Final TMDL Report
NORTHEAST DISTRICT • UPPER EAST COAST BASIN

Nutrient TMDL for Palm Coast, WBID 2363D

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Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

http://www.dep.state.fl.us/water/tmdl/index.htm

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2012 305(b) Report

http://www.dep.state.fl.us/water/docs/2012_integrated_report.pdf

Water Quality Status Report: Upper East Coast Basin

http://www.dep.state.fl.us/water/basin411/uppereast/status.htm

Water Quality Assessment Report: Upper East Coast Basin
http://www.dep.state.fl.us/water/basin411/uppereast/assessment.htm

U.S. Environmental Protection Agency, National STORET Program

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

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads for nutrients for a portion of the South Matanzas River in the Pellicer Creek Planning Unit of the Upper East Coast Basin. This segment has been identified as Palm Coast and was verified as impaired for nutrients based on chlorophyll *a* (chl*a*) during the second basin management cycle. It was included on the Verified List of impaired waters for the Upper East Coast Basin that was adopted by Secretarial Order on February 7, 2012. Based on the median total nitrogen/total phosphorus (TN/TP) ratio of 5.55, TN was identified as the limiting nutrient. These TMDLs establish the allowable loadings to this portion of the Intracoastal Waterway (ICWW) that would restore the waterbody so that it meets its applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

The Tolomato-Matanzas Estuary is located south of the city of Jacksonville, in St. Johns and Flagler Counties, along the northeast coast of Florida. It extends for approximately 80 kilometers and is connected to the Atlantic Ocean via the St. Augustine and Matanzas Inlets. The Tolomato and Matanzas Rivers are part of the ICWW, which extends along the east coast of the United States. This TMDL report addresses the section of the South Matanzas (Palm Coast) located in Flagler County that extends from the city of Palm Coast to the northern portions of Flagler Beach. The watershed is located approximately 7.7 miles south of the Matanzas Inlet and includes 9.2 miles of the ICWW. Most of the Palm Coast watershed is located east of Interstate 95, except for the upper portion of the watershed near Palm Coast, which extends west of the interstate (**Figure 1.1)**. The mean tidal range at the Matanzas Inlet is 3.64 feet and declines to 0.88 feet at Highway 100, near Flagler Beach.

For assessment purposes, the Florida Department of Environmental Protection has divided the Upper East Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Matanzas River south of St. Augustine was divided into six assessment polygons. This TMDL addresses Palm Coast, WBID 2363D, for nutrients (**Figure 1.2**).

The Palm Coast watershed is part of the Pellicer Creek Planning Unit. Planning units are groups of smaller watersheds (WBIDs) that are part of a larger basin unit, in this case the Upper East Coast Basin.

The Pellicer Creek Planning Unit consists of 26 WBIDs. **Figure 1.3** shows the locations of these WBIDs and the Palm Coast WBID in the planning unit.

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.

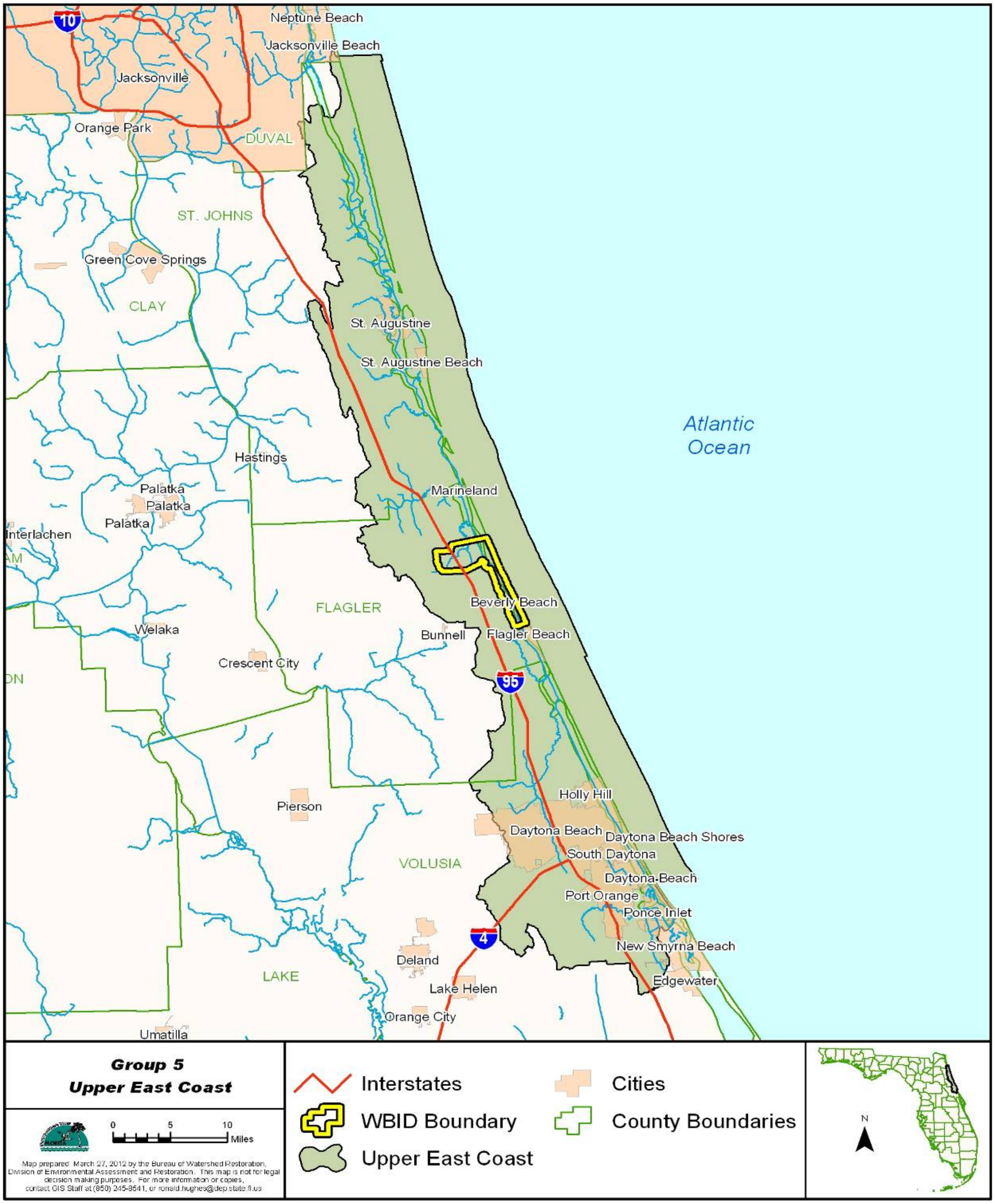

Figure 1.1. Location of the Palm Coast Watershed (WBID 2363D) in the Upper East Coast Basin

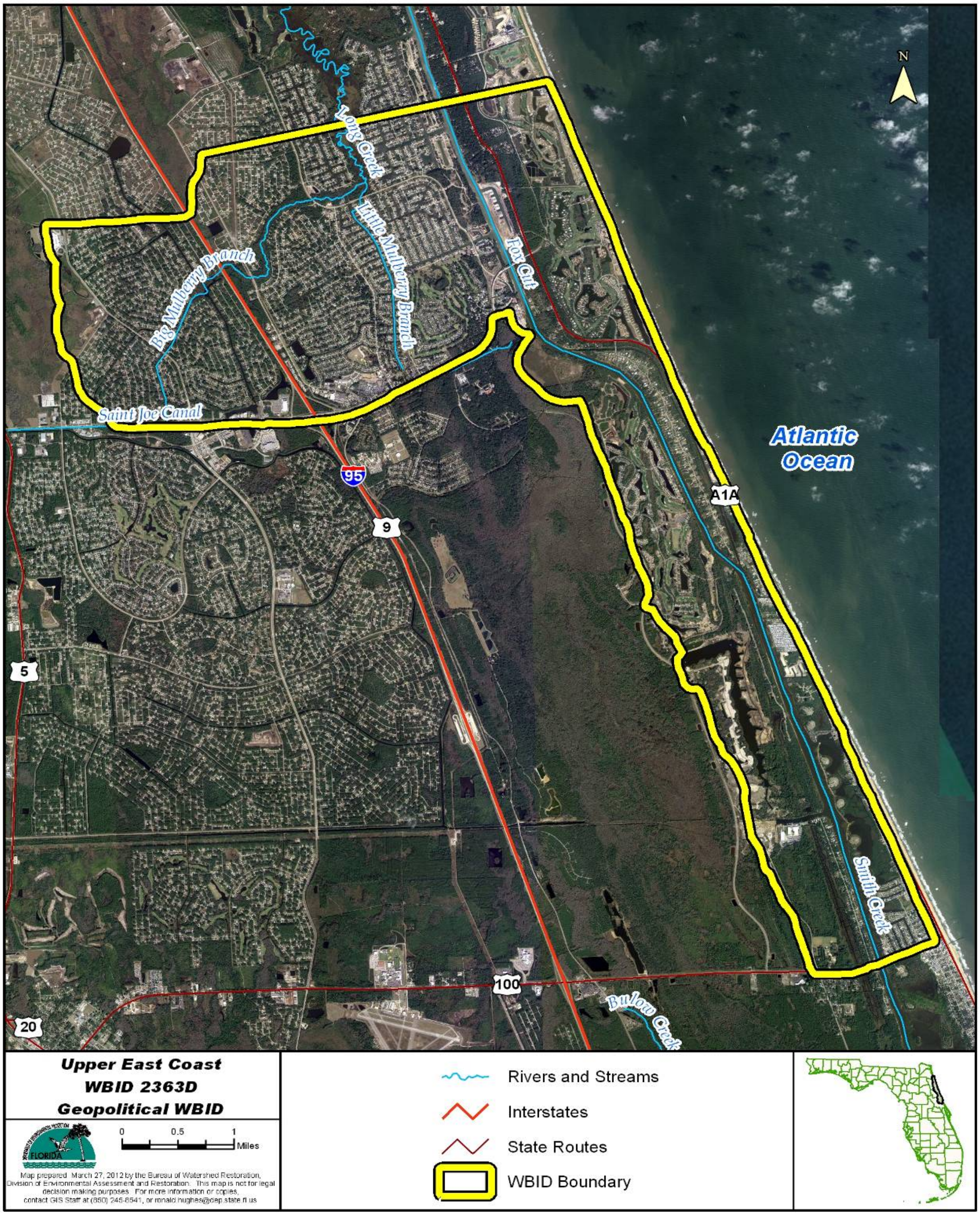

Figure 1.2. Location of the Palm Coast Watershed (WBID 2363D) in Flagler County and Major Hydrologic Features in the Area

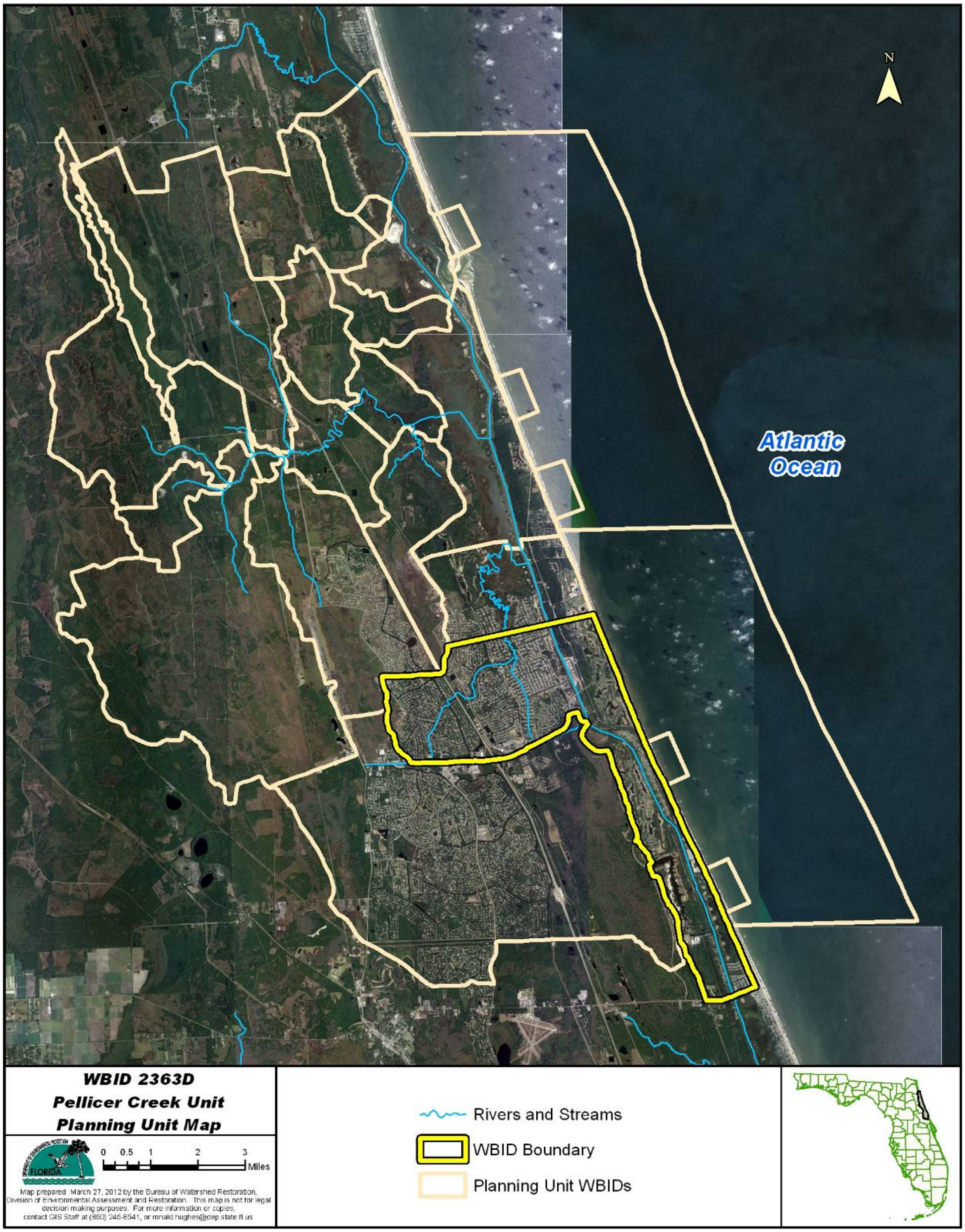

Figure 1.3. WBIDs in the Pellicer Creek Planning Unit

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 15 waterbodies and 50 parameters in the Upper East Coast Basin. 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 adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Palm Coast watershed and has verified that this waterbody segment is impaired for nutrients, based on data in the Department's IWR database. **Tables 2.1** and **2.2** summarize the chl*a* data for the verified period, which for Cycle 2 of the Group 5 waters was January 1, 2004, through June 30, 2011.

The IWR listing threshold for nutrients in estuaries was based on exceeding the historical minimum of 3 micrograms per liter (µg/L) by more than 50% in at least two consecutive years (2009–10). Possible relationships between chl*a* and other water quality parameters are further assessed in Chapter 5, using the complete historical dataset.

Table 2.1. Summary of Corrected Chlorophyll *a* (CHLAC) Monitoring Data for Palm Coast (WBID 2363D) During the Verified Period (January 1, 2004–June 30, 2011)

Parameter	CHLAC (µg/L)
Total number of samples	124
IWR-annual average threshold for the Verified List	5
Number of observed exceedances	2
Number of observed nonexceedances	4
Number of seasons during which samples were collected	4
Annual average resulting in listing (µg/L)	5
Lowest individual observation (µg/L)	1
Highest individual observation (µg/L)	28
Median TN/TP ratio for 133 observations	5.5
Possible causative pollutant by IWR	TN
FINAL ASSESSMENT	**Impaired**

Table 2.2. Summary of Annual Average CHLAC for the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

- = Empty cell/no data
CHLAC is in µg/L.
Precipitation is based on Daytona Beach International Airport (**Appendix G**).

Year	Number of Samples	Minimum	Maximum	Annual Mean	Number of Exceedances	Mean Precipitation (inches)
2004	10	2.4	15.5	8	0	62.97
2005	37	1.0	12.2	5	0	65.77
2006	12	2.0	7.3	4	0	31.36
2007	12	2.2	12.6	6	0	45.02
2008	12	1.2	10.0	5	0	42.67
2009	24	1.6	21.0	6	0	50.3
2010	12	2.4	28.0	10	1	39.39
2011	5	3.4	7.8	-	-	48.71

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria 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)**

The South Matanzas River in the Palm Coast watershed (WBID 2363D) is a Class III marine waterbody, 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 these TMDLs are for nutrients.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

The nutrient criterion in Rule 62-302, F.A.C., is expressed as a narrative, as follows:

> ***Nutrients.***
>
> *In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna [Note: For Class III waters in the Everglades Protection Area, this criterion has been numerically interpreted for phosphorus in Section 62-302.540, F.A.C.].*

To assess whether this narrative criterion is being exceeded, the IWR provides thresholds for nutrient impairment in estuaries based on annual average chl*a* levels. The following language is found in Rule 62-303, F.A.C.:

Section 62-303.353 Nutrients in Estuaries and Open Coastal Waters.

Estuaries, estuary segments, or open coastal waters shall be included on the planning list for nutrients if their annual mean chlorophyll a for any year is greater than 11 µg/L or if data indicate annual mean chlorophyll a values have increased by more than 50% over historical values for at least two consecutive years.

Section 62-303.450 Interpretation of Narrative Nutrient Criteria.

(1) A water shall be placed on the verified list for impairment due to nutrients if there are sufficient data from the last five years preceding the planning list assessment, combined with historical data (if needed to establish historical chlorophyll a levels or historical TSIs), to meet the data sufficiency requirements of subsection 62-303.350(2), FA.C. If there are insufficient data, additional data shall be collected as needed to meet the requirements. Once these additional data are collected, the Department shall determine if there is sufficient information to develop a site-specific threshold that better reflects conditions beyond which an imbalance in flora or fauna occurs in the water segment. If there is sufficient information, the Department shall re-evaluate the data using the site-specific thresholds. If there is insufficient information, the Department shall re-evaluate the data using the thresholds provided in Rules 62-303.351-.353, F.A.C., for streams, lakes, and estuaries, respectively. In any case, the Department shall limit its analysis to the use of data collected during the five years preceding the planning list assessment and the additional data collected in the second phase. If alternative thresholds are used for the analysis, the Department shall provide the thresholds for the record and document how the alternative threshold better represents conditions beyond which an imbalance in flora or fauna is expected to occur.

The annual average chl*a* concentrations in 2009 and 2010 exceeded the historical minimum of 3.4 µg/L by 50% or greater and, based on the TN/TP ratio, nitrogen was identified as the limiting nutrient.

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 pollutants 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 uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act 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, such as 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 Clean Water Act definitions, the term "point source" will be 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 (see **Section 6.1**). 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 Sources of Nutrients in the Palm Coast Watershed

4.2.1 Point Sources

Three NPDES facilities currently discharge into this portion of the South Matanzas River, as follows:

- ***Palm Coast WWTF #1 (FL0116009)****, an advanced secondary wastewater treatment facility located in Palm Coast, has a permitted capacity of 6.83 million gallons per day (MGD). The final effluent is primarily reused via slow-rate public access irrigation and rapid rate infiltration via percolation ponds. This facility also has a permitted wet weather discharge of 1.6 MGD annual average daily flow (AADF) to the ICWW via a multiport diffuser. A second discharge of 2.05 MGD AADF or 748 million gallon annual permitted discharge under the Apricot Act (Section 403.086(7), F.S.) to the St. Joe Canal that enters the Matanzas River has been authorized; however, no discharges have occurred. Based on discharge monitoring reports from January 1997 to April 2012, discharge TN concentrations (51 values) ranged between 2.4 and 25 milligrams per liter (mg/L), with a median concentration of 9.3 mg/L (mean of 10.0 mg/L). TP concentrations over the same period (51 values) ranged between 0.006 and 12.0 mg/L, with a median concentration of 2.70 mg/L (mean of 2.74 mg/L). Over the 159-month period, there were 69 months in which a discharge occurred, and the 12-month rolling average discharge was 1.01 MGD.*

- ***Beverly Beach WWTF (FL0039756)****, located in Beverly Beach, has a permitted capacity of 0.215 MGD. Discharge from this facility is via a pipe to the ICWW. The facility has an annual TN limit of 4,606 lbs/yr. Based on discharge monitoring reports from January 2000 to April 2012, the monthly average discharge was 0.032 MGD (117 values), and the 12-month rolling annual average discharge was 0.045 MGD (140 values). The monthly average TN discharge over the March 2011 to March 2012 period was 140.9 lbs/month (13 values), with a 12-month rolling annual average of 1,435 lbs/yr. Reported monthly maximum TN concentrations (61 values) over the January 1997 to March 2012 period ranged between 0.28 and 35 mg/L with a median concentration of 15.1 mg/L (mean of 14.8 mg/L). The average TP from monthly single samples was 0.767 mg/L (19 values), with a range from 0.11 to 1.87 mg/L (median of 0.5 mg/L). The range for monthly maximum TP samples over the January 1997 to March 2012 period (56 values) was 0.01 to 28 mg/L, with a median concentration of 4.1 mg/L (mean of 4.55 mg/L).*

- ***Dunes CDD-RO Concentrate (FL0355259),*** *an industrial wastewater facility, has a permitted capacity of 0.25 MGD for the discharge of reverse osmosis (RO) concentrate to the ICCW via a pipe. Based on discharge monitoring reports over from January 2000 to April 2012, the monthly average discharge was 0.79 MGD (31 values), and the 12-month* *rolling annual average discharge was 0.09 MGD (24 values). Reported daily maximum TN concentrations (16 values) ranged between 0.048 and 4.0 mg/L, with a median value of 1.85 mg/L (mean of 2.01 mg/L). Reported daily maximum TP concentrations (16 values) ranged between < 0.046 and 1.02 mg/L, with a median value of 0.435 mg/L (mean of 0.424 mg/L).*

A new advanced wastewater treatment facility, **Palm Coast WWTF #2 (FL0710008)**, which is permitted for 2.0 MGD, will not be operational until 2014, with a permitted discharge of 0.6 MGD to Huelett Swamp under the Apricot Act.

Municipal Separate Storm Sewer System Permittees

Portions of the Palm Coast watershed fall within the boundaries of the Phase II municipal separate storm sewer system (MS4) permit for the city of Flagler Beach (FLR04E102). The Florida Department of Transportation (FDOT) District 5 also has an MS4 permit (FLR04E024) for Flagler County.

4.2.2 Land Uses and Nonpoint Sources

Nutrient loadings to the South Matanzas River are generated from nonpoint sources in the watershed. These potential sources include loadings from surface runoff, ground water inflow, and septic tanks.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the St. Johns River Water Management District's (SJRWMD) 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the Level 3 land use codes and tabulated in **Table 4.1**. **Figure 4.1** shows the acreage of the principal land uses in the watershed at the Level 1 land use code. The SJRWMD's 2009 land use coverage was also compared with the 2004 coverages, and there were insignificant differences between the two periods.

As shown in **Table 4.1**, the total area of the Palm Coast watershed is about 11,086 acres. Residential land use accounts for approximately 47% of the watershed, with 36% of the watershed classified as medium-density residential. Waterways and reservoirs represent 12% of the watershed, with forests and wetlands accounting for 11% and 9%, respectively. Agricultural and rangeland land uses represent less than 7% of the watershed area.

Table 4.1. Classification of Land Use Categories in the Palm Coast Watershed in 2004

- = Empty cell/no data

Level 3 Land Use Code	Attribute	Acres	% of Total
1100	Residential, low density - less than 2 dwelling units/acre	549.43	4.96%
1190	Low density under construction	87.38	0.79%
1200	Residential, medium density - 2-5 dwelling units/acre	3978.96	35.89%
1290	Medium density under construction	227.61	2.05%
1300	Residential, high density - 6 or more dwelling units/acre	294.32	2.65%
1390	High density under construction	54.91	0.50%
1400	Commercial and services	213.06	1.92%
1490	Commercial and services under construction	17.67	0.16%
1550	Industrial	35.71	0.32%
1562	Other heavy industrial	36.33	0.33%
1630	Rock quarries	50.86	0.46%
1650	Reclaimed lands	43.53	0.39%
1700	Institutional	46.11	0.42%
1800	Recreational	24.19	0.22%
1810	Swimming beach	1.9	0.02%
1820	Golf courses	429.38	3.87%
1840	Marinas and fish camps	29.69	0.27%
1850	Parks and zoos	32.14	0.29%
1860	Community recreational facilities	25.25	0.23%
1900	Open land	10.64	0.10%
1920	Inactive land with street pattern but no structures	4.78	0.04%
2110	Improved pastures (monocult, planted forage crops)	7.93	0.07%
2130	Woodland pastures	4.37	0.04%
3100	Herbaceous upland nonforested	214.89	1.94%
3200	Shrub and brushland (wax myrtle or saw palmetto, occasionally scrub)	363.94	3.28%
3300	Mixed upland nonforested/mixed rangeland	163.37	1.47%
4110	Pine flatwoods	185.07	1.67%
4200	Upland hardwood forests	38.13	0.34%
1860	Community recreational facilities	25.25	0.23%
1900	Open land	10.64	0.10%
1920	Inactive land with street pattern but no structures	4.78	0.04%
2110	Improved pastures (monocult, planted forage crops)	7.93	0.07%
2130	Woodland pastures	4.37	0.04%
3100	Herbaceous upland nonforested	214.89	1.94%
3200	Shrub and brushland (wax myrtle or saw palmetto, occasionally scrub)	363.94	3.28%
3300	Mixed upland nonforested/mixed rangeland	163.37	1.47%
4110	Pine flatwoods	185.07	1.67%
4200	Upland hardwood forests	38.13	0.34%
6250	Hydric pine flatwoods	39.41	0.36%
6300	Wetland forested mixed	124.03	1.12%

Level 3 Land Use Code	Attribute	Acres	% of Total
6410	Freshwater marshes	32.4	0.29%
6420	Saltwater marshes	317.5	2.86%
6430	Wet prairies	12.68	0.11%
6460	Treeless hydric savanna/mixed scrub-shrub wetland	227.1	2.05%
7400	Disturbed land	2.79	0.03%
7410	Rural land in transition without positive indicators of intended activity	304.83	2.75%
7430	Spoil areas	22.09	0.20%
8140	Roads and highways (divided 4-lanes with medians)	124.43	1.12%
8180	Auto Parking Facilities (when not directly related to other land use)	1.83	0.02%
8310	Electrical power facilities	3.97	0.04%
8320	Electrical power transmission lines	45.89	0.41%
8330	Water supply plants	0.38	0.00%
8340	Sewage treatment	20.62	0.19%
8370	Surface water collection basins	2.57	0.02%
-	**SUM**	**11,086.17**	**100.00**

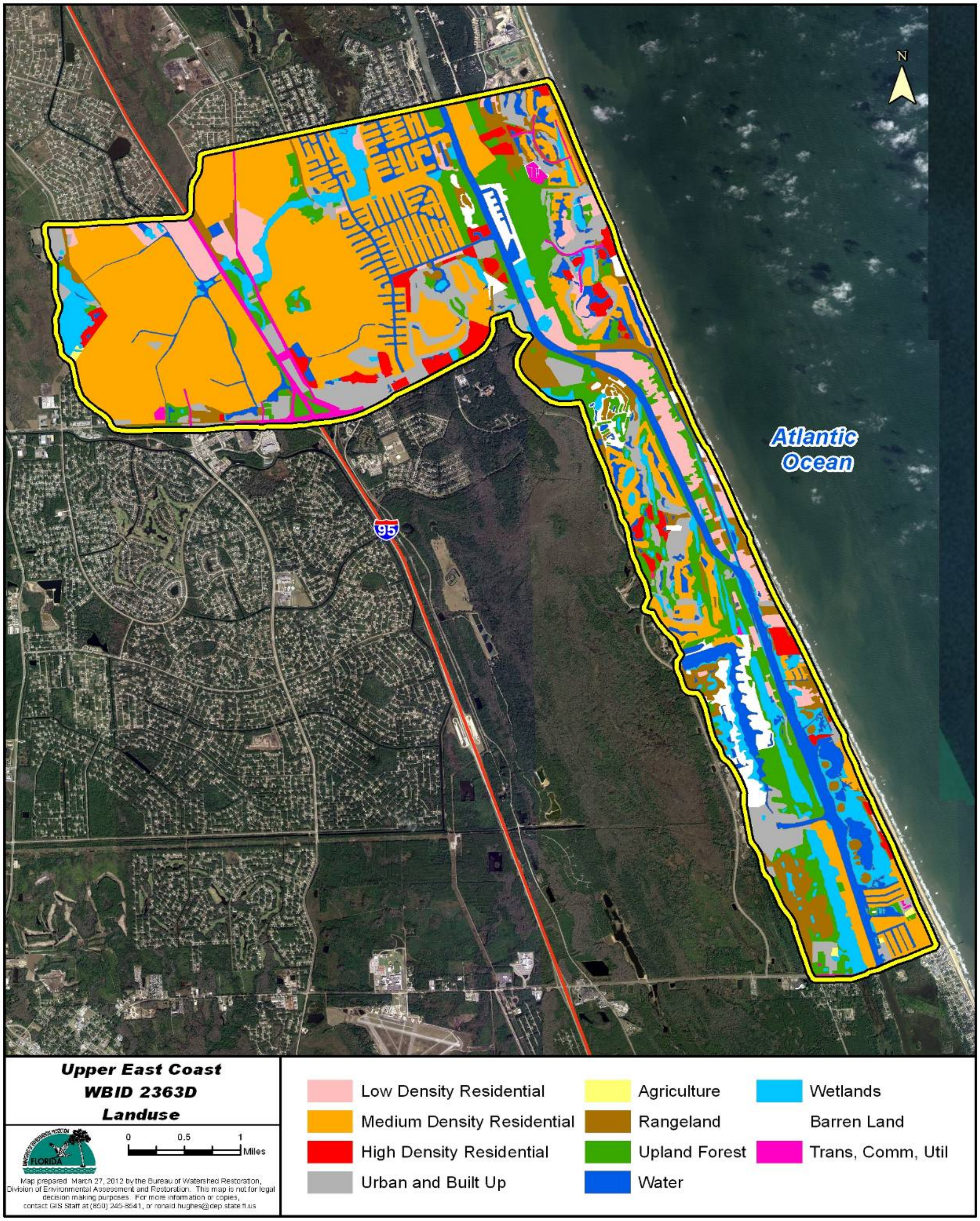

Figure 4.1. Principal Land Uses in the Palm Coast Watershed in 2004

Soil Characteristics

The Soil Survey Geographic Database (SSURGO) in the Department's GIS database from the SJRWMD was accessed to provide coverage of hydrologic soil groups in the Palm Coast watershed (**Figure 4.2**). **Table 4.2** briefly describes the major hydrologic soil classes. As seen in **Figure 4.2**, Soil Group A was the most common in the watershed.

Table 4.2. Description of Hydrologic Soil Classes from the SSURGO Database

Source: U.S. Department of Agriculture–Natural Resources Conservation Service (USDA–NRCS) 2009.

Hydrologic Soil Class	Description
A	Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10% clay and more than 90% sand or gravel and have gravel or sand textures.
B	Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10% and 20% clay and 50% to 90% sand and have loamy sand or sandy loam textures.
C	Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20% and 40% clay and less than 50% sand, and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures.
D	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40% clay, less than 50% sand, and clayey textures.
Dual hydrologic soil groups	Certain wet soils are placed in Group D based solely on the presence of a water table within 60 centimeters (24 inches) of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of defining the term "hydrologic soil group," adequately drained means that the seasonal high water table is kept at least 60 centimeters (24 inches) below the surface in a soil where it would be higher in a natural state.

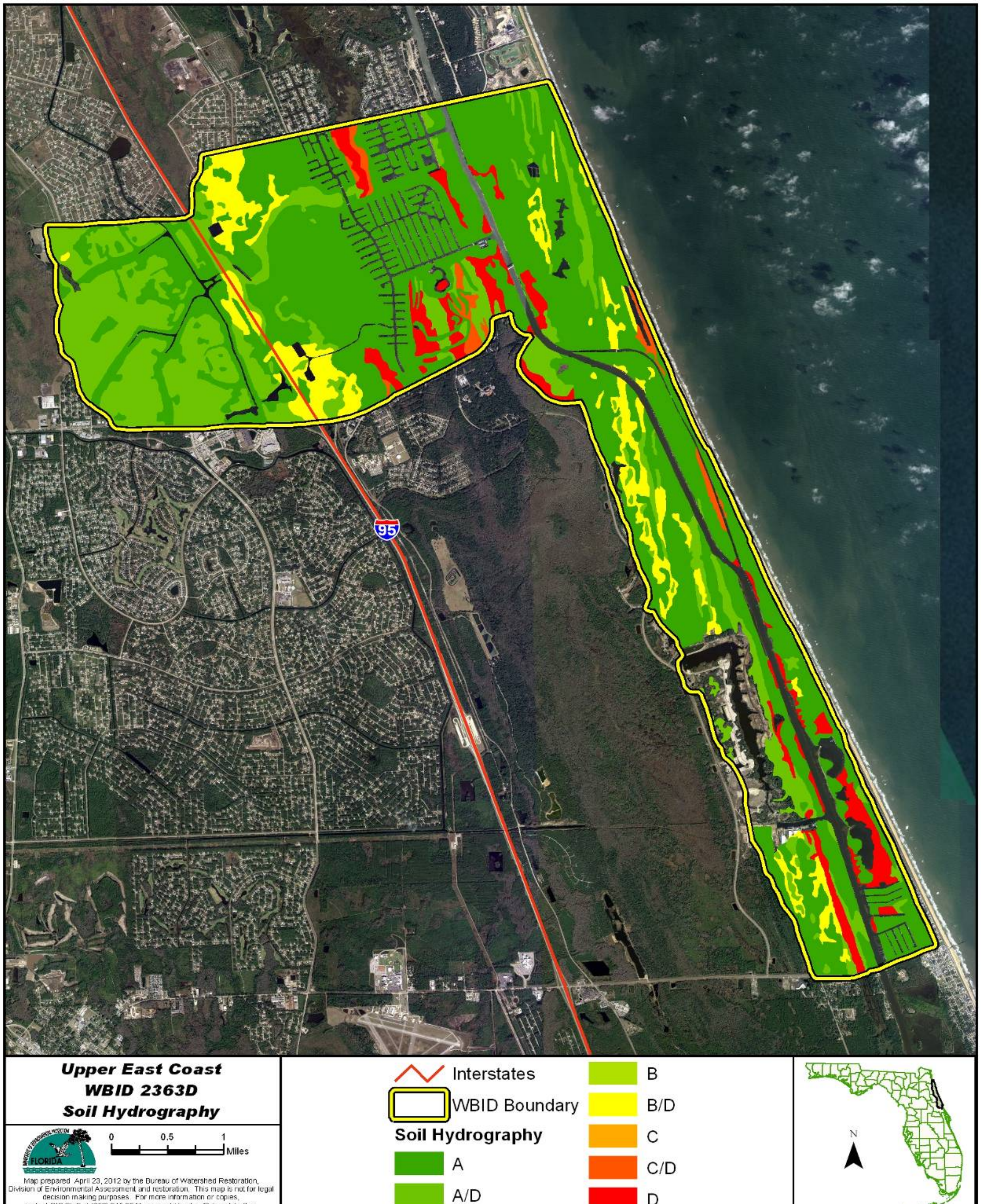

Figure 4.2. Distribution of Hydrologic Soil Groups in the Palm Coast Watershed

Population

The 2010 U.S. Census block data were used to estimate the human population in the Palm Coast watershed. Total population data for census blocks covering the Palm Coast watershed were clipped using GIS to estimate the population within the watershed based on the fraction of the block contained within the watershed. This yielded an estimated population of 24,457 in the Palm Coast watershed. Based on an average of 2.52 persons per household in Flagler County (U.S. Census Bureau website 2010), there were an estimated 9,705 occupied residential units within the WBID boundary.

Septic Tanks

Based on the Florida Department of Health's (FDOH) January 2012 GIS coverage of on-site sewage treatment and disposal systems (OSTDS), there were approximately 175 septic tanks located in the watershed (**Figure 4.3**). Using an estimate of 70 gallons/day/person (EPA 1999), and drainfield TN and TP concentrations of 36 and 15 mg/L, respectively, potential annual ground water loads of TN and TP were calculated. This is a screening-level calculation, and soil types, the age of the system, vegetation, proximity to a receiving water, and other factors will influence the degree of attenuation of this load (**Table 4.3**).

Table 4.3. Estimated Nitrogen and Phosphorus Annual Loading from Septic Tanks in the Palm Coast Watershed

[1] U.S Census Bureau
[2] EPA 1999

Estimated Number of Households on Septic	Estimated Number of People Per Household[1]	Gallons Per Person Per Day[2]	TN in Drainfield (mg/L)	TP in Drainfield (mg/L)	Estimated Annual TN Load (lbs/yr)	Estimated Annual TP Load (lbs/yr)
175	252	70	36	15	3,385	1,410

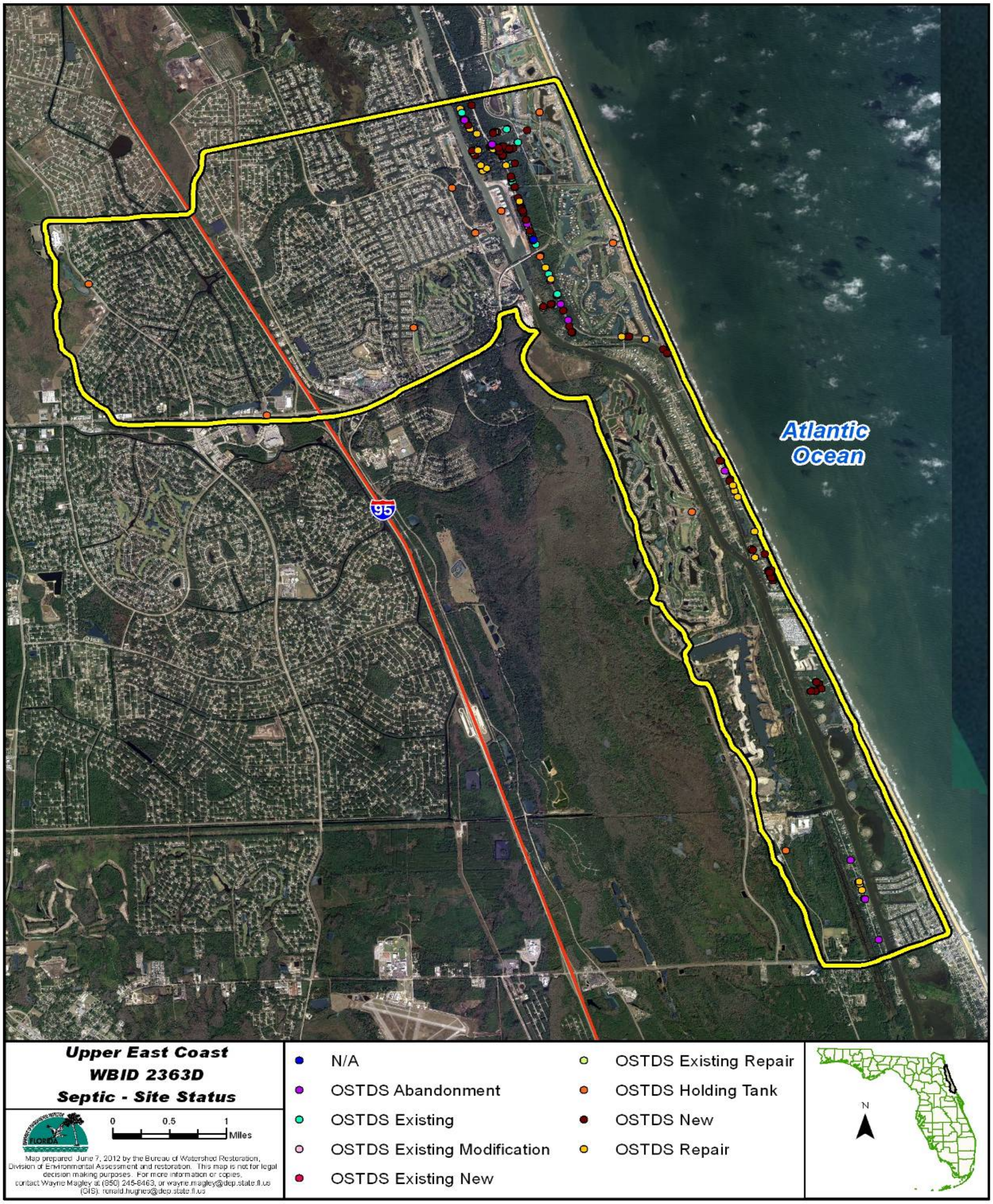

Figure 4.3. OSTDS in the Palm Coast Watershed

4.3 Source Summary

4.3.1 Summary of Nutrient Loadings to the South Matanzas River from Point Sources

Section 4.2.1 provided information on the three point source discharges in the watershed. A conservative approach was used to estimate annual TN and TP loads based on discharge monitoring reports. For each facility, the annual average discharge volume was used with the overall median monthly maximum TN and TP concentrations presented in **Section 4.2.1** to calculate an annual TN and TP contribution from each facility. **Table 4.4** presents the combined estimated annual discharge volumes, TN loads, and TP loads.

Table 4.4. Estimated Annual Average Discharge Volumes and TN and TP Loads from Permitted Point Sources, 1997–2011

Year	Discharge (mg/acre-ft)	TN Load (lbs/yr)	TP Load (lbs/yr)
1997	22/68	2,787	762
1998	24/75	3,062	837
1999	34/104	3,347	940
2000	14/44	1,782	487
2001	177/542	14,250	4,113
2002	264/810	21,143	6,109
2003	406/1244	32,118	9,296
2004	550/1689	43,265	12,537
2005	554/1699	43,724	12,661
2006	595/1827	46,745	13,547
2007	176/541	13,554	3,896
2008	818/2509	62,169	18,001
2009	217/667	15,662	4,497
2010	172/527	11,912	3,395
2011	115/354	7,243	2,052

4.3.2 Summary of Nutrient Loadings to the South Matanzas River from Nonpoint Sources

As part of the EPA's efforts to establish numeric nutrient criteria for Florida's estuaries, Tetra Tech setup a watershed model, Loading Simulation Program in C++ (LSPC), to estimate nutrient loadings to the Matanzas and Halifax River Estuaries. The model simulation covered the 1997 to 2009 period. Ms. Erin Lincoln (Tetra Tech, personal communication, May 2, 2012) provided model outputs of daily flow, TN concentrations, TP concentrations, TN loads, and TP loads based on HUC 12 delineations. Daily flows and nutrient loads were summed by year to obtain estimates of annual nitrogen and phosphorus loadings to the South Matanzas River from contributing watersheds (including the Palm Coast WBID) (**Table 4.5**). These estimates did not include potential contributions from tidally influenced waters outside the modeled contributing watersheds. **Appendix C** describes the calibration of the LSPC watershed model.

Table 4.5. Estimated Annual Average LSPC-Derived Discharge and TN and TP Loads and Concentrations to the South Matanzas River, 1997–2009

Precipitation is based on Daytona International Airport (**Appendix G**).

Year	Discharge (acre-ft)	TN Load (lbs/yr)	TP Load (lbs/yr)	Mean TN (mg/L)	Mean TP (mg/L)	Rainfall (inches/yr)
1997	217,737	1,017,873	106,092.2	1.65	0.216	54.69
1998	196,111.9	946,873.7	90,270.7	1.80	0.268	40.51
1999	133,195.3	616,852.2	84,016.46	1.72	0.254	46.37
2000	143,833.9	662,054.8	77,588.07	1.53	0.226	40.16
2001	357,063.4	1,610,493	140,699.8	1.61	0.215	58.27
2002	252,154.4	1,120,132	113,353.9	1.48	0.204	59.94
2003	306,477.4	1,404,698	123,015.1	1.36	0.154	57.3
2004	378,654.5	1,728,444	156,165.7	1.56	0.232	62.97
2005	447,999	2,088,344	182,382.5	1.41	0.152	65.77
2006	121,388.9	567,917.1	70,194.48	1.75	0.282	31.36
2007	169,527.4	777,632.9	85,321.45	1.88	0.259	45.02
2008	211,126.1	1,071,625	118,306.7	2.22	0.364	42.67
2009	248,300.4	1,181,983	119,331.5	2.08	0.344	50.3
AVERAGE	**244,890**	**1,138,071**	**112,826**	**1.70**	**0.244**	**50.41**

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

5.1.1 Data Used in the Determination of the TMDL

There are 18 sampling stations in the watershed, of which 6 have historical CHLAC observations (**Figure 5.1**). **Table 5.1** contains summary information on each of the stations (N represents the number of CHLAC observations). **Table 5.2** provides a statistical summary of CHLAC observations at each station, and **Appendix B** contains historical CHLAC, temperature (TEMPC), TN, TP, and total suspended solids (TSS) available observations from sampling sites in WBID 2363D from 1971 to 2012. **Figure 5.2** displays the historical CHLAC observations over time. The simple linear regression of CHLAC versus sampling date in **Figure 5.2** was significant at an alpha (α) level of 0.05 ($R^2 = 0.063$) and indicated an increasing trend in CHLAC. **Appendix F** contains plots of CHLAC by year, season, and station.

Figures 5.3 through **5.6** present historical TN, TP, COLOR, and TSS observations, respectively. Linear regressions of each parameter versus sampling date indicated that all the regressions were significant at an alpha (α) level of 0.05. All the regressions indicated a declining trend over time for the respective parameter. **Appendix F** contains additional plots by year, season, and station. **Table 5.3** presents a statistical summary of major water quality parameters from the available data.

Table 5.1. Sampling Station Summary for Palm Coast

Station	STORET ID	Station Owner	Years with Data	Number of Samples
ICWW MARKER AT ITT NP PALM CST C	21FLA 27010102	Department	1971–2012	14
ICWW AT ST JOE CANAL	21FLA 27010103	Department	1971–2010	13
ICWW MARKER 1 AT FOX CUT	21FLA 27010104	Department	1971–2005	9
ICW @ CM 3 S FOX CUT	21FLA 27010105	Department	1971–2010	13
ICWW FLAGLER PALM COAST MID CANAL	21FLA 27010150	Department	1978–2010	14
ICWW MARKER @ FOX CUT	21FLSJWMJXTR26	SJRWMD	1997–2012	168

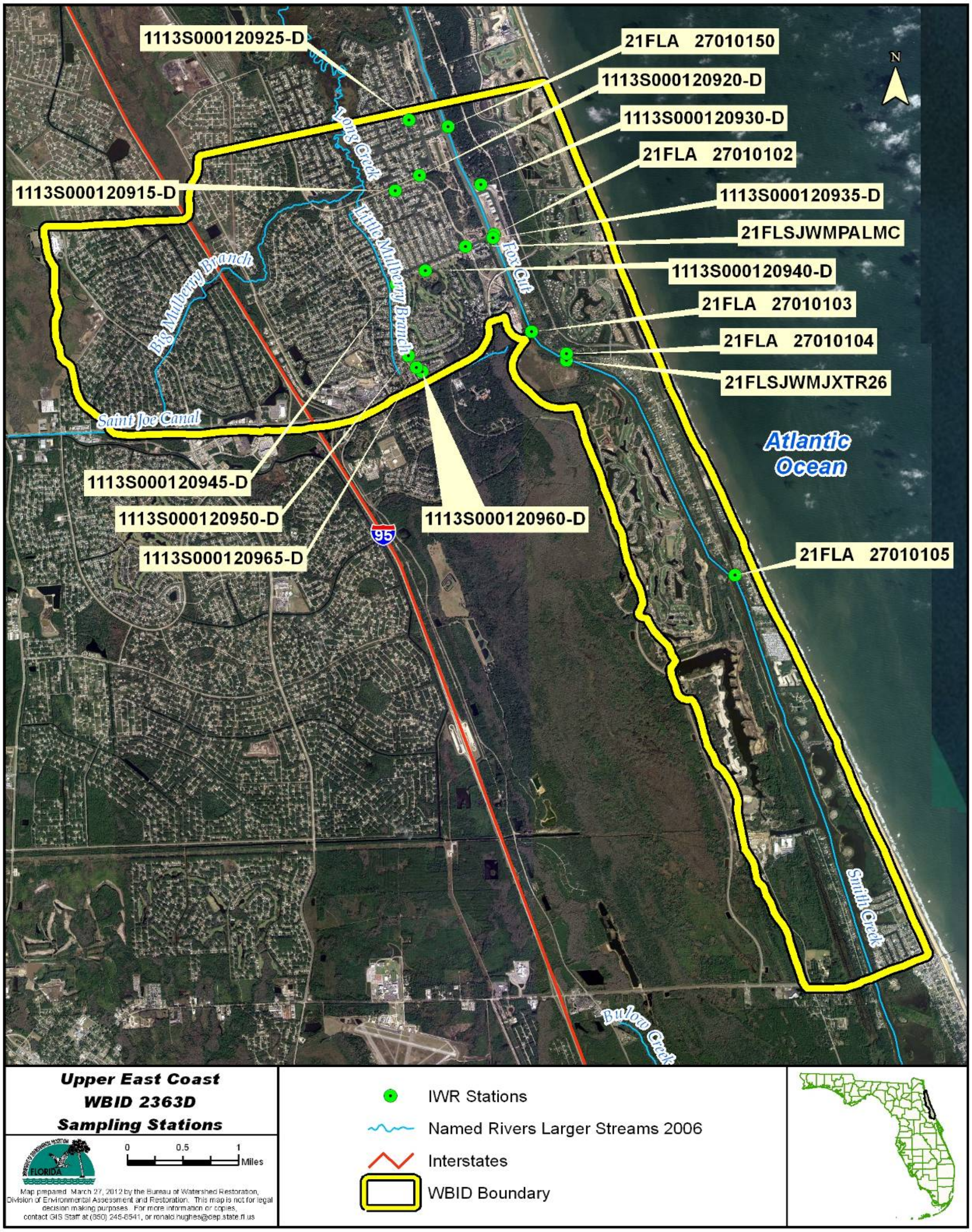

Figure 5.1. Historical Sampling Sites in Palm Coast

Table 5.2. Statistical Summary of Historical CHLAC Data for Palm Coast

CHLAC concentrations are µg/L

Station	Number of Samples	Minimum	Maximum	Median	Mean
ICWW MARKER AT ITT NP PALM CST C	14	1	7.8	3.6	3.6
ICWW AT ST JOE CANAL	13	1	14.0	2.1	4.3
ICWW MARKER 1 AT FOX CUT	9	1	8.3	1.3	3.0
ICW @ CM 3 S FOX CUT	13	1	21.0	3.0	5.0
ICWW FLAGLER PALM COAST MID CANAL	14	1	12.0	3.0	4.3
ICWW MARKER @ FOX CUT	168	1	28.0	4.8	5.7

.

Table 5.3. Summary Statistics for Major Water Quality Parameters Measured in Palm Coast

BOD = Biochemical oxygen demand; Pt-Co = Platinum cobalt units; COND = Conductivity; µs/cm = micromohs per centimeter; DO = Dissolved oxygen; DOSAT = DO saturation concentration; NH4 = Ammonia; NO3O2 = nitrite+nitrate; su = Standard units; ppt = parts per thousand; TEMPC = Water temperature in °C; SD = Secchi depth; INORGN = Inorganic nitrogen; INORGP = Inorganic phosphorus; TURB = Turbidity; NTU = Nephelometric turbidity units

Parameter	Number of Samples	Minimum	25%	Median	Mean	75%	Maximum
BOD (mg/L)	195	0.1	0.9	1.4	1.5	1.9	7.5
CHLAC (µg/L)	231	1.0	2.2	4.2	5.3	6.9	28.0
COLOR (PT-CO)	333	5	15	30	41	53	242
COND (µS/cm)	359	816	38000	45000	43203	49953	56230
DO (mg/L)	415	2.10	5.60	6.60	6.62	7.44	10.98
DOSAT (%)	238	26.92	75.00	84.91	84.76	95.79	137.00
NH4 (mg/L)	235	0.000	0.023	0.050	0.084	0.089	1.120
NO3O2 (mg/L)	313	0.004	0.010	0.018	0.024	0.033	0.221
pH (su)	388	6.00	7.63	7.81	7.77	7.94	8.90
SALINITY (ppt)	347	5.14	26.77	30.04	28.95	33.16	39.00
SD (m)	334	0.3	0.8	1.0	1.0	1.1	2.6
TEMPC (°C)	409	8.72	19.30	23.00	23.23	28.93	32.50
INORGN (mg/L)	216	0.012	0.050	0.070	0.089	0.110	0.491
TN (mg/L)	314	0.08	0.40	0.50	0.57	0.66	2.38
INORGP (mg/L)	281	0.000	0.015	0.027	0.033	0.041	0.120
TP (mg/L)	360	0.014	0.066	0.088	0.120	0.128	1.000
TSS (mg/L)	342	2	16	23	35	39	431
TURB (NTU)	295	1	4	6	6	8	21
TN/TP RATIO	307	0.36	4.44	6.04	6.89	8.38	32.63
INORGN/INORGP	134	0.26	1.53	3.40	4.29	5.23	40.88

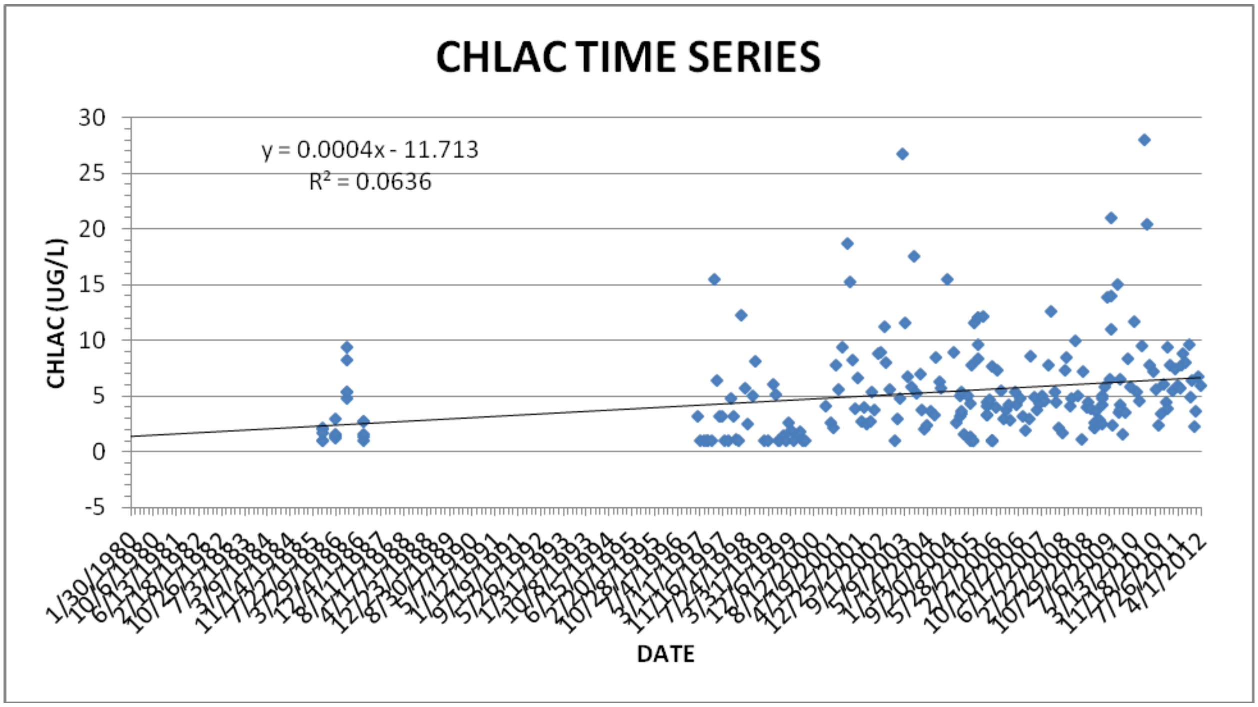

Figure 5.2. Historical CHLAC Observations for Palm Coast

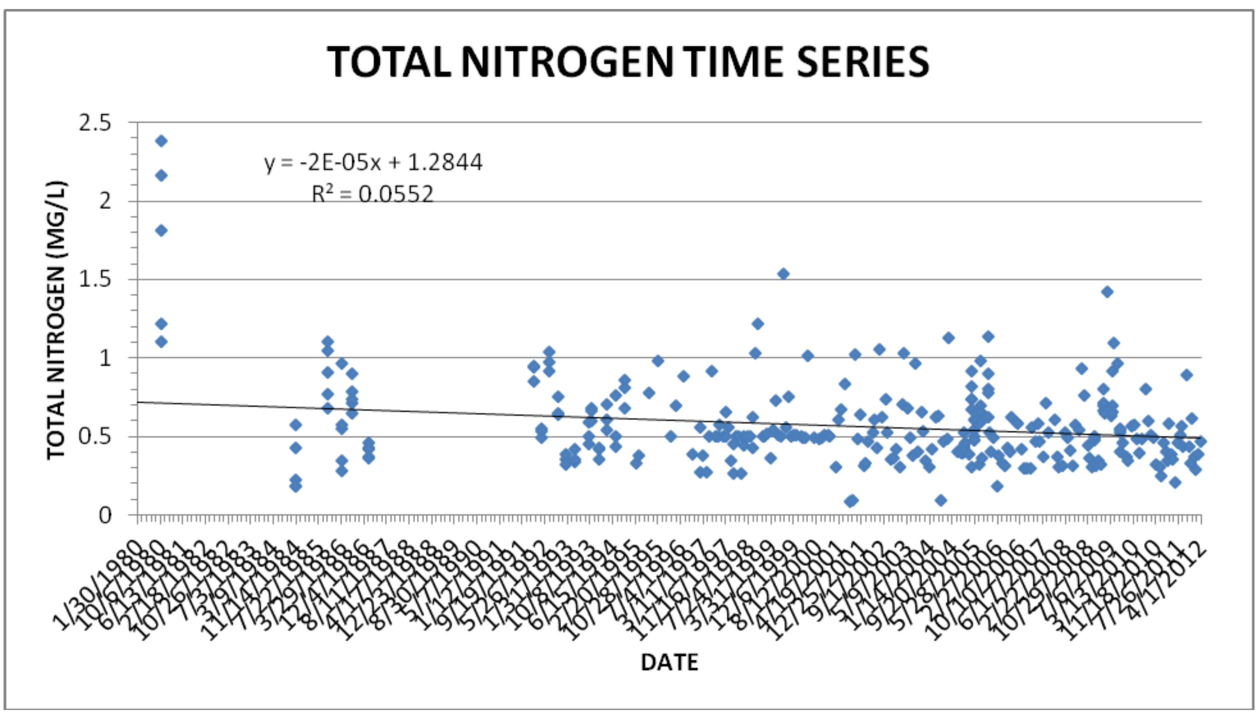

Figure 5.3. Historical TN Observations for Palm Coast

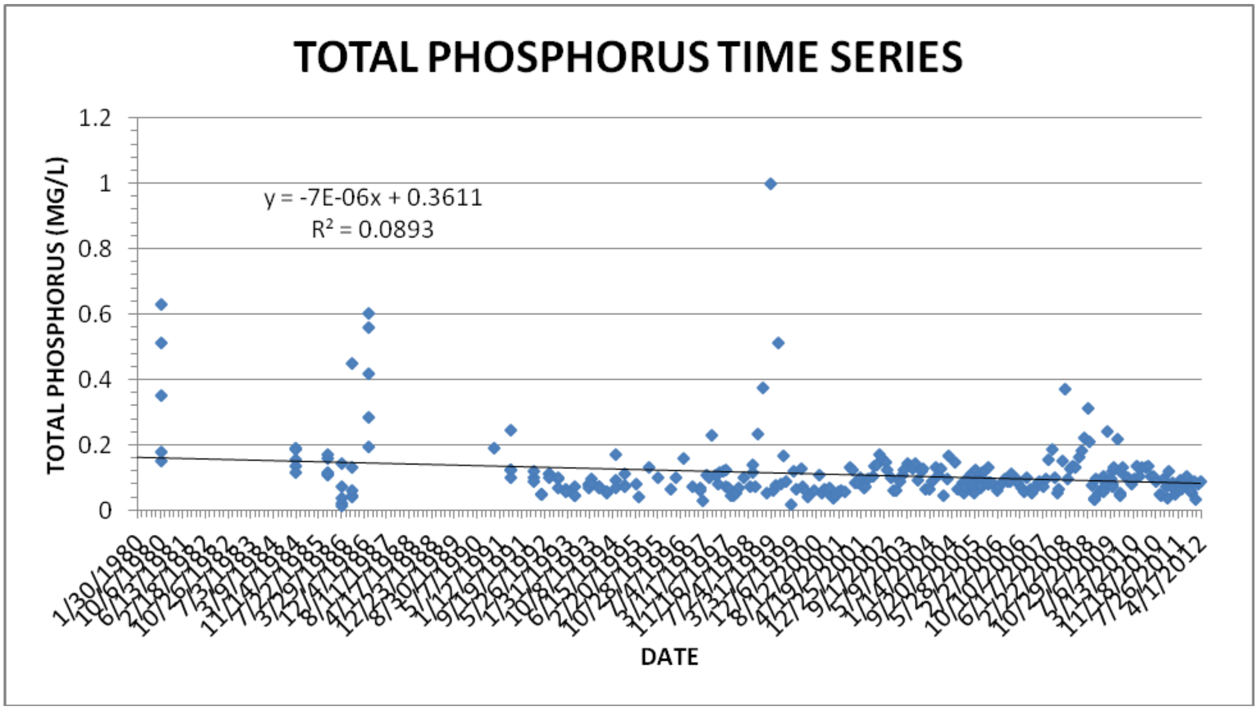

Figure 5.4. Historical TP Observations for Palm Coast

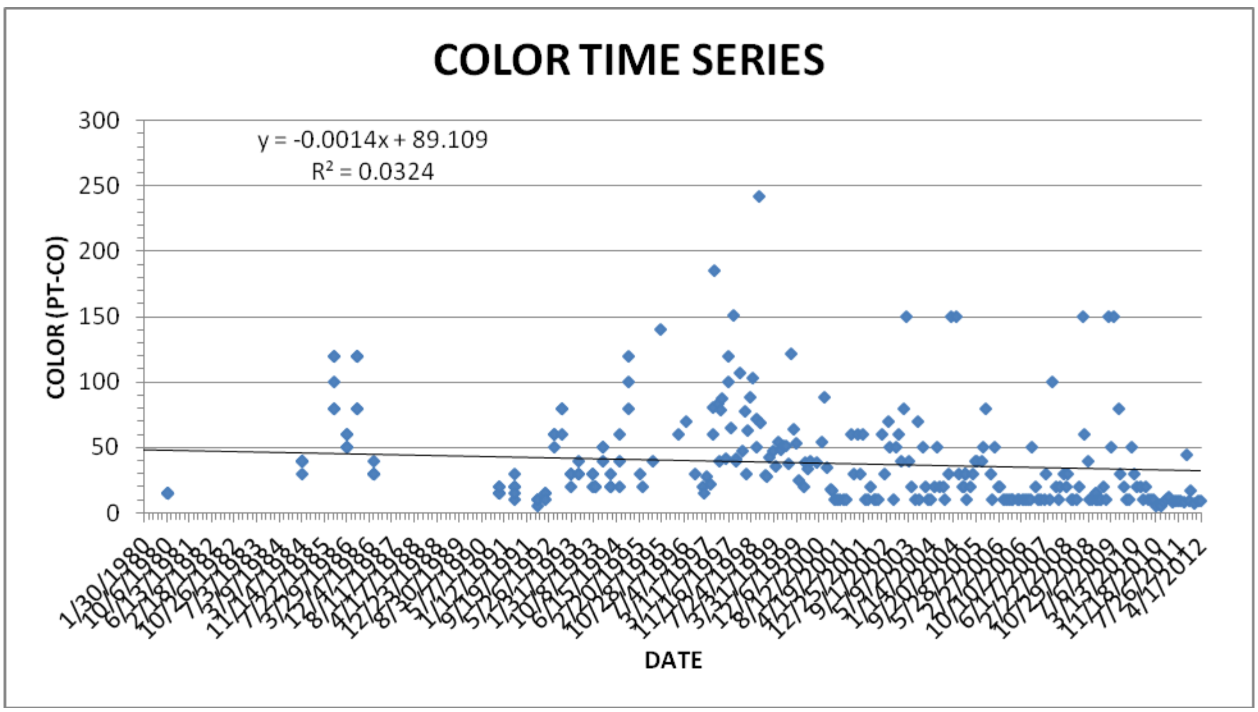

Figure 5.5. Historical Color Observations for Palm Coast

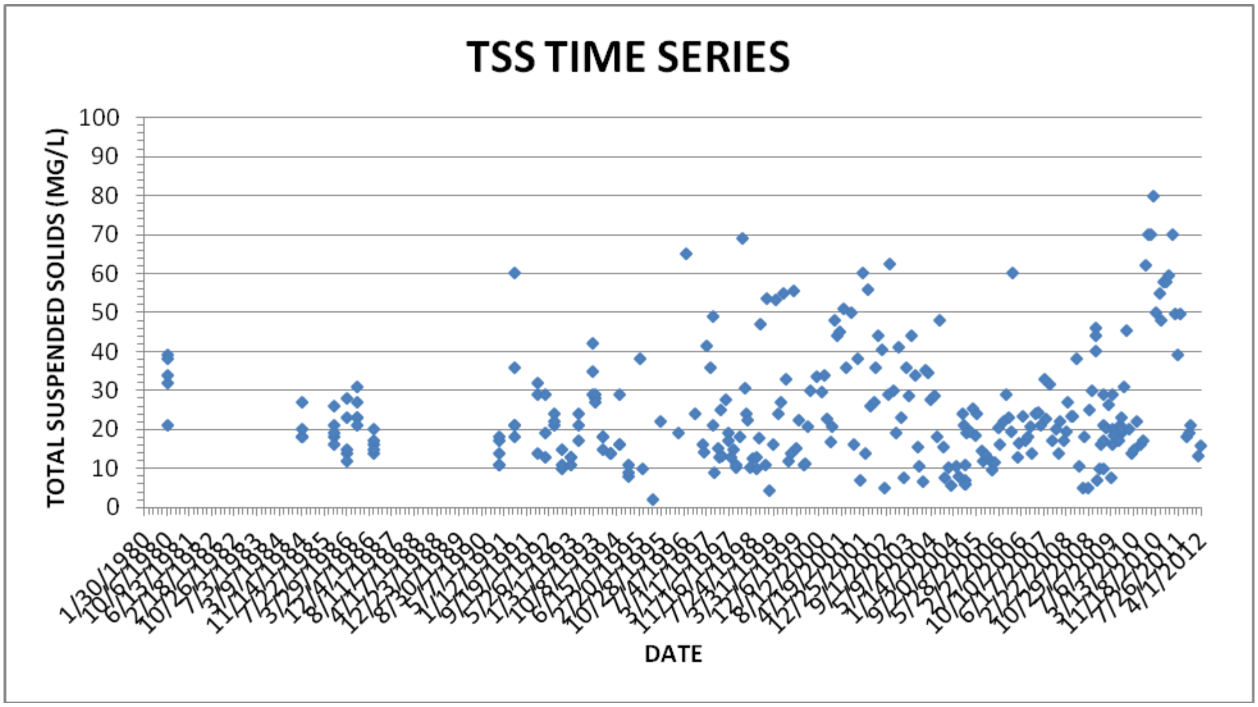

Figure 5.6. Historical TSS Observations for Palm Coast

Available CHLAC, TN, and TP measurements were also summarized by year (**Tables 5.4** through **5.6**). The methodology used in the IWR was used to calculate annual averages. A nonparametric test (Kruskal-Wallis) was applied to the CHLAC, INORGN, TN, INORGP, TP, COND, COLOR, and TSS datasets to determine whether there were significant differences among seasons (**Appendix D**). At an α level of 0.05, differences were significant among seasons for all the parameters. A similar test for differences among years was significant for all the parameters (**Appendix E**).

Table 5.4. Statistical Summary of Historical CHLAC Data by Year for Palm Coast, 1985–2012

CHLAC concentrations are µg/L.
- = Cases where data were not collected in each of the four quarters.

Year	Number of Samples	Minimum	Maximum	Median	Mean
1985	5	1.0	2.1	1.7	-
1986	10	1.2	9.3	3.9	-
1987	5	1.0	2.7	1.6	-
1997	11	1.0	15.5	1.0	3.3
1998	10	1.0	12.3	4.0	4.6
1999	10	1.0	6.1	1.2	2.4
2000	6	1.0	4.1	1.3	-
2001	10	2.2	18.7	7.2	8.3
2002	11	2.5	11.3	5.3	5.9
2003	12	1.0	26.7	5.6	7.9
2004	10	2.4	15.5	4.7	7.6
2005	37	1.0	12.2	3.4	5.2
2006	12	2.0	7.3	4.1	4.2
2007	12	2.2	12.6	4.7	5.5
2008	12	1.2	10.0	4.6	5.2
2009	24	1.6	21.0	4.0	6.1
2010	12.0	2.4	28.0	7.5	9.7
2011	16.0	3.4	9.6	6.2	6.6
2012	6.0	2.2	9.4	6.3	-

Table 5.5. Statistical Summary of Historical TN Data by Year for Palm Coast, 1973–2012

TN concentrations are mg/L.
- = Cases where data were not collected in each of the four quarters.

Year	Number of Samples	Minimum	Maximum	Median	Mean
1973	2	0.32	0.42	0.37	-
1976	9	0.17	0.51	0.40	-
1978	5	0.93	1.35	1.09	-
1980	5	1.10	2.38	1.81	-
1984	5	0.18	0.57	0.22	-
1985	5	0.68	1.10	0.90	-
1986	10	0.28	0.96	0.68	-
1987	5	0.36	0.46	0.42	-
1992	12	0.49	1.04	0.80	0.77
1993	12	0.32	0.68	0.44	0.47
1994	12	0.35	0.86	0.57	0.59
1995	4	0.33	0.98	0.58	0.62
1996	4	0.39	0.89	0.60	0.62
1997	13	0.27	0.91	0.50	0.51
1998	15	0.27	1.22	0.50	0.56
1999	12	0.36	1.54	0.51	0.63
2000	10	0.49	1.01	0.49	0.56
2001	10	0.08	1.02	0.56	0.48
2002	12	0.31	1.05	0.50	0.53
2003	12	0.30	1.03	0.51	0.58
2004	10	0.10	1.13	0.44	0.51
2005	37	0.30	1.14	0.54	0.59
2006	12	0.18	0.62	0.39	0.40
2007	11	0.30	0.72	0.47	0.49
2008	12	0.30	0.93	0.47	0.50
2009	24	0.31	1.42	0.59	0.63
2010	12.00	0.30	0.80	0.49	0.49
2011	16.00	0.20	0.89	0.43	0.45
2012	6.00	0.29	0.47	0.40	-

Table 5.6. Statistical Summary of Historical TP Data by Year for Palm Coast, 1972–2012

TP concentrations are mg/L.
- = Cases where data were not collected in each of the four quarters.

Year	Number of Samples	Minimum	Maximum	Median	Mean
1971	32	0.040	0.590	0.190	-
1972	4	0.050	0.060	0.053	-
1973	8	0.039	0.422	0.095	-
1974	1	0.030	0.030	0.030	-
1976	9	0.070	0.230	0.090	-
1978	5	0.040	0.070	0.060	-
1980	5	0.150	0.630	0.350	-
1984	5	0.115	0.191	0.154	-
1985	5	0.108	0.169	0.114	-
1986	10	0.014	0.448	0.053	-
1987	5	0.193	0.603	0.416	-
1990	1	0.190	0.190	0.190	-
1991	5	0.100	0.246	0.122	-
1992	12	0.050	0.120	0.098	0.087
1993	12	0.044	0.094	0.070	0.069
1994	12	0.052	0.170	0.072	0.081
1995	4	0.041	0.130	0.090	0.088
1996	4	0.063	0.160	0.087	0.099
1997	13	0.030	0.229	0.098	0.098
1998	11	0.044	0.375	0.072	0.117
1999	10	0.018	1.000	0.085	0.231
2000	10	0.042	0.128	0.063	0.070
2001	11	0.036	0.130	0.069	0.080
2002	12	0.062	0.169	0.114	0.115
2003	12	0.060	0.144	0.122	0.111
2004	11	0.046	0.164	0.094	0.102
2005	37	0.053	0.130	0.078	0.082
2006	12	0.057	0.113	0.085	0.084
2007	12	0.051	0.186	0.078	0.091
2008	12	0.076	0.369	0.158	0.178
2009	24	0.033	0.242	0.078	0.090
2010	12	0.050	0.136	0.102	0.104
2011	16	0.038	0.119	0.069	0.073
2012	6	0.033	0.089	0.084	-

5.1.2 TMDL Development Process

As part of evaluating potential relationships between CHLAC and other variables, rainfall records for Daytona International Airport were used to determine rainfall amounts associated with individual sampling dates. Rainfall recorded on the day of sampling (PRECIP), the cumulative total for the day of and the previous 2 days (V3DAY), the cumulative total for the day of and the previous 6 days (V7DAY), the cumulative total for the day of and the previous 13 days (V14DAY), and the cumulative total for the day of and the previous 20 days (V21DAY) were all paired with the respective water quality parameter observation.

A Spearman correlation matrix was used to assess potential relationships between CHLAC and other water quality parameters (**Appendix H**). At an alpha (α) level of 0.05, correlations between CHLAC and COND, SALINITY, TEMPC, Total Kjeldahl Nitrogen (TKN), TN, TSS, TURB, V14DAY, and V21DAY were significant. A simple linear regression of CHLAC versus TEMPC explained nearly 21% of the variance in CHLAC, while the regression with TURB explained 12% of the variance in CHLAC. The regression with TN explained nearly 6% of the variance in CHLAC (**Appendix I**).

The impairment listing identified TN as the limiting nutrient. **Figure 5.7** illustrates the time series of the TN/TP ratio. Although the trendline indicates a decline in the TN/TP ratio, the regression was not significant at an alpha (α) level of 0.05. A similar plot of the INORGN/INORGP ratio had a slope of 0.0005. Summary statistics for the ratios can be found in **Table 5.3**. Based on the INORGN/INORGP ratio, it appeared that inorganic forms of nitrogen were typically limiting compared with inorganic phosphorus (75% value was 4.99).

Since the impairment for nutrients was based on an annual average for CHLAC, annual averages for water quality parameters were also calculated using available data, and linear regressions were performed. The calculations of annual averages followed the methodology described in the IWR for the calculation of annual CHLAC averages.

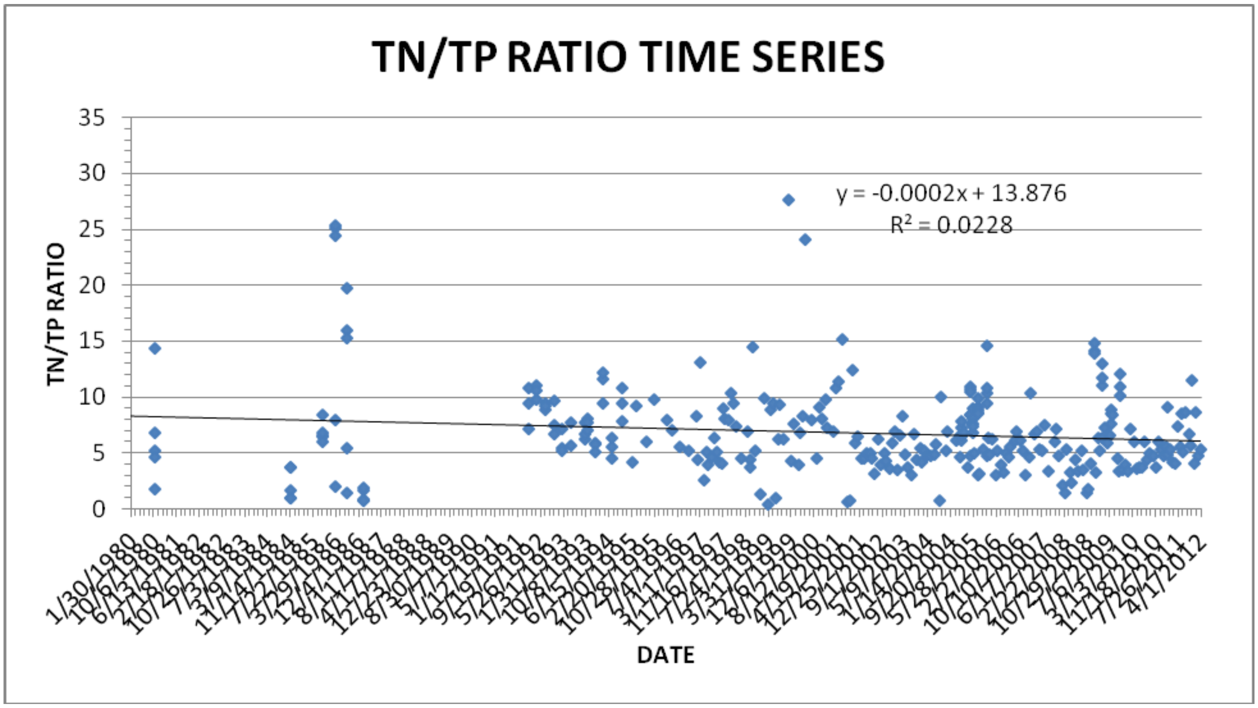

Figure 5.7. Historical Time Series of the TN/TP Ratio for the South Matanzas River

Based on simple linear regression using annual averages, the correlations between CHLAC and INORGP and TURB were significant at an alpha (α) level of 0.05 (**Appendix J**). Approximately 62% of the variance in the annual average CHLAC was explained with the annual average TURB concentration. Annual average INORGP concentrations explained approximately 36% of the variance in the annual average CHLAC concentrations (**Figure 5.8**). Individual regressions between COLOR, COND, INORGN, NH4, NO3O2, SALINITY, TEMPC, TN, TP, TSS, or annual RAINFALL and CHLAC were not significant at an alpha (α) level of 0.05. Annual TN and TP loads from the LSPC watershed model simulation (**Table 4.5**) were regressed against the annual average CHLAC concentration, and the regression with TN load was significant at an alpha (α) level of 0.05 (explained 40% of the variance).

Although the regression between CHLAC and annual rainfall was not significant (r^2 = 0.044, p=0.406), annual rainfall patterns were examined further to evaluate whether there were cumulative effects due to reduced rainfall. Annual rainfall totals over the 1937 through 2011 period were ranked (**Appendix K**). With the exception of 2009 (50.3 inches), rainfall totals over the 2008 to 2011 period were below the long-term annual average of 49.63 inches. To evaluate the longer term effects of below-average rainfall years, an annual rainfall deficit was calculated based on the long-term average. The cumulative effect of deficits was calculated by summing over a 3-year (current year and 2 previous years) and a 5-year (current year and the 4 previous years) period. Simple linear regressions of the annual average CHLAC versus the annual rainfall deficit, the 3-year cumulative deficit, and the 5-year cumulative deficit were not significant at an alpha (α) level of 0.05 (**Appendix J**). Plots of the annual rainfall deficit and cumulative 3- and 5-year deficits can be found in **Appendix K**. As seen in the plots, following the high rainfall in 2005 (65.77 inches), the cumulative 3- and 5-year deficits increased sharply.

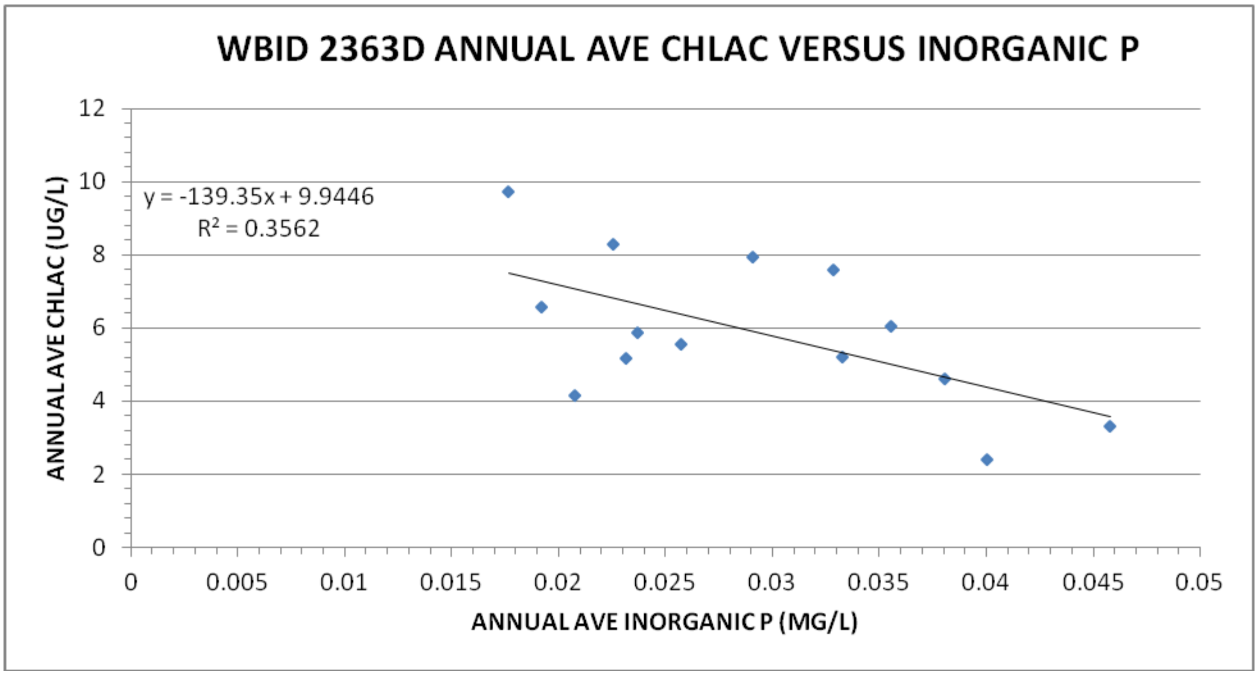

Figure 5.8. Annual Average CHLAC versus INORGANP for the South Matanzas River

As seen in **Table 5.1**, the majority of CHLAC measurements for this waterbody were obtained at the ICWW channel marker 1 at Fox Cut (Stations 21FLSJWMJXTR26 and 21FLA 27010104). Relationships between CHLAC and other water quality parameters were further explored at this location. Since this location had the majority of the water quality data, time series for CHLAC, TN, TN, and COLOR were very similar to those shown in **Figures 5.2** through **5.5**. The time series trendline for COLOR had a larger slope and higher R^2 (-0.0023 and 0.046, respectively) when compared with **Figure 5.5**. Linear regressions between CHLAC and the same water quality parameters considered in **Appendix J** yielded significant relationships with INORGP, TURB, TN load, and TP load. Note that there were only 7 years of data available at this site for NH4. TURB explained 65% of the variance in CHLAC. Regressions of CHLAC versus TN loads and TP loads explained 50% and 39% of the variance in CHLAC, respectively (**Figures 5.9** and **5.10**).

Since the nutrient impairment listing was based on exceeding an annual average CHLAC concentration of 5 µg/L for 2 consecutive years, a target annual average CHLAC concentration of 4.5 µg/L was used to develop nutrient reductions. Based on the linear regression between annual average CHLAC concentrations at the ICWW channel marker at Fox Cut and watershed model TN loads, a 29% reduction in the average TN load (from 1,138,071 to 807,418 lbs/yr) would be required to achieve a target CHLAC annual average of 4.5 µg/L. A 23% reduction in the average TP load (from 112,826 to 86,685 lbs/yr), based on the linear regression annual average CHLAC and watershed model TP load, would be required to meet the CHLAC target.

5.1.3 Critical Conditions/Seasonality

The nonparametric tests (Kruskal-Wallis) presented in **Appendices C** and **D** illustrated significant differences in CHLAC and nutrients on both a seasonal and annual basis. The nutrient impairment was based on annual average CHLAC concentrations exceeding a historical minimum by 50% or more over 2 consecutive years. The methodology used for calculating an annual average is based on computing individual seasonal averages. Consequently, seasonality is incorporated into the process of assessment and TMDL development. Reductions in TN and TP loads were based on setting a CHLAC target below the historical listing threshold.

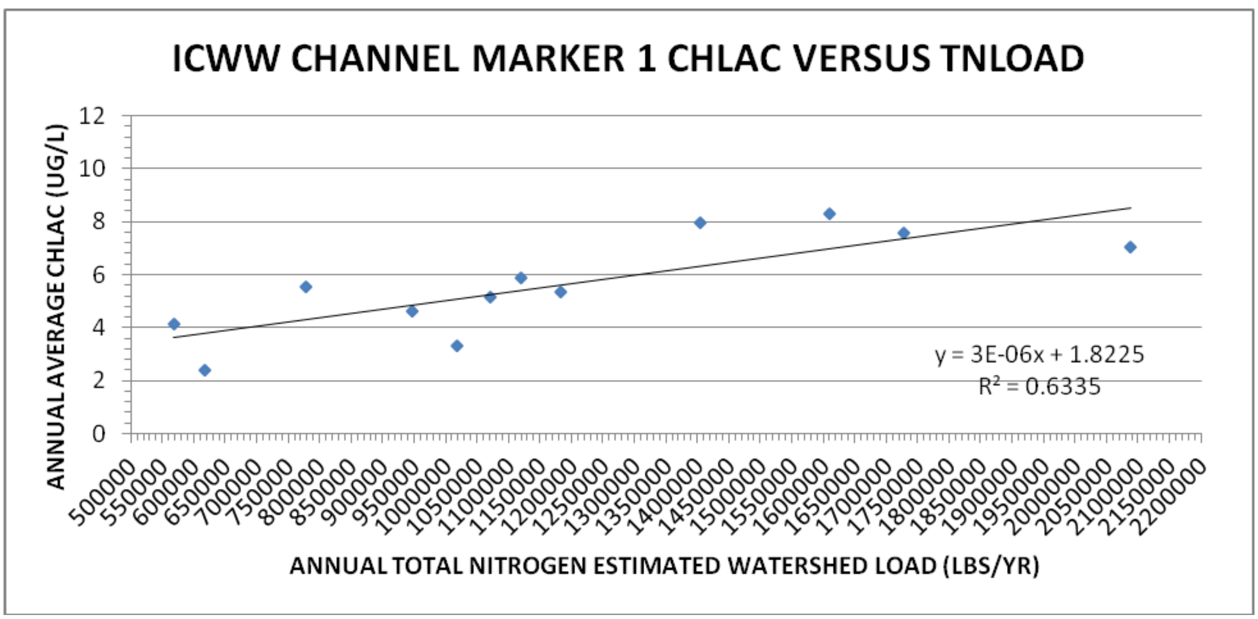

Figure 5.9. Annual Average CHLAC at ICWW Channel Marker 1 at Fox Cut versus Estimated Annual TN Watershed Loads

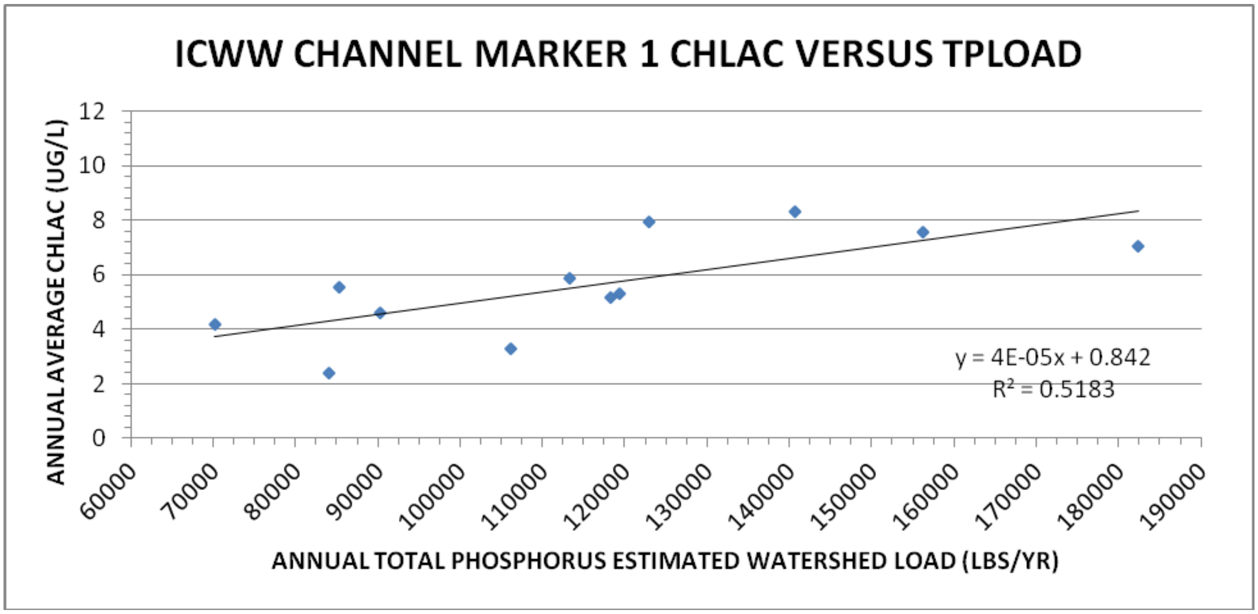

Figure 5.10. Annual Average CHLAC at ICWW Channel Marker 1 at Fox Cut versus Estimated Annual TP Watershed Loads

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. A TMDL is 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), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \square \text{WLAs} + \sum \square \text{LAs} + \text{MOS}$$

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

$$\textbf{TMDL} \cong \sum \square \text{WLAs}_{\textbf{wastewater}} + \sum \square \text{WLAs}_{\textbf{NPDES Stormwater}} + \sum \square \text{LAs} + \text{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) 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 (2) 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 regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDLs for Palm Coast are expressed in terms of a percent reduction in TN and TP, to meet the nutrient criteria (**Table**

6.1). To calculate the total maximum annual average daily load that should be expected, divide the annual average load by 365.25.

Table 6.1. TMDL Components for Palm Coast (WBID 2363D)

[1] As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.

WBID	Parameter	TMDL (lbs/yr)	WLA for Wastewater (lbs/yr)	WLA for NPDES Stormwater (% reduction)1	LA (% reduction)[1]	MOS
2363D	TN	807,418	122,190	29%	29%	Implicit
2363D	TP	86,685	33,120	23%	23%	Implicit

6.2 Load Allocation

TN and TP reductions of 29% and 23%, respectively, are required from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There are currently 3 permitted NPDES dischargers in the Palm Coast watershed. Based on conservative estimates of their contribution, existing TN and TP loads are less than 2% and 6% of the current nonpoint contribution. The combined WLA for the 4 permitted facilities in **Table 6.1** was derived from permitted limits and/or existing effluent characteristics summarized in **Section 4.2.1**. Palm Coast WWTF # 1 has 2 discharges with a combined flow of 3.65 MGD AADF and, based on mean TN and TP concentrations of 10 and 2.74 mg/L, result in annual TN and TP loads of 111,190 and 30,466 lbs, respectively. The Beverly Beach WWTF has an annual TN load limit of 4,606 lbs. Based on an average TP concentration of 0.767 mg/L, the corresponding annual TP load would be 503 lbs. The Dunes CDD-RO Concentrate facility had average daily maximum TN and TP concentrations of 2.01 and 0.424 mg/L, respectively. At a permitted capacity of 0.25 MGD, the annual TN and TP loads would be 1,531 and 323 lbs, respectively. Although the Palm Coast WWTF #2 facility will not be operational until 2014, its contribution was estimated at 5,483 and 1,828 lbs/yr of TN and TP, respectively. Monitoring requirements for both TN and TP need to remain in place for these facilities. Any future discharge permits issued in the watershed will also be required to contain appropriate discharge limitations on nitrogen and phosphorus that will comply with the TMDL.

6.3.2 NPDES Stormwater Discharges

Portions of the Palm Coast watershed fall within the boundaries of the Phase II MS4 permits for the city of Flagler Beach (FLR04E102) and FDOT District 5 (FLR04E024) which would be responsible for a 29% and 23% reduction in current anthropogenic TN and TP loading, respectively. It should be noted that any MS4 permittee is only responsible for reducing the loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001), an implicit MOS was used in the development of this TMDL by setting an annual CHLAC target concentration of 4.5 µg/L and applying a 21% reduction in annual average TN loads and a 16% reduction in annual average TP loads. Reductions in both TN and TP watershed loads should result in annual average CHLAC concentrations below 4.5 µg/L.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending upon the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. **Often** this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines a BMAP is needed to support the implementation of these TMDLs, a BMAP will be developed through a transparent stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDLs).*
- *Refined source identification.*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible).*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach.*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDLs.*
- *Timetables for implementation.*
- *Implementation funding mechanisms.*
- *An evaluation of future increases in pollutant loading due to population growth.*

- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures.*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

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Appendices

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 (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

Rule 62-40, F.A.C., also 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.

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 permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in 1990. 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 the 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 implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's stormwater/ERP programs is that the NPDES Program covers both new and existing discharges, while the state's program focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. 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. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Historical CHLAC, TEMP, TN, TP, and TSS Observations in Palm Coast, 1971–2012

- = Empty cell/no data

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010102	1/28/1971	-	14.00	-	0.230	105
21FLA 27010103	1/28/1971	-	14.00	-	0.280	87
21FLA 27010104	1/28/1971	-	13.00	-	0.190	148
21FLA 27010105	1/28/1971	-	15.00	-	0.180	91
21FLA 27010102	2/23/1971	-	20.00	-	0.040	98
21FLA 27010103	2/23/1971	-	20.00	-	0.110	47
21FLA 27010104	2/23/1971	-	19.00	-	0.080	204
21FLA 27010105	2/23/1971	-	20.00	-	0.070	103
21FLA 27010102	3/17/1971	-	21.00	-	0.270	41
21FLA 27010103	3/17/1971	-	22.00	-	0.370	38
21FLA 27010104	3/17/1971	-	21.00	-	0.300	63
21FLA 27010105	3/17/1971	-	21.00	-	0.130	51
21FLA 27010102	4/27/1971	-	24.00	-	0.220	121
21FLA 27010103	4/27/1971	-	26.00	-	0.310	57
21FLA 27010104	4/27/1971	-	25.00	-	0.150	123
21FLA 27010105	4/27/1971	-	26.00	-	0.590	121
21FLA 27010102	5/24/1971	-	28.00	-	0.190	95
21FLA 27010103	5/24/1971	-	29.00	-	0.360	169
21FLA 27010104	5/24/1971	-	29.00	-	0.320	119
21FLA 27010105	5/24/1971	-	28.00	-	0.280	122
21FLA 27010102	6/28/1971	-	27.00	-	0.430	119
21FLA 27010103	6/28/1971	-	28.00	-	0.320	126
21FLA 27010104	6/28/1971	-	29.00	-	0.440	115
21FLA 27010105	6/28/1971	-	28.00	-	0.420	151
21FLA 27010102	7/29/1971	-	30.00	-	0.070	139
21FLA 27010103	7/29/1971	-	30.00	-	0.080	127
21FLA 27010104	7/29/1971	-	30.00	-	0.070	140
21FLA 27010105	7/29/1971	-	30.00	-	0.080	93
21FLA 27010102	8/18/1971	-	-	-	0.070	94
21FLA 27010103	8/18/1971	-	-	-	0.080	128
21FLA 27010104	8/18/1971	-	-	-	0.070	114
21FLA 27010105	8/18/1971	-	-	-	0.080	115
21FLA 27010103	11/15/1971	-	20.00	-	-	33
21FLA 27010102	11/20/1972	-	20.50	-	0.050	92

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010103	11/20/1972	-	20.50	-	0.055	100
21FLA 27010104	11/20/1972	-	20.00	-	0.060	431
21FLA 27010105	11/20/1972	-	20.50	-	0.050	88
21FLA 27010102	4/17/1973	-	20.00	-	0.090	27
21FLA 27010102	5/7/1973	-	23.00	-	0.039	71
21FLA 27010103	5/7/1973	-	23.00	-	-	-
21FLA 27010104	5/7/1973	-	23.00	-	-	-
21FLA 27010105	5/7/1973	-	23.00	-	0.045	69
21FLA 27010102	10/3/1973	-	27.50	0.42	0.100	24
21FLA 27010103	10/3/1973	-	28.00	0.32	0.090	27
21FLA 27010102	10/29/1973	-	21.50	-	0.422	17
21FLA 27010103	10/29/1973	-	22.00	-	0.367	19
21FLA 27010104	10/29/1973	-	22.00	-	0.210	18
21FLA 27010102	1/14/1974	-	15.00	-	-	42
21FLA 27010103	1/14/1974	-	18.00	-	0.030	32
21FLA 27010104	1/14/1974	-	18.00	-	-	39
21FLA 27010102	7/29/1974	-	28.00	-	-	49
21FLA 27010103	7/29/1974	-	28.50	-	-	40
21FLA 27010104	7/29/1974	-	28.50	-	-	30
21FLA 27010105	7/29/1974	-	29.00	-	-	40
21FLA 27010102	4/6/1976	-	-	-	-	-
1113S000120915-D	8/2/1976	-	29.85	-	-	-
1113S000120920-D	8/2/1976	-	31.30	-	-	-
1113S000120925-D	8/2/1976	-	31.00	-	-	-
1113S000120930-D	8/2/1976	-	28.80	-	-	-
1113S000120935-D	8/2/1976	-	29.50	-	-	-
1113S000120940-D	8/2/1976	-	30.75	-	-	-
1113S000120945-D	8/2/1976	-	31.15	-	-	-
1113S000120950-D	8/2/1976	-	31.25	-	-	-
1113S000120955-D	8/2/1976	-	30.80	-	-	-
1113S000120915-D	8/3/1976	-	29.40	0.51	0.080	-
1113S000120920-D	8/3/1976	-	29.50	0.40	0.080	-
1113S000120925-D	8/3/1976	-	29.90	0.43	0.090	-
1113S000120930-D	8/3/1976	-	28.20	0.17	0.070	-
1113S000120935-D	8/3/1976	-	28.80	0.24	0.090	-
1113S000120940-D	8/3/1976	-	29.80	0.33	0.120	-
1113S000120945-D	8/3/1976	-	30.00	0.41	0.120	-
1113S000120950-D	8/3/1976	-	30.30	0.40	0.165	-

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
1113S000120955-D	8/3/1976	-	30.00	0.45	0.230	-
1113S000120915-D	8/4/1976	-	29.40	-	-	-
1113S000120920-D	8/4/1976	-	29.25	-	-	-
1113S000120925-D	8/4/1976	-	29.70	-	-	-
1113S000120930-D	8/4/1976	-	26.95	-	-	-
1113S000120935-D	8/4/1976	-	28.00	-	-	-
1113S000120940-D	8/4/1976	-	30.00	-	-	-
1113S000120945-D	8/4/1976	-	29.55	-	-	-
1113S000120950-D	8/4/1976	-	30.00	-	-	-
1113S000120955-D	8/4/1976	-	29.30	-	-	-
1113S000120960-D	8/4/1976	-	29.40	-	-	-
1113S000120965-D	8/4/1976	-	29.50	-	-	-
21FLA 27010102	1/18/1978	-	13.00	1.31	0.040	30
21FLA 27010103	1/18/1978	-	13.50	0.93	0.060	36
21FLA 27010104	1/18/1978	-	13.50	1.09	0.060	36
21FLA 27010105	1/18/1978	-	14.00	1.05	0.060	26
21FLA 27010150	1/18/1978	-	12.20	1.35	0.070	21
21FLA 27010103	9/10/1979	-	-	-	-	-
21FLA 27010104	9/10/1979	-	-	-	-	-
21FLA 27010105	9/10/1979	-	-	-	-	-
21FLA 27010102	10/15/1980	-	24.00	1.22	0.180	21
21FLA 27010103	10/15/1980	-	24.80	2.16	0.150	32
21FLA 27010104	10/15/1980	-	24.00	1.81	0.350	34
21FLA 27010105	10/15/1980	-	24.20	2.38	0.510	39
21FLA 27010150	10/15/1980	-	24.00	1.10	0.630	38
21FLA 27010102	11/13/1984	-	18.00	0.18	0.191	18
21FLA 27010103	11/13/1984	-	18.00	0.22	0.135	20
21FLA 27010104	11/13/1984	-	18.00	0.43	0.115	18
21FLA 27010105	11/13/1984	-	17.50	0.57	0.154	27
21FLA 27010150	11/13/1984	-	18.00	0.18	0.184	18
21FLA 27010102	11/4/1985	1.00	23.00	1.05	0.159	21
21FLA 27010103	11/4/1985	1.00	20.00	1.10	0.169	18
21FLA 27010104	11/4/1985	2.13	23.00	0.90	0.108	19
21FLA 27010105	11/4/1985	2.09	23.00	0.68	0.114	16
21FLA 27010150	11/4/1985	1.74	23.00	0.77	0.113	26
21FLA 27010102	3/31/1986	1.32	22.00	0.55	0.022	14
21FLA 27010103	3/31/1986	1.50	22.20	0.57	0.072	28
21FLA 27010104	3/31/1986	1.24	22.00	0.34	0.014	12

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010105	3/31/1986	2.99	22.00	0.96	0.038	15
21FLA 27010150	3/31/1986	1.61	22.50	0.28	0.142	23
21FLA 27010102	7/30/1986	5.34	31.00	0.79	0.040	23
21FLA 27010103	7/30/1986	4.81	30.00	0.71	0.131	23
21FLA 27010104	7/30/1986	5.34	32.00	0.65	0.448	31
21FLA 27010105	7/30/1986	8.25	32.00	0.73	0.046	21
21FLA 27010150	7/30/1986	9.34	31.00	0.90	0.059	27
21FLA 27010102	1/27/1987	2.67	12.50	0.37	0.416	14
21FLA 27010103	1/27/1987	1.00	10.00	0.43	0.603	16
21FLA 27010104	1/27/1987	1.34	12.30	0.46	0.285	20
21FLA 27010105	1/27/1987	1.62	12.50	0.42	0.558	15
21FLA 27010150	1/27/1987	2.70	12.90	0.36	0.193	17
21FLA 27010102	11/14/1990	-	21.00	-	-	11
21FLA 27010103	11/14/1990	-	21.00	-	-	17
21FLA 27010104	11/14/1990	-	20.50	-	-	18
21FLA 27010105	11/14/1990	-	21.00	-	-	14
21FLA 27010150	11/14/1990	-	20.50	-	0.190	11
21FLA 27010102	5/14/1991	-	24.20	-	0.125	21
21FLA 27010103	5/14/1991	-	24.00	-	0.246	60
21FLA 27010104	5/14/1991	-	25.50	-	0.122	36
21FLA 27010105	5/14/1991	-	25.80	-	0.122	21
21FLA 27010150	5/14/1991	-	24.00	-	0.100	18
21FLA 27010102	1/21/1992	-	12.50	0.94	0.100	29
21FLA 27010103	1/21/1992	-	13.00	0.85	0.120	32
21FLA 27010150	1/21/1992	-	12.50	0.95	0.088	14
21FLA 27010102	4/15/1992	-	24.00	0.55	0.050	19
21FLA 27010103	4/15/1992	-	22.00	0.53	0.050	29
21FLA 27010150	4/15/1992	-	22.00	0.49	0.050	13
21FLSJWMPALMC	5/28/1992	-	-	-	-	-
21FLA 27010102	7/20/1992	-	30.00	1.04	0.110	24
21FLA 27010103	7/20/1992	-	31.00	0.97	0.110	21
21FLA 27010150	7/20/1992	-	30.00	0.92	0.100	22
21FLA 27010102	10/21/1992	-	22.90	0.64	0.096	10
21FLA 27010103	10/21/1992	-	21.00	0.75	0.100	15
21FLA 27010150	10/21/1992	-	23.00	0.65	0.067	11
21FLA 27010102	1/19/1993	-	16.00	0.35	0.065	11
21FLA 27010103	1/19/1993	-	16.00	0.32	0.061	13
21FLA 27010150	1/19/1993	-	16.00	0.39	0.055	13

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010102	4/19/1993	-	22.00	0.34	0.044	17
21FLA 27010103	4/19/1993	-	22.00	0.42	0.074	24
21FLA 27010150	4/19/1993	-	22.00	0.35	0.045	21
21FLA 27010102	9/22/1993	-	30.00	0.50	0.081	29
21FLA 27010103	9/22/1993	-	30.00	0.59	0.076	42
21FLA 27010150	9/22/1993	-	30.00	0.45	0.067	35
21FLA 27010102	10/18/1993	-	-	0.68	0.084	28
21FLA 27010103	10/18/1993	-	-	0.66	0.094	29
21FLA 27010150	10/18/1993	-	-	0.60	0.078	27
21FLA 27010102	1/19/1994	-	10.30	0.42	0.072	18
21FLA 27010103	1/19/1994	-	11.00	0.43	0.074	15
21FLA 27010150	1/19/1994	-	9.70	0.35	0.069	18
21FLA 27010102	4/13/1994	-	25.70	0.60	0.052	14
21FLA 27010103	4/13/1994	-	26.30	0.70	0.058	14
21FLA 27010150	4/13/1994	-	25.70	0.54	0.058	14
21FLA 27010102	7/18/1994	-	31.40	0.50	0.091	16
21FLA 27010103	7/18/1994	-	31.70	0.76	0.170	29
21FLA 27010150	7/18/1994	-	31.00	0.43	0.069	16
21FLA 27010102	11/2/1994	-	22.30	0.81	0.075	11
21FLA 27010103	11/2/1994	-	22.90	0.86	0.110	8
21FLA 27010150	11/2/1994	-	22.70	0.68	0.072	9
21FLA 27010104	3/2/1995	-	17.80	0.33	0.080	38
21FLA 27010104	4/4/1995	-	20.10	0.38	0.041	10
21FLA 27010104	7/26/1995	-	30.68	0.78	0.130	2
21FLA 27010104	10/25/1995	-	24.90	0.98	0.100	22
21FLA 27010104	3/13/1996	-	-	0.50	0.063	-
21FLA 27010104	5/8/1996	-	28.00	0.70	0.100	19
21FLA 27010104	7/31/1996	-	30.76	0.89	0.160	65
21FLA 27010104	11/13/1996	-	18.50	0.39	0.074	24
21FLA 27010104	2/5/1997	-	17.60	0.56	0.067	16
21FLSJWMJXTR26	2/10/1997	3.20	16.40	0.27	0.062	14
21FLSJWMJXTR26	3/10/1997	1.00	22.10	0.38	0.030	41
21FLSJWMJXTR26	4/21/1997	1.00	22.00	0.27	0.106	36
21FLA 27010104	5/19/1997	-	27.10	-	-	21
21FLSJWMJXTR26	5/19/1997	1.00	27.40	0.50	0.098	49
21FLSJWMJXTR26	6/9/1997	1.00	24.90	0.91	0.229	9
21FLSJWMJXTR26	7/21/1997	1.00	30.70	0.50	0.107	15
21FLA 27010104	8/5/1997	-	29.50	-	-	13

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLSJWMJXTR26	8/18/1997	15.50	31.60	0.50	0.078	25
21FLSJWMJXTR26	9/8/1997	6.40	27.90	0.58	0.115	13
21FLSJWMJXTR26	10/13/1997	3.20	26.20	0.50	0.118	28
21FLSJWMJXTR26	11/10/1997	3.20	19.20	0.50	0.123	19
21FLA 27010104	11/18/1997	-	17.50	0.65	0.073	17
21FLSJWMJXTR26	12/8/1997	1.00	14.80	0.55	0.069	13
21FLSJWMJXTR26	1/12/1998	1.00	16.70	0.35	0.044	15
21FLSJWMJXTR26	2/9/1998	4.80	13.70	0.27	-	10
21FLA 27010104	2/11/1998	-	14.90	0.45	0.044	11
21FLSJWMJXTR26	3/16/1998	3.20	17.20	0.50	0.053	18
21FLSJWMJXTR26	4/13/1998	1.06	20.20	0.50	0.068	69
21FLSJWMJXTR26	5/11/1998	1.00	26.40	0.27	-	31
21FLA 27010104	6/3/1998	-	30.60	0.44	0.098	24
21FLSJWMJXTR26	6/8/1998	12.30	27.10	0.50	-	22
21FLSJWMJXTR26	7/13/1998	5.70	28.90	0.50	-	10
21FLSJWMJXTR26	8/10/1998	2.51	30.80	0.50	0.072	13
21FLA 27010104	9/14/1998	-	27.50	0.62	0.140	13
21FLSJWMJXTR26	9/14/1998	-	27.90	0.43	0.116	10
21FLSJWMJXTR26	10/12/1998	5.06	27.70	1.03	0.071	18
21FLSJWMJXTR26	11/9/1998	8.12	20.80	1.22	0.234	47
21FLSJWMJXTR26	12/28/1998	-	17.50	0.50	0.375	11
21FLSJWMJXTR26	1/11/1999	-	13.30	0.50	-	54
21FLSJWMJXTR26	2/8/1999	1.00	21.20	0.52	0.052	4
21FLSJWMJXTR26	3/22/1999	1.00	20.80	0.36	1.000	16
21FLSJWMJXTR26	4/19/1999	-	20.90	0.54	0.061	53
21FLSJWMJXTR26	5/24/1999	6.09	27.90	0.73	0.077	24
21FLSJWMJXTR26	6/21/1999	5.19	27.50	0.51	0.513	27
21FLSJWMJXTR26	7/12/1999	1.00	30.50	0.50	0.080	55
21FLSJWMJXTR26	8/9/1999	1.00	30.70	1.54	0.165	33
21FLSJWMJXTR26	9/13/1999	1.47	28.60	0.56	0.089	12
21FLSJWMJXTR26	10/11/1999	1.00	26.60	0.76	-	14
21FLSJWMJXTR26	11/8/1999	2.58	20.90	0.50	0.018	56
21FLSJWMJXTR26	12/13/1999	1.87	20.10	0.51	0.119	15
21FLSJWMJXTR26	1/10/2000	1.00	18.80	0.51	0.066	23
21FLSJWMJXTR26	2/28/2000	1.50	20.80	0.50	0.128	11
21FLSJWMJXTR26	3/13/2000	1.79	21.30	0.49	0.072	11
21FLSJWMJXTR26	4/10/2000	1.00	19.40	0.49	0.059	21
21FLSJWMJXTR26	5/8/2000	1.00	26.83	1.01	0.042	30

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLSJWMJXTR26	7/24/2000	-	29.90	0.49	0.062	33
21FLSJWMJXTR26	9/11/2000	-	28.20	0.49	0.107	30
21FLSJWMJXTR26	10/16/2000	-	22.40	0.49	0.054	34
21FLSJWMJXTR26	11/13/2000	-	21.60	0.51	0.063	23
21FLSJWMJXTR26	12/18/2000	4.09	18.10	0.51	0.052	17
21FLSJWMJXTR26	1/8/2001	-	12.00	0.50	0.069	21
21FLSJWMJXTR26	2/12/2001	2.66	15.80	-	0.036	48
21FLSJWMJXTR26	3/12/2001	2.16	18.70	0.30	0.044	44
21FLSJWMJXTR26	4/9/2001	7.73	25.10	0.61	0.056	45
21FLSJWMJXTR26	5/14/2001	5.57	27.50	0.68	0.060	51
21FLSJWMJXTR26	6/18/2001	9.40	29.90	0.83	0.055	36
21FLSJWMJXTR26	8/13/2001	18.73	31.00	0.08	0.130	50
21FLSJWMJXTR26	9/10/2001	15.20	29.90	0.09	0.124	16
21FLSJWMJXTR26	10/15/2001	8.27	25.80	1.02	0.082	38
21FLSJWMJXTR26	11/13/2001	3.87	20.70	0.49	0.083	7
21FLSJWMJXTR26	12/10/2001	6.67	23.70	0.64	0.099	60
21FLSJWMJXTR26	1/17/2002	2.74	16.00	0.31	0.069	14
21FLSJWMJXTR26	2/12/2002	3.98	18.40	0.33	0.072	56
21FLSJWMJXTR26	3/11/2002	2.48	21.70	0.47	0.095	26
21FLSJWMJXTR26	4/29/2002	2.77	27.20	0.52	0.105	27
21FLSJWMJXTR26	5/13/2002	5.32	29.30	0.61	0.136	36
21FLSJWMJXTR26	6/10/2002	3.81	28.40	0.43	0.139	44
21FLSJWMJXTR26	7/15/2002	8.81	32.00	1.05	0.169	41
21FLSJWMJXTR26	8/12/2002	8.93	28.90	0.63	0.160	5
21FLSJWMJXTR26	9/23/2002	11.26	29.80	0.74	0.148	29
21FLSJWMJXTR26	10/10/2002	8.03	29.10	0.53	0.122	63
21FLSJWMJXTR26	11/20/2002	5.63	18.50	0.36	0.101	30
21FLSJWMJXTR26	12/18/2002	-	16.10	0.36	0.062	19
21FLSJWMJXTR26	1/14/2003	1.00	13.00	0.42	0.060	41
21FLSJWMJXTR26	2/20/2003	2.97	17.40	0.30	0.088	23
21FLSJWMJXTR26	3/18/2003	4.74	21.10	0.70	0.107	8
21FLSJWMJXTR26	4/8/2003	26.70	25.21	1.03	0.125	36
21FLSJWMJXTR26	5/12/2003	11.61	29.40	0.68	0.142	29
21FLSJWMJXTR26	6/12/2003	6.79	30.50	0.50	0.133	44
21FLSJWMJXTR26	7/16/2003	5.87	27.08	0.38	0.126	34
21FLSJWMJXTR26	8/18/2003	17.54	30.70	0.97	0.144	16
21FLSJWMJXTR26	9/9/2003	5.31	25.20	0.40	0.092	11
21FLSJWMJXTR26	10/22/2003	6.96	25.11	0.66	0.120	7

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLSJWMJXTR26	11/11/2003	3.76	23.33	0.53	0.127	35
21FLSJWMJXTR26	12/9/2003	2.02	16.48	0.34	0.066	35
21FLSJWMJXTR26	1/8/2004	2.41	12.97	0.30	0.063	28
21FLSJWMJXTR26	2/16/2004	3.62	15.95	0.42	0.088	29
21FLSJWMJXTR26	3/23/2004	3.36	15.39	0.63	0.130	18
21FLSJWMJXTR26	4/15/2004	8.53	19.04	0.63	0.108	48
21FLSJWMJXTR26	5/25/2004	6.25	28.43	0.10	0.129	15
21FLSJWMJXTR26	6/14/2004	5.74	30.14	0.46	0.046	8
21FLSJWMJXTR26	7/27/2004	-	30.87	0.49	0.094	10
21FLSJWMJXTR26	8/18/2004	15.48	27.96	1.13	0.164	6
21FLSJWMJXTR26	10/19/2004	8.90	24.82	-	0.147	11
21FLSJWMJXTR26	11/22/2004	2.59	21.54	0.40	0.065	8
21FLSJWMJXTR26	12/29/2004	3.18	13.35	0.40	0.060	24
21FLSJWMJXTR26	1/11/2005	5.00	19.40	0.39	0.084	21
21FLA 27010102	1/25/2005	3.40	10.90	0.40	0.063	6
21FLA 27010103	1/25/2005	-	11.50	0.44	0.072	11
21FLA 27010104	1/25/2005	5.40	11.60	0.53	0.072	7
21FLA 27010105	1/25/2005	-	11.90	0.42	0.065	6
21FLA 27010150	1/25/2005	3.60	11.20	0.42	0.054	6
21FLSJWMJXTR26	2/9/2005	1.59	14.82	0.46	0.068	19
21FLSJWMJXTR26	3/24/2005	4.98	20.20	0.38	0.103	20
21FLSJWMJXTR26	4/20/2005	4.33	20.51	0.30	0.065	25
21FLA 27010102	4/25/2005	1.10	21.00	0.67	0.062	-
21FLA 27010103	4/25/2005	1.40	21.10	0.82	0.098	-
21FLA 27010104	4/25/2005	1.00	21.10	0.92	0.110	-
21FLA 27010105	4/25/2005	1.20	21.80	0.73	0.069	-
21FLA 27010150	4/25/2005	1.20	20.00	0.73	0.070	-
21FLSJWMJXTR26	5/16/2005	7.82	26.90	0.60	0.079	19
21FLA 27010102	5/25/2005	1.00	25.50	0.47	0.059	-
21FLA 27010103	5/25/2005	1.00	26.50	0.54	0.080	-
21FLA 27010104	5/25/2005	1.00	26.50	0.50	0.066	-
21FLA 27010105	5/25/2005	1.00	26.80	0.54	0.074	-
21FLA 27010150	5/25/2005	1.00	25.00	0.47	0.053	-
21FLSJWMJXTR26	6/9/2005	11.56	29.34	0.60	0.121	24
21FLSJWMJXTR26	7/25/2005	9.67	29.50	0.32	0.108	15
21FLA 27010102	7/26/2005	-	29.90	0.64	0.071	-
21FLA 27010103	7/26/2005	12.00	30.10	0.59	0.069	-
21FLA 27010104	7/26/2005	8.30	30.10	0.69	0.078	-

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010105	7/26/2005	12.00	30.40	0.98	0.100	-
21FLA 27010150	7/26/2005	12.00	30.40	0.65	0.077	-
21FLSJWMJXTR26	8/9/2005	-	30.58	0.36	0.116	12
21FLSJWMJXTR26	9/14/2005	12.18	27.21	0.63	0.118	14
21FLA 27010102	10/25/2005	4.10	20.86	1.14	0.078	-
21FLA 27010103	10/25/2005	4.50	21.12	0.62	0.130	-
21FLA 27010104	10/25/2005	-	21.42	0.81	0.078	-
21FLA 27010105	10/25/2005	3.30	22.11	0.90	0.084	-
21FLA 27010150	10/25/2005	3.30	21.01	0.78	0.083	-
21FLSJWMJXTR26	11/3/2005	4.30	21.89	0.53	0.084	12
21FLSJWMJXTR26	11/28/2005	4.63	19.60	0.41	0.085	10
21FLA 27010102	12/27/2005	1.00	12.90	-	-	-
21FLA 27010103	12/27/2005	1.00	13.20	-	-	-
21FLA 27010104	12/27/2005	1.00	13.40	-	-	-
21FLA 27010105	12/27/2005	1.00	13.60	-	-	-
21FLA 27010150	12/27/2005	1.00	13.10	-	-	-
21FLSJWMJXTR26	12/27/2005	7.64	13.11	0.50	0.080	12
21FLSJWMJXTR26	1/31/2006	3.98	17.30	0.18	0.061	21
21FLSJWMJXTR26	2/22/2006	7.34	18.13	0.37	0.072	16
21FLSJWMJXTR26	3/30/2006	5.50	19.57	0.33	0.083	22
21FLSJWMJXTR26	4/27/2006	2.94	26.49	0.31	0.096	29
21FLSJWMJXTR26	5/22/2006	3.70	26.76	0.43	0.087	23
21FLSJWMJXTR26	6/21/2006	4.19	29.08	0.40	0.087	20
21FLSJWMJXTR26	7/13/2006	2.84	29.63	0.62	0.113	60
21FLSJWMJXTR26	8/29/2006	5.37	30.47	0.59	0.097	13
21FLSJWMJXTR26	9/18/2006	4.17	28.86	0.58	0.084	17
21FLSJWMJXTR26	11/1/2006	4.76	22.45	0.42	0.069	24
21FLSJWMJXTR26	11/28/2006	3.18	18.67	0.30	0.057	17
21FLSJWMJXTR26	12/19/2006	1.96	19.42	0.30	0.100	18
21FLSJWMJXTR26	1/29/2007	2.94	-	0.30	0.064	21
21FLSJWMJXTR26	2/12/2007	8.54	15.60	0.55	0.054	14
21FLSJWMJXTR26	3/27/2007	4.94	24.08	0.46	0.069	24
21FLSJWMJXTR26	4/25/2007	3.77	23.81	0.58	0.085	25
21FLSJWMJXTR26	5/21/2007	4.37	24.69	0.47	0.089	21
21FLSJWMJXTR26	6/25/2007	5.01	30.36	0.37	0.072	33
21FLSJWMJXTR26	7/18/2007	4.51	29.81	0.72	0.095	23
21FLSJWMJXTR26	8/27/2007	7.74	31.03	0.52	0.156	32
21FLSJWMJXTR26	9/26/2007	12.64	-	-	0.186	17

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLSJWMJXTR26	11/5/2007	5.38	21.10	0.61	0.101	20
21FLSJWMJXTR26	11/26/2007	4.49	21.12	0.37	0.051	14
21FLSJWMJXTR26	12/19/2007	2.18	15.23	0.31	0.065	22
21FLSJWMJXTR26	1/28/2008	1.69	13.28	0.31	0.153	17
21FLSJWMJXTR26	2/26/2008	7.30	21.12	0.53	0.369	19
21FLSJWMJXTR26	3/17/2008	8.50	20.77	0.50	0.094	27
21FLSJWMJXTR26	4/21/2008	4.09	22.27	0.41	0.128	24
21FLSJWMJXTR26	5/14/2008	4.81	23.45	0.31	0.134	23
21FLSJWMJXTR26	6/18/2008	10.01	30.15	0.57	0.131	38
21FLSJWMJXTR26	7/22/2008	5.07	30.05	0.54	0.163	11
21FLSJWMJXTR26	8/25/2008	1.16	26.52	0.93	0.180	5
21FLSJWMJXTR26	9/18/2008	7.16	28.91	0.76	0.221	18
21FLSJWMJXTR26	10/29/2008	4.01	18.12	0.44	0.311	5
21FLSJWMJXTR26	11/11/2008	4.41	19.85	0.36	0.210	25
21FLSJWMJXTR26	12/10/2008	3.92	17.45	0.30	0.076	30
21FLA 27010103	1/14/2009	2.10	16.00	0.48	0.034	46
21FLA 27010105	1/14/2009	2.20	15.81	0.49	0.033	44
21FLA 27010150	1/14/2009	2.60	16.00	0.50	0.036	40
21FLSJWMJXTR26	1/28/2009	3.69	16.64	0.31	0.096	7
21FLSJWMJXTR26	2/25/2009	2.80	15.26	0.34	0.054	10
21FLA 27010103	3/16/2009	-	23.15	-	-	-
21FLA 27010105	3/16/2009	-	23.58	-	-	-
21FLA 27010150	3/16/2009	-	22.88	-	-	-
21FLSJWMJXTR26	3/19/2009	2.86	21.00	0.32	0.062	16
21FLSJWMJXTR26	4/15/2009	2.51	22.28	0.66	0.104	10
21FLA 27010103	4/16/2009	5.00	23.00	0.70	0.063	21
21FLA 27010105	4/16/2009	4.20	23.09	0.80	0.068	17
21FLA 27010150	4/16/2009	4.80	22.60	0.71	0.055	29
21FLSJWMJXTR26	5/11/2009	5.82	28.92	0.64	0.089	21
21FLSJWMJXTR26	6/9/2009	13.82	26.97	1.42	0.242	27
21FLA 27010103	6/17/2009	-	29.63	-	-	-
21FLA 27010105	6/17/2009	-	29.52	-	-	-
21FLA 27010150	6/17/2009	-	29.01	-	-	-
21FLSJWMJXTR26	7/13/2009	6.46	28.94	0.63	0.096	8
21FLA 27010103	7/22/2009	14.00	29.20	0.69	0.081	16
21FLA 27010105	7/22/2009	21.00	29.60	0.92	0.120	20
21FLA 27010150	7/22/2009	11.00	28.90	0.65	0.074	29
21FLA 27010103	7/27/2009	-	29.20	-	-	-

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010105	7/27/2009	-	29.50	-	-	-
21FLA 27010150	7/27/2009	-	29.20	-	-	-
21FLSJWMJXTR26	8/10/2009	2.32	30.21	1.10	0.131	19
21FLSJWMJXTR26	9/28/2009	15.01	29.60	0.97	0.218	17
21FLSJWMJXTR26	10/15/2009	3.54	28.04	0.40	0.119	21
21FLA 27010103	10/27/2009	6.50	24.90	0.55	0.050	19
21FLA 27010105	10/27/2009	4.20	25.00	0.52	0.052	20
21FLA 27010150	10/27/2009	3.80	24.80	0.54	0.045	23
21FLSJWMJXTR26	11/24/2009	1.63	21.43	0.46	0.130	31
21FLSJWMJXTR26	12/28/2009	3.51	15.35	0.37	0.098	46
21FLA 27010103	12/29/2009	-	13.40	-	-	-
21FLA 27010105	12/29/2009	-	14.41	-	-	-
21FLA 27010150	12/29/2009	-	13.60	-	-	-
21FLSJWMJXTR26	1/20/2010	8.32	14.50	0.34	0.100	20
21FLSJWMJXTR26	2/23/2010	5.87	15.87	0.56	0.079	14
21FLSJWMJXTR26	3/24/2010	11.64	17.53	0.58	0.097	15
21FLA 27010103	3/30/2010	-	19.30	-	-	-
21FLA 27010105	3/30/2010	-	19.50	-	-	-
21FLA 27010150	3/30/2010	-	19.30	-	-	-
21FLSJWMJXTR26	4/22/2010	5.39	22.91	0.49	0.136	22
21FLSJWMJXTR26	5/27/2010	4.53	27.29	0.39	0.102	16
21FLSJWMJXTR26	6/24/2010	9.53	31.57	0.48	0.129	17
21FLSJWMJXTR26	7/27/2010	27.98	32.50	0.80	0.132	62
21FLSJWMJXTR26	8/25/2010	20.44	29.96	0.60	0.135	70
21FLSJWMJXTR26	9/22/2010	7.80	28.70	0.51	0.103	70
21FLSJWMJXTR26	10/25/2010	7.26	24.68	0.49	0.103	80
21FLSJWMJXTR26	11/18/2010	5.63	20.22	0.32	0.087	50
21FLSJWMJXTR26	12/29/2010	2.40	8.72	0.30	0.050	55
21FLSJWMJXTR26	1/20/2011	3.36	13.26	0.25	0.046	48
21FLSJWMJXTR26	2/17/2011	6.09	14.36	0.46	0.097	58
21FLSJWMJXTR26	3/16/2011	4.42	19.58	0.40	0.073	58
21FLA 27010102	3/29/2011	3.90	19.64	0.35	0.038	-
21FLSJWMJXTR26	4/6/2011	9.35	21.90	0.58	0.119	60
21FLA 27010102	5/5/2011	7.80	25.23	0.39	0.072	-
21FLSJWMJXTR26	5/23/2011	5.53	28.36	0.35	0.086	70
21FLSJWMJXTR26	6/20/2011	7.48	29.39	0.20	0.050	50
21FLSJWMJXTR26	7/21/2011	5.94	29.85	0.46	0.062	39
21FLSJWMJXTR26	8/18/2011	5.75	30.45	0.51	0.092	50

Station	Sample Date	CHLAC (µg/L)	Temp (°C)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
21FLA 27010102	8/30/2011	7.80	29.78	0.57	0.066	-
21FLSJWMJXTR26	9/21/2011	8.81	28.55	0.44	0.085	
21FLSJWMJXTR26	10/20/2011	8.0367	24.01	0.8926	0.1029	18
21FLSJWMJXTR26	11/21/2011	9.612	21.385	0.4332	0.0646	19.1
21FLSJWMJXTR26	12/13/2011	4.9395	18.085	0.3275	0.0585	21
21FLA 27010102	12/19/2011	6.40	17.24	0.62	0.054	-
21FLSJWMJXTR26	1/19/2012	2.2428	15.835	0.366	0.0892	-
21FLA 27010102	1/31/2012	3.70	16.90	0.29	0.033	-
21FLSJWMJXTR26	2/28/2012	6.7017	-	0.3903	0.0818	13.3
21FLSJWMJXTR26	3/27/2012	5.9007	23.48	0.4673	0.088	15.9
21FLSJWMJXTR26	4/26/2012	6.6483	-	0.4191	0.0853	27
21FLSJWMJXTR26	5/31/2012	9.3717	27.105	0.4325	0.075	25.7

Appendix C: LSPC Modeling Methodology, Daytona Watershed

An LSPC model was utilized to estimate the nutrient loads within and discharge from the Daytona watershed, including loads from the Guana, Pellicer, and Tomoka Rivers.

LSPC is a watershed modeling system that includes streamlined Hydrological Simulation Program–Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality, as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by EPA Region 3 (under contract with Tetra Tech) and has been widely used for the development of TMDLs. In 2003, EPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the EPA TMDL Modeling Toolbox. It was used to simulate runoff (flow, BOD, TN, TP, and DO) from the land surface using a daily timestep for current and natural conditions. LSPC provided tributary flows and temperature to the Environmental Fluid Dynamics Code (EFDC) estuary models and tributary water quality concentrations to Water Quality Analysis Simulation Program 7 (WASP7) estuary models.

To evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of subwatersheds for each of the models. The subwatersheds for the Daytona Watershed model were developed using the 12-digit hydrologic unit code (HUC 12) watershed data layer and the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) (**Figure C.1**).

The LSPC model has a representative reach defined for each subwatershed, and the main channel stem within each subwatershed was used as the representative reach. The characteristics for each reach included the length and slope of the reach, the channel geometry and the connectivity between the subwatersheds. Length and slope data for each reach were obtained using the USGS Digital Elevation Model (DEM) and NHD data.

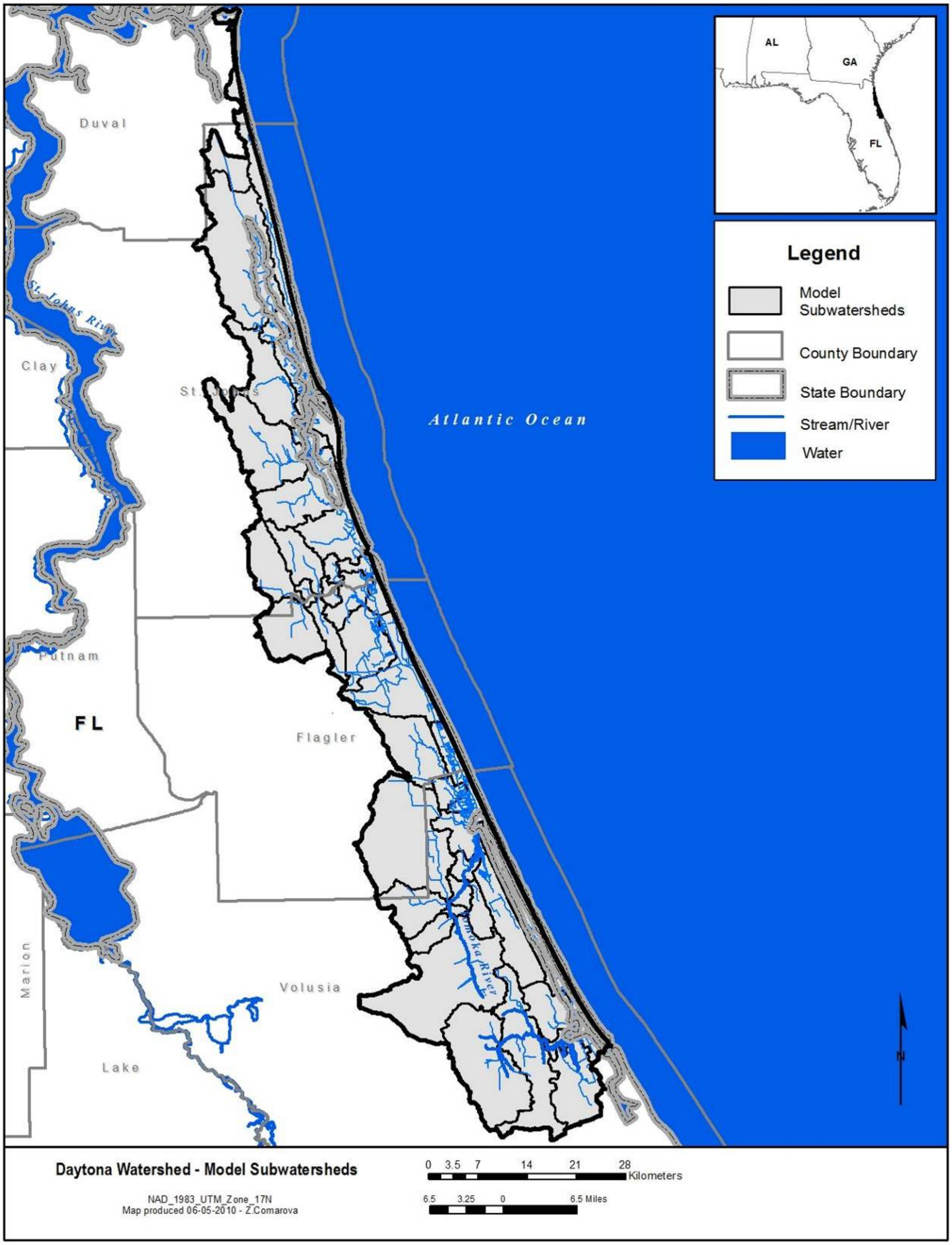

Figure C.1. LSPC Subwatershed Boundaries for the Daytona Watershed

The attributes supplied for each reach were used to develop a function table (FTABLE) that describes the hydrology of the stream reach by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. The assumption of a fixed depth, area, volume, outflow relationship rules out cases where the flow reverses direction or where one reach influences another upstream reach in a time-dependent way.

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loadings. The Department's Level III Florida land use, specifically the SJRWMD 2004 dataset, was used to determine the land use representation. The National Land Cover Dataset (NLCD) was used to develop the impervious land use representations.

The SJRWMD coverage utilized a variety of land use classes that were grouped and reclassified into 18 land use categories, as follows: beaches/dune/mud, open water, utility swaths, developed open space, developed low intensity, developed medium intensity, developed high intensity, clear-cut/sparse, quarries/strip mines, deciduous forest, evergreen forest, mixed forest, golf courses, pasture, row crop, forested wetland, nonforested wetland (salt/brackish), and nonforested wetland (freshwater). The LSPC model requires the division of land uses in each subwatershed into separate pervious and impervious land units. The NLCD 2006 percent impervious coverage was used to determine the percent impervious area associated with each land use category. Any impervious areas associated with utility swaths, developed open space, and developed low intensity were grouped together and placed into a new land use category named *low intensity development impervious*. Impervious areas associated with medium-development and high-intensity development were kept separate and placed into two new categories for *medium-intensity development impervious and high-intensity development impervious*, respectively. Finally, any impervious areas not already accounted for in the three developed impervious categories were grouped together into a fourth new category for all remaining impervious land use (**Figure C.2**).

Soil data for the Florida watersheds was obtained from the SSURGO database produced and distributed by the USDA–NRCS. The SSURGO data were used to determine the total area that each hydrologic soil group covered within each subwatershed. The subwatersheds were represented by the hydrologic soil group that had the highest percentage of coverage within the boundaries of the subwatershed. There dominant soil groups in Daytona are D and D-type soils (B/D), which have a high water table due to characteristics such as slow infiltration rates or shallow soils over an impervious layer (**Figure C.3**).

Facilities permitted under the NPDES Program are, by definition, considered point sources. The NPDES GIS coverages provided by the Department were adopted as the starting point for the evaluation of point sources for the Florida watershed models and reflected discharges as of December 2009. In areas where data were incomplete, data from the EPA Permit Compliance System (PCS) were used. Following data collection, any remaining gaps in the data of three months or less were filled by averaging data from before and after gap months. If the gaps in the data were larger than three months, the long-term average was supplied. Stormwater discharges, such as MS4s, were not input directly into the model but were assumed to be included in the urban land use loading. Point sources that were designated as reuse facilities were not input directly into the model but were accounted for in the adjustment of the hydrologic calibration parameters. **Figure C.4** shows the point sources directly discharging to the Daytona Watershed that were included in the watershed model.

In the watershed model, nonpoint source loadings and hydrologic conditions are dependent on weather conditions. Hourly data from weather stations within the boundaries of, or close to, the subwatersheds were applied to the watershed model. A weather data forcing file was generated in ASCII format (*.air) for each meteorological station used in the hydrologic evaluations in LSPC. Each meteorological station file contained atmospheric data used in modeling the hydrologic processes. These data included precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data were used directly, or calculated from the observed data. The Daytona Watershed model weather stations contained data from 1996 through 2009. **Table C.1** lists the meteorological stations used in the model.

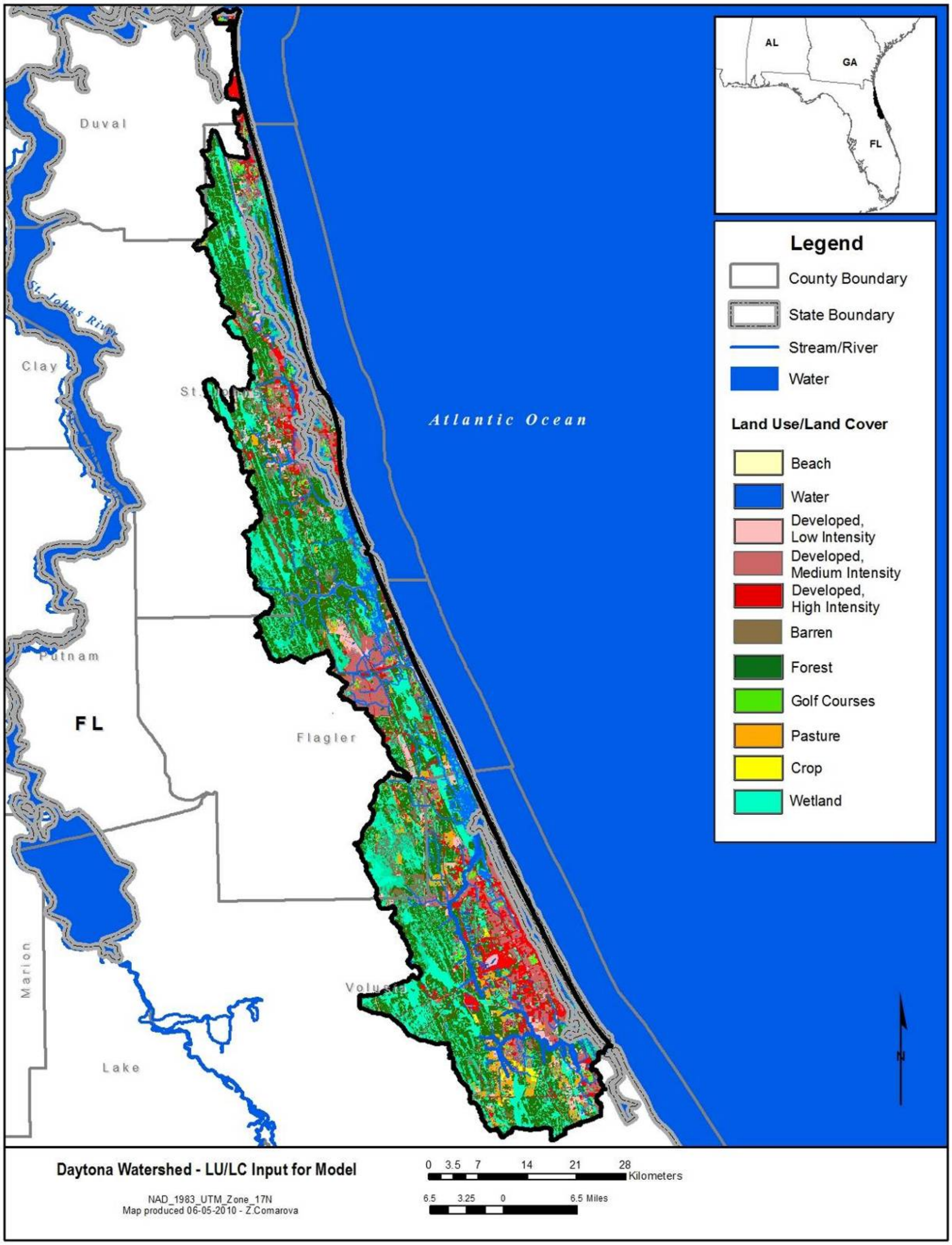

Figure C.2. Reclassified SJRWMD 2004 Land Use Coverage of the Daytona Watershed

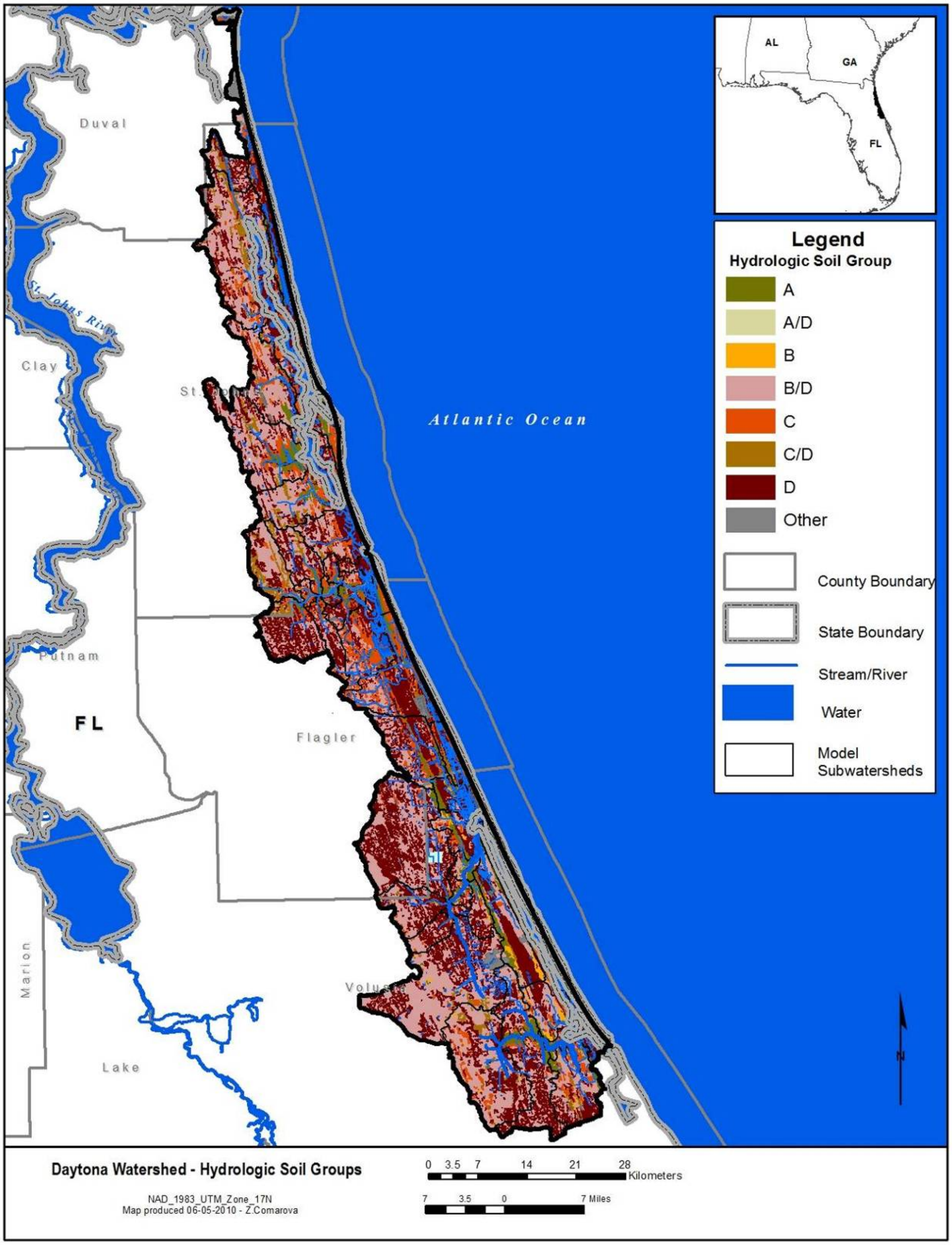

Figure C.3. Hydrologic Soil Groups for the Daytona Watershed

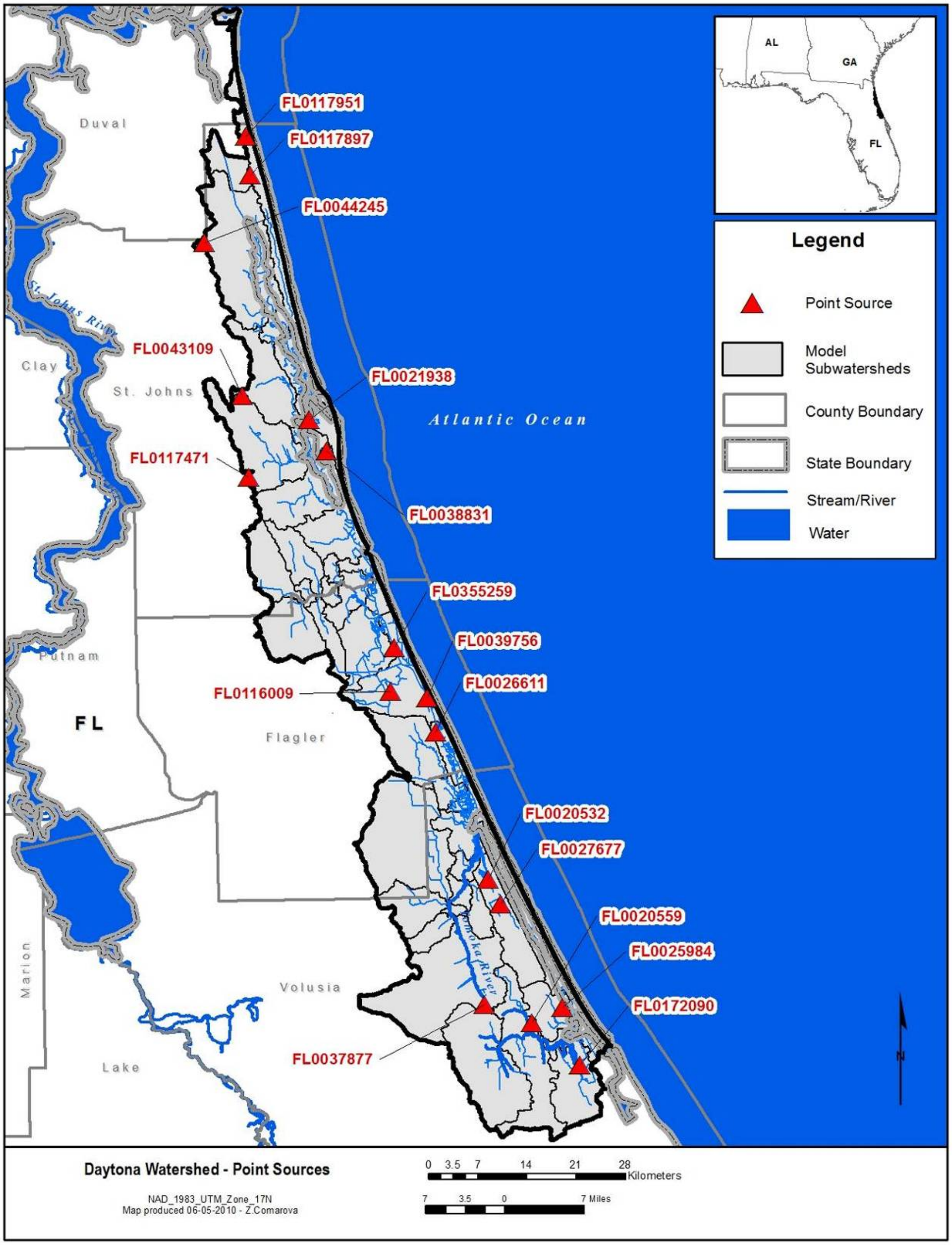

Figure C.4. Point Sources Included in the Daytona Watershed Model

Table C.1. Meteorological Stations used in the Daytona Watershed Model

Station ID	LSPC ID	Station Name	Elevation	County	Latitude	Longitude
082150	1	Daytona Beach	29	Volusia, FL	29.1903	-81.0636
082158	2	Daytona Beach Intl Airport	31	Volusia, FL	29.1828	-81.0483
084366	3	Jacksonville Beach	10	Duval, FL	30.2900	-81.3922
086767	4	Palm Coast 6 NE	5	Flagler, FL	29.6347	-81.2061
087826	5	St. Augustine Lighthouse	12	St. Johns FL	29.8875	-81.2917

The calibration of the LSPC watershed hydrology model involved comparing simulated stream flows with the USGS flow stations. The calibration of the hydrologic parameters was performed from January 1, 1997, through December 31, 2009. The best available gages were used as hydrology calibration stations.

LSPC's algorithms are identical to those in HSPF. The LSPC/HSPF modules used to represent watershed hydrology include PWATER (water budget simulation for pervious land units) and IWATER (water budget simulation for impervious land units). A detailed description of relevant hydrological algorithms is presented in the *HSPF Version 12 User's Manual* (Bicknell *et al.* 2004).

Calibration parameters were adjusted within the *BASINS Technical Note 6* (EPA 2000) typical minimum and maximum ranges for both hydrologic soil group and land use. Parameters were not adjusted outside the possible minimum and maximum ranges. To calibrate, information on the watersheds' topography, geology, climate, land use, and anthropogenic influences was researched. Parameters were adjusted within reasonable constraints until an acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted included evapotranspiration, infiltration, upper and lower zone storage, ground water storage, losses to the deep ground water system, and Manning's roughness coefficient "n."

A rating system was applied to the calibration and validations stations to determine the overall calibration success. A weighted score was assigned to simulated versus observed errors, with total flow, storm flow, and low flow volumes having the greatest weight. The summation of the weighted scores was assigned a qualitative descriptor of Very Good (VG), Good (G), Fair (F), or Poor (P). The highest possible score was 80 and the lowest possible score was 20. Scores from 80 to 76 were rated as VG, 75 to 56 G, 55 to 36 F, and 35 to 20 P.

Figures C.5 through **C.10** and **Tables C.2** and **C.3** present the hydrologic calibration results.

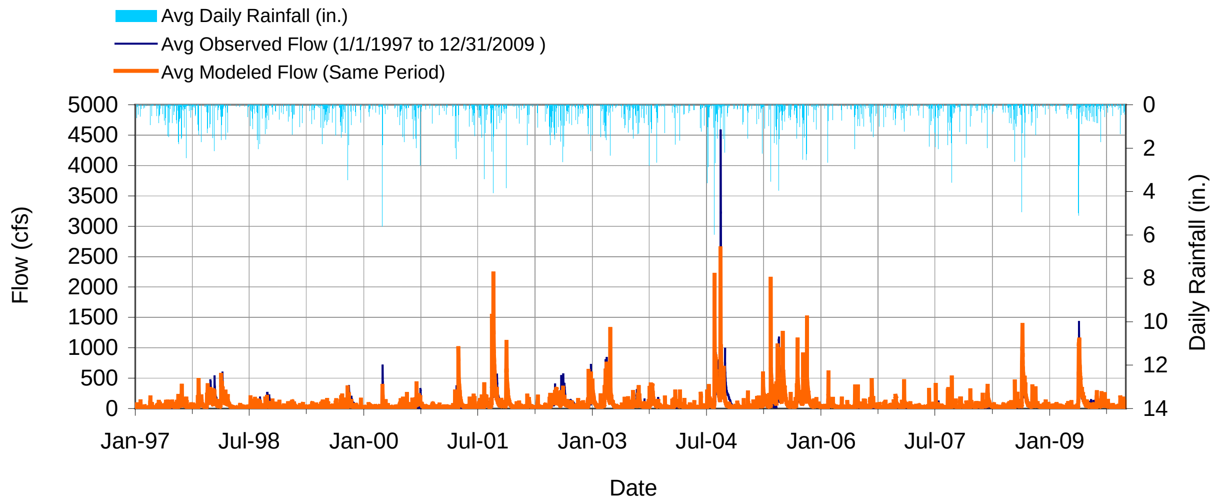

Figure C.5. Mean Daily Flow: Model Outlet 120015 versus USGS 02247510 Tomoka River near Holly Hill, FL

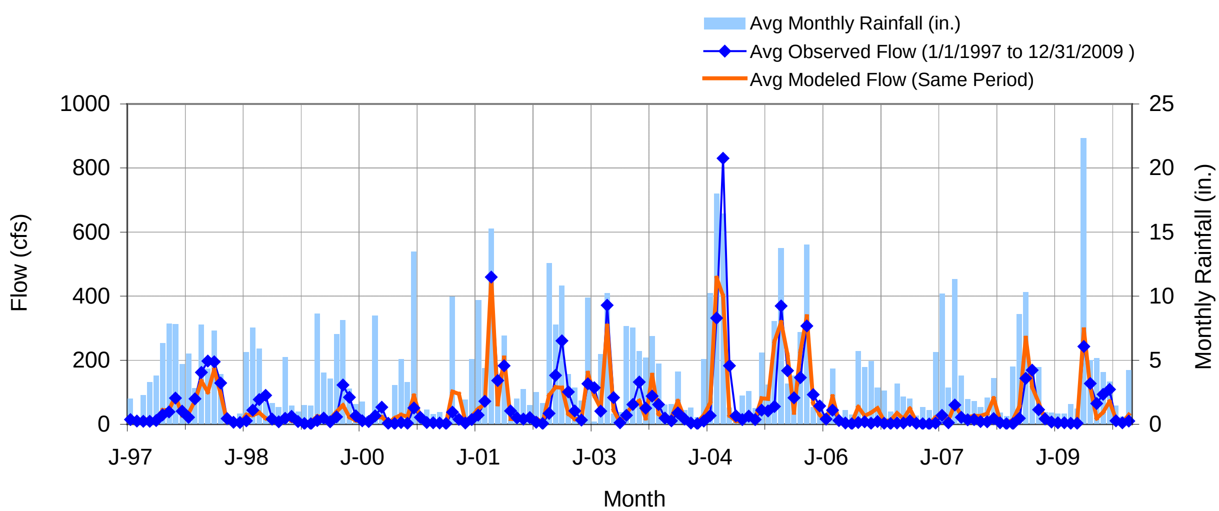

Figure C.6. Mean Monthly Flow: Model Outlet 120015 versus USGS 02247510 Tomoka River near Holly Hill, FL

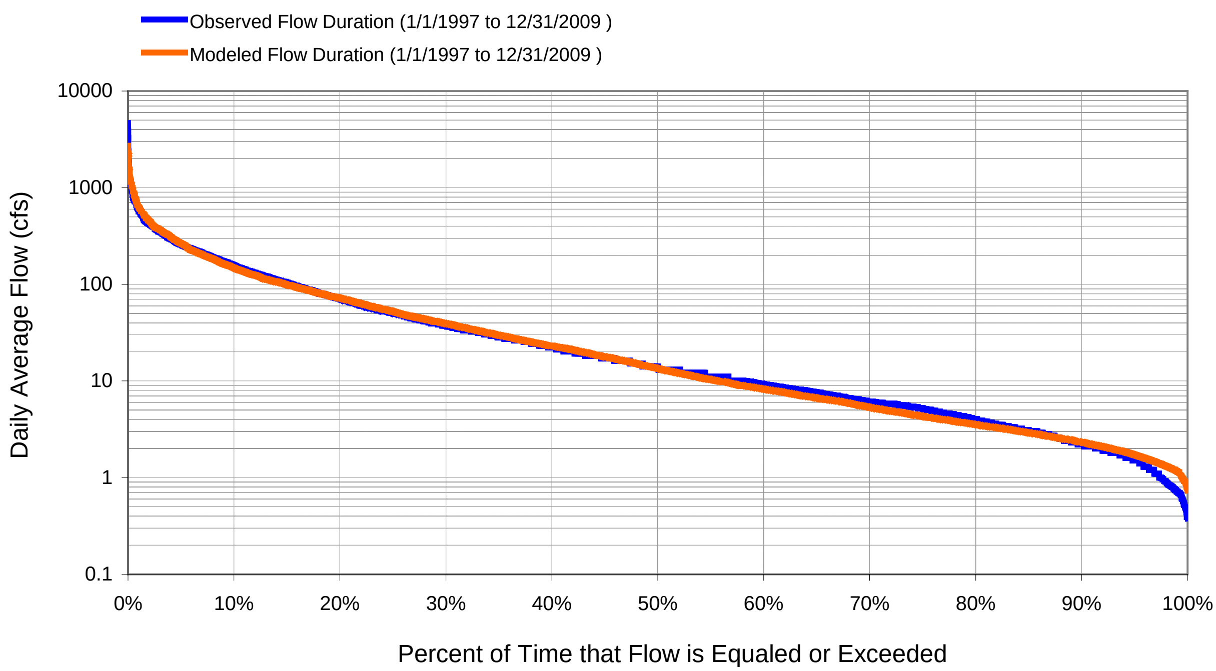

Figure C.7. Flow Exceedance: Model Outlet 120015 versus USGS 02247510 Tomoka River near Holly Hill, FL

Table C.2. Summary Statistics: Model Outlet 120015 versus USGS 02247510 Tomoka River near Holly Hill, FL

LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 120015 13-Year Analysis Period: 1/1/1997 - 12/31/2009 Flow volumes are (inches/year) for upstream drainage area		USGS 02247510 TOMOKA RIVER NEAR HOLLY HILL, FL Hydrologic Unit Code: 3080201 Latitude: 29.21748099 Longitude: -81.1086687 Drainage Area (sq-mi): 76.8		
Total Simulated In-stream Flow:	**10.09**	Total Observed In-stream Flow:		**10.20**
Total of simulated highest 10% flows:	**6.16**	Total of Observed highest 10% flows:		**6.14**
Total of Simulated lowest 50% flows:	**0.45**	Total of Observed Lowest 50% flows:		**0.50**
Simulated Summer Flow Volume (months 7-9):	**4.15**	Observed Summer Flow Volume (7-9):		**4.56**
Simulated Fall Flow Volume (months 10-12):	**2.11**	Observed Fall Flow Volume (10-12):		**2.51**
Simulated Winter Flow Volume (months 1-3):	**1.86**	Observed Winter Flow Volume (1-3):		**1.76**
Simulated Spring Flow Volume (months 4-6):	**1.97**	Observed Spring Flow Volume (4-6):		**1.38**
Total Simulated Storm Volume:	**4.22**	Total Observed Storm Volume:		**2.95**
Simulated Summer Storm Volume (7-9):	**1.76**	Observed Summer Storm Volume (7-9):		**1.44**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	*Score*	
Error in total volume:	-1.07	10	16	
Error in 50% lowest flows:	**-10.09**	10	9	
Error in 10% highest flows:	0.20	15	12	
Seasonal volume error - Summer:	-8.89	30	8	
Seasonal volume error - Fall:	-15.90	30	8	
Seasonal volume error - Winter:	5.81	30	8	
Seasonal volume error - Spring:	**42.90**	30	4	
Error in storm volumes:	**43.01**	20	1	
Error in summer storm volumes:	22.56	50	4	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.250	Total Score	70	
Baseline adjusted coefficient (Garrick), E':	0.362	Rating	G	

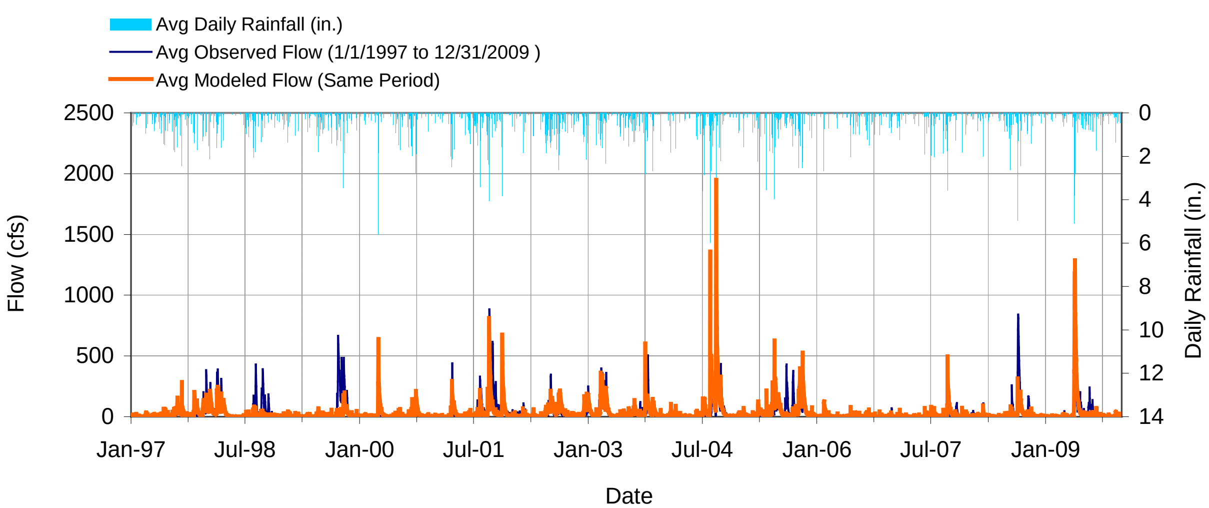

Figure C.8. Mean Daily Flow: Model Outlet 120007 versus USGS 02248000 Spruce Creek near Samsula, FL

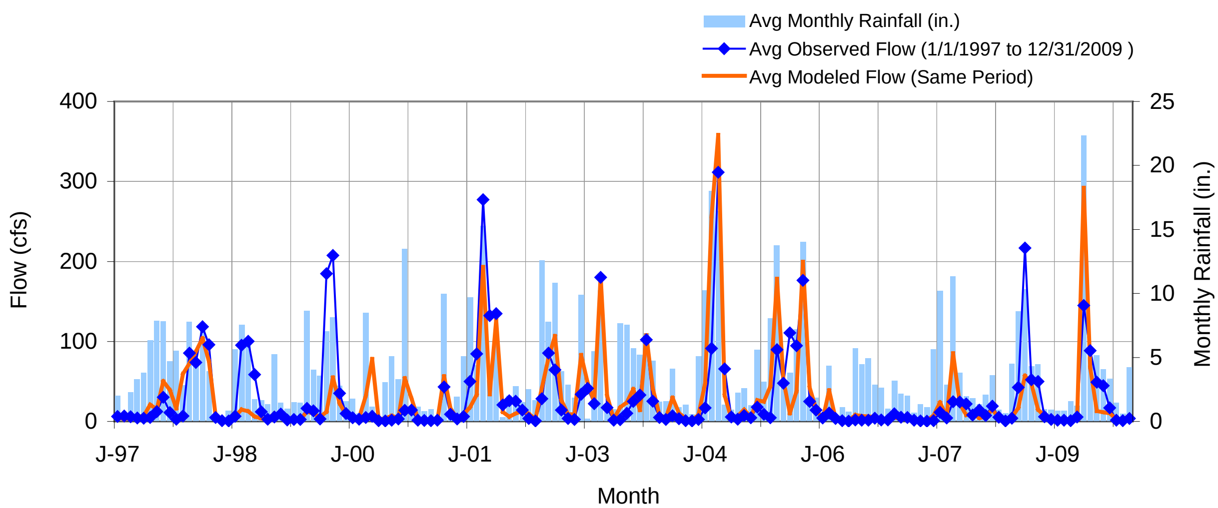

Figure C.9. Mean Monthly Flow: Model Outlet 120007 versus USGS 02248000 Spruce Creek near Samsula, FL

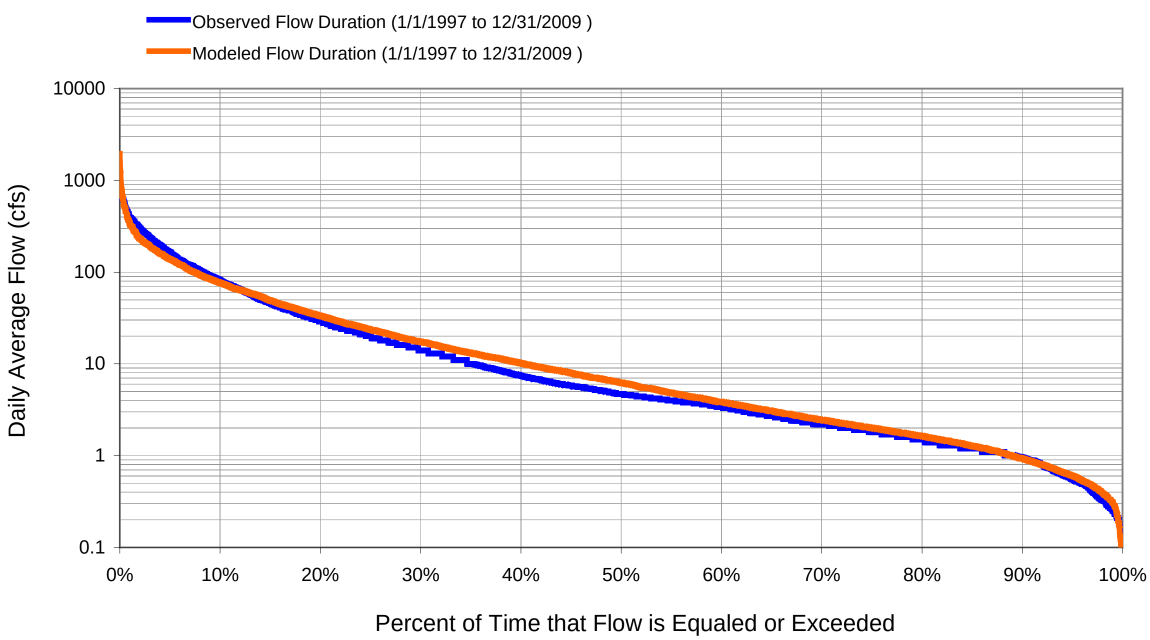

Figure C.10. Flow Exceedance: Model Outlet 120007 versus USGS 02248000 Spruce Creek near Samsula, FL

Table C.3. Summary Statistics: Model Outlet 120007 versus USGS 02248000 Spruce Creek near Samsula, FL

LSPC Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM SUBBASIN 120007 13-Year Analysis Period: 1/1/1997 - 12/31/2009 Flow volumes are (inches/year) for upstream drainage area		USGS 02248000 SPRUCE CREEK NEAR SAMSULA, FL Hydrologic Unit Code: 3080201 Latitude: 29.05081845 Longitude: -81.0464455 Drainage Area (sq-mi): 33.4	
Total Simulated In-stream Flow:	**12.29**	Total Observed In-stream Flow:	**12.73**
Total of simulated highest 10% flows:	**7.88**	Total of Observed highest 10% flows:	**8.83**
Total of Simulated lowest 50% flows:	**0.48**	Total of Observed Lowest 50% flows:	**0.42**
Simulated Summer Flow Volume (months 7-9):	**4.75**	Observed Summer Flow Volume (7-9):	**5.91**
Simulated Fall Flow Volume (months 10-12):	**2.89**	Observed Fall Flow Volume (10-12):	**3.48**
Simulated Winter Flow Volume (months 1-3):	**2.23**	Observed Winter Flow Volume (1-3):	**2.09**
Simulated Spring Flow Volume (months 4-6):	**2.43**	Observed Spring Flow Volume (4-6):	**1.25**
Total Simulated Storm Volume:	**4.12**	Total Observed Storm Volume:	**4.58**
Simulated Summer Storm Volume (7-9):	**1.71**	Observed Summer Storm Volume (7-9):	**2.10**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	*S core*	
Error in total volume:	-3.47	10	16	
Error in 50% lowest flows:	**15.18**	10	6	
Error in 10% highest flows:	-10.82	15	12	
Seasonal volume error - Summer:	-19.67	30	8	
Seasonal volume error - Fall:	-17.12	30	8	
Seasonal volume error - Winter:	6.64	30	8	
Seasonal volume error - Spring:	**93.90**	30	2	
Error in storm volumes:	-10.05	20	4	
Error in summer storm volumes:	-18.54	50	4	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.227	Total Score	68	
Baseline adjusted coefficient (Garrick), E':	0.404	Rating	G	

The calibration of the LSPC water quality model involved comparing simulated water quality concentration and loads with the measured water quality concentrations and loads. The calibration of the water quality parameters was performed from January 1, 1997, through December 31, 2009. Water quality stations used for model calibration were co-located with hydrology stations used for model calibration.

LSPC models water quality parameters by using algorithms identical to those in HSPF. The LSPC/HSPF modules used to represent water temperature include PSTEMP (soil temperature) and HTRCH (heat exchange and water temperature). The LSPC/HSPF modules used to represent DO include PWTGAS (pervious water temperature and dissolved gas concentrations), IWTGAS (impervious water temperature and dissolved gas concentrations), and OXRX (primary DO and BOD balances). The LSPC/HSPF modules used to represent sediment include SEDMNT (pervious production and removal of sediment), SOLIDS (accumulation and removal of solids), and SEDTRN (behavior of inorganic sediment). The LSPC/HSPF module used to represent nutrients was GQUAL. A detailed description of relevant temperature algorithms is presented in the *HSPF Version 12 User's Manual* (Bicknell *et al.* 2004).

Initial water quality parameters were based on previous modeling efforts in the Chattahoochee and Flint River Basins along with information in the *BASINS Technical Note 8* (EPA 2006) and Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (EPA 1985). Information on TN and TP loading and application rates for specific land uses was used to determine initial TN and TP accumulation rates and interflow and ground water concentrations. Water quality parameters were adjusted within accepted minimum and maximum ranges for each hydrologic soil group, land use, and reach group.

Temperature, DO, and BOD were calibrated simultaneously because the DO algorithms require water temperature, and the DO and BOD algorithms are interrelated. Temperature was calibrated by adjusting surface and interflow temperature slopes and intercepts, ground water temperature, and radiation coefficients until the simulated data closely matched the observed data. Following temperature calibration, DO and BOD were calibrated by adjusting reaeration, DO interflow and ground water concentration, BOD decay rate, BOD settling rate, and benthic oxygen demand. Sediment was calibrated by adjusting detachment, scour, and buildup/washoff coefficients. The nutrient constituents were modeled by buildup/washoff and assigning land use associated concentrations in ground water and interflow. Adjustments were made to monthly accumulation rate, monthly storage limit, interflow concentration, and ground water concentration for TN and TP until the simulated data were in range with the observed field data.

Both visual and statistical metrics were utilized during calibration. Visual calibration was accomplished by matching the trends in the measured water quality concentration data. Loading metrics, including annual loading percent error, were utilized for statistical calibration. Annual loading was only analyzed when two or more water quality samples were taken in a given year, and measured flow data were collected that year. If no measured flow data were collected but the contributing area of the water quality station had similar land uses and soil types as the contributing area of a neighboring hydrology station, weighted measured flow was used to calculate the loadings. A rating system was applied to the percent error of the average annual loadings at the calibration and validation stations to determine the overall calibration success. The average annual loading percent error was assigned a qualitative descriptor of Very Good (VG), Good (G), Fair (F), or Poor (P). Scores from ±0-40% were rated as VG, ±40 to 90% G, ±90 to 150% F, and ±150 to 500% P.

Figures C.11 through **C.22** and **Tables C.4** through **C.7** present nutrient concentration and loading calibration results.

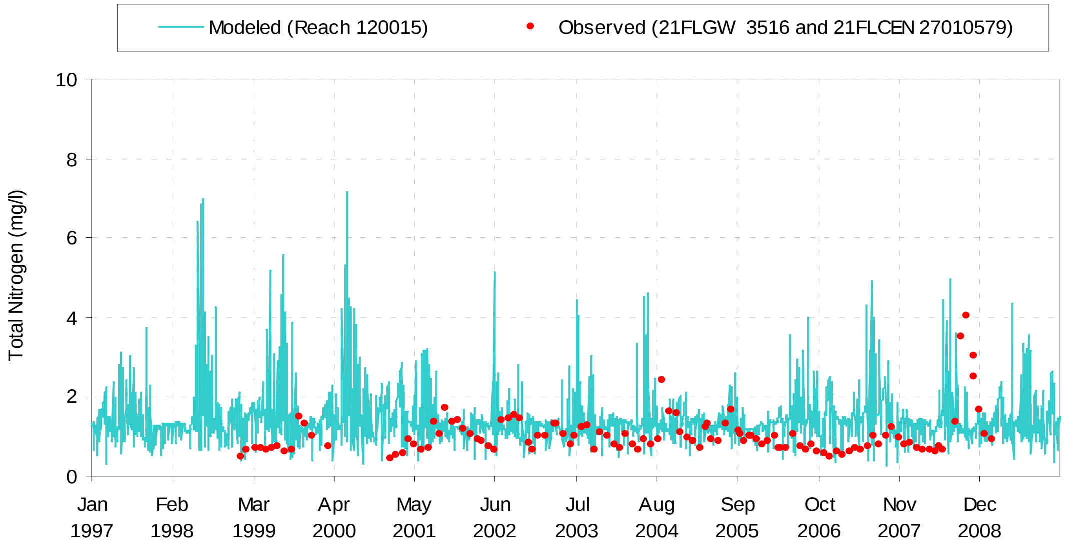

Figure C.11. Modeled versus Observed TN (mg/L) at 21FLGW 3516 and 21FLCEN 27010579

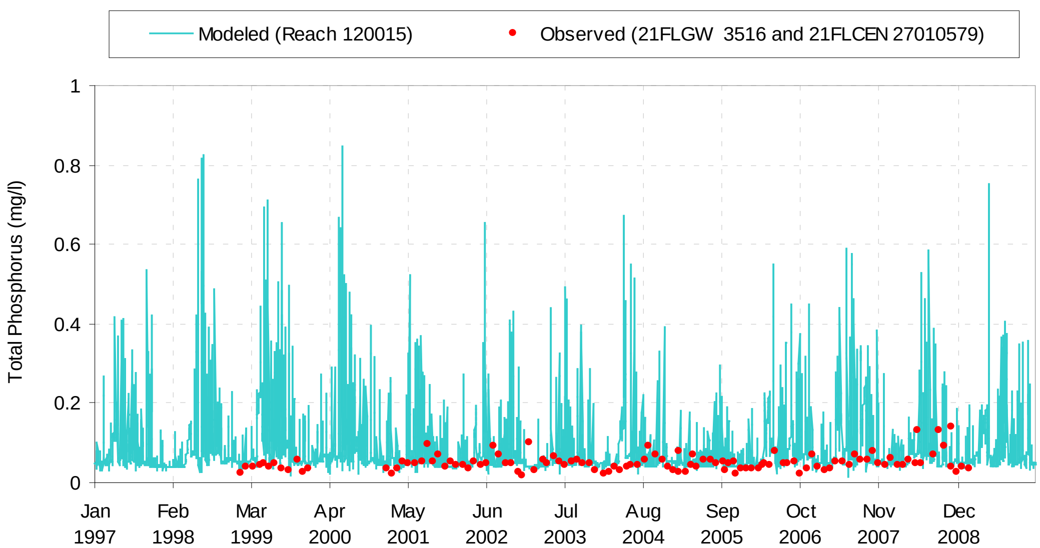

Figure C.12. Modeled versus Observed TP (mg/L) at 21FLGW 3516 and 21FLCEN 27010579

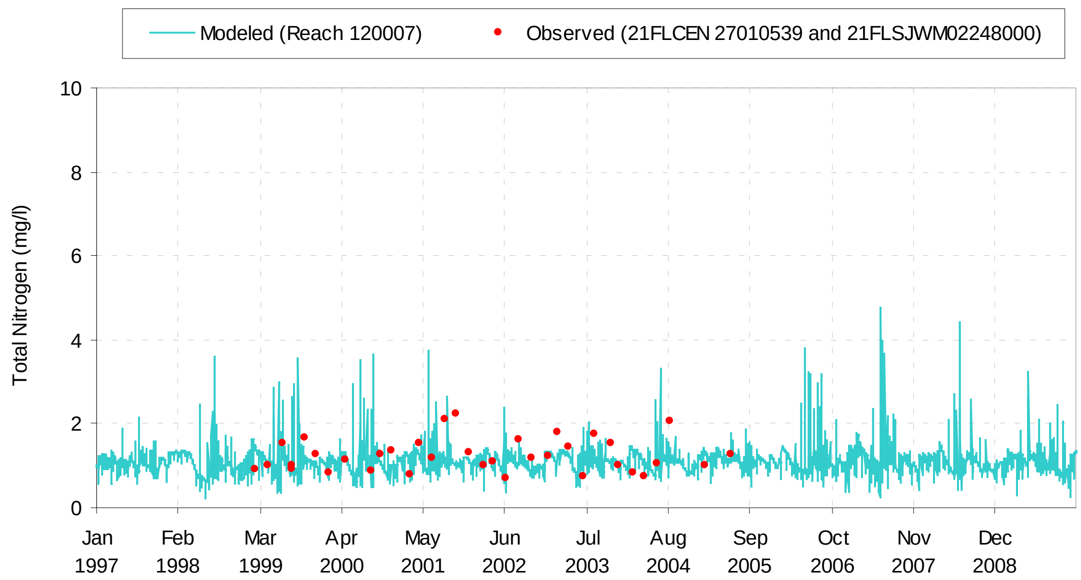

Figure C.13. Modeled versus Observed TN (mg/L) at 21FLCEN 27010539 and 21FLSJWM02248000

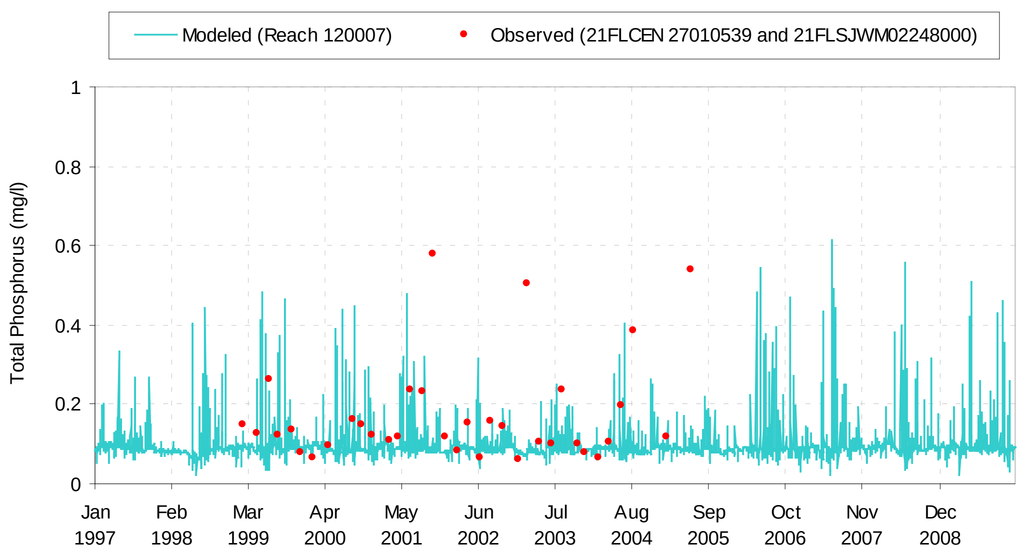

Figure C.14. Modeled versus Observed TP (mg/L) at 21FLCEN 27010539 and 21FLSJWM02248000

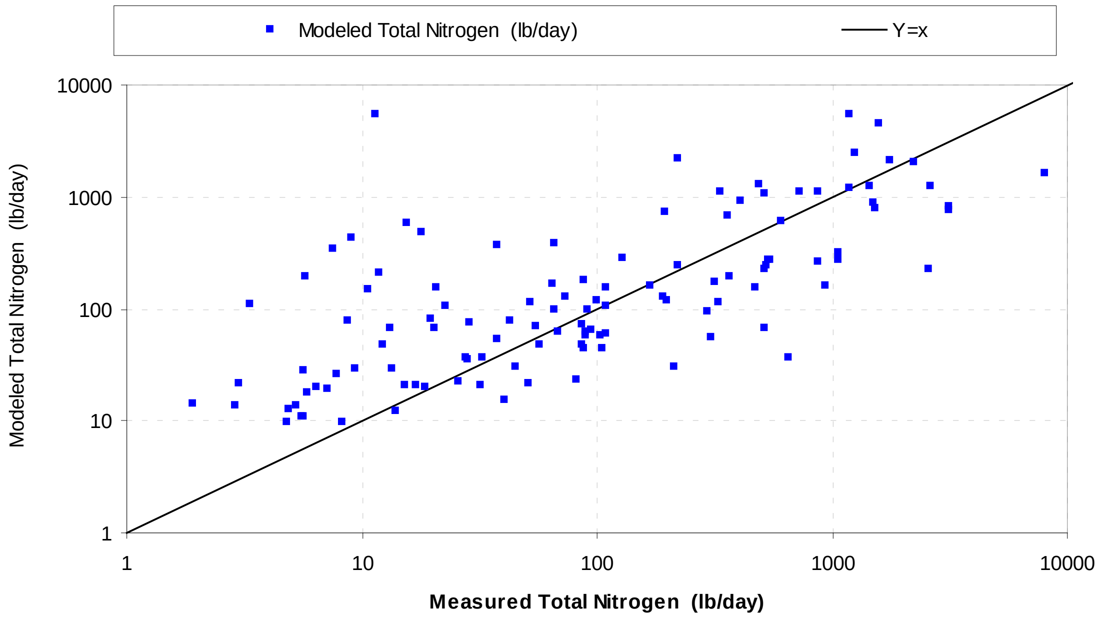

Figure C.15. TN (mg/L) Load Scatter Plot at 21FLGW 3516 and 21FLCEN 27010579

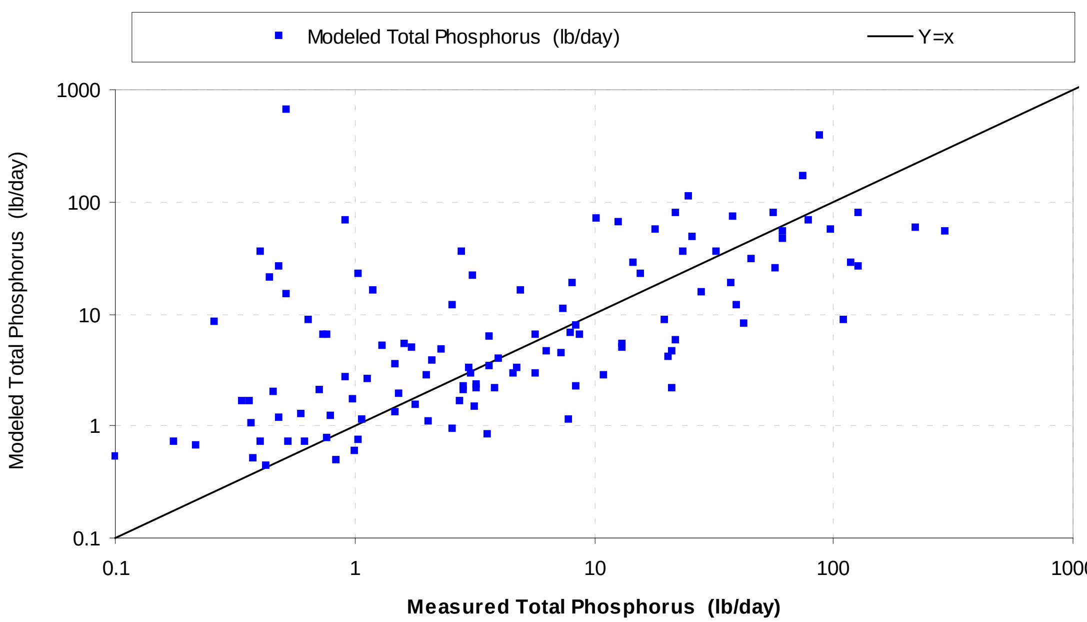

Figure C.16. TP (mg/L) Load Scatter Plot at 21FLGW 3516 and 21FLCEN 27010579

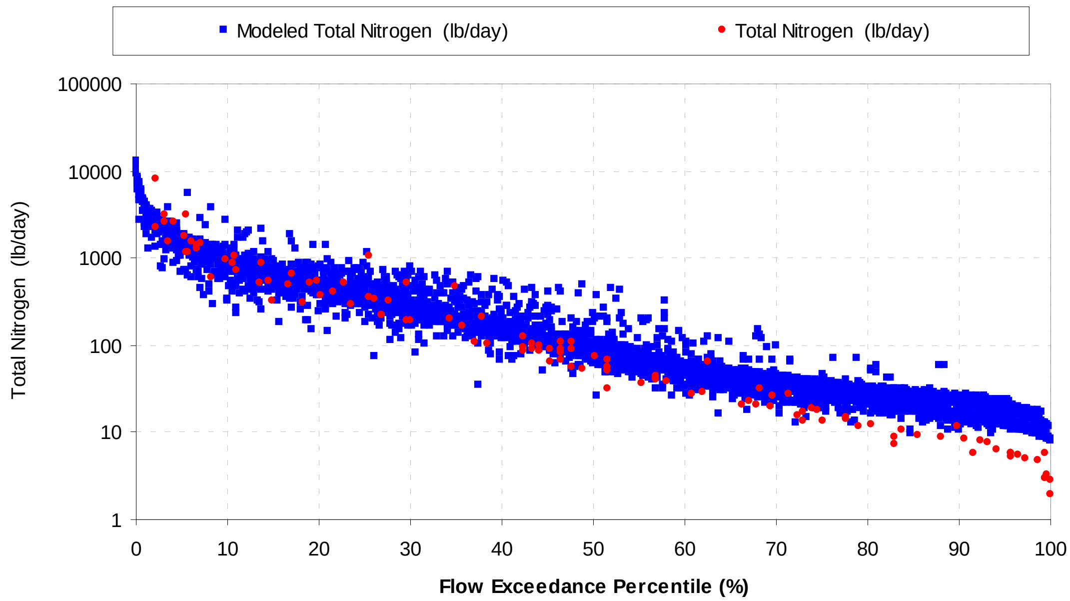

Figure C.17. TN (mg/L) Load Duration Curve at 21FLGW 3516 and 21FLCEN 27010579

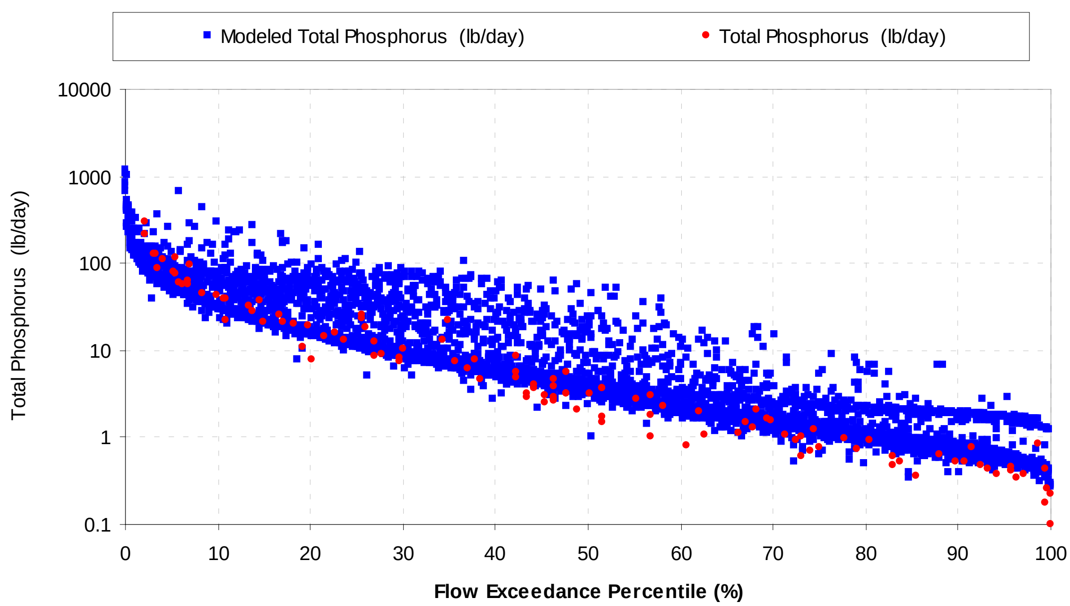

Figure C.18. TP (mg/L) Load Duration Curve at 21FLGW 3516 and 21FLCEN 27010579

Table C.4. TN (lbs/yr) Percent Error for Measured and Modeled Loading by Year at 21FLGW 3516 and 21FLCEN 27010579

- = Empty cell/no data

Year	TN (lbs/yr) Measured	TN (lbs/yr) Modeled	TN % Error
1997	-	-	-
1998	-	-	-
1999	65,823	57,694	-12.4%
2000	20,510	54,931	167.8%
2001	217,319	209,770	-3.5%
2002	170,835	126,810	-25.8%
2003	200,075	179,481	-10.3%
2004	447,592	222,788	-50.2%
2005	250,005	334,621	33.9%
2006	14,820	66,834	351.0%
2007	26,375	57,432	117.8%
2008	209,614	142,172	-32.2%
2009	103,072	124,330	20.6%
Average	**156,913**	**143,351**	**-8.6%**
Rating	**-**	**-**	**VG**

Table C.5. TP (lbs/yr) Percent Error for Measured and Modeled Loading by Year at 21FLGW 3516 and 21FLCEN 27010579

- = Empty cell/no data

Year	TP (lbs/yr) Measured	TP (lbs/yr) Modeled	TN % Error
1997	-	-	-
1998	-	-	-
1999	2,428	5,353	120.5%
2000	1,113	4,459	300.7%
2001	9,510	11,052	16.2%
2002	8,501	7,084	-16.7%
2003	9,399	8,837	-6.0%
2004	18,250	12,059	-33.9%
2005	11,603	16,828	45.0%
2006	720	4,169	478.8%
2007	1,637	4,454	172.0%
2008	7,209	7,792	8.1%
2009	3,922	7,281	85.7%
Average	**6,754**	**8,124**	**20.3%**
Rating	**-**	**-**	**VG**

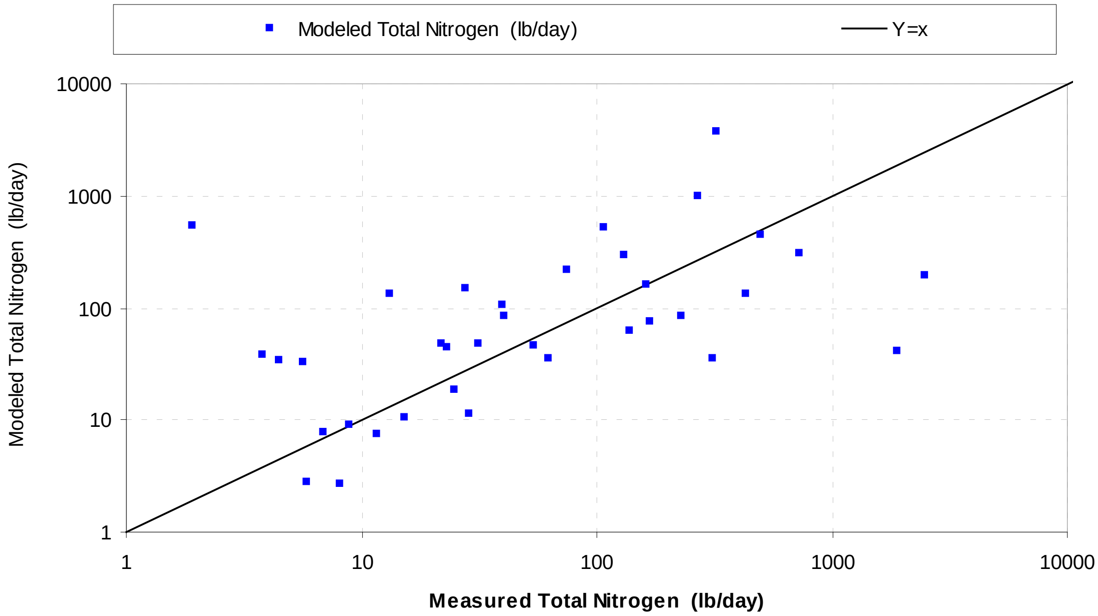

Figure C.19. TN (mg/L) Load Scatter Plot at 21FLCEN 27010539 and 21FLSJWM02248000

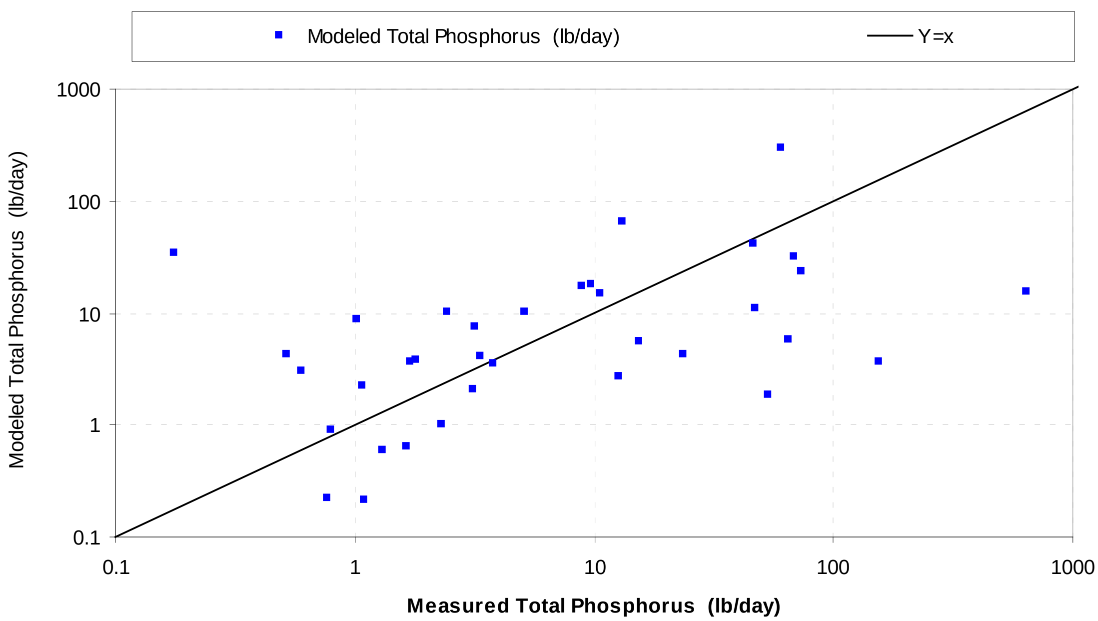

Figure C.20. TP (mg/L) Load Scatter Plot at 21FLCEN 27010539 and 21FLSJWM02248000

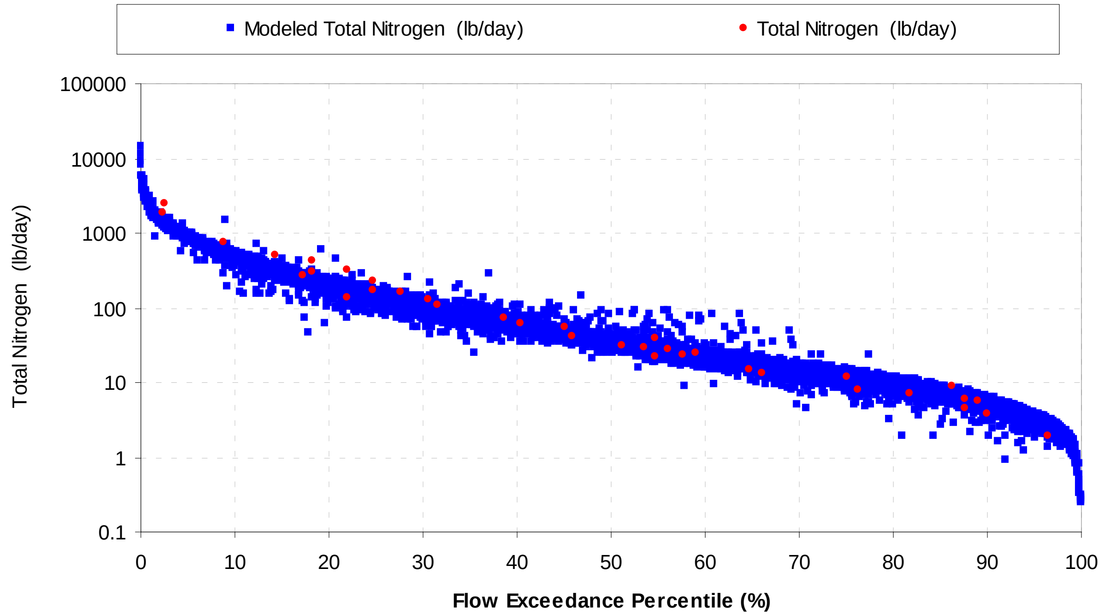

Figure C.21. TN (mg/L) Load Duration Curve at 21FLCEN 27010539 and 21FLSJWM02248000

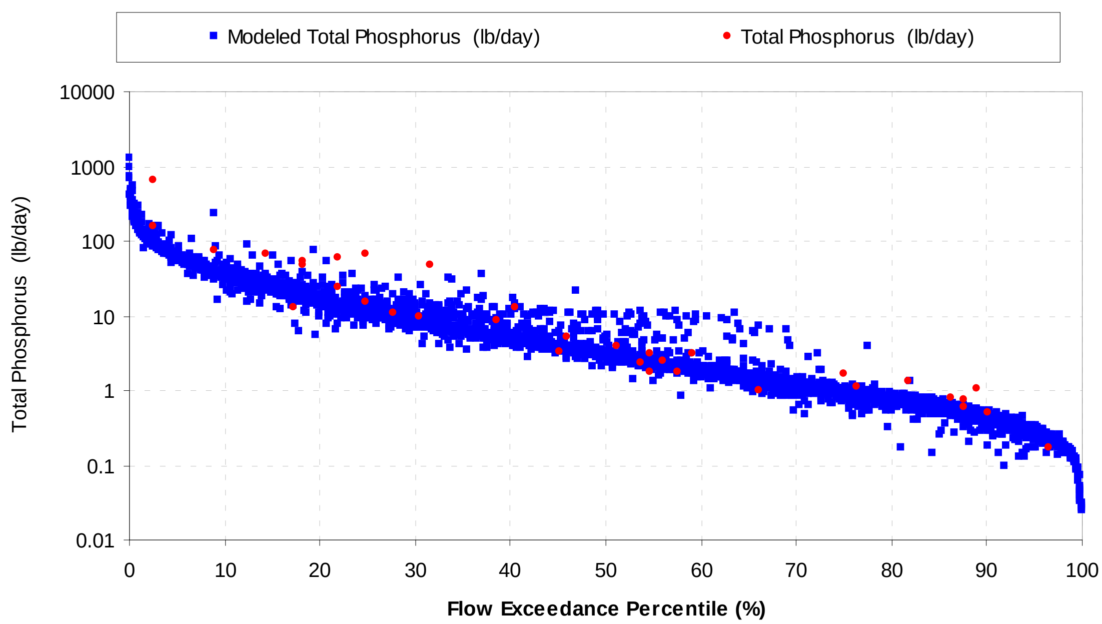

Figure C.22. TP (mg/L) Load Duration Curve at 21FLCEN 27010539 and 21FLSJWM02248000

Table C.6. TN (lbs/yr) Percent Error for Measured and Modeled Loading by Year at 21FLCEN 27010539 and 21FLSJWM02248000

- = Empty cell/no data

Year	TN (lbs/yr) Measured	TN (lbs/yr) Modeled	TN % Error
1997	-	-	-
1998	-	-	-
1999	119,768	26,204	-78.1%
2000	9,961	42,424	325.9%
2001	242,469	94,435	-61.1%
2002	60,424	74,404	23.1%
2003	118,289	108,736	-8.1%
2004	151,387	145,047	-4.2%
2005	123,844	124,677	0.7%
2006	-	-	-
2007	-	-	-
2008	-	-	-
2009	-	-	-
Average	**118,020**	**87,989**	**-25.4%**
Rating	**-**	**-**	**VG**

Table C.7. TP (lbs/yr) Percent Error for Measured and Modeled Loading by Year at 21FLCEN 27010539 and 21FLSJWM02248000

Year	TP (lbs/yr) Measured	TP (lbs/yr) Modeled	TP % Error
1997	-	-	-
1998	-	-	-
1999	11,010	2,371	-78.5%
2000	1,149	3,265	184.2%
2001	45,523	7,424	-83.7%
2002	5,675	5,882	3.7%
2003	15,842	7,964	-49.7%
2004	27,323	11,279	-58.7%
2005	52,024	9,700	-81.4%
2006	-	-	-
2007	-	-	-
2008	-	-	-
2009	-	-	-
Average	**22,649**	**6,841**	**-69.8%**
Rating	**-**	**-**	**G**

References

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U.S. Environmental Protection Agency. 1985. Rates, constants, and kinetics. *Formulations in surface water quality modeling (Second Edition).* EPA/600/3-85/040. Athens, GA: Environmental Research Laboratory.

———. 2000. *BASINS Technical Note 6. Estimating hydrology and hydraulic parameters for HSPF.* EPA-823-R00-012. Washington, DC: Office of Water.

———. 2006. *BASINS Technical Note 8. Sediment parameter and calibration guidance for HSPF.* Washington, DC: Office of Water.

Appendix D: Kruskal-Wallis Analysis of Corrected Chla, INORGN, TN, INORGP, TP, COND, COLOR, TSS, and TURB Observations versus Season in Palm Coast

Kruskal-Wallis One-Way Analysis of Variance for 231 cases
Dependent variable is CHLAC
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	59	5978.500
SPRING	59	6886.000
SUMMER	50	8245.500
WINTER	63	5686.000

Kruskal-Wallis Test Statistic = 39.077
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 216 cases
Dependent variable is INORGN
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	56	7522.000
SPRING	49	3753.500
SUMMER	55	6222.000
WINTER	56	5938.500

Kruskal-Wallis Test Statistic = 22.814
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 314 cases
Dependent variable is TN
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	82	13990.500
SPRING	72	11612.000
SUMMER	76	14137.500
WINTER	84	9715.000

Kruskal-Wallis Test Statistic = 27.183
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 281 cases
Dependent variable is INORGP
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	61	8702.500
SPRING	80	11324.500
SUMMER	64	10734.500
WINTER	76	8859.500

Kruskal-Wallis Test Statistic = 13.851
Probability is 0.003 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 360 cases
Dependent variable is TP
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	90	16987.000
SPRING	90	16563.000
SUMMER	84	17486.000
WINTER	96	13944.000

Kruskal-Wallis Test Statistic = 17.622
Probability is 0.001 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 359 cases
Dependent variable is COND
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	103	16003.000
SPRING	86	19301.500
SUMMER	76	12635.000
WINTER	94	16680.500

Kruskal-Wallis Test Statistic = 22.961
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 333 cases
Dependent variable is COLOR
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	84	15170.500
SPRING	81	11806.000
SUMMER	71	15188.000
WINTER	97	13446.500

Kruskal-Wallis Test Statistic = 31.247
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 342 cases
Dependent variable is TSS
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	90	13802.000
SPRING	82	16862.500
SUMMER	74	12749.000
WINTER	96	15239.500

Kruskal-Wallis Test Statistic = 14.416
Probability is 0.002 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 295 cases
Dependent variable is TURBIDITY
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	80	12324.000
SPRING	67	10231.000
SUMMER	63	11434.500
WINTER	85	9670.500

Kruskal-Wallis Test Statistic = 24.012
Probability is 0.000 assuming Chi-square distribution with 3 df

Appendix E: Kruskal-Wallis Analysis of CHLAC, INORGN,TN, INORGP, TP, COND, COLOR, TSS, and TURB Observations versus Year in Palm Coast

Kruskal-Wallis One-Way Analysis of Variance for 231 cases
Dependent variable is CHLAC
Grouping variable is YEAR

Group	Count	Rank Sum
1985	5	191.000
1986	10	1055.500
1987	5	244.000
1997	11	744.000
1998	10	1046.000
1999	10	544.000
2000	6	250.500
2001	10	1580.000
2002	11	1513.000
2003	12	1692.500
2004	10	1338.500
2005	37	3582.000
2006	12	1324.000
2007	12	1618.000
2008	12	1553.000
2009	24	2987.500
2010	12	2077.500
2011	16	2591.000
2012	6	864.000

Kruskal-Wallis Test Statistic = 64.021
Probability is 0.000 assuming Chi-square distribution with 18 df

Kruskal-Wallis One-Way Analysis of Variance for 216 cases
Dependent variable is INORGN
Grouping variable is YEAR

Group	Count	Rank Sum
1976	9	1400.000
1984	5	878.500
1985	5	820.500
1986	10	1535.000
1987	5	767.500
1990	5	881.000
1992	12	1113.000
1993	12	847.500
1994	12	1012.000
1995	4	373.000
1996	4	149.000
1997	2	176.000
1998	3	187.500
2004	2	408.000
2005	33	2429.000
2006	12	1270.500
2007	12	1404.000
2008	12	1126.000
2009	24	2475.500
2010	12	1130.000
2011	15	2205.500
2012	6	847.000

Kruskal-Wallis Test Statistic = 67.036
Probability is 0.000 assuming Chi-square distribution with 21 df

Kruskal-Wallis One-Way Analysis of Variance for 314 cases
Dependent variable is TN
Grouping variable is YEAR

Group	Count	Rank Sum
1973	2	127.500
1976	9	678.500
1978	5	1496.000
1980	5	1548.500
1984	5	319.500
1985	5	1378.500
1986	10	2007.500
1987	5	425.500
1992	12	2923.000
1993	12	1508.500
1994	12	2200.000
1995	4	658.500
1996	4	747.000
1997	13	1937.500
1998	15	2121.000
1999	12	2209.000
2000	10	1618.500
2001	10	1559.500
2002	12	1747.500
2003	12	1932.500
2004	10	1269.000
2005	37	6601.000
2006	12	1082.000
2007	11	1448.000
2008	12	1581.500
2009	24	4434.500
2010	12	1610.500
2011	16	1815.500
2012	6	469.000

Kruskal-Wallis Test Statistic = 93.363
Probability is 0.000 assuming Chi-square distribution with 28 df

Kruskal-Wallis One-Way Analysis of Variance for 281 cases
Dependent variable is INORGP
Grouping variable is YEAR

Group	Count	Rank Sum
1971	32	5374.500
1972	4	716.000
1973	7	1466.000
1974	7	1395.000
1978	5	557.500
1990	1	266.000
1991	5	1082.500
1992	9	1706.500
1997	11	1958.000
1998	8	1577.500
1999	10	1794.000
2000	10	1249.000
2001	11	1201.500
2002	12	1400.000
2003	12	1675.000
2004	11	1564.000
2005	37	5013.500
2006	12	1157.000
2007	12	1225.500
2008	12	1256.000
2009	24	3661.000
2010	12	962.000
2011	12	1112.500
2012	5	250.500

Kruskal-Wallis Test Statistic = 61.786
Probability is 0.000 assuming Chi-square distribution with 23 df

Kruskal-Wallis One-Way Analysis of Variance for 360 cases
Dependent variable is TP
Grouping variable is YEAR

Group	Count	Rank Sum
1971	32	8212.500
1972	4	178.500
1973	8	1647.500
1974	1	5.000
1976	9	1948.500
1978	5	318.500
1980	5	1665.000
1984	5	1468.500
1985	5	1336.500
1986	10	1166.500
1987	5	1719.000
1990	1	318.000
1991	5	1338.000
1992	12	1958.000
1993	12	1283.000
1994	12	1609.000
1995	4	663.000
1996	4	730.500
1997	13	2309.000
1998	11	1845.500
1999	10	1865.500
2000	10	1033.500
2001	11	1378.000
2002	12	2702.000
2003	12	2694.000
2004	11	2020.000
2005	37	5512.000
2006	12	1910.000
2007	12	1866.000
2008	12	3421.000
2009	24	3508.500
2010	12	2591.000
2011	16	1910.000
2012	6	848.500

Kruskal-Wallis Test Statistic = 125.160
Probability is 0.000 assuming Chi-square distribution with 33 df

Kruskal-Wallis One-Way Analysis of Variance for 359 cases
Dependent variable is COND
Grouping variable is YEAR

Group	Count	Rank Sum
1971	1	1.000
1972	4	416.000
1973	10	1970.000
1974	7	842.500
1978	5	327.000
1980	5	766.000
1984	5	329.000
1985	5	77.500
1986	10	1124.500
1987	5	276.000
1990	5	956.000
1991	5	898.000
1992	12	1752.500
1993	12	2268.500
1994	12	1592.500
1995	4	471.500
1996	3	669.500
1997	15	2151.500
1998	15	2650.000
1999	12	2892.500
2000	10	2068.000
2001	11	1541.000
2002	12	2067.500
2003	12	1583.000
2004	11	1856.000
2005	42	6829.000
2006	12	3547.000
2007	12	2543.000
2008	12	2568.000
2009	36	7600.500
2010	15	3308.000
2011	16	4711.500
2012	6	1965.500

Kruskal-Wallis Test Statistic = 116.811
Probability is 0.000 assuming Chi-square distribution with 32 df

Kruskal-Wallis One-Way Analysis of Variance for 333 cases
Dependent variable is COLOR
Grouping variable is YEAR

Group	Count	Rank Sum
1971	32	6385.000
1972	4	1090.000
1973	8	1648.500
1974	6	1029.000
1978	5	774.500
1980	5	417.500
1984	5	1001.000
1985	5	1532.000
1986	10	2787.000
1987	5	869.000
1990	5	479.500
1991	5	521.500
1992	12	1919.500
1993	12	1771.500
1994	12	2590.000
1995	4	811.500
1996	3	710.000
1997	15	3599.000
1998	15	3922.000
1999	12	2808.000
2000	10	1882.000
2001	11	1433.000
2002	12	1567.500
2003	12	2184.000
2004	11	1768.500
2005	17	2872.000
2006	12	669.000
2007	12	1321.000
2008	12	1578.500
2009	15	2011.500
2010	12	1004.000
2011	12	543.000
2012	5	111.000

Kruskal-Wallis Test Statistic = 146.484
Probability is 0.000 assuming Chi-square distribution with 32 df

Kruskal-Wallis One-Way Analysis of Variance for 342 cases
Dependent variable is TSS
Grouping variable is YEAR

Group	Count	Rank Sum
1971	33	10449.000
1972	4	1293.000
1973	8	1552.000
1974	7	1787.000
1978	5	1070.500
1980	5	1140.000
1984	5	687.000
1985	5	681.500
1986	10	1502.500
1987	5	470.500
1990	5	355.500
1991	5	972.000
1992	12	1551.500
1993	12	1938.000
1994	12	968.000
1995	4	443.000
1996	3	617.500
1997	15	1998.000
1998	15	1718.500
1999	12	2066.000
2000	10	1582.500
2001	11	2445.000
2002	12	2415.000
2003	12	2032.500
2004	11	1175.500
2005	17	1276.000
2006	12	1764.500
2007	12	1843.500
2008	12	1617.500
2009	24	3554.000
2010	12	2444.000
2011	11	2706.500
2012	4	535.500

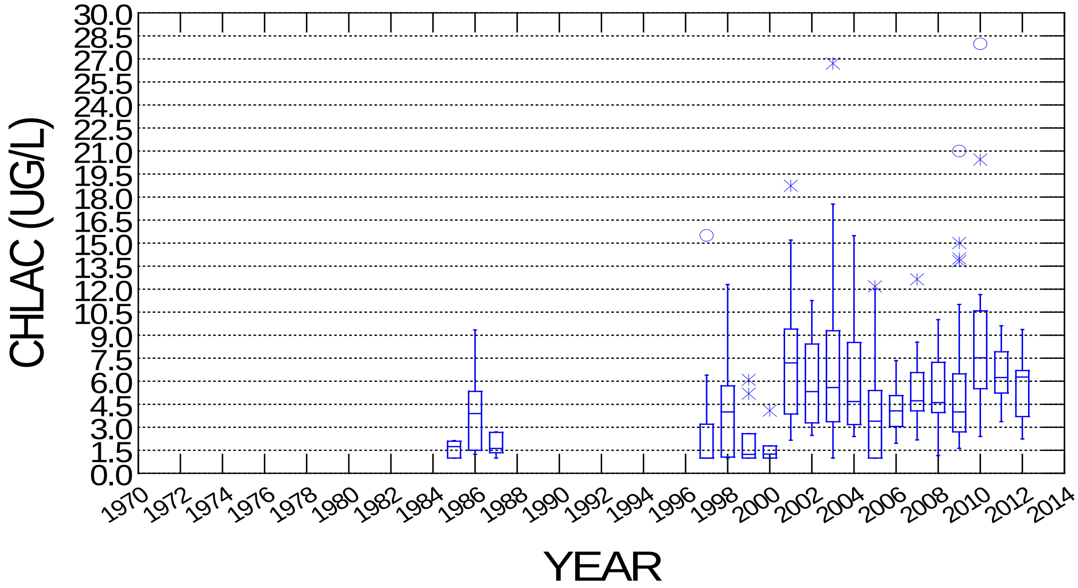
Kruskal-Wallis Test Statistic = 157.582
Probability is 0.000 assuming Chi-square distribution with 32 df

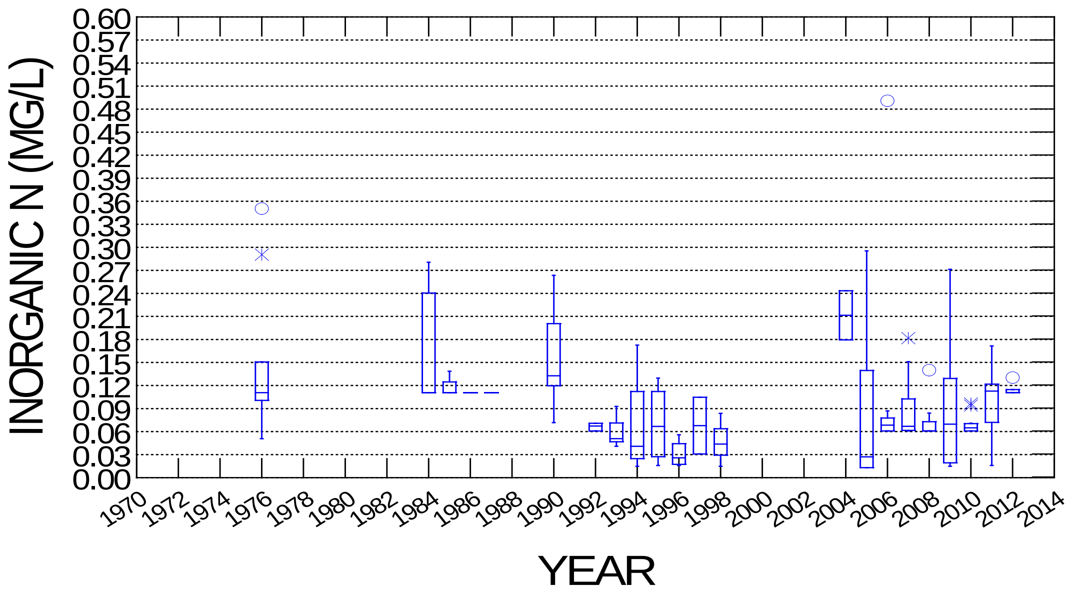
Kruskal-Wallis One-Way Analysis of Variance for 295 cases
Dependent variable is TURB
Grouping variable is YEAR

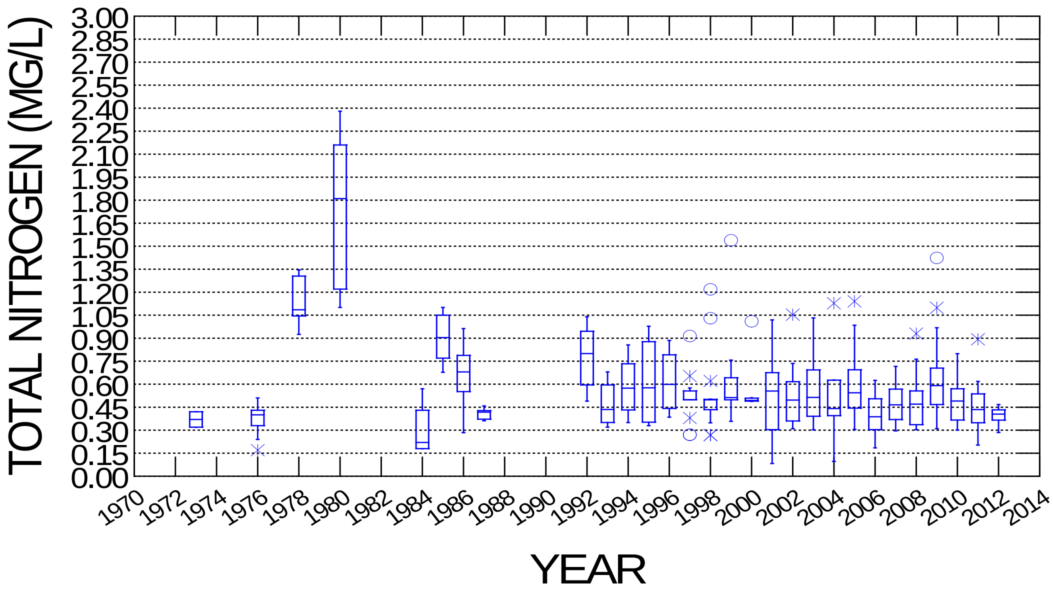
Group	Count	Rank Sum
1978	5	67.000
1980	5	812.000
1984	5	1358.000
1985	5	1326.500
1986	10	2487.500
1987	5	1050.500
1990	5	345.000
1991	5	279.500
1992	12	1439.000
1993	12	921.000
1994	12	1412.500
1995	4	481.500
1996	3	615.500
1997	15	1648.000
1998	15	1803.500
1999	12	1425.000
2000	10	444.500
2001	11	1959.500
2002	12	1775.500
2003	12	2166.000
2004	11	2264.500
2005	17	2876.000
2006	12	2041.500
2007	12	1973.500
2008	12	1844.500
2009	27	3289.000
2010	12	2102.500
2011	12	2549.000
2012	5	902.000

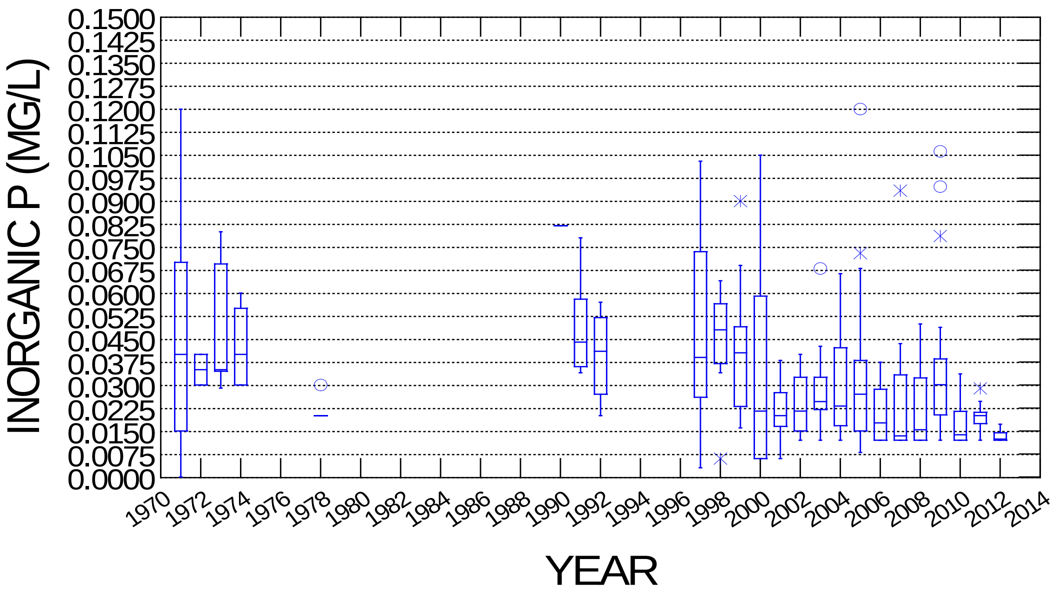
Kruskal-Wallis Test Statistic = 114.822
Probability is 0.000 assuming Chi-square distribution with 28 df

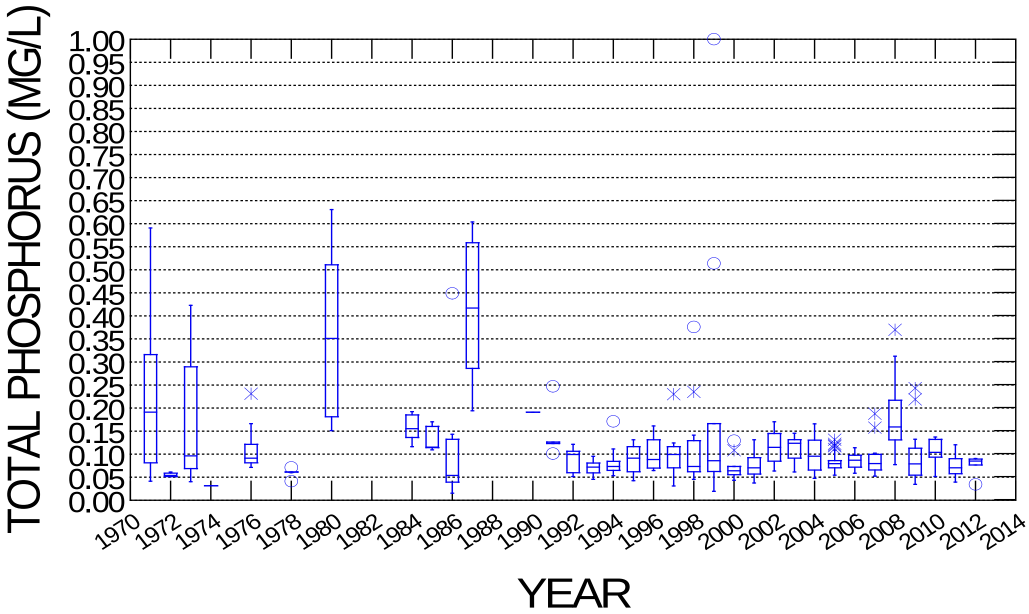
Appendix F: Chart of CHLAC, INORGN TN, INORGP, TP, COND, COLOR, and TSS Observations by Year, Season, and Station, in Palm Coast

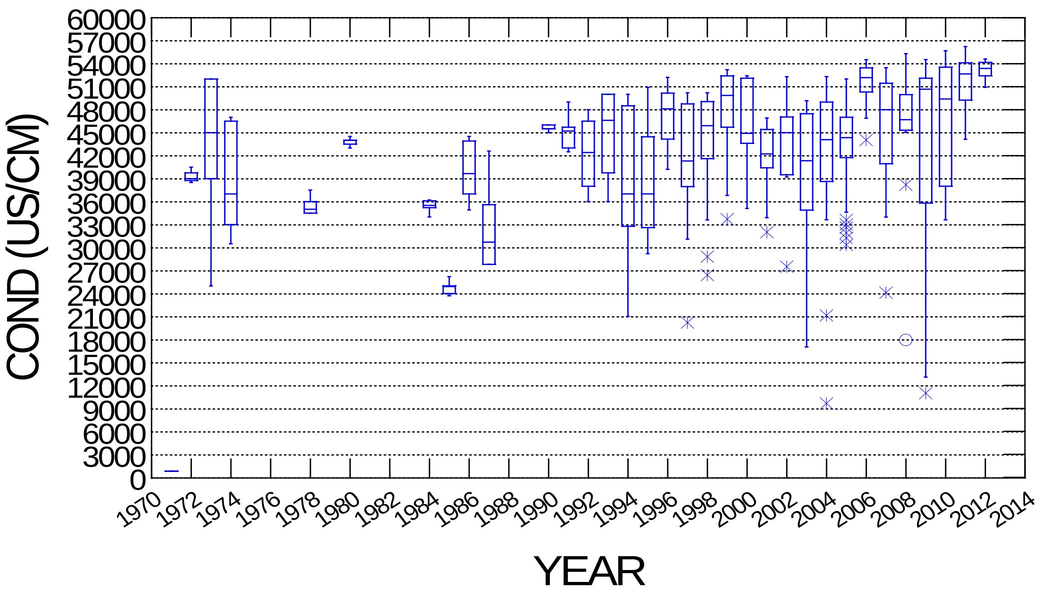


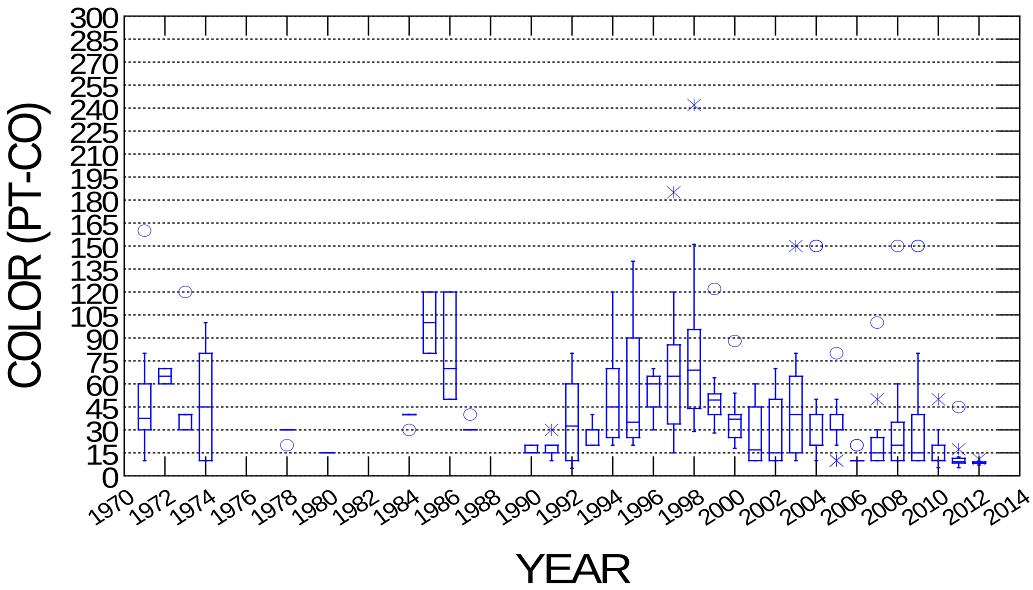


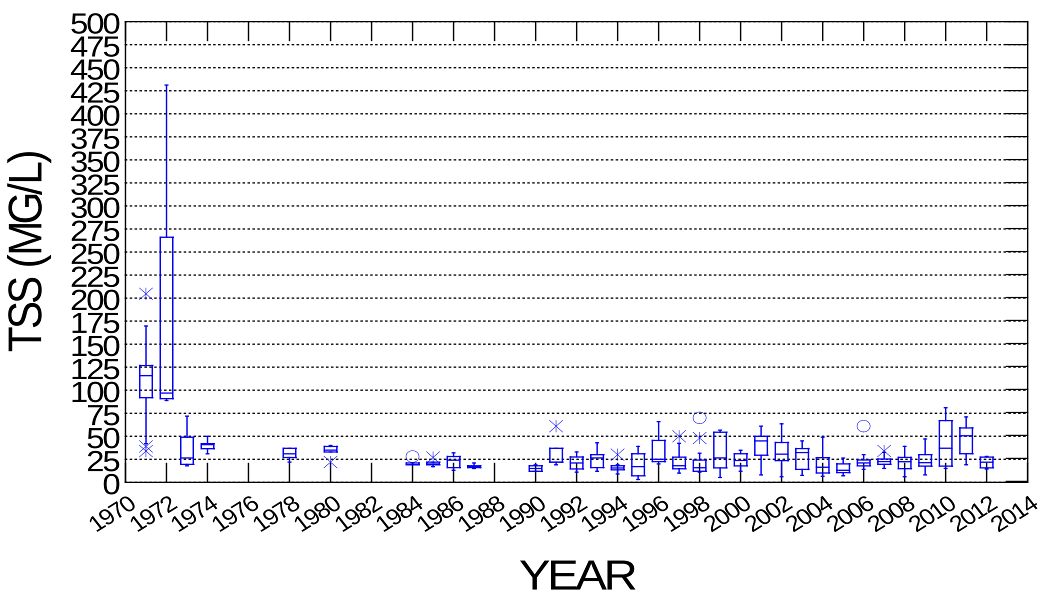

TOTAL NITROGEN (MG/L)
3.00
2.85
2.70
2.55
2.40
2.25
2.10
1.95
1.80
1.65
1.50
1.35
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
YEAR

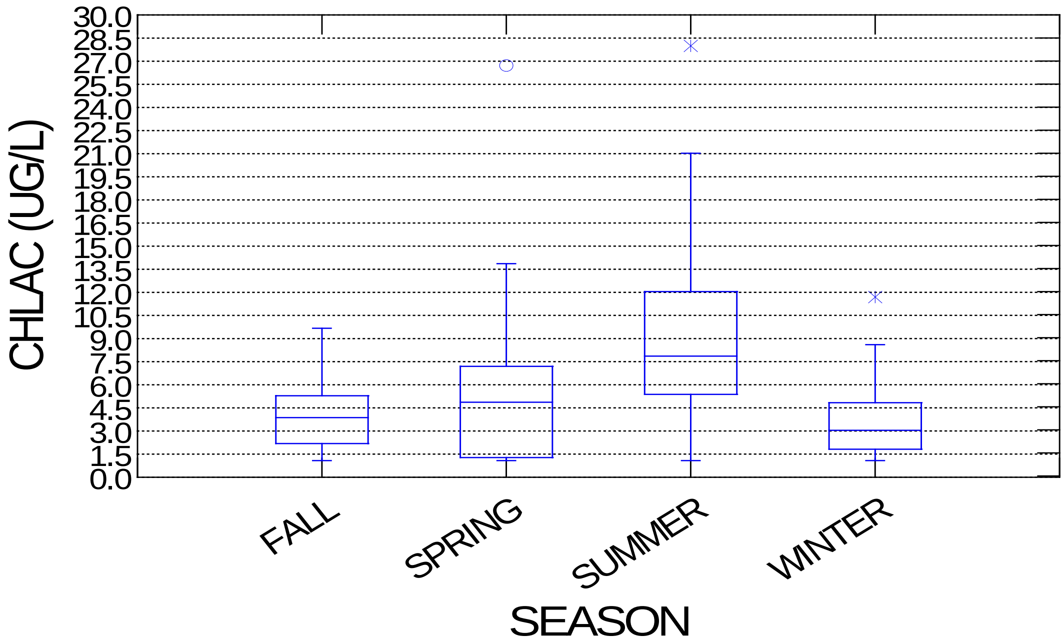

INORGANIC P (MG/L)
0.1500
0.1425
0.1350
0.1275
0.1200
0.1125
0.1050
0.0975
0.0900
0.0825
0.0750
0.0675
0.0600
0.0525
0.0450
0.0375
0.0300
0.0225
0.0150
0.0075
0.0000
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
YEAR

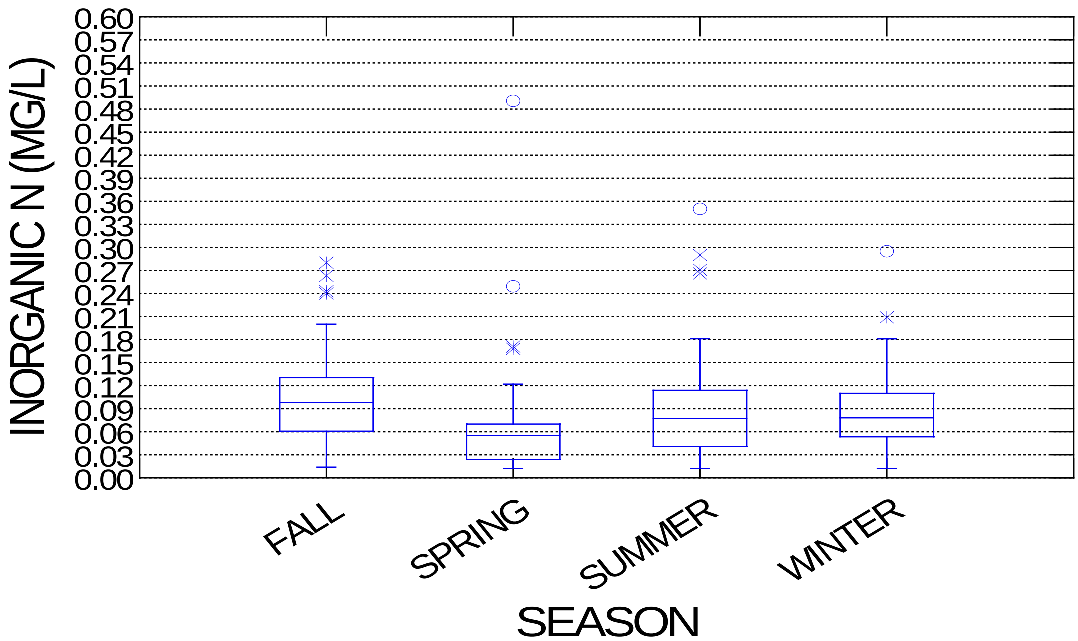

TOTAL PHOSPHORUS (MG/L)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
YEAR


COND (US/CM)
60000
57000
54000
51000
48000
45000
42000
39000
36000
33000
30000
27000
24000
21000
18000
15000
12000
9000
6000
3000
0
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
YEAR


COLOR (PT-CO)
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
YEAR


TSS (MG/L)
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
YEAR


CHLAC (UG/L)
30.0
28.5
27.0
25.5
24.0
22.5
21.0
19.5
18.0
16.5
15.0
13.5
12.0
10.5
9.0
7.5
6.0
4.5
3.0
1.5
0.0
FALL
SPRING
SUMMER
WINTER
SEASON


INORGANIC N (MG/L)
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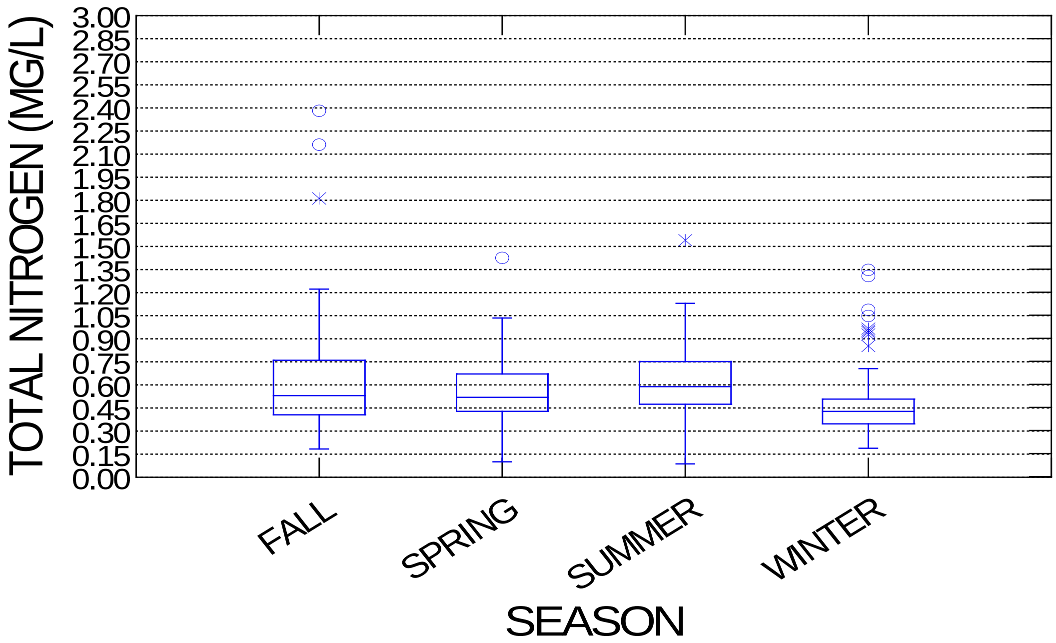
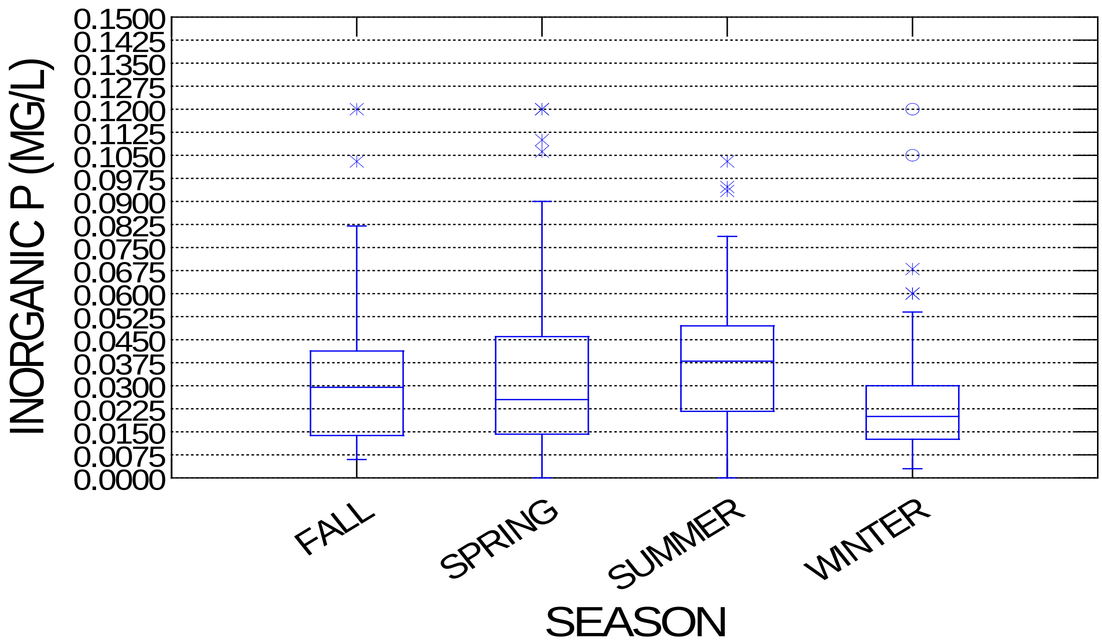
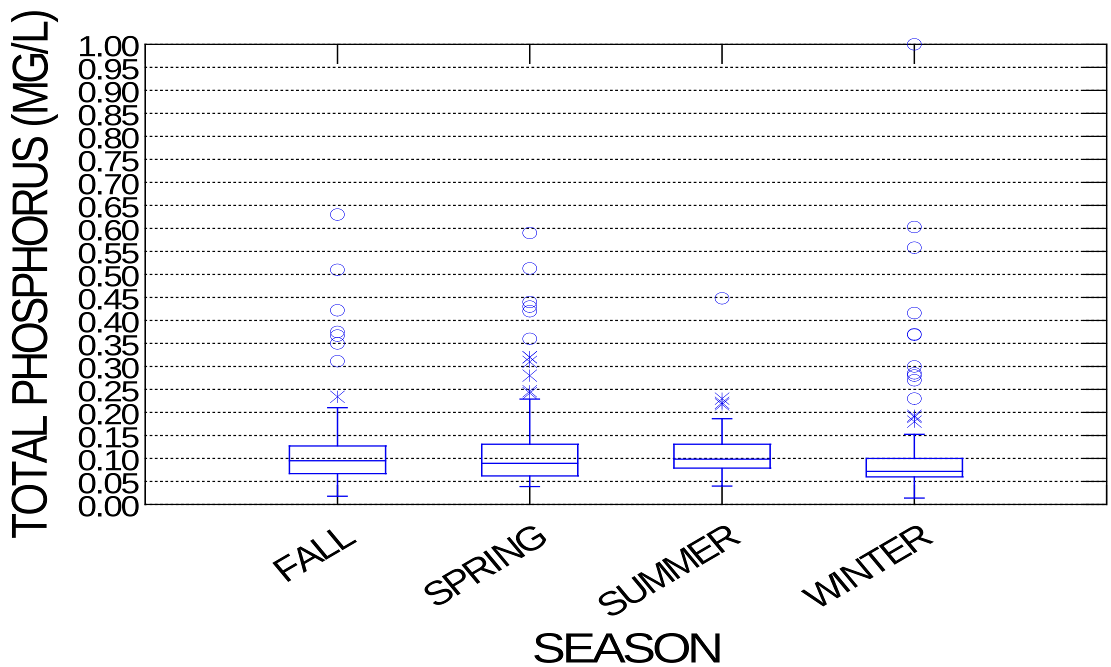
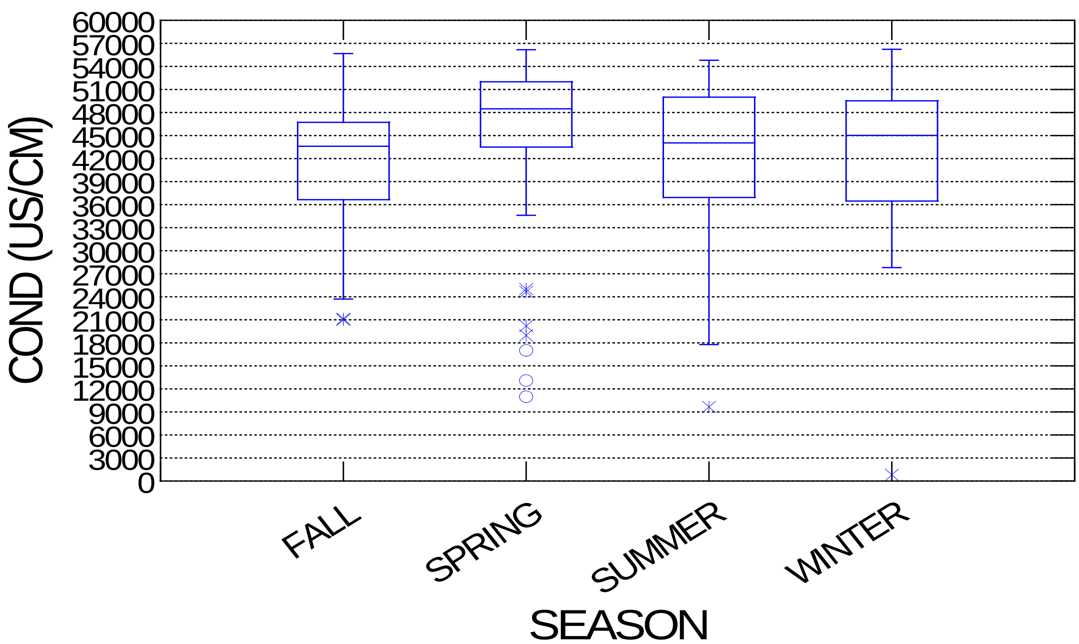
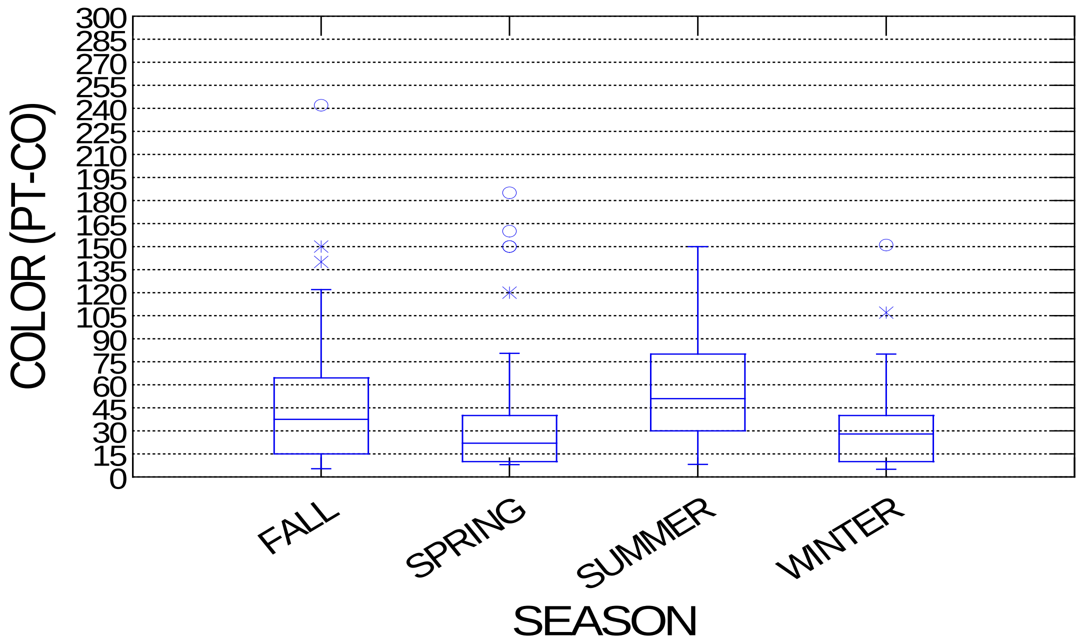
0.57
0.54
0.51
0.48
0.45
0.42
0.39
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
FALL
SPRING
SUMMER
WINTER
SEASON

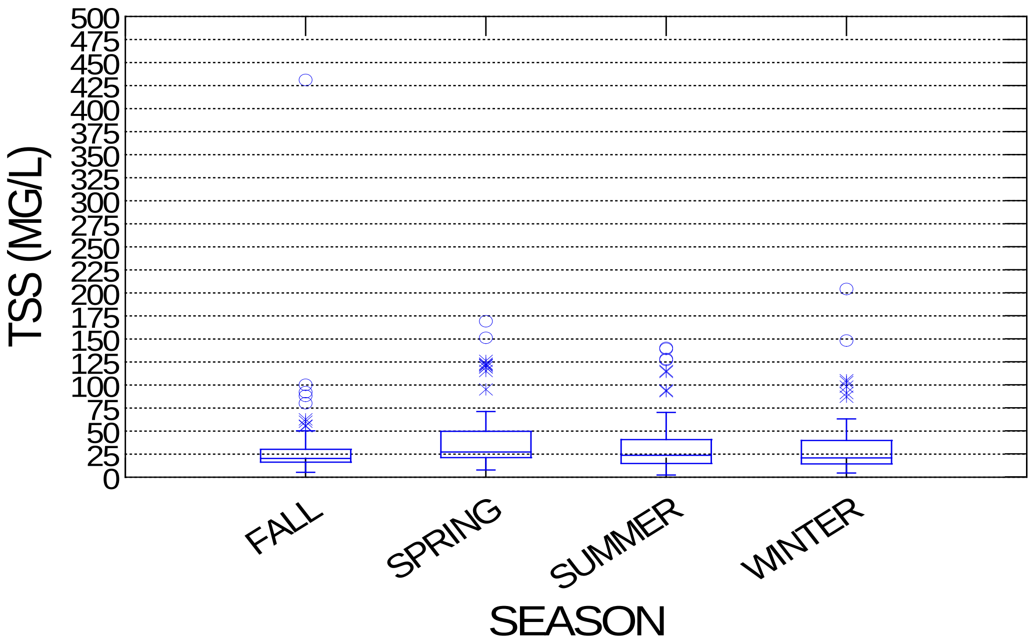

TOTAL NITROGEN (MG/L)
3.00
2.85
2.70
2.55
2.40
2.25
2.10
1.95
1.80
1.65
1.50
1.35
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
FALL
SPRING
SUMMER
WINTER
SEASON

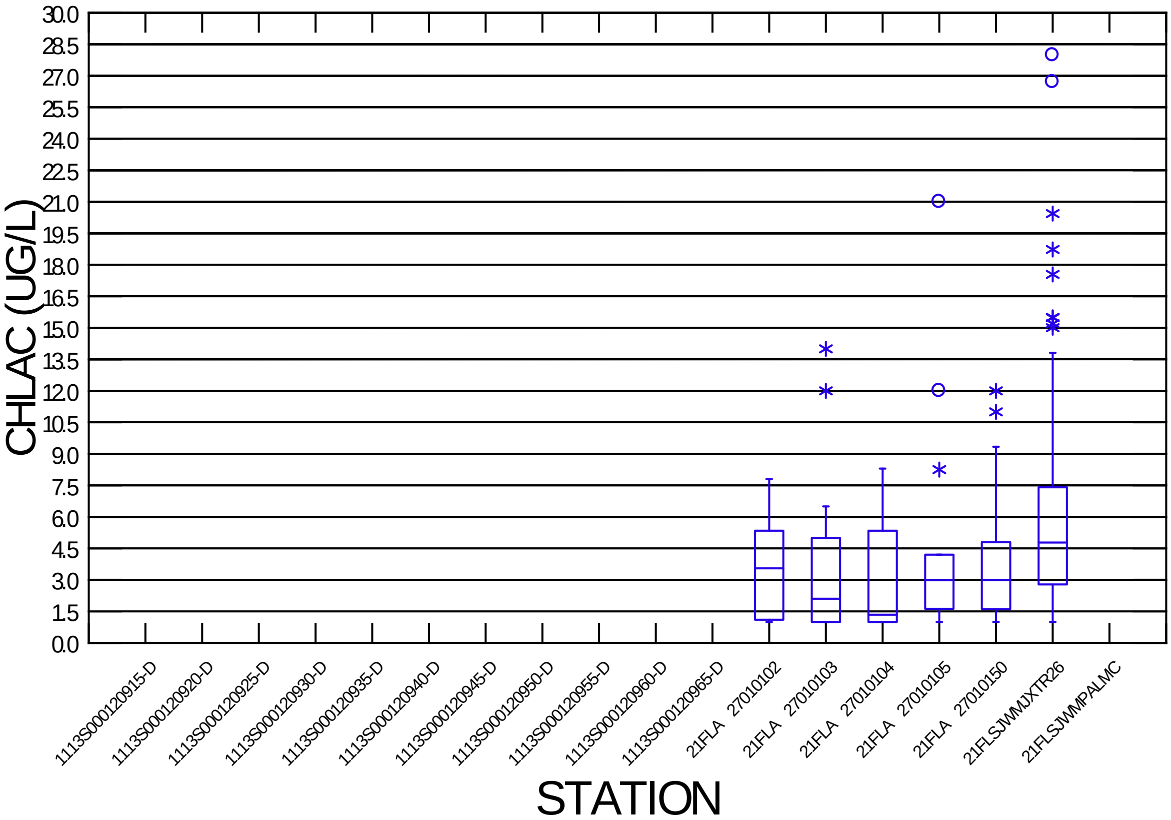

INORGANIC P (MG/L)
0.1500
0.1425
0.1350
0.1275
0.1200
0.1125
0.1050
0.0975
0.0900
0.0825
0.0750
0.0675
0.0600
0.0525
0.0450
0.0375
0.0300
0.0225
0.0150
0.0075
0.0000
FALL
SPRING
SUMMER
WINTER
SEASON

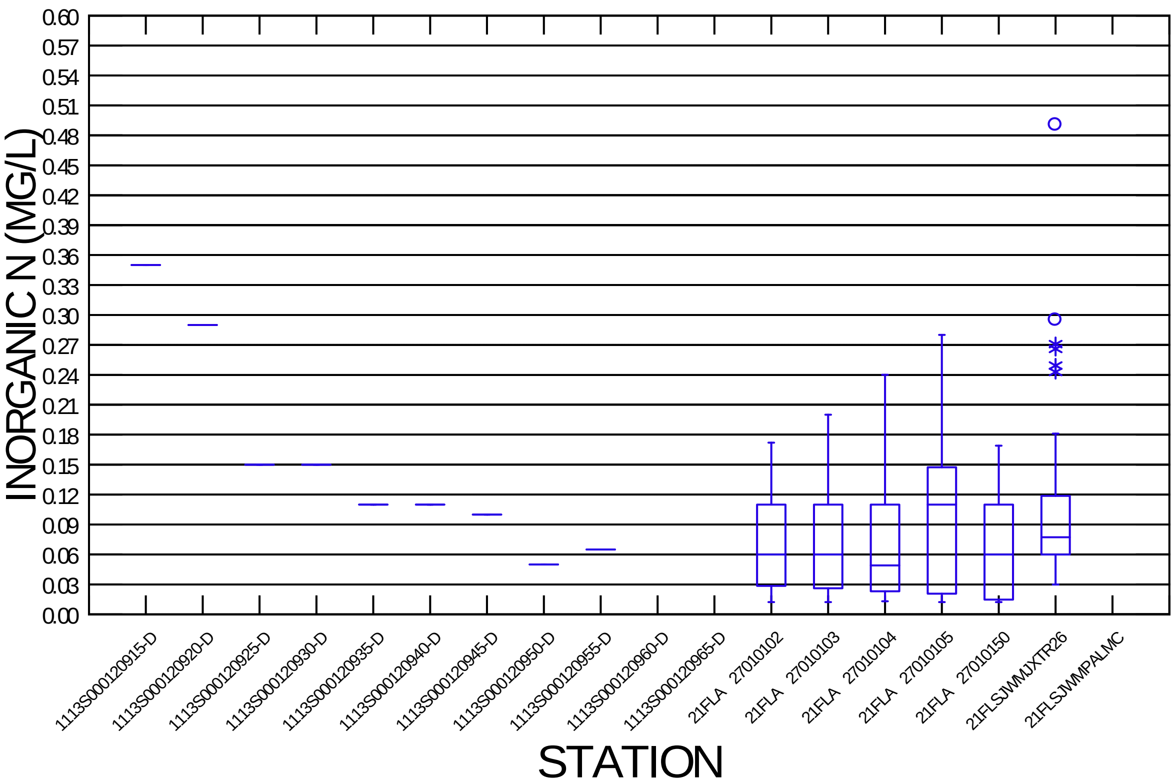

TOTAL PHOSPHORUS (MG/L)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
FALL
SPRING
SUMMER
WINTER
SEASON

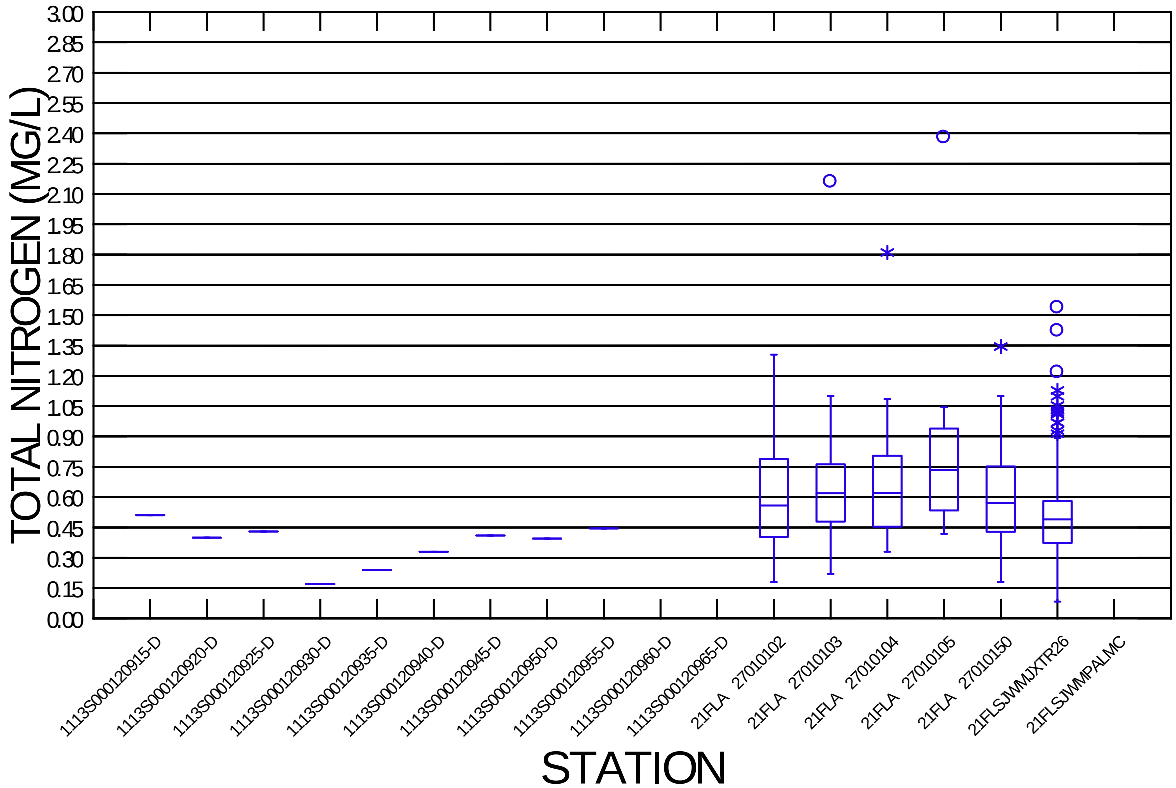

COND (US/CM)
60000
57000
54000
51000
48000
45000
42000
39000
36000
33000
30000
27000
24000
21000
18000
15000
12000
9000
6000
3000
0
FALL
SPRING
SUMMER
WINTER
SEASON

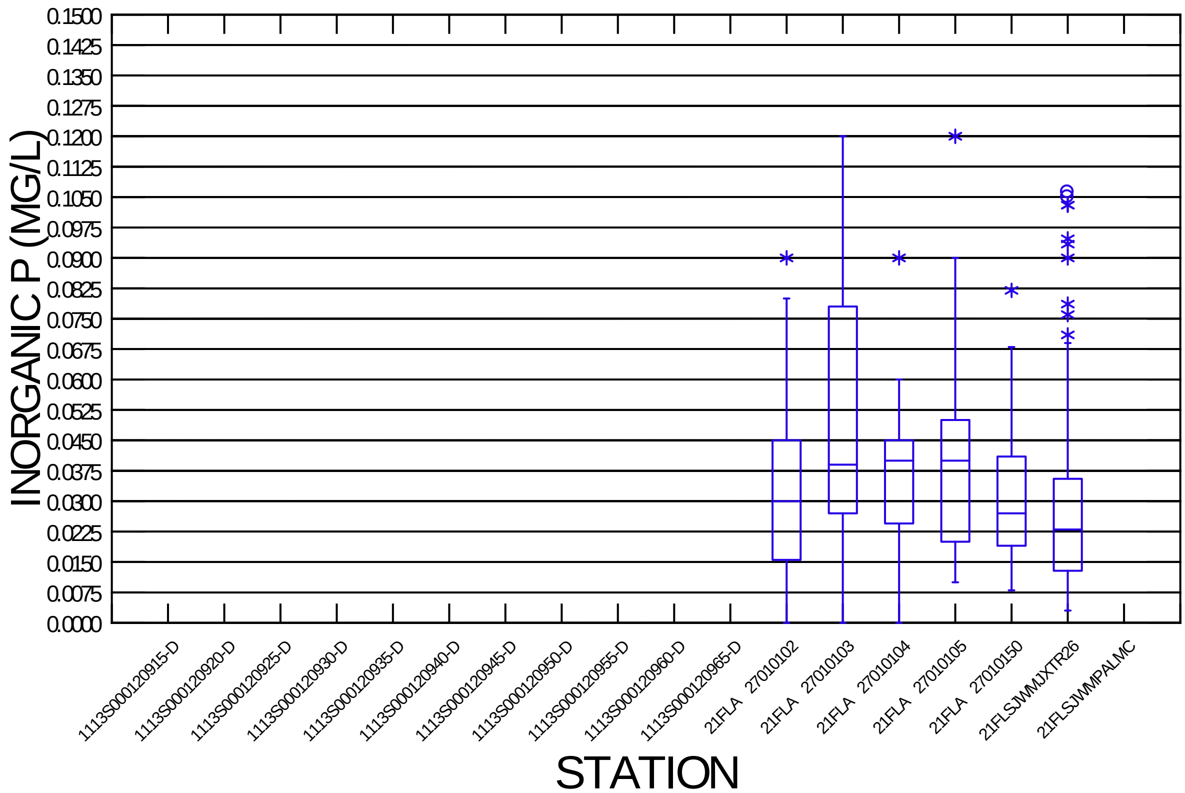

COLOR (PT-CO)
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
FALL
SPRING
SUMMER
WINTER
SEASON

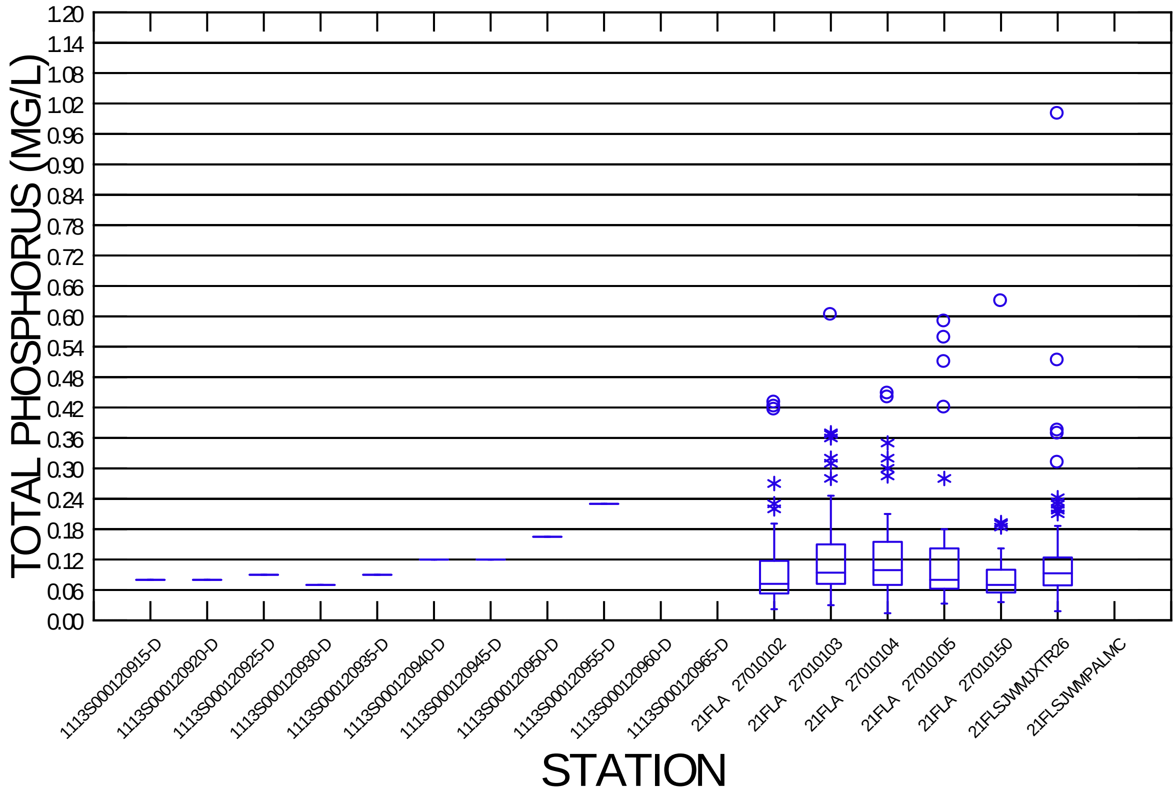

TSS (MG/L)
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
FALL
SPRING
SUMMER
WINTER
SEASON

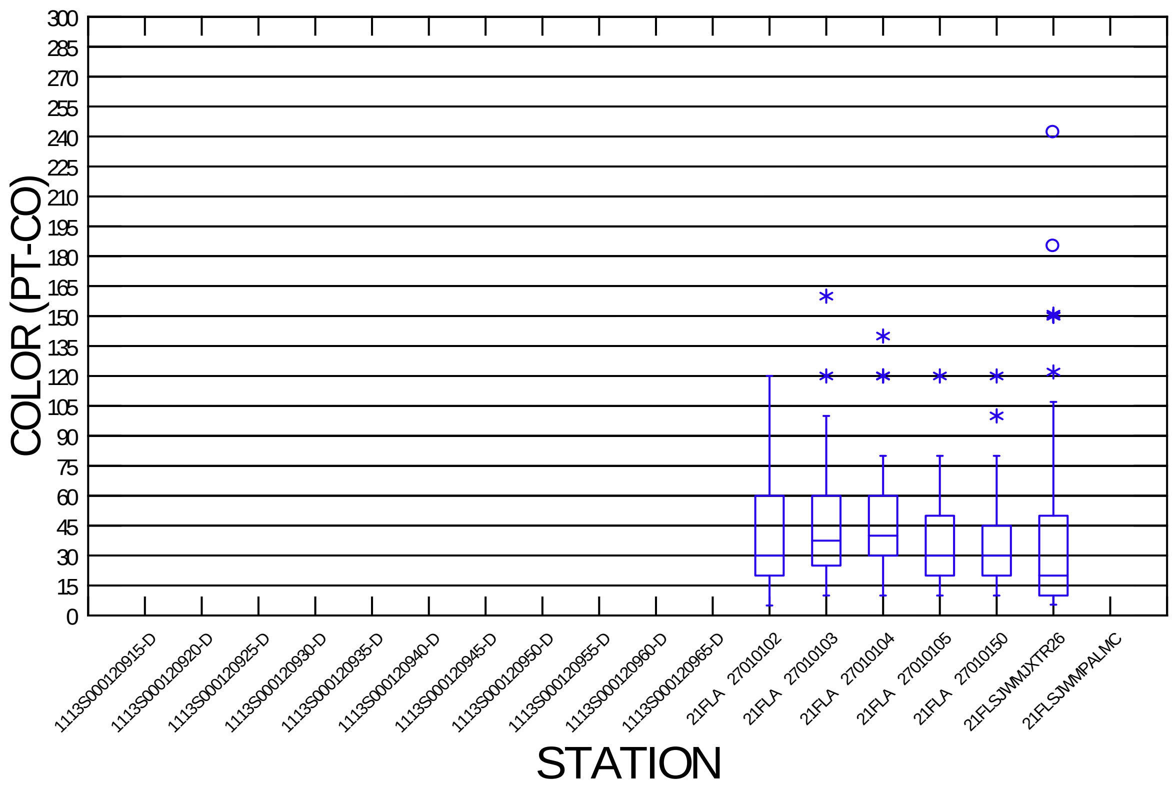

CHLAC (UG/L)
STATION
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC

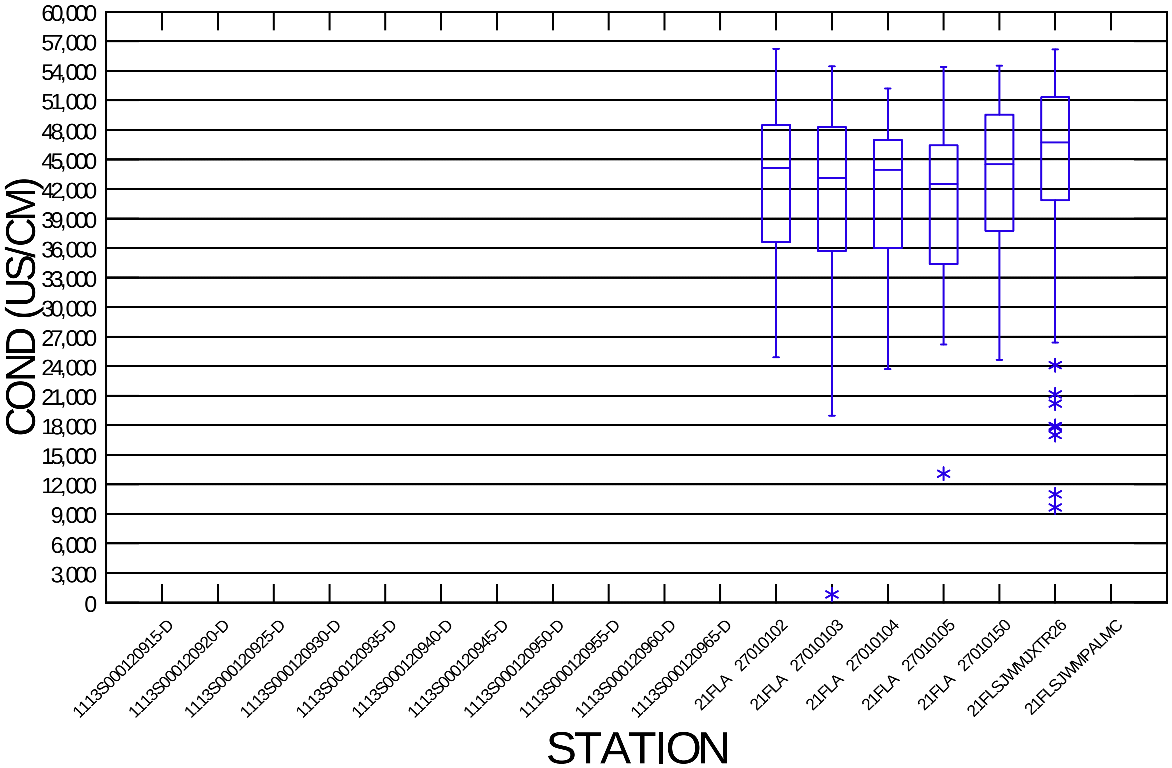

INORGANIC N (MG/L)
STATION
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC

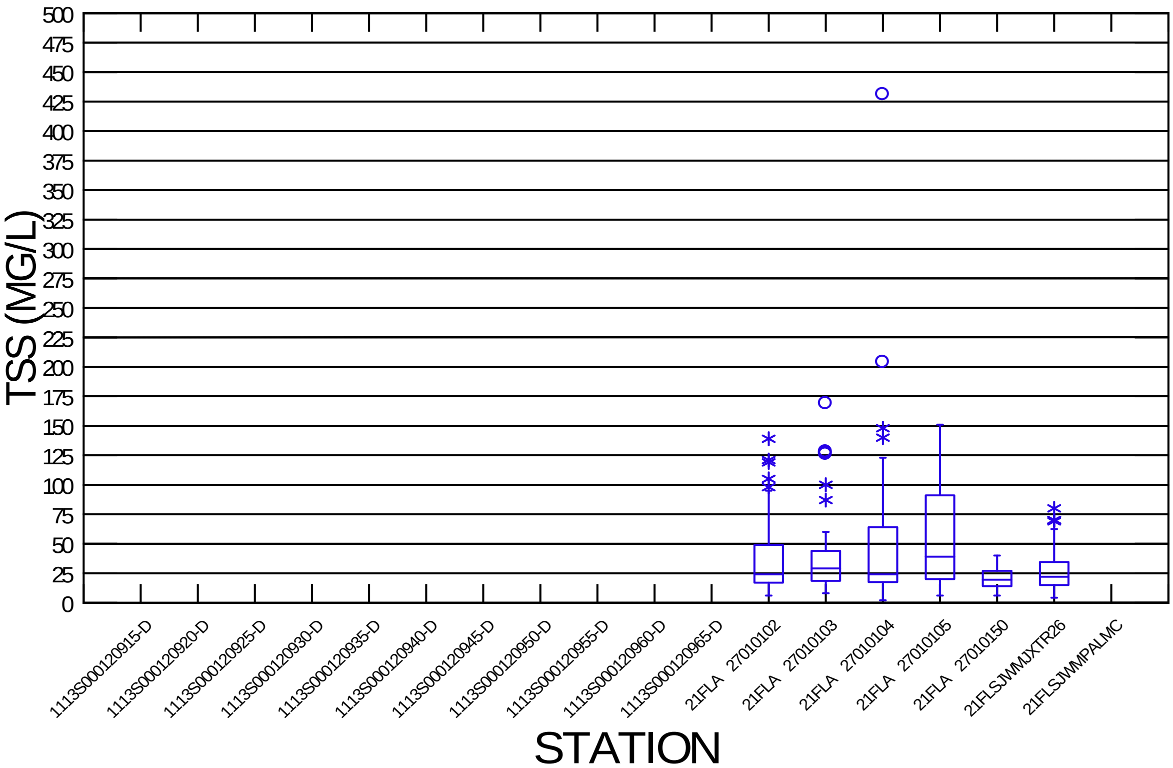

TOTAL NITROGEN (MG/L)
STATION
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC

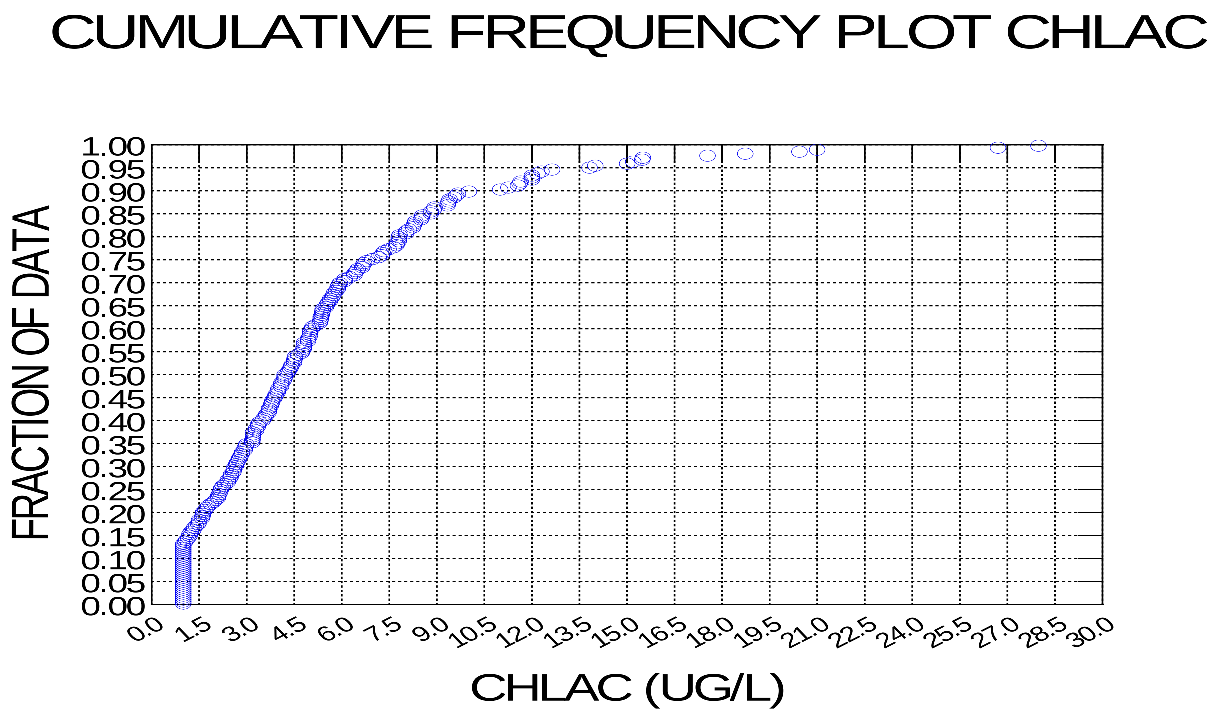

INORGANIC P (MG/L)
STATION
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC

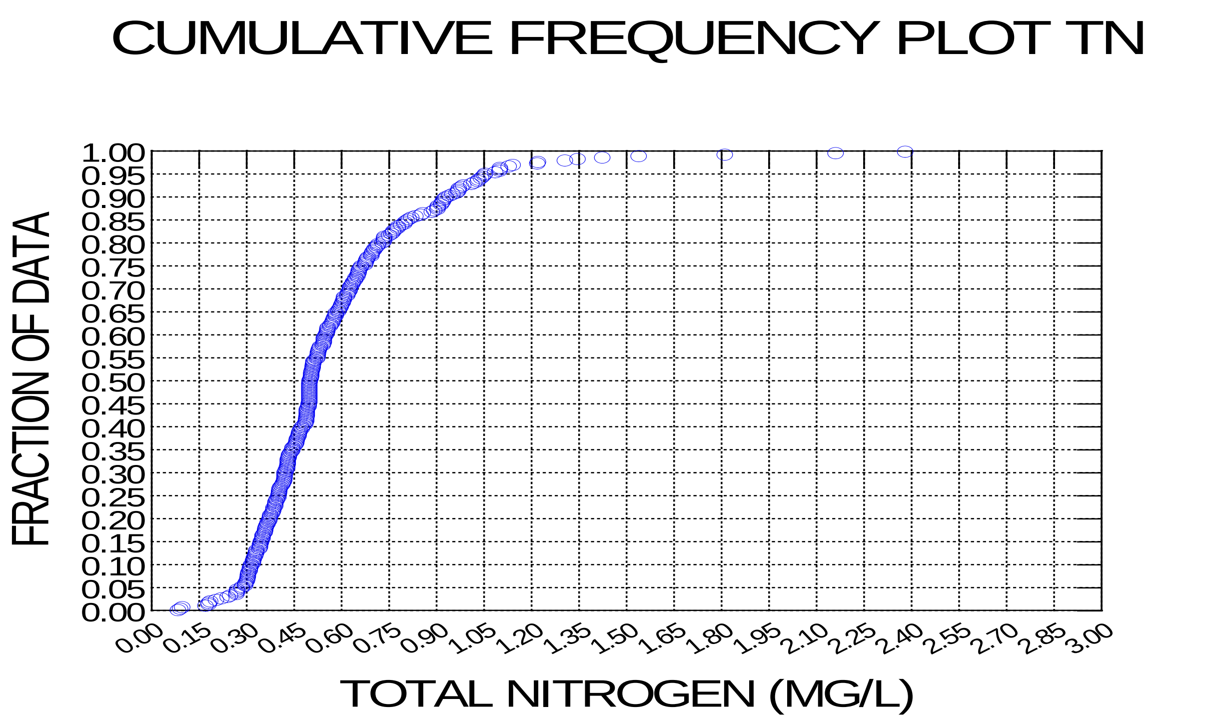

TOTAL PHOSPHORUS (MG/L)
1.20
1.14
1.08
1.02
0.96
0.90
0.84
0.78
0.72
0.66
0.60
0.54
0.48
0.42
0.36
0.30
0.24
0.18
0.12
0.06
0.00
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC
STATION


COLOR (PT-CO)
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMJXTR26
21FLSJWMPALMC
STATION

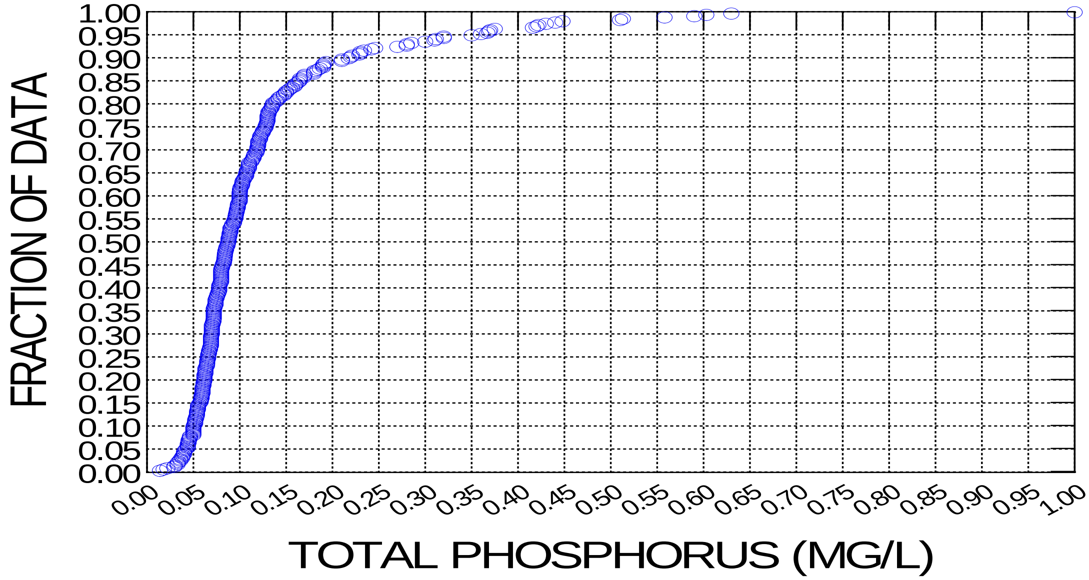

COND (US/CM)
60,000
57,000
54,000
51,000
48,000
45,000
42,000
39,000
36,000
33,000
30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMMJXTR26
21FLSJWMPALMC
STATION


TSS (MG/L)
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
1113S000120915-D
1113S000120920-D
1113S000120925-D
1113S000120930-D
1113S000120935-D
1113S000120940-D
1113S000120945-D
1113S000120950-D
1113S000120955-D
1113S000120960-D
1113S000120965-D
21FLA 27010102
21FLA 27010103
21FLA 27010104
21FLA 27010105
21FLA 27010150
21FLSJWMMJXTR26
21FLSJWMPALMC
STATION

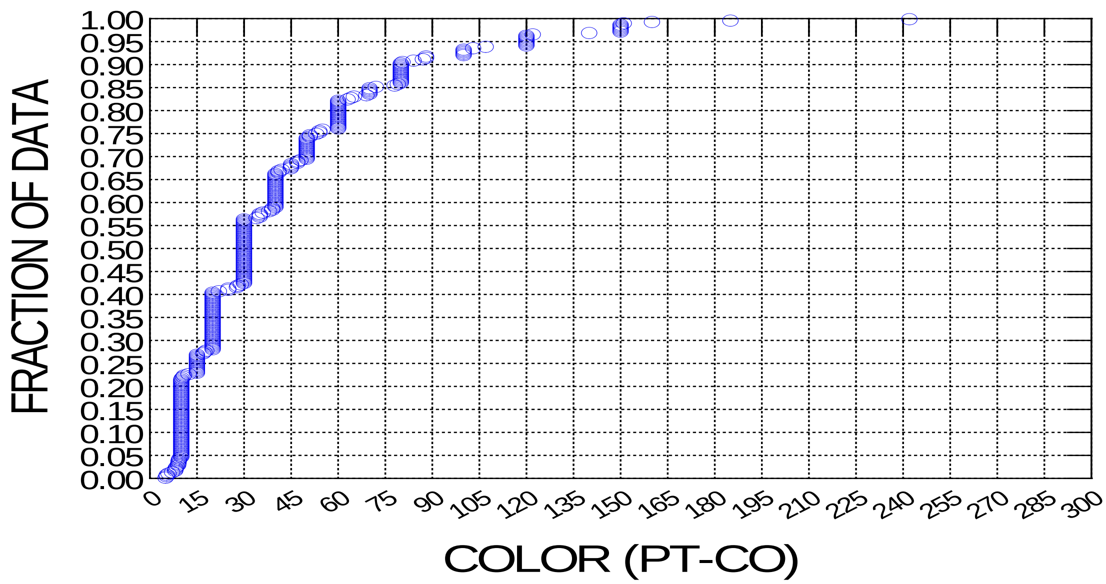

CUMULATIVE FREQUENCY PLOT CHLAC
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0 1.5 3.0 4.5 6.0 7.5 9.0 10.5 12.0 13.5 15.0 16.5 18.0 19.5 21.0 22.5 24.0 25.5 27.0 28.5 30.0
CHLAC (UG/L)

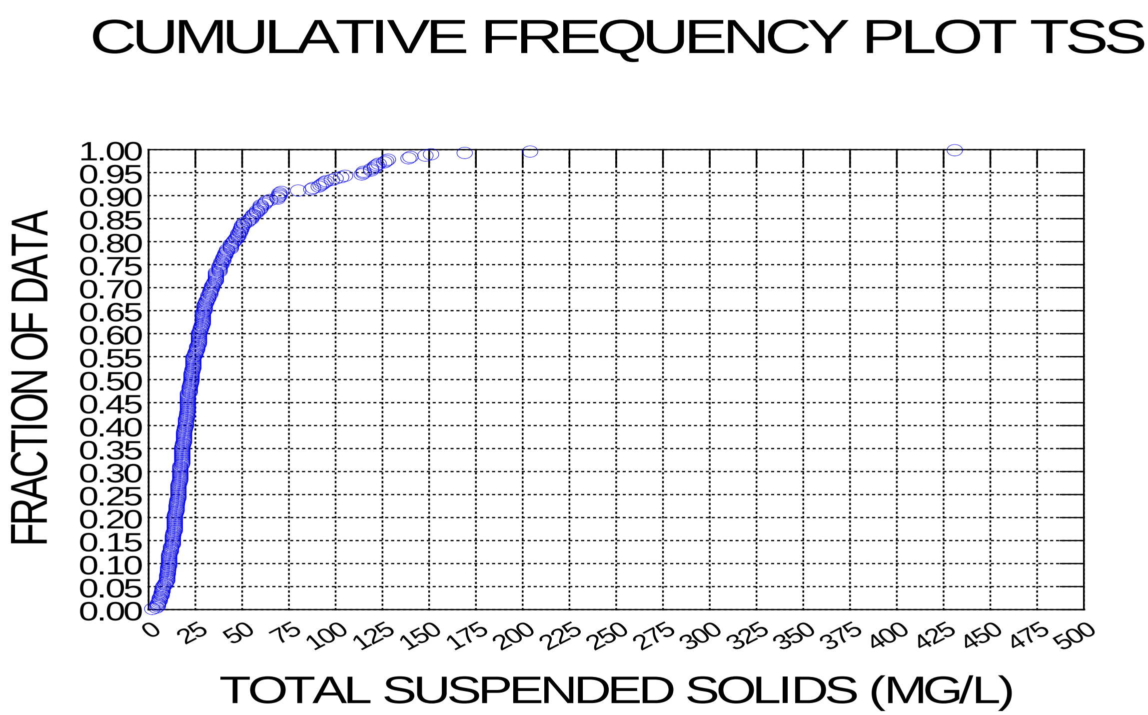

CUMULATIVE FREQUENCY PLOT TN
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20 1.35 1.50 1.65 1.80 1.95 2.10 2.25 2.40 2.55 2.70 2.85 3.00
TOTAL NITROGEN (MG/L)

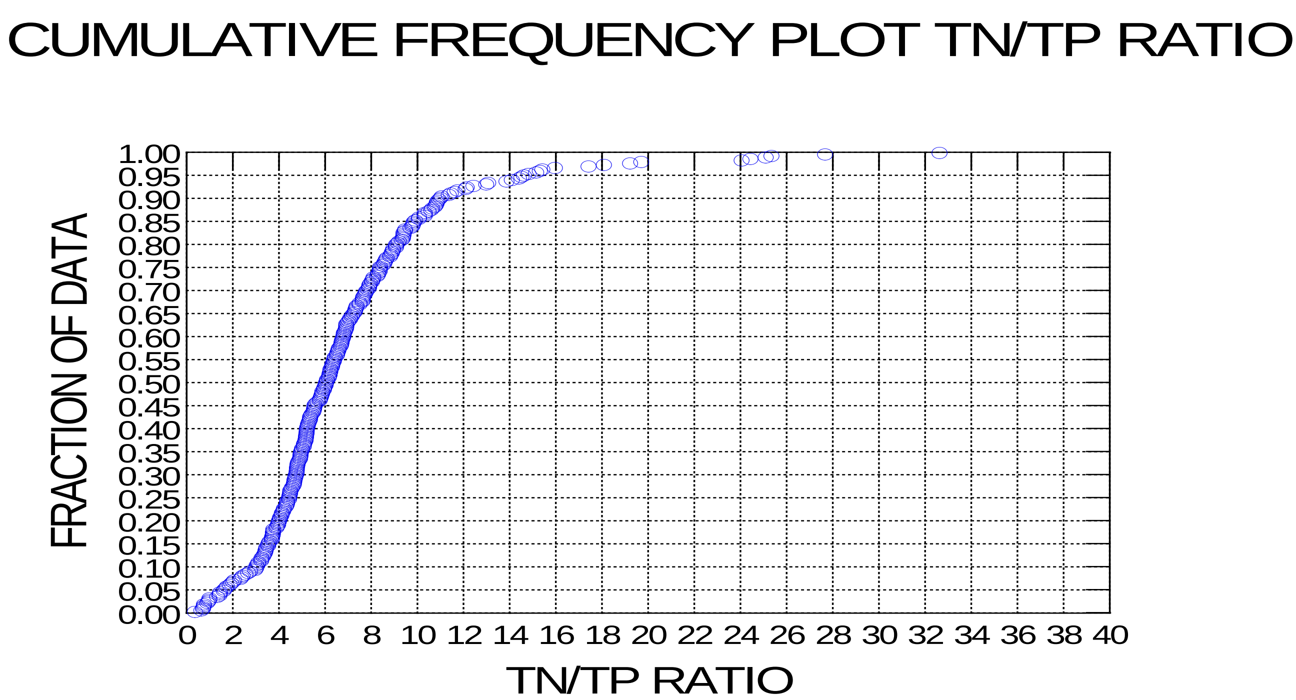
CUMULATIVE FREQUENCY PLOT TP

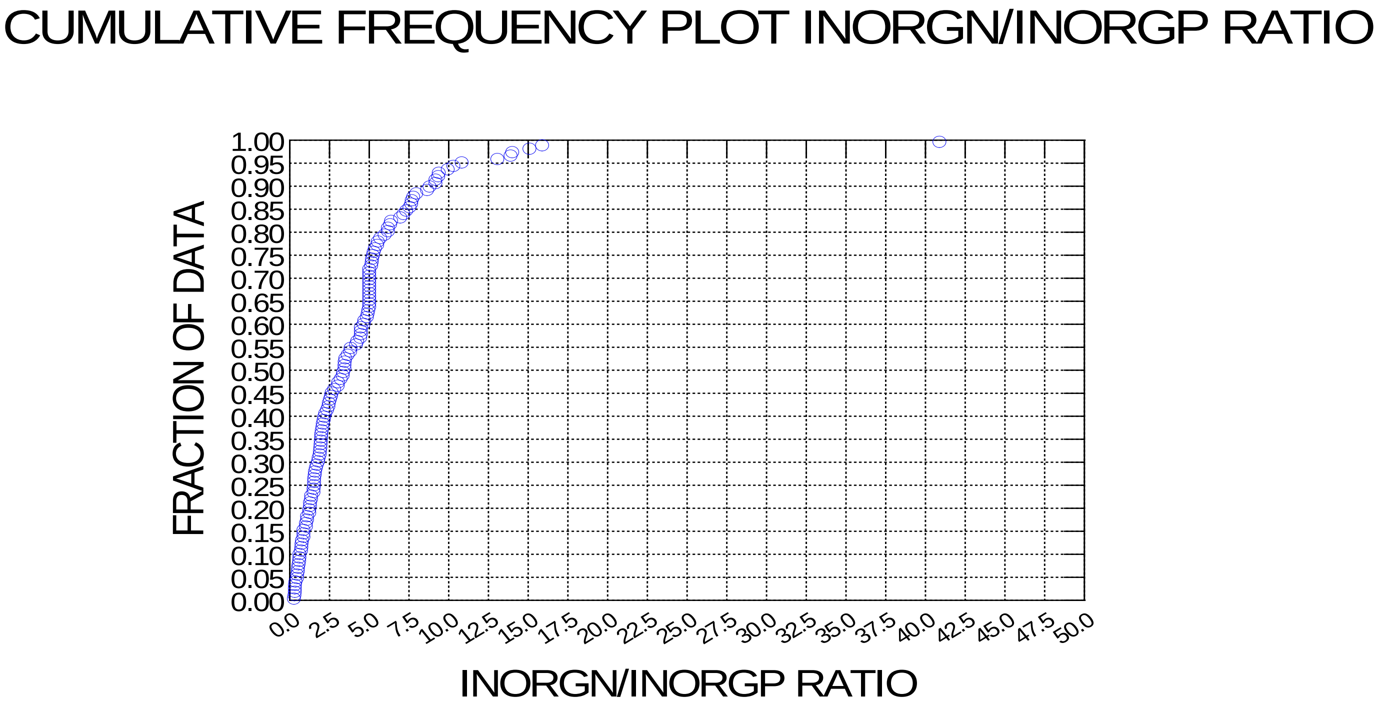


CUMULATIVE FREQUENCY PLOT COLOR




CUMULATIVE FREQUENCY PLOT TSS
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500
TOTAL SUSPENDED SOLIDS (MG/L)


CUMULATIVE FREQUENCY PLOT TN/TP RATIO
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
TN/TP RATIO


CUMULATIVE FREQUENCY PLOT INORGN/INORGP RATIO
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0
INORGN/INORGP RATIO

Appendix G Monthly and Annual Precipitation at Daytona International Airport, 1937–2011

Rainfall is in inches, and represents data from Daytona International Airport.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1937	2.22	4.73	4.14	2.69	2.59	2.96	5.64	7.72	7.96	5.69	7.43	1.52	55.29
1938	0.73	3.18	1.69	1.04	1.96	2.84	8.36	2.82	8.14	3.23	3.93	1.37	39.29
1939	1.09	0.45	1.48	5.29	2.4	6.96	9.53	5.78	7.67	2.83	0.45	1.16	45.09
1940	1.65	2.24	1.98	2.45	0.97	5.21	8.53	4.44	8.59	0.04	0.16	4.3	40.56
1941	3.42	4.4	2.01	3.11	1.32	7.29	11.46	6.56	2.86	13.68	7.47	3.72	67.3
1942	2.15	2.52	5.68	0.98	2.35	10.12	2.38	3.73	6.54	2.67	1.06	2.22	42.4
1943	1.51	0.18	6.57	2.86	3.09	4.35	11.01	10.47	11.71	7.14	0.55	0.67	60.11
1944	1.28	0.29	7.21	2.87	0.45	8.27	14.58	9.33	6.46	4.4	0.55	0.12	55.81
1945	3.62	0.88	0.41	1.53	1.56	7	7.45	6.83	9.65	5.14	0.79	4.5	49.36
1946	1.62	2.98	1.76	0.49	2.8	4.23	8.17	10.21	10.75	3.87	2.81	0.61	50.3
1947	0.78	6.04	5.29	5.31	4.82	13.43	8.65	6.97	5.75	5.72	1.98	0.9	65.64
1948	4.52	1.22	5.13	2.37	0.49	2.4	10.43	7.33	9.82	8.29	1.07	1.93	55
1949	0.37	1.95	2.01	7.12	1.4	4.24	5.97	11.46	6.26	3.65	1.86	3.93	50.22
1950	0.15	0.59	3.53	2.79	2.13	6.45	5.56	3.88	5.86	13	0.74	2.54	47.22
1951	0.77	2.46	1.18	3.28	2.53	2.66	3.8	4.19	14.02	8.54	3.15	2.88	49.46
1952	0.66	6.76	3.01	1.66	4.39	1.35	1.25	9.02	11.92	5.41	1.96	0.71	48.1
1953	1.75	3.35	7.75	4.97	1.46	1.37	8.67	19.89	10	12.93	2.3	4.85	79.29
1954	0.37	0.86	2.33	6.29	3.21	2.35	3.5	3.04	1.88	4.91	3.98	1.24	33.96
1955	2.47	1.43	1.84	1.78	1.55	7.76	5.67	2.64	6.66	3.17	2.61	1.22	38.8
1956	2.55	0.9	0.25	2.42	2.48	7.41	3.01	4.06	1.94	5.82	0.46	0.06	31.36
1957	0.97	1.62	3.13	1.73	5.65	4.23	10.53	4.01	10.65	1.8	0.82	1.34	46.48
1958	3.94	4.73	5.52	2.24	2.27	6.06	1.96	4	2.19	8.52	1.77	1.95	45.15
1959	4.53	2.13	7.7	3.17	2.4	8.13	5.68	3.6	5.26	7.12	4.26	2.26	56.24
1960	1.16	9.13	7.52	0.76	0.62	10.75	8.7	6.84	10.96	0.97	0.53	1.24	59.18
1961	1.96	3.7	1.17	2.16	2.39	6.81	5.16	7.68	3.2	2.25	2.85	0.73	40.06
1962	0.9	0.82	1.82	0.78	0.16	7.96	10.04	8.5	8.84	3.57	2.49	0.71	46.59
1963	2.91	5.83	1.46	1.4	6.82	7.42	6.89	2.01	5.43	2.71	7.98	2.17	53.03
1964	5.29	2.65	4.84	3.61	2.58	4.73	7.67	10.81	11.39	3.54	3.13	2.52	62.76
1965	2.22	3	3.05	1	0.08	9	3.72	2.97	4.33	3.65	0.97	2.14	36.13
1966	2.89	5.58	0.36	2.56	6.77	15.19	7.09	7.93	4.49	4.6	1.19	1.6	60.25
1967	1.26	3.98	0.31	0	0.73	7.51	9.04	3.02	5.56	0.19	0	2.98	34.58
1968	0.42	1.73	1.79	0.4	4.79	14.38	6.25	11.09	6.07	7.44	2.43	1.38	58.17
1969	1.53	2.03	2.74	0.12	6.47	2.47	2.61	9.4	8.89	6.97	1.96	5.03	50.22
1970	3.94	3.79	3.59	2.08	1.68	2.62	3.65	3.61	3.54	3.87	0.31	0.72	33.4
1971	0.61	5.48	2	2.57	3.12	4.73	3.2	3.97	7.2	9.53	1.33	2.49	46.23
1972	2.37	3.97	6.66	1.41	4.02	7.06	3.22	8.29	0.42	3.08	10.96	2.48	53.94
1973	4.66	2.02	2.63	3.09	2.41	4.32	4.69	7.58	5.14	4.4	0.75	2.54	44.23
1974	0.3	1.1	3.19	0.44	2.66	8.65	6.31	9.96	10.5	1.42	0.48	2.2	47.21
1975	1.66	2.27	1.52	2.96	2.99	9	6.89	3.16	6.61	5.84	1.46	0.83	45.19
1976	0.6	0.7	2.03	4.27	12.33	11.14	1.07	3.8	5.1	1.9	3.38	6	52.32
1977	4.69	2.45	1.43	0.41	4.61	1.15	2.23	7.91	6.55	1.46	3.04	4.74	40.67
1978	2.89	5.98	2.31	3.3	0.56	7.48	5.53	7.99	4.63	8.31	0.07	4.89	53.94
1979	7.1	1.94	4.08	3.96	6.13	3.03	11.69	5.24	15.2	2.13	7.96	0.56	69.02
1980	3.75	0.76	2.41	2.54	3.62	5.57	5.82	4.13	1.83	2.42	3.12	1.39	37.36

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1981	0.32	5.54	3	0.29	1.74	1.03	4.69	7.19	7.59	1.08	2.57	4.64	39.68
1982	2.46	2.08	5.81	6.04	4.68	8.29	5.31	3.21	4.96	3.23	1.58	2.53	50.18
1983	2.51	5.96	7.71	6.17	3.86	6.37	1.92	6.82	8.57	10.11	2.01	11.98	73.99
1984	1.46	3.44	1.31	5.29	6.04	2.84	6.77	4.02	10.73	1.09	3.52	0.2	46.71
1985	0.79	0.58	1.49	3.14	3.42	6.81	2.16	9.83	10.62	4.08	0.41	2.05	45.38
1986	7.16	1.28	1.85	0.44	0.99	3.5	14.43	3.47	3.58	3.47	5.08	2.76	48.01
1987	2.21	6.64	7.94	0.28	2.65	3.81	2.78	4.89	5.63	2.77	5.87	0.25	45.72
1988	5.36	1.72	4.57	1.68	1.78	2.39	2.94	4.79	6.81	1.24	6.7	0.93	40.91
1989	6.82	0.64	2.01	2.92	2.02	1.84	2.44	4.47	5.04	11.64	0.88	3.93	44.65
1990	1.42	5.61	1.94	1.48	1.45	2.71	5.85	7	1.61	5.88	0.83	0.34	36.12
1991	2.25	1.65	8.11	5.57	6.79	12.67	11.97	7.6	5.52	2.94	0.61	1.51	67.19
1992	2.42	1.71	2.28	2.81	3.13	10.64	0.16	8.86	6.57	5.21	2.15	0.47	46.41
1993	4.29	3.02	5.56	0.33	0.65	2.19	5.05	2.66	2.74	5.53	1.83	1.86	35.71
1994	5.6	2.66	3.44	5.05	3.09	6.54	6.91	7.08	5.93	4.72	12.91	2.71	66.64
1995	1.53	1.39	2.01	1.34	1.26	6.61	6.59	10.71	14.13	3.99	1.44	3.44	54.44
1996	5.53	1.32	12.15	2.22	2.28	11.35	1.9	5.7	3.92	11.15	0.96	2.01	60.49
1997	2.03	0.46	2.3	3.3	3.77	6.38	7.69	7.91	4.78	5.29	3.02	7.76	54.69
1998	4.33	7.25	3.97	0.14	0.16	0.83	5.63	7.56	5.79	1.84	1.66	1.35	40.51
1999	4.88	1.81	1.01	1.48	1.47	8.54	4.03	3.58	7.05	7.84	3.12	1.56	46.37
2000	1.8	0.65	8.48	1.15	0.32	3.08	5.09	3.17	13.55	0.93	1.14	0.8	40.16
2001	0.88	0.38	9.98	0.28	1.77	5.26	9.55	3.57	16.11	3.22	6.92	0.35	58.27
2002	2.01	2.76	1.51	2.53	1.66	12.3	7.35	11.56	3.86	2.94	1.85	9.61	59.94
2003	0.51	5.17	10.57	0.81	0.96	7.05	7.3	6.55	4.15	7.95	4.75	1.53	57.3
2004	1.25	4.47	1.1	1.19	0.49	5.2	10.34	17.96	16.46	1.34	0.93	2.24	62.97
2005	2.6	1.25	5.51	3.17	7.97	13.67	2.73	4.29	7.35	13.51	1.87	1.85	65.77
2006	0.24	4.33	0.08	1.11	0.78	5.72	4.48	4.81	2.97	2.53	1.1	3.21	31.36
2007	1.53	2.64	0.7	1.34	0.91	5.78	10.23	2.88	11.36	3.49	2.32	1.84	45.02
2008	1.3	2.12	3.2	1.34	0.63	3.64	9.48	10.33	4.29	4.45	0.96	0.93	42.67
2009	0.82	0.8	1.39	1.47	22.33	5.03	5.19	3.77	3.65	1.44	0.6	3.81	50.3
2010	5.92	3.92	6.2	1.04	4.74	2.86	3.88	5.83	3.49	0.18	0.95	0.38	39.39
2011	4.37	1.2	5.55	0.46	0.65	12.29	3.15	5.75	6.23	5.88	0.1	3.08	48.71
AVG	2.44	2.79	3.62	2.32	2.99	6.20	6.15	6.48	6.98	4.78	2.52	2.36	49.63

Appendix H: Spearman Correlation Matrix Analysis for Water Quality Parameters in Palm Coast

Spearman Correlation Matrix

- = Empty cell/no data

-	CHLAC	COLOR	DO	NH4	NO3O2
CHLAC	1.000	-	-	-	-
COLOR	-0.077	1.000	-	-	-
DO	-0.279	-0.264	1.000	-	-
NH4	-0.023	0.027	-0.084	1.000	-
NO3O2	-0.073	0.329	0.028	0.404	1.000
SALINITY	-0.021	-0.687	0.016	-0.079	-0.236
SD	-0.162	-0.382	0.321	-0.037	-0.157
TEMPC	0.461	0.230	-0.814	-0.060	-0.102
TN	0.200	0.402	-0.293	-0.059	0.150
TP	0.214	0.172	-0.273	0.160	0.233
TSS	0.100	-0.115	-0.058	0.119	-0.087
TURB	0.333	0.070	-0.229	0.168	0.112
INORGP	0.140	0.474	-0.346	-0.025	0.328
INORGN	0.003	0.132	-0.097	0.941	0.621
PRECP	0.266	0.076	-0.325	0.069	-0.134
V3DAY	0.129	0.091	-0.290	0.209	0.044
V7DAY	0.127	0.146	-0.303	0.202	0.122
V14DAY	0.241	0.322	-0.242	0.196	0.148
V21DAY	0.249	0.368	-0.185	0.124	0.155
BOD	0.316	-0.126	0.090	-0.263	-0.285

- = Empty cell/no data

-	SALINITY	SD	TEMPC	TN	TP
SALINITY	1.000	-	-	-	-
SD	0.297	1.000	-	-	-
TEMPC	0.012	-0.369	1.000	-	-
TN	-0.337	-0.329	0.295	1.000	-
TP	-0.261	-0.300	0.246	0.193	1.000
TSS	0.254	-0.254	0.126	0.045	0.066
TURB	-0.085	-0.397	0.380	0.112	0.343
INORGP	-0.322	-0.290	0.290	0.470	0.428
INORGN	-0.169	-0.081	-0.015	-0.019	0.263
PRECP	0.011	-0.075	0.311	-0.091	0.140
V3DAY	-0.123	-0.109	0.221	0.079	0.146
V7DAY	-0.177	-0.091	0.237	0.057	0.045
V14DAY	-0.362	-0.195	0.231	0.199	0.113
V21DAY	-0.437	-0.261	0.177	0.306	0.069
BOD	0.118	-0.157	0.096	0.266	-0.127

Spearman Correlation Matrix (cont.)

- = Empty cell/no data

-	TSS	TURB	INORGP	INORGN	PRECP
TSS	1.000	-	-	-	-
TURB	0.228	1.000	-	-	-
INORGP	-0.057	-0.016	1.000	-	-
INORGN	0.058	0.284	0.098	1.000	-
PRECP	0.042	-0.001	0.154	0.024	1.000
V3DAY	0.084	0.021	0.252	0.164	0.509
V7DAY	-0.034	0.011	0.257	0.190	0.353
V14DAY	-0.066	0.087	0.285	0.205	0.205
V21DAY	-0.065	0.103	0.295	0.119	0.111
BOD	0.068	-0.159	0.048	-0.350	-0.218

- = Empty cell/no data

-	V3DAY	V7DAY	V14DAY	V21DAY	BOD
V3DAY	1.000	-	-	-	-
V7DAY	0.677	1.000	-	-	-
V14DAY	0.445	0.719	1.000	-	-
V21DAY	0.341	0.572	0.826	1.000	-
BOD	-0.099	-0.058	0.035	0.108	1.000

Pairwise Frequency Table

- = Empty cell/no data

-	CHLAC	COLOR	DO	NH4	NO3O2
CHLAC	231	-	-	-	-
COLOR	194	333	-	-	-
DO	228	328	415	-	-
NH4	144	189	230	235	-
NO3O2	224	269	308	221	313
SALINITY	227	264	344	213	303
SD	227	280	330	221	298
TEMPC	227	322	406	227	305
TN	223	268	308	222	302
TP	221	314	354	230	303
TSS	201	329	337	199	276
TURB	203	283	290	198	278
INORGP	196	249	276	147	224
INORGN	143	173	212	216	216
PRECP	231	333	415	235	313
V3DAY	231	333	415	235	313
V7DAY	231	333	415	235	313
V14DAY	231	333	415	235	313
V21DAY	231	333	415	235	313
BOD	57	151	195	135	124

- = Empty cell/no data

-	SALINITY	SD	TEMPC	TN	TP
SALINITY	347	-	-	-	-
SD	313	334	-	-	-
TEMPC	341	328	409	-	-
TN	293	299	307	314	-
TP	295	302	348	308	360
TSS	271	288	331	277	323
TURB	276	291	288	277	280
INORGP	220	230	273	224	275
INORGN	208	203	208	210	212
PRECP	347	334	409	314	360
V3DAY	347	334	409	314	360
V7DAY	347	334	409	314	360
V14DAY	347	334	409	314	360
V21DAY	347	334	409	314	360
BOD	125	140	188	125	174

Pairwise Frequency Table (cont.)

= Empty cell/no data

-	TSS	TURB	INORGP	INORGN	PRECP
TSS	342	-	-	-	-
TURB	290	295	-	-	-
INORGP	259	211	281	-	-
INORGN	180	182	134	216	-
PRECP	342	295	281	216	426
V3DAY	342	295	281	216	426
V7DAY	342	295	281	216	426
V14DAY	342	295	281	216	426
V21DAY	342	295	281	216	426
BOD	162	110	106	118	195

= Empty cell/no data

-	V3DAY	V7DAY	V14DAY	V21DAY	BOD
V3DAY	426	-	-	-	-
V7DAY	426	426	-	-	-
V14DAY	426	426	426	-	-
V21DAY	426	426	426	426	-
BOD	195	195	195	195	195

Appendix I: Linear Regression Analysis of CHLAC Observations versus COND, SALINITY, TEMPC, Nutrients, COLOR, TSS, TURBIDITY, and Rainfall in Palm Coast

Note: - = Empty cell/no data in all the tables in this appendix.

Dep Var: CHLAC N: 231 Multiple R: 0.170 Squared multiple R: 0.029

Adjusted squared multiple R: 0.025 Standard error of estimate: 4.309

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	8.861	1.408	0.000	-	6.294	0.000
COND	-0.000	0.000	-0.170	1.000	-2.611	0.010

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	126.525	1	126.525	6.816	0.010
Residual	4250.979	229	18.563	-	-

*** WARNING ***
Case 2 has large leverage (Leverage = 0.103)
Case 256 is an outlier (Studentized Residual = 4.775)
Case 272 has large leverage (Leverage = 0.067)
Case 399 is an outlier (Studentized Residual = 5.789)
Case 400 is an outlier (Studentized Residual = 3.767)

Durbin-Watson D Statistic 0.993
First Order Autocorrelation 0.497

Dep Var: CHLAC N: 227 Multiple R: 0.192 Squared multiple R: 0.037

Adjusted squared multiple R: 0.032 Standard error of estimate: 4.305

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.142	1.341	0.000	-	6.817	0.000
SALINITY	-0.133	0.045	-0.192	1.000	-2.928	0.004

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	158.871	1	158.871	8.572	0.004
Residual	4170.282	225	18.535	-	-

*** WARNING ***
Case 256 is an outlier (Studentized Residual = 4.693)
Case 399 is an outlier (Studentized Residual = 5.793)
Case 400 is an outlier (Studentized Residual = 3.769)

Durbin-Watson D Statistic 1.012
First Order Autocorrelation 0.487

Dep Var: CHLAC N: 227 Multiple R: 0.453 Squared multiple R: 0.205

Adjusted squared multiple R: 0.201 Standard error of estimate: 3.904

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-2.572	1.056	0.000	-	-2.435	0.016
TEMPC	0.340	0.045	0.453	1.000	7.614	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	883.639	1	883.639	57.969	0.000
Residual	3429.763	225	15.243	-	-

*** WARNING ***
Case 256 is an outlier (Studentized Residual = 5.672)
Case 399 is an outlier (Studentized Residual = 5.335)

Durbin-Watson D Statistic 1.247
First Order Autocorrelation 0.373

Dep Var: CHLAC N: 144 Multiple R: 0.062 Squared multiple R: 0.004

Adjusted squared multiple R: 0.000 Standard error of estimate: 4.119

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.698	0.527	0.000	-	10.804	0.000
NH4	-4.535	6.162	-0.062	1.000	-0.736	0.463

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	9.188	1	9.188	0.542	0.463
Residual	2409.005	142	16.965	-	-

*** WARNING ***
Case 65 has large leverage (Leverage = 0.176)
Case 66 has large leverage (Leverage = 0.110)
Case 85 has large leverage (Leverage = 2.498)
Case 86 has large leverage (Leverage = 1.922)
Case 87 has large leverage (Leverage = 1.840)
Case 88 has large leverage (Leverage = 2.091)
Case 89 has large leverage (Leverage = 1.494)
Case 276 has large leverage (Leverage = 0.115)
Case 321 has large leverage (Leverage = 0.381)
Case 374 is an outlier (Studentized Residual = 3.939)
Case 399 is an outlier (Studentized Residual = 6.158)
Case 400 is an outlier (Studentized Residual = 3.818)

Durbin-Watson D Statistic 1.001
First Order Autocorrelation 0.492

Dep Var: CHLAC N: 224 Multiple R: 0.022 Squared multiple R: 0.000

Adjusted squared multiple R: 0.000 Standard error of estimate: 4.382

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.255	0.413	0.000	-	12.725	0.000
NO3O2	4.096	12.415	0.022	1.000	0.330	0.742

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.091	1	2.091	0.109	0.742
Residual	4262.761	222	19.202	-	-

*** WARNING ***
Case 180 has large leverage (Leverage = 0.096)
Case 256 is an outlier (Studentized Residual = 5.177)
Case 380 has large leverage (Leverage = 0.317)
Case 399 is an outlier (Studentized Residual = 5.495)

Durbin-Watson D Statistic 1.087
First Order Autocorrelation 0.452

Dep Var: CHLAC N: 143 Multiple R: 0.012 Squared multiple R: 0.000

Adjusted squared multiple R: 0.000 Standard error of estimate: 4.130

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.449	0.596	0.000	-	9.143	0.000
INORGN	-0.783	5.418	-0.012	1.000	-0.145	0.885

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.357	1	0.357	0.021	0.885
Residual	2405.492	141	17.060	-	-

*** WARNING ***
Case 65 has large leverage (Leverage = 0.124)
Case 321 has large leverage (Leverage = 0.284)
Case 374 is an outlier (Studentized Residual = 3.996)
Case 399 is an outlier (Studentized Residual = 6.173)
Case 400 is an outlier (Studentized Residual = 3.830)

Durbin-Watson D Statistic 0.975
First Order Autocorrelation 0.505

Dep Var: CHLAC N: 225 Multiple R: 0.241 Squared multiple R: 0.058

Adjusted squared multiple R: 0.054 Standard error of estimate: 4.228

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.894	0.713	0.000	-	4.059	0.000
TKN	4.622	1.247	0.241	1.000	3.708	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	245.703	1	245.703	13.747	0.000
Residual	3985.751	223	17.873	-	-

*** WARNING ***
Case 94 has large leverage (Leverage = 0.178)
Case 95 has large leverage (Leverage = 0.101)
Case 96 has large leverage (Leverage = 0.300)
Case 215 has large leverage (Leverage = 0.090)
Case 236 is an outlier (Studentized Residual = 3.824)
Case 256 is an outlier (Studentized Residual = 4.794)
Case 399 is an outlier (Studentized Residual = 5.451)

Durbin-Watson D Statistic 1.034
First Order Autocorrelation 0.475

Dep Var: CHLAC N: 223 Multiple R: 0.231 Squared multiple R: 0.053

Adjusted squared multiple R: 0.049 Standard error of estimate: 4.247

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.918	0.736	0.000	-	3.963	0.000
TN	4.382	1.241	0.231	1.000	3.533	0.001

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	225.093	1	225.093	12.479	0.001
Residual	3986.420	221	18.038	-	-

*** WARNING ***
Case 94 has large leverage (Leverage = 0.226)
Case 95 has large leverage (Leverage = 0.140)
Case 96 has large leverage (Leverage = 0.291)
Case 215 has large leverage (Leverage = 0.088)
Case 236 is an outlier (Studentized Residual = 3.790)
Case 256 is an outlier (Studentized Residual = 4.817)
Case 368 has large leverage (Leverage = 0.070)
Case 399 is an outlier (Studentized Residual = 5.419)

Durbin-Watson D Statistic 1.037
First Order Autocorrelation 0.474

Dep Var: CHLAC N: 196 Multiple R: 0.080 Squared multiple R: 0.006

Adjusted squared multiple R: 0.001 Standard error of estimate: 4.493

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.109	0.540	0.000	-	9.451	0.000
INORGP	16.626	14.842	0.080	1.000	1.120	0.264

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	25.330	1	25.330	1.255	0.264
Residual	3915.944	194	20.185	-	-

*** WARNING ***
Case 2 has large leverage (Leverage = 0.095)
Case 14 has large leverage (Leverage = 0.095)
Case 18 has large leverage (Leverage = 0.076)
Case 24 has large leverage (Leverage = 0.095)
Case 256 is an outlier (Studentized Residual = 5.031)
Case 306 has large leverage (Leverage = 0.095)
Case 399 is an outlier (Studentized Residual = 5.427)

Durbin-Watson D Statistic 1.091
First Order Autocorrelation 0.452

Dep Var: CHLAC N: 221 Multiple R: 0.024 Squared multiple R: 0.001

Adjusted squared multiple R: 0.000 Standard error of estimate: 4.377

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.246	0.440	0.000	-	11.930	0.000
TP	1.071	2.975	0.024	1.000	0.360	0.719

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.485	1	2.485	0.130	0.719
Residual	4195.641	219	19.158	-	-

*** WARNING ***
Case 16 has large leverage (Leverage = 0.111)
Case 96 has large leverage (Leverage = 0.079)
Case 97 has large leverage (Leverage = 0.130)
Case 119 has large leverage (Leverage = 0.117)
Case 121 has large leverage (Leverage = 0.097)
Case 210 has large leverage (Leverage = 0.371)
Case 213 has large leverage (Leverage = 0.080)
Case 256 is an outlier (Studentized Residual = 5.161)
Case 399 is an outlier (Studentized Residual = 5.510)

Durbin-Watson D Statistic 1.046
First Order Autocorrelation 0.473

Dep Var: CHLAC N: 194 Multiple R: 0.106 Squared multiple R: 0.011

Adjusted squared multiple R: 0.006 Standard error of estimate: 4.291

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.880	0.438	0.000	-	11.132	0.000
COLOR	0.011	0.008	0.106	1.000	1.471	0.143

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	39.855	1	39.855	2.165	0.143
Residual	3534.759	192	18.410	-	-

*** WARNING ***
Case 205 has large leverage (Leverage = 0.135)
Case 256 is an outlier (Studentized Residual = 5.100)
Case 399 is an outlier (Studentized Residual = 5.783)
Case 400 is an outlier (Studentized Residual = 3.735)

Durbin-Watson D Statistic 1.100
First Order Autocorrelation 0.444

Dep Var: CHLAC N: 201 Multiple R: 0.149 Squared multiple R: 0.022

Adjusted squared multiple R: 0.017 Standard error of estimate: 4.382

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.372	0.600	0.000	-	7.285	0.000
TSS	0.043	0.020	0.149	1.000	2.132	0.034

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	87.324	1	87.324	4.547	0.034
Residual	3821.331	199	19.203	-	-

*** WARNING ***
Case 1 has large leverage (Leverage = 0.136)
Case 2 has large leverage (Leverage = 0.083)
Case 3 has large leverage (Leverage = 0.317)
Case 4 has large leverage (Leverage = 0.094)
Case 5 has large leverage (Leverage = 0.114)
Case 7 has large leverage (Leverage = 0.668)
Case 8 has large leverage (Leverage = 0.130)
Case 13 has large leverage (Leverage = 0.194)
Case 15 has large leverage (Leverage = 0.202)
Case 16 has large leverage (Leverage = 0.194)
Case 17 has large leverage (Leverage = 0.105)
Case 18 has large leverage (Leverage = 0.433)
Case 19 has large leverage (Leverage = 0.187)
Case 20 has large leverage (Leverage = 0.198)
Case 21 has large leverage (Leverage = 0.187)
Case 22 has large leverage (Leverage = 0.215)
Case 23 has large leverage (Leverage = 0.171)
Case 24 has large leverage (Leverage = 0.332)
Case 25 has large leverage (Leverage = 0.273)
Case 26 has large leverage (Leverage = 0.219)
Case 27 has large leverage (Leverage = 0.277)
Case 28 has large leverage (Leverage = 0.099)
Case 29 has large leverage (Leverage = 0.102)
Case 30 has large leverage (Leverage = 0.223)
Case 31 has large leverage (Leverage = 0.168)
Case 32 has large leverage (Leverage = 0.171)
Case 34 has large leverage (Leverage = 0.097)
Case 35 has large leverage (Leverage = 0.120)
Case 36 has large leverage (Leverage = 3.431)
Case 37 has large leverage (Leverage = 0.086)
Case 256 is an outlier (Studentized Residual = 5.047)
Case 374 is an outlier (Studentized Residual = 3.725)
Case 399 is an outlier (Studentized Residual = 5.168)

Durbin-Watson D Statistic 1.105
First Order Autocorrelation 0.443

Dep Var: CHLAC N: 203 Multiple R: 0.349 Squared multiple R: 0.122

Adjusted squared multiple R: 0.118 Standard error of estimate: 4.144

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.200	0.684	0.000	-	3.217	0.002
TURB	0.480	0.091	0.349	1.000	5.284	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	479.287	1	479.287	27.916	0.000
Residual	3450.945	201	17.169	-	-

*** WARNING ***
Case 176 has large leverage (Leverage = 0.097)
Case 256 is an outlier (Studentized Residual = 4.638)
Case 374 is an outlier (Studentized Residual = 3.824)
Case 399 is an outlier (Studentized Residual = 5.532)
Case 402 has large leverage (Leverage = 0.076)

Durbin-Watson D Statistic 1.155
First Order Autocorrelation 0.412

Dep Var: CHLAC N: 231 Multiple R: 0.111 Squared multiple R: 0.012

Adjusted squared multiple R: 0.008 Standard error of estimate: 4.345

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.112	0.299	0.000	-	17.090	0.000
PRECP	2.603	1.543	0.111	1.000	1.687	0.093

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	53.751	1	53.751	2.847	0.093
Residual	4323.753	229	18.881	-	-

*** WARNING ***
Case 21 has large leverage (Leverage = 0.622)
Case 22 has large leverage (Leverage = 0.622)
Case 23 has large leverage (Leverage = 0.622)
Case 24 has large leverage (Leverage = 0.622)
Case 55 has large leverage (Leverage = 1.799)
Case 182 has large leverage (Leverage = 0.088)
Case 183 has large leverage (Leverage = 0.088)
Case 202 has large leverage (Leverage = 0.312)
Case 239 has large leverage (Leverage = 0.112)
Case 256 is an outlier (Studentized Residual = 5.050)
Case 311 has large leverage (Leverage = 0.109)
Case 367 has large leverage (Leverage = 0.070)
Case 374 is an outlier (Studentized Residual = 3.769)
Case 399 is an outlier (Studentized Residual = 5.616)

Durbin-Watson D Statistic 1.073
First Order Autocorrelation 0.459

Dep Var: CHLAC N: 231 Multiple R: 0.008 Squared multiple R: 0.000

Adjusted squared multiple R: 0.000 Standard error of estimate: 4.372

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.247	0.311	0.000	-	16.896	0.000
V3DAY	0.045	0.381	0.008	1.000	0.118	0.906

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.266	1	0.266	0.014	0.906
Residual	4377.238	229	19.115	-	-

*** WARNING ***
Case 21 has large leverage (Leverage = 0.073)
Case 22 has large leverage (Leverage = 0.073)
Case 23 has large leverage (Leverage = 0.073)
Case 24 has large leverage (Leverage = 0.073)
Case 55 has large leverage (Leverage = 0.099)
Case 174 has large leverage (Leverage = 0.084)
Case 256 is an outlier (Studentized Residual = 5.184)
Case 305 has large leverage (Leverage = 0.159)
Case 306 has large leverage (Leverage = 0.159)
Case 307 has large leverage (Leverage = 0.159)
Case 308 has large leverage (Leverage = 0.159)
Case 309 has large leverage (Leverage = 0.159)
Case 399 is an outlier (Studentized Residual = 5.541)

Durbin-Watson D Statistic 1.062
First Order Autocorrelation 0.465

Dep Var: CHLAC N: 231 Multiple R: 0.088 Squared multiple R: 0.008

Adjusted squared multiple R: 0.003 Standard error of estimate: 4.355

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.998	0.348	0.000	-	14.376	0.000
V7DAY	0.303	0.227	0.088	1.000	1.335	0.183

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	33.821	1	33.821	1.783	0.183
Residual	4343.683	229	18.968	-	-

*** WARNING ***
Case 174 has large leverage (Leverage = 0.070)
Case 226 has large leverage (Leverage = 0.085)
Case 256 is an outlier (Studentized Residual = 5.244)
Case 349 has large leverage (Leverage = 0.178)
Case 374 is an outlier (Studentized Residual = 3.736)
Case 399 is an outlier (Studentized Residual = 5.632)

Durbin-Watson D Statistic 1.076
First Order Autocorrelation 0.458

Dep Var: CHLAC N: 231 Multiple R: 0.266 Squared multiple R: 0.071

Adjusted squared multiple R: 0.067 Standard error of estimate: 4.215

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.284	0.363	0.000	-	11.804	0.000
V14DAY	0.526	0.126	0.266	1.000	4.173	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	309.392	1	309.392	17.416	0.000
Residual	4068.112	229	17.765	-	-

*** WARNING ***
Case 256 is an outlier (Studentized Residual = 5.174)
Case 272 has large leverage (Leverage = 0.148)
Case 374 is an outlier (Studentized Residual = 3.751)
Case 399 is an outlier (Studentized Residual = 5.978)
Case 400 is an outlier (Studentized Residual = 3.769)

Durbin-Watson D Statistic 1.061
First Order Autocorrelation 0.465

Dep Var: CHLAC N: 231 Multiple R: 0.277 Squared multiple R: 0.077

Adjusted squared multiple R: 0.073 Standard error of estimate: 4.201

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.060	0.390	0.000	-	10.410	0.000
V21DAY	0.442	0.101	0.277	1.000	4.364	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	336.124	1	336.124	19.046	0.000
Residual	4041.380	229	17.648	-	-

*** WARNING ***
Case 256 is an outlier (Studentized Residual = 5.221)
Case 272 has large leverage (Leverage = 0.095)
Case 368 has large leverage (Leverage = 0.076)
Case 374 is an outlier (Studentized Residual = 3.841)
Case 399 is an outlier (Studentized Residual = 5.912)

Durbin-Watson D Statistic 1.073
First Order Autocorrelation 0.459

Appendix J: Linear Regression Analysis of Annual Average CHLAC Observations versus COND, SALINITY, TEMPC, Nutrients, COLOR, TSS, Rainfall, TURBIDITY, and Annual Rainfall Deficits in Palm Coast

Note: - = Empty cell/no data in all the tables in this appendix.

Dep Var: CHLAC N: 13 Multiple R: 0.249 Squared multiple R: 0.062

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.107

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	12.027	7.288	0.000	-	1.650	0.127
COND	-0.000	0.000	-0.249	1.000	-0.852	0.413

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	3.219	1	3.219	0.725	0.413
Residual	48.826	11	4.439	-	-

*** WARNING ***
Case 16 is an outlier (Studentized Residual = 3.663)

Durbin-Watson D Statistic 1.381
First Order Autocorrelation 0.006

Dep Var: CHLAC N: 13 Multiple R: 0.193 Squared multiple R: 0.037

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.134

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	10.166	6.650	0.000	-	1.529	0.155
SALINITY	-0.152	0.233	-0.193	1.000	-0.653	0.527

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	1.942	1	1.942	0.426	0.527
Residual	50.103	11	4.555	-	-

*** WARNING ***
Case 16 is an outlier (Studentized Residual = 3.638)

Durbin-Watson D Statistic 1.411
First Order Autocorrelation 0.011

Dep Var: CHLAC N: 13 Multiple R: 0.197 Squared multiple R: 0.039

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.133

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	18.791	19.475	0.000	-	0.965	0.355
TEMPC	-0.552	0.830	-0.197	1.000	-0.665	0.520

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.013	1	2.013	0.443	0.520
Residual	50.032	11	4.548	-	-

Durbin-Watson D Statistic 1.425
First Order Autocorrelation 0.093

Dep Var: CHLAC N: 6 Multiple R: 0.506 Squared multiple R: 0.256

Adjusted squared multiple R: 0.070 Standard error of estimate: 1.863

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	10.121	3.606	0.000	-	2.807	0.048
INORGN	-43.699	37.228	-0.506	1.000	-1.174	0.306

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4.781	1	4.781	1.378	0.306
Residual	13.880	4	3.470	-	-

*** WARNING ***
Case 2 has large leverage (Leverage = 1.838)
Case 16 is an outlier (Studentized Residual = 4.559)

Durbin-Watson D Statistic 1.243
First Order Autocorrelation 0.106

Dep Var: CHLAC N: 6 Multiple R: 0.463 Squared multiple R: 0.214

Adjusted squared multiple R: 0.017 Standard error of estimate: 1.915

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.311	3.283	0.000	-	2.836	0.047
NH4	-47.354	45.379	-0.463	1.000	-1.044	0.356

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	3.993	1	3.993	1.089	0.356
Residual	14.668	4	3.667	-	-

*** WARNING ***
Case 2 has large leverage (Leverage = 1.544)
Case 11 has large leverage (Leverage = 0.685)
Case 16 is an outlier (Studentized Residual = 4.675)

Durbin-Watson D Statistic 1.479
First Order Autocorrelation -0.079

Dep Var: CHLAC N: 13 Multiple R: 0.346 Squared multiple R: 0.119

Adjusted squared multiple R: 0.039 Standard error of estimate: 2.041

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	7.146	1.209	0.000	-	5.911	0.000
NO3O2	-56.839	46.521	-0.346	1.000	-1.222	0.247

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	6.219	1	6.219	1.493	0.247
Residual	45.826	11	4.166	-	-

*** WARNING ***
Case 15 has large leverage (Leverage = 0.745)

Durbin-Watson D Statistic 1.354
First Order Autocorrelation 0.128

Dep Var: CHLAC N: 13 Multiple R: 0.220 Squared multiple R: 0.049

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.122

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.685	5.161	0.000	-	1.877	0.087
TN	-7.320	9.763	-0.220	1.000	-0.750	0.469

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.530	1	2.530	0.562	0.469
Residual	49.515	11	4.501	-	-

Durbin-Watson D Statistic 1.332
First Order Autocorrelation 0.130

Dep Var: CHLAC N: 13 Multiple R: 0.587 Squared multiple R: 0.345

Adjusted squared multiple R: 0.285 Standard error of estimate: 1.760

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.887	1.750	0.000	-	5.649	0.000
INORGP	-134.647	55.935	-0.587	1.000	-2.407	0.035

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	17.957	1	17.957	5.795	0.035
Residual	34.088	11	3.099	-	-

Durbin-Watson D Statistic 1.641
First Order Autocorrelation 0.104

Dep Var: CHLAC N: 13 Multiple R: 0.474 Squared multiple R: 0.225

Adjusted squared multiple R: 0.154 Standard error of estimate: 1.915

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	8.559	1.612	0.000	-	5.310	0.000
TP	-23.216	12.997	-0.474	1.000	-1.786	0.102

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	11.702	1	11.702	3.191	0.102
Residual	40.343	11	3.668	-	-

*** WARNING ***
Case 5 has large leverage (Leverage = 0.671)

Durbin-Watson D Statistic 1.153
First Order Autocorrelation 0.153

Dep Var: CHLAC N: 12 Multiple R: 0.631 Squared multiple R: 0.398

Adjusted squared multiple R: 0.338 Standard error of estimate: 1.470

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.574	1.215	0.000	-	2.118	0.060
TNLOAD	0.000	0.000	0.631	1.000	2.572	0.028

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	14.290	1	14.290	6.614	0.028
Residual	21.608	10	2.161	-	-

*** WARNING ***
Case 14 is an outlier (Studentized Residual = -3.334)

Durbin-Watson D Statistic 1.932
First Order Autocorrelation -0.048

Dep Var: CHLAC N: 12 Multiple R: 0.7087570 Squared multiple R: 0.5023364

Adjusted squared multiple R: 0.4525701 Standard error of estimate: 1.3315726

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.2392320	1.1008362	0.0000000	-	2.03412	0.06933
TNLOAD	0.0000028	0.0000009	0.7087570	1.00E+00	3.17709	0.00987

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	17.8973404	1	17.8973404	10.0938953	0.0098681
Residual	17.7308559	10	1.7730856	-	-

*** WARNING ***
Case 11 is an outlier (Studentized Residual = -2.6792447)

Durbin-Watson D Statistic 1.8617739
First Order Autocorrelation -0.0205059

Dep Var: CHLAC N: 12 Multiple R: 0.6266030 Squared multiple R: 0.3926314

Adjusted squared multiple R: 0.3318945 Standard error of estimate: 1.4710353

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.4833495	1.6421455	0.0000000	-	0.90330	0.38761
TPLOAD	0.0000348	0.0000137	0.6266030	1.00E+00	2.54253	0.02924

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	13.9887475	1	13.9887475	6.4644657	0.0292360
Residual	21.6394488	10	2.1639449	-	-

Durbin-Watson D Statistic 2.0448704
First Order Autocorrelation -0.1062962

Dep Var: CHLAC N: 13 Multiple R: 0.265 Squared multiple R: 0.070

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.098

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.173	2.987	0.000	-	1.062	0.311
RAINFALL	0.053	0.058	0.265	1.000	0.911	0.382

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	3.650	1	3.650	0.830	0.382
Residual	48.395	11	4.400	-	-

*** WARNING ***
Case 16 is an outlier (Studentized Residual = 3.149)

Durbin-Watson D Statistic 1.622
First Order Autocorrelation -0.097

Dep Var: CHLAC N: 13 Multiple R: 0.392 Squared multiple R: 0.153

Adjusted squared multiple R: 0.076 Standard error of estimate: 2.001

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	7.503	1.302	0.000	-	5.764	0.000
COLOR	-0.041	0.029	-0.392	1.000	-1.411	0.186

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	7.981	1	7.981	1.992	0.186
Residual	44.064	11	4.006	-	-

Durbin-Watson D Statistic 1.849
First Order Autocorrelation -0.047

Dep Var: CHLAC N: 13 Multiple R: 0.441 Squared multiple R: 0.194

Adjusted squared multiple R: 0.121 Standard error of estimate: 1.952

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.833	1.924	0.000	-	1.473	0.169
TSS	0.119	0.073	0.441	1.000	1.629	0.132

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	10.118	1	10.118	2.654	0.132
Residual	41.927	11	3.812	-	-

*** WARNING ***
Case 5 is an outlier (Studentized Residual = -2.770)

Durbin-Watson D Statistic 1.531
First Order Autocorrelation 0.130

Dep Var: CHLAC N: 13 Multiple R: 0.859 Squared multiple R: 0.739

Adjusted squared multiple R: 0.715 Standard error of estimate: 1.112

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-4.207	1.828	0.000	-	-2.301	0.042
TURB	1.559	0.280	0.859	1.000	5.576	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	38.443	1	38.443	31.089	0.000
Residual	13.602	11	1.237	-	-

*** WARNING ***
Case 6 has large leverage (Leverage = 0.796)

Durbin-Watson D Statistic 1.511
First Order Autocorrelation 0.157

Dep Var: CHLAC N: 13 Multiple R: 0.265 Squared multiple R: 0.070

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.098

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.803	0.583	0.000	-	9.949	0.000
ANNUALDEFIC	0.053	0.058	0.265	1.000	0.911	0.382

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	3.650	1	3.650	0.830	0.382
Residual	48.395	11	4.400	-	-

*** WARNING ***
Case 16 is an outlier (Studentized Residual = 3.149)

Durbin-Watson D Statistic 1.622
First Order Autocorrelation -0.097

Dep Var: CHLAC N: 13 Multiple R: 0.027 Squared multiple R: 0.001

Adjusted squared multiple R: 0.000 Standard error of estimate: 2.174

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.826	0.625	0.000	-	9.323	0.000
VDEFICIT3YEA	0.003	0.031	0.027	1.000	0.089	0.931

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.038	1	0.038	0.008	0.931
Residual	52.007	11	4.728	-	-

Durbin-Watson D Statistic 1.516
First Order Autocorrelation 0.028

Dep Var: CHLAC   N: 13   Multiple R: 0.422   Squared multiple R: 0.178

Adjusted squared multiple R: 0.103   Standard error of estimate: 1.972

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	6.233	0.603	0.000	-	10.331	0.000
DEFICIT5YEAR	-0.036	0.023	-0.422	1.000	-1.542	0.151

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	9.251	1	9.251	2.378	0.151
Residual	42.794	11	3.890	-	-

Durbin-Watson D Statistic 1.702
First Order Autocorrelation 0.049

Appendix K: Precipitation at Daytona International Airport

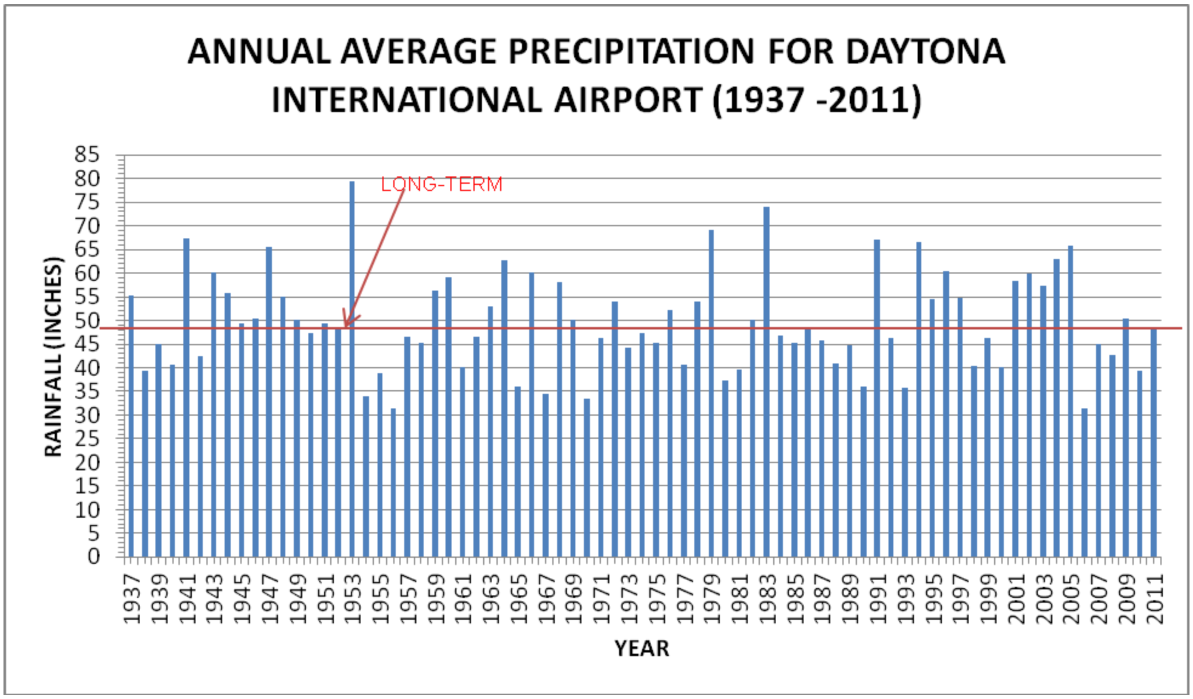


Figure K.1. Annual Average Precipitation at Daytona International Airport (1937–2011)

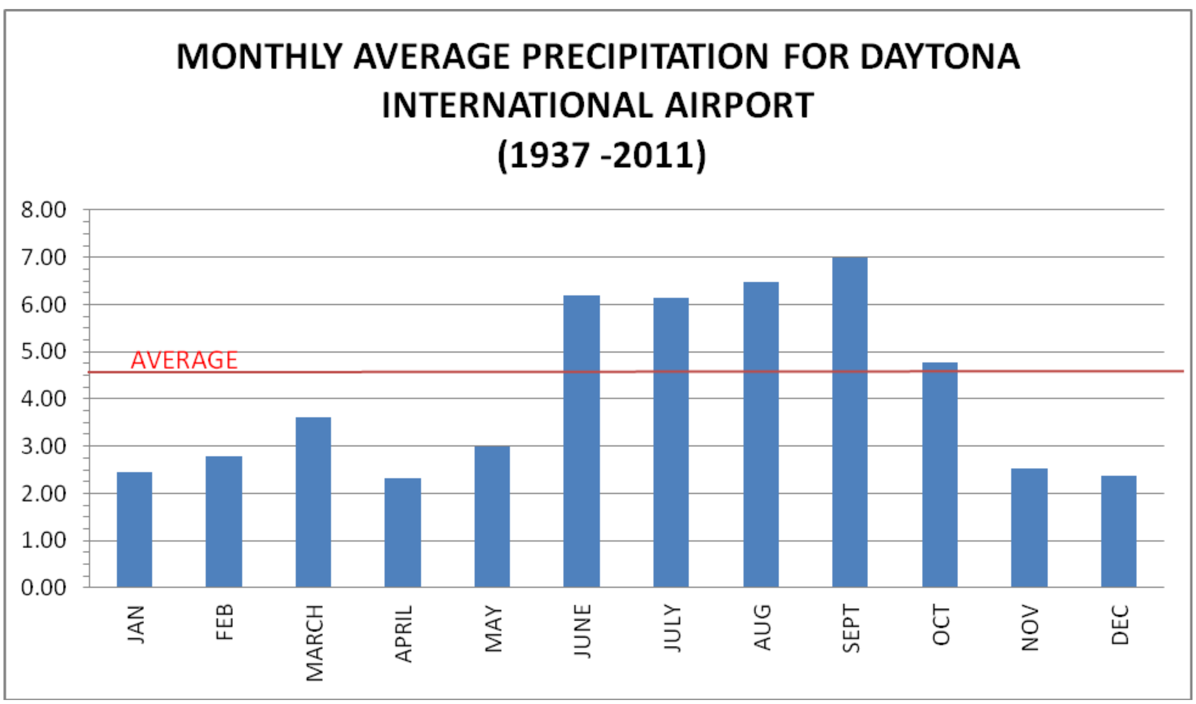


Figure K.2. Monthly Average Precipitation at Daytona International Airport (1937–2011)

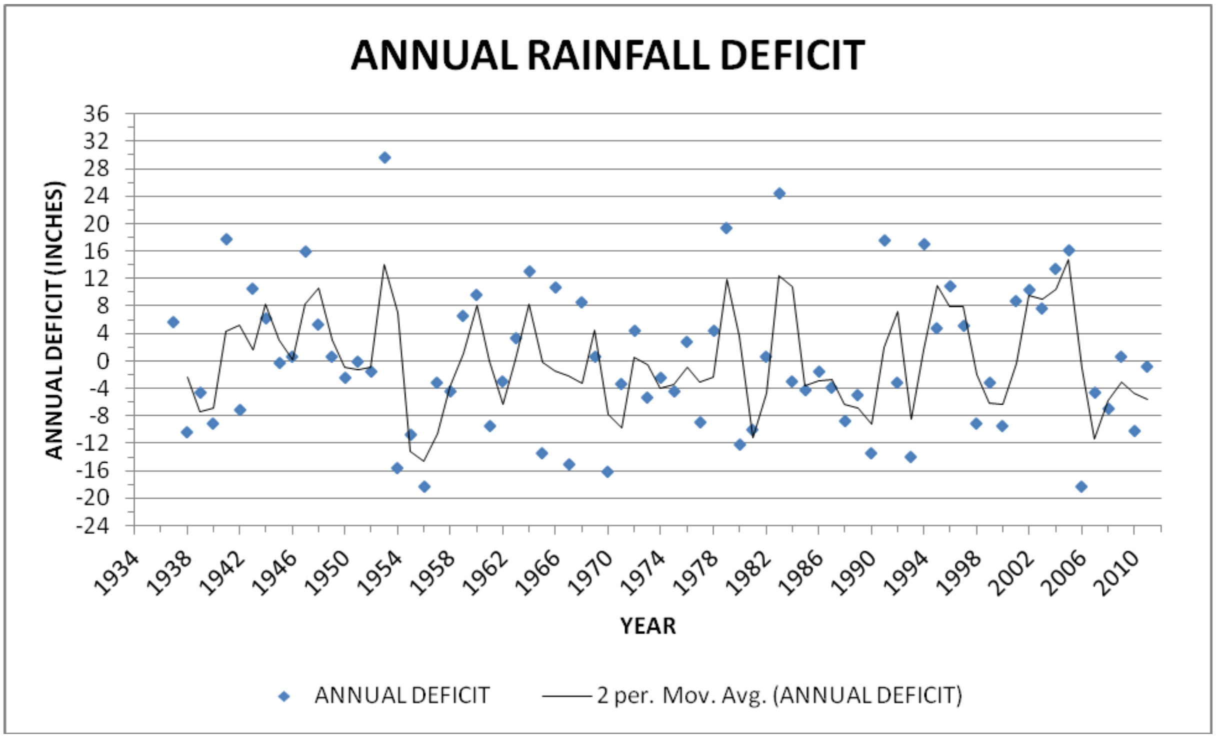


Figure K.3. Annual Rainfall Deficit at Daytona International Airport (1937–2011)

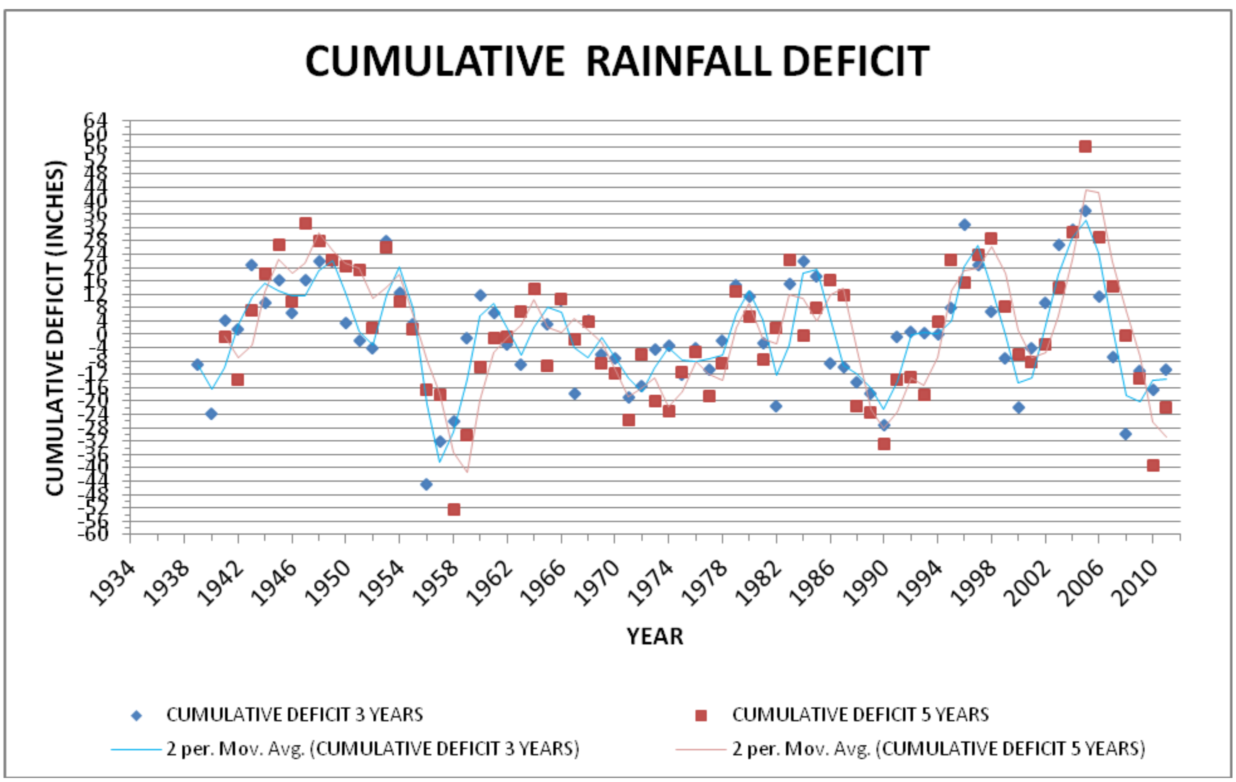


Figure K.4. Cumulative Rainfall Deficit at Daytona International Airport (1937–2011)

Table K.1. Annual Rainfall Ranks and Percentiles

Note: Ranking of years 2008 – 2011 are highlighted in yellow

Year	Annual Total (inches)	Rank	Percentile
1956	31.36	1	1.33%
2006	31.36	2	2.67%
1970	33.4	3	4.00%
1954	33.96	4	5.33%
1967	34.58	5	6.67%
1993	35.71	6	8.00%
1990	36.12	7	9.33%
1965	36.13	8	10.67%
1980	37.36	9	12.00%
1955	38.8	10	13.33%
1938	39.29	11	14.67%
2010	**39.39**	**12**	**16.00%**
1981	39.68	13	17.33%
1961	40.06	14	18.67%
2000	40.16	15	20.00%
1998	40.51	16	21.33%
1940	40.56	17	22.67%
1977	40.67	18	24.00%
1988	40.91	19	25.33%
1942	42.4	20	26.67%
2008	**42.67**	**21**	**28.00%**
1973	44.23	22	29.33%
1989	44.65	23	30.67%
2007	45.02	24	32.00%
1939	45.09	25	33.33%
1958	45.15	26	34.67%
1975	45.19	27	36.00%
1985	45.38	28	37.33%
1987	45.72	29	38.67%
1971	46.23	30	40.00%
1999	46.37	31	41.33%
1992	46.41	32	42.67%
1957	46.48	33	44.00%
1962	46.59	34	45.33%
1984	46.71	35	46.67%
1974	47.21	36	48.00%
1950	47.22	37	49.33%
1986	48.01	38	50.67%
1952	48.1	39	52.00%

Year	Annual Total (inches)	Rank	Percentile
2011	**48.71**	**40**	**53.33%**
1945	49.36	41	54.67%
1951	49.46	42	56.00%
1982	50.18	43	57.33%
1949	50.22	44	58.67%
1969	50.22	45	60.00%
1946	50.3	46	61.33%
2009	**50.3**	**47**	**62.67%**
1976	52.32	48	64.00%
1963	53.03	49	65.33%
1972	53.94	50	66.67%
1978	53.94	51	68.00%
1995	54.44	52	69.33%
1997	54.69	53	70.67%
1948	55	54	72.00%
1937	55.29	55	73.33%
1944	55.81	56	74.67%
1959	56.24	57	76.00%
2003	57.3	58	77.33%
1968	58.17	59	78.67%
2001	58.27	60	80.00%
1960	59.18	61	81.33%
2002	59.94	62	82.67%
1943	60.11	63	84.00%
1966	60.25	64	85.33%
1996	60.49	65	86.67%
1964	62.76	66	88.00%
2004	62.97	67	89.33%
1947	65.64	68	90.67%
2005	65.77	69	92.00%
1994	66.64	70	93.33%
1991	67.19	71	94.67%
1941	67.3	72	96.00%
1979	69.02	73	97.33%
1983	73.99	74	98.67%
1953	79.29	75	100.00%

Appendix L: Response to Comments

Comments prepared on behalf of FDOT by Applied Technology and Management, Inc.

COMMENTS ON
FDEP Proposed Total Maximum Daily Load for Nutrients
Palm Coast (WBID 2363D)

September 21, 2012

TMDL SUMMARY

TMDL Waste Load and Load Allocation for Palm Coast (WBID 2363D)

[1]As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.

Parameter	WLA for Wastewater (lbs/yr)	WLA for NPDES Stormwater (% reduction)[1]	Load Allocation (% reduction)[1]	Margin of Safety	TMDL (mg/L)
TN	122,190A	21	21	Implicit	901,338
TP	33,120	16	16	Implicit	94,593

The Total Maximum Daily Load (TMDL) was determined based on the linear regression between the Station 21FLSJWMJXTR26 annual average Chlorophyll *a* (CHLAC) and Loading Simulation Program in C++ (LSPC) watershed model total nitrogen (TN) and total phosphorus (TP) loading results. A 21 percent reduction in the average TN load [from 1,138,071 pounds per year (lb/yr) to 901,338 lb/yr] would be required to achieve a target CHLAC annual average of 4.5 micrograms per liter (µg/L). A 16 percent reduction in the average TP load (from 112,826 lb/yr to 94,593 lb/yr) based on the linear regression between the station 21FLSJWMJXTR26 annual average CHLAC and watershed model TP load, would be required to meet the CHLAC target.

SUMMARY OF FINDINGS

The following are the key issues identified in this review of the TMDL proposal.

1. The TMDL was determined based on the linear regression on data from one station, Station 21FLSJWMJXTR26 annual average CHLAC and LSPC watershed model TN and TP loading results. This excludes approximately 30 percent of the available CHLAC data from the regression.

Response: Table 5.1 identified the 6 stations with historical CHLAC measurements. In response to this comment, tables and graphs in Chapter 5 have been updated with additional observations at Station 21FLSJWMJXTR26 obtained in a recent Florida STORET submittal by the SJRWMD. As a result, an annual average CHLAC could be calculated for 2011. Nearly 73% of the CHLAC measurements are from this station. Since Station 21FLA 27010104 is also at the same location as 21FLSJWMJXTR26, data from the 2 sites were combined for the annual average regressions (77% of all the observations). With respect to the comment regarding the exclusion of nearly 30% of the observations from the regression, 17 of the 54 observations (31% of the observations from these sites and 7% of the total observations) from the remaining 4 stations (21FL 27010102, 21FL 27010103, 21FL 27010105, and 21FL 27010150) occurred in years in which insufficient measurements were available in all 4 quarters and precluded the calculation of an annual CHLAC average. The draft analysis included an annual average CHLAC value for 2000 but there was a quarter without data, and so this year was removed from the regressions. The above changes resulted in the TMDL TN reduction increasing from 21% to 29% and the TP reduction increasing from 16% to 23%.

2. The LSPC model results (provided by Tetra Tech) were used in the development of the TMDL, both in the development of the CHLAC-nutrient relationships and the calculation of the existing loads. No presentation of modeling methodology or calibration is included in the report and, as such, a complete review of the model and its assumptions is not possible. The report references the larger scale watershed model for the Matanzas and Halifax Rivers that was developed as part of the U.S. Environmental Protection Agency (EPA) efforts to establish numeric nutrient criteria for Florida estuaries. Unfortunately, the documents that describe this and other similar efforts by EPA do not appear to be available. Therefore, no documentation whatsoever is provided for the larger scale models. This lack of sufficient information does not allow for a complete assessment/review of the model and resulting TMDL.

Response: Appendix C has been added to the document that describes the application of the LSPC watershed model to the Daytona Basin.

3. The TMDL report indicates that the possible causative pollutant is TN. Reductions are proposed for both TN and TP.

Response: As described in Section 1.1, TN was identified as the limiting nutrient in the listing process based on the median TN/TP ratio. A more detailed analysis of the relationship between CHLAC and various water quality parameters is provided in Chapter 5. Appendix J presents simple linear regressions of annual average CHLAC concentrations versus various annual average water quality parameters. The regression of annual average CHLAC versus annual average inorganic P was significant at an α level of 0.05, as were the regressions with annual TN and TP loads estimated from the LSPC watershed model.

4. Although not on the Florida Department of Environmental Protection (FDEP) list of municipal separate storm sewer system (MS4) permit holders for Flagler County, Florida Department of Transportation (FDOT) District 5 does have an MS4 permit for Flagler County.

Response: Section 4.2 has been updated to include the FDOT District 5 as an MS4 permittee in the watershed.

Recommendation: The primary issue with the TMDL is the lack of complete information within the TMDL report regarding how the modeling was performed. Given the lack of documentation on model, it is recommended that EPA provide FDEP updated and complete modeling reports. Once complete modeling reports are provided, the TMDLs should be re-issued as draft for review.

Response: A report on the LSPC watershed model application to the Daytona Basin has been provided and is included as Appendix C.