Proposed TMDL
Environmental Protection Agency

TMDL Report

Dissolved Oxygen TMDL for Long Branch Creek
WBID 1627

September 29, 2004

United States Environmental Protection Agency

Region 4 serving the southeast

Acknowledgments

EPA would like to acknowledge that the contents of this report and the total maximum daily load (TMDL) contained herein were developed by the Florida Department of Environmental Protection (FDEP). Many of the text and figures may not read as though EPA is the primary author for this reason, but EPA is officially proposing the TMDL for dissolved oxygen for Long Branch Creek and soliciting comment. EPA is proposing this TMDL in order to meet consent decree requirements pursuant to the Consent Decree entered in the case of Florida Wildlife Federation, et al. v. Carol Browner, et al., Case No. 98-356-CIV-Stafford. EPA will accept comments on this proposed TMDL for 60 days in accordance with the public notice issued on September 30, 2004. Should EPA be unable to approve a TMDL established by FDEP for the 303(d) listed impairment addressed by this report, EPA will establish this TMDL in lieu of FDEP, after full review of public comment

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Web sites

Florida Department of Environmental Protection, Bureau of Watershed Management

TMDL Program

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

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf

STORET Program

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

2000 305(b) Report

http://www.dep.state.fl.us/water/305b/index.htm

Criteria for Surface Water Quality Classifications

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

Basin Status Report for the Tampa Bay Basin

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

Water Quality Assessment Report for the Tampa Bay Basin

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

Allocation Technical Advisory Committee (ATAC) Report

http://www.dep.state.fl.us/water/tmdl/docs/Allocation.pdf

U.S. Environmental Protection Agency, National STORET Program

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

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for dissolved oxygen (DO) impairment in the freshwater segment of the Long Branch Creek (LBC) watershed. Using the methodology to identify and verify water quality impairments described in Chapter 62-303, Florida Administrative Code, (Identification of Impaired Surface Waters or IWR), the freshwater segment was verified as impaired for dissolved oxygen, and was included on the verified list of impaired waters for the Coastal Old Tampa Bay Planning Unit that was adopted by Secretarial Order on August 28, 2002. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions.

1.2 Identification of Waterbody

The Long Branch Creek watershed covers an area of approximately 2.0 square miles or 1,258 acres and is located in a highly urbanized area in central Pinellas County (**Figure 1.1**). Near the headwaters of the stream is Swan Lake, a small lake surrounded by residential homes. The outlet of this lake is one of the main sources of water contributing flow in the stream. The main channel is about 3.3 miles in length and flows to the northeast into Old Tampa Bay. The freshwater stream reach is approximately 2.5 miles in length and flows into the tidal segment of the basin. The freshwater segment of LBC is considered to be a second-order stream and exhibits characteristics associated with riverine aquatic environments. Additional information about the river's hydrology and geology are available in the Tampa Bay Group 1 Basin Status Report (Florida Department of Environmental Protection, 2001).

There are no individual permitted wastewater or industrial facilities in the LBC watershed. Urban and suburban stormwater runoff are considered to be major contributors to non-point source pollution. The predominant land uses are high and medium density residential and commercial development, which account for 75 percent of the land use.

For assessment purposes, the Department has divided the Long Branch Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Long Branch basin is located in the Coastal Old Tampa Bay planning unit and has been divided into three segments, as shown in **Figure 1.2** and listed below. This TMDL addresses the DO impairment in the freshwater stream segment.

- WBID 1627 - Freshwater Stream Segment;
- WBID 1627A - Swan Lake; and
- WBID 1627B - Estuarine Segment.

1.3 Background

This report was developed as part of the Florida Department of Environmental Protection's (Department) 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 fifty-two 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).

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. TMDLs provide important water quality restoration goals that will guide restoration activities.

This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, to address the DO impairment in the LBC watershed. The action plan activities will depend heavily on the active participation of Pinellas County, the Southwest Florida Water Management District, 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 impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rule-Making History

Section 303(d) of the federal Clean Water Act requires states to submit to the Environmental Protection Agency a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant source in each of these impaired waters on a schedule. The Department has developed these lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin is also required by the FWRA (Subsection 403.067[4)] Florida Statutes [F.S.]). Florida's 1998 303(d) list included the Long Branch Creek Basin. The list is amended annually to include updates for each basin statewide. The 1998 303(d) list identified 47 waterbodies (WBIDs) in the Tampa Bay Basin.

However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists (i.e., those done prior to the adoption of the FWRA) were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rule-making process, 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 list of waters for which impairments have been verified using the methodology in the IWR is referred to as the Verified List.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the LBC watershed and has verified the impairments listed in **Table 2.1**. The minimum state criterion for dissolved oxygen in Class III freshwater streams is 5.0 mg/L. The IWR methodology was used to determine if there were a sufficient number of DO exceedances to verify impairment. The freshwater segment was determined to be impaired for DO because, from 1995 to 2002, more than 10 percent of the DO results did not meet the DO freshwater criterion of 5 mg/L. Summary statistics for dissolved oxygen during the verified period are provided in **Table 2.2.** The individual DO measurements used in the assessment are provided in **Appendix B**.

The three monitoring stations located in the freshwater segment of the basin (WBID 1627) that were used to identify DO impairment are displayed in **Figure 1.2**. The stations include a long-term station monitored by the Pinellas County Department of Environmental Management (PCDEM) and two DEP Tampa District stations. Station PCDEM 22-5 (Pinellas County) accounts for the majority of the observed data collected in the verified period. The monthly and annual average DO results, based on the IWR assessment methodology, are shown in **Figures 2.1** and **2.2,** respectively.

Depressed DO concentrations may be caused by several factors including the decay of oxygen demanding waste from point and non-point sources, conversion of ammonia to nitrate by bacteria, algal and macrophyte respiration, excessive epiphyte or floating macrophyte growth blocking light to submerged aquatic vegetation, and sediment oxygen demand. Nutrients may also influence DO levels indirectly. Algal populations can increase rapidly if nutrients are available and the production of oxygen as a result of photosynthesis during daylight hours and algal respiration or consumption of oxygen from the water column at night can result in large diurnal fluctuations of DO in the water column. A fraction of any increased algal biomass will also become part of the organic material that will be broken down by microbes or settle to the bottom. Processes that consume oxygen from the water column such as microbial breakdown of organic material and sediment oxygen demand are fairly constant over the short term.

In the freshwater segment of the Long Branch Creek Basin, low DO concentrations are suspected to be related to organic enrichment which exerts a biochemical oxygen demand in the water column. Ammonia concentrations may also affect DO due to the conversion of ammonia to nitrate in the nitrification process, where oxygen is consumed by aerobic nitrifying bacteria. Phytoplankton (suspended algae) biomass is relatively low in the stream and is not expected to have much of an influence on DO concentrations. During the verified period, individual and annual average chlorophyll *a* concentrations were below the IWR's threshold for nutrient impairment in streams of 20 μg/L.

The organic enrichment noted above is based on the intricate the relationship between carbonaceous biochemical oxygen demand (CBOD), total organic nitrogen (TON), nitrogenous biochemical oxygen demand (NBOD), and ammonia as nitrogen (NH_3-N), which is a component of NBOD. "Ultimate CBOD" or $CBOD_u$ is a measure of the total amount of oxygen required to degrade the carbonaceous portion of the organic matter present in the water. NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in NBOD. In Long Branch Creek, CBOD, TON, and NBOD may be contributing to the low dissolved oxygen concentrations (see Chapter 5).

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

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

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

The freshwater segment of Long Branch Creek is a Class III waterbody with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criteria applicable to the observed impairment addressed in this TMDL are the DO and narrative BOD criteria.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

3.2.1 DO Criterion

The Class III freshwater criterion for DO, as established by Subsection 62-302.530(31), F.A.C., states that DO shall not be less than 5.0 mg/L, and normal daily and seasonal fluctuations above these levels shall be maintained.

3.2.2 Interpretation of Narrative BOD Criterion

Florida's BOD criterion is narrative only and states that BOD shall not be increased to exceed values which would cause DO to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

For this study, the Department applied the Alabama Department of Environmental Management (ADEM) Spreadsheet Water Quality Model (SWQM) in Long Branch Creek to determine the appropriate BOD loading for the DO TMDL. The modeling assessment indicated that even under natural background conditions for the critical low DO event simulated, the DO criterion of 5 mg/L can not be achieved.

For the purpose of this TMDL, a dissolved oxygen water quality target was established based on the model simulation for natural background conditions. Natural background was defined as 100 percent forest land cover throughout the watershed being modeled. The pollutant concentrations associated with forest cover were used in the ADEM Spreadsheet Water Quality Model to predict the natural background DO concentration for the critical low DO event simulated. To establish the TMDL, pollutant loadings for $CBOD_u$ and NBOD were derived by reducing the existing load to achieve a DO prediction that was within 0.2 mg/L of natural background conditions. The DO target selected for this TMDL is a concentration 3.3 mg/L.

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 nutrients in the LBC 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 Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with 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 source assessment section 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 wastewater facility discharges to the Long Branch Creek Basin.

4.2.2   Municipal Separate Storm Sewer System Permittees

Phase 1 or Phase 2 MS4s. Municipal Separate Storm Sewer Systems (MS4s) may also discharge nutrients to waterbodies in response to storm events. EPA developed the federal National Pollutant Discharge Elimination System (NPDES) stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more; and eleven categories of industrial activities, one of which is large construction activity that disturbs 5 or more acres of land. Phase II, promulgated in 1999, addresses additional sources, including MS4s not regulated under Phase I, and small construction activity disturbing between 1 and 5 acres. The areas covered under Phase II program began receiving permitsin 2003. Regulated Phase II MS4s are defined in Section 62-624.800, F.A.C. and typically cover urbanized areas serving jurisdictions with a population of at least 10,000 and discharge into either Class I, Class II, or Class III Florida waters.

In October 2000, EPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian Country lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (F.S.). The NPDES stormwater program regulates point source discharges of stormwater into surface waters of the State of Florida from certain municipal, industrial, and construction activities. The NPDES stormwater permitting program is separate from the State's stormwater / environmental resource permitting program, and local stormwater / water quality programs, which have their own regulations and permitting requirements.

Within the Long Branch Creek Basin, the stormwater collection systems are owned and operated by Pinellas County, in conjunction with the Florida Department of Transportation, and are covered by an NPDES (MS4) Phase I permit. At this time, no local governments in the basin have applied for coverage under the Phase II NPDES MS4 permit.

4.3 Land Uses and Nonpoint Sources

Nutrient loading from urban areas is most often attributable to multiple sources including storm water 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. With the LBC Basin being primarily urban, wildlife, and agricultural animals / livestock sources are not expected to contribute to nutrient or organic loadings.

Total annual nonpoint source loads generated in the watershed during the verified period for BOD, TN, and TP were estimated using the Watershed Management Model (WMM). WMM uses rainfall, land use attributes, and event mean concentrations (EMCs) to quantify loads. Part of the surface runoff loads are loads coming from atmospheric deposition that fall directly onto the land surface. Although not specifically quantified, the runoff from residential areas includes leachate from septic systems.

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

4.3.1 Land Uses

As part of the central / eastern Pinellas County area, the Long Branch Creek watershed has undergone extensive urbanization with high and medium density residential and commercial areas accounting for the majority of land use in the impaired watershed **(see Figure 4.1).**

Land use categories in the LBC watershed were aggregated using the Florida Land Use, Cover and Forms Classification System (FLUCCS) Level 1 through Level 3 codes. The spatial distribution and acreage of different land use categories for WMM and SWQM were identified using the 1999 land use coverage (scale 1:24,000) contained in the Department's GIS library (Florida Department of Environmental Protection, Bureau of Information Services, 2004). The dominant land use categories are high and medium density residential areas and commercial/services. As noted in **Section 1.2**, these categories alone account for 75 percent of the land use in the watershed. Transportation, utilities, industrial use, low density residential, and pine flatwoods account for the majority of remaining land uses. The areas occupied by non-anthropogenic land uses account for only 9.3 percent of the watershed. The Level 3 distribution of land cover for the Long Branch Creek Basin is tabulated in **Table 4.1**.

4.3.1.1 Population

According to the U.S Census Bureau, the population density in and around WBID 1627 in the year 2000 was at or less than 3,292 people per square mile (10 person/mi^2 is the minimum used by the Census Bureau). The Bureau reports that, in Pinellas County, which includes (but is not exclusive to) WBID 1627, the total population for 2000 was 921,482 with 481,573 housing units. For all of Pinellas County, the Bureau reported a housing density of 1,720 houses per square mile. This places Pinellas County as having "the highest" housing density in the state of Florida in 2000 (U.S. Census Bureau, 2004). This is also supported by the land use, where 56 percent of the land use in WBID 1627 is dedicated to residences.

4.3.1.2 Septic Tanks

The Florida Department of Health (DOH) reports that as of fiscal year 2001, there were 23,578 permitted septic tanks in Pinellas County (Florida Department of Health, 2004). Data for septic tanks are based on 1970 – 2001 census results with year-by-year additions based on new septic tank construction. The data do not reflect septic tanks that may have been removed. From fiscal years 1991–2002, 1,722 permits for repairs were issued. For fiscal year 2001 to 2002, 185 permits were issued for repair (Florida Department of Health, 2004). Based on the number of permitted septic tanks and housing units located in the county as of 2001, approximately 95 percent of the housing units in the county are connected to a wastewater treatment facility with the remaining 5 percent utilizing septic tank systems.

4.3.2 Estimating Nonpoint Loadings Using the Watershed Management Model (WMM)

To estimate nonpoint source loadings generated in the freshwater segment of the watershed, the Watershed Management Model (WMM) was used to estimate BOD, TN, and TP loadings based on effective precipitation, land use attributes, and local event mean concentrations (EMCs). The loadings in the watershed are derived using St. Petersburg, Florida, annual average rainfall totals from 1995 to 2003. During this nine year period the annual rainfall averaged 56.3 inches compared to the long-term annual average rainfall from 1948 to 2003 of 52.1 inches (National Weather Service, 2003).

Nonpoint source loads were estimated for nutrient and oxygen demanding substances generated upstream of the Long Branch Creek tidal area. WMM is designed to estimate annual or seasonal pollutant loadings from a given watershed and evaluate the effect of watershed management strategies on water quality (User's Manual: Watershed Management Model, 1998). The Department originally funded the WMM development under contract to Camp Dresser and McKee (CDM), and CDM has subsequently refined the model. While the strength of the model is its capability to characterize pollutant loadings from nonpoint sources (such as those from stormwater runoff, stream baseflow, and leakage of septic tanks), the model also handles point sources such as discharges from wastewater treatment facilities. The estimation of pollution load reduction from partial or full-scale implementation of on-site or regional best management practices (BMPs) was not incorporated into model.

The fundamental assumption of the model is that the amount of stormwater runoff from any given land use is in direct proportion to annual rainfall. The quantity of runoff is controlled by that fraction of the land use category that is characterized as impervious and the runoff coefficients of both pervious and impervious area. The governing equation is as follows:

(1) $R_L = [C_p + (C_I - C_p) IMP_L] * I$

Where:

R_L = total average annual surface runoff from land use L (in/yr);
IMP_L = fractional imperviousness of land use L;
I = long-term average annual precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.

The model estimates pollutant loadings based on nonpoint pollution loading factors (expressed as lbs/ac/yr) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor, M_L, is computed for each land use L by the following equation:

(2) $M_L = EMC_L * R_L * K$

Where:

M_L = loading factor for land use L (lbs/ac/yr);
EMC_L = event mean concentration of runoff from land use L (mg/L); EMC varies by land use and pollutant;
R_L = total average annual surface runoff from land use L computed from Equation (1) (in/yr); and
K = 0.2266, a unit conversion constant.

The data required for applying the WMM include the following:

- Area of all the land use categories and the area served by septic tanks;
- Percent impervious area of each land use category;
- EMC for each pollutant type and land use category;
- Percent EMC of each pollutant type that is in suspended form;
- Annual precipitation;
- Annual baseflow and baseflow concentrations of pollutants; and
- Point source flows and pollutant concentrations.

Data Requirements for Estimating BOD, TN, and TP Loadings

To estimate the BOD, TN, and TP loadings generated in the watershed using WMM, the following data were obtained:

A. Rain precipitation data were obtained from the weather station located in St. Petersburg, Florida (National Weather Sercive Station 87886). These data were retrieved from the National Weather Service (NWS) Climate Interactive Rapid Retrieval User System (CIRRUS) hosted by the Southeast Regional Climate Center. **Figure 4.2** depicts annual average precipitation and annual average flow at the Allan Creek U.S. Geological Survey (USGS) gage 02307731 from 1999 to 2003 (surrogate gage site for LBC). The 1995 to 2003 annual average rainfall was used in the WMM model as the rainfall total.

B. Areas of different land use categories in the freshwater segment of the LBC basin were obtained by aggregating Level 1 through Level 3 land use coverages and by separating out the low, medium, and high density residential land uses from the urban land use category. The ten land use categories applied in the WMM are shown in **Table 4.2**. These land use categories were used because land use runoff concentrations were available for the ten land uses. The dominant land use category in the LBC watershed is high density residential, which accounts for about 45 percent of the total area of the watershed. Commercial and services account for 21 percent with medium density residential accounting for 9 percent of the watershed area.

C. Percent impervious area of each land use category is a very important parameter in estimating surface runoff using the WMM. Nonpoint pollution monitoring studies throughout the United States over the past fifteen years have shown that annual per-acre discharges of urban stormwater pollution are positively related to the amount of imperviousness in land use (User's Manual: Watershed Management Model, 1998). Ideally, the impervious area is the area that does not retain water and therefore, 100 percent of the precipitation falling on the impervious area should become surface runoff. In practice, however, the runoff coefficient for impervious area typically ranges between 95 and 100 percent. Impervious runoff coefficients lower than this range were observed in the literature, but usually the number should not be lower than 80 percent. For the pervious area, the runoff coefficient usually ranges between 10 and 20 percent. However, values lower than this range were also observed (Watershed Management Model User's Manual, 1998).

It should be noted that the impervious area percentages do not necessarily represent the directly connected impervious area (DCIA). Using a single-family residence as an example, rain falls on rooftops, sidewalks, and driveways. The sum of these areas may represent 30 percent of the total lot. However, much of the rain that falls on the roof drains to the grass and infiltrates to the ground or runs off the property, and thus does not run directly to the street. For the WMM modeling purpose, whenever the area of the watershed that contributes to the surface runoff was considered, DCIA was used in place of impervious area. **Table 4.2** lists the area and percent of DCIA for different land use categories in the watershed.

D. Local event mean concentrations (EMC) of BOD, TN, and TP for different land use categories for Southwest Florida were obtained from Harper and Baker, 2003, and are presented in **Table 4.3**.

E. The sediment delivery ratio determines how much BOD, TN, and TP attached to suspended particles will be delivered to the destination waterbody. In this study, the sediment delivery ratio was estimated using the correlation between delivery ratio and watershed area developed by Roehl (1962), which in this analysis is 1.0.

Atmospheric Loading of TN and TP into LBC. One source of TN and TP loading to the LBC basin that was not considered by the WMM was the TN and TP falling directly into the stream through precipitation. The surface water area in the watershed is relatively small, so the atmospheric load falling directly on the water is expected to be minimal.

WMM Estimated Loads

The estimated BOD, TN, and TP annual average loadings for the 1995 to 2003 period are 66,343 lbs/year, 15,880 lbs/year, and 2,896 lbs/year, respectively (**Table 4.4**). During this nine year period, the minimum annual loads occurred in 1996, the lowest rainfall year, and the maximum loads occurred in 1997, the highest rainfall year. These loading estimates represent the maximum amount of loadings generated in the freshwater segment of the basin.

Figures 4.3, 4.4, and **4.5** display the percent relative contributions of BOD, TN, and TP loads, respectively, from each land use category. The figures show that high density residential and highway / transportation land use contribute the largest quantities of BOD, TN, and TP to the LBC Basin. For BOD, high-density residential land use contributes 80.8 percent of the load with highway / transportation contributing 10.2 percent of the load. For TN, high-density residential land use contributes 74.3 percent of the load with highway / transportation contributing 14.2 percent of the load. For TP, 82.6 percent of the load is derived from high-density residential areas, with 9.4 percent derived from highway / transportation land use.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Overall Approach

The goal of the TMDL development for LBC is to identify the maximum allowable biochemical oxygen demand loading to the watershed so that the freshwater segment will meet the dissolved oxygen (DO) target and maintain its function and designated use as a Class III water. The following two steps were taken to achieve this goal.

1. Using the ADEM Surface Water Quality Model (SWQM) estimate the oxygen demanding loads from nonpoint sources that will meet the established DO target for the critical low DO event simulated.

2. Apply the percent load reduction needed to meet the DO target to the annual BOD and TN loads estimated using the Watershed Management Model (see Chapter 4).

5.2 Water Quality Model Background

The SWQM is based on the Streeter-Phelps dissolved oxygen deficit equation with modifications to account for the oxygen demand resulting from nitrification of ammonia (nitrogenous oxygen demand) and the organic demand found in the waterbody sediment. The modified Streeter-Phelps equation takes into account the oxygen demand due to carbonaceous decay plus the oxygen demand generated from the nitrification process (ammonia decay). The equation below shows the Streeter-Phelps relationship with the additional components to account for nitrification and sediment oxygen demand (Alabama Department of Environmental Protection, 2001).

$$D = \frac{K_1 L_0}{K_2 - K_1}\left(e^{-K_1 t} - e^{-K_2 t}\right) + \frac{K_3 N_0}{K_2 - K_3}\left(e^{-K_3 t} - e^{-K_2 t}\right) + \frac{SOD}{K_2 H}(1 - e^{-K_2 t}) + D_0 e^{-K_2 t}$$

where: D = dissolved oxygen deficit at time t, mg/l

L_0 = initial CBOD, mg/l

N_0 = initial NBOD, mg/l (NBOD = NH_3-N x 4.57)

D_0 = initial dissolved oxygen deficit, mg/l

K_1 = CBOD decay rate, 1/day

K_2 = reaeration rate, 1/day

K_3 = nitrification rate, 1/day

SOD=sediment oxygen demand, g O_2/ft^2/day

H=average stream depth, ft

t = time, days

SWQM methodology and equations are provided in **Appendix D** (Alabama Department of Environmental Protection, 2001). The calibrated SWQM used in developing the LBC dissolved oxygen TMDL and load reductions is provided in **Appendix E**.

The ADEM SWQM is a steady-state model relating dissolved oxygen concentration in a flowing stream to carbonaceous biochemical oxygen demand (CBOD), total organic nitrogen (TON), ammonia as nitrogen (NH3-N), nitrogenous biochemical oxygen demand (NBOD), sediment oxygen demand (SOD), and reaeration. The model allows the loading of CBOD, TON, and NH3-N to the stream to be partitioned among different land uses (nonpoint sources).

The ADEM has a SWQM model guidance document that explains the theoretical basis for the physical/chemical mechanisms and principles that form the foundation of the model (Alabama Department of Environmental Management, 2001).

The spreadsheet water quality model (SWQM) developed by the ADEM was selected for this TMDL for the following reasons:

- It is a simplified approach with the ability to modify model inputs to conform with specific stream characteristics;
- It conforms to DEP standard practices for developing load and wasteload allocations;
- It lends itself to being developed with limited water quality data and flow data; and
- It has the ability to handle tributary inputs and both point and nonpoint source inputs.

The spreadsheet model also provides a complete spatial view of a stream, upstream to downstream, showing differences in stream hydraulics and water chemistry at various locations along the model reach.

5.3 Model Scenarios for TMDL Development

The ADEM SWQM was used to estimate the nonpoint source loadings of carbonaceous biochemical oxygen demand (CBOD), total organic nitrogen (TON), ammonia as nitrogen (NH3-N), and nitrogenous biochemical oxygen demand (NBOD) needed to meet the DO target at the critical low DO event simulated. The pollutant load for the TMDL is expressed as the ultimate biochemical oxygen demand (BOD_u) which is the sum of ultimate carbonaceous biochemical oxygen demand ($CBOD_u$) and nitrogenous biochemical oxygen demand (NBOD). NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in the NBOD component of the TMDL.

Three SWQM model scenarios were utilized in developing the target DO concentration and corresponding oxygen demanding load. The “calibrated” model is the primary SWQM model used in developing the Long Branch Creek DO TMDL. The forest land cover model and 70 percent load reduction model were developed from the calibrated model to estimate the loadings for this TMDL. The three SWQM models and their corresponding organic loading results are provided in **Appendices E** (calibrated model), **F** (forest model), and **G** (70 percent reduction model).

The calibrated model is based on what is considered a critically low DO event in the stream. The critical low DO event was selected by first identifying the lower 10^{th} percentile DO value (=2.5 mg/L) for measurements collected between 1995 and 2003. Then a summer low DO event nearest to the lower 10^{th} percentile value was selected from the period when LBC flow estimates were derived using the adjacent Allen Creek gage flow record (August 1999 to December 2003). The September 24, 2001 sampling event, where the DO measured was 2.6 mg/L, was selected as the critical low DO event for the calibration model. The estimated stream flow on this date is 4.3 cfs. The model was set up based on conditions observed on this date and input values (reaction rates and concentrations) were adjusted to match the observed data for model calibration.

As noted above, a surrogate USGS continuous flow gage at Allen Creek (USGS station 02307731) near Largo, Florida, was used in the model calibration because there is no gaging station within the Long Branch Creek watershed. This gage was used because of its location in relation to Long Branch Creek, similar watershed topographic and geologic characteristics, and similar drainage area size and creek ratio. Continuous flow data from Allen Creek were only available from 1999 to 2003, which is why the critical conditions period for model calibration occurred during this time frame.

According to USGS methodology, flows may be estimated at ungaged sites using drainage area ratios to a nearby gaged stream when the weighted drainage ratios of the two sites are within 0.5 to 1.5 square miles (Ries and Friesz, 2000; U.S. Environmental Protection Agency, 2004). The Long Branch Creek and Allen Creek drainage area ratio is 1.05 square miles, almost identical in size, and within the range recommended by USGS.

After the model was calibrated to the September 24, 2001 sampling event, the forest land cover model, where all land use in the freshwater segment was converted to forest, was used to estimate the DO concentration under natural background conditions. The natural background DO was estimated to be 3.5 mg/L. The DO target used in this TMDL is 3.3 mg/L, to allow for loadings associated with human development that would not considerably lower the DO from natural background conditions.

Model load reduction scenario iterations were then performed to determine the load reductions necessary to meet the target. It was determined that a 70 percent reduction in existing oxygen demanding loads under the critical low DO event would meet the DO target of 3.3 mg/L.

5.4 Long Branch Creek Spreadsheet Water Quality Model Development

The following describes the model set up and data used to develop the SWQM model for the freshwater segment of Long Branch.

A. Subbasin Delineations

The freshwater segment of the LBC Basin was divided into five subbasins for modeling purposes. These subbasins include the headwaters, a tributary, and subbasins adjacent to the three stream segments. The freshwater stream segment of LBC (WBID 1627) including the headwaters is approximately 2.5 miles in length and flows into WBID 1627B, the estuarine segment of the basin. The last mile of the freshwater portion of the creek was simulated using the SWQM and was divided into three segments taking into consideration hydrology and land use. A headwaters input, one tributary input, and three subbasin inputs were included in the SWQM. The three creek segments were assumed to be the functional equivalent of a completely mixed zone and each received inflow from their adjacent subbasins. The upstream segment is 0.36 miles, the middle segment is 0.27 miles, and lower segment is 0.34 miles in length. The one tributary included in the model flows into segment one **(Figure 5.1)**.

B. Areas of Different Land Use Categories

Areas of different land use in the LBC Basin for the ADEM SWQM were obtained by using Level 1 or Level 3 land use coverages. Low, medium, and high density residential level 3 land uses were separated from the urban land use category. The nine land use categories and event mean concentrations applied in the ADEM model for the headwaters, tributary one, and segments one, two, and three are shown in **Tables 5.1, 5.2, 5.3, 5.4, and 5.5,** respectively. These land use categories were used because land use runoff coefficients and concentrations for Southwest Florida are available (Harper and Baker 2003). As noted in **Table 4.1**, the dominant land use category in the freshwater segment of the watershed is high density residential, which accounts for about 45 percent of the total area of the watershed. Commercial and services account for 21 percent with medium density residential accounting for 9 percent. The areas occupied by non-anthropogenic land uses account for only 9.3 percent of the total area. See **Tables 5.1 through 5.5** for the dominant land uses and runoff coefficients for each segment used in the model. See **Figure 5.2** for land use percentiles for all model segments in LBC Basin.

C. Local Event Mean Concentrations (EMCs)

Local event mean concentrations of BOD and TN for different land use categories for Southwest Florida were obtained from Harper and Baker, 2003. The reported EMC values were converted to CBODu, TON, and NH3-N concentrations for use in the SWQM. The CBODu EMC was obtained by multiplying the BOD EMC by 1.5. This multiplier was obtained from the “State/EPA Region IV Agreement on the Development of Wasteload Allocations and Wastewater Permit Limitations” (Florida Department of Environmental Regulation and U.S. Environmental Protection Agency, 1982). To obtain the TON and NH3-N EMCs needed for the SWQM, PCDEM station 22-5 (1995-2003) water quality data were used in converting the TN EMCs into values for TON and NH3-N. The TON EMC concentration was determined by using the ratio of TON/TN in the stream and then multiplying each land use TN EMC value by this ratio. The NH3-N EMC concentration was determined by using the ratio of NH3-N/TN in the stream and then multiplying each land use TN EMC value by this ratio. Land use runoff concentrations for CBODu, TON, and NH3-N for the headwater, tributary, and segment subbasins are presented in **Table 5.1 through 5.5**.

D. Headwaters and Tributary Flow Conditions

Required inputs for the headwater and tributary subbasins include flow, temperature, and DO concentrations. Flow in Long Branch Creek was estimated based on data from the USGS continuous flow gage at a nearby stream, Allen Creek (USGS 02307731) near Largo, Florida. The stream flow estimated on September 24, 2001, using the Allen Creek gage, was 4.3 cubic feet per second (cfs). The baseflow component of this flow was determined by applying a baseflow separation formula. A baseflow of 2.1 cfs was calculated. To determine the headwaters and tributary inflow, the base flow was subtracted from 4.3 cfs resulting in a total flow of 2.2 cfs. Flow input values of 1.2 and 0.17 cfs were incorporated into the model for the headwaters and tributary, respectively by the multiplying the total runoff flows by the ratio of each subbasin area to total freshwater drainage basin area. These inflow values represent a percentage of the total flow of 2.18 based on their respective contributing sub-basin area (**Table 5.7**). The temperature input is the temperature recorded at station PCDEM 22-5 on September 24, 2001. A DO concentration of 6.8 mg/L was used for the headwaters and tributary conditions in the model. As recommended by the SWQM, this DO concentration value was determined by using 85 percent of the DO saturation concentration (8.02 mg/L) at a temperature of 26.5^{o} Celsius. The input of CBODu, TON, and NH3-N concentrations from the headwater and tributary are land use and runoff coefficient weighted values.

E. Incremental Inflow Conditions (Segments One, Two, and Three)

Incremental inflow (IF) refers to all natural streamflow not considered by the other two sources of flow – headwaters and tributaries. In this model it encompasses flows from small tributaries not considered in the model and nonpoint source runoff. Required inputs for incremental flow are the same as those for the headwaters and tributary. The temperature input is the temperature recorded at station PCDEM 22-5 on the day of the critical low DO event, 9/24/01. Flow input values of 0.36, 0.23, and 0.22 cfs were incorporated into the model for segments one, two, and three, respectively. As noted above, these inflow values represent a percentage of the total runoff flow of 2.2 cfs based on their respective contributing sub-basin area. (**Table 5.7**). As recommended by SWQM, the incremental inflow DO was assumed to be 70 percent of the saturation value on 9/24/01. A DO concentration of 5.6 mg/L was used as input to segments one through three. As recommended by the SWQM, this DO concentration value was determined by using 70 percent of the DO saturation concentration (8.02 mg/L) at a temperature of 26.5^{o} Celsius. Incremental inflow for each reach is assumed to be proportional to the length of the reach. The input of $CBOD_u$, TON, and NH_3-N concentrations into each segment are land use and runoff coefficient weighted values.

F. Baseflow and Effluent Conditions

The point source conditions include all wastewater discharges from point sources in a watershed. Required input for point sources are pollutant concentrations, flows and temperatures. There are no permitted point source discharges in the Long Branch Creek watershed.

A base flow input of 2.1 cfs was incorporated into the model based on a predicted base flow that corresponds with the critical condition used for model calibration. The baseflow accounts for groundwater contributions to stream flow and water chemistry. Concentration values for baseflow were based on unconfined surficial groundwater well data collected in the Tampa Bay area (Florida Department of Environmental Protection Groundwater Database, 2004). A groundwater $CBOD_5$ value of 0.5 mg/L was assumed as input since there were no measurements of BOD in the groundwater database. Groundwater database mean values for DO and NH_3-N initially used as input, were adjusted in the model to facilitate model calibration.

F. Section Characteristics

Required input for section characteristics are segment lengths, upstream elevation for segment 1, and all segment downstream elevations. Upstream elevations for all other segments are calculated in the model once all downstream elevations have been entered. Elevations and lengths were estimated using a USGS 1:24,000 scale quadrangle map (U.S. Geological Survey, 1987). Average elevation, slope, and stream velocity values were calculated by the model.

G. Reaction Rates

Reaction rates consists of two parts – a mandatory input section and an optional one. Input requirements for the mandatory section are the carbonaceous BOD decay rate (K_d of 1.2 1/day), nitrification rate (K_{NH3} of 0.3 1/day), and organic nitrogen hydrolysis rate (K_{TON} 0.5 1/day). The reaeration coefficients for segment one, two, and three (K_a of 1.4, 2.8, and 2.3 1/day) were manually input and adjusted to facilitate model calibration.

Sediment oxygen demand (SOD) may be an important part of the oxygen demand budget in shallow streams. However, for shallow streams with sand and mineral soils, the SOD component is generally small. These hydrogeological conditions are representative of the LBC watershed so the SOD for this stream is considered minimal. The SOD value used in the model was obtained from Florida's Simplified Analytical Method (FSAM) for Development of Point Source Wasteload Allocations for Florida Streams (Bowman and McClelland, Florida Bureau of Water Analysis, 1984). The stream depth used in each segment of the model was that measured during the critical low DO sample event.

5.5 Source Assessment

Both point and non-point sources may contribute CBOD and NBOD (i.e., organic loading) to a given waterbody. As noted in Chapter 4, there are no point sources in the LBC watershed. Potential sources of organic loading are numerous and often occur in combination. In rural areas, storm runoff from row crops, livestock pastures, animal waste application sites, and feedlots can transport significant organic loading.

Nationwide, poorly treated municipal sewage comprises a major source of organic compounds that are hydrolyzed to create additional organic loading. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows may also be significant sources of organic loading.

Because no point source dischargers were identified in the LBC watershed, nutrient and organic loadings appear to be generated strictly from nonpoint sources. Potential nonpoint sources of nutrient and organic loading in the LBC watershed were identified based on an evaluation of 1999 land use information in the watershed. The source assessment was used as the basis for development of the model.

The largest land use area is high and medium density residential homes which make up 54 percent of the watershed, followed by commercial and services at about 21 percent (Table 4.1). These land uses are the major sources of nutrient and organic loadings within the LBC Basin. Each land use has the potential to contribute to organic loading in the watershed due to organic material on the land surface that is washed off into the receiving waters during heavy rainfall and/or storm events. Compared to other land uses in the watershed, organic enrichment from forested land, nurseries/vineyards, and open land is considered to be small. These nonpoint sources only make up 9.3 percent of the land use in the watershed and tend to serve as a filter of pollution originating within its drainage areas. However, organic loading can originate from forested areas and open land due to the presence of wild animals such as deer, raccoons, turkeys, and waterfowl. Control of these sources is usually limited to land best management practices (BMPs) and may be impracticable in most cases. There are no pastures/rangeland, agricultural land or animal feeding operations in the watershed.

5.6 TMDL Development Approach Using the SWQM

Data collected at station PCDEM 22-5 in September 2001 were used as input into the SWQM for model calibration. The model calibration plots are provided in Appendix D. After the calibration process was complete, load reduction design runs were performed to attempt to bring the waterbody into compliance with the 5 mg/L DO criterion. The design runs indicated the criterion could not be achieved under the critical low DO event simulated.

Subsequently, land use indicative of natural background conditions (i.e., 100 percent forested land) was incorporated into the model to establish a target threshold.
This was accomplished by replacing all the existing land use with forested land use in the calibrated model. The forested land use condition resulted in an “average” DO concentration of 3.5 mg/L along segments one, two, and three of the model. The Department selected a target 0.2 mg/L below the natural background DO. Meeting a DO target of 3.3 mg/L, would not considerably lower the DO from natural background conditions and still allow for an anthropogenic loading to the watershed.

Model load reduction scenario iterations were then performed to determine the reductions in existing loads needed to meet the target. Nonpoint source load reductions were simulated by reducing the land use EMCs, used in calibration, an equal percentage throughout the watershed being modeled. It was determined that a 70 percent reduction in the EMCs, or oxygen demanding loads, under the critical low DO event would meet the DO target of 3.3 mg/L. The loads of $CBOD_u$ and NBOD for the 70 percent load reduction run subtracted from the existing loads for the calibration run indicate the amount the load has to be reduced for the critical low DO event. A summary of the water quality concentrations and pollutant loads obtained from the calibrated model, forested model, and 70 percent load reduction model are presented in **Table 5.8.**

The lowest DO concentrations observed throughout the verified period occurred during the summer months, however, low DO values have been observed thoughout the year. To develop the TMDL on an annual basis, the 70 percent load reduction is applied to the annual average BOD and TN loadings for the 1995 to 2003 period, estimated using the WMM. The reduction in the existing BOD and TN annual load by 70 percent would address the reductions in organic loading needed to meet the DO target using the SWQM. Applying the percent load reduction, developed for the critical low DO condition, on an annual basis provides for an implicit margin of safety in TMDL development.

5.7 Critical Conditions

Lower flow summer conditions are generally considered critical conditions for dissolved oxygen in streams. The higher summer temperatures increase microbial metabolism which consumes more oxygen and reduced water velocities under low flows results in decreased reaeration rates. Also in Florida’s summer wet season, higher organic loadings would occur due to greater surface runoff and lower flows would increase the organic loading residence time. This increased time permits more organic matter decay to occur. Reaction rates for $CBOD_u$ and NBOD (i.e., organic loading) increase with higher temperatures resulting in an increase in the decay process that depletes the dissolved oxygen supply in the water column.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. The goal of the TMDL development for Long Branch Creek is to identify the maximum allowable nutrient and organic loadings to the watershed so that the freshwater segment will meet applicable water quality standards and maintain its function and designated use as a Class III water.

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

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

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

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

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

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

This approach is consistent with federal regulation 40 CFR § 130.2[I] (USU.S. Environmental Protection Agency, 2003), which states that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. As discussed in Section 5.3, this TMDL was established by developing an alternative DO target because modeling indicated that the state Class III freshwater DO criterion of 5.0 mg/L could not be achieved under critical DO conditions. This TMDL provides the basis for an alternative DO criterion of 3.5 mg/L for the creek based on natural background conditions. However, the amount of data on which this report is based are limited. The Department plans to collect additional data in order to develop a Site Specific Alternative Criterion (SACC) for DO in Long Branch Creek. As additional information become available, the TMDLs may be updated. The Long Branch Creek TMDLs that address the DO impairment are expressed in terms of pounds (lbs) per year of BOD and TN and represent the maximum organic loadings the freshwater segment of Long Branch can assimilate to achieve the DO target of 3.3 mg/L. The nonpoint source pollutant load targets for BOD and TN needed to achieve the DO target for this TMDL are provided in **Table 6.1.**

6.2 Load Allocation (LA)

As described in Chapters 4 and 5, the nonpoint source loadings for this TMDL were estimated using the Watershed Management Model and the ADEM Spreadsheet Water Quality Model (SWQM). The LA to nonpoint sources is 19,903 lbs/year of BOD and 4,764 lbs/year of TN (**Table 6.1**). The annual nonpoint source loadings for the TMDL are based on the maximum amount of pollutant load that is generated in the freshwater segment of the watershed.

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

There are no permitted NPDES wastewater discharges to Long Branch Creek. As such, the WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with a Municipal Separate Storm Sewer System (MS4) permit is a 70 percent reduction in BOD and TN loading, which is the same percent load reduction that is required for nonpoint sources to meet the allowable loading of 19,903 lbs/year of BOD and 4,764 lbs.year of TN **(Table 6.1)**. It should be noted that any MS4 permittee will only be responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and is not responsible for reducing other nonpoint source loads within its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a margin of safety in the analysis. The margin of safety 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 (CWA section 303(d)(1)(c)). Considerable uncertainty is usually inherent in estimating nutrient and organic loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management measures (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

There are two methods for incorporating a margin of safety (MOS) in TMDL analysis: (1) by implicitly incorporating a MOS using conservative model assumptions to develop allocations, or (2) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations. Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, 2001), an implicit MOS was used in the development of this TMDL. The reduction in the existing BOD and TN annual load by 70 percent is based on the reduction in nutrient and organic loading needed to meet the DO target for the critical low DO condition. Applying the percent load reduction, developed for the critical low DO condition, on an annual basis provides for an implicit margin of safety in TMDL development.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan (BMAP) for the Long Branch Creek basin. This document will be developed over the next year in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished. The BMAP will include the following:

- Appropriate allocations among the affected parties,
- A description of the load reduction activities to be undertaken,
- Timetables for project implementation and completion,
- Funding mechanisms that may be utilized,
- Any applicable signed agreement,
- Local ordinances defining actions to be taken or prohibited,
- Local water quality standards, permits, or load limitation agreements, and
- Monitoring and follow-up measures.

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

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 master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (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 the Florida Department of Transportation throughout the fifteen 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 will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The Department recently accepted delegation from the EPA for the stormwater part of the NPDES Program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.

APPENDIX B: Long Branch Creek Dissolved Oxygen Water Quality Data, 1995 to 2002

HUC	WBID	Station[1]	Date	Time	Sample Depth	DO[2] (mg/l)
3100206	1627	21FLPDEM22-05	1/18/1995	1132	0.33	5.46
3100206	1627	21FLPDEM22-05	2/15/1995	913	0.33	**3.32**
3100206	1627	21FLPDEM22-05	3/15/1995	1053	0.33	**4.83**
3100206	1627	21FLPDEM22-05	4/12/1995	918	0.33	**4.04**
3100206	1627	21FLPDEM22-05	5/10/1995	1117	0.33	**4.85**
3100206	1627	21FLPDEM22-05	6/7/1995	921	0.33	**2.22**
3100206	1627	21FLPDEM22-05	7/5/1995	1117	0.33	**3.02**
3100206	1627	21FLPDEM22-05	8/9/1995	901	0.33	**1.55**
3100206	1627	21FLPDEM22-05	9/6/1995	838	0.33	**1.98**
3100206	1627	21FLPDEM22-05	9/27/1995	917	0.66	**2.47**
3100206	1627	21FLPDEM22-05	10/25/1995	1246	0.66	**3.87**
3100206	1627	21FLPDEM22-05	11/29/1995	1116	0.33	**2.74**
3100206	1627	21FLPDEM22-05	1/17/1996	1141	0.33	5.46
3100206	1627	21FLPDEM22-05	2/14/1996	1125	0.33	5.95
3100206	1627	21FLPDEM22-05	3/13/1996	1239	0.66	7.00
3100206	1627	21FLPDEM22-05	4/10/1996	1100	0.66	**4.39**
3100206	1627	21FLPDEM22-05	5/8/1996	1054	0.33	**3.19**
3100206	1627	21FLPDEM22-05	5/29/1996	1346	0.33	**4.70**
3100206	1627	21FLPDEM22-05	7/10/1996	835	0.33	**1.52**
3100206	1627	21FLPDEM22-05	7/31/1996	954	0.33	**3.45**
3100206	1627	21FLPDEM22-05	8/27/1996	1109	0.33	**3.19**
3100206	1627	21FLPDEM22-05	9/18/1996	1127	0.33	**2.78**
3100206	1627	21FLPDEM22-05	10/23/1996	1101	0.33	**3.88**
3100206	1627	21FLPDEM22-05	11/20/1996	1118	0.66	**3.73**
3100206	1627	21FLPDEM22-05	1/22/1997	1231	0.33	9.59
3100206	1627	21FLPDEM22-05	2/26/1997	1149	0.33	7.21
3100206	1627	21FLPDEM22-05	3/19/1997	1144	0.66	**4.61**
3100206	1627	21FLPDEM22-05	4/23/1997	1011	0.66	**4.57**
3100206	1627	21FLPDEM22-05	5/14/1997	1100	0.33	**4.39**
3100206	1627	21FLPDEM22-05	6/4/1997	1120	0.33	**3.90**
3100206	1627	21FLPDEM22-05	7/2/1997	1018	0.33	**2.91**
3100206	1627	21FLPDEM22-05	7/30/1997	1143	0.33	**3.70**
3100206	1627	21FLPDEM22-05	9/3/1997	1029	0.66	**1.43**
3100206	1627	21FLPDEM22-05	9/24/1997	1155	0.33	**2.54**
3100206	1627	21FLPDEM22-05	10/15/1997	1126	0.33	**2.60**
3100206	1627	21FLPDEM22-05	11/12/1997	1253	0.33	5.26
3100206	1627	21FLPDEM22-05	12/17/1997	1158	0.33	5.46
3100206	1627	21FLPDEM22-05	1/28/1998	946	0.66	5.26
3100206	1627	21FLPDEM22-05	2/25/1998	854	0.33	**3.89**
3100206	1627	21FLPDEM22-05	3/25/1998	1115	0.33	5.07
3100206	1627	21FLPDEM22-05	4/21/1998	1039	0.66	**4.23**
HUC	**WBID**	**Station[1]**	**Date**	**Time**	**Sample**	**DO[2]**

					Depth	(mg/l)
3100206	1627	21FLPDEM22-05	5/20/1998	1104	0.33	**4.82**
3100206	1627	21FLPDEM22-05	6/17/1998	1126	0.33	**2.37**
3100206	1627	21FLPDEM22-05	7/15/1998	1039	0.33	**1.57**
3100206	1627	21FLPDEM22-05	8/12/1998	1130	0.33	**2.95**
3100206	1627	21FLPDEM22-05	9/9/1998	1048	0.33	**3.21**
3100206	1627	21FLPDEM22-05	10/7/1998	1149	0.33	**3.43**
3100206	1627	21FLPDEM22-05	11/4/1998	1219	0.33	**3.78**
3100206	1627	21FLPDEM22-05	12/9/1998	1039	0.33	**4.57**
3100206	1627	21FLPDEM22-05	1/20/1999	1256	.	5.74
3100206	1627	21FLPDEM22-05	2/18/1999	1101	.	5.29
3100206	1627	21FLPDEM22-05	3/23/1999	1129	.	5.87
3100206	1627	21FLPDEM22-05	4/14/1999	1156	.	**4.58**
3100206	1627	21FLPDEM22-05	5/12/1999	1158	.	**3.68**
3100206	1627	21FLPDEM22-05	6/9/1999	1027	.	**2.56**
3100206	1627	21FLPDEM22-05	7/7/1999	1211	.	**4.46**
3100206	1627	21FLPDEM22-05	8/4/1999	1115	.	**1.36**
3100206	1627	21FLPDEM22-05	9/8/1999	1227	.	**4.30**
3100206	1627	21FLPDEM22-05	9/29/1999	1120	.	**3.11**
3100206	1627	21FLPDEM22-05	10/27/1999	1325	.	6.43
3100206	1627	21FLPDEM22-05	11/30/1999	1031	.	**4.02**
3100206	1627	21FLPDEM22-05	12/14/1999	1201	.	5.30
3100206	1627	21FLPDEM22-05	1/19/2000	1243	.	7.85
3100206	1627	21FLPDEM22-05	2/16/2000	1222	.	6.90
3100206	1627	21FLPDEM22-05	3/15/2000	1154	.	**3.68**
3100206	1627	21FLPDEM22-05	4/11/2000	1035	.	6.22
3100206	1627	21FLPDEM22-05	5/10/2000	1331	.	9.10
3100206	1627	21FLPDEM22-05	7/5/2000	1212	.	**0.13**
3100206	1627	21FLPDEM22-05	8/8/2000	1104	.	**2.68**
3100206	1627	21FLPDEM22-05	8/30/2000	1230	.	**4.94**
3100206	1627	21FLPDEM22-05	9/27/2000	1142	.	**2.26**
3100206	1627	21FLPDEM22-05	10/25/2000	1051	.	**2.78**
3100206	1627	21FLPDEM22-05	11/21/2000	1110	.	8.48
3100206	1627	21FLPDEM22-05	1/17/2001	1302	.	9.86
3100206	1627	21FLPDEM22-05	2/15/2001	1120	.	8.85
3100206	1627	21FLPDEM22-05	3/15/2001	1202	.	8.78
3100206	1627	21FLPDEM22-05	4/11/2001	1111	.	8.35
3100206	1627	21FLPDEM22-05	5/10/2001	1221	.	5.70
3100206	1627	21FLPDEM22-05	6/6/2001	1204	.	9.56
3100206	1627	21FLPDEM22-05	6/26/2001	1058	.	5.82
3100206	1627	21FLPDEM22-05	8/1/2001	853	.	**3.46**
3100206	1627	21FLPDEM22-05	8/29/2001	1014	.	**2.63**
3100206	1627	21FLPDEM22-05	9/24/2001	845	.	**2.60**
3100206	1627	21FLPDEM22-05	10/31/2001	1056	.	6.15
3100206	1627	21FLPDEM22-05	11/19/2001	1038	.	6.09
3100206	1627	21FLPDEM22-05	1/16/2002	1135	0.12	7.37
HUC	**WBID**	**Station[1]**	**Date**	**Time**	**Sample Depth**	**DO[2] (mg/l)**

3100206	1627	21FLPDEM22-05	2/13/2002	1126	0.32	8.11
3100206	1627	21FLPDEM22-05	3/13/2002	1223	0.16	9.16
3100206	1627	21FLPDEM22-05	4/9/2002	1102	0.11	6.20
3100206	1627	21FLPDEM22-05	5/8/2002	1215	0.1	8.60
3100206	1627	21FLPDEM22-05	6/5/2002	1133	0.08	5.33
3100206	1627	21FLPDEM22-05	7/17/2002	1147	0.3	5.14
3100206	1627	21FLPDEM22-05	7/23/2002	1011	0.1	**4.08**
3100206	1627	21FLPDEM22-05	9/24/2002	1104	0.11	**2.85**
3100206	1627	21FLPDEM22-05	10/23/2002	948	0.15	**2.36**
3100206	1627	21FLPDEM22-05	11/19/2002	1124	0.23	5.14
3100206	1627	21FLPDEM22-05	12/11/2002	1103	0.34	6.48
3100206	1627	21FLTPA 275442308244165	4/23/2002	945	0.3	**0.98**
3100206	1627	21FLTPA 275442308244165	5/7/2002	945	0.2	**3.1**
3100206	1627	21FLTPA 275442308244165	6/4/2002	940	0.2	**1.9**
3100206	1627	21FLTPA 275442308244165	7/23/2002	1210	0.2	5.97
3100206	1627	21FLTPA 275442308244165	8/20/2002	1010	0.2	**3.72**
3100206	1627	21FLTPA 275442308244165	9/25/2002	1005	0.2	**4.6**
3100206	1627	21FLTPA 275442308244165	10/21/2002	1030	0.2	**3.99**
3100206	1627	21FLTPA 275442308244165	11/20/2002	1000	0.2	8.07
3100206	1627	21FLTPA 275442308244165	12/4/2002	955	0.2	5.53
3100206	1627	21FLTPA 275443208244235	4/23/2002	1215	0.3	**2.49**
3100206	1627	21FLTPA 275443208244235	5/7/2002	1050	0.2	5.58
3100206	1627	21FLTPA 275443208244235	6/4/2002	1035	0.2	**0.45**
3100206	1627	21FLTPA 275443208244235	7/23/2002	1140	0.3	**1.6**
3100206	1627	21FLTPA 275443208244235	8/20/2002	1115	0.2	**3.13**
3100206	1627	21FLTPA 275443208244235	9/25/2002	1100	0.3	**1.67**
3100206	1627	21FLTPA 275443208244235	10/21/2002	1110	0.2	**1.29**
3100206	1627	21FLTPA 275443208244235	11/20/2002	1030	0.2	**2.76**
3100206	1627	21FLTPA 275443208244235	12/4/2002	1025	0.3	5.62

1: For station 21FLPDEM22-5, per IWR methodology for deil measurements, the DO result is the median or 10th percentile value based on top, middle, and bottom water column measurements. If the top, middle, and bottom measurements were all above the acute toxicity level of 1.5 mg/L, the median all three measurements was calculated. If one or more of the top, middle, or bottom measurement were below the acute toxicity level of 1.5 mg/L, the 10th percentile of all three measurements was calculated.
2: Bold DO results represent measurements that were below the state's Class III freshwater water quality criterion of 5.0 mg/L.

APPENDIX C: Long Branch Creek Water Quality Data and Flow Data (Allen Creek), 1995 to 2003

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umhos/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	1/18/1995	1132		0.1		0	630	16.9	5.5	1.3		1.29		0.51	1.8	0.15	5.8
PCDEM 22-05	2/15/1995	913		0.1		0	600	19.1	**3.3**	1.5		1.2		0.33	1.53	0.1	6.6
PCDEM 22-05	3/15/1995	1053		0.1		0	720	20.3	**4.8**	1.7		1.24		0.17	1.41	0.17	4.2
PCDEM 22-05	4/12/1995	918		0.1		0	290	23.0	**4.0**	2.2		0.88		0.17	1.05	0.26	16.8
PCDEM 22-05	5/10/1995	1117		0.1		0	750	26.8	**4.9**	1.8		1.1		0.06	1.16	0.17	16.9
PCDEM 22-05	6/7/1995	921		0.1		0	540	26.8	**2.2**	1.3		0.94		0.12	1.06	0.14	7.2
PCDEM 22-05	7/5/1995	1117		0.1		0	660	28.9	**3.0**	1.3		0.98		0.25	1.23	0.12	1.9
PCDEM 22-05	8/9/1995	901		0.1		0	650	27.9	**1.6**	1.2		2.45		0.1	2.55	0.15	2
PCDEM 22-05	9/6/1995	838		0.1		0	370	26.5	**2.0**	1.4		1.05		0.18	1.23	0.12	6.2
PCDEM 22-05	9/27/1995	917		0.2		0	780	26.9	**2.5**	1.4		1.3		0.12	1.42	0.1	0.9
PCDEM 22-05	10/25/1995	1246		0.2		0	610	25.0	**3.9**	1		1.11		0.29	1.4	0.09	1.1
PCDEM 22-05	11/29/1995	1116		0.1		0	620	21.5	**2.7**	1.5		0.76		0.14	0.9	0.08	1.3
PCDEM 22-05	1/17/1996	1141	0.2	0.1		0	640	17.2	5.5	1		0.74		0.25	0.99	0.05	1.5
PCDEM 22-05	2/14/1996	1125		0.1		0	710	14.1	6.0	1.2		0.75		0.14	0.89	0.12	4.3
PCDEM 22-05	3/13/1996	1239		0.2		0	660	16.1	7.0	2.3	0.48	0.56	0.08	0.28	0.84	0.13	2
PCDEM 22-05	4/10/1996	1100		0.2		0	630	17.5	**4.4**	1.3	0.64	0.7	0.06	0.19	0.89	0.1	1
PCDEM 22-05	5/8/1996	1054		0.1		0	670	25.4	**3.2**	1.7	0.64	0.69	0.05	0.12	0.81	0.14	1.6
PCDEM 22-05	5/29/1996	1346		0.1		0	530	29.1	**4.7**	2.6	0.8	0.83	0.03	0.06	0.89	0.3	10.5

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umhos/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	7/31/1996	954		0.1		0	740	28.5	**3.5**	1	0.45	0.5	0.05	0.05	0.55	0.14	3.1
PCDEM 22-05	8/27/1996	1109	0.1	0.1		0	460	27.2	**3.2**	2.2	0.31	0.39	0.08	0.11	0.5	0.04	2.6
PCDEM 22-05	9/18/1996	1127	0.2	0.1		0	710	28.7	**2.8**	1.2	1.07	1.29	0.22	0.13	1.42	0.16	1.9
PCDEM 22-05	10/23/1996	1101	0.1	0.1		0	730	23.2	**3.9**	1	0.76	0.82	0.06	0.12	0.94	0.02	1.7
PCDEM 22-05	11/20/1996	1118		0.2		0	800	21.2	**3.7**	1	0.31	0.34	0.03	0.14	0.48	0.06	1.1
PCDEM 22-05	1/22/1997	1231		0.1		0	830	16.3	9.6	1	0.6	0.62	0.02	0.03	0.65	0.07	1.1
PCDEM 22-05	2/26/1997	1149	0.3	0.1		0	730	23.2	7.2	2	0.68	0.7	0.02	0.02	0.72	0.08	6.6
PCDEM 22-05	3/19/1997	1144		0.2		0	770	23.7	**4.6**	2	0.8012	0.85	0.0488	0.02	0.87	0.16	1.2
PCDEM 22-05	4/23/1997	1011	0.2	0.2		0	800	24.6	**4.6**	1	0.6256	0.65	0.0244	0.02	0.67	0.16	1.9
PCDEM 22-05	5/14/1997	1100		0.1		0	630	24.3	**4.4**	1	0.3546	0.44	0.0854	0.08	0.52	0.04	4.9
PCDEM 22-05	6/4/1997	1120		0.1		0	660	26.2	**3.9**	1	0.7556	0.78	0.0244	0.02	0.8	0.04	0.7
PCDEM 22-05	7/2/1997	1018		0.1		0	410	26.8	**2.9**	2	0.655	0.96	0.305	0.03	0.99	0.07	2.4
PCDEM 22-05	7/30/1997	1143	0.2	0.1		0	450	29.2	**3.7**	1	0.7556	0.78	0.0244	0.07	0.85	0.07	3.2
PCDEM 22-05	9/3/1997	1029		0.2		0	530	27.8	**1.4**	2	1.0412	1.09	0.0488	0.03	1.12	0.1	3.9
PCDEM 22-05	9/24/1997	1155	0.1	0.1		0	720	27.6	**2.5**	4	1.6658	1.8	0.1342	0.2	2	0.7	11.7
PCDEM 22-05	10/15/1997	1126	0.2	0.1		0	740	24.9	**2.6**	4	0.7292	1.51	0.7808	0.46	1.97	0.23	5.1
PCDEM 22-05	11/12/1997	1253		0.1		0	650	22.4	5.3	1	0.5818	0.96	0.3782	0.28	1.24	0.1	2.7
PCDEM 22-05	12/17/1997	1158		0.1		0	560	17.4	5.5	1	0.112	1.21	1.098	0.38	1.59	0.13	1.2
PCDEM 22-05	1/28/1998	946	0.2	0.2		0	530	15.6	5.3	2	0.54	0.99	0.45	0.24	1.23	0.09	1.7

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umhos/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	2/25/1998	854	0.1	0.1		0	580	16.4	**3.9**	2	0.32	0.9	0.58	0.21	1.11	0.12	3
PCDEM 22-05	3/25/1998	1115	0.1	0.1		0	570	19.3	5.1	1	0.42	0.77	0.35	0.21	0.98	0.12	1.8
PCDEM 22-05	4/21/1998	1039		0.2		0	740	23.4	**4.2**	2	0.72	0.81	0.09	0.22	1.03	0.08	5.3
PCDEM 22-05	5/20/1998	1104		0.1		0	840	26.5	**4.8**	1	0.65	0.67	0.02	0.03	0.7	0.06	2.3
PCDEM 22-05	6/17/1998	1126	0.2	0.1		0	740	29.7	**2.4**	2	0.64	0.69	0.05	0.07	0.76	0.1	5.4
PCDEM 22-05	7/15/1998	1039	0.2	0.1		0	490	27.8	**1.6**	1	0.69	0.76	0.07	0.04	0.8	0.22	11.2
PCDEM 22-05	8/12/1998	1130		0.1		0	540	29.2	**3.0**	1	0.54	0.64	0.1	0.12	0.76	0.18	1
PCDEM 22-05	9/9/1998	1048	0.2	0.1		0	500	27.9	**3.2**	1	0.66	0.78	0.12	0.21	0.99	0.15	4.7
PCDEM 22-05	10/7/1998	1149	0.2	0.1		0	670	27.8	**3.4**	1	0.73	0.86	0.13	0.18	1.04	0.1	0.5
PCDEM 22-05	11/4/1998	1219		0.1		0.09	930	24.3	**3.8**	3	0.65	0.71	0.06	0.24	0.95	0.08	1.6
PCDEM 22-05	12/9/1998	1039	0.2	0.1		0.1	980	21.5	**4.6**	1	0.56	0.6	0.04	0.16	0.76	0.07	1.1
PCDEM 22-05	1/20/1999	1256		0.1		0	730	21.3	5.7	1	0.56	0.63	0.07	0.17	0.8	0.07	1.1
PCDEM 22-05	2/18/1999	1101	0.2	0.2		0	850	20.1	5.3	1	0.43	0.47	0.04	0.09	0.56	0.07	0.5
PCDEM 22-05	3/23/1999	1129		0.12		0	750	20.2	5.9	2	0.49	0.54	0.05	0.02	0.56	0.08	1.1
PCDEM 22-05	4/14/1999	1156		0.1		0.1	880	23.5	**4.6**	1	0.42	0.46	0.04	0.02	0.48	0.1	0.8
PCDEM 22-05	5/12/1999	1158		0.1		0	750	26.1	**3.7**	1	0.5	0.52	0.02	0.02	0.54	0.1	1.3
PCDEM 22-05	6/9/1999	1027		0.1		0.1	940	25.9	**2.6**	1	0.55	0.57	0.02	0.05	0.62	0.12	1.4
PCDEM 22-05	7/7/1999	1211		0.1		0	500	28.7	**4.5**	1	0.64	0.71	0.07	0.16	0.87	0.08	4.1
PCDEM 22-05	8/4/1999	1115		0.1	1.25	0	550	28.7	**1.4**	1	0.4	0.45	0.05	0.05	0.5	0.09	1.8

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umho s/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	9/29/1999	1120	0.1	0.1	3.45	0	450	27.4	**3.1**	2	0.52	0.61	0.09	0.14	0.75	0.06	6.4
PCDEM 22-05	10/27/1999	1325		0.2	0.75	0	810	22.1	6.4	1	0.65	0.72	0.07	0.24	0.96	0.07	2.1
PCDEM 22-05	11/30/1999	1031		0.25	0.48	0.06	890	18.2	**4.0**	1	0.84	0.86	0.02	0.07	0.93	0.12	17.5
PCDEM 22-05	12/14/1999	1201		0.23	0.59	0.07	900	21.5	5.3	1	0.59	0.63	0.04	0.08	0.71	0.02	0.9
PCDEM 22-05	1/19/2000	1243	0.1	0.06	0.38	0.09	940	18.8	7.9	1	0.48	0.52	0.04	0.02	0.54	0.03	1.5
PCDEM 22-05	2/16/2000	1222		0.08	1.15	0	650	19.6	6.9	1	0.55	0.59	0.04	0.02	0.61	0.07	0.8
PCDEM 22-05	3/15/2000	1154		0.09	0.51	0.11	970	21.1	**3.7**	2	0.76	0.8	0.04	0.02	0.82	0.1	1
PCDEM 22-05	4/11/2000	1035		0.12	0.24	0.08	920	20.3	6.2	1	0.71	0.73	0.02	0.02	0.75	0.05	0.6
PCDEM 22-05	5/10/2000	1331		0.11	0.1	0.17	1090	29.0	9.1	1	0.69	0.75	0.06	0.03	0.78	0.11	2
PCDEM 22-05	7/5/2000	1212		0.23	0.3	0	450	29.5	**0.1**	1	1.18	1.2	0.02	0.03	1.23		5
PCDEM 22-05	8/8/2000	1104	0.15	0.15	2.41	0	670	29.6	**2.7**	1.5	0.75	0.92	0.17	0.005	0.925	0.15	4.4
PCDEM 22-05	8/30/2000	1230		0.13	1.15	0	710	29.1	**4.9**		1.2	1.428	0.228	0.131	1.559	0.153	3
PCDEM 22-05	10/25/2000	1051	0.36	0.16	0.51	0.1	960	21.9	**2.8**	1	0.63	0.64	0.01	0.02	0.66	0.04	1.7
PCDEM 22-05	11/21/2000	1110	0.12	0.12	0.36	0	380	17.3	8.5	1	0.65	0.66	0.01	0.11	0.77	0.06	1.2
PCDEM 22-05	1/17/2001	1302	0.23	0.23	1.25	0.01	780	19.2	9.9	1	0.75	0.8	0.05	0.11	0.91	0.1	3.3
PCDEM 22-05	2/15/2001	1120	0.34	0.11	0.38	0.03	820	22.6	8.9	1	0.74	0.79	0.05	0.04	0.83	0.12	2.6
PCDEM 22-05	3/12/2001	1202	0.28	0.14	0.17	0.05	870	23.7	8.8	2	0.75	0.78	0.03	0.05	0.83	0.17	2.9
PCDEM 22-05	4/11/2001	1111	0.1	0.1	0.75	0	680	25.1	8.4	1	0.74	0.76	0.02	0.04	0.8	0.12	2.7
PCDEM 22-05	5/10/2001	1219		0.32		0.13	1010	24.3	5.2								

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umhos/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	5/10/2001	1221	0.32	0.1	0.12	0.13	1020	25.5	10.5	1	0.65	0.68	0.03	0.02	0.7	0.08	2.3
PCDEM 22-05	6/6/2001	1204	0.44	0.18	4.81	0.09	940	30.4	9.6	1	0.77	0.78	0.01	0.02	0.8	0.08	4.1
PCDEM 22-05	6/26/2001	1057		0.48		0	510	27.8	5.8								
PCDEM 22-05	6/26/2001	1058		0.05	1.01	0	510	28.2	6.2	1	0.69	0.7	0.01	0.02	0.72	0.17	2.9
PCDEM 22-05	8/1/2001	853	0.22	0.15	1.67	0	640	26.9	**3.5**	1	0.73	0.74	0.01	0.05	0.79	0.12	1.3
PCDEM 22-05	8/29/2001	1012		0.46		0	500	27.1	**3.1**								
PCDEM 22-05	8/29/2001	1014	0.46	0.1	39.74	0	440	27.1	**2.6**	3	0.95	0.96	0.01	0.04	1	0.12	6.7
PCDEM 22-05	9/24/2001	845	0.4	0.4	4.29	0	670	26.5	**2.6**	1	1.07	1.48	0.41	0.04	1.52	0.11	**3.7**
PCDEM 22-05	10/31/2001	1056	0.41	0.11	0.93	0	760	21.2	6.2	1	0.73	0.77	0.04	0.24	1.01	0.05	1.7
PCDEM 22-05	11/19/2001	1037		0.52		0.07	900	21.5	6.1								
PCDEM 22-05	11/19/2001	1038	0.52	0.1	0.71	0.07	900	21.5	6.3	1	0.59	0.6	0.01	0.13	0.73	0.04	1.4
PCDEM 22-05	1/16/2002	1135	0.32	0.12	1.88	0	540	16.3	7.4	1	0.76	0.77	0.01	0.14	0.91	0.06	6.8
PCDEM 22-05	2/13/2002	1126	0.35	0.32	0.56	0.02	820	17.3	8.1		0.7	0.71	0.01	0.07	0.78	0.09	1.3
PCDEM 22-05	3/13/2002	1223	0.16	0.16	0.3	0.03	830	23.3	9.2	1	0.7	0.71	0.01	0.03	0.74	0.08	1.4
PCDEM 22-05	4/9/2002	1101		0.47		0	450	22.3	7.0								
PCDEM 22-05	4/9/2002	1102		0.11	0.47	0.02	810	22.4	6.1	1	0.89	0.9	0.01	0.04	0.94	0.15	9.1
PCDEM 22-05	5/8/2002	1215	0.3	0.1	0.19	0.1	1030	28.6	8.6	1	0.76	0.77	0.01	0.04	0.81	0.11	3.1
PCDEM 22-05	6/5/2002	1133	0.08	0.08	0.14	0.1	940	27.2	5.3	1	0.79	0.8	0.01	0.04	0.84	0.09	11.5
PCDEM 22-05	7/17/2002	1147	0.3	0.3	1.36	0	690	30.1	5.1	1	1.12	1.24	0.12	0.14	1.38	0.14	3

Station ID[1]	Date	Time	Stream Depth (ft)	Sample Depth (ft)	Daily Stream Flow[2] (cfs)	Salinity (ppt)	Cond (umhos/cm)	Temp (deg C)	DO[3] (mg/L)	BOD 5 day (mg/L)	Organic - N (mg/L)	TKN (mg/L)	Ammonia -N (mg/L)	Nitrate+ Nitrite-N (mg/L)	Total N (mg/L)	Total P (mg/L)	Chlor *a* (ug/L)
PCDEM 22-05	7/23/2002	1011	0.2	0.1	1.57	0	720	27.1	**4.1**	1	0.89	0.94	0.05	0.12	1.06	0.1	2.9
PCDEM 22-05	9/24/2002	1104	0.34	0.11	2.3	0	650	28.0	**2.9**	1	0.84	1	0.16	0.23	1.23	0.11	1.6
PCDEM 22-05	10/23/2002	948	0.21	0.15	1.78	0	700	25.5	**2.4**	1	0.81	0.93	0.12	0.12	1.05	0.18	4.1
PCDEM 22-05	11/19/2002	1124	0.23	0.23	1.67	0	630	17.4	5.1	1	0.61	0.66	0.05	0.29	0.95	0.07	3.2
PCDEM 22-05	12/11/2002	1103	0.32	0.34	9.41	0	430	19.6	6.5	2	0.77	0.92	0.15	0.31	1.23	0.09	14.4
PCDEM 22-05	1/22/2003	1149	0.13	0.13	2.3	0.42	815.8	18.1	7.6		0.82	0.89	0.07	0.45	1.34	0.05	7.1
PCDEM 22-05	2/26/2003	1040	0.14	0.14	2.3	0.37	713.2	20.0	6.2		0.74	0.83	0.09	0.19	1.02	0.09	4.5
PCDEM 22-05	4/1/2003	1253	0.4	0.28	1.46	0.37	719.2	18.8	7.8		1.05	1.06	0.01	0.21	1.27	0.14	22.6
PCDEM 22-05	5/13/2003	1021	0.23	0.22	0.77	0.35	684.6	26.8	5.0		0.57	0.58	0.01	0.08	0.66	0.06	1.5
PCDEM 22-05	6/26/2003	1115		0.55		0.22	437.4	27.5	**4.2**								
PCDEM 22-05	6/26/2003	1116	0.55	0.23	13.59	0.22	434.7	27.6	**4.0**		0.82	1.01	0.19	0.27	1.28	0.13	3.6
PCDEM 22-05	8/6/2003	1348	0.41	0.21	4.18	0.24	477.7	29.6	**4.2**		0.79	0.94	0.15	0.24	1.18	0.22	0.8
PCDEM 22-05	9/17/2003	1112	0.19	0.19	3.35	0.35	676.8	27.1	**3.3**		0.75	0.93	0.18	0.18	1.11	0.12	1.7
PCDEM 22-05	10/22/2003	1056	0.14	0.14	1.2	0.4	764.2	23.1	**2.3**		0.84	0.92	0.08	0.29	1.21	0.09	1.2
PCDEM 22-05	12/4/2003	1123	0.16	0.16	0.99	0.43	822.2	18.5	5.9		0.53	0.54	0.01	0.33	0.87	0.08	1.6

1: For station 21FLPDEM22-5, per IWR methodology for deil measurements, the DO result is the median or 10th percentile value based on top, middle, and bottom water column measurements. If the top, middle, and bottom measurements were all above the acute toxicity level of 1.5 mg/L, the median all three measurements was calculated. If one or more of the top, middle, or bottom measurement were below the acute toxicity level of 1.5 mg/L, the 10th percentile of all three measurements was calculated.
2: Flow estimation based on Allen Creek USGS Gage 02307731.
3: Bold DO results represent measurements that were below the state's Class III water quality criterion of 5.0 mg/L.

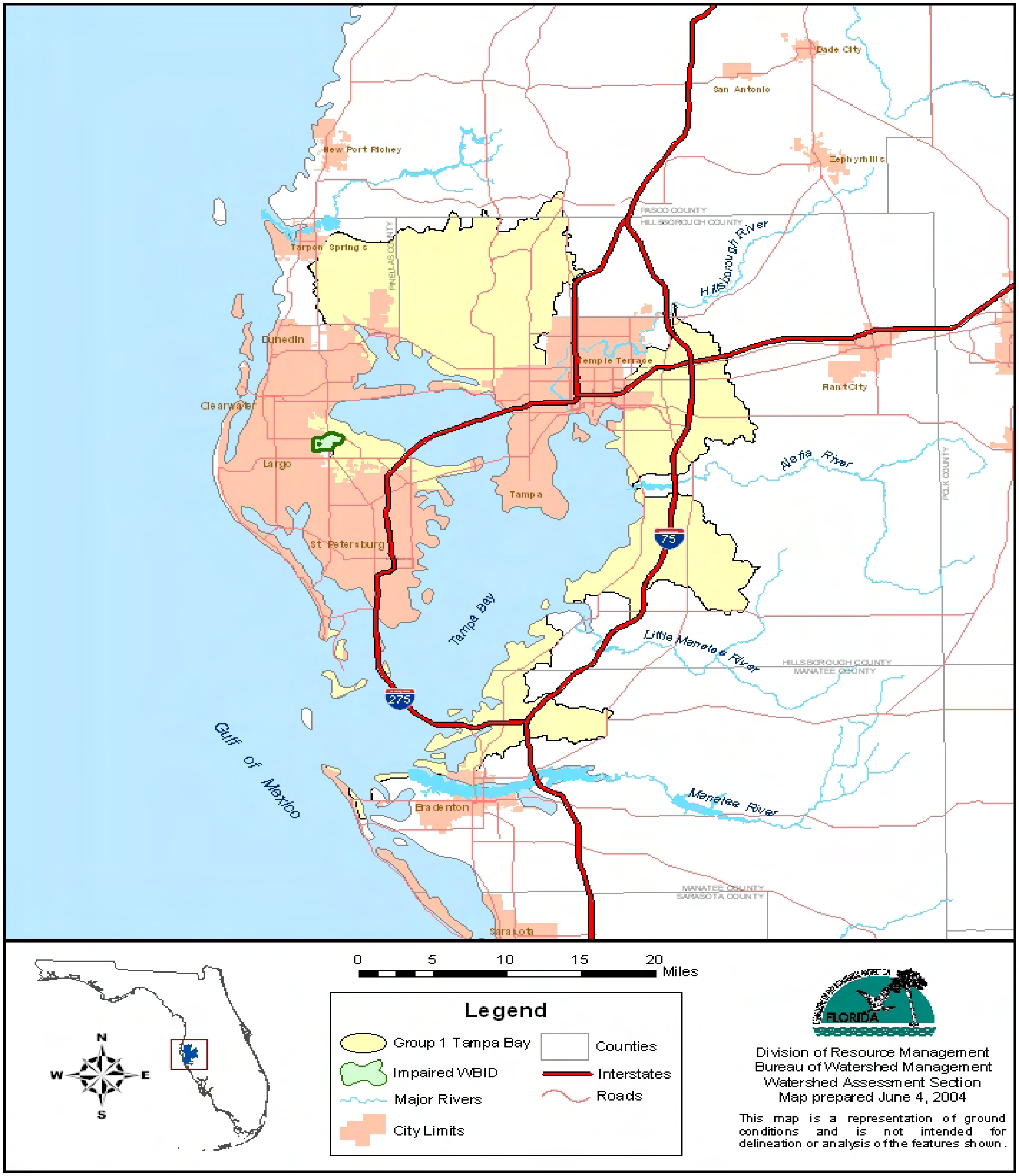


Figure 1.1 Location of Long Branch Creek Basin and Major Geopolitical Features in the Coastal Old Tampa Bay Planning Unit

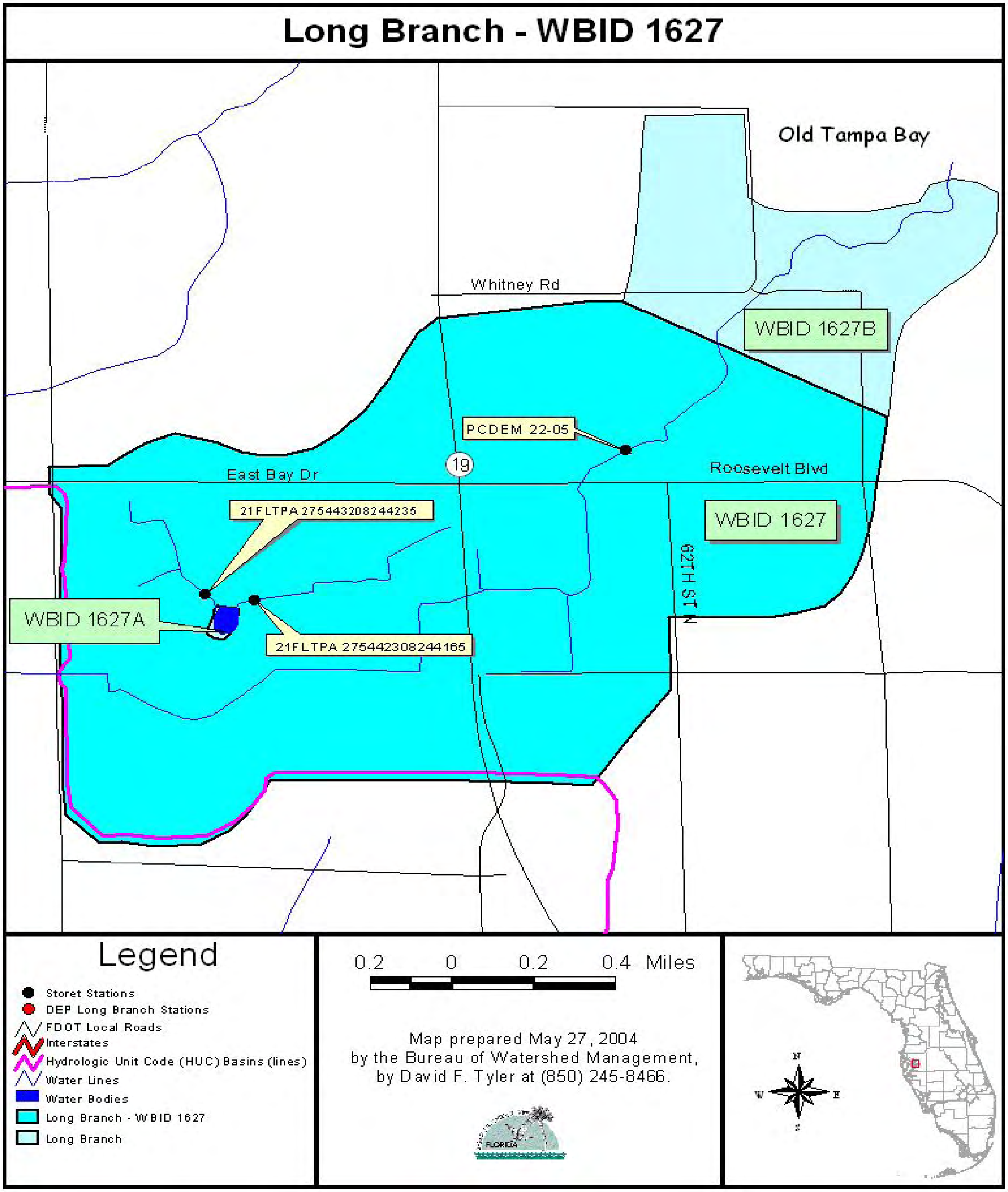


Figure 1.2 Location of the Long Branch Creek Basin, WBIDs, and Monitoring Stations

Table 2.1 Verified Impaired Segments in the Long Branch Creek Basin

WBID	Waterbody Segment	Parameters of Concern	Priority for TMDL Development	Projected Year for TMDL Development*
1627	Long Branch Basin	Total Coliform	High	2003
1627	Long Branch Basin	Fecal Coliform	High	2003
1627	Long Branch Basin	Dissolved Oxygen	High	2003

Note: The parameters listed in Table 2.1 provide a complete picture of the impairment in the stream; the TMDL for this report only addresses dissolved oxygen impairment.

*This TMDL was scheduled to be completed by December 31, 2003, based on a Consent Decree between the EPA and EarthJustice, but the Consent Decree allows a 9-month extension for completing the TMDLs.

Table 2.2 Summary Statistics for Dissolved Oxygen for Long Branch Creek During the Verified Period, 1995 to 2002

WBID	Station ID	Water Quality Variable	Number of Samples	Number of Exceedances	Percent Exceedance	DO Minimum	DO Maximum	DO Mean	DO Median
1627	PCDEM 22-5	Dissolved Oxygen	97	59	60.8	0.13	9.86	4.67	4.39
1627	TPA[1]	Dissolved Oxygen	18	13	72.2	0.45	8.07	3.47	3.115
1627	PCDEM 22-5 & TPA	Dissolved Oxygen	115	72	62.3	0.13	9.86	4.48	4.23

1: TPA represents DEP Tampa District stations 21FLTPA 275442308244165 and 21FLTPA 275443208244235.

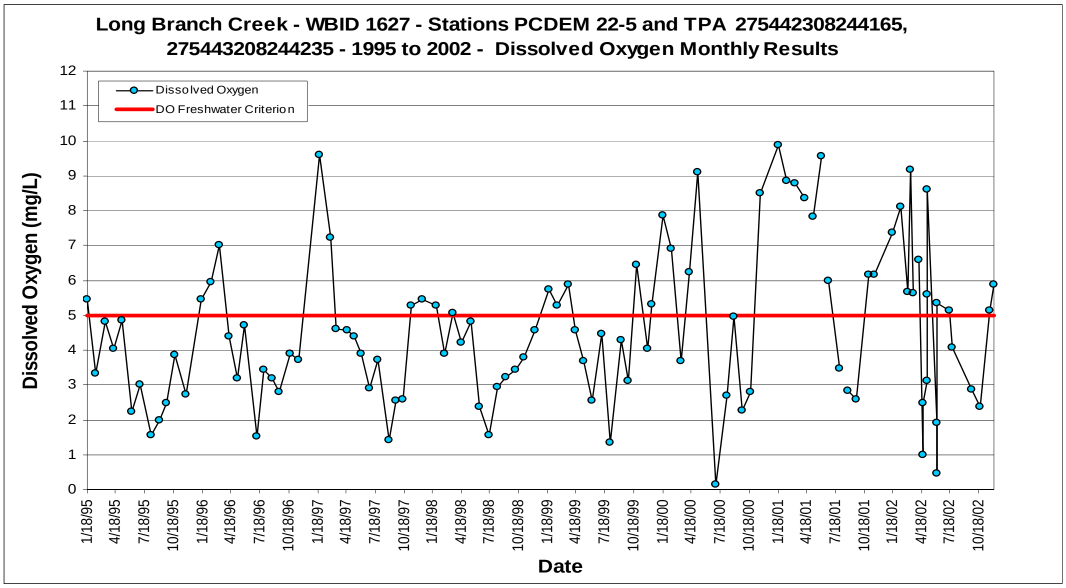


Figure 2.1 Long Branch Creek DO Monthly Results for the Verified Period, 1995 to 2002

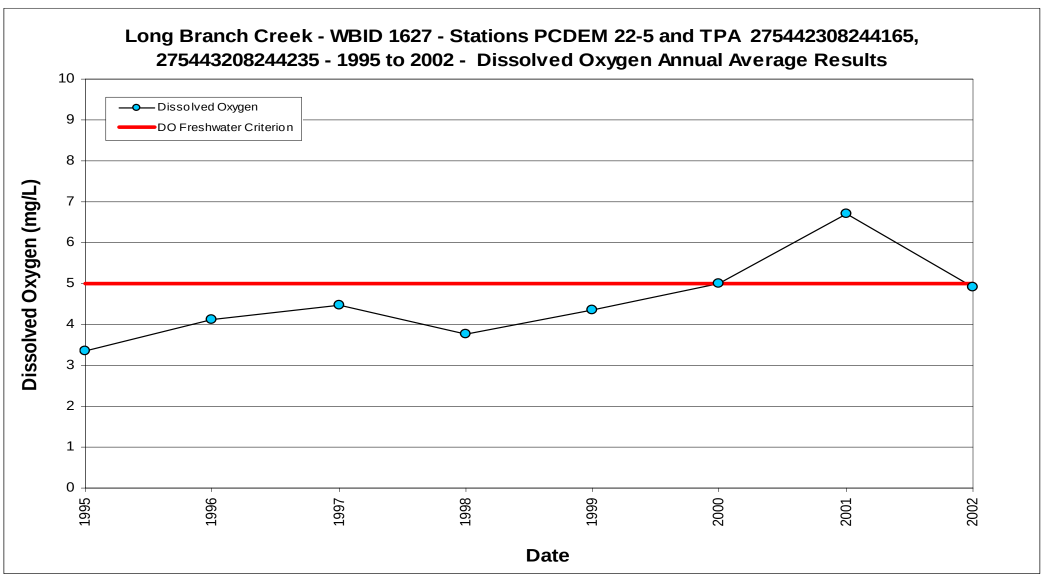


Figure 2.2 Long Branch Creek DO Annual Average Results for the Verified Period, 1995 to 2002

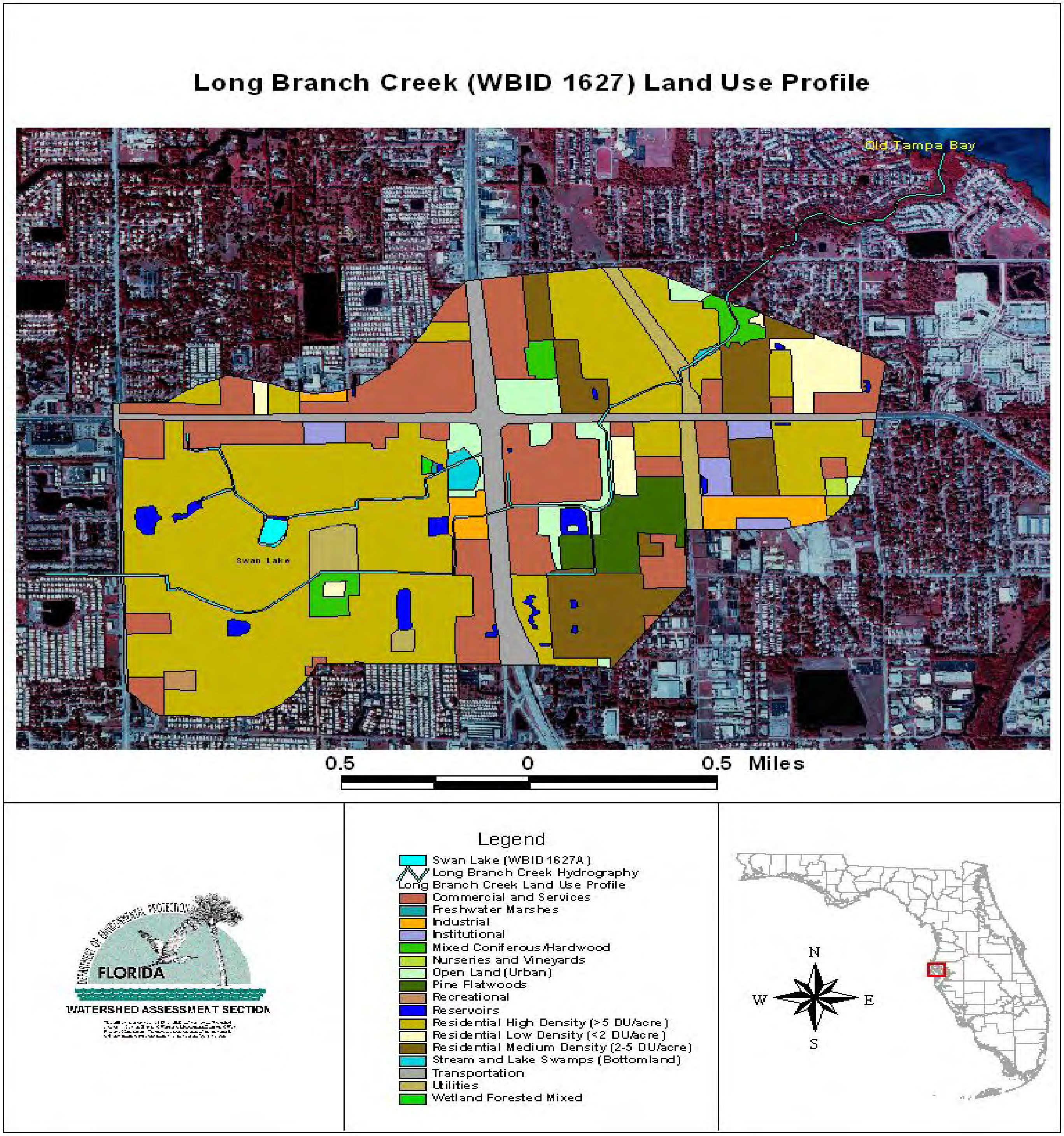
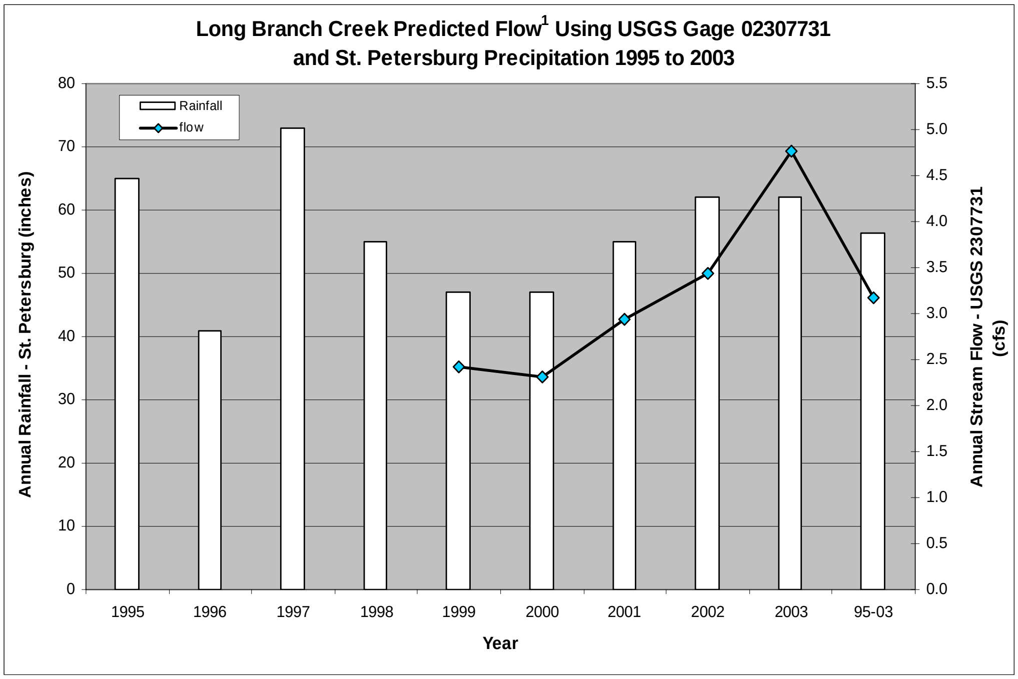


Figure 4.1 Long Branch Creek Basin Land Use Attributes, WBID 1627

Table 4.1 Classification of Land Use Categories in the Long Branch Creek Watershed

Level3	Attribute	Acres	Sq Miles	Percent
1300	Residential High Density	565.4	0.884	44.96%
1400	Commercial And Services	264.8	0.414	21.05%
1200	Residential Med Density 2->5 Dwelling Unit	111.5	0.174	8.86%
1900	Open Land	35.0	0.055	2.78%
1100	Residential Low Density < 2 Dwelling Units	33.3	0.052	2.64%
1500	Industrial	29.7	0.046	2.36%
1700	Institutional	18.7	0.029	1.49%
1800	Recreational	3.4	0.005	0.27%
4110	Pine Flatwoods	39.0	0.061	3.10%
4340	Hardwood Conifer Mixed	9.2	0.014	0.73%
5300	Reservoirs	24.6	0.038	1.96%
6150	Stream And Lake Swamps (bottomland)	7.4	0.012	0.59%
6300	Wetland Forested Mixed	0.9	0.001	0.07%
6410	Freshwater Marshes	0.3	0.000	0.02%
8100	Transportation	76.2	0.119	6.06%
8300	Utilities	38.4	0.060	3.05%
Total		1257.8	1.97	100%



1: The predicted Long Branch Creek daily flow values are based on the drainage area ratio of Long Branch Creek and the index/surrogate flow site, USGS gage 02307731 at Allen Creek.
Note: Flow data are not available from January, 1995 to July, 1999.

Figure 4.2 Annual Average Rainfall in St. Petersburg,Florida, from 1995 to 2002 Versus Predicted Flow from USGS gage 02307731, Allen Creek

Table 4.2 Percent DCIA Different Land Use Categories in the Long Branch Creek Watershed, WBID 1627

Land Use Attributes	Area (acres)	Percent Impervious[1]	Impervious Runoff Coefficient	Pervious Runoff Coeffecient	Runoff (acre-feet)
Forest/Rural Open	48.2	0.5%	0.95	0.159	36.9
Urban Open	351.6	0.5%	0.95	0.041	75.9
Low density residential	33.3	14.7%	0.95	0.150	41.9
Medium density residential	111.5	28.1%	0.95	0.088	172.7
High density residential	565.4	67.0%	0.95	0.120	1,794.4
Communication/Highways	114.6	36.2%	0.95	0.542	371.0
Water	24.6	52.6%	0.95	0.000	57.7
Wetlands	8.6	0.0%	0.95	0.230	9.3
Total	1257.80				2,559.82

1: Percent impervious is the percent area of directly connected impervious area (DCIA).

Table 4.3 Land Use Runoff Coefficients (Event Mean Concentrations) in Southwest Florida (Harper and Baker, 2003)

FLUCCS ID	Land Use	BOD (mg/L)	Total N (mg/L)	Total P (mg/L)
4000	Forest/Rural Open	1.23	1.09	0.046
1000-(1100+1200+1300)	Urban Open	7.4	1.12	0.18
2000	Agriculture	3.8	2.32	0.344
1100	Low Density Residential	4.3	1.64	0.191
1200	Medium Density Residential	7.4	2.18	0.335
1300	High Density Residential	11.0	2.42	0.49
8000	Communication and Transportation	6.7	2.23	0.27
3000+7000	Rangeland	3.8	2.32	0.344
5000	Water	1.6	1.60	0.067
6000	Wetlands	2.63	1.01	0.09

Table 4.4 Long Branch Creek WMM Annual Average Loadings from 1995 to 2003

Year	Annual Loadings	Annual	Annual

	BOD (lbs)	TN (lbs)	TP (lbs)	Precipitation[1] (inches/year)	Runoff (acre-feet)
1995	76,432.6	18,295.0	3,336.3	64.87	2,947.9
1996	48,767.4	11,673.1	2,128.7	41.39	1,880.9
1997	85,787.8	20,534.3	3,744.7	72.81	3,308.7
1998	64,332.0	15,398.6	2,808.1	54.6	2,481.2
1999	55,247.8	13,224.2	2,411.6	46.89	2,130.8
2000	55,188.9	13,210.1	2,409.0	46.84	2,128.6
2001	64,685.5	15,483.2	2,823.6	54.9	2,494.8
2002	73,392.7	17,567.4	3,203.6	62.29	2,830.7
2003	73,251.3	17,533.6	3,197.5	62.17	2,825.2
1995 to 2003 Annual Average	66,342.9	15,880.0	2,895.9	56.31	2,558.8

1: Annual precipitation data comes from National Weather Service station COOP: 087886 located in St. Petersburg, Florida.

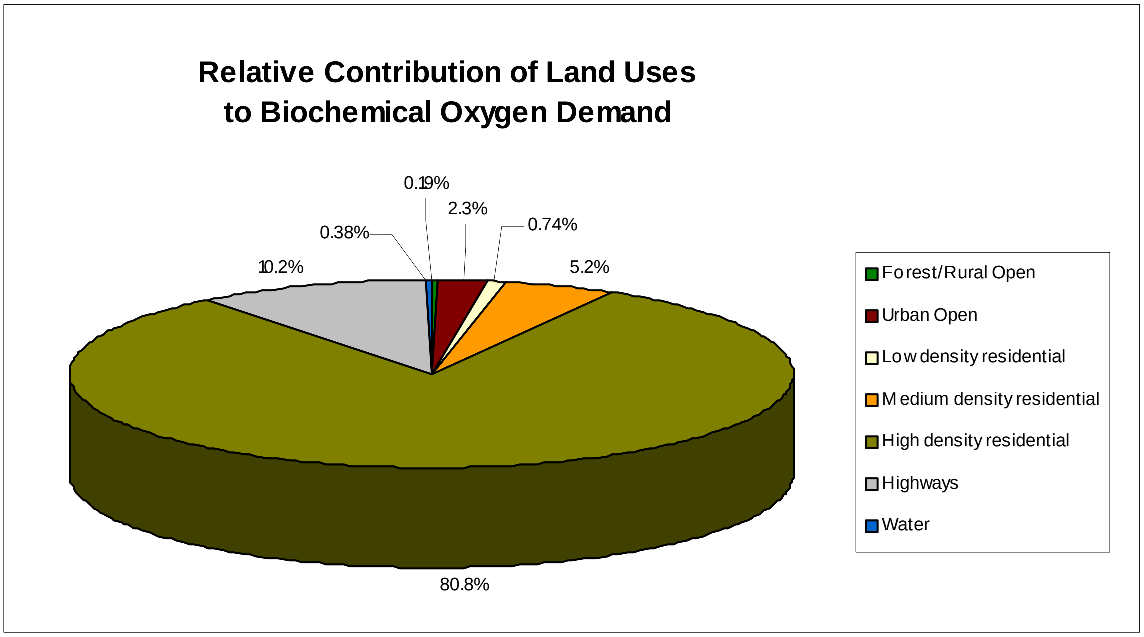


Figure 4.3 Long Branch Creek Percent Contribution of BOD Loads from Different Land Use Attributes

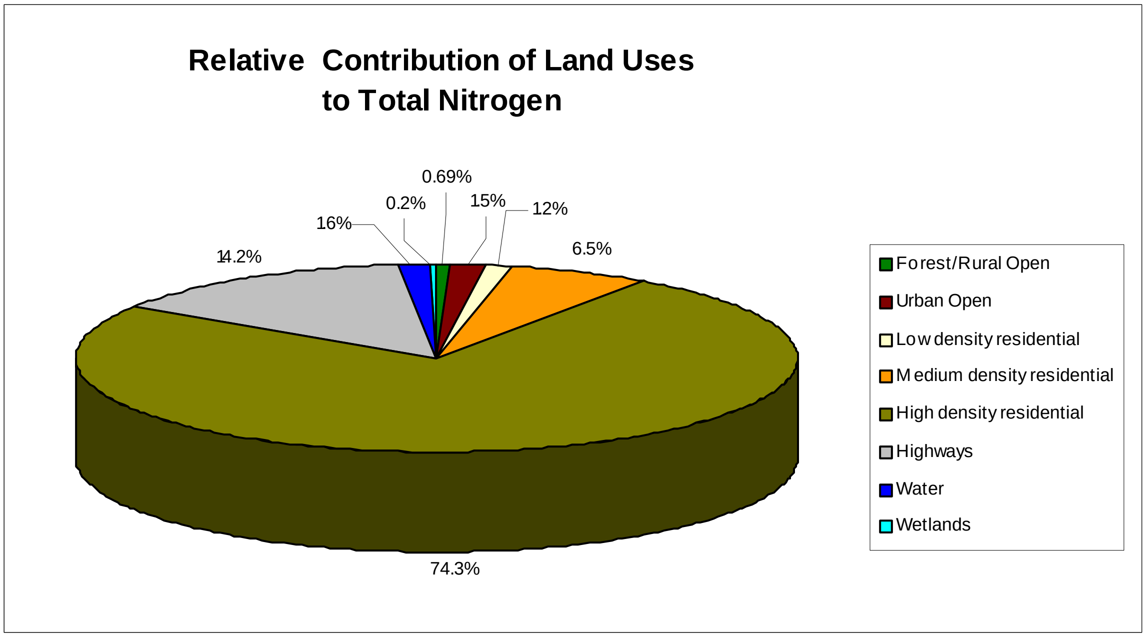


Figure 4.4 Long Branch Creek Percent Contribution of TN Loads from Different Land Use Attributes

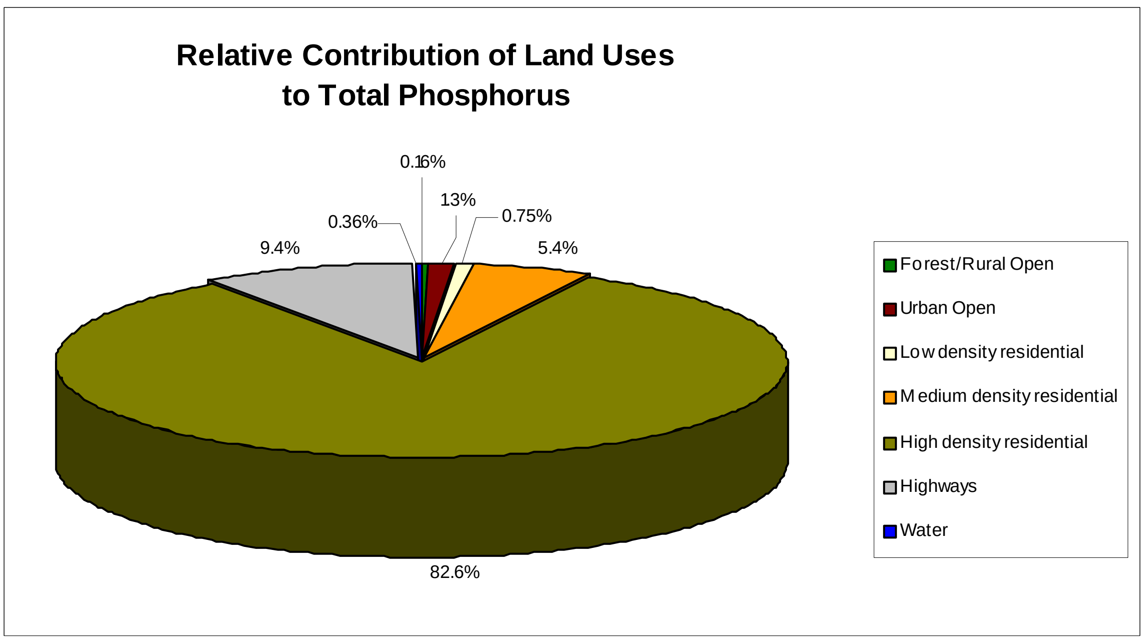


Figure 4.5 Long Branch Creek Percent Contribution of TP Loads from Different Land Use Attributes

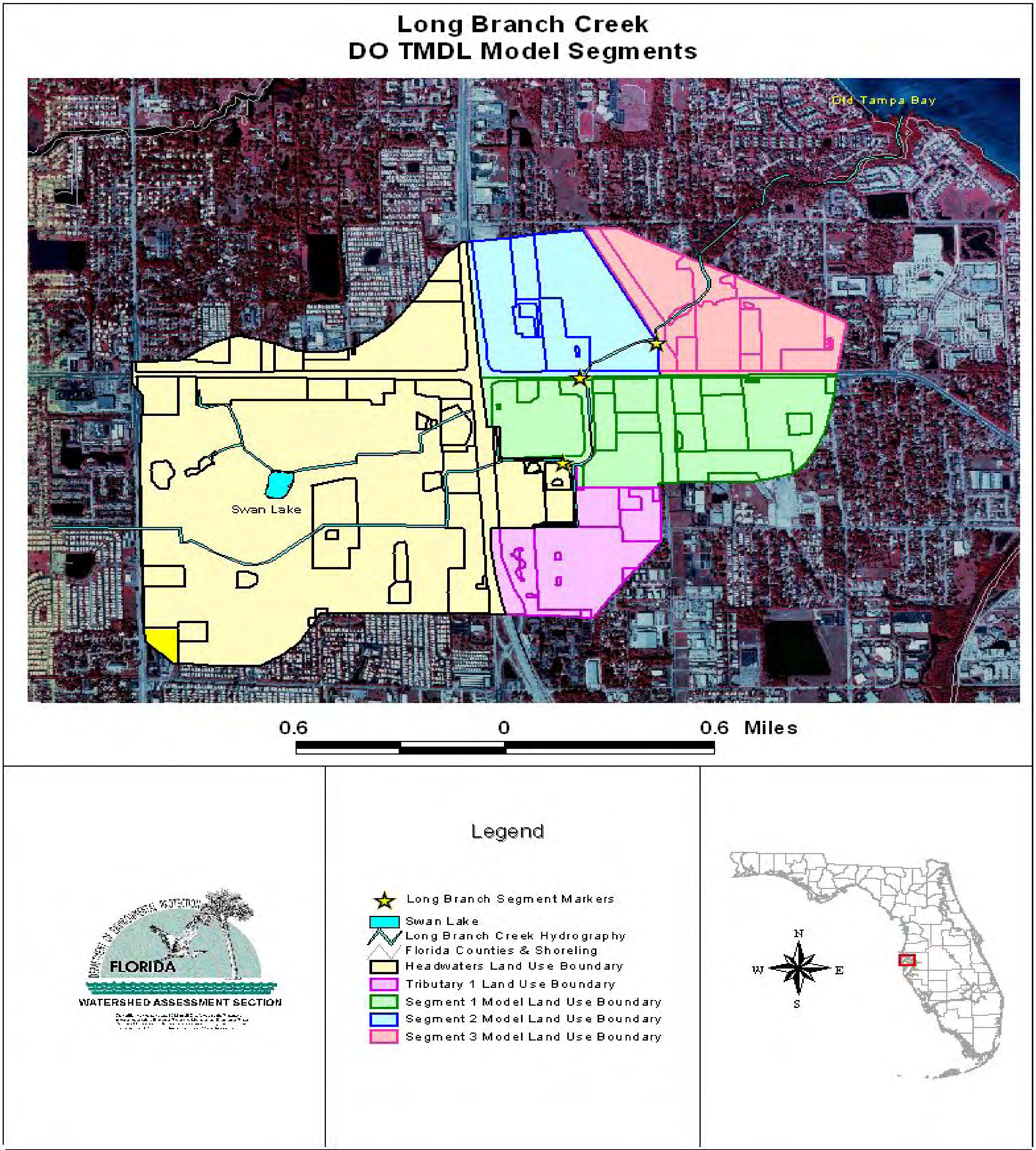


Figure 5.1 Long Branch Creek Dissolved Oxygen SWQM TMDL Model Segments

Table 5.1 Long Branch Creek Headwaters Land Use and Event Mean Concentration

Headwater Land Use					Headwater Runoff Coefficients							
Level 3	Headwater Attributes	Model Land Use	Acres	%	FLUCCS ID	EMC Land Use	BOD mg/l	TN mg/l	TP mg/l	CBOD u mg/l	NH3-N mg/l	TON mg/l
1200	Residential Med Density 2->5 Dwelling Unit	Other (medium residential)	3.0	0.43	1200	Medium Density Residential	7.4	2.18	0.34	11.1	0.131	1.5
1300	High Density Residential	Blank	407.9	59.1	1300	High Density Residential	11	2.42	0.49	16.5	0.145	1.67
1400/ 1500/ 1700/ 1800/ 1900	Commercial And Services/Industrial/ Institutional/Open Land/Recreational	Urban/ Commercial	186.4	27.0	1000- (1100+ 1200+ 1300)	Urban Open	7.4	1.12	0.18	11.1	0.067	0.772
4110	Pine Flatwoods	Forest	5.7	0.83	4000	Forest/Rural Open	1.23	1.09	0.046	1.85	0.065	0.752
5300/ 6300/ 6410/ 6150	Reservoirs/Wetland Forested Mixed/ Freshwater Marshes/Stream and Lake Swamps	Open Water	27.3	3.95	5000+ 6000	Water/ Wetlands	2.63	1.01	0.09	3.95	0.060	0.697
8100/ 8300	Utilities/ Transportation	Open/Barren	59.9	8.68	8000	Communication/ Transportation	6.7	2.23	0.27	10.05	0.134	1.54
Total			690.3	100								

Table 5.2 Long Branch Creek Tributary One Land Use and Event Mean Concentrations

Tributary 1 Land Use					Tributary 1 Runoff Coefficients							
Level 3	Tributary Attributes	Model Land Use	Acres	%	FLUCCS ID	EMC Land Use	BOD mg/l	TN mg/l	TP mg/l	CBODu mg/l	NH3-N mg/l	TON mg/l
1200	Residential Med Density 2->5 Dwelling Unit	Other (medium residential	49.6	51.8	1200	Medium Density Residential	7.4	2.2	0.34	11.1	0.131	1.5
1300	Residential High Density	Blank	14.6	15.3	1300	High Density Residential	11	2.4	0.49	16.5	0.145	1.67
1400/ 1900	Commercial and Services/Open Land	Urban/ Commercial	11.8	12.3	1000-(1100+ 1200+ 1300)	Urban Open	7.4	1.1	0.18	11.1	0.067	0.77
4110	Pine Flatwoods	Forest	11.0	11.5	4000	Forest/Rural Open	1.23	1.09	0.046	1.85	0.065	0.752
5300	Reservoirs	Open Water	1.5	1.6	5000+ 6000	Water/ Wetlands	2.63	1	0.09	3.95	0.06	0.7
8300	Transportation	Open/Barren	7.3	7.6	8000	Communication/ Transportation	6.7	2.2	0.27	10.05	0.134	1.54
Total			95.8	100								

Table 5.3 Long Branch Creek Segment One Land Use and Event Mean Concentrations

Segment 1 Land Use					Segment 1 Runoff Coefficients							
Level 3	Segment 1 Attributes	Model Land Use	Acres	%	FLUCCS ID	EMC Land Use	BOD mg/l	TN mg/l	TP mg/l	CBODu mg/l	NH3-N	TON mg/l

										mg/l	
1100	Residential Low Density < 2 Dwelling Units	Residential	7.5	3.6	1100	Low Density Residential	4.3	1.6	0.19	6.45	0.098	1.13
1200	Residential Med Density 2->5 Dwelling Unit	Other (medium residential)	14.6	7.1	1200	Medium Density Residential	7.4	2.2	0.34	11.1	0.131	1.5

Segment 2 Land Use					Segment 2 Runoff Coefficients							
Level 3	Segment 2 Attributes	Model Land Use	Acres	%	FLUCCS ID	EMC Land Use	BOD mg/l	TN mg/l	TP mg/l	CBODu mg/l	NH3-N mg/l	TON mg/l
1200	Residential Med Density 2->5 Dwelling Unit	Other (medium residential)	23.9	17.7	1200	Medium Density Residential	7.4	2.2	0.34	11.1	0.131	1.5
1300	Residential High Density	Blank	60.3	44.5	1300	High Density Residential	11	2.4	0.49	16.5	0.145	1.67
1400/ 1900	Commercial And Services/Open Land	Urban/ Commercial	37.8	27.9	1000- (1100+ 1200+ 1300)	Urban Open	7.4	1.1	0.18	11.1	0.067	0.77
5300	Reservoirs	Open Water	2.0	1.5	5000+ 6000	Water/ Wetlands	2.63	1	0.09	3.95	0.06	0.7
8100/ 8300	Utilities/ Transportation	Open/Barren	11.4	8.4	8000	Communication/ Transportation	6.7	2.2	0.27	10.05	0.134	1.54
Total			135.5	100								

1300	Residential High Density	Blank	44.7	21.6	1300	High Density Residential	11	2.4	0.49	13.5	0.145	1.67
1400/ 1500/ 1700/ 1900	Commercial And Services/ Industrial/ Institutional/Open Land	Urban/ Commercial	98.4	47.6	1000- (1100+ 1200+ 1300)	Urban Open	7.4	1.1	0.18	11.1	0.067	0.77
4110	Pine Flatwoods	Forest	22.2	10.8	4000	Forest/Rural Open	1.23	1.09	0.046	1.85	0.065	0.752
5300	Reservoirs	Open Water	0.7	0.36	5000+ 6000	Water/ Wetlands	2.63	1	0.09	3.95	0.06	0.7
8100/ 8300	Transportation/ Utilities	Open/Barren	18.5	8.9	8000	Communication/ Transportation	6.7	2.2	0.27	10.05	0.134	1.6
Total			206.7	100								

Table 5.4 Long Branch Creek Segment Two Land Use and Event Mean Concentrations

Table 5.5 Long Branch Creek Segment Three Land Use and Event Mean Concentrations

Segment 3 Land Use					Segment 3 Runoff Coefficients							
Level 3	Segment 3 Attributes	Model Land Use	Acres	%	FLUCCS ID	EMC Land Use	BOD mg/l	TN mg/l	TP mg/l	CBODu mg/l	NH3-N mg/l	TON mg/l
1100	Residential Low Density < 2 Dwelling Units	Residential	23.3	18.0	1100	Low Density Residential	4.3	1.64	0.191	6.45	0.098	1.13
1200	Residential Med Density 2->5 Dwelling Unit	Other	22.8	17.6	1200	Medium Density Residential	7.4	2.18	0.335	11.1	0.131	1.5
1300	Residential High Density	Blank	37.9	29.3	1300	High Density Residential	11	2.42	0.49	16.5	0.145	1.67
1400	Commercial And Services	Urban/ Commercial	17.1	13.2	1000-(1100+ 1200+ 1300)	Urban Open	7.4	1.12	0.18	11.1	0.067	0.77
4340	Hardwood Conifer Mixed	Forest	9.2	7.1	4000	Forest/Rural Open	1.23	1.09	0.046	1.85	0.065	0.752
5300/ 6150	Reservoirs/Stream and Lake Swamps	Open Water	1.6	1.3	5000+ 6000	Water/ Wetlands	2.63	1.01	0.09	3.95	0.06	0.7
8100/ 8300	Utilities/ Transportation	Open/Barren	17.5	13.5	8000	Communication/ Transportation	6.7	2.23	0.27	10.05	0.134	1.54
Total			129.4	100								

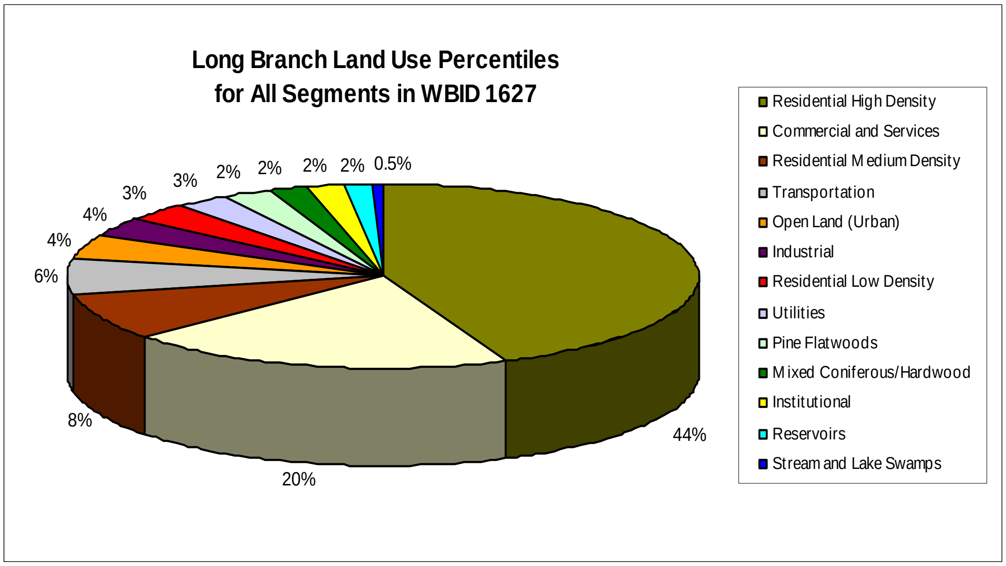


Figure 5.2 SWQM Modeled Land Use Attributes for the Freshwater Segment of Long Branch Creek, WBID 1627

Table 5.6 ADEM SWQM Event Mean Concentrations (EMCs) for the Long Branch Creek Watershed

FLUCCS ID	Land Use Attributes	CBODu[1] EMC (mg/L)	NH3-N EMC[2] (mg/L)	TON EMC[3] (mg/L)
4000	Forest/Rural Open	1.85	0.065	0.752
1000-(1100+1200+1300)	Urban Open	11.10	0.067	0.772
2000	Agriculture	5.70	0.139	1.598
1100	Low Density Residential	6.45	0.098	1.130
1200	Medium Density Residential	11.10	0.131	1.500
1300	High Density Residential	16.50	0.145	1.67
8000	Communication and Transportation	10.05	0.134	1.540
3000+7000	Rangeland	5.70	0.139	1.598
5000+6000	Water/ Wetlands	3.95	0.060	0.697

1: Default value from Florida State/EPA Region IV Agreement on the Development of Wasteload Allocations and Wastewater Permit Limitions (1.5).
2: Median of NH3-N values from station 22-5 from 1995-2003 (0.06) multiplied by Harvey Harper (2003) TN EMC value.
3: Median of TKN minus HN3-N values for station 22-5 from 1995-2003 (0.69) multiplied by Harvey Harper (2003) TN EMC value.

Table 5.7 Long Branch Creek SWQM Flow Input Data for Modeled Segments

Long Branch Subbasin Flow Separation	CFS	Drainage Area Above Tidal Reach		
Total Stream Flow on 9/24/01	4.29	Sub-basin	Acres	Percent
Baseflow	2.11	Headwaters	690	54.9
Total Runoff Flow	2.18	Trib A	96	7.6
Headwaters	1.20	Segment 1	207	16.4
Tributary A	0.17	Segment 2	136	10.8
Segment 1	0.36	Segment 3	129	10.3
Segment 2	0.23			
Segment 3	0.22	Total	1,258	100.0

Table 5.8 Long Branch Creek ADEM SWQM Calibrated, 70 Percent Reduction, and Forest Model Predictions

Model Runs		Range of Values: Segments 1 to 3					DO at PCDEM 22-5	DO Average: Segments 1 to 3
		CBODu	NH3-N	NBOD	TON	DO		
9/24/2001 Calibrated Model	Concentration (mg/L)	4.01 - 6.01	0.29 - 0.35		0.96 - 0.99	2.1 - 3.3	2.4	2.5
	Loadings (lbs/day)	161.6	1.5	84.9	17.1			
9/24/2001 70% Reduction Model	Concentration (mg/L)	1.36 - 2.13	0.24 - 0.32		0.49 - 0.55	2.9 - 3.7	3.4	3.3
	Loadings (lbs/day)	48.5	0.4	25.5	5.1			
9/24/2001 100 % Forest Model	Concentration (mg/L)	0.7 - 1.2	0.25 - 0.33		0.65 - 0.67	3.1 - 4.0	3.6	3.5
	Loadings (lbs/day)	21.7	0.8	43.9	8.8			

Calibrated Model: Original EMCs and critical conditions.
Calibrated Model: Original EMCs and critical conditions.
Forest Model: 100% forest land use.

Table 6.1 TMDL Components and Annual Loadings for the Long Branch Creek Watershed

Parameter (mg/L)	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
	Wastewater (lbs/year)	NPDES Stormwater (percent reduction)				
BOD	NA	70	19,902.9	Implicit	19,902.9	70
TN	NA	70	4,764.0	Implicit	4,764.0	70