FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHWEST DISTRICT • PENSACOLA BASIN

Final REPORT

Nutrient TMDLs
North Escambia Bay (WBID 548AA)
Judges Bayou (WBID 493B)
Bayou Chico (WBIDs 846C and 846)

Dissolved Oxygen TMDL
Judges Bayou (WBID 493A)

Douglas Gilbert

June 7, 2013

Acknowledgments

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Websites

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 Integrated 305(b) Report

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

Criteria for Surface Water Quality Classifications

http://www/dep.state.fl.us/legal/legaldocuments/rules/ruleslistnum.htm

Basin Status Report: Pensacola Bay

http://www.dep.state.fl.us/water/basin411/pensacola/index.htm

Water Quality Assessment Report: Pensacola Bay

http://www.dep.state.fl.us/water/basin411/pensacola/index.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 (TMDL) for nutrients for multiple impaired waters in the Pensacola Bay Basin. **Figure 1.1** depicts the major features of the basin. The impaired waters consist of two marine segments of Bayou Chico and the marine segment of Judges Bayou, which are verified as impaired for nutrients due to elevated chlorophyll *a* (Chla). The North Escambia Bay segment is verified as impaired for nutrients because it exceeded the threshold for historical Chla. Additionally, the freshwater tributaries to Judges Bayou are verified as impaired for dissolved oxygen (DO) and linked to elevated nitrogen concentrations. These waters were included on the Verified List of impaired waters for the Pensacola Bay Basin that was adopted by Secretarial Order on November 2, 2010. The TMDLs establish the allowable loadings to these waters that would restore each waterbody so that it meets the applicable water quality standards.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Pensacola Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. North Escambia Bay is WBID 548AA; Judges Bayou is WBIDs 493A (freshwater) and 493B (marine); and Bayou Chico is WBIDs 846 and 846C (both marine).

1.2.1 Bayou Chico

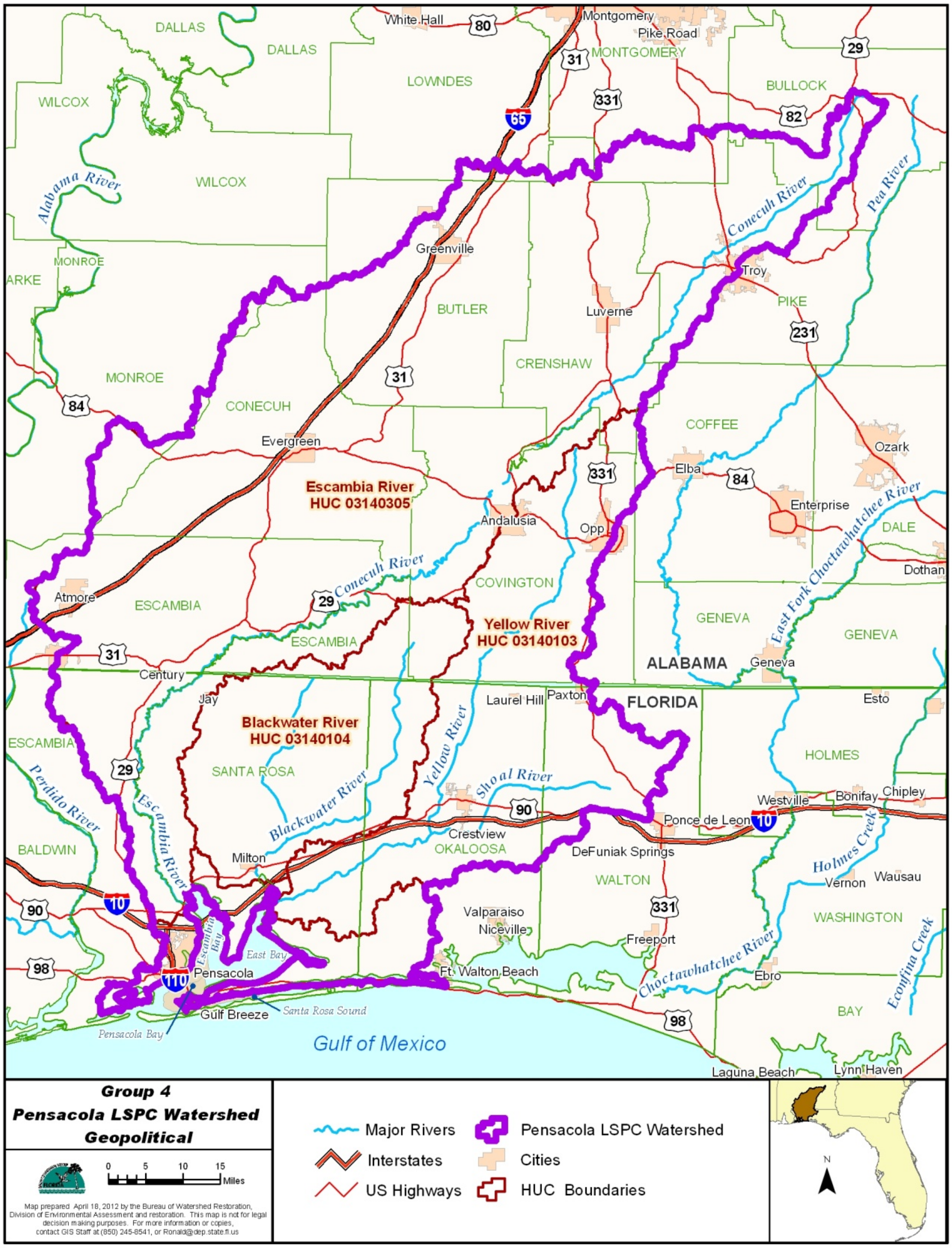
The Bayou Chico watershed (10.36 square miles) is located at the southern end of Escambia County (**Figure 1.2**) and includes drainage from a small area in the city of Pensacola. Bayou Chico has two tributaries: Jackson Creek to the north, a first-order stream, and Jones Creek to the south, potentially a third-order stream (Department 1999; 2006).

1.2.2 Judges Bayou

The Judges Bayou watershed (1.89 square miles) is located along the eastern side of North Escambia Bay in Santa Rosa County (**Figure 1.2**). Two creek systems drain to the marine portion of Judges Bayou. St. Regis Branch, located to the north, drains the Sterling Fibers Facility (National Pollutant Discharge Elimination System [NPDES] Permit FL0002593) upper landfill, new Pond No. 3, the original wastewater spray irrigation field, and sludge lagoons A, B, and C. This first-/second-order stream originates on the seepage slopes below the industrial waste ponds, as depicted in **Figure 2.16** (Department 2001a). The second tributary, Judges Branch—also a first-/second-order stream—is situated south of St. Regis Branch, as shown in **Figure 2.16** (Department 2001b).

1.2.3 North Escambia Bay

The Escambia Bay watershed, located in Escambia and Santa Rosa Counties, Florida, has an 18,000-square-kilometer (km^2) drainage area (Department 2012) reaching into Alabama



Group 4
Pensacola LSPC Watershed
Geopolitical

Map prepared April 18, 2012 by the Bureau of Watershed Restoration, Division of Environmental Assessment and restoration. This map is not for legal decision making purposes. For more information or copies, contact GIS Staff at (850) 245-8541, or Ronald@dep.state.fl.us

Figure 1.1. Major Geopolitical and Hydrologic Features of the Pensacola Basin in Alabama and Florida

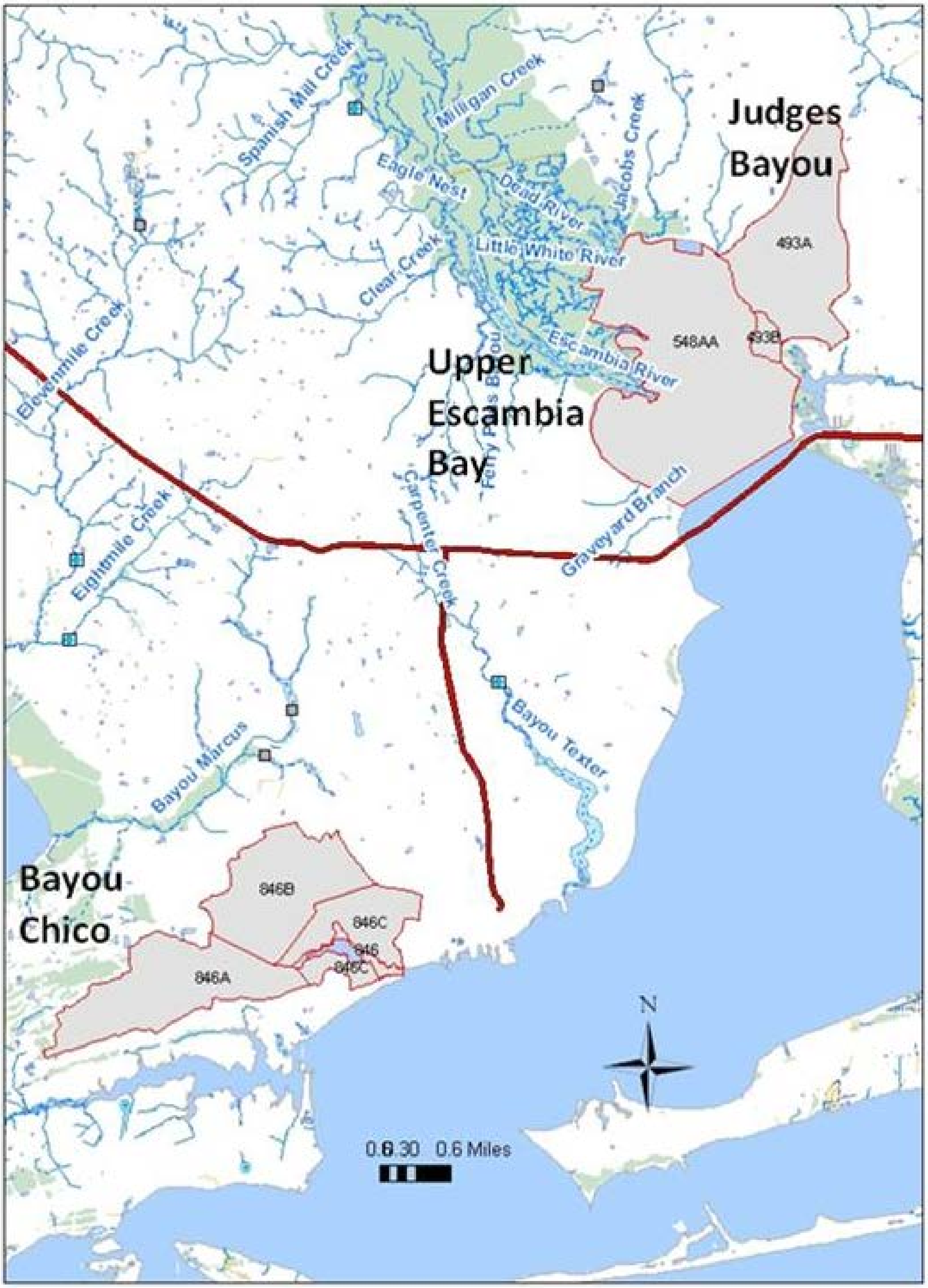


Figure 1.2. Location of the North Escambia Bay, Judges Bayou, and Bayou Chico Watersheds in the Pensacola Bay Basin

(**Figure 1.1**). Approximately 29% (5,143 km^2) of the watershed is located in the state of Florida and the remaining 71% in Alabama. The Escambia River (the Conecuh River in Alabama) is about 240 miles long (Thorpe 1997). In Florida, the Escambia River runs about 60 miles from the state line to the mouth of Escambia Bay (U.S. Army Corps of Engineers [ACOE] 1985). Major centers of population in the Alabama portion of the watershed include Troy, Luverne, Greenville, Evergreen, Andalusia, and Brewton. Major population centers in Florida include Century, Pensacola, Milton, and Crestview. The Escambia River is a fifth-order river fed by the sand and gravel aquifer.

Additional information about the river's hydrology and geology is available in the *Water Quality Status Report: Pensacola Bay* (Department 2004); the report *The Ecological Condition of the Pensacola Bay System, Northwest Florida* (U.S. Environmental Protection Agency [EPA] 2005); and the document *Site-Specific Information in Support of Establishing Numeric Nutrient Criteria for Pensacola Bay* (Department 2012).

1.3 Background

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet its designated uses. A waterbody that does not meet its designated uses is defined as impaired. TMDLs must be developed and implemented for each of the state's impaired waters, unless the impairment is documented to be a naturally occurring condition that cannot be abated by a TMDL or unless a management plan already in place is expected to correct the problem.

This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan(s), or BMAP(s), to reduce the amount of nutrients that caused the verified impairments in Bayou Chico, Judges Bayou, and North Escambia Bay. These activities will depend heavily on the active participation of the state of Alabama (for North Escambia Bay), the Northwest Florida Water Management District (NWFWMD), local governments, businesses, and other stakeholders. While the required nonpoint source percent reduction for nutrients is specified in Chapter 6, no specific projects are currently identified. The Department will work with these organizations and individuals during the development of the BMAP to identify specific projects to reduce nutrient discharges and achieve the established TMDLs for the impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Legislative and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of the 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 Florida Watershed Restoration Act (FWRA) (Subsection 403.067[4)], Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Bayou Chico, Judges Bayou, and North Escambia Bay were included on Florida's 1998 303(d) list. 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. 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 amended in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Pensacola Bay Basin and has verified the nutrient and DO impairments listed in **Table 2.1** in accordance with the impairment thresholds and water quality criteria described in Chapter 3.

All raw data included in the report are available by contacting the Department's Watershed Evaluation and TMDL Sections. Data from IWR Run 44 were processed by examining each result for appropriateness. All results are for corrected chlorophyll (CChla). Any results that were rejected are flagged with the remark code (Rcode) xxx in the Excel spreadsheets used to process the data. These spreadsheets are available on request.

The remaining data provide the basis for preparing the figures and summary statistics. The annual averages were calculated from these data by averaging for each calendar quarter and then averaging the four quarters to determine the annual average. In all figures and tables, years with at least one result in each calendar quarter are represented with the number **4** as a suffix to the label. Data presented that do not include at least one result from each calendar quarter are presented with the suffix **<** added to the label, and these data are not used to plot trend lines. Data used to make a determination of impairment in a waterbody must meet the stringent data quality and temporal and spatial processing requirements of the IWR. This may result in some data being excluded from the assessment process. Any data not included in the assessment are flagged in the IWR dataset. Subsequent to the presentation of the assessment results, all data that met the general quality control requirements for data were incorporated. This may result in summary statistics that are different from the assessment results.

Table 2.1. Verified Impaired Segments (Nutrients and DO) in the Pensacola Bay Basin

WBID	Waterbody Segment	Parameters Identified Using the IWR
548AA	North Escambia Bay (marine)	Nutrients (historical chlorophyll)
493A	Judges Bayou (freshwater)	DO (nutrients)
493B	Judges Bayou (marine)	Nutrients (Chlorophyll)
846	Bayou Chico (Lower, marine)	Nutrients (Chlorophyll)
846C	Bayou Chico (Upper, marine)	Nutrients (Chlorophyll)

2.3 Summary of Verified Impairments

2.3.1 Bayou Chico (WBIDs 846 and 846C) Impairments

Bayou Chico was verified as impaired for nutrients (**Table 2.1**) based on an elevated annual average CChla concentration over the Cycle 2 verified period (the verified period for the Group 4 basins was January 1, 2003, to June 30, 2010). **Table 2.2** provides the assessment results for CChla for the verified period.

Table 2.2. Assessment Results for Bayou Chico (WBIDs 846 and 846C)

- = Empty cell/no data
µg/L = Micrograms per liter

Year/Quarter	Lower Bayou Chico (WBID 846) CChla (µg/L)	Upper Bayou Chico (WBID 846C) CChla (µg/L)
2003	**12.06**	**-**
1	6.55	-
2	6.39	-
3	23.48	-
4	11.82	-
2004	**7.08**	**13.60**
1	6.60	20.97
2	5.06	5.80
3	6.86	13.40
4	9.78	14.23
2009	**9.53**	**-**
1	5.43	-
2	17.00	-
3	11.53	-
4	4.17	-

From these data it can be determined that both Lower Bayou Chico (2003, CChla = 12.1 µg/L) and Upper Bayou Chico (2004, CChla = 13.6 µg/L) exceeded the threshold CChla concentration of 11 µg/L and therefore met the conditions for being included on the Verified List of impaired waters.

2.3.2 Judges Bayou (WBIDs 493A and 493B) Impairments

The impairments in the Judges Bayou watershed are based on data from the Cycle 2 verified period (the verified period for the Group 4 basins was January 1, 2003, to June 30, 2010).

DO

Judges Bayou (freshwater) was verified as impaired for low DO linked to elevated nutrients (**Table 2.1**). The DO impairment was linked to elevated nitrogen in the freshwater creeks. **Tables 2.3** and **2.4** present the assessment results for DO. The IWR specifies that for a waterbody to be verified as impaired for DO, with 15 results, 5 must be below the criterion. There were 8 results below the criterion, and thus the freshwater tributaries to Judges Bayou were verified as impaired for DO.

Table 2.3. DO Assessment Results for Judges Bayou (Freshwater) (WBID 493A)

Mg/L = Milligrams per liter

Station Number	S-Alias	Date	DO (mg/L)
21FLBRA 493-C	151	3/24/2004	3.84
21FLPNS 33020151	152	3/24/2004	7.17
21FLPNS 33020151	153	3/24/2004	8.19
21FLPNS 33020151	154	3/24/2004	5.9
21FLPNS 33020152	493-1	3/24/2004	7.65
21FLPNS 33020153	151	5/12/2004	1.85
21FLPNS 33020153	153	5/12/2004	7.63
21FLPNS 33020153	154	5/12/2004	4.54
21FLPNS 33020154	493-1	5/12/2004	4.66
21FLPNS 33020154	151	8/11/2004	3.14
21FLPNS 33020154	153	8/11/2004	5.87
21FLPNS 33020154	154	8/11/2004	0.25
21FLPNS 3302A4931	493-1	8/11/2004	3.58
21FLPNS 3302A4931	154	12/22/2004	5.09
21FLPNS 3302A4931	493-C	1/18/2007	4.79

Table 2.4. DO Impairment in Judges Bayou (Freshwater) (WBID 493A)

Parameter	Result
Total Number	15
Results Less 5.0 (mg/L)	8
% Exceedance	53.3%
IWR Exceedances Required	5

Nutrients

Judges Bayou (marine) was verified as impaired for nutrients (**Table 2.1**) based on an elevated annual average CChla concentration exceeding the IWR threshold of 11 μg/L during the verified period. **Table 2.5** provides the assessment results for CChla for the verified period.

Table 2.5. Nutrient Impairment in Judges Bayou (marine) (WBID 493B)

- = Empty cell/no data

Year/Quarter	Quarter CChla (mg/L)	Annual CChla (mg/L)
2004	**-**	**-**
1	5.00	-
2	5.00	-
3	22.40	-
2006	**-**	**-**
4	1.00	-
2007	**-**	**-**
1	1.58	-
2009	**-**	**13.16**
1	3.80	-
2	21.97	-
3	25.53	-
4	1.35	-

2.3.3 Escambia Bay (WBID 548AA) Impairments

The impairments in the Escambia Bay watershed are based on data from the Cycle 2 verified period (the verified period for the Group 4 basins was January 1, 2003, to June 30, 2010).

North Escambia Bay was verified as impaired for nutrients (**Table 2.1**) based on CChla annual averages exceeding the historical minimum by at least 50% in at least 2 consecutive years during the verified period. The historical minimum is based on comparing changes in Chla with historical levels. The historical levels are based on the lowest 5-year average for the period of record. To calculate a 5-year average, there must be annual means (including data in all 4 quarters) from at least 3 years of the 5-year period. For the purposes of determining impairment in North Escambia Bay, the Department has reviewed the available data and established the threshold at 7.5 µg/L (50% above the historical minimum). The data in **Table 2.6** show that North Escambia Bay exceeded this threshold in each year of the verified period. Additionally, a marine water is also verified as impaired if the annual average CChla exceeds 11 µg/L in any 1 year of the verified period. In North Escambia Bay, the threshold of 11 µg/L was exceeded in 5 of the 7 years. **Table 2.6** provides assessment results for CChla for the verified period.

Table 2.6. Nutrient Assessment Results for North Escambia Bay (Marine) (WBID 548AA)

Year/Quarter	Annual CChla (mg/L)
2003	13.01
2004	11.26
2005	9.34
2006	13.22
2007	11.89
2008	13.23
2009	10.00

2.4 Summary of Verified Period Data

2.4.1 Bayou Chico Watershed (WBIDs 846A, 846B, 846, and 846C) Data

Appendix B includes the complete set of tables and figures summarizing and depicting the data for both freshwater creeks (Jones and Jackson) and the marine portion of Bayou Chico. All tables/figures presented below are also included in **Appendix B**.

Appendix B, Table B.1, lists the more than 30 stations that have been sampled in the Bayou Chico watershed. **Figure 2.1** depicts the station locations.

The results for salinity/conductivity (**Appendix B**, **Table B.2** and **Figures B.2** through **B.5**) show that Jackson Creek and Jones Creek are typically freshwater systems with median conductivities during the verified period of 186 and 90 micromohs per centimeter (µmhos/cm), respectively. The Upper Bayou has a median verified period salinity of 7.8 parts per thousand (ppt) and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period salinity of 13.5 ppt.

Appendix B, **Table B.3** and **Figures B.6** through **B.9**, provide the results for nitrate nitrogen (NO3-N). These data show that Jackson Creek has a higher concentration (verified period median, 1.80 mg/L) than Jones Creek (verified period median, 0.06 mg/L). The Upper Bayou has a median verified period concentration of 1.04 mg/L, and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 0.57 mg/L. The data indicate a large source of NO3-N entering the bayou from the Jackson Creek area and potentially from benthic flux as well.

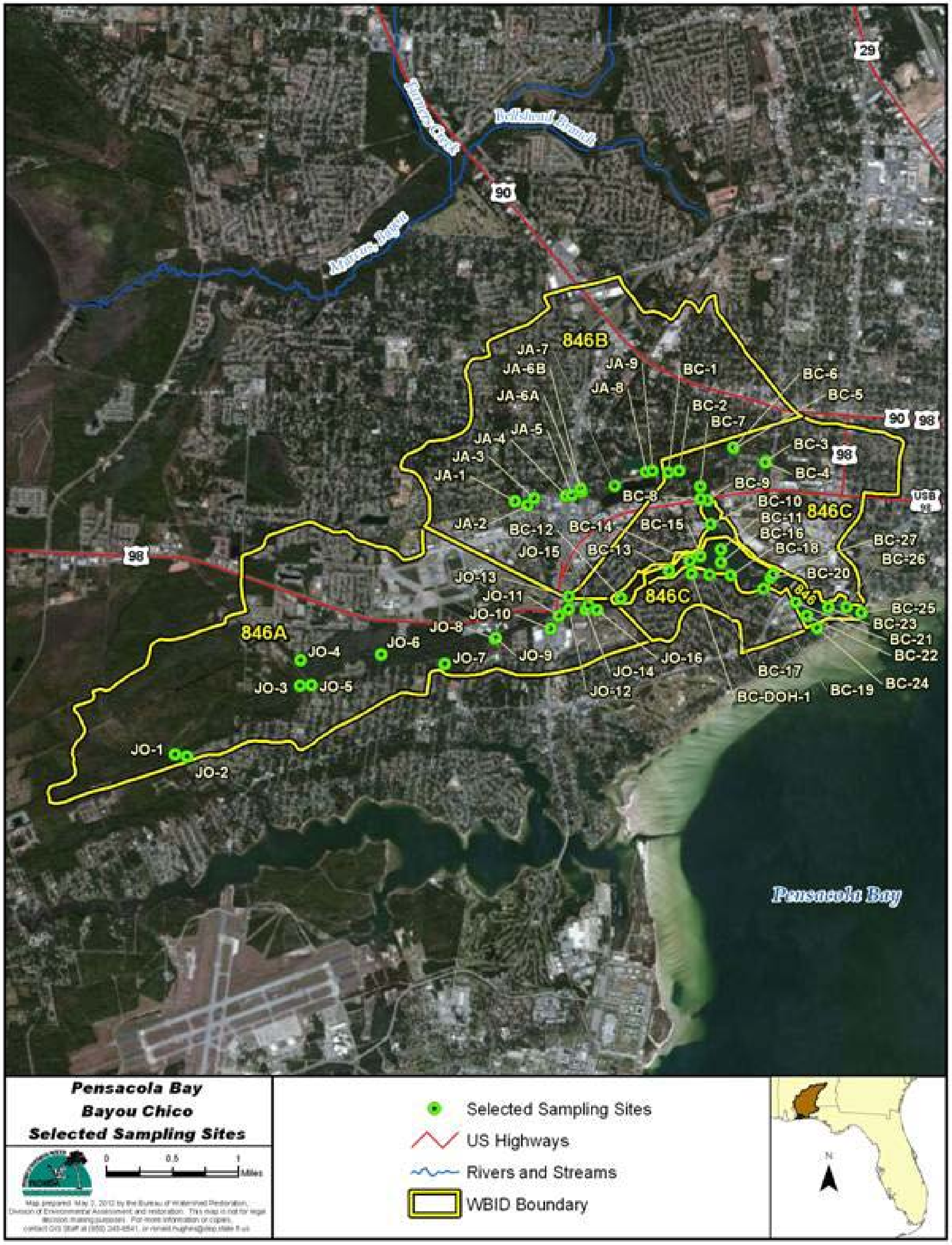


Figure 2.1. Monitoring Stations in Bayou Chico (WBIDs 846, 846A, 846B, and 846C)

Appendix B, **Table B.4** and **Figures B.10** through **B.13**, provide the results for ammonia nitrogen (NH4-N). These data show that both Jackson Creek and Jones Creek have the same verified period median concentration of 0.05 mg/L. The Upper Bayou has a median verified period concentration of 0.11 mg/L, and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 0.03 mg/L. The concentration of NH4-N in the upper portion of the bayou is over double that in the freshwater creeks. This information is supportive of the presence of a benthic flux of NH4-N in the bayou.

Appendix B, **Table B.5** and **Figures B.14** through **B.17**, present the results for organic nitrogen (Org-N). These data show that Jackson Creek has a lower verified period median concentration (0.33 mg/L) than Jones Creek (0.56 mg/L). The Upper Bayou has a median verified period Org-N of 0.56 mg/L (same as Jones Creek) and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 0.44 mg/L.

The data for TN presented in **Figures 2.2** through **2.5** and in **Appendix B**, **Table B.6** and **Figures B.18** through **B.27**, indicate that concentrations of TN in both Jackson and Jones Creeks declined between 1971 and 1985. Concentrations after 1985 in Jackson Creek oscillated around 2 mg/L, while concentrations in Jones Creek have oscillated around 1 mg/L, with some indications of additional improvement since 2005. The data for TN in the bayou indicate that concentrations of TN in the Upper Bayou have varied between 0.1 and just over 2.5 mg/L for some time, with concentrations in the Lower Bayou varying between 0.4 and 2.3 mg/L.

The results show that Jackson Creek has over twice the concentration of TN (verified period median, 2.24 mg/L) than Jones Creek (0.76 mg/L). Additionally, it appears that a substantial amount of the TN in Jackson Creek is in the form of nitrate-N. The Upper Bayou has a median verified period TN of 1.86 mg/L, and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 1.19 mg/L. There appears to be a well-developed gradient in nitrogen, with elevated concentrations in the upper portion of the watershed. Overall, the concentrations of nitrogen in the impaired waters are elevated, and the export of the excess nitrogen to downstream waters could be problematic.

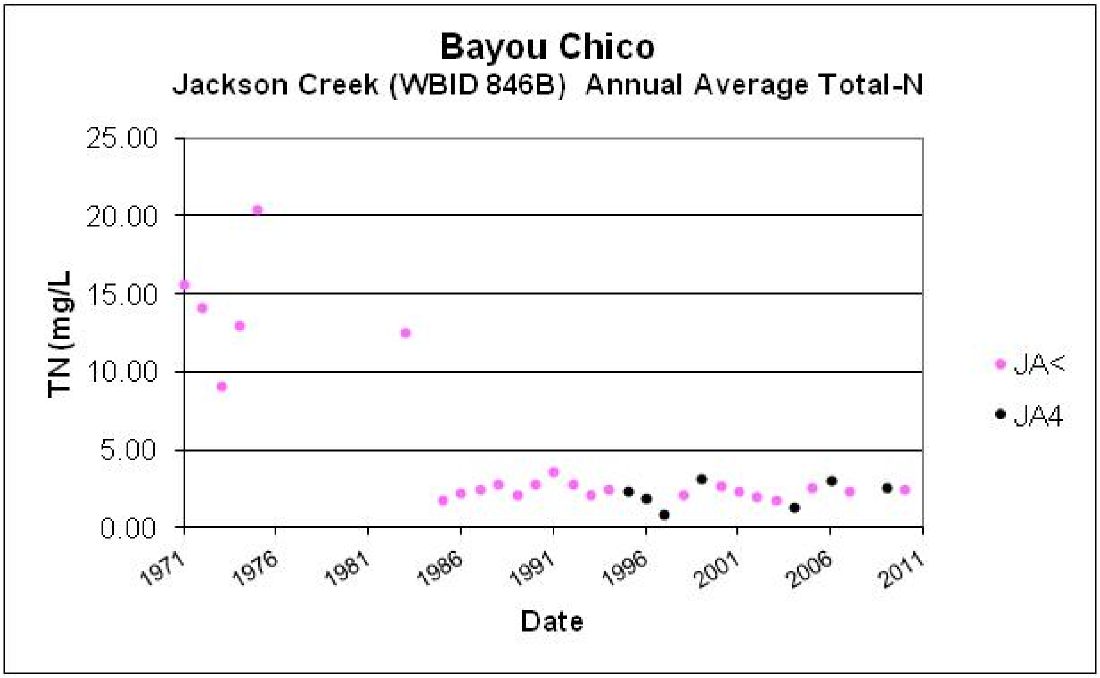


Figure 2.2. Annual Average TN in Jackson Creek (WBID 846B), 1971–2011

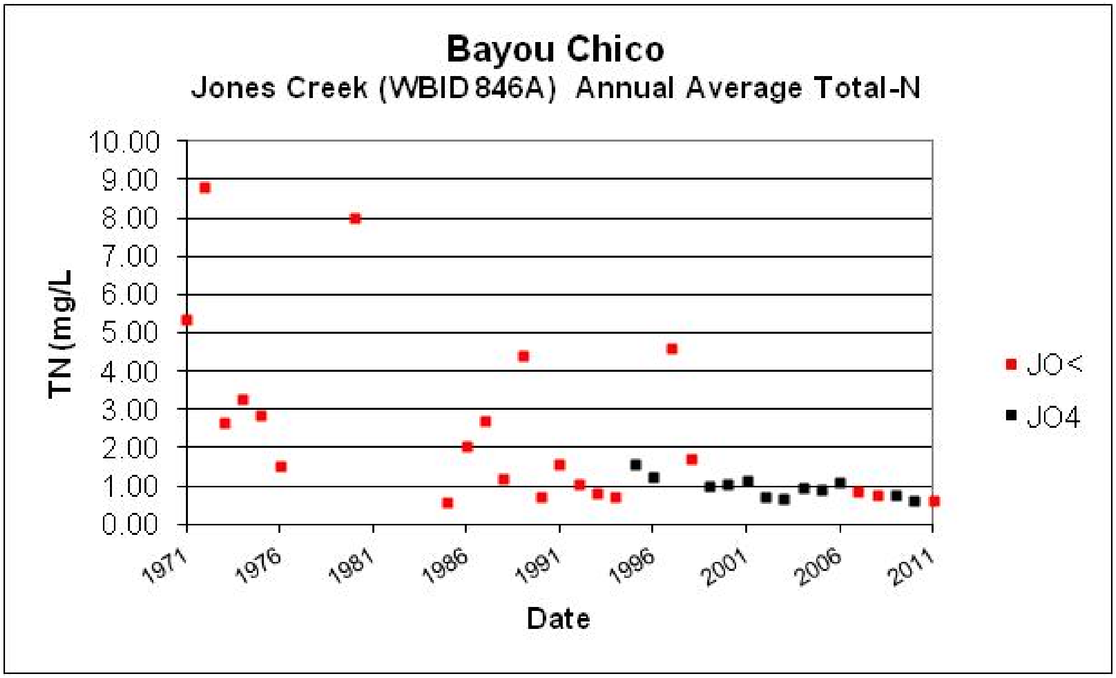


Figure 2.3. Annual Average TN in Jones Creek (WBID 846A), 1971–2011

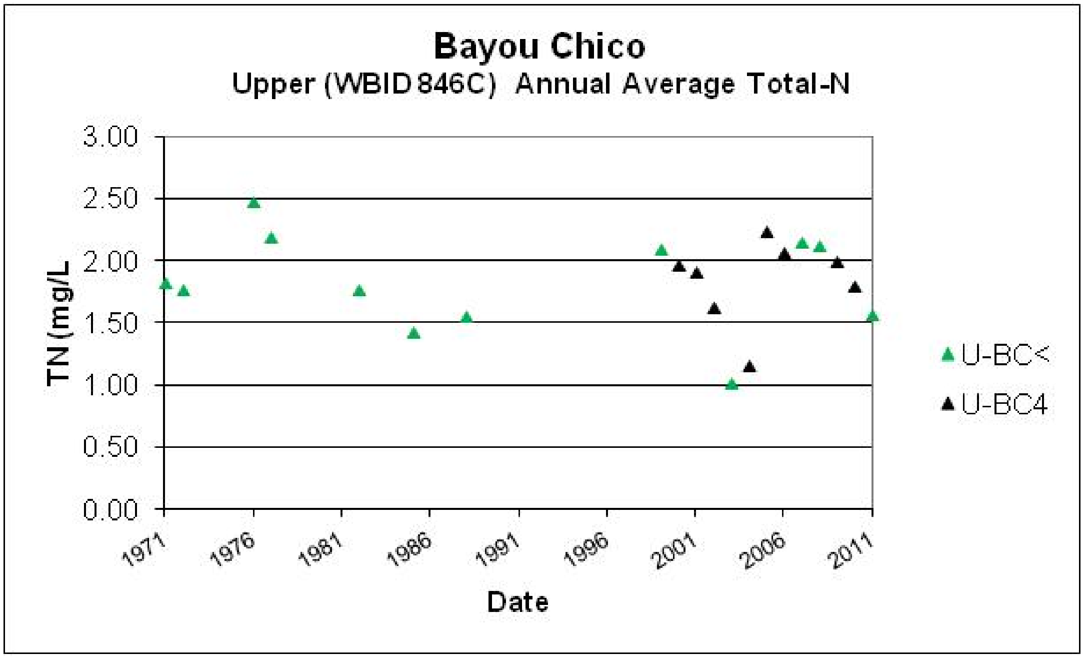


Figure 2.4. Annual Average TN in Upper Bayou Chico (WBID 846C), 1971–2011

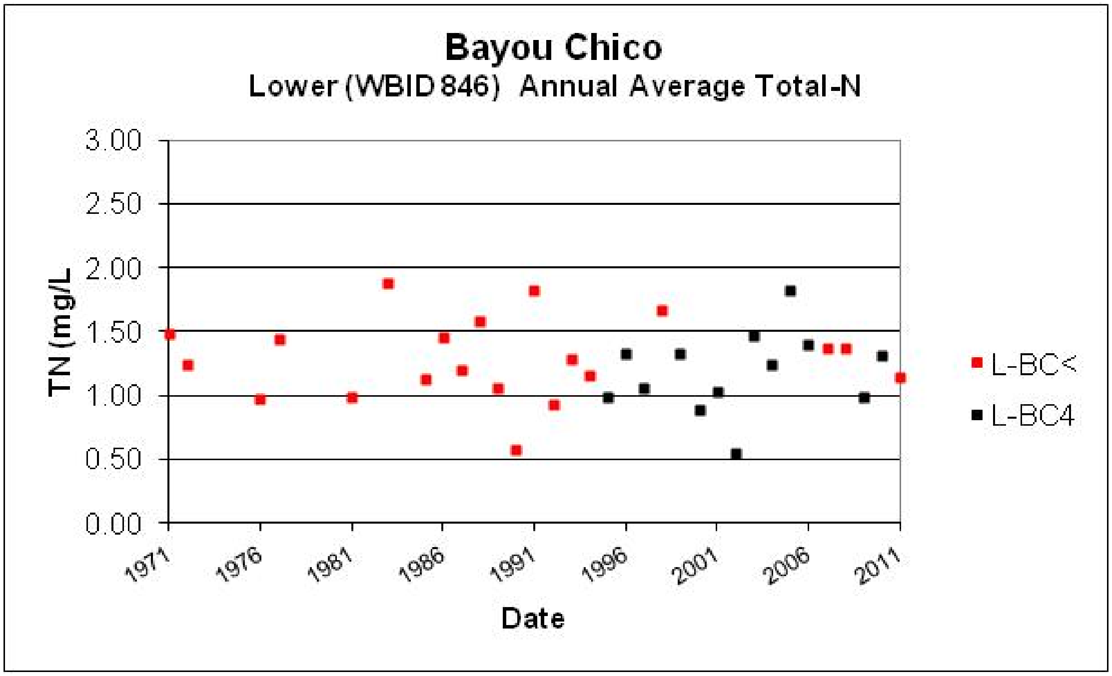


Figure 2.5. Annual Average TN in Lower Bayou Chico (WBID 846), 1971–2011

The data for orthophosphate (**Appendix B**, **Table B.7** and **Figures B.28** through **B.30**) show that Jackson Creek has nearly twice the concentration (verified period median, 0.014 mg/L) than Jones Creek (verified period median, 0.008 mg/L). No orthophosphate (PO4-P) data were available for the Upper Bayou. The Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 0.005 mg/L (the same as Middle Pensacola Bay).

The data for TP presented in **Figures 2.6** through **2.9** and **Appendix B**, **Table B.8** and **Figures B.31** through **B.42,** indicate that concentrations have decreased over time in all areas of the system. Both Jackson and Jones Creeks had median concentrations of 0.11 mg/L before 2003 and 0.04 mg/L for the verified period. The data indicate that the Upper Bayou median concentration was 0.13 mg/L before 2003, and the Lower Bayou concentration was 0.06 mg/L. During the verified period, the median concentration in the Upper Bayou was 0.04 mg/L and 0.02 mg/L in the Lower Bayou.

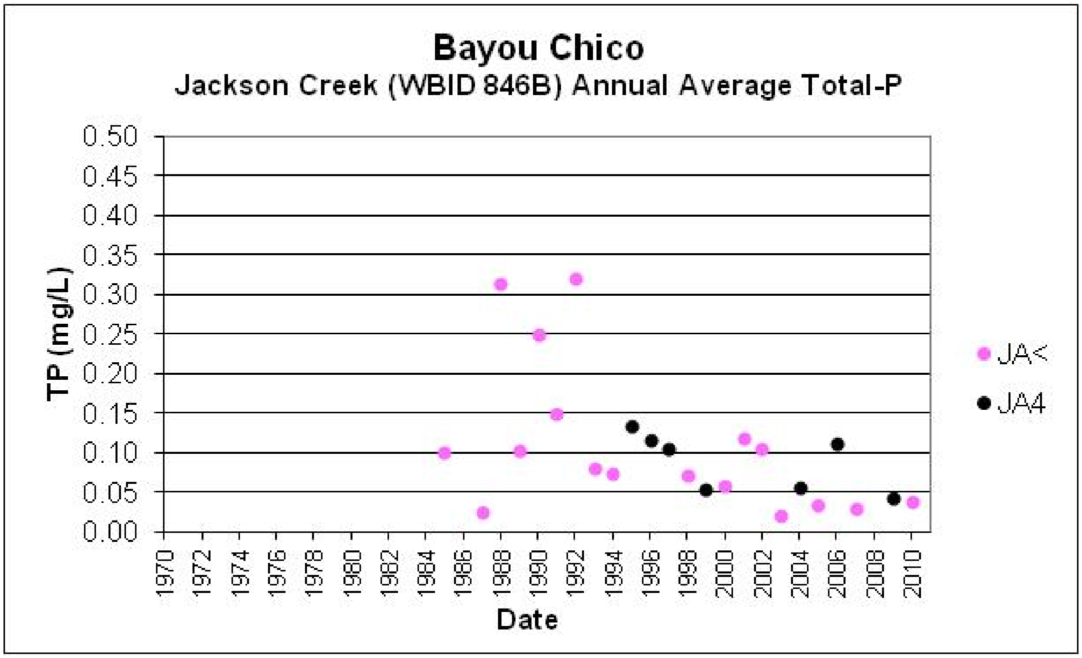


Figure 2.6. Annual Average TP in Jackson Creek (WBID 846B) over the Period of Record

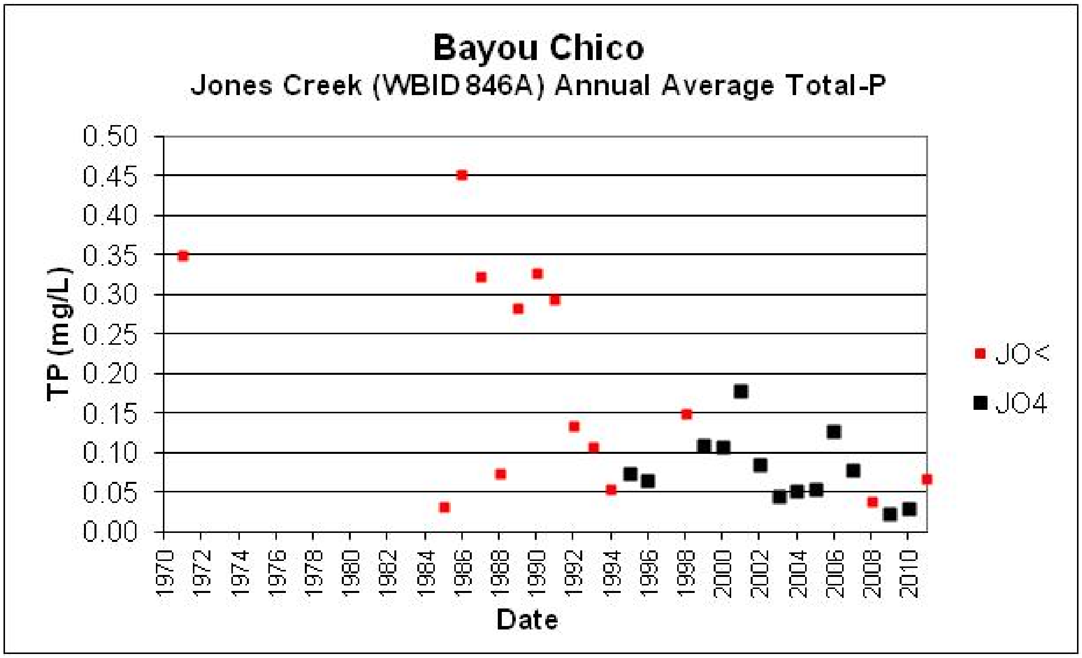


Figure 2.7. Annual Average TP in Jones Creek (WBID 846A) over the Period of Record

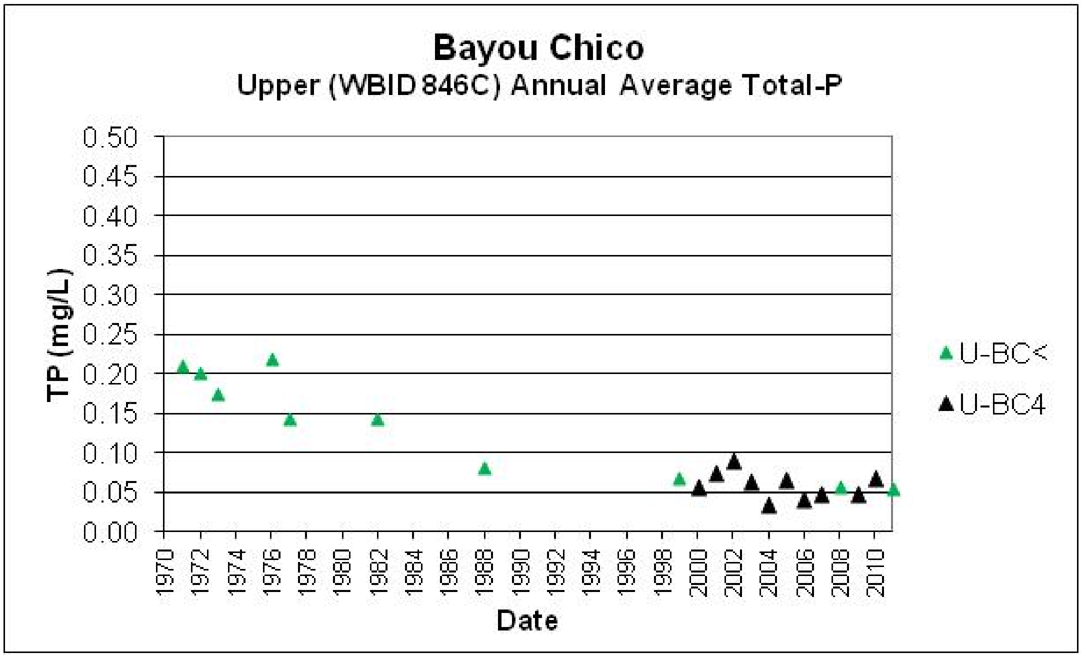


Figure 2.8. Annual Average TP in Upper Bayou Chico (WBID 846C) over the Period of Record

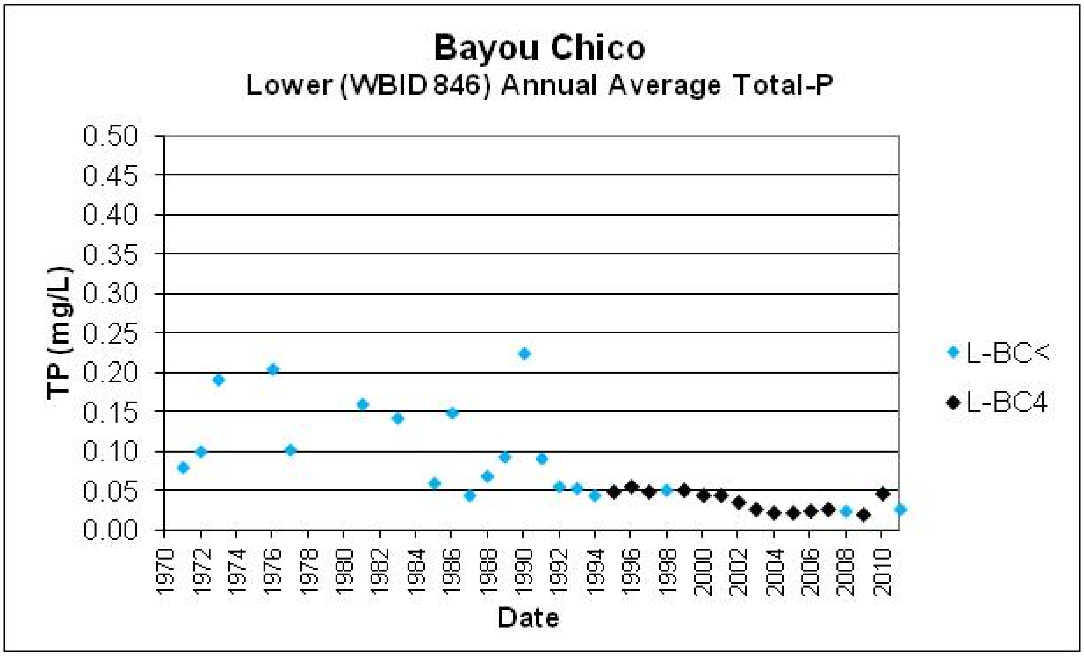


Figure 2.9. Annual Average TP in Lower Bayou Chico (WBID 846) over the Period of Record

The data presented for CChla in Jackson Creek (**Figures 2.10** through **2.13** and **Appendix B**, **Table B.8** and **Figures B.43** through **B.51**) show highly variable annual averages, ranging from 2.5 µg/L in 2003 to over 25 µg/L in 2006. The data indicate that conditions for CChla in Jones Creek are more stable, with averages ranging from 2 µg/L to just over 3 µg/L. The Upper Bayou has annual averages ranging from 5 µg/L to just over 13 µg/L. The Lower Bayou has annual averages as high as 20 µg/L (2001), while more recent data show results less than 10 µg/L. These results show that both Jackson and Jones Creeks have the same CChla median concentration of 2.50 mg/L. The Upper Bayou has a verified period median CChla concentration of 7.95 µg/L, and the Lower Bayou that drains to Middle Pensacola Bay has a median verified period concentration of 6.90 µg/L.

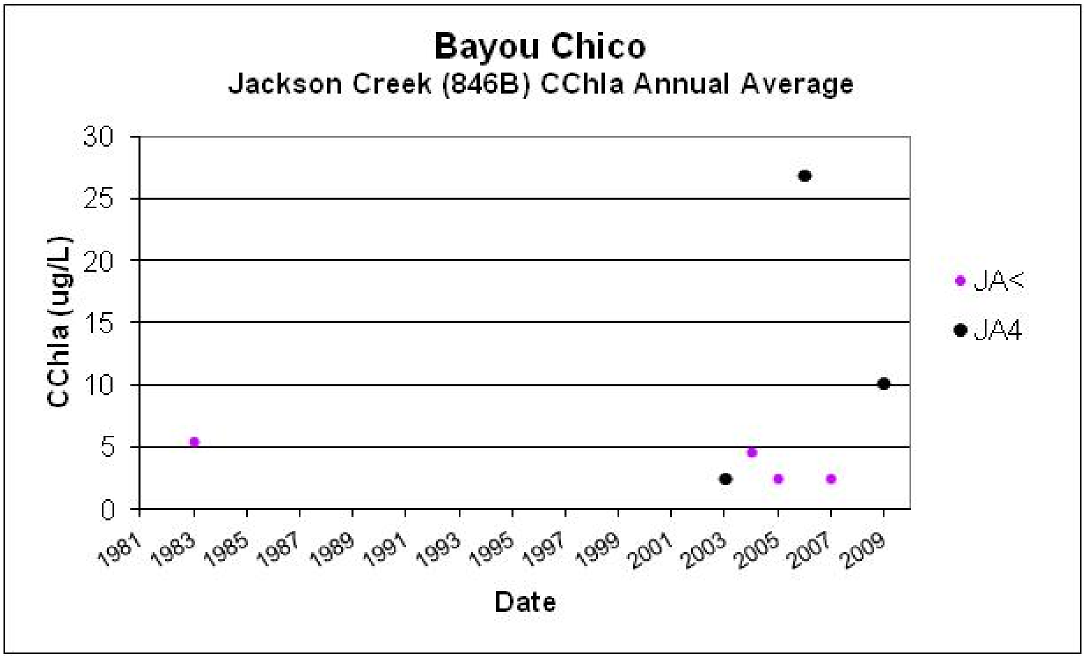


Figure 2.10. Annual Average Chla in Jackson Creek (WBID 846B) over the Period of Record

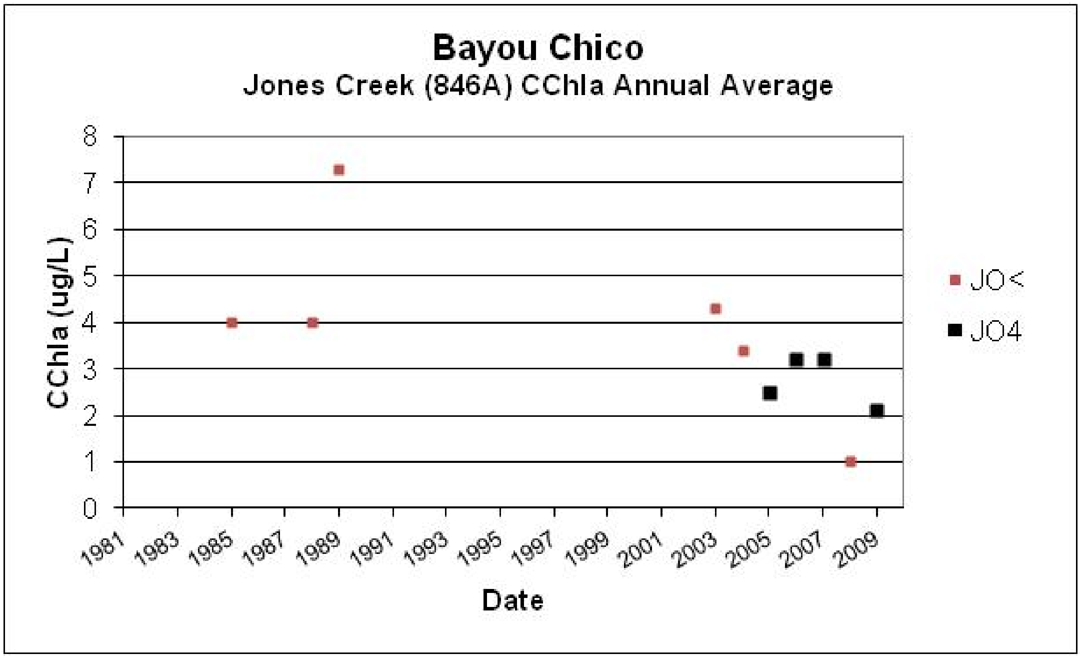


Figure 2.11. Annual Average Chla in Jones Creek (WBID 846A) over the Period of Record

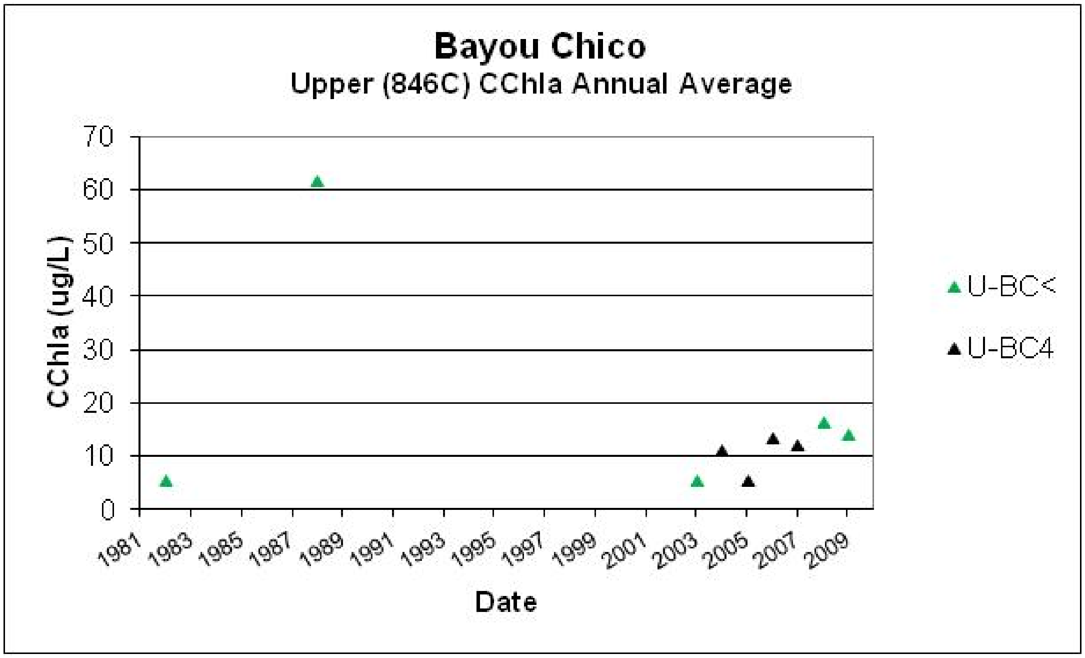


Figure 2.12. Annual Average Chla in Upper Bayou Chico (WBID 846C) over the Period of Record

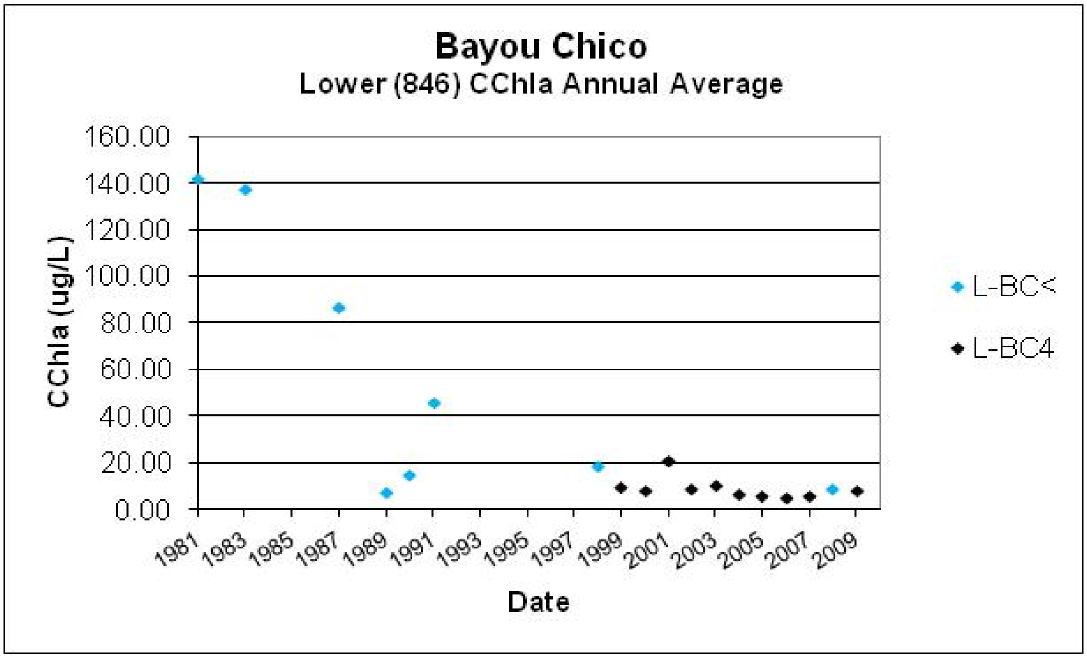


Figure 2.13. Annual Average Chla in Lower Bayou Chico (WBID 846) over the Period of Record

2.4.2 Middle Pensacola Bay Watershed (WBID 548D) Data

Bayou Chico drains to the area of Pensacola Bay known as Middle Pensacola Bay and identified as WBID 548D. **Figure 2.14** depicts the set of stations making up the dataset, and **Appendix B, Table B.10,** provides the list of stations. A summary of this information is provided to characterize the water quality of the tidal waters moving into and out of Bayou Chico and as a summary of data used to drive the Bayou Chico model boundary conditions discussed in Chapter 5. **Appendix B, Tables B.10** through **B.12** and **Figures B.52** through **B.60**, contains a complete set of figures and tables depicting the data. **Table 2.7** lists the annual average conditions for TN, TP, and CChla in Middle Pensacola Bay. The data indicate that water quality conditions in Middle Pensacola Bay for TN remain unchanged. However, conditions for TP and CChla have improved slightly over time.

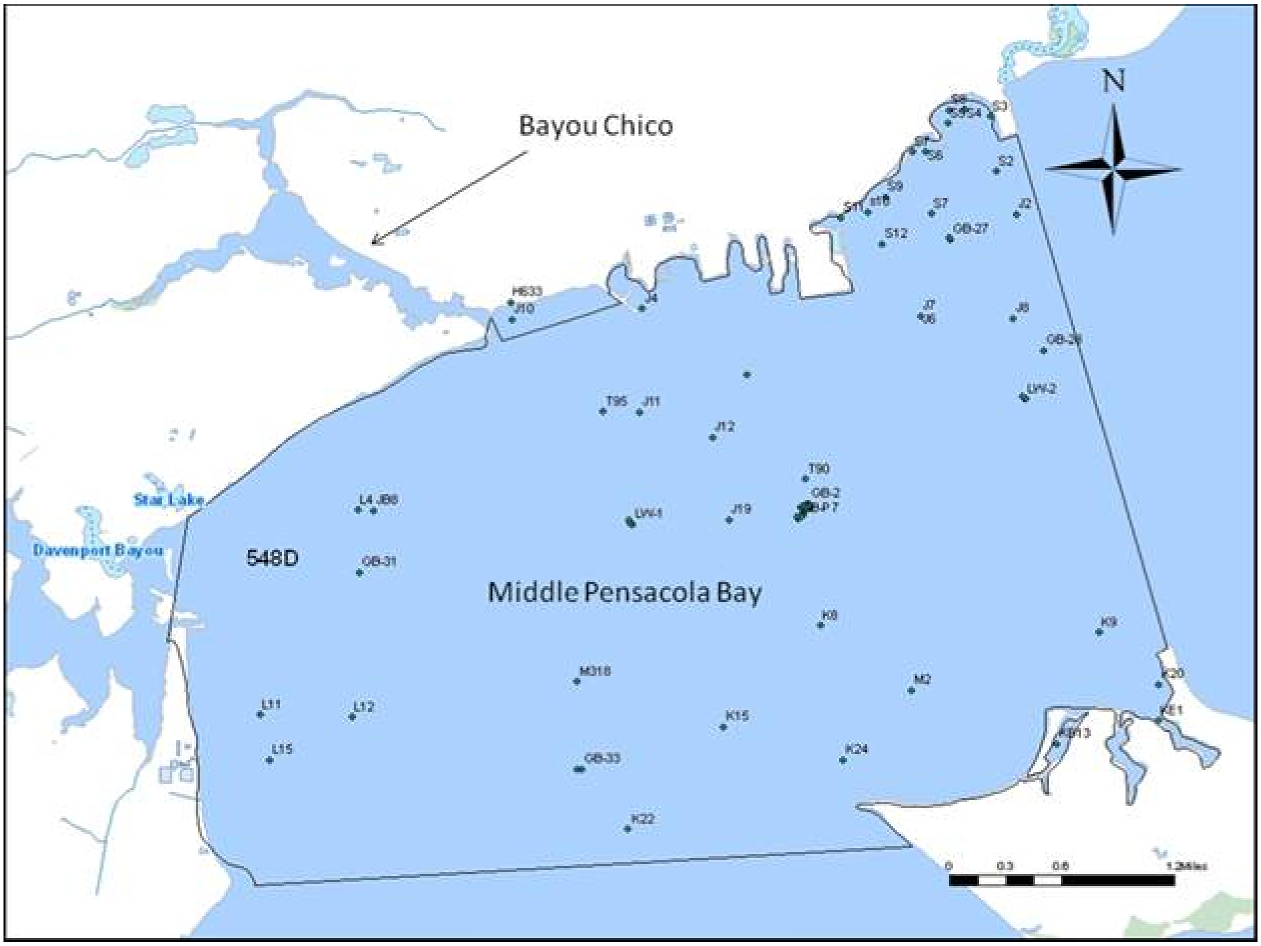


Figure 2.14. Monitoring Stations in Middle Pensacola Bay (WBID 548D)

Table 2.7. Summary of Annual Average Data for Middle Pensacola Bay (WBID 548D)

Note: Only years with all four quarters are represented.

Time		TN (mg/L)	TP (mg/L)	CChla (µg/L)
Through 2002	Average	0.42	0.02	5.85
Through 2002	Median	0.43	0.02	5.77
After 2002	Average	0.42	0.01	4.83
After 2002	Median	0.43	0.01	4.46

2.4.3 Judges Bayou Watershed (WBIDs 493A and 493B) Data

Appendix C Includes a complete set of tables and figures summarizing and depicting the data for both freshwater creeks (St. Regis and Judges Branches) and Judges Bayou (Upper and Lower). Any figure or table presented below is also included in **Appendix C**.

The original Judges Bayou freshwater and marine segments (WBIDs 493A and 493B, respectively) included areas that drain either directly to the bay or to features not connected to the Judges Bayou watershed. The Department used light detection and ranging (LiDar) 1-foot elevation contour data provided by the NWFWMD, information provided by staff in the Department's Northwest District Office, and best professional judgment to delineate the area within these two WBIDs that drains to Judges Bayou (**Figure 2.15**). **Figure 2.15** shows the original WBID boundaries, the new delineated watershed for Judges Bayou, the location of the Taminco (formerly Air Products) and Sterling Fibers state-permitted facilities, and five-foot counter intervals. **Figure 2.16** shows the ambient water quality and sprayfield monitoring stations in the two WBIDs.

Ground water flow in the Judges Bayou watershed follows the surface topography and moves toward Judges Bayou and ultimately Escambia Bay (R. Hicks, personal communication).

There is one NPDES-permitted facility in the basin, Sterling Fibers (NPDES Permit FL0002593). The facility is not permitted to discharge any treated process water to any surface waterbody. The current permit was issued on October 10, 2011, and will expire on October 9, 2016. The facility historically produced acrylic fiber from monomeric acrylonitrile and vinyl acetate. Since 2005, it has focused on the downstream processing of purchased fiber, including fibrillation, fiber conductivity enhancements, and short fiber cutting. In addition to no longer requiring raw materials for manufacturing, the change in manufacturing operations has also lowered the volume and affected the composition of wastewater from the facility and the operational schedules for the wastewater disposal facilities.

The wastewater from the facility is normally treated in an aerated lagoon/stabilization pond, biological treatment system. Effluent disposal from the lagoons is accomplished through land application (R001 sprayfield). Sterling Fibers has the option of sending the wastewater to its deep underground injection treatment and disposal system as long as the discharge meets the conditions of Underground Injection Control (UIC) Permit 0066268. Following permit issuance, Sterling will have the option of accepting up to 1.4 million gallons per day (MGD) of highly treated effluent from Pace Water Systems (PWS) following Department approval of an engineering plan to be submitted outlining the details of the project. Sterling's acceptance of the

PWS effluent will be authorized once the Department reviews and approves the engineering plan. Following approval, the engineering plan will become a part of the permitting documents for the Sterling Fibers Plant. The current permit requires no additional monitoring, as the PWS effluent is highly treated.

Figure 2.17 depicts the location of the ground water monitoring wells, sprayfield, Outfall D002, and sampling locations for the Sterling Fibers effluent applied to the sprayfield. The text below on surface water discharge and land application is from the recently issued Sterling Fibers permit.

Effluent Disposal

Outfall D-001: Discharge via D-001 to Escambia Bay has been eliminated and is not allowed by this permit.

Outfall D-002: The permittee is authorized to discharge from Outfall D-002, stormwater and ground water from the lower landfill to an unnamed tributary, located approximately at Latitude 300 33' 53" N, Longitude 870 08' 38" W. The effluent consists of accumulated stormwater and ground water from the closed landfill, ground water from the spray irrigation site, and direct rainfall captured by a five-acre pond. The discharge is to an unnamed creek that flows to Escambia Bay and does not drain into Judges Bayou.

Land Application (R-001): The facility uses a 1.9-MGD design capacity, spray irrigation system. Wastewater (and other stored water) from the treatment lagoons is spray irrigated to a 164.3-acre land application area. If the capacity of the sprayfield irrigation system is exceeded at any time for any reason—including, but not limited to, storm events in excess of a 25-year, 24-hour storm, chronic rainfall equivalent to a 25-year storm, or other catastrophic events—the permittee must notify the Department. Following notification, the permittee may direct discharges to its deep underground injection surface impoundment as long as the discharge meets the conditions of UIC Permit 0066268. If, for some reason, deep well discharge is not an option and sprayfield (R-001) capacity is exceeded, the permittee must cease generating wastewater, or find other means of storing or disposing of the wastewater until sprayfield capacity is restored.

The stations depicted in the figures and described in the tables in **Appendix C** are ordered from upstream on the southern freshwater branch (Judges Branch) to the confluence with St. Regis Branch (northern stream) in Judges Bayou, and then from upstream along St. Regis Branch through Judges Bayou to North Escambia Bay.

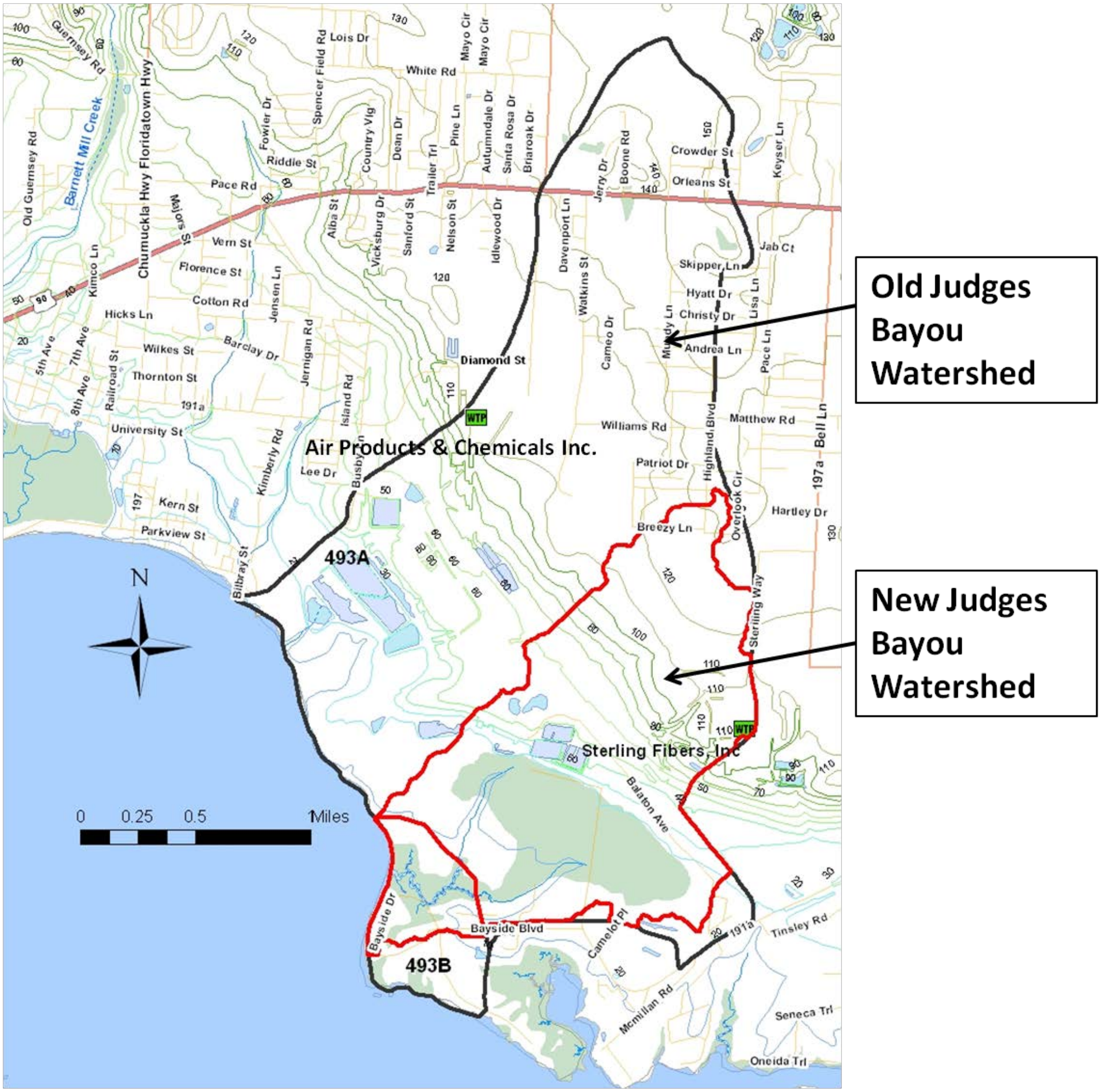


Figure 2.15. Judges Bayou Watershed (WBIDs 493A and 493B) Showing the New Delineated Watershed

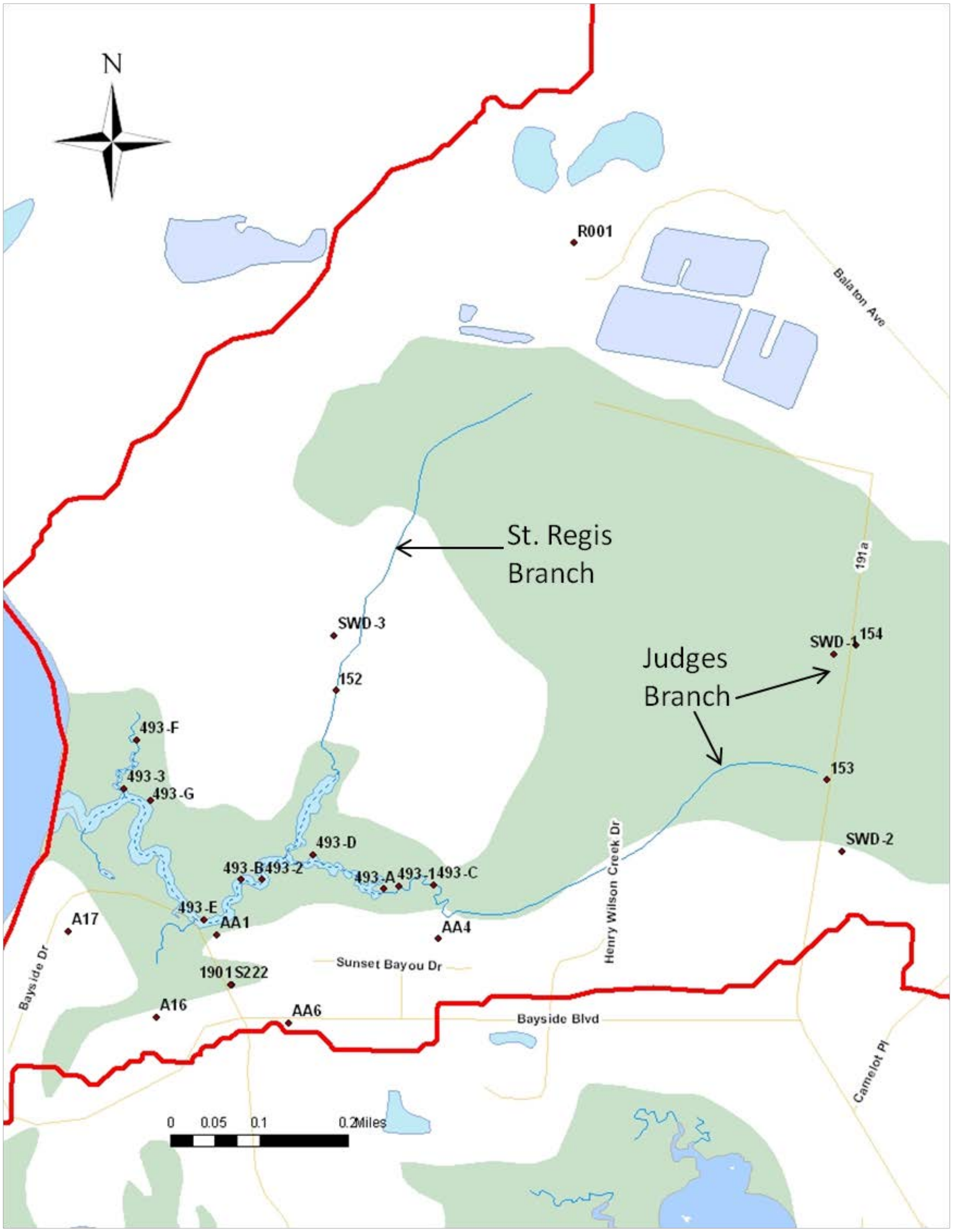


Figure 2.16. Ambient Water Quality and Sprayfield (R001) Monitoring Stations in the Judges Bayou Watershed (WBIDs 493A and 493B)

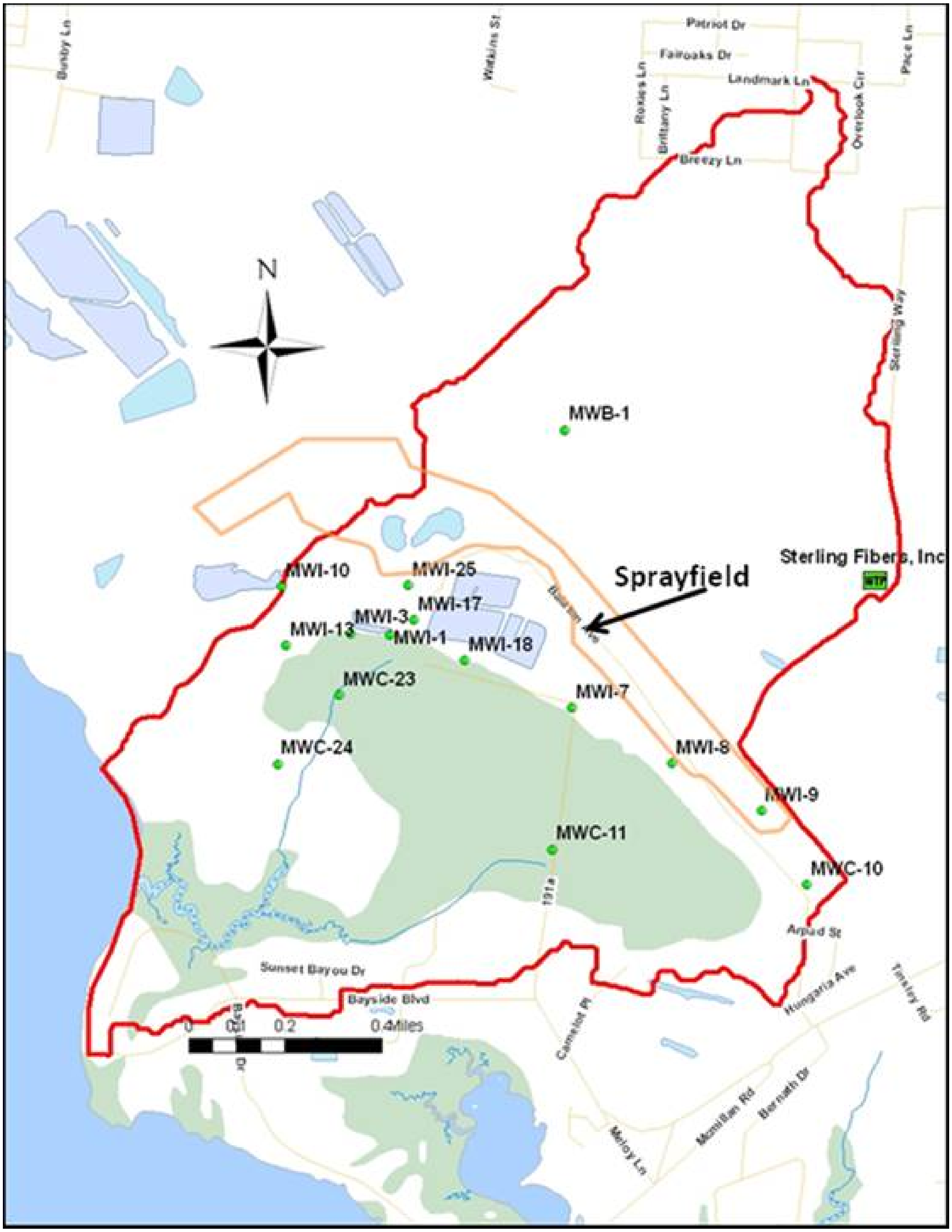


Figure 2.17. Location of Monitoring Wells and Sprayfield Area at the Sterling Fibers Facility

Monitoring Well Data

The monitoring well data for wells located in the Judges Bayou watershed cover the period from 1998 to 2010.

Conductivity

The background well has a median conductivity of 28.9 umhos/cm. Wells located below the sprayfield have median values ranging from 40 to 942 umhos/cm, with concentrations decreasing towards the south and the bayou.

Nitrate

These data are particularly relevant, as they indicate elevated concentrations of nitrate in the ground water that provides baseflow to the streams, as it flows towards the bayou and Escambia Bay. Similar to conductivity, the median concentrations increase in the wells, from 0.16 mg/L along the southeast side of the watershed to over 6.0 mg/L near the headwaters of St. Regis Branch. The well that measures background conditions has a median concentration of 0.11 mg/L. **Figure 2.18** shows the median nitrate-N concentrations in Sterling Fibers' monitoring wells.

Ammonia Well Data

The data have the same pattern as NO3-N, but the median concentrations of the wells are generally only twice the background well value of 0.32 mg/L, with the exception of several wells below the sprayfield along the northern edge of the Sterling Fiber property. Concentrations of total ammonia in these wells range from 2.2 to 8.6 mg/L.

From these data, it seems apparent why the concentration of nitrogen is elevated in the creeks. What is not so apparent is the role that the Sterling Fiber sprayfield plays in these elevated concentrations. **Figure 2.19** depicts the area that has been delineated as a Groundwater Contamination Zone for NO3-N that runs along the eastern edge of Escambia Bay and extends into the Judges Bayou watershed. While an active ground water remediation plan (Consent Order) is in effect, the focus is not on reducing nitrate or ammonia concentrations, as these data show the ground water criterion for nitrate of 10.0 mg/L is normally met. The focus of the remediation plan is on the following two compounds, which were in the initial Consent Order and will be carried through the revised Consent Order (still in draft):

- *2,4-dinitrotoluene; and*
- *2,6-dinitrotoluene*

The well data for PO4-P (no TP data) have concentrations similar to that of the background well (0.01 mg/L), with the exception of one well along the upper slope that has a median concentration of 0.13 mg/L.

Figure 2.18. Median Nitrate-N Concentrations in Sterling Fibers' Monitoring Wells

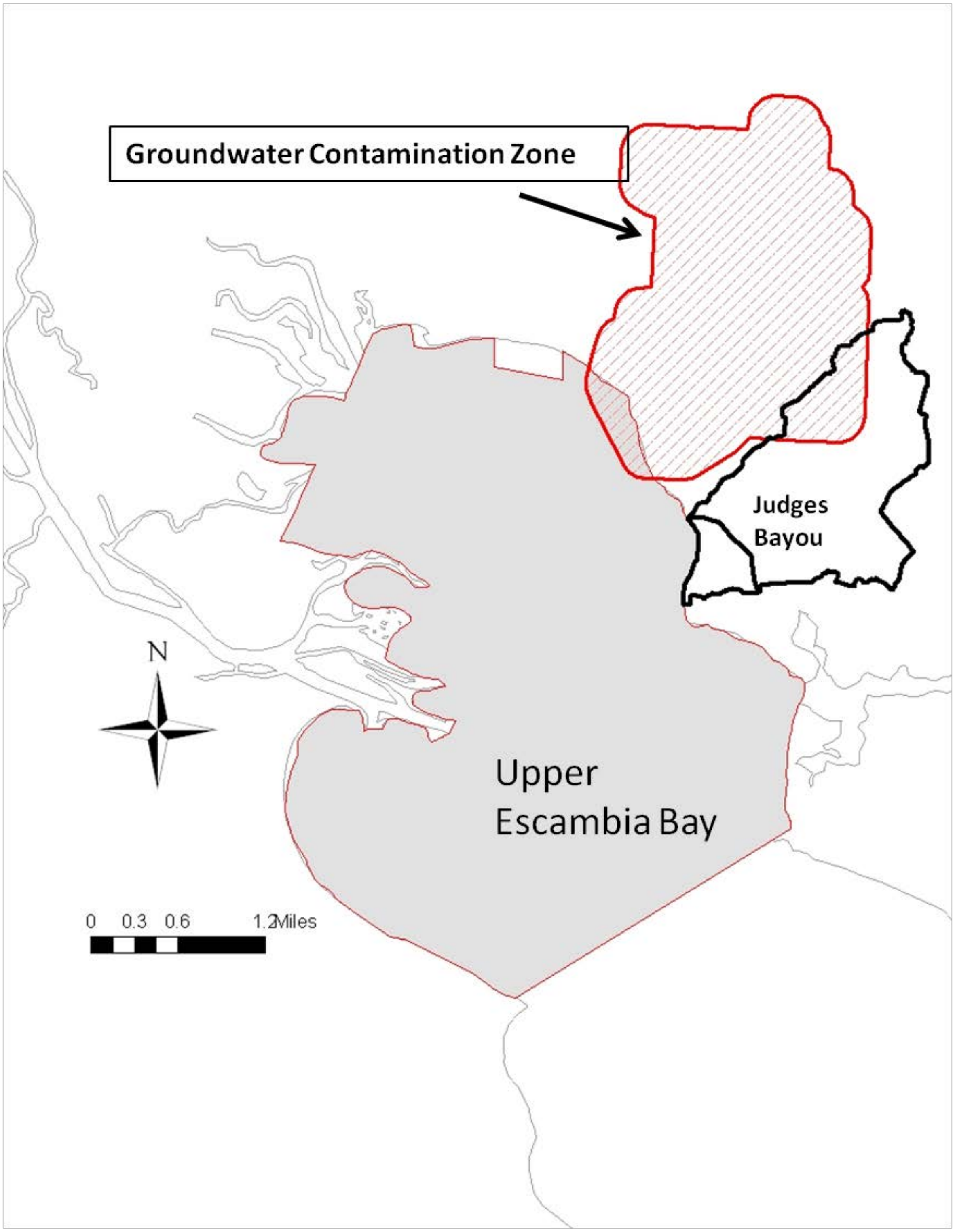


Figure 2.19. Ground Water Nitrate Contamination Zone

S In summary, the monitoring well data collected since 2000 within the Sterling Fiber property show elevated concentrations of inorganic nitrogen. The concentrations increase across the watershed in the direction of the contamination zone, with median concentrations of NO3-N over 6.0 mg/L along the southern edge of the zone. Also in this area, one of the ground water wells below the sprayfield had a median concentration of PO4-P of 0.13 mg/L.

Sprayfield Effluent (R001)

The data for the effluent applied to the Sterling Fiber sprayfield (Station R001) indicate that a large reduction in flow has occurred since 2000. However, the concentration of NO3-N applied appears to have increased over time, with a median concentration of 4.53 mg/L. This pattern is also apparent for TN. The median TN at R001 is 15.2 mg/L. The results for PO4-P (no TP data) indicate that values have declined over time. R001 has a median PO4-P concentration of 0.34 mg/L (2000–10).

Surface Water Data

Conductivity/Salinity

Appendix C, **Table C.7** and **Figures C.8** through **C.12**, present the conductivity/salinity data. The available data for the freshwater creeks indicate that conductivity has declined over time and for Judges Branch, decreases in a downstream direction. For the marine areas, the stations in the Upper Bayou (20 results) have higher salinities than the stations located closer to the bay (4 results). The overall median salinity for the bayou is 2.69 ppt, while the median salinity of the stations located nearby in North Escambia Bay is 16 ppt (5,371 results).

Nitrate-N

Appendix C, **Table C.8** and **Figures C.13** through **C.19**, present the NO3-N data. Monitoring results in Upper Judges Branch indicate that concentrations declined to below 1 mg/L after 2009. The data from 2000 to 2011 for the freshwater creeks show a median concentration of 0.91 mg/L. For the bayou, the median is 0.18 mg/L. The median for North Escambia Bay is 0.078 mg/L (226 results, 1998–2011). These data indicate that the freshwater tributaries may be contributing excessive inorganic nitrogen to the bayou.

Ammonia-N

Appendix C, **Table C.9** and **Figures C.20** through **C.24,** present the NH4-N data. The median NH4-N concentration in the freshwater creeks is 0.38 mg/L, while the concentration in the bayou is 0.03 mg/L, the same as in North Escambia Bay.

TN

Appendix C, **Table C.11** and **Figures C.28** through **C.34**, present the TN data. Monitoring in Upper Judges Branch indicates that concentrations have declined since 2009. However, the data (2000–11) for the freshwater creeks show a median concentration of 3.59 mg/L (153 results). For the bayou, the median is 0.94 mg/L (22 results). The median for North Escambia Bay is 0.60 mg/L (170 results, 1998–2011). These data indicate that the freshwater tributaries may be contributing excessive nitrogen to the bayou.

Orthophosphate (PO4-P)

Appendix C, **Table C.12** and **Figures C.35** through **C.43**, present the PO4-P data. While before 2009 both creeks had individual measurements over 4 mg/L of PO4-P, subsequently, the results are mostly less than 0.02 mg/L. The overall median (132 results, 2000–11) is 0.016 mg/L. For the bayou, the median is 0.004 mg/L (17 results). The median for North Escambia Bay is 0.005 mg/L (160 results, 1998–2011).

TP

Appendix C, **Table C.13** and **Figures C.44** through **C.48,** present the TP data. The median TP of 0.023 mg/L for the freshwater creeks is based on only 12 results. The median of 0.031 mg/L for the bayou is based on 22 results. The median for North Escambia Bay is 0.040 mg/L (138 results, 1998–2011). These data indicate that both the watershed and North Escambia Bay could be a source of inorganic phosphate in the bayou.

CChla

Appendix C, **Table C.14** and **Figures C.49** through **C.53**, present the CChla data. The median CChla of 2.5 µg/L for the freshwater creeks is based on 12 results. The median of 1.60 µg/L for the marine areas of the bayou is based on 23 results. The impairment for nutrients is based on data from Station 493-2 (14 results), which has an average of 13.6 µg/L and a median of 3.15 µg/L. These results were strongly influenced by 3 results (47 µg/L, 57 µg/L, and 22 µg/L) during the 2009 growing season. During the same period, data for North Escambia Bay ranged between 3.5 and 20.0 µg/L, with a long-term median of 6.9 µg/L (447 results, 1998–2011).

BOD5

Appendix C, **Table C.15** and **Figures C.54** through **C.60**, present the 5-day biochemical oxygen demand/chemical oxygen demand (BOD5/COD5) data. There were no years for the freshwater WBID (493A) with BOD5 data in all 4 calendar quarters. Based on the available data (11 samples), the median BOD5 during the verified period was 0.80 mg/L. It does not appear that BOD5 is contributing to the low DO measured in the creeks.

There is a DO impairment in the freshwater creeks of the Judges Bayou watershed. **Appendix C**, **Table C.16** and **Figures C.61** through **C.65**, present the DO data. Based on the available data, both creeks regularly have DO lower than the criterion of 5.0 mg/L, with a median DO of 4.80 mg/L (113 results). By comparison, the median DO in the bayou is 8.92 mg/L (29 results).

2.4.4 North Escambia Bay (WBID 548AA) Data

Appendix D contains a complete set of tables and figures summarizing and depicting the data for North Escambia Bay. Any figure or table presented below is also included in **Appendix D**.

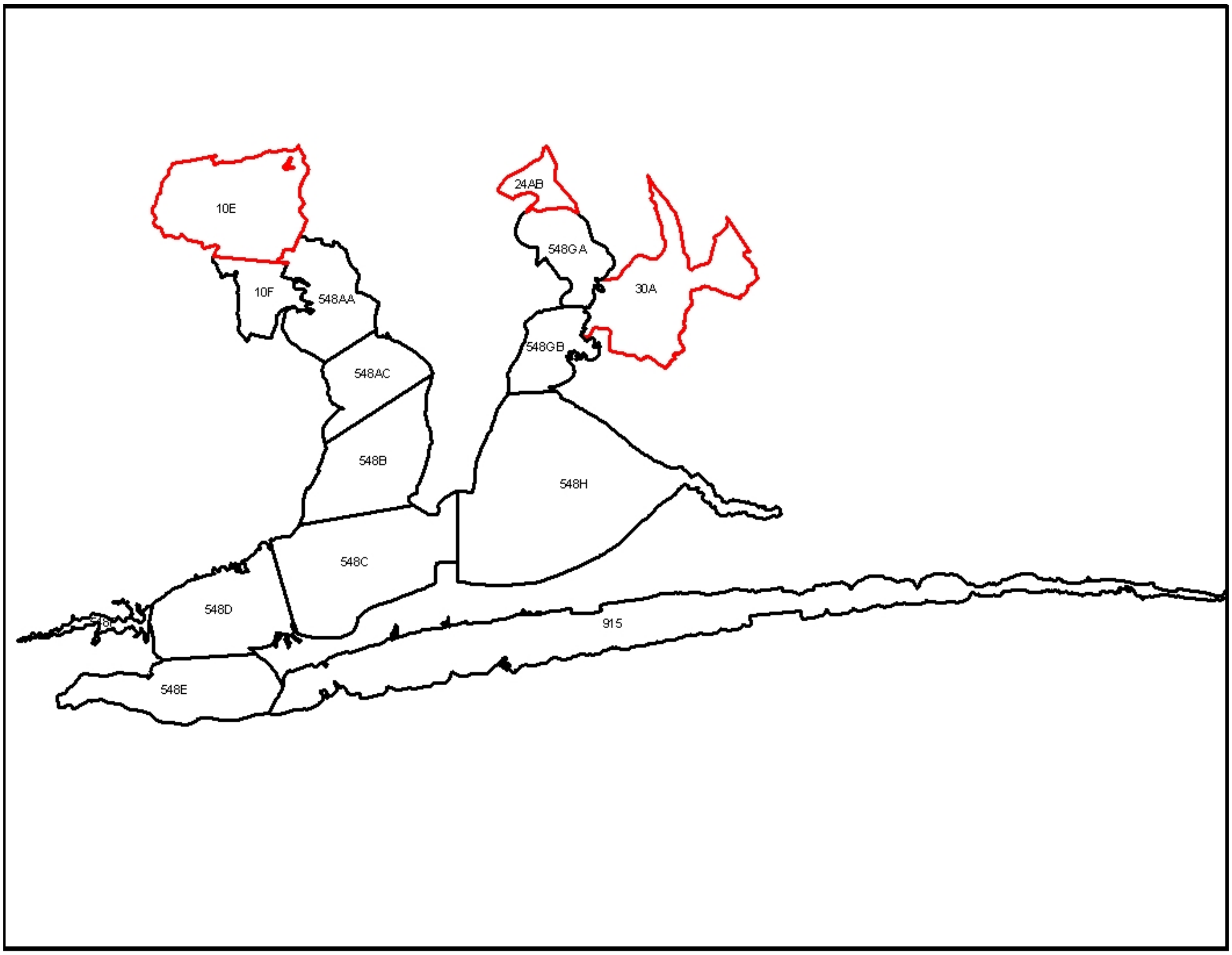
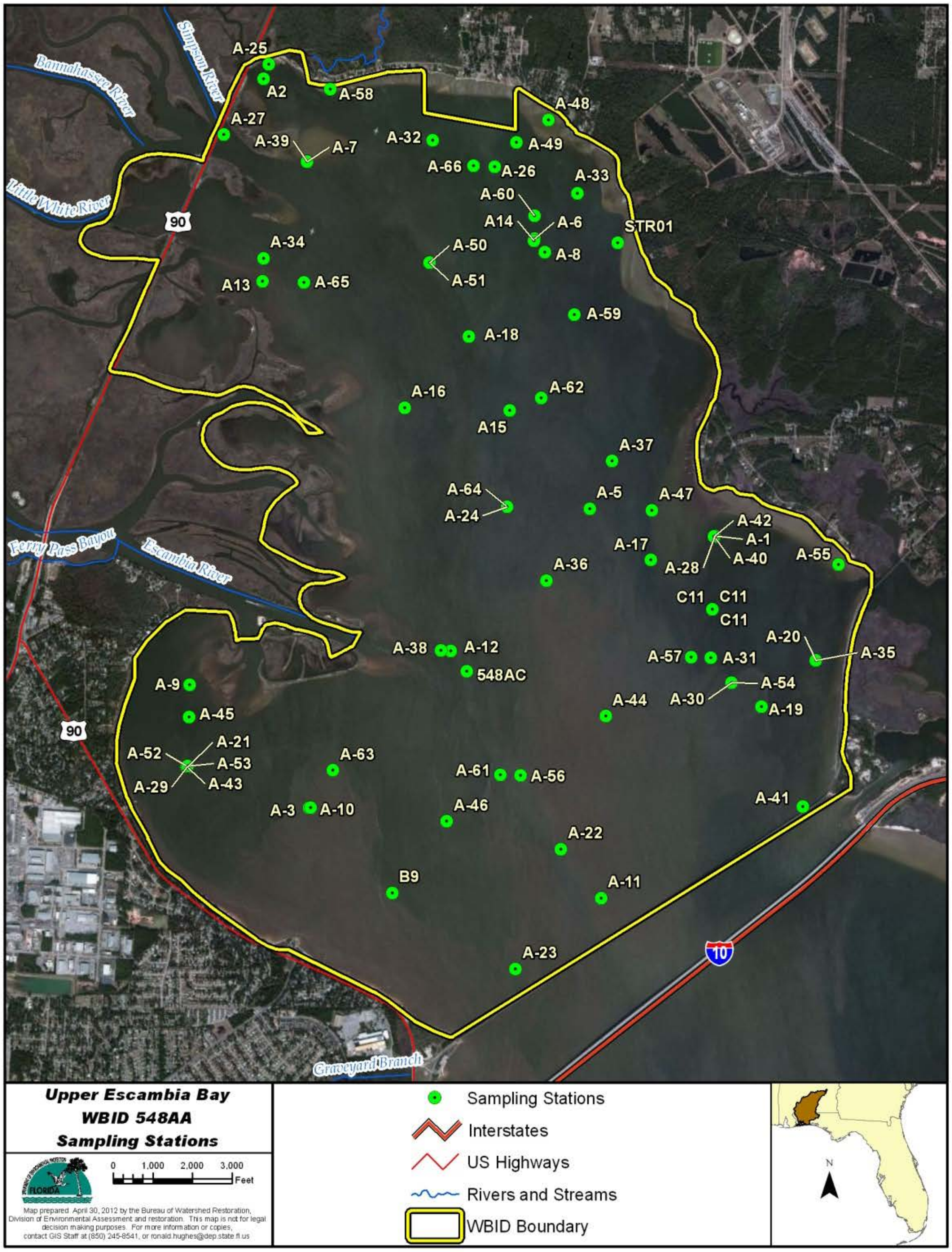


Figure 2.20. Pensacola Bay WBIDs, Including Impaired WBID 548AA

Note: WBIDs 10E, 24AB, and 30A, shown in red, are fresh water.

Figure 2.20 depicts the location and WBID number for each area of Pensacola Bay for which data summaries are provided later in this Chapter. **Figure 2.21** shows the location of all sampling locations in North Escambia Bay. **Figure 2.22** shows the location of all stations used by EPA to calibrate the bay model.



Map prepared April 30, 2012 by the Bureau of Watershed Restoration, Division of Environmental Assessment and restoration. This map is not for legal decision making purposes. For more information or copies, contact GIS Staff at (850) 245-8541, or ronald.hughes@dep.state.fl.us

Figure 2.21. IWR Water Quality Stations in North Escambia Bay (WBID 548AA)

Figure 2.22. EPA Calibration Stations with Station A4

Conductivity/Salinity

Appendix D, **Table D.2.3** and **Figures D.2.2** through **D.2.4,** present the conductivity/salinity data. The salinity in North Escambia Bay ranges from less than 1 ppt up to a maximum measured value of 46 ppt. The median salinity from 1970 to 1998 was 9.1 ppt (1,195 results), while the median of the more recent data (1998–2011, 5,371 results) was 16.1 ppt. The increase is in response to low-flow conditions in the Escambia River during the latter period. The annual averages on **Figure 2.23** demonstrate the variable nature of the salinity in North Escambia Bay as it changes in response to freshwater inflows.

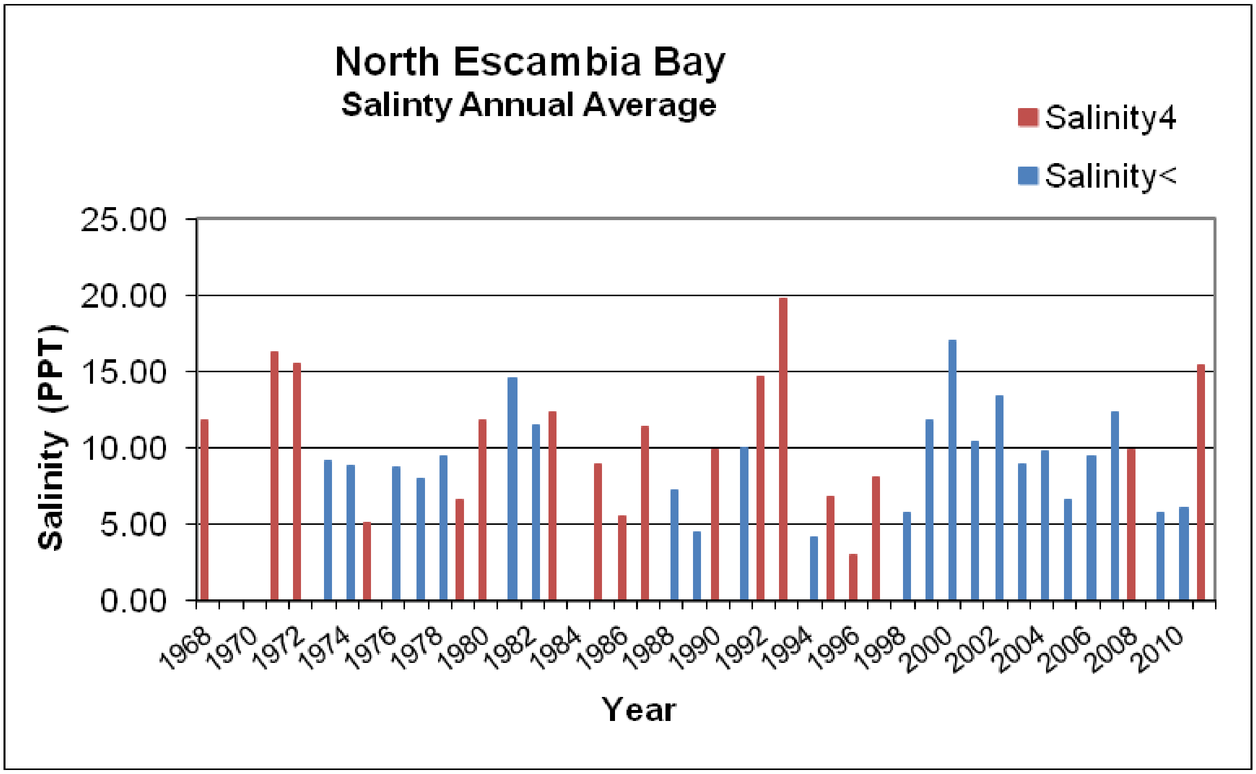


Figure 2.23. North Escambia Bay Salinity Annual Average over the Period of Record

Color

Appendix D, **Table D.2.4** and **Figures D.2.5** through **D.2.7**, present the color data. The color ranges from 1.5 to 400 platinum cobalt units (PCU) with a median of about 50 PCU (542 results) over the period of record. The results shown in **Figures 2.23** and **2.24** demonstrate the influence of the Escambia River flow on color in the bay (years with high salinity correspond to low color).

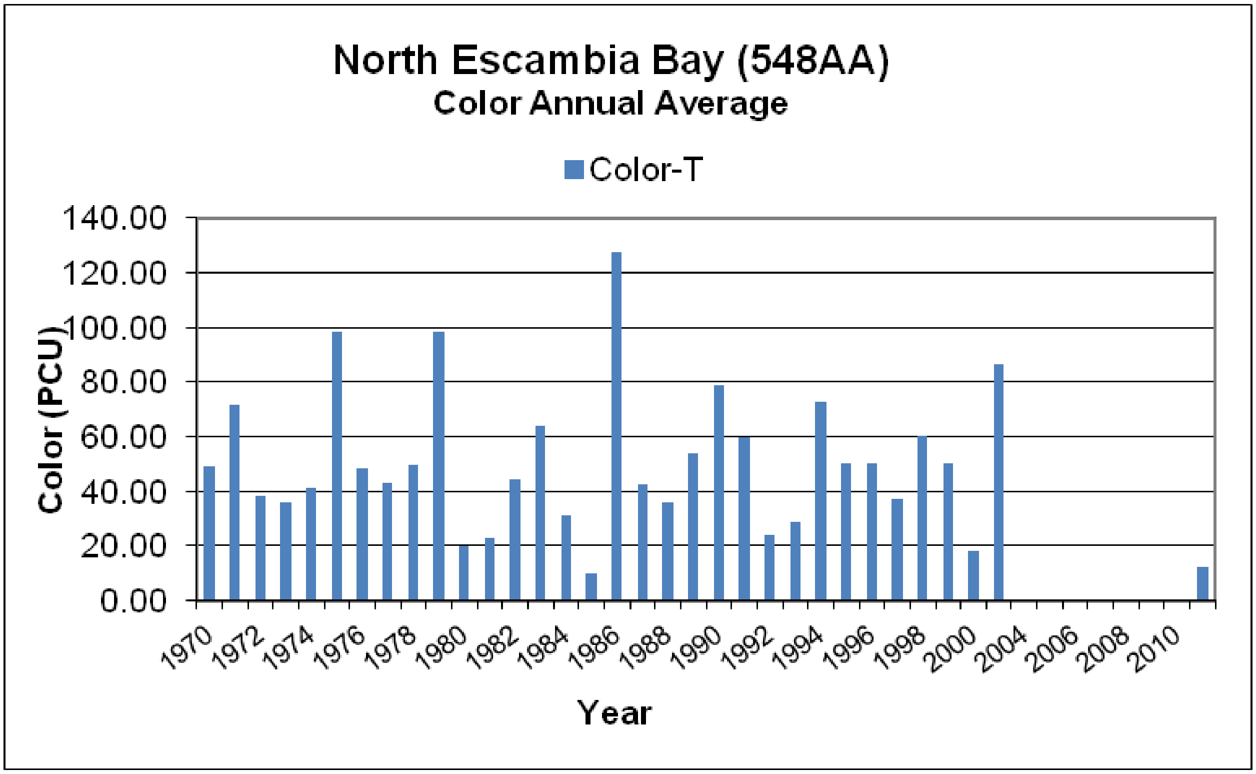


Figure 2.24. Annual Average Color in North Escambia Bay (WBID 548AA) over the Period of Record

Nitrate-N

Appendix D, **Tables D.2.1** and **D.2.3** and **Figures D.2.11** through **D.2.14**, present the NO3-N data. The median NO3-N for the period from 1972 to 1989 was 0.090 mg/L (786 results). The median for the period from 1990 to 2011 is 0.071 mg/L (418 results), a decrease over the historical value. However, as depicted in **Figure 2.25**, the annual averages for 2009 (0.12 mg/L) and 2010 (0.13 mg/L) are back above the historical values.

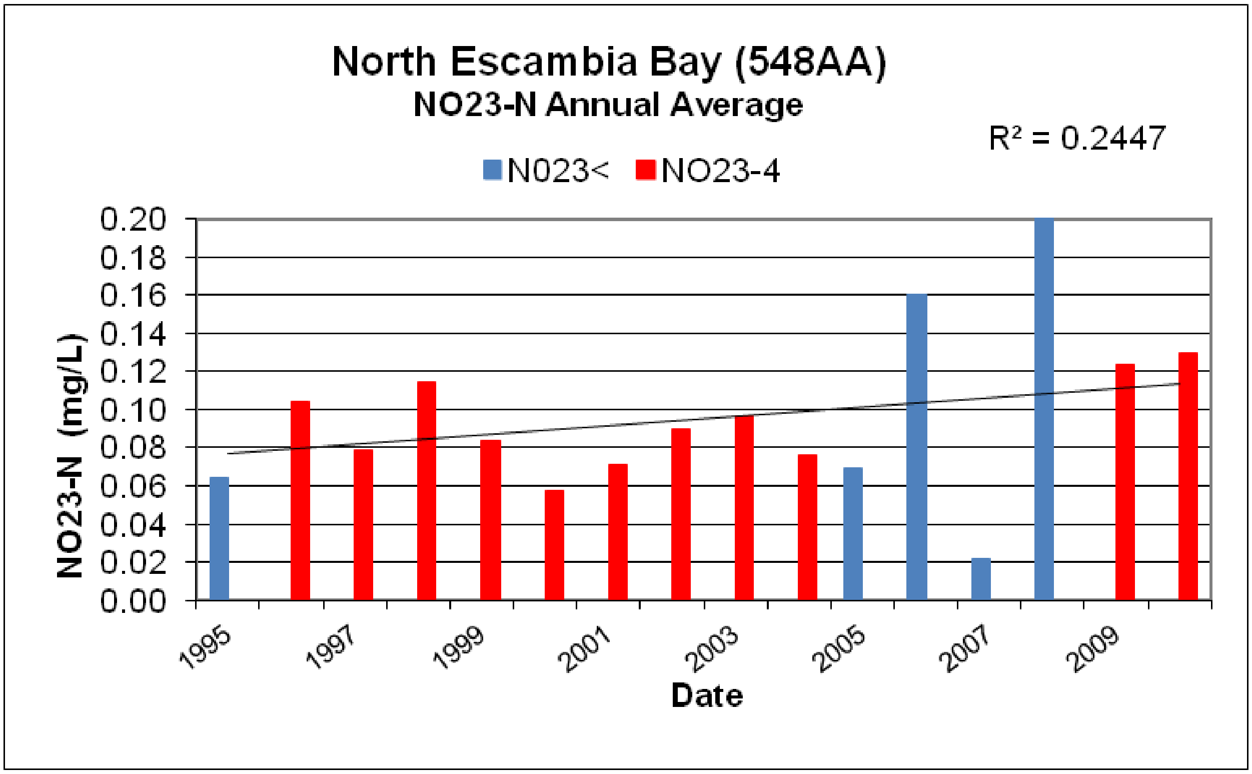


Figure 2.25. Annual Average NO3-N in North Escambia Bay (WBID 548AA), 1995–2010

Ammonia-N

Appendix D, **Tables D.2.1** and **D.2.3** and **Figures D.2.15** through **D.2.18**, present the NH4-N data. The median NH4-N for the period from 1972 to 1989 was 0.053 mg/L (937 results). The median for the period from 1990 to 2011 is 0.034 mg/L (392), a decrease over the historical value. Although, as depicted in **Figure 2.26**, annual averages for a number of more recent years—0.055 mg/L in 2002, 0.051 mg/L in 2003, 0.079 mg/L in 2004, and 0.052 mg/L in 2010—are above the historical value.

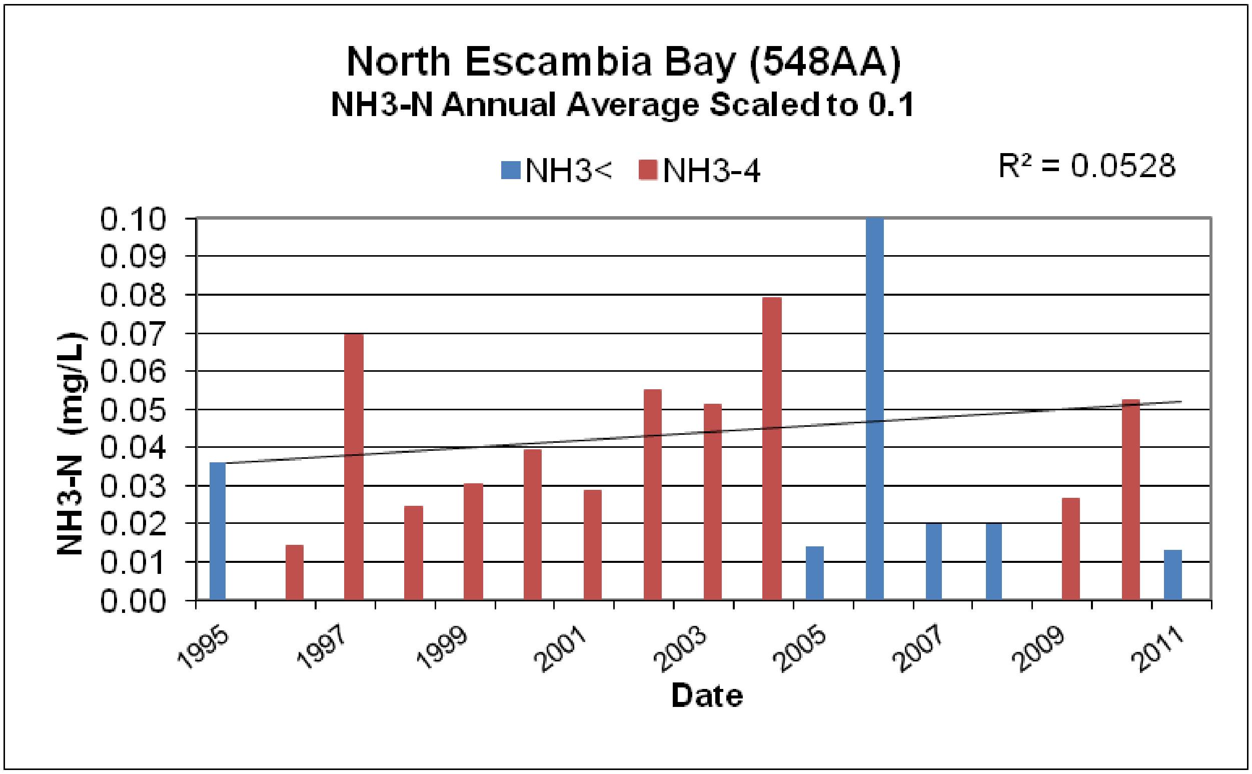


Figure 2.26. Annual Average NH4-N in North Escambia Bay (WBID 548AA), 1995–2011

Organic-N

Appendix D, **Tables D.2.1** and **D.2.3** and **Figures D.2.19** through **D.2.21**, present the organic-N data. The median for the period from 1972 to 1989 was 0.38 mg/L (899 results). The median for the period from 1990 to 2011 is 0.56 mg/L (251 results), an increase over the historical value. Annual averages for 2004 (0.69 mg/L) and 2009 (0.68 mg/L) are well above the historical value.

TN

Appendix D, **Tables D.2.1** and **D.2.3** and **Figures D.2.22** through **D.2.25**, present the TN data. The median TN for the period from 1970 to 1989 was 0.54 mg/L (907 results). The median for the period from 1990 to 2011 is 0.59 mg/L (356 results), a slight but insignificant increase over the historical value. It appears that the increase is primarily a result of increases in organic nitrogen. **Figure 2.27** below shows the reduction in TN since the 1970s.

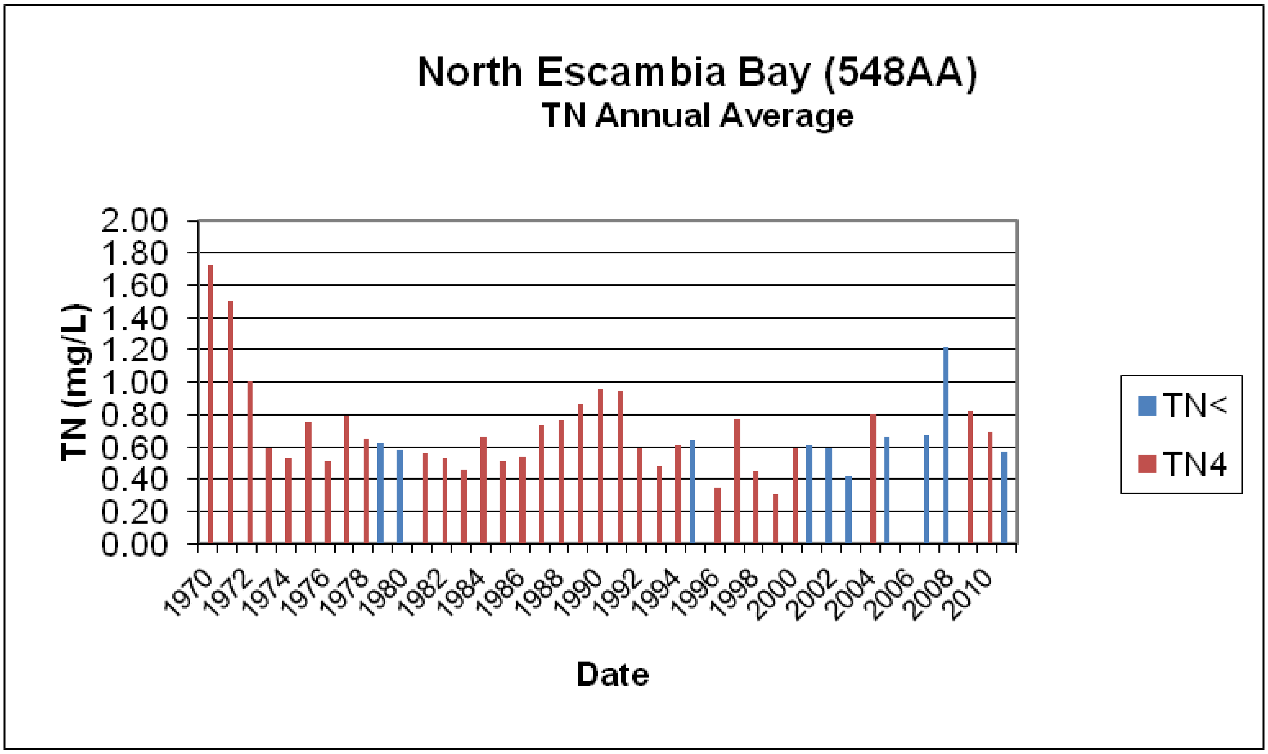


Figure 2.27. Annual Average TN in North Escambia Bay (WBID 548AA) over the Period of Record

Orthophosphate Phosphorus

Appendix D, **Tables D.2.1** and **D.2.4** and **Figures D.2.26** through **D.2.28**, present the PO4-P data. There are long periods when no PO4-P data were collected in North Escambia Bay (**Figure 2.28**), creating time gaps that make interpreting the data difficult. The median of 501 results for the period from 1970 to 1989 was 0.005 mg/L, while the median for the period from 1990 to 2011 was 0.013 mg/L (239 results). The increase during this period was due to two periods with elevated PO4-P, one during the mid 1980s and one in the late 1990s. However, the median for the period from 1998 to 2011 is back to 0.005 mg/L (160 results).

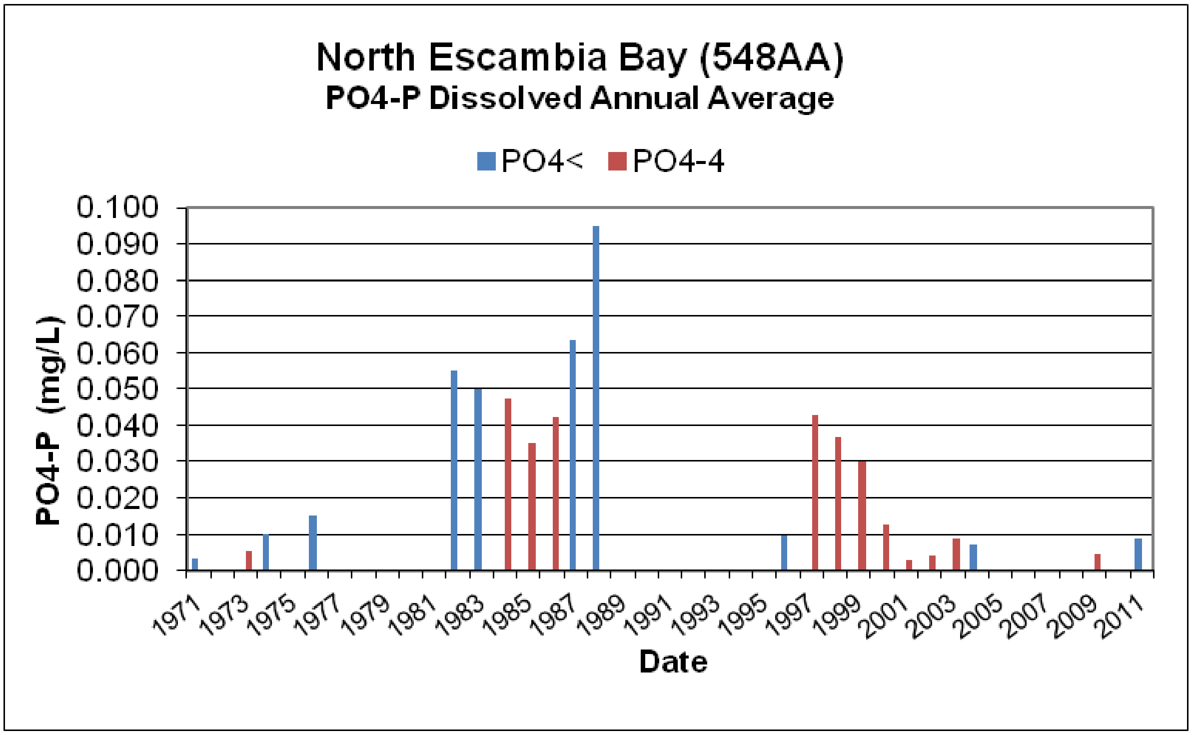


Figure 2.28. Annual Average PO4-P in North Escambia Bay (WBID 548AA) over the Period of Record

TP

Appendix D, **Tables D.2.1 and D.2.4** and **Figures D.2.29** through **D.2.33** present the TP data. The median of 908 results for the period from 1970 to 1989 was 0.030 mg/L, while the median for the period from 1990 to 2011 was 0.037 mg/L (260 results) and 0.040 mg/L (138 results) for the period from 1998 to 2011. As shown in **Figure 2.29**, the increase during this period was in part due to elevated TP during 2004 (annual average of 0.048 mg/L). The data indicate a progressive increase in TP from 1971 to 1985, the opposite trend of TN. Then, in the mid-1980s, TP generally declined while TN increased through 1990.

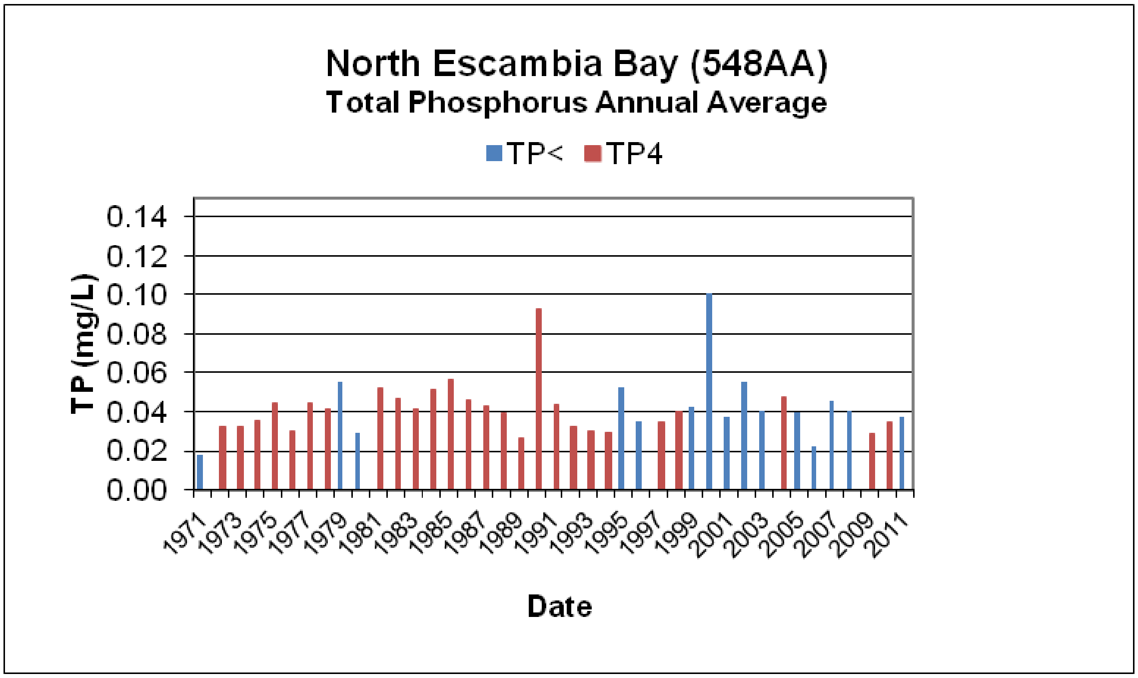


Figure 2.29. Annual Average TP in North Escambia Bay (WBID 548AA) over the Period of Record

CChla

Appendix D, **Tables D.2.1** and **D.2.4** and **Figures D.2.34** through **D.2.37**, present the CChla data. The median of 86 results for the period from 1980 to 1989 was 5.0 µg/L with values ranging between 2 µg/L and 47 µg/L. The median for the period from 1990 to 2011 was 6.14 µg/L (624 results) and 6.9 µg/L (447 results) for 1998 to 2011. As shown in **Figure 2.30**, the CChla annual average concentrations only rose above 8.0 µg/L once (8.41 µg/L in 1987) until 1989, when the annual average was 18.9 µg/L. After 1995, annual averages increased, as shown in **Figure 2.31**. The purpose of the TMDL is to address this increase in CChla over historical levels.

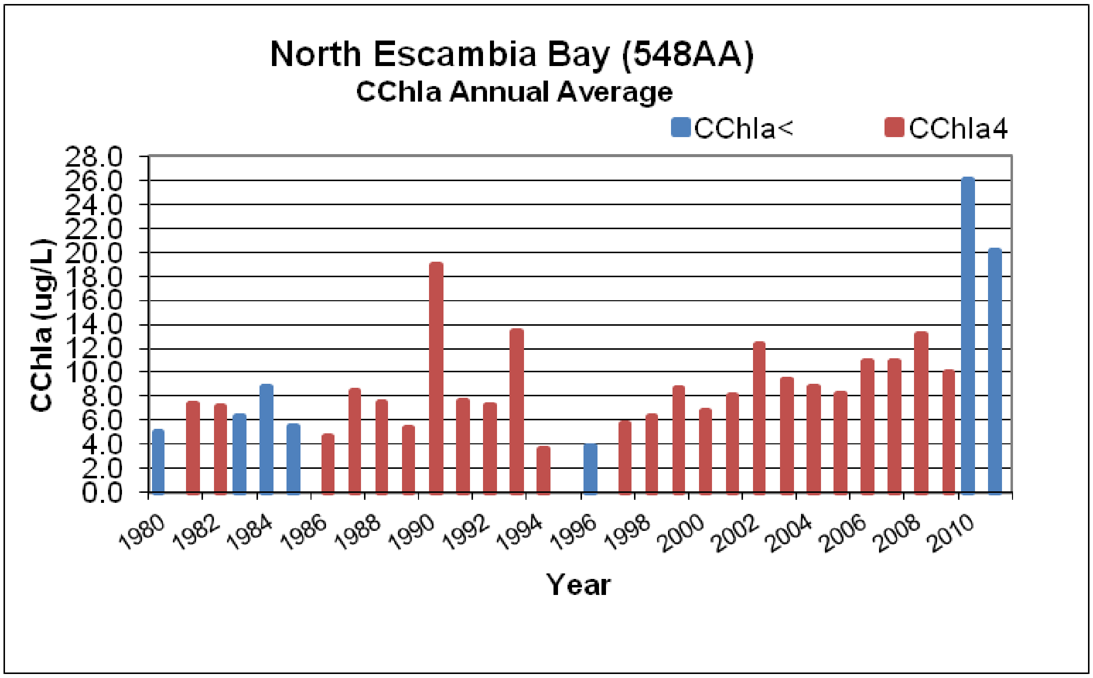


Figure 2.30. Annual Average CChla in North Escambia Bay (WBID 548AA) over the Period of Record

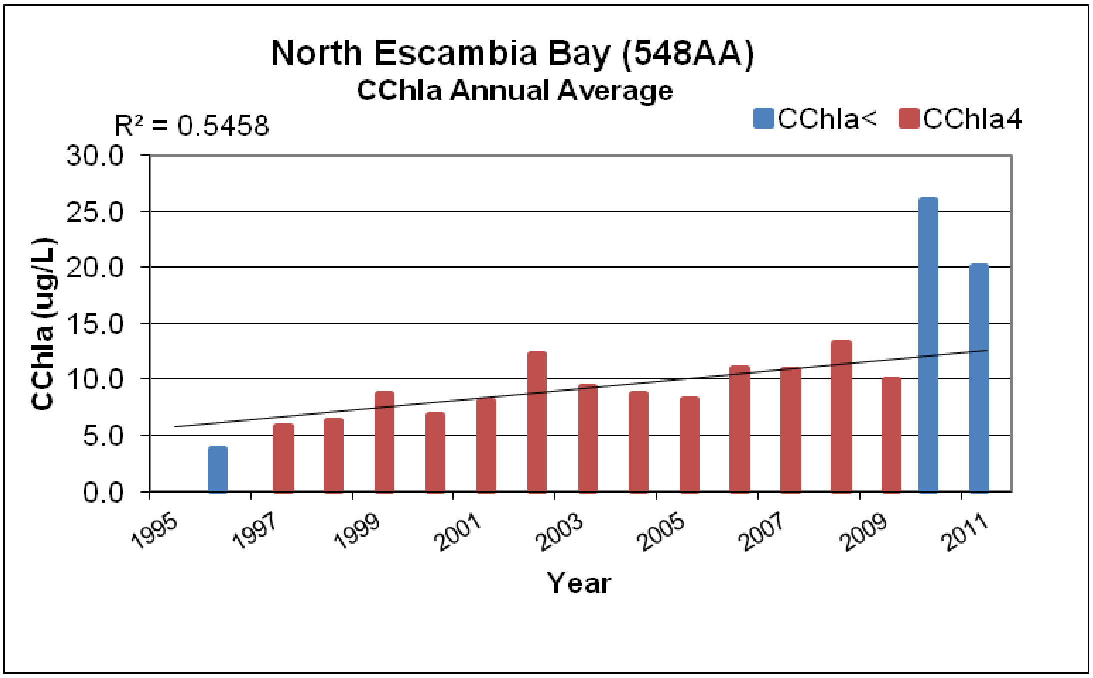


Figure 2.31. Annual Average CChla in North Escambia Bay (WBID 548AA), 1995–2011

The next section contains results comparing North Escambia Bay with the rest of the Pensacola Bay system. **Appendix D**, **Tables D.3.1** through **D.11.1** and **Figures D.3.1** through **D.12.3**, present the data. **Figures 2.32** through **2.34** show the median concentrations (1998–2011) for each WBID in the main areas of the Pensacola Bay system. The data in each figure are in the format of median/number of observations.

For TN, the results indicate that the median concentration in the Lower Escambia River of 0.59 mg/L is slightly lower than in the Blackwater River (0.65 mg/L), with the Yellow River the lowest of all the rivers at 0.41 mg/L. North Escambia Bay has a median TN concentration of 0.60 mg/L. The fact that TN concentrations did not decrease between the river and the bay may be in part explained by the elevated concentrations of TN and inorganic nitrogen (median TN of 3.59 mg/L, NH4 of 0.38 mg/L, and NO3-N of 0.91 mg/L) in several tributaries along the eastern margin of the bay. As noted previously, the eastern side of North Escambia Bay may be receiving high concentrations of nitrogen from an area delineated as a ground water contamination zone.

South of WBID 548AA, concentrations of TN generally decrease towards the Gulf, except for a slight increase in Middle Pensacola Bay. This portion of the bay system receives high nitrogen concentrations from Bayou Texar and Bayou Chico (median TN of 2.59 mg/L, 95 results, 2003–11), areas that drain portions of Escambia County and the city of Pensacola. For the period from 1995 to 2011, annual average TN concentrations increased in all WBIDs, except in WBID 548E near the Gulf of Mexico and Upper Blackwater Bay (very limited data).

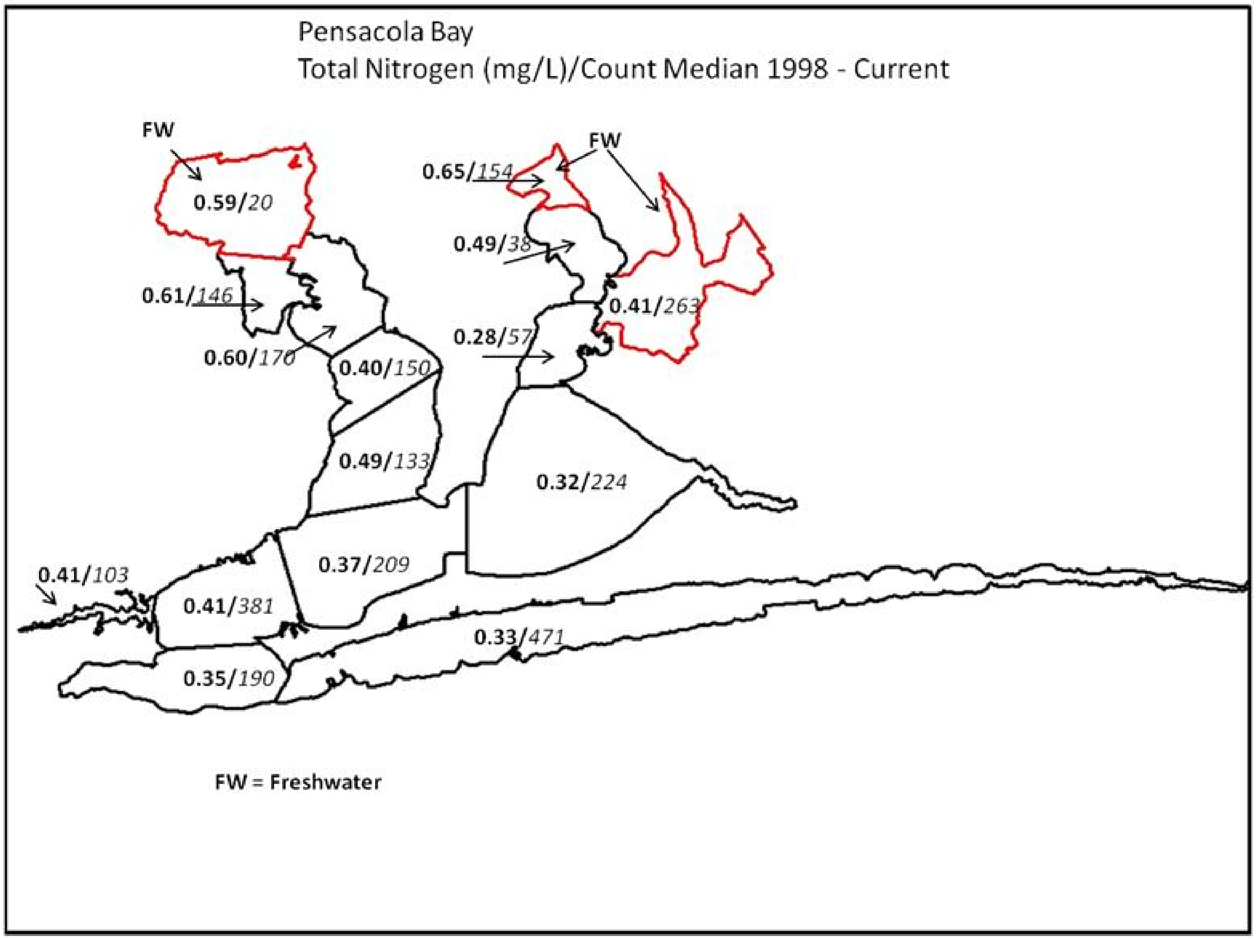


Figure 2.32. TN Median/Count for the Pensacola Bay WBIDs, 1998–2011

For TP, the results indicate that the median concentration of 0.032 mg/L in the lower Escambia River is over twice that of the Blackwater River (0.013 mg/L), with the Yellow River in between at 0.020 mg/L. North Escambia Bay has a median of 0.040 mg/L, almost twice as high as the Blackwater and Pensacola Bay areas. Additionally, one of the ground water monitoring wells in the Judges Bayou watershed had elevated concentrations of PO4-P. The TP generally declines from headwater areas of the river towards the Gulf, except for WBID 548E near the mouth of the bay, where the median (1998–2011) is 0.020 mg/L (135 results). For the period from 1995 to 2011, annual average TP concentrations decreased in all WBIDs except for WBID 548E near the Gulf of Mexico and WBID 548GB, South Blackwater Bay (very limited data). The general trend during the period from 1995 to 2011 is decreasing TP annual averages.

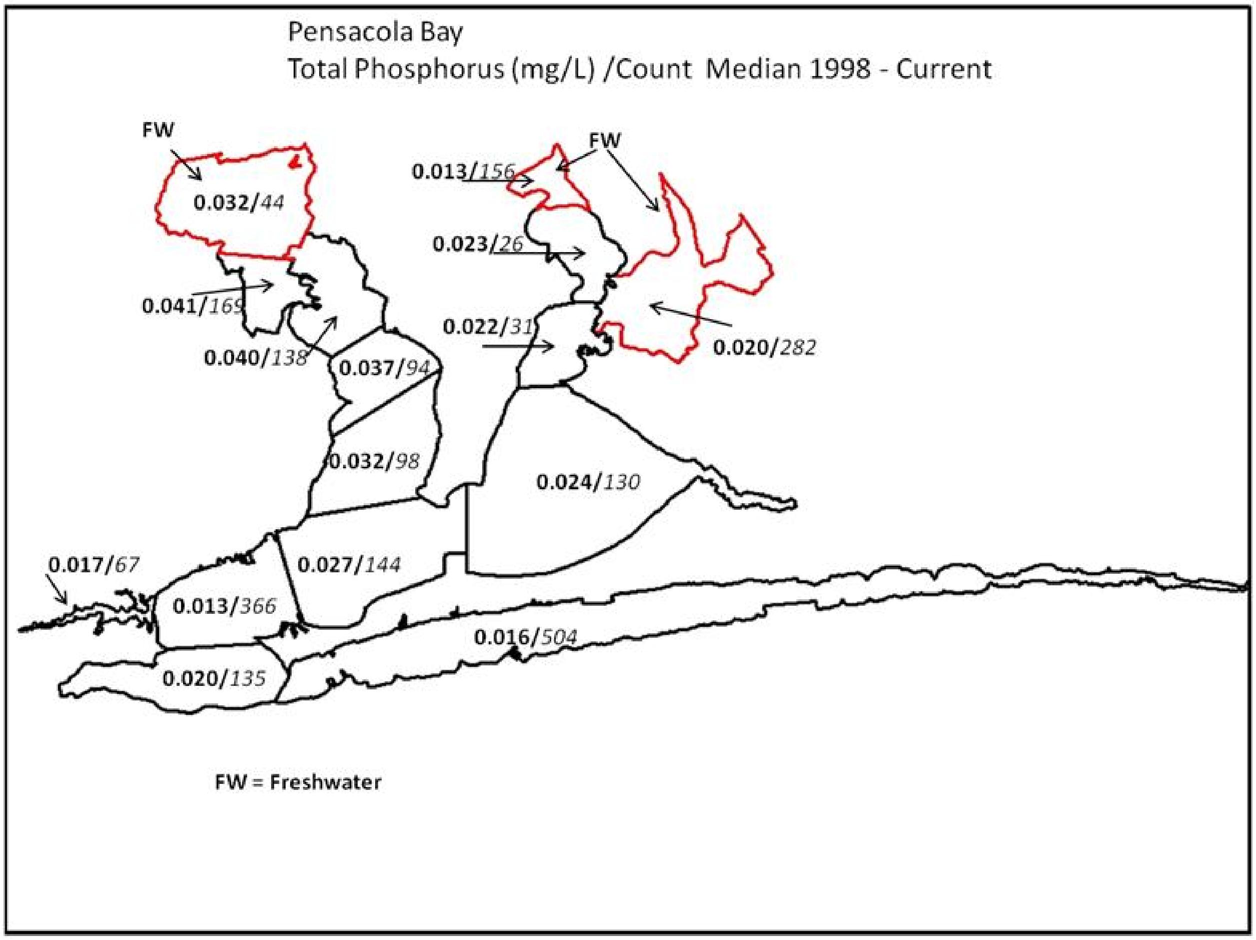


Figure 2.33. TP Median/Count for the Pensacola Bay WBIDs, 1998–2011

For CChla, the results indicate that the only area of the bay system with a median concentration over 3.0 µg/L is North Escambia Bay, with a median concentration of 6.90 µg/L. The median CChla concentration in the majority of the system is 2.50 µg/L. During the period from 1995 to 2011, annual average CChla concentrations increased in all areas of the bay except East Bay (WBID 548H).

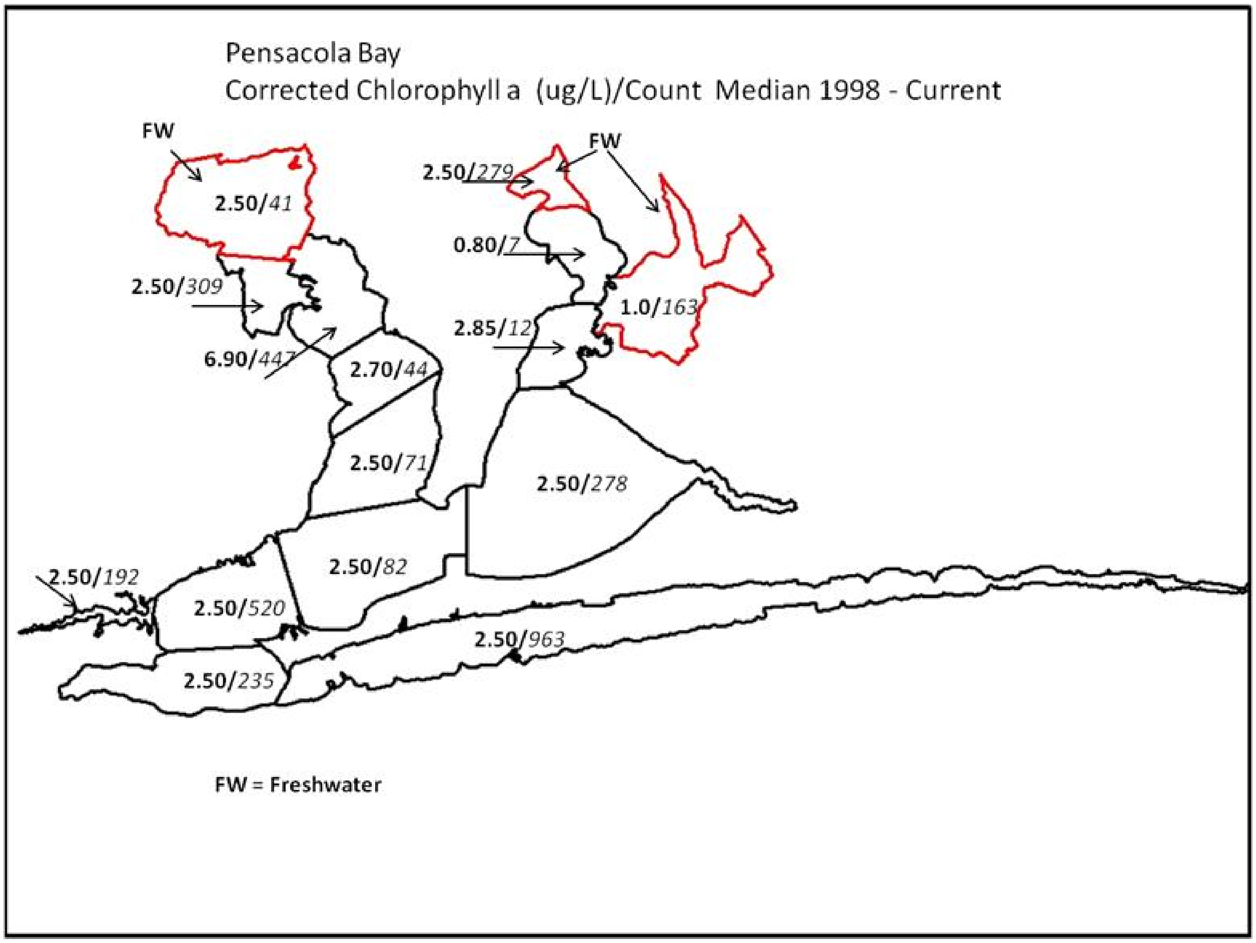


Figure 2.34. CChla Median/Count for the Pensacola Bay WBIDs, 1998–2011

As documented by the Department in the series of publications related to the development of numeric interpretations of the narrative water quality criteria (Department 2012), with the exception of North Escambia Bay, all other areas of the bay currently meet their designated uses and have a healthy and well-balanced population of fish and wildlife. The data presented above indicate that trends in nutrients and CChla should be closely monitored to ensure that current watershed loadings and future growth do not exceed the assimilative capacity of these areas.

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)**

North Escambia Bay (WBID 548AA), Judges Bayou (WBID 493B), and Bayou Chico (WBIDs 846 and 846C) are Class III marine waterbodies (with a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife). The Class III water quality criterion applicable to the observed impairments (nutrients) for these waters is the state of Florida’s narrative nutrient criterion in Paragraph 62-302.530(48)(b), Florida Administrative Code (F.A.C.).

Judges Bayou (WBID 493A) is a Class III fresh 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 criterion applicable to the observed impairment (DO) for this waterbody is the state of Florida’s DO criterion (Subsection 62-302.530(30), F.A.C.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 Nutrients

Florida’s nutrient criterion is narrative only, i.e., nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. Rule 62-303, F.A.C. (Nutrients in Estuaries), states that “segments shall be included on the planning list for nutrients if their annual mean CChla for any year is greater than 11 µg/L or if data indicate annual mean CChla values have increased by more than 50% over historical values for at least two consecutive years." The rule states that 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), F.A.C.” The TMDL goal is to determine the appropriate combination of TN and TP concentrations for the marine portions of Bayou Chico, Judges Bayou, and North Escambia Bay to meet the nutrient criterion and Judges Bayou freshwater streams to meet the DO criterion. The TN and TP concentrations are functions of the loading received from a variety of sources surrounding the waterbodies, as described in the next chapter.

3.2.2 Chlorophyll

Chlorophyll, a green pigment found in plants, is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide and water into carbohydrates and oxygen. The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll *a* (Chla). The measurement of Chla in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with an analysis of algal growth potential (AGP) and species abundance. Typically, the greater the abundance of Chla, the greater the abundance of algae. Algae are the primary producers in the aquatic food web and thus are very important in characterizing the productivity of waterbodies.

3.2.3 Nitrogen Total as N (TN)

TN is the combined measurement of nitrate (NO_3), nitrite (NO_2), ammonia, and organic nitrogen found in water. Nitrogen compounds function as important nutrients for many aquatic organisms and are essential to the chemical processes that occur between land, air, and water. The most readily bioavailable forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major sources of excessive amounts of nitrogen in surface water are the effluent from domestic and industrial facilities and runoff from urban and agricultural sites. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody's biological community and drive an aquatic system into an accelerated rate of eutrophication, or rapid aging. Usually, the eutrophication process is observed as a change in the structure of the algal community and may include algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by depletion in DO concentrations as a result of algal decomposition.

3.2.4 Phosphorus Total as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, percolation, and terrestrial runoff. Municipal treatment plants, industrial activities, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

3.2.5 DO Freshwater

Florida's DO criterion for Class I and III fresh waterbodies states that DO "shall not be less than 5.0 mg/L, and the normal daily and seasonal fluctuations above this levels shall be maintained." However, DO concentrations in ambient waters can be controlled by many factors, including DO solubility, which is controlled by temperature and salinity; DO enrichment processes influenced by reaeration, which is controlled by flow velocity; the photosynthesis of phytoplankton, periphyton, and other aquatic plants; DO consumption from the decomposition of organic materials in the water column and sediment and the oxidation of some reductants such as ammonia and metals; and respiration by aquatic organisms.

The DO concentration in some seasons could be naturally low because of the high bacteria respiration supported by a large and constant supply of dissolved organic carbon (DOC) originating from the watershed. Bacteria activities can be significantly stimulated if nitrogen and phosphorus are added into the system because they provide bacteria with nutrients. The further stimulation of bacterial activities can be observed if DOCs of human origin (usually represented as biochemical oxygen demand [BOD]) are added to the system. Human DOCs are usually easy to decompose and can be readily used by bacteria. These DOCs not only can enhance the metabolic activities of bacteria species that use recalcitrant DOCs, but also provide a carbon source to bacteria species that cannot use recalcitrant DOCs. Therefore, human sources of DOC into aquatic systems should be properly controlled to improve the DO condition in these waters.

Another source of DO consumption may originate from the organic materials accumulated in a waterbody over time. Due to the limited amount of time available, factors that control DO concentration in each waterbody were not examined by measuring the actual DO consumption rate from each source. Instead, this analysis focused on TN, TP, and CChla concentrations. The possible impacts of these nutrients and phytoplankton on the DO level of each waterbody were evaluated by comparing the results from various modeled scenarios discussed later.

One of the major sources of DO consumption originates from organic sediments accumulated in an aquatic system over time. This organic matter has both natural and human-derived components. The bottom organic sediments can be deposited from different sources (i.e., wastewater effluents, nonpoint source runoff, and allochthonous particulates). Sediment oxygen demand (SOD) is the sum of DO needed for the oxidation of organic matter in bottom sediments via biological and chemical processes that take up DO. Major factors affecting SOD are temperature, the organic content of the sediment, and the oxygen concentration of the overlying waters (Chapra 1997).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern 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 discernible, 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 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. 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 Impaired Watersheds

4.2.1 Point Sources

Bayou Chico

There are no permitted wastewater treatment facilities that discharge directly to Bayou Chico or its tributaries, Jackson and Jones Creeks.

Judges Bayou

There are no permitted wastewater treatment facilities that discharge directly into either the freshwater streams (St. Regis Branch, Judges Branch) or Judges Bayou.

North Escambia Bay

In Florida, currently only three WWTFs have NPDES permits allowing direct discharge into the Escambia River or Escambia Bay, and one facility has an indirect discharge to the Simpson River (tributary to Escambia Bay) (**Figure 4.1**). Facilities with NPDES surface water discharge permits all have permit numbers starting with FLO and are listed in **Table 4.1**. These facilities are permitted through the NPDES Program in Florida.

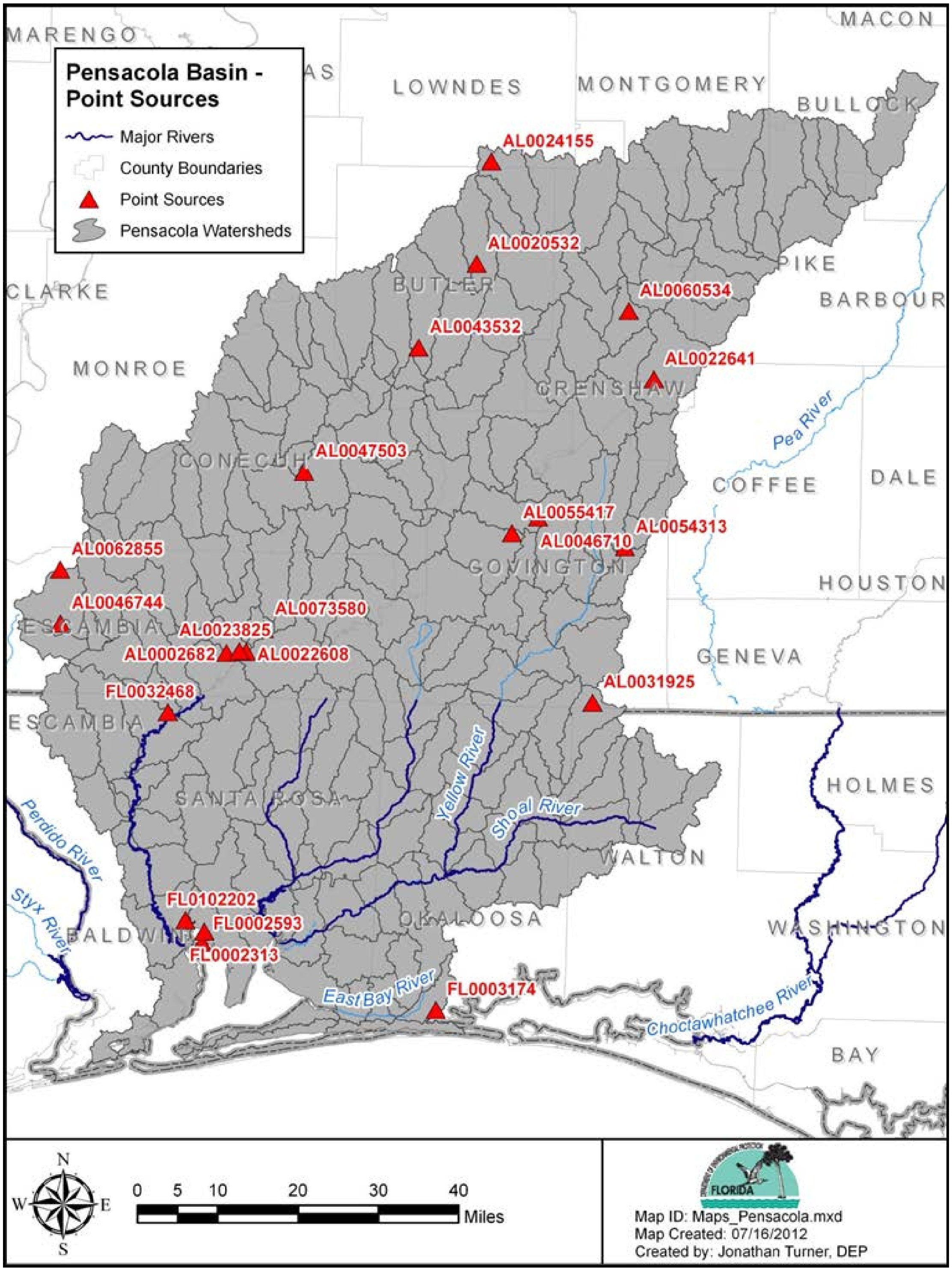


Figure 4.1. Wastewater Facilities in the Pensacola Bay Basin (Alabama and Florida)

Table 4.1. Point Sources in the Escambia Bay Basin (Florida)

- = Empty cell/no data
IW = Industrial wastewater
DW = Domestic wastewater
A = NPDES Active Permit

Permit Number	Facility Name	Type	Status	NPDES	Design Flow (MGD)	County
-	**FLORIDA**	-	-	-	-	-
FL0002275	Gulf Power Company - Crist Power Plant	IW	A	Yes	18.00	Escambia
FL0002488	Ascend Performance Materials LLC	IW	A	Yes	27.00	Escambia
FL0559351	Central Water Reclamation Facility	DW	A	Yes	0.0	Escambia
FL0032468	Century, Town of - WWTF	DW	A	Yes	0.45	Escambia
FL0102202	Pace Water System, Inc WWTP	DW	A	Yes	2.00	Santa Rosa
-	**ALABAMA**	-	-	-	-	-
AL0002682	Georgia-Pacific Brewton LLC	IW	A	Yes	Report	Escambia
AL0022608	East Brewton WWTF	DW	A	Yes	0.3	Escambia
AL0073580	City of Brewton (North Brewton Lagoon)	DW	A	Yes	0.5	Escambia
AL0023825	City of Brewton (Brewton Lagoon)	DW	A	Yes	1.5	Escambia
AL0046744	City of Atmore	DW	A	Yes	1.6	Escambia
AL0023493	Town of Flomaton	DW	A	Yes	0.49	Escambia
AL0062855	Huxford Pole & Timber Company Inc.	IW	A	Yes	Report	Escambia
AL0031925	Lockhart/Florala WWTF	DW	A	Yes	0.35	Covington
AL0054313	City of Opp Westside WWTF	DW	A	Yes	1.2	Covington
AL0055417	City of Andalusia Riverside WWTF	DW	A	Yes	2.84	Covington
AL0047503	City of Evergreen	DW	A	Yes	1.5	Conecuh
AL0043532	City of Georgiana Water Works and Sewer Board	DW	A	Yes	0.3	Butler
AL0022641	Town of Brantley	DW	A	Yes	0.2	Crenshaw
AL0060534	City of Luverne Water Works and Sewer Board	DW	A	Yes	0.80	Crenshaw
AL0020532	Greenville Water Works and Sewer Board	DW	A	Yes	2.0	Butler
AL0024155	Fort Deposit Water Works and Sewer Board	DW	A	Yes	0.24	Lowndes

The town of Century (NPDES Permit FL0032468) is a 0.45-MGD monthly average daily flow, conventional extended aeration, secondary domestic wastewater treatment plant. The facility discharges to the Escambia River near the state line. The current permit does not require monitoring for TP or PO4-P, the constituents addressed by the draft TMDL.

Pace Water System, Inc. (NPDES Permit FL0102202) is an activated sludge, advanced wastewater treatment plant with a 5-MGD annual average daily flow (AADF) capacity, mostly for reuse water. The permit authorizes a 1-MGD AADF discharge through D-001 to Pace Swamp wetlands (144 acres). Pace Swamp drains to the Simpson River, a tributary to Escambia Bay. The permit contains a limit of 321 pounds per month for TP.

There are no longer any direct discharges into North Escambia Bay (WBID 548AA). However, Gulf Power Company–Crist Power Plant (NPDES Permit FL0002275) discharges cooling water in WBID 10F, just upstream of the impaired WBID 548AA. The current permit, issued in January 2011, expires in January 2016. The facility has undergone modifications to accept reuse water as part of the cooling water system. The impacts of these modifications on North Escambia Bay were examined using multidimensional hydrodynamic and water quality models (ECOMSED and RCA, Hydro Qual 2011). These models have been used since the 1990s to help the Department make permit decisions for North Escambia Bay. The results from the modeling conducted by the permittee and reviewed by the Department (March 2011) under low-flow, critical growing season conditions demonstrated that the facility is not causing or contributing to the elevated chlorophyll in the impaired waterbody.

Additionally, Ascend Performance Materials LLC (NPDES Permit FL0002488) discharges into the Escambia River about 2.7 miles upstream of the Gulf Power cooling water discharge. The current permit was issued in March 2011 and expires in March 2016. The facility's primary product is nylon 6,6 polymers, but it also produces nylon chemical intermediates, resins and fibers, and maleic hydrogen. CEREX Advanced Fabrics, L.P. uses Ascends' south outfall (D-001) for nonprocess wastewater discharge made up of once-through noncontact cooling water, well water, potable water, fire water, and steam condensate.

All water used by Ascend is either drawn from the Escambia River or from wells on site. Approximately 95% to 98% is discharged through Outfall D-001 and the remainder through Outfall D002. Ascend has a 27.7 MGD average monthly flow from industrial nonprocess water. The process water from CEREX, all domestic wastewater, cooling tower blowdown, chilled water blowdown, and boiler blowdown are disposed of by underground injection under Permit UIC 0001150/006/UO/1. Under the permit, no process wastewater is discharged to surface waters.

In April 2011, the Department's Biology Section conducted a bioassessment of Ascend. The AGP results indicated that the north outfall, D-002 (only 2% to 5% of average flow), is contributing to nutrient enrichment in the area around the outfall with an AGP about 5 times the problem threshold. The main discharge location, D-001, also had an AGP about 5 times the problem threshold, but there was no evidence of nutrient enrichment at the south test site in the river. The results indicated nitrogen-phosphorus colimitation at the north test site and phosphorus limitation at the south test site. The facility has a continuous discharge and was discharging 2.225 MGD at the south outfall and 16.2 MGD at the north outfall during September 2009. There is no nutrient monitoring in the current permit. However, data collected during the biological assessment (bioassessment) indicate that there may be a need to include monitoring for nutrients. Orthophosphate concentrations of 0.068 mg/L were measured at D-001 (north) and 0.020 mg/L at D-002 (south). TP was 0.16 mg/L at the north outfall and 0.05 mg/L at the south outfall. TN concentrations of 0.63 mg/L (north) and 0.81 mg/L (south) are slightly higher than data for the Escambia River at WBID 10D, about 2 miles upstream of Ascend. The TP in the discharge is elevated over upstream concentrations, as is the PO4-P. WBID 10D for the period of record has a mean TN of 0.58 mg/L, TP of 0.039 mg/L, and PO4-P of 0.0224 mg/L.

The most recent revisions to the permit for Sterling Fibers (NPDES Permit FL0002593) no longer allow for any direct discharge to the bay. Additionally, the Emerald Coast Utilities Authority (ECUA) Central Water Reclamation Facility (NPDES Permit FL0559351) is located near Spanish Mill Creek, a tributary of the Escambia River. This facility has no discharge to surface waters.

In Alabama, there are currently 14 domestic and 2 industrial facilities (**Table 4.1**) discharging to the Conecuh/Escambia River or tributaries that are permitted by Alabama.

These dischargers are taken into consideration in the Loading Simulation Program in C++ (LSPC) model that delivers loadings to Escambia Bay.

4.2.2 Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003. Regulated Phase II MS4s, defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters. For Phase II MS4s, only the “urbanized area” in a county is subject to the MS4 permit.

In the Pensacola Bay Basin, the stormwater collection systems owned and operated by Escambia County, the city of Pensacola, the town of Century, and the Florida Department of Transportation (FDOT) District 3 (NPDES MS4 Permit FLS000019) in Escambia County are covered by a Phase I NPDES MS4 permit. The University of West Florida (FLR04E057) and the Pensacola Naval Air Station (FLR04E058), also in Escambia County, have Phase II MS4 permits. Several other local governments in the basin have coverage under Phase II NPDES MS4 permits. These include Santa Rosa County (FLR04E069), the city of Milton (FLR04E104), and the city of Gulf Breeze (FLR04E085) in Santa Rosa County.

4.2.3 Land Uses and Nonpoint Sources

Additional nutrient loadings to the impaired waters are generated from nonpoint sources in the watersheds. Potential nonpoint sources of nutrients are characterized by their pathway or delivery to the bayou by runoff, ground water, sediment nutrient release, and atmospheric deposition. Nonpoint sources can also be described by the type of land use where the sources are generated.

Land Uses

The spatial distribution and acreage of different land use categories in Florida were identified using the 2009–10 NWFWMD land use coverage contained in the Department’s Geographic Information System (GIS) library. Land use categories in each watershed were aggregated to the simplified Level 1 codes depicted in **Figures 4.2** through **4.6** and tabulated in **Tables 4.2** through **4.9**.

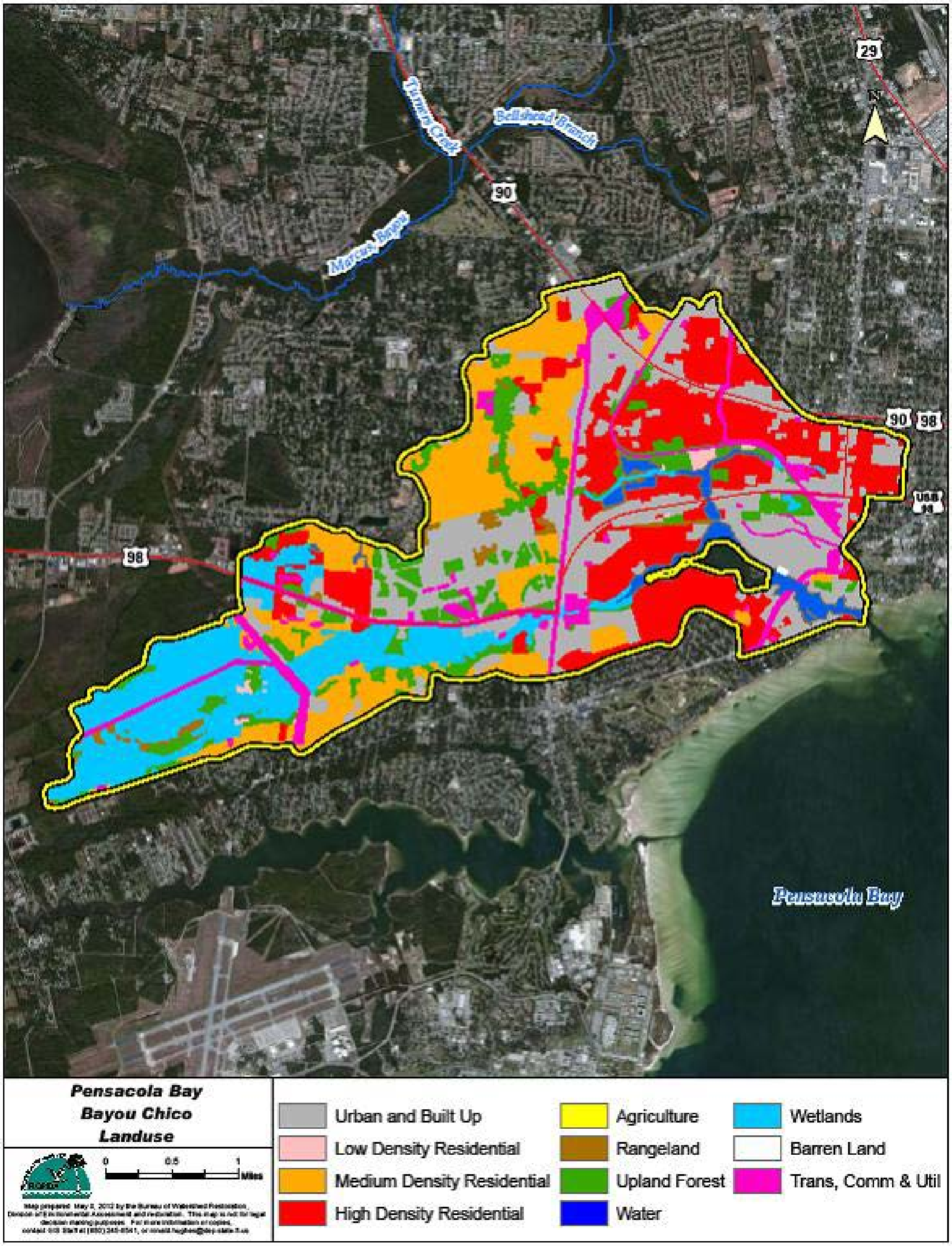


Figure 4.2. Principal Land Uses in the Bayou Chico Watershed, 2009–10

Table 4.2. Classification of Level 1 Land Use Categories in the Bayou Chico Watershed, 2009–10

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	4,552.61	7.11	67.76%
3000	Rangeland	114.60	0.18	1.71%
4000	Upland Forests	538.30	0.84	8.01%
5000	Water	171.95	0.27	2.56%
6000	Wetlands	992.61	1.55	14.77%
7000	Barren Land	1.42	0.00	0.02%
8000	Transportation, Communication, and Utilities	347.63	0.54	5.17%
-	**Total**	**6,719.13**	**10.50**	**100.00%**

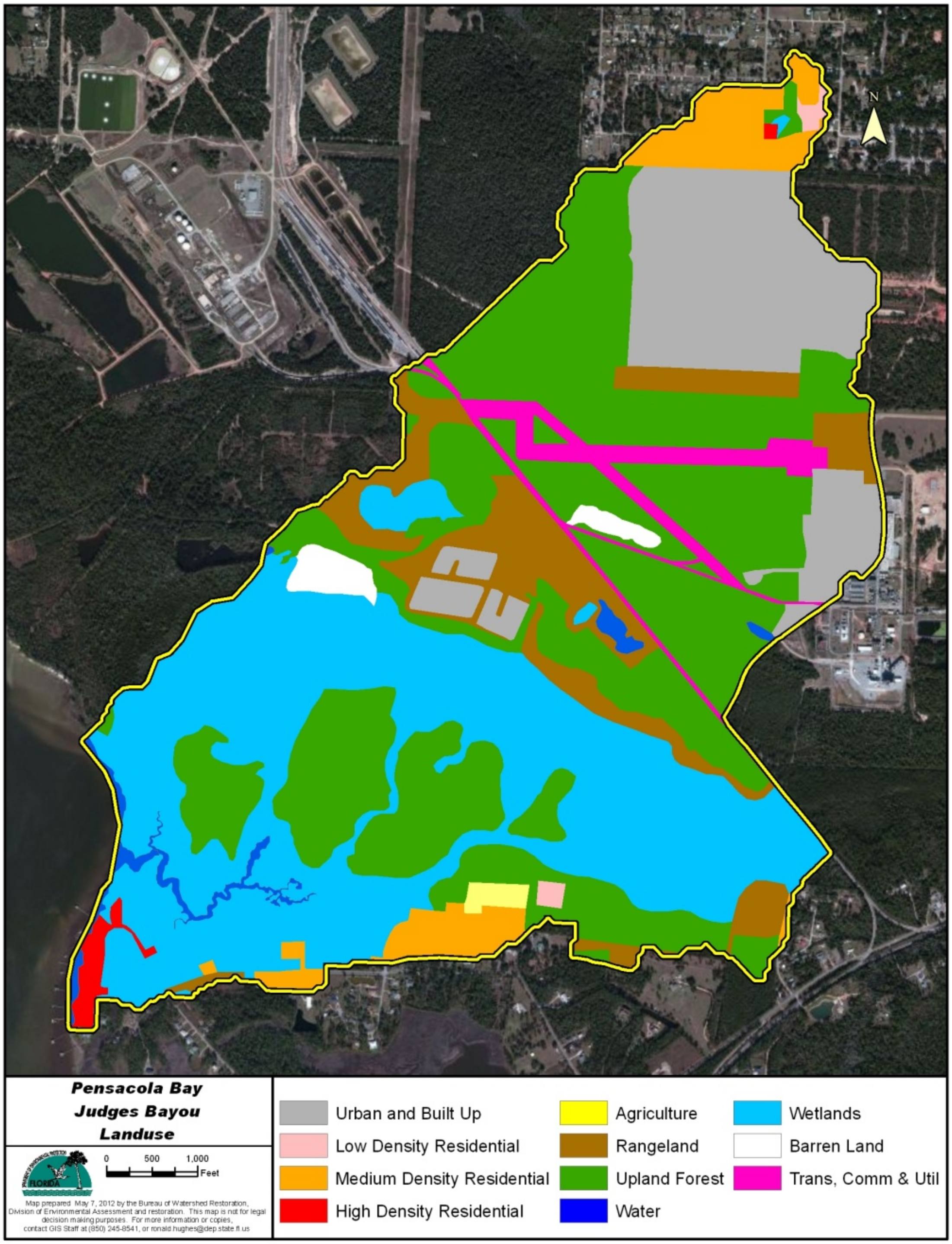
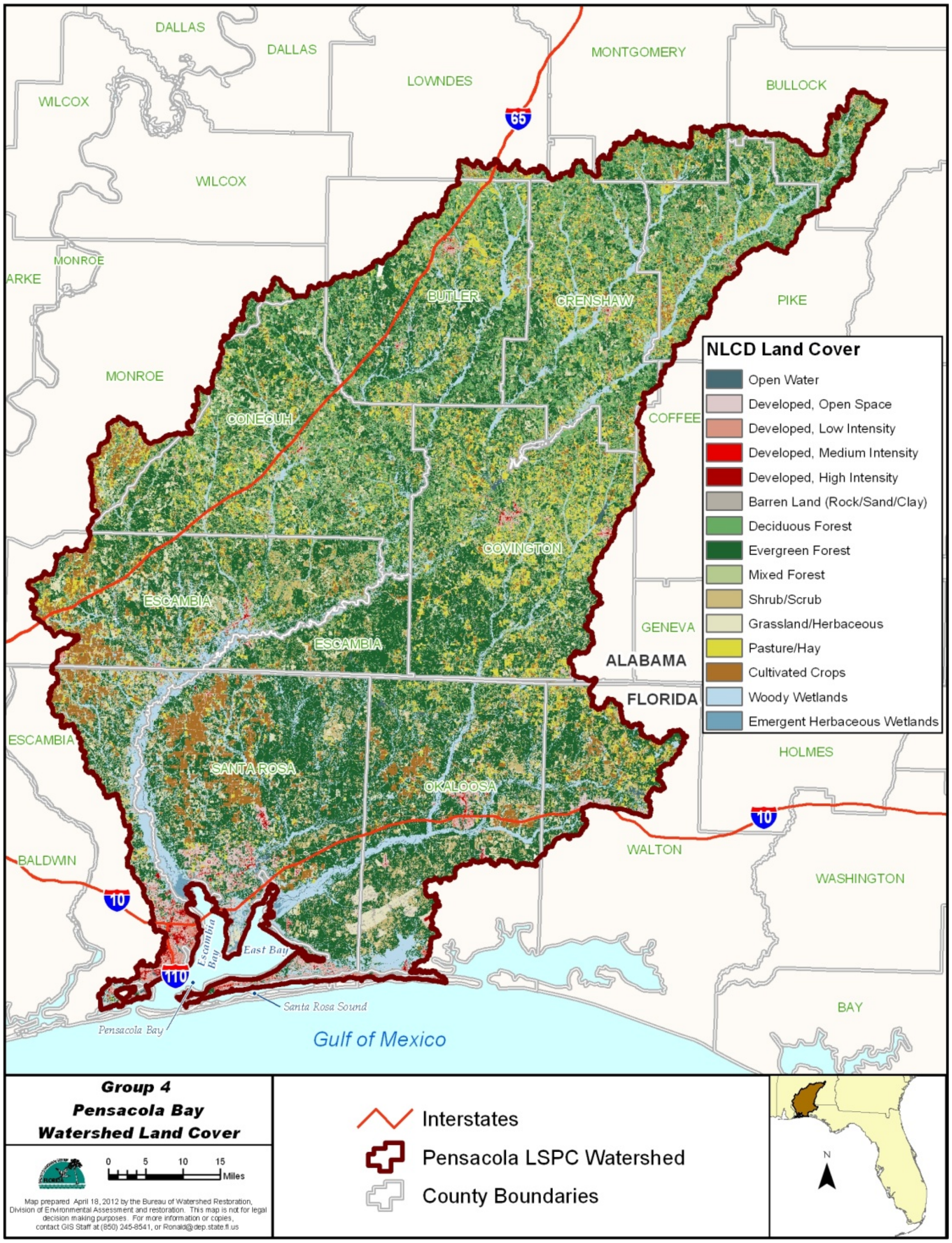


Figure 4.3. Principal Land Uses in the Judges Bayou Watershed, 2009–10

Table 4.3. Classification of Level 1 Land Use Categories in the Judges Bayou Watershed, 2009–10

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	216.6	0.34	17.86%
2000	Agriculture	4.4	0.01	0.36%
3000	Rangeland	107.1	0.17	8.83%
4000	Upland Forests	440.1	0.69	36.29%
5000	Water	13.2	0.02	1.09%
6000	Wetlands	379.3	0.59	31.27%
7000	Barren Land	13.9	0.02	1.15%
8000	Transportation, Communication, and Utilities	38.3	0.06	3.16%
-	**Total**	**1,212.8**	**1.9**	**100.0%**



Map prepared April 18, 2012 by the Bureau of Watershed Restoration, Division of Environmental Assessment and restoration. This map is not for legal decision making purposes. For more information or copies, contact GIS Staff at (850) 245-8541, or Ronald@dep.state.fl.us

Figure 4.4. Principal Land Uses in the Pensacola Bay Basin, 2009–10

Table 4.4. Classification of Level 1 Land Use Categories in the Pensacola Bay Basin, 2009–10

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	148,813.5	232.52	10.10%
2000	Agriculture	148,217.2	231.59	10.06%
3000	Rangeland	103,422.1	161.60	7.02%
4000	Upland Forests	733,397.6	1,145.94	49.78%
5000	Water	16,051.8	25.08	1.09%
6000	Wetlands	296,166.4	462.76	20.10%
7000	Barren Land	1,450.3	2.27	0.10%
8000	Transportation, Communication, and Utilities	25,737.8	40.22	1.75%
-	**Total**	**1,473,256.7**	**2,302.0**	**100.0%**

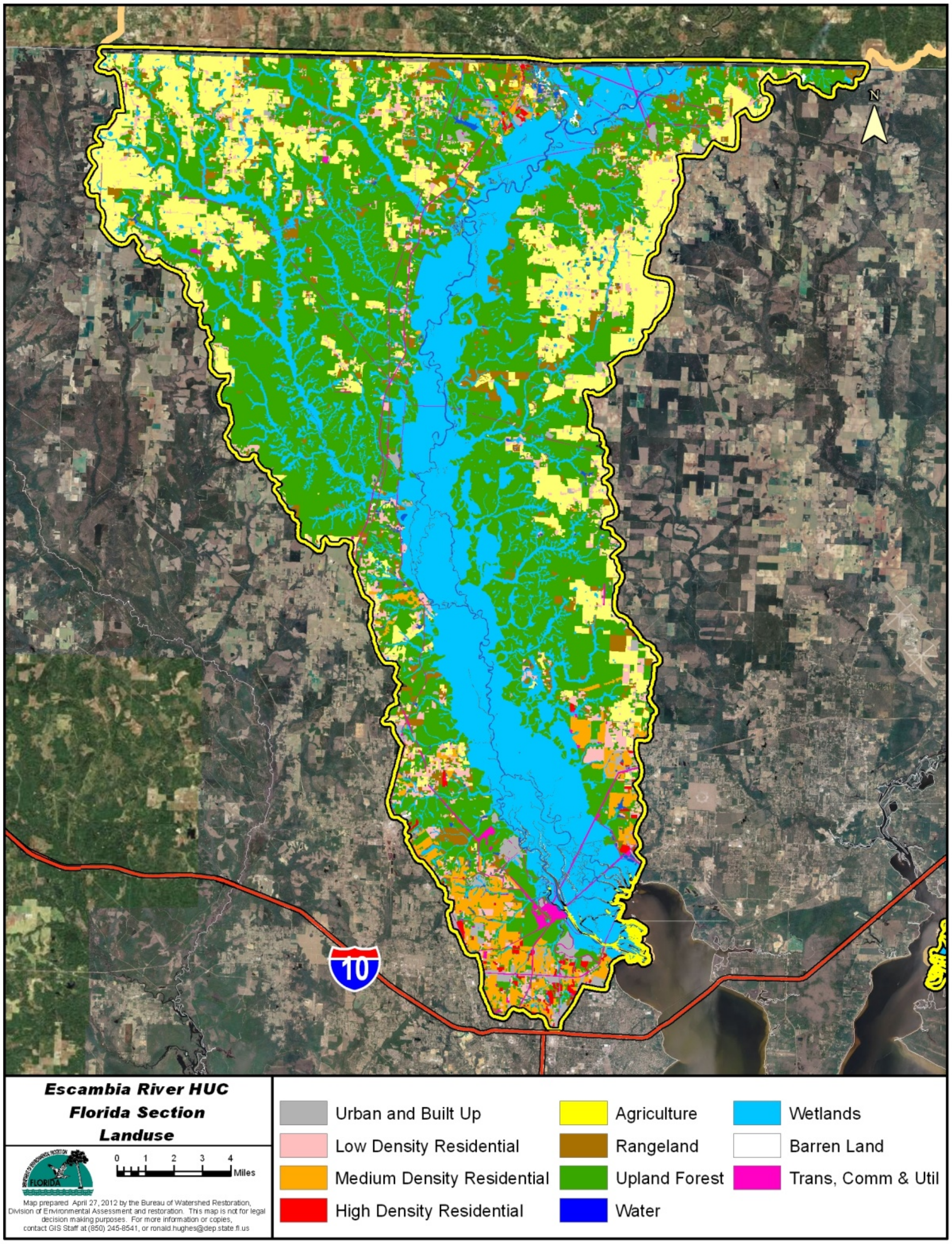


Figure 4.5. Principal Land Uses in the Escambia River Watershed in Florida, 2009–10

Table 4.5. Classification of Level 1 Land Use Categories in the Escambia River Watershed in Florida, 2009–10

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	23,484.4	36.7	9.1%
2000	Agriculture	37,003.1	57.8	14.4%
3000	Rangeland	10,237.8	16.0	4.0%
4000	Upland Forests	107,855.5	168.5	41.9%
5000	Water	4,507.1	7.0	1.8%
6000	Wetlands	70,758.5	110.6	27.5%
7000	Barren Land	327.0	0.5	0.1%
8000	Transportation, Communication, and Utilities	3,325.2	5.2	1.3%
-	**Total**	**257,498.4**	**402.3**	**100.0%**

The watershed model Loading Simulation Program in C (LSPC) used to develop the TMDL consists of areas called basins with embedded streams called Reaches. The model is further described in Chapter 5.

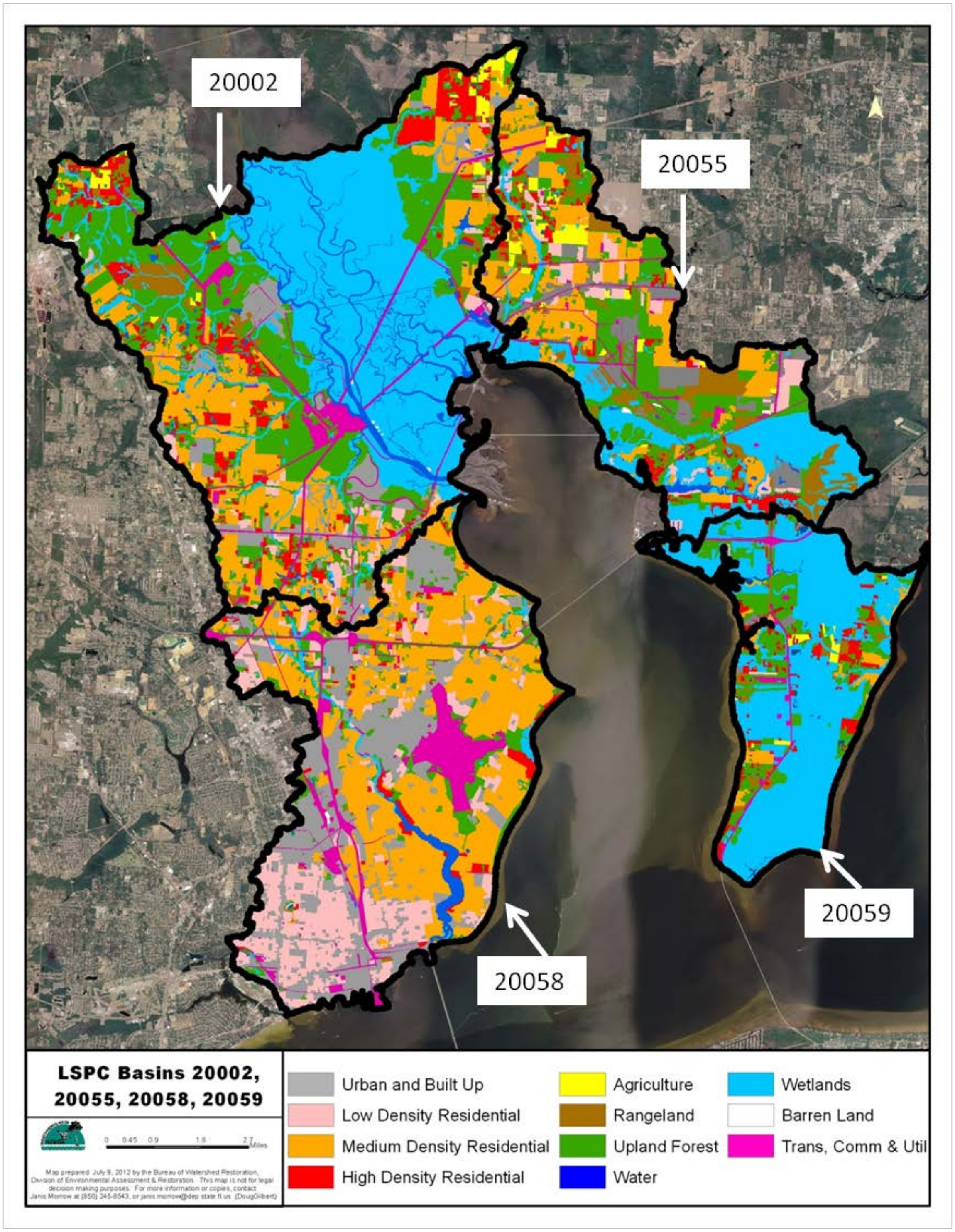


Figure 4.6. Principal Land Uses in the Escambia Bay Watershed, LSPC Basins 20002, 20055, 20058, and 20059

Table 4.6. Classification of Level 1 Land Use Categories in LSPC Basin 20002 of the Escambia Bay Watershed

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	10,924.7	17.07	30.87%
2000	Agriculture	449.7	0.70	1.27%
3000	Rangeland	1,107.8	1.73	3.13%
4000	Upland Forests	7,970.6	12.45	22.52%
5000	Water	1,679.1	2.62	4.75%
6000	Wetlands	11,677.1	18.25	33.00%
7000	Barren Land	26.9	0.04	0.08%
8000	Transportation, Communication, and Utilities	1,550.9	2.42	4.38%
-	**Total**	**35,386.8**	**55.29**	**100.00%**

Table 4.7. Classification of Level 1 Land Use Categories in LSPC Basin 20058 of the Escambia Bay Watershed (Pensacola/Escambia County)

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	18,935.5	29.59	78.54%
2000	Agriculture	1.9	0.00	0.01%
3000	Rangeland	120.2	0.19	0.50%
4000	Upland Forests	1,738.8	2.72	7.21%
5000	Water	660.8	1.03	2.74%
6000	Wetlands	391.4	0.61	1.62%
7000	Barren Land	16.3	0.03	0.07%
8000	Transportation, Communication, and Utilities	2,244.0	3.51	9.31%
-	**Total**	**24,108.9**	**37.67**	**100.00**

Table 4.8. Classification of Level 1 Land Use Categories in LSPC Basin 20055 of the North Escambia Bay Watershed (Santa Rosa County)

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	6,798.6	10.62	39.88%
2000	Agriculture	427.5	0.67	2.51%
3000	Rangeland	1,762.5	2.75	10.34%
4000	Upland Forests	3,641.7	5.69	21.36%
5000	Water	231.8	0.36	1.36%
6000	Wetlands	3,578.6	5.59	20.99%
7000	Barren Land	22.4	0.03	0.13%
8000	Transportation, Communication, and Utilities	584.2	0.91	3.43%
-	**Total**	**17,047.2**	**26.64**	**100.00%**

Table 4.9. Classification of Level 1 Land Use Categories in LSPC Basin 20059 of the Lower Escambia Bay Watershed (Santa Rosa County)

- = Empty cell/no data

Level 1	Land Use	Acres	Square Miles	%
1000	Urban and Built-Up	1,164.9	1.82	10.45%
2000	Agriculture	110.1	0.17	0.99%
3000	Rangeland	272.2	0.43	2.44%
4000	Upland Forests	1,704.1	2.66	15.29%
5000	Water	361.2	0.56	3.24%
6000	Wetlands	7,191.5	11.24	64.51%
7000	Barren Land	31.4	0.05	0.28%
8000	Transportation, Communication, and Utilities	311.8	0.49	2.80%
-	**Total**	**11,147.3**	**17.42**	**100.00%**

4.2.4 Population

Escambia County

According to the U.S. Census Bureau, the population of Escambia County in 2011 was 299,144 and, with an area of 656.46 square miles, the county has a population density of nearly 453 people per square mile. The Bureau reports that in Escambia County there are 136,703 housing units and 113,313 households. For all of Escambia County, the Bureau reported a housing density of 173 households per square mile (208 housing units per square mile). This places Escambia County among the highest in housing densities in Florida (U.S. Census Bureau website 2012).

Santa Rosa County

According to the U.S. Census Bureau, the population of Santa Rosa County in 2011 was 154,104 and, with an area of 1,011.6 square miles, the county has a population density of nearly 150 people per square mile. The Bureau reports that in Santa Rosa County there are 64,760 housing units and 54,860 households. For all of Santa Rosa County, the Bureau reported a housing density of 54 households per square mile (64 housing units per square mile). This places Santa Rosa County well below the average housing density in Florida of 167.6 housing units per square mile (U.S. Census Bureau website 2012).

4.2.5 Septic Tanks

Onsite sewage treatment and disposal systems (OSTDS), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDS are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDS can be a source of nutrients, coliforms, pathogens, and other pollutants to both ground water and surface water.

Based on information from the Florida Department of Health (FDOH) website (2010), the Bayou Chico watershed had 786 septic systems classified as existing, existing new, and new (**Figure 4.7** and **Table 4.10**). The Judges Bayou watershed data indicate only 7 OSTDS (**Figure 4.8** and **Table 4.11**), although aerial photographs of the watershed indicate the possibility (based on the number of houses present) for more than 7. In the Florida portion of the Pensacola Bay Basin, data indicate the presence of approximately 48,400 OSTDS (**Figure 4.9** and **Table 4.12**). **Table 4.13** summarizes the number of septic tanks in each category in the Pensacola Bay Basin in Florida.

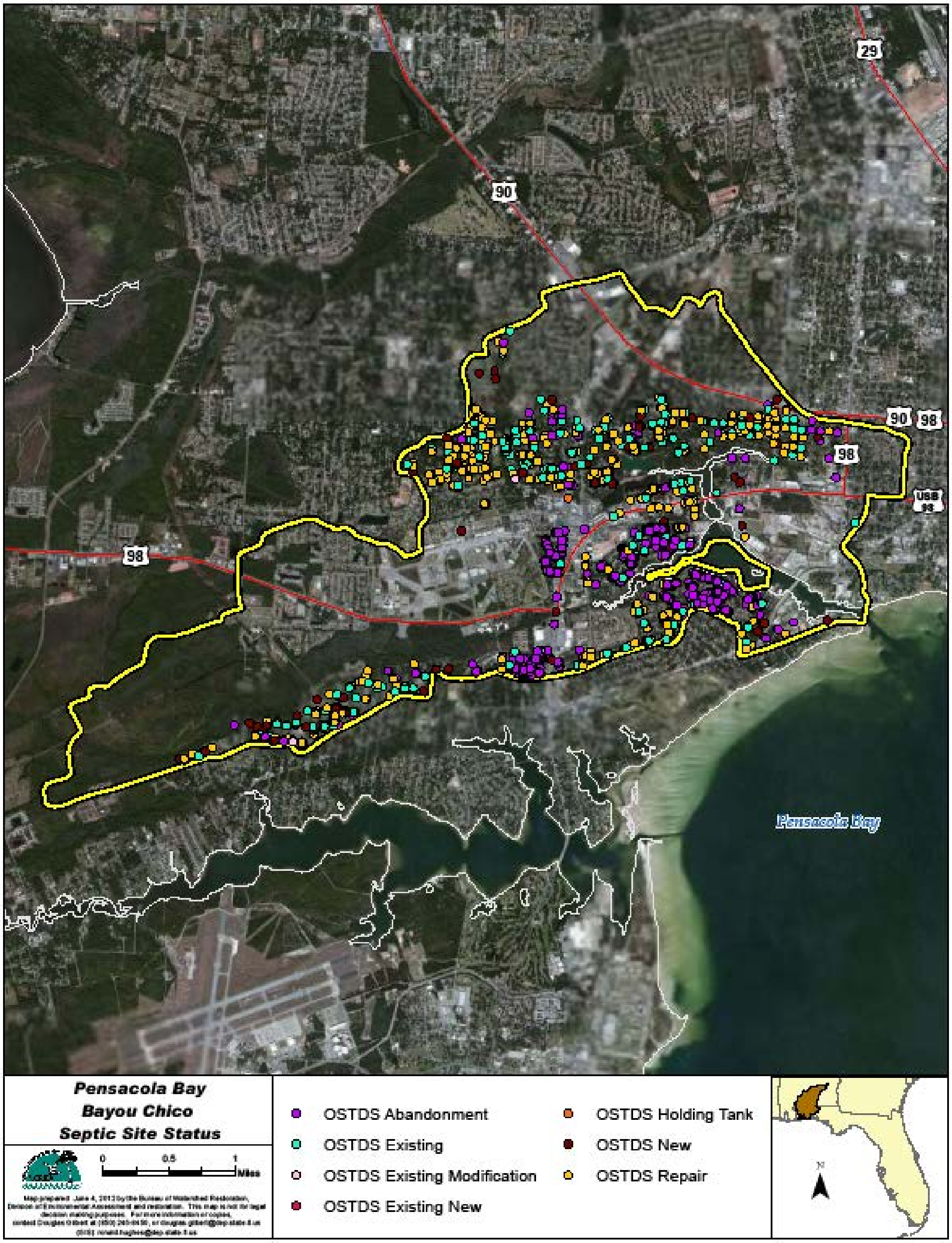
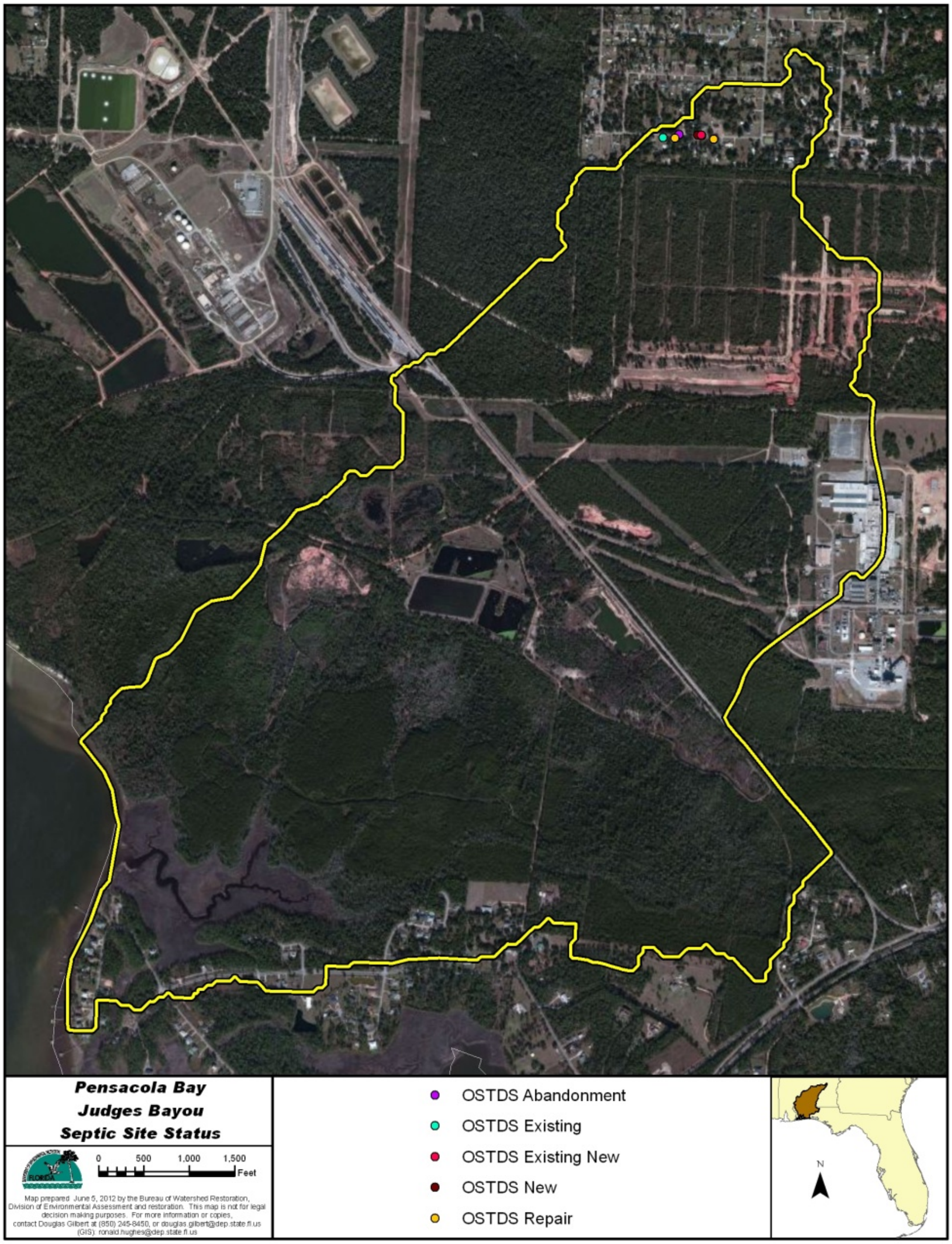


Figure 4.7. Septic Tanks in the Bayou Chico Watershed, 2010

Table 4.10. Septic Tanks in the Bayou Chico Watershed, 2010

Type	Count
OSTDS Abandonment	1,051
OSTDS Existing	601
OSTDS Existing Modification	10
OSTDS Existing New	1
OSTDS Existing Repair	10
OSTDS Holding Tank	1
OSTDS New	184
OSTDS Repair	803
TOTAL (Existing, Existing New, and New)	**786**



Map prepared June 5, 2012 by the Bureau of Watershed Restoration, Division of Environmental Assessment and restoration. This map is not for legal decision making purposes. For more information or copies, contact Douglas Gilbert at (850) 245-8450, or douglas.gilbert@dep.state.fl.us (GIS): ronald.hughes@dep.state.fl.us

Figure 4.8. Septic Tanks in the Judges Bayou Watershed, 2010

Table 4.11. Septic Tanks in the Judges Bayou Watershed, 2010

- = Empty cell/no data

County Name	Type	Count
Santa Rosa	OSTDS Abandonment	1
Santa Rosa	OSTDS Existing	1
Santa Rosa	OSTDS Existing New	1
Santa Rosa	OSTDS New	1
Santa Rosa	OSTDS Repair	3
-	**TOTAL**	**7**

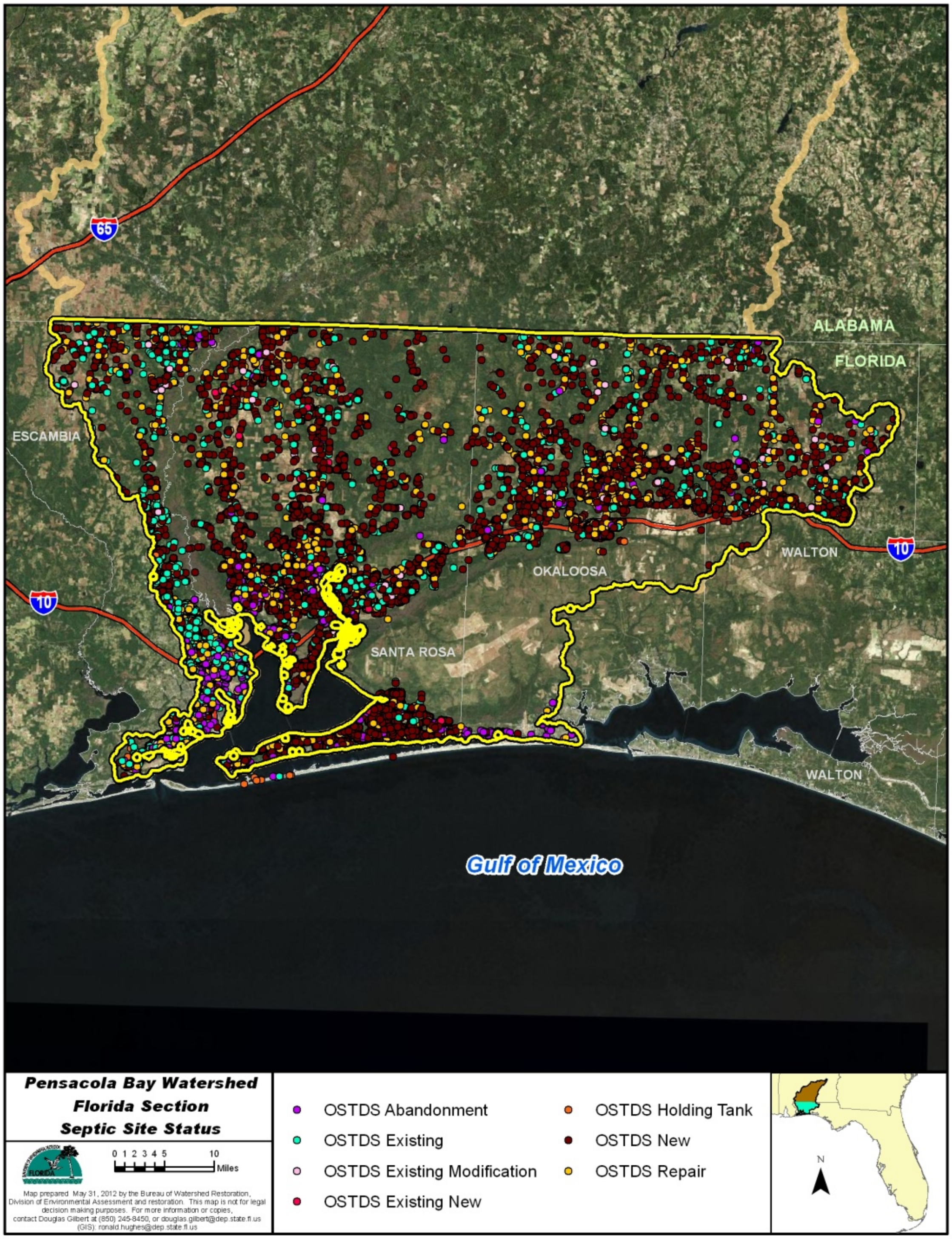


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Figure 4.9. Septic Tanks in the Pensacola Bay Basin in Florida, 2010

Table 4.12. Septic Tanks in the Pensacola Bay Basin in Florida, by County, 2010

- = Empty cell/no data

County	Type	Count
Escambia	-	5
Escambia	OSTDS Abandonment	3,401
Escambia	OSTDS Existing	3,604
Escambia	OSTDS Existing Modification	159
Escambia	OSTDS Existing New	14
Escambia	OSTDS Existing Repair	96
Escambia	OSTDS Holding Tank	49
Escambia	OSTDS New	2,061
Escambia	OSTDS Repair	3,916
Okaloosa	OSTDS Abandonment	319
Okaloosa	OSTDS Existing	579
Okaloosa	OSTDS Existing Modification	75
Okaloosa	OSTDS Existing New	1
Okaloosa	OSTDS Holding Tank	11
Okaloosa	OSTDS New	6,130
Okaloosa	OSTDS Repair	2,793
Santa Rosa	-	1
Santa Rosa	OSTDS Abandonment	1,671
Santa Rosa	OSTDS Existing	1,398
Santa Rosa	OSTDS Existing Modification	184
Santa Rosa	OSTDS Existing New	230
Santa Rosa	OSTDS Existing Repair	22
Santa Rosa	OSTDS Holding Tank	4
Santa Rosa	OSTDS New	15,179
Santa Rosa	OSTDS Repair	4,233
Walton	OSTDS Abandonment	18
Walton	OSTDS Existing	315
Walton	OSTDS Existing Modification	87
Walton	OSTDS Existing New	6
Walton	OSTDS Existing Repair	1
Walton	OSTDS New	1,573
Walton	OSTDS Repair	259
Total	**-**	**48,394**

Table 4.13. Septic Tanks in the Pensacola Bay Basin, 2010

- = Empty cell/no data

Type	Count
-	
OSTDS Abandonment	5,409
OSTDS Existing	5,898
OSTDS Existing Modification	505
OSTDS Existing New	251
OSTDS Existing Repair	119
OSTDS Holding Tank	64
OSTDS New	24,945
OSTDS Repair	11,202
Total	**48,393**

4.2.6 Sediment Nutrient Release

Nutrients in Escambia Bay are released to the water column under a variety of conditions. Historically, the EPA (Olinger 1975) determined the nutrient release rates at 6 sites in Escambia Bay using sediment cores analyzed in the lab. Average values for TN were 10.49E-06 kilograms per square meter per day (kg/m^2/day) and TP of 0.272E-06 kg/ m^2/day. More recently, data collected by the EPA's Gulf Breeze Lab (2003–04) were used to evaluate sediment flux rates at 9 to 11 sites. The results indicated both positive flux out of the sediment and negative flux into the sediment.

During the calibration of the Bayou Chico model, presented in Chapter 5, watershed loadings were insufficient to reproduce the measured water quality in the bayou. Additionally, median values measured in the Upper Bayou for NH4-N and TP (almost no PO4-P data) exceeded concentrations in both the tributaries and the open waters in Pensacola Bay. Based on this information, nutrient flux rates for NH4-N and PO4-P were incorporated into the Bayou Chico model. The Water Quality Analysis Simulation Program (WASP) model selected for use only allows for NH4-N to be fluxed from the bed. To match the measured NO3-N in the bayou, a higher nitrification rate (**Appendix E, Table E.1.2**) was used. Average flux rates for NH4-N and PO4-P reported by Murrell *et al.* (2009) were used as starting values.

Based on the 2009 study, the average NH4-N flux from all sites, of 1.11 ± 0.98 millimoles (mmol) of N and 0.01 ± 0.09 mmol of P for dissolved inorganic phosphorus (expressed per meter square per day [m^2/d]) were converted to 19.01 mg NH4-N/m^2/d and 0.95 mg PO4-P/ m^2/d for use in the WASP model. The calibration involved adjusting flux rates until the best agreement was reached with the measured water column data.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication are widespread and are frequently manifested far (in both time and space) from their source. Addressing eutrophication involves relating water quality and biological effects (such as photosynthesis, decomposition, and nutrient recycling), as acted on by hydrodynamic factors (including flow, wind, tide, and salinity) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. The assimilative capacity should be related to some specific hydrometeorological condition such as an "average" during a selected time span or to cover some range of expected variation in these conditions.

In the development of a TMDL, there needs to be a method for relating current loadings to the observed water quality problem. This relationship could be statistical (regression for a cause-and-effect relationship), empirical (based on observations not necessarily from the waterbody in question), mechanistic (physically and/or stochastically based that inherently relates cause and effect using physical and biological relationships), or a reference condition from unimpaired waters.

A reference approach was used to develop the DO TMDL for the freshwater streams in the Judges Bayou watershed. To determine the loading capacity of the impaired marine waters of Pensacola Bay, several mechanistic models were developed. These models were used in the development of the Bayou Chico and North Escambia Bay/Judges Bayou TMDLs to relate the physical and biological relationships.

The modeling assumptions are outlined in the *Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and Southern Inland Flowing Waters – Volume 1: Estuaries, Appendix C: Watershed Hydrology and Water Quality Modeling Report for 19 Florida Watersheds* (EPA 2012a).

The calibration results for the Pensacola Bay Basin are available in the *Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and Southern Inland Flowing Waters – Volume 1: Estuaries, Appendix C Attachment 2: The Pensacola Watershed* (EPA 2012b).

The calibration results for the Pensacola Bay Estuary are available in the *Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and Southern Inland Flowing Waters – Volume 1: Estuaries, Appendix D Attachment 1: Pensacola Bay Hydrodynamic and Water Quality Model Calibration and Validation: Tables and Figures* (EPA 2012c).

The models have the capability of modeling various species of nitrogen and phosphorus, Chla, coliform bacteria, and metals in receiving waters (bacteria and metals can be simulated as a "general" pollutant with potential instream processes, including first-order decay and adsorption/desorption with suspended and bed solids). A dynamic watershed model, LSPC, was used to predict the quantity of water and pollutants associated with runoff from rain events.

LSPC simulates surface and subsurface flow for pervious land areas and surface flow from impervious land areas and determines nutrient loading by using buildup-washoff algorithms. The model also can simulate direct point sources to the stream. The watershed model was linked to a hydrodynamic model, Environmental Fluid Dynamics Code (EFDC), that simulated tidal influences in the impaired waters. Both models were linked to a water quality simulation model, the Water Quality Analysis Simulation Program Version 7.4.1 (WASP7), that integrated loadings and flow from the watershed model with flow from the hydrodynamic model to predict water quality in the receiving waterbodies (**Figure 5.1**).

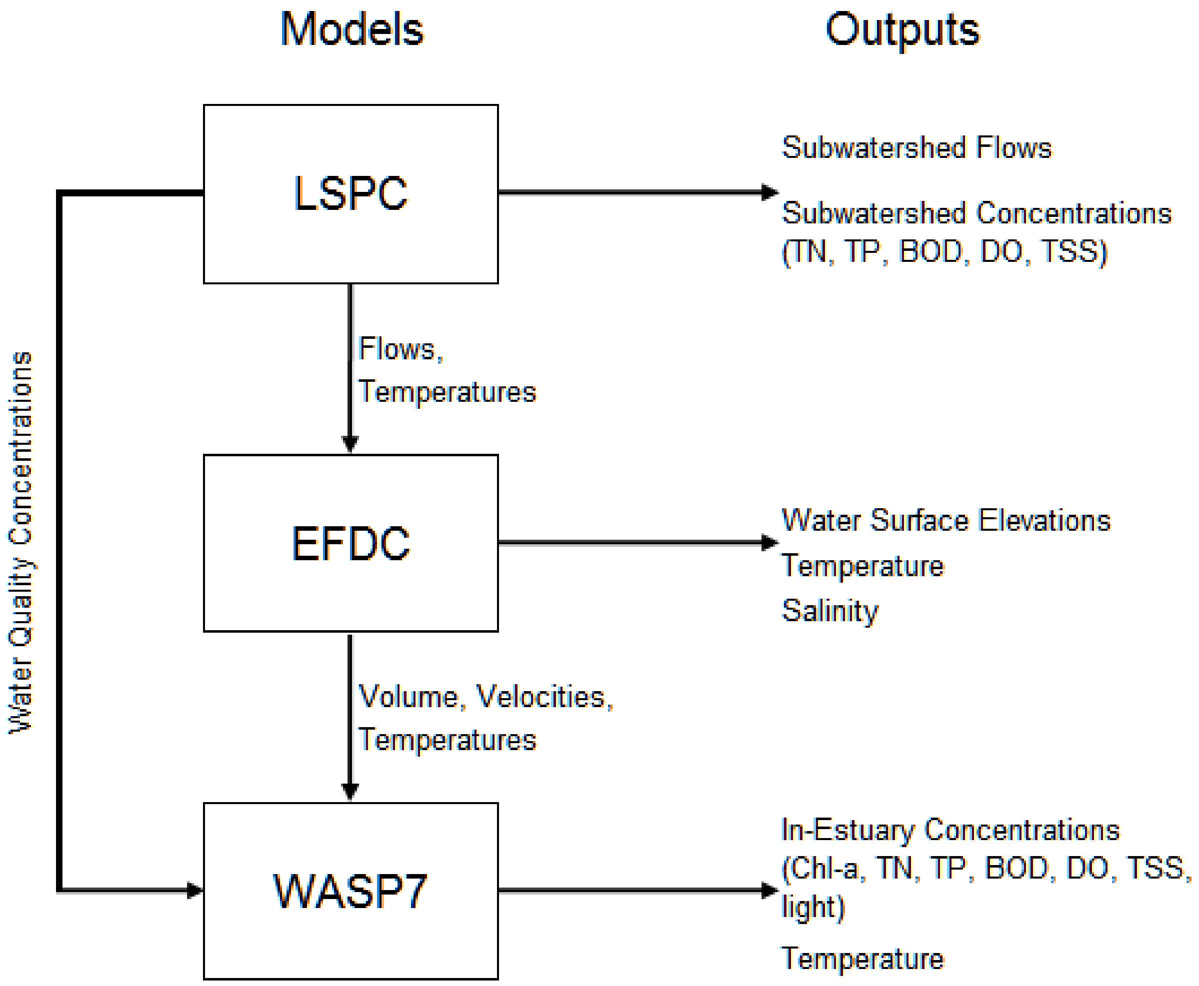

Figure 5.1. Model Framework for LSPC, EFDC, and WASP

5.2 Overview of Modeling Process

5.2.1 Mechanistic Models

LSPC

LSPC is a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality overland, 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 the EPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the 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 time step for current and natural conditions. LSPC provided tributary flows and temperature to EFDC estuary models and tributary water quality concentrations to WASP7 estuary models.

EFDC

The EFDC model is a part of the EPA TMDL Modeling Toolbox due to its application in many TMDL-type projects. As such, the code has been peer reviewed and tested and has been freely distributed and supported by Tetra Tech. EFDC was developed by Dr. John Hamrick (Hamrick 1992) and is currently supported by Tetra Tech for the EPA's Office of Research and Development (ORD), EPA Region 4, and EPA Headquarters. The models, tools, and databases in the TMDL Modeling Toolbox are continually updated and upgraded through TMDL development in Region 4. EFDC is a multifunctional, surface water modeling system, which includes hydrodynamic, sediment contaminant, and eutrophication components. The EFDC model is capable of one-, two-, and three-dimensional spatial resolution. It employs a curvilinear-orthogonal horizontal grid and a sigma or terrain-following vertical grid.

The EFDC hydrodynamic model can run independently of a water quality model. The model simulates the hydrodynamic and constituent transport and then writes a hydrodynamic linkage file for a water quality model such as the WASP7 model. This model linkage, from EFDC hydrodynamics to WASP water quality, has been applied on many EPA Region 4 projects in support of TMDLs.

WASP

WASP7 is an enhanced Windows version of WASP (Di Toro *et al.* 1983; Ambrose *et al.* 1988), with upgrades to the user's interface and the model's capabilities. The major upgrades to WASP have been the addition of multiple BOD components, sediment diagenesis routines, and periphyton routines. The hydrodynamic file generated by EFDC is compatible with WASP7, and it transfers segment volumes, velocities, temperature, and salinity, as well as flows between segments. The time step is set in WASP7 based on the hydrodynamic simulation.

WASP7 helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. It is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program. Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit the easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP7 comes with two such models: TOXI for toxicants and EUTRO for conventional water quality.

5.2.2 Model Development

LSPC Model Development

An LSPC model was used to estimate the nutrient loads within and discharged from the Bayou Chico and North Escambia Bay watersheds. The Pensacola Bay Basin model created for the Florida numeric nutrient criteria was used for the North Escambia Bay watershed, while the Bayou Chico models were developed by rescaling the larger Pensacola Bay Basin model (EPA 2012a; 2012b).

To evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources in the watershed model, the contributing drainage area was represented by a series of subwatersheds for each of the models. The subwatersheds for the Pensacola Bay Basin model were developed using the 12-digit hydrologic unit code (HUC12) watershed data layer and the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD). The subwatersheds were redelineated at a smaller scale for the Bayou Chico watershed models using the USGS NHD catchments and the USGS National Elevation Dataset (NED) Digital Elevation Model (DEM).

The LSPC model has a representative reach defined for each subwatershed, and the main channel stem in each subwatershed was used as the representative reach. The characteristics for each reach include 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 DEM and NHD data.

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. LSPC does not model the tidal flow in low-lying estuaries, and therefore the main Pensacola Bay Basin model was calibrated to nontidally influenced USGS gages. The Bayou Chico and Pensacola Bay Basin models were linked to the EFDC and WASP models to simulate the areas of the estuary that were tidally influenced.

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loadings. The Department's Level 3 Florida Land Use, specifically the NWFWMD 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 NFWMD coverage utilized a variety of land use classes, which were grouped and reclassified into 18 land use categories: 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 and placed into a new land use category named *low intensity development impervious*. Impervious areas associated with medium- 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 into a fourth new category for all remaining impervious land use.

Soil data for the Florida watersheds were obtained from the Soil Survey Geographic Database (SSURGO). The database was produced and distributed by the Natural Resources Conservation Service (NRCS)–National Cartography and Geospatial Center (NCGC). The SSURGO data were used to determine the total area of each hydrologic soil group in each subwatershed. The subwatersheds were represented by the hydrologic soil group with the highest percentage of coverage within the subwatershed boundaries. There were four hydrologic soil groups that varied in their infiltration rates and water storage capacity.

In the watershed models, nonpoint source loadings and hydrologic conditions depend on weather conditions. Hourly data from weather stations within the boundaries of, or in close proximity 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 are used directly, or calculated from the observed data.

Facilities permitted under the NPDES Program are, by definition, considered point sources. The NPDES GIS coverages—provided by the Department, Alabama Department of Environmental Management (ADEM), and Georgia Environmental Protection Division (GAEPD)—were adopted as the starting point for the evaluation of point sources for the Florida watershed models and reflected discharges as of December 2009. Stormwater discharges, such as MS4s, were not input directly into the model but were assumed to be included in the urban land use loading. Permits that discharged directly into the estuaries were excluded from the watershed models but were included as direct inputs in the estuary models. The remaining permits with data were processed into a time series from 1996 through 2009 and input into the watershed models. There were no NPDES point sources located in the Bayou Chico watershed model, but there were 22 in the Pensacola Bay Basin model.

EFDC Model Development

The EFDC model was used to simulate the three-dimensional circulation dynamics of hydrodynamic state variables (water surface elevation, salinity, and temperature) in the Bayou Chico and Escambia Bay Estuaries. The Pensacola Bay EFDC model that was created for the Florida numeric nutrient criteria was used for the North Escambia Bay watershed, while the Bayou Chico models were developed by rescaling the larger Pensacola Bay EFDC model (EPA 2012c; 2012d).

An orthogonal, curvilinear grid system consisting of 998 horizontal cells and 5 equally spaced vertical layers was developed for the Pensacola Bay EFDC model. The grid was developed using Gulf of Mexico bathymetry data. The large grid was reduced in size and scale for the

Bayou Chico EFDC model. Major watershed flows into the Pensacola Bay EFDC grid included discharges from the Escambia, Blackwater, and Yellow Rivers.

The EFDC model predicts water surface elevation, salinity, and temperature, in response to a set of multiple factors: wind speed and direction, freshwater discharge, tidal water level fluctuation, rainfall, surface heat flux, and temperature and salinity associated with boundary fluxes. Hourly measurements of atmospheric pressure, dry and wet bulb atmospheric temperatures, rainfall rate, wind speed and direction, and fractional cloud cover were obtained from data collected at Station WBAN 13899, Pensacola, for the period from 1997 to 2009. Solar shortwave radiation was calculated using the CE-Qual-W2 method.

The Pensacola Bay model used hourly water surface elevation time series data from the National Oceanic and Atmospheric Administration (NOAA) tidal stations to simulate tides at the open boundary. Observed temperature data at water quality stations were used to simulate the temperature at the open boundaries, and average salinity in the Gulf of Mexico was used to simulate salinity. The Pensacola Bay Model was calibrated to measured NOAA tidal stations, and the Pensacola Bay model was used to simulate the open boundary conditions in the Bayou Chico model. The inland boundary grid cells for all three models received LSPC-simulated watershed discharges. Additionally, six major point sources that directly discharged to the Pensacola Bay model were input into the model. No point sources were located in the immediate areas of Bayou Chico.

WASP Model Development

The purpose of the WASP7 water quality modeling was to reproduce the three-dimensional transport and chemical and biological interactions of major components of water quality in Bayou Chico and Escambia Bay. WASP7 was used to model TN and its speciation (**Table 5.1a**), TP and its speciation (**Table 5.1b**), Chla, DO, and carbonaceous biochemical oxygen demand (CBOD). The model predicts these parameters in response to a set of hydrologic, meteorological, atmospheric, and chemical and biological factors: loads from point and nonpoint sources, benthic ammonia and phosphate fluxes, SOD, solar radiation, air temperature, reaeration, and offshore and inland boundary conditions.

The same grid cells that were developed for the Pensacola Bay EFDC model were used in the Pensacola Bay WASP7 model. Open boundary water quality conditions used measured water quality data from the Gulf of Mexico. Water quality loading from the LSPC model was used to simulate loads coming from rivers and streams into the estuary. The six major point sources that directly discharged to the Pensacola Bay model were input into the model. No point sources were located in the immediate areas of Bayou Chico. **Appendix E, Table E1.2**, provides the final WASP parameterization for each impaired water.

Table 5.1a. Partitioning of LSPC Watershed TN into Inorganic N

TN Partition for LSPC Output		
NH4	OrgN	NOx
0.1	0.5	0.4

Table 5.1b. Partitioning of LSPC Watershed TP into Inorganic P

TP Partition for LSPC Output	
PO4	OrgP
0.5	0.5

5.3 TMDL Development Process

5.3.1 Bayou Chico (WBIDs 846 and 846C)

Bayou Chico was divided into a series of subwatersheds to evaluate the contributing sources to the waterbody and to represent the spatial variability of these sources. The Pensacola Bay model was redelineated to represent the contributing watershed to Bayou Chico (**Figure 5.2**). The contributing drainage area was represented by a series of subwatersheds that were developed using the USGS NHD catchments and the USGS NED DEM) The Bayou Chico watershed consisted of six subwatersheds and included the Jones Creek and Jackson Creek tributaries.

The hydrology and water quality calibration parameters from the Pensacola Bay model were used to populate the Bayou Chico watershed model. No measured flow data were located in the Bayou Chico watershed. The Pensacola Bay LSPC model was calibrated to USGS flow gages, and the calibration was categorized as very good (EPA 2012b). Therefore, the hydrology calibration parameters were not adjusted in the Bayou Chico model.

The Bayou Chico EFDC grid consisted of 96 cells, specifically 48 cells in the horizontal direction and 2 layers in the vertical direction (**Figure 5.3**). The grid was developed using bathymetry data from the larger Pensacola Bay model. The Pensacola Bay model used Gulf of Mexico bathymetry to create the grid for the EFDC model. Gulf of Mexico bathymetry was unavailable for the inland, tidally influenced streams, and channel slope from the USGS NED DEM was used to estimate slope in the channel. The Bayou Chico grid extended from the Pensacola Bay into Bayou Chico and into the 3 major tributaries, which included Jones Creek and Jackson Creek.

Because there were no NOAA tidal stations located in Bayou Chico, water surface elevation in the modeled cells could not be directly calibrated. Salinity and temperature measurements from IWR Run 44 data were used to review the Bayou Chico EFDC calibration. Following model review, the salinity and temperature parameters were adjusted accordingly.

The hydrodynamic simulation from the Bayou Chico EFDC model was input into the WASP7 model. Water quality and nutrient loadings from the LSPC model were input into the inland cells. The open boundaries in Pensacola Bay were set to the average water quality of WBID 548D for the period from 2002 to 2009 (IWR Run 44). The model calibration was reviewed following the adjustments made to the model. The calibration was then adjusted accordingly to provide the best existing scenario model calibration for the water quality parameters of concern.

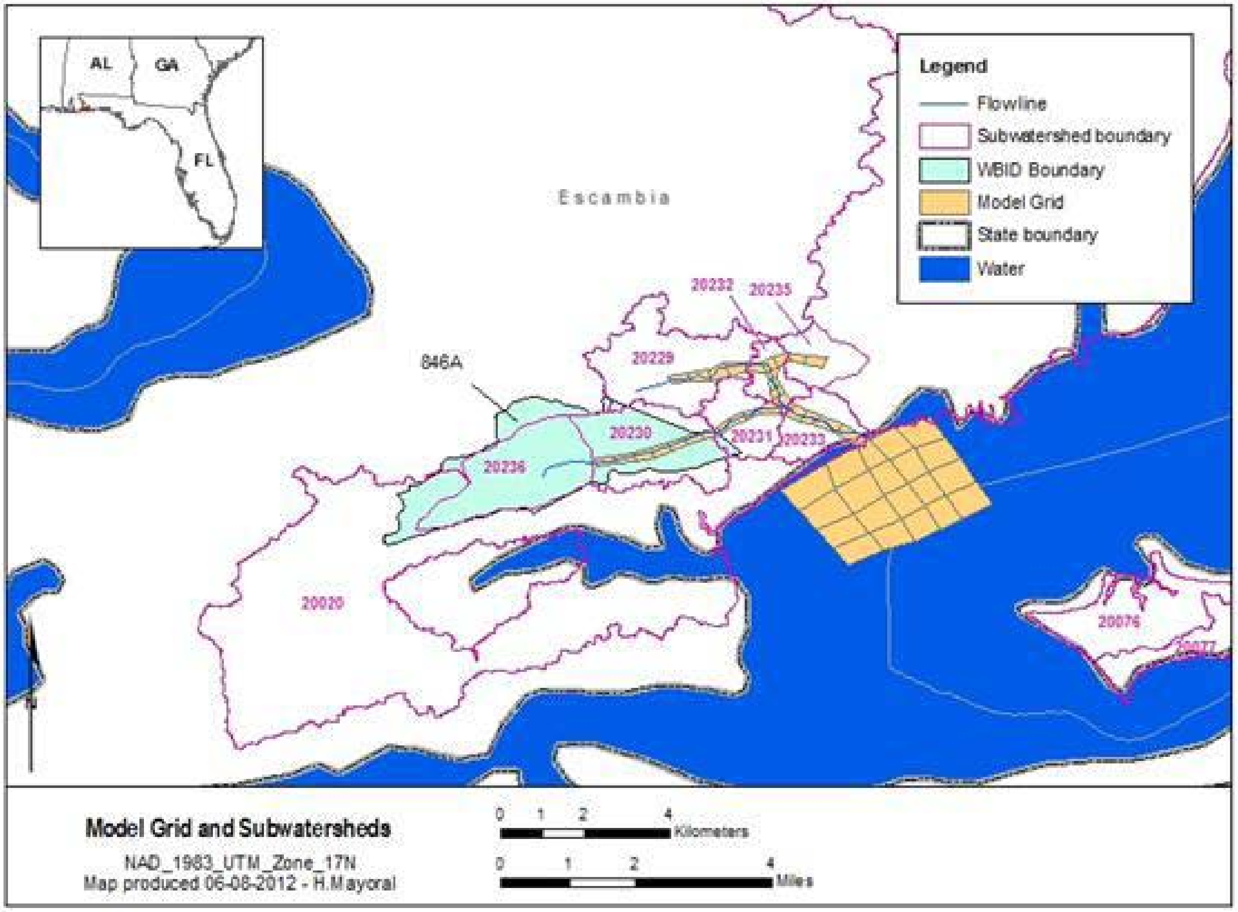

Figure 5.2. LSPC Subwatershed Boundaries and WASP Model Grid for the Bayou Chico Watershed

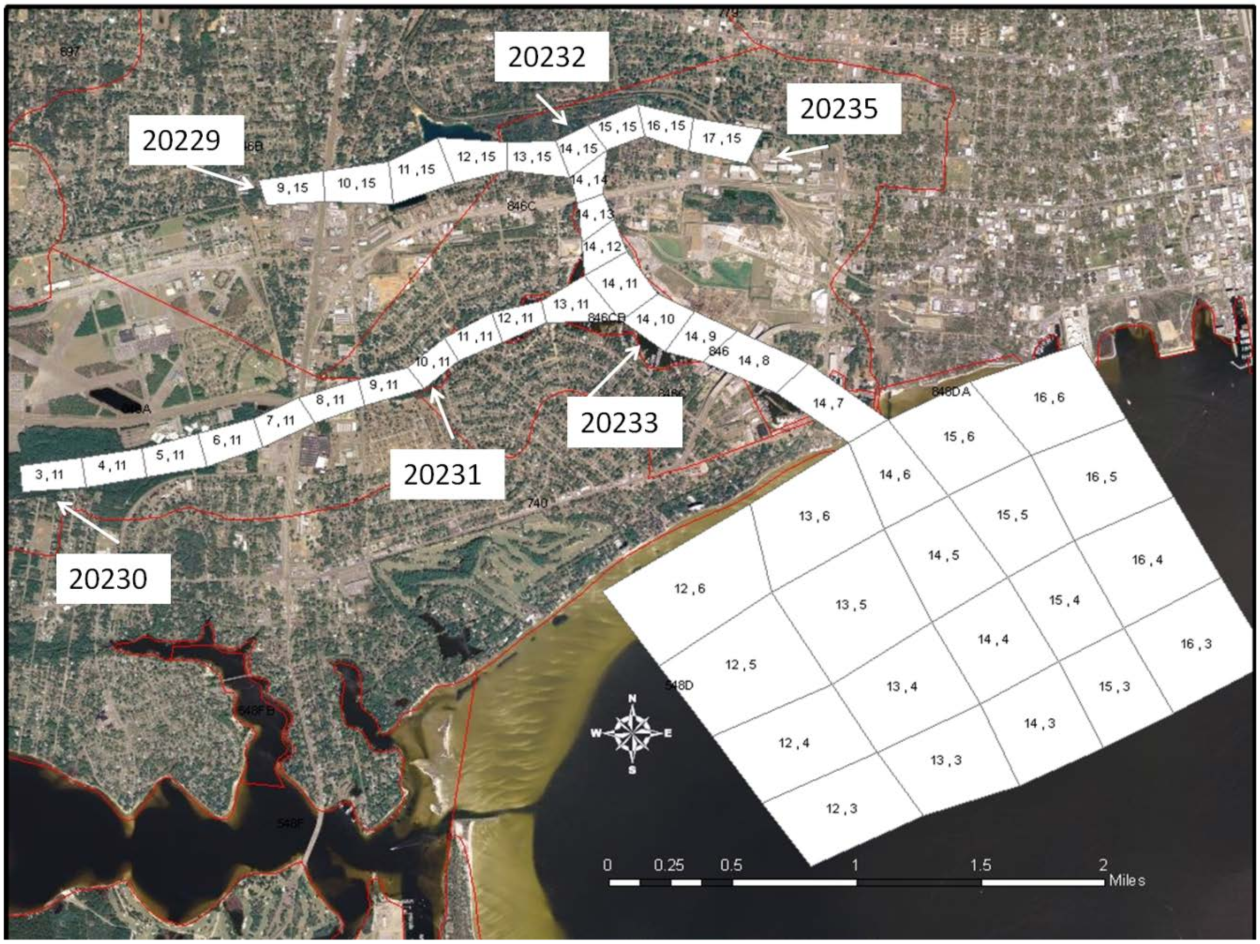

Figure 5.3. WASP Model Grid and Subbasin Input Locations for the Bayou Chico Watershed

Modeling Scenarios

Three modeling scenarios were developed and evaluated: a current condition, a natural condition, and the TMDL scenario. **Appendix E, Sections E.2**, **E.3**, and **E.4**, present all model results.

For all scenarios, the open boundaries in Middle Pensacola Bay were set to the average concentrations of PO4-P, organic-P, NO3-N, NH4-N, and organic-N based on data for WBID 548D from IWR Run 44. These concentrations were 0.005 mg/L PO4-P, 0.015 mg/L organic-P, 0.024 mg/L NO3-N, 0.025 mg/L NH4-N, and 0.4 mg/L organic-N.

Both NH4-N and PO4-P fluxes were implemented in bottom segments of the model and included in the calibrated, natural condition, and TMDL model runs. **Appendix E, Table E.2.2**, presents flux rates and associated model segments.

Current Condition

The current condition scenario involved calibrating the model of the bayou to the current hydrologic and water quality conditions of the watershed, specifically water quality concentration and loadings for Upper and Lower Bayou Chico. **Tables 5.3** and **5.4** present the current condition annual average loadings of TN and TP, respectively, for each subbasin. **Table 5.5** presents the total annual average watershed loads of TN and TP for the current condition. The current condition simulation was used to determine the base loadings for the impaired waters. These base loadings, when compared with the TMDL scenarios, were used to determine the percent reduction in nutrient loads needed to achieve water quality standards.

Differences between model calibration and the available measured data were calculated based on WBID averages for Upper Bayou Chico ((WBID 846C) and Lower Bayou Chico (WBID 846) from 2002 through 2009 and compared with the corresponding calibration targets in **Table E.1.3**. **Appendix E, Tables E.2.3** through **E.2.16** and **Figures E.2.3** through **E.2.16**, present the results.

Differences were calculated as ((measured – predicted)/measured)*100 and expressed as a percentage.

The calibration, as evaluated according to the EPA (**Table 5.2**), for NH4-N was very good (14.4%) in the Upper Bayou and good (-32.5%) in the Lower Bayou. The calibration for NO3-N was very good in both the Upper and Lower Bayou (13% and -1.4%, respectively). Overall the calibration for TN was very good in both the Upper and Lower Bayou (15% and 6.6%, respectively). There were no PO4-P data from the Upper Bayou and only 7 results from 2009 in the Lower Bayou. Based on these limited data, the PO4-P calibration in the Lower Bayou was very good (-4.1%). Overall the calibration for TP was good (33.7%) in the Upper Bayou and very good (2.9%) in the Lower Bayou. The calibration for CChla was very good in both the Upper Bayou (-13.8%) and Lower Bayou (-17.3%).

Table 5.2. Calibration/Validation Targets for EFDC/WASP Applications for Florida Estuaries (% Difference Between Simulated and Observed Values)

Source: EPA, Donigian, 2000

Variable	Very Good	Good	Fair
Salinity	<15%	15-25%	25-40%
Water Temperature	<7%	8-12%	13-18%
Water Quality/DO	<15%	15-25%	25-35%
Nutrients/Chla	<30%	30-45%	45-60%

Table 5.3. TN Subbasin Loads Calibration and Natural Condition

- = Empty cell/no data
C = Calibration
NC = Natural condition

Subbasin	Jackson Creek TN-C (lbs/yr) (LSPC Basin 20229)	Jackson Creek TN-NC (lbs/yr) (LSPC Basin 20229)	Upper Bayou Chico Mid TN-C (lbs/yr) (LSPC Basin 20232)	Upper Bayou Chico Mid TN-NC (lbs/yr) (LSPC Basin 20232)	Upper Bayou Chico East TN-C (lbs/yr) (LSPC Basin 20235)	Upper Bayou Chico East TN-NC (lbs/yr) (LSPC Basin 20235)	Jones Creek Headwater TN-C (lbs/yr) (LSPC Basin 20230)	Jones Creek Headwater TN-NC (lbs/yr) (LSPC Basin 20230)	Jones Creek @ Bayou TN-C (lbs/yr) (LSPC Basin 20231)	Jones Creek @ Bayou TN-NC (lbs/yr) (LSPC Basin 20231)	Lower Bayou Chico TN-C (lbs/yr) (LSPC Basin 20233)	Lower Bayou Chico TN-NC (lbs/yr) (LSPC Basin 20233)
Year	-	-	-	-	-	-	-	-	-	-	-	-
2002	9,227	400	1,698	74	3,120	127	10,692	775	3,939	148	3,885	128
2003	12,806	833	2,283	182	4,123	259	14,465	1,706	5,423	365	4,861	316
2004	11,782	618	1,951	118	3,955	197	13,368	1,259	4,600	237	4,276	205
2005	18,460	1,418	2,795	292	5,966	445	21,214	2,905	6,789	585	5,567	507
2006	6,882	341	1,233	64	2,359	109	8,019	626	2,851	127	2,816	111
2007	8,465	491	1,571	101	2,806	152	9,652	911	3,674	200	3,481	174
2008	9,407	504	1,720	93	3,119	161	10,615	983	4,026	186	3,844	161
2009	15,922	1,008	2,499	215	5,293	315	17,772	2,050	5,995	430	5,184	373
Average	**11,619**	**702**	**1,969**	**143**	**3,843**	**221**	**13,225**	**1,402**	**4,662**	**285**	**4,239**	**247**

Table 5.4. TP Subbasin Loads Calibration and Natural Condition

- = Empty cell/no data
C = Calibration
NC = Natural condition

Subbasin	Jackson Creek TP-C (lbs/yr) (LSPC Basin 20229)	Jackson Creek TP-NC (lbs/yr) (LSPC Basin 20229)	Upper Bayou Chico Mid TP-C (lbs/yr) (LSPC Basin 20232)	Upper Bayou Chico Mid TP-NC (lbs/yr) (LSPC Basin 20232)	Upper Bayou Chico East TP-C (lbs/yr) (LSPC Basin 20235)	Upper Bayou Chico East TP-NC (lbs/yr) (LSPC Basin 20235)	Jones Creek Headwater TP-C (lbs/yr) (LSPC Basin 20230)	Jones Creek Headwater TP-NC (lbs/yr) (LSPC Basin 20230)	Jones Creek @ Bayou TP-C (lbs/yr) (LSPC Basin 20231)	Jones Creek @ Bayou TP-NC (lbs/yr) (LSPC Basin 20231)	Lower Bayou Chico TP-C (lbs/yr) (LSPC Basin 20233)	Lower Bayou Chico TP-NC (lbs/yr) (LSPC Basin 20233)
Year	-	-	-	-	-	-	-	-	-	-	-	
2002	387	58	86	11	125	18	592	95	173	21	213	19
2003	524	121	111	29	161	37	866	209	228	57	253	49
2004	490	89	94	18	158	28	786	152	194	35	223	31
2005	764	198	131	47	239	60	1,302	349	278	93	274	80
2006	302	50	64	10	99	16	466	79	127	19	159	16
2007	354	73	80	18	111	22	550	119	161	35	189	30
2008	385	73	84	14	122	23	605	122	170	27	202	23
2009	653	144	120	36	208	43	1,065	248	250	70	265	61
Average	**482**	**101**	**96**	**23**	**153**	**31**	**779**	**172**	**197**	**45**	**222**	**39**

Table 5.5. TN and TP Total Watershed Loads Calibration and Natural Condition

C = Calibration
NC = Natural condition

Year	Total TN-C (lbs/yr)	Total TN-NC (lbs/yr)	Total TP-C (lbs/yr)	Total TP-NC (lbs/yr)
2002	32,563	1,653	1,577	222
2003	43,961	3,661	2,143	501
2004	39,933	2,635	1,945	352
2005	60,791	6,151	2,988	827
2006	24,161	1,378	1,217	189
2007	29,649	2,030	1,446	297
2008	32,731	2,089	1,566	282
2009	52,666	4,392	2,560	602
Average	**39,557**	**2,999**	**1,930**	**409**

Natural Condition

The natural condition scenario was developed to estimate water quality conditions with no impact from anthropogenic sources. Any point sources located in the watershed or waterbody were removed for the natural condition analysis. Land uses associated with anthropogenic activities (urban, agriculture, transportation, barren lands, and rangeland) were converted to upland forests or forested wetlands based on the current ratio of forest and wetland land uses in the model.

The purpose of the natural conditions scenario was to determine whether water quality standards could be achieved under natural conditions and to ensure that the TMDL would not attempt to abate the naturally occurring loads from the watershed.

Appendix E.3, Tables E.3.1 through **E.3.6** and **Figures E.3.1** through **E.3.6**, present the natural condition water quality predictions. The natural condition annual average loadings of TN and TP for each subbasin are presented in **Tables 5.3** and **5.4**, respectively. **Table 5.5** presents the total annual average watershed loads of TN and TP for the natural condition.

The annual average (2002–09) natural condition TN concentration was 1.26 mg/L in the Upper Bayou and 1.12 mg/L in the Lower Bayou. The annual average (2002–09) natural condition TP concentration was 0.02 mg/L in both the Upper and Lower Bayous. The annual average (2002–09) natural condition CChla concentration was 8.07 µg/L in the Upper Bayou and 7.96 µg/L in the Lower Bayou.

TMDL Condition

Once the model was calibrated and a natural background condition established using the same model parameterization and benthic fluxes as in the calibration, the response of the bayou to reductions in nutrient loadings was evaluated.

The TMDL target is based on restoring healthy, well-balanced natural populations of flora and fauna from the effects of anthropogenic nutrient enrichment. As reported by the Department (2012), seagrasses are one of the most nutrient-sensitive biological endpoints in the bay. However, except for the area around the mouth of the bayou, seagrasses would not be expected to occur in the rest of Bayou Chico due to the naturally ocurring dark water from the wetlands in the watershed. The target for restoration of Bayou Chico will focus on determining the nutrient concentrations needed to achieve a chlorophyll-based target that will allow all nutrient-related water quality standards to be attained. In a shallow, mostly enclosed estuary such as Bayou Chico, it is important to recognize that the oligohaline zone (the lower salinity portion of the estuary where fresh water first enters the estuary) has very different ecological characteristics than the higher salinity areas in the lower reaches that are more influenced by open bay waters. Because of their distinct ecological characteristics, there should be different expectations for nutrients, turbidity, chlorophyll, and biological productivity in these oligohaline areas.

The Department report notes that during the past 27 years, the annual geometric mean Chla (based on a minimum of 4 values per station per year) in Santa Rosa Sound, where healthy seagrass beds prevail, has ranged from 0.8 to 7.95 µg/L. Except for slightly higher values in certain bayous (Chico, Grande, and Texar), Chla in most of Pensacola Bay (Lower Escambia Bay, East Bay, and main Pensacola Bay) also had values in this range, suggesting that current nutrient and Chla conditions are appropriate for seagrass protection in these areas. In establishing the target for the TMDL, it is important to consider that low-salinity areas (i.e., areas where fresh waters initially mix with more saline estuarine waters) may be expected to exhibit higher nutrient and Chla levels than higher salinity, open water areas. For this reason, and in the absence of historical seagrass beds, the Department believes that a long-term annual average CChla target of less than 9.0 µg/L is appropriate for Bayou Chico.

Besides determining the level of nutrient reductions needed to achieve the desired level of primary production, part of the goal of restoration should be to have a balanced relationship between TN and TP loadings. The natural condition average TN/TP ratio was 59. After running many combinations of reductions in TN and TP, reducing both equally resulted in the lowest overall required nutrient reductions and the highest TN/TP ratio (49). The model run with a 30% reduction in watershed loadings for both TN and TP met the restoration target for CChla and resulted in the highest TN/TP ratio of 49. **Appendix E.4, Tables E.4.1** through **E.4.6** and **Figures E.4.1** through **E.4.6**, present the TMDL condition water quality predictions.

The result of reducing TN by 30% was a long-term average (2002–09) concentration in the Upper Bayou of 1.4 mg/L (current condition, 1.83 mg/L) and 1.22 mg/L in the Lower Bayou (current condition, 1.41 mg/L). The result of reducing TP by 30% was a long-term average (2002–09) concentration in the Upper Bayou of 0.027 mg/L (current condition, 0.05 mg/L) and 0.025 mg/L in the Lower Bayou (current condition, 0.031 mg/L). The effect on CChla of reducing TN and TP by 30% was a long-term average (2002–09) concentration in the Upper Bayou of 8.88 µg/L (current condition, 9.43 µg/L) and 8.93 µg/L in the Lower Bayou (current condition, 10.37 µg/L).

5.3.2 Judges Bayou (WBIDs 493A and 493B)

Although there are no direct point sources located in the Judges Bayou watershed, a Land Application System (LAS) managed by Sterling Fiber is situated within the watershed boundary. Nutrient concentration data collected within the LAS and immediately downstream in St. Regis and Judges Branches indicate that the LAS is a potential source of nutrient loading, specifically from interflow and baseflow contributions to the streams.

DO Impairment in Judges Bayou (freshwater) (WBID 493A)

A reference condition approach was used to address the DO impairment in the freshwater tributaries to Judges Bayou (WBID 493A). IWR Run 44 data were used to select data from freshwater WBIDs in the same general basin (Escambia Bay watershed) as the impaired water. The WBIDs were selected based on sufficient data to be assessed for DO and no impairment for nutrients. The four WBIDs were WBID 586 (Thompson Bayou [freshwater]), WBID 10A (Escambia River), WBID 10D (Escambia River), WBID 5 (Canoe Creek), and WBID 10 (Big Escambia Creek). The mean of the individual WBID means for TN and TP was then calculated and is presented in **Table 5.6** with the means from the tributaries to Judges Bayou and the percent reductions needed to restore the freshwater tributaries of Judges Bayou.

Table 5.6. TN and TP Reference Conditions and Percent Reduction for Judges Bayou (WBID 493A)

- = Empty cell/no data
Min = Minimum
Max = Maximum

Waterbody	WBID	TN (mg/L) Min	TN (mg/L) Max	TN (mg/L) Mean	TP (mg/L) Min	TP (mg/L) Max	TP (mg/L) Mean	DO (mg/L) Min	DO (mg/L) Max	DO (mg/L) Mean	DO (mg/L) % >5 mg/L
Pine Barren Creek	5	0.42	1.07	0.81	0.008	0.053	0.021	4.4	12.2	8.2	98.6
Canoe Creek	7	0.65	2.45	0.97	0.005	0.142	0.018	2.5	11.7	8.6	99.1
Thompson Bayou	586	0.18	1.34	0.59	0.010	0.140	0.042	3.7	9.8	6.6	77.0
Escambia River	10D	0.22	0.86	0.56	0.007	0.101	0.035	1.6	12.3	7.3	96.0
Reference Values	**-**	**0.37**	**1.43**	**0.73**	**0.008**	**0.109**	**0.029**	**-**	**-**	**-**	**-**
Judges Bayou (freshwater)	-	2.08	4.20	2.81	0.018	0.032	0.024	1.5	8.2	4.7	40.0
% Reduction	**-**	**-**	**-**	**74.0%**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

The percent reduction was calculated as follows:

((Impaired Concentration – Reference Concentration)/Impaired Concentration) * 100

The reference concentration for TP of 0.029 mg/L is greater than the TP concentrations in the impaired streams; therefore no reductions in TP are required to address the DO impairment. However, both Judges Bayou (marine) (WBID 493B) and North Escambia Bay (WBID 548AA) are impaired for nutrients linked to elevated CChla, and additional reductions in TN and/or reductions in TP may be required in WBID 493A to restore the nutrient conditions in these impaired waters.

Nutrient Impairment in Judges Bayou (marine) (WBID 493B)

Judges Bayou drains into North Escambia Bay, which is also impaired by elevated CChla concentrations linked to nutrients. Given that both waterbodies are interconnected and the tidal exchange with the impaired waters of North Escambia Bay to a large degree controls the water quality of Judges Bayou (marine), the TMDL for nutrients in Judges Bayou (marine) will be addressed by the combination of the nutrient TMDL for the freshwater tributaries to the bayou and the nutrient TMDL for North Escambia Bay. The TMDL target selection and modeling results for North Escambia Bay are provided in the next section.

5.3.3 North Escambia Bay (WBID 548AA)

The nutrient impairment for North Escambia Bay (WBID 548AA) is based on the historical increase of 50% above the baseline level during 2 consecutive years of the verified period. The threshold for impairment was established as 7.5 µg/L of CChla. The development of the restoration target is discussed later in this section.

As discussed below, there are two different sets of watershed, hydrodynamic, and water quality models available for use in the Pensacola Bay system. One set (LSPC, EFDC, and WASP) was calibrated by Tetra Tech for the EPA and originally provided to the Department in February 2012. The EPA provided an updated calibration in early May 2012, and the results from this version are discussed below. A final calibration of the second set of models (ECOMSED and RCA; 10 vertical layers) provided to the Department on July 13, 2012, by the Escambia Bay TMDL Coalition (EBTC) is still under review, including submodels not in the WASP model. These include a state variable for color and a dynamic sediment flux submodel that provides for a direct time-varying calculation of SOD and benthic fluxes of nutrients. Additionally, the flow and loads from the Escambia River delivered to North Escambia Bay in the EBTC model are proportionally distributed across the upper bay in a manner that mimics the actual distribution of flow.

Murrell *et al.* (2007) suggest that Escambia Bay may experience nitrogen limitation during low-flow periods and phosphorus limitation during more normal flow conditions. They report that the time to flush the bay varies from 1 day during high-flow conditions to up to 20 days during drought conditions. The report concludes that the flow from the Escambia River has a strong influence on both nutrient fluxes and CChla concentrations in the bay.

Murrell *et al.* (2009) studied the fluxes of inorganic nutrients from the bay sediments (16 sampling events in 2003 and 2004) and estimated both water column and benthic productivity. The results of this study suggest that the shallow water areas of the bay may have “substantial benthic productivity,” with the deeper channel areas demonstrating lower productivity than the shallower areas. The report provided data that suggest benthic productivity could account for between 16% and 32% of the total bay productivity. The study also found that compared with literature values for sediment nutrient fluxes in other systems, the bay values are low. The authors report that nutrient fluxes of ammonia were higher than fluxes of nitrate, and that rates in the deeper areas were higher than those in shallower areas. The results indicate that fluxes of dissolved inorganic phosphate (DIP) were near zero in the shallow areas and negative in the channel sites. The data suggest that Pensacola Bay hypoxic conditions may not be severe enough to result in the degree of sediment nutrient flux characteristic of eutrophication in systems undergoing significant hypoxia.

The majority of CChla was collected at one station (A4), located in a shallow area in the northernmost section of the bay (**Figure 5.4**). This led to concerns by the Department that this station may not be representing the general conditions of the upper bay and could be overestimating the overall productivity of North Escambia Bay.

To address this concern the Department took three approaches. The first approach was to take the data for the WBID and subdivide it into two groups: "Not A4," meaning all the stations except A4, and "A4," meaning all data from Station A4. The second approach was to subdivide the data into stations with mean low water (MLW) depths less than three feet, between three and six feet, and greater than six feet. The third approach was to conduct sampling at nine stations representing all areas of North Escambia Bay during the summer and fall of 2011.

For the first approach, all CChla data from the beginning of the verified period in 1998 through 2011 were pulled, and the stations were categorized as "Not A4" and "A4." Annual average CChla concentrations were calculated for each group for years in which "Not A4" and "A4" both had data in all four calendar quarters. The results are presented in **Table 5.7**. The column Average is the average of "Not A4" and "A4." The results demonstrate that if all of the data from A4 were discarded ,the WBID would have still been verified as impaired for both the historical threshold of 7.5 µg/L and the annual average threshold of 11 µg/L. Additionally, for 3 of the 6 years when there were sufficient data to calculate annual averages for both groups, the CChla at A4 was less than the other stations (very low-flow year, wetter than average year, and slightly lower than average flow year).

The same data were used for the second approach but were aggregated into stations with MLW depths of less than three feet, between three and six feet, and greater than six feet. The results in **Table 5.8** indicate that, while CChla concentrations are generally higher at the shallow water stations than at the deeper stations, there are years (three out of six, including years with very low flow and above average flow) when the deeper stations have higher annual averages. The data indicate that even if only CChla from the deeper areas of the bay were used, the waterbody would still be verified as impaired for both the historical threshold and the single-year annual average.

Additionally, the Department's TMDL Section conducted two water quality surveys (June and October 2011) that involved sampling nine different stations in WBID 548AA on the same day. **Appendix D, Figures D.13.1** through **13.5**, depict the selected results. During each survey, a calibrated YSI chlorophyll probe was deployed at half the Secchi disk depth at each station. All water quality samples were also collected at half the Secchi disk depth. Escambia River flows in June were 83% below normal and in October, 71% below normal. The annual average flow for 2011 was 63% below the long-term average flow of the river. Under these conditions, the residence time of the upper bay is at a maximum, and elevated concentrations of CChla would be expected.

Table 5.7. CChla at Station A4 vs. All Other Stations (North Escambia Bay, WBID 548AA)

- = Empty cell/no data

Year	CChla at “Not A4” (µg/L)	Count	CChla at “A4” (µg/L)	Count	Average of “Not A4” and “A4” (µg/L)	Flow (cfs) (Century USGS gage average flow = 6,152 cfs)
1999	6.02	12	9.73	26	7.88	4,663
2000	8.11	17	5.56	23	6.83	1,732
2001	8.97	11	7.82	26	8.39	6,874
2002	12.27	19	11.13	26	11.70	4,051
2003	5.41	26	13.13	26	9.27	8,016
2004	6.03	29	14.11	13	10.07	6,910
Average	**7.80**	**-**	**10.25**	**-**	**9.02**	**-**

Table 5.8. CChla at Stations Less than Three Feet MLW, Greater than Three and Less than Six Feet, and Greater than Six Feet in North Escambia Bay (WBID 548AA)

- = Empty cell/no data

Year	Stations <3 feet CChla (µg/L)	Count	Stations >3<6 feet CChla (µg/L)	Count	Stations >6 feet CChla (µg/L)	Count
1998	7.38	21	6.35	29	5.20	9
1999	9.73	26	7.84	4	5.14	8
2000	5.75	24	-	-	7.31	13
2001	7.82	26	-	-	8.75	10
2002	11.13	26	-	-	12.27	19
2003	13.13	26	-	-	5.41	22
2004	12.69	23	-	-	5.67	19
2009	10.53	6	-	-	9.25	4
Average 1998–99	**8.56**	**-**	**7.09**	**-**	**5.17**	**-**
Average	**9.77**	**178**	**-**	**33**	**7.37**	**104**
Overall Average of Individual Results 1998–2011	**10.45**	**285**	**5.43**	**49**	**9.08**	**113**

All results for NH4-N were less than the detection limit in both June and October. The only measurable concentrations of inorganic nitrogen were for NO3-N during October from the 3 stations located closest to the freshwater sources (Stations A2, A13, and 548AC). The results for PO4-P were less than detection at all stations in October, but measurable concentrations were found at several stations during the June survey, with the highest concentration off the mouth of the Escambia River near the channel (Station 548AC). The CChla lab results for June ranged from about 18 to 120 µg/L, with the highest concentrations also at the station with the highest PO4-P (Station 548AC).

In summary, even if all of the data from A4 were excluded, or if only the data from the deeper stations were used, the WBID would still be impaired for both exceeding the historical threshold of 7.5 µg/L and exceeding the 11 µg/L annual average threshold. Additionally, the results from the surveys indicate that the CChla measured at Station A4 may not be unusual for the bay. During the June survey, Station A4 had some of the lowest CChla concentrations measured, and the deeper stations had the higher values. Taking the long-term averages from the shallow stations (10.45 µg/L) and the deeper stations (9.08 µg/L) and averaging them results in a long-term equal weighted average (shallow and deep) of 9.77 µg/L. The unweighted long-term average for the WBID of 10.15 µg/L is only 0.38 µg/L greater than the equal weighted average. The shallow areas of North Escambia Bay are responsible for a significant amount of the overall bay productivity, and it is important to include these data both in evaluating impairment and in determining the restoration target. The results of the Department's surveys and data analysis suggest that at any point in time during the growing season, very high concentrations of CChla can be found at any location within the impaired WBID.

General information on the EPA Model Toolbox is provided at the beginning of this chapter and in **Appendix E, Section E.1**.

While comparisons will be made with the EBTC findings, the LSPC, EFDC, and WASP models were used to establish the TMDLs for North Escambia Bay.

Modeling Scenarios

Three modeling scenarios were developed and evaluated in this analysis: a current condition, a natural condition, and the TMDL scenario. **Appendix E, Sections E.5**, **E.6**, **E.7, and E.8**, present the WASP water quality model results.

Watershed Loadings

Appendix E, Figure E.1.2, presents the LSPC basins and the location of the watershed point sources.

An evaluation of the LSPC-predicted flow, TN, and TP calibration at the Century Florida USGS gage was conducted (**Appendix E, Figures E.1.2.7a** through **1.2.16** and **Tables E.1.2.1** through **E.1.2.4**). The results from this evaluation indicate that the flow calibration is very good, with the cumulative flows separated by only 1.1%. However, the model may be overpredicting TN at the state line (54% difference in paired data for 1997 through 2009). The calibration for TP is very good, with only a 0.4% difference between paired TP data for the observed and modeled results.

The results of a statistical comparison of measured data (1980–2011) for TN and TP concentrations at both Century and Molino are provided in **Appendix E, Table E.1.2.5,** and summarized below. The results indicate that TN or TP concentrations have not changed significantly over time at the upstream USGS flow gage near Century, Florida, while there has been a significant reduction in both TN and TP over time at the downstream USGS flow gage near Molino, Florida. The results also show that while there is no significant reduction in TN between Century and Molino, there has been a significant reduction in TP.

Tables 5.9 through **5.12** provide the results from the LSPC TN and TP loading to the Pensacola Bay system for both the calibrated model and the natural condition**. Table 5.13** provides the LSPC summary loading for TN and TP to Pensacola Bay. A comparison of these LSPC loadings with the estimated loadings from the EBTC submittal for the period from 1997 to 2010 indicates a high degree of similarity. This should be expected for the nonriver loadings, as the Department understands that the EBTC used the LSPC loadings for these subbasins. For the Escambia River loadings, the EPA relied on LSPC, while the EBTC calculated loadings from the measured data. The LSPC predicts an average TP loading of 713 kilograms per day (kg/d) vs. EBTC results of 665 kg/d.

Additionally, while the paired data evaluation for TN suggests that the LSPC model may be overpredicting the watershed loadings at Century, a comparison with the EBTC results (based on measured data) suggests that the two models are predicting the same daily average load for TN. LSPC predicts a TN loading to North Escambia Bay of 10,308 kg/day from the Escambia River vs. the EBTC results of 9,501 kg/d.

LSPC predicts an average watershed loading for the entire Pensacola Bay system for TN of 20,715 kg/d (2002–09) and 1,128 kg/d for TP. Compared with the natural condition, TN loads are on average 49% higher under existing conditions, and TP loads are 58% higher.

Table 5.9. LSPC TN Calibration Terminal Reach Loading to Pensacola Bay

Year	Escambia River TN (lbs) (LSPC Basin 20002)	Bayou Mulatto TN (lbs) (LSPC Basin 20055)	Indian Bayou TN (lbs) (LSPC Basin 20059)	Bayou Texar TN (lbs) (LSPC Basin 20058)	Bayou Chico TN (lbs) (LSPC Basin 20020)	Blackwater River TN (lbs) (LSPC Basin 20057)	Yellow River TN (lbs) (LSPC Basin 20001)	East Bay River TN (lbs) (LSPC Basin 20056)	East Bay Dean Creek TN (lbs) (LSPC Basin 20060)	East Bay Tom King TN (lbs) (LSPC Basin 20076)	SRS Williams Creek TN (lbs) (LSPC Basin 20077)	SRS Russell TN (lbs) (LSPC Basin 20078)	Total TN (lbs)
2002	5,303,305	181,751	46,916	393,809	148,602	2,164,610	2,039,535	249,397	77,110	120,355	88,100	141,279	**10,954,769**
2003	10,453,210	222,670	76,200	492,162	209,312	3,878,893	4,250,534	495,374	147,541	179,947	118,588	183,289	**20,707,720**
2004	10,808,607	220,917	73,656	466,452	189,336	3,216,690	4,400,206	432,412	117,948	159,411	120,779	180,018	**20,386,432**
2005	13,110,569	339,690	138,356	728,503	326,912	4,830,731	5,811,061	683,249	257,504	293,460	203,500	292,203	**27,015,738**
2006	3,255,355	144,205	25,676	290,438	110,126	1,361,866	1,275,807	186,801	60,789	90,208	57,706	109,362	**6,968,339**
2007	4,398,062	184,414	47,164	355,492	142,929	1,396,437	1,665,000	222,953	91,156	122,973	84,167	135,041	**8,845,788**
2008	8,528,226	184,995	49,324	400,167	160,079	2,783,845	3,140,882	311,480	95,519	135,229	87,698	146,701	**16,024,145**
2009	10,497,328	278,781	112,265	595,946	257,269	4,237,936	5,051,893	598,666	183,812	228,345	166,201	242,530	**22,450,972**
Sum	**66,354,663**	**1,757,423**	**569,557**	**3,722,969**	**1,544,565**	**23,871,008**	**27,634,918**	**3,180,332**	**1,031,379**	**1,329,928**	**926,739**	**1,430,423**	**133,353,904**
Average	**8,294,333**	**219,678**	**71,195**	**465,371**	**193,071**	**2,983,876**	**3,454,365**	**397,542**	**128,922**	**166,241**	**115,842**	**178,803**	**16,669,238**
Lbs/d	**22,724**	**602**	**195**	**1,275**	**529**	**8,175**	**9,464**	**1,089**	**353**	**455**	**317**	**490**	**45,668**
Kg/d	**10,308**	**273**	**88**	**578**	**240**	**3,708**	**4,293**	**494**	**160**	**207**	**144**	**222**	**20,715**
% of Total	**49.8%**	**1.3%**	**0.4%**	**2.8%**	**1.2%**	**17.9%**	**20.7%**	**2.4%**	**0.8%**	**1.0%**	**0.7%**	**1.1%**	**100.0%**

Table 5.10. LSPC TP Calibration Terminal Reach Loading to Pensacola Bay

Year	Escambia River TP (lbs) (LSPC Basin 20002)	Bayou Mulatto TP (lbs) (LSPC Basin 20055)	Indian Bayou TP (lbs) (LSPC Basin 20059)	Bayou Texar TP (lbs) (LSPC Basin 20058)	Bayou Chico TP (lbs) (LSPC Basin 20020)	Blackwater River TP (lbs) (LSPC Basin 20057)	Yellow River TP (lbs) (LSPC Basin 20001)	East Bay River TP (lbs) (LSPC Basin 20056)	East Bay Dean Creek TP (lbs) (LSPC Basin 20060)	East Bay Tom King TP (lbs) (LSPC Basin 20076)	SRS Williams Creek TP (lbs) (LSPC Basin 20077)	SRS Russell TP (lbs) (LSPC Basin 20078)	Total TP (lbs)
2002	409,983	9,135	955	11,103	3,457	80,316	112,320	7,091	864	1,814	3,644	2,681	**643,363**
2003	643,176	8,817	1,382	11,068	3,743	143,371	198,937	10,407	1,495	2,071	3,686	2,514	**1,030,667**
2004	800,565	9,480	1,363	11,544	3,718	129,537	244,484	9,404	1,135	2,046	4,294	3,108	**1,220,678**
2005	868,693	11,963	2,412	13,057	4,724	186,473	286,804	13,184	2,457	3,030	5,892	4,093	**1,402,783**
2006	294,204	7,793	567	8,244	2,549	46,097	72,336	6,371	628	1,349	2,669	2,199	**445,007**
2007	333,211	8,640	961	8,405	2,820	50,801	92,050	7,052	1,205	1,614	2,927	2,221	**511,906**
2008	568,844	8,232	820	9,162	2,936	98,505	167,365	8,362	843	1,528	2,867	2,182	**871,646**
2009	672,261	10,603	2,056	12,038	4,192	156,991	245,744	12,770	1,888	2,492	4,838	3,391	**1,129,264**
Sum	**4,590,938**	**74,663**	**10,516**	**84,621**	**28,139**	**892,091**	**1,420,041**	**74,641**	**10,515**	**15,944**	**30,817**	**22,389**	**7,255,315**
Average	**573,867**	**9,333**	**1,315**	**10,578**	**3,517**	**111,511**	**177,505**	**9,330**	**1,314**	**1,993**	**3,852**	**2,799**	**906,914**
lbs/d	**1,572**	**602**	**195**	**1,275**	**529**	**8,175**	**9,464**	**1,089**	**353**	**455**	**317**	**490**	**24,516**
kg/d	**713**	**12**	**2**	**13**	**4**	**139**	**221**	**12**	**2**	**2**	**5**	**3**	**1,128**
% of Total	**63.3%**	**1.0%**	**0.1%**	**1.2%**	**0.4%**	**12.3%**	**19.6%**	**1.0%**	**0.1%**	**0.2%**	**0.4%**	**0.3%**	**100.0%**

Table 5.11. LSPC TN Natural Condition Terminal Reach Loading to Pensacola Bay

- = Empty cell/no data

Year	**Escambia River TN (lbs) (LSPC Basin 20002)**	**Bayou Mulatto TN (lbs) (LSPC Basin 20055)**	**Indian Bayou TN (lbs) (LSPC Basin 20059)**	**Bayou Texar TN (lbs) (LSPC Basin 20058)**	**Bayou Chico TN (lbs) (LSPC Basin 20020)**	**Blackwater River TN (lbs) (LSPC Basin 20057)**	**Yellow River TN (lbs) (LSPC Basin 20001)**	**East Bay River TN (lbs) (LSPC Basin 20056)**	**East Bay Dean Creek TN (lbs) (LSPC Basin 20060)**	**East Bay Tom King TN (lbs) (LSPC Basin 20076)**	**SRS Williams Creek TN (lbs) (LSPC Basin 20077)**	**SRS Russell TN (lbs) (LSPC Basin 20078)**	**Total TN (lbs)**
2002	2,369,797	41,616	36,473	144,871	64,617	1,163,267	1,079,623	168,631	57,752	44,572	36,690	50,379	**5,258,288**
2003	5,042,404	63,019	61,353	166,717	95,001	2,250,862	2,409,172	361,513	117,876	71,688	50,970	66,264	**10,756,839**
2004	5,506,686	60,123	58,968	162,256	84,878	1,833,706	2,493,999	305,915	92,359	62,385	51,486	66,168	**10,778,928**
2005	6,796,770	108,192	111,225	217,474	145,152	2,806,915	3,351,948	503,784	207,521	117,424	85,841	107,967	**14,560,214**
2006	1,316,012	24,564	19,138	103,210	46,943	722,696	679,491	125,844	46,495	33,295	22,957	38,024	**3,178,668**
2007	1,761,847	41,505	36,063	120,128	59,965	721,744	821,593	143,147	68,610	44,932	33,795	46,666	**3,899,994**
2008	4,105,871	42,514	37,971	136,811	68,546	1,518,864	1,694,114	216,898	73,528	49,619	35,526	50,775	**8,031,036**
2009	5,007,727	87,038	91,110	185,331	112,660	2,347,800	2,819,134	430,818	145,661	88,418	70,697	86,188	**11,472,582**
Sum	**31,907,114**	**468,570**	**452,301**	**1,236,799**	**677,762**	**13,365,854**	**15,349,074**	**2,256,548**	**809,801**	**512,334**	**387,961**	**512,431**	**67,936,550**
Average	**3,988,389**	**58,571**	**56,538**	**154,600**	**84,720**	**1,670,732**	**1,918,634**	**282,069**	**101,225**	**64,042**	**48,495**	**64,054**	**8,492,069**
lbs/d	**10,927**	**160**	**155**	**424**	**232**	**4,577**	**5,257**	**773**	**277**	**175**	**133**	**175**	**23,266**
kg/d	**4,956**	**73**	**70**	**192**	**105**	**2,076**	**2,384**	**351**	**126**	**80**	**60**	**80**	**10,553**
% of Total	**47.0%**	**0.7%**	**0.7%**	**1.8%**	**1.0%**	**19.7%**	**22.6%**	**3.3%**	**1.2%**	**0.8%**	**0.6%**	**0.8%**	**-**
% Reduction from Calibration	**52.6%**	**73.3%**	**20.6%**	**66.8%**	**56.1%**	**44.0%**	**44.5%**	**29.0%**	**21.5%**	**61.5%**	**58.1%**	**64.2%**	**49.4%**

Table 5.12. LSPC TP Natural Condition Terminal Reach Loading to Pensacola Bay

Year	Escambia River TP (lbs) (LSPC Basin 20002)	Bayou Mulatto TP (lbs) (LSPC Basin 20055)	Indian Bayou TP (lbs) (LSPC Basin 20059)	Bayou Texar TP (lbs) (LSPC Basin 20058)	Bayou Chico TP (lbs) (LSPC Basin 20020)	Blackwater River TP (lbs) (LSPC Basin 20057))	Yellow River TP (lbs) (LSPC Basin 20001)	East Bay River TP (lbs) (LSPC Basin 20056)	East Bay Dean Creek TP (lbs) (LSPC Basin 20060)	East Bay Tom King TP (lbs) (LSPC Basin 20076)	Williams Creek TP (lbs) (LSPC Basin 20077)	SRS Russell TP (lbs) (LSPC Basin 20078)	Total TP (lbs)
2002	136,565	2,072	646	6,674	2,061	33,117	41,384	2,904	645	1,064	2,103	1,482	**230,719**
2003	241,047	2,540	996	6,640	2,232	67,686	81,512	5,851	1,200	1,242	2,182	1,352	**414,480**
2004	395,256	2,529	970	6,890	2,207	62,429	119,069	5,120	874	1,210	2,492	1,679	**600,724**
2005	437,303	3,709	1,794	7,463	2,745	97,194	145,337	8,173	2,027	1,811	3,386	2,202	**713,145**
2006	76,947	1,337	355	4,766	1,462	18,615	24,671	2,117	463	759	1,433	1,109	**134,036**
2007	95,328	1,882	667	5,079	1,691	19,991	31,894	3,093	937	974	1,718	1,246	**164,501**
2008	221,336	1,748	536	5,642	1,761	42,560	70,519	3,603	639	915	1,692	1,213	**352,164**
2009	251,948	3,249	1,546	7,129	2,481	68,836	103,663	7,476	1,534	1,488	2,856	1,825	**454,029**
Sum	**1,855,730**	**19,066**	**7,510**	**50,284**	**16,641**	**410,429**	**618,049**	**38,336**	**8,320**	**9,463**	**17,862**	**12,108**	**3,063,798**
Average	**231,966**	**2,383**	**939**	**6,285**	**2,080**	**51,304**	**77,256**	**4,792**	**1,040**	**1,183**	**2,233**	**1,514**	**382,975**
lbs/d	**636**	**7**	**3**	**17**	**6**	**141**	**212**	**13**	**3**	**3**	**6**	**4**	**1,049**
kg/d	**288**	**3**	**1**	**8**	**3**	**64**	**96**	**6**	**1**	**1**	**3**	**2**	**476**
% of Total	**60.6%**	**0.6%**	**0.2%**	**1.6%**	**0.5%**	**13.4%**	**20.2%**	**1.3%**	**0.3%**	**0.3%**	**0.6%**	**0.4%**	**-**
% Reduction from Calibration	**57.3%**	**74.5%**	**28.6%**	**40.6%**	**40.9%**	**54.0%**	**56.5%**	**48.6%**	**20.9%**	**40.6%**	**42.0%**	**45.9%**	**56.3%**

Table 5.13. LSPC TN and TP Summary Loading to Pensacola Bay

- = Empty cell/no data

Year	Total Calibration TN (lbs)	Total Natural TN (lbs)	Total Calibration TP (lbs)	Total Natural TP (lbs)
2002	10,954,769	5,258,288	643,363	230,719
2003	20,707,720	10,756,839	1,030,667	414,480
2004	20,386,432	10,778,928	1,220,678	600,724
2005	27,015,738	14,560,214	1,402,783	713,145
2006	6,968,339	3,178,668	445,007	134,036
2007	8,845,788	3,899,994	511,906	164,501
2008	16,024,145	8,031,036	871,646	352,164
2009	22,450,972	11,472,582	1,129,264	454,029
Sum	**133,353,904**	**67,936,550**	**7,255,315**	**3,063,798**
Average	**16,669,238**	**8,492,069**	**906,914**	**382,975**
lbs/d	**45,668**	**23,266**	**24,516**	**1,049**
kg/d	**20,715**	**10,553**	**1,128**	**476**
% Reduction	**-**	**49.1%**	**-**	**57.8%**

EFDC/WASP Model Results (WBID 548AA)

The results are presented for the top two layers of the model, as these comprise the volume in the water column where the majority of the data were collected. The calibration did not include measured data identified as being near the bottom. Two stations (**Figure 5.4**) were selected for comparison: Station PO2, located south of the river mouth in a more open part of the bay, and Station A4, located in the shallow waters in the northern part of the bay. Additionally, as the impairment is based on annual average conditions for the entire WBID, model results are also presented for the WBID.

All tables/figures presented below are also included in **Appendix E.** The tables in **Appendix E** that show percent differences between model predictions and measured data are intended to provide a consistent methodology to compare relative differences between the EPA and Department calibrations and are not a quantitative evaluation of the calibrations. Each table provides the number of observations at the station for each year.

Hydrodynamic Calibration (WBID 548AA)

Appendix E, **Tables E.5.1** through **E.5.4** and **Figures E.5.2** through **E.5.5,** present selected results for the hydrodynamic calibration in WBID 548AA. These results demonstrate that EFDC is able to reproduce both the temperature and salinity fluctuations at the deeper, more centrally located Station PO2, as well as in the shallow areas of North Escambia Bay represented by Station A4.

Figure 5.4. EPA Calibration Stations and Station A4

EPA/Department WASP Calibration (WBID 548AA)

While representing water quality for most of the Pensacola Bay system fairly well, the EPA calibration did not predict the elevated CChla concentrations measured at Station A4 or as a WBID average in North Escambia Bay. Given that the EPA-calibrated model did not reproduce the impairment, the Department performed a recalibration focusing only on inorganic nutrients and CChla at both Stations PO2 and A4 in WBID 548AA. **Appendix E**, **Section 5**, **Tables E.5.6** through **E.5.12** and **Figures E.5.6** through **E.5.13,** present the EPA WASP calibration for inorganic nutrients and CChla at Stations PO2 and A4. **Appendix E**, **Section 5**, **Tables E.5.13** through **E.5.20** and **Figures E.5.14** through **E.5.21**, present the Department's WASP calibration for inorganic nutrients and CChla at Stations PO2 and A4.

The annual average CChla of the measured data (25 results) at Station PO2 is 8.05 µg/L; the EPA calibration predicted 4.98 µg/L, underpredicting the response variable by 38.2%. In no year (2002–09) at Station PO2 did the EPA calibration predict concentrations over either the IWR threshold of 11.0 µg/L or the historical minimum threshold of 7.5 µg/L. The Department calibration at PO2 predicted 9.37 µg/L, overpredicting by 16.4%. The measured data annual average for 2002 at PO2 was 14.47 µg/L. The Department prediction for 2002 was 11.07 µg/L vs. the EPA prediction of 4.92 µg/L. The annual average CChla of the measured data (158 results) at Station A4 is 11.59 µg/L; the EPA calibration predicted an average of 6.87 µg/L, underpredicting by 41%. The Department calibration predicted an average of 13.41 µg/L, overpredicting the CChla by 16%. The Department calibration effectively reproduces both the annual pattern in the CChla data, as well as the impairment.

When comparing the WBID-wide average measured data with the predictions for TN, TP, and CChla presented in **Appendix E**, **Section 6**, **Tables E.6.1** through **E.6.3** and **Figures E.6.1** through **E.6.4**, it can be seen that WASP is underpredicting TN, primarily as a result of underpredicting the concentration of organic nitrogen in the water column. Both versions of the model have similar predictions of TN for the WBID average (EPA, 0.53 mg/L vs. Department, 0.50 mg/L) and TP (EPA, 0.034 mg/L vs. Department, 0.033 mg/L). The two versions of the model have significantly different predictions for the response variable. The WBID average of the measured data for CChla is 10.47 µg/L vs. the EPA prediction of 5.31 µg/L and the Department prediction of 10.07 µg/L. The Department calibration achieved this WBID-wide result while accurately predicting lower CChla concentrations in the deeper areas of the bay and higher concentrations in the shallower areas of the bay, a pattern generally consistent with the measured data.

Appendix E, **Section 8** and **Figures 8.1** through **8.60**, provide the calibration results from the Department recalibration of the WASP model for all areas of Pensacola Bay other than North Escambia Bay. The results are for inorganic nutrients and CChla at Station PO1 and Stations PO3 through PO16. These results indicate that the model is overpredicting inorganic nitrogen throughout the bay system, potentially due to the rate at which organic nitrogen is being cycled back to the inorganic fractions. The calibration for DIP appears acceptable throughout the bay system. The phytoplankton group is overpredicted throughout the system, except within the impaired water, where the model and data are in close agreement.

Natural Condition vs. EPA/Department WASP Calibration (WBID 548AA)

The natural condition scenario was developed to estimate water quality conditions if there was no impact from anthropogenic sources. Any point sources located in the watershed or waterbody were removed for the natural condition analysis. Land uses that were associated with anthropogenic activities (urban, agriculture, transportation, barren lands, and rangeland) were converted to upland forests or forested wetlands based on the current ratio of forest and wetland land uses in the model.

The purpose of the natural condition scenario was to determine whether water quality standards could be achieved under natural conditions and to ensure that the TMDL would not attempt to abate the naturally occurring loads from the watershed.

Appendix E, **Section 6**,**Tables E.6.1** through **E.6.3** and **Figures E.6.1** through **E.6.4**, present the results for the nonanthropogenic model runs. The Department version of the model predicts a background concentration of TN (as a WBID average) of 0.24 mg/L, for TP 0.014 mg/L, and for CChla 4.53 µg/L.

North Escambia Bay Nutrient TMDL

As discussed previously, Murrell *et al.* (2007) found that nitrogen limitation can occur during low-flow conditions, but that phosphorus limitation occurred in the bay under normal flow conditions. The TMDL is for long-term average conditions, and under these conditions the bay is predominantly phosphorus limited. Therefore, considering that the WASP model is well calibrated for both PO4-P and CChla, it was determined suitable for use in the determination of the TMDL.

Once the PO4-P and CChla calibrations in WBID 548AA were determined to be acceptable, both the EPA and Department versions were tested to determine how they would respond to increases in TN and TP. Two runs were made for each version: one with a 10% increase in TN and a separate run with a 10% increase in TP. Increases were only made to concentrations from the Escambia River (Reach 20002) and sources along the eastern side of Escambia Bay (Reaches 20055 and 20059). The results, summarized in **Appendix E, Section 7, Table E.7.1**, show that both versions of the model were sensitive to increases in TP. The EPA model predicted a 32% increase in CChla with a 10% increase in TP, and the Department model predicted a 6% increase in CChla. The EPA version predicted only a 6% increase in CChla after applying a 10% increase in TN, with the Department version predicting a 0% increase.

TMDL Target Development

The TMDL target is based on restoring healthy, well-balanced natural populations of flora and fauna by reducing anthropogenic nutrient enrichment. As reported by the Department (2012) seagrasses are one of the most nutrient-sensitive biological endpoints in the bay. Therefore, the TMDL target for restoration focuses on determining the nutrient concentrations needed to achieve a chlorophyll-based target that will allow for healthy seagrass beds and otherwise result in meeting all nutrient-related water quality standards. In an estuary such as Pensacola Bay that is dominated by a large, alluvial river (the Escambia River), it is important to recognize that the oligohaline zone (the lower salinity portion of the estuary where river water first enters the estuary) has very different ecological characteristics than the higher salinity areas in the lower reaches of the estuary that are more influenced by Gulf of Mexico waters. Because of their distinct ecological characteristics, there should be different expectations for nutrients, turbidity, chlorophyll, and biological productivity in these oligohaline areas.

The Department report (2012) notes that during the past 27 years, the annual geometric mean Chla (based on a minimum of 4 values per station per year) in Santa Rosa Sound, where healthy seagrass beds prevail, has ranged from 0.8 to 7.95 µg/L. Except for slightly higher values in certain bayous (Chico, Grande, and Texar), most of Pensacola Bay (Lower Escambia Bay, East Bay, and Main Pensacola Bay) also had Chla values in this range, suggesting that current nutrient and Chla conditions are appropriate for seagrass protection in these areas.

In establishing the target for the TMDL, it is important to consider that low-salinity areas (i.e., areas where freshwater rivers initially mix with more saline estuarine waters) may be expected to exhibit higher nutrient and Chla levels than higher salinity, open water areas. For this reason, the Department believes that a CChla target in the upper end of the range (0.8to 7.95 µg/L) is appropriate for the oligohaline waters of North Escambia Bay. Because chlorophyll *a* annual average concentrations less than 7.95 ug/L are not expected to interfere with the ability of submerged aquatic vegetation (SAV) to photosynthesize, targeting nutrient concentrations that result in a long-term annual average CChla concentration below this level will result in a level of production that represents a healthy system. The target for the TMDL is to reduce the long-term (2002–09) annual average CChla in WBID 548AA in the Department version of WASP from the current level of 10.07 µg/L in the calibrated model to a long-term annual average concentration of less than 7.95 µg/L, and to provide for a margin of safety (MOS).

TMDL Results

Numerous model runs were made, reducing first TN, then TP, and then TN and TP together. While these preliminary model results indicated that increases in either TN or TP would result in increases in CChla, reducing TN either alone or in combination with TP did not result in any measurable difference over reducing just TP. Model runs were made to assess the response of CChla in North Escambia Bay based on where reductions were made in the overall Pensacola Bay system. If all reductions were made in the Escambia River, TP would be lowered to below the natural condition. Similarly, if reductions were only made to TP from the Escambia River (Reach 20002) and the two terminal reaches coming into Escambia Bay from Bayou Mulatto (Reach 20055) and Indian Bayou (Reach 20059), the resulting concentration in these reaches would be below the natural condition. Given that all of the watersheds draining to Pensacola Bay have experienced increases in TP loading over the natural condition (**Table 5.12**) ranging from 20.9% to 74.5%, the Department approach to the TMDL is a percent reduction applied to all sources.

Additional model runs were made to determine what level of reductions would be required if all 12 terminal reaches were reduced equally. A 35% reduction in TP was initiated at all 12 reaches, and the resulting WBID-wide average CChla concentration was reduced to 7.43 µg/L. This meets the restoration target of a long-term annual average CChla concentration of less than 7.95 µg/L, provides for an MOS, and is the basis for the TMDL. Additionally, as discussed in the section for EBTC/EPA model results below, all other nutrient-related water quality standards will be achieved if the target TMDL CChla condition is achieved.

Figures 5.5 through **5.7** present the TN, TP, and CChla long-term (2002–09) WBID-wide annual average results from the TMDL run, together with the Department calibration and natural condition results. **Table 5.14** provides TMDL summary information for TN and TP in Pensacola Bay.

LSPC modeling of the watershed indicates that the current condition for TN loads is 49% higher than the natural condition load. The modeling results for TN indicate that additional increases in TN alone will result in measurable increases in CChla.

LSPC modeling of the watershed indicates that the current condition for TP load is 56% higher than the natural condition load. The modeling results for TP indicate that additional increases in TP alone will result in measurable increases in CChla, and reductions in TP alone will result in meeting the CChla restoration target without reductions in TN. The Department calibration for TP resulted in a long-term annual average concentration of 0.033 mg/L, a TMDL condition of 0.024 mg/L, and a natural condition of 0.014 mg/L.

The modeling results for CChla indicate that a 35% reduction in TP from all sources in the Pensacola Bay watershed will result in meeting the restoration goals for nutrients and CChla.

The TMDL for the 8-year simulation in WBID 548AA resulted in TN annual averages ranging between 0.43 and 0.56 mg/L, with a long-term average of 0.50 mg/L. TP annual averages ranged between 0.021 and 0.025 mg/L, with a long-term average of 0.023 mg/L. CChla annual averages were between 5.77 and 9.93 µg/L, with a long-term average of 7.43 µg/L.

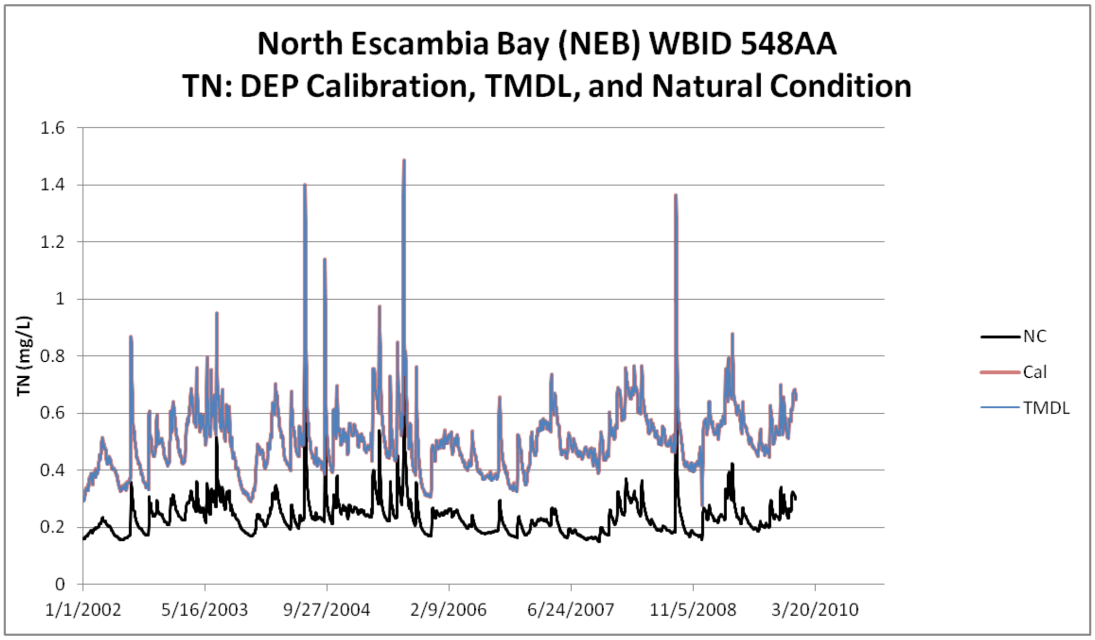

Figure 5.5. TN: Department Calibration, TMDL, and Natural Condition for North Escambia Bay (WBID 548AA)

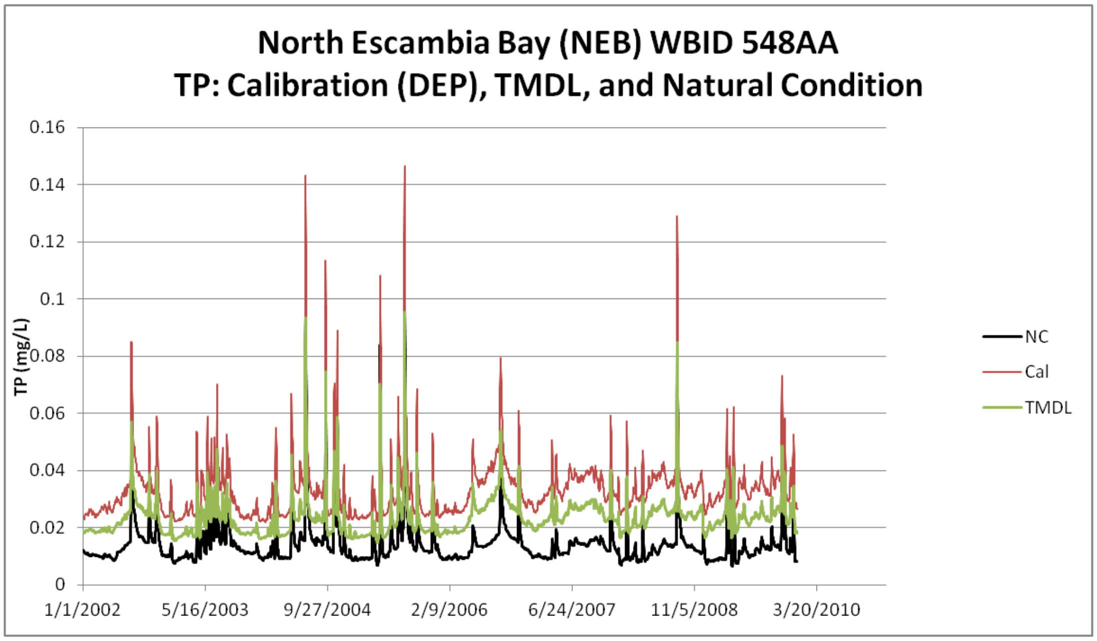

Figure 5.6. TP: Department Calibration, TMDL, and Natural Condition for North Escambia Bay (WBID 548AA)

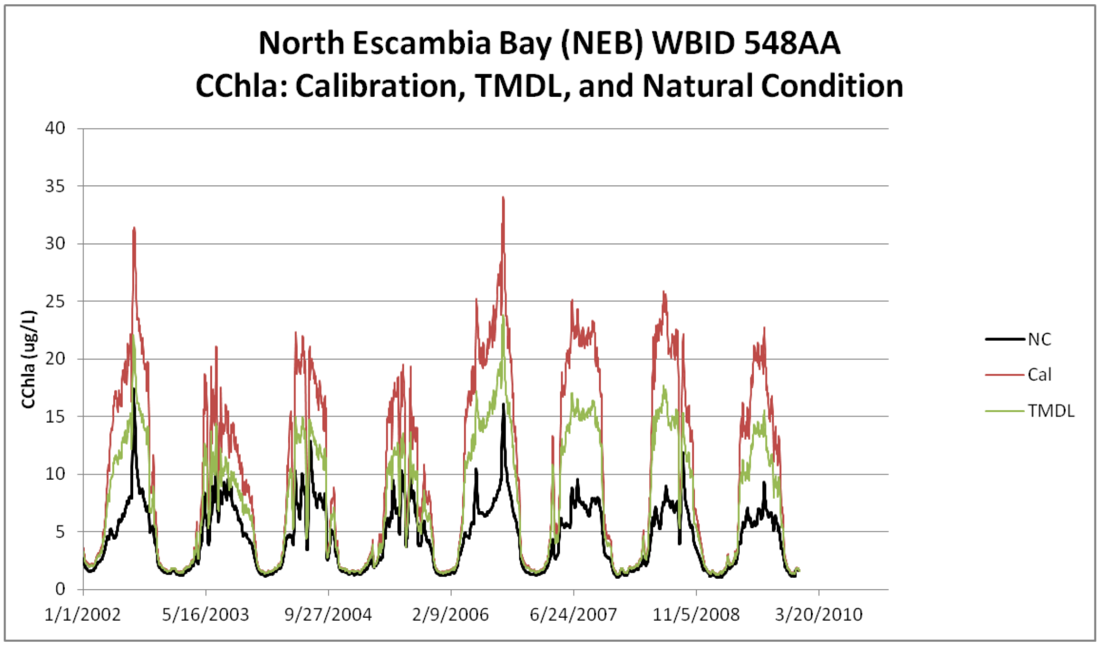

Figure 5.7. CChla: Department Calibration, TMDL, and Natural Condition for North Escambia Bay (WBID 548AA)

Table 5.14. Pensacola Bay TMDL Summary Table (WBID 548AA)

[1] The TMDL in Chapter 6 includes the TN and TP WLA wastewater loads.

Average Load	Calibration (lbs/yr)	TMDL (LA) (lbs/yr)[1]	% Reduction
TN	16,669,238	16,669,238	0%
TP	906,914	589,494	35%

EBTC/EPA Model Results and Downstream Waters

The Department must ensure that the reductions required to restore the impaired waters in North Escambia Bay will be sufficient to protect all downstream waters. For North Escambia Bay, this involves all of the other waters in the Pensacola Bay system.

The modeling results submitted to the Department by the EBTC indicate that during 2003 (a high-flow year) PO4-P concentrations increased in North Escambia Bay. The results indicate that high flows during the summer will result in lower CChla predictions, due to deceased residence time, resulting in less PO4-P uptake in the upper bay. Under these same high-flow conditions, the model predicts lower DO concentrations and higher PO4-P fluxes from the sediments. Model predictions resulted in higher NH4-N during the summer and lower concentrations in the winter. Of particular interest, the EBTC model predicts higher NO3-N concentrations in the upper bay, a finding consistent with the measured data.

The model results indicate that CChla is higher in North Escambia Bay during low-flow years and the peak concentrations occur farther to the south as flow increases, with higher concentrations in Lower Escambia Bay during average flow years and farther south in Upper Pensacola Bay during high-flow years.

All documents and copies of the models provided to the Department by the EBTC are available on request.

North Escambia Bay/Pensacola Bay System

The Department and EPA approaches to the development of numeric nutrient criteria that ensure water quality standards are met and designated uses protected have similar endpoints, as follows:

- *Balanced faunal communities;*
- *Healthy seagrass communities; and*
- *Balanced phytoplankton biomass and production.*

Department staff met with EPA Headquarters' modeling consultants from Tetra Tech in Atlanta, Georgia, in February 2012. The purpose of the meeting was to go over modeling results and evaluation criteria, and to obtain copies of the LSPC, EFDC, and WASP models that the EPA used to assess both the current condition (EPA-calibrated model) and a background (natural) condition, as described above. Based on the information provided by Tetra Tech, it is the Department's understanding that the EPA is using a multiple-line-of-evidence approach to determine if Pensacola Bay meets the state of Florida narrative criteria for nutrients. Central to the methodology is the establishment of a series of nine "zones" based on salinity gradients in the Pensacola Bay system. These zones are depicted in **Appendix E**, **Figure E.1.2**.

The multiple lines of evidence considered include the following:

- *Balanced faunal communities:*
  - Ensure that within each zone, a daily average DO of 5.0 mg/L (as a water column average) is obtained 90% of the time over the 2002 to 2009 simulation period.
  - Ensure that within each zone, a minimum DO of 4.0 mg/L (as a water column average) is obtained 90% of the time over the 2002 to 2009 simulation period.
  - Ensure that within each zone, the 3-hour average DO does not fall below 1.5 mg/L (as an average of the bottom 2 layers in WASP and the bottom 4 layers of RCA) over the 2002 to 2009 simulation period.
- *Healthy seagrass communities:*
  - Relate colonization depth targets to CChla limits.
  - Determine where the growing season average bottom light equals or exceeds 20% of the surface light for both current and natural conditions.
  - Compare the areas where the bottom light is 20% of surface light or greater with historical seagrass coverages (for both current and natural conditions).
  - Compare areas where the growing season average 20% light depth on the bottom is achieved against the zone depth targets developed by the EPA.
- *Balanced phytoplankton biomass and production:*
  - Use CChla as an indicator of balanced phytoplankton biomass and production.
  - Develop TN and TP criteria based on the relationships between TN and/or TP and CChla.
  - Ensure that CChla over the 2002 to 2009 simulation period does not exceed 20.0 µg/L more than 10% of the time in any zone. This is intended to prevent CChla from reaching levels that may result in harmful algal blooms.

The EPA's final reports and findings have not yet been released. Information provided by EPA consultants (Tetra Tech) during February and May 2012 should be considered preliminary, as refinements in both the model calibration and the evaluation metrics may have continued. It is the Department's understanding, based on the preliminary model results provided by Tetra Tech during a teleconference on May 3, 2012, that all of the zones in the bay system either meet these evaluation metrics, or the current and background conditions were nearly identical. In those cases where the background and current condition DO were the same, the results imply that reducing nutrients would result in no improvement in the current condition for DO, and reductions in nutrients were not warranted.

The EBTC modeling results provided to the Department that considered the same evaluation metrics and zones (July 13, 2012) indicate that with the exception of DO in the Upper Pensacola Zone, where the 90% DO concentration was 4.91 mg/L under the current condition and 4.92 mg/L in the natural condition, all metrics were met in all zones. The current and natural condition DO were within 0.01 mg/L, indicating that current levels of nutrients and CChla concentrations were not adversely affecting daily average DO.

The EBTC results for the North Escambia Bay Zone indicate that (for the 14-year simulation period), the range in annual average concentrations of CChla, TN, and TP that would result in meeting all targets for seagrasses, light penetration, CChla, and DO were CChla annual average concentrations ranging from 3.5 to 8.4 µg/L, TN from 0.37 to 0.56 mg/L, and TP from 0.022 to 0.041 mg/L. The EBTC found that reducing nutrients to natural conditions resulted in lower TN, TP, and CChla but did not result in significant changes to DO and available light.

Based on these results, the TMDL for North Escambia Bay (WBID 548AA) will be fully protective of all downstream waters.

5.4 Critical Conditions/Seasonality

The critical condition for chla in a given watershed depends on many factors, including the presence of point sources and the land use pattern in the watershed. Typically, the critical condition for nonpoint sources is an extended dry period followed by a rainfall runoff event. During the wet weather period, rainfall washes off nutrients that have built up on the land surface under dry conditions. However, significant nonpoint source contributions can also appear under dry conditions without any major surface runoff event. This may happen when nonpoint sources contaminate the surficial aquifer, and nutrients are brought into the receiving waters through baseflow. In addition, sediments that have accumulated for months may provide a flux of nutrients to the water column under certain weather or DO conditions. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

A TMDL can be expressed as the sum of all point source loads (wasteload allocations or WLAs), nonpoint source loads (load allocations or LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty about the relationship between effluent limitations and water quality:

As mentioned previously, 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 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 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 is also different than 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 NPDES Stormwater WLA is expressed as a percent reduction in the stormwater from MS4 areas. The LA and TMDL for Bayou Chico, Judges Bayou, and North Escambia Bay are expressed as loads and percent reductions, and represent the long-term annual average load of TN and TP from all watershed sources that these waterbodies can assimilate and maintain the Class III narrative nutrient criterion (**Tables 6.1** through **6.4**). The expression and allocation of each of the TMDLs in this report are based on the loadings necessary to achieve the water quality criteria and designated uses of the surface waters.

Table 6.1. Bayou Chico (WBIDs 846 and 846C) TN and TP TMDL Allocations

N/A = Not applicable

WBID	Parameter	WLA for Wastewater (lbs/yr)	WLA for Stormwater (% reduction)	LA (% reduction)	MOS	TMDL (% reduction)
846C	TN	N/A	30%	30%	Implicit	30%
846C	TP	N/A	30%	30%	Implicit	30%
846	TN	N/A	30%	30%	Implicit	30%
846	TP	N/A	30%	30%	Implicit	30%

These reductions will result in long-term average Bayou Chico concentrations for TP in WBID 846C of 0.027 mg/L and in WBID 846 of 0.025 mg/L. For TN in WBID 846C, the concentration is 1.4 mg/L and in WBID 846, 1.22 mg/L. For CChla in WBID 846C, the concentration is 8.88 µg/L and in WBID 846, 8.93 µg/L. The reductions are based on data from 2002 to 2009. As these reductions are provided as a percentage, they are applicable over any time frame, including daily.

Table 6.2. Judges Bayou (freshwater) (WBID 493A) DO TMDL Allocations

N/A = Not applicable

WBID	Parameter	WLA for Wastewater (lbs/yr)	WLA for Stormwater (% reduction)	LA (% reduction)	MOS	TMDL (% reduction)
493A	TN	N/A	74%	74%	Implicit	74%

These reductions will result in long-term average concentrations for TN in Judges Bayou (freshwater) of 0.73 mg/L and DO concentrations that meet the water quality criterion. The reductions are based on data from 2003 to 2010. As these reductions are provided as a percentage, they are applicable over any time frame, including daily.

Table 6.3. Judges Bayou (marine) (WBID 493B) Nutrient TMDL Allocations

N/A = Not applicable

WBID	Parameter	WLA for Wastewater (lbs/yr)	WLA for Stormwater (% reduction)	LA (% reduction)	MOS	TMDL (% reduction)
493B	TP	N/A	35%	35%	Implicit	35%

The reductions for TP required to address the nutrient impairment in North Escambia Bay, in combination with the TN reductions required to restore the freshwater tributaries to Judges Bayou, are the basis for the TMDL proposed for the marine portion of Judges Bayou. The TP reductions will result in a long-term average TP concentration in the tidal waters flushing Judges Bayou of 0.023 mg/L and 7.43 µg/L of CChla. The reductions are based on data from 2002 to 2009. As these reductions are provided as a percentage, they are applicable over any time frame, including daily.

Table 6.4. TMDL Allocations for North Escambia Bay (WBID 548AA)

[1] The WLA wastewater is divided between Gulf Power Company (NPDES Permit FL0002275), Pace Water System, Inc. (NPDES Permit FL0102202), and Ascend Performance Materials LLC (NPDES Permit FL0002488). These facilities discharge into the Lower Escambia River or the North Escambia Bay area. The Gulf Power Company allocation for TP is 7.8 lbs/day (2,852 lbs/yr) and 58.6 lbs/day (21,392 lbs/yr) for TN. The Pace Water System, Inc. allocation for TP is 10.5 lbs/day (3,852 lbs/yr) and 87.8 lbs/day (32,052 lbs/yr) for TN. For Ascend, the estimate of the TP WLA is based on the average facility loading in the WASP model of 14.1 lbs/day (2002–09) (5,147 lbs/year); the TN WLA is 200.5 lbs/day (73,171 lbs/yr).

[2] The existing watershed TN total annual average load to the Pensacola Bay Estuary (2002–09) is 16,669,238 lbs/yr. The TMDL requires a 0% reduction in this long-term TN annual average load. Therefore, the long-term annual average TN nonpoint source load for the TMDL condition is 16,669,238 lbs/yr. The TMDL is the sum of the WLA stormwater and LA load of 16,669,238 lbs/yr and the WLA for wastewater of 126,615 lbs/yr, or 16,795,853 lbs/yr. The existing watershed TP total annual average load to the Pensacola Bay Estuary (2002–09) is 906,914 lbs/yr. The TMDL requires a 35% reduction in this long-term TP annual average load. Therefore the long-term annual average TP nonpoint source load for the TMDL condition is 589,494 lbs/yr. The TMDL is the sum of the stormwater load of 589,494 lbs/yr and the WLA for wastewater of 11,851 lbs/yr, or 601,345 lbs/yr. The reductions for TP are required to maintain or restore the biological conditions affected by nutrient conditions in North Escambia Bay. This reduction resulted in a long-term average TP concentration of 0.023 mg/L and 7.43 µg/L of CChla in North Escambia Bay. The total TP TMDL of 1,647.5 lbs/day (601,345 lbs/yr) includes the watershed loading of 1,615.1 lbs/day (589,494 lbs/yr) plus the WLA for facility discharges of 32.5 lbs/day (11,851 lbs/yr).

WBID	Parameter	WLA for Wastewater (lbs/yr)[1]	WLA for Stormwater (% reduction)	LA (% reduction)	MOS	TMDL (lbs/yr)[2]
548AA	TP	11,851	35%	35%	Implicit	601,345
548AA	TN	126,615	0%	0%	Implicit	16,795,853

6.2 Load Allocation (LA)

Because the exact boundaries between those areas of the watershed covered by the WLA for stormwater and the LA for nonpoint sources are not known, both the LA and the WLA for stormwater will receive the same percent reduction. It should be noted that the LA may include loading from stormwater discharges regulated by the Department and the water management district that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.2.1 Bayou Chico (WBIDs 846 and 846C)

The LA is a 30% reduction in TP and TN of the total nonpoint source watershed loadings for the period from 2002 to 2009. As the TMDL is based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reductions for the anthropogenic sources may be greater.

6.2.2 Judges Bayou (freshwater) (WBID 493A)

The LA is a 74% reduction in TN of the total nonpoint source watershed loadings for the period from 2002 to 2009. As the TMDL is based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reductions for the anthropogenic sources may be greater.

While the LAS operated by Sterling Fibers in the Judges Bayou watershed is not a direct discharger to the impaired waters, it has been linked by the data analysis to the elevated nutrients in the creeks that accumulate along the slope below the sprayfield. The data collected from the ground water monitoring network and the streams in the watershed show a clear relationship to activities at the sprayfield. Considering this information, it is the Department's recommendation that Sterling Fibers be required to reduce the nitrogen loadings to the sprayfield by 74% from the baseline condition of the years between 2002 and 2009.

6.2.3 North Escambia Bay (WBID 548AA) and Judges Bayou (marine) (WBID 493B)

The LA is a 35% reduction in TP of the total nonpoint source watershed loadings for the period from 2002 to 2009. As the TMDL is based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reductions for the anthropogenic sources may be greater.

The Town of Century WWTF (NPDES Permit FL0032468) is a 0.45-MGD monthly average daily flow, conventional extended aeration, secondary domestic wastewater treatment plant. The facility discharges in the Escambia River near the state line, about 60 miles from the impaired water. The loading from this facility is embedded in the LA for the watershed. The detailed allocation for the facility will be established during the development of the BMAP.

6.2.4 Alabama

The Department will work within the BMAP process to establish the most equitable and cost-effective manner to allocate any nutrient reductions required of Alabama under the LA component of the TMDL.

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

As noted in Chapter 4, there are no active NPDES-permitted facilities located in the Bayou Chico or Judges Bayou watersheds that discharge directly to the surface waters of the impaired waterbodies. Therefore, the $\text{WLA}_{\text{wastewater}}$ for the Bayou Chico and Judges Bayou TMDL is not applicable because there are no domestic or industrial wastewater NPDES facilities that discharge directly to the impaired waters.

North Escambia Bay (WBID 548AA)

As noted in Chapter 4, there are no active NPDES-permitted facilities located in the Escambia Bay watershed that are considered direct dischargers to the surface waters of the impaired water (WBID 548AA). However, several NPDES surface water dischargers located in Florida upstream of the impaired water discharge into the lower Escambia River, its tributaries, or a wetland that flows to the Simpson River and then to North Escambia Bay.

Pace Water System, Inc. (NPDES Permit FL0102202) is an activated sludge advanced wastewater treatment plant with a 5-MGD AADF capacity. The facility has a 5.0-MGD AADF permitted capacity, slow-rate public access general reuse area. The boundaries of the general reuse area are defined by the boundaries of the utility franchise area. The facility also consists of an existing 1.0-MGD AADF permitted surface water discharge, D-001, to approximately 144 acres of the Pace Swamp wetlands. Pace Swamp's water flows to the Simpson River (Class III fresh waters), a tributary to North Escambia Bay. The $\text{WLA}_{\text{wastewater}}$ for this advanced WWTF is to maintain the current limits of 87.8 lbs/day (32,052 lbs/yr) for TN and 10.5 lbs/day (3,852 lbs/yr) for TP.

The Department approved the Gulf Power Company (NPDES Permit FL0002275) current limits for TN and TP based on modeling reviewed in March 2011. The Department found that the existing permitted discharge of nutrients to the tidally influenced portion of the Escambia River is not causing or contributing to any impairment in the Escambia River or the increasing levels of CChla measured in North Escambia Bay. Therefore the $WLA_{wastewater}$ for this facility is to maintain the current limits of 58.6 lbs/day (21,392 lbs/yr) for TN and 7.8 lbs/day (2,852 lbs/yr) for TP.

The Ascend Performance Materials LLC facility(NPDES Permit FLO002488) has 2 outfalls, D-001 and D-002, that are authorized to discharge 27.7 MGD of steam condensate, noncontact cooling water, fire protection water losses, hydrostatic test water, treated and nontreated production well ground water, ion-exchange regeneration wastewater, potable water, Escambia River water, and stormwater within dikes and stormwater runoff from areas associated with industrial activity. As discussed in Chapter 4, during a recent bioassessment of the facility, the pollutant of concern (PO4-P) was measured at 0.068 mg/L (0.16 mg/L of TP) in the primary discharge location (D-001), and both outfalls (D-001 and D-002) had AGP results about 5 times the problem threshold level. Both PO4-P and TP were elevated over concentrations typically found in the Escambia River.

Given that the discharge is not just returning water taken from the Escambia River, but also contains water from on-site wells, ion-exchange regeneration wastewater, potable water, and stormwater from areas of industrial activity, the Department will require the facility to obtain a TP WLA for wastewater. Currently, the permit does not contain any monitoring conditions for nutrients, and so there are insufficient effluent data to use as the basis for establishing a precise TP WLA. For the TMDL, the estimate of the TP WLA is based on the average facility loading in the WASP model of 14.1 lbs/day (2002–09), or 5,147 lbs/yr. For the TMDL, the estimate of the TN WLA is based on the average facility loading in the WASP model of 200.47 lbs/day (2002–09) or 73,172 lbs/yr. The $WLA_{wastewater}$ for this facility is based on no increases in nutrient loading over current conditions, and on rhw modification of the Ascend permit to include monitoring to characterize the concentration and loading of nutrients to the Escambia River from D-001 and D-002, as well as from the various sources of water that make up the discharge to the river.

6.3.2 NPDES Stormwater Discharges

Bayou Chico (WBIDs 846C and 846)

Escambia County, the city of Pensacola, and Florida Department of Transportation (FDOT) District 3, holders of MS4 Permit FLS000019, must achieve a 30% reduction in current TN and TP loading based on the period from 2002 to 2009. These are the required percent reductions in stormwater nonpoint sources.

It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic 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. As the TMDL is based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reduction for only the anthropogenic sources may be greater.

Judges Bayou (freshwater) (WBID 493A)

Santa Rosa County, holder of Phase II MS4 Permit FLR04E069, must achieve a 74% reduction in current TN loading based on the period from 2002 to 2009, as applicable. The Department notes that for Phase II MS4s, only the "urbanized area" in a county is subject to the MS4 permit.

North Escambia Bay and Judges Bayou (marine) (WBIDs 548AA and 493B)

In the Pensacola Bay Basin, the stormwater collection systems owned and operated by Escambia County, city of Pensacola, town of Century, and FDOT District 3 in Escambia County are covered by a Phase I NPDES MS4 permit (FLS000019).

The University of West Florida (Permit FLR04E057) and the Pensacola Naval Air Station (Permit FLR04E058), also in Escambia County, have Phase II MS4 permits. Several other local governments in these watersheds are also covered under Phase II NPDES MS4 permits. These include Santa Rosa County (Permit FLR04E069), the city of Milton (Permit FLR04E104), and the city of Gulf Breeze (Permit FLR04E085) in Santa Rosa County. As applicable, these MS4 entities must obtain a 35% reduction in TP loading based on the period from 2002 to 2009.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating an MOS into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (Clean Water Act, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings.

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001c), an implicit MOS was used in the development of the Bayou Chico, Judges Bayou, and North Escambia Bay TMDLs because the TMDL was based on conservative decisions associated with a number of the modeling and calculation assumptions used in the development of assimilative capacity.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of these TMDLs by rule, the Department will work cooperatively with stakeholders to development a plan to restore the waterbodies. This will be accomplished by creating a Basin Management Action Plan, referred to as the BMAP. 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. The BMAP will be designed to reduce the amount of nutrients that caused the verified impairments in Bayou Chico, Judges Bayou, and North Escambia Bay. These activities will depend heavily on the active participation of the state of Alabama (North Escambia Bay), NWFWMD, local governments, businesses, and other stakeholders.

While Chapter 6 specifies the required nonpoint source percent reduction for nutrients, no specific projects have been identified at this time. The Department will work with these organizations and individuals during BMAP development to identify specific projects directed at reducing the discharge of nutrients and achieve the established TMDLs for the impaired waterbodies.

The 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. **Section 7.2** provides a framework for the issues and activities that need to be completed as part of BMAP development.

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; and*
- *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.

7.2 Next Steps for TMDL Implementation

The Department will establish the detailed allocation for the WLA for stormwater and the LA for nonpoint sources under Paragraph 403.067(6)(b), F.S.

Although there are nutrient and CChla data for the Escambia River (both in Florida and Alabama) and for North Escambia Bay, there is no empirical correlation between river nutrient loads and the recent increased CChla levels in North Escambia Bay. To investigate what is causing the CChla increase in North Escambia Bay, additional data collection is essential. In addition, other unknown nutrient sources around the upper bay that may be contributing to the observed CChla increases may not be represented in the models.

The BMAP will be developed over three years to allow for additional data collection for the river, marshes, stormwater, and bay to determine nutrient loads contributed from Alabama, other potential nutrient sources to the upper bay, and further refinement of the models. This approach is needed to increase the scientific precision and accuracy of the load reductions for the WLA stormwater and LA components of the TMDL.

In addition, the development of the BMAP under Paragraph 403.067(6)(b), F.S., will allow time for further monitoring and modeling to better understand the relationship between river flow and nutrient loading, DO, light transparency, nutrients, and algae (CChla). This approach is warranted because, as discussed earlier, some uncertainty remains in the existing data and model predictions.

Important next steps are as follows:

1. **Evaluate the synergistic impacts of the BMAP for fecal coliform in the Bayou Chico watershed.**

There is an adopted BMAP for fecal coliform in the Bayou Chico watershed (August 2011). The BMAP lists numerous projects that, in addition to reducing fecal coliform, will reduce nutrients (removing septic tanks from areas adjacent to the water), improve the flushing characteristics of the bayou (removing constrictions between the upper and lower areas of the bayou), or remove contaminated sediments. The Department intends to work with the BMAP partners and determine the level of credit for nutrient reductions that can be assigned to those projects with the potential to improve overall water quality in Bayou Chico and its tributaries. If it is determined that the nutrient reductions achieved by implementing projects in the fecal coliform BMAP will achieve the required reductions of the nutrient TMDL, the Department will not require additional projects to reduce nutrients further in Bayou Chico. Additionally, the feasibility of reducing nutrient loadings in other basins using the BMPs indentified in the Bayou Chico fecal coliform BMAP should be investigated.

2. Further assess the ground water contamination zone in western Santa Rosa County.

The results presented in this TMDL report reveal elevated concentrations of inorganic nutrients associated with activities at the Sterling Fibers sprayfield and a large area delineated as a Ground Water Contamination Zone along the eastern side of Upper Escambia Bay. The contamination zone may contribute to the baseflow and interflow that give rise to a number of streams along the upper bay (not just in Judges Bayou). There are currently insufficient data to assess these other streams. The Department proposes to establish a group of interested stakeholders to evaluate the potential for the contaminated ground water to be causing or contributing to nutrient impairment in either the freshwater streams or in Upper Escambia Bay/Judges Bayou. The complete set of monitoring well data from the western side of Santa Rosa County should be evaluated.

As a first step, the data should be reviewed to determine if there is sufficient information to evaluate the potential for inorganic nutrients in the contamination zone to be causing or contributing to the impairments in Escambia Bay and/or Judges Bayou. If there are insufficient data to make this determination, then a Plan of Study will be developed to identify the data gaps and develop a schedule to gather the missing information.

3. Develop allocations for the WLA stormwater and LA components of the TMDL.

A flow-adjusted trend analysis by the Department's Status and Trends staff for the period from January 1999 through June 2011 indicates that TN and CChla show a significant increasing trend at both the state line and Molino, while TP has remained unchanged at the state line but decreased at Molino. There is a need to assess water quality data at USGS gage sites (or other long-term flow sites) in Alabama to determine if nutrient load reductions are occurring in that state.

The Department will work within the BMAP process to establish the most equitable and cost-effective approach to allocate any nutrient reductions required.

4. Address data and modeling issues.

The Department will work cooperatively with the stakeholders to resolve the issues identified below. This effort will be readdressed no later than three years from the effective date of this TMDL, taking into account the additional data collected and the refinements in the models.

It is the position of the Department that any model used must be able to reproduce the magnitude and spatial and temporal patterns of CChla in the impaired area of the bay. The EPA and Department are available to provide support with refinements of LSPC/EFDC/WASP. The Department does not currently have the in-house experience to take the lead in making revisions to the ECOMSED/RCA set of tools and postprocessing of the results. If the decision is made to use the ECOMSED/RCA set of models, then the stakeholder group(s) must make a commitment to fully fund the effort. The Department will allocate technical resources if this option is selected.

Data and modeling issues to be addressed include the following:

- *Review the parameterization of the model(s) selected to determine if the values used are within acceptable ranges.*
- *Review existing water quality data for the Escambia, Blackwater, and Yellow Rivers to determine if additional studies should be conducted to refine/update the information on the particulate vs. dissolved nutrient fractions.*
- *Review existing water quality data for the Escambia, Blackwater, and Yellow Rivers to determine if additional studies should be conducted to refine/update the information on the split between organic and inorganic nutrient fractions.*
- *Review existing urban stormwater data to determine if additional studies should be conducted to refine/update the characterization of urban stormwater in LSPC.*
- *Evaluate the appropriate chlorophyll and biological endpoints.*
- *Evaluate the potential for other sources of nutrients to Pensacola Bay, such as ground water contamination and contributions from wetlands, that are not accounted for in the current model.*

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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.

The rule requires the state's water management districts to establish stormwater Pollutant Load Reduction Goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. No PLRG has been developed for Lake Cypress.

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 NPDES Program and other state stormwater permitting programs is that the NPDES Program covers both new and existing discharges, while the other state programs focus on new discharges. 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: Bayou Chico (WBIDs 846 and 846C) and Middle Pensacola Bay (WBID 548D) Data Tables/Figures (Separate Document)

Appendix C: Judges Bayou (WBIDs 493A and 493B) Data Tables/Figures (Separate Document)

Appendix D: Pensacola Bay (WBIDs 548AA, 548AC, 548B, 548GA, 548GB, 548H, 548C, 548D, 548E, and 915) Data Tables/Figures (Separate Document)

Appendix E: Pensacola Basin TMDL Model Results: Bayou Chico (WBIDs 846 and 846C) and North Escambia Bay (WBID 548AA) Figures/Tables (Separate Document)

Appendix F: Pensacola Basin TMDL Public Comments and Department Reponses: Bayou Chico (WBIDs 846 and 846C), Judges Bayou (WBIDs 493A and 493B), and North Escambia Bay (WBID 548AA) (Separate Document)

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