Total Maximum Daily Load (TMDL) for the Palatlakaha River to Address Dissolved Oxygen Impairment

Lake County, Florida

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1.0 INTRODUCTION

1.1 Purpose of Report

This report presents Total Maximum Daily Loads (TMDLs) for biochemical oxygen demand (BOD), total nitrogen, and total phosphorus developed to address the dissolved oxygen (DO) impairment in the Palatlakaha River. Using the methodology to identify and verify water quality impairments described in the Impaired Waters Rule (IWR), Chapter 62-303, Florida Administrative Code (FAC), the river was verified impaired for DO as well as nutrients, and was included on the verified list of impaired waters for the Ocklawaha Basin that was adopted by Secretarial Order on August 28, 2002. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions.

1.2 Identification of Waterbody

The Palatlakaha River is located in the Ocklawaha River Basin in central Florida and is approximately 12.3 miles long. It is connected to the Clermont Chain of Lakes through Lake Emma and to the Harris Chain of Lakes through Lake Harris at its downstream-most point. The small cities of Clermont and Minneola lie within the watershed of the Palatlakaha River. The predominant land cover in the watershed are wetlands, agriculture, and residential areas. The distribution of land cover for the Palatlakaha River is tabulated in **Table 1** and displayed in **Figure 1**. Several small domestic wastewater facilities operate within its watershed, however there are no permitted surface water discharges to this waterbody.

The Palatlakaha River Basin is located in the Central Highlands geomorphic region of the Florida peninsula. The Central Highlands are characterized by a series of relict beach ridges and valleys that run approximately parallel to the Atlantic Coast. The largest physiographic feature of the region is the Central Valley, which is a low area with flat to gently rolling terrain. Lakes, swamps, and streams, including the Palatlakaha River, are common. Most of the Central Valley is underlain by sand with a minor amount of silt and clay that acts as a veneer over the underlying limestone bedrock.

Figure 2 shows the Palatlakaha River Basin and its long- term water quality monitoring stations and flow gages. The Palatlakaha River is a highly meandered river, and the water flow is controlled by six dams that maintain water levels and provide irrigation water for agricultural activities. An earthen dam at the outlet of Cherry Lake maintains the elevation of upstream lakes during prolonged periods of dry weather. There are five gated dams along the river between Cherry Lake and Lake Harris.

For assessment purposes, the watersheds within the Ocklawaha River Basin have been broken out into smaller watersheds, with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed. The impaired segment of the Palatlakaha River that is the subject of this TMDL was assigned WBID 2839.

2.0 STATEMENT OF PROBLEM

The Palatlakaha River was listed as impaired for dissolved oxygen in Florida's 1998 303(d) list of impaired waters. Through analysis according to Rule 62-303, FAC (Identification of Impaired Surface Waters or IWR), the river was subsequently verified impaired for DO as well as nutrients, and it was included on the list of impaired surface waters adopted by Secretarial Order on August 28, 2002, and then submitted to EPA as part of the 2002 update to Florida's 303(d) list.

The river was verified as impaired for DO because greater than 10 percent of the Palatlakaha River DO values exceeded the Class III freshwater DO criterion of 5.0 mg/L during the period used to identify impaired water segments for the 2002 303(d) listing (1995-2002). During this period, 55 DO measurements out of 117 samples exceeded the criterion. **Figure 3** displays the DO data collected over the last 12 years at the three long-term monitoring stations (the values are tabulated in Appendix A). The DO levels are typically less than the criterion throughout the river segment.

Table 1. Palatlakaha River Land Use and Land Cover in 2000[1]

Land Use and Land Cover	Total Acres	% Distribution
Urban and Built Up	4,137.1	17.0
Agriculture	5,377.4	22.1
Rangeland[2]	3,922.0	16.1
Upland Forests	2,238.8	9.2
Water	2,499.9	10.3
Wetlands	5,861.8	24.1
Barren Land	54.7	0.2
Transportation, Communication and Utilities	260.3	1.1
Total	24,352.0	100.0

1. Acreage represents the land use distribution in the impaired WBID and not the entire drainage area.
2. Rangeland includes shrubland, grassland, and herbaceous land cover.

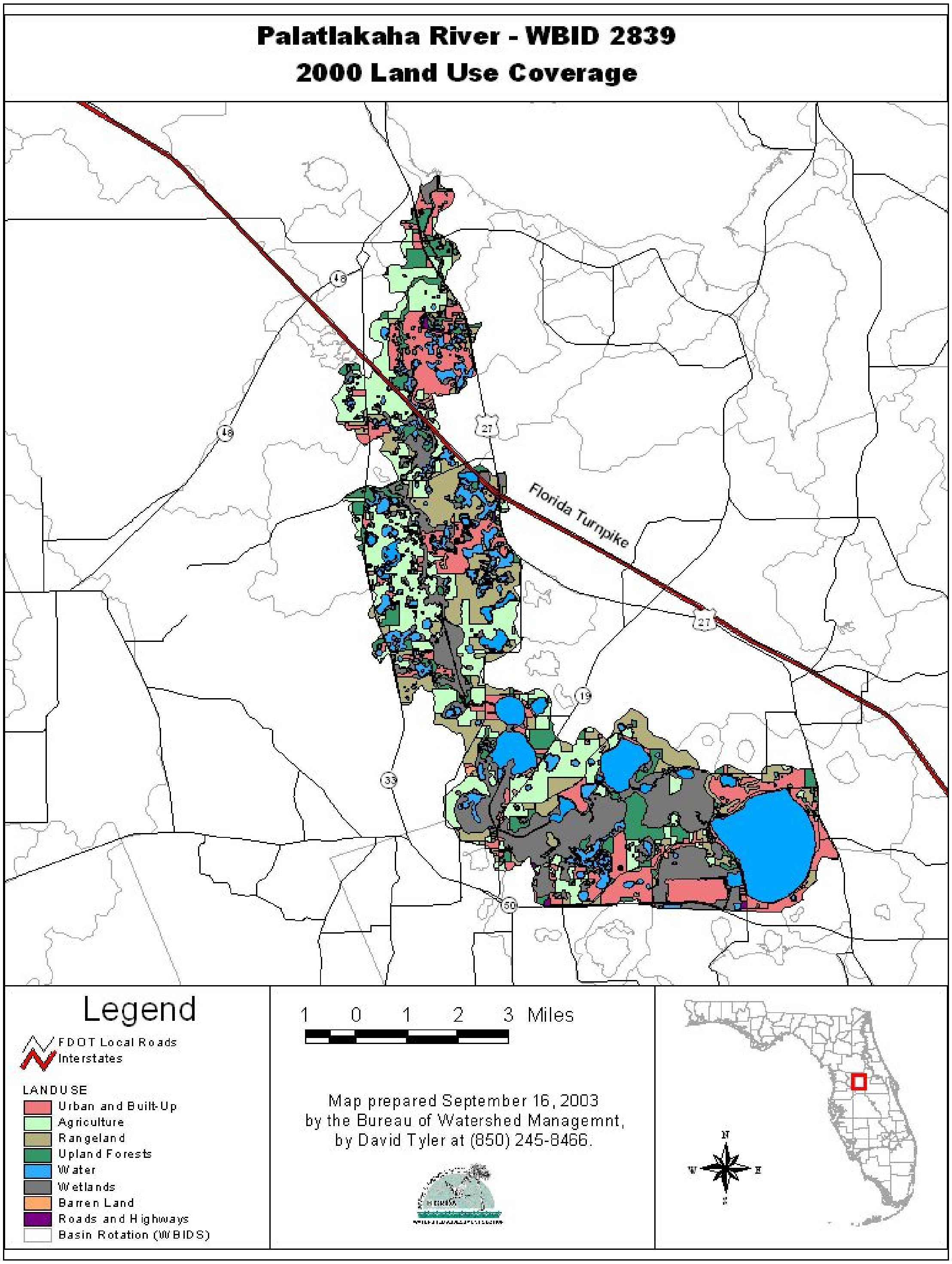

Figure 1. Palatlakaha River Land Use and Land Cover in 2000

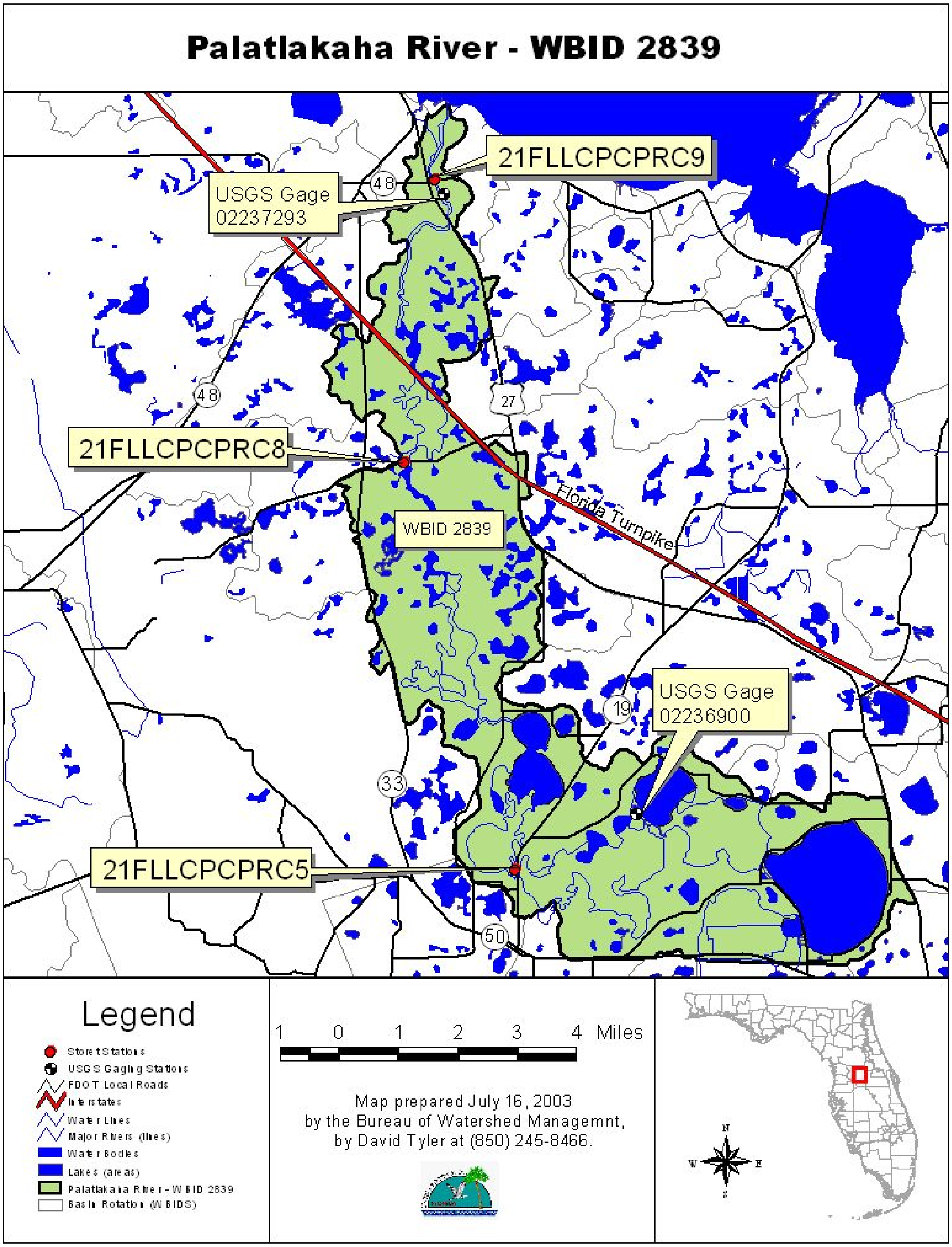

Figure 2. Palatlakaha River Monitoring Locations

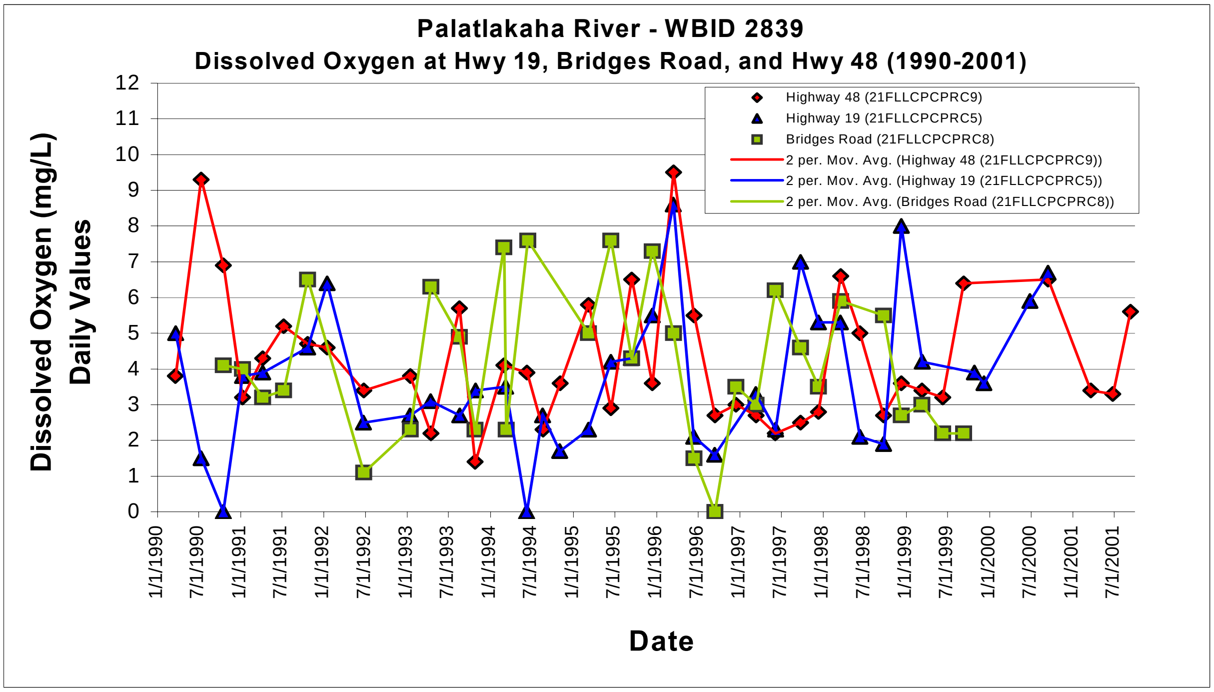

Figure 3. Dissolved Oxygen Measurements at the Long-term Monitoring Stations

3.0 DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGET

The Palatlakaha River is a Class III waterbody with designated uses of recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife. The Class III freshwater criterion for DO, as established by Rule 62-302.530(31), Florida Administrative Code, states that the dissolved oxygen shall not be less than 5 mg/L and that normal daily and seasonal fluctuations above these levels shall be maintained.

While the river was verified to not meet the Class III DO criterion, there is evidence indicating DO levels are less than the freshwater criterion due to natural conditions. The lower DO levels in the Palatlakaha River can be partly attributed to drainage from wetland areas that border the river channel. As noted in Table 1, wetlands is the largest land use and makes up 24 percent of the Palatlakaha River WBID area. Further, Palatlakaha River DO measurements are comparable to the DO levels in the Big Creek segment located upstream of the Palatlakaha River segment. Big Creek was used as a reference stream in the 1980s to develop site specific alternative criteria for DO in Reedy Creek. The cumulative frequency plots of DO in the Palatlakaha River and Big Creek show that DO levels in both systems typically fall below the DO criterion of 5 mg/L (**Figure 4**). Additionally, the Palatlakaha River passed a Stream Condition Index (SCI) bioassessment in January 1992, which indicates that, although the DO levels were consistently below 5 mg/L during that period, the macroinvertebrate biota were adapted to these low DO conditions and the river is likely meeting its designated use for aquatic life-use support. Based on this information, the development of an alternative DO criterion appears to be warranted in the Palatlakaha River.

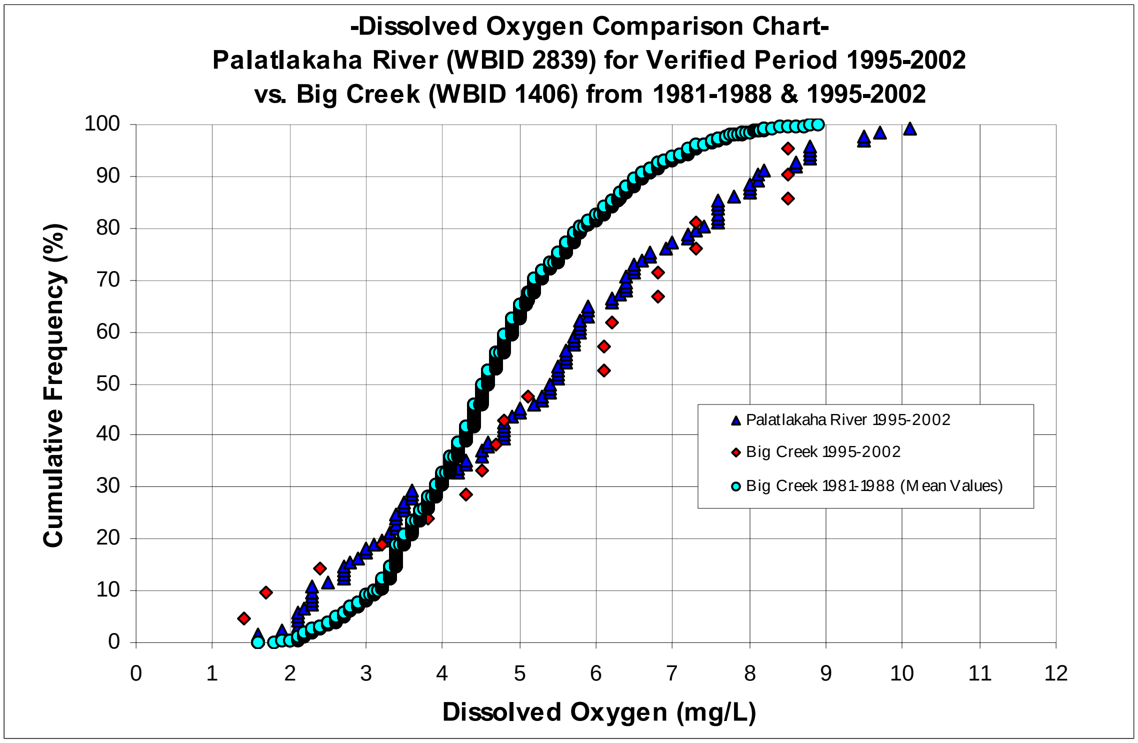

Figure 4. Dissolved Oxygen in the Palatlakaha River and Big Creek

4.0 LOADING CAPACITY – LINKING WATER QUALITY AND POLLUTANT SOURCES

The loading capacity for the river is based on the premise that the low DO levels observed around the time of the January 1992 bioassessment are due to natural conditions and that the river met its designated uses for aquatic life use support. To develop a loading capacity that addresses the low DO levels, pollutant loadings for the year prior to the bioassessment, 1991, were established for biochemical oxygen demand, total nitrogen, and total phosphorus.

4.1 Types of Sources

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of biochemical oxygen demand, total nitrogen, and total phosphorus in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either "point sources" or "nonpoint sources." Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, runoff from agriculture, runoff from silviculture, runoff from mining, discharges from failing septic systems, and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under EPA's National Pollutant Discharge Elimination Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and from a wide variety of industries (see Appendix B for background information about the State and Federal Stormwater Programs).

To be consistent with Clean Water Act definitions, the term "point source" will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) AND stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see Section 6). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Point Source Descriptions

4.2.1 NPDES Permitted Wastewater Facilities

There are no NPDES permitted dischargers in the Palatlakaha River basin.

4.2.2 NPDES MS4 Areas

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

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

4.3 Nonpoint Source Descriptions

4.3.1 Wildlife

Wildlife deposit nutrients and bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams. The nutrient and bacteria load from wildlife is assumed background, as the contribution from this source is small relative to the load from urban and agricultural areas. In addition, any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

4.3.2 Agricultural Animals

Agricultural animals are the source of nutrient, oxygen demanding substances, and coliform loadings to streams. Agricultural activities including runoff from pastureland and cattle in streams impact water quality. Livestock data from the 1997 Census of Agriculture for the counties encompassing the impaired WBIDs are listed in **Table 2**. Cattle, including beef and dairy cows, is the predominate livestock in these counties. In Lake County, horses represent a significant portion of the livestock. Confined Animal Feeding Operations (CAFOs) are not known to operate in the impaired WBIDS. The US Department of Agriculture (USDA) is currently in the process of updating the agricultural census for 2002. Data from the 2002 Census will be released in Spring 2004.

Table 2. Livestock Distribution by County (Source: NASS, 1997)

Livestock (inventory)	Lake County
Cattle and calves	34,442
Beef Cows	17,693
Dairy Cows	2,577
Swine	414
Poultry (broilers sold)	58
Sheep	232
Horses and Ponies	1,461

4.3.3 Onsite Sewerage Treatment and Disposal Systems

Onsite sewage treatment and disposal systems (OSTDs), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. **Table 3** provides the number of septic systems in Lake County estimates of countywide failure rates and total daily discharge of wastewater from septic tanks.

Table 3. County Estimates of Septic Tanks (FDEP, 2001)

County	Number of Septic Tanks[1]	Percent of 1995 Population Using Septic Tanks[2]	Failure Rate per 1000[3]	Estimated Discharge (MGD)[4]
Lake	63,656	50.1	11.81	8.59

Notes:
1. Total number is based on 1970 census figures plus the number of systems installed since 1970 through June 30, 2000. Numbers do not reflect the removal of septic systems by connection to central sewers.
2. Source: St. Johns River Water Management District, May 2000, p. 97, cited in FDEP, 2001.
3. Defined as the number of repairs divided by the number of installed systems for July 1, 1999 to June 30, 2000.
4. Based on value of 135 gallons per day per tank (FDEP, 2001).

4.3.4 Urban Development

Nutrient and oxygen demanding substances loadings 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.

4.4 Pollutant Loading Assessment

As noted previously, there are no NPDES wastewater permitted facilities that discharge to surface waters in the Palatlakaha River. The total nonpoint source loads for each pollutant were quantified based on land use areas in the river segment. The loadings include runoff from agricultural areas, urban areas, and transportation and utility areas. Part of the surface runoff loads are loads coming from atmospheric deposition that fall directly onto the land surface. Although not specifically quantified, the runoff from residential areas include leachate from septic systems.

The 1991 nonpoint source loadings used to estimate the loading capacity were estimated by applying a watershed loading model using 1991 land use coverages. The land use and land cover data for 2000 were then applied in the model to estimate the existing loads, and the differences in the nonpoint source pollutant loading estimates between 1991 and 2000 were used to determine the percent reduction in loading necessary to meet the loading capacity.

The Watershed Management Model (WMM, 1998) was used to estimate the annual loadings derived from the land cover and land use activities in the river segment. Each land use is a combination of pervious and impervious areas, and runoff coefficients for pervious area and for impervious area control runoff volume. The annual rainfall amount applied in the model is converted into surface runoff. Runoff coefficients, land use types, surface areas, and percentage of pervious and impervious areas for each land use are included in estimating surface runoff. The nonpoint loadings are the products of total surface runoff and event mean concentrations (EMC) of runoff for a given land use. **Table 4** provides the runoff coefficients, impervious area percentages, and EMCs used in the WMM model.

Table 4. Runoff Loading Parameters Used in the WMM Model

Land Use	Pervious Runoff Coefficient	Impervious Runoff Coefficient	Percent Impervious	EMC BOD (mg/L)	EMC TN (mg/L)	EMC TP (mg/L)
Forest/Rural Open	0.019737	0.92	0.08	1.00	0.35	0.050
Urban Open	0.019737	0.92	0.08	8.20	1.18	0.150
Agriculture	0.019737	0.92	0.08	3.80	2.32	0.344
Low Density Residential	0.019737	0.92	1.64	4.40	1.77	0.177
Medium Density Residential	0.019737	0.92	4.93	7.40	2.29	0.300
High Density Residential	0.019737	0.92	8.22	11.00	2.42	0.490
Communication and Transportation	0.019737	0.92	5.92	5.60	2.08	0.340
Rangeland	0.019737	0.92	0.08	3.80	2.32	0.344
Water/ Wetlands	0.019737	0.92	4.93	4.63	1.60	0.190

Land use information from 1988 and 1995 were used to estimate watershed loadings in 1991 because there was no aerial imagery available from 1991. To estimate 1991 land use, the annual rates of change in the selected land use categories were calculated between 1988 and 1995. The rate of change between 1988 and 1991 were then added to the 1988 land use areas to derive the 1991 land use. **Table 5** provides the observed land use information along with the results for the estimated 1991 land use areas. Land use data are available for 2000 (presented in **Table 5**), and this information was applied to estimate the existing loads.

Table 5. Palatlakaha River Land Use Applied in Loading Model

Land Use	2000 Observed (acres)	1995 Observed (acres)	1988 Observed (acres)	1988 to 1995 Rate of Change (acres/year)	1991 Estimate (acres)
Forest/Rural Open	2238.8	1531.3	1089.8	63.1	1,279.0
Urban Open	1387.0	1346.8	1003.6	49.0	1,150.7
Agriculture	5377.4	5926.4	12117.9	-884.5	9,464.4
Low Density Residential	1209.1	1145.4	510.6	90.7	782.7
Medium Density Residential	700.1	713.5	305.8	58.3	480.5
High Density Residential	840.9	211.2	406.9	-28.0	323.0
Communication and Transportation	260.3	242.7	224.2	2.6	232.1
Rangeland	3976.7	5307.4	518.2	684.2	2,570.7
Water/ Wetlands	8361.7	7974.2	8183.7	-29.9	8,093.9
Totals	24352.0	24398.9	24360.6		24,377.0

The watershed loadings for the 1991 land uses were calculated using the annual precipitation measured in 1991 at Clermont (43.18 inches). To provide an estimate of the existing watershed loads that are comparable to the 1991 loads, the 1991 rainfall was also applied in the model scenario using year 2000 land use areas. By using the same rainfall amounts in the analysis, the nonpoint source load differences (i.e. allowable load minus existing load) are solely the result of land use activity changes in the WBID. **Table 6** presents the loading estimates for 1991 and 2000 using the WMM. The percent reductions in existing loads needed to meet the 1991 land use load are 12.8 %, 5.2 %, and 7.2 % for BOD, TN, and TP, respectively.

Table 6. Palatlakaha River Watershed Annual Loadings

Year	Pollutant Loading (lbs/year)		
	Biochemical Oxygen Demand	Total Nitrogen	Total Phosphorus
1991	43,042	16,696	2,207
2000	49,351	17,604	2,377

5.0 CRITICAL CONDITIONS

Since only one bioassessment has been performed in this water segment, there is insufficient information to determine if critical DO conditions have occurred in the river that would effect the aquatic macroinvertebrates. Further study is needed to determine what the appropriate DO levels are for this river segment and if there are any specific critical DO periods that influence the biota.

The TMDL is based on the 1991 annual loadings. Rainfall and river flow were below normal in 1991, so the hydrologic conditions may have negatively effected the macroinvertebrate community.

6.0 DETERMINATION OF TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Waste Load Allocations), nonpoint 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:

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

As mentioned in Section 4.1, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\mathbf{TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS}$$

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

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

This approach is consistent with federal regulations [40 CFR § 130.2(I)], which state that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or **other appropriate measure**. The TMDLs for the Palatlakaha River (**Table 7**) are expressed in terms of pounds/year and percent reduction.

Table 7. Palatlakaha River TMDL Components

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL[1] (lbs/year)	Percent Reduction[2]
		Wastewater (lbs/year)	NPDES Stormwater (% reduction)				
2839	BOD	NA	12.8	43,042	Implicit	43,042	12.8
2839	TN	NA	5.2	16,696	Implicit	16,696	5.2
2839	TP	NA	7.2	2,207	Implicit	2,207	7.2

1. TMDL represents annual watershed loads in 1991.
2. Overall reduction in the existing load (year 2000) needed to achieve the TMDL.

6.1 Load Allocation

The allowable LA is 43,042 lbs/year for BOD, 16,696 lbs/year for TN, and 2,207 lbs/year for TP. This corresponds to reductions from the existing loads of 12.8 percent for BOD, 5.2 percent for TN, and 7.2 percent for TP. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the Water Management Districts that are not part of the NPDES Stormwater Program (see Appendix B).

The total nonpoint source loads represent both the load allocation and TMDL for each pollutant. The loadings include runoff from agricultural areas, urban areas, and transportation and utility areas. Part of the surface runoff loads are loads coming from atmospheric deposition that fall directly onto the land surface.

Florida's Stormwater Rule requires the treatment of stormwater from all new development. Additionally, the SJRWMD regulates certain pumped agricultural operations to minimize their impacts. Finally, the Florida Watershed Restoration Act requires the Department of Agriculture and Consumer Services to adopt, by rule, best management practices to reduce agricultural nonpoint source pollution.

6.2 WasteLoad Allocation

<u>NPDES Stormwater Discharges</u>

As previously noted in Sections 4 and 6, loads from stormwater discharges permitted under the NPDES Stormwater Program are placed in the WLA, rather than the LA. This includes loads from municipal separate storm sewer systems (MS4). Based on the 2000 census, the Palatlakaha River watershed includes areas (Leesburg-Eustis) that will be covered by the MS4 Program. The WLA for stormwater discharges is a 12.8 percent reduction of current BOD loading, a 5.2 percent reduction of current TN loading, and a 7.2 percent reduction of current TP loading from the MS4. It should be noted that any MS4 permittees will only be responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and is not responsible for reducing other nonpoint source loads within its jurisdiction.

<u>NPDES Wastewater Discharges</u>

There are no NPDES permitted wastewater treatment facilities that discharge to surface waters in the Palatlakaha River so the wasteload allocation is zero.

6.3 Margin of Safety (MOS)

There are two methods for incorporating a MOS in a TMDL analysis: 1) implicitly incorporate the MOS using conservative model 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, an implicit MOS was used. An implicit margin of safety was incorporated by not accounting for treatment controls required by Florida stormwater regulations in calculating the allowable loads (TMDL) and existing loads. There is a greater amount of urban area in the year 2000 that would be effected by the stormwater regulations.

7.0 SEASONAL VARIATION

There were no apparent seasonal differences in the occurrence of the low DO levels that do not meet the state criterion. Seasonality is partly accounted for using the annual loadings to establish the TMDLs.

8.0 NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan for the Oklawaha River Basin. This document will be developed in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished.

The Basin Management Action Plan (B-MAP) will include:

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

It should be noted that TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent Watershed Management cycles. The Department acknowledges the uncertainty associated with TMDL development and allocation, particularly in estimates of nonpoint source loads and allocations for NPDES stormwater discharges, and fully expects that it may be further refined or revised over time. If any changes in the estimate of the assimilative capacity AND/OR allocation between point and nonpoint sources are required, the rule adopting this TMDL will be revised, thereby providing a point of entry for interested parties.

9.0 REFERENCES

National Agricultural Statistics Service (NASS), Agricultural Census for 1997. U.S. Department of Agriculture.

Watershed Management Model (WMM) User’s Manual, Version 4.1. 1998. Rouge River national wet weather demonstration project. Wayne County, Michigan. PRO-NPS-TM27.02.

Appendix A

	Station	Station Description	Date	Time	DO Result (mg/L)
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	3/21/90	1505	5
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	7/11/90	1115	1.5
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	10/16/90	1420	0
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	1/9/91	1100	3.8
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	4/8/91	1110	3.9
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	10/22/91	1520	4.6
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	1/15/92	1255	6.4
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	6/24/92	1045	2.5
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	1/13/93	1438	2.7
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	4/14/93	1449	3.1
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	8/19/93	1440	2.7
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	10/27/93	1530	3.4
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	3/8/94	1636	3.5
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	6/9/94	1345	0
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	8/18/94	1455	2.7
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	11/2/94	1500	1.7
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	3/7/95	1440	2.3
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	6/13/95	1600	4.2
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	9/12/95	1500	4.3
2839	21FLLCPC20020331	PALATLAKAHA (RIVER) @ HWY 19 BRIDGE	12/12/95	1515	5.5
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	3/13/96	1522	8.6
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	6/12/96	1433	2.1
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	9/11/96	1200	1.6
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	3/11/97	1535	3.3
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	6/5/97	1430	2.3
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	9/23/97	1520	7
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	12/10/97	1133	5.3
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	3/17/98	1538	5.3
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	6/11/98	1414	2.1
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	9/23/98	1500	1.9
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	12/9/98	1500	8
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	3/11/99	1458	4.2
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	10/26/99	955	3.9
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	12/7/99	1600	3.6
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	6/26/00	1240	5.9
2839	21FLLCPCPRC5	PALATLAKAHA RIVER @ SR 19 BRIDGE	9/13/00	1615	6.7

2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	3/20/90	1155	
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	7/11/90	1350	
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	10/17/90	1220	4.1
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	1/9/91	1130	4
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	4/8/91	1135	3.2
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	7/9/91	1250	3.4
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	10/22/91	1545	6.5
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	1/15/92	1320	
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	6/24/92	1105	1.1
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	1/14/93	1020	2.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	4/15/93	1020	6.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	8/18/93	1505	4.9
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	10/26/93	940	2.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	3/1/94	1650	7.4
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	6/14/94	1515	7.6
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	8/18/94	1530	
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	3/11/94	1255	2.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	3/8/95	1320	5
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	6/14/95	1205	5.9
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	9/13/95	1135	4.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	12/13/95	1225	7.3
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	3/14/96	1300	5
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	6/13/96	1210	1.5
2839	21FLLCPC20020330	PALATLAKAHA (RIVER) @ STRUCTURE	9/12/96	1100	0
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	6/13/96	1210	4.8
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	12/13/96	1050	3.5
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	3/12/97	1120	3
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	6/4/97	1105	6.2
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	9/24/97	1125	4.6
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	12/10/97	1055	3.5
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	3/18/98	1130	5.9
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	6/10/98	1125	
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	9/22/98	1115	5.5
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	12/10/98	1305	2.7
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	3/10/99	1130	3
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	6/9/99	1150	2.7
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	9/9/99	1405	2.2
2839	21FLLCPCPRC8	PALATLAKAHA RIVER @ BRIDGES ROAD	12/8/99	1025	

2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	3/20/90	1205	3.8
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	7/11/90	1410	9.3
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	10/17/90	1240	6.9
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	1/9/91	1150	3.2
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	4/8/91	1150	4.3
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	7/9/91	1315	5.2
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	10/22/91	1615	4.7
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	1/15/92	1335	4.6
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	6/24/92	1125	3.4
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	1/14/93	1000	3.8
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	4/15/93	955	2.2
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	8/18/93	1445	5.7
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	10/26/93	915	1.4
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	3/1/94	1700	4.1
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	6/10/94	1400	3.9
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	8/19/94	935	2.3
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	11/3/94	1345	3.6
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	3/8/95	1140	5.8
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	6/14/95	1105	2.9
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	9/13/95	1045	6.5
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	12/13/95	1125	3.6
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	3/14/96	1150	9.5
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	6/13/96	1455	5.5
2839	21FLLCPC20020324	PALATLAKAHA (RIVER) @ 48 BRIDGE	9/12/96	1000	2.7
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	3/14/96	1150	9.5
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	6/13/96	1455	5.5
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/12/96	1000	2.7
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	12/13/96	955	3
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	3/12/97	1035	2.7
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	6/4/97	1020	2.2
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/24/97	1045	2.5
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	12/10/97	1030	2.8
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	3/18/98	1030	6.6
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	6/10/98	1045	5
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/22/98	1030	2.7
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	12/10/98	1130	3.6
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	3/10/99	1055	3.4
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	6/9/99	1110	3.2
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/9/99	1320	6.4
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/13/00	1420	6.5
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	3/20/01	1505	3.4
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	6/25/01	1410	3.3
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	9/11/01	1435	5.6
2839	21FLLCPCPRC9	PALATLAKAHA RIVER @ CR48 BRIDGE	4/4/02	1400	3.4

Appendix B

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, 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, Florida Administrative Code (F.A.C.).

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

In 1987, the U.S. Congress established section 402(p) as part of the Federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES to designate certain stormwater discharges as “point sources” of pollution. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000 [which are better known as “municipal separate storm sewer systems” (MS4s)]. However, because the master drainage systems of most local governments in Florida are interconnected, EPA has implemented Phase 1 of the MS4 permitting program on a county-wide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the DOT (Department of Transportation) throughout the 15 counties meeting the population criteria.

An important difference between the federal and the state stormwater permitting programs is that the federal program covers both new and existing discharges while the state program focuses on new discharges. Additionally, Phase 2 of the NPDES stormwater permitting program will expand the need for these permits to construction sites between one and five acres, and to local governments with as few as 10,000 people. These revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as “point sources” for the purpose of regulation, they are still diffuse sources of pollution that can not be easily collected and treated by a central treatment facility similar to other point sources of pollution, such as domestic and industrial wastewater discharges. The DEP recently accepted delegation from EPA for the stormwater part of the NPDES program. It should be noted that most MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs once they are formally adopted by rule.