PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL)

For
Nutrients
In
Pompano Canal
(WBID 3271)

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LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: Southeast Coast Basin Group

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
3271	Pompano Canal	Southeast Coast	Broward	Nutrients (TN, TP)

2. **TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):**
   Dissolved Oxygen = 5.0 mg/l

   Florida's nutrient criterion is narrative only. It states that the discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.] 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 and fauna [Section 62.302530 F.A.C.].

3. **3271 Nutrient Allocation:**

Parameter	WLA	WLA_{MS4}	LA	TMDL	Reduction
TN	NA	55 percent reduction	55 percent reduction	55 percent reduction	55 percent reduction
TP	NA	45 percent reduction	45 percent reduction	45 percent reduction	45 percent reduction

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

5. **EPA Lead on TMDL (EPA or blank):** EPA

6. **TMDL Considers Point Source, Non-point Source, or both:** Non-point source

7. **NPDES Discharges to surface waters addressed in TMDLs:**
   Broward County MS4 Permit FLS 000016

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR NUTRIENTS IN POMPANO CANAL WATER BODY ID

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 non-point 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 DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 4 basin is shown in Figure 1 and includes the Southeast Coast River Basins. The Southeast Coast Basins encompass many square miles. To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, the FDEP subdivided the Group 4 area into smaller areas called planning units. Planning units help organize information and management strategies around prominent subbasin characteristics and drainage features. To the extent possible, planning units were chosen to reflect subbasins that had previously been defined by the South Florida Water Management District (SFWMD). The Southeast Coast – Biscayne Bay Basins contain three planning units: Broward County, Upper Dade, and Lower Dade. Water quality assessments were conducted on individual waterbody segments within planning units. Each waterbody segment is assigned a unique waterbody identification (WBID) number. Waterbody segments are the assessment units or polygons that have historically been used by the FDEP to define waterbodies in their biannual inventory and reporting of water quality to EPA under Section 305(b) of the federal Clean Water Act. The same WBIDs are also the assessment units identified in the FDEP's biannual lists of impaired waters submitted to EPA as part of their reporting under Section 303(d) of the Clean Water Act.

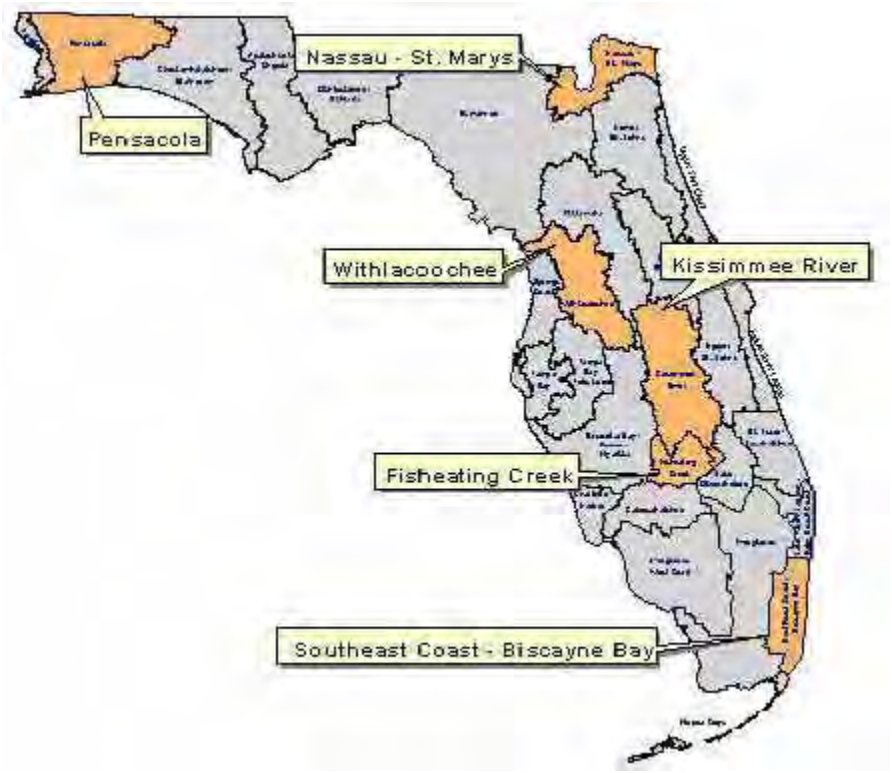

Figure 1: FDEP Group 4 River Basins

Figure 2: Location of the Pompano Canal Watershed in the Broward County Planning Unit

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBID 3271 in the Southeast Coast Basin as not supporting water quality standards (WQS) due to nutrients. After assessing all readily available water quality data, EPA is responsible for developing a nutrient TMDL in WBID 3271, Pompano Canal. The location of WBID 3271 is shown in Figure 2. The TMDL addressed in this document is being proposed pursuant to EPA 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).

WBID 3271 is designated as a Class III fresh water. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh or marine waters.

3. WATERSHED DESCRIPTION

The Pompano Canal watershed is located in northeastern Broward County, in the city of Pompano Beach (Figure 2). The watershed is approximately 7.2 square miles. Pompano Canal is connected to the Cypress Creek Canal (C-14) via a gated culvert at its western end at the G65 control structure. However, it has not received water through this culvert from C-14 for more than a decade (D. Markward, pers. comm. to FDEP). The canal extends eastward approximately 2.5 miles to the G57 control structure. This structure is used primarily to prevent saltwater intrusion into the canal and can be manipulated to allow stormwater overflows to run to tide. East of the G57 structure, the waterway rejoins with C-14 before flowing into Lake Santa Barbara which ultimately flows to the Intracoastal Waterway (FDEP, 1999). The watershed is generally bordered on the east by NE 18th and NE 5th Avenues and on the west by the railroad berm down to NW 15 St, where it follows 15th Avenue westward to Hammondville Road, then south on NW 27th Avenue, west on 31st Avenue and south to Atlantic Boulevard. From there it cuts east on Atlantic Boulevard to Powerline Road, south on Powerline to Race Track Rd. It is bordered on the south by Race Track Road, then 1 block south along the railroad berm to an unnamed road, and extending eastward to NE 18th Avenue. On the north it is bordered by Sample Road, between Andrews Avenue and NE 3rd Avenue (Figure 3).

Since the cessation of operation of the G65 structure at the west end of Pompano Canal, all water inputs have come from stormwater runoff and ground water. However, ground water inputs are relatively negligible, as the well-field east of I-95 in the watershed keeps the water table drawn down. In fact, current practices by Broward County in the C-1 drainage ditch adjacent to I-95 are designed to retain water in this ditch to recharge the well-field with fresh water and prevent saltwater intrusion (D. Markward, pers. comm. to FDEP). Thus, the canal receives stormwater runoff from the area between I-95 and Dixie Highway, from the area between Hammondville Road and Atlantic Boulevard, and from the downtown Pompano Beach area.

The climate in Broward County is sub-tropical to tropical. The average annual rainfall is approximately 62 inches. The wet season is 4 months long during the summer, usually beginning in June and ending in September. The summer is hot and humid, with daily high temperatures in the 90s and an average summer temperature of 84°F. Afternoon thunderstorms of high intensity and short duration are common during the wet season (Broward County, 2003).

The topography of the Pompano Canal watershed reflects its location astride the Atlantic Coastal Ridge. Elevations range from around 3 feet above sea level in the western and eastern parts of the watershed to around 21 feet above sea level on the ridge running north-south up its center (Whitman et al., 2000).

Soils range in type from medium to fine sand and exhibit moderate to good natural drainage (FDEP, 1999). Drainage is enhanced in the eastern portion of the watershed by a well-field, which lowers surficial ground water levels (D. Markward, pers. comm.).

The Pompano Canal watershed is among the most heavily urbanized in Broward County. Approximately 72.1 percent of the land use is urban and built-up, which includes high-density residential, commercial, industrial, and institutional development. Approximately 12.5 percent of the land use is transportation and utilities related. These two categories account for 84.6 percent of the land use in the watershed (FDEP, 2006).

Significant residential areas are located in the southwestern and eastern portions of the watershed. The watershed contains no traditional agricultural areas. The largest concentration of commercial/industrial land use is located along the western edge of the I-95 corridor. There is also significant commercial development along Atlantic Boulevard and Sample Road (FDEP, 2006).

For assessment purposes, the Florida Department of Environmental Protection has divided the state into water assessment polygons with a unique waterbody identification (WBID) number for each water segment or stream reach. This TMDL specifically addresses the nutrient impairment identified in the Pompano Canal drainage basin (WBID 3271) in the Broward County Planning Unit (Figure 3).

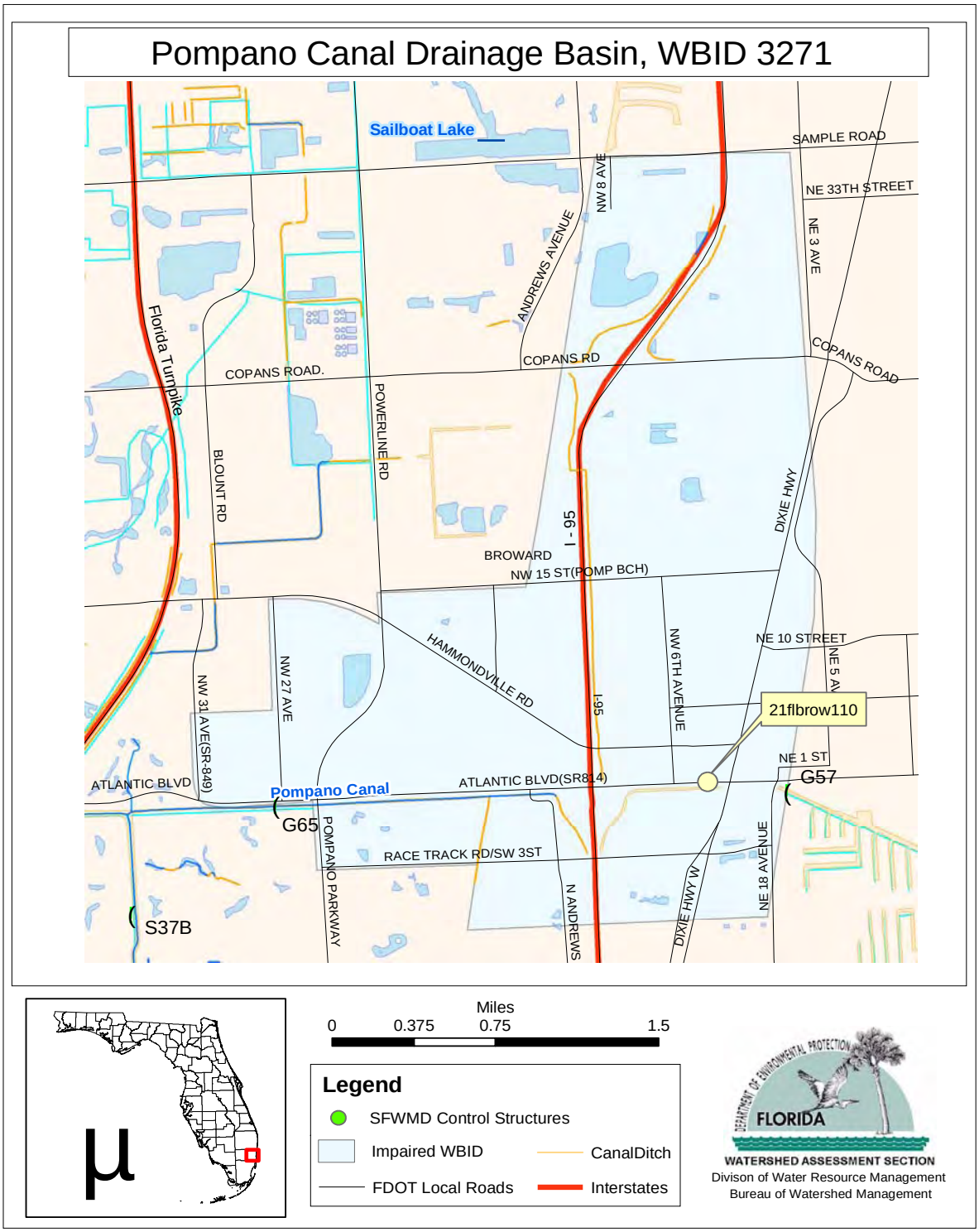

Figure 3: Pompano Canal Drainage Basin

Table 1: Land Cover Distribution for WBID 3271 in acres and percentage.

Land Use	Acreage	Percent Acreage
Residential (1100-1390)	1491	41%
Comm, Ind, Public (1400, 1500, 1800)	1169	32%
Agriculture (2000 series)	0	0%
Rangeland (3000)	369	10%
Forest (4000 series)	38	1%
Water (5000 series)	110	3%
Wetlands (6000 series)	3	0%
Barren & Extractive (7000, 1600)	0	0%
Transp & Utilities (8000 series)	470	13%
TOTAL (acres)	3652	100%

4. WATER QUALITY STANDARD FOR NUTRIENTS AND TARGET IDENTIFICATION

The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530.

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)

Pompano Canal is designated as a Class III surface water. The Class III water quality criteria applicable to the observed impairment is the narrative nutrient criteria.

Florida's nutrient criterion is narrative only. It states that the discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.] 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 and fauna [Section 62.302530 F.A.C.].

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

USEPA evaluated the water quality data and considered several options for the nutrient target for Pompano Canal.

- Since this canal functions similar to a reservoir, trophic state index (TSI) values were calculated for the years with available data. The highest annual average TSI was 58 which is approaching the threshold of 60 that FDEP uses for assessment. Any value higher than 60 is generally an indication of poor water quality in lakes and reservoirs. The TSI was not used as a target for this water body nutrient impairment.
- Nutrient loadings were estimated by PLOAD, a simple watershed model that is based on event mean concentrations and rainfall runoff. Undeveloped background nutrient loading and ratios were also developed with PLOAD. The reductions required to decrease estimated current loadings to undeveloped background loadings were then calculated (see Table 7 and Table 8 for results.).
- The third option was the EPA recommended nutrient criteria development approach. In this approach the total phosphorus and total nitrogen data sets for all freshwater streams in the Florida Southeast Coast- Biscayne Bay Basin Group were evaluated. As recommended by the EPA Nutrient Criteria group, the 25^{th} percentile was determined. This method returned a very low TP value that was deemed inappropriate, and this method was not used as a target for this TMDL.
- Since the nutrient standard states that discharge of nutrients shall be limited as needed to prevent violations of other standards, a fourth option was to target the dissolved oxygen water quality standard. This states that Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L, and normal daily and seasonal fluctuations above these levels shall be maintained.

EPA applied the DO standard as the target and included information from the watershed model to allocate the loads. This method gives the most certainty that the resulting nutrient concentrations will not cause an imbalance in natural populations of aquatic flora or fauna. In addition, to provide additional insight, a regression model relating total nitrogen and total phosphorus to chlorophyll-a was developed based on the site-specific trend data for Pompano Canal (WBID 3271). Since the targets are based a small sample of site-specific data, the TMDL may be revisited in the future to determine if new data warrants an adjustment of the targets.

5. WATER QUALITY ASSESSMENT

To determine the status of surface water quality in Florida, 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 (F.A.C.). The IWR defines FDEP's threshold for identifying water quality limited WBIDs to be included on the state's 303 (d) list. In addition, all waters on the 1998 303 (d) list that were not de-listed remain on the current 303 (d) list and require TMDLs. WBID 3271 is on FDEP's verified list as impaired for nutrients.

According to FDEP's Ecosummary Report for Pompano Canal, in the mid 1970's inorganic nitrogen and total phosphorus concentrations were approximately 0.2 and 0.3 mg/l respectively. Although inorganic nitrogen and total phosphorus nutrients appear to be improving, nutrient concentrations remain elevated (see the downward trends in Figure 4 and Figure 5).

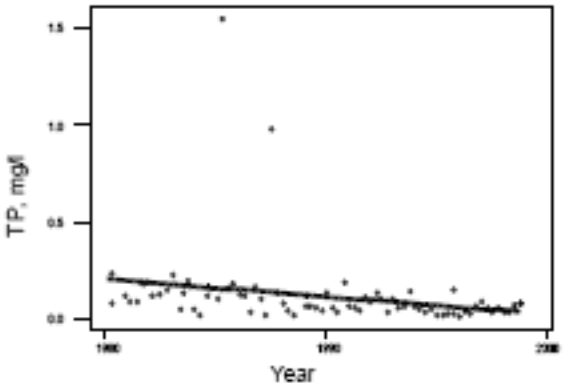

Figure 4: Total Phosphorus concentrations in the canal appear to be improving from 1980 to 1999 (FDEP, 1999).

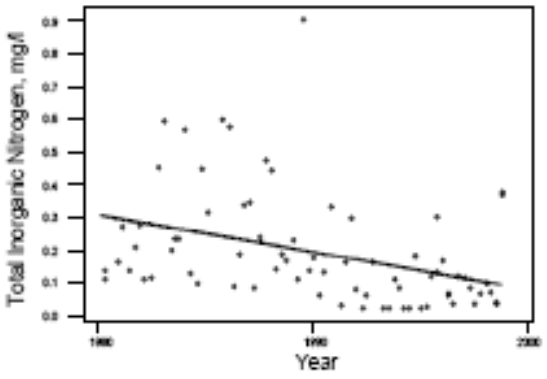

Figure 5: Nitrogen concentrations in the canal appear to be improving from 1980 to 1999 (FDEP, 1999).

FDEP currently maintains ambient monitoring stations throughout the basin. All data stored in IWR-24 database collected at monitoring stations within the impaired WBID are used in the analysis. For WBID 3271 this database includes data from 1993 to 2005. Table 2 provides a list of the monitoring stations, and shows that according to the FDEP IWR24 database only 26 chlorophyll-a samples were collected from 1999 to 2004. Five additional samples were collected in April 2006. Table 3 shows a summary of the chlorophyll-a data and Figure 6 shows the annual average chlorophyll-a data.

Nutrient and DO data are also summarized in Table 3. Plots of the data are shown in Figure 7 through Figure 9. A regression model was developed for DO based on TN and TP yielding a reasonably strong relationship. A statistical F-test analysis was performed to determine the probability that the variances in DO and the nutrients TN and TP are significantly different. The test results returned an F-ratio of 4.8, a probability of the relationship occurring by chance (p) less than 0.024, a correlation coefficient (R^2) of 0.39, number of samples (N) of 15. Figure 10 shows a plot of the predicted DO using this regression model versus the observed DO data. This model was used to determine the nutrient reductions necessary to improve the DO to the water quality standard as discussed in the analytical approach section of this report.

Table 2: Monitoring Stations used in the Development of this Nutrient TMDL

Station ID	Station Name	Number of Observations
21FLBROW110	Pompano Canal at Dixie Highway	24
21FLWPB 28030506	POMP CNL .2 MI W POWRLN RD POMP	2

Table 3. Summary of Water Quality Monitoring Data in WBID 3271

Parameter	Number of Samples	Maximum Concentration (ug/l)	Average Concentration (ug/l)	Median Concentration (ug/l)	Minimum Concentration (ug/l)
Chlorophyll-a	31	60	15	9.4	0.85
TN	21	1.228	0.816	0.817	0.349
TP	21	0.161	0.072	0.063	0.021
DO	28	9.8	5.6	5.5	2.3

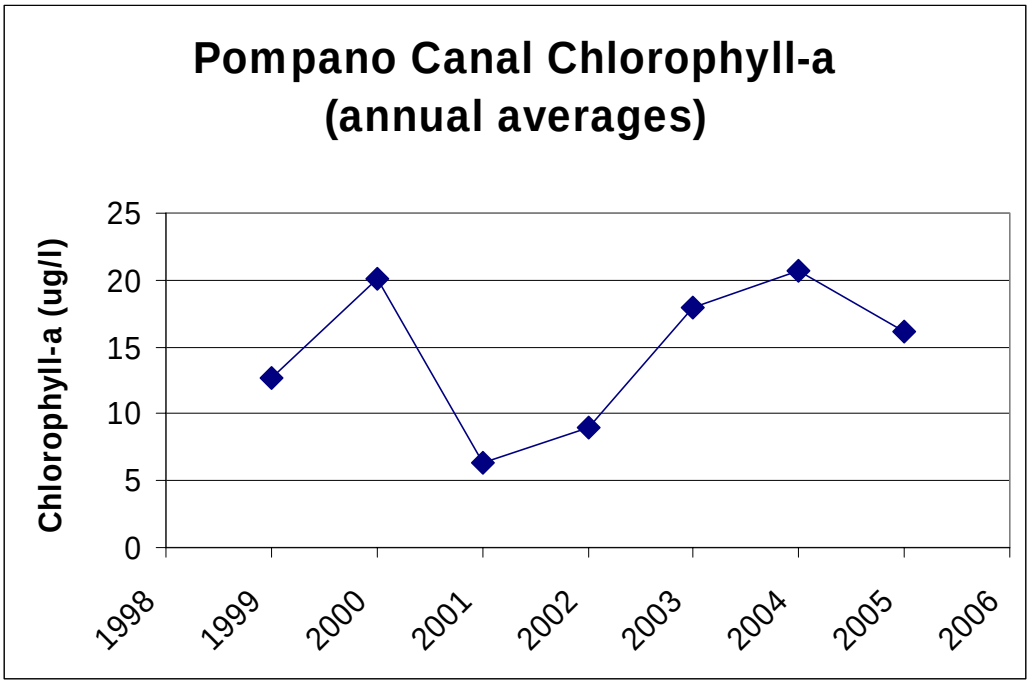

Figure 6: Annual average Chlorophyll-a in WBID 3271 from FDEP's IWR24 database.

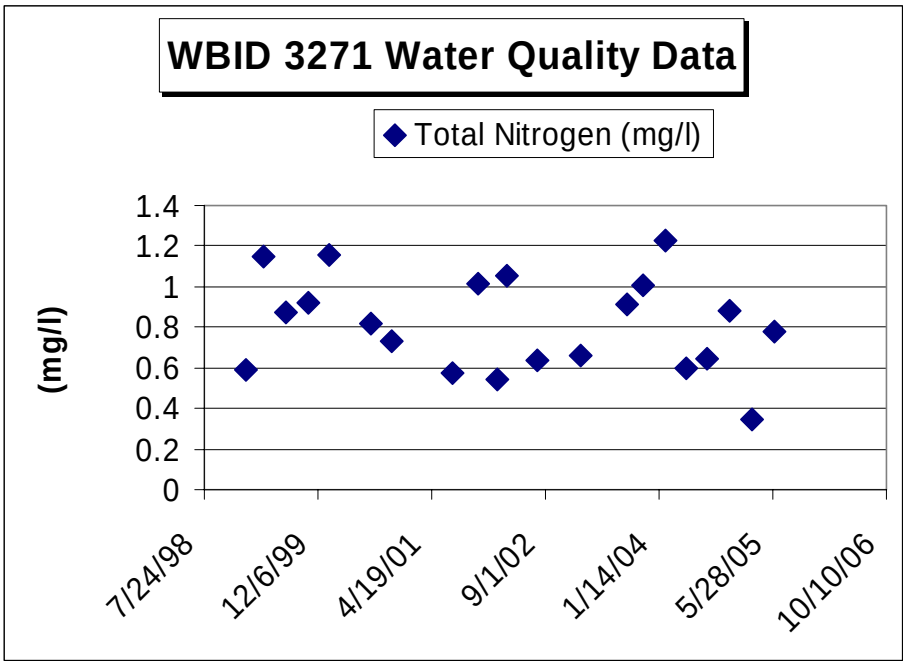

Figure 7: Total Nitrogen in WBID 3271

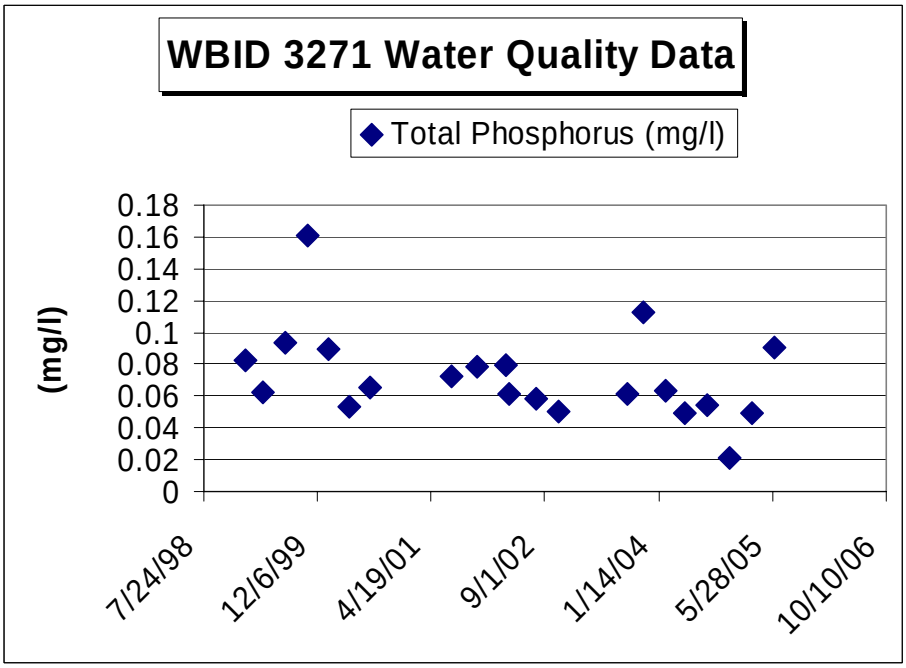

Figure 8: Total Phosphorus in WBID 3271

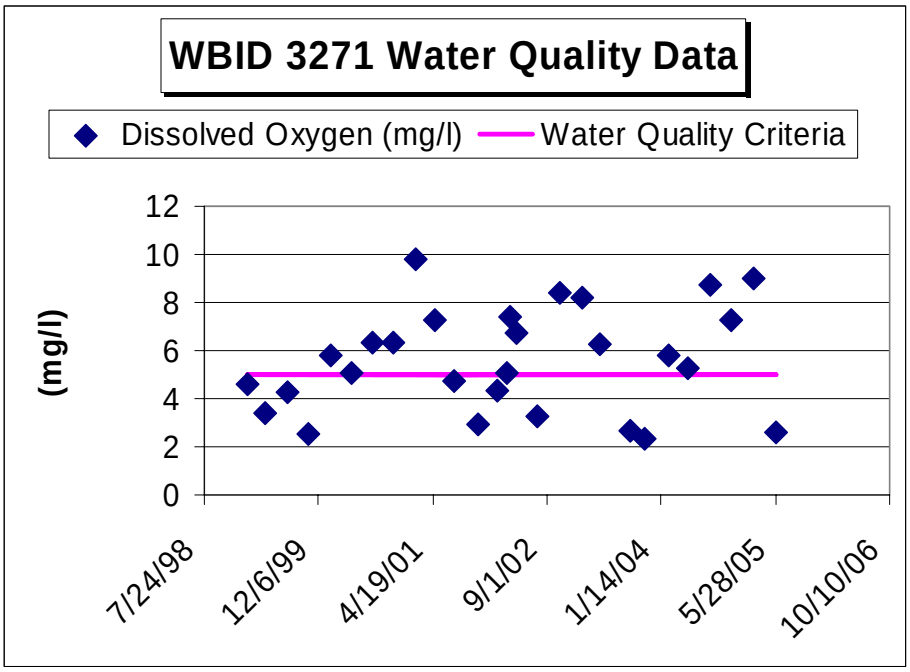

Figure 9: Dissolved Oxygen in WBID 3271

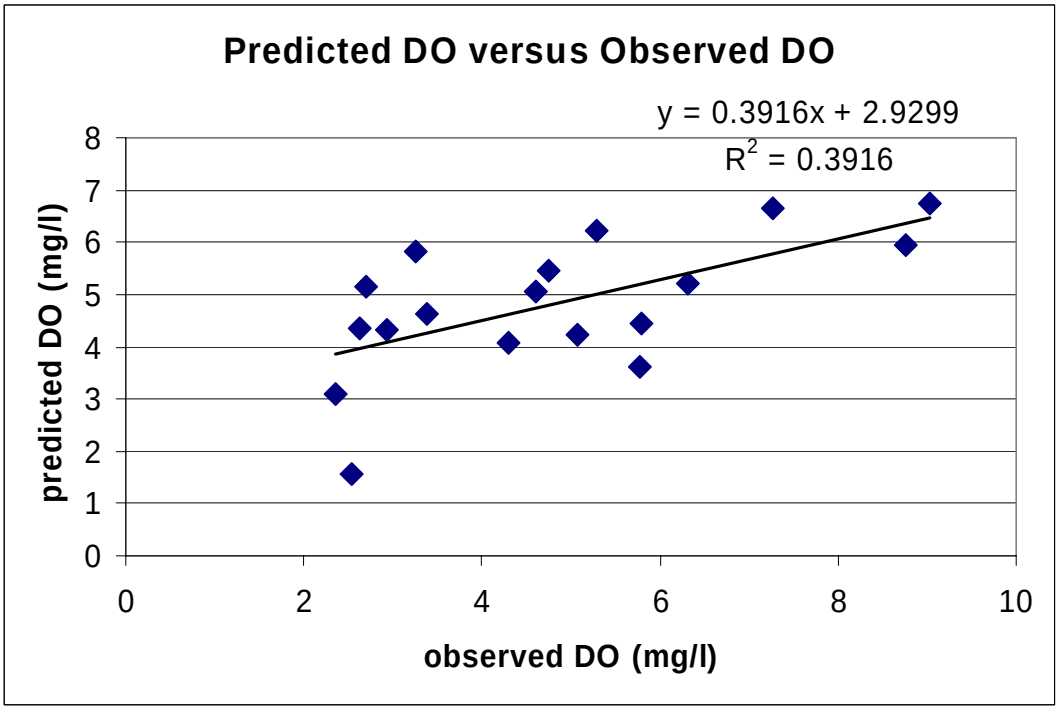

Figure 10: DO Regression Model vs Observed DO

FDEP inspected precipitation data from station G57_S (SFWMD, DBHYDRO database) for the

verified period and found interesting results. Regressing same-day rainfall on chlorophyll-a yielded an F-ratio of 23.8209, $p < 0.0001$, $R^2 = 0.5315$, N = 23. This demonstrates a strong association between chlorophyll-a measurements and precipitation. Further, in two of the three years in which there was no rain on the summer sample date, chlorophyll-a values were below the threshold (Table 4). Using a binomial probability for rain and chlorophyll-a exceedence, the joint probability for this relationship is 0.5. The probability of this relationship occurring, as it did, in 6 of 7 years by chance alone is (0.5)6 = 0.0156.

Table 4: Event Summary for Chlorophyll-a Exceedences and Same-Day Rainfall on Summer Sampling Dates During the IWR Verified Period (1998 – 2005), Pompano Canal Watershed, WBID 3271

Event	1999	2000	2001	2002	2003	2004	2005
Rain chlorophyll-a	-	+	-	-	+	+	+
>20 ug/L	+	+	-	-	+	+	+

FDEP concluded that these results suggest that runoff from summer rains is carrying algae-laden water into the canal near the sampling station. Sampling on days when this occurs shows high chlorophyll-a data. Sampling on days when there was no rainfall shows low chlorophyll-a data.

As a result, in April 2006 the FDEP began a sampling program throughout the drainage basin to test for areas that were sources of high levels of chlorophyll-a that flushed into the canal during rain events. Five sites were selected throughout the basin that would sample drainages from surrounding land uses (Figure 2.2). Water quality data are shown in Table 2.4. It is noteworthy that very high chlorophyll-a levels were found in the secondary canal running adjacent to I-95. Flow into Pompano Canal from this secondary canal is controlled by two control structures, one at Hammondville Rd. and one at NW 15th St. These are manipulated in order to retain water in the secondary canal for the purpose of recharging the well-field to the east and mitigating saltwater intrusion. When runoff from rain events exceeds the capacity of these canal segments, water is released into Pompano Canal. This analysis has been able to support the mechanism that runoff from rain events is causing water with high chlorophyll-a levels to spill into Pompano Canal where the more routine sampling is taking place.

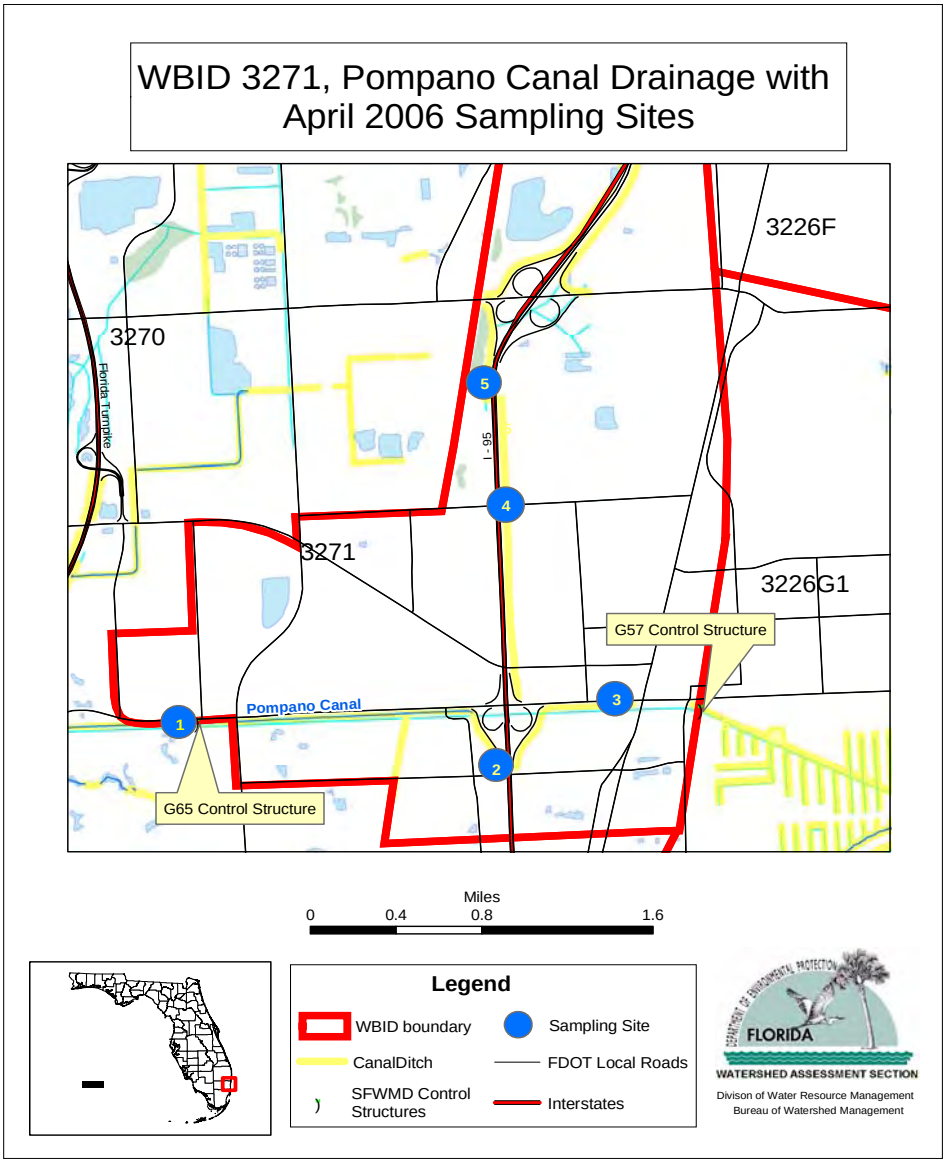

Figure 11: Pompano Canal Drainage Basin with April, 2006 Sample Sites

Table 5: Water Quality Data from Sampling Sites in Pompano Canal Drainage Basin, WBID 3271, in April 2006

Sample Site	Date	TN	TP	Chlorophyll-a
		(mg/L)	(mg/L)	(ug/L)
1	4/11/2006	0.782	0.033	0.85
2	4/11/2006	0.637	0.074	21
3	4/11/2006	0.702	0.053	4.43
4	4/11/2006	0.846	0.071	60
5	4/11/2006	0.895	0.033	30

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of nutrients in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point 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 National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources.

Non-point sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of nutrients on land surfaces and wash off as a result of storm events. Typical non-point sources include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

A geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential nutrient sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

6.1 Point Sources

There are no permitted wastewater treatment facilities or industrial facilities that discharge either directly or indirectly into the Pompano Canal watershed. The primary loadings of nutrients into the canal are likely generated by nonpoint sources or MS4-permitted areas in the watershed. Municipal Separate Storm Sewer Systems (MS4s) discharge nutrients to water-bodies in response to storm events. Large, medium, and small MS4s serving populations greater than 50,000 people, or with an overall population density of 1,000 people per square mile, are required to obtain a NPDES storm water permit. The stormwater collection systems in the Pompano Canal watershed, which are owned and operated by Broward County, the city of Pompano Beach, and the Florida Department of Transportation, are all covered by a Phase I MS4 permit (# FLS 000016).

6.2 Non-point Sources

The spatial distribution and acreage of different land use categories were identified using the South West Florida Water Management District (SWFWMD)'s year 1999 land use coverage (scale 1:40,000) contained in the FDEP's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the simplified Level 1 codes and tabulated in, the dominant land use category in the basin is residential, which accounts for about 41 percent of the total basin area. About 1,639 acres of the basin is occupied by other urban and built-up area, which accounts for about 45% of the total basin area. Natural landuse areas, which include water/wetlands and upland forest, occupy only about 4 percent of the total basin area. Because the Pompano Canal watershed is primarily urban, wildlife and agricultural animals or livestock sources are not expected to contribute significantly to nutrient loads. An exception to this could be the Pompano Racetrack, located in the southwestern portion of the WBID, which does have a paddock area where racehorses are kept. As part of the current sampling regime, a sample site has been located near, but downstream of, the racetrack in order to monitor for this occurrence.

6.2.1. Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. The State of Florida Department of Health (http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm) publishes septic tanks data on a county basis. Table 6 summarizes the cumulative number of septic systems installed since the 1970 census. The data does not reflect septic tanks removed from service.

Table 6. County Estimates of Septic Tank Installations (FDEP, 2004)

County	Number Septic Tanks (1970- 2002)
Broward	106,418

6.2.2. Urban Development

Nutrient loading from urban areas 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 non-point source pollution by requiring new development and redevelopment to treat storm-water before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon 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. Florida's storm-water program is unique in having a performance standard for older storm-water systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older storm-water management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5) (c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's storm-water 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 storm-water peak discharge rate, volume, and pollutant loadings that accompany urbanization.

7. ANALYTICAL APPROACH

EPA applied nutrient reductions based on meeting the water quality standard for dissolved oxygen. The following equation based on the multiple regression of observed water quality data discussed in section 5 was used to determine the nutrient reductions to achieve a DO concentration of 5.0 mg/l (see Equation 1).

Equation 1

$$DO = -2.05 * TN + 35.57 * TP + 9.20$$

Reductions were applied to TN and TP in proportions to achieve a minimum DO of 5.0 mg/l. The proportion of reductions of each nutrient was determined by analysis of estimated natural or

undeveloped conditions. First it was determined that both nutrients should be targeted because the observed TN:TP ratio varies from below 7.2 to 42 in the Pompano Canal. Figure 13 shows that either nutrient is potentially limiting and both should be controlled. This concept is based on the biomass TN:TP ratio of 7.2 and is a general rule of thumb, not an exact science. Next, the TN:TP ratio of the undeveloped background conditions (Table 7) was calculated to be 11. Finally, a TP reduction of 45 percent and a TN reduction of 55 percent would be necessary to meet the DO target and a TN:TP ratio of 11.

Estimated non-point source loads and concentrations of total nitrogen, and phosphorus for the Pompano Canal WBID are shown in Table 8. Although these concentrations are higher than the concentrations measured in the water column, they represent loads delivered to the canal before any aquatic processes occur. These were calculated by the EPA Simple method formula shown in Table 9 from the BASINS PLOAD version 3.0 model (EPA, 2001) using EMC values and runoff coefficients for Florida compiled by Harper, 2003 (see Figure 12). Landuse was based on the SWFWMD 1999 land use/cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). The features were photointerpreted from 1:12,000 UGSG color infrared (CIR) digital orthophoto quarter quadrangles (DOQQs). These can be downloaded from the internet at http://www.swfwmd.state.fl.us/data/gis/libraries/physical_dense.htm.

In addition to determining the nutrient reductions required to meet the DO standard, it is also interesting to estimate the resulting chlorophyll-a. A regression model was developed for chlorophyll-a based on TN and TP yielding a F-ratio of 12, $p < 0.002$, $R2 = 0.547$, $N = 20$, that indicates a strong relationship. The following equation was developed (see Equation 2).

Equation 2

$$\text{Chlorophyll} = 21 * \text{TN} + 5.84 * \text{TP}$$

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

Figure 12: Event Mean Concentrations from Evaluation of Alternative Stormwater Regulations for Southwest Florida (Harper and Baker, 2003)

Table 7: Estimated Non-point Source Loads from Undeveloped Background Conditions in the Pompano Canal Watershed.

Parameter	Total Load (kg/d)	Total Load (kg/year)	Total Load (mg/l)
TN	2.45	1973	1.01
TP	0.22	175	0.09

Table 8: Estimated Non-point Source Loads from Existing Conditions in the Pompano Canal Watershed.

Parameter	Total Load (kg/d)	Total Load (kg/year)	Total Load (mg/l)
TN	4.89	3935	1.88
TP	0.86	693	0.33

Table 9: Pollutant Load Equation from EPA BASINS PLOAD users manual

LP = Σ u (P * PJ* RVu * Cu* Au * 2.72 / 12)
Where: LP = Pollutant load, lbs
P = Precipitation, inches/year
PJ = Ratio of storms producing runoff (default = 0.9)
RVu= Runoff Coefficient for land use type u, inches of runoff/inches of rain
Cu = Event Mean Concentration for land use type u, milligrams/liter
Au = Area of land use type u, acres

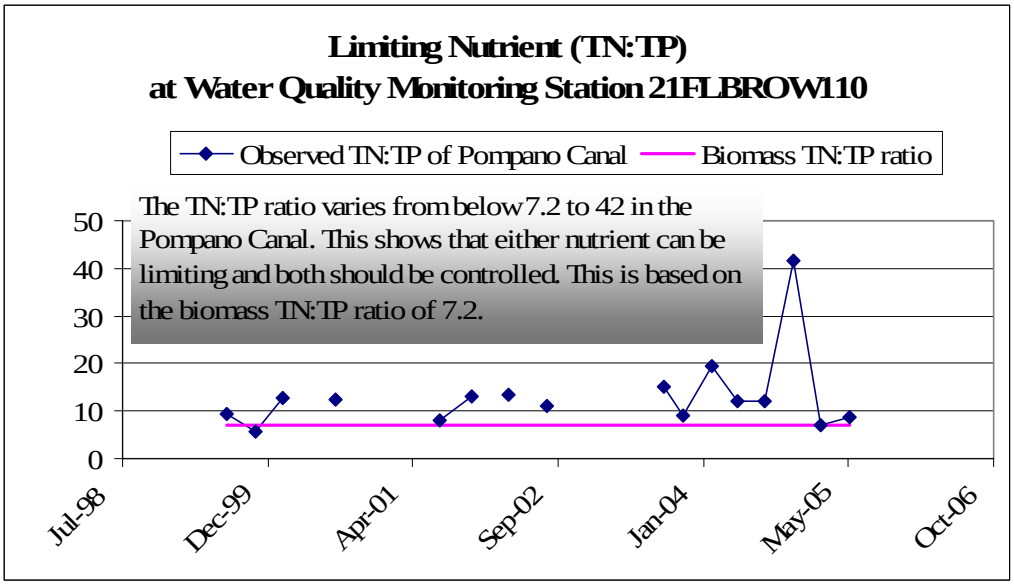

Figure 13: TN:TP ratio of observed condition in the Pompano WBID.

8. DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

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 can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

Equation 3

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The objective of a TMDL is to allocate loads among all of 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 measures. The nutrient TMDL for the Pompano Canal WBID is expressed as a percent reduction of TN and TP.

8.1 Critical Conditions

Nutrient transport and increased productivity occur over varied hydrologic and environmental conditions and both point and non-point sources contribute to the impairment of water quality. Point sources are fairly constant and non-point sources are intermittent due to seasonal activity or storm events. Once abundant nutrients have been transported to the canal, plants and algae can respond rapidly when light and temperatures are optimal. This TMDL is based on trend data from 1999 to present, a time period that covers various hydrologic and environmental conditions including both wet and dry conditions.

8.2 Margin of Safety

TMDLs shall include a margin of safety that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In this TMDL, the measured water quality was used directly to determine the reduction to meet the water quality target. Therefore a small margin of safety is appropriate. In this Pompano Canal TMDL the 45 percent reduction of TP and 55 percent reduction in TN result in minimum DO of 5.2 which is about 4 percent above the standard of 5.0.

8.3 Determination of TMDL, LA and WLA

The TMDL values represent the reduction required to attain the nutrient concentrations the stream can assimilate and sustain a balance in natural populations of aquatic flora or fauna. TMDL components for the impaired water-body are summarized in Table 10. The TMDL for Pompano Canal is expressed in terms of percent reduction and represents the maximum annual load the canal system can assimilate and maintain the water quality criterion for DO. The 45 percent reduction in TP results in an average concentration of 0.039 mg/l, and the 55 percent reduction of TN results in a concentration of 0.367 mg/l. These concentrations will result in a chlorophyll-a concentration of about 8 ug/l, based on the nutrient to chlorophyll regression model in Equation 3. Since the load allocation in this TMDL is exclusively for non-point sources, the daily load allocation represents the average daily concentration assuming average precipitation every day of the year. These concentrations should be targeted as an annual average in order to account for seasonal and daily variability in precipitation.

Table 10. Summary of TMDL Components

Stream Name / WBID	Parameter	WLA for MS4	WLA for facilities	LA	TMDL
Pompano Canal (3271)	TN	55 % reduction	NA	55 % reduction	55 % reduction
Pompano Canal (3271)	TP	45% reduction	NA	45% reduction	45% reduction

8.4 Waste Load Allocations

There are no NPDES facilities in the Pompano Canal WBID (3271) and so a waste load allocation for treatment facilities is not applicable. Permitted municipal separated storm sewer systems are present in the area and the waste load allocation for these is 55 percent reduction of existing total nitrogen and 45 percent reduction of existing total phosphorus.

8.5 Load Allocations

The load allocation for WBID 3271 is 55 percent reduction of existing total nitrogen and 45 percent reduction of existing total phosphorus.

8.6 Seasonal Variation

Seasonality was addressed by using all water quality data associated with the impaired WBIDs, which was collected during multiple seasons.

8.7 Recommendations

This TMDL may be updated to reflect new water quality data, precipitation data, impervious area data, or updated landuse information. The PLOAD model applied in this TMDL is very similar to

the FDEP's WMM model, and either tool is appropriate for this analysis.

9. REFERENCES

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APPENDIX A: Water Quality Data

Table 11: WBID 3271, Pompano Canal Water Quality Data From IWR 24

WBID	Station ID	Date	CHLAC	DO	TP	TN
3271	21FLWPB 28030506	3/26/2002 11:45	24.11	7.41	0.061	
		3/12/2002 14:30	16.05	5.075	0.079	1.051
	21FLBROW110	7/26/2000 0:00	59.4	6.31	0.065	0.817
		11/18/2004 12:58	18.9	7.26	0.021	0.877
		6/2/2005 11:45	29	2.62	0.091	0.78
		2/23/2005 13:25	3.3	9.03	0.049	0.349
		7/24/2002 10:45	2.23	3.26	0.0579	0.6401
		7/18/2001 11:05	16.5	4.74	0.072	0.5746
		4/25/2001 13:05	3.23	7.3		
		4/24/2002 0:00	2.06	6.74		
		10/25/2000 0:00	9.38	6.32		0.732
		7/20/1999 0:00	25.4	4.3	0.094	0.874
		1/26/1999 0:00	3.74	4.6	0.082	0.593
		8/28/2003 11:00	24.4	2.7	0.061	0.915
		2/12/2004 14:35	26.3	5.79	0.063	1.228
		8/12/2004 12:10	30.2	8.76	0.054	0.648
		10/30/2002 0:00	8.35	8.4	0.0504	
		1/30/2002 0:00	1.25	4.36		0.5431
		1/31/2001 11:10	3.04	9.8		
		4/23/2003 0:00		6.26		
		10/25/1999 0:00	12.6	2.53	0.161	0.924
		11/7/2001 0:00	2.8	2.93	0.0784	1.014
		4/26/2000 0:00	8.07	5.09	0.053	

		1/26/2000 0:00	**3.61**	**5.77**	**0.09**	**1.155**
		4/13/1999 0:00	**8.77**	**3.38**	**0.062**	**1.149**
		2/5/2003 0:00		**8.2**		**0.659**
		11/5/2003 10:30	**11.6**	**2.35**	**0.113**	**1.01**
		5/9/2004 23:55	**7.27**	**5.28**	**0.049**	**0.6**