Total Maximum Daily Loads

for

Dissolved Oxygen and Nutrients

in

Phillippi Creek (WBID 1937)

July 2011

Region4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing this Total Maximum Daily Load (TMDL) for nutrients and dissolved oxygen in Phillippi Creek (WBID 1937). Subsequent actions must be consistent with this TMDL.

____________________________________ __________

James D. Giattina, Director
Water Protection Division

Date

Table of Contents

List of Tables

List of Figures

LIST OF ABBREVIATIONS

BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CO_2	Carbon Dioxide
DO	Dissolved Oxygen
DYNHYD	Dynamic Estuary Model Hydrodynamic Program
EMC	Event Mean Concentration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Use Cover Classification System
FS	Florida Statutes
GIS	Geographic Information System
HUC	Hydrologic Unit Code
IWR	Impaired Waters Rule
KM^2	Square Kilometers
L	Liters
L/FT^3	Liters per Cubic Foot
LA	Load Allocation
LB/YR	Pounds per year
MF	Membrane Filter
MGD	Million Gallons per Day
MG/L	Milligram per liter
ML	Milliliters
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NH_4	Ammonia Nitrogen
NHD	National Hydrography Data
NO_2	Nitrite
NO_3	Nitrate
NPDES	National Pollutant Discharge Elimination System

OBS	Observations
PLRG	Pollutant Load Reduction Goal
SEC/DAY	Seconds per Day
SIMPLE	Spatially Integrated Model for Pollutant Loading Estimates
SWFWMD	Southwest Florida Water Management District
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WQS	Water Quality Standards
WMD	Water Management District
WTF	Water Treatment Facility
WWTP	Waste Water Treatment Plant
YR	Year

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**

   State: Florida

   Major River Basins: Sarasota Bay (HUC 03100201).

1998 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	County	Class and Waterbody Type	Constituent(s)
1937	Phillippi Creek	Sarasota	Class III Freshwater Stream	Dissolved Oxygen, Nutrients

2. **TMDL Endpoints (i.e., Targets)**

Class III Waters (Fresh):

Dissolved Oxygen:

The target for the dissolved oxygen (DO) TMDL is based upon the State of Florida's water quality criteria, which require that in no case shall the concentration of dissolved oxygen be less than 5 mg/L in freshwater streams, and that normal daily and seasonal fluctuations above that level be maintained. The effects of pollutants with potential impacts on dissolved oxygen were analyzed, including biochemical oxygen demand (BOD), total nitrogen (TN), and total phosphorus (TP). The TMDL allocations for DO are the average annual loadings of BOD, TN and TP that are expected to maintain DO concentrations above the applicable limit.

Nutrients:

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242, FAC. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.

Biochemical Oxygen Demand:

BOD shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

3. **TMDL Approach**

The TMDL allocations to address nutrients and dissolved oxygen were determined by analyzing the effects of BOD, TN, and TP loads on DO concentrations in the Phillippi Creek watershed. The hydrodynamic model DYNHYD was used to simulate water movement through the stream channel considering variable upstream flows and downstream tidal controls. A WASP Eutrophication model was used to evaluate the in-stream impacts of pollutant loads from both point and nonpoint sources. Current pollutant loads were estimated using the SIMPLE model, and these loads were reduced until model simulations indicated the DO criterion of 5 mg/L was attained.

4. TMDL Allocations

Parameter[1]	TMDL (lb/day)[2]	WLA[3]		LA (%)
		Facility (lb/day)	MS4 (%)[4]	
TN	201	NA	70	70
TP	56	NA	70	70
BOD	618	NA	70	70

Notes for TMDL Allocations table:

1. TN= total nitrogen; TP= total phosphorus; BOD= biochemical oxygen demand.
2. The nutrient and DO TMDLs are intended to be implemented on an annual basis. The annual average pounds per day should not exceed these values. Daily variation above and below these values within the year is expected.
3. The WLA is separated into an allocation for continuous NPDES facilities and an allocation for the MS4. WBID 1937 is within the collection area for Phase I MS4 permit # FLS000004, which is held by the City of Sarasota, Sarasota County, and other co-permittees. Due to the infeasibility of separating the contributions from diffuse MS4 and non-MS4 sources, MS4s are allocated the same percent reductions as the Load Allocation. The NPDES facilities that currently operate within the Phillippi Creek watershed discharge to land or storage ponds and are not expected to cause or contribute to impairments, therefore WLAs for these individual facilities are not provided.
4. Percent reduction in total pollutant loading from current conditions to achieve the applicable standard. The percent reductions are applied to nonpoint sources (LA) and MS4s.

5. **Endangered Species (yes or blank):** Yes

6. **USEPA Lead on TMDL (USEPA or blank):** USEPA

7. **TMDL Considers Point Source, Nonpoint Source, or both:** Both

8. **Major NPDES Discharges to surface waters addressed in TMDL:**

NPDES Permit	Facility Name	Discharge Type
FLS000004	Sarasota County, City of Sarasota	MS4

NOTE: There are also three active NPDES facilities in the Phillippi Creek Watershed. However, since none of the facilities were believed to cause or contribute significantly to the impairments, none of the facilities were assigned WLAs.

1. Introduction

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for developing and implementing TMDLs. The state's 52 basins are divided into 5 groups, and water quality is assessed in each group on a rotating 5-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. Phillippi Creek is a Group 3 waterbody managed by the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMDs divided the district into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. This TMDL report addresses WBID 1937 of Phillippi Creek. The geographic location of this WBID is shown in Figure 1.

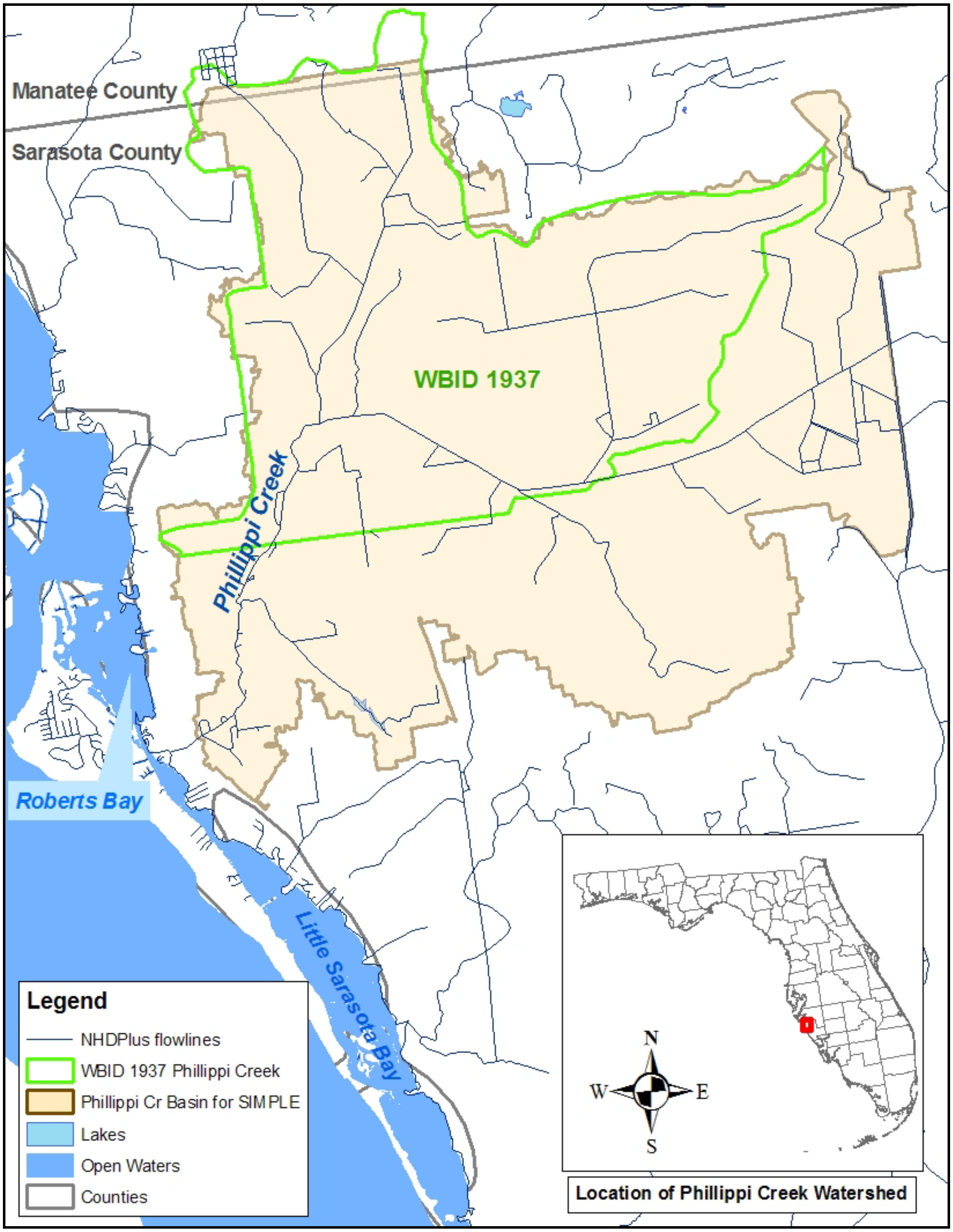

Figure 1. Location of WBID 1937 (Phillippi Creek).

2. Problem Definition

To determine the status of surface water quality in the state, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list. The IWR defines the thresholds for determining if waters should be placed on the state's planning and verified lists.

Florida's final 1998 Section 303(d) list identified Water Body Identifications (WBIDs) in the Sarasota Bay Basin that are not supporting water quality standards (WQS). The TMDLs addressed in this document are being established pursuant to USEPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). After assessing all readily available water quality data, USEPA is responsible for determining whether TMDLs should be developed for dissolved oxygen and nutrients in WBID 1937 of Phillippi Creek.

The format of the remainder of this report is as follows: Chapter 3 is a general description of the impaired watershed; Chapter 4 describes the water quality standards and target criteria; and Chapter 5 describes the data assessments; Chapter 6 describes the sources contributing to the impairments; Chapter 7 describes the approach used to develop the TMDL; and Chapter 8 explains the TMDL allocations.

3. Watershed Description

Phillippi Creek drains approximately 56 square miles of northern Sarasota County, including part of the city of Sarasota. The watershed consists of a network of natural streams and man-made channels that carry water away from relatively flat, low-lying, and poorly drained soils. Phillippi Creek flows southwesterly toward its mouth, emptying into a southern segment of Sarasota Bay called Roberts Bay. The sub-basin, which is the third largest in Sarasota County, is the largest contributor of freshwater, nutrients, and metals to Roberts Bay (FDEP, 2003).

As can be seen in Figure 2, landuse in the Phillippi Creek watershed is largely developed. Over 70 percent of the watershed area consists of urban, residential, commercial, or industrial developments (Table 1). In fact, private residences and their back yards and docks directly abut many segments of Phillippi Creek. Sarasota County holds Phase I Municipal Separate Storm Sewer System (MS4) permit #FLS000004, which covers the city of Sarasota, as well as other co-permittees. Approximately seven percent of the watershed is used for agricultural purposes such as cropland and pastureland, mostly in the eastern portion. Forest, water, wetlands, and transportation and utilities each take up about five percent of the overall landuse. There are two Water Treatment Facilities (WTFs), as well as a minor Waste Water

Treatment Plant (WWTP), located in the Phillippi Creek watershed. All of these facilities discharge to percolation ponds, which may overflow to Phillippi Creek during periods of high rainfall. The South Gate WWTP (FL0032808) is a major domestic facility that had discharged directly to Phillippi Creek until June 2008, when the effluent started being sent to the Bee Ridge Water Reclamation Facility (David Pouso, personal communication). Additional information about these National Pollutant Discharge Elimination System (NPDES) facilities may be found in Section 6.1.

Table 1. Land Cover Distribution for Phillippi Creek Watershed.[1]

Impaired Waterbody	WBID(s)	Unit[2]	Urban Residential & Built-Up	Agriculture	Upland Nonforested	Forest	Water	Wetlands	Transportation & Utilities	Disturbed Land	Total
Phillippi Creek	1937, 1941, 1947, 1966, 1971, 1971A	Km^2	103.4	9.8	0.6	7.4	7.6	6.7	7.7	0.09	143.3
		percent	72%	7%	0.4%	5%	5%	5%	5%	0.1%	100%

Notes:

1. Land use data are based on 2006 SWFWMD land cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). The features were photointerpreted from 2006 one-foot color infrared digital aerial photographs at the 1:12,000 scale. Areas in the table represent the watershed, not just the area draining to the impaired segment (WBID 1937).
2. Km^2= square kilometers.
3. The urban/residential and built-up category includes commercial, industrial and extractive uses.
4. The upland nonforested category includes shrub and brushland.

Many of the residential developments in the Phillippi Creek watershed were designed to have their sewage treated by onsite septic tanks and small, private package plants. The elevated bacteria levels that lead to Phillippi Creek being 303(d)-listed for fecal coliforms has been attributed to failures of these septic systems. To mitigate this problem, Sarasota County established the Phillippi Creek Septic System Replacement Program in 2000. The main program goal is to remove approximately 14,000 septic systems, replacing them with connections to a central sewer line (Sarasota County Government, 2009). This multi-year program has already completed septic system replacement in some service areas of the watershed. Work will continue in other areas, with priority being placed on those areas deemed to have a higher likelihood of septic system failure. Removing failing septic systems from service will reduce loadings of bacteria and nutrients to Phillippi Creek.

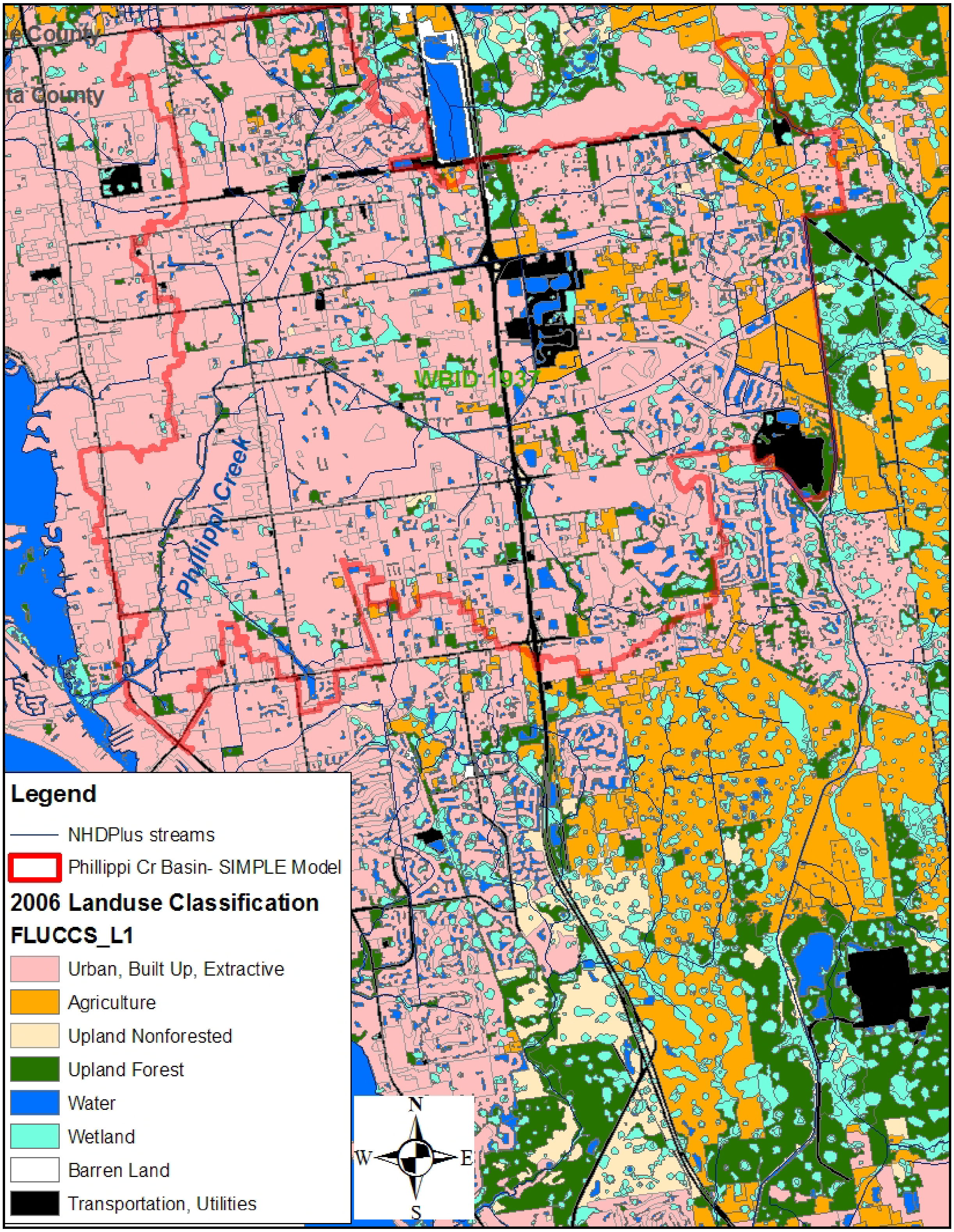

Figure 2. Landuse in the Phillippi Creek Watershed.

4. Water Quality Standards

WBID 1937, the segment of Phillippi Creek addressed in this TMDL report, is a predominantly freshwater Class III stream. Downstream of this is WBID 1947, a Class III marine estuary. The designated uses of Class III waters include recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (FAC), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards that apply to all waters, including Section 62-302.500 FAC [Surface Waters: Minimum Criteria, General Criteria], unless alternative or more stringent criteria are specified in FAC Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria addressed in this TMDL document are provided in the following section.

4.1. Nutrients (Class III, Freshwater and Marine):

The State of Florida has a narrative water quality criterion for nutrients that applies to Classes I, II, and III (including fresh and marine waters) and states that:

> "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." [Section 62.302.530 (48)(b) FAC]

The state also has an additional narrative water quality criterion for nutrients that applies to all classes of water and states that:

> "The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242, FAC" [see Section 62.302.530 (48)(a) FAC]

Because the State of Florida does not yet have numeric criteria for nutrients, chlorophyll and DO levels are commonly used to indicate whether nutrients are present in excessive amounts.

4.2. Dissolved Oxygen (Class III Freshwater and Marine):

The water quality criteria for dissolved oxygen in Class III Fresh and Marine waters are as follows:

Freshwater: "Shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained." [FAC 62-302.530 (31)]

Marine: "Shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained." [FAC 62-302.530 (31)]

4.3. Biochemical Oxygen Demand (Class III Freshwater):

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions. [FAC 62-302.530 (12)]

5. Water Quality Assessment

A water quality assessment was conducted to review pertinent water quality data for WBID 1937 of Phillippi Creek. The primary constituents evaluated were: dissolved oxygen (DO), biochemical oxygen demand (BOD), total organic carbon (TOC), pH, chlorophyll *a*, and nutrients. Water quality data from Version 35 of FDEP's IWR database were assessed, along with information provided by Sarasota County. The IWR database contains data from various sources within the state of Florida, including the Water Management Districts and counties.

Table 2 identifies monitoring stations located within WBID 1937 of Phillippi Creek and lists their time period of record. The locations of these sampling stations are displayed in Figure 3, and summary statistics for water quality data collected in the WBID between December 1997 and March 2008 are provided in Table 3. The original data are included in the Administrative Record for this report, and are also available upon request. Explanations of data remark codes are provided in Appendix A.

Table 2. Water Quality Monitoring Stations in WBID 1937.

Station	Station Name	First Date	Last Date	Obs.
21FLBRA 1937-A	1937 - Phillippi Creek - bridge on Fruitville Rd	06/20/2007	01/17/2008	141
21FLGW 3502	Philippe Creek near Bee Ridge Road.	10/12/1998	03/03/2008	3411
21FLGW FLO0100	Philippe Creek near Bee Ridge Road	12/03/1997	09/23/1998	181
21FLGW FLO0102	Philippe Creek	12/03/1997	09/23/1998	184
21FLTPA 27183038230361	TP183-Philippe Creek	02/22/2003	01/15/2004	158
21FLTPA 27192228228518	TP184-Philippe Creek	02/22/2003	01/12/2004	153

NOTES:
Obs= number of observations

Table 3. Summary Statistics of Water Quality Data for WBID 1937.

Parameter	Obs.	Mean	Min.	Max.	First Date	Last Date
BOD, carbonaceous 5-day (mg/l)	15	2.013	2.000	2.200	02/22/2003 09:00	01/17/2008 10:40
Chlorophyll a (µg/l)	11	4.182	1.000	12.000	06/20/2007 13:45	03/03/2008 10:00
Chlorophyll a, corrected (µg/l)	110	2.402	1.000	31.000	11/01/1999 16:00	03/03/2008 10:00
Color (PCU)	138	67.754	10.000	200.000	12/03/1997 11:15	03/03/2008 10:00
Conductance (mohm)	169	648.609	323.000	2521.000	12/03/1997 11:15	03/03/2008 10:05

Parameter	Obs.	Mean	Min.	Max.	First Date	Last Date
Dissolved Oxygen (mg/l)	162	6.074	0.880	13.160	12/03/1997 11:15	03/03/2008 10:05
DO Saturation (%)	12	76.383	52.557	127.898	12/03/1997 11:15	09/23/1998 14:10
Fecal Coliform (MPN/100ml)	134	1235.8	18	32000	12/03/1997 11:15	03/03/2008 10:00
Nitrogen Ammonia as N (mg/l)	137	0.079	0.009	0.280	12/03/1997 11:15	03/03/2008 10:00
Nitrate Nitrite (mg/l)	138	0.204	0.004	0.600	12/03/1997 11:15	03/03/2008 10:00
pH (su)	165	7.4	6.6	8.2	12/03/1997 11:15	03/03/2008 10:05
Pheophytin-a (µg/l)	108	1.687	0.000	17.000	11/01/1999 16:00	03/03/2008 10:00
Dissolved Orthophosphate as P (mg/l)	134	0.255	0.004	0.910	12/03/1997 11:15	03/03/2008 10:00
Salinity (ppt)	95	0.328	0.180	1.300	12/03/1997 11:15	01/17/2008 10:40
Secchi Depth (m)	133	0.666	0.200	1.800	12/03/1997 11:15	03/03/2008 10:05
Water Temperature (Celsius)	165	23.393	11.170	31.150	12/03/1997 11:15	03/03/2008 10:05
Nitrogen Kjeldahl as N (mg/l)	137	0.944	0.140	2.100	12/03/1997 11:15	03/03/2008 10:00
Nitrogen, Total as N (mg/l)	137	1.147	0.144	2.470	12/03/1997 11:15	03/03/2008 10:00
Total Organic Carbon (mg/l)	138	13.609	10.000	20.000	12/03/1997	03/03/2008

Parameter	Obs.	Mean	Min.	Max.	First Date	Last Date
					11:15	10:00
Phosphorus Total as P (mg/l)	139	0.396	0.130	1.100	12/03/1997 11:15	03/03/2008 10:00
Total Suspended Solids (TSS;mg/l)	138	7.246	1.000	53.000	12/03/1997 11:15	03/03/2008 10:00
Turbidity (NTU)	139	5.936	0.600	40.000	12/03/1997 11:15	03/03/2008 10:00
Unionized Ammonia (mg/l)	128	0.001	0.000	0.003	12/03/1997 11:15	12/03/2007 10:00

NOTES:

1. Obs= number of observations; Max= maximum value; Min= minimum value; Mean= average value.
2. Some values contributing to these statistics are below the practical quantification or reporting limit; in those instances the value was left as the reported limit. Please see original data for associated remark codes.

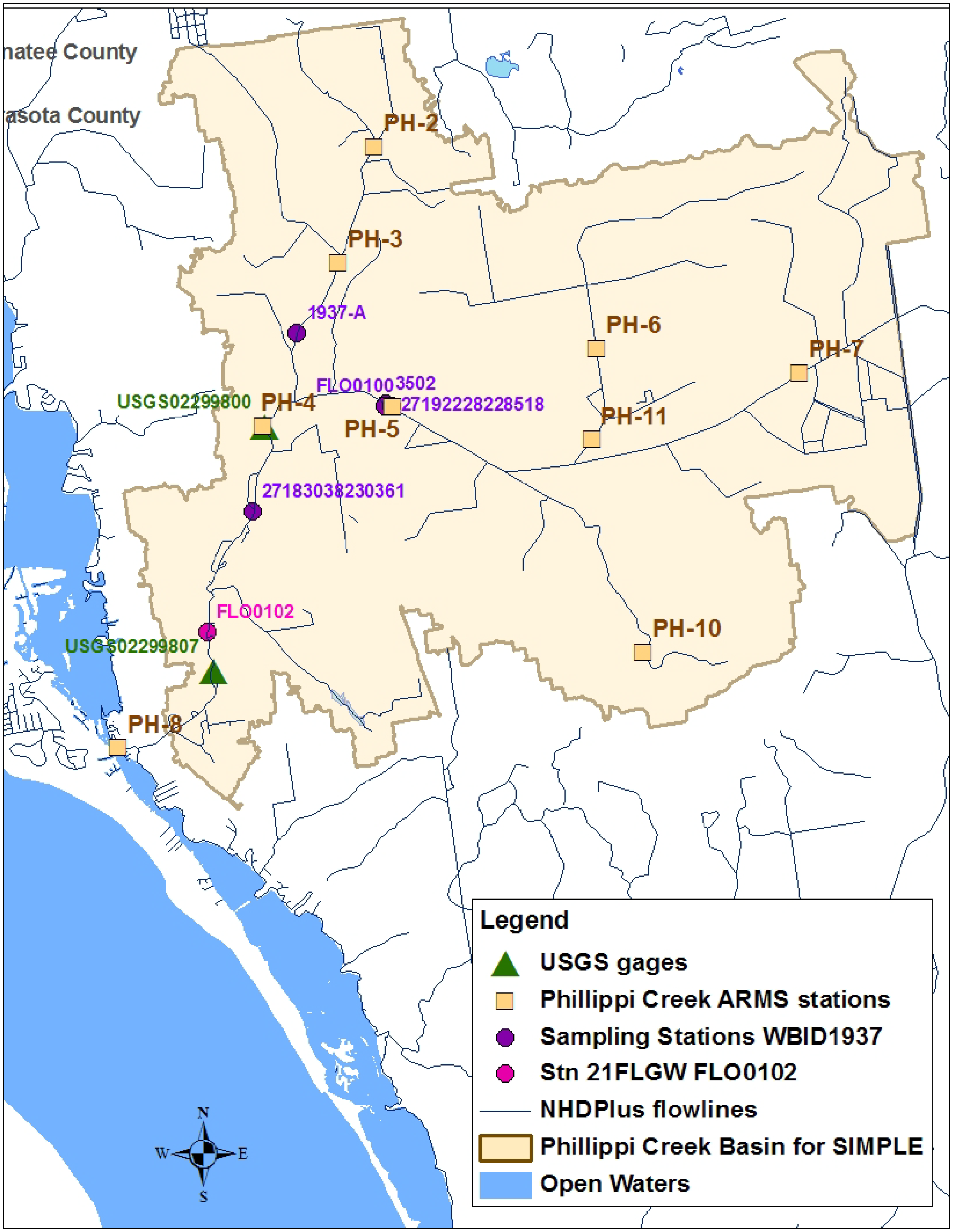

Figure 3. Locations of sampling stations in the Phillippi Creek Watershed.

5.1. Water Quality Data:

5.1.1. Nutrients and Chlorophyll

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating.

While the State of Florida does not have numeric criteria for nutrients, a narrative criterion exists as described in the Water Quality Standards section of this report. High chlorophyll and/or low dissolved oxygen concentrations may provide evidence that nutrients are present in excessive amounts. Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-*a* is a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-*a* measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region. Chlorophyll-*a* and corrected chlorophyll-*a* were measured for Phillippi Creek between November 1999 and March 2008. The chlorophyll-*a* concentrations in these samples range from as low as 1 to as high as 31 μg/l (Table 3). The mean value of corrected chlorophyll- *a* is only 2.4 μg/l, while the mean of chlorophyll- *a* is only 4.1 μg/l. However, it is important to realize that measuring chlorophyll concentrations in a water sample only captures phytoplankton, the free-floating algae, and will not capture other types such as attached algae (periphyton), algae growing on bottom sediments (benthic), and other aquatic plants (macrophytes). The two highest corrected chlorophyll-*a* measurements were made in June 2004 and July 2007 at station 21FLGW3502 (Figure 4). During a visit to Phillippi Creek by EPA and other personnel on May 7, 2009, several instances of algal mats were observed (Figure 5). These images, combined with the record of chlorophyll data, suggest that concentrations of free-floating algae in the water are low most of the time, but that there is definitely a potential for algal blooms during the warmer months of the year.

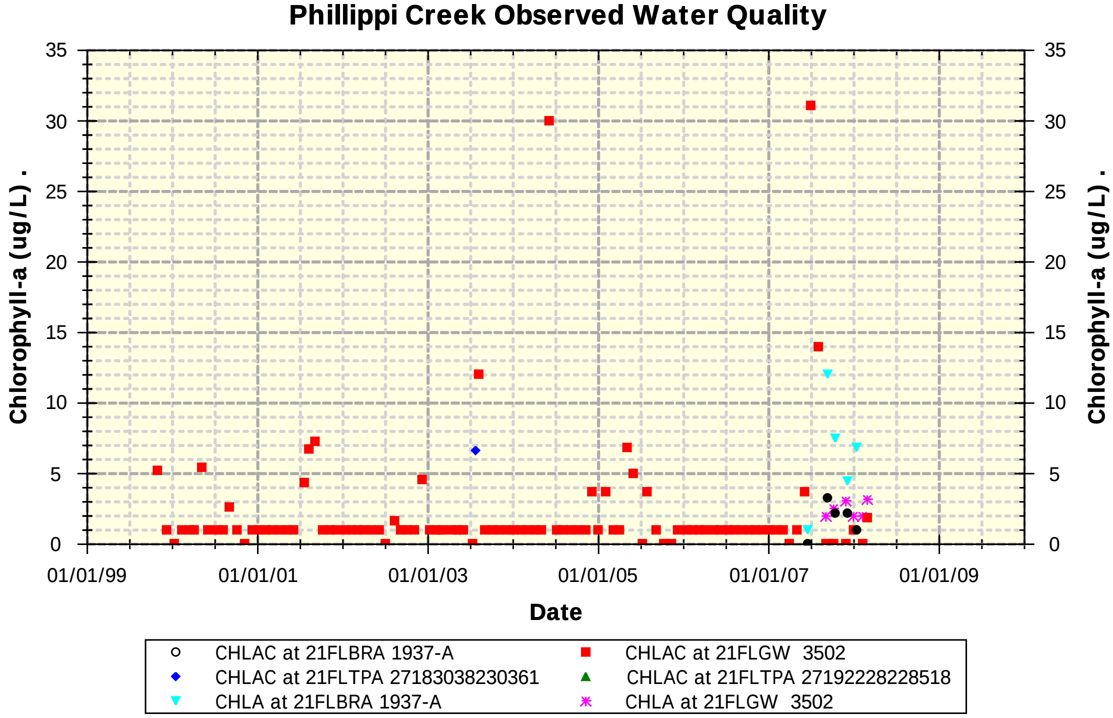

Figure 4. Chlorophyll-*a* Measurements in WBID 1937 (Phillippi Creek).

Figure 5. Photos taken on the downstream segment of Phillippi Creek (May 7, 2009).

Although most of the corrected chlorophyll-a measurements are relatively low, the average total phosphorus (TP) concentration exceeds FDEP's screening threshold for streams of 0.22 mg/L. Total phosphorus measurements in Phillippi Creek ranged from 0.13 mg/l to 1.10 mg/l, and had an average of 0.96 mg/l (Table 3 and Figure 6). In natural waters, total phosphorus exists in either in soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. The concentrations of dissolved orthophosphate in Phillippi Creek WBID 1937 are displayed in Figure 7. High levels of TP may result from wastewater and septic system effluent, agriculture (including fertilizers and animal waste), soil erosion, phosphate mining, or industrial sources. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which uses up oxygen from the water. In turn, low oxygen levels near the stream bottom can free additional phosphorus from the sediments.

Phosphorus is usually the growth-limiting nutrient in freshwaters. The ratio of total nitrogen to total phosphorus in Phillippi Creek ranges between 0.2 to 6.7, with a mean of 3.2 (+- 1.1). A ratio less than 7.2 generally indicates nitrogen limitation, whereas a high ratio indicates that phosphorus is the limiting nutrient. These ratios indicate that nitrogen is typically the limiting nutrient in Phillippi Creek. However, nutrient limitation is complex and can be dynamic over both space and time such that the different nutrients can influence productivity at different times and locations within a waterbody. As conditions change, aquatic organisms may adapt and waterbodies may spend some fraction of the time in co-limitation. Given this complexity, EPA believes that in most cases, it is important to control both nitrogen and phosphorus to prevent impairment from excessive nutrients.

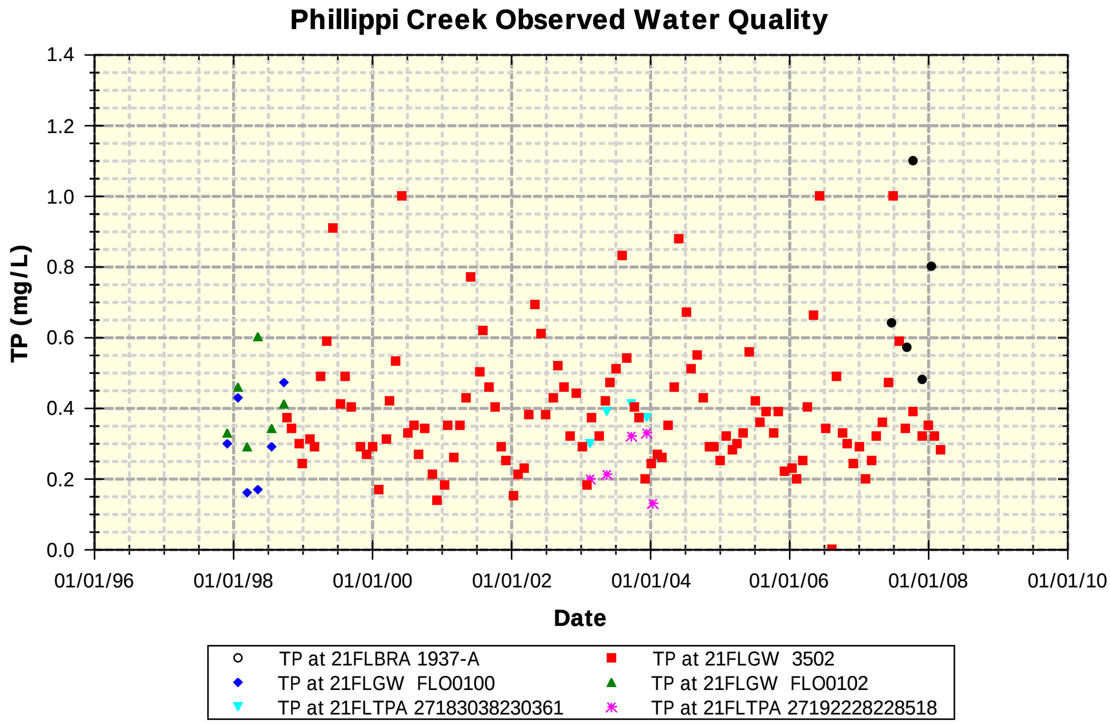

Figure 6. Total Phosphorus Measurements in Phillippi Creek WBID 1937.

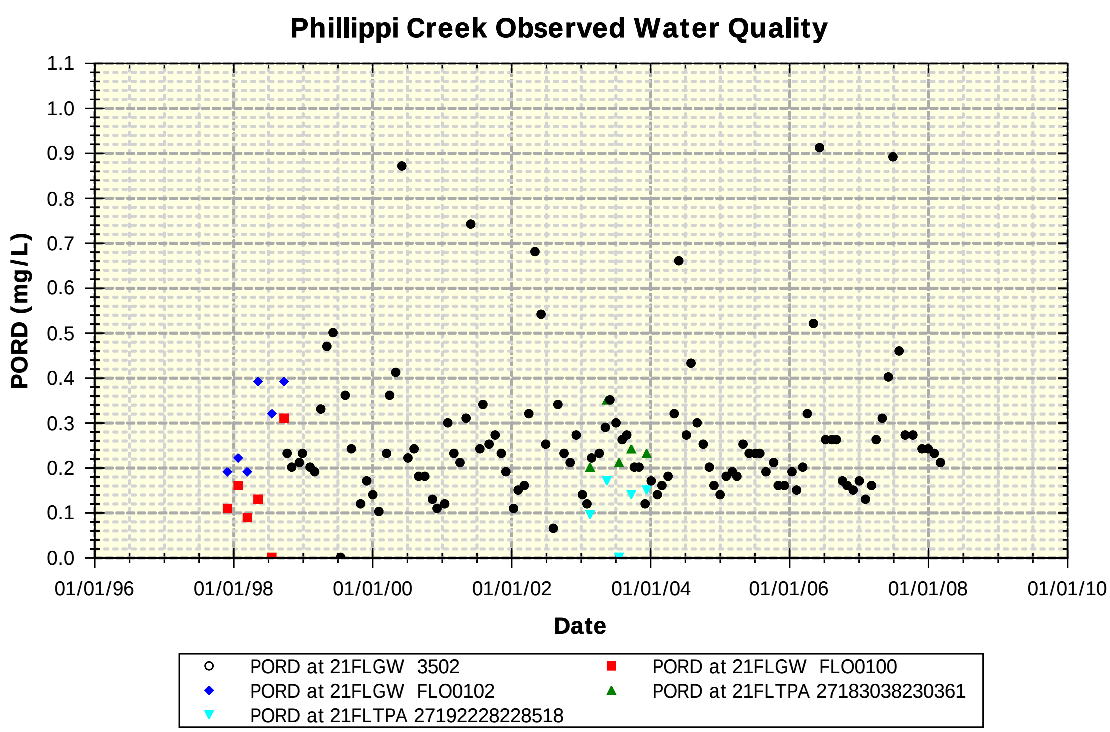

Figure 7. Dissolved Ortho-phosphorus Measurements in Phillippi Creek WBID 1937.

Total Nitrogen (TN) is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen (NH4). TN measurements in Phillippi Creek ranged from 0.14 mg/l to 2.47 mg/l, and had an average of 1.15 mg/l (Table 3 and Figure 8). Most of the TN appears to consist of Total Kjeldahl Nitrogen (TKN), which is the sum of organic nitrogen and ammonia (see Figure 9, Figure 10, and Figure 11). High concentrations of TKN typically result from the decay of organic matter, such as plant and animal wastes. These organic materials may be natural, or they may result from urban or industrial sources. Fertilizer runoff is another potential source. Nitrification of ammonia to nitrite and then nitrate can use up dissolved oxygen from the water.

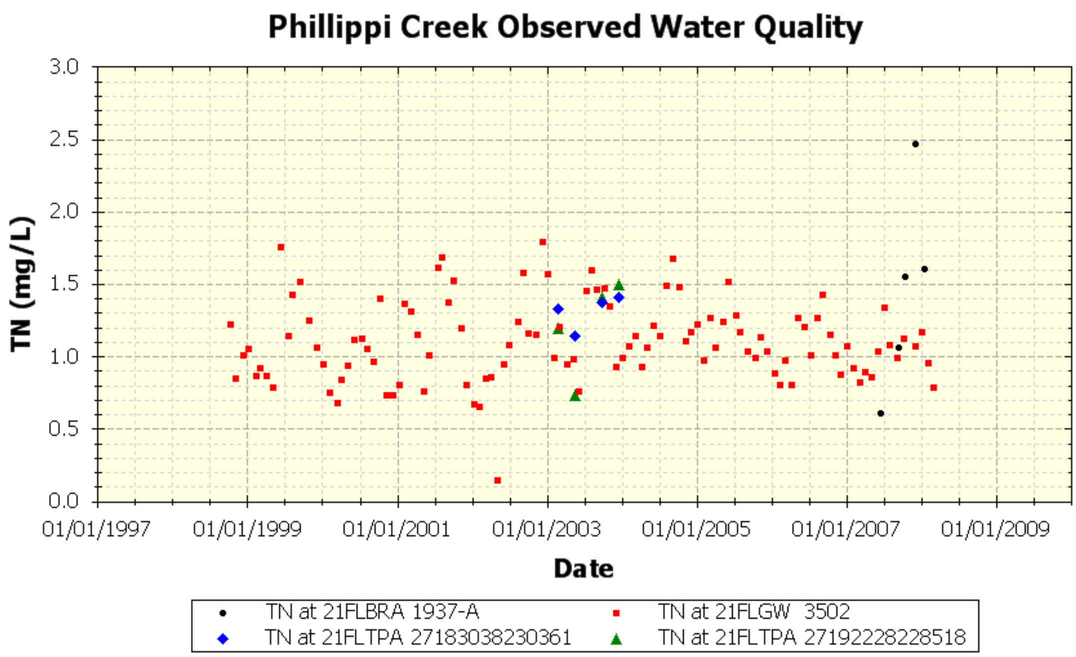

Figure 8. Total Nitrogen Measurements in Phillippi Creek WBID 1937.

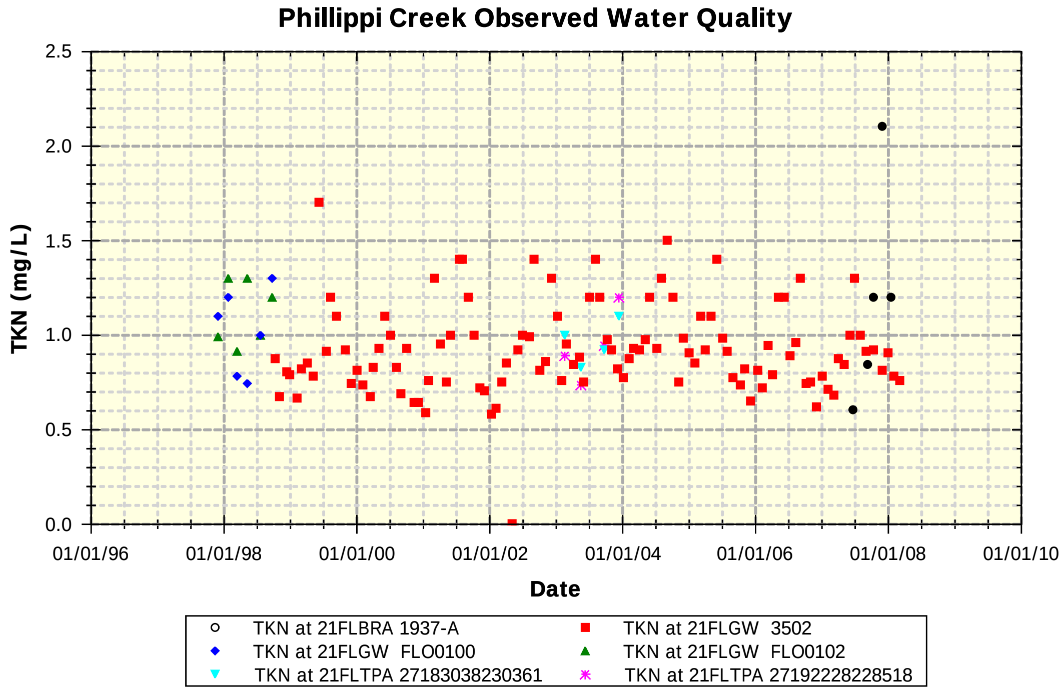

Figure 9. Total Kjeldahl Nitrogen Measurements in Phillippi Creek WBID 1937.

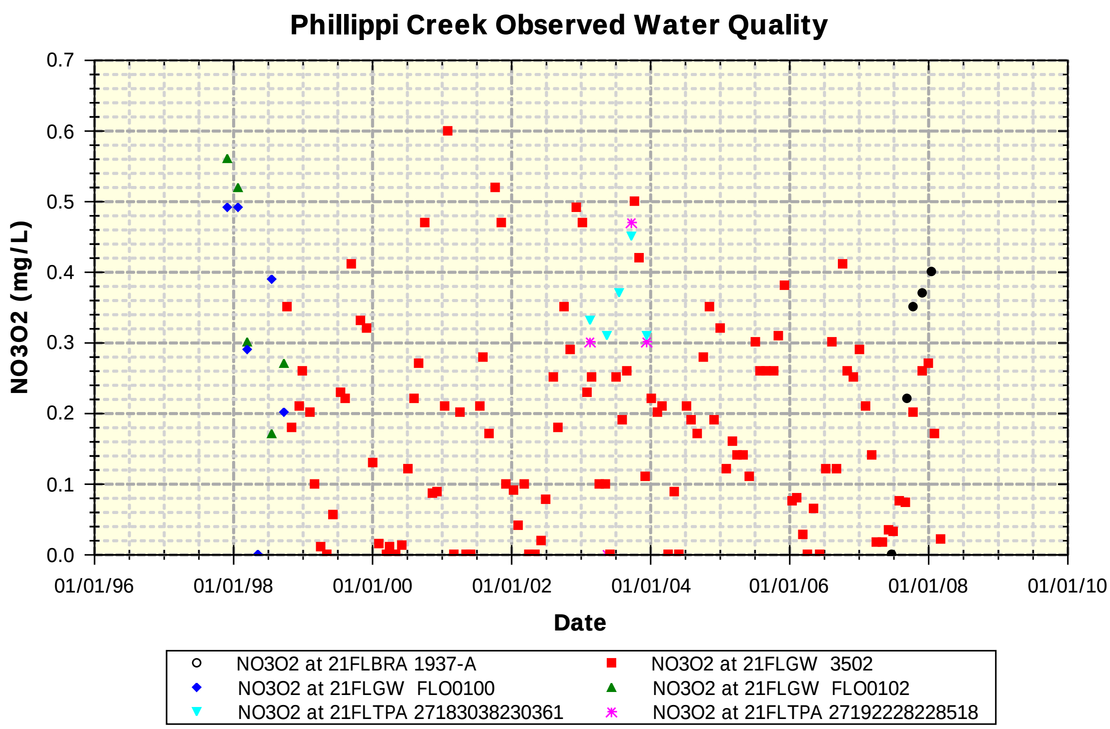

Figure 10. Nitrate-Nitrite Nitrogen Measurements in Phillippi Creek WBID 1937.

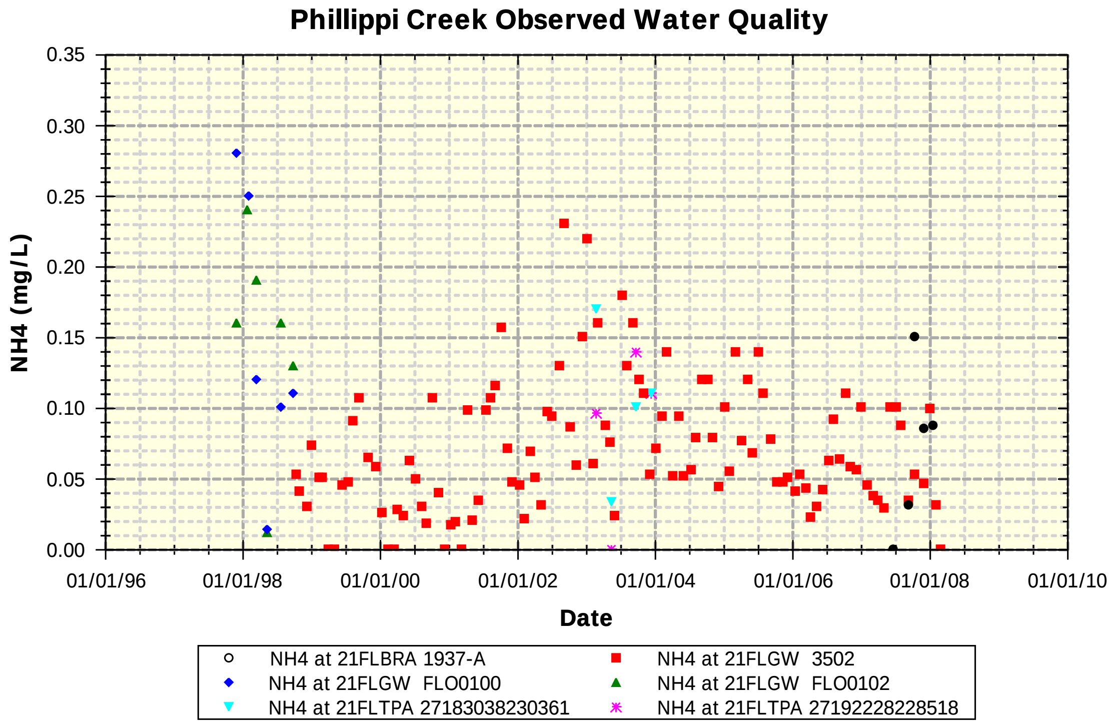

Figure 11. Ammonia Measurements in Phillippi Creek WBID 1937.

5.1.2. Dissolved Oxygen and Biochemical Oxygen Demand

There are several factors that affect the concentration of dissolved oxygen (DO) in a waterbody. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of higher DO water (e.g. from tributaries). Dissolved oxygen concentrations are lowered by processes that use up oxygen from the water, such as respiration and decomposition, and by additions of water with lower DO (e.g. swamp or groundwater). Natural dissolved oxygen levels are a function of water temperature, water depth and velocity, and relative contributions of groundwater. Warm water holds less oxygen than cool water, and slower-flowing, less turbulent water has less diffusion of atmospheric oxygen into it. Because it is not in contact with air, groundwater naturally has lower concentrations of dissolved oxygen. Decomposition of organic matter, such as dead plants and animals, also uses up dissolved oxygen. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen used by bacteria as they stabilize organic matter.

DO levels naturally fluctuate over the course of a day. Respiration and decomposition may consume oxygen dissolved in the water. During daylight, submerged aquatic plants take up carbon dioxide and produce oxygen as by-products of photosynthesis. At night, photosynthesis does not occur and so the oxygen-consuming processes dominate. The available data indicate that the DO concentrations in Phillippi Creek are frequently below the Class III Freshwater Water Quality Criterion of 5.0 mg/L (Figure 12). Dissolved oxygen values measured between December 1997 and March 2008 range from 0.880 to 13.160 mg/l, with an average of 6.1 mg/l. Despite the low chlorophyll concentrations, the very wide range in DO concentrations suggests a strong influence of photosynthesis and respiration.

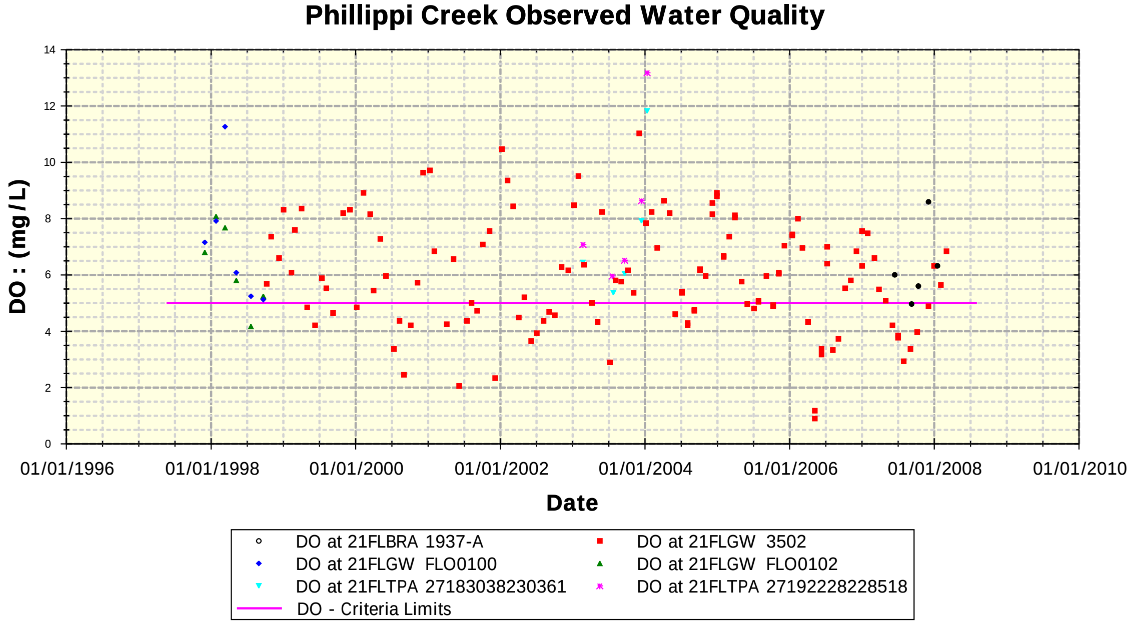

Figure 12. DO measurements in Phillippi Creek WBID 1937.

In order to understand the likely cause of low DO in Phillippi Creek, the influence of respiration (as indicated by chlorophyll and pH), temperature, flow, nutrients, and degradation of organic matter (as indicated by biochemical oxygen demand and total organic carbon) was considered.

Photosynthesis by algae and other submerged plants is usually associated with an increase in both DO and pH, as the plants take up carbon dioxide and release oxygen into the water. Respiration is associated with lower DO concentrations and lower pH, as plants use up oxygen and release carbon dioxide back into the water. Carbon dioxide (CO_2) dissociates in water to create carbonic acid, so increasing its concentration tends to make the water more acidic (i.e. have lower pH), while decreasing CO_2 tends to make the water more alkaline (i.e. have a higher pH). In Phillippi Creek, pH is consistently between 6.6 to 8.2 standard units, within the allowed 6.0-8.5 pH range for Class III waters (Figure 13).

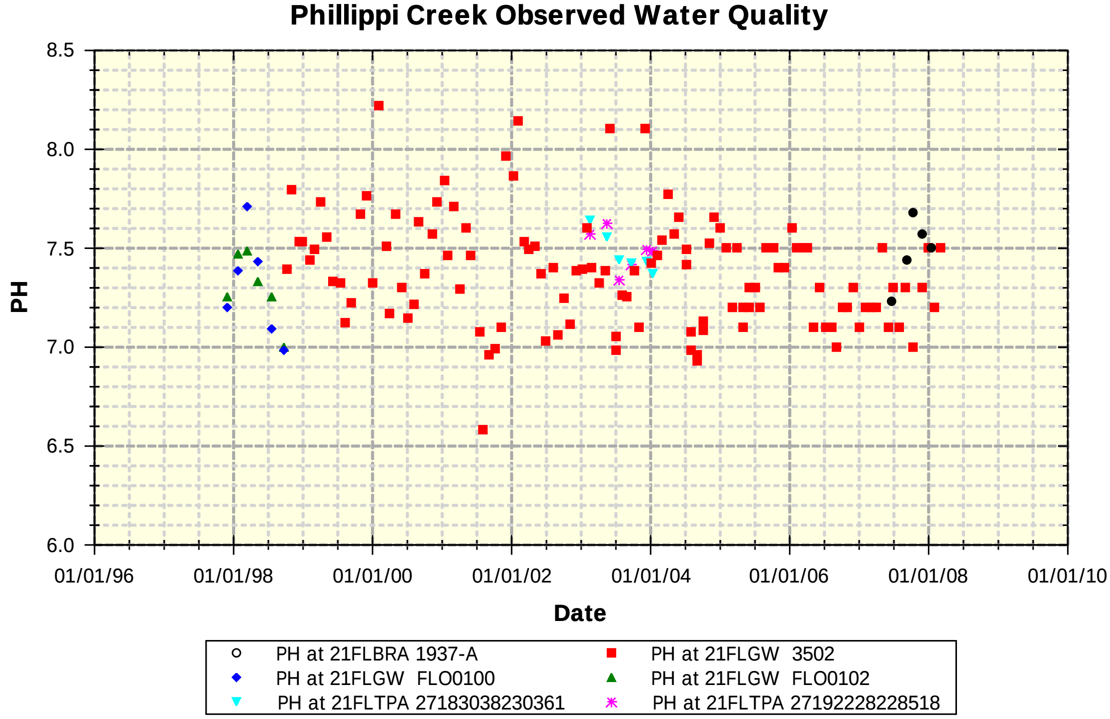

Figure 13. pH measurements in Phillippi Creek WBID 1937.

Biochemical oxygen demand is a measure of the amount of oxygen consumed by organisms in breaking down organic material. It is difficult to draw firm conclusions about the relationship between biochemical oxygen demand (BOD) and low DO in Phillippi Creek, since the BOD dataset consists of only 15 samples and includes many values below the Method Detection Limit (Figure 14). BOD ranges from 2.0 mg/l (the Method Detection Limit) to 2.2 mg/l, with an average of 2 mg/l (Table 3).

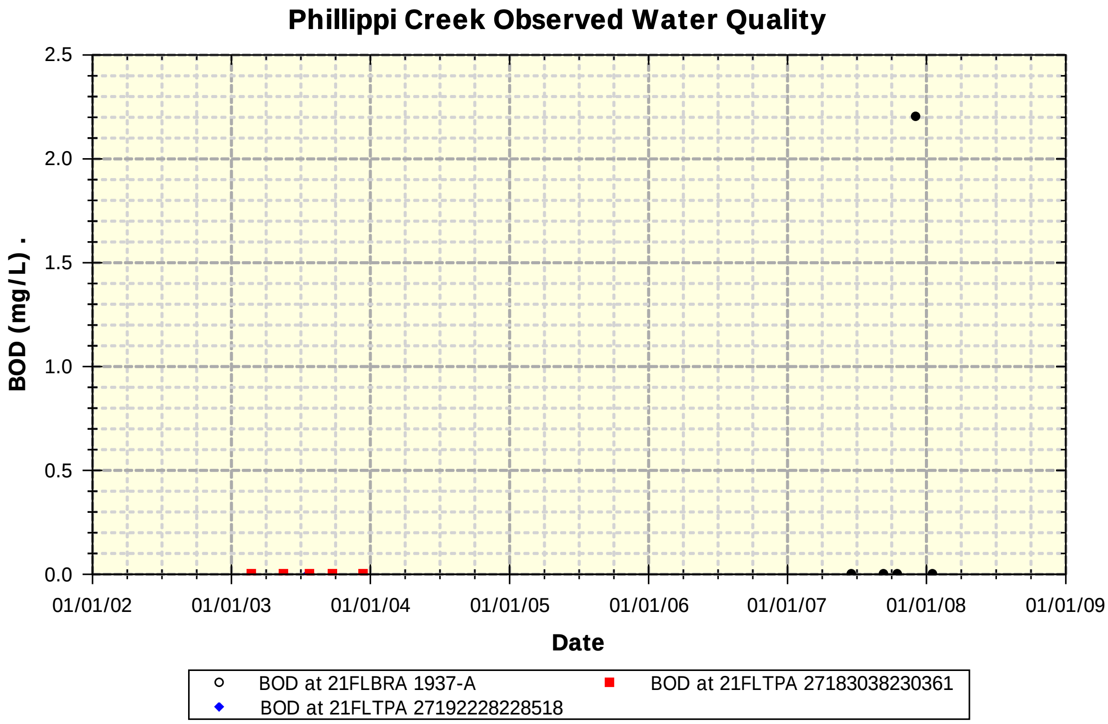

Figure 14. Biochemical Oxygen Demand in Phillippi Creek WBID 1937.

Total Organic Carbon (TOC) is a measure of the organic content of the water. TOC is important because higher carbon/organic contents generally mean that more oxygen will be consumed when this matter is decomposed by microorganisms. Natural vegetation is a source of such organic material, although TOC may also be contributed by wastewater treatment plant discharges, septic systems, carbon-containing industrial effluents, and agriculture. Total organic carbon (TOC) in Phillippi Creek, which ranges from 10 mg/l to 20 mg/l and averages around 13.6 mg/l, shows some correlation with dissolved oxygen such that an increase in organic matter (as indicated by TOC) is associated with a decrease in dissolved oxygen (Figure 15).

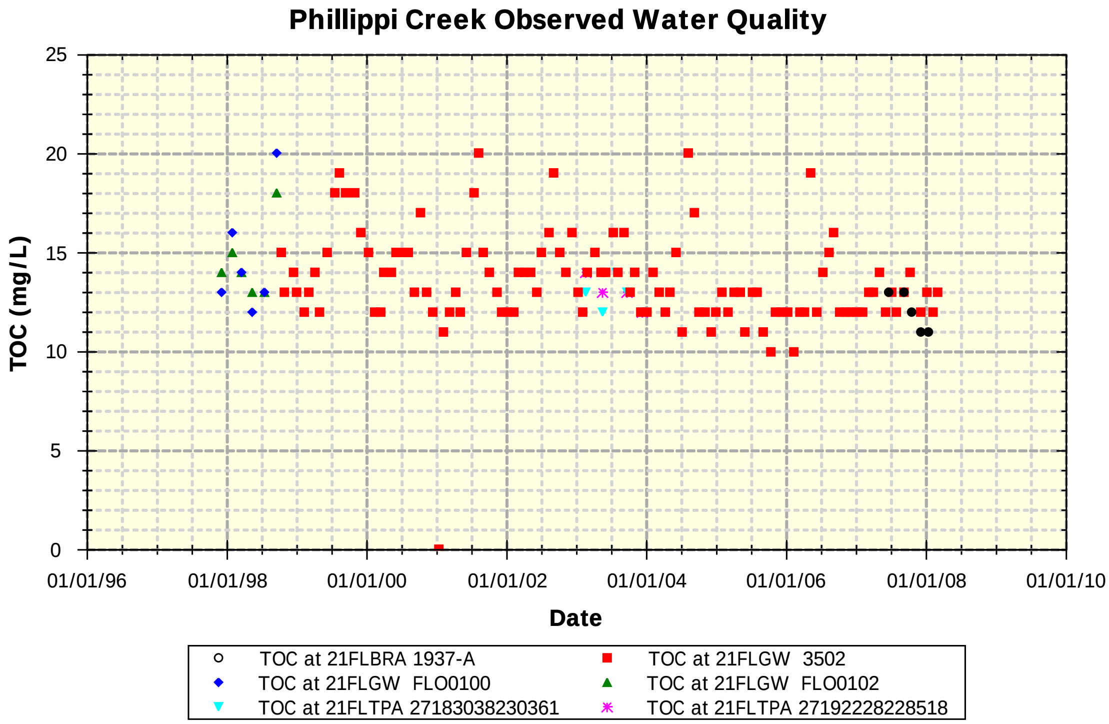

Figure 15. Total Organic Carbon Measurements in Phillippi Creek WBID 1937.

5.1.3. Stream Flow

Stream flow is an important factor affecting water quality, especially insofar as it determines the available loading capacity for pollutants such as nutrients and bacteria. Flow conditions also influence DO concentrations more directly. Typically, higher flows are associated with higher DO, since the increased flow leads to greater turbulence and aeration. Measurements taken at the United States Geological Survey (USGS) Gage #02299780, near Bee Ridge Florida, show that the stream flow of Phillippi Creek is highly variable, but usually below 60 cubic feet per second (cfs; Figure 16). The flow at that gage is below two cfs less than one percent of the time.

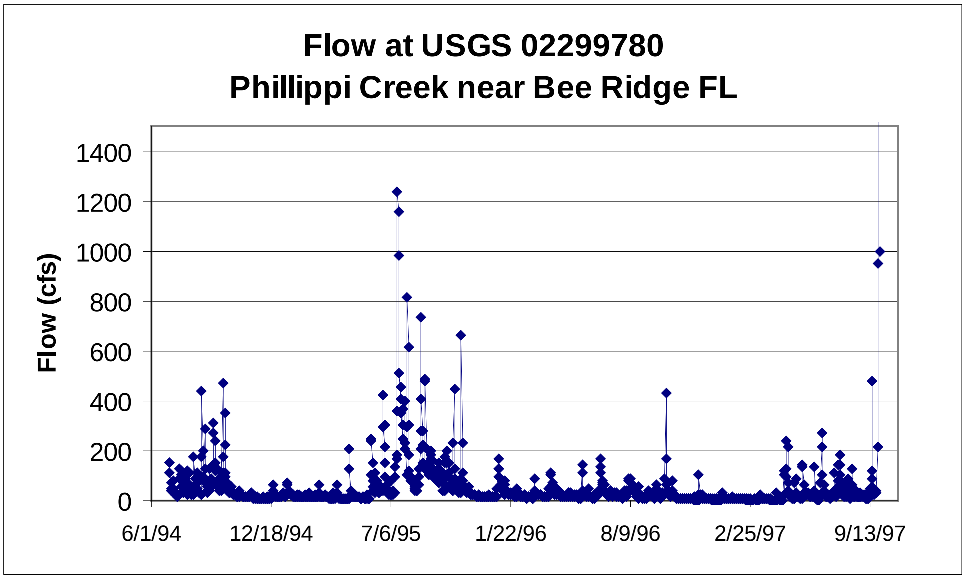

Figure 16. Flow in WBID 1937 of Phillippi Creek at USGS Gage 02299780.

5.2. Summary of Data Assessments:

Although most of the chlorophyll-a measurements in Phillippi Creek are relatively low, the average TP concentration exceeds FDEP's screening threshold for streams of 0.22 mg/L. The nutrient data suggest that Phillippi Creek is usually nitrogen-limited and that the majority of TN is organic in nature. Common sources of organic nitrogen are plant matter and animal wastes, including septic systems and sewer lines. DO has a wide range in concentration and is frequently below the Class III freshwater criterion of 5 mg/l, even at different times of the year. Sediment oxygen demand is thought to be an important factor affecting DO concentrations. Based on this information, and the presence of potential point and nonpoint sources of relevant pollutants, TMDLs for DO and nutrients are being proposed for WBID 1937.

6. Source and Load Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each. Sources are broadly classified as either point or nonpoint sources depending on how diffuse they are and whether or not they are permitted under the National Pollutant Discharge Elimination System (NPDES) program. Pollutants, including nutrients, may enter surface waters from both point and nonpoint sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by NPDES permits. NPDES permitted entities, including certain urban stormwater discharges such as Municipal Separate Storm Sewer Systems (MS4 areas), certain industrial facilities, and construction sites over one acre, are stormwater driven sources considered "point sources" in this report. Typically, high nutrient concentrations that occur during periods of reduced rainfall result from a lack of dilution for point source discharges or other sources located close to the waterbody.

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources generally, but not always, involve accumulation of pollutants on land surfaces and wash-off as a result of storm events. For nutrients, these sources include runoff from agricultural fields and pastures, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas.

6.1. Point Sources:

6.1.1. Permitted Point Sources

A TMDL wasteload allocation (WLA) is given to NPDES permitted facilities discharging to surface waters within an impaired watershed. Facilities that dispose of wastewater by means other than a surface water discharge, such as spray irrigation or underground injection wells, typically treat wastewater to less stringent secondary standards. Any pollutant loads emanating from these facilities would be accounted for in the TMDL's load allocation (LA) for nonpoint sources. There are four NPDES-permitted facilities that discharge within the Phillippi Creek watershed, including two water treatment facilities, and two wastewater treatment plants (Figure 17).

The South Gate WWTP (FL0032808) is a major domestic wastewater treatment plant that discharged its effluent directly to Phillippi Creek until June 2008. The permit for this facility includes limits for fecal coliform bacteria, nutrients, BOD, DO, and total suspended solids (TSS), as well as a few other parameters (FDEP, 2004a). The construction of a master lift station at the site allowed the effluent to be sent to the Bee Ridge Water Reclamation Facility. This facility sends reclaimed water to Sarasota County's North Master Reuse System (permit #FLA177008; David Pouso, personal communication). Pollutant loads from this facility are included in the TMDL analysis.

The Dolomite Utilities Fruitville WWTP (FL0134589) is permitted to discharge up to 2.4 million gallons per day (MGD) 3-Month Average Daily Flow (FDEP, 2004b). The effluent eventually flows from contact basins, over weirs, to a common wet well, from which water is pumped into different reclaimed water storage ponds. Some fraction of the reclaimed water is discharged into a storm water storage lake system at the Tatum Ridge Golf Course, which can intermittently overflow to the Sarasota County Celery Fields storm water facility and then into Phillippi Creek, when the water level rises above the daily storage capacity of the lakes. The Tatum Ridge Ponds can hold up to 8.1 million gallons of water, representing approximately 3.4 days of storage if the facility were to discharge its full design capacity only to these ponds.

Other available storage ponds do not flow to Phillippi Creek. Discharges from this WWTP were accounted for in the modeling analysis of pollutant loads being delivered to Phillippi Creek. The facility was not assigned a TMDL WLA, because it is not expected to significantly cause or contribute to impairment. The permit requires the facility to measure and report the number and duration of any discharges from the reuse system, but it does not include water quality limits for reclaimed water. For the 22 month period between August 2007 and June 2009, the facility did not report any discharges from any of the ponds, including those located on the Tatum Ridge Golf Course which may overflow to Phillippi Creek (Michelle Duggan, FDEP Southwest District, personal communication 08/11/09). Surface water discharges from the storage ponds are very infrequent, and occur only during high rainfall events.

Camelot Lakes (FL0188999) is a water treatment facility which utilizes reverse osmosis to provide potable water to the residents of Camelot Communities (FDEP, 2006a). The facility has a design flow of 0.041 MGD (0.063 cfs). The filtered concentrate is not treated prior to being discharged to an on-site stormwater pond for dilution and storage. During periods of high rainfall, water may overflow from this pond into an unnamed ditch which carries it to Phillippi Creek. Because the discharge is rainfall dependent, it is highly variable. Algal growth potential tests of the stormwater pond, which may receive runoff from other sources in addition to the WTF, indicated that the effluent is nutrient enriched. Although the effluent samples from the pond were not acutely toxic, and did not violate any permit conditions during the bioassay sampling, there have been past excursions below the DO permit limits of 5.0 mg/L (FDEP, 2006a). Discharges from this facility are included in the TMDL analysis of estimated pollutant loads being delivered to Phillippi Creek. Although the facility has a potential for indirect surface water discharge to the stream during periods of high rainfall, it is not assigned a TMDL WLA because it is not expected to significantly cause or contribute to impairment. The effluent will be diluted in the storage pond, and only overflow to Phillippi Creek during stormwater-driven events. Even assuming that the entire design flow of the facility were to be discharged directly to the stream, 99 percent of the time, the discharge would constitute less than 4 percent of the overall stream flow as measured at USGS 0229780/PH-5. The fraction of flow contributed from the plant would likely be much less than four percent during the rainfall events when overflow of the storage pond would occur.

The Lake Tippecanoe Owners Association (FL0188981) is a water treatment plant which provides drinking water to residents of Lake Tippecanoe Condominiums (FDEP, 2006b). The water plant uses reverse osmosis to remove minerals from water, before discharging them to on-site stormwater pond. The only treatment for the mineral concentrate is the dilution provided by any stormwater in the pond, so the actual degree of dilution will vary depending on the antecedent rainfall conditions. The maximum daily flow to the pond is 0.014 MGD (0.022 cfs). Any overflow from the pond is discharged through a concrete pipe to a ditch along Bliss Road, where it may drain to Phillippi Creek. As such, this facility is only expected to result in a discharge to Phillippi Creek during periods of high rainfall. Discharges from this water treatment plant were also accounted for in the estimated pollutant loads being delivered to Phillippi Creek. Similar to Camelot Communities, this facility has a potential for indirect surface water discharge to the stream during periods of high rainfall.

However, since the facility is not expected to cause or contribute to impairment in Phillippi Creek, it is not assigned a TMDL WLA. Effluent from the facility is diluted in the on-site stormwater pond, overflowing to Phillippi Creek only during stormwater-driven events. Even assuming that the entire design flow of the facility were to be discharged directly to the stream, without any dilution, the discharge would only contribute slightly more than one percent of the overall stream flow as measured at USGS 0229780/PH-5 even at the lowest flows. The fraction of flow contributed from the plant would likely be much less than one percent during the rainfall events when overflow of the storage pond would occur.

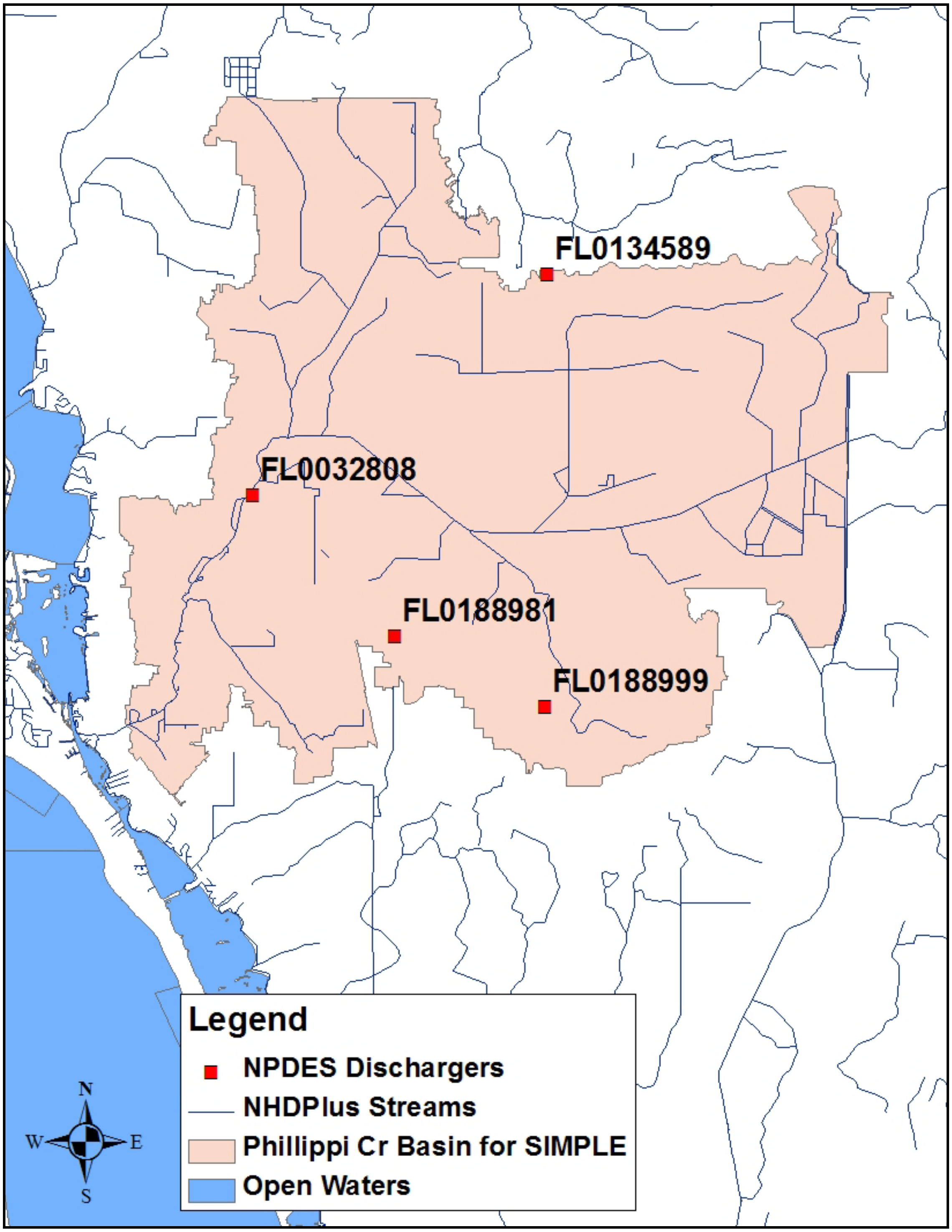

Figure 17. Location of NPDES facilities in the Phillippi Creek Watershed.

6.1.2. Municipal Separate Storm System Permits

The 1987 amendments to the Clean Water Act designated certain stormwater discharges as point sources requiring NPDES stormwater permits. The regulated activities involve Municipal Separate Storm Sewer Systems (MS4s), construction sites over one acre, and specific industrial operations. Although these types of stormwater discharges are now considered point sources with respect to permitting and TMDLs, they behave similarly to nonpoint sources in that they are driven by rainfall-runoff processes leading to the intermittent discharge of pollutants from land use activities in response to storms.

According to 40 CFR 122.26(b)(8), an MS4 is defined as "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

> (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States.
>
> (ii) Designed or used for collecting or conveying storm water;
>
> (iii) Which is not a combined sewer; and
>
> (iv) Which is not part of a Publicly Owned Treatment Works."

In 1990, EPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants washed into MS4s by stormwater runoff, or dumped directly into them, from being delivered to local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (generally serving populations of 100,000 or more) to implement a stormwater management program as a means of controlling polluted discharges. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, and hazardous waste treatment, etc. Because the master drainage systems of most local governments in Florida are interconnected, EPA implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities, Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria.

Phase II of the NPDES stormwater rule extended coverage to certain “small” MS4s and to construction sites between one and five acres. Small MS4s are defined as any municipal stormwater collection system that does not meet the criteria of a medium or large MS4 covered by Phase I. Only a select subset of small MS4s requires an NPDES stormwater permit. These “regulated small MS4s” include those located in "urbanized areas" as defined by the Bureau of Census, and other small MS4s designated by NPDES permitting authorities.

In October 2000, US EPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP’s authority to administer the NPDES program is set forth in Section 403.0885, FS. The three major components of NPDES stormwater regulations are:

- MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.

- Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.

- Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

WBID 1937 of Phillippi Creek is affected by Phase I MS4 permit FLS000004, which covers Sarasota County and the city of Sarasota, as well as other co-permittees. Stormwater discharges conveyed through the storm sewer system covered by the permit are subject to the WLA of the TMDL. Any newly designated MS4s will also be required to achieve the percent reduction allocation presented in this TMDL.

6.2. Nonpoint Sources:

Nonpoint source pollution generally involves a buildup of pollutants on the land surface that wash off during rain events and as such, represent contributions from diffuse sources, rather than from a defined outlet. Potential nonpoint sources are commonly identified, and their loads estimated, based on land cover data. Most methods calculate nonpoint source loadings as the product of the water quality concentration and runoff water volume associated with certain land use practices. The mean concentration of pollutants in the runoff from a storm event is known as the Event Mean Concentration, or EMC.

The land use distribution of the Phillippi Creek watershed provides insight into potential nonpoint sources of nutrients and oxygen-demanding substances. As can be seen in Figure 2, much of the watershed consists of urban, residential, and commercial areas associated with the city of Sarasota. Agriculture is an important potential source in the eastern half of the basin. Landcover acreages and percentages for the Phillippi Creek watershed were provided in Table 1.

6.2.1. Urban, Residential, and Commercial Development

The urban land use category accounts for residential, industrial, commercial and recreational uses, including golf courses. Pollutant loads of nutrients and oxygen-demanding materials originating from urban areas (whether within an MS4 jurisdiction or not) is 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.

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 outlined in Chapter 403 of the Florida Statutes (FS), was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-40-.432 (5) (c), FAC).

In 1994, state legislation created the Environmental Resource Permitting program to consolidate stormwater quantity, stormwater quality, and wetlands protection into a single permit. Presently, the majority of environmental resource permits are issued by the state's water management districts, although DEP continues to issue permits for specific projects.

Nonstructural and structural BMPs are an integral part of Florida's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Urban, residential, and commercial developments are likely the most important nonpoint sources of nutrients and oxygen-demanding substances in the Phillippi Creek watershed. Landuses in this category comprise over 70 percent of the watershed area.

6.2.2. Agriculture

Agricultural lands include improved and unimproved pasture, row and field crops, tree crops, nurseries, and specialty farms. Agricultural activities, including runoff of fertilizers or animal wastes from pasture and cropland and direct animal access to streams, can generate nutrient loading to streams. While agriculture represents only about seven percent of the overall area in the Phillippi Creek watershed, it is a more common in the eastern, less urbanized areas of the basin. Almost 70 percent of the existing agricultural use is classified as cropland and pastureland, with 14 percent (i.e. less than 1 percent of the overall watershed area) comprised of open, rural lands, and 10 percent used for tree crops.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA NASS, 2007). The "Census of Agriculture Act of 1997" (Title 7, United States Code, Section 2204g) directs the Secretary of Agriculture to conduct an agricultural census on a 5-year cycle, collecting data for the years ending in 2 and 7. According to 2007 Census of Agriculture data, there were 100 farms which fertilized approximately 7,975 acres with commercial fertilizer, lime and soil conditioners in Sarasota County, Florida. The census also shows that approximately 554 acres of 29 farms were fertilized with manure. Livestock counts of cattle and pigs in Sarasota County are provided in Table 4. Because agricultural census data are collected at the county level, the extent to which these values pertain to agricultural fields within the impaired watershed is not specified. Land use data and aerial coverage of the watershed show that Phillippi Creek and its tributaries are bordered by some agricultural uses in the upper watershed (Figure 2). As such, agricultural uses could be a relevant source of nutrient loading to some sections of Phillippi Creek.

Table 4. 2007 Agricultural Census Data for Livestock in Sarasota County, Florida.

County	Livestock	Number of Farms	Number of Animals
Sarasota	Cattle and Calves	149	16,845
	Hogs and Pigs	19	44

Note: 1. A farm is defined as any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year.

6.2.3. Wildlife

Wildlife deposit their feces onto land surfaces where it can be transported to nearby streams during storm events. Generally, the pollutant load from wildlife is assumed to represent background concentrations, as the contribution from this source is small relative to the load from urban and agricultural areas in most impaired watersheds. This appears to be the case for Phillippi Creek, where undeveloped forest and wetland areas are minimal. Any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

6.2.4. Onsite Sewage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs), including septic tanks, are commonly used where providing access to sewer systems is not cost effective or practical. Most septic tanks are used for individual households or small commercial establishments that are in rural or remote areas, or in urban areas not served by a domestic wastewater facility. Water from septic tanks is typically released to the ground through on-site, subsurface drain fields or boreholes that allow the water from the tank to percolate (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water.

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 receives natural biological treatment in the soil and 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. Failure of septic systems is probably a very important source of organic and nutrient loading in the Phillippi Creek watershed.

The State of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 5 summarizes the cumulative number of septic systems installed in Sarasota County since the 1970 census and the total number of repair permits issued for the ten years between 1998-99 and 2007-08 (FDOH, 2009). The data do not reflect septic tanks removed from service. The number of septic tanks in the Phillippi Creek watershed has been estimated at 32,000 (Peeler et al, 2006). Section 3 provides some information about the Phillippi Creek Septic System Replacement Program, an effort initiated by Sarasota County to identify and replace failing septic systems in the watershed.

Table 5. County Estimates of Septic Tanks and Repair Permits.

County	Number Septic Tanks (1970- 2008)	Number of Repair Permits Issued (1998 – 2008)
Sarasota	80,014	4158

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

7. Analytical Approach

7.1. NUTRIENT AND DO TMDLS:

The TMDL allocations to address nutrients and dissolved oxygen were determined by analyzing the effects of BOD, TN, and TP loads on DO concentrations in the Phillippi Creek watershed. The hydrodynamic model DYNHYD was used to simulate water movement through the stream channel considering variable upstream flows and downstream tidal controls. A WASP eutrophication model was used to evaluate the in-stream impacts of pollutant loads from both point and nonpoint sources. Current pollutant loads were estimated using the SIMPLE model, and these loads were reduced until model simulations indicated that the DO criterion of 5 mg/L was attained. SIMPLE model loads account for both point and nonpoint source pollutant loads. The modeling effort is described generally in the following sections. Additional details may be found in the TMDL modeling report, which will also be available as part of the TMDL record (EPA, 2009).

7.1.1. DYNHYD Model:

DYNHYD was selected as the hydrodynamic model to simulate the motion of water in the Phillippi Creek watershed. DYNHYD solves the one-dimensional equations of continuity and momentum for a branching or channel-junction (link-node) network. Unsteady hydrodynamic flows are simulated from variable upstream flows (i.e. stream flow toward the mouth) and downstream heads (i.e. incoming and outgoing tides), and the results are averaged for use in WASP simulations of water quality (Ambrose et al, 1993).

DYNHYD, as well as other link-node models, uses a network which solves the equations of motion and continuity at alternating grid points. At each time step in the model, the equation of motion is solved at the links, yielding velocities for the mass transport calculations, and the equation of continuity is solved at the nodes, yielding heads for use in the pollutant concentration calculations. Links can be thought of as channel sections that convey water between two junctions, whose midpoints are at each end of the channel. Parameters influencing the motion of water are defined by the channel network, so the channels account for all water movement in the river or estuary. Nodes are like junctions that store volumetric units of water for transport through channels. The parameters influencing water storage are defined in the junction network, so that the junctions account for the entire water volume of the river or estuary being simulated. Essentially, the link-node computational network can be thought of as two overlapping, but closely related, networks of channels and junctions.

Junctions correlate to WASP segments, whereas channels correspond to the interfaces between those segments. Channel flows are used to calculate mass transport between segments in WASP, and junction volumes are used to calculate pollutant concentrations within the water quality segments. A simplified representation of the DYNYHD link (channel)-node (junction) network, and their relationship to WASP segments is displayed in Figure 18.

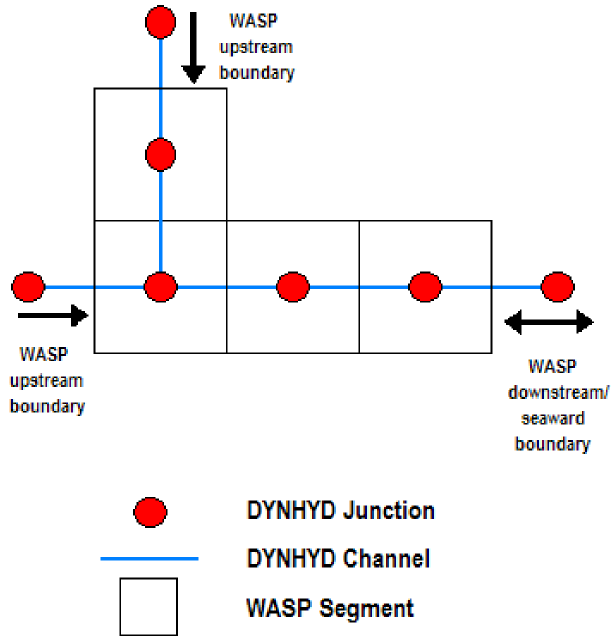

Figure 18. Correspondence of the DYNHYD and WASP Networks.

7.1.2. SIMPLE-Monthly Model:

The Spatially Integrated Model for Pollutant Loading Estimates, or SIMPLE model, was used to estimate pollutant loadings in the Phillippi Creek watershed. SIMPLE was developed by Jones Edmunds under contract to Sarasota County, Florida and the Southwest Florida Water Management District as a way to estimate the effect of pollutant reduction measures in Sarasota County (Jones Edmunds and Associates, 2009a and 2009b). The computational methods used in the model are based on the Watershed Management Model (WMM) and the Harvey Harper method (Harper, 2003). In the SIMPLE-Monthly version of the model, the timestep was reduced to monthly in order to more closely correspond to the response time of the county's bay systems. Loads from point sources and nonpoint sources, including septic tanks, are included. A spreadsheet-based hydrologic model uses NEXRAD rainfall data, estimates of evapotranspiration, and information on soils and Event Mean Concentration (EMC) landuse to calculate a water budget. The resultant estimates of runoff, baseflow, and rainfall volumes are then fed into the pollutant loading model, which works within a Geographic Information Systems (GIS) framework. Separate modules are used to simulate runoff, baseflow, wet and dry deposition, irrigation, point source loads, and septic tank loads. Additional details about the setup and use of SIMPLE-Monthly, including input data requirements, may be found in the final Design Report and Operations Manual (Jones Edmunds and Associates, 2009a and 2009b).

7.1.3. WASP Model:

The WASP model helps users interpret and predict water quality responses to natural phenomena and anthropogenic pollution to aid in various types of pollution management decisions. WASP7 is a dynamic compartment-modeling program for aquatic systems, capable of simulating both the water column and underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program (Wool et al, 2001).

Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to allow easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP7 comes with two such models -- TOXI for toxicants and EUTRO for conventional water quality. Earlier versions of WASP have been used to examine eutrophication of Tampa Bay; phosphorus loading to Lake Okeechobee; eutrophication of the Neuse River and estuary; eutrophication and PCB pollution of the Great Lakes, eutrophication of the Potomac Estuary, volatile organic pollution of the Delaware Estuary, and heavy metal pollution of the Deep River, North Carolina (Wool et al, 2001).

The flexibility afforded by the Water Quality Analysis Simulation Program is unique. WASP7 permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions.

For this project, the eutrophication module of WASP7 was applied in order to simulate dynamic water quality responses resulting from changes in the loading of nutrients and oxygen-demanding pollutants (Figure 19). Additional details about the model setup are provided in the modeling report (EPA, 2009). Water quality conditions were simulated for the period of January 1, 2006 through December 31, 2007.

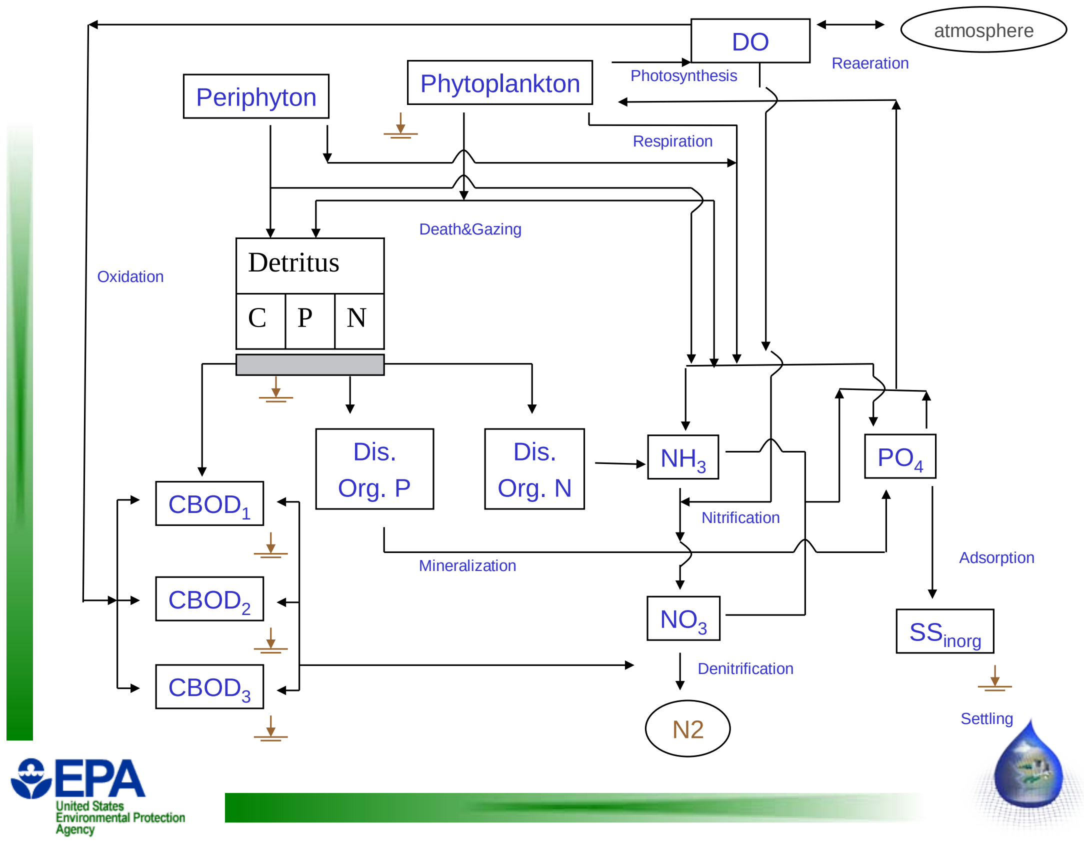

Figure 19. Processes impacting DO concentrations in WASP.

7.1.4. Modeling Results:

Details of the Phillippi Creek model configuration and calibration are described in the TMDL modeling report (EPA, 2009). The calibrated model was used to evaluate the response of dissolved oxygen to load reductions. The model indicates that a 70 percent reduction of nutrients, BOD, and SOD will attain the 5.0 mg/L DO water quality standard.

8. TMDLs

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. A TMDL for a given pollutant and waterbody can be expressed as the sum of all point source loads (Waste

Load Allocations or WLA), non-point source loads (Load Allocations or LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality. Conceptually, this definition is represented by the equation:

$$TMDL = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + MOS$$

The objective of a TMDL is to allocate loads among the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure.

The nutrient and dissolved oxygen TMDLs for WBID 1937 of Phillippi Creek are expressed as annual average pounds per day of total BOD, TN, and TP loading that are expected to achieve the narrative nutrient criteria and numeric DO standard (Table 6). It is important to consider nutrient loading over time, since nutrients can accumulate in waterbodies. The TMDLs are intended to be implemented on an annual basis with daily variation above and below these values. Load Allocations for the nonpoint sources and Waste Load Allocations for NPDES permits are provided in their respective sections below.

Table 6. TMDL Allocations for Phillippi Creek WBID 1937.

Parameter[1]	TMDL (lb/day)[2]	WLA[3]		LA (%)
		Facility (lb/day)	MS4 (%)[4]	
TN	201	NA	70	70
TP	56	NA	70	70
BOD	618	NA	70	70

Notes:

1. TN= total nitrogen; TP= total phosphorus; BOD= biochemical oxygen demand.
2. The nutrient and DO TMDLs are intended to be implemented on an annual basis. The annual average pounds per day should not exceed these values. Daily variation above and below these values within the year is expected.
3. The WLA is separated into an allocation for continuous NPDES facilities and an allocation for the MS4. WBID 1937 is within the collection area for Phase I MS4 permit # FLS000004, which is held by the City of Sarasota, Sarasota County, and

other co-permittees. Due to the infeasibility of separating the contributions from diffuse MS4 and non-MS4 sources, MS4s are allocated the same percent reductions as the Load Allocation. Because none of the NPDES facilities that currently operate within the Phillippi Creek watershed are expected to cause or contribute to impairments, WLAs for these individual facilities are not provided and no reductions are necessary. Any increase in potential nutrient or BOD loading from these facilities should be evaluated to determine if such an increase would cause or contribute to impairment for dissolved oxygen or nutrients in the Phillippi Creek watershed.

4. Percent reduction in total pollutant loading, including both regulated and non-regulated stormwater from current conditions to achieve the applicable standard. The percent reductions are applied to nonpoint sources (LA) and MS4s.

8.1. Existing Conditions

Existing conditions represent the current water quality conditions of a waterbody. DYNHYD, SIMPLE, and WASP models were developed and used to simulate existing conditions in the watershed, as outlined in Section 7 of this report, and in the accompanying modeling report.

8.2. Critical Conditions and Seasonal Variation

USEPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition is the combination of environmental factors creating the "worst case" scenario of water quality conditions in the waterbody. By achieving the water quality standards at critical conditions, it is expected that water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year, and that the TMDLs account for any seasonal change in flow or pollutant discharges, and any applicable water quality criteria or designated uses (such as swimming) that are expressed on a seasonal basis.

The critical condition for nonpoint source loadings is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, pollutants build up on the land surface, and are washed off by rainfall. The critical condition for continuous point source loading typically occurs during periods of low stream flow when dilution is minimized.

Since Phillippi Creek is impaired for nutrients and low dissolved oxygen, a number of processes that affect DO needed to be considered. These include BOD discharged directly from facilities and from non-point sources, SOD from the accumulation of organic material over long periods of time, and excess primary production resulting from excess available nutrients. Although low DO occurs during high temperature, low flow conditions, when reaeration is minimal and retention times are long, it should be kept in mind that this resultant low DO lags introduction of pollutants in space and time. That fact must be considered when evaluating critical conditions. In this case, the complex water quality issue was evaluated by simulating a two year period containing wet, normal, and dry conditions. Both wet events and dry events were analyzed in this Jan. 2006 through Dec. 2007 period. Figure 20 shows that 2006 had more rainfall than normal and 2007 had much less rainfall than normal.

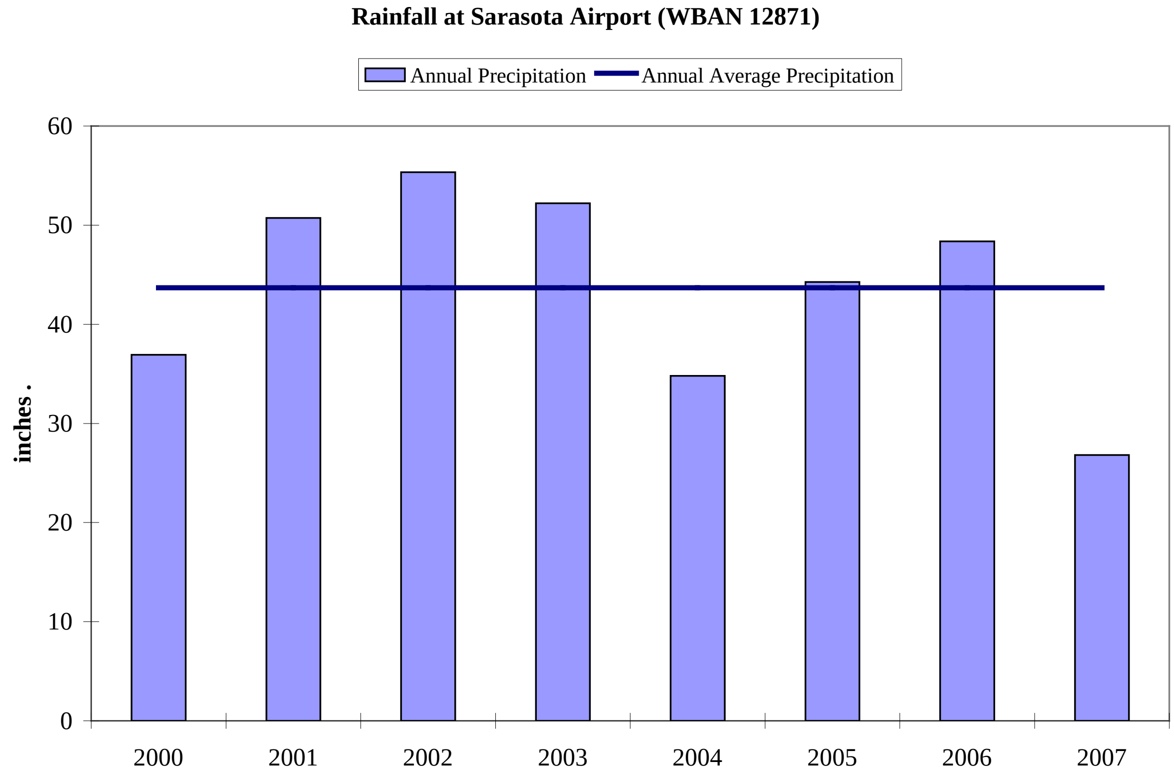

Figure 20: Rainfall at Sarasota Airport.

8.3. Margin of Safety

The Margin of Safety accounts for uncertainty in the relationship between a pollutant load and the resultant condition of the waterbody. There are two methods for incorporating a Margin of Safety in the analysis: a) implicitly incorporate the MOS using conservative assumptions to develop TMDL allocations; or b) explicitly reserve a portion of the TMDL as the MOS and use the remainder for point and nonpoint source allocations. The nutrient and DO TMDLs were developed using an implicit margin of safety. The worst case condition in the two year simulation from Jan. 2006 through Dec. 2007 was addressed to meet standards.

8.4. Waste Load Allocations

8.4.1. NPDES Dischargers

WBID 1937 of Phillippi Creek has three NPDES facilities that maintain NPDES permits to discharge within the watershed: FL0134589 Dolomite Utilities Fruitville; FL0188999 Camelot Lakes; and FL0188981 Lake Tippecanoe Owners Association. While the loadings from these facilities were included in the modeling analysis, none of these facilities are assigned WLAs, since their discharges are indirect, non-continuous and minor, and are not expected to cause or contribute to impairment of Phillippi Creek. All three NPDES permittees normally discharge to groundwater or surface application. The discharge only reaches surface waters in the Phillippi Creek watershed during very infrequent, high rainfall events, and on those rare occasions, the discharge should represent insignificant fractions of the stream flow. However, an expansion or increase in potential nutrient or BOD loading from these facilities should be evaluated to determine if such an increase would cause or contribute to impairment for dissolved oxygen or nutrients in the Phillippi Creek watershed. Loads from the South Gate WWTP (FL0032808) are also included in the TMDL modeling analysis, but the facility is not assigned a WLA because it does not currently have a surface water discharge.

8.4.2. Municipal Separate Storm System Permits

Phillippi Creek is also affected by Phase I MS4 permit # FLS000004, which is held by the City of Sarasota, Sarasota County, and other co-permittees. At this time is not possible to isolate the loading discharging exclusively from the MS4 area. The WLA assigned to the MS4 area is expressed in terms of the percent reduction required to attain the applicable TMDL target. Each permittee covered in the permit is ultimately responsible for the anthropogenic loads associated with stormwater outfalls they own or over which they otherwise have responsible control.

The WLA for MS4s are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate loadings coming exclusively from the MS4 areas. Although the aggregate WLAs for stormwater discharges are expressed in numeric form, i.e. percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by these TMDLs often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

These TMDLs assume for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, these TMDLs assume that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for nutrients for the purpose of determining whether the BMPs in fact are achieving the aggregate wasteload allocation.

The percent reduction calculated for nonpoint sources is assigned to the MS4 as loads from both sources typically occur in response to storm events. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. Best management practices for the MS4 service should be developed to meet the percent reduction targets in Table 6. All Phase 1 MS4 permits issued in Florida include a re-opener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida may designate an area as a regulated Phase II MS4 in accordance with Rule 62-620.800, FAC. Florida's Phase II MS4 Generic Permit has a "self-implementing" provision that requires MS4 permittees to update their stormwater management program as needed to meet their TMDL allocations once those TMDLs are adopted. Any future MS4s permitted in the area are automatically assigned a WLA equivalent to the prescribed percent reduction.

8.5. Load Allocations

The primary mode for transport of nutrients and BOD to streams is during a storm event. Urban development modifies the land surface from a pervious land cover to an impervious surface and this results in higher peak flow rates that wash pollutant-enriched water into the stream. The load allocation calls for reductions in average annual BOD and nutrient loadings from nonpoint sources throughout the watershed equal to the loads provided in Table 6. These reductions are expected to result in attainment of the dissolved oxygen standard.

8.6. Recommendations

This TMDL is based on mechanistic modeling of the dissolved oxygen and eutrophication processes using available meteorologic data, hydrologic data, stream geometry, water chemistry data and the evidence of low reaeration, high detrital loading, strong photosynthetic activity, and strong SOD. The lack of SOD measurements, reaeration measurements, aquatic macrophyte and periphyton measurements introduces uncertainty into this TMDL. Collection of these additional data will help reduce uncertainty and better assess the contribution of potential sources, the timing of any water quality exceedances, and necessary reductions.

The initial step in implementing a TMDL is to more specifically locate pollutant source(s) in the watershed. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

References

Ambrose, R.B., T.A. Wool, and J.L. Martin. 1993. *The Water Quality Analysis Simulation Program, WASP5, Part A: Model Documentation*. U.S. Environmental Protection Agency, Center for Exposure Assessment Modeling, Athens, GA.

Cleland, Bruce, 2003. *TMDL development from the "bottom up" – Part III: Duration curves and wet-weather assessments.* America's Clean Water Foundation, Washington, DC. September 15, 2003.

Florida Administrative Code (FAC). Chapter 62-302, Surface Water Quality Standards.

Florida Department of Environmental Protection (FDEP), 2003. *Water Quality Status Report, Sarasota Bay and Peace and Myakka Rivers*, DEP Division of Water Resource Management, Southwest District, Group 3 Basin.

Florida Department of Environmental Protection (FDEP), 2004a. *Permit for Southgate AWWTP (Permit #FL0032808),* FDEP Southwest District Office, September 2004.

Florida Department of Environmental Protection (FDEP), 2004b. *Draft permit for Fruitville WWTP (Permit #FL0134589),* FDEP Southwest District Office, August 2004.

Florida Department of Environmental Protection (FDEP), 2006a. *Bioassays of Camelot Lakes (Camelot Communities), Sarasota County, NPDES #FL0188999*, Biology Section, Bureau of Laboratories, Division of Resource Assessment and Management, April 2006.

Florida Department of Environmental Protection (FDEP), 2006b. *Bioassays of Lake Tippecanoe Owners Association, Inc, Sarasota County, NPDES #FL0188981*, Biology Section, Bureau of Laboratories, Division of Resource Assessment and Management, November 2006.

Florida Department of Health (FDOH), 2009, Onsite Sewage Treatment and Disposal Systems Statistical Data, Bureau of Onsite Sewage Programs. http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

Harper, H. H. and D.M. Baker. 2003. Evaluation of Alternative Stormwater Regulations for Southwest Florida. Environmental Research & Design, Inc.

Jones Edmunds and Associates, 2009a. *Sarasota County Pollutant Loading Model Development (W552) SIMPLE-Monthly Design Report*. Report prepared for Sarasota County and SWFWMD, by Jones Edmunds and Associates, PBS&J, University of Florida, Dewberry, and Betty Rushton. June 2009.

Jones Edmunds and Associates, 2009b. *Sarasota County Pollutant Loading Model Development (W552) SIMPLE-Monthly Operations Manual*. Manual prepared for Sarasota County and SWFWMD, by Jones Edmunds and Associates, PBS&J, University of Florida, Dewberry, and Betty Rushton. June 2009.

Peeler, K.A.; Opsahl, S.P.; Chanton, J.P., 2006. Tracking anthropogenic inputs using caffeine, indicator bacteria, and nutrients in rural freshwater and urban marine systems *Environ. Sci. Technol.* **2006** 24 7616 7622.

Sarasota County Government, 2009. "Sarasota County Sewers: Phillippi Creek Septic Tank Replacement Program." Sarasota County Government Online, 13 July 2009 http://sewers.scgov.net/HOME.aspx.

USDA National Agricultural Statistics Service (USDA NASS), 2007. *2007 Census of Agriculture*, U.S. Department of Agriculture.

United States Environmental Protection Agency (USEPA), 1991. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

United States Environmental Protection Agency (USEPA), 2009. *Phillippi Creek: One Dimensional Hydrodynamic and Water Quality Modeling Report.* U.S. Environmental Protection Agency, Division of Water, TMDL Development Section, Atlanta, GA. September 2009.

Wool, Tim A., Robert B. Ambrose, James L. Martin, and Edward A. Comer, 2001. 2001, *Water Quality Analysis Simulation Program (WASP) Version 6.0 DRAFT: User's Manual*, U.S. Environmental Protection Agency – Region 4 Atlanta, GA.

9. Appendix A- Water Quality Remark Codes.

Table A- 1. Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition
A	Value reported is mean of two or more samples
B	Result based on colony counts outside the acceptable range
E	Extra sample taken in compositing process
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.
K	Off-scale low. Actual value not known, but known to be less than value shown
L	Off-scale high. Actual value not known, but known to be greater than value shown
Q	Sample held beyond normal holding time
T	Value reported is less than the criteria of detection
U	Material was analyzed for but not detected. Value stored is the limit of detection.
<	NAWQA – actual value is known to be less than the value shown

10. Appendix B- Background Information on State and Federal 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. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the state's water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Chapter 62-40, F.A.C., also requires the 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.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria. EPA authorized the Department to implement the NPDES stormwater program (with the exception of Indian lands) in October 2000.

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

11. Appendix C- Phillippi Creek: One Dimensional Hydrodynamic and Water Quality Modeling Report.

This report is included in a separate file.