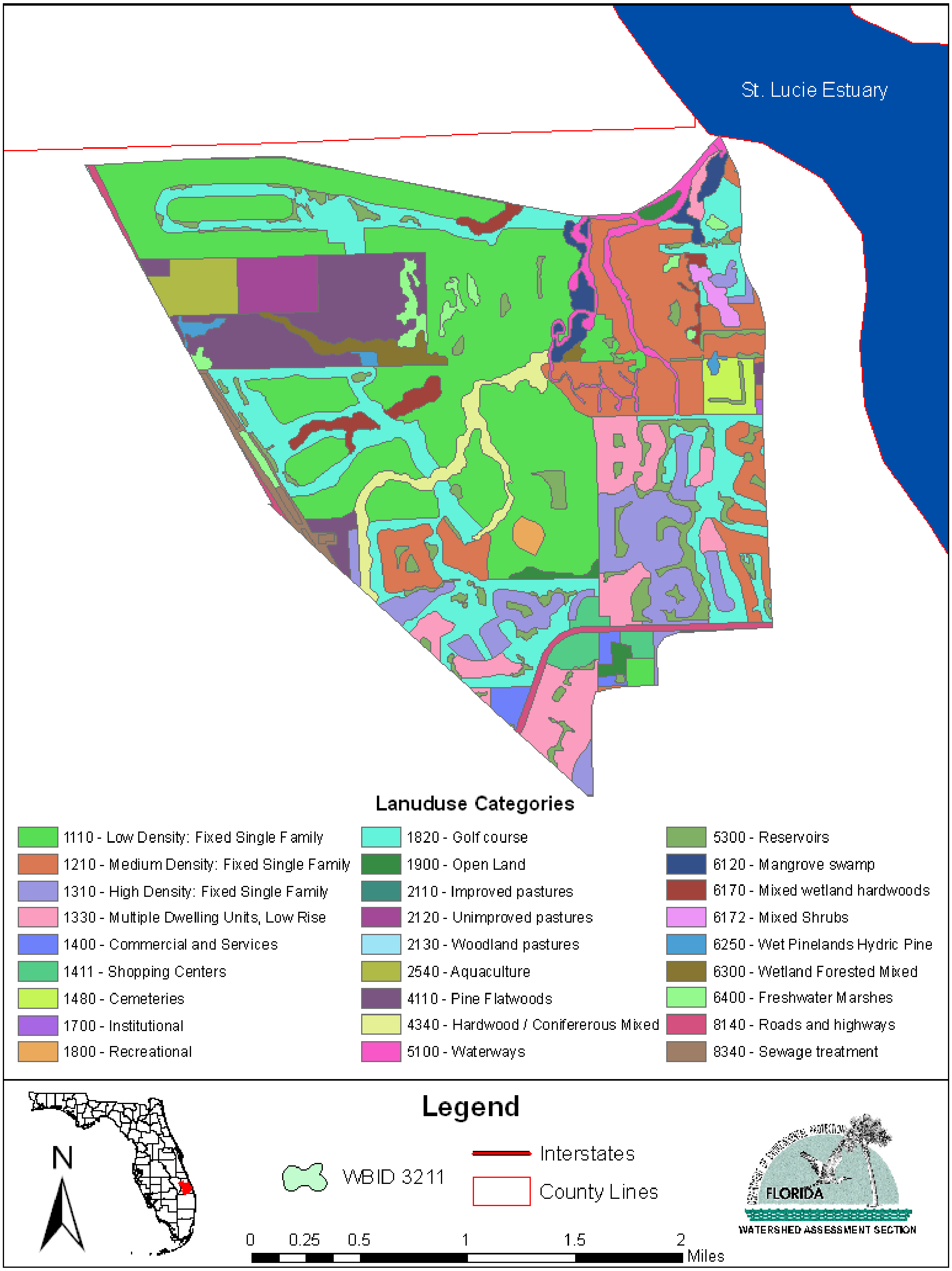
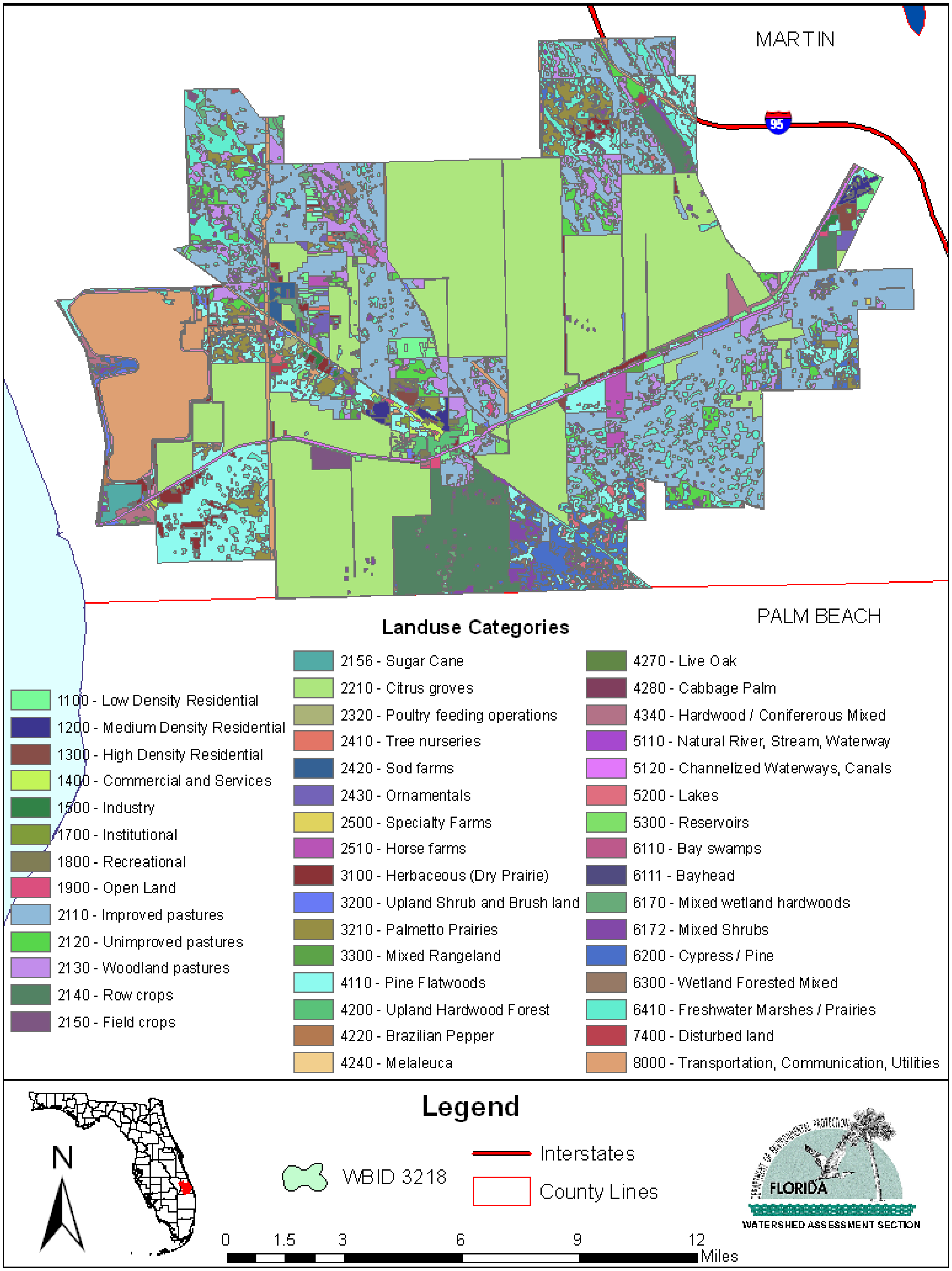


Figure B.9 WBID 3218 2004-05 Level 1 and Level 2 FLUCCS Landuse



Appendix C

Total Number of Samples and Annual TN and TP Mean Concentrations by WBID for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)

Table C.1 WBID 3193 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	45	0.11	45	1.04
1997	31	0.1	30	1.1
1998	32	0.14	32	1.5
1999	53	0.16	51	0.66
2000	49	0.1	49	0.61
2001	23	0.18	22	0.85
2002	26	0.13	25	0.82
2003	22	0.14	24	0.82
2004	23	0.18	22	0.9
2005	21	0.19	22	1.1

Table C.2 WBID 3194 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	43	0.2	42	1.33
1997	27	0.25	25	1.32
1998	26	0.31	26	1.54
1999	40	0.29	40	0.94
2000	39	0.24	39	0.9
2001	108	0.16	108	1
2002	601	0.1	595	0.9
2003	421	0.14	423	0.9
2004	369	0.14	368	0.98
2005	261	0.131	268	0.98

Table C.3 WBID 3194B Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	84	0.19	84	1.3
1997	38	0.19	34	1.2
1998	42	0.26	43	1.6
1999	68	0.22	68	0.8
2000	68	0.16	68	0.8
2001	69	0.21	69	1.1
2002	237	0.15	254	0.9
2003	161	0.14	168	0.9
2004	26	0.3	26	1.03
2005	164	0.26	163	1.1

Table C.4 WBID 3197 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	22	0.23	22	1.5
1997	62	0.24	56	1.7
1998	71	0.29	62	1.7
1999	191	0.34	187	1.6
2000	158	0.27	155	1.5
2001	83	0.25	83	1.5
2002	121	0.28	121	1.2
2003	70	0.27	66	1.4
2004	58	0.33	56	1.4
2005	90	0.32	85	1.6

Table C.5 WBID 3200 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	36	0.23	34	1.3
1997	76	0.28	79	1.6
1998	91	0.4	85	1.6
1999	106	0.5	102	1.7
2000	109	0.4	102	1.3
2001	74	0.5	75	1.6
2002	91	0.5	91	1.4
2003	83	0.34	82	1.4
2004	71	0.5	71	1.4
2005	106	0.4	139	1.6

Table C.6 WBID 3210 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	39	0.17	40	1.3
1997	24	0.18	22	1.3
1998	26	0.21	26	1.6
1999	64	0.21	64	0.9
2000	50	0.18	50	0.9
2001	57	0.21	57	0.1
2002	255	0.17	263	1.1
2003	160	0.18	164	1.1
2004	89	0.14	89	1.1
2005	217	0.22	217	1.4

Table C.7 WBID 3210A Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	16	0.16	16	1.4
1997	10	0.2	9	1.8
1998	10	0.23	10	1.6
1999	30	0.2	30	1.2
2000	28	0.24	28	1.4
2001	37	0.25	37	1.4
2002	118	0.17	117	1.1
2003	80	0.24	80	1.4
2004	23	0.24	22	1.7
2005	22	0.23	23	1.8

Table C.8 WBID 3211 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	-		-	
1997	-		-	
1998	-		-	
1999	-		-	
2000	-		-	
2001	18	0.22	18	0.99
2002	83	0.15	94	0.89
2003	57	0.15	59	0.97
2004	26	0.19	30	0.88
2005	25	0.18	27	1.1

Table C.9 WBID 3218 Number of Samples and Annual TN and TP Concentrations

Year	# Samples	TP Conc. (mg/L)	# Samples	TN Conc. (mg/L)
1996	22	0.13	21	1.3
1997	21	0.12	20	1.4
1998	51	0.17	49	1.7
1999	121	0.19	121	1.4
2000	173	0.17	170	1.4
2001	47	0.22	47	1.3
2002	82	0.16	82	1.2
2003	95	0.22	95	1.4
2004	80	0.18	78	1.8
2005	101	0.22	100	1.8

Appendix D

Total Number of Samples and BOD Mean Concentrations by WBID for the St. Lucie Basin (WBIDs 3193, 3194, 3194B, 3197, 3200, 3210, 3210A, 3211, and 3218)

Table D.1 BOD Average Concentration Values and Number of Samples from 1996 - Present

WBID	# Samples	Average	Exceeded Threshold?
3193	12	1.5	
3194	43	2.1	Yes
3194B	12	1.8	
3197	18	2.7	Yes
3200	12	2.8	Yes
3210	28	2.0	
3210A	13	2.0	
3211	34	2.0	
3218	15	1.2	

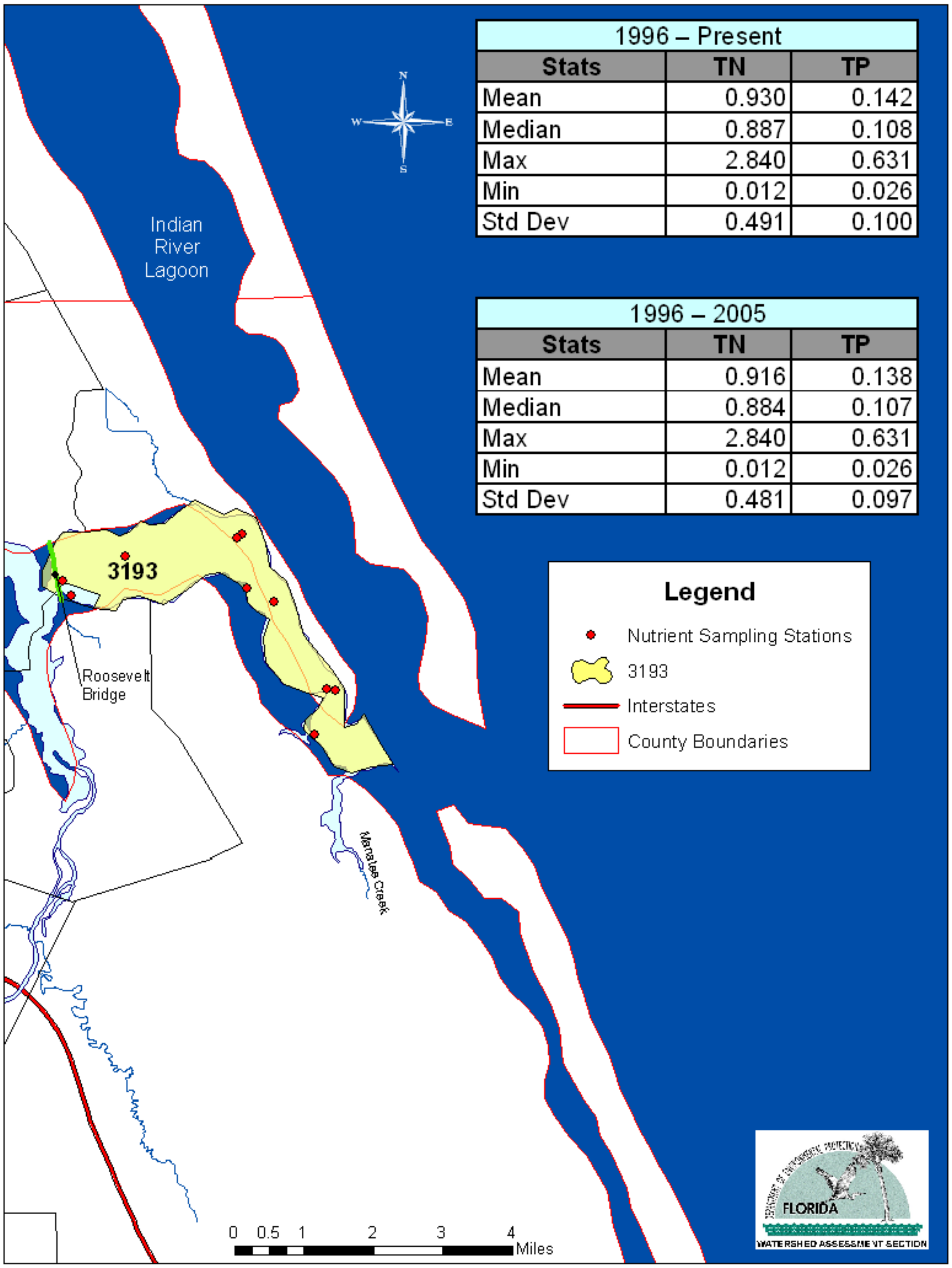
Table D.2 BOD Average Concentration Values and Number of Samples from 1996 - 2005

WBID	# Samples	Average	Exceeded Threshold?
3193	No Data	No Data	
3194	24	2.1	Yes
3194B	2	1.8	
3197	3	2.6	Yes
3200	No Data	No Data	
3210	4	1.7	
3210A	No Data	No Data	
3211	24	2.0	
3218	No Data	No Data	

Appendix E

Impaired WBID Maps with Sampling Station Locations, Yearly Statistical Values, and 10-year Average Flow

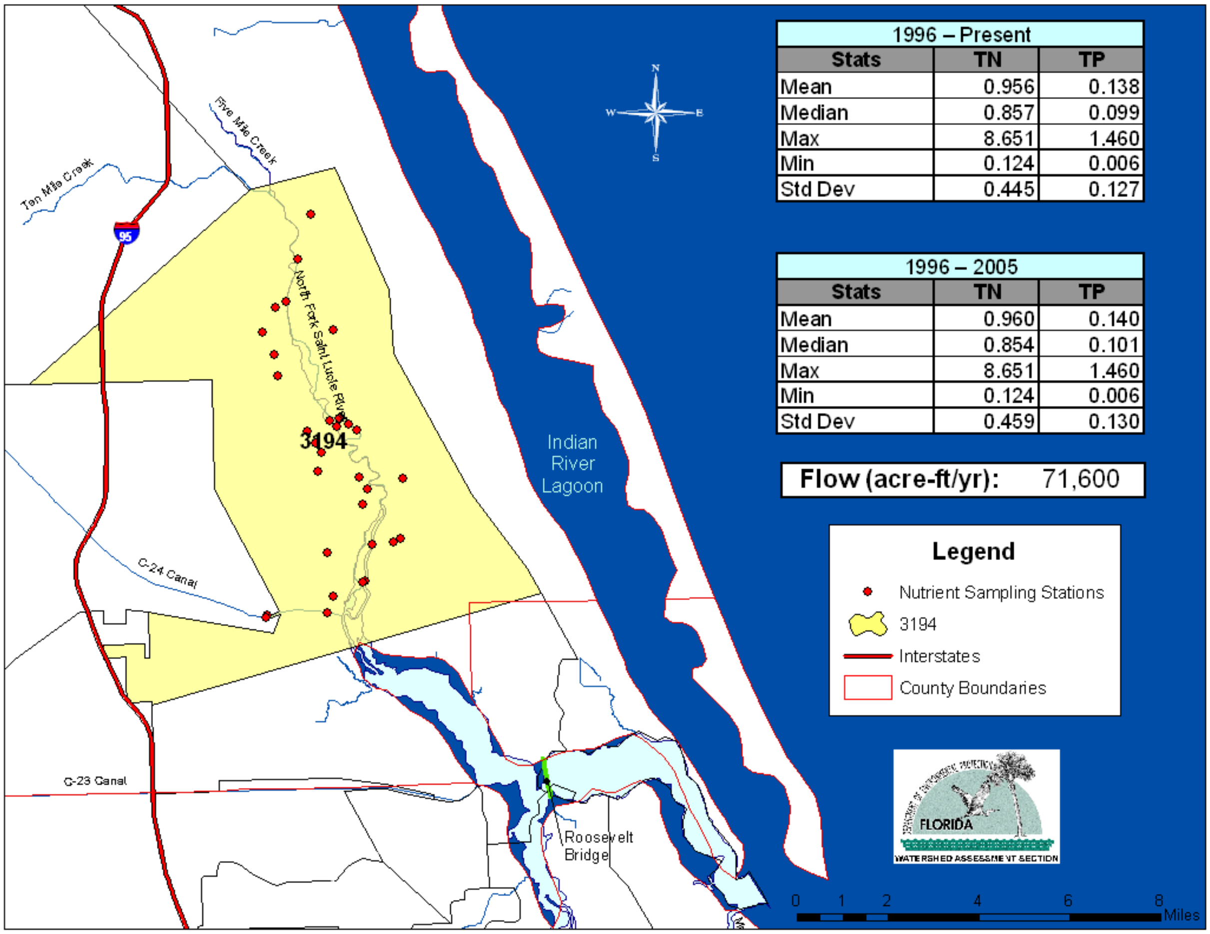
Figure E.1 WBID 3193 Sampling Locations and Data



1996 – Present		
Stats	TN	TP
Mean	0.930	0.142
Median	0.887	0.108
Max	2.840	0.631
Min	0.012	0.026
Std Dev	0.491	0.100

1996 – 2005		
Stats	TN	TP
Mean	0.916	0.138
Median	0.884	0.107
Max	2.840	0.631
Min	0.012	0.026
Std Dev	0.481	0.097

Figure E.2 WBID 3194 Sampling Locations, Data, and Flow

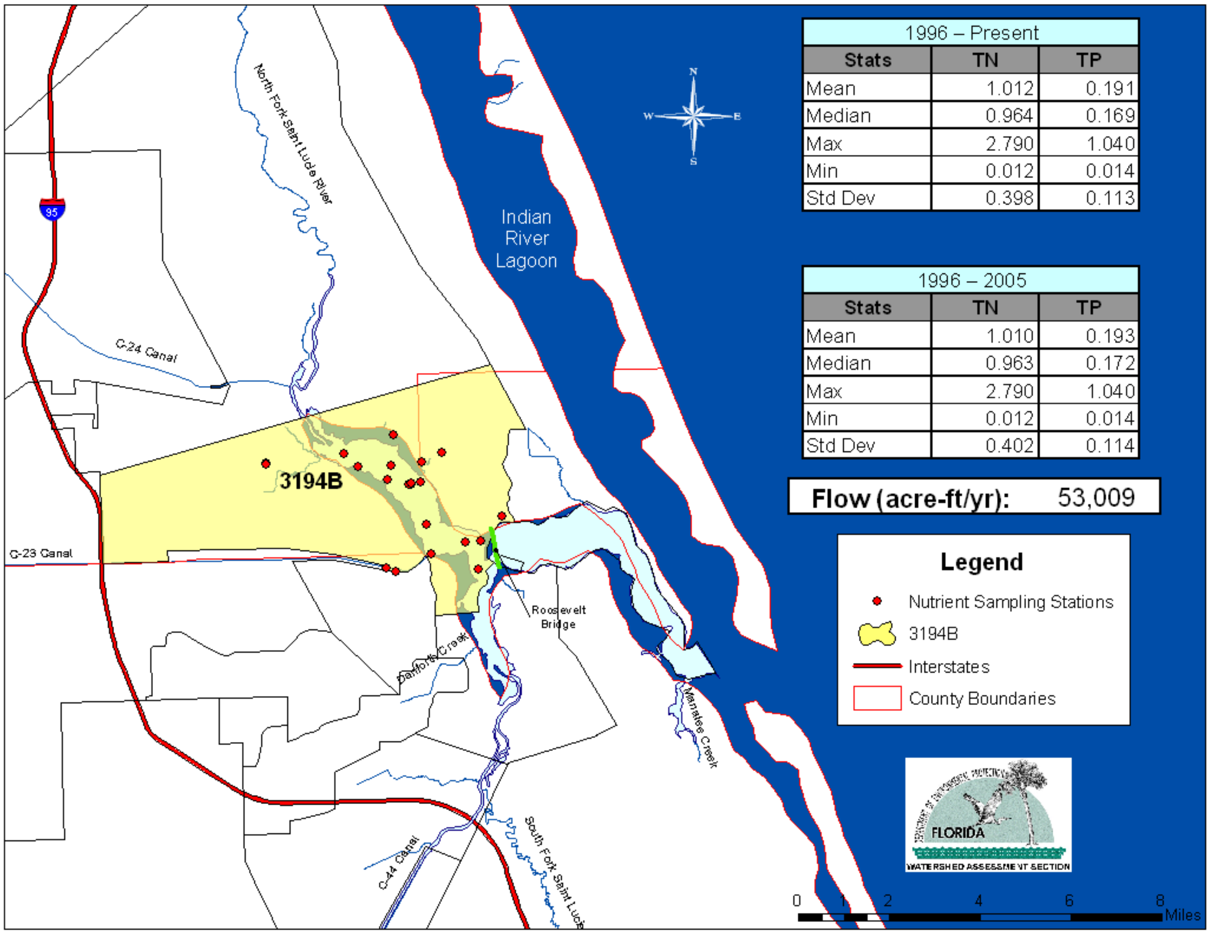


1996 – Present		
Stats	**TN**	**TP**
Mean	0.956	0.138
Median	0.857	0.099
Max	8.651	1.460
Min	0.124	0.006
Std Dev	0.445	0.127

1996 – 2005		
Stats	**TN**	**TP**
Mean	0.960	0.140
Median	0.854	0.101
Max	8.651	1.460
Min	0.124	0.006
Std Dev	0.459	0.130

Flow (acre-ft/yr): 71,600

Figure E.3 WBID 3194B Sampling Locations, Data, and Flow



1996 – Present

Stats	TN	TP
Mean	1.012	0.191
Median	0.964	0.169
Max	2.790	1.040
Min	0.012	0.014
Std Dev	0.398	0.113

1996 – 2005

Stats	TN	TP
Mean	1.010	0.193
Median	0.963	0.172
Max	2.790	1.040
Min	0.012	0.014
Std Dev	0.402	0.114

Flow (acre-ft/yr): 53,009

Figure E.4 WBID 3197 Sampling Locations, Data, and Flow

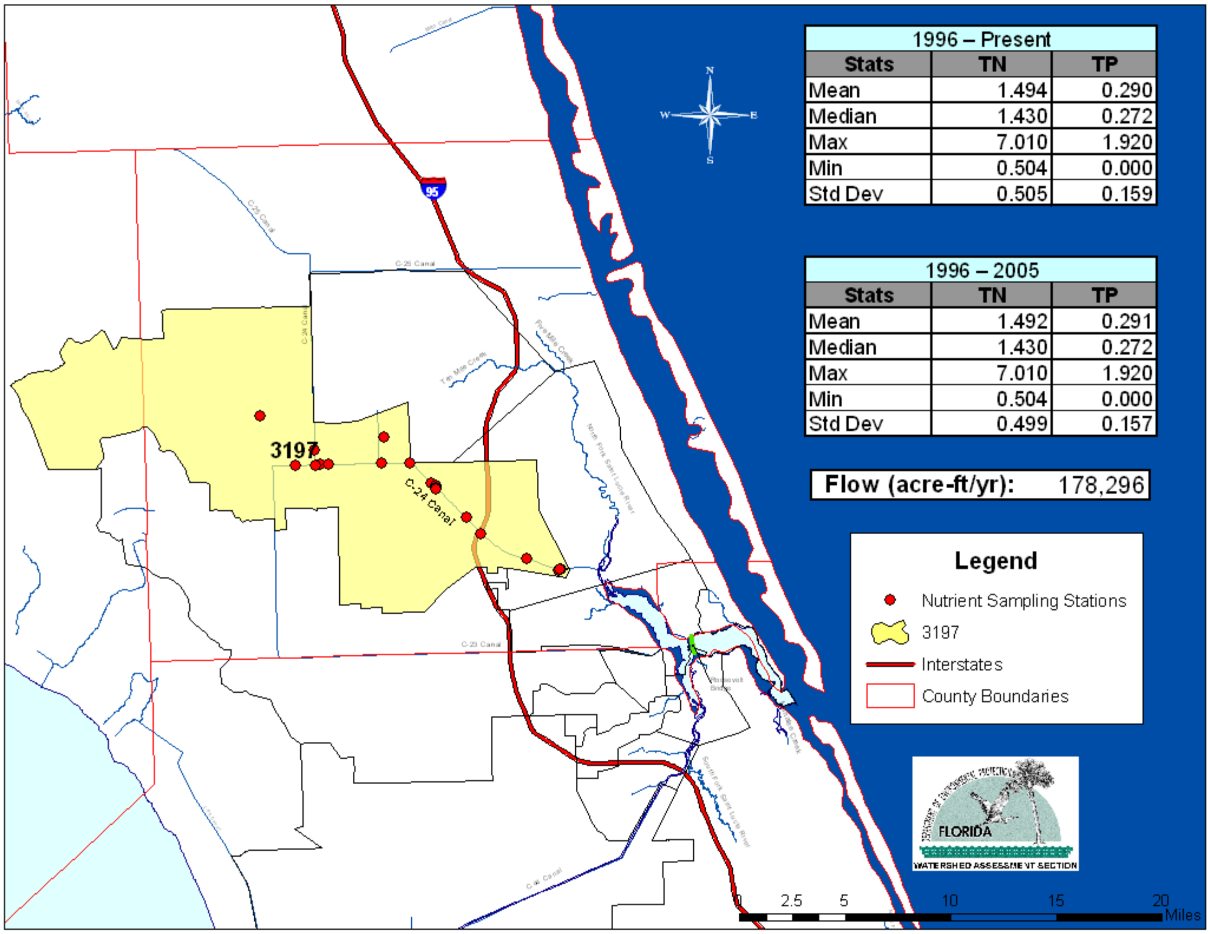
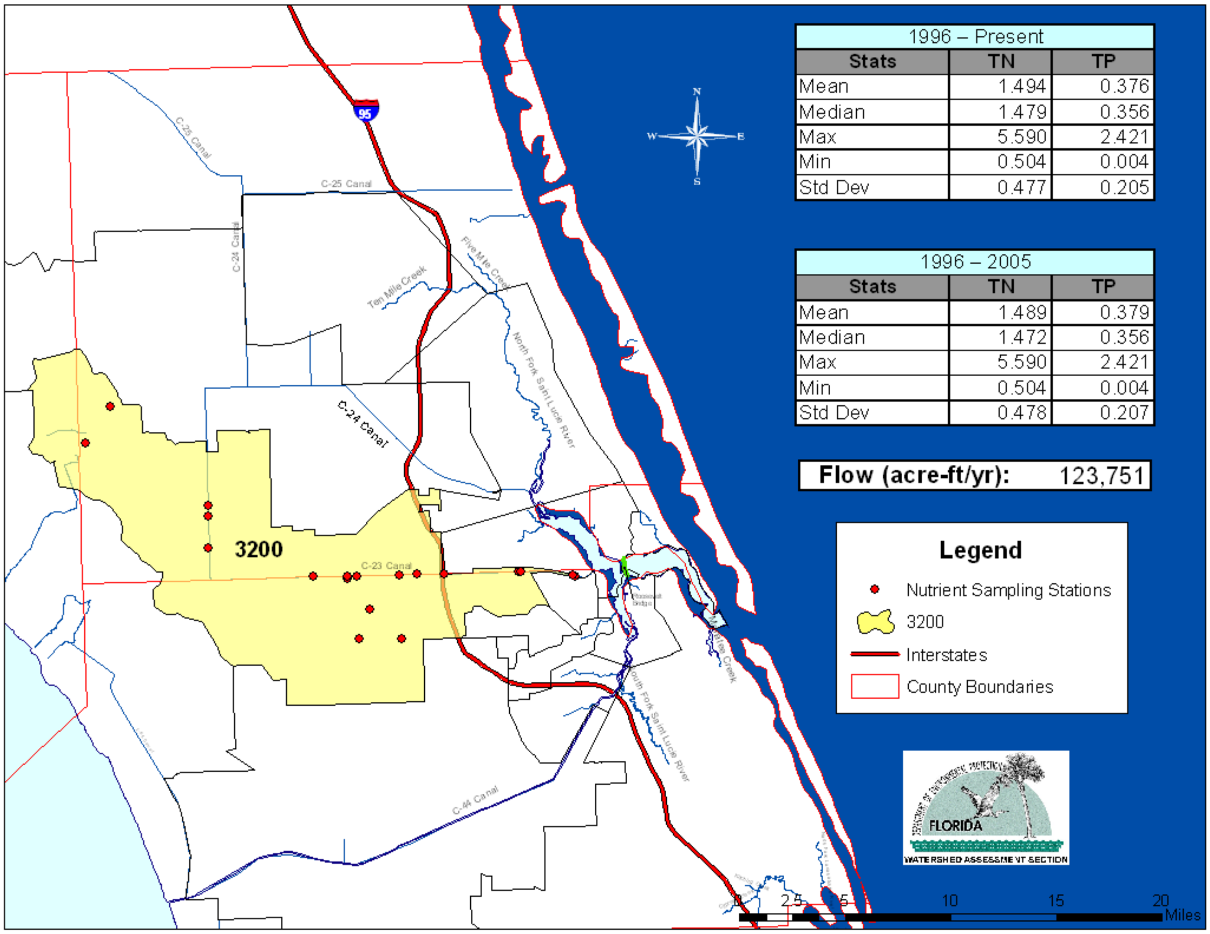


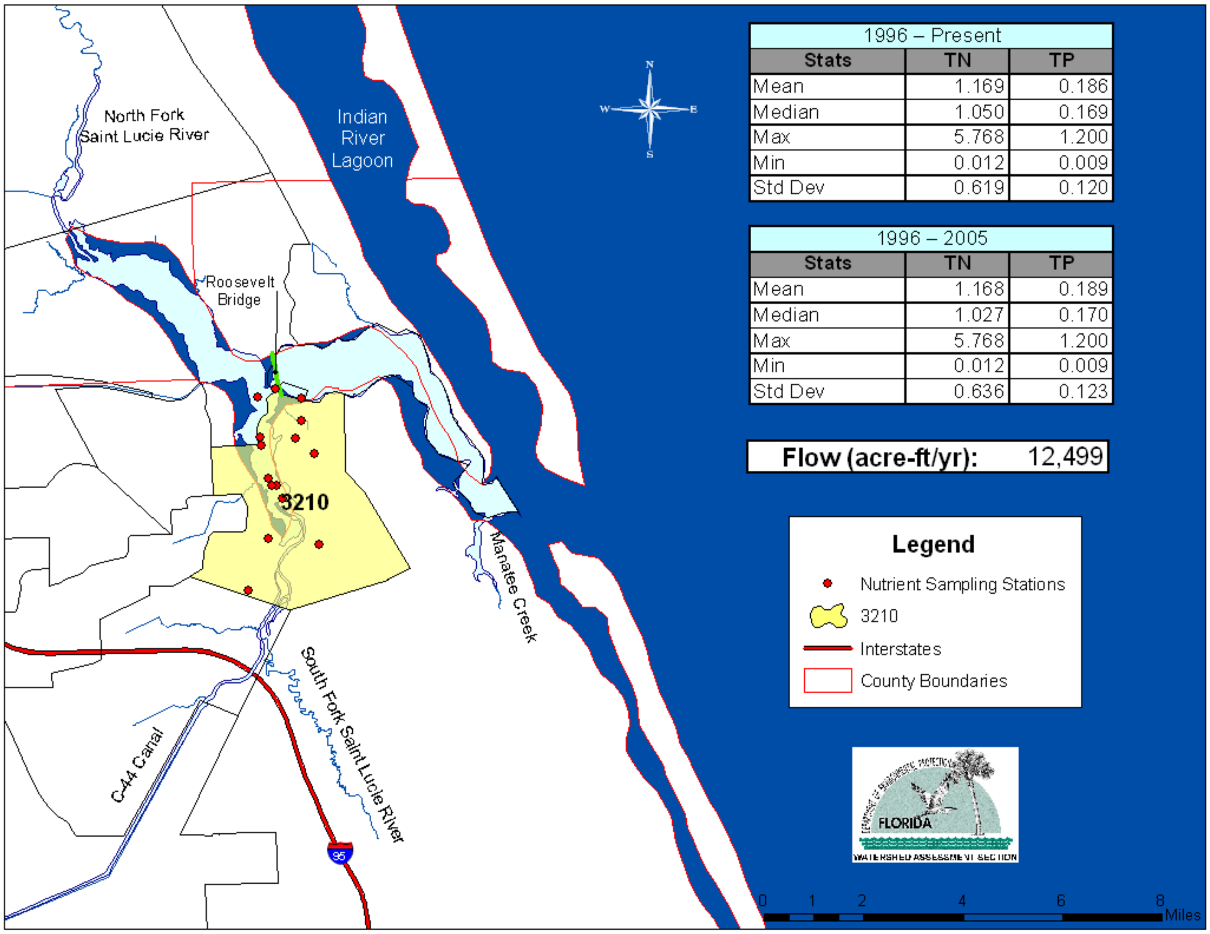
Figure E.5 WBID 3200 Sampling Locations, Data, and Flow



1996 – Present		
Stats	TN	TP
Mean	1.494	0.376
Median	1.479	0.356
Max	5.590	2.421
Min	0.504	0.004
Std Dev	0.477	0.205

1996 – 2005		
Stats	TN	TP
Mean	1.489	0.379
Median	1.472	0.356
Max	5.590	2.421
Min	0.504	0.004
Std Dev	0.478	0.207

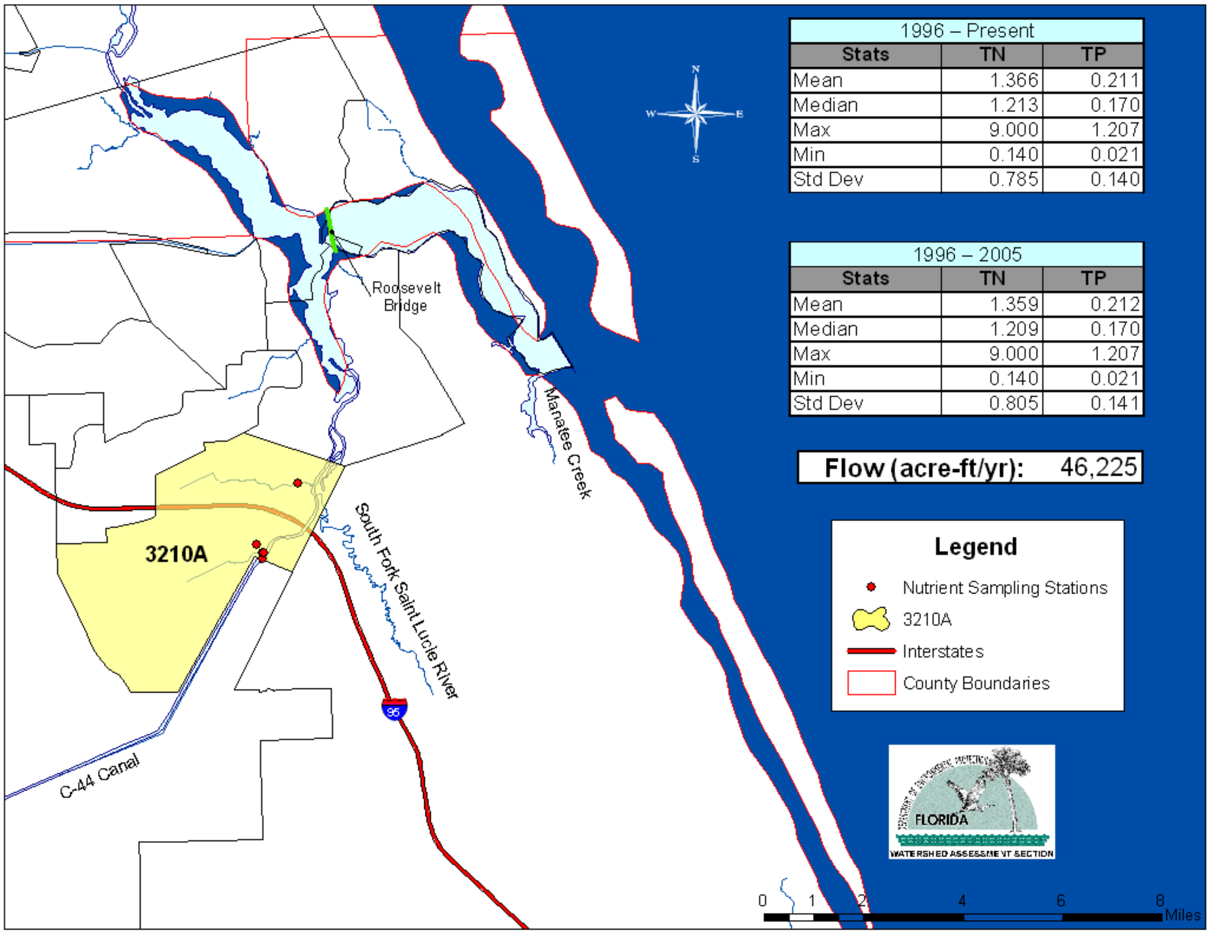
Figure E.6 WBID 3210 Sampling Locations, Data, and Flow



1996 – Present		
Stats	TN	TP
Mean	1.169	0.186
Median	1.050	0.169
Max	5.768	1.200
Min	0.012	0.009
Std Dev	0.619	0.120

1996 – 2005		
Stats	TN	TP
Mean	1.168	0.189
Median	1.027	0.170
Max	5.768	1.200
Min	0.012	0.009
Std Dev	0.636	0.123

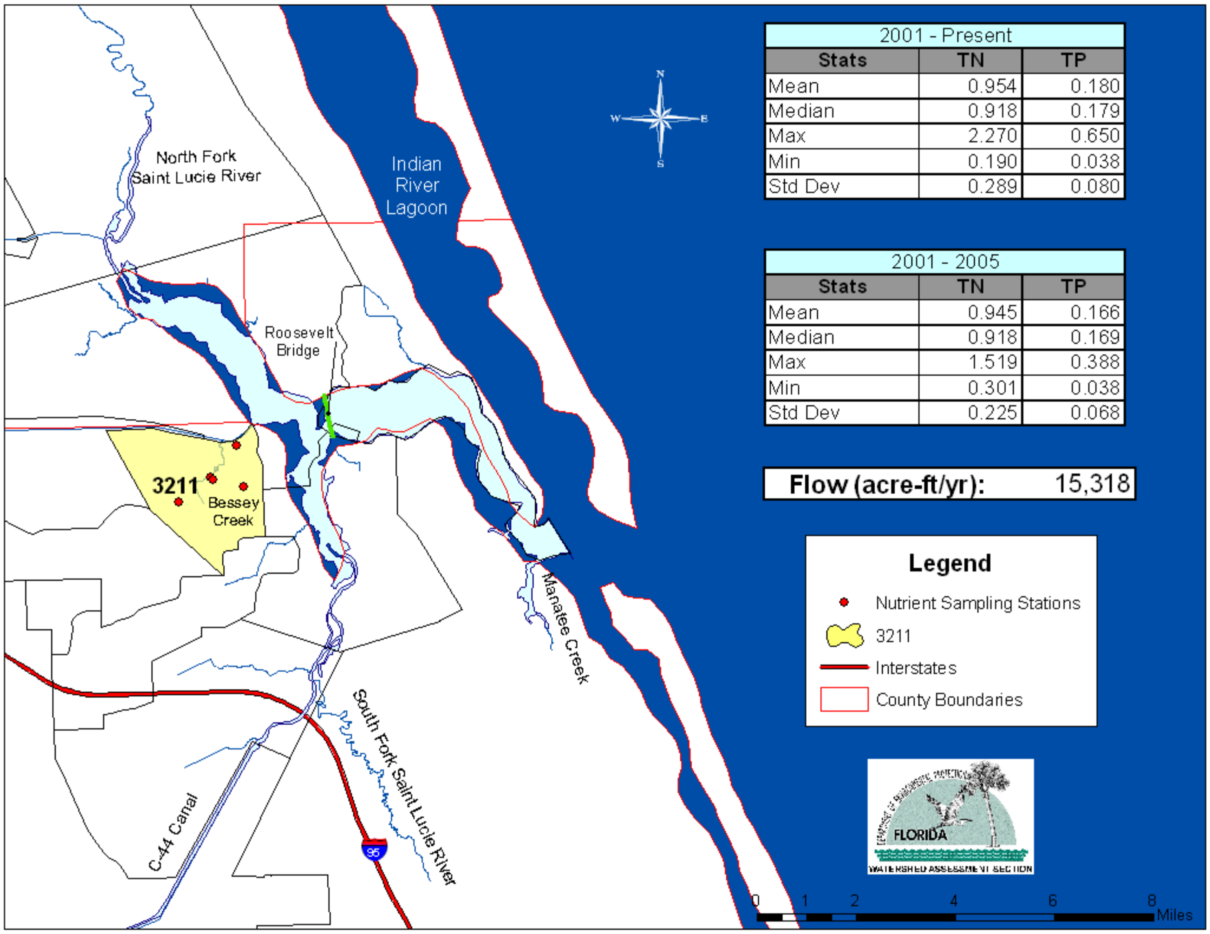
Figure E.7 WBID 3210A Sampling Locations, Data, and Flow



1996 – Present		
Stats	TN	TP
Mean	1.366	0.211
Median	1.213	0.170
Max	9.000	1.207
Min	0.140	0.021
Std Dev	0.785	0.140

1996 – 2005		
Stats	TN	TP
Mean	1.359	0.212
Median	1.209	0.170
Max	9.000	1.207
Min	0.140	0.021
Std Dev	0.805	0.141

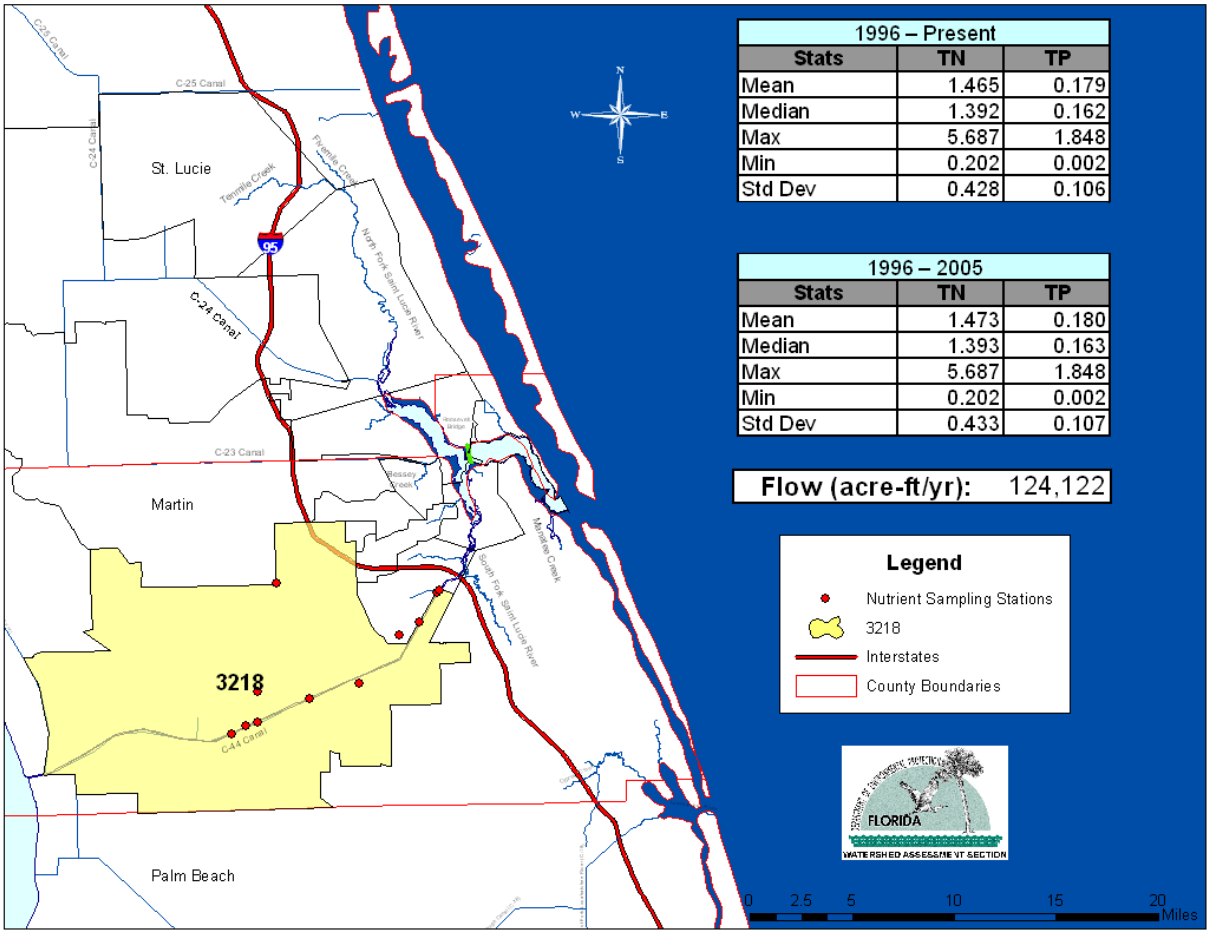
Figure E.8 WBID 3211 Sampling Locations, Data, and Flow



2001 - Present		
Stats	TN	TP
Mean	0.954	0.180
Median	0.918	0.179
Max	2.270	0.650
Min	0.190	0.038
Std Dev	0.289	0.080

2001 - 2005		
Stats	TN	TP
Mean	0.945	0.166
Median	0.918	0.169
Max	1.519	0.388
Min	0.301	0.038
Std Dev	0.225	0.068

Figure E.9 WBID 3218 Sampling Locations, Data, and Flow



1996 – Present		
Stats	TN	TP
Mean	1.465	0.179
Median	1.392	0.162
Max	5.687	1.848
Min	0.202	0.002
Std Dev	0.428	0.106

1996 – 2005		
Stats	TN	TP
Mean	1.473	0.180
Median	1.393	0.163
Max	5.687	1.848
Min	0.202	0.002
Std Dev	0.433	0.107

Flow (acre-ft/yr): 124,122

Appendix F

Outlier Analysis Summary Results

The Tukey-Kramer Mean Comparison statistical analysis uses a t-statistic when sample sizes are not equal. Tukey-Kramer was designed to be used with unequal sample sizes but is appropriate only if population variances are equal. Database (.JMP) and Journal Files (.JRN) for tables and figures displaying the summarized data are available upon request. View using JMP software.

WBID 3193

Within the IWR database, the majority of TN and TP data (77%) for WBID 3193 is sampled at stations 21FLSFWMSE 01 and 21FLSFWMSE 02 (SE 01: TP mean = 0.121 mg/L, n = 135 and TN mean = 0.90 mg/L, n = 133; SE 02: TP mean = 0.158 mg/L, n = 134 and TN mean = 1.00 mg/L, n = 132). All other stations within the WBID have a sample size (n) less than or equal to 26 at each station. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3194

Within the IWR database, the TN and TP data for WBID 3194 is proportional distributed across all sample stations. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3194B

Within the IWR database, the TN and TP data for WBID 3194B is proportional distributed across all sample stations. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3197

Within the IWR database, the majority of TN and TP data (82%) for WBID 3197 is sampled at the control structure station 21FLSFWMC24S49 (TP mean = 0.278 mg/L, n = 805 and TN mean = 1.45 mg/L, n = 773). All other stations within the WBID have a sample size (n) less than or equal to 22 at each station. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3200

Within the IWR database, the majority of TN and TP data (88%) for WBID 3200 is sampled at the control structure station 21FLSFWMC23S48 (TP mean = 0.37 mg/L, n = 833 and TN mean = 1.49 mg/L, n = 802). All other stations within the WBID have a sample size (n) less than or equal to 20 at each station. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, between stations within the WBID only one station significantly differed from the mean. Station 21FLWPB 28010391 TP mean = 12.54 mg/L, n = 8 and TN mean = 38.8 mg/L, n = 7. However, further investigation is necessary into this station because of the extremely high unrealistic average values.

WBID 3210

Within the IWR database, the TN and TP data for WBID 3210 is proportional distributed across all sample stations. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3210A
Within the IWR database, the TN and TP data for WBID 3210A is proportional distributed across all sample stations. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID for TN. However, for TP only one station significantly differed from the mean between all stations within the WBID. Station 21FLSFWMSLT-4, located in Mapps Creek a tributary off the main stem of the South Fork St. Lucie River, TP mean = 0.121 mg/L, n = 70.

WBID 3211
Within the IWR database, the TN and TP data for WBID 3211 is proportional distributed across all sample stations. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, no significant difference exists between stations within the WBID.

WBID 3218
Within the IWR database, the majority of TN and TP data (90%) for WBID 3218 is sampled at the control structure station 21FLSFWMC44S80 (TP mean = 0.17 mg/L, n = 774 and TN mean = 1.47 mg/L, n = 763). All other stations within the WBID have a sample size (n) less than or equal to 27 at each station. Using the Tukey-Kramer Mean Comparison statistical analysis with a significance level of 0.05, between stations within the WBID only one station significantly differed from the mean. Station 21FLWPB 28010415 TP mean = 1.10 mg/L, n = 3 and TN mean = 3.52 mg/L, n = 3.

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