# FINAL TMDL Report

**SOUTHWEST DISTRICT • SPRINGS COAST BASIN •**
**ANCLOTE RIVER/COASTAL PINELLAS COUNTY PLANNING UNIT**

# Dissolved Oxygen and Nutrient TMDL for McKay Creek Tidal Segment, WBID 1633

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## Florida Department of Environmental Protection, Bureau of Watershed Management

***Total Maximum Daily Load (TMDL) Program***
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***Identification of Impaired Surface Waters Rule***
**http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf**

***Florida STORET Program***
**http://www.dep.state.fl.us/water/storet/index.htm**

***2014 305(b) Report***
**http://www.dep.state.fl.us/water/docs/2014_integrated_report.pdf**

***Criteria for Surface Water Quality Classifications***
**http://www.dep.state.fl.us/water/wqssp/classes.htm**

***Water Quality Status and Assessment Reports for the Springs Coast Basin***
**http://www.dep.state.fl.us/water/basin411/springscoast/index.htm**

## U.S. Environmental Protection Agency

***Region 4: Total Maximum Daily Loads in Florida***
**http://www.epa.gov/region4/water/tmdl/florida/**

***National STORET Program***
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# Chapter 1: INTRODUCTION

## 1.1 Purpose of Report

This report presents the Total Maximum Daily Loads for nutrients and dissolved oxygen (DO) for the tidal portion of McKay Creek, located in the Anclote River/Coastal Pinellas County Planning Unit, which in turn is part of the larger Springs Coast Group 5 Basin. The waterbody segment was verified as impaired for DO and nutrients, and was included on the Verified List of impaired waters for the Springs Coast Basin that was adopted by Secretarial Order in December 2007.

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality. The TMDLs establish the allowable loadings to the tidal segment of McKay Creek that would restore the waterbody so that it meets its applicable water quality criteria for DO and nutrients.

## 1.2 Identification of Waterbody

The McKay Creek watershed encompasses 8.8 square miles (5,652 acres) in west-central Pinellas County (**Figure 1.1**). The watershed area spans several jurisdictions, including parts of the cities of Largo, Belleair Bluffs, and Seminole, as well as unincorporated areas of Pinellas County. Land uses in the watershed are predominantly high-density residential and urban open space, and over 90% of the area is urbanized.

The headwaters of the creek are located in the southern part of the basin in an unincorporated area of Pinellas County (**Figure 1.2**). The main channel of McKay Creek originates near the intersection of 86th Ave. North and 125th St. North and flows generally northwest for approximately 7.7 miles, where it enters Clearwater Harbor. There are two impoundments along the creek: Walsingham Reservoir and Taylor Lake. Church Creek, a tributary to McKay Creek, discharges into the tidal area near South Indian Rocks Rd. and has a channel length of about 1.7 miles.

***Figure 1.1.  Location of McKay Creek Tidal Segment, WBID 1633, in the McKay Creek Watershed and Major Geopolitical and Hydrologic Features in Pinellas County***

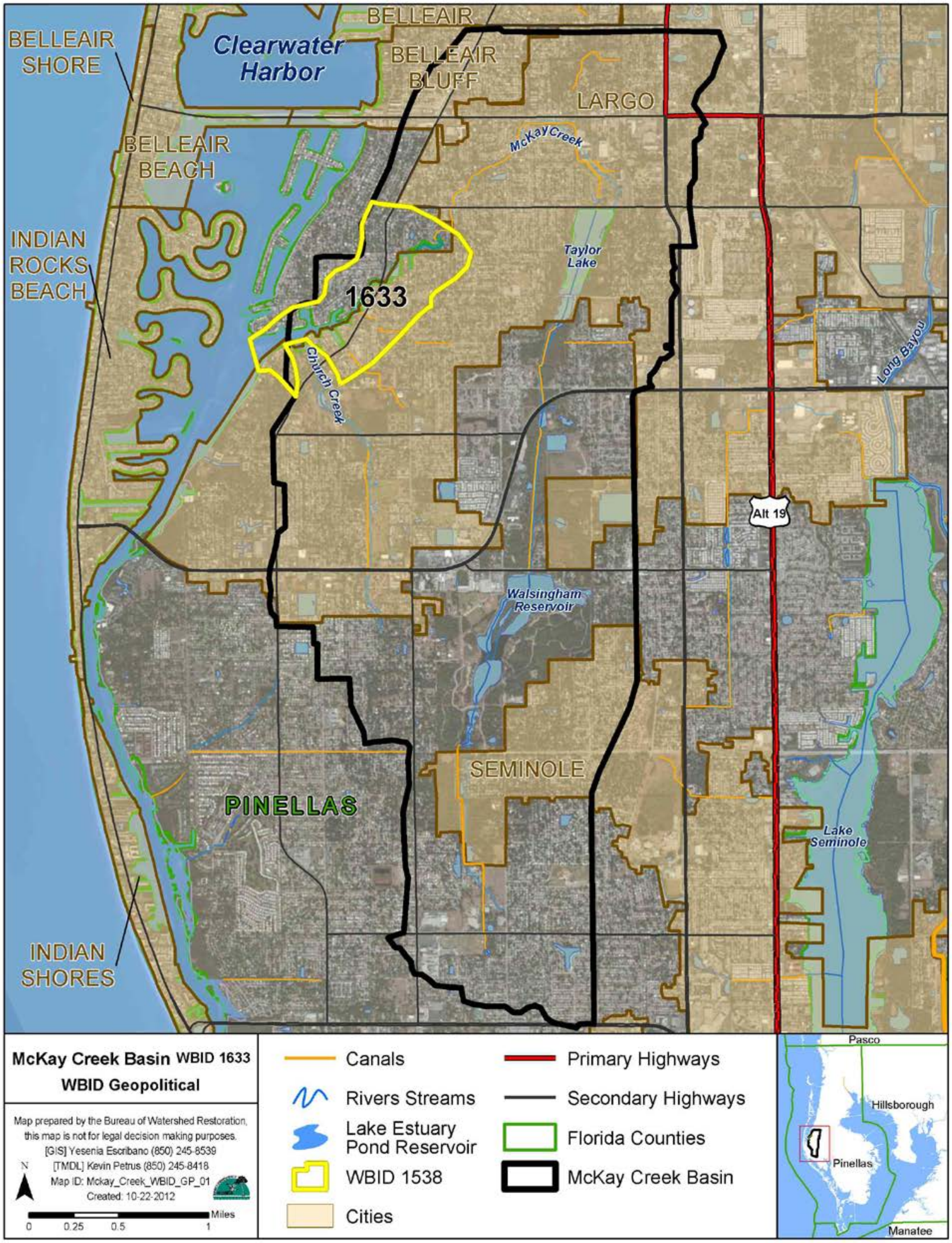

***Figure 1.2.	Location of McKay Creek Tidal Segment, WBID 1633, in the McKay Creek Watershed and Major Geopolitical and Hydrologic Features in the Area***

For assessment purposes, the Florida Department of Environmental Protection has divided the Springs Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. McKay Creek Tidal Segment is WBID 1633. **Figure 1.2** shows the location of the WBID in the McKay Creek watershed. The creek channel within the tidal segment is approximately 1.5 miles long.

McKay Creek Tidal Segment is one of 93 waterbody segments in the Springs Coast Basin, Anclote River/Coastal Pinellas County Unit, and one of 22 waterbody segments in the Springs Coast Basin included on the initial 1998 303(d) list submitted by the Department to the United States Environmental Protection Agency (EPA). The 1998 303(d) list was incorporated into a 1999 Consent Decree between the EPA and EarthJustice.

The initial list used data from stations listed in the Department's 1996 305(b) report. The report used the best available information at the time to generally characterize the quality of Florida's waters. Some of the delineations of waterbody areas and locations of sampling stations for the 1998 303(d) list were inaccurate due to technical limitations at that time. With the primary goal of providing more accurate assessments, the Department has revised these delineations over time. The EPA has labeled the redrawing of WBID boundaries "resegmentation," as the original stations corresponded to specific WBID areas or segments. Resegmented WBIDs are those WBIDs that have been altered from the initial 1998 303(d) Consent Decree or previous cycle boundaries. As a result of the resegmentation process for the Group 5 basins, there are currently 40 Consent Decree waterbody segments in the Springs Coast Basin. This number is based on the results of Impaired Surface Waters Rule (IWR) database Run 44x.

McKay Creek is located in the west-central coastal region of peninsular Florida, in the area identified as the Gulf Coastal Lowlands physiographic region, where soils are poorly drained and the water table is near the land surface. Soils in this region are variable, ranging from excessively drained sands to moderate or poorly drained soils with a sandy subsoil (United States Department of Agriculture [USDA] 2006). As a result of extensive changes of the land surface for development, large portions of this area have soil types characterized as urban land (Southwest Florida Water Management District [SWFWMD] 2002).

Two main aquifers are found in Pinellas County: the surficial aquifer and the Floridan aquifer. The surficial aquifer system consists of undifferentiated sands, shell material, silts, and clayey sands of varying thickness (Causseaux 1985). The principal uses for the surficial aquifer in Pinellas County are irrigation, limited domestic use, and dewatering projects for mining and infrastructure installation (SWFWMD

2006). The Floridan aquifer system consists primarily of highly permeable carbonate rocks and is separated into two principal zones consisting of the fresh potable water of the upper Floridan aquifer and the highly mineralized water of the lower Floridan aquifer (Causseaux 1985). In Pinellas County, the upper Floridan aquifer is the principal source of water and is used for industrial, mining, public supply, domestic use, and irrigation purposes, as well as brackish water desalination in coastal communities (SWFWMD 2006).

An important feature of the area is karst topography. Watersheds located in karst regions are extremely vulnerable to contamination. Many of these karst features infiltrate the water table, forming a direct connection between the land surface and the underlying aquifer systems, allowing interaction between surface and ground waters (SWFWMD 2002) and increasing the threat of ground water contamination from surface water pollutants (Trommer 1987). Potential sources of contamination include saltwater encroachment and the infiltration of contaminants carried in surface water, direct infiltration of contaminants (chemicals or pesticides applied to or spilled on the land, fertilizer carried in surface runoff), landfills, septic tanks, sewage plant treatment ponds, and wells used to dispose of stormwater runoff or industrial waste (Miller 1990).

Additional information about the region's hydrology and geology is available in the Water Quality Status Report for the Springs Coast (Department 2006a).

## 1.3 Background

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

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

This TMDL report will be followed by the development and implementation of a restoration plan to reduce the amount of pollutants that caused the verified impairment of McKay Creek Tidal Segment. These activities will depend heavily on the active participation of the SWFWMD, local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for the impaired waterbody.

# Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

## 2.1 Statutory Requirements and Rulemaking History

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

Florida's 1998 303(d) list included 22 waterbodies in the Springs Coast Basin. However, the FWRA (Chapter 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 Chapter 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 in McKay Creek Tidal Segment and verified the impairment for DO and nutrients (**Table 2.1**) in the Cycle 1 verified period (January 1, 1999–June 30, 2006) that was adopted by Secretarial Order in December 2007. The tidal segment was reassessed in 2011 for the Cycle 2 verified period (January 1, 2004–June 30, 2011). This assessment included water quality results from one additional year, 2010, collected by the Department's Southwest District Office.

The sources of data for the Cycle 1 and Cycle 2 IWR assessments of WBID 1633 came from stations sampled by the Pinellas County Department of Environmental Management (21FLPDEM…) and the Department's Southwest District (21FLTPA…). **Figure 2.1** shows the watershed-wide sampling locations**,** and **Figure 2.2** shows the sampling locations specific to WBID 1633. Sampling was conducted by Pinellas County at Station 21FLPDEMAMB 27-1 between 1999 and 2002. The Department also collected data from the following stations between 2004 and 2010: 21FLTPA 27542338248020, 21FLTPA 27541328249207, and 21FLTPA 275356708249530. The majority of the data from WBID 1633 were collected at South Indian Rocks Rd. at Pinellas County Station 21FLPDEMAMB 27-1 and

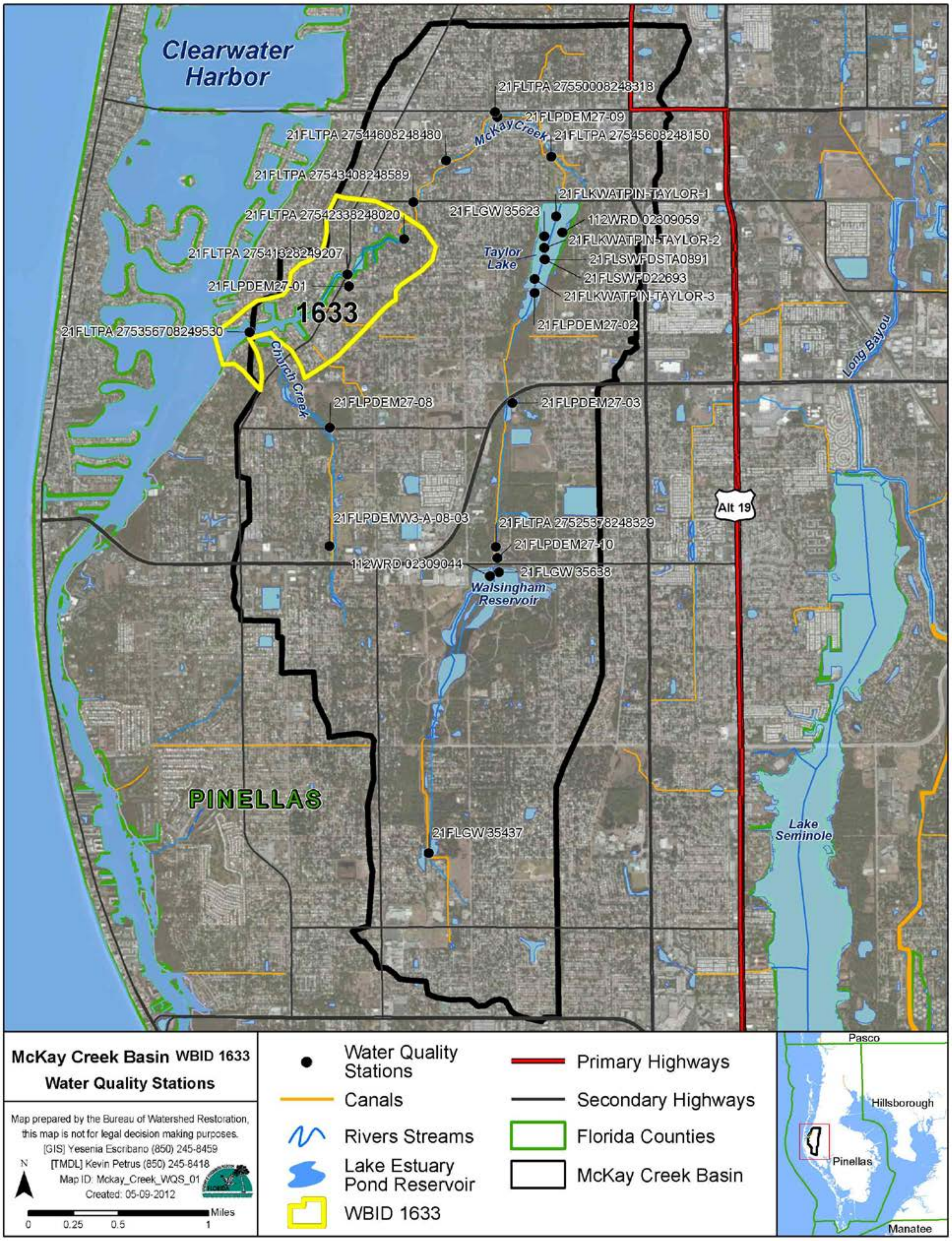

***Figure 2.1. Surface Water Monitoring Locations in the McKay Creek Watershed***

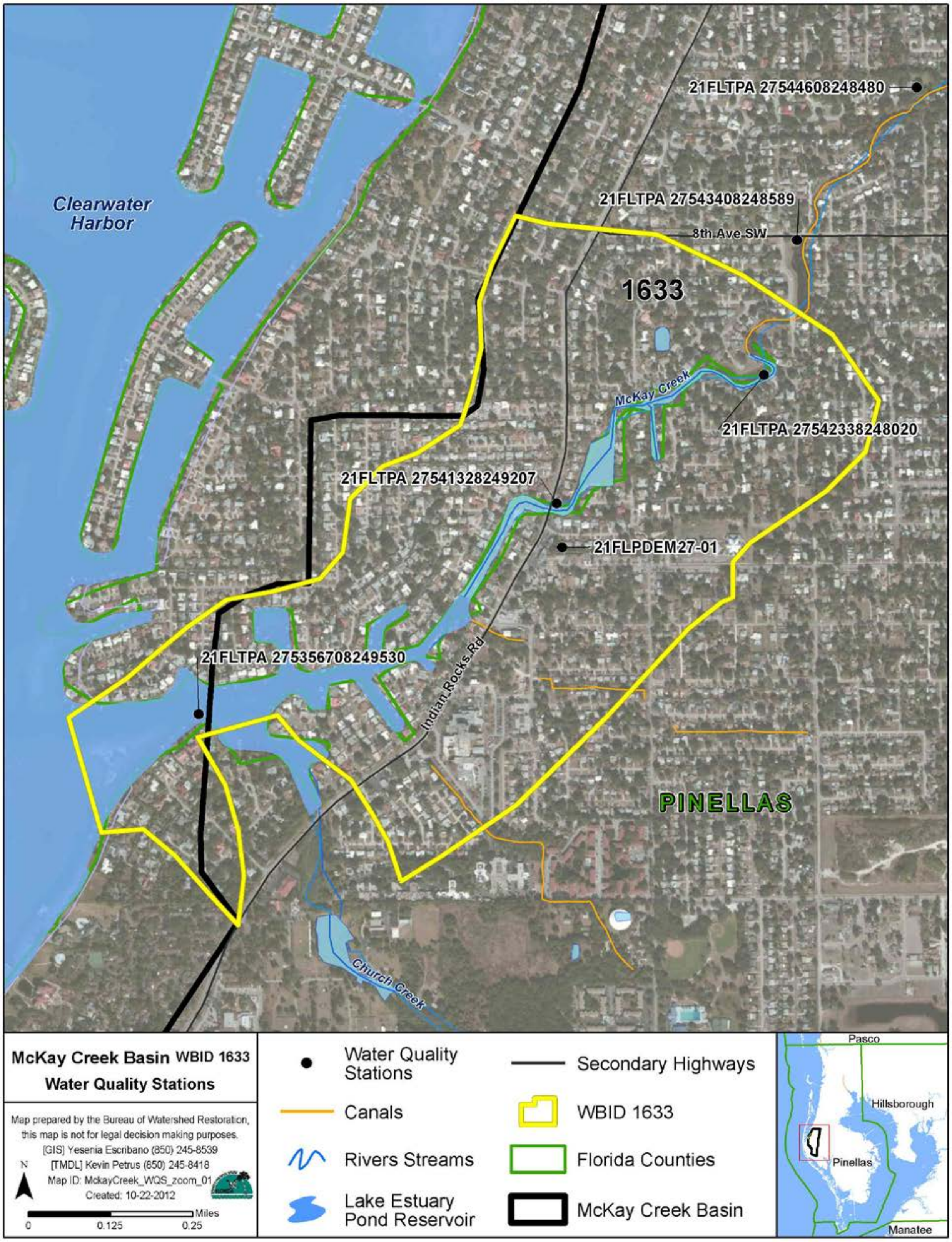

*Figure 2.2. Surface Water Monitoring Locations in McKay Creek Tidal Segment, WBID 1633*

Department Station 21FLTPA 27541328249207. The individual water quality measurements used in this analysis are available in the IWR database (Run 44x) and are available on request.

**Table 2.2** summarizes the DO data collected during the Cycle 1 verified period and Figure 2.3 displays the results. The WBID was verified as impaired for DO because more than 10% of the values were below the Class III marine criterion of 4 milligrams/liter (mg/L) over the course of the verified period. In performing estuarine nutrient evaluations following the IWR methodology, annual average chlorophyll *a* values serve as the primary measurement for assessing nutrient impairment. Chlorophyll *a* is typically used as the primary indicator of nutrient enrichment because its concentrations are a good measure of phytoplankton biomass (the microscopic algae suspended in the water column) that utilize nutrients for growth. The results used to calculate the annual average chlorophyll a values are displayed in Figure 2.4. During the Cycle 1 verified period, the annual average chlorophyll *a* values for McKay Creek Tidal Segment (WBID 1633) were above the estuarine impairment threshold of 11 micrograms per liter (µg/L), in 2000 and 2004. Between 1999 and 2004, annual averages varied between 11 and 17 µg/L (**Table 2.3** and **Figure 2.5**).

Subsequent to the verified impairment listings in Cycle 1, the tidal segment was reassessed for the Cycle 2 verified period (January 1, 2004–June 30, 2011) (**Table 2.2**). This Cycle 2 assessment included water quality results from only one additional year, 2010, that were collected by the Department's Southwest District Office. The results suggest improvements in DO conditions compared with the Cycle 1 verified period. The percent of results below the DO criterion of 4 mg/L is lower in the Cycle 2 verified period: six exceedances out of a total of 43 samples (**Table 2.2**). This exceedance rate suggests that the segment is no longer impaired for DO; however, the exceedance rate is not low enough to delist the segment for DO impairment following the IWR methodology. The annual average chlorophyll *a* value in 2010 was 15 µg/L (**Table 2.3** and **Figure 2.5**).

The graphs in **Appendix B** display water quality results for the period of record for variables relevant to this TMDL analysis.

***Table 2.1. Verified Impairment in McKay Creek Tidal Segment, WBID 1633, During Cycle 1***

| Parameter Causing Impairment | Priority for TMDL Development | Projected Year For TMDL Development |
|---|---|---|
| DO | Low | 2011 |
| Nutrients | Low | 2011 |

***Table 2.2. Summary of DO Data for McKay Creek Tidal Segment, WBID 1633, During the Cycle 1 and Cycle 2 Verified Periods***

| Verified Period | Number of Samples | Minimum (mg/L) | Mean (mg/L) | Median (mg/L) | Maximum (mg/L) | Number of Exceedances |
|---|---|---|---|---|---|---|
| Cycle 1 | 147 | 0.5 | 3.7 | 3.6 | 9.2 | 84 |
| Cycle 2 | 43 | 2.3 | 5.7 | 5.5 | 9.2 | 6 |

***Table 2.3. Summary of Chlorophyll a Data for McKay Creek Tidal Segment, WBID 1633, During the Cycle 1 and Cycle 2 Verified Periods***

| Year | Annual Mean Chlorophyll *a* (µg/L) |
|---|---|
| 1999 | 11 |
| 2000 | 13 |
| 2001 | 11 |
| 2002 | 11 |
| 2004 | 17 |
| 2010 | 15 |

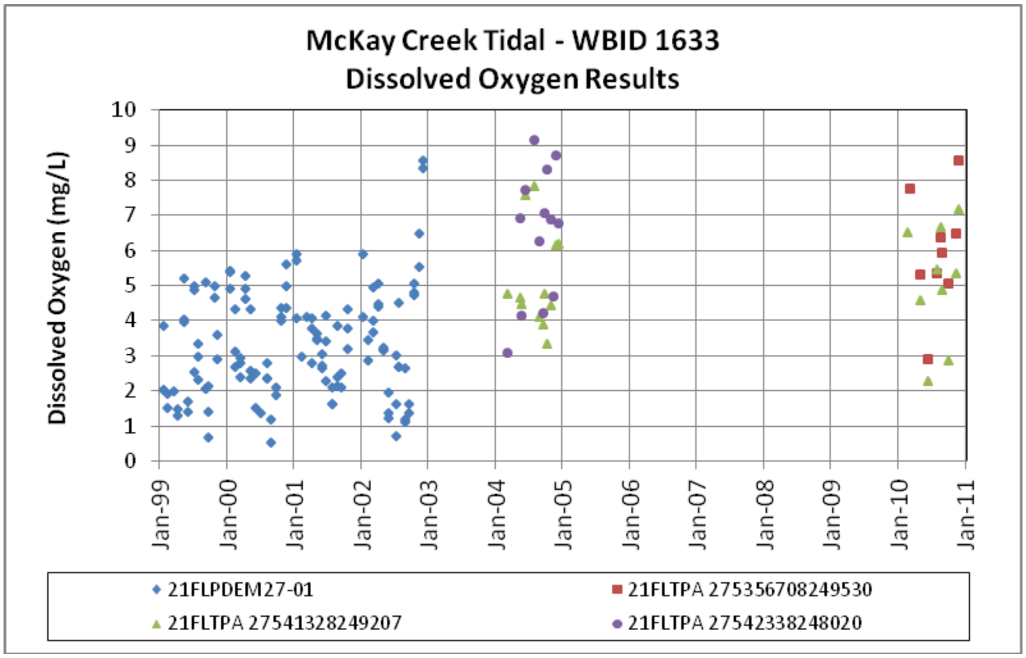

***Figure 2.3. DO Measurements in McKay Creek Tidal Segment, WBID 1633, During the Cycle 1 and Cycle 2 Verified Periods***

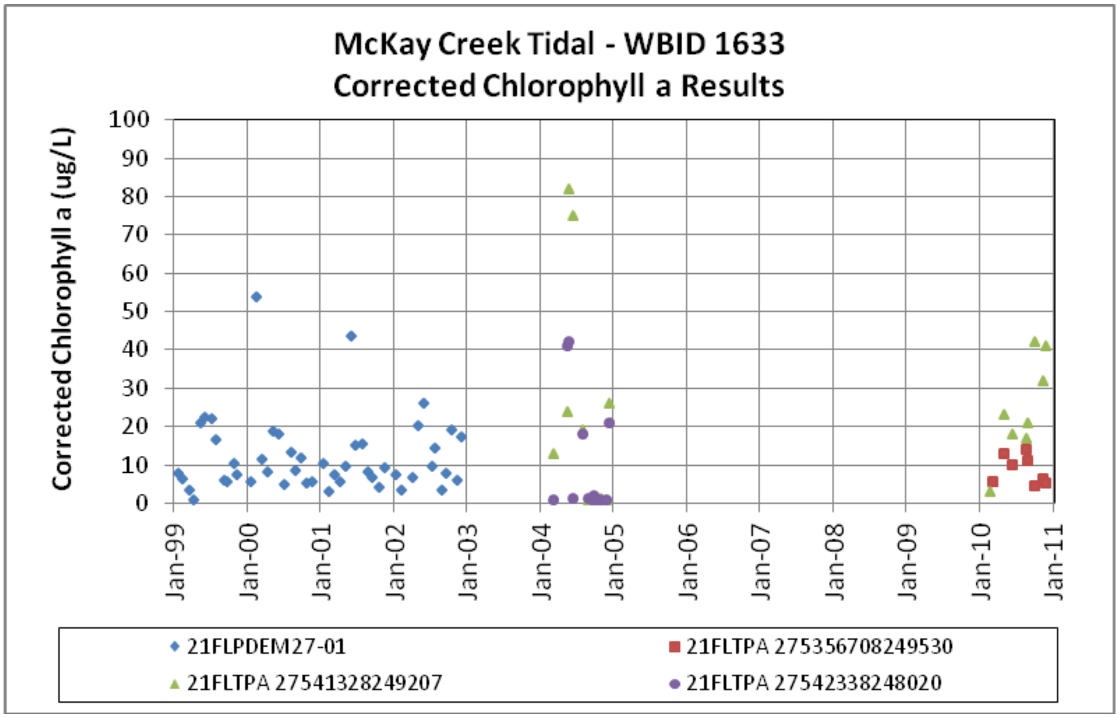

***Figure 2.4. Chlorophyll a Measurements in McKay Creek Tidal Segment, WBID 1633, During the Cycle 1 and Cycle 2 Verified Periods***

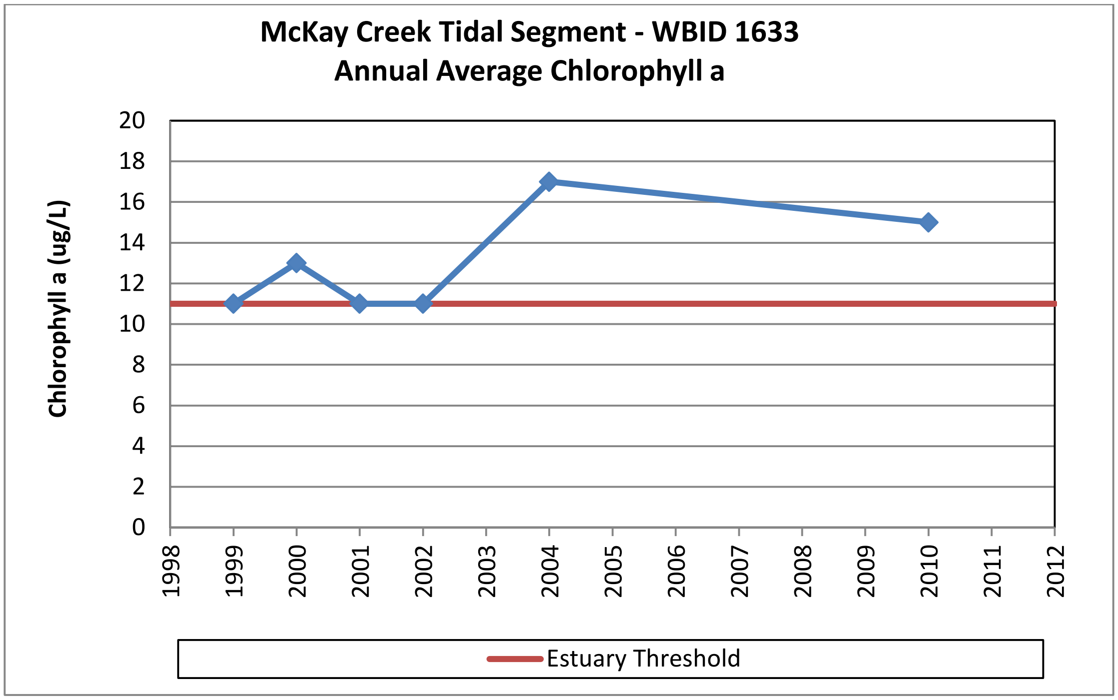

***Figure 2.5. Chlorophyll a Annual Averages in McKay Creek Tidal Segment, WBID 1633, During the Cycle 1 and Cycle 2 Verified Periods***

As part of the verified listing process, the Department attempts to identify the limiting nutrient or nutrients for the impaired waterbody. The limiting nutrient, generally nitrogen or phosphorus, is defined as the nutrient that limits plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll *a*, and macrophytes to grow. Once the limiting nutrient in a waterbody is exhausted, algae stop growing. If more of the limiting nutrient is added, larger algal populations will result until nutrients or other environmental factors again limit their growth.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients, and nitrogen is typically the limiting nutrient in most Florida estuaries. There is a general understanding in the marine scientific community that nitrogen is the principal cause of nutrient overenrichment in coastal systems (National Research Council 1993 and 2000), and an analysis of the data from McKay Creek Tidal Segment supports this conclusion.

Determining the limiting nutrient in a waterbody can be accomplished by calculating the ratio of nitrogen to phosphorus in the waterbody, with water column ratios of total nitrogen (TN) to total phosphorus (TP) of less than 10 indicating that nitrogen is limiting. The median TN to TP ratio is 6.0 (computed from 86 paired values reported in the Cycle 1 and Cycle 2 verified periods), indicating that nitrogen is the limiting nutrient in McKay Creek Tidal Segment.

As nitrogen is the limiting nutrient, decreased levels of TN would be expected to result in decreases in algal growth, as measured by chlorophyll *a* concentrations. Reductions in TN are also expected to result in additional benefits, including increases in DO and decreases in biochemical oxygen demand (BOD). BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions (Sawyer and McCarty 1967). Reductions in nutrients will result in lower algal biomass levels in the water column, and lower algal biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids (TSS), and reduced BOD.

# Chapter 3: DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS

## 3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

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

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

The tidal portion of McKay Creek is a Class III estuarine waterbody, with designated uses of recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the impairment addressed by these TMDLs are for DO and the narrative nutrient criterion.

## 3.2 Applicable Water Quality Standards and Numeric Water Quality Target

### *3.2.1 DO Criterion*

The Class III marine criterion for DO, as established by Subsection 62-302.530(30), F.A.C., states that DO shall not average less than 5.0 mg/L in a 24-hour period, and shall not be less than 4 mg/L, and that normal daily and seasonal fluctuations above these levels shall be maintained.

### *3.2.2 Interpretation of Narrative Nutrient Criterion*

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 is needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for estuaries based on annual average chlorophyll *a* levels, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. In fact, in recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Rule 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

In translating the narrative nutrient criterion for this TMDL analysis, the Department selected estuarine segments not considered impaired for nutrients to identify a target chlorophyll *a* concentration for establishing the TMDL. **Table 3.1** summarizes results for the estuarine segments where the average chlorophyll *a* concentrations are less than the 11 µg/L impairment threshold for estuaries. These waters include both open-water estuarine segments and tidal stream segments in the area of McKay Creek that are located in the Anclote River/Coastal Pinellas County Planning Unit. Given the uncertainty of nutrient reactions within estuaries, the Department applied a chlorophyll *a* target of 8.0 µg/L for establishing the TMDL, a level that falls within the range of long-term average chlorophyll *a* concentrations in the estuarine waters not listed as impaired for nutrients. Using this target value for establishing the TMDL is expected to result in annual average chlorophyll *a* values below the estuarine impairment threshold of 11 µg/L. This approach minimizes the potential for listing the water as impaired in the future.

### *Table 3.1. Summary of Chlorophyll a Results for Estuarine Segments Used To Establish the Chlorophyll a Target*

= Empty cell/no data

**Note:** Annual average chlorophyll *a* values during the 1999 to 2010 period as contained in IWR Database Run 44x.

| Year | Clearwater Harbor (WBID 1528) | The Narrows (WBID 1528A) | Clearwater Harbor North (WBID 1528C) | Boca Ciega Bay Central (WBID 1694A) | Boca Ciega Bay North (WBID 1694B) | St. Joseph Sound (WBID 8045D) | Direct Runoff to Gulf (Minnow Creek) (WBID 1535) | Anclote River Tidal Segment (WBID 1440) |
|---|---|---|---|---|---|---|---|---|
| 1999 | 8 | 8 | 7 | 6 | 7 | 6 | 5 | 5 |
| 2000 | 7 | 7 | 6 | 7 | 6 | 7 | 4 | 5 |
| 2001 | 7 | 7 | 5 | 7 | 6 | 5 | 5 | 5 |
| 2002 | 8 | 7 | 6 | 6 | 6 | - | - | 5 |
| 2003 | 9 | 8 | 5 | 7 | 7 | 3 | - | 4 |
| 2004 | 5 | 9 | 6 | 6 | 8 | 3 | - | 4 |
| 2005 | 7 | 7 | 5 | 8 | 8 | 3 | - | 4 |
| 2006 | 4 | 7 | 3 | 5 | 5 | 2 | - | 6 |
| 2007 | 4 | 7 | 3 | 6 | 5 | 2 | - | 5 |
| 2008 | 5 | 6 | 3 | 7 | 6 | 2 | - | 6 |
| 2009 | 6 | 10 | 4 | 8 | 6 | 3 | - | 4 |
| 2010 | 5 | 7 | 3 | 6 | 7 | 4 | 8 | 8 |
| **Long-Term Average** | **6** | **8** | **5** | **7** | **6** | **4** | **6** | **5** |

# 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 pollutants 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 discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

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

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

## 4.2 Point Sources

### *4.2.1 NPDES Permitted Wastewater Facilities*

There are no NPDES-permitted facilities with discharges to the surface waters of McKay Creek Tidal Segment or upstream areas of the watershed.

### *4.2.2 Municipal Separate Storm Sewer System Permittees*

Municipal separate storm sewer systems (MS4s) may also discharge pollutants to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase 1, promulgated in 1990, addresses large and medium-size MS4s located in incorporated areas and counties with populations of 100,000 or more. Phase 2 permitting began in 2003. Regulated Phase 2 MS4s are defined in Rule 62-624.800, F.A.C., and typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharging into Class I or Class II waters, or into Outstanding Florida Waters (OFWs).

There is one MS4 permit that covers the McKay Creek watershed. Pinellas County, in conjunction with the Florida Department of Transportation (FDOT) District 7, is covered by a Phase 1 MS4 permit (FLS000005). The cities of Largo, Belleair Bluffs, and Seminole, which have land areas in the McKay Creek watershed, are co-permittees in the MS4 permit.

## 4.3 Land Uses and Nonpoint Sources

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Because the McKay Creek watershed is primarily urban, agricultural fertilizing or nutrients from wildlife and agricultural livestock wastes are not expected to contribute significantly to the TN load.

### *4.3.1. Land Uses*

The spatial distribution and acreage of different land use categories were identified using the SWFWMD 2009 land use coverage contained in the Department's Geographic Information System (GIS) library.

Land use categories in the McKay Creek watershed were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low-, medium-, and high-density residential) and tabulated in **Table 4.1**. **Figure 4.1** shows the spatial distribution of the principal land uses in the watershed. Land use is predominately urban and residential, with approximately 65% of the land area developed as residential. The next largest land use is surface waters and wetlands, which combined represent over 6% of the area. Within WBID 1633, land use comprises primarily high-density residential areas and urban open area.

### *Table 4.1. Classification of Land Use Categories in the McKay Creek Watershed in 2009*

- = Empty cell/no data

| Level 1 Code | Land Use | Acreage | % of Total |
|---|---|---|---|
| 1000 | Urban Open | 1,425 | 25.2% |
| 1100 | Low-Density Residential | 86 | 1.5% |
| 1200 | Medium-Density Residential | 239 | 4.2% |
| 1300 | High-Density Residential | 3,361 | 59.5% |
| 2000 | Agriculture | 27 | 0.5% |
| 3000+4000 | Rangeland + Forest/Rural Open | 54 | 1.0% |
| 5000 | Water | 261 | 4.6% |
| 6000 | Wetlands | 98 | 1.7% |
| 7000 | Barren Land | 0 | 0.0% |
| 8000 | Communication and Transportation | 101 | 1.8% |
| **Total** | **-** | **5,652** | **100.0%** |

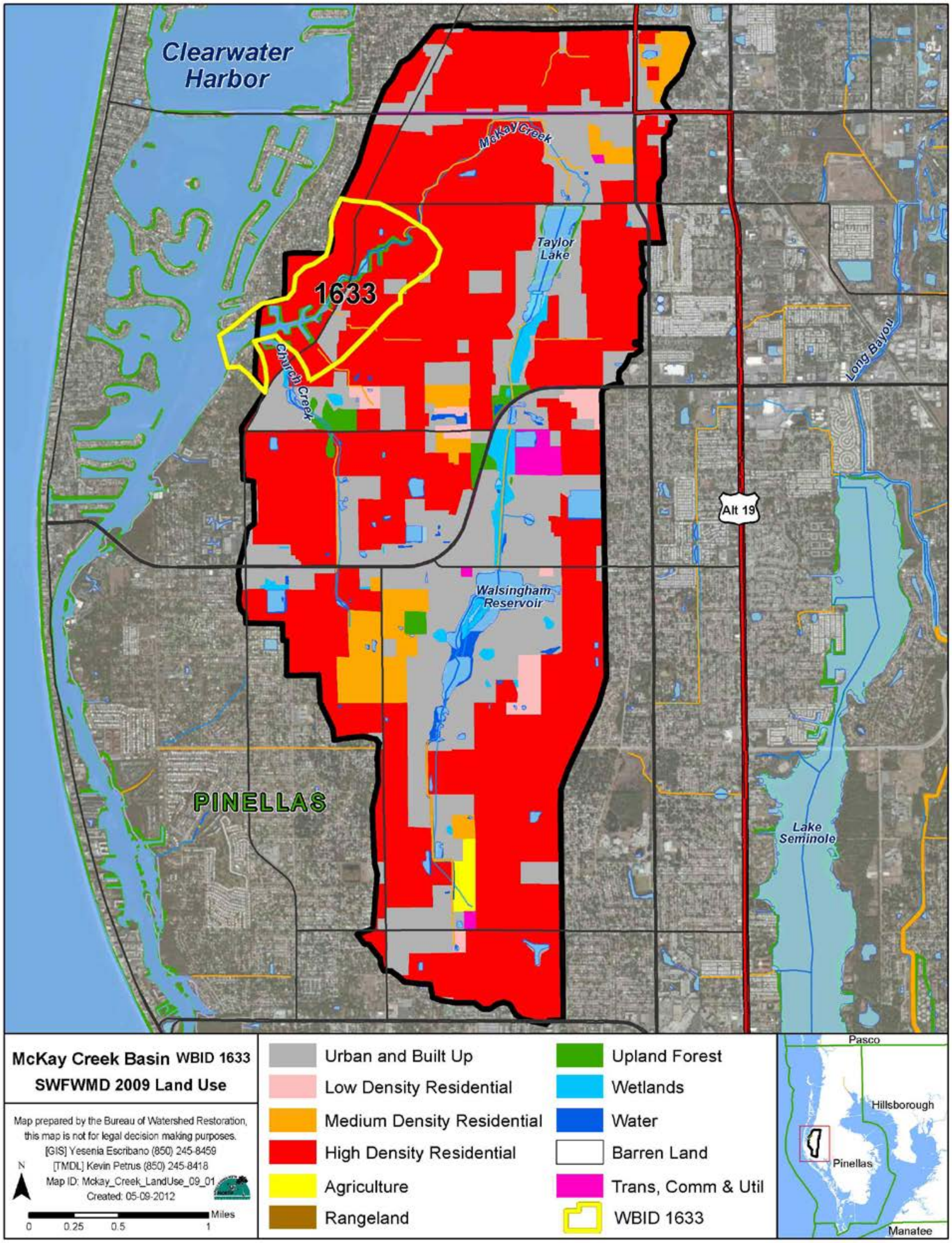

***Figure 4.1. Principal Land Uses in the McKay Creek Watershed in 2009***

### 4.3.2 Septic Tanks

Septic tanks are another potentially important source of pollution, including nitrogen. Information on the location of septic systems was obtained from the Florida Department of Health (FDOH) Onsite Sewage Treatment Disposal Systems GIS coverage (available: http://www.floridahealth.gov/healthy-environments/onsite-sewage/ostds-statistics.html).

**Figure 4.2** shows the locations of septic tanks in the McKay Creek watershed. Currently, the number of septic tanks is estimated to be 31. There are no septic tanks located in McKay Creek Tidal Segment, WBID 1633.

## 4.4 Watershed Loading Estimates

Loadings of nutrients and BOD were developed using the Loading Simulation Program in C++ (LSPC) model. The model simulated watershed flows and water quality constituent concentrations that were used to drive the receiving water hydrodynamic and water quality models that were in turn used to develop the TMDLs. Section 5.2 describes the model development and calibration. Table 4.2 presents the simulated annual watershed loadings of TN, TP, and 5-day BOD (BOD5) delivered to McKay Creek Tidal Segment.

***Table 4.2. Annual Average Watershed Loads to McKay Creek Tidal Segment, 2002–11***

| Year | TN Load (lbs/yr) | TP Load (lbs/yr) | $BOD_5$ Load (lbs/yr) |
|---|---|---|---|
| 2002 | 32,544 | 3,354 | 75,384 |
| 2003 | 17,558 | 1,914 | 34,185 |
| 2004 | 42,878 | 4,577 | 91,573 |
| 2005 | 23,246 | 2,187 | 42,826 |
| 2006 | 19,197 | 2,104 | 46,897 |
| 2007 | 16,268 | 1,889 | 35,098 |
| 2008 | 27,650 | 2,820 | 54,269 |
| 2009 | 36,935 | 4,084 | 77,086 |
| 2010 | 32,834 | 3,145 | 66,447 |
| 2011 | 33,846 | 3,154 | 67,242 |
| **Average** | **28,296** | **2,923** | **59,101** |

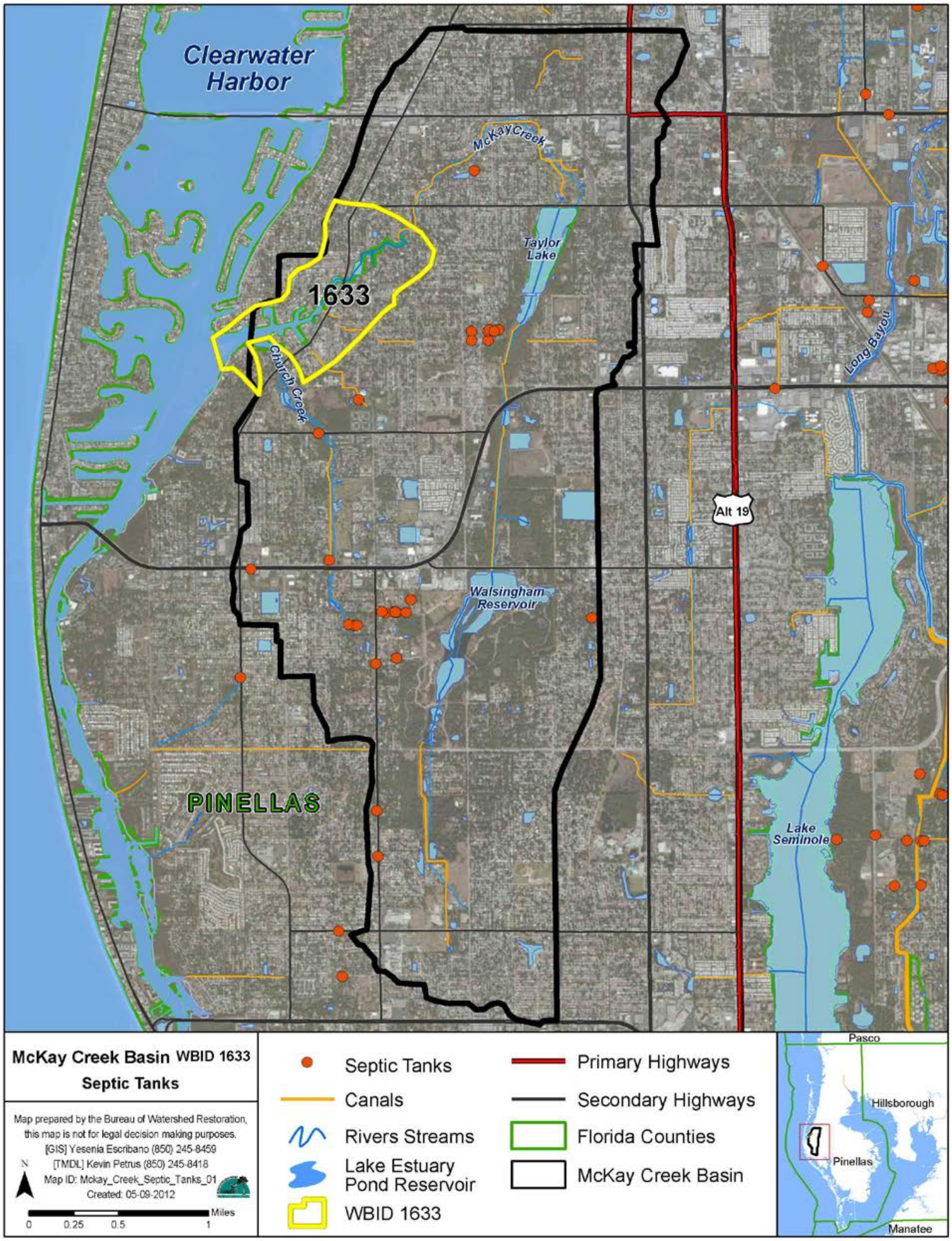

***Figure 4.2. Septic Tank Locations in the McKay Creek Watershed***

# Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

## 5.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication tend to be 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 upon 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) or mechanistic (physically and/or stochastically based) that inherently relate cause and effect using physical and biological relationships.

To determine the loading capacity of McKay Creek, three mechanistic models were developed: one watershed and two estuary models. These models were used in the development of the TMDL to relate the physical and biological relationships. To develop the McKay Creek models, data inputs and calibration parameters from larger models developed for use in Florida numeric nutrient criteria development were used. The McKay Creek Watershed model utilized information from the Crystal Watershed model, and the McKay Creek Estuary models utilized information from the Big Bend Environmental Fluid Dynamics Code (EFDC) Hydrodynamic model. The modeling assumptions for the Crystal Watershed model are provided in the Crystal Watershed Modeling Report (**Appendix E**). The modeling assumptions for the Big Bend Hydrodynamic model are provided in the Hydrodynamic Modeling Report for the Big Bend Estuary Systems (**Appendix F**).

The models have the capability of simulating various species of nitrogen and phosphorus, chlorophyll *a*, 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 has the ability to simulate direct point sources to the stream. The watershed model was linked to a hydrodynamic model that simulated tidal influences in the impaired waters, *i.e.,* EFDC. Both models were linked to a water quality simulation model, the Water Quality Analysis Simulation Program Version 7.4.1 (WASP7), that integrated the loadings and flow from the watershed model with flow from the hydrodynamic model to predict water quality in the receiving waterbodies (**Figure 5.1**).

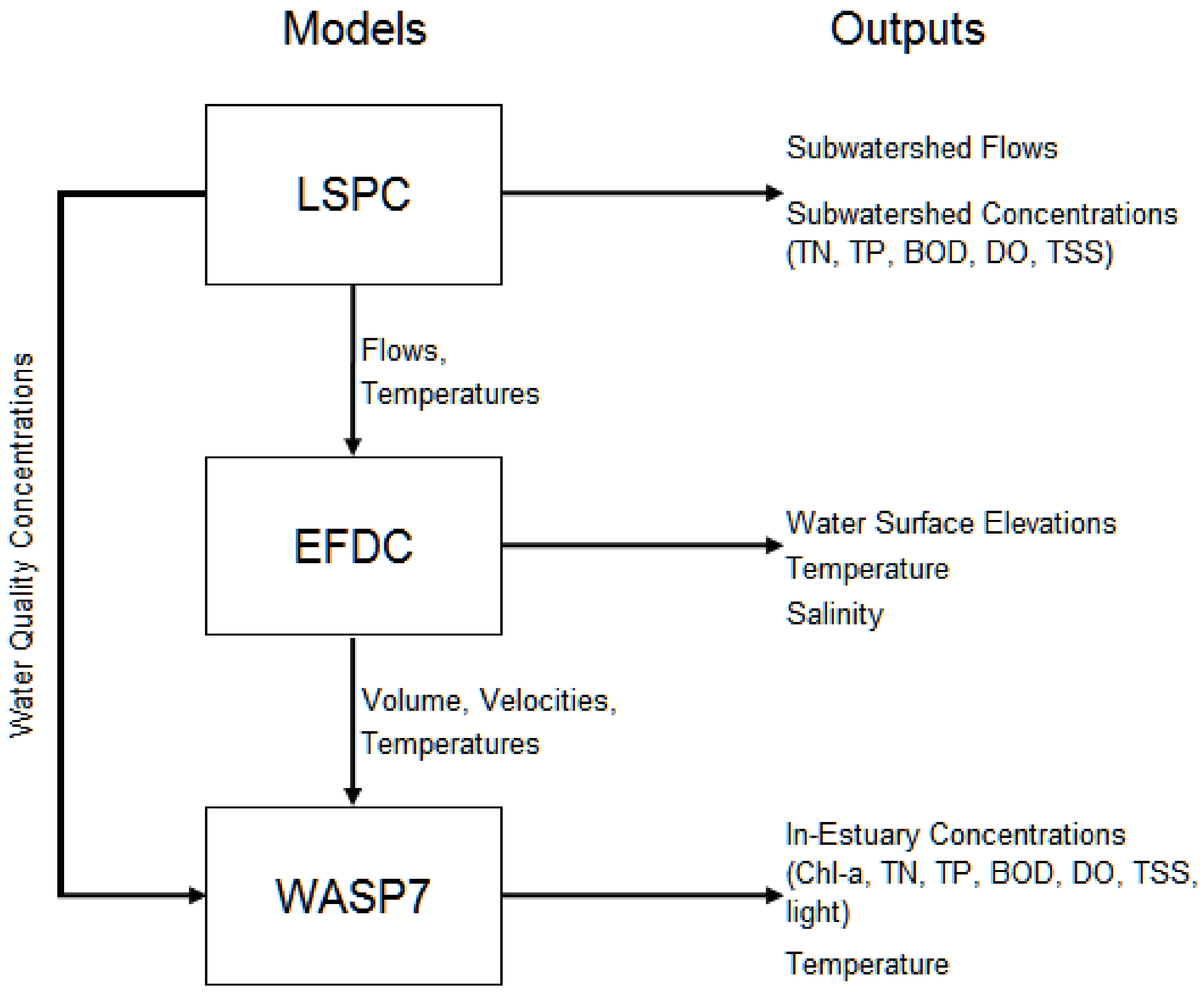

***Figure 5.1. Model Framework for LSPC, EFDC, and WASP***

## 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 EPA Region 3 (under contract with Tetra Tech, Inc.) and has been widely used for TMDLs. In 2003, EPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the EPA TMDL Modeling Toolbox. It was used to simulate runoff (flow, BOD, TN, TP, and DO) from the land surface using a daily time step for current and natural conditions. LSPC provided tributary flows and temperature to the EFDC estuary models and tributary water quality concentrations to the 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. The model 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. It simulates 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 to many EPA Region 4 projects in support of TMDLs and has been well tested (Wool *et al.* 2003).

**WASP**

WASP Version 7.4.1 is an enhanced Windows version of EPA 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. WASP7 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.

## 5.3 Model Development

### *5.3.1 LSPC Model Development*

An LSPC model was utilized to estimate the nutrient loads within and discharged from the McKay Creek watershed. The model utilized the data inputs, including land use and weather data, from the larger Crystal Watershed model (**Appendix E**).

To evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of subwatersheds for each of the models. The subwatersheds for the Crystal Watershed model were developed using the 12-digit hydrologic unit code (HUC12) watershed data layer and the United States Geological Survey (USGS) National Hydrography Dataset (NHD). The subwatersheds were redelineated at a smaller scale for the McKay Creek watershed model, which used the Pinellas County subwatershed delineations (**Figure 5.2**). Church Creek was included in the delineation because it drains into the estuary.

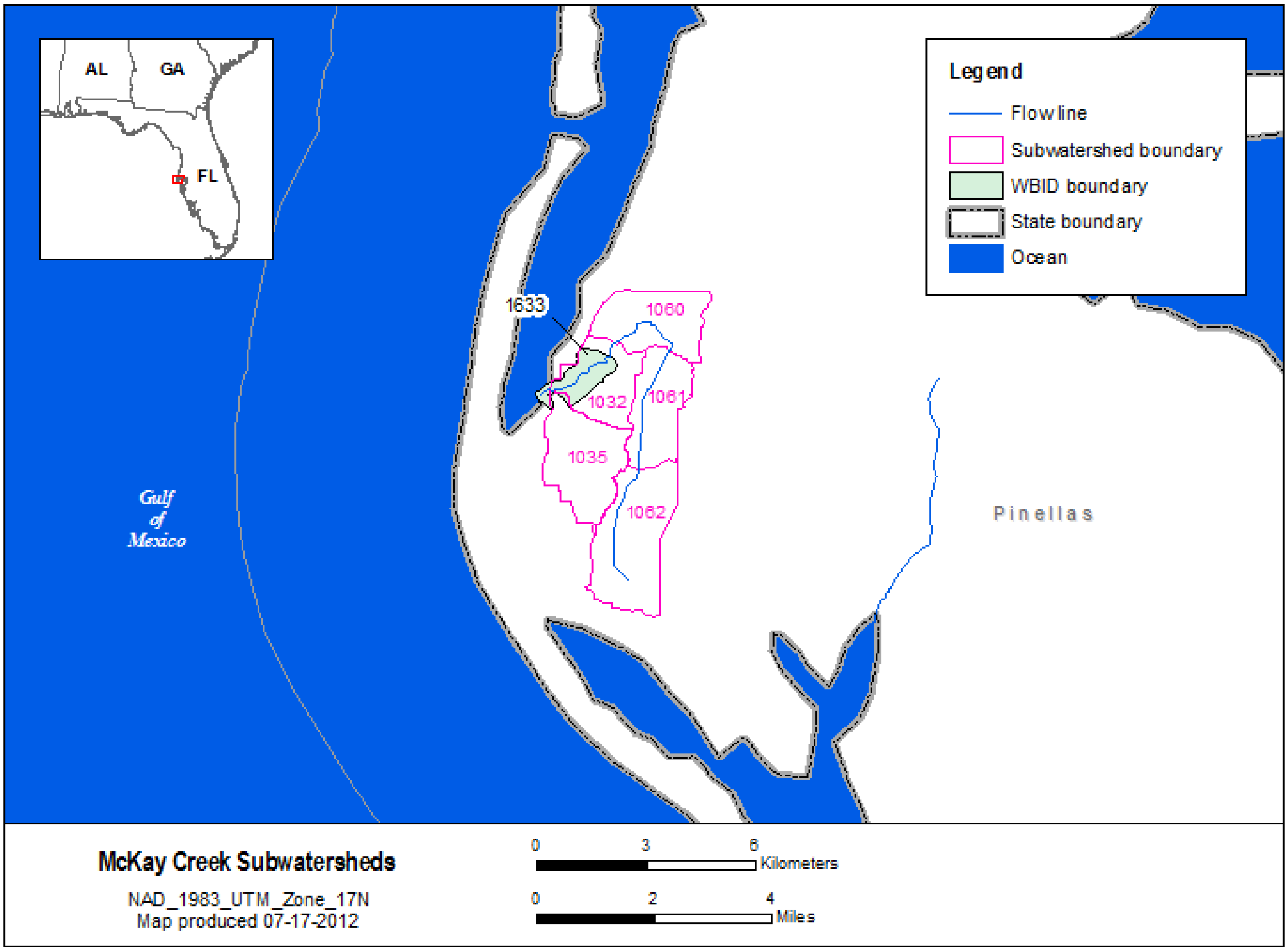

*Figure 5.2. Location of McKay Creek LSPC Subwatersheds*

The LSPC model has a representative reach defined for each subwatershed, and the main channel stem within each subwatershed was used as the representative reach. The characteristics for each reach include the length and slope of the reach, the channel geometry, and the connectivity between subwatersheds. Length and slope data for each reach were obtained using the USGS Digital Elevation Model (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 flow reverses direction or where one reach influences another upstream of it in a time-dependent way. LSPC does not model the tidal flow in the low-lying estuaries, and therefore the main Crystal Watershed model was calibrated to nontidally influenced USGS gages. The McKay

Creek Watershed model was 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 SWFWMD 2004 dataset, was used to determine the land use representation. The National Landuse Coverage Dataset (NLCD) was used to develop the impervious land use representations.

The SWFWMD coverage utilized a variety of land use classes that 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 together and placed into a new land use category named *low intensity development impervious*. Impervious areas associated with medium-intensity development and high-intensity development were kept separate and placed into two new categories: *medium intensity development impervious* and *high intensity development impervious*, respectively. Finally, any impervious areas not already accounted for in the three developed impervious categories were grouped together into a fourth new category for all remaining impervious land use.

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

In the watershed models, nonpoint source loadings and hydrological conditions depend on weather conditions. Hourly data from weather stations within the boundaries of, or close to, the subwatersheds were applied to the watershed model. A weather data–forcing file was generated in ASCII format (*.air) for each meteorological station used in the hydrological evaluations in LSPC. Each meteorological station file contained atmospheric data used in modeling the hydrological processes. These data included precipitation, air temperature, dewpoint temperature, wind speed, cloud cover, evaporation, and solar radiation. These data were used directly, or calculated from the observed data. The Crystal Watershed model weather stations only contained data through 2009. These stations were appended with data through 2011, and the LSPC model was evaluated through 2011.

The hydrodynamic calibration parameters from the larger Crystal Watershed model were used to populate the McKay Creek Watershed model. The Crystal Watershed model was calibrated to continuous flow USGS gages. No continuous measured flow data were available in the McKay Creek watershed, but several instantaneous measurements were taken in the freshwater portion of McKay Creek (**Figures 5.3** and **5.4**). Modeled discharge is also shown at the outlet of Subwatershed 1060 (**Figure 5.5**). Additionally, the water quality parameters from the larger Crystal Watershed model were used to populate the McKay Creek Watershed model. The Crystal Watershed model was calibrated to several water quality stations whose data were taken from IWR Run 38. The McKay Creek watershed was calibrated to water quality data from IWR Run 44, specifically to Stations 21FLPDEM27-10 and 21FLDEPM27-09, which both contained large data records for all parameters of interest. **Figures 5.6** through **5.15** present the LSPC water quality calibration results.

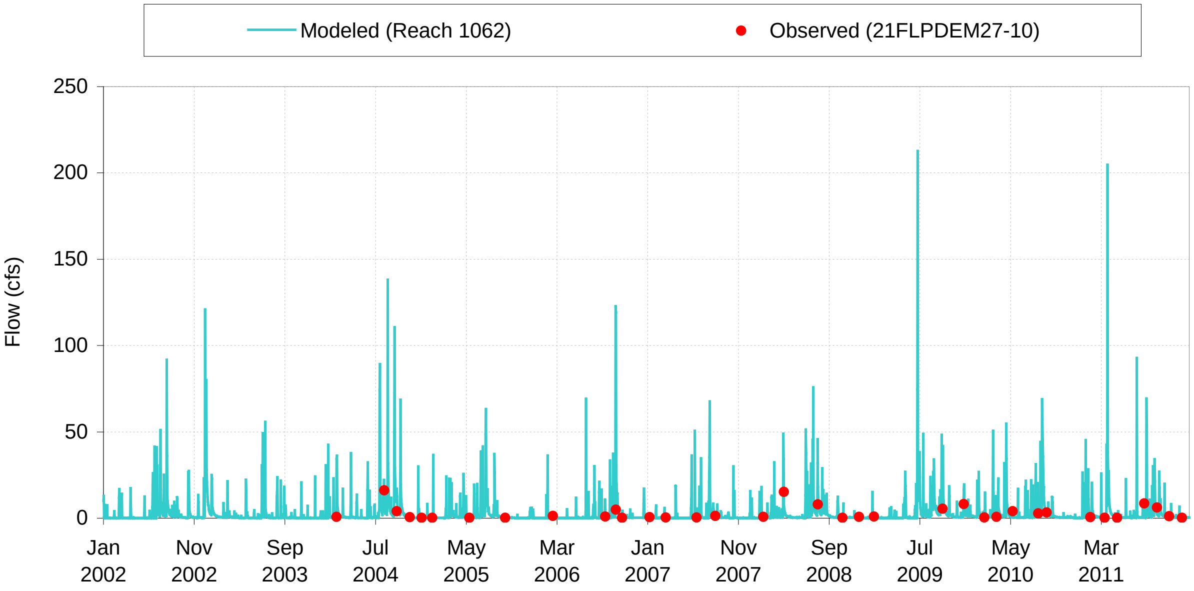

***Figure 5.3. Modeled vs. Observed Flow (cubic feet per second [cfs]) at 21FLPDEM27-10***

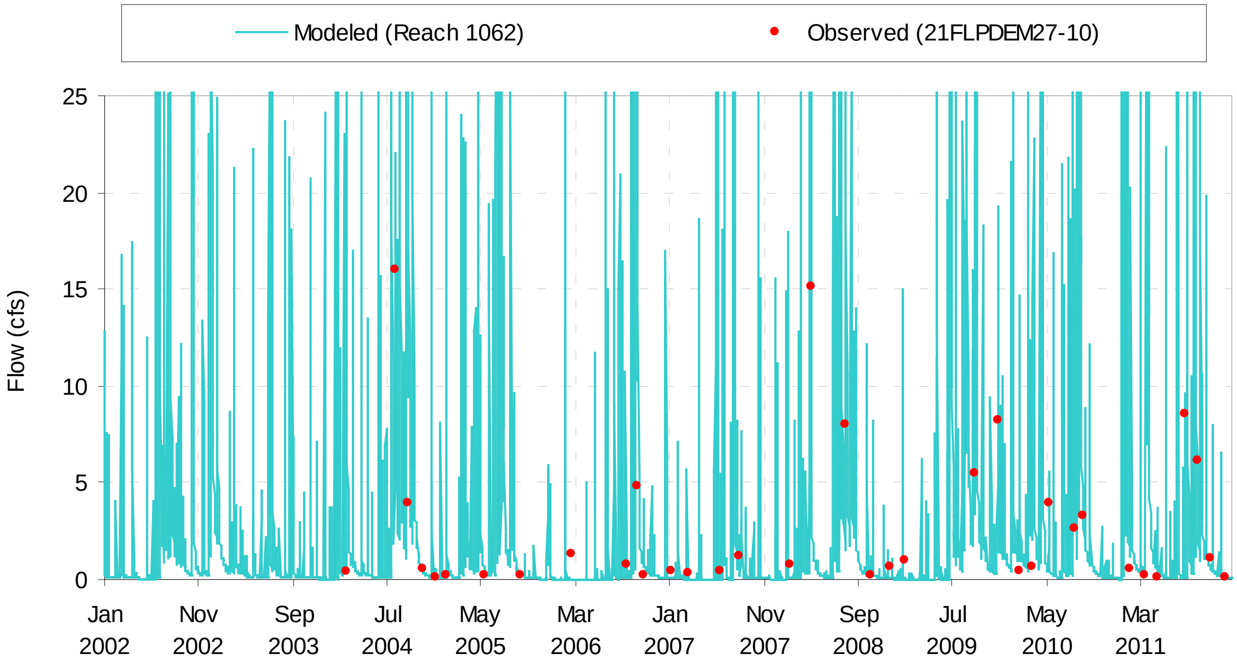

***Figure 5.4. Modeled vs. Observed Flow (cfs) at 21FLPDEM27-10***

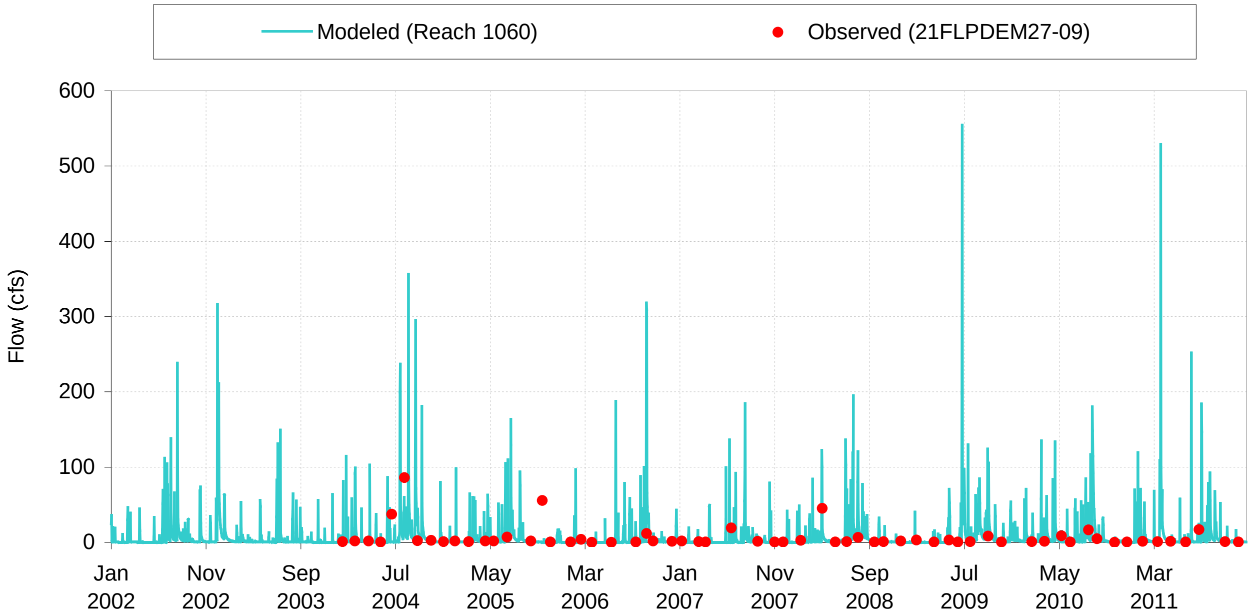

***Figure 5.5. Modeled vs. Observed Flow (cfs) at 21FLPDEM27-09***

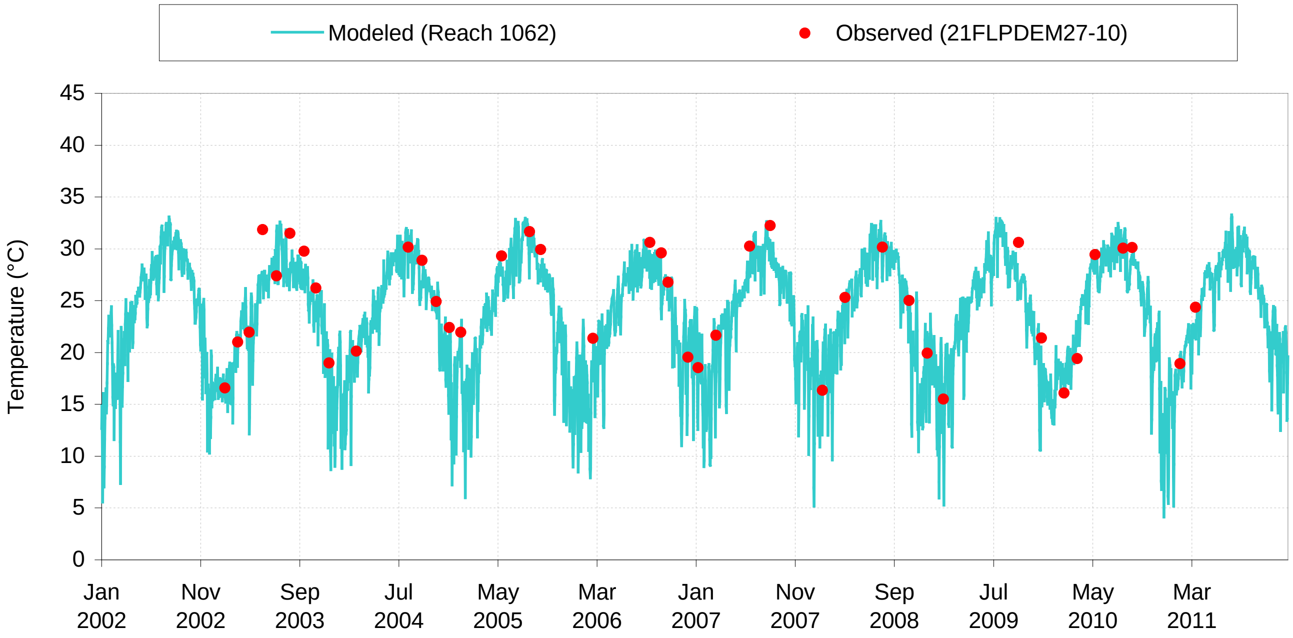

*Figure 5.6. Modeled vs. Observed Temperature (°C) at 21FLPDEM27-10*

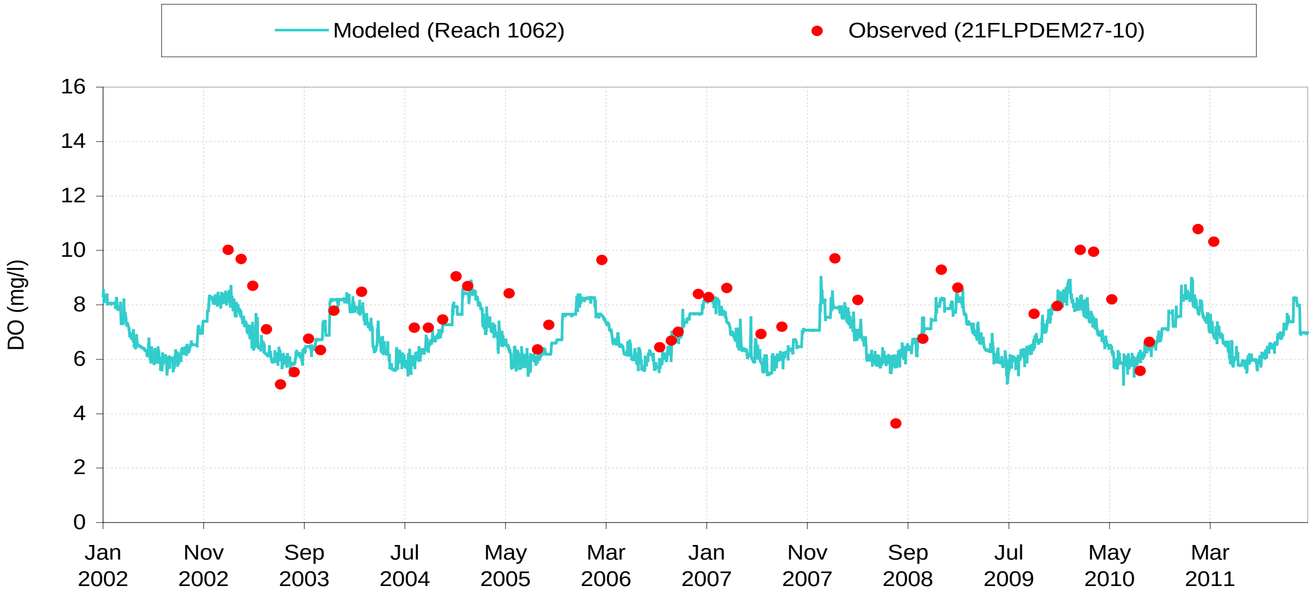

*Figure 5.7. Modeled vs. Observed DO (mg/L) at 21FLPDEM27-10*

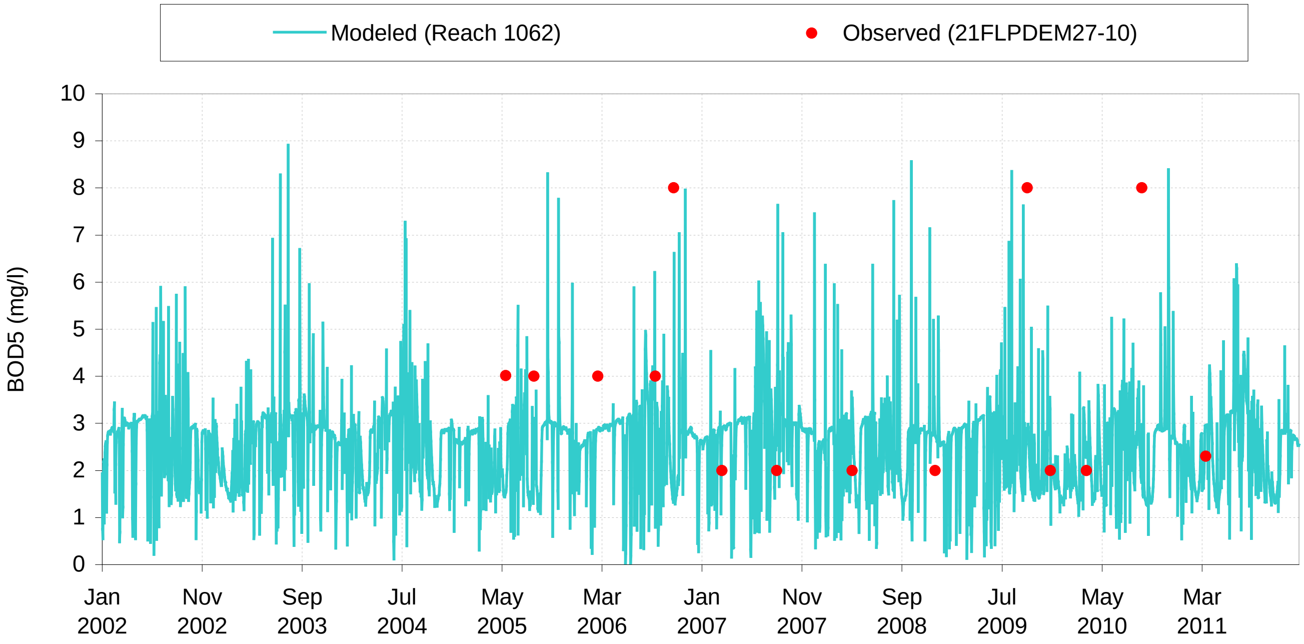

*Figure 5.8.* ***Modeled vs. Observed $BOD_5$ (mg/L) at 21FLPDEM27-10***

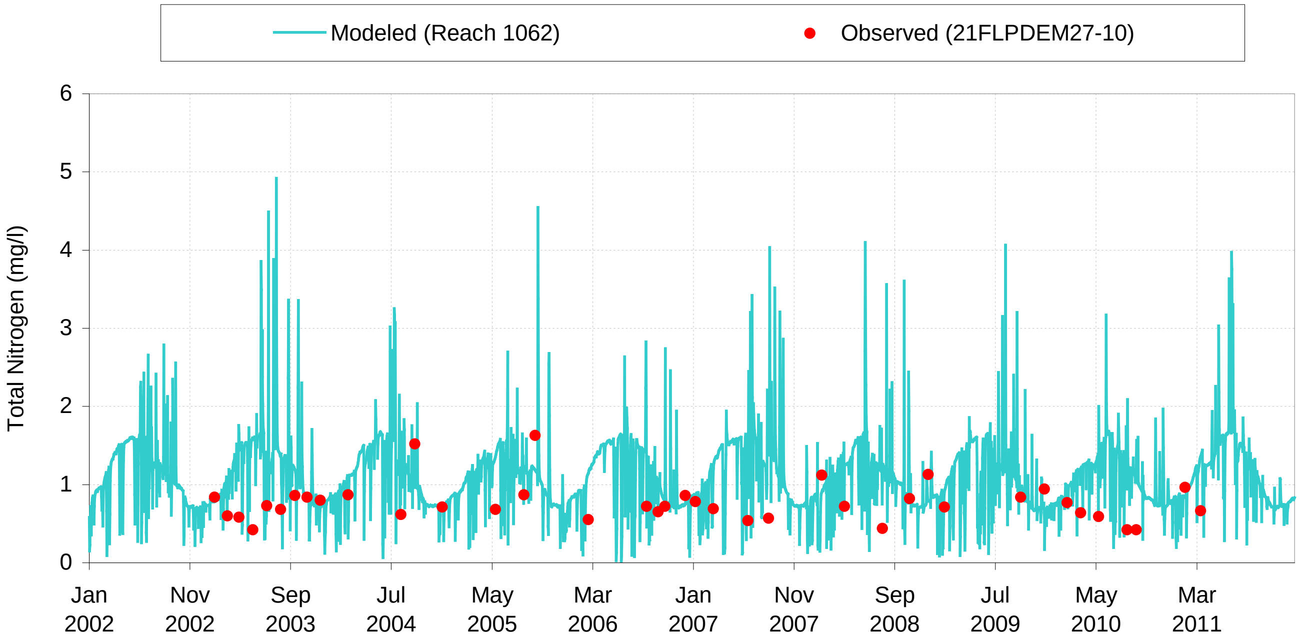

***Figure 5.9.*** ***Modeled vs. Observed TN (mg/L) at 21FLPDEM27-10***

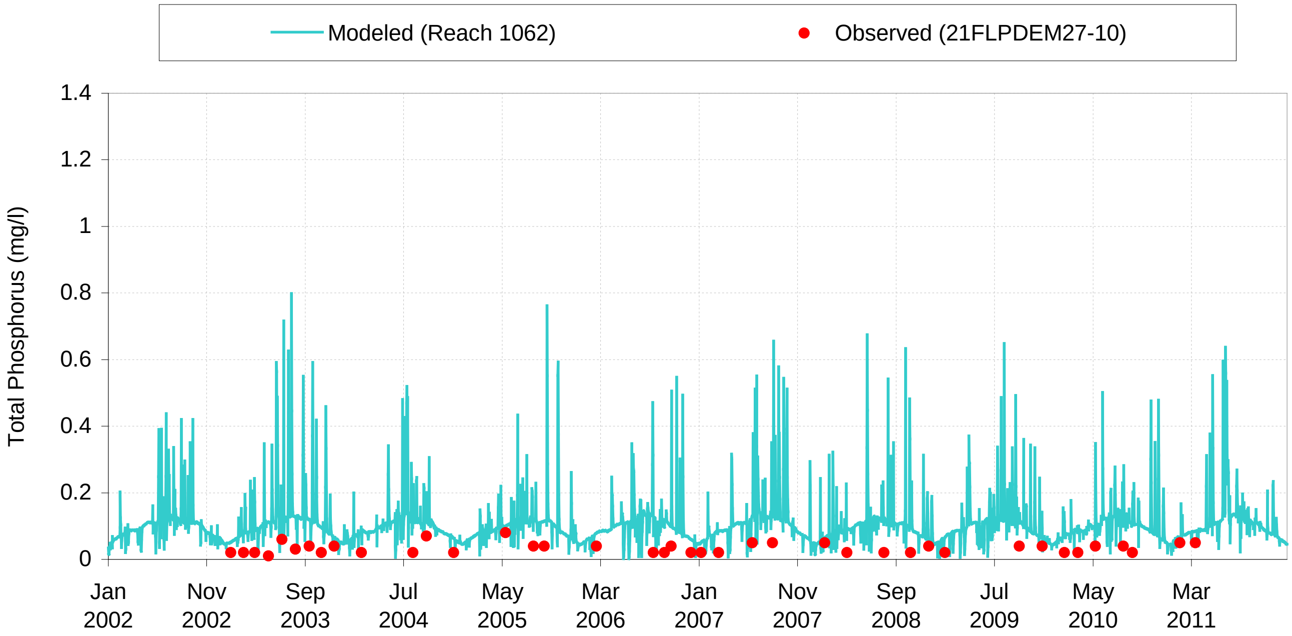

***Figure 5.10. Modeled vs. Observed TP (mg/L) at 21FLPDEM27-10***

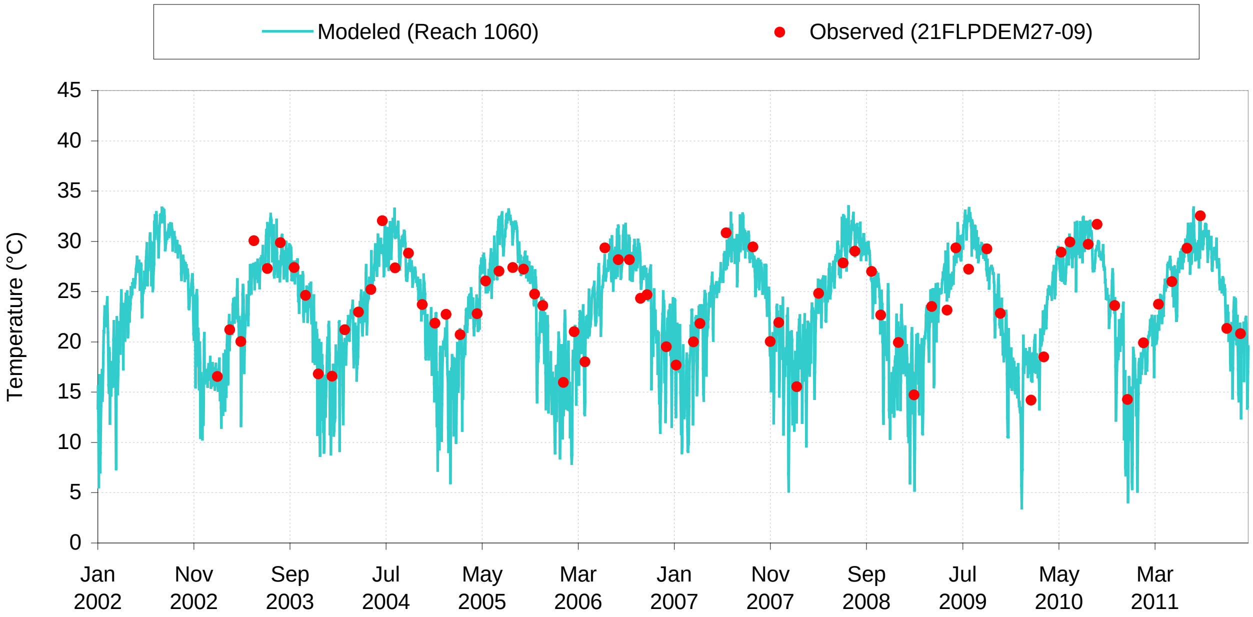

***Figure 5.11. Modeled vs. Observed Temperature (°C) at 21FLPDEM27-09***

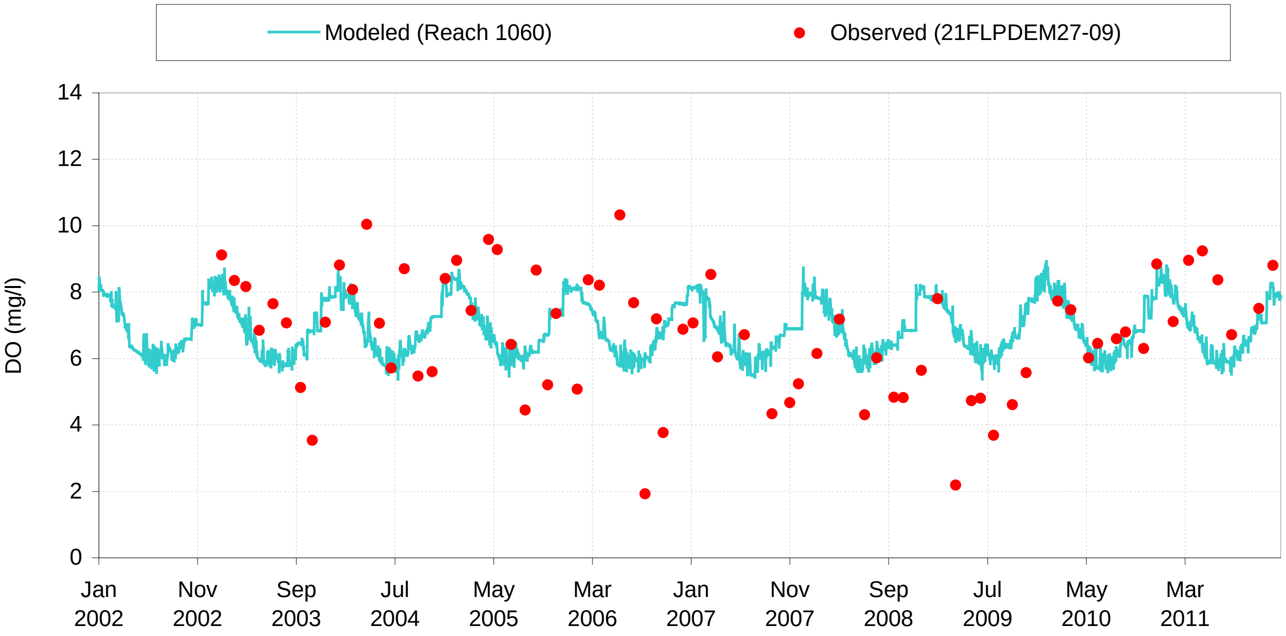

*Figure 5.12. Modeled vs. Observed DO (mg/L) at 21FLPDEM27-09*

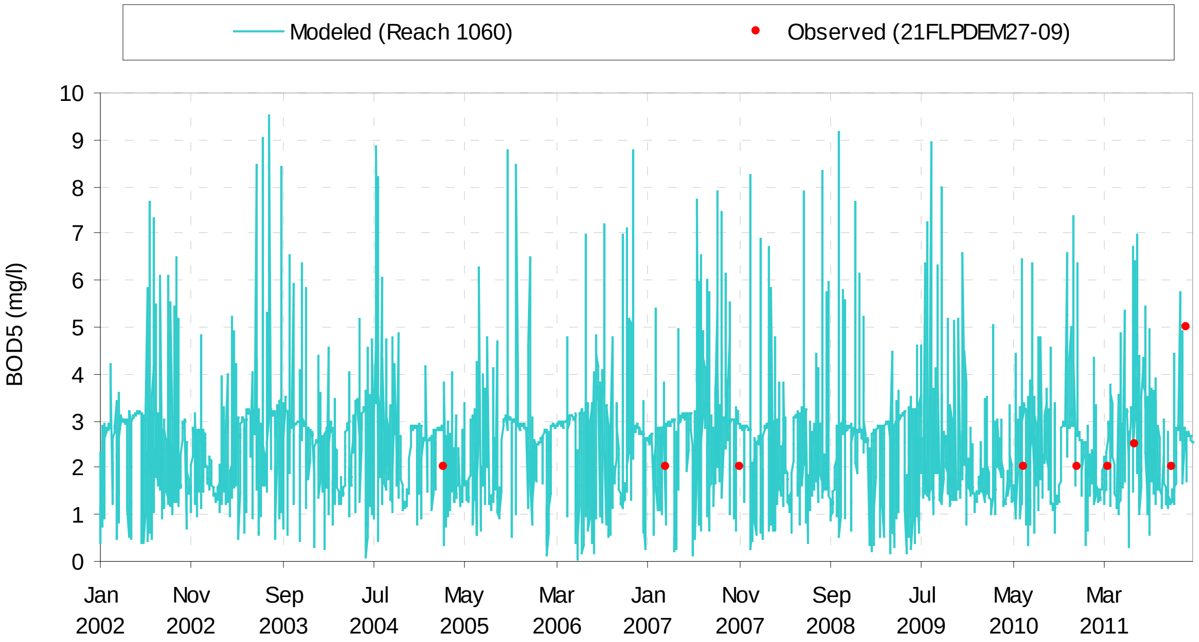

*Figure 5.13. Modeled vs. Observed $BOD_5$ (mg/L) at 21FLPDEM27-09*

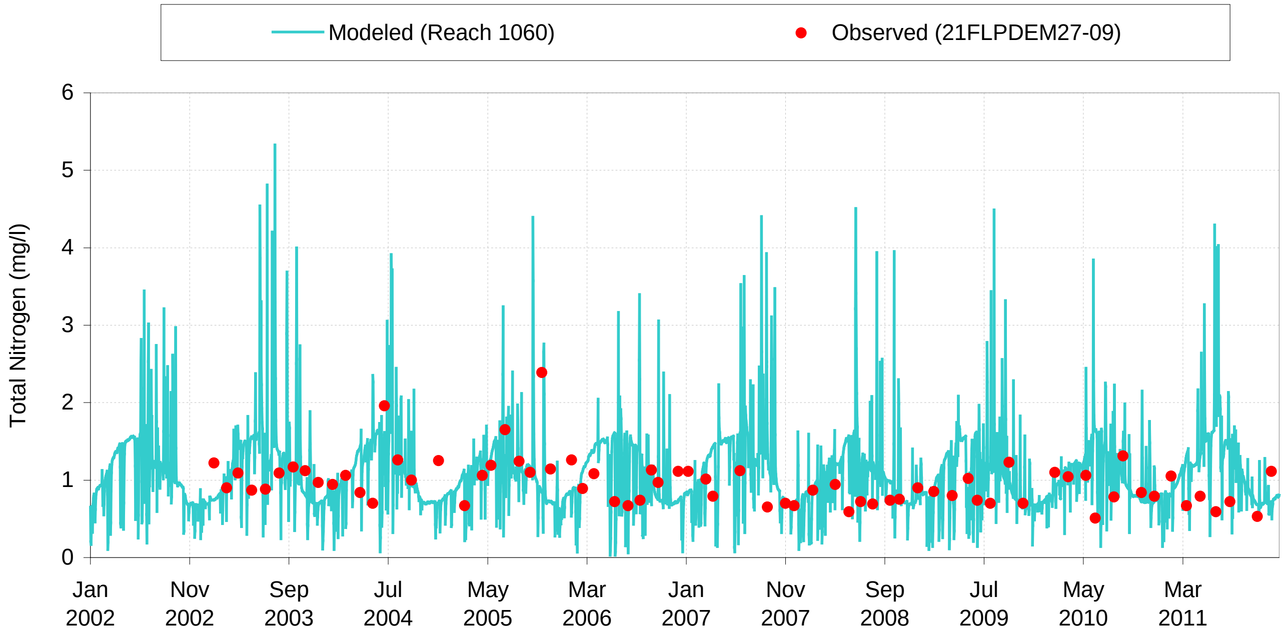

*Figure 5.14. Modeled vs. Observed TN (mg/L) at 21FLPDEM27-09*

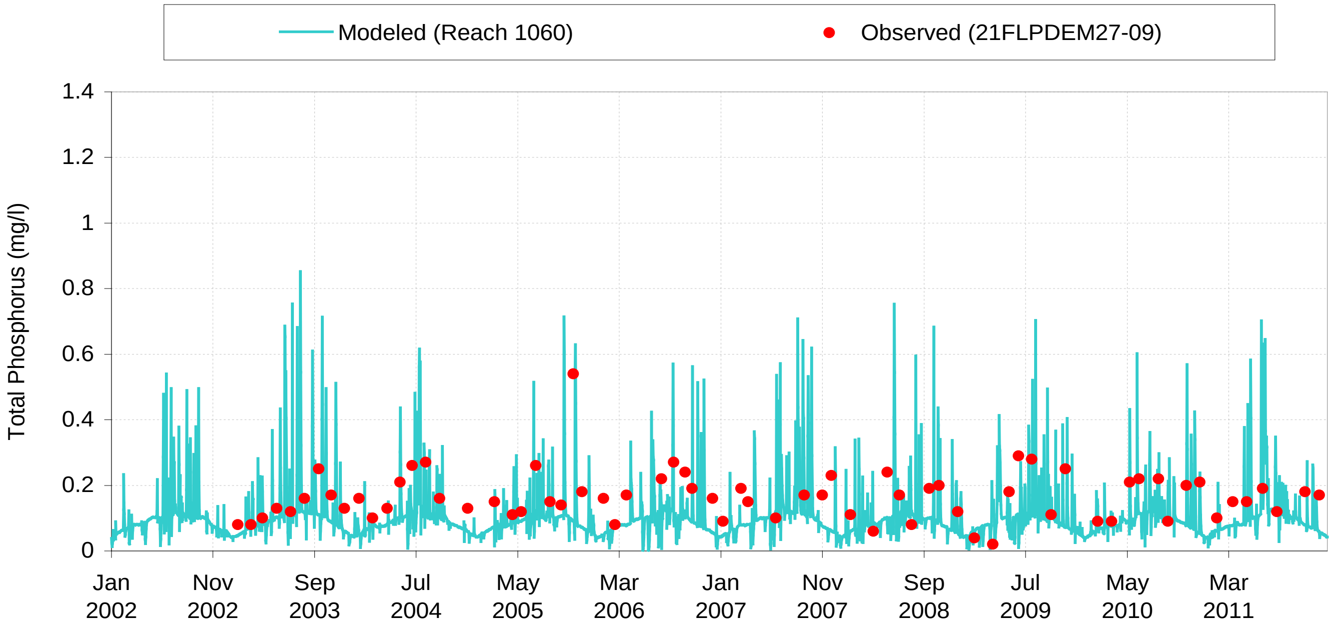

*Figure 5.15. Modeled vs. Observed TP (mg/L) at 21FLPDEM27-09*

### *5.3.2 EFDC Model Development*

The EFDC model was utilized to simulate the three-dimensional circulation dynamics of hydrodynamic state variables (water surface elevation, salinity, and temperature) in the McKay Creek estuary. The McKay Creek model utilized the Big Bend EFDC Hydrodynamic model (**Appendix F**), which was resized to meet the modeling needs of McKay Creek.

An orthogonal, curvilinear grid system consisting of 3,995 horizontal cells and four equally spaced vertical layers was developed for the Big Bend EFDC model. The grid was developed using Gulf of Mexico bathymetry data. The large grid was reduced in size and scale for the McKay Creek EFDC models.

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 two Weather Bureau Army Navy (WBAN) stations, Apalachicola and Clearwater, for 2002 through 2011. Solar short-wave radiation was calculated using the CE-Qual-W2 method.

The Big Bend Estuary 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 Big Bend Estuary was calibrated to measured NOAA tidal stations, and the Big Bend model was used to simulate the open boundary conditions in the McKay Creek model. The inland boundary grid cells for all three models received LSPC-simulated watershed discharges.

The McKay Creek EFDC grid consisted of 64 cells, specifically, 32 cells in the horizontal direction and two layers in the vertical direction (**Figure 5.16**). The grid was developed using bathymetry data from the larger Big Bend model and NOAA tidal charts. Bathymetry was unavailable for the inland, tidally influenced streams, and channel slope from the USGS digital elevation model was used to estimate slope within the channel. The McKay Creek grid extended from Clearwater Harbor into McKay Creek and Church Creek.

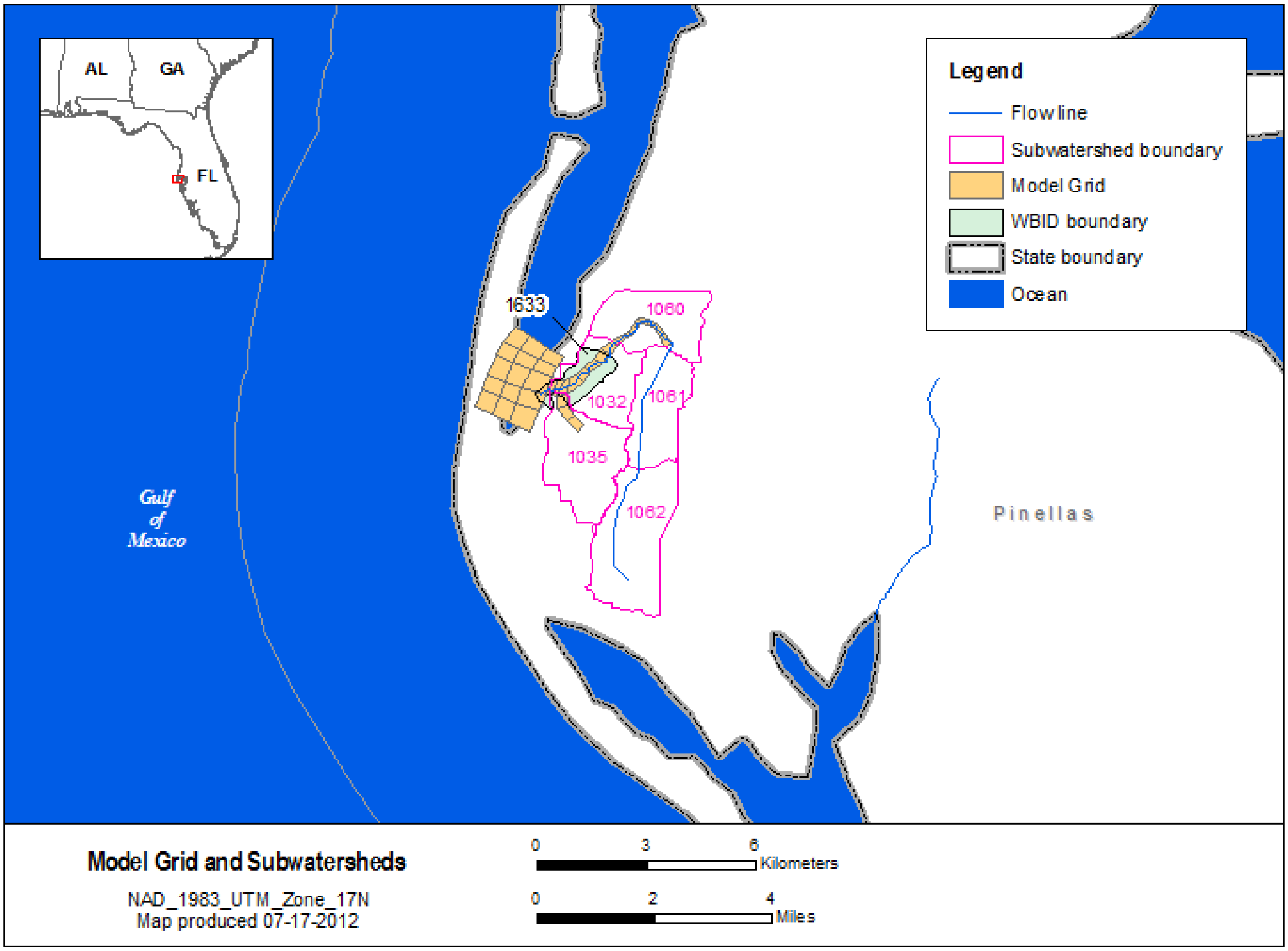

*Figure 5.16. Location of McKay Creek LSPC Subwatersheds and EFDC Grid*

Because there were no NOAA tidal stations located within McKay Creek estuary, water surface elevation within the modeled cells could not be directly calibrated. Salinity measurements from IWR Run 44 data were used to review the McKay Creek estuary EFDC calibration. Following model review, the salinity and temperature parameters were adjusted accordingly. The model simulated and measured salinity results are presented in Figure 5.17.

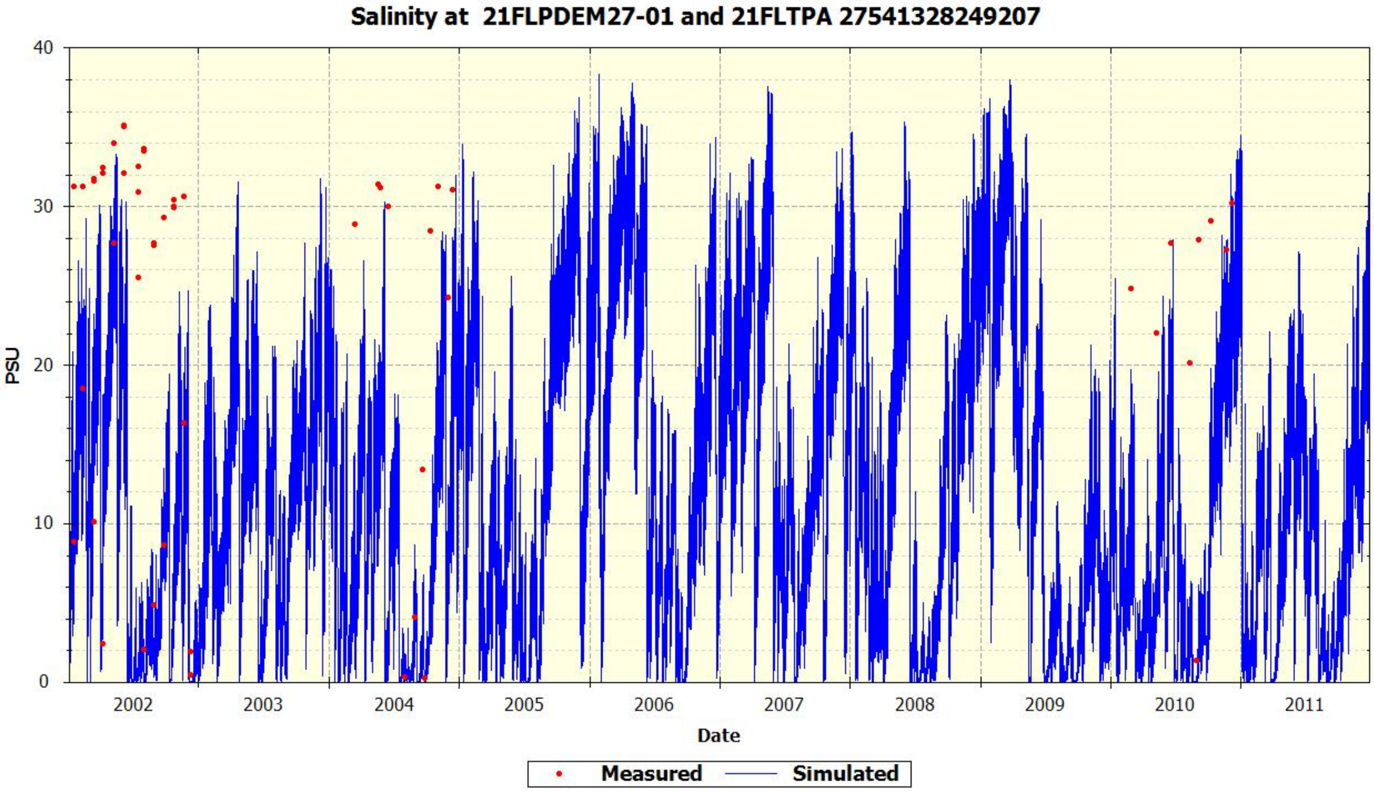

*Figure 5.17. Measured vs. Modeled Salinity (practical salinity units [PSU]) in McKay Creek at Station 21FLPDEM27-01*

### *5.3.3 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 McKay Creek estuary. WASP7 modeled TN and its speciation, TP and its speciation, chlorophyll *a*, DO, and carbonaceous biological oxygen demand (CBOD). The model predicts these parameters in response to a set of hydrological, meteorological, atmospheric, and chemical and biological factors: loads from point and nonpoint sources, benthic ammonia and phosphate fluxes, sediment oxygen demand (SOD), solar radiation, air temperature, reaeration, and offshore and inland boundary conditions.

The McKay Creek WASP7 model utilized the same grid cells that were developed for the McKay Creek EFDC model. The hydrodynamic simulation from the McKay Creek EFDC model was input into the WASP7 model. Open boundary water quality conditions used measured water quality data from Clearwater Harbor. Water quality loading from the LSPC model was used to simulate loads coming from rivers and streams into the estuary.

Because the LPSC model simulated TN, TP, and BOD and the WASP model simulated TN and its speciation, TP and its speciation, and CBOD, the water quality concentrations from LSPC were adjusted for WASP simulation prior to being input into the WASP model. TN was speciated into nitrate-nitrite (NOX), ammonia (NH4), and organic nitrogen (ON), and TP was speciated into orthophosphate (PO4) and organic phosphorus (OP). Water quality data in the McKay Creek watershed were reviewed to determine the ratio of NOX, NH4, and ON in TN, and the ratio of PO4 and OP in TP. These ratios were used to develop the partitioning percentages for TN and TP loads from the LSPC model. For the McKay Creek WASP model, 25% of the TN loading was partitioned to NOX, 5% to NH4, and 70% to ON, while 50% of the TP loading was portioned to both PO4 and OP. The instream BOD loads from LSPC were converted to ultimate CBOD using an f-ratio of 1.5.

Water quality in the Big Bend model was simulated using EFDC and not WASP7. For this reason, water quality parameters from the Tampa Bay WASP7 model were used to populate the McKay Creek WASP7 model. The McKay Creek estuary model calibration was reviewed against water quality data located in IWR Run 44. Following review, the calibration was adjusted accordingly to provide the best existing scenario model calibration for the water quality parameters of concern. **Appendix C** (**Figures C.1** through **C.30**) presents WASP results at select water quality stations.

## 5.4 Determination of Loading Capacity

The calibrated watershed and receiving waterbody models developed for McKay Creek are designed to assist in predicting future water quality responses, as a result of reductions in existing pollutant loads, to determine the waterbody's assimilative capacity to meet the applicable DO and nutrient surface water quality criteria and establish the TMDLs.

The models were set up to simulate conditions during the 2002 to 2011 period. The Department applied the models in assessing pollutant load reductions required for the tidal reach of the creek to meet the applicable criteria for DO and nutrients. The loading capacity for the tidal segment was determined by performing model design runs where the watershed source loads were adjusted until the applicable water quality targets were met. Reductions in the watershed nonpoint source loads were evaluated with the WASP model to determine a load reduction alternative for meeting the water quality targets and setting TMDLs for BOD and TN loadings.

As a result of reduced loadings, the SOD and benthic nutrient flux rates are expected to be reduced as a result of reduced inputs of organic matter, primarily in the form of algal biomass, deposited to stream sediments. Therefore, the SOD and benthic nutrient flux rates were modified to account for this mechanism. The approach chosen for adjusting SOD and benthic nutrient flux rates was to use a linear relationship between the rates and the organic carbon content of sediment related to water column primary productivity.

The formula for the linear assumption that reductions in SOD and benthic nutrient flux rates are directly related to reductions in algal (phytoplankton) primary productivity is as follows:

$$(\mathrm{SOD})_{rev} = \frac{(\mathrm{Chl\ a})_{out}}{(\mathrm{Chl\ a})_{cal}} \times (\mathrm{SOD})_{cal}$$

Where:

$(\mathrm{SOD})_{rev}$ is the revised SOD (or benthic ammonia and/or phosphorus flux) rate under the reduction scenario under evaluation.

$(\mathrm{Chl\ a})_{out}$ is the chlorophyll *a* annual average value from the reduction scenario model run.

$(\mathrm{Chl\ a})_{cal}$ is the chlorophyll *a* annual average value from the calibrated model run.

$(\mathrm{SOD})_{cal}$ is the SOD (or benthic ammonia and/or phosphorus flux) rate from the calibrated model run.

After each load reduction scenario was completed, the same WASP model was rerun with the revised SOD and benthic nutrient flux rates. The DO and chlorophyll *a* results from the model runs with the adjusted sediment rates were then evaluated against the appropriate water quality targets. The simulated results from the WASP model that were compared with the water quality targets were obtained from the model segment where the majority of water quality data were collected in the 2002 to 2011 period (*i.e.*, the monitoring location at South Indian Rocks Rd.).

The objective of the evaluation for establishing the TMDLs was to identify a model scenario where the predicted average chlorophyll *a* value would not exceed the selected target of 8 µg/L and result in DO conditions that would allow the tidal creek to meet the minimum DO criterion of 4 mg/L.

The design scenario that results in the tidal creek meeting the water quality targets for chlorophyll *a* and DO is a 45% reduction in TN and $BOD_5$ watershed loadings. **Table 5.1** lists the model-simulated annual average chlorophyll *a* concentrations for the existing conditions and selected load reduction scenario. **Figure 5.18** presents the predicted DO results for the current condition and selected load reduction scenario. The load reduction scenario selected for establishing the TMDLs is expected to result in annual average chlorophyll *a* values less than the target of 8 µg/L, thus achieving the narrative nutrient criterion, and DO concentrations above the minimum criterion of 4 mg/L.

## 5.5 Critical Conditions

The TMDLs were based on conditions observed throughout the ten-year model simulation period rather than critical/seasonal conditions because the methodology used to determine impairment was based on water quality results collected throughout the year.

***Table 5.1. WASP-Simulated Annual Average Chlorophyll a Values in McKay Creek Tidal Segment***

| Year | Existing Conditions – Chlorophyll *a* (µg/L) | 45% Reduction in Watershed Loads – Chlorophyll *a* (µg/L) |
|---|---|---|
| 2002 | 9.5 | 6.5 |
| 2003 | 10.6 | 6.5 |
| 2004 | 10.1 | 7.0 |
| 2005 | 10.5 | 6.9 |
| 2006 | 9.4 | 6.2 |
| 2007 | 10.1 | 6.7 |
| 2008 | 10.4 | 7.1 |
| 2009 | 10.3 | 7.0 |
| 2010 | 11.9 | 7.9 |
| 2011 | 11.9 | 7.6 |

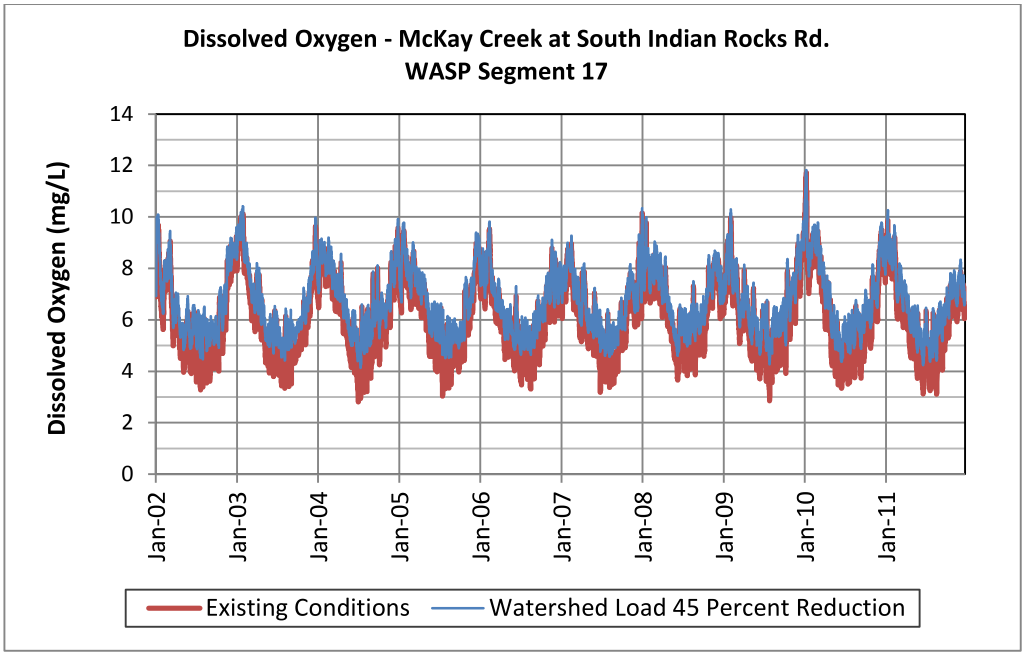

***Figure 5.18. WASP-Simulated DO Concentrations in McKay Creek Tidal Segment***

# Chapter 6: DETERMINATION OF THE TMDL

## 6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\mathbf{TMDL} = \Sigma \square \mathrm{WLAs} + \Sigma \square \mathrm{LAs} + \mathrm{MOS}$$

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

$$\mathbf{TMDL} \cong \Sigma \square \mathrm{WLAs}_{\mathbf{wastewater}} + \Sigma \square \mathrm{WLAs}_{\mathbf{NPDES\ Stormwater}} + \Sigma \square \mathrm{LAs} + \mathrm{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (*e.g.,* the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

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

This approach is consistent with federal regulation 40 CFR § 130.2[I] (EPA 2003), which states that TMDLs can be expressed in terms of mass per time (*e.g.,* pounds per day), toxicity, or other appropriate measure. The TMDLs for McKay Creek Tidal Segment (WBID 11633) are expressed in terms of pounds per year and pounds per day in **Tables 6.1.a.** and **Table 6.1.b.**, respectively. The TMDLs represent the maximum annual and daily load the tidal segment can assimilate to maintain the marine DO water quality criterion and the narrative nutrient criterion. The TMDLs to be implemented are those expressed on a mass per year basis, and the expression of the TMDL on a mass per day basis is for informational purposes only.

***Table 6.1a. TMDL Components Expressed as an Annual Load for McKay Creek Tidal Segment, WBID 1633***

NA = Not applicable

| Parameter | WLA for Wastewater (lbs/yr) | WLA for NPDES Stormwater (% reduction) | LA (lbs/yr) | MOS | TMDL (lbs/yr) |
|---|---|---|---|---|---|
| $BOD_5$ | NA | 45% | 32,505 | Implicit | 32,505 |
| TN | NA | 45% | 15,563 | Implicit | 15,563 |

***Table 6.1b. TMDL Components Expressed as a Daily Load for McKay Creek Tidal Segment, WBID 1633***

NA = Not applicable

| Parameter | WLA for Wastewater (lbs/yr) | WLA for NPDES Stormwater (% reduction) | LA (lbs/yr) | MOS | TMDL (lbs/yr) |
|---|---|---|---|---|---|
| $BOD_5$ | NA | 45% | 89 | Implicit | 89 |
| TN | NA | 45% | 43 | Implicit | 43 |

## 6.2 Load Allocation

A TN reduction of 45% is required from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

## 6.3 Wasteload Allocation

### *6.3.1 NPDES Wastewater Discharges*

There are no permitted wastewater facilities that discharge into McKay Creek Tidal Segment or watershed; therefore, there are no allocations to this source category.

### *6.3.2 NPDES Stormwater Discharges*

There is one MS4 permit that covers the McKay creek watershed. Pinellas County, in conjunction with FDOT District 7, is covered by a Phase 1 MS4 permit (FLS000005). The cities of Largo, Belleair Bluffs, and Seminole, which have land areas within the McKay Creek watershed, are co-permittees in the MS4 permit. Areas within the jurisdictions of each permitted entity, along with local governments that are co-permittees, may be responsible for a 45% reduction in current anthropogenic TN and $BOD_5$ loadings. 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 noted in **Chapter 4,** loadings from stormwater discharges permitted under the NPDES Stormwater Program (*i.e.,* MS4 areas) are placed in the WLA, rather than the LA. The WLA is expressed as a percent reduction and was set at the same percent reduction needed for nonpoint sources to meet the LA. The actual loads from NPDES-permitted stormwater discharges are included in the LA, and the LA will be apportioned between all parties responsible for nonpoint source loadings when the specific source information becomes available.

## 6.4 Margin of Safety

TMDLs must address uncertainty issues by incorporating a margin of safety (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 pollutant 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.

In the TMDL development for McKay Creek Tidal Segment, an implicit MOS was accounted for by selecting a load reduction scenario that results in annual average chlorophyll *a* values below the target of 8 µg/L and DO concentrations above the minimum criterion of 4 mg/L.

# 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 determine the best course of action regarding their implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, 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.

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

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

- An evaluation of future increases in pollutant loading due to population growth.
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures.
- Stakeholder statements of commitment (typically a local government resolution).

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

### 7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

A multitude of assessment tools are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize sources of pollution. Based on work in the Lower St Johns River Tributaries and Hillsborough Basins, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work. In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

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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 Chapter 62-40, F.A.C. 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 Chapter 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

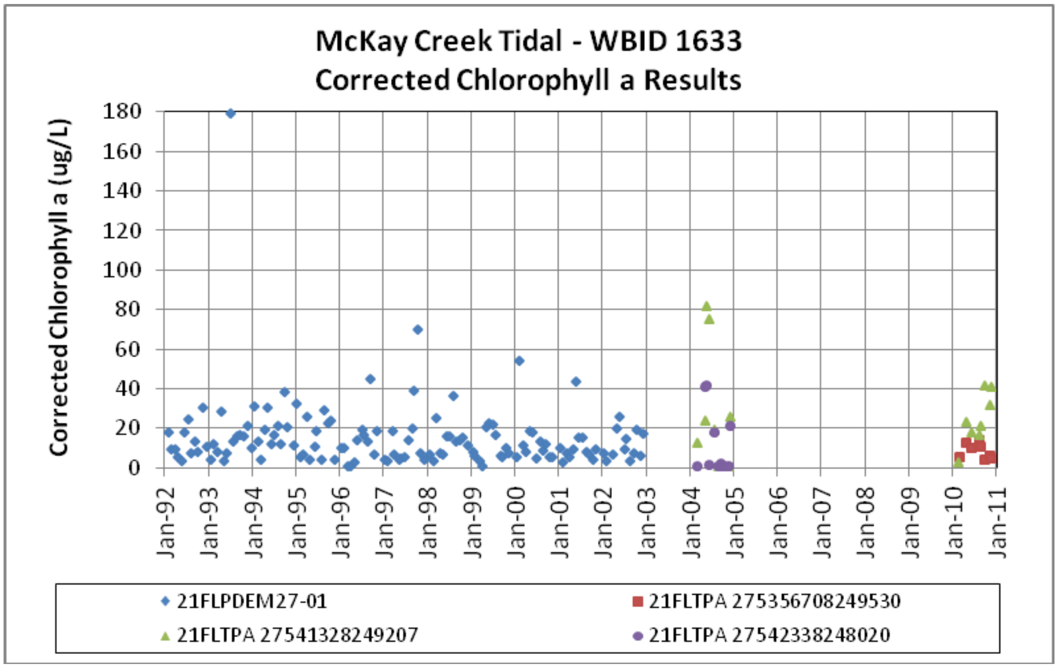
The rule also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

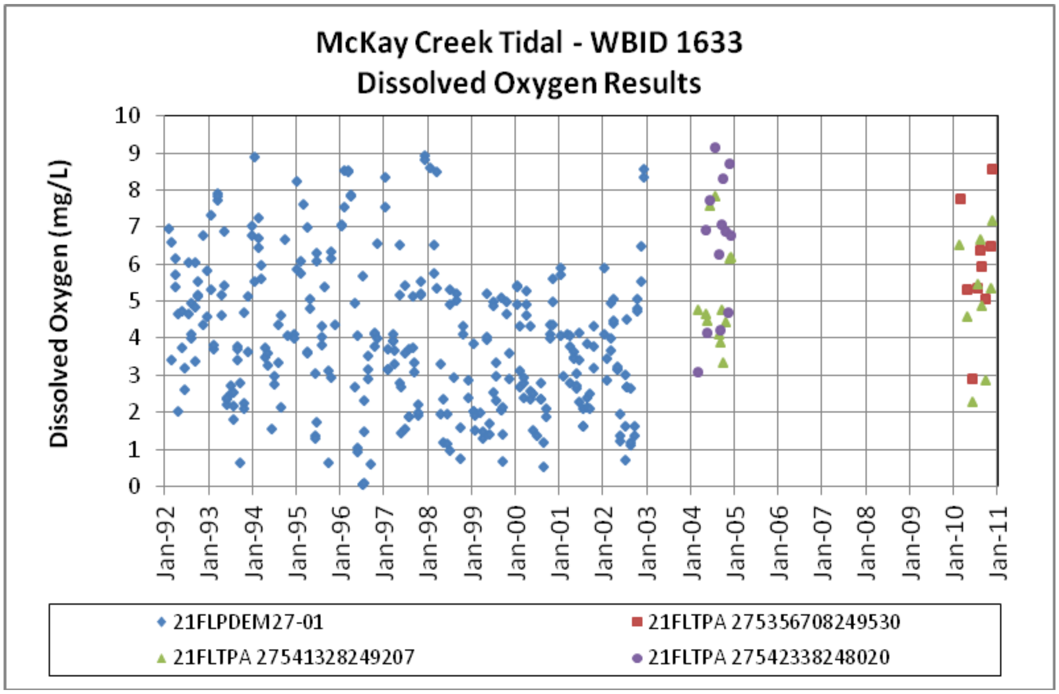
In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES stormwater permitting program to designate certain stormwater discharges as "point sources" of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing five 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 has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria.

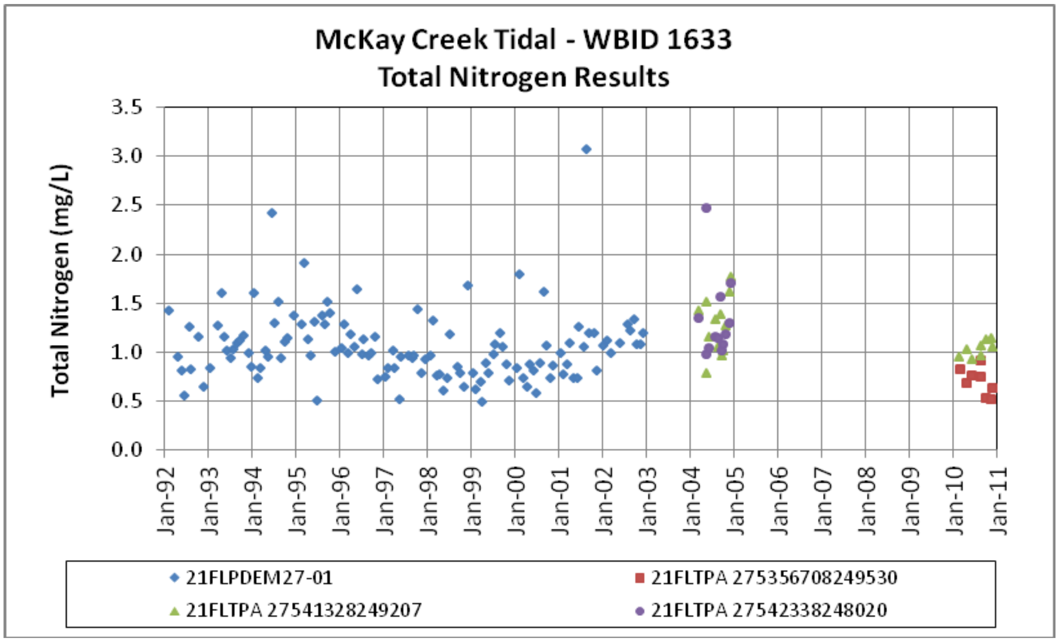
An important difference between the federal and state stormwater permitting programs is that the federal program covers both new and existing discharges, while the state program focuses on new discharges.

Additionally, Phase 2 of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between one and five 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 most MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

# Appendix B: Graphs of Surface Water Quality Results Source: IWR Run 44x Database






McKay Creek Tidal - WBID 1633
Total Nitrogen Results
Total Nitrogen (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
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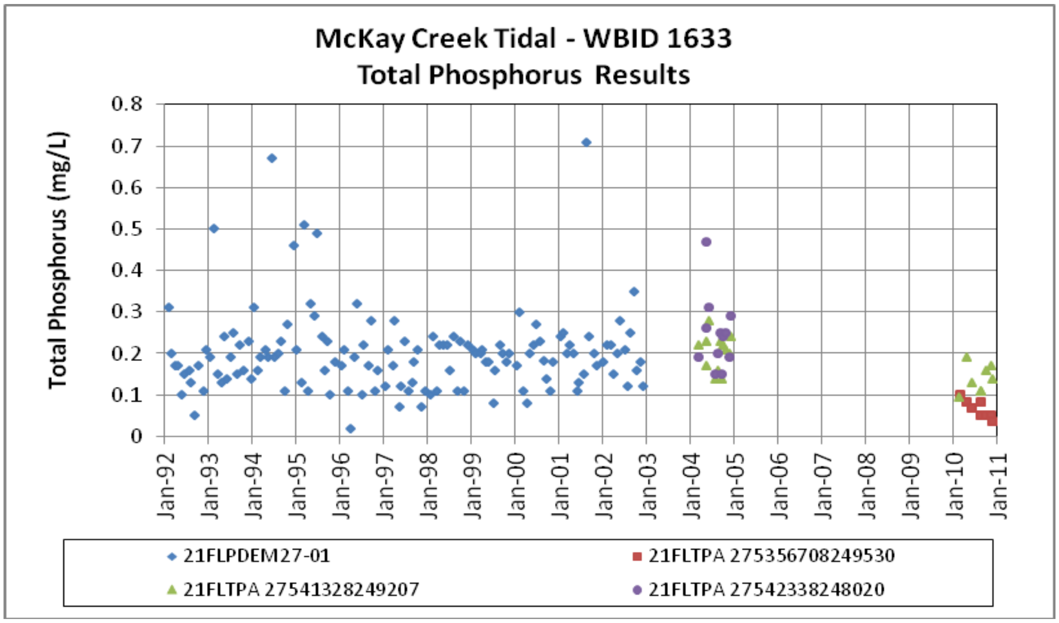
▲ 21FLTPA 27541328249207
● 21FLTPA 27542338248020


McKay Creek Tidal - WBID 1633
Total Phosphorus Results
Total Phosphorus (mg/L)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
◆ 21FLPDEM27-01
■ 21FLTPA 275356708249530
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● 21FLTPA 27542338248020

# Appendix C: WASP7 Water Quality Model Results

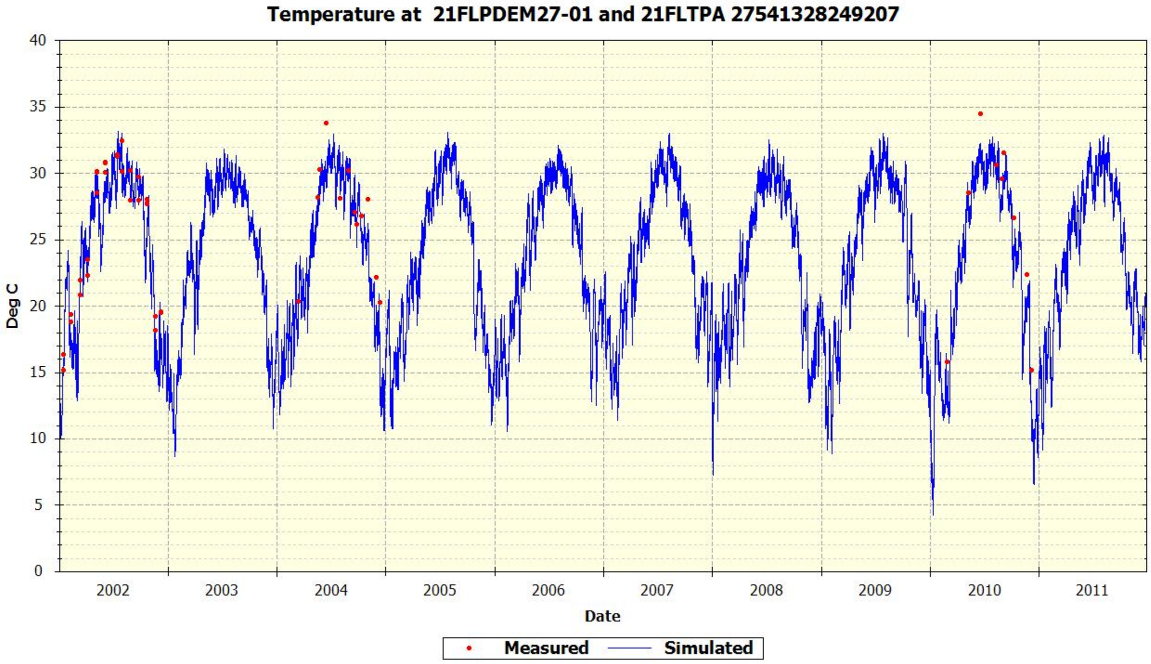


***Figure C.1. Measured vs. Modeled Temperature (˚C) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207***

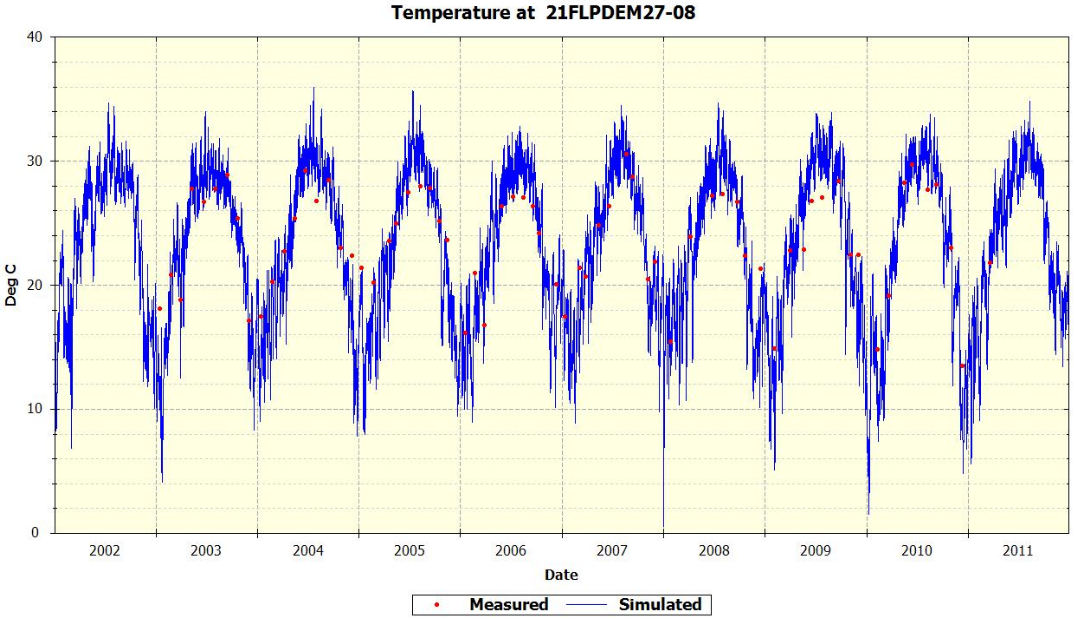


***Figure C.2. Measured vs. Modeled Temperature (˚C) in Church Creek at Station 21FLPDEM27-08***

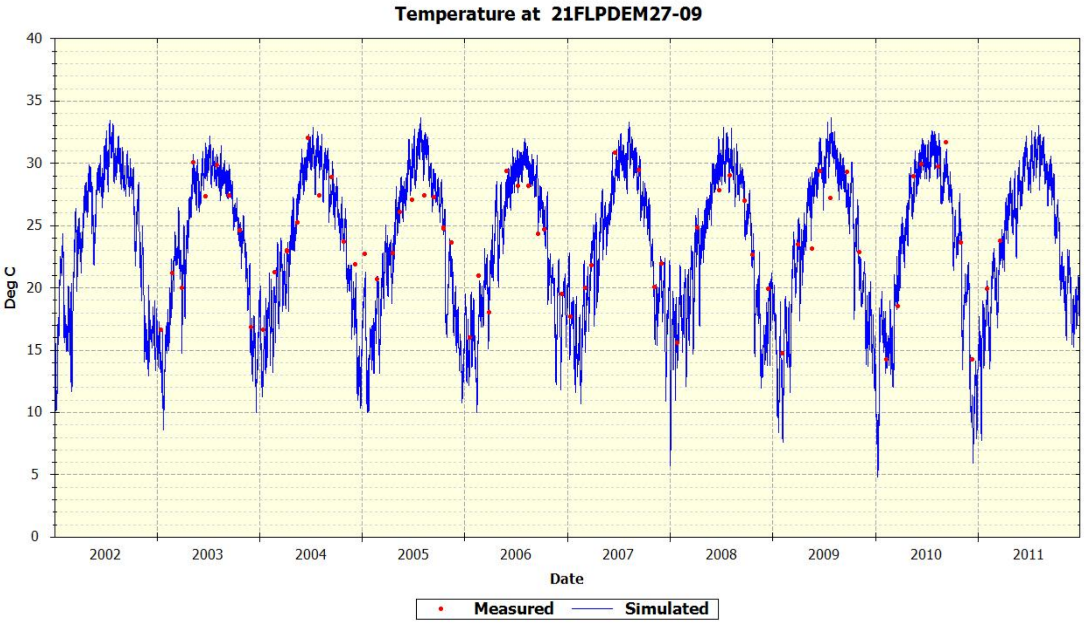


*Figure C.3. Measured vs. Modeled Temperature (˚C) in McKay Creek at Station 21FLPDEM27-09*

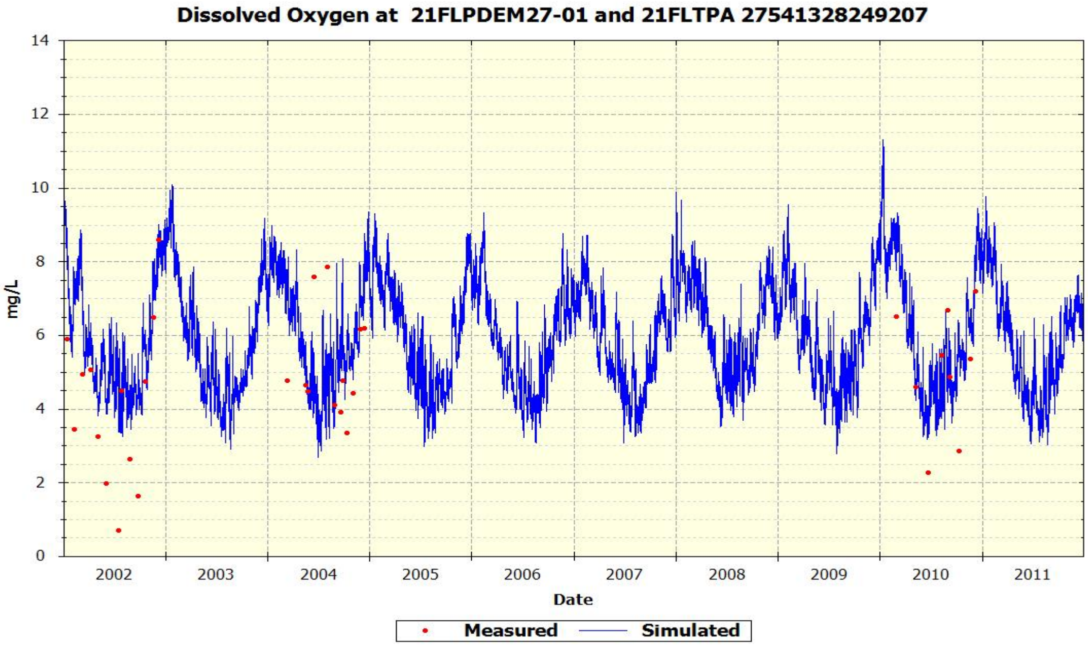
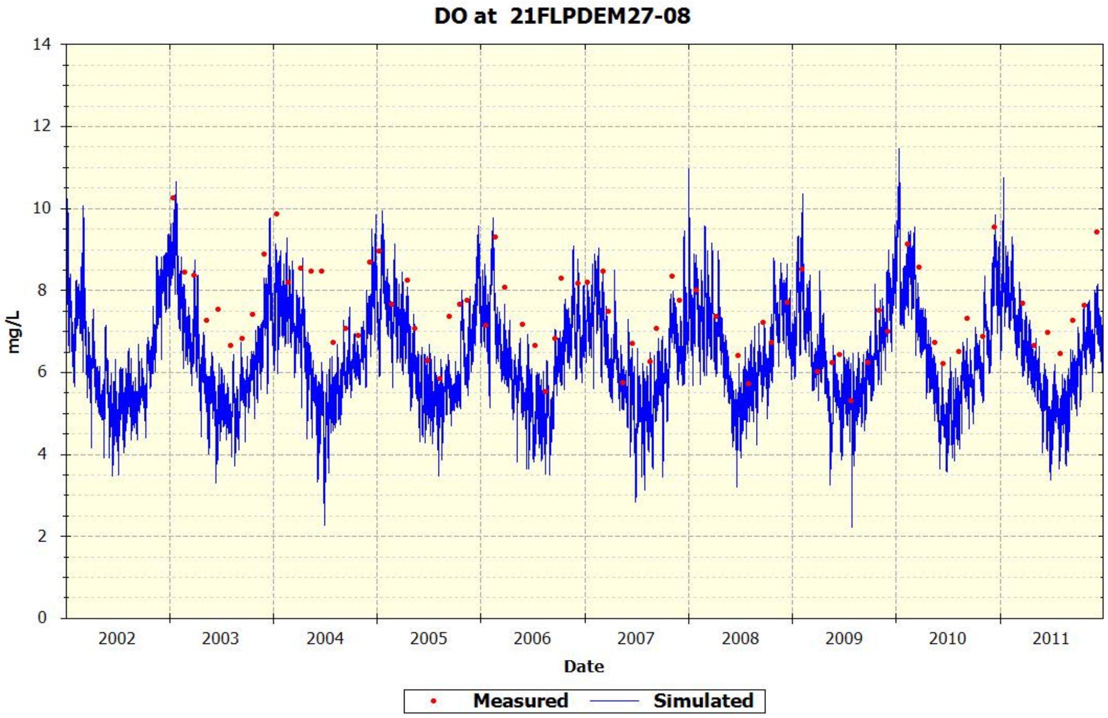


*Figure C.4. Measured vs. Modeled DO (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*



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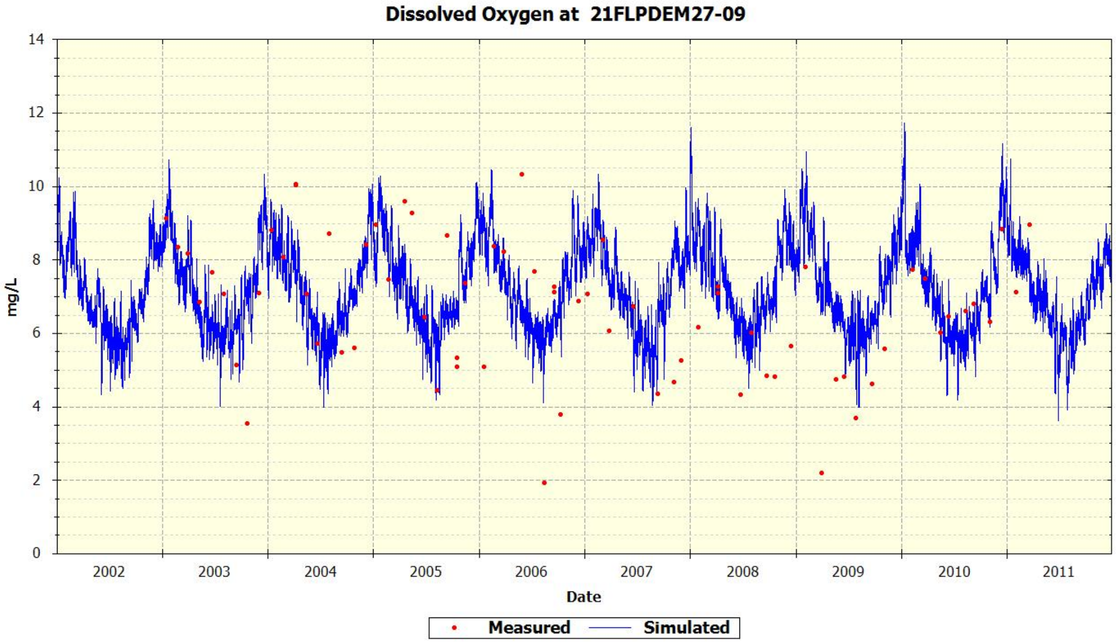


***Figure C.6. Measured vs. Modeled DO (mg/L) in McKay Creek at Station 21FLPDEM27-09***

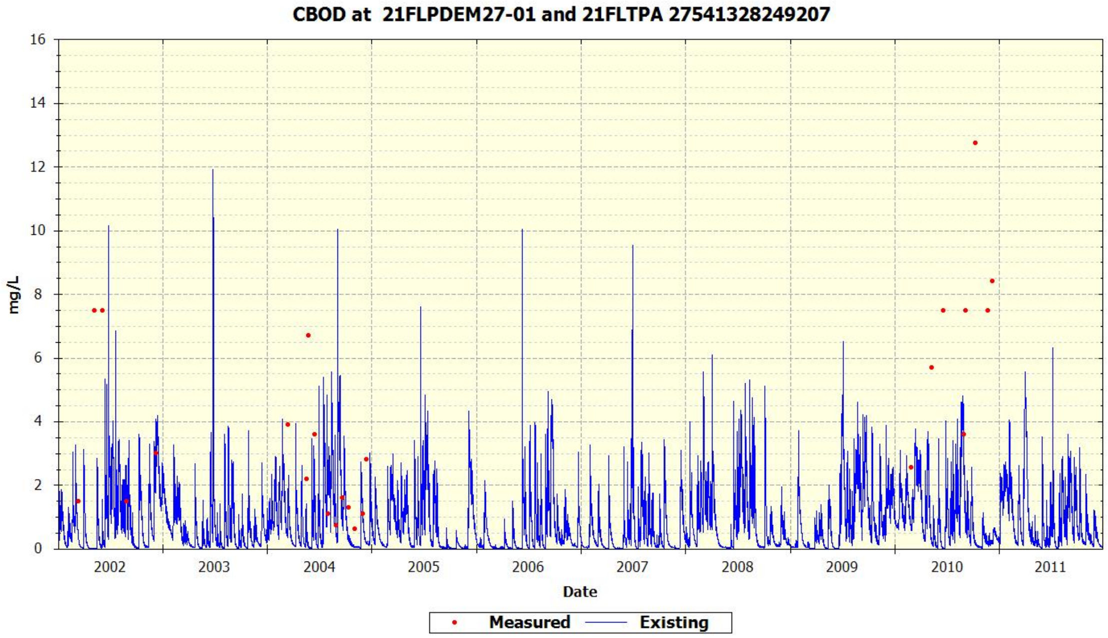


***Figure C.7. Measured vs. Modeled CBOD (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207***

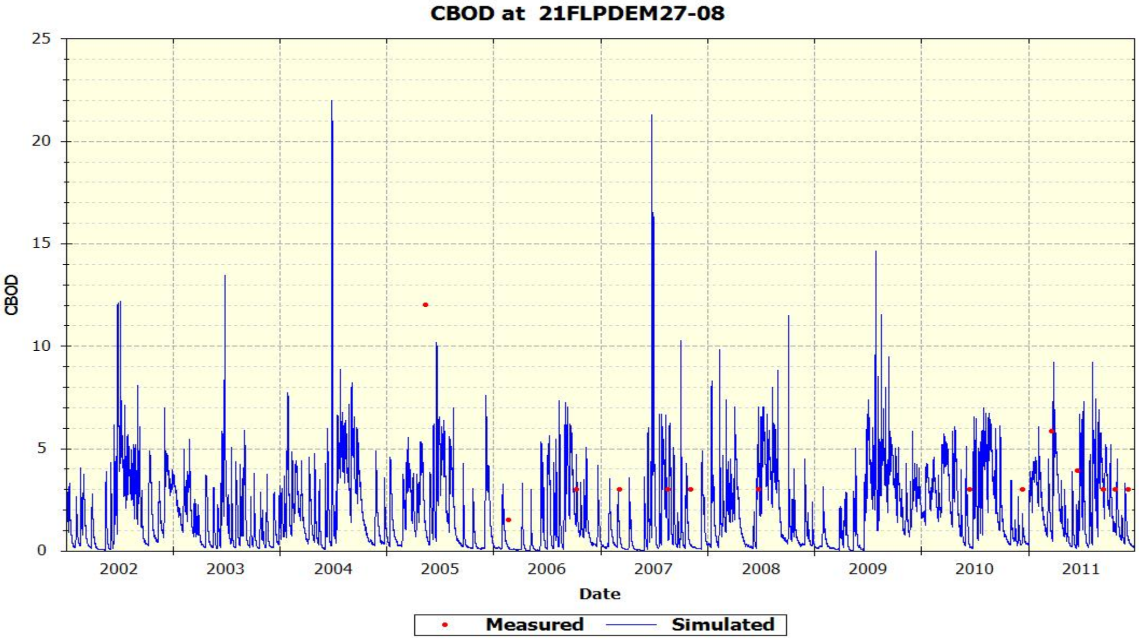


***Figure C.8. Measured vs. Modeled CBOD (mg/L) in Church Creek at Station 21FLPDEM27-08***

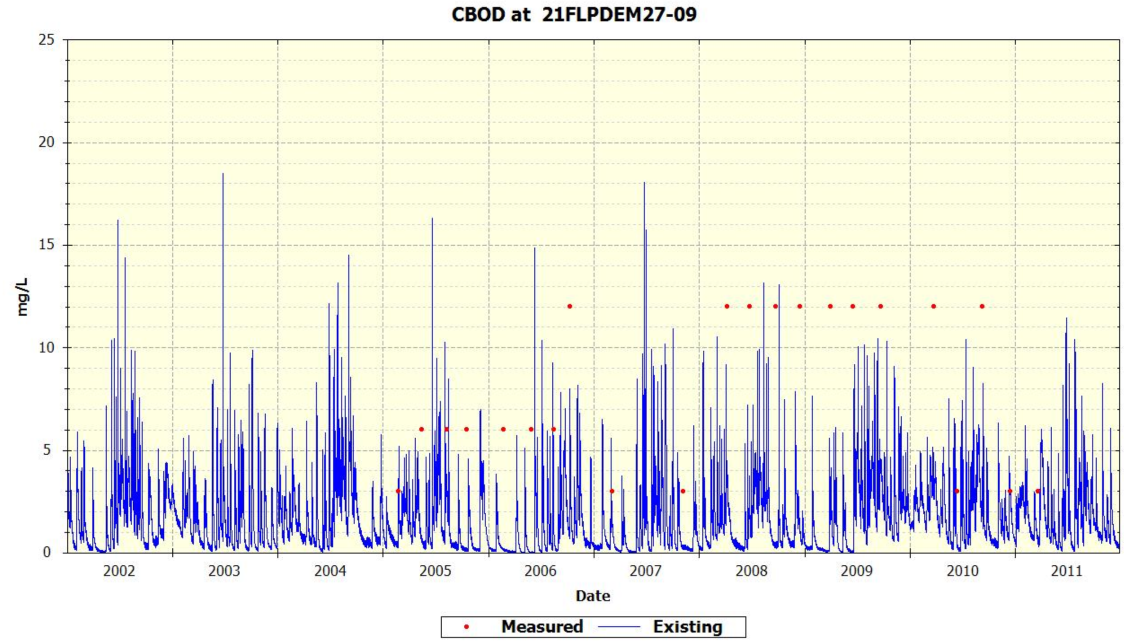


*Figure C.9. Measured vs. Modeled CBOD (mg/L) in McKay Creek at Station 21FLPDEM27-09*

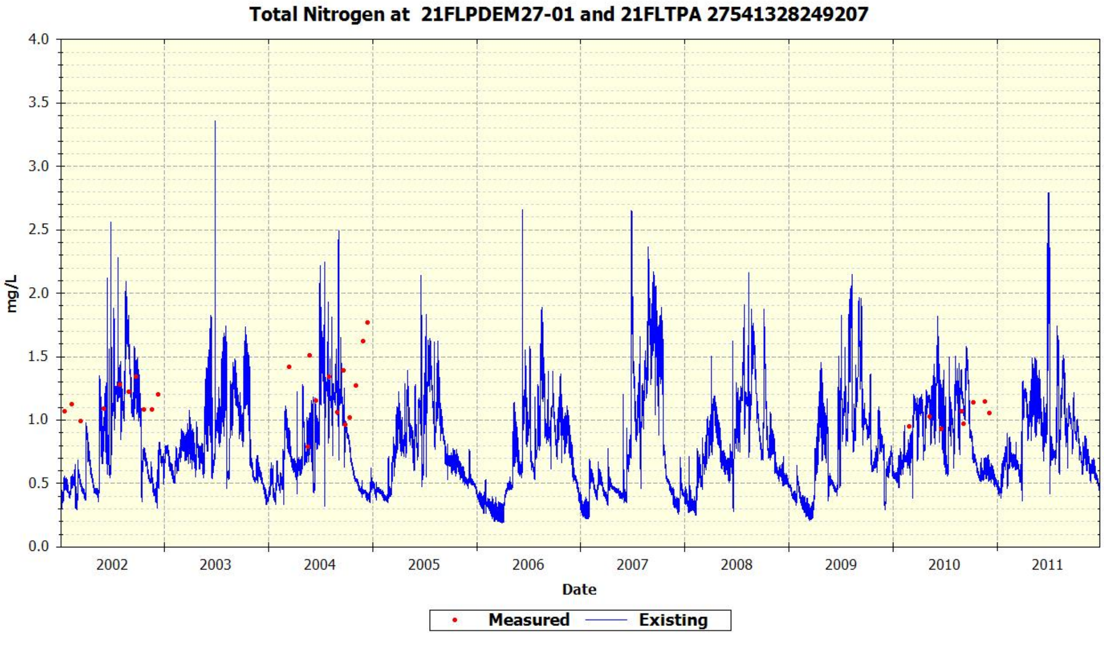


*Figure C.10. Measured vs. Modeled TN (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*

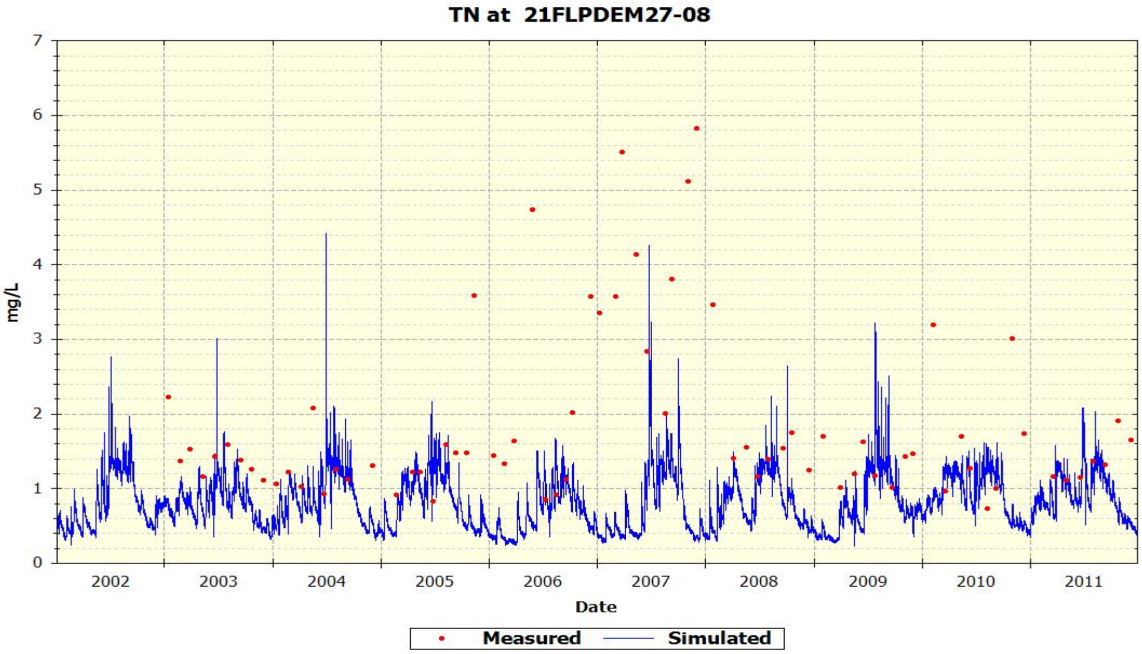


*Figure C.11. Measured vs. Modeled TN (mg/L) in Church Creek at Station 21FLPDEM27-08*

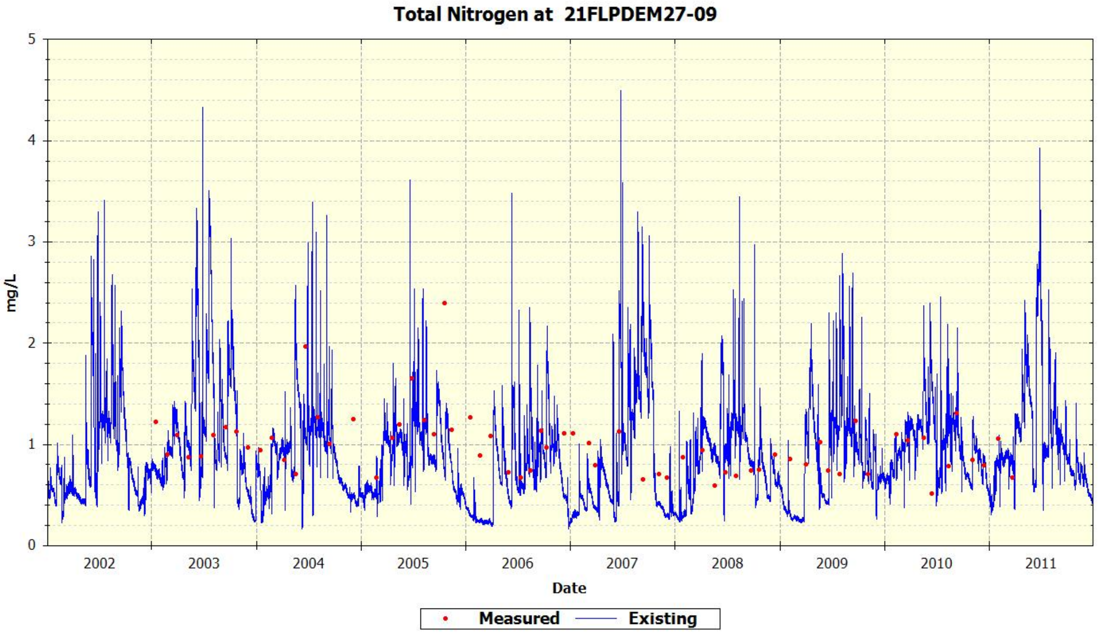


*Figure C.12. Measured vs. Modeled TN (mg/L) in McKay Creek at Station 21FLPDEM27-09*

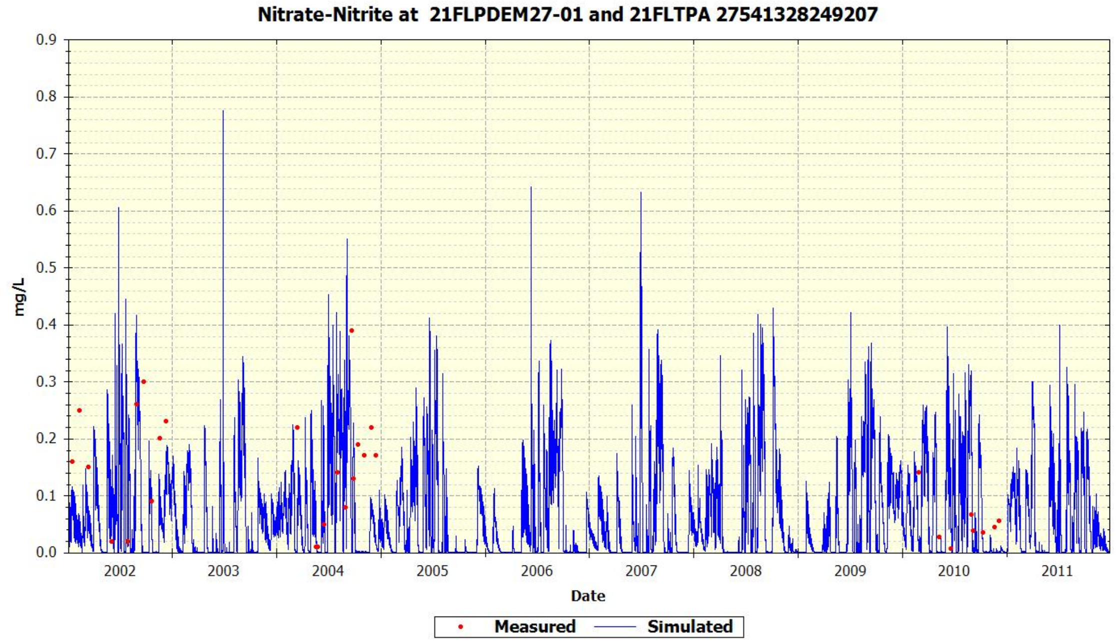
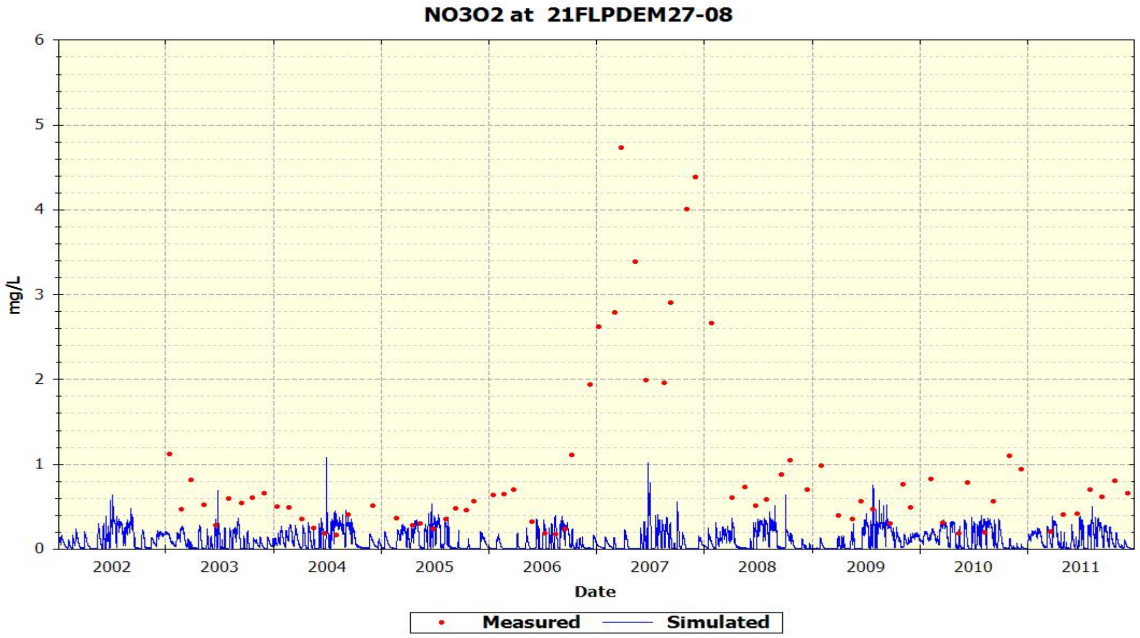


*Figure C.13. Measured vs. Modeled Nitrate-Nitrite (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*



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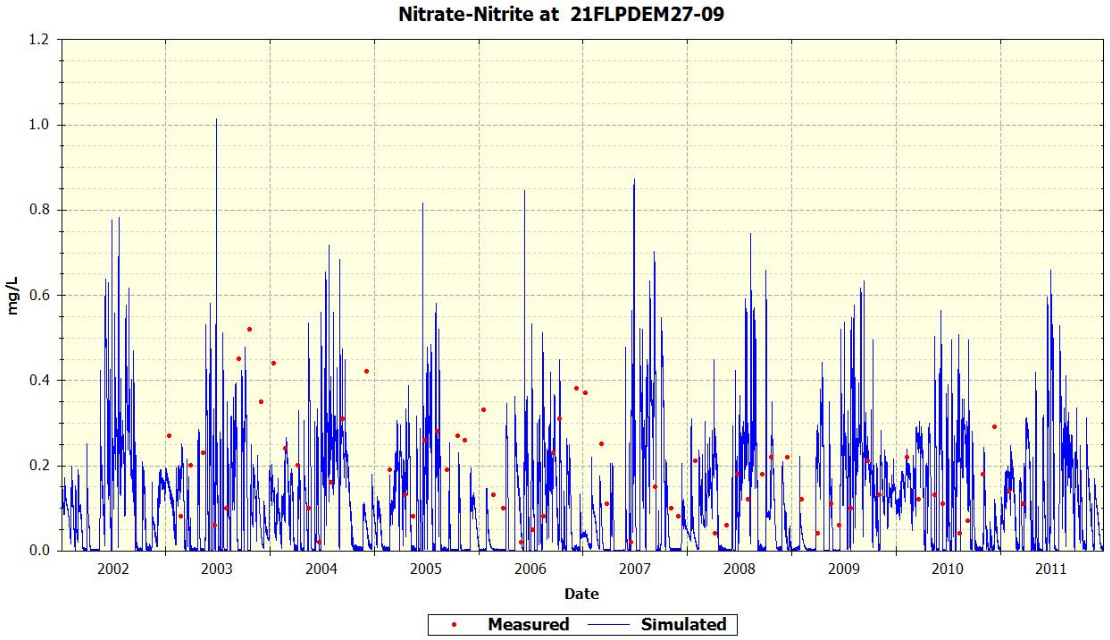


*Figure C.15. Measured vs. Modeled Nitrate-Nitrite (mg/L) in McKay Creek at Station 21FLPDEM27-09*

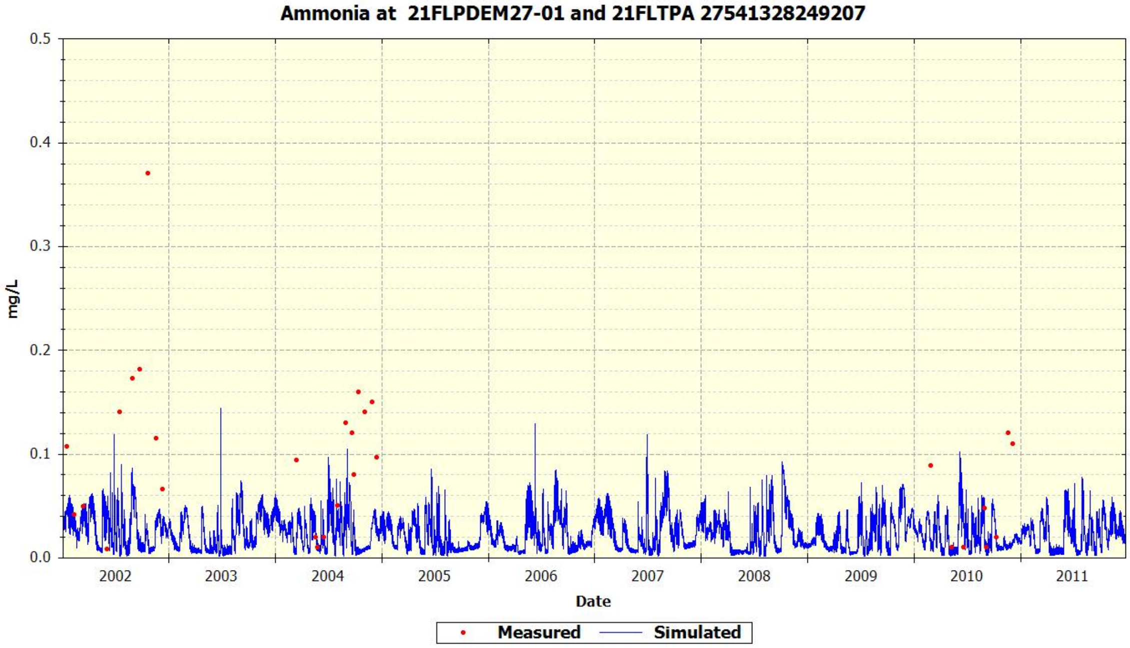


*Figure C.16. Measured vs. Modeled Ammonia (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*

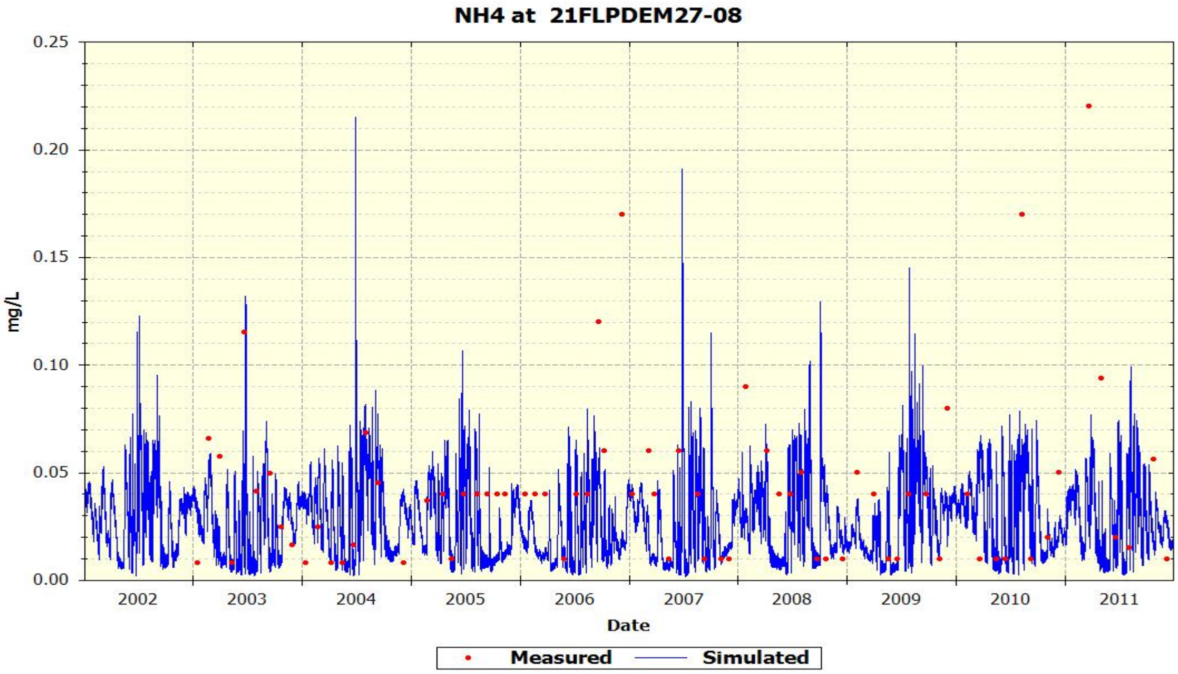


***Figure C.17. Measured vs. Modeled Ammonia (mg/L) in Church Creek at Station 21FLPDEM27-08***

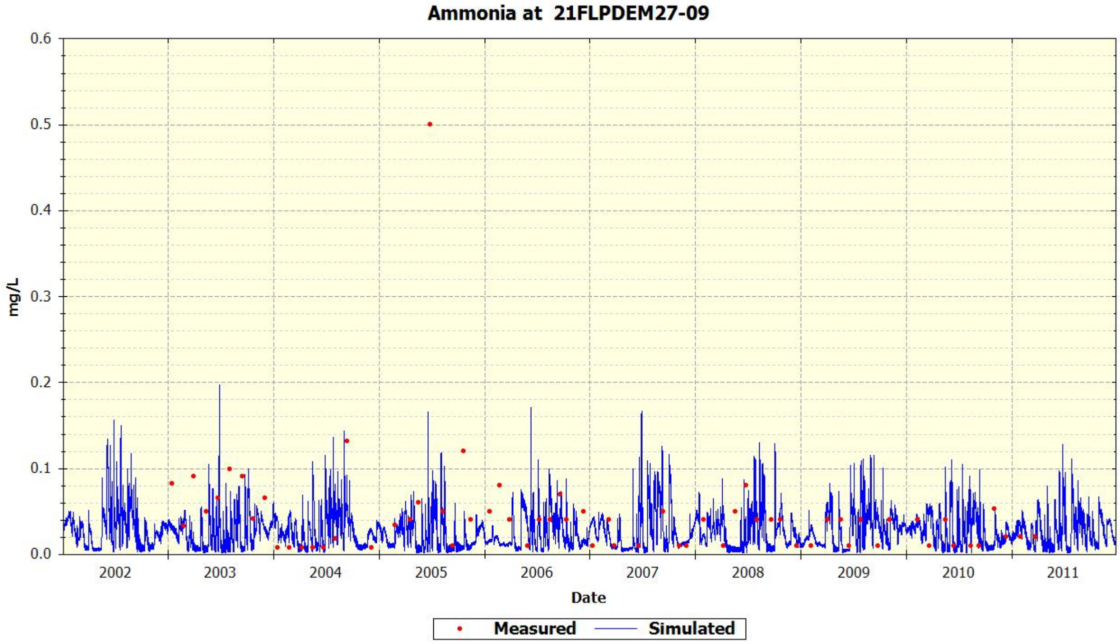


***Figure C.18. Measured vs. Modeled Ammonia (mg/L) in McKay Creek at Station 21FLPDEM27-09***

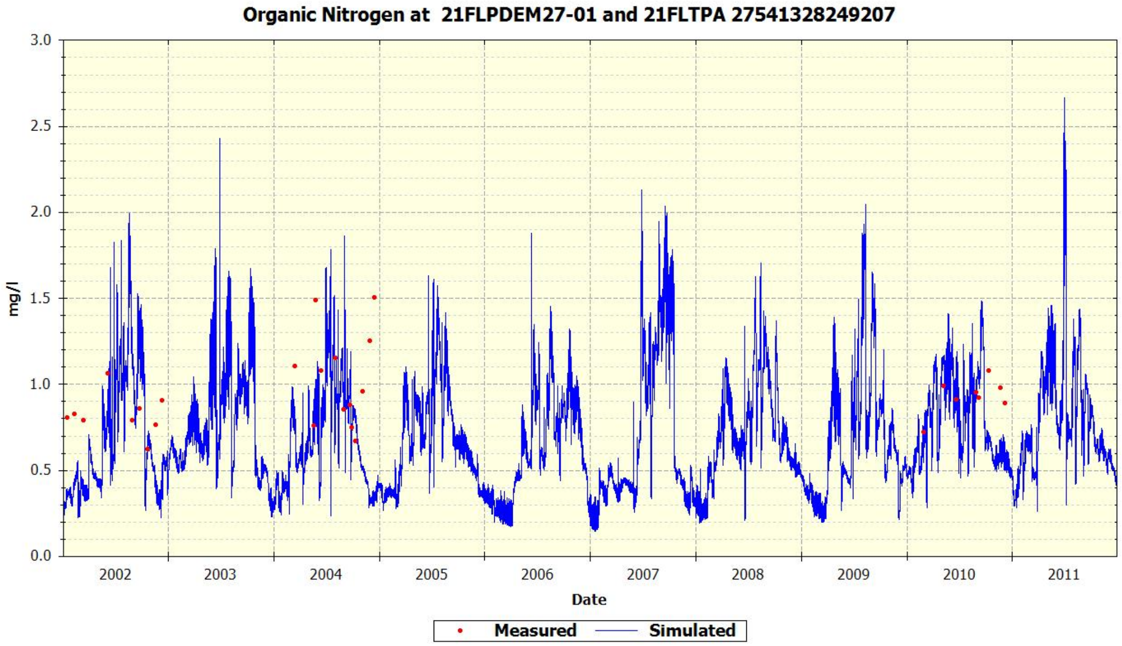


***Figure C.19. Measured vs. Modeled Organic Nitrogen (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207***

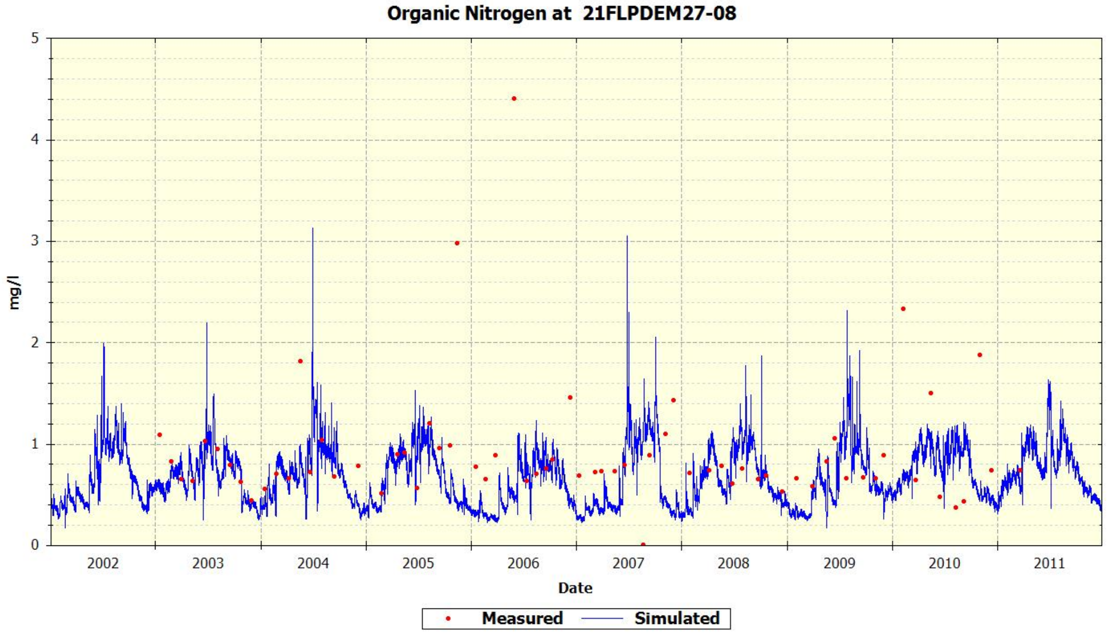


***Figure C.20. Measured vs. Modeled Organic Nitrogen (mg/L) in Church Creek at Station 21FLPDEM27-08***

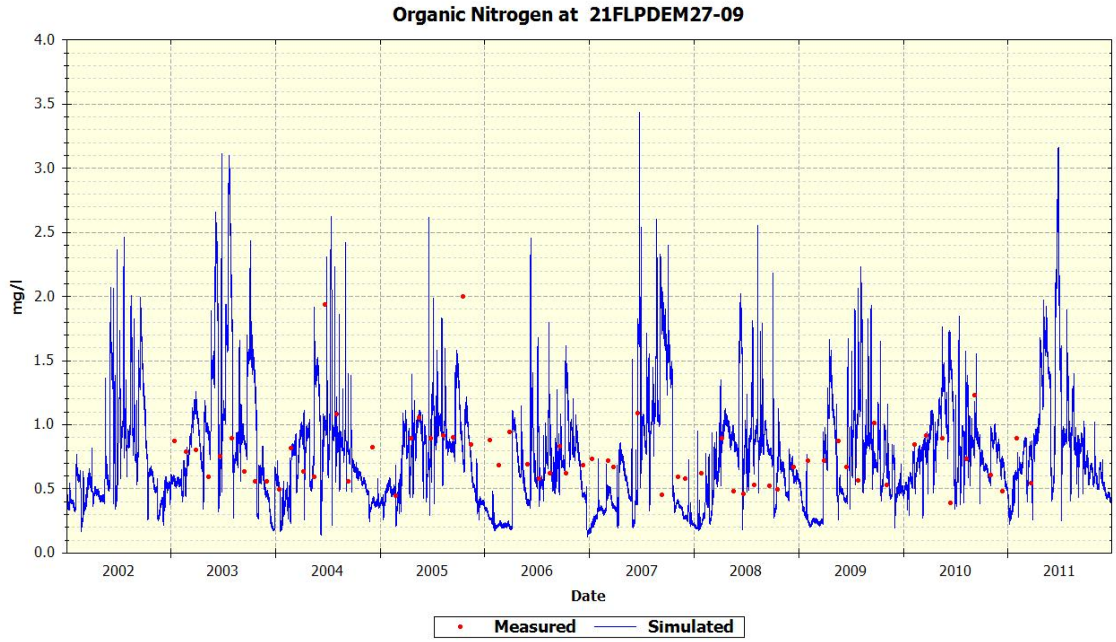


*Figure C.21. Measured vs. Modeled Organic Nitrogen (mg/L) in McKay Creek at Station 21FLPDEM27-09*

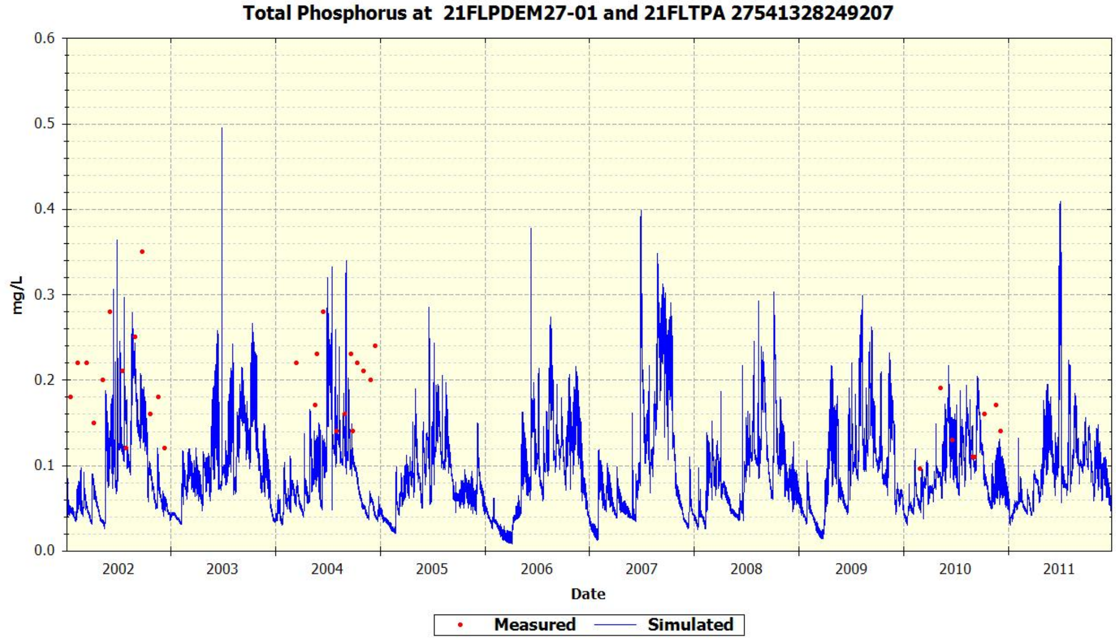


*Figure C.22. Measured vs. Modeled TP (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*

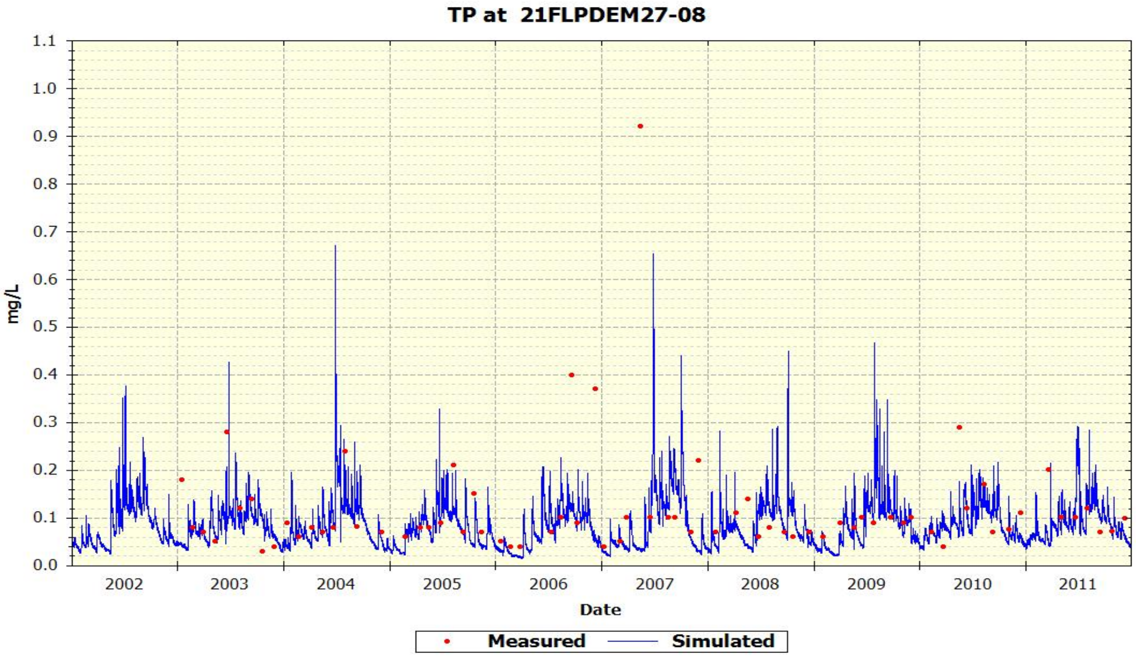


***Figure C.23. Measured vs. Modeled TP (mg/L) in Church Creek at Station 21FLPDEM27-08***

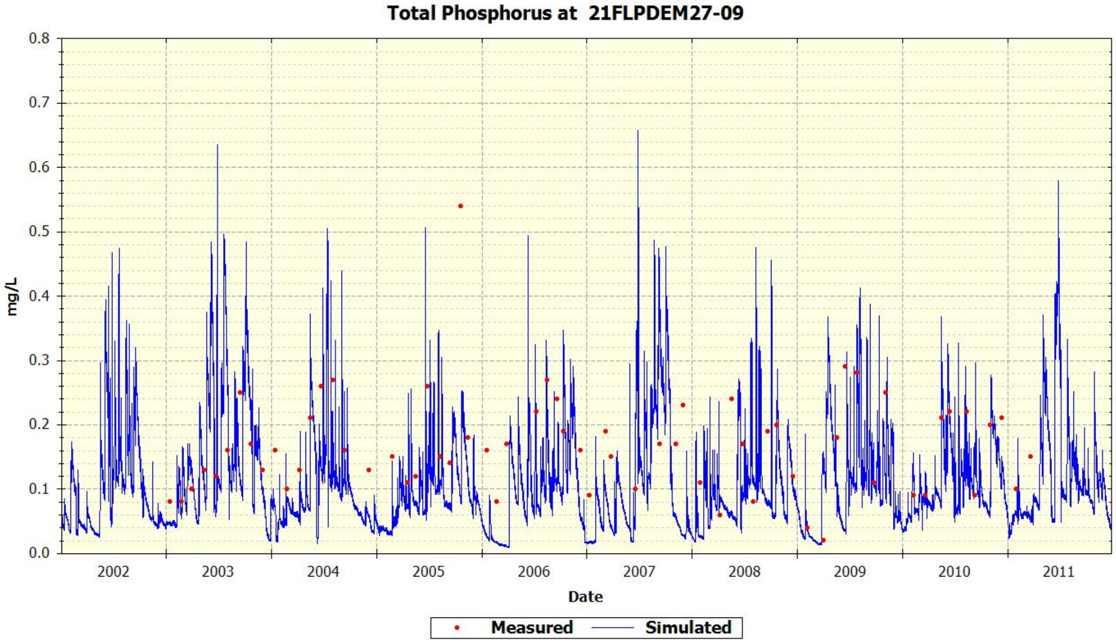


***Figure C.24. Measured vs. Modeled TP (mg/L) in McKay Creek at Station 21FLPDEM27-09***

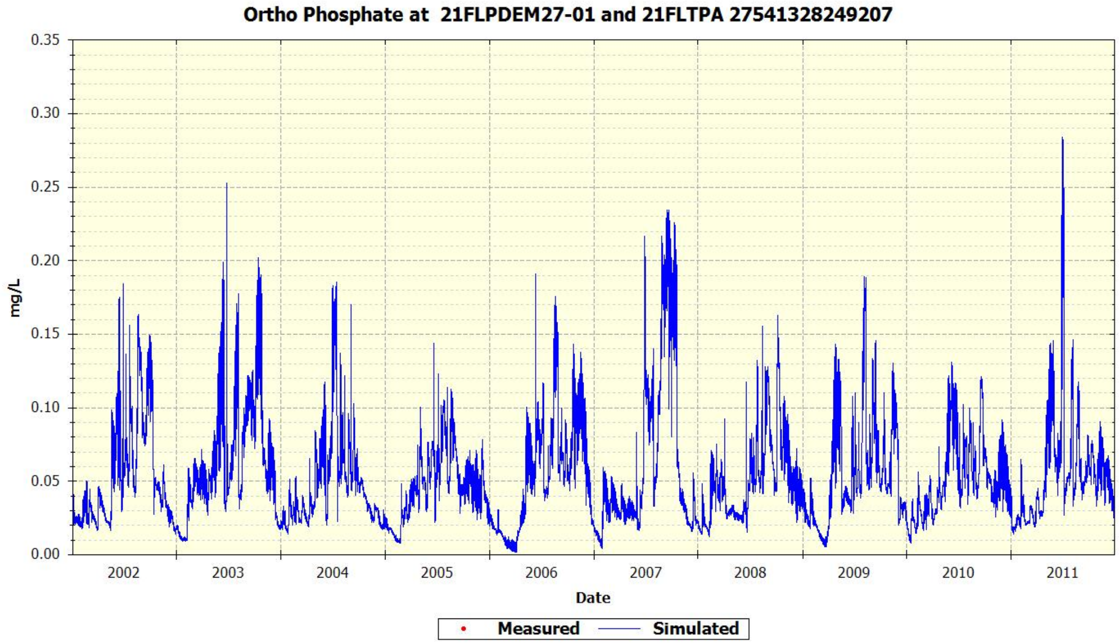


***Figure C.25. Modeled Orthophosphate (mg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207 (no data)***

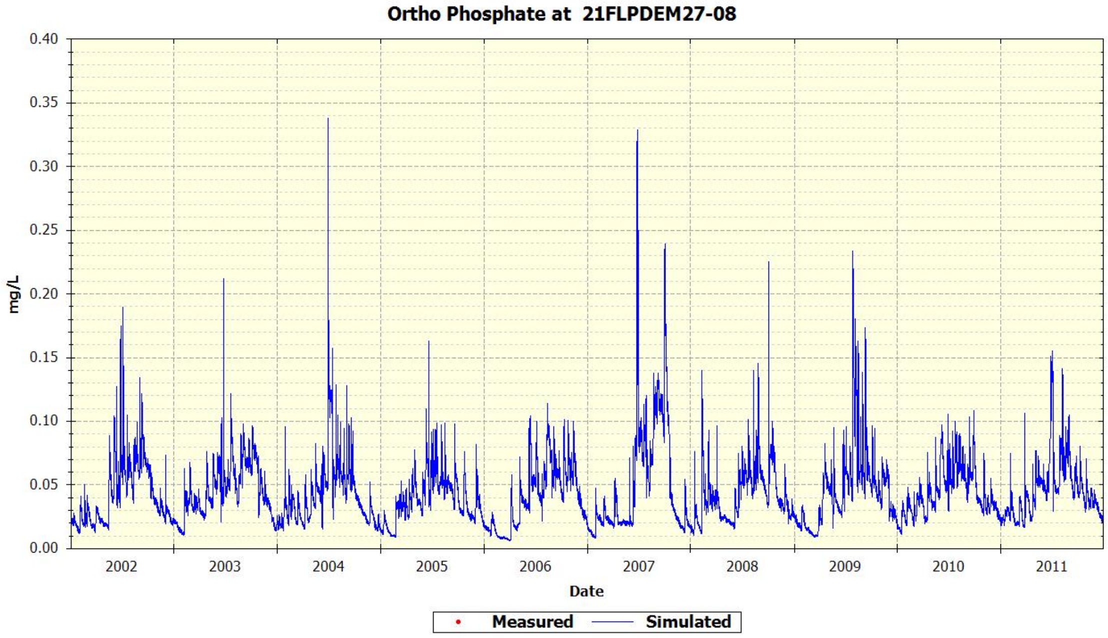


***Figure C.26. Modeled Orthophosphate (mg/L) in Church Creek at Station 21FLPDEM27-08 (no data)***

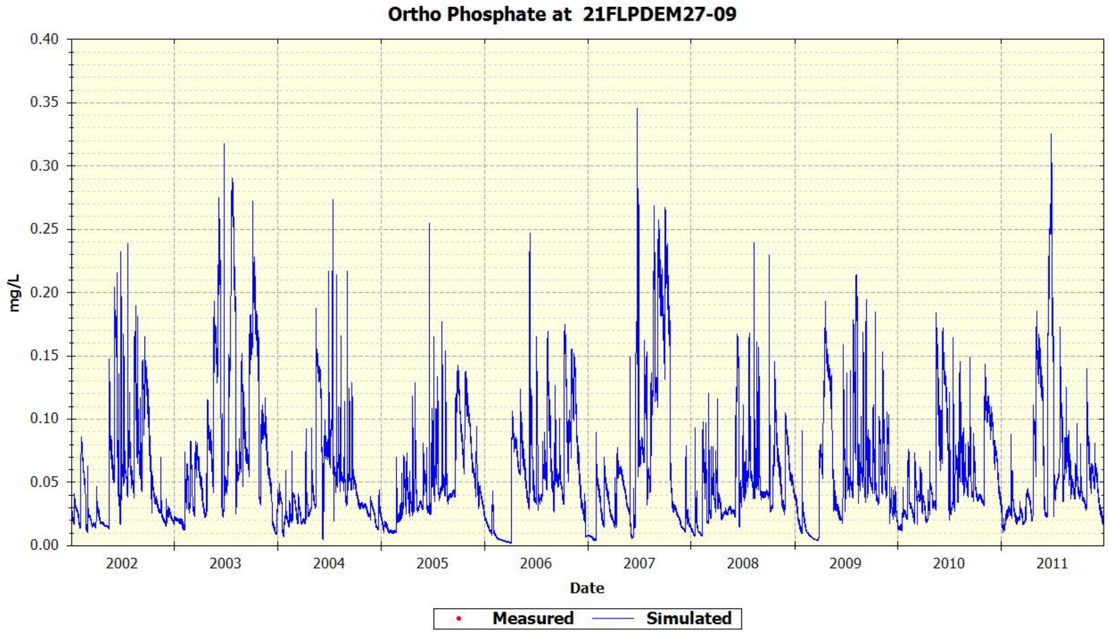


*Figure C.27. Modeled Orthophosphate (mg/L) in McKay Creek at Station 21FLPDEM27-09 (no data)*

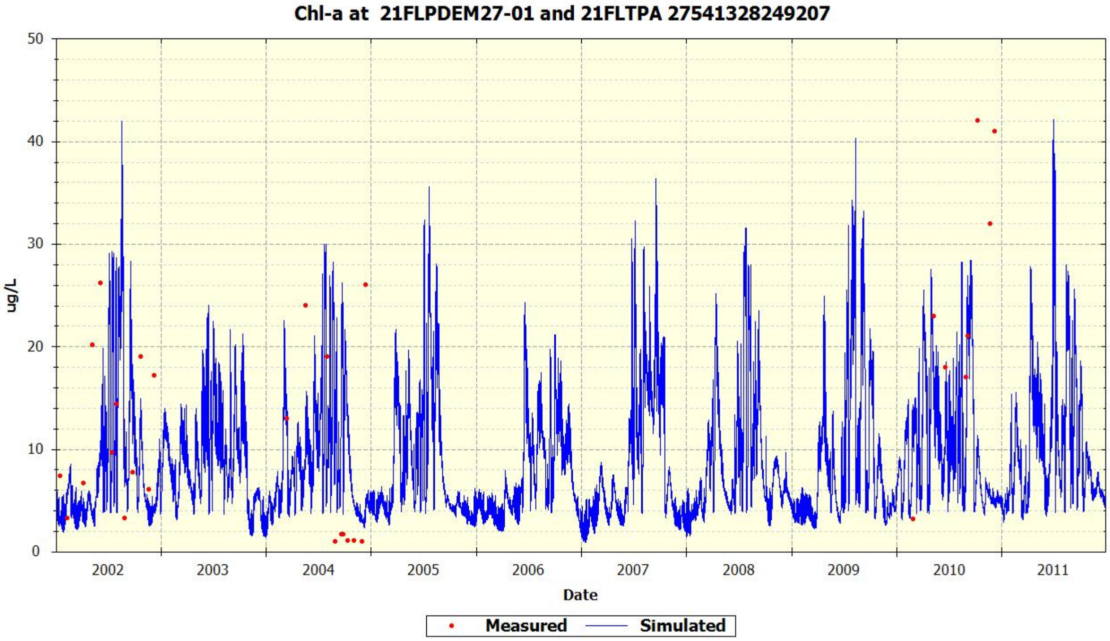


*Figure C.28. Measured vs. Modeled Chlorophyll-a (µg/L) in McKay Creek at Stations 21FLPDEM27-01 and 21FLTPA 27541328249207*

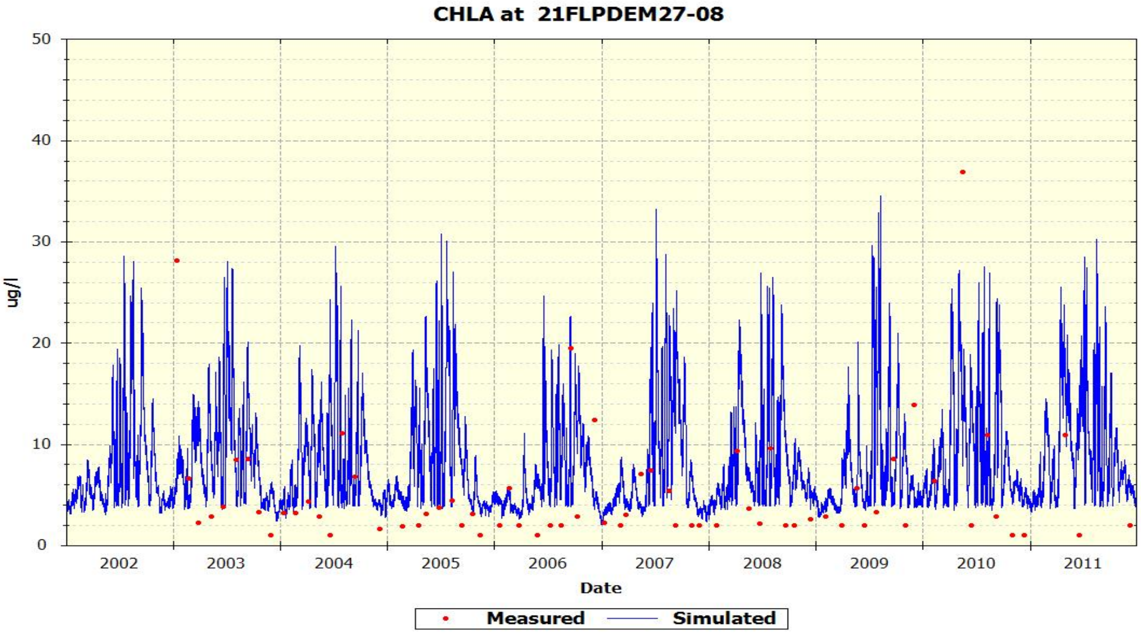


*Figure C.29. Measured vs. Modeled Chlorophyll a (µg/L) in Church Creek at Station 21FLPDEM27-08*

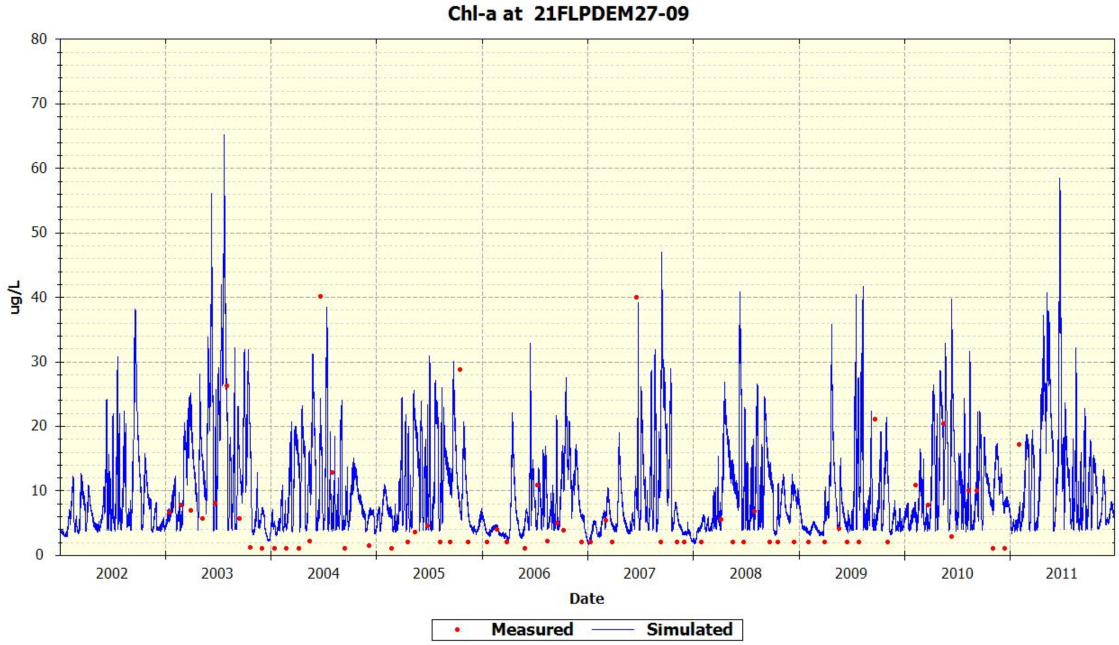


*Figure C.30. Measured vs. Modeled Chlorophyll a (µg/L) in McKay Creek at Station 21FLPDEM27-09*

## Appendix D: Public Comments on Draft TMDL Report and Department Responses to Comments

November 9, 2012

Ms. Kelli Hammer Levy
Pinellas County Department of Environment and Infrastructure
Watershed Management
300 South Garden Avenue
Clearwater, FL 33756

SUBJECT: Response to Comments on the Proposed Dissolved Oxygen and Nutrient TMDLs for the Curlew Creek Tidal Segment (WBID 1538) and the McKay Creek Tidal Segment (WBID 1633)

Dear Ms. Levy:

The Department has reviewed the Pinellas County comments, dated September 5, 2012, submitted on the draft Dissolved Oxygen and Nutrient TMDLs for the Curlew Creek Tidal Segment, (WBID 1567), and the McKay Creek Tidal Segment (WBID 1633) that were proposed in August 2012. We have prepared responses to each of your comments as itemized below.

In the order in which they were presented, what follows are the comments and our responses (shown in blue).

### Comments Applicable to both TMDLs

1. Several citations included on page 2 do not appear in the reference section including USDA, 2006; SWFWMD 2002; SWFWMD 2006; Causseaux, 1985; Trommer 1987; and Miller 1990.

   **Department Response:** The reference section of the reports has been updated with the information for the citations on page 2.

2. According to the number of exceedances, three of the reference waters (WBIDs 1535, 1140, and 1701) are impaired for dissolved oxygen, but no causative pollutant has been found and they are not impaired for nutrients, demonstrating that site specific factors play an important role in dissolved oxygen in systems in this area. The reference approach used in development of these TMDLs does not take into account these site specific factors which may include hydrology, stream morphology and alterations, land use, and temperature.

**Department Response:** The waters used for establishing a chlorophyll a target are all the estuarine waters in the vicinity of Curlew Creek and McKay Creek that are not impaired for nutrients, based on the evaluation using annual average chlorophyll a concentrations. These waters exhibit a wide range of conditions in both tidal creeks and open waters and represent what we consider as the best information available for selecting reference waters in the area along the Pinellas County Gulf coast.

3. The majority of the WBIDS in Table 3.1 used to establish the target chlorophyll a concentration are estuarine open water waters, and are not appropriate for establishing targets in tidal creeks. There is insufficient support of the chlorophyll a target of 8 µg/L and it appears an arbitrary decision using the limited reasoning that it falls within a range of values for open estuaries not impaired for nutrients. If the Department proceeds with using the reference approach, the more appropriate chlorophyll a target is the corrected annual average of 10 µg/L for Bear Creek (see the first bullet under comment 4 below), a tidal creek rather than an open estuary.

**Department Response:** The estuarine segments presented in Table 3.1, are located in the vicinity of Curlew Creek and McKay Creek and are not impaired for nutrients based on the assessment of chlorophyll a results in the IWR Run 44 database. After further review of the Bear Creek results in the Run 44 database it was determined that the estuarine portion of the water, in recent years was incorrectly assessed using data collected at station 39-02 located in the freshwater area of the creek. The annual average chlorophyll a values reported for the 2008 to 2010 period are well below the 11 µg/L estuary threshold for impairment; however, it was determined that these values were calculated using results collected at Pinellas County's freshwater site. The annual average chlorophyll a values calculated for the period of 1999 to 2002 ranged between 11 to 13 µg/L and are based on results collected at Pinellas County's estuary monitoring site, station 39-01. Based on the averages calculated using results from the estuary site, the Bear Creek estuarine area is considered potentially impaired for nutrients and is therefore not appropriate to use as a water for establishing a chlorophyll a target.

The other two tidal creek segment averages presented in Table 3.1, the Anclote River (WBID 1440) and Minnow Creek (WBID 1535), are considered appropriate to use in establishing a chlorophyll a target as they are not impaired for nutrients, based on annual average values calculated using results from estuarine sites. It should be noted that the average chlorophyll a values in these two tidal creeks are near the lower end in the range of chlorophyll a values for estuarine segments not impaired for nutrients. The average chlorophyll a values for the tidal stream segments are 5 µg/L in the Anclote River and 6 µg/L in Minnow Creek. The open estuarine segments in Table 3.1, considered in developing the chlorophyll a target, have average chlorophyll a values equal to or greater than those found in the tidal stream segments. The chlorophyll a value of 8 µg/L was selected as a target for TMDL development because it falls within the range of existing conditions in estuarine segments not impaired for nutrients along the Gulf Coast of Pinellas County. This target was considered appropriate to apply in the impaired tidal creeks as estuary segments in this area with good water quality, including open bay waters and tidal streams, have annual average chlorophyll a values at or below 8 µg/L. We consider the chlorophyll a results from both the tidal creeks and open water estuaries presented in Table 3.1, with the exception of the Bear Creek results, as the best information available for reasonably selecting a chlorophyll a target for the impaired estuary segments. The Bear Creek results have been removed from Table 3.1.

4. The following issues were found in the data from IWR Database Run 44x used in the calculation of average chlorophyll a concentrations for reference WBIDs in Table 3.1:

   - WBID 1701: No data is available for 2003 through 2007. County staff calculated an average chlorophyll a of 10 µg/L in this WBID, rather than the 5.0 µg/L reported. Ensure data from station 21FLPDEM 39-01 was included in the Department's calculation. The average chlorophyll a value without this data is equal to the 5.0 µg/L given in Table. 3.1. It is possible that the Department did not include station 39-01 in the calculation because the lat/long information in the IWR station run 44 shapefile does not correspond to the lat/longs in STORET or County files. The IWR files locate this station on dry land, outside WBID 1701 boundaries. The lat/long for station 39-01 needs to be corrected and this station included in the average chlorophyll a calculation for WBID 1701.

   - WBID 1528 and WBID 1528C: Data reported by 21FLTPA in 2004 are from stations named Boca Ciega Bay rather than Clearwater Harbor North and South, although the lat/longs indicate the stations are in WBID 1528 and 1528C. The majority of chlorophyll a results at these stations are less than the MDL and the maximum is 1.7 µg/L. These results are much lower than the typical range in these WBIDs. The results, lat/longs, and WBID designation for these data points need to be verified.

   - WBID 1535: No data is available for 2003, 2005, 2006, or 2007. No data is available for the first quarter of 2004. There is only one sample from 2008 and 2009, both taken during October. The available data is limited and not representative of variable hydrologic conditions that occur throughout the year. This WBID should not be used in determining chlorophyll a targets due to insufficient data.

   - WBID 1400: Ensure data from station 21FLGW 20085 were not used in average chlorophyll a determination. The station is not located in the river, rather an adjacent waterbody and is not representative of conditions in Anclote River Tidal Segment.

**Department Response:** WBID 1701 – As described in the response to comment 3, based on a re-evaluation of the chlorophyll a results, the Bear Creek estuary segment contained in the IWR database is not correctly assessed as WBID 1701 contains monitoring results collected in both a freshwater area and estuarine area of the creek. The annual average chlorophyll a values calculated for the period of 1999 to 2002 ranged between 11 to 13 µg/L and are based on results collected at the Pinellas County estuary monitoring site, station 39-01. Based on the averages calculated using results from the estuary site, the Bear Creek estuarine area is considered potentially impaired for nutrients and is therefore not appropriate to use as a water for establishing a chlorophyll a target. The Department's Watershed Assessment Section has been advised of the issues surrounding WBID 1701, so that the appropriate revisions can be made to the assessment of this segment in the IWR database. Removing this WBID from consideration as a reference water, does not affect the chlorophyll a value selected as the water quality target for TMDL development.

WBID 1528 and 1528C – The annual average chlorophyll a concentrations were recalculated by excluding the 2004 results from the stations named Boca Ciega Bay, which were collected by the DEP SW District Office (21FLTPA). The 2004 annual averages increased from 4 µg/L to 5 µg/L for the Clearwater Harbor South segment (WBID 1528) and from 5 µg/L to 6 µg/L for the Clearwater Harbor North segment (WBID 1528C). However, for both segments the long-term average chlorophyll a concentrations for the 1999 to 2010 period, that are presented in Table 3.1 of the TMDL report, do not change with the results from the Boca Ciega Bay stations removed. The Department's Watershed Assessment Section has been advised of the comments regarding the station assignments for WBIDs 1528 and 1528C in the IWR database so that the issue can be reviewed.

WBID 1535 – The chlorophyll a results for the years 2004, 2008, and 2009 that are referenced in the comment were not used in the calculation of the long term average value. The annual average values calculated for this segment that are provided in the IWR database are from the years 1999, 2000, 2001, and 2010. We believe it is useful to present the chlorophyll a average, based on these four years, in Table 3.1 as it provides further information about chlorophyll a conditions for estuary segments not impaired for nutrients.

WBID 1440 – The annual average chlorophyll a concentration was recalculated by excluding the one chlorophyll a result collected at station 21FLGW 20085 in 2003. The 2003 annual average, 4 µg/L, did not change with this one result removed, so it does not influence the long-term average chlorophyll a value shown in Table 3.1. The Department's Watershed

Assessment Section has been advised of the comment regarding the assignment of station 21FLGW 20085 to WBID 1440 so that the issue can be reviewed.

In summary, the issues identified with some of the reference water segments does not have an effect on the long-term average chlorophyll a concentrations that were used to select the chlorophyll a target.

5. 4.3.2 Septic Tanks: The FDOH GIS data downloaded from http://www.doh.state.fl.us/environment/programs/ehgis/EhGisDownload.htm used to determine the number of septic tanks results in a gross underestimation of the actual number septic tanks. Selecting data from this file for all tanks located in Pinellas County results in a total of 3,661 records for existing, new, or repaired septic tanks. From this data the Department found that 31 tanks were located in the McKay Creek watershed and 278 in the Curlew Creek watershed. According to the statistics at http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm, there are a total of 23,869 septic tanks in Pinellas County. This is 20,208 septic tanks more than the number contained in the county-wide GIS data. The primary reason for the discrepancy is that the oldest record in the GIS data is from 1998, while the statistics are based on 1970 census data plus the number of systems installed since 1970. Any septic that was installed prior to 1998 without a DOH repair permit is not reflected in the GIS data. The GIS data is not appropriate for estimating septic tank numbers. It likely underestimates the number of septic tanks in these watersheds at a similar magnitude to the county-wide underestimation.

   **Department Response:** Our understanding is that the Florida DOH GIS coverage of septic tanks is the only one available for Pinellas County at this time. We were informed that the county is working on developing a coverage, but that this project is in the beginning stages and that it is expected to take at least several months to complete. The DOH septic tank information was not used to develop the TMDLs for either the Curlew Creek or McKay Creek tidal segments. The Curlew Creek TMDL was developed using an empirical approach based on the relationship between in-stream total nitrogen concentrations and chlorophyll a values. For the McKay Creek TMDL, it was determined based on the GIS coverage, that there are a small number of septic systems in the watershed and they were not explicitly accounted for in the watershed modeling. We have reviewed coverages of wastewater treatment plant service areas that were made available, in order to identify potential septic systems in the McKay Creek watershed. The service areas located in the McKay Creek watershed indicate that the majority of the watershed is served by wastewater treatment facilities, which supports that there are a minimal number of septic systems in the basin.

**McKay Creek Tidal Segment, WBID 1633, Dissolved Oxygen and Nutrient TMDL**

1. Identification of Waterbody: The list of cities that the watershed covers is incorrect. The headwaters are not located in the City of St. Petersburg. The city boundaries in Figure 1.2 are inaccurate. Figure 1 below shows the McKay Creek basin and nearby city limits using municipal boundary data available at http://gis.pinellascounty.org/gisData/gisDataSets.aspx.

   **Department Response:** An accurate city limit coverage has been obtained and the report maps and text have been updated to exclude the references made to the City of St. Petersburg.

2. Two chlorophyll a values used in the calculation of the 2004 annual mean in Table 2.3 were Q qualified as shown in the IWR database because they failed to meet holding time. According to STORET, samples from both 21FLTPA sites on 5/25/2004 were 19 days past the 48 hour holding time. Removal of these points from the dataset reduces the annual mean from the reported 17 µg/L to 15 µg/L. County staff has concerns that poor data quality may impact the TMDL determination.

   **Department Response:** As noted in the comment, when the two values collected on 5/25/2004, 42 µg/L and 82 µg/L, that have an associated remark code of "Q" are excluded from the analysis the 2004 annual average is 15 µg/L. The removal of these two values from the calculation of the annual average does not change the nutrient assessment for the tidal segment as the 2004 average is still greater than the 11 µg/L estuary impairment threshold. In the development of the surface water quality model there was not an attempt made to adjust model coefficients to simulate the chlorophyll a levels reported on 5/25/2004, therefore the results in question would not have an impact on TMDL development. The proposed TMDLs were established based on conditions observed throughout the multi-year model simulation period rather than on any one critical/seasonal condition because the methodology used to determine impairment is based on water quality results collected in multiple years. The Department's Watershed Assessment Section has been advised of this comment so that the issue can be reviewed in the context of the surface water assessment for the tidal segment.

3. 4.2.2 Municipal Separate Storm Sewer System Permitees and 6.3.2 NPDES Stormwater Discharges: Remove all references to the City of St. Petersburg MS4 permit. See Figure 1.

   **Department Response:** The report text has been corrected to remove all references made to the City of St. Petersburg MS4 permit.

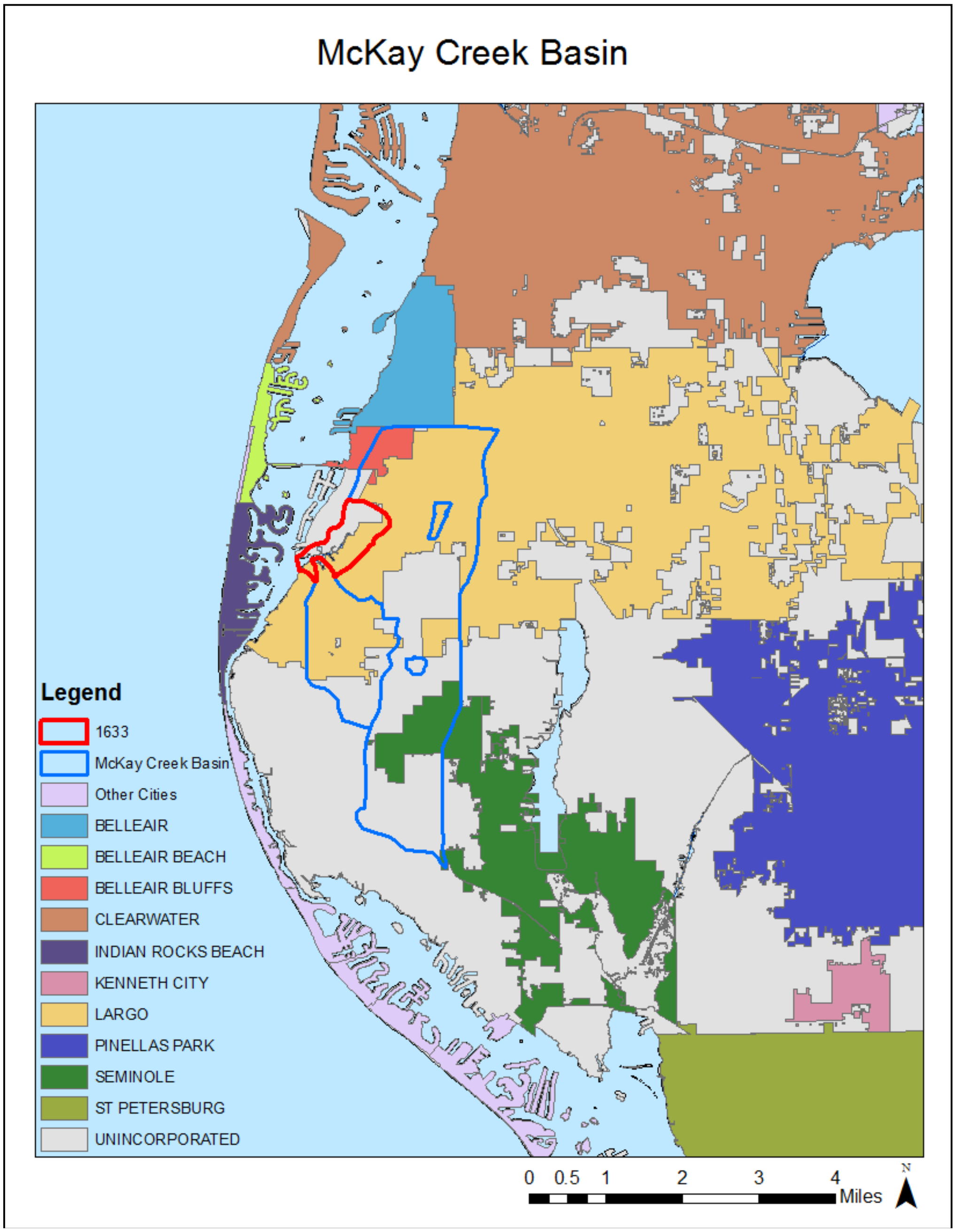


**Figure 1. Map of the McKay Creek Basin and Nearby Municipalities**

4. The Technical Support Documents for the LSPC, EFDC, and WASP7 models used for TMDL determination are not available to the public. Without being able to view model assumptions, calibrations, and other details contained in these reports, Pinellas County and other stakeholders are unable to fully review, understand, and comment on the development of the TMDL. We request these documents be made available and the comment period be extended for an additional 30 days once they are available.

   **Department Response:** Technical support documents for the larger LSPC and EFDC models have been provided to the Department and are enclosed for review. The documents will be included as appendices to the TMDL report. A spreadsheet documenting the WASP coefficients used in the McKay Creek model have been provided to the Department and is enclosed for review.

5. 5.3 Model Development: McKay Creek flows through three lakes with operable weir structures-Walsingham Reservoir, Taylor Lake, and a 5-acre unnamed lake. How were these accounted for in the modeling?

   **Department Response:** The reservoirs were accounted for in the land use as open water. No data were available for daily operation of the weir flow based on an interview search, and they were assumed to be "run-of-the-stream" weirs, meaning that flow into the lakes is equal to flow out of the lakes, in the model calibration.

6. 5.3 Model Development: Sub-watersheds were assigned the hydrologic soil group that has the highest percentage of coverage within the sub-watershed boundaries. Many of the sub-watersheds have a high percentage of more than one soil group. Can the hydrologic soil groups be defined at a smaller scale for a more accurate representation?

   **Department Response:** The sub-watersheds can only be represented by one hydrologic soil group. A finer delineation is required to change the hydrologic soils assignment. In the McKay Creek watershed, different soils assignments will likely not have a large influence on results because the land use is predominantly high density development, and parameterization of high density land uses will be similar for all soil groups.

7. 5.3 Model Development: How did the Department ensure the accuracy of modeled discharge given the lack of continuous flow data in McKay Creek for calibration of the watershed model?

**Department Response:** Flow calibration was performed using all the available flow results and we believe the simulated flows are well calibrated to the available instantaneous flow results. Much of the flow data appears to be collected during low flow periods, and the simulated discharge is in close approximation to the measured data. Additionally, the McKay Creek watershed model used the Crystal Watershed hydrodynamic calibration which was calibrated to continuous flow measurements collected at the USGS station in the Anclote River (see enclosed Crystal Watershed report).

8. 5.3 Model Development: The County has the McKay Creek watershed delineated at a smaller scale into 26 sub-basins that is available for watershed modeling.

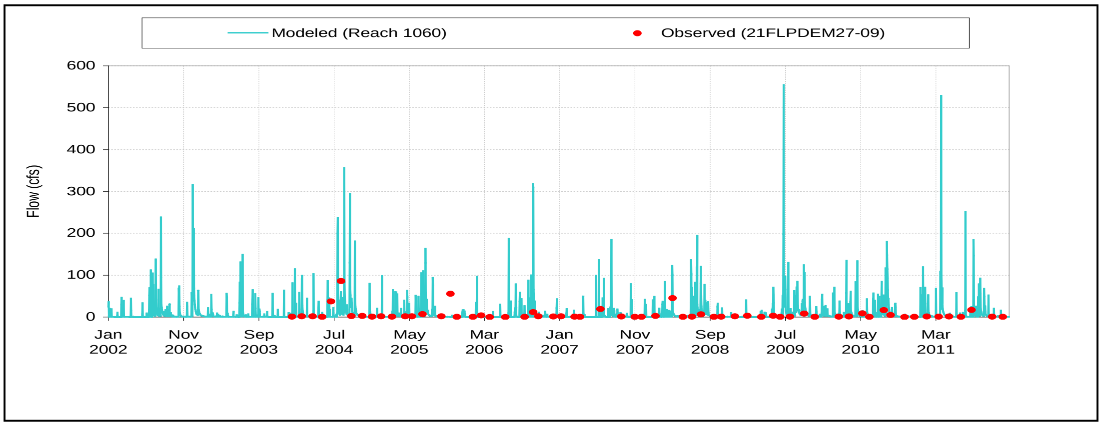
**Department Response:** The County delineation was used to develop the boundaries for the sub-watersheds. The LSPC model is a lumped land use model, and using smaller delineations would not change the land uses and therefore not change the water quality loadings from the land uses in the sub-watersheds. Adding additional sub-basins, specifically at that fine of a scale, will not impact the model nutrient calibration, but would increase the run time.

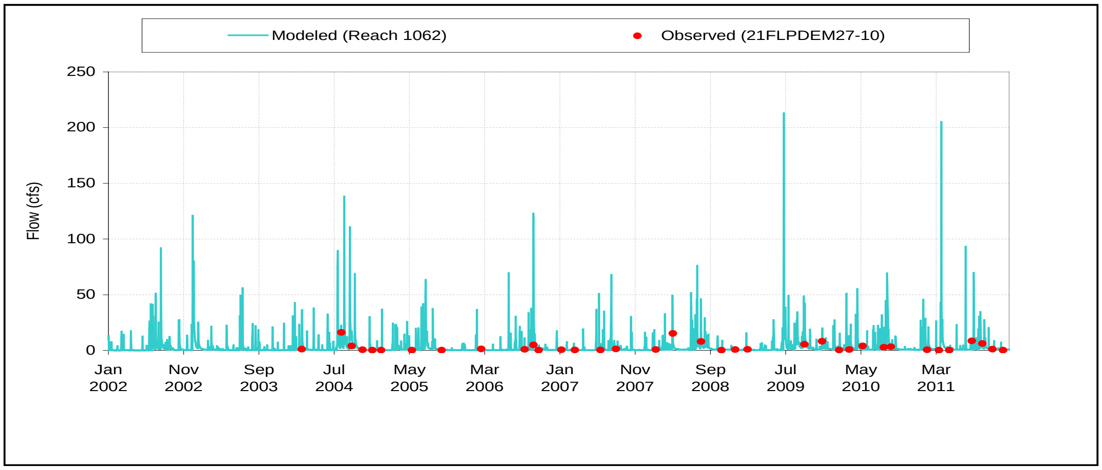
9. 5.3. Model Development: There is additional Pinellas County data available in McKay Creek at 27-03. Why was this not used in model calibration? This station is located at a boundary of one of the 26 sub-basins. Would the use of smaller sub-basins enable calibration to this data?

**Department Response:** Station 27-03 was not used in calibration because it was not located near an outlet of a sub-watershed. A finer sub-watershed delineation would allow for validation to this station. Additionally, the purpose of the LSPC model was to provide nutrient loading to the downstream water quality model and station 21FLPDEM27-09 would still be the priority calibration station because it is downstream of 21FLPDEM27-03.

10. No flow data was plotted in Figure 5.3 or 5.4 for 2005 through mid 2009. Pinellas County flow data is available for sites 27-09 and 27-10 in STORET, but does not appear in the IWR database. The IWR database should be corrected and this data included in the graphs.

**Department Response:** The flow data in question located in STORET was not included in the IWR database because incorrect units were attached to the flow results. The missing results have been added to the flow calibration graphs provided below and have been included in the report figures. The county will need to include the correct units for the flow results in STORET so that these results can be included in the IWR database.





11. Figures 5.11 through 5.15, only show data at 27-09 through June 2009, but data is available in the IWR database through 2011. What time period was used for calibration?

    **Department Response:** The period of calibration was from 2002 through 2009. The missing data from 2009 to 2011 has been added to the graphs and have been used for model verification for the years 2010 and 2011.

12. Calibration of the LSPC model using available data is inadequate based on the following:
    - Modeled flow appears significantly higher than observed flow for many of the data points. Use of this model could overestimate loading considerably.
    - The model underestimates dissolved oxygen at 27-10 in many instances and rarely overestimates DO. DO is regularly observed at levels greater than 8 mg/L, but according to the model, DO rarely surpasses this value. The model is also a poor fit for measured dissolved oxygen at 27-09. The modeled DO range is approximately 5.5 to 9 mg/L, but measured DO ranges from 1.92 to 10.32 mg/L.

- The model overestimates TN compared to actual measured TN. Modeled TN concentrations regularly exceed the maximum measured concentration and are often more than double the highest ever observed in the creek.

- The model overestimates TP at both stations. At 27-10, nearly all measured values fall below modeled values indicating inadequate calibration with available data. The highest measured TP at 27-10 was 0.08 mg/L which occurred on May 16, 2005. Nearly all modeled concentrations exceed this value and reach up to 10x the maximum observed value.

**Department Response:** We believe that the modeled flow during low flow periods is well calibrated to the data provided. Much of the flow data appears to be collected during low flow periods, and the simulated discharge is in close approximation to the measured data. The higher flow values occur during storm events, and data is not always available for calibration during these time periods. Additionally, the model used the Crystal Watershed hydrodynamic calibration which was calibrated to flow at the USGS station in the Anclote River (see enclosed Crystal Watershed report). Calibration at this station, which included continuous USGS discharge flow data, indicated that the model slightly under predicted high flows, although the calibration to high flows was still within the accepted USGS error percentage range.

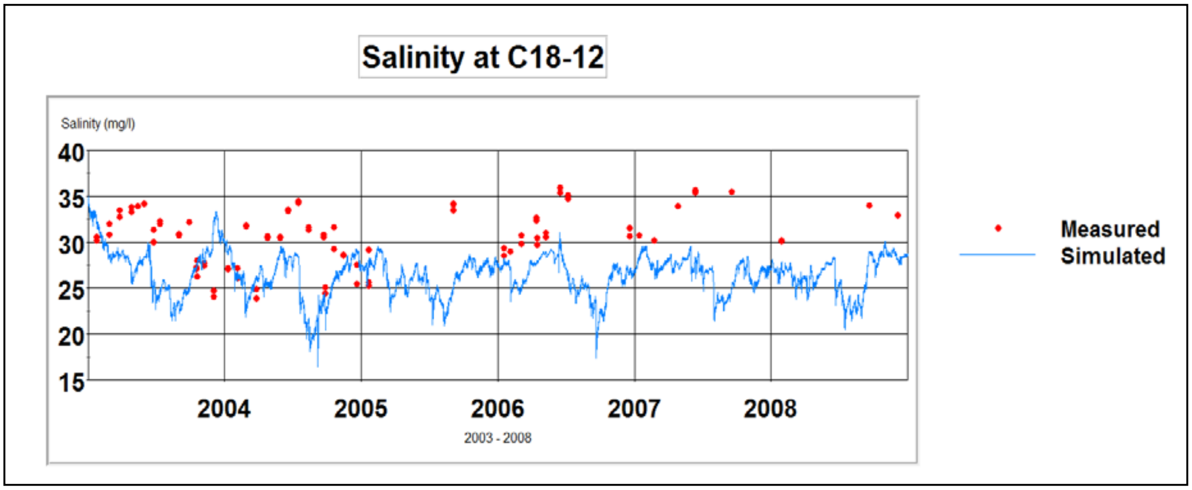
The purpose of the LSPC model was to provide loads to the WASP water quality model. For that reason all in-stream transformations that impact DO were not simulated in the LSPC model, but were simulated in the WASP model. The purpose of the LSPC model was to represent the general trends occurring in the measured DO. The model represents the low DO measurements that occurred in the summer of 2003 and 2010 at station 27-10. The low DO measurements in the WASP model are used as the critical condition to develop the TMDL load, and increasing DO concentrations during the winter months, when the highest DO results were measured, would not impact the TMDL reductions for this reason. The DO at station 27-09, located in the WASP model domain, has the same trend as DO at station 27-10.

The TN calibration was performed to best represent the overall loading to the WASP water quality model. The TN concentrations are higher during summer rainfall events, likely because of the flashiness that occurs in the developed watersheds. Additionally, the model also has periods of modeled TN that are lower than measured.

The TP calibration was done to best represent the overall loading to the WASP water quality model. TP concentrations are higher during summer rainfall events, likely because of the flashiness that occurs in the developed watersheds. Additionally, the model also has periods of modeled TP that are lower than measured TP at station 27-09, which is the downstream station located in the WASP model domain that is closest to where the watershed loads enter the WASP water quality model.

13. 5.3.2 EFDC Model Development: Measured salinity at station 21FLDPEM27-01 and Pinellas County stations in Clearwater Harbor are better representations of salinity for use with the EFDC model than average Gulf of Mexico salinity and are more appropriate for use in model simulation.

    **Department Response:** The time series salinity model output from the Big Bend model was used as a boundary condition for the McKay Creek model, not the average salinity in Gulf of Mexico. See the calibration plot below for the Big Bend salinity outputs at the calibration station located closest to McKay Creek. Salinity outputs for the entire Big Bend model can be found in the enclosed Big Bend Hydrodynamic Model appendix. Additionally, Figure 5.17 in the TMDL report shows that modeled salinity in McKay Creek is similar to measured salinity at station 21FLDPEM27-01. The model is able to predict periods of both high and low salinity.



**Modeled vs. Observed salinity at Station C18-12, Clearwater Harbor**

14. 5.3.2. EFDC Model Development: USGS Station 02309110 located in WBID 1633 has gage height data available since 2007. Was data from this site considered for calibrating water surface elevation?

    **Department Response:** USGS station 02309110 was not used for calibrating surface elevation. The EFDC hydrodynamic model is based on grids and each grid cell represents the average width and depth of the channel over a large area. The cross-section at the USGS gage site may not be representative of the entire grid cell, and bathymetry at this location may be different than bathymetry for the entire cell.

15. 5.3.3 WASP Model Development, pg. 36: Previous reports have used a 2.47 ratio to convert BOD to CBOD based on the EPA's 1997 Technical Guidance for Developing Total Maximum Daily Loads. Please provide explanation for the 1.5 ratio used here.

    **Department Response:** The f ratio used in the McKay model was based on the decay rate for the CBOD used in the model. The decay rate for the CBOD used in the McKay Creek model is 0.2 per day and the corresponding f ratio value is 1.5. The f ratio is a factor also used in modeling to convert BOD to CBOD.

16. Modeled existing chlorophyll a conditions in McKay Creek tidal segment in Table 5.1 meet the 11 µg/L criteria for impairment for all years except 2010 and 2011 and there have been significant improvements in DO seen during the Cycle 2 verified period. Only 6 of 43 DO measurements did not meet criteria in Cycle 2 suggesting the WBID is no longer impaired for DO. These factors bring into question the need for a TMDL in this WBID, and make the stormwater load reduction requirement of 45% appear excessive.

    **Department Response:** The models used for TMDL development were calibrated to best represent the fit to the range and pattern in the measured data. The loads used to establish the TMDLs were the loads applied in the calibrated model that were found to be necessary to meet the minimum marine DO criteria of 4 mg/L at all times and the chlorophyll a target of 8 µg/L, as an annual average, for the 10-year model simulation period. Using this approach to establish the TMDLs provides for an adequate margin of safety, which is necessary in TMDL development to address the uncertainties in the relationship between pollutant loads and receiving water quality. Please note that the segment remains on the verified list for DO because the number of criteria exceedances is not low enough to delist the segment for DO impairment following the IWR methodology. Table 4 of the IWR shows the data requirements that must be met to delist a water body for DO. In this case, with 43 results, not more than 1 value can exceed the criteria to support delisting the segment.

17. Calibration of the WASP7 model using available data is inadequate based on the following:

    - The modeled DO range is narrow compared to the measured DO. Discrepancies are especially obvious in 2002 in McKay Creek Tidal and in the fluctuation patterns at 27-09.
    - TN is modeled over a much larger range of concentrations in McKay Creek segments and a smaller range in Church Creek than measured concentrations.
    - The high range of measured nitrate-nitrite concentrations in Church Creek are not captured in the model predictions.

- The lower end of chlorophyll a measurements in all segments are not represented in the model predictions.

  **Department Response:** The WASP model provides the best overall calibration for all stations used in model calibration. In 2002 at station 27-01, the model simulation DO is higher than the measured DO. The measured data from 2002 was collected at several depths, including 0.1 meters, and the model represents average DO concentrations. Additionally, causes of the low DO in 2002 may have been removed from the system in the last decade, which is why the model was unable to represent the low DO that year. The model matches the seasonal trend for the years 2004 and 2010 in McKay Creek at this station. Additionally, the model predicts the overall trends at station 27-09. The model predicts DO between 4 mg/L and 11 mg/L, and the measured DO ranged from 2 mg/L to 10 mg/L, with most measured DO occurring within the 4 mg/L to 10 mg/L range. Calibrations at these two stations show that the model is predicting the overall trend in DO in McKay Creek and estuary. Within Church Creek, the modeled DO is also similar to the measured DO trends.

  Both Church Creek and McKay Creek consist of high intensity developed land, and the modeled loads and nutrient concentrations from both watersheds were similar for this reason. The calibration was accomplished by reviewing all calibration stations in the watershed and producing the best overall result. The TN loads from the LSPC model were partitioned to provide the best representation of the TN species.

  All three modeled species, NOx, NH4, and organic nitrogen were similar to the measured data, with the exception of NOx in Church Creek. Measured concentrations of NOx were greater than modeled concentrations, including NOx concentrations during storm events, which indicated that there may be an unidentified source of NOx in Church Creek. Measured NOx values in McKay typically ranged from approximately 0.01 mg/L to 0.4 mg/L, while modeled values were typically within this range as well. Overall, the model captured the NH4 and organic nitrogen ranges in the measured data at all three stations.

  The chlorophyll a calibration was done to best represent the entire range of data collected, including the summer growth periods. The lower range of the calibrated chlorophyll a is approximately 1-2 µg/L higher than the measured data, which represents a small increase over the measured data, which is well within the acceptable difference when modeling chlorophyll.

18. The models were run through the end of 2011, but only calibrated with available data through March 2011. Pinellas County data for stations 27-08, 27-09, 27-10 are available through the end of 2011 in STORET and should be included for better calibration.

    **Department Response:** Revised plots featuring additional data collected through the end of 2011 at stations 27-08, 27-09, and 27-10 will be included in the updated TMDL report.

**Curlew Creek Tidal Segment, WBID 1538, Dissolved Oxygen and Nutrients TMDL**

1. 1.2 Identification of Waterbody: The City of Safety Harbor is not within the boundaries of the Curlew Creek watershed.

   **Department Response:** An accurate city limit coverage has been obtained and the report maps and text have been updated to exclude the City of Safety Harbor.

2. Table 2.1: The table is incorrectly titled Mckay Creek Tidal.

   **Department Response:** The title for Table 2.1 has been corrected.

3. 4.2.2 MS4 Co-permitees and 6.3.2 NPDES Stormwater Discharges: Remove Safety Harbor from the list of co-permittees.

   **Department Response:** The report text has been corrected to remove Safety Harbor as a co-permittee to the Pinellas County MS4 permit.

4. 4.4 Nonpoint Loading Estimates: Include station IDs for the water quality data at County Road 1 used to calculate loads.

   **Department Response:** The text in section 4.4 has been revised to identify the stations for the water quality data at County Road 1 used to calculate loads. Monthly nutrient loadings were calculated using all available total nitrogen and total phosphorus results collected at County Road 1. The results used were from sampling conducted by the USGS (site 112WRD 02309425), Pinellas County (site 21FLPDEM10-02), and the DEP SW District Office (site 21FLTPA 28024988245339), that are available in the IWR Run 44 database, and sampling results collected by the City of Dunedin (site 6), that were provided by the city.

5. 4.4 Nonpoint Loading Estimates: Monthly loads were summed to find annual loads. Please provide information on the methods used to calculate monthly loads given the stream flow measurements are available at 15 minute intervals and water quality data are available at varying intervals with some months having multiple water quality measurements and some months having no water quality measurements.

   **Department Response:** The text in section 4.4 has been revised to include the methods used to calculate monthly loads. Loadings at the USGS gage were calculated as follows. Monthly hydrologic loads were calculated by averaging the daily average flows, which were downloaded from the USGS stream flow web site, for each month to determine a monthly average daily flow in cubic feet per second (cfs). The monthly average daily flows were then converted to a total monthly flow volume in cubic meters per month.

Monthly nutrient loadings were calculated using all available total nitrogen and total phosphorus results collected at County Road 1 at the sites identified in the response to comment 4. In months when one result is reported, that value represents the monthly concentration value. In months when more than one result is reported, the values were averaged to obtain a monthly value. In months when no results are reported, the average of the previous month and the succeeding month values was used as the monthly concentration value. The monthly concentration values, along with the monthly flow volumes, were used to calculate a monthly loading estimate for total nitrogen and total phosphorus.

6. Figure 4.6: Why are Mid-County TP results for 2005 not available? Include the calculated total load for 2005 in the graph.

   **Department Response:** The 2005 Mid-County WWTP total phosphorus results have been obtained directly from the DEP Southwest District Office and Figure 4.6 has been updated to include the annual loading estimates for 2005.

7. The City of Dunedin data was provided to attendees at the public workshop on 8/21/2012. The files do not indicate whether or not the reported chlorophyll a values were corrected for pheophytin. For TMDL use, data should meet the guidelines set forth in *Applicability of Chlorophyll a Methods* (DEP-SAS-002/10, October 24, 2011).

   **Department Response:** The City of Dunedin confirmed in a September 13, 2012 email (enclosed), which was sent to the Department and Pinellas County, that the method used for the city's chlorophyll a analysis includes correction for pheophytin.

8. 5.2 Pinellas County began monitoring the tidal segment at station 10-01 in 1991 (not 1992). Data from 1991 is available in the IWR database, but was not used in the analyses in the section. Please include 1991 data or provide an explanation for its exclusion.

   **Department Response:** Based on the IWR database, there are water quality results at station 10-01 in 1991 for dissolved oxygen beginning in January and for chlorophyll a beginning in June. However, there are only results in the IWR database for total nitrogen and total phosphorus beginning in February 1992, so the analysis conducted for TMDL development started in 1992. For information purposes, the dissolved oxygen and chlorophyll a graphs in Appendix B have been updated to include the results from 1991. Text has been added to the report to explain why the analysis for TMDL development started in 1992.

9. 5.2 Analysis of water quality: Include the station names for sites at Alternate US 19 used in the analysis.

   **Department Response:** The text in section 5.2 has been revised to include the monitoring site identification numbers at Alternate US 19.

10. 5.2 Analysis of water quality: A comparison of individual results for exploratory variables in addition to TN (TP, freshwater inflow, and nutrient loads) would aid in determining whether or not other relationships exist. Although analyses are provided comparing annual average values in Appendix C, a comparison of individual results, like was done with TN as shown in Figure 5.3, would provide a larger sample size and may reveal other relevant relationships.

    **Department Response:** The original analysis performed included a comparison of both individual results and annual average values. Appendix C has been updated to include the results of the regression analyses comparing individual results of chlorophyll a concentrations to explanatory variables. The analysis of individual results did not show a strong relationship of chlorophyll a results to explanatory variables. The strongest relationship identified was between annual average in-stream chlorophyll a and total nitrogen concentrations. The annual average relationship is most useful for TMDL development, as annual average chlorophyll a concentrations are used to identify nutrient impairment following the state's Impaired Waters Rule methodology.

11. 5.2 Analysis of water quality, pg 27, par 5: "The 2011 annual average chlorophyll a concentration was lower than the selected chlorophyll a target based on current conditions." Please provide the 2011 average.

    **Department Response:** Please note that after the Department proposed the TMDL, the City of Dunedin's contract laboratory provided an accurate chlorophyll a result for the 9/22/2011 sampling event that was not included in the original analysis. There was an error in the reporting of chlorophyll a results for the September 2011 sampling event and the city's result at the Alternate US 19 location on Curlew Creek, previously provided, was off by 1000. The correct result for 9/22/2011 is 12 µg/L. The 2011 annual average without the September result is 6.7 µg/L and with the result included it is 7.2 µg/L. The updated 2011 annual average chlorophyll a value of 7.2 µg/L has been added to Section 5.2 of the report.

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Including the chlorophyll a and total nitrogen results for the 9/22/2011 sampling event in the regression analysis, 12 µg/L and 0.94 mg/L respectively, results in a 2011 annual average chlorophyll a value of 7.2 µg/L and an annual value for total nitrogen of 1.12 mg/L. The r-square value of the relationship between annual average chlorophyll a and total nitrogen improves slightly to 0.58 with the September 2011 results included. Chapter 5 of the report has been revised with the updated regression analysis.

12. The relationship between chlorophyll a and TN as shown in Figures 5.3 and 5.4 is skewed by the high chlorophyll a concentration of 404 µg/L from 1/26/1994. Field notes and other data from this sampling day (ex. dissolved oxygen, pH, turbidity) are not indicative of an algae bloom, brining into question the validity of the chlorophyll a result. Does the $r^2$ improve if this data point is removed? If it does, the Department should consider removing the data point and recalculating the TMDL based on the revised regression equation.

**Department Response:** The regression analysis used to establish the total nitrogen TMDL was also performed by excluding the 1/26/1994 total nitrogen and chlorophyll a results and including the results for 9/22/2011, as explained in the response to comment 11. The r-square value of the relationship between annual average chlorophyll a and total nitrogen concentrations is 0.51 ($p$ value $< 0.05$) when the 1/26/1994 results are excluded. If the regression equation for this relationship is applied, the total nitrogen concentration needed to meet the chlorophyll a target is lower and results in a higher percent reduction in the existing total nitrogen concentration.

13. Only 57 percent of the variation in average chlorophyll a concentration is explained by average TN concentrations indicating other variables may significantly influence chlorophyll a values.

**Department Response:** It is recognized that other factors besides nutrient concentrations will influence chlorophyll a values in surface waters. However, we believe that the significant relationship identified between annual average chlorophyll a and total nitrogen values is sufficient for establishing a nutrient TMDL and is the best way to move forward in addressing water quality problems in the Curlew Creek tidal segment.

14. Using the formula $y = 29.372x - 20.403$ provided in Figure 5.4 and a target chlorophyll a concentration of 8 µg/L, the target TN load is calculated as 0.97, rather than the 0.96 mg/L stated in the report. This change makes the required reduction 15%, rather than the reported 16%. Please verify whether the difference is due to rounding or calculation error and correct as needed.

**Department Response:** The slight discrepancy in the calculation of the total nitrogen target is due to a difference in rounding. The Department used the regression equation to calculate a total nitrogen concentration that results in achieving a chlorophyll a concentration of 8.0 µg/L. Using a total nitrogen concentration of 0.97 mg/L in the equation results in a chlorophyll a concentration of 8.1 µg/L.

As noted in the response to comment 11, the regression equation has been updated with the results from the September 2011 sampling event. The updated regression equation is y=28.928x – 19.625, and using this equation results in a total nitrogen concentration of 0.95 mg/L to achieve a chlorophyll a value of 8.0 µg/L. The existing total nitrogen concentration, using the 2011 average of 1.12 mg/L, is slightly lower than the value originally used. The existing total nitrogen concentration will need to be reduced by 15 percent to achieve the revised target concentration of 0.95 mg/L. Chapters 5 and 6 of the report have been revised using the updated total nitrogen concentration target and percent reduction calculation.

15. Load reductions required to meet the concentration target were not determined.

**Department Response:** The analysis conducted for TMDL development included the comparison of watershed loads at the USGS gage to chlorophyll a results, however, there were no significant relationships found. The establishment of a TMDL based on a concentration target and percent reduction is an appropriate method for expressing a TMDL. We believe this method is the best way to move forward in addressing water quality problems in the Curlew Creek tidal segment. EPA supports using either (or both) a concentration or load target when setting nutrient TMDLs, as appropriate.

16. 6.3.2 NPDES Stormwater Dischargers: This section states that permitees “may be responsible for a 29 percent reduction in current anthropogenic total nitrogen loading”; however the derived TMDL was calculated as a total nitrogen concentration. No relationship has been established between loading and concentration.

**Department Response:** As noted in the response to comment 14, the reduction needed in the existing ambient concentration to meet the total nitrogen target is 15 percent, using the updated regression analysis. As indicated in Section 6.3.2, jurisdictions in the watershed may be responsible for meeting the TMDL percent reduction in their current anthropogenic load. This determination can be made after further evaluation in the development of a restoration plan. Other factors, such as in-stream processes which also influence algal biomass, can be taken into consideration when developing the specific load reductions in the restoration plan and may result in anthropogenic load reductions that are different than the percent reduction expressed in the TMDL.

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We greatly appreciate the County's involvement in reviewing and commenting on the TMDL reports which resulted in improvements to the reports. If you have any questions about our comments, please contact me or Kevin Petrus at 850-245-8449.

Sincerely,

Jan Mandrup-Poulsen, Environmental Administrator
Watershed Evaluation and TMDL Section

Enclosures

cc: Sarah Malone, Pinellas County, w/o Enclosures
Thomas Burke, City of Dunedin, w/o Enclosures
ec: Kevin O'Donnell, DEP, w/o Enclosures
ec: Terry Hansen, DEP, w/o Enclosures

November 14, 2012

Mr. Steven Peene, Vice President
Applied Technology and Management, Inc.
1435 East Piedmont Drive, Suite 210
Tallahassee, FL 32308

SUBJECT: Response to Comments on the Proposed Dissolved Oxygen and
Nutrient TMDLs for the McKay Creek Tidal Segment (WBID 1633)

Dear Mr. Peene:

The Department has reviewed the Applied Technology and Management, Inc.'s comments on the proposed Dissolved Oxygen and Nutrient TMDL for the McKay Creek Tidal Segment, (WBID 1633) that were submitted via email on September 8, 2012 on behalf of the Florida Department of Transportation. We have prepared responses to each of your comments as itemized below.

In the order in which they were presented, what follows are the comments and our responses (shown in blue).

## Response to Comments in SUMMARY OF FINDINGS

1. There is a significant amount of information missing from the TMDL report regarding how the modeling was performed, and as such, a complete review of the model and its assumptions is not possible. The TMDL relies primarily upon three models, a localized McKay Creek watershed model (LSPC), a localized McKay Creek hydrodynamic model (EFDC), and a localized receiving water quality model (WASP). The report references various larger scale models to provide input coefficients and boundary conditions to the localized McKay Creek models. While reference documents are cited for the larger scale models, the documents do not appear to be available. Therefore, no documentation whatsoever is provided for the larger scale models. Additionally, while limited calibration plots are provided for the localized models, there is a significant amount of missing information on the input conditions from the large-scale model used to drive the localized model, the input conditions for the localized model that came from Clearwater Harbor data, geometric information on the localized model grid, or the coefficients utilized in the localized models.

> Generally for this type of work, a modeling report which outlines all that went into the development of the localized McKay Creek model would be provided with the TMDL document. The calibration plots presented indicate that there may be issues with how the model(s) represent hydrologic, hydrodynamic, and water quality processes in the system. This lack of sufficient information does not allow for a complete assessment/review of the model(s) and resulting TMDL.

**Department Response:** Technical support documents for the larger Crystal Watershed LSPC model and the Big Bend Estuary EFDC model have been provided to the Department and are enclosed for review. The documents will be included as appendices to the TMDL report. The McKay Creek watershed model used the same data inputs and modeling assumptions as those applied in the development of the Crystal Watershed model. The delineation of the watershed was revised for the McKay Creek model, which is outlined in the second paragraph of section 5.2.1, LSPC Model Development.

The Tampa Bay WASP7 model was used as the starting point for the WASP inputs, which were then modified to make modeling in the McKay Creek system reasonable. A spreadsheet documenting the WASP coefficients used in the McKay Creek model have been provided to the Department and are enclosed for review. Additionally, the geometric information from the localized grid has been provided and is enclosed in the dxdy.inp file.

The McKay Creek model presents the best overall calibration using the data collected in the watershed and the data available. A review of the calibration is presented in the response to comment 12.

2. The use of a reference approach for developing Chl *a* targets may not be the best method for determining target Chl *a* in tidal tributaries. In tidal waters surrounding Tampa Bay, targets developed based on impacts to resources and habitat (seagrasses for example) have ranged as high as 15 µg/L. Presently there are ongoing studies in the Tampa Bay area to define appropriate Chl *a* targets for tidal tributaries. While it is recognized that these studies are ongoing and not completed, the report should recognize this ongoing effort, and the limitations of a reference approach.

**Department Response:** The Department recognizes that there are limitations to the reference approach and is aware of the efforts in the Tampa Bay area to identify targets for tidal tributaries. It is also important to note that in other segments of Tampa Bay chlorophyll a targets less than the IWR threshold of 11 µg/L, (as low as 5 µg/L) were established for seagrass restoration. We believe the reference approach used to develop a chlorophyll a target for the impaired tidal creek segments is the best information currently available for deriving an estuary water quality target along the Pinellas County Gulf coast. In the future, if the approach being applied to develop targets for Tampa Bay tidal tributaries is successful, consideration can be given to investigating it’s applicability in other tidal systems.

3. At present, Florida is in the process of revising its DO criteria. While it is recognized at this time that the Florida Department of Environmental Protection (FDEP) cannot assess against these criteria, and must utilize the existing criteria, some acknowledgement of the determinations that have been made and recorded by the FDEP that the DO criteria are at issue and are being modified should be put into the TMDL report. While it is recognized that ultimately for this TMDL it was Chl *a* that drove the reductions, this DO issue should still be acknowledged.

**Department Response:** We acknowledge the current ongoing efforts to revise the existing DO criteria. However, until such time that revised DO criteria are promulgated it would be premature to document any proposed modifications to the criteria in the current TMDL effort. The TMDLs developed for the impaired tidal segments are designed to address the water quality criteria currently in effect. In the future, if revised DO criteria are promulgated by the state and approved by the US EPA, the DO conditions of the impaired segments can be evaluated by applying the new criteria.

**Response to comments in DETAILED COMMENTS**

**Data:**

1. It would be useful to provide a zoomed in figure showing the water quality monitoring stations within the tidal WBID along with the broader view shown in Figure 2.1.

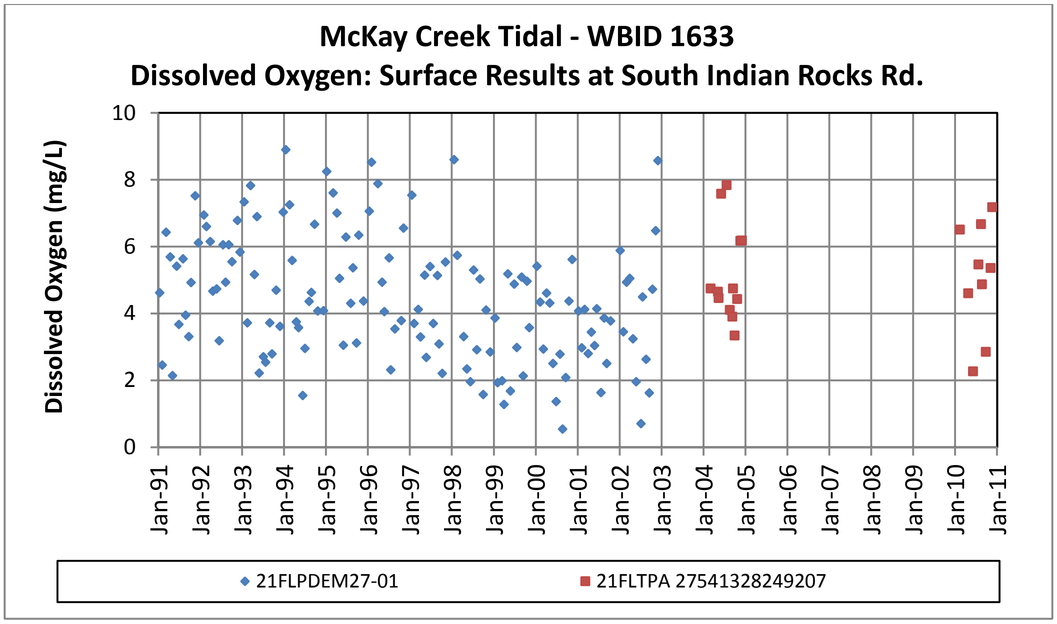
**Department Response:** The report has been updated to include a new Figure 2.2 that is zoomed to the tidal segment WBID to display the monitoring stations.

2. While the data are limited, the report did identify that DO conditions in the system appears to have changed significantly between the two assessment periods. Did FDEP staff contact Pinellas County to discuss this and see if they have some potential explanation for this shift? If there was a significant change that might have caused this it would need to be reflected in the modeling.

**Department Response:** The Department contacted Pinellas County to determine if they had any information to explain the change in DO concentrations over time. However, the County had no information to offer that would explain the shift. The Department has performed a further review of the DO results from the McKay Creek tidal segment.

Part of the shift in the DO criteria exceedance rate may be explained by the differences in monitoring methods between Pinellas County and the DEP SWD Office. When the County collected DO measurements between 1991 and 2002, results were recorded near the surface and bottom and sometimes at mid-depth. When the DEP monitored the creek in 2004 and 2010, DO measurements were only recorded near the surface.

However, the criteria exceedance rate is also lower in the Cycle 2 period compared to the Cycle 1 period for surface DO results. There are a greater number of surface values exceeding the criteria between 1991 and 2002 when the county was monitoring, versus the time DEP collected samples in 2004 and 2010. The graph below displays the surface results collected at South Indian Rocks Road by the county and DEP, which is the location where most of the monitoring has occurred. One thing that is apparent in the graph is that the criteria exceedance rate was generally higher in the 1998 to 2002 period when there were a considerable number of DO results less than 2 mg/L and the vast majority of results were less than 6 mg/L. In three of the years in that period (1999-2001) rainfall amounts were generally lower than average in southwest Florida.



3. It was good to see the evaluation of the limiting nutrient in the system.

**Department Response:** Comment acknowledged.

4. The limited data do seem to identify that some longitudinal variations in the system, i.e., Chl a levels at the Indian Rocks Beach Road location are elevated in general in relation to the measurements downstream. FDEP specifically designs their monitoring to make sure they try to capture these types of issues. Although the data are limited in the more recent years, some discussion of this should be provided. This type of pattern is important information to bring to the modeling. Coincident data are available from the FDEP stations (21FLTPA27542338248020, 21FLTPA27541328249207, and 21FLTPA275356708249530).

**Department Response:** When the Department's SW District conducted monitoring of the tidal segment in 2004 and 2010 only two stations were sampled in each year. In both years, monitoring was conducted at the South Indian Rocks Road location (site 21FLTPA 27541328249207). The site upstream of this location (21FLTPA 27542338248020) was sampled in 2004, whereas the site downstream of this location (21FLTPA 275356708249530) was sampled in 2010. There is very limited information available to describe any longitudinal variation in water quality in the tidal reach. A review of the water quality results in 2004 and 2010 does indicate that the South Indian Rocks Road location generally exhibited higher chlorophyll a levels and lower DO concentrations compared to the other sampling locations. It appears justified to focus on the model results at the South Indian Rocks Road location for TMDL development, as this is the location where the vast majority of results were collected and where generally poorer water quality was observed.

5. Where modeling is part of a TMDL the data analyses become important to identify the spatial and temporal patterns seen from the available data, additional analyses and presentations could have been completed and provided to lead into the modeling effort.

**Department Response:** As explained in the response to comment 4, there are very limited results in the tidal segment for describing spatial patterns in the data. The response to comment 2 provides further information about the temporal pattern observed in the DO measurements, but there is no clear explanation currently available to explain the pattern. Appendix B of the report provides period of record time series graphs of the individual results for parameters relevant to the TMDL effort.

**<u>Water Quality Criteria:</u>**

1. In the text it is identified that the 11 µg/L Chl a target used in the IWR is somewhat arbitrary and does not necessarily reflect the appropriate target for a waterbody. The appropriate Chl a target for any individual waterbody or tidal tributary is a function of multiple issues. In the Tampa Bay area Chl a criteria established based upon restoration of seagrasses have ranged up to near 15 µg/L.

   The reference system approach used assumed up front that the Chl a target for this waterbody would be below 11 µg/L as it was used as the screening criteria. It is recognized that for this type of system there are not a lot of data to aide in determining the appropriate target. At present efforts are underway by the TBEP to identify appropriate targets for tidal tributaries. While this work is not completed to date, the limitations of the approach and the potential for alteration of the target based upon future studies should be put into the report.

**Department Response:** The Department recognizes that there are limitations to the reference approach and is aware of the TBEP efforts to identify targets for tidal tributaries. It is also important to note that in other segments of Tampa Bay chlorophyll a targets less than the IWR threshold of 11 µg/L, (as low as 5 µg/L) were established for seagrass restoration. We believe the reference approach used to develop a chlorophyll a target for the impaired tidal creek segments is the best information currently available for deriving an estuary water quality target along the Pinellas County Gulf coast. In the future, if the approach being applied to develop targets for Tampa Bay tidal tributaries is successful, consideration can be given to investigating its applicability to other tidal systems. Any TMDL can be modified in the future based on the results of additional studies.

2. Additionally, the ongoing efforts to revise the marine DO criteria need to be acknowledged.

**Department Response:** We acknowledge the current ongoing efforts to revise the existing marine DO criteria. However, until such time that revised DO criteria are promulgated it would be premature to document any proposed modifications to the criteria in the current TMDL effort. The TMDLs developed for the impaired tidal segments are designed to address the water quality criteria currently in effect. In the future, if revised DO criteria are promulgated by the state and approved by the US EPA the DO conditions of the impaired segments can be evaluated by applying the new criteria.

## Modeling:

1. No documentation is provided for the larger scale model(s) (or appears to be available) and it is somewhat confusing as to what data were utilized from the larger scale models to drive or populate conditions in the localized McKay Creek model(s). It would be best to focus upon presenting complete documentation on the development and calibration of the localized McKay Creek model(s) as these were the ones actually utilized in the TMDL development.

**Department Response:** Additional documentation for the larger Crystal Watershed model and Big Bend hydrodynamic model has been provided to the Department and are enclosed for review. The documents will be included as appendices to the TMDL report. The Tampa Bay WASP calibration coefficients were used as the starting point in development of the McKay Creek model and were adjusted as necessary to achieve satisfactory calibration of the McKay Creek model. The enclosed WASP coefficients used for the McKay Creek model are provided.

2. The report needs to provide a complete and comprehensive presentation of what went into the development of the McKay Creek LSPC model, including all physical, hydrologic, and chemical inputs and all relevant model coefficients. Some presentation of the GIS layers utilized are presented but additional data for the localized model needs to be provided.

**Department Response:** Additional documentation has been provided that presents the development of the McKay Creek model, including the physical, hydrologic, and chemical inputs and model coefficients included in the attached Crystal Watershed Report.

3. The parameterization of the localized McKay Creek watershed LSPC model, based upon the text, came from the larger Crystal Watershed model. To support this, plots of some comparisons of discrete flows and water quality in the upper watershed are provided. The comparisons were provided for 21FLPDEM27-10 and 21FLDEPM27-09. 27-10 is located upstream of Taylor Lake while 27-09 is below Taylor Lake. As Taylor Lake could have a significant impact upon the water quality constituents flowing downstream into the marine portion. As such the discussion of the results is limited to comparisons at 27-09.

**Department Response:** The main purpose of the LSPC model was to provide loadings to the downstream EFDC and WASP models. For this reason, calibration at the downstream LSPC station was considered to be more relevant and the discussion was included in the report for this reason. The reservoirs were accounted for in the land use as open water. No data were available for daily operation of the weir flow, and they were assumed to be “run-of-the-stream” weirs, meaning that flow into the lake is assumed to equal flow out of the lake, in the model calibration.

a. The discrete measured flows do not seem to support the high levels simulated in the model. Pinellas County does have a gage on McKay Creek below Taylor Lake, although this gage only reports stage based upon a cursory examination of USGS data, perhaps this information could be used to help establish if the LSPC model is reasonably simulating conditions on the stream. FDEP staff should follow up with Pinellas County if this has not been done already.

**Department Response:** Modeled flow during low flow periods is well calibrated to the available data. Much of the flow data appears to be collected during low flow periods, and the simulated modeled discharge is in close approximation to the measured data. The higher flow values occur during storm events, and data are not always available for calibration during these time periods. Additionally, the model used the Crystal Watershed hydrodynamic calibration, which was calibrated to flow at the USGS station in the Anclote River (see Crystal Watershed attachment). Calibration at this station, which included continuous USGS discharge flow data, indicated that the model slightly under predicted high flows, although the calibration to high flows was still within the accepted USGS error percentage range.

McKay Creek gage height data collected at USGS station 02309110 was not used for calibration as the LSPC watershed model reaches use an average cross-section to determine reach characteristics. The cross-section at the USGS gage site may not be representative of the entire sub-watershed reach, and stream depth at this point may be different than stream depth for the entire watershed.

b. The BOD5 data appear to be all non-detects, FDEP staff should identify if this is the case, and if so then comparisons are not valid.

**Department Response:** We have determined that Pinellas County BOD5 results reported as 4 mg/L and 8 mg/L with an associated remark code of "I" are not valid measurements and have been removed from the calibration graphs. The county results reported as 2 mg/L with an associated remark code of "U" are considered valid results. Although the results reported as 2 mg/L are less than the method detection limits, we consider them to be useful in making comparisons to the model simulated results.

c. It appears that the TN levels projected by the LSPC model are too high. Some statistical assessments of the model and data should be provided to identify if this is the case. As nitrogen is the limiting nutrient, this could be a significant issue in the modeling.

**Department Response:** The TN calibration was done to best represent overall loading to the WASP water quality model. Much of the measured data appears to be collected during low flow periods, as shown in the flow calibration graphs. TN concentrations are higher during summer rainfall events, likely because of the flashiness that occurs in the developed watersheds. Higher flow values and nutrient concentrations typically occur during storm events, and data is not always available for calibration during these time periods. Additionally, the model also has periods of modeled TN that are lower than measured. The LSPC TN concentrations represent the loads from the watershed needed to produce satisfactory in-stream modeled concentrations in the WASP model.

4. The report references the Big Bend EFDC model as providing the forcing functions for the localized McKay Creek EFDC model. No documentation of the results from the Big Bend model nor the tidal forcing that was utilized are provided this is a key input to the EFDC hydrodynamics.

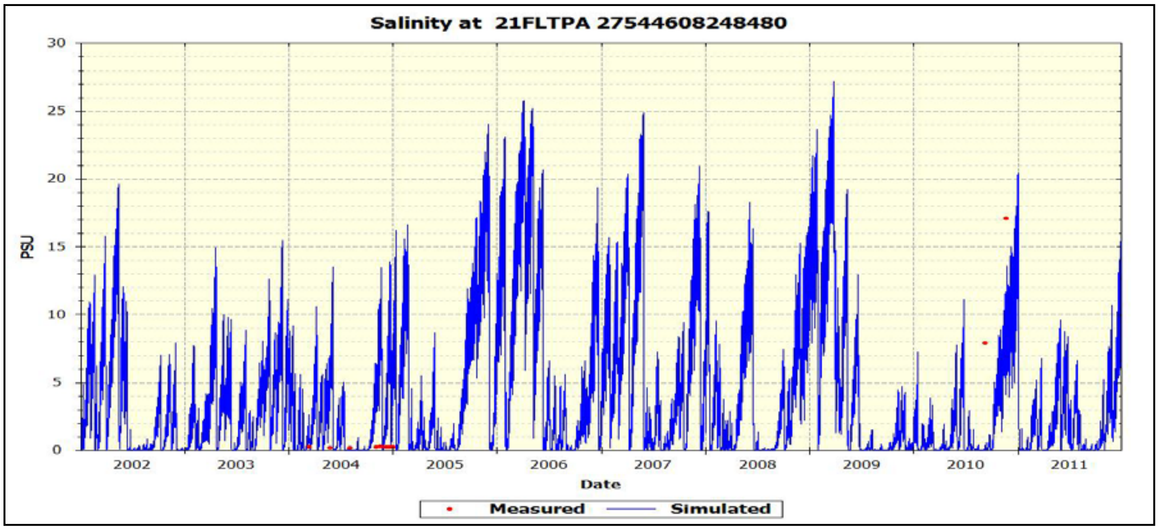
**Department Response:** The enclosed documentation for the Big Bend EFDC model includes EFDC hydrodynamic outputs. The time series of the tidal forcing function from the Big Bend model was used at the boundary, and the amplitude was adjusted to calibrate to salinity. Modeled salinity in McKay Creek was able to represent both periods of low and high salinity that were measured in the creek, as shown in Figure 5.17 of the TMDL report.

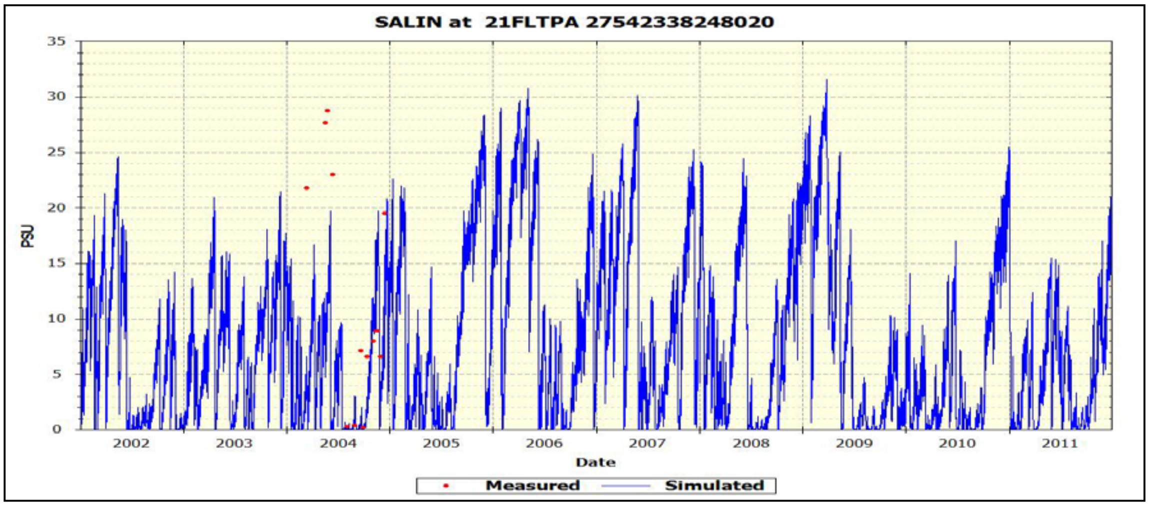
5. The grid map presented in the report is shown below. The McKay Creek EFDC grid consisted of 64 cells, specifically 32 cells in the horizontal direction and was two layers in the vertical direction. Additionally, no geometric information on bathymetry or grid cross-sections and depths is provided, and the map provided is insufficient to identify if the model is reasonably representing the local bathymetry/geometry of the bay or tributaries. Simply looking at the grid as presented, it does not seem like it represents the system (especially the tributary geometry) well.

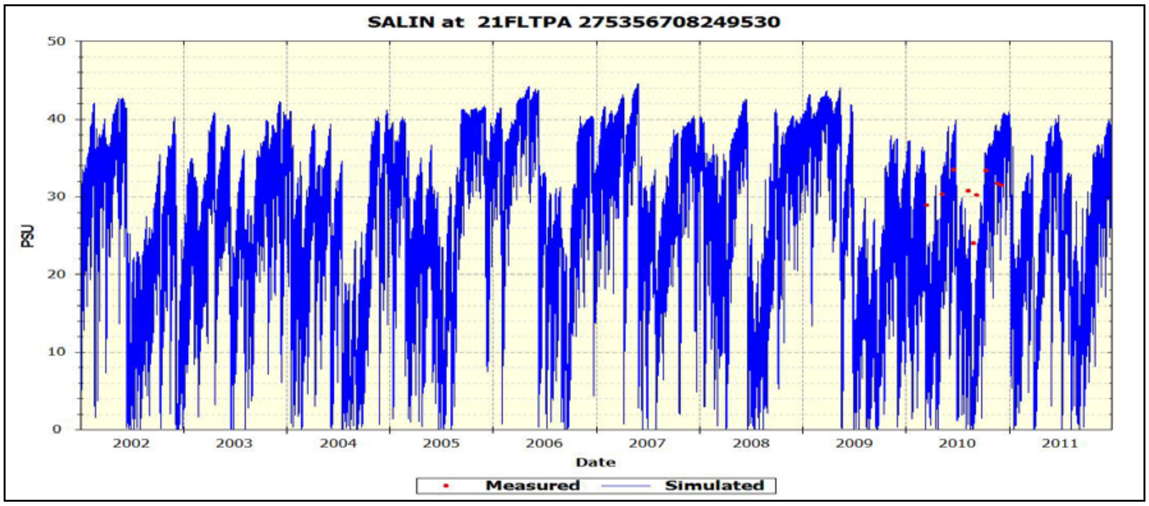
**Department Response:** No high resolution bathymetric data were available, and a gradual slope bathymetry was used for the grid. The DEM was also used to determine possible bathymetry. The shapefile shown in the figure provides a visual representation of the geometry used in the model. The enclosed dxdy EFDC input file outlines the geometry of the model, and along with the shapefile identifies the i, j locations of the grid.

6. The calibration of the EFDC model is based upon salinity comparisons at Indian Rocks Beach location. Data were also available for those times at the downstream and upstream FDEP stations. These results should also be provided.

**Department Response:** Calibration of the EFDC model was compared to salinity data at stations 21FLPDEM27-01 and station 21FLTPA 27541328249207, both of which are located mid-way on McKay Creek in the estuarine WBID, therefore providing a good overall calibration for the entire marine portion of McKay Creek. Additional salinity plots at stations 21FLTPA 27544608248480, 21FLTPA 275356708249530, and 21FLTPA 27542338248020 are provided below.







7. The Tampa Bay WASP modeling coefficients were utilized for the McKay Creek WASP model. As no documentation for the WASP modeling of Tampa Bay nor the coefficients used in the McKay Creek modeling are provided, this aspect of the WASP modeling cannot be performed. A full presentation of the WASP coefficients is needed to perform an evaluation of the modeling effort.

**Department Response:** The Tampa Bay WASP modeling coefficients were used as the starting point for the McKay Creek WASP model. The coefficients were adjusted as necessary to produce a satisfactory calibration of McKay Creek and the estuary. The coefficients and rates used in the McKay Creek WASP model are enclosed.

8. The water quality kinetics in Tampa Bay is not necessarily applicable to what is going on in McKay Creek. It cannot therefore be assumed that the coefficients are transferable.

**Department Response:** As explained in the response to Comment 7, the water quality kinetics from the Tampa Bay WASP model were used as a starting point and were adjusted as necessary to produce a satisfactory calibration of the McKay Creek WASP model.

9. The report states a WASP grid was developed for the Coastal Pinellas County Model and parameterized using the Tampa Estuary Model WASP7 parameters. The issues raised above for the grid would also apply for the WASP modeling.

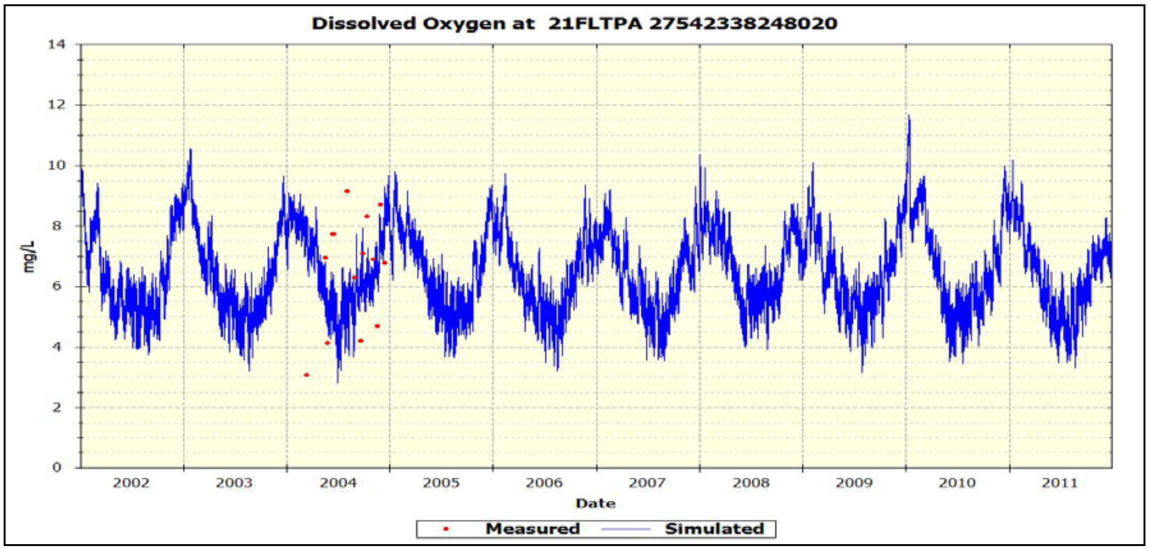
**Department Response:** The grid developed for WASP used the same bathymetry and cell size as the EFDC model. Responses provided for Comments 5, 7, and 8 provide additional detail on the use of the Tampa Bay Model WASP7 parameters.

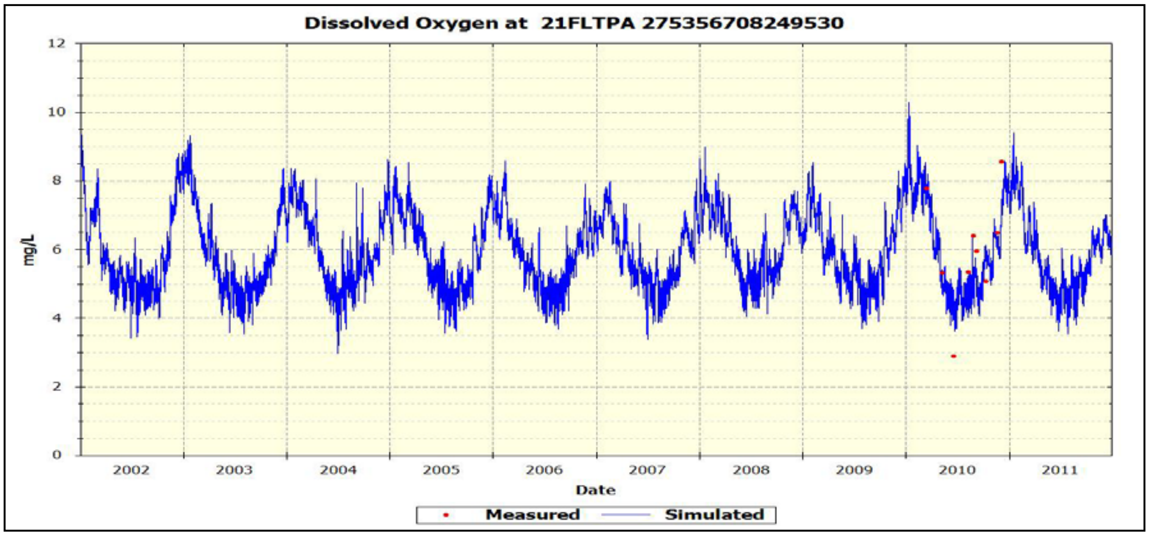
10. The WASP model calibration plots presented for the various nutrient constituents and the BOD show some potential issues with the modeling. These are not sufficiently evaluated and discussed in the text provided. There is simply this statement "*The McKay Creek estuary model calibration was reviewed against water quality data located in IWR44. Following review, the calibration was adjusted accordingly to provide the best existing scenario model calibration for the water quality parameters of concern. WASP results at select water quality stations are presented in Appendix C (Figures C.1 through C.30).*"

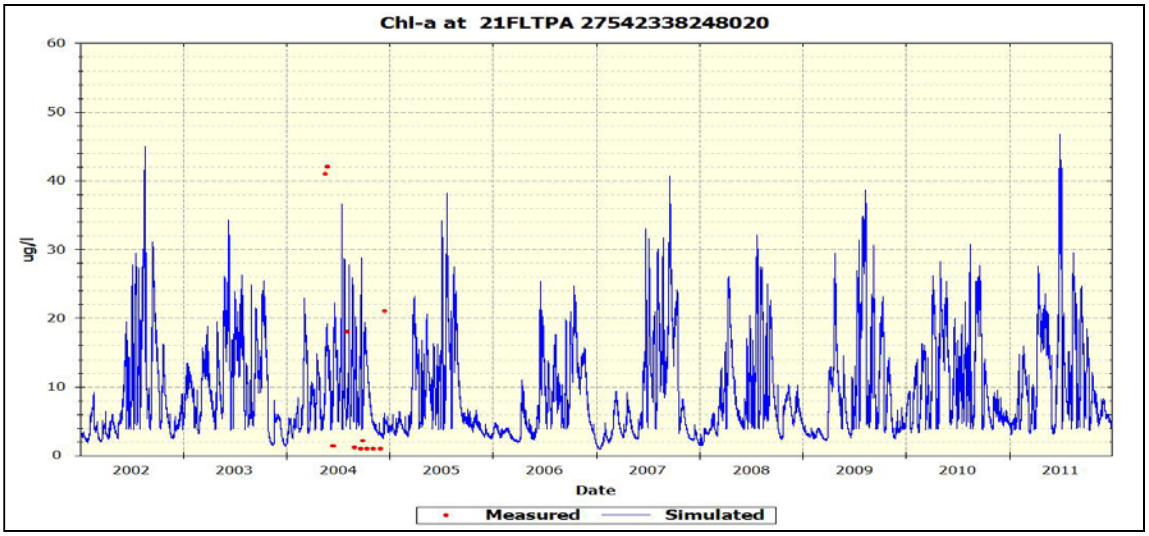
**Department Response:** Please see the response to Comment 12 for an evaluation of the model calibration.

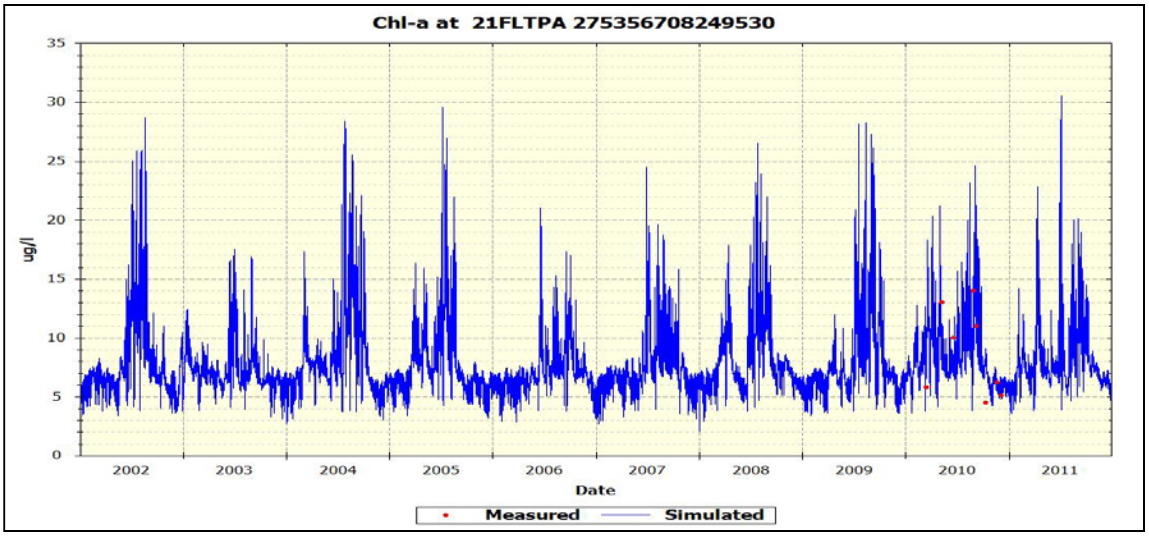
11. In Appendix C WASP model results are presented at three locations, these are at the station in what appears to be the freshwater portion of McKay Creek outside of the tidal area (21FLDEPM27-09 and 21FLDEPM27-08), and at one station in the marine portion (21FLPDEM27-01/21FLTPA 27541328249207). Two other stations within the marine portion are available, and based upon some of the simultaneous measurements provide some useful information on longitudinal patterns that could support the calibration given the limited data.

**Department Response:** The WASP model encompassed both the freshwater and marine portion of McKay Creek, which is why calibration occurred within the freshwater portion of McKay Creek as well. Graphs for both DO and chlorophyll a results at stations 21FLTPA 27542338248020 and 21FLTPA 275356708249530, located in the estuarine portion of McKay Creek, are shown below. These figures show the comparison between modeled and measured DO and chlorophyll a, and indicate the model provides a reasonable simulation of the measured results in other areas of the tidal segment.


Dissolved Oxygen at 21FLTPA 27542338248020
mg/L
0
2
4
6
8
10
12
14
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date
Measured
Simulated


Dissolved Oxygen at 21FLTPA 275356708249530
mg/L
0
2
4
6
8
10
12
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Date
Measured
Simulated





12. Calibration graphs from the station in the marine portion (21FLPDEM27-01/21FLTPA 27541328249207), which is where the TMDL compliance should be evaluated are discussed.

    a. The DO graph does not support that the model is well calibrated.
    b. The TN comparisons also do not support that the model is calibrated. It appears that the under predictions are based upon low simulated values of organic nitrogen as well as ammonia.
    c. TP has the same issues as TN the levels are under predicted at times.
    d. Chl a predictions are within range, but given the TN and TP issues some of the coefficients (growth rate, etc) may be off in order to account for the TN/TP errors.

**Department Response: a.** The WASP model provides the best overall calibration for all stations used in model calibration. In 2002, at station 27-01, the model simulation DO is higher than the measured DO. The measured data from 2002 was collected at several depths, including 0.1 meters, and the model represents average DO concentrations. Also, as previously mentioned in the responses to comments in the Data section, other than recognizing the drought (and associated low flow conditions), there is no apparent explanation currently available for the lower DO levels observed in the 1998 to 2002 period. More emphasis should be placed on model performance in more recent years. The model matches the seasonal trend for the years 2004 and 2010 in McKay Creek at this estuary station. Additionally, the model predicts the overall trends at station 27-09. The model predicts DO between 4 mg/L and 11 mg/L, and the measured DO ranged from 2 mg/L to 10 mg/L, with most measured DO values occurring within the 4 mg/L to 10 mg/L range. Calibration results at these two stations show that the model is predicting the overall trend in DO in the McKay Creek area within the model domain. Within Church Creek, at station 27-08, the modeled DO is also similar to the measured DO trends.

Both Church Creek and McKay Creek consist of high intensity developed land, and the modeled loads and nutrient concentrations from both watersheds were similar for this reason. The calibration was accomplished by reviewing all calibration stations in the watershed and producing the best overall result. The TN loads from the LSPC model were partitioned to provide the best representation of the TN species.

**b**. All three modeled nitrogen species (NOx, NH4, and organic nitrogen) were similar to the measured data, with the exception of NOx in Church Creek. Measured concentrations of NOx were greater than modeled concentrations, including NOx concentrations during storm events, which indicated that there may be an unidentified source of NOx in Church Creek. Measured NOx values in McKay Creek typically ranged from approximately 0.01 mg/L to 0.4 mg/L, while modeled values were typically within this range, as well. Overall, the model captured the NH4 and organic nitrogen ranges in the measured data at all three stations.

**c.** Measured TP values ranged from 0.01 mg/L to 0.9 mg/L in Church Creek, and 0.01 to 0.5 mg/L in McKay Creek. The modeled TP values ranged from 0.01mg/L to 0.6 mg/L in Church Creek and 0.01 mg/L to 0.6 mg/L in McKay Creek. The model therefore correctly captured the range of measured TP values and also simulated the seasonal patterns that occurred in the measured TP data.

**d.** The coefficients in the WASP model were adjusted to produce the best overall calibration. The modeled results are often within the range of the measured results, or represent the overall trend in the measured values.

13. There are clearly some spatial differences in the system behavior that are not seen in the modeling which appears to be more uniform in its projections of Chl *a* and DO. These characteristics should be discussed as part of a detailed analysis of the available data and as part of the presentation of the model comparisons.

**Department Response:** Please see responses to comment 12 in the Modeling section and responses to comments 2, 4, and 5 in the Data section for a description of the spatial variability in the measured and modeled results.

14. The report states that the objective of the evaluation for establishing the TMDLs was to identify a model scenario where the predicted average Chl *a* value would not exceed the selected target of 8 µg/L and result in DO conditions that would allow the tidal creek to meet the minimum DO criterion of 4 mg/L. Given the calibration issues discussed above, an effort to improve model calibration, and the level of documentation, should be performed so that the TMDL development effort can be performed with more confidence. This will also affect the SOD values used both in the current and TMDL model scenarios as (SOD)rev is adjusted based on predicted algal primary productivity per Section 5.4.

**Department Response:** We believe that the existing models are sufficiently calibrated for use in TMDL development and that our responses to comments and the enclosed documentation address all of the modeling issues. The models used for TMDL development were calibrated to best represent the fit to the range and pattern in the measured data throughout the model domains.

Thank you for your time and effort in reviewing the proposed McKay Creek TMDL. Your input resulted in improvements to the report. If you have any questions about our comments, please contact me or Kevin Petrus at 850-245-8449.

Sincerely,

Jan Mandrup-Poulsen, Environmental Administrator
Watershed Evaluation and TMDL Section

Enclosures

cc: Janet Hearn, ATM – w/o Enclosures
Robert Burleson, ATM – w/o Enclosures
Sue Moore, Florida DOT – w/o Enclosures
ec: Terry Hansen, DEP – w/o Enclosures

## Appendix E: Crystal Watershed Modeling Report

Report under separate cover.

## Appendix F: Hydrodynamic Modeling Report for the Big Bend Estuary Systems

Report under separate cover.