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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration
Water Quality Evaluation and TMDL Program

SOUTHWEST DISTRICT • WITHLACOOCHEE BASIN • UPPER WITHLACOOCHEE PLANNING UNIT

TMDL Report

Nutrient TMDL For Mud Lake (WBID 1467)

and Documentation in Support of Development of Site Specific Numeric Interpretations of the Narrative Nutrient Criteria

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Acknowledgments

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDL) developed to address the nutrient impairment of Mud Lake, which is located in the Upper Withlacoochee Planning Unit that is part of the larger Withlacoochee Basin. The TMDLs will constitute the site specific numeric interpretation of the narrative nutrient criterion set forth in paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria in subsection 62-302.531(2) for this particular water, pursuant to paragraph 62-302.531(2)(a), F.A.C. The lake was verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR, Rule 62-303, F.A.C.), and was included on the Verified List of impaired waters for the Withlacoochee Group 4 Basin that was adopted by Secretarial Order on May 3, 2006.

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

1.2 Identification of Waterbody

Mud Lake is located in Polk City, Florida within Polk County (**Figure 1.1**). The Mud Lake watershed encompasses 2.1 square miles (1,333 acres) in north central Polk County. The estimated surface area of the lake is 139 acres and the average depth is 3 ft. (0.91 m) with a maximum depth of 9 ft. (2.7 m). The normal pool topographic elevation of the water surface is 137.4 feet National Geodetic Vertical Datum (NGVD29) (Polk County, 2015). The lake has control structures at the inlet on the western side, and at the outlet on its northeastern end (**Figure 1.2**). The outlet discharges into an unnamed creek which eventually flows into Pony Creek. Pony Creek discharges to the Upper Withlacoochee River. Surface waters make up approximately twelve percent of the watershed area. There are no other significant waterbodies in the watershed. Mud Lake receives flow from a canal located in a residential neighborhood in the western area of the lake watershed.

The watershed land use consists of urban development, predominantly residential throughout the basin, and agricultural activity primarily located in the southern area. The watershed area is within the Southwestern Flatlands Lake Region (Region 75-36), which consists of lakes that range from somewhat acidic to alkaline and are typically highly colored and eutrophic (Griffith et al. 1997).

For assessment purposes, the Department has divided the Withlacoochee Basin into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Mud Lake has been given the WBID number 1467. **Figure 1.3** displays the location of the lake WBID along with the major geopolitical and hydrologic features.

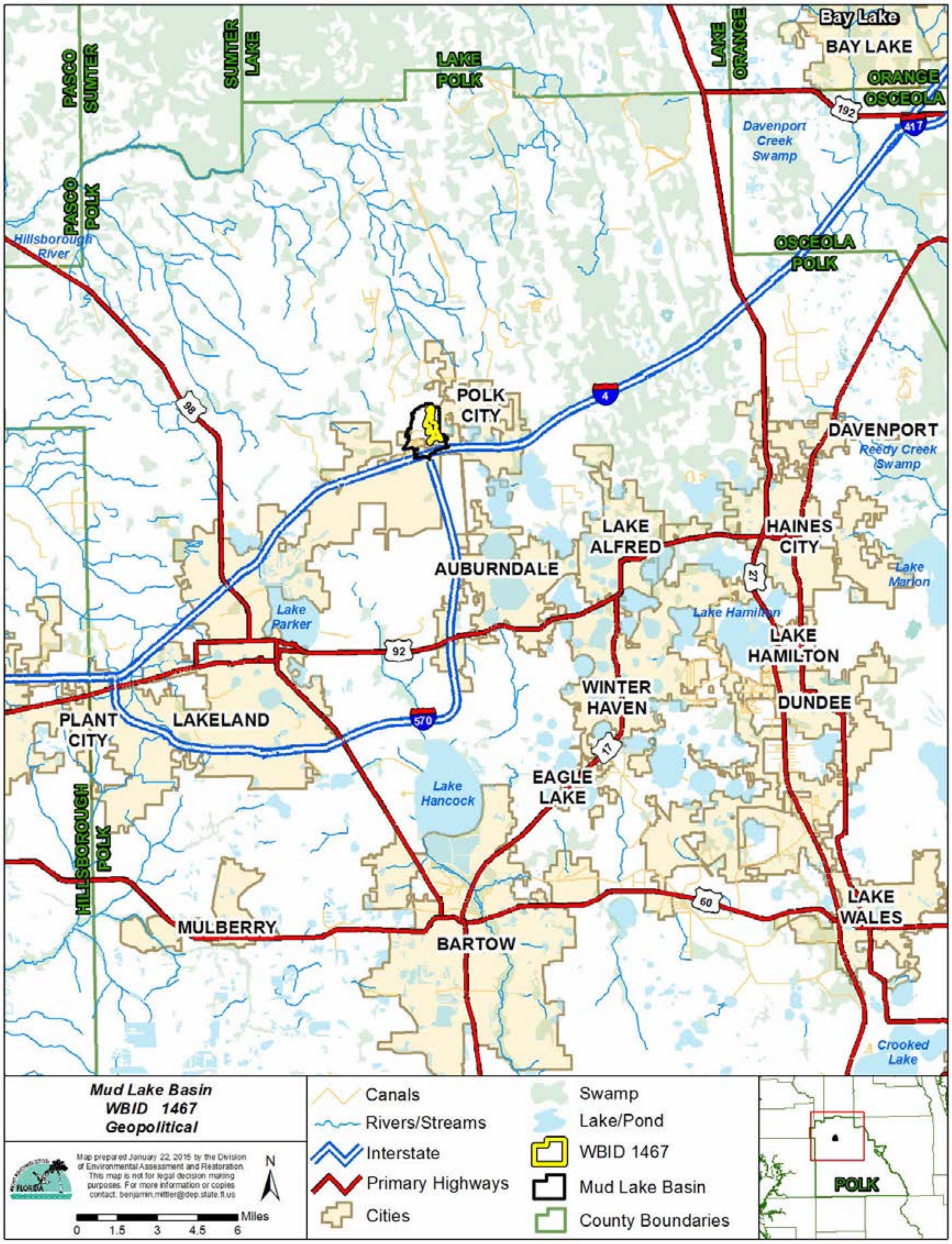

Figure 1.1 Location of the Mud Lake Basin and Major Geopolitical Features in North Central Polk County.

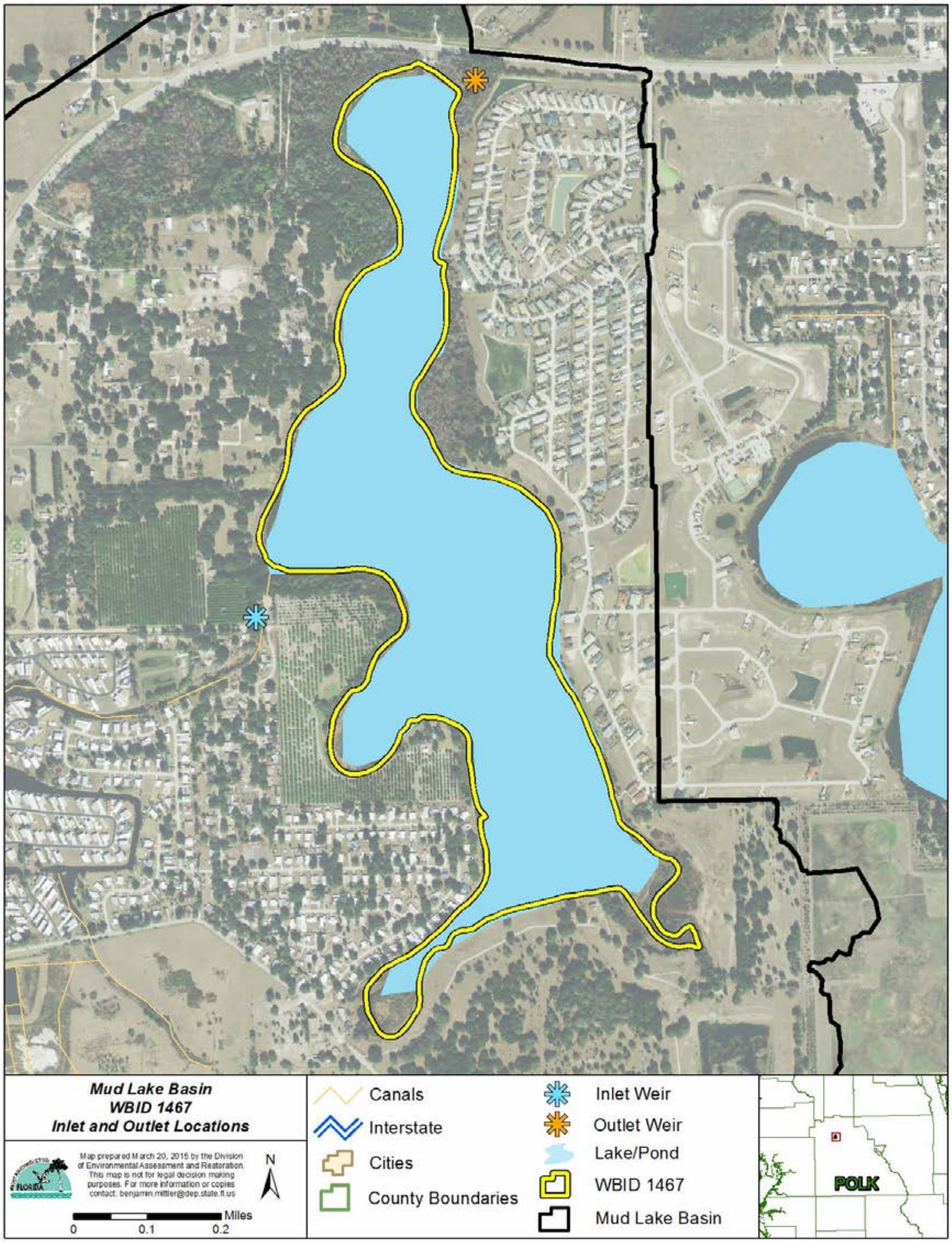

Figure 1.2 Mud Lake Inlet and Outlet Locations.

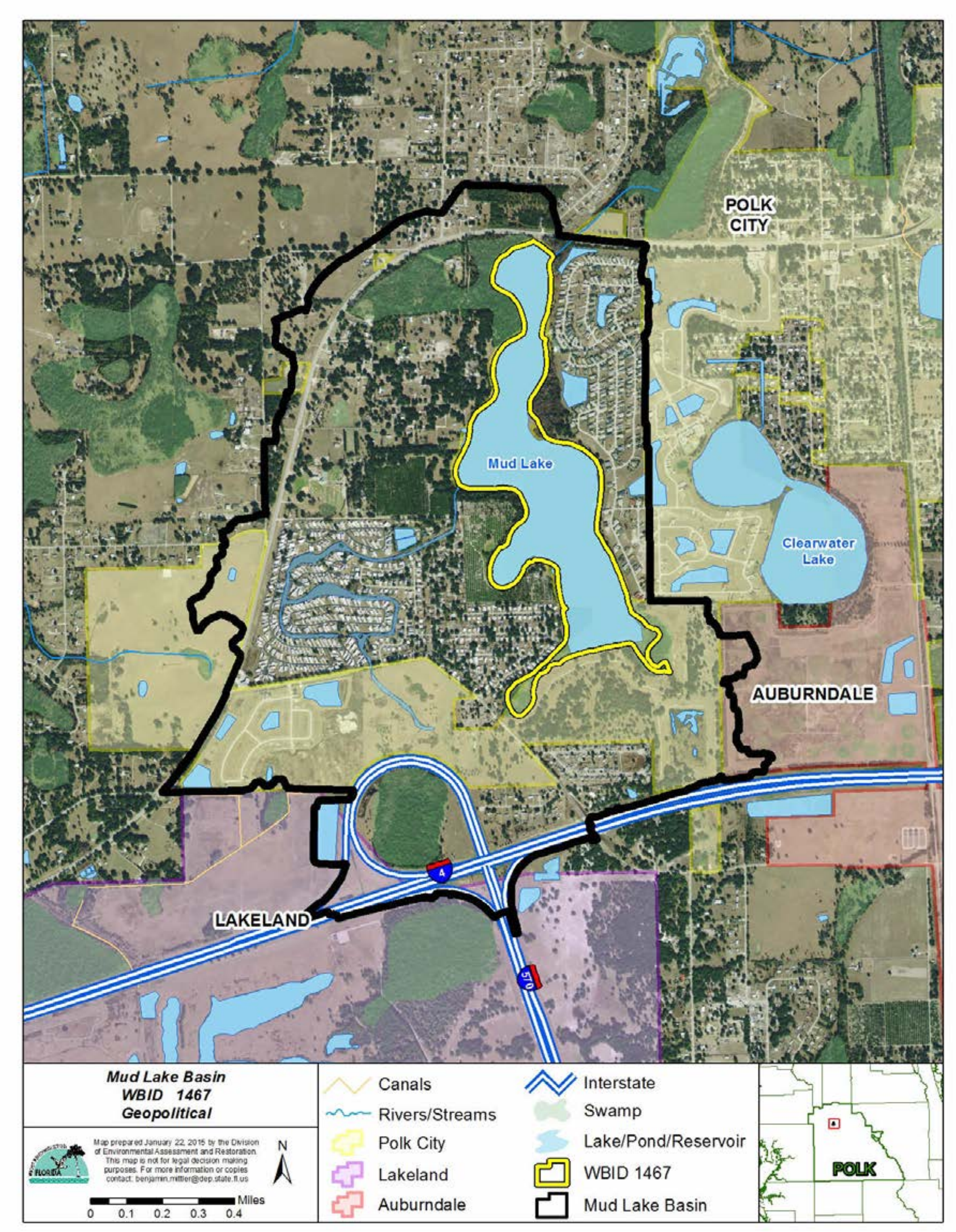

Figure 1.3 The Mud Lake Basin with Major Geopolitical and Hydrologic Features.

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA, Chapter 99-223, Laws of Florida); as amended.

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

This TMDL Report will be followed by the development and implementation of a restoration plan to reduce the amount of pollutants that caused the verified impairment of Mud Lake. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for the impaired waterbody.

Chapter 2: STATEMENT OF WATER QUALITY PROBLEM

2.1 Legislative and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U. S. Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant identified as causing the impairment of the listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The state's list of impaired waters, referred to as the Verified List, is required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]). It is amended annually to include basin updates and these updates are submitted to EPA for inclusion on the state's 303(d) list.

Florida's 1998 303(d) list included 10 waterbodies in the Withlacoochee Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was amended in 2006, 2007, 2012, and 2013.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Mud Lake, and the lake was verified as impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 1 verification period (the verified period for the Group 4 basins is from January 1998 to June 2005). At the time the Cycle 1 assessment was performed, the IWR methodology used the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values and in interpreting Florida's narrative nutrient threshold. The TSI is calculated based on concentrations of TP, TN, and chlorophyll *a*. The TSI thresholds were set based on annual mean color, where high color lakes (> 40 PCU) had a TSI threshold of 60, and lower color lakes (≤ 40 PCU) had a TSI threshold of 40. Exceeding the TSI threshold in any one year of the verified period was sufficient for identifying a lake as impaired for nutrients. For the Cycle 1 assessment, the annual mean TSI value exceeded the applicable impairment threshold of 60 in 2002. In the more recent Cycle 2 verification period (January 2003 to June 2010), the annual mean TSI values exceeded the threshold of 60 in 2003 and 2004. Additionally, Mud Lake exhibited low annual mean color and exceeded the TSI threshold of 40 during the years 2007, 2008, and 2009.

Florida adopted new numeric nutrient standards for lakes, spring vents, and streams in 2011, which were approved by the EPA in 2012 and became effective on October 27, 2014. It is envisioned that these standards, in combination with the related bioassessment tools, will facilitate the assessment of designated use attainment for its waters and provide a better means to protect state waters from the adverse effects of nutrient over-enrichment. The new lake numeric nutrient criteria (NNC), which are set forth in subparagraph 62-302.531(2)(b)1., F.A.C., are expressed as annual geometric mean values for chlorophyll a, TN, and TP, which are further described in Chapter 3.

Although the Department has not formally assessed the data for Mud Lake using the new NNC, based on an analysis of the data from 2003 to 2013 in IWR Database Run 49, the preliminary results indicate that Mud Lake would not attain the lake NNC for chlorophyll *a* and TN for high color (> 40 PCU) lakes, and thus remains impaired for nutrients. This time frame represents the Cycle 2 verification period and water quality in more recent years that has been reported. Under the NNC, Mud Lake is classified as a lake with higher color (>40 PCU), based on the long-term geometric mean values for color as shown in **Table 2.1**. The preliminary annual geometric mean values for chlorophyll *a*, TN, and TP during the 2003 to 2013 period are presented in **Table 2.2**.

The sources of data for the Cycle 1 and Cycle 2 IWR assessments of WBID 1467 come from stations sampled by Polk County (21FLPOLK…), the Southwest Florida Water Management District (21FLSWFD…), the Florida Game and Freshwater Fish Commission (21FLGFWF…), and the Florida DEP Southwest District Office (21FLTPA…). The majority of the available data comes from the monitoring conducted by Polk County. The county has been sampling at the center of the lake since 1993 at station 21FLPOLKMUD1. In 1999, the county began sampling for corrected chlorophyll *a*, which is the more common form of chlorophyll *a* used in assessing surface water quality. The Florida DEP Southwest District Office conducted monitoring of the lake in 2004 and again in 2013. The other sampling organizations conducted monitoring intermittently prior to 2003. The sampling locations are displayed in **Figure 2.1**. The individual water quality measurements used in this analysis are available in the IWR database (Run 49), and are available upon request. Water quality results for the period of record for variables relevant to this TMDL effort, which were collected by all sampling entities, are displayed in the graphs in **Appendix B**.

Table 2.1 Mud Lake Long-Term Geometric Means for Color and Alkalinity for the Period of Record.

Parameter	Long Term Geometric Mean	Number of samples
Color (PCU)	52	82
Alkalinity (mg/L $CaCO_3$)	17	54

Table 2.2 Mud Lake Annual Geometric Mean Values for the 2003 to 2013 Period.

Year	Chlorophyll *a* (µg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
2003	22	1.09	0.06
2004	29	1.20	0.08
2005	25	1.15	ID
2006	24	1.25	ID
2007	44	2.12	0.09
2008	58	2.70	0.11
2009	53	2.54	0.09
2010	30	1.68	0.05
2011	38	2.06	0.04
2012	31	1.66	0.05
2013	14	1.13	0.04

ID - Insufficient Data to Calculate Geometric Means per the Requirements of Rule 62-303.

Note: Values shown shaded are greater than the new NNC for lakes. Rule 62-302.531(2)(b)1., F.A.C., states that the applicable numeric interpretations for TN, TP, and chlorophyll a shall not be exceeded more than once in any consecutive three year period.

In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. The limiting nutrient is defined as the nutrient(s) that limit plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll *a*, and macrophytes to grow. In the past, management activities to control lake eutrophication focused on phosphorus reduction as phosphorus was generally recognized as the limiting nutrient in freshwater systems. Recent studies, however, have supported that the reduction of both nitrogen and phosphorus is necessary to control algal growth in aquatic systems (Conley et al. 2009, Paerl 2009, Lewis et al. 2011, Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC support this idea as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (Florida DEP, 2012).

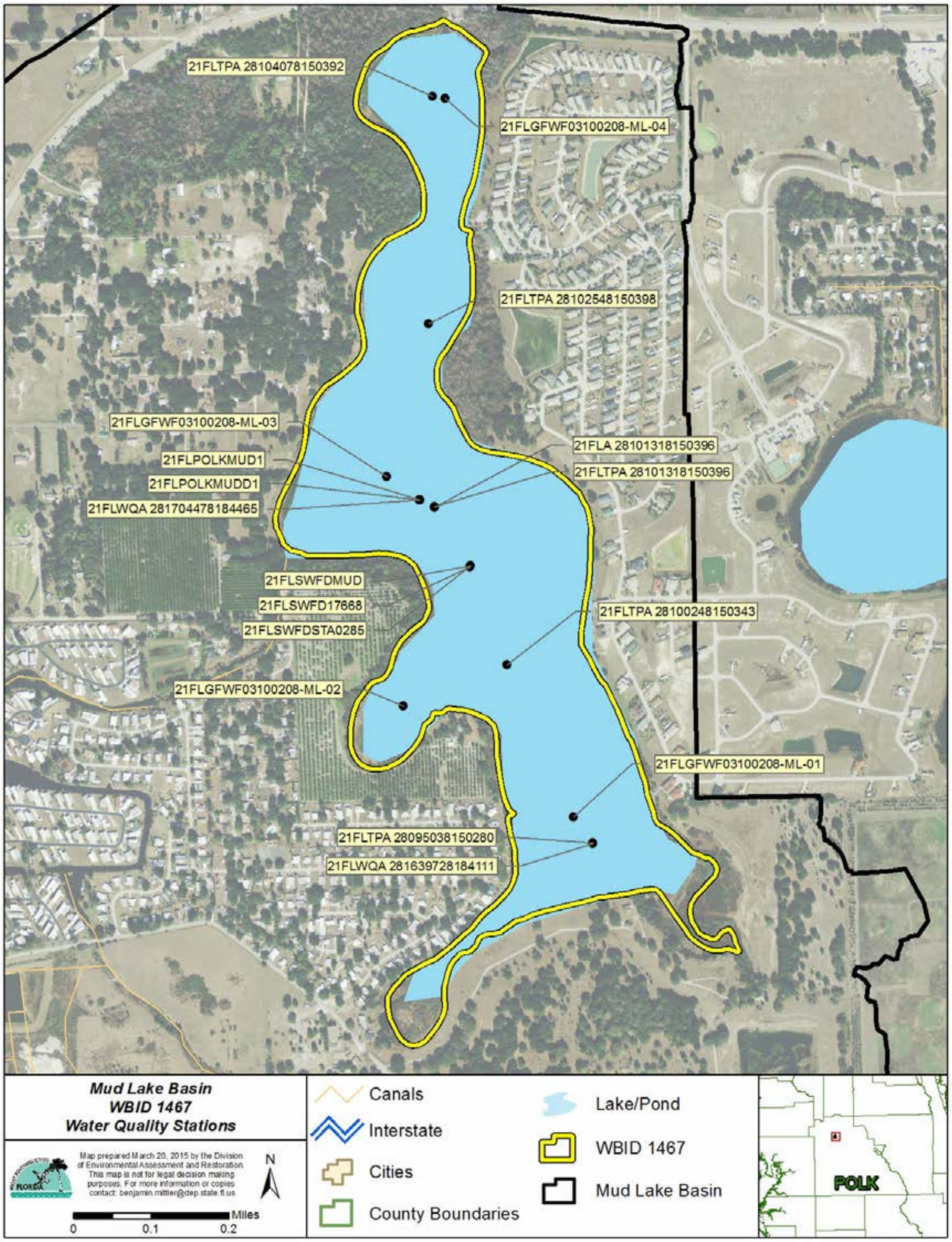

Figure 2.1 Surface Water Monitoring Locations in Mud Lake.

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface water is protected for six designated use classifications, as follows:

Class I	**Potable Water Supplies**
Class II	**Shellfish Propagation or Harvesting**
Class III	**Fish Consumption; Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife**
Class III-Limited	**Fish Consumption; Recreation or Limited Recreation; and/or Propagation and Maintenance of a Limited 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)**

Mud Lake is classified as a Class III freshwater waterbody, with a designated use of fish consumption; recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for this water is the state of Florida's nutrient criteria in Paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.). Florida has adopted lake criteria in Rule 62-302.531, F.A.C., for total nitrogen, total phosphorous, and chlorophyll *a* that went into effect on October 27, 2014. The Department has not formally assessed the data for Mud Lake using the new criteria. However, based on preliminary analysis of the available data, Mud Lake would not attain the new NNC for chlorophyll *a* and total nitrogen, and is expected to remain listed as verified impaired for nutrients under the new criteria.

The nutrient TMDLs presented in this report constitutes a site specific numeric interpretation of the narrative nutrient criterion set forth in paragraph 62-302.530(47)(b), F.A.C., that will replace the otherwise applicable NNC in subsection 62-302.531(2), F.A.C., for this particular water, pursuant to paragraph 62-302.531(2)(a), F.A.C. The Water Quality Standards Template Document in **Appendix E**, provides a summary of the relevant TMDL information, including information that the TMDL provides for the protection of Mud Lake and for the attainment and maintenance of water quality standards in downstream waters (pursuant to subsection 62-302.531(4)), F.A.C., to support using the TMDL nutrient targets as the site specific numeric interpretations of the narrative nutrient criterion.

Targets used in TMDL development are designed to restore surface water quality to meet a waterbody's designated use. Similarly, water quality criteria are based on scientific information used to establish specific levels of water quality constituents that protect aquatic life and human health for particular designated use classifications. As a result, TMDL targets and water quality criteria serve the same purpose as both are designed to protect surface water designated uses.

3.2 Numeric Interpretation of Narrative Nutrient Criterion

The applicable lakes NNC is dependent on the alkalinity and true color (color), based on the long-term period of record (POR) geometric means (GM), **Table 3.1**. Using this methodology, Mud Lake is classified as high color (>40 PCU) lake, as presented in **Table 2.1**. Mud Lake is considered a low alkalinity lake (<20 mg/L $CaCO_3$), however, alkalinity is not a factor in determining the applicable NNC for high color lakes.

The chlorophyll *a* NNC for high color lakes is an annual geometric mean value of 20 µg/L, which is not to be exceeded more than once in any consecutive three-year period. The associated TN and TP criterion for a lake can vary on an annual basis, depending on the availability of data for chlorophyll *a* and the concentrations of nutrients and chlorophyll *a* in the lake, as described below. If there are sufficient data to calculate an annual geometric mean for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type in **Table 3.1**, then the TN and TP numeric interpretations for that calendar year are the annual geometric means of lake TN and TP samples, subject to the minimum and maximum TN and TP limits in the table below. If there are insufficient data to calculate the annual geometric mean chlorophyll *a* for a given year, or the annual geometric mean chlorophyll *a* exceeds the values in **Table 3.1** for the lake type, then the applicable numeric interpretations for TN and TP are the minimum values in the table. The analyses supporting the criteria represent the best scientific understanding of nutrient and chlorophyll *a* concentrations that each lake type can support while maintaining designated uses and were used as evidence for establishing the appropriate targets for TMDL development for Mud Lake.

The development of the lake NNC are based on an evaluation of a response variable (chlorophyll *a*) and stressor variables (nitrogen and phosphorus) to develop water quality thresholds that are protective of designated uses (Florida DEP, 2012). Based on several lines of evidence, the DEP developed a chlorophyll *a* threshold of 20 µg/L for colored lakes (above 40 PCU) and clear lakes with alkalinity above 20 mg/L CaCO3. Since the Department has demonstrated that the chlorophyll *a* threshold of 20 µg/L is protective of designated uses, this value will be used as the water quality target to address the nutrient impairment of Mud Lake. Empirical equations that describe the relationships between chlorophyll *a* and nutrient concentrations in Mud Lake were then used in the TMDL development approach, which is explained in detail in Chapter 5.

Table 3.1 State Adopted Lake Criteria.

Long Term Geometric Mean Lake Color and Alkalinity	Annual Geometric Mean Chlorophyll *a*	Minimum Calculated Annual Geometric Mean Total Phosphorus NNC	Minimum Calculated Annual Geometric Mean Total Nitrogen NNC	Maximum Calculated Annual Geometric Mean Total Phosphorus NNC	Maximum Calculated Annual Geometric Mean Total Nitrogen NNC
>40 Platinum Cobalt Units	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L[1]	2.23 mg/L
≤ 40 Platinum Cobalt Units and > 20 mg/L CaCO3	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 Platinum Cobalt Units and ≤ 20 mg/L CaCO3	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93 mg/L

1 - For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit shall be the 0.49 mg/L TP streams threshold for the region.

3.3 Water Quality Variable Definitions

Chlorophyll *a*

Chlorophyll is a green pigment found in plants and is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide (CO_2) and water (H_2O) into carbohydrates and oxygen (O_2). The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll *a*. The measurement of chlorophyll *a* in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algal growth potential and species abundance. The greater the abundance of chlorophyll *a*, typically the greater the abundance of algae. Algae are the primary producers in the aquatic web, and thus are very important in characterizing the productivity of lakes and streams. As noted earlier, chlorophyll *a* measurements are also used to estimate the trophic conditions of lakes and other lentic waters.

Total Nitrogen as N (TN)

Total nitrogen is the sum of nitrate (NO_3), nitrite (NO_2), ammonia (NH_3), and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential to the chemical processes that exist between land, air, and water. The most readily bioavailable forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major sources of excessive amounts of nitrogen in surface water are the effluent from wastewater treatment plants and runoff from urban and agricultural land areas. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody's biological community and drive an aquatic system into an accelerated rate of eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by a depletion in dissolved oxygen concentrations as a result of algal decomposition.

Total Phosphorus as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in fresh water. Phosphate, the predominant form of phosphorus found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, ground water percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms. The very high levels of phosphorus in some of Florida's streams and estuaries are usually caused by phosphate mining and fertilizer processing activities.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication, or accelerated aging, of a waterbody. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over 5 acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

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

4.2 Point Sources

4.2.1 NPDES Permitted Wastewater Facilities

There are no NPDES permitted domestic or industrial wastewater facilities that discharge within the watershed.

4.2.2 Municipal Separate Storm Sewer System Permittees

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

The stormwater collection systems in the Mud Lake watershed, which are owned and operated by Polk County, in conjunction with the Florida Department of Transportation (FDOT) District 1, are covered by a NPDES Phase I MS4 permit (Permit No. FLS000015). The City of Polk City is a co-permittee in the MS4 permit and a large portion of the watershed is within the city limits.

4.3 Land Uses and Nonpoint Sources

Nutrient loading from urban areas is most often attributable to multiple sources, including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. The largest anthropogenic land use in the Mud Lake watershed are urban areas, so urban sources are a significant source of nutrients in the watershed. There is a sizable area of agricultural lands as well, particularly in the southern part of the watershed, which is also an anthropogenic nutrient load in the basin.

In addition to the nutrient sources associated with anthropogenic activities, birds and other wildlife can also contribute considerable amounts of nutrients to waterbodies through their feces, particularly in areas that have bird rookeries. While detailed source information is not always available for accurately quantifying the loadings from wildlife sources, land use information can be used to help identify areas where there is the potential for wildlife to congregate.

4.3.1 Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD 1999 and 2011 land use coverage contained in the Department's geographic information system (GIS) library.

Land use categories within the Mud Lake watershed were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low, medium, and high density residential). **Table 4.1** lists SWFWMD's land use types and their corresponding acreages in the Mud Lake watershed for 1999 and 2011, and the change of acreage of these land use types between 1999 and 2011. **Figures 4.1** and **4.2** show the spatial distribution of different land use types in the Mud Lake watershed in 1999 and 2011, respectively. The predominant land use in the watershed is urban use, making up 50 percent of the watershed area. Low density residential is the largest urban use type covering 18 percent of the basin. Surface waters cover 12 percent of the watershed area. Agricultural land, primarily located in the southwest area, includes tree crops, cropland and pastureland, and encompasses 20 percent of the watershed area. Wetlands cover almost 23 percent of the watershed and are primarily located in the northern area adjacent to the lake. Between 1999 and 2011, urban land, notably high density residential and open land, has increased the largest amount. Agricultural land use, primarily pasture and tree crops, has decreased since 1999.

Table 4.1 Classification of Land Use Categories in the Mud Lake Watershed in 1999 and 2011.

SWFWMD's Land Use	1999 Land Use (acres)	1999 Percent of Total	2011 Land Use (acres)	2011 Percent of Total	Difference between 1999 and 2011(acres)	Percent Difference
Low Density Residential	234.5	18%	244.7	18%	10.2	4%
Medium Density Residential	172.5	13%	129.7	10%	-42.7	-25%
High Density Residential	48.3	4%	196.8	15%	148.5	307%
Recreational	30.8	2%	23.1	2%	-7.6	-25%
Open Land	10.8	1%	65.4	5%	54.5	503%
Pastures and Fields	277.3	21%	186.5	14%	-90.8	-33%
Tree Crops	103.4	8%	42.2	3%	-61.2	-59%
Other Agriculture Lands	56.2	4%	40.4	3%	-15.7	-28%
Upland Forests	17.3	1%	19.8	1%	2.4	14%
Water	177.2	13%	161.9	12%	-15.2	-9%
Wetlands	116.3	9%	139.0	10%	22.7	19%
Barren Land	65.4	5%	0.0	0%	-65.4	-100%
Communication and Transportation	23.1	2%	83.5	6%	60.4	261%
Total	1333.1	100%	1333.1	100%		

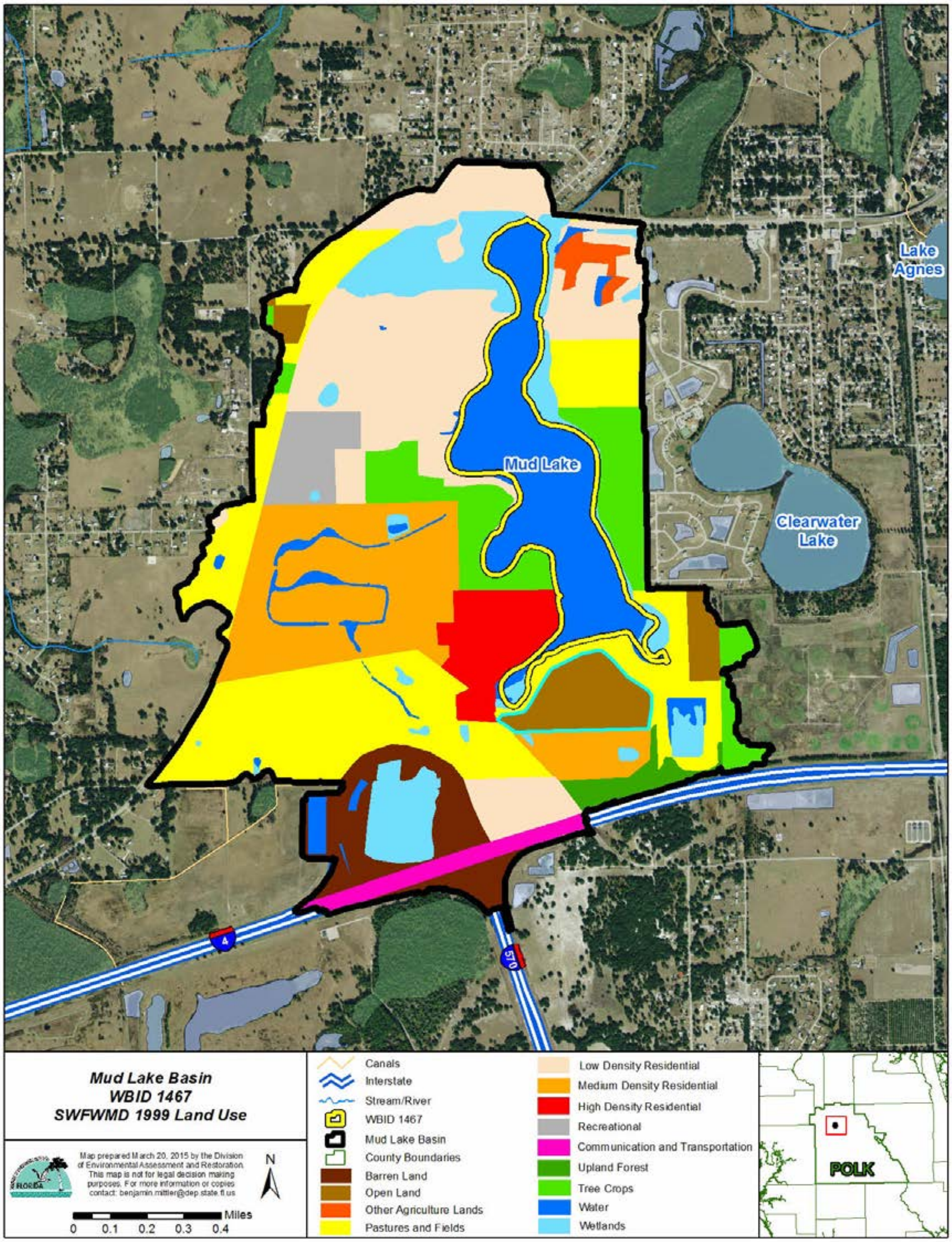

Figure 4.1 Principle Land Uses in the Mud Lake Watershed in 1999.

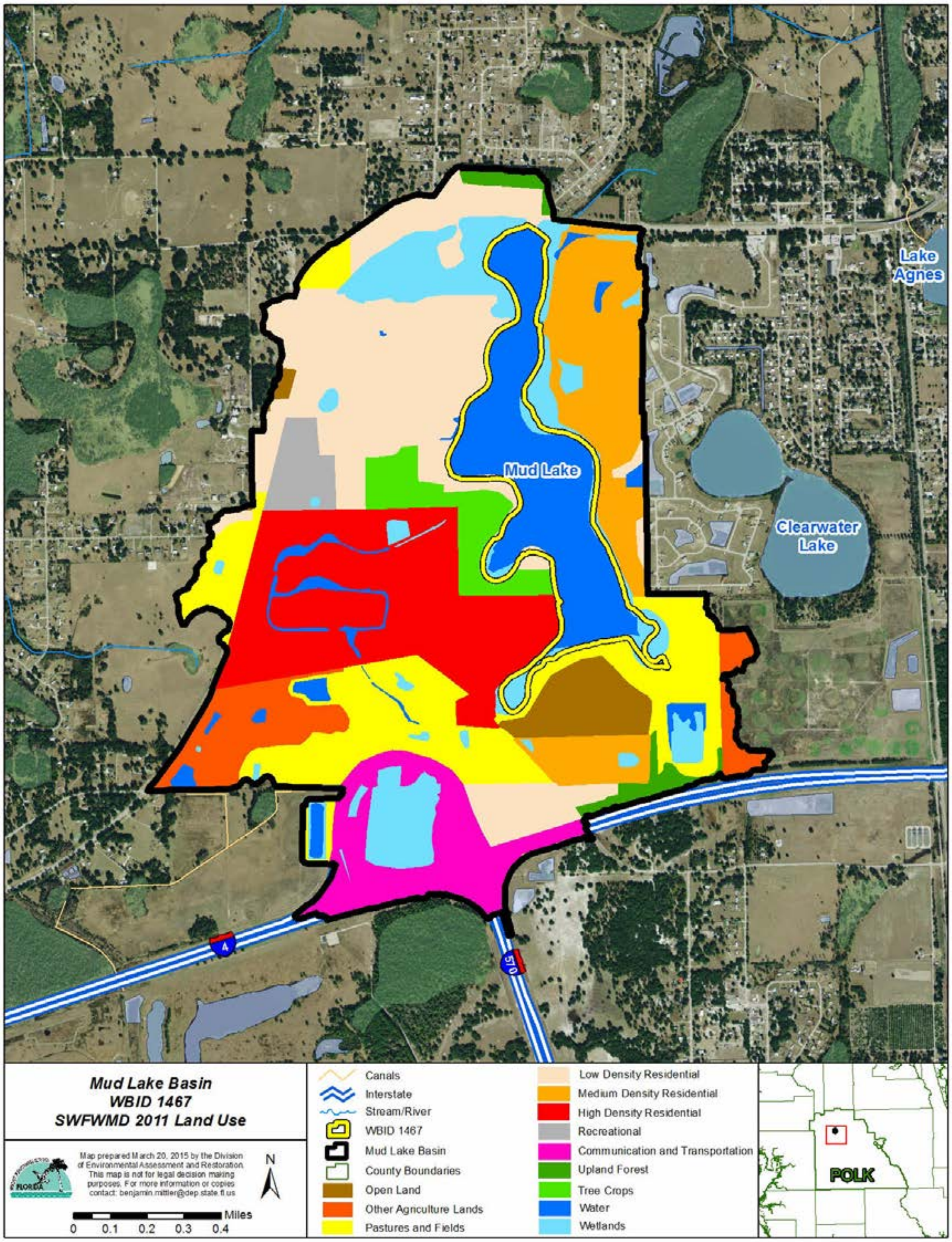

Figure 4.2 Principle Land Uses in the Mud Lake Watershed in 2011.

Polk County Population

According to the U.S Census Bureau, the population density in Polk County, in the year 2010, was 334.9 persons per square mile. The Census Bureau reports that the total population in 2010 for Polk County, which includes (but is not exclusive to) the Mud Lake watershed, was 602,095, with 279, 872 housing units. Polk County occupies an area of approximately 1,798 square miles. For all of Polk County, the housing density is 155.7 houses per square mile. (U. S. Census Bureau Web site, 2015).

Polk County Septic Tanks

Onsite sewage treatment and disposal systems (OSTDSs), including septic tanks, are commonly used where providing central sewer service is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDSs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, OSTDSs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. Information on the location of septic systems was obtained from a Florida Department of Health Onsite Sewage Treatment and Disposal Systems GIS coverage dated November 2013.

The septic tanks located in the Mud Lake watershed are displayed in **Figure 4.3**. Currently the number of septic tanks in the watershed is estimated to be 36 and are distributed throughout the watershed. A majority are located in the northwest area of the watershed, in close proximity to Mud Lake.

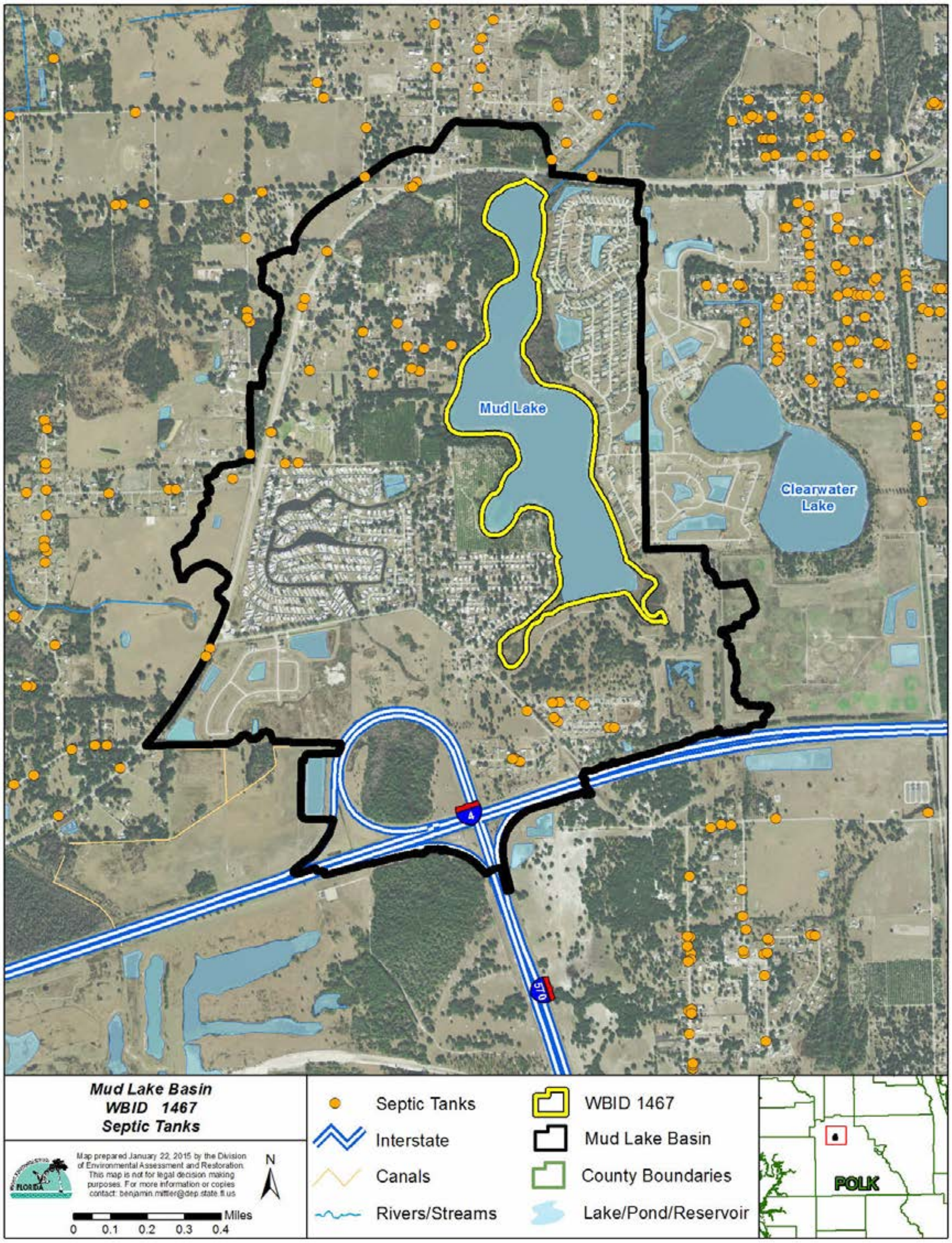

Figure 4.3 Septic Tank Locations within the Mud Lake Watershed.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The TMDL development process identifies nutrient target concentrations and nutrient reductions for Mud Lake in order for the waterbody to achieve the applicable nutrient water quality criteria, and maintain its function and designated use as a Class III fresh water. The method utilized to address the nutrient impairment included the development of regression equations that relate lake nutrient concentrations to the annual geometric mean chlorophyll *a* levels. For addressing nonpoint sources (both NPDES stormwater discharges and non-NPDES stormwater discharges), the TMDLs are expressed as percent reductions in the existing lake water total nitrogen and total phosphorus concentrations necessary to meet the applicable chlorophyll *a* target.

The primary focus in the implementation of this TMDL is to maintain the lake's annual geometric mean chlorophyll *a* values at or below the target concentration of 20 µg/L through reductions in nutrient inputs to the system. Nutrient reductions are also expected to result in improvements of dissolved oxygen (DO) levels within the lake. When algae die they become part of the organic matter pool in the water column and the sediments. The decomposition of organic substrates by microbial activity exerts an oxygen demand which leads to a lowering of DO levels. Lower algal biomass should lower the biochemical oxygen demand levels in the water column, and sediment oxygen demand in the lake should also decrease over time as reductions in algal biomass will result in less accumulation of organic matter in the lake sediments.

5.2 Analysis of Water Quality

Mud Lake water quality monitoring in recent years, since 2003, has been performed by several organizations. Polk County has been routinely sampling the lake since 1993, and a large portion of the data used to assess water quality were collected by Polk County at station 21FLPOLKMUD1, which is located near the center of the lake. The Florida DEP Southwest District Office (21FLTPA…) conducted monitoring in 2004 and again in 2013. Other sampling organizations, including the Southwest Florida Water Management District and Florida Fish and Wildlife Conservation Commission, conducted monitoring intermittently up to 2003. The individual water quality results for variables relevant to this TMDL effort for the period of record, collected by all sampling organizations, are displayed in the graphs in **Appendix B**.

The results collected at the Polk County sampling location near the center of the lake were evaluated to determine if relationships exist between nutrient concentrations and chlorophyll *a* levels. The county monitoring at this location provides a consistent data set for evaluating surface water quality. The nutrient and chlorophyll *a* annual geometric means were used in this evaluation to be consistent with the expression of the adopted NNC for lakes. In 1999, the county began sampling for corrected chlorophyll *a*, which is the more common form of chlorophyll *a* used in assessing surface water quality. For the purpose of this analysis, a minimum of two samples per year collected in different quarters of the year were used to calculate the annual geometric means. In the 1999 to 2013 period, there were sufficient results collected in each year to calculate annual geometric mean values for corrected chlorophyll *a* and nutrients.

Annual geometric mean values for total nitrogen (TN) and total phosphorus (TP) results measured at the center of the lake are presented in **Figure 5.1**. During the 1999 to 2013 period, TN annual geometric means ranged from 1.15 mg/L to 2.70 mg/L and the TP annual geometric means ranged from 0.05 mg/L to 0.11 mg/L. The TP geometric mean values exhibited a decreasing trend over the last fifteen years, however the TN geometric mean values reveal a slight increasing trend.

The chlorophyll *a* annual geometric mean values, along with annual total rainfall, are presented in **Figure 5.2**. The chlorophyll *a* annual geometric mean values in Mud Lake were above 20 µg/L in the 1999 to 2013 period, with the exception of 2013 when the annual geometric mean was 16 µg/L. Geometric means above the target ranged from 24 µg/L in 2006 to 62 µg/L in 2001. There is no direct, statistically significant relationship between the annual geometric mean chlorophyll *a* results and contemporaneous annual rainfall. However, a moderately strong and significant relationship (r square = 0.58, p value < 0.05) was found between the annual average lake level and the previous year's rainfall, as presented in **Figure 5.3**. A concrete control structure located on the inlet channel to the lake upstream of Duey Road, see **Figure 1.2** and **Figure 5.4**, is a factor that potentially accounts for the delay in the lake level response to rainfall. The structure holds back inflow from the southwest portion of the watershed. Additionally, analysis between the chlorophyll *a* annual geometric means and concurrent annual average lake level presented in **Figure 5.5** indicates a moderately strong and very significant inverse relationship between these values (r square = 0.64, p value < 0.001). The results suggest that lake residence time and internal cycling of nutrients exhibit greater influence on lake chlorophyll *a* levels than external nutrient loadings since years with presumably higher watershed nutrient loadings (i.e. higher rainfall and higher lake levels) tend to have lower chlorophyll *a* results.

The relationships between the chlorophyll *a* and TN and between chlorophyll *a* and TP annual geometric mean concentrations are presented in **Figure 5.6** and **Figure 5.7**, respectively. The annual geometric means were logarithmically transformed in order to create more approximately normal distributions for each variable and were analyzed using simple linear regression models. Chlorophyll *a* exhibits a strong and significant positive relationship with TN (r square = 0.80, p value < 0.0001). There is a moderate and significant positive relationship between geometric mean chlorophyll *a* and TP (r square = 0.52, p value < 0.05). These observations suggest that with a lowering of the in-lake nutrient concentrations the chlorophyll *a* concentrations will likewise decrease.

There is other information available which supports that other factors, in addition to watershed nutrient loadings, are effecting lake water quality. This information includes recent monitoring results collected by the DEP to enumerate the phytoplankton community and to analyze nutrients and other parameters at different depths at two sites in Mud Lake. Samples for phytoplankton enumeration, sediment grain size analysis and organic composition, and water quality characterization were collected in August 2014 at the center, station 21FLWQA 281704478184465 (MUD01) and near the southern end, station 21FLWQA 281639728184111 (MUD02) of the lake, as presented in **Figure 2.1**. The phytoplankton community results are presented in **Appendix C.** Results for water quality and sediment analyses, as well as depth profiles for physical parameters, are presented in **Appendix D**. Phytoplankton in the Phylum Cyanophycota (the blue-green algae) were the dominant group, representing 76 and 83 percent of the algal community based on cell densities at MUD01 and MUD02, respectively (**Figure 5.8**). Many blue-green algae taxa are capable of fixing atmospheric nitrogen.

The depth profiles in **Appendix D** and the measured dissolved oxygen (mg/L) at time of the sample collection, presented in **Figure 5.9**, exhibit patterns of lake stratification. Stratification in lakes can produce anoxic conditions, leading to the production of ammonia when organic matter is decomposed under anaerobic conditions. Water quality results for ammonia (mg N/L) at the surface and bottom of sites MUD01 and MUD02, presented in **Figure 5.10**, indicate a considerably higher level of ammonia is present at the bottom of Mud Lake at site MUD01. Ammonia has the potential to be released into the water column from sediments, and during lake mixing events, could stimulate phytoplankton growth.

Invasive aquatic plants (most notably hydrilla, water hyacinth, and water lettuce) occur within Mud Lake, and herbicide treatment is conducted at times to control the spread of these plants in the lake. This practice may enhance the cycling of nutrients within the lake, as the decomposition of dead plant material leads to the release of nutrients into the water column which can be a nutrient source for the phytoplankton community. Herbicide treatment information (acres treated and targeted vegetation) was obtained from the Polk County Parks and Natural Resources Office and compared to the lake chlorophyll *a* results, **Figure 5.11**. Since 2000, herbicides have been applied to small lake areas (no more than 6 percent of the lake surface area was treated during each treatment event) and 36 treatment events occurred. There does not appear to be any relationship between herbicide applications and chlorophyll *a* results.

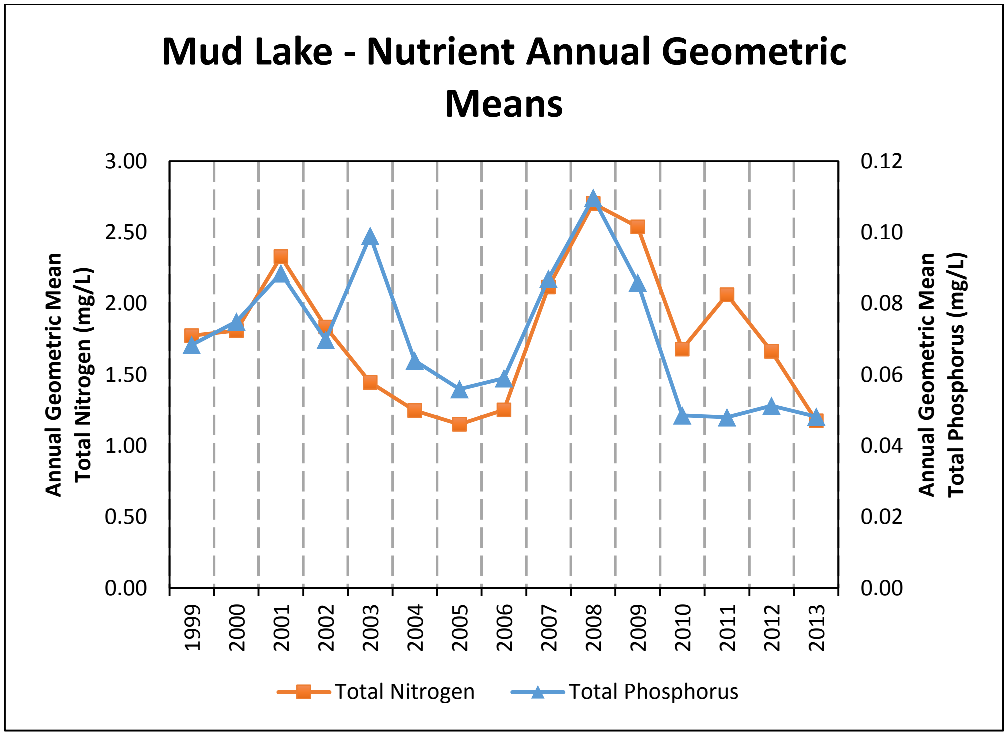

Figure 5.1 Total Nitrogen and Total Phosphorus Annual Geometric Means in Mud Lake.

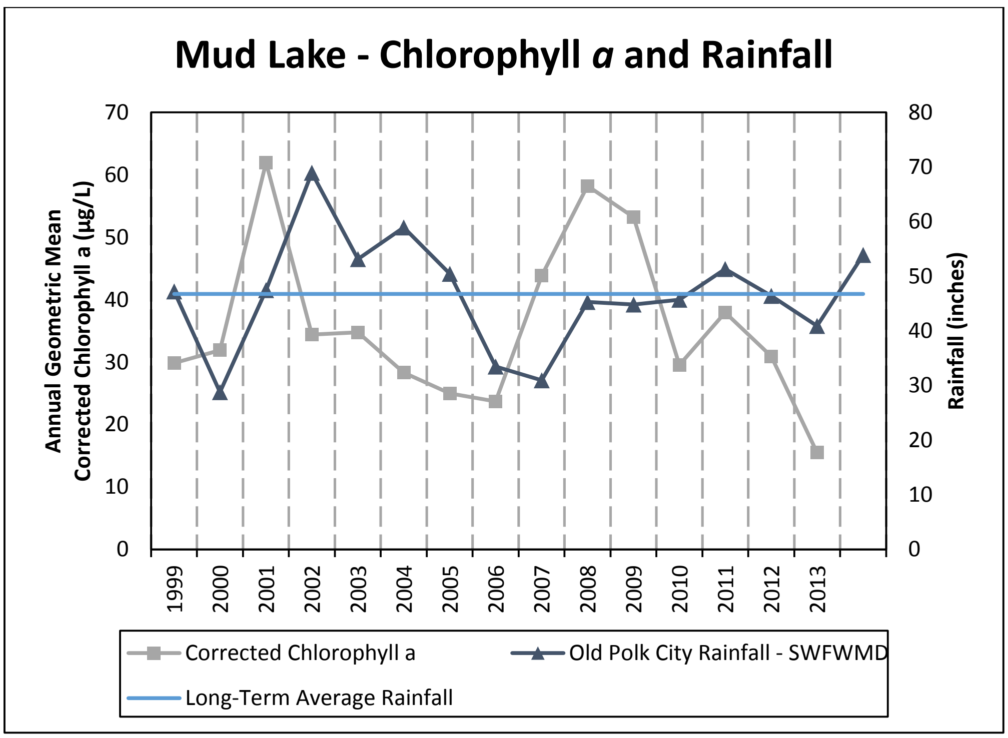

Figure 5.2 Mud Lake Chlorophyll *a* Annual Geometric Means and Annual Rainfall.

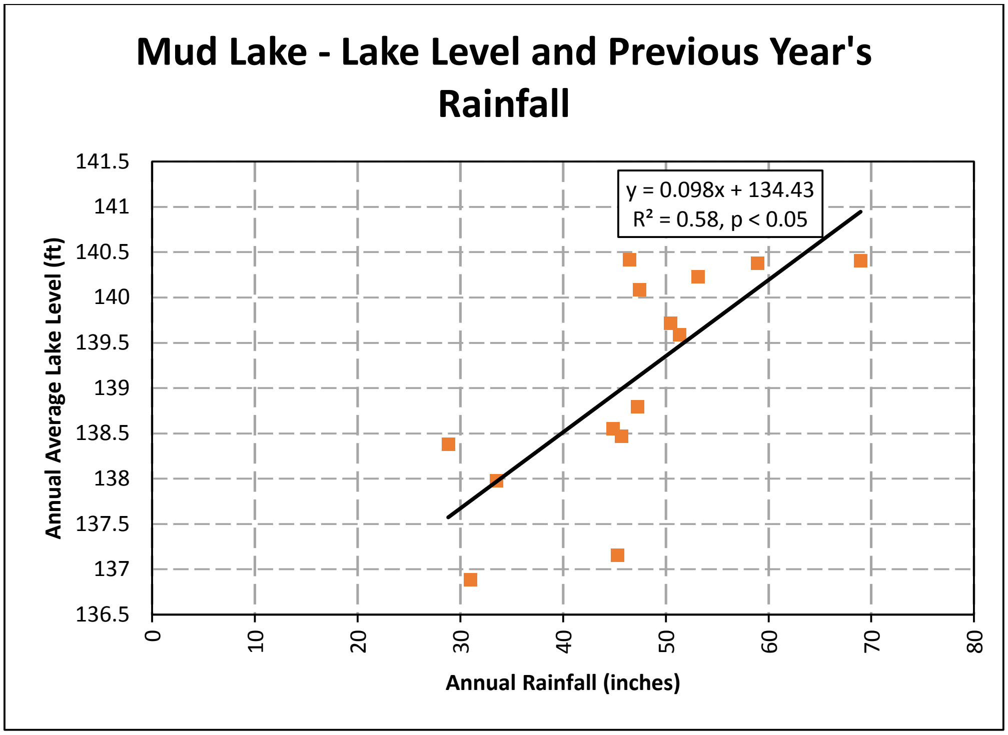

Figure 5.3 Relationship Between Mud Lake Level and Previous Year's Rainfall.

Figure 5.4 Control Structure on Mud Lake Inlet Channel.

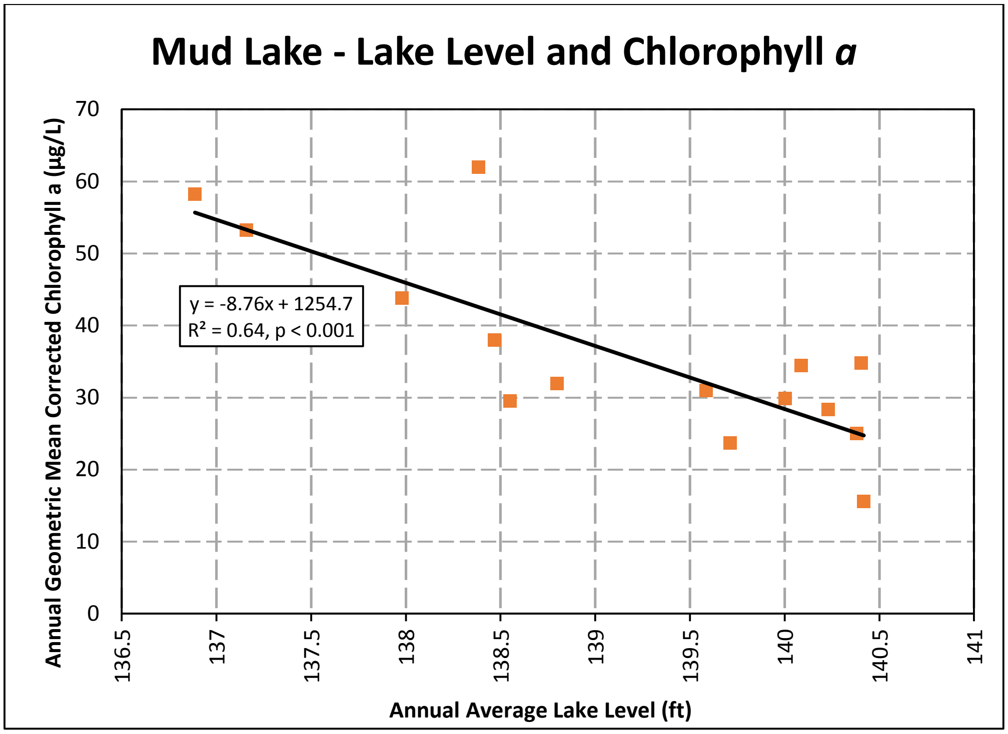

Figure 5.5 Relationship Between Mud Lake Level and Chlorophyll *a* Annual Geometric Means.

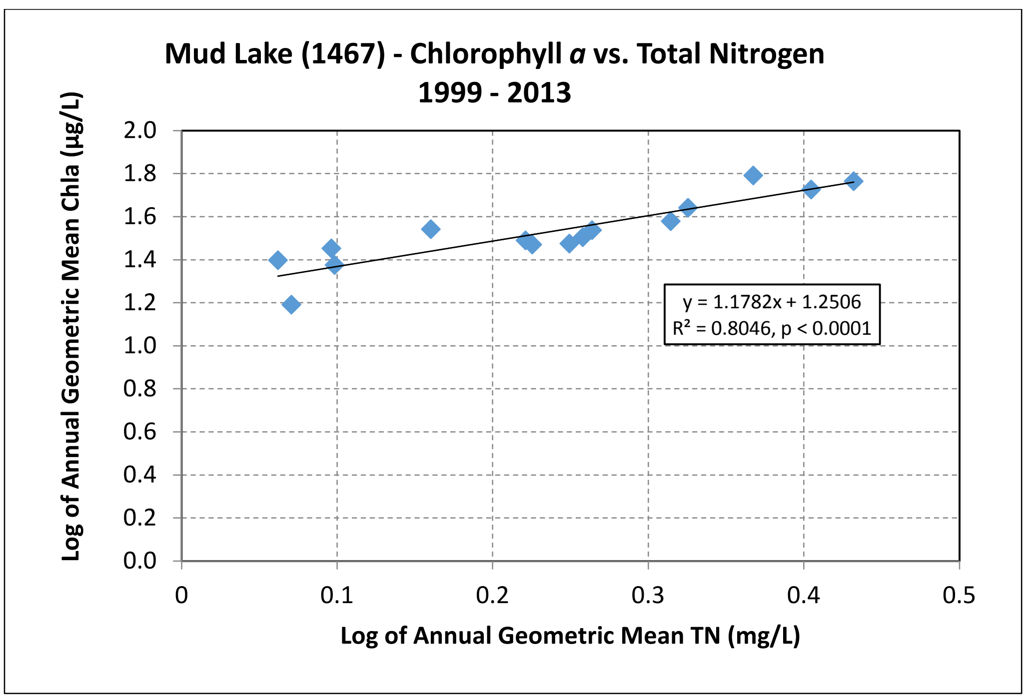

Figure 5.6 Relationship Between Logarithmically Transformed Annual Geometric Means of Chlorophyll *a* and Total Nitrogen in Mud Lake.

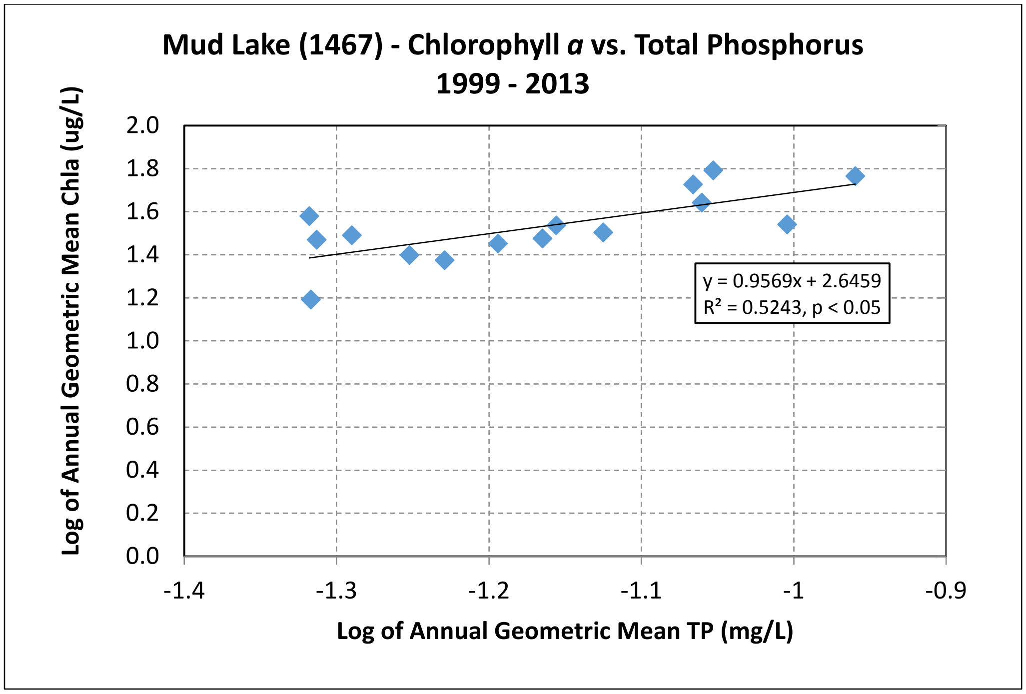

Figure 5.7 Relationship Between Logarithmically Transformed Annual Geometric Means of Chlorophyll *a* and Total Phosphorus in Mud Lake.

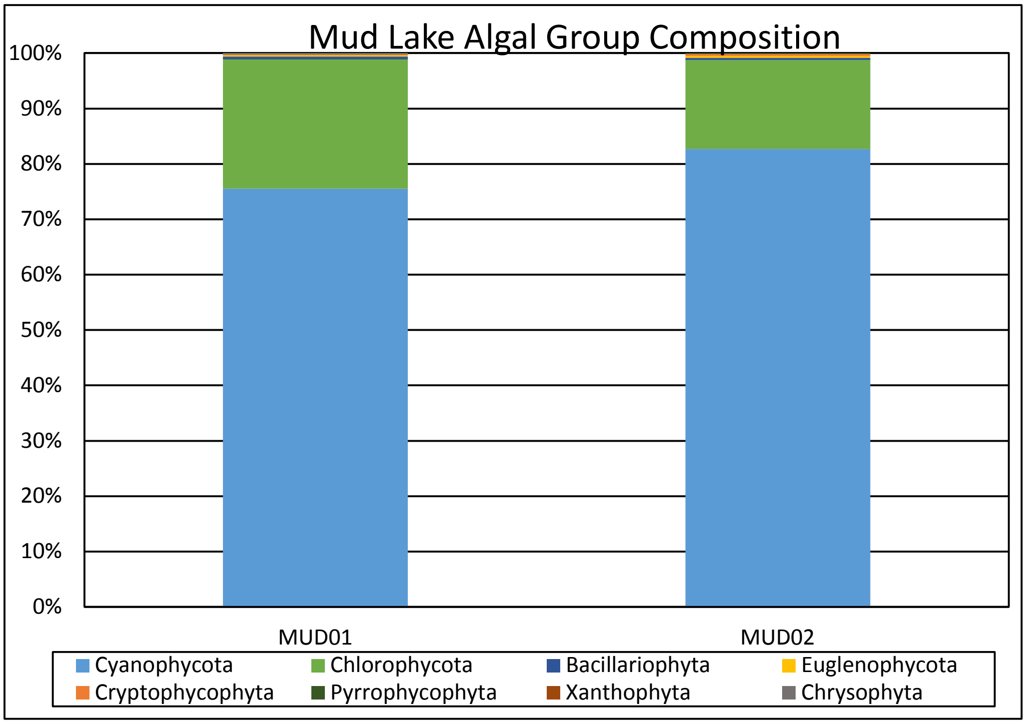

Figure 5.8 Mud Lake Algal Group Composition by Lake Station.

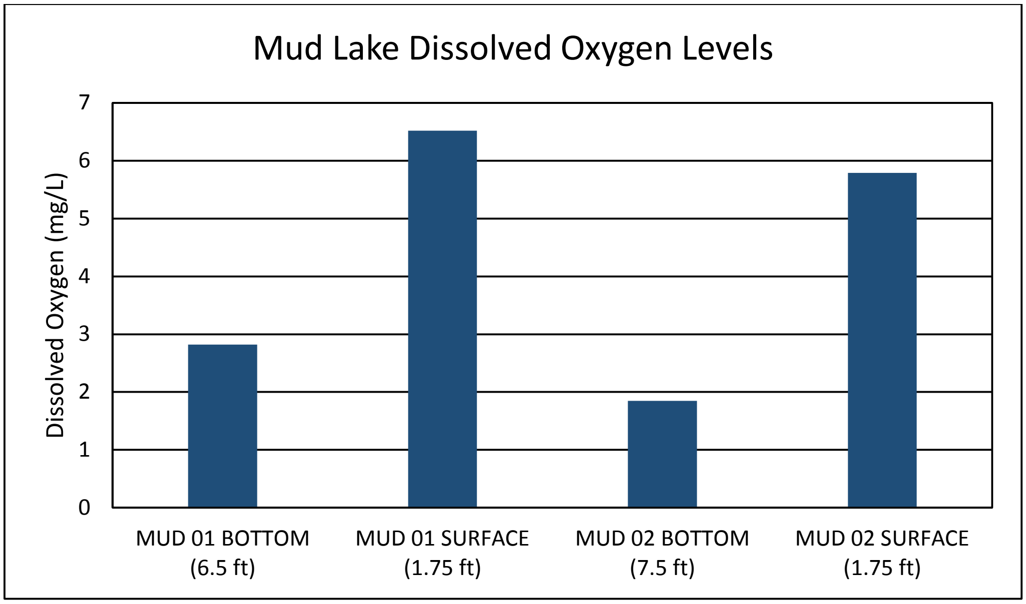

Figure 5.9 Mud Lake Dissolved Oxygen Levels.

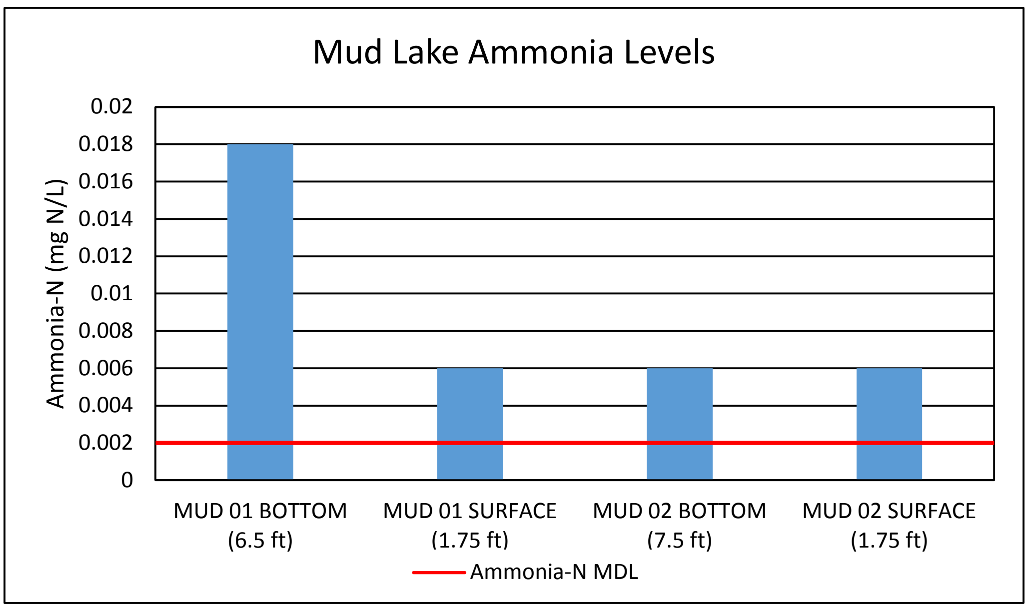

Figure 5.10 Mud Lake Ammonia Levels.

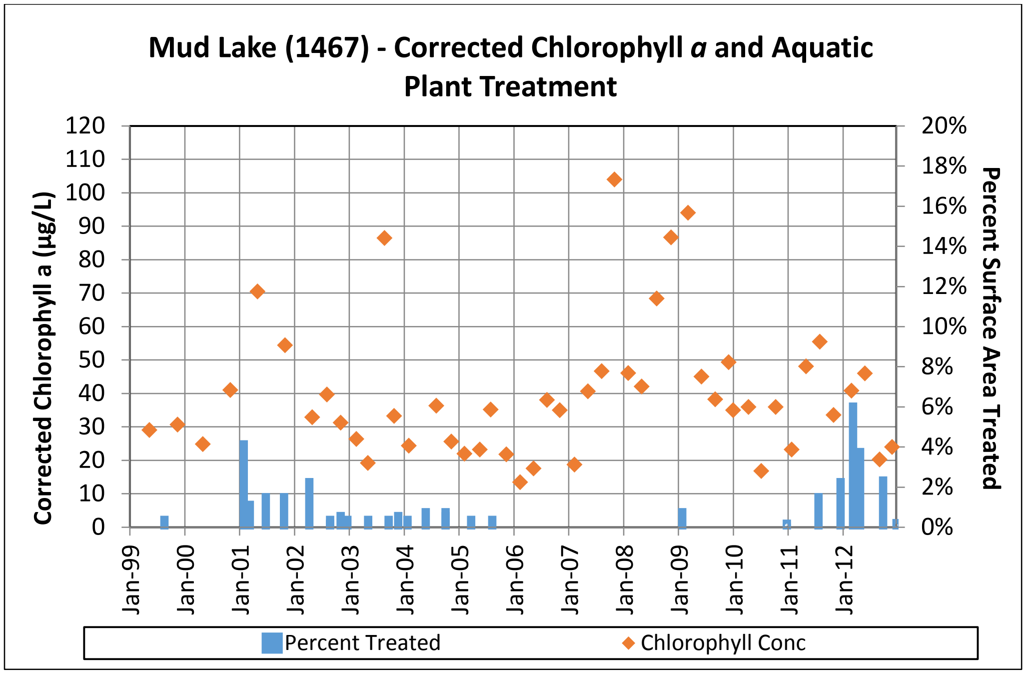

Figure 5.11 Mud Lake Chlorophyll *a* Results and Lake Area Treated for Invasive Aquatic Plant Growth.

5.3 The TMDL Development Process

The method used for developing the nutrient TMDL is a percent reduction approach, whereby the percent reduction in the existing lake TN concentration was calculated to meet the TN target. As discussed in Chapter 3, the NNC chlorophyll *a* threshold of 20 µg/L, expressed as an annual geometric mean, was selected as the response variable target for TMDL development. To identify the TN water quality target, the regression equation explaining the relationship between annual geometric mean chlorophyll *a* and TN, **Figure 5.6**, was used to determine the TN concentration necessary to meet the chlorophyll *a* target of 20 µg/L. An annual TN geometric mean of 1.10 mg/L results in a chlorophyll *a* annual geometric mean of 20 µg/L.

Based on an assessment of the lake results as presented in **Table 2.2**, the TP annual geometric means did not exceed the applicable NNC of 0.05 mg/L for four consecutive years after the last exceedance. The most recent geometric means, in the 2010 to 2013 period, are at or below 0.05 mg/L. The available data indicate that the lake TP results are meeting the applicable NNC. However, the relationship between chlorophyll *a* and TP annual geometric mean concentrations was significant and moderately strong, **Figure 5.7**, suggesting that the TP condition is a potential contributor to lake eutrophication. The available information indicates that the existing lake phosphorus concentrations are having an adverse effect on surface water quality, and there is cause to develop a TMDL for TP. The regression equation explaining the relationship between annual geometric mean chlorophyll *a* and TP, **Figure 5.7**, was used to determine the TP concentration necessary to meet the chlorophyll *a* target of 20 µg/L. An annual TP geometric mean of 0.04 mg/L results in a chlorophyll *a* annual geometric mean of 20 µg/L.

Mud Lake is expected to meet the applicable nutrient criteria and maintain its function and designated use as a Class III water when surface water TN and TP levels are reduced to the target concentrations, which will address the anthropogenic contributions to the water quality impairment. The approach used to establish the nutrient targets and the TMDL, addresses meeting the chlorophyll *a* target, which is protective of the lake's designated use.

The existing lake nutrient conditions evaluated for establishing the TMDL were the TN and TP concentrations measured in the 2003-2013 period. This period includes the entire Cycle 2 verified period and water quality in more recent years. The geometric means were calculated from TN and TP results available in IWR Database Run 49. For the purpose of establishing the TMDL, the existing nutrient conditions used in the percent reduction calculation are the maximum TN and TP annual geometric mean values in the 2003-2013 time frame. The highest geometric mean values for TN and TP, 2.7 mg/L and 0.11 mg/L, respectively, occurred in 2008, **Table 5.1**. The use of the maximum geometric mean value in setting the TMDL is considered a conservative assumption for establishing reductions as this will ensure that all exceedances of the nutrient targets are addressed.

The equation used to calculate the percent reduction is as follows:

$$\frac{\textbf{[measured exceedance – target]}}{\textbf{measured exceedance}} \quad \textbf{X 100}$$

The measured exceedances in this case are the maximum TN and TP annual geometric mean values. For the maximum TN value of 2.7 mg/L to achieve the target concentration of 1.10 mg/L, a 59 percent reduction in the lake TN concentration is necessary. A 64 percent reduction in the existing annual geometric mean TP concentration of 0.11 mg/L is necessary to meet the target concentration of 0.04 mg/L. The nutrient TMDL value, which is expressed as an annual geometric mean not to be exceeded in any year, addresses the anthropogenic nutrient inputs which contribute to the exceedances of the chlorophyll *a* restoration target.

Table 5.1 Mud Lake Nutrient Annual Geometric Means Used to Calculate Percent Reductions Needed to Meet the Water Quality Targets.

Year	IWR Run 49 TN Annual Geometric Mean (mg/L)	IWR Run 49 TP Annual Geometric Mean (mg/L)
2003	1.09	0.06
2004	1.20	0.08
2005	1.15	ID
2006	1.25	ID
2007	2.12	0.09
2008	2.70	0.11
2009	2.54	0.09
2010	1.68	0.05
2011	2.06	0.05
2012	1.66	0.05
2013	1.13	0.04
Maximum Geometric Mean	**2.70**	**0.11**

ID - Insufficient Data to Calculate Geometric Means per the Requirements of Rule 62-303.

5.4 Critical Conditions

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions because (a) the methodology used to determine the assimilative capacity does not lend itself very well to short-term assessments, (b) the Department is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, and (c) the methodology used to determine impairment is based on annual conditions (annual geometric means or arithmetic means).

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

A TMDL can be expressed as the sum of all point source loads (wasteload allocations or WLAs), nonpoint source loads (load allocations or LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty about the relationship between effluent limitations and water quality:

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

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

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 Mud Lake are expressed in terms of a nutrient concentration targets and the percent reductions for nonpoint sources necessary to meet the targets, **Table 6.1,** and represent the maximum lake nutrient concentrations the surface water can assimilate to meet the applicable nutrient criteria. The TMDL will constitute the site specific numeric interpretation of the narrative nutrient criterion set forth in paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria in subsection 62-302.531(2) for this particular water, pursuant to paragraph 62-302.531(2)(a), F.A.C.

Table 6.1. TMDL Components for Mud Lake

WBID	Parameter	TMDL (mg/L)[1]	WLA Wastewater (lbs/year)	WLA NPDES Stormwater (% Reduction)[2]	LA (% Reduction)[2]	MOS
1467	Total Nitrogen	1.10	NA	59%	59%	Implicit
1467	Total Phosphorus	0.04	NA	64%	64%	Implicit

[1] Represents the annual geometric mean lake value that is not to be exceeded in any year.
[2] As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.
NA - Not Applicable

These TMDLs are based on application of an empirical model developed using data from the 1999-2013 period.

6.2 Load Allocation (LA)

A total nitrogen reduction of 59 percent and a total phosphorus reduction of 64 percent is required from nonpoint sources. The percent reductions will result in achieving the in-lake chlorophyll *a* target of 20 µg/L. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

There are no NPDES wastewater facilities that discharge directly to Mud Lake or its watershed. As such, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

Polk County and Co- Permittees (FDOT District 1 and the City of Polk City) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000015) and areas within their jurisdiction in the Mud Lake watershed may be responsible for a 59 percent total nitrogen reduction and a 64 percent total phosphorus reduction in current anthropogenic loading. The percent reductions will result in achieving the in-lake chlorophyll *a* target of 20 µg/L. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a MOS into the analysis. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody [Clean Water Act, Section 303(d)(1)(c)]. Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings. Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of the TMDL because of the conservative assumptions that were applied. The TMDL was developed using the highest TN and TP annual geometric mean values to calculate the percent reduction. Additionally, the TMDL nutrient concentration target is established as an annual limit not to be exceeded.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation takes place through various measures. Implementation of TMDLs may occur through specific requirements in NPDES wastewater and municipal separate storm sewer (MS4) permits, and, as appropriate, through local or regional water quality initiatives or Basin Management Action Plans (BMAPs).

Facilities with NPDES permits that discharge to the TMDL waterbody must respond to the permit conditions that reflect target concentrations, reductions, or wasteload allocations identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require that the permit holder prioritize and take action to address a TMDL unless their management actions are already defined in a BMAP. MS4 Phase II permit holders must also implement responsibilities defined in a BMAP.

7.2 Basin Management Action Plans

BMAPs are discretionary and are not initiated for all TMDLs. A BMAP is a TMDL implementation tool that integrates the appropriate management strategies applicable through the existing water quality protection programs. The Department or a local entity may develop a BMAP that addresses some or all of the contributing areas to the TMDL waterbody.

Section 403.067, Florida Statutes, called the “Florida Watershed Restoration Act” provides for the development and implementation of BMAPs. BMAPs are adopted by the Secretary of the Department and are legally enforceable.

BMAPs describe the management strategies that will be implemented as well as funding strategies, project tracking mechanisms, water quality monitoring, as well as fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed. BMAPs also identify mechanisms to address potential pollutant loading from future growth and development. The most important component of a BMAP is the list of management strategies to reduce the pollution sources, as these are the activities needed to implement the TMDL. The local entities that will conduct these management strategies are identified and their responsibilities are enforceable. Management strategies may include wastewater treatment upgrades, stormwater improvements, and agricultural best management practices.

Additional information about BMAPs is available at the following Department web site: http://www.dep.state.fl.us/water/watersheds/bmap.htm

7.3 Implementation Considerations for Mud Lake

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources (e.g., sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. In the case of Mud Lake, the recent phytoplankton monitoring results and analysis of lake nutrient results suggest that other factors besides watershed loading inputs, such as lake residence time, sediment nutrient fluxes and/or nitrogen fixation, may also be influencing the lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the lake.

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Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL.

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

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

Appendix B: Graphs of Surface Water Quality Results

Figure B-1. Mud Lake Phytoplankton Results for Period of Record.

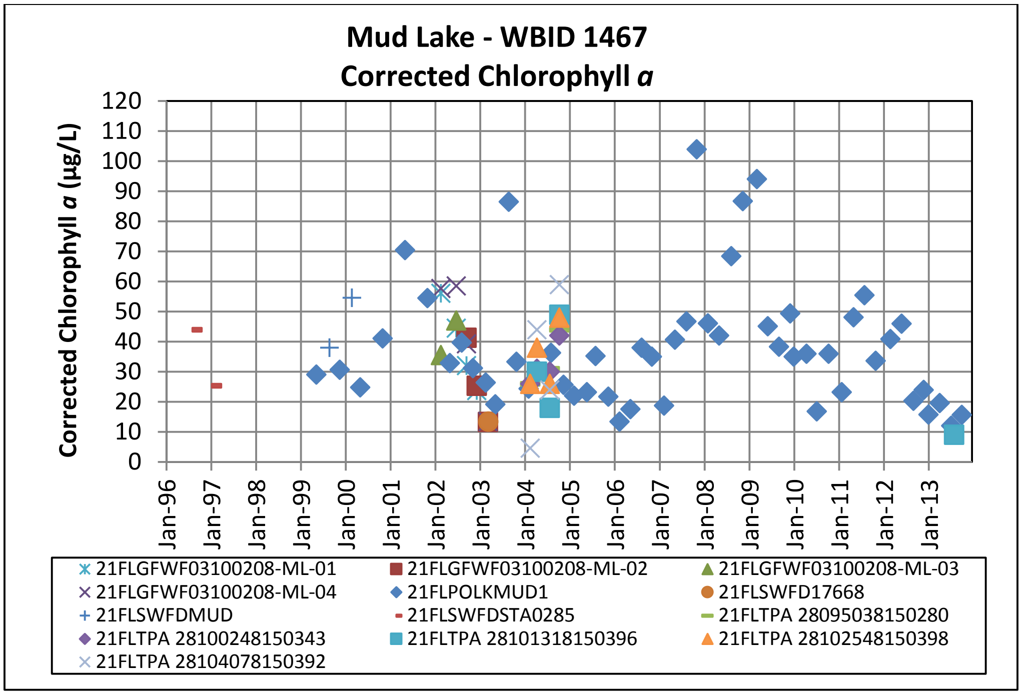


Figure B-2. Mud Lake Total Nitrogen Results for Period of Record.

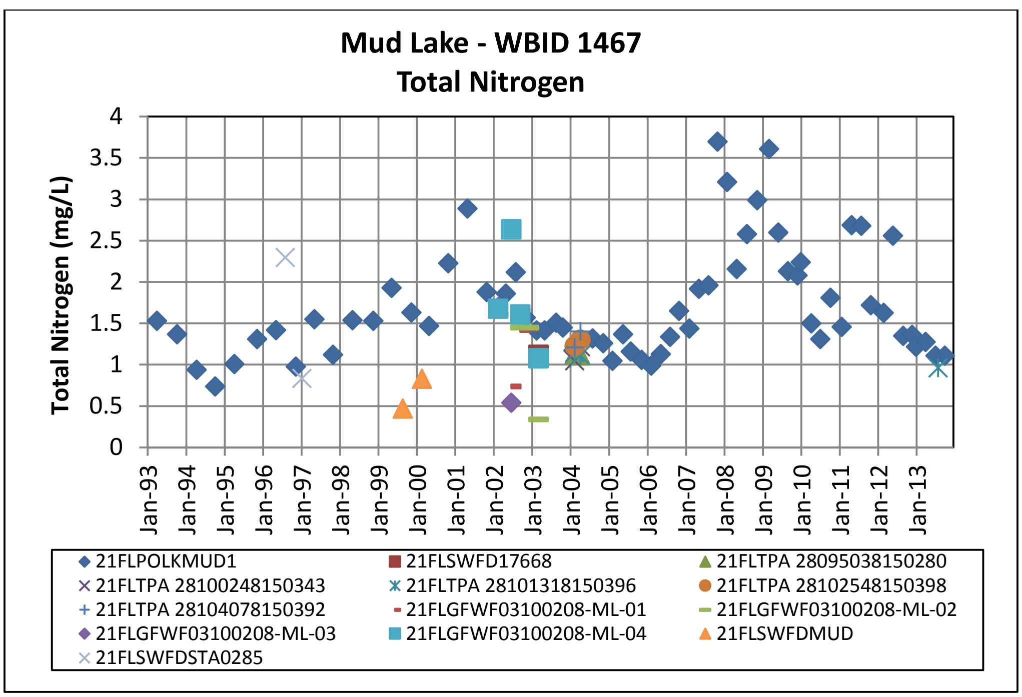


Figure B-3. Mud Lake Total Phosphorus Results for Period of Record.

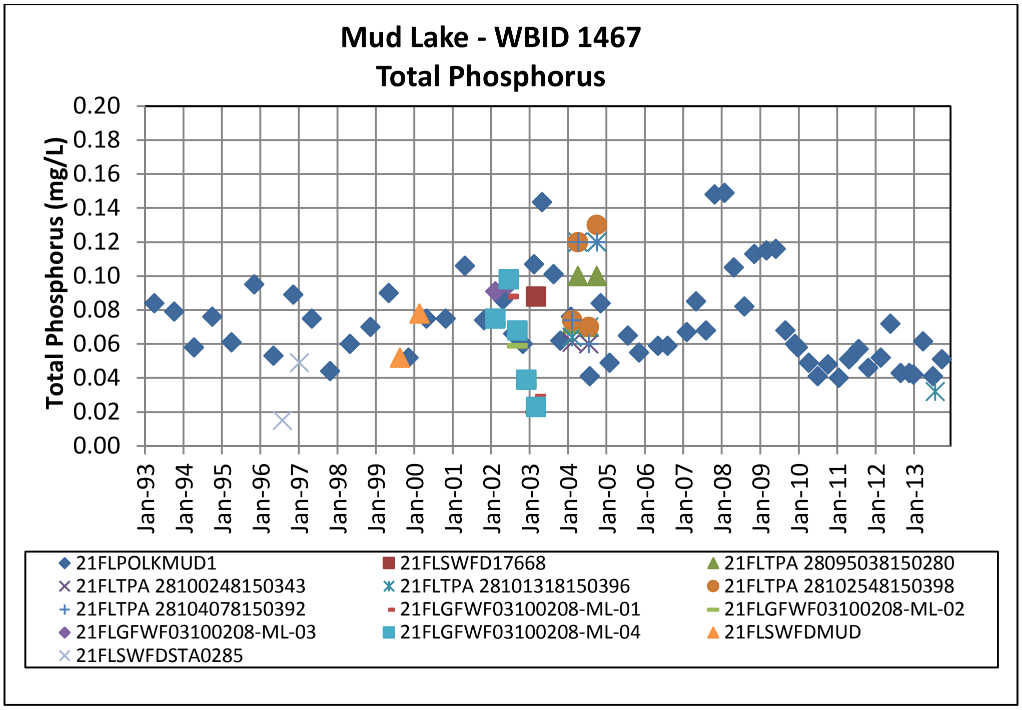


Figure B-4. Mud Lake Color Results for Period of Record.

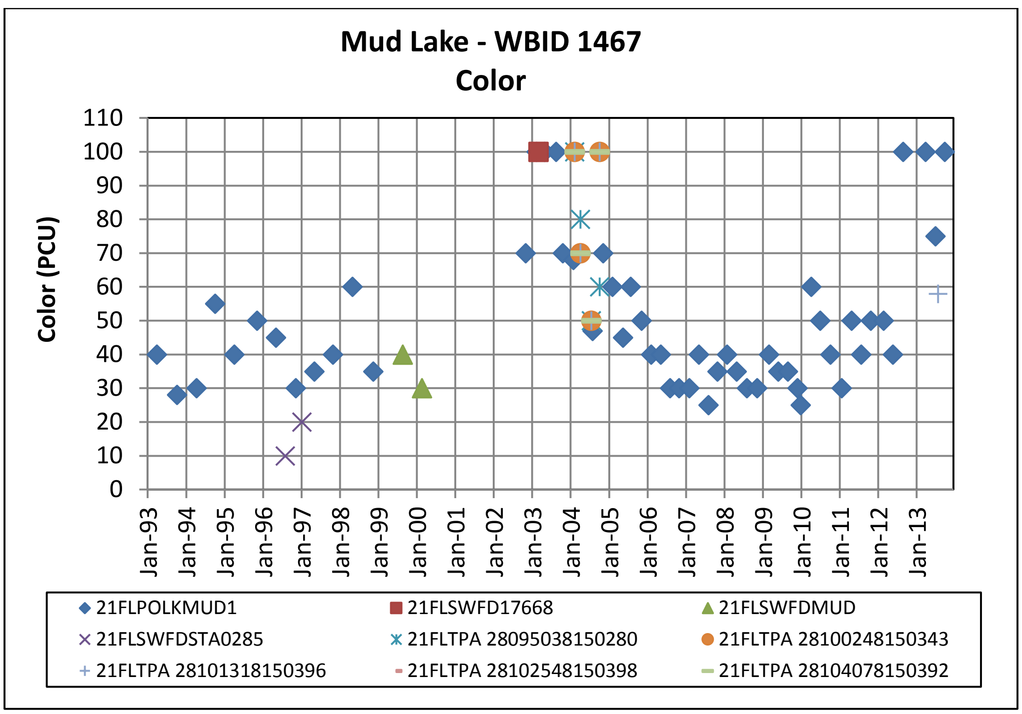
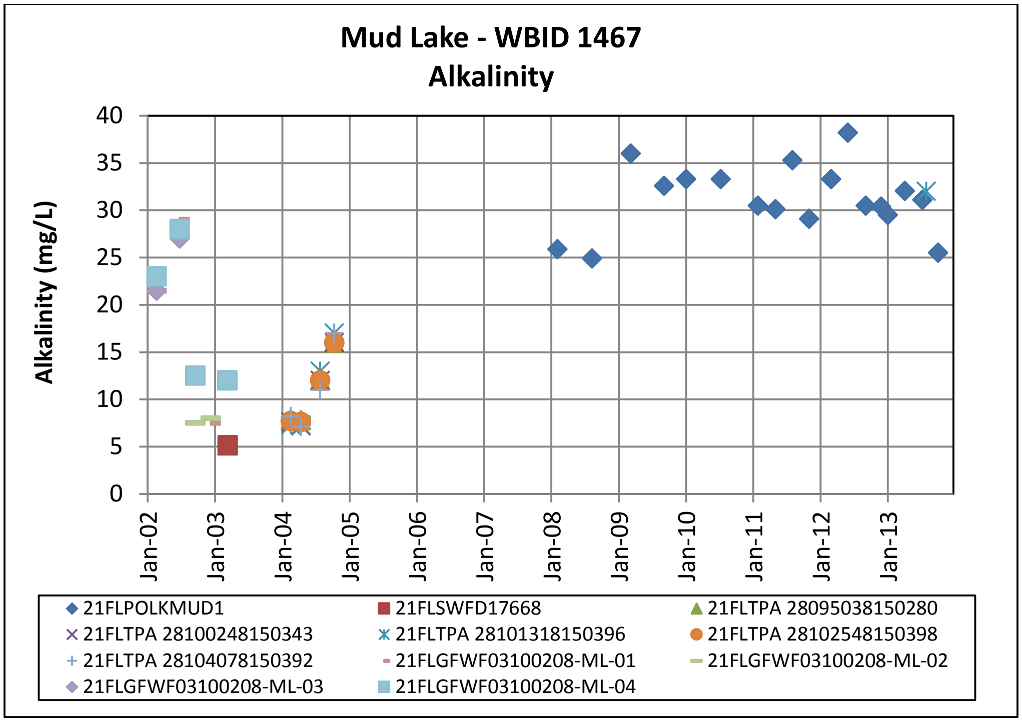


Figure B-5. Mud Lake Alkalinity Results for Period of Record.



Appendix C: Mud Lake Phytoplankton Results – Collected August 5, 2014

Table C-1. MUD01 Phytoplankton Results.

Phylum	Class	Order	Family	Genus	Taxon Name	# cells counted	# cells per mL	Phylum (%)
Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	12	153	0.5
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Euastrum	Euastrum denticulatum	1	13	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Schroederia	Schroederia setigera	1	13	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron minimum	1	13	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron trigonum	1	13	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Chlorococcum	Chlorococcum humicola	2	25	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Cosmarium	Cosmarium	2	25	
Chlorophycota	Chlorophyceae	Zygnematales	Zygnemataceae	Mougeotia	Mougeotia	2	25	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Nephrocytium	Nephrocytium limneticum	4	51	
Chlorophycota	Chlorophyceae	Volvocales	Chlamydomonadaceae	Chlamydomonas	Chlamydomonas	5	64	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	Ankistrodesmus falcatus	7	89	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Actinastrum	Actinastrum	8	102	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Kirchneriella	Kirchneriella contorta	8	102	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus quadricauda	8	102	
Chlorophycota	Chlorophyceae	Chlorococcales	Hydrodictyaceae	Pediastrum	Pediastrum	12	153	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus bijuga	12	153	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	Crucigenia rectangularis	16	204	
Chlorophycota	Chlorophyceae	Klebsormidiales	Elakatotrichaceae	Elakatothrix	Elakatothrix gelatinosa	16	204	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	Crucigenia tetrapedia	20	255	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella	25	318	
Chlorophycota	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Dictyosphaerium	Dictyosphaerium ehrenbergianum	32	408	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Oocystis	Oocystis	37	471	
Chlorophycota	Chlorophyceae	Tetrasporales	Palmellaceae	Sphaerocystis	Sphaerocystis	74	942	

Phylum	Class	Order	Family	Genus	Taxon Name	# cells counted	# cells per mL	Phylum (%)
Chlorophycota	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Botryococcus	Botryococcus braunii	220	2802	23.3
Chrysophyta	Chrysophyceae	Ochromonadales	Dinobryaceae	Dinobryon	Dinobryon sertularia	2	25	0.1
Cryptophycophyta	Cryptophyceae	Cryptomonadales	Cryptomonadaceae	Chroomonas	Chroomonas	3	38	0.1
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	Cylindrospermopsis catemaco	3	38	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya contorta	5	64	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Pseudanabaena	Pseudanabaena mucicola	5	64	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Anabaena	Anabaena	16	204	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Limnothrix	Limnothrix vacuolifera	16	204	
Cyanophycota	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	Oscillatoria	Oscillatoria limosa	20	255	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Dolichospermum	Dolichospermum circinale	31	395	
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Synechocystis	Synechocystis	42	535	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Jaaginema	Jaaginema gracile	108	1375	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya limnetica	138	1757	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	Cylindrospermopsis raciborskii	309	3935	
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	Aphanocapsa delicatissima	430	5476	
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	Aphanocapsa	540	6877	75.5
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Phacus	Phacus	1	13	
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	Trachelomonas	1	13	
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Trachelomonas	Trachelomonas intermedia	1	13	
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Phacus	Phacus orbicularis	2	25	0.2
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	Glenodinium	2	25	0.1
Xanthophyta	Xanthophyceae	Mischococcales	Centritractaceae	Centritractus	Centritractus belanophorus	1	13	0.0
					Total	2202	28044	100.0

Table C-2. MUD02 Phytoplankton Results.

Phylum	Class	Order	Family	Genus	Taxon Name	# cells counted	# cells per mL	Phylum (%)
Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	Bacillariophyta	7	616	0.441441
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Closterium	Closterium	1	88	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Kirchneriella	Kirchneriella	1	88	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Selenastrum	Selenastrum	1	88	
Chlorophycota	Chlorophyceae	Zygnematales	Desmidiaceae	Staurastrum	Staurastrum	1	88	
Chlorophycota	Chlorophyceae	Volvocales	Chlamydomonadaceae	Chlamydomonas	Chlamydomonas	2	176	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Chlorococcum	Chlorococcum humicola	3	264	
Chlorophycota	Chlorophyceae	Chlorococcales	Micractiniaceae	Golenkinia	Golenkinia radiata	3	264	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Kirchneriella	Kirchneriella contorta	4	352	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Schroederia	Schroederia	4	352	
Chlorophycota	Chlorophyceae	Chlorococcales	Chlorococcaceae	Tetraedron	Tetraedron caudatum	4	352	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Chlorella	Chlorella	6	528	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Ankistrodesmus	Ankistrodesmus falcatus	9	792	
Chlorophycota	Chlorophyceae	Chlorococcales	Oocystaceae	Oocystis	Oocystis	11	968	
Chlorophycota	Chlorophyceae	Volvocales	Volvocaceae	Gonium	Gonium	12	1057	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Crucigenia	Crucigenia tetrapedia	16	1409	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus quadricauda	24	2113	
Chlorophycota	Chlorophyceae	Klebsormidiales	Elakatotrichaceae	Elakatothrix	Elakatothrix gelatinosa	28	2465	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Scenedesmus	Scenedesmus bijuga	32	2817	
Chlorophycota	Chlorophyceae	Chlorococcales	Scenedesmaceae	Willea	Willea rectangularis	40	3522	
Chlorophycota	Chlorophyceae	Chlorococcales	Dictyosphaeriaceae	Dictyosphaerium	Dictyosphaerium ehrenbergianum	52	4578	16.024451
Cryptophycophyta	Cryptophyceae	Cryptomonadales	Cryptomonadaceae	Cryptomonas	Cryptomonas	6	528	0.378378
Cyanophycota	Cyanophyceae	Chroococcales	Synechococcaceae	Cyanobium	Cyanobium parvum	2	176	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya contorta	5	440	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Geitlerinema	Geitlerinema	6	528	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	Cylindrospermopsis catemaco	8	704	

Phylum	Class	Order	Family	Genus	Taxon Name	# cells counted	# cells per mL	Phylum (%)
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Romeria	Romeria	9	792	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Dolichospermum	Dolichospermum circinale	34	2993	
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	Aphanocapsa	80	7043	
Cyanophycota	Cyanophyceae	Chroococcales	Chroococcaceae	Synechocystis	Synechocystis	94	8276	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Jaaginema	Jaaginema gracile	100	8804	
Cyanophycota	Cyanophyceae	Oscillatoriales	Pseudanabaenaceae	Planktolyngbya	Planktolyngbya limnetica	156	13735	
Cyanophycota	Cyanophyceae	Nostocales	Nostocaceae	Cylindrospermopsis	Cylindrospermopsis raciborskii	187	16464	
Cyanophycota	Cyanophyceae	Chroococcales	Merismopediaceae	Aphanocapsa	Aphanocapsa delicatissima	630	55467	82.714289
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Phacus	Phacus	2	176	
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	Lepocinclis	Lepocinclis	3	264	0.315315
Pyrrophycophyta	Dinophyceae	Peridiniales	Glenodiniaceae	Glenodinium	Glenodinium	2	176	0.126126
					Total	1585	139543	100

Appendix D: Mud Lake Survey Results – Collected August 5, 2014

Table D-1. Water Quality Results.

Parameter	MUD01 Surface Results	MUD01 Surface Qualifier Code	MUD01 Bottom Results	MUD01 Bottom Qualifier Code	MUD02 Surface Results	MUD02 Surface Qualifier Code	MUD02 Bottom Results	MUD02 Bottom Qualifier Code
Alkalinity (mg CaCO3/L)	28		28		28		28	
Ammonia-N (mg N/L)	0.006		0.018		0.006		0.006	
Biochemical Oxygen Demand-5 Day, N-Inhib (mg/L)	1.7	I	2.1		2.8		2.3	
Calcium (mg/L)	11.7		12.2		12.2		12.3	
Chloride (mg Cl/L)	34		34		35		35	
Chlorophyll-a, Corrected (µg/L)	21		20		33		26	
Color - true (PCU)	60		61		58	A	58	
Dissolved Oxygen (mg/L)	6.52		2.82		5.79		1.85	
Fluoride (mg F/L)	0.21		0.21		0.21		0.21	
Kjeldahl Nitrogen (mg N/L)	1.1		1.1		1.2		1.2	
Magnesium (mg/L)	5.3		5.51		5.5		5.58	
NO2NO3-N (mg N/L)	0.004	U	0.004	U	0.004	U	0.004	U
O-Phosphate-P (mg P/L)	0.004	U	0.004	U	0.004	U	0.004	U
Organic Carbon (mg C/L)	15		15		15		15	
pH (SU)	6.82		6.44		6.61		6.27	
Phaeophytin-a (µg/L)	4.6		5.2		3.3		3.6	
Potassium (mg/L)	4.1		4.2		4.3		4.3	
Sample Depth (m)	0.5		2		0.5		2.3	
Sodium (mg/L)	20.3		21		21.1		21.5	
Specific Conductance (umhos/cm)	224		223		227		232	
Sulfate (mg SO4/L)	17		17		18		19	
TDS (mg/L)	148		158		152		149	
Temperature (deg. C)	31.17		30.15		31.18		30.63	
Total-P (mg P/L)	0.031		0.036		0.041		0.036	
TSS (mg/L)	4	I	2	I	4	I	3	I
Turbidity (NTU)	1.8		2.1		2.7		2.3	

A - Value reported is the arithmetic mean (average) of two or more determinations.
I - The reported value is greater than or equal to the laboratory method detection limit but less than the laboratory practical quantitation limit.
U - Indicates that the compound was analyzed for but not detected.

Table D-2. Sediment Grain Size Analysis and Percent Organic Material.

Parameter	MUD01 Bottom Results	MUD01 Bottom Qualifier Code	MUD02 Bottom Results	MUD02 Bottom Qualifier Code
Sediment % Organic	1	K	62	
Sediment Particle Size, %, <0.063 mm	3.6	A	37	
Sediment Particle Size, %, 0.063-0.125mm	2.6	A	26.9	
Sediment Particle Size, %, 0.125-0.25 mm	25.2	A	23.4	
Sediment Particle Size, %, 0.25-0.5 mm	54.2	A	10.4	
Sediment Particle Size, %, 0.5-2.0 mm	14.3	A	2.36	
Sediment Particle Size, %, >2.0 mm	1	K	1	K

A - Value reported is the arithmetic mean (average) of two or more determinations.
K – Actual value is known to be less than value given.

Figure D-1. Depth Profile for Dissolved Oxygen (mg/L) at MUD01.

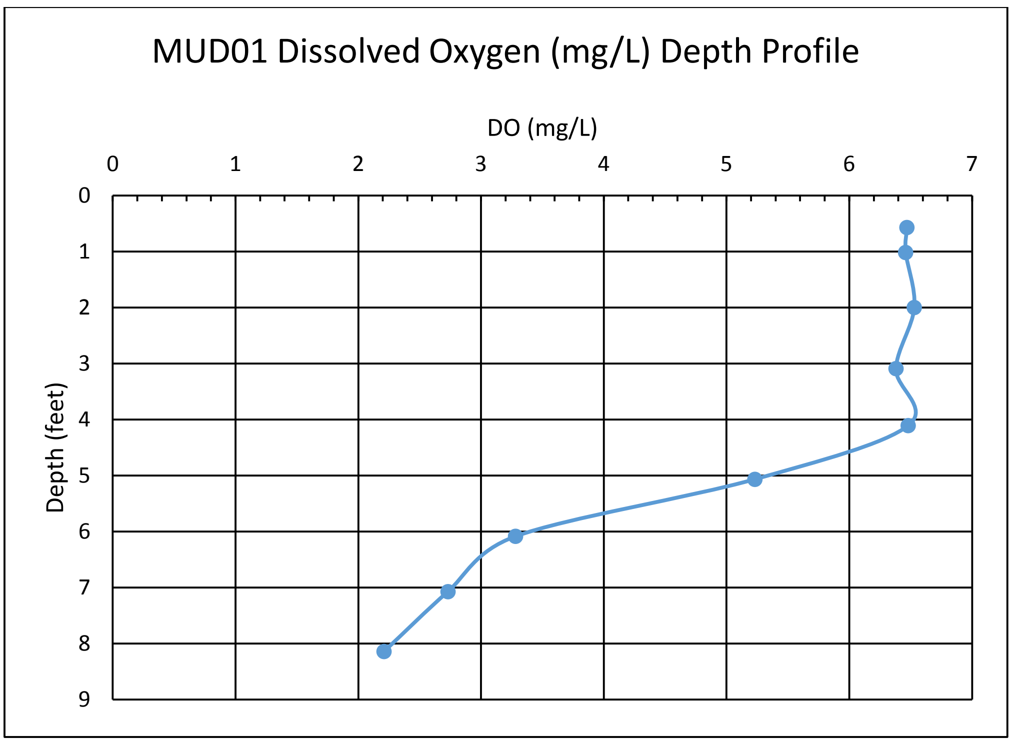


Figure D-2. Depth Profile for pH at MUD01.

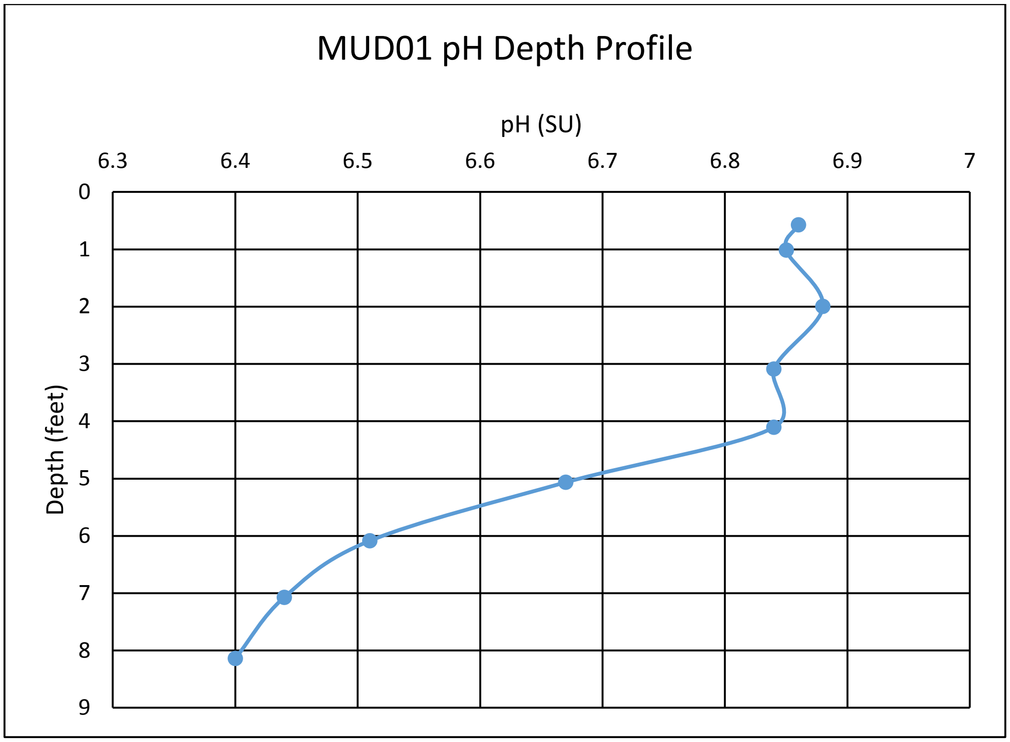


Figure D-3. Depth Profile for Specific Conductivity at MUD01.

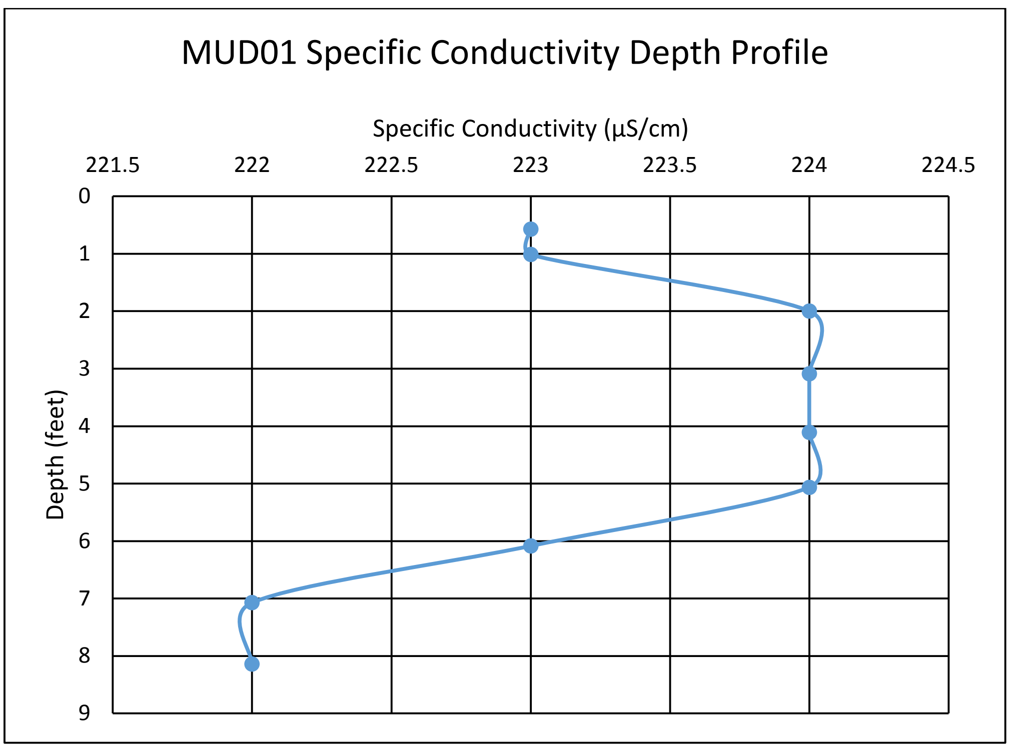


Figure D-4. Depth Profile for Temperature at MUD01.

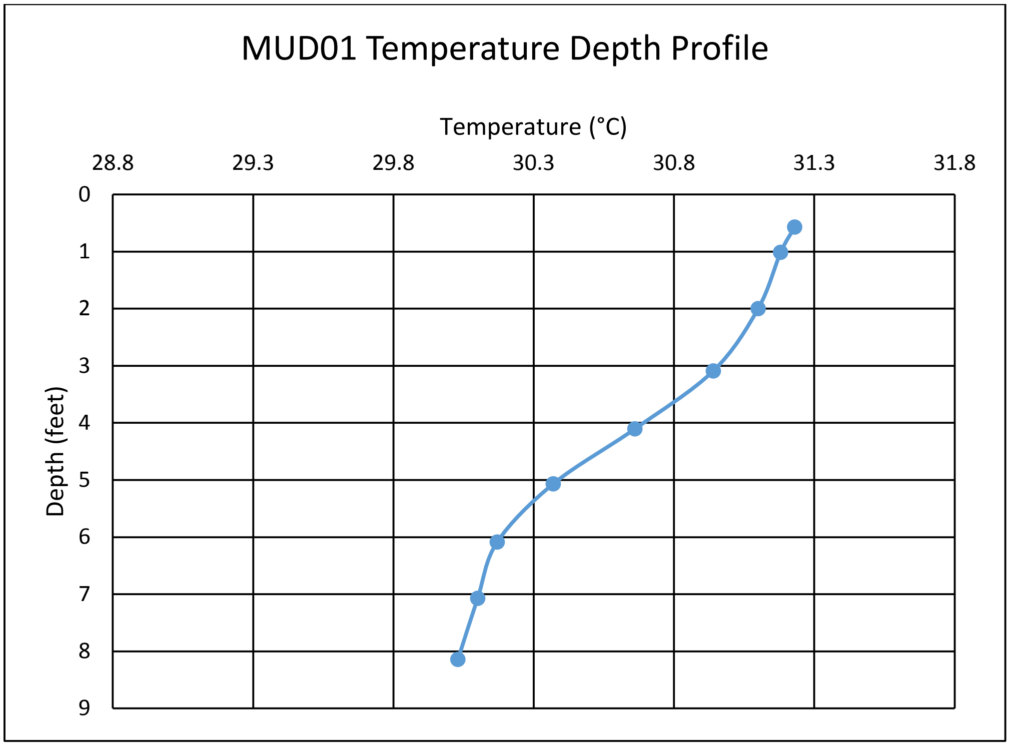


Figure D-5. Depth Profile for Dissolved Oxygen (mg/L) at MUD02.

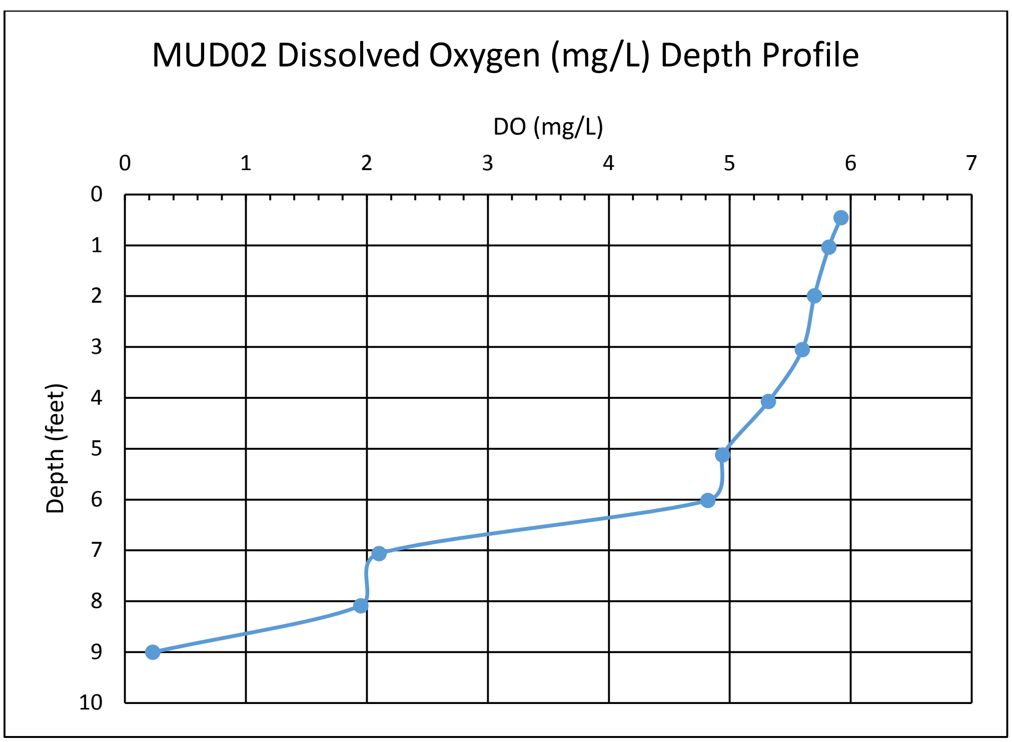


Figure D-6. Depth Profile for pH at MUD02.

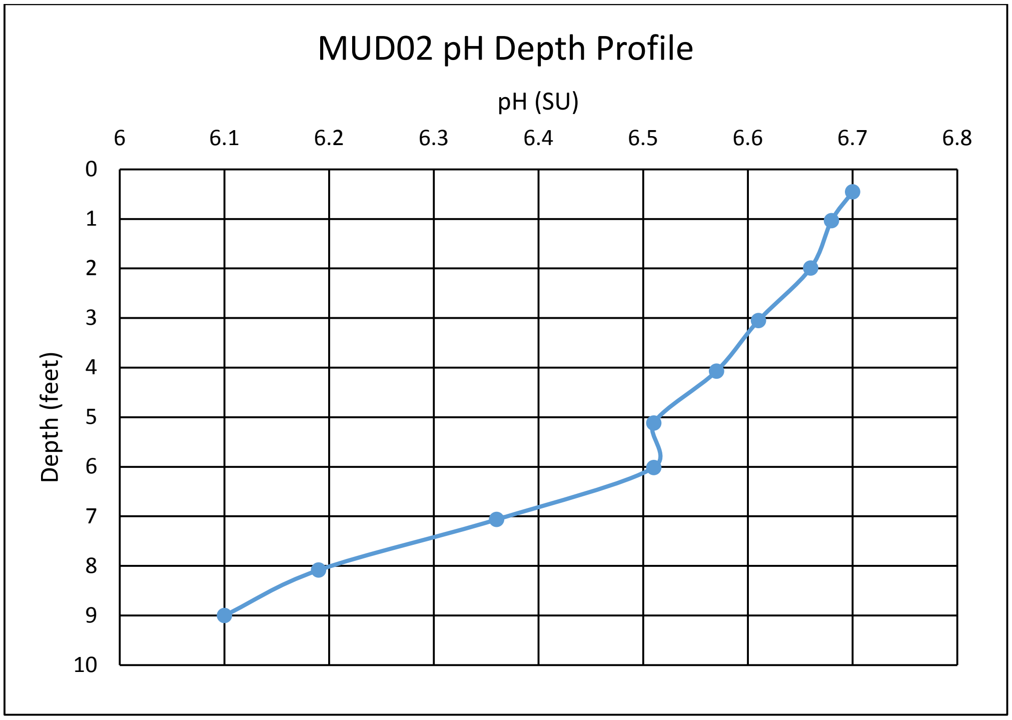


Figure D-7. Depth Profile for Specific Conductivity at MUD02.

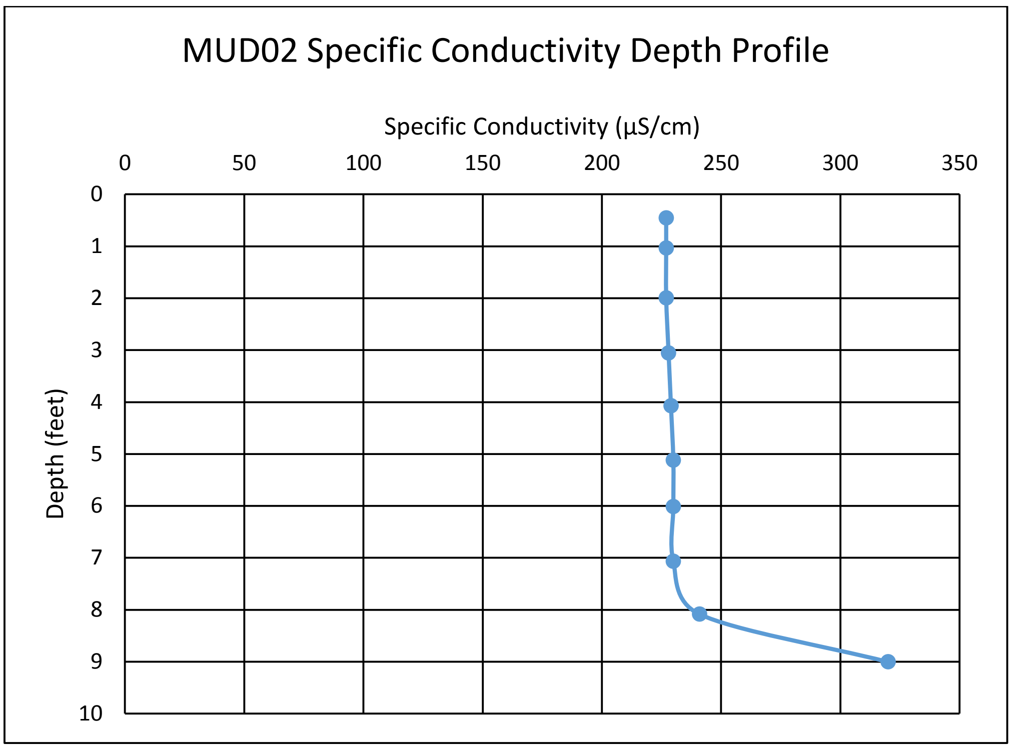
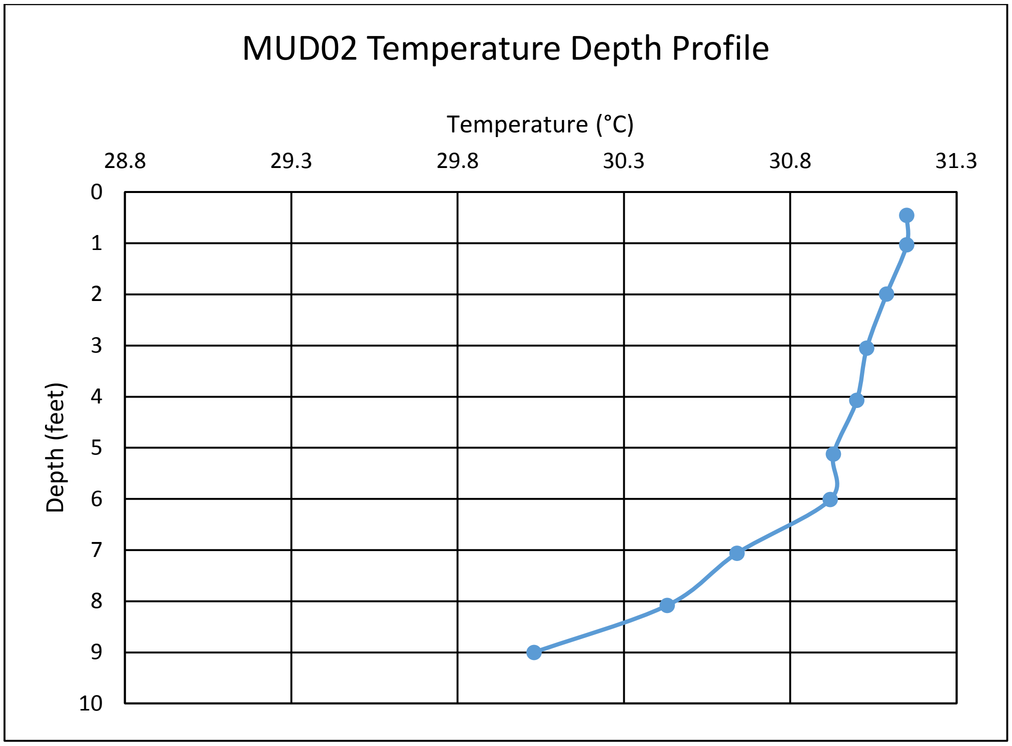


Figure D-8. Depth Profile for Temperature at MUD02.



Appendix E: Water Quality Standards Template Document

Table E-1. Spatial Extent of the Numeric Interpretation of the Narrative Nutrient Criterion: Documentation of location and descriptive information

Location	**Description**
Waterbody Name	Mud Lake
Waterbody Type(s)	Lake
Water Body ID (WBID)	WBID 1467 (See Figure E-1)
Description	Mud Lake is located inside Polk City, Polk County, Florida. The surface area of the lake is 139 acres and the lake's watershed encompasses 1,333 acres. The average depth of the lake is 3.0 feet, with a maximum depth of 9 feet. There are no other significant waterbodies in the watershed. The lake has a control structure at its northeastern end that discharges into an unnamed creek, which eventually flows into Pony Creek. Pony Creek discharges to the Upper Withlacoochee River.
Specific Location (Latitude/ Longitude or River Miles)	The center of Mud Lake is located at N: 28^0 10'13"/ W: -81^0 50'40". The site specific criteria apply as a spatial average for the lake, as defined by WBID 1467.
Map	The general location of Mud Lake and its watershed are shown in Figure E-1, and the land uses of the watershed are shown in Figure E-2 (provided at the end of this document). Land use is predominately urban, with approximately 24.5 percent of the land area developed into medium and high density residential areas. Other land uses include agricultural land use (20.2 percent) and transportation and telecommunication land use (6.3 percent). Surface waters and wetlands combined cover 22.5 percent of the watershed, with wetlands, located primarily along the north shore of the lake, representing approximately 12 percent of the area.
Classification(s)	Class III Freshwater
Basin Name (HUC 8)	Withlacoochee Basin (03100208)

Table E-2. Description of the Numeric Interpretation of the Narrative Nutrient Criterion: Provides specific list of parameters/constituents for which revised water quality criteria are being adopted; Provides sufficient detail on magnitude, duration, and frequency to ensure criteria can be used to verify impairment or delisting in the future; Indicates how criteria developed are spatially and temporally representative of the waterbody or critical condition

Numeric Nutrient Criteria	**Description**
Numeric Nutrient Criteria (NNC) Summary: Default Nutrient Watershed Region or Lake Classification (if applicable) and corresponding numeric nutrient criteria	Mud Lake is high color (> 40 Platinum Cobalt Units), and the default NNC, which are expressed as Annual Geometric Mean (AGM) concentrations not to be exceeded more than once in any three year period, are Chlorophyll *a* (Chla) of 20 µg/L, total nitrogen (TN) of 1.27 mg/L – 2.23 mg/L, and total phosphorus (TP) of 0.05 mg/L – 0.16 mg/L.
Proposed TN, TP, chlorophyll *a*, and/or nitrate+nitrite (Magnitude, Duration, and Frequency)	Numeric Interpretations of the Narrative Nutrient Criterion: TN = 1.10 mg/L, expressed as an annual geometric mean lake concentration not to be exceeded in any year. TP = 0.04 mg/L, expressed as an annual geometric mean lake concentration not to be exceeded in any year. Establishing the frequency as not to be exceeded in any year ensures that a chlorophyll *a* concentration of 20 µg/L as an annual geometric mean, which is protective of the designated use, is achieved in every year.
Period of Record Used to Develop the Numeric Interpretations of the Narrative Nutrient Criterion for TN and TP Criteria	The TN and TP criteria are based on application of an empirical model developed using data from the 1999-2013 period. The primary dataset for this period is the IWR Run 49 database.

Numeric Nutrient Criteria	**Description**
Indicate how criteria developed are spatially and temporally representative of the waterbody or critical condition Are the stations used representative of the entire extent of the WBID and where the criteria area apply? In addition, for older TMDLs, an explanation of the representativeness of the data period is needed (e.g., has data or information become available since the TMDL analysis?). These details are critical to demonstrate why the resulting criteria will be protective as opposed to the otherwise applicable criteria (in cases where a numeric criterion is otherwise in effect unlike this case).	The water quality results applied in the analysis spanned the 1999 - 2013 period, which included both wet and dry years. The annual average rainfall for 1999-2013 was 45.25 inches/year. The years 2000, 2006, 2007, and 2013 were dry years, 1999 and 2008 to 2010 were average years, and 2002 to 2005 and 2011 were wet years. Figure E-3 (below) shows the sampling stations in Mud Lake. The Polk County data collected near the center of the lake at station 21FLPOLKMUD1 were used to develop the regression equations relating nutrient concentrations to chlorophyll *a* levels. The majority of data were collected at this Polk County monitoring station. Results collected at other lake sampling locations were similar to the results observed there. Water quality data for variables relevant to TMDL development are presented in graphs in Appendix D of the Mud Lake TMDL report.

Table E-3. Summary of how the designated use(s) are demonstrated to be protected by the criteria; Summarizes the review associated with the more recent data collected since the development of the TMDL, and evaluates the current relevance of assumptions made in the TMDL development (most likely applicable for existing TMDLs that are subsequently submitted as changes to WQS); Contains sufficient data to establish and support the TMDL target concentrations or resulting loads

Designated Use	**Description**
History of assessment of designated use support.	Mud Lake was initially verified as impaired during the Cycle 1 assessment (the verified period was January 1, 1998, to June 30, 2005) due to excessive nutrients because the Trophic State Index (TSI) threshold of 60 was exceeded using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.). As a result, the lake was included on the Cycle 1 Verified List of impaired waters for the Withlacoochee Basin that was adopted by Secretarial Order on May 6, 2006. During the Cycle 2 assessment (verified period of January 1, 2003, to June 30, 2010), the impairment for nutrients was documented as continuing, as the TSI threshold of 60 was exceeded during high color years and the TSI threshold of 40 was exceeded for low color years. Based on an analysis of the data from 2003 to 2013 in IWR Database Run 49, the results indicate that Mud Lake would not attain the default lake NNC for chlorophyll *a*, TN, and TP for high color lakes, and thus remains impaired for nutrients.
Quantitative indicator(s) of use support	A Chla value of 20 µg/L was selected as the response variable target for use in establishing the nutrient TMDLs. This target is based on information in the Department's 2012 document titled, *Technical Support Document: Development of Numeric Nutrient Criteria for Florida Lakes, Spring Vents and Streams*, which demonstrated that a Chla threshold of 20 µg/L is protective of designated uses for high color lakes.
Summarize Approach Used to Develop Criteria and How it Protects Uses	The methods used to address the nutrient impairment included the development of regression equations that relate the lake TN and TP concentrations to the annual geometric mean chlorophyll *a* levels, with TN and TP values set at the level that achieves the target Chla value. The criteria are expressed as maximum annual geometric mean concentrations not to be exceeded in any year. Establishing the frequency as not to be exceeded in any year ensures that the chlorophyll *a* NNC, which is protective of the designated use, will be achieved in every year.

Designated Use	Description
Discuss how the TMDL will ensure that nutrient related parameters are attained to demonstrate that the TMDL will not negatively impact other water quality criteria. These parameters must be analyzed with the appropriate frequency and duration. If compliance with 47(a) is not indicated within the TMDL, it should be clear that further reductions may be required in the future.	The method indicated that the Chla concentration target for the lake will be attained at the TMDL in-lake TN and TP concentrations. The Department notes that there were no impairments for nutrient- related parameters (such as DO or unionized ammonia). The proposed reductions in nutrient inputs will result in further improvements in water quality.

Table E-4. Documentation of the means to attain and maintain WQS of downstream waters

Downstream Protection and Monitoring	Description
Identification of Downstream Waters: List receiving waters and identify technical justification for concluding downstream waters are protected.	The lake has a control structure at its northeastern end that discharges into an unnamed creek, which eventually flows into Pony Creek. The Mud Lake nutrient concentration targets of 1.10 mg/L for TN and 0.04 mg/L for TP are less than the Peninsula Nutrient Watershed Region thresholds of 1.54 mg/L for TN and 0.12 mg/L for TP that are applicable to Pony Creek. The Peninsula Nutrient Watershed Region stream thresholds, expressed as annual geometric means, may be exceeded once in a three year period and are higher than the annual geometric mean lake TMDL nutrient targets. Since the TMDL nutrient targets are lower than the stream nutrient thresholds for the area and are expressed as a frequency of "not to be exceeded in any year," the TMDL targets are clearly protective of the applicable stream thresholds. The reductions in nutrient concentrations prescribed in the TMDL are not expected to cause nutrient impairments downstream and will result in water quality improvements to downstream waters.
Provide summary of existing monitoring and assessment related to implementation of rule 62-302.531(4) and trends tests within Chapter 62-303, F.A.C.	Polk County conducts routine monitoring of Mud Lake, approximately four times per year. Future monitoring results from Mud Lake will be used to assess the effect of the established site specific numeric interpretation of the narrative nutrient criterion on the lake.

Table E-5. Documentation to demonstrate administrative requirements are met

Administrative Requirements	Description
Notice and comment notifications	The draft TMDL will be provided to the general public for review for a period of 30 days. Public comments on the TMDL will be collected during this period, and responses from the Department will be provided. A public workshop will be held by the Department on June 25, 2015 in Bartow, Florida to present the draft Mud Lake TMDL to local stakeholders. The Department will announce the workshop through a notice published on the Florida Administrative Register (FAR), a TMDL workshop announcement on the Department TMDL homepage and Sharepoint website, an advertisement in a local newspaper, and an email notice to interested parties. After the public comment period ends, if the public comments received by the Department do not result in a significant revision of the TMDL, the Department will publish a Notice of Proposed Rule (NPR) to initiate the TMDL rule adoption process.
Hearing requirements and adoption format used; Responsiveness summary	Following the publication of NPR, the Department will provide a 21 day-challenge period.
Official submittal to EPA for review and GC Certification	If the Department does not receive a challenge, the certification package for the rule will be prepared by the Department's program attorney. At the same time, the Department will prepare the TMDL and Site Specific Interpretation package for the TMDL and submit these documents to EPA.

Figure E-1. Location of the Mud Lake Watershed in North Central Polk County, Florida.

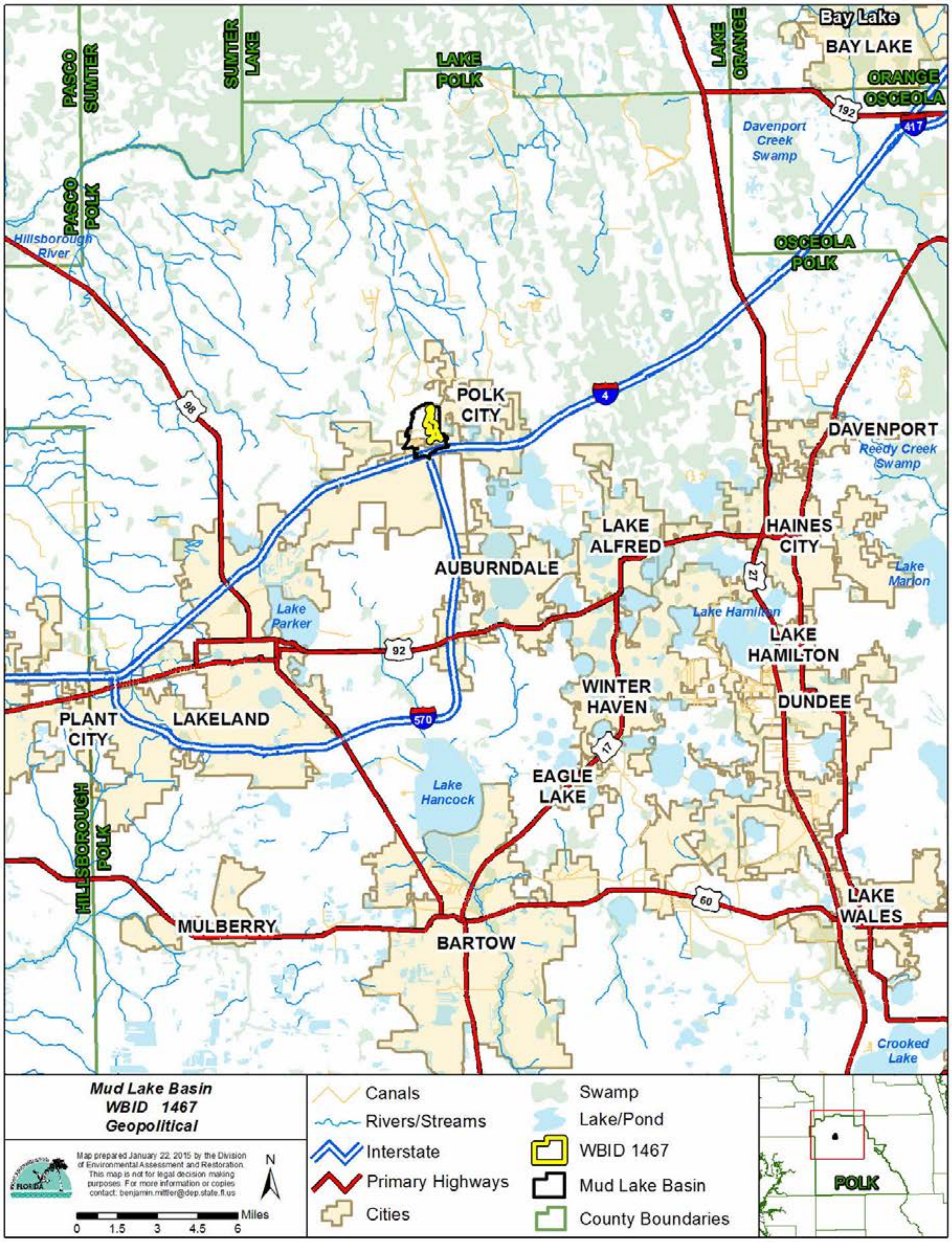


Figure E-2. Mud Lake Watershed Land Use in 2011.

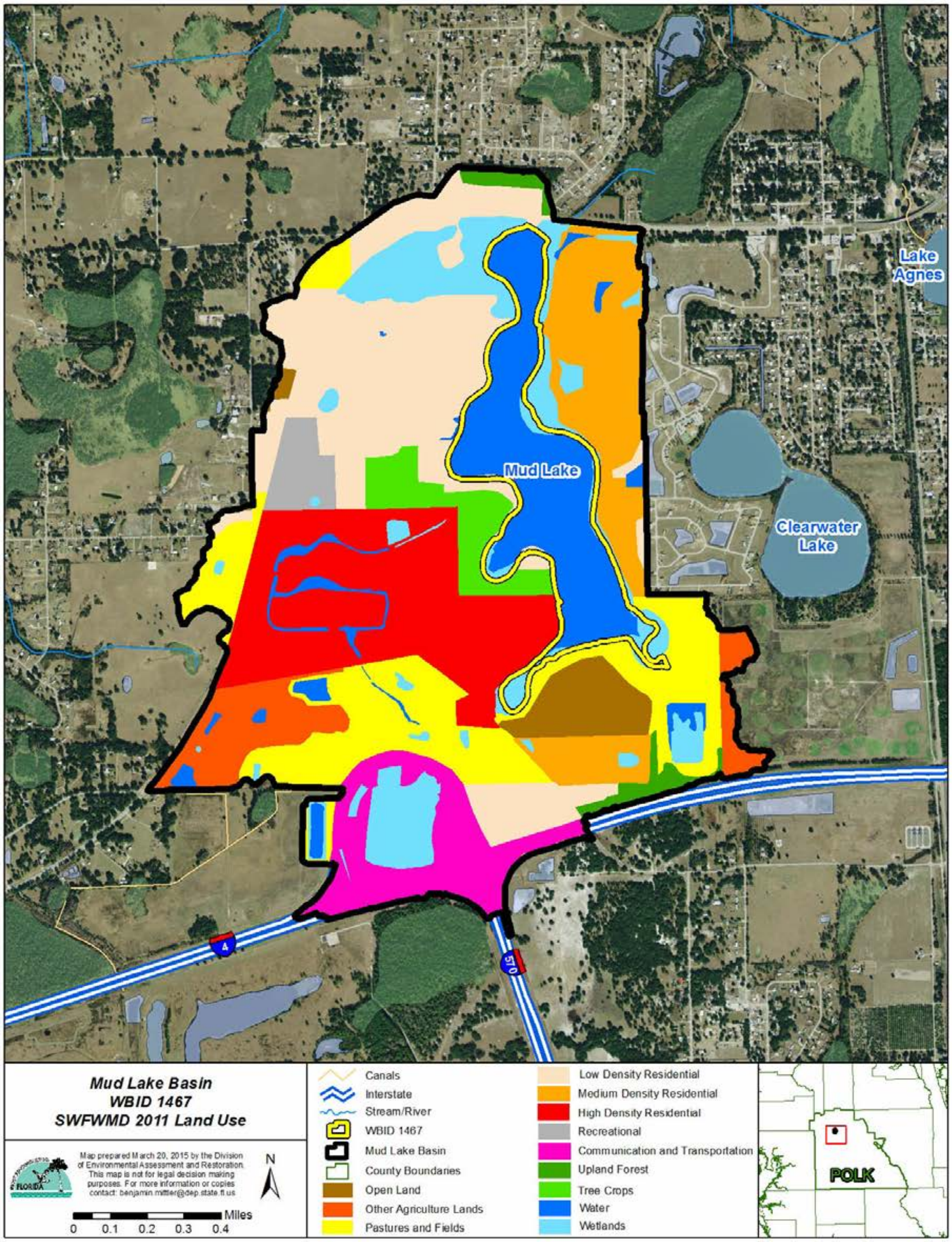


Figure E-3. Mud Lake Sampling Stations.