South District • Kissimmee River Basin

Draft Report

Nutrient TMDLs for Lake Glenada (WBID 1813L), Huckleberry Lake (WBID 1893), Red Water Lake (WBID 1938F), and Lake Placid (WBID 1938C)

Janelle Strong
Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

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2600 Blair Stone Road
Mail Station 3000
Tallahassee, FL 32399-2400
https://floridadep.gov

Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments for the following segments with waterbody identification numbers (WBIDs): Lake Glenada (WBID 1813L), Huckleberry Lake (WBID 1893), Red Water Lake (1938F), and Lake Placid (WBID 1938C). These segments are located in the Kissimmee River Basin in Highlands County, Florida. Lake Glenada is located near the City of Avon Park, Huckleberry Lake is situated near the City of Sebring, and Red Water Lake and Lake Placid are located near the Town of Lake Placid.

These four waterbodies were identified as impaired for nutrients based on elevated chlorophyll *a* concentrations exceeding the numeric nutrient criteria (NNC) in Subsection 62-302.531(2), Florida Administrative Code (F.A.C.). Red Water Lake and Huckleberry Lake were also identified as impaired for nutrients based on elevated total nitrogen (TN) and total phosphorus (TP) concentrations exceeding the NNC in Subsection 62-302.531(2), F.A.C. Lake Glenada, Red Water Lake, and Lake Placid were verified as impaired for nutrients and were included on the Verified List of Impaired Waters for the Kissimmee River Basin Group 4 in Assessment Cycle 3, adopted by Secretarial Order in June 2017. Huckleberry Lake is anticipated to be verified as impaired for nutrients on the Verified List of Impaired Waters for the Kissimmee River Basin Group 4 basin in the 2022 biennial assessment, which will be adopted by Secretarial Order in May 2022.

Theses TMDLs will not constitute site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C. The TMDLs will be based on the generally applicable NNC in Subsection 62-302.531(2), F.A.C.

TMDLs for TN and TP have been developed, and **Table EX-1** lists supporting information for the TMDLs. The TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the U.S. Environmental Protection Agency.

Table EX-1. Summary of TMDL supporting information for Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid

Type of Information	Description
Waterbody name/ WBID number	Lake Glenada/WBID 1813L, Huckleberry Lake/WBID 1893, Red Water Lake/WBID 1938F, and Lake Placid/WBID 1938C
Hydrologic Unit Code (HUC) 8	03090101
Use classification/ Waterbody designation	Class III/Fresh
Targeted beneficial uses	Fish consumption; recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife
303(d) listing status	**Lakes Glenada, Placid, and Red Water:** Placed on the Verified List of Impaired Waters for the Kissimmee River Group 4 Basin adopted via Secretarial Order in June 2017. **Huckleberry Lake:** Anticipated to be included on the Verified List of Impaired Waters for the Kissimmee River Group 4 Basin that will be adopted by Secretarial Order in May 2022.
TMDL pollutants	TN and TP
Generally applicable chlorophyll *a* criterion	**Lake Glenada and Huckleberry Lake are high-color (color ≥ 40 PCU) lakes:** **Chlorophyll *a***: 20 micrograms per liter (µg/L), expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **Red Water Lake and Lake Placid are low-color (color < 40 PCU), low-alkalinity (< 20 mg/L) lakes:** **Chlorophyll *a***: 6 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.
TMDLs	**Lake Glenada (WBID 1813L):** **TN:** 14% reduction to meet the generally applicable NNC for high-color lakes. **TP:** 31% reduction to meet the generally applicable NNC for high-color lakes. **Huckleberry Lake (WBID 1893):** **TN:** 24% reduction to meet the generally applicable NNC for high-color lakes. **TP:** 54% reduction to meet the generally applicable NNC for high-color lakes. **Red Water Lake (WBID 1938F):** **TN:** 64% reduction to meet the generally applicable NNC for low-color, low-alkalinity lakes. **TP:** 50% reduction to meet the generally applicable NNC for low-color, low-alkalinity lakes. **Lake Placid (WBID 1938C):** **TN:** 30% reduction to meet the generally applicable NNC for low-color, low-alkalinity lakes. **TP:** 41% reduction to meet the generally applicable NNC for low-color, low-alkalinity lakes.

Acknowledgments

This analysis was accomplished thanks to significant contributions from staff in the Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration, specifically, the Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, and Watershed Evaluation and TMDL Section. DEP would like to acknowledge Clinton Howerton Jr., Dawn Ritter, and J.D. Forster of Highlands County; Chris Zajac and Catherine Wolden of the Southwest Florida Water Management District; Bert Harris of the Town of Lake Placid; Scott Noethlich of the City of Sebring; and Rick Whalen of the City of Avon Park for the support provided.

For additional information regarding the development of this report, please contact the Division of Environmental Assessment and Restoration office at:

2600 Blair Stone Road
Mail Station 3000
Tallahassee, FL 32399-2400
Phone: (850) 245–8668

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µg/L	Micrograms Per Liter
AGM	Annual Geometric Mean
BMAP	Basin Management Action Plan
BMP	Best Management Practice
$CaCO_3$	Calcium Carbonate
CFR	Code of Federal Regulations
CWA	Clean Water Act
DEP	Florida Department of Environmental Protection
DWM	Dispersed Water Management
EPA	U.S. Environmental Protection Agency
F.	Fahrenheit
F.A.C.	Florida Administrative Code
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FLUCCS	Florida Land Use, Cover and Forms Classification System
F.S.	Florida Statutes
ft	Feet
FWRA	Florida Watershed Restoration Act
HUC	Hydrologic Unit Code
ID	Insufficient Data
in/yr	Inches/Year
IWR	Impaired Surface Waters Rule
LA	Load Allocation
MDL	Minimum Detection Limit
mg/L	Milligrams Per Liter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
NAD	North American Datum
NNC	Numeric Nutrient Criteria
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTDS	Onsite Sewage Treatment and Disposal System
PCU	Platinum Cobalt Unit
PLRG	Pollutant Load Reduction Goal
POR	Period of Record
SFWMD	South Florida Water Management District
STA	Stormwater Treatment Area

SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management (Program)
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
WBID	Waterbody Identification (Number)
WLA	Wasteload Allocation
WWTF	Wastewater Treatment Facility

Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid, located in the Kissimmee River Basin in Highlands County. The TMDLs are established to achieve the generally applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), Florida Administration Code (F.A.C.), and are intended to attain the chlorophyll *a* criteria applicable to each lake. The TMDL targets are not being adopted as Hierarchy 1 site-specific interpretations of the NNC because the generally applicable NNC fully protect designated uses.

The waterbodies are impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.). Lake Glenada, Red Water Lake, and Lake Placid were included on the Verified List of Impaired Waters for the Kissimmee River Basin that was adopted by Secretarial Order in June 2017. Huckleberry Lake is anticipated to be included on the Verified List of Impaired Waters for the Kissimmee River Basin that will be adopted by Secretarial Order in May 2022.

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 criteria based on the relationship between pollutant sources and water quality in the receiving waterbody. The TMDLs establish the allowable nutrient concentrations for Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid and associated nutrient reductions that would restore the waterbodies so that they meet their applicable water quality criteria for nutrients.

1.2 Identification of Waterbodies

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Kissimmee River Basin (Hydrologic Unit Code [HUC] 8 - 03090101) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Glenada is WBID 1813L, Huckleberry Lake is WBID 1893, Red Water Lake is WBID 1938F, and Lake Placid is WBID 1938C. In the Kissimmee River Basin, Lake Glenada and Huckleberry Lake are located in the Lake Istokpoga Planning Unit, and Red Water Lake and Lake Placid are situated in the Lake Placid Planning Unit. **Figure 1.1** shows the location of the WBIDs and their watersheds in the basin. **Figures 1.2** through **1.5** contain detailed maps of the WBIDs and their watersheds, and the major geopolitical and hydrologic features surrounding them.

Lake Glenada (WBID 1813L) is located in Highlands County, south of the City of Avon Park. The lake has an irregular shape and a surface area of 182 acres (University of South Florida

Water Institute 2021), with a mean depth of 7.8 feet (ft) (Romie 2000). Huckleberry Lake (WBID 1893), located just outside the Sebring city limits in Highlands County, has a surface area of 110 acres (University of South Florida Water Institute 2021), with a depth of 26 ft (Foster 2019). Red Water Lake (WBID 1938F), located 4.3 miles northeast of Lake Placid in Highlands County, has a surface area of 71 acres (University of South Florida Water Institute 2021), with a mean depth of 8.2 ft (Romie 2000). Lake Placid (WBID 1938C), located just outside the southern city limits of Lake Placid in Highlands County, is the third largest lake in the county and has a surface area of 3,393 acres (University of South Florida Water Institute 2021), with a mean depth of 20.7 ft (Romie 2000).

Lake Glenada drains via a culvert under West College Drive to a ditch that connects to the southeast corner of Lake Lelia (WBID 1813J), which eventually drains to Carter Creek (WBID 1813) via Lake Lotela (WBID 1813B), Little Bonnet Lake (WBID 1813G), Lake Letta (WBID 1813C), and Bonnet Lake (WBID 1813E). These lakes are part of the Carter Creek Chain of Lakes, which ultimately flows to Lake Istokpoga (WBID 1856B) via Arbuckle Creek (WBID 1761J).

Huckleberry Lake receives water via a canal from the west. It drains to the east via a canal that connects to a stream and flows to Jackson Creek (WBID 1860C), which flows south to Lake Josephine (WBID 1860B). Lake Josephine then drains to Josephine Creek (WBID 1860A) and ultimately flows to Lake Istokpoga (WBID 1856B).

Red Water Lake receives direct discharge from Little Red Water Lake (WBID 1938F1) via a 25-ft-wide and 64-ft-long channel and then drains to Lake Francis (WBID 1938G). Lake Francis drains to Josephine Creek (WBID 1860A) via Jack Creek (WBID 1938Z) and ultimately flows to Lake Istokpoga (WBID 1856B).

Lake Placid receives surface runoff inflow from Lake Annie (WBID 1938H), a small lake to the south, and from two small surface drainages southwest of the lake. The lake drains northwest to Lake June in Winter (WBID 1938A), which discharges northward to a canal that empties into Jack Creek. Jack Creek flows northward to Josephine Creek (WBID 1860A), which then flows to Lake Istokpoga (WBID 1856B).

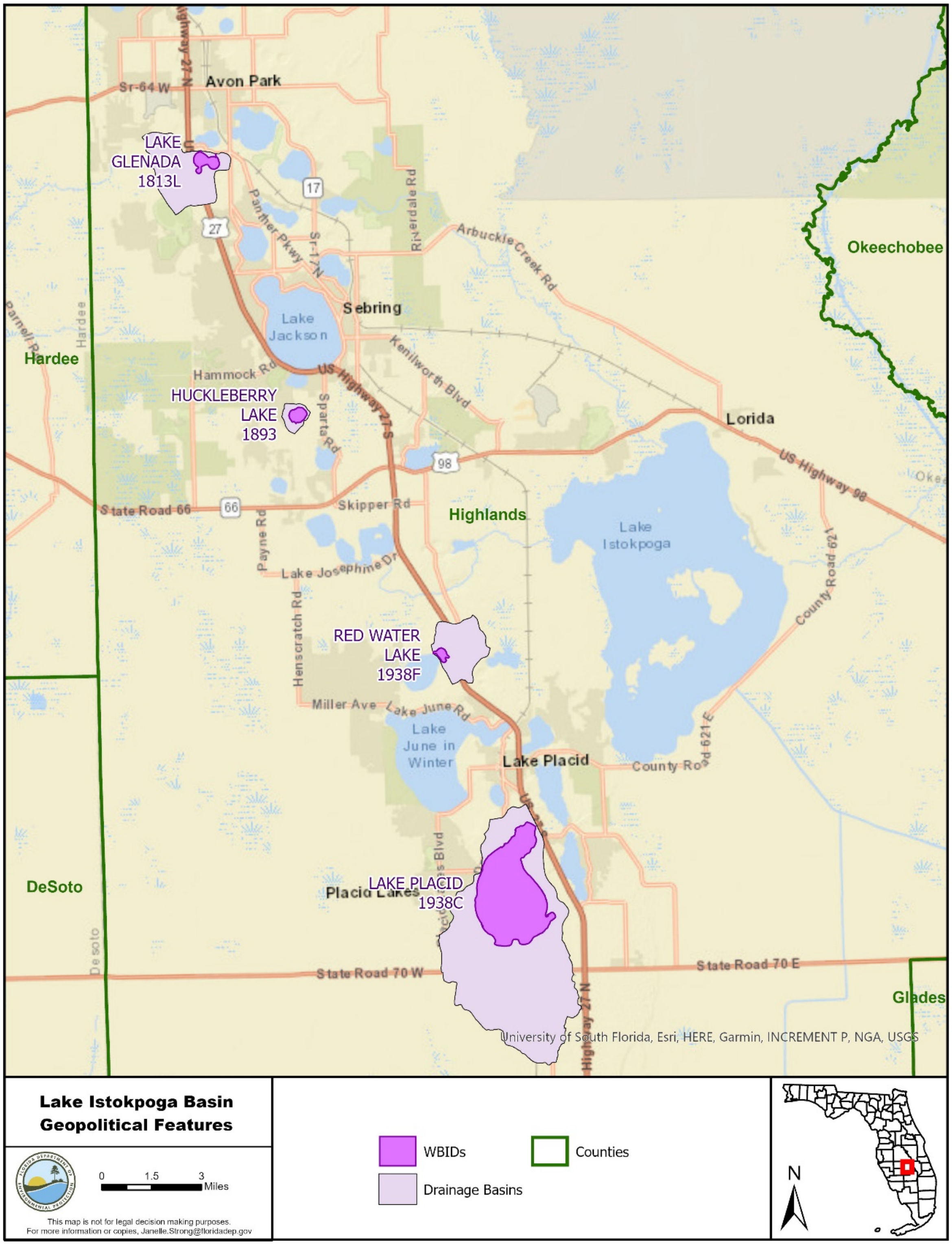

Figure 1.1. Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds and major hydrologic features in the Kissimmee River Basin

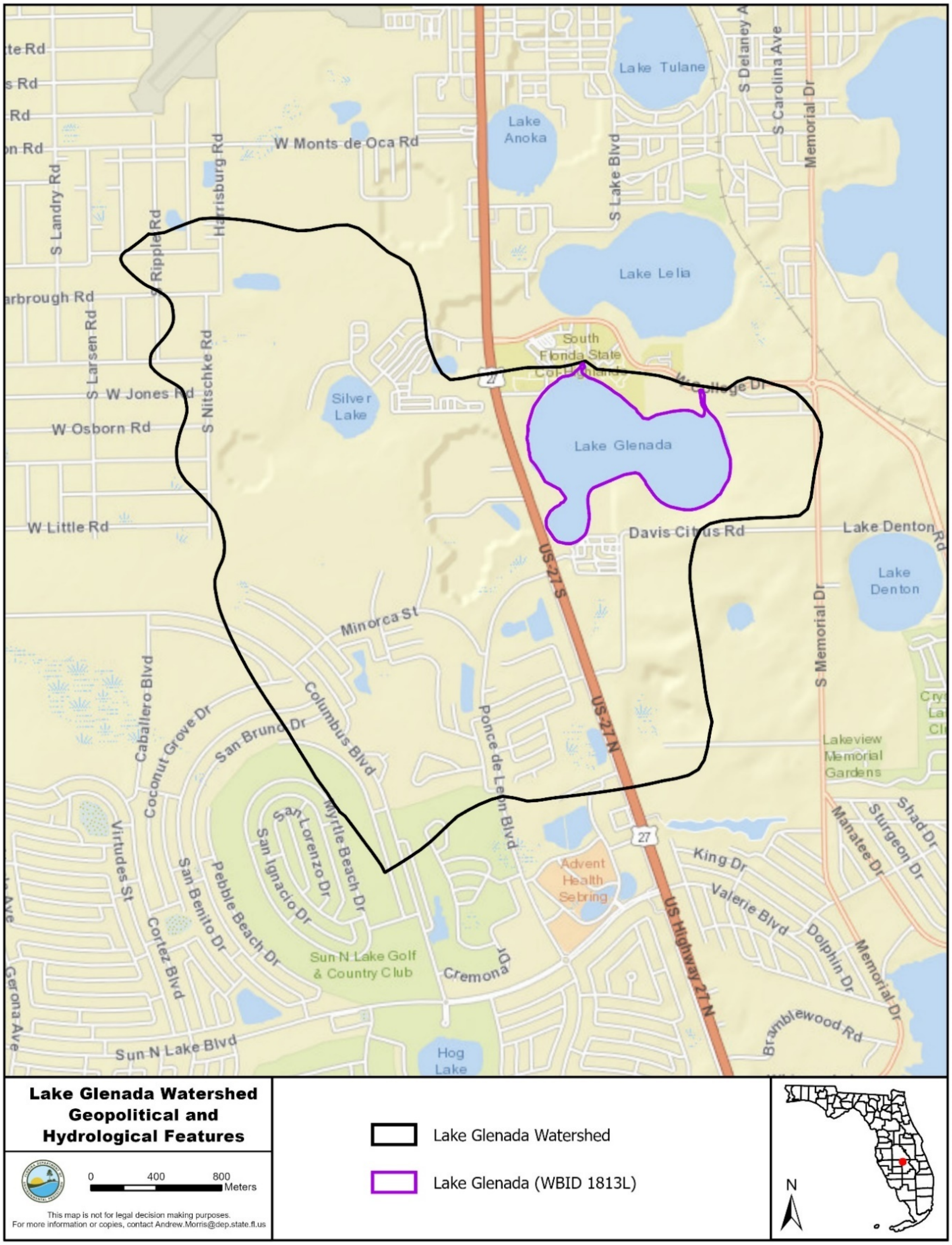

Figure 1.2. Lake Glenada (WBID 1813L) and the Lake Glenada Watershed

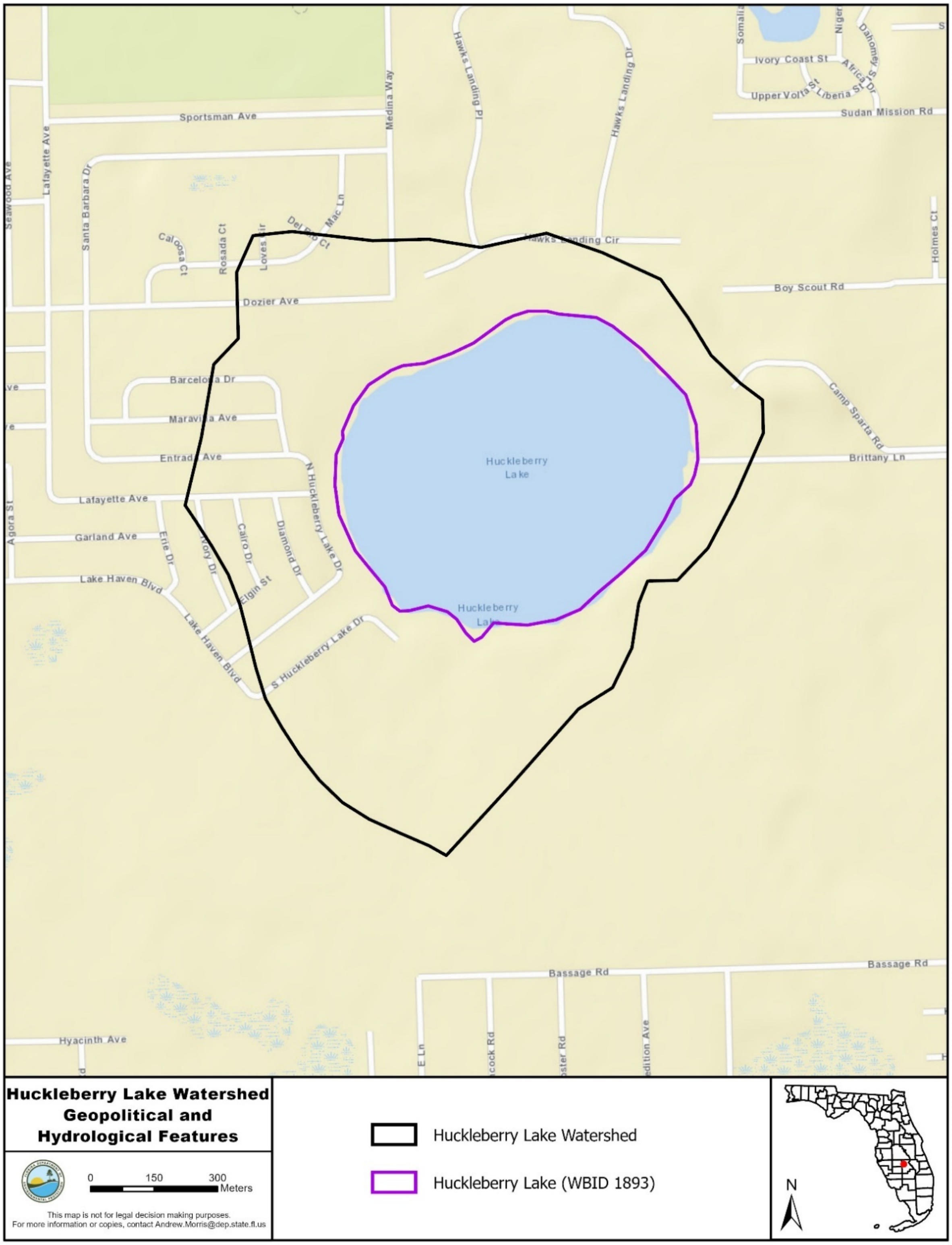

Figure 1.3. Huckleberry Lake (WBID 1893) and the Huckleberry Lake Watershed

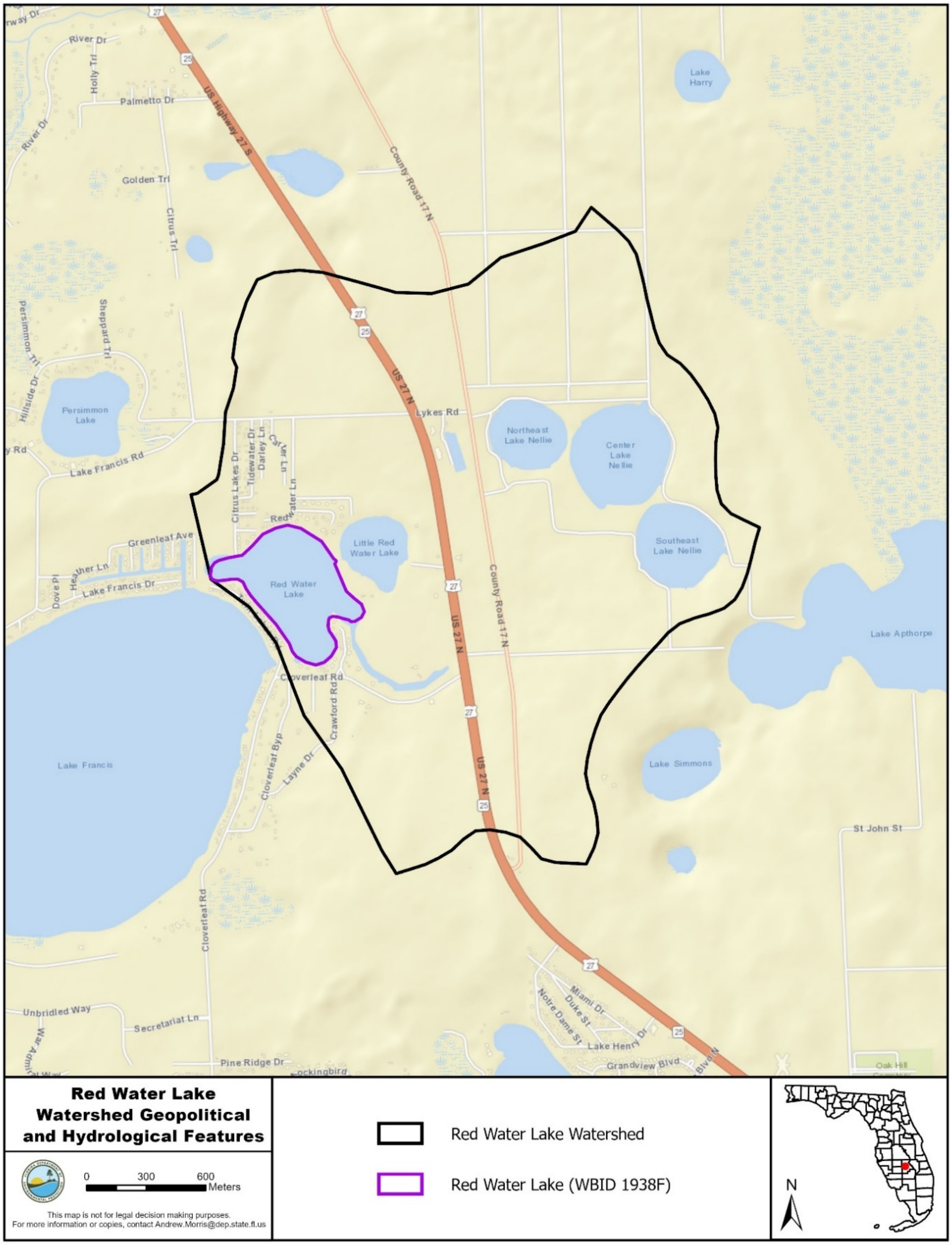

Figure 1.4. Red Water Lake (WBID 1938F) and the Red Water Lake Watershed

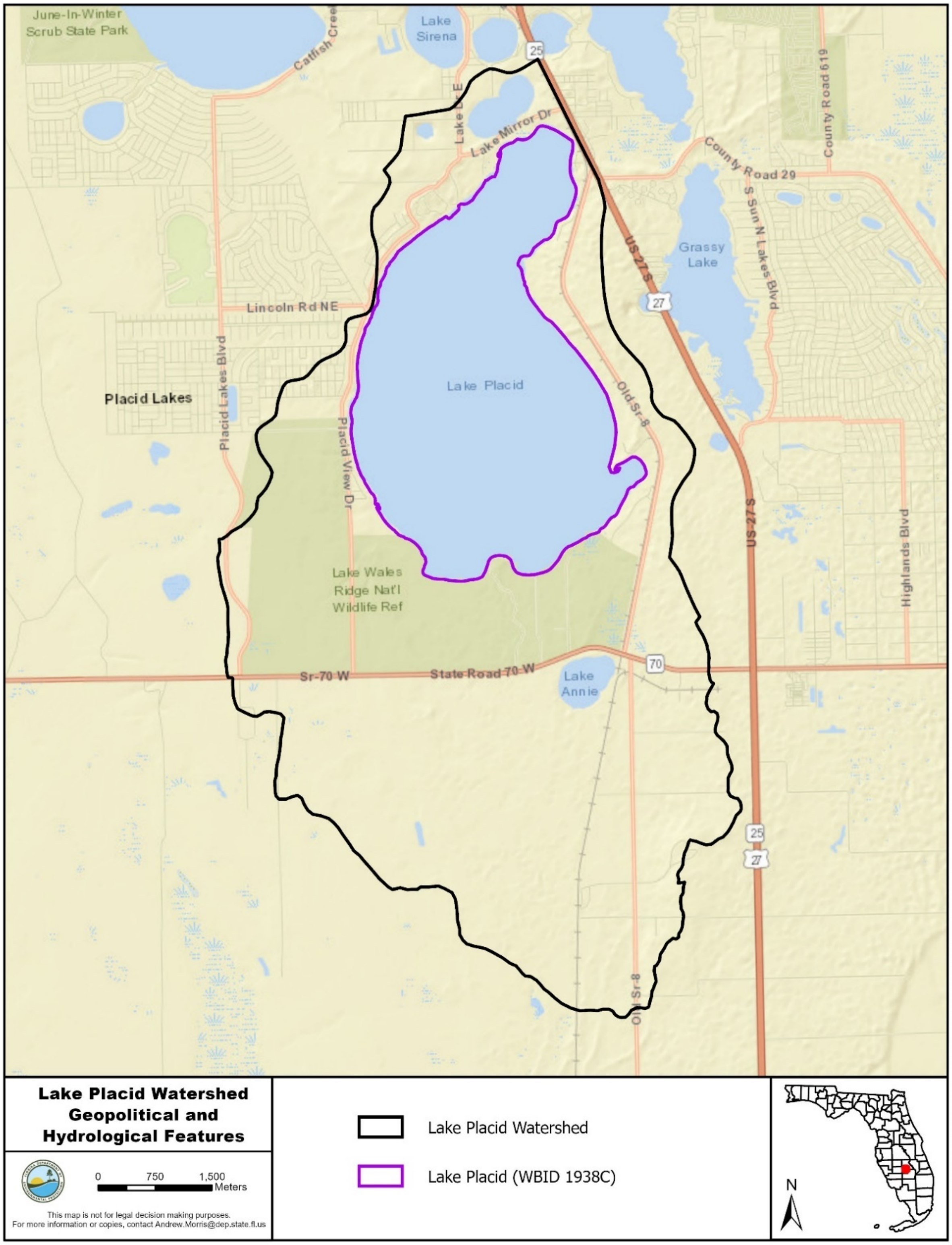

Figure 1.5. Lake Placid (WBID 1938C) and the Lake Placid Watershed

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid, and their respective watersheds, are all located in Highlands County. Lake Glenada is located in the northwest portion of the county, Huckleberry Lake in the west portion, Red Water Lake in the central portion, and Lake Placid in the south-central portion. According to the data (U.S. Census Bureau 2020), the population of Highlands County is 101,235, with a density of 99.5 persons per square mile. Highlands County occupies a land area of 1,017 square miles and has 56,107 housing units, with a housing density of 55.2 houses per square mile (U.S. Census Bureau 2019).

Highlands County has three incorporated cities: Avon Park, Sebring (the county seat), and the Town of Lake Placid. Lake Glenada is located just south of the City of Avon Park. Huckleberry Lake is situated south of the City of Sebring. Lake Placid is located south of the Town of Lake Placid, while Red Water Lake is located north of the Town of Lake Placid.

1.3.2 Topography

Lake Glenada, Huckleberry Lake, and Red Water Lake lie in the Lake Wales Ridge Transition (75-34) lake region, which includes the ridge margin or transition lakes that are darker colored with higher nutrients than the lakes found in the Southern Lake Wales Ridge (75-33) lake region (Griffith et al. 1997). There are more extensive areas of poorly drained soils, such as the Satellite and Basinger series. Peaty muck Samsula soils border many of the lakes. The lake region also includes the narrow Bombing Range Ridge on the east and a small area of upland soils near Lake Buffum on the west. Most of the lakes are acidic, although about one-third of them tend to be alkaline. They have low to moderate nutrients and are slightly to moderately colored (Griffith et al. 1997).

Lake Placid lies in the Southern Lake Wales Ridge (75-33) lake region, which contains part of the southern ridge and the Intraridge Valley where there are mostly clearwater lakes. Soils are generally in the sandy, well-drained Astatula–Paola–Tavares association. Lakes in the region range from acidic to alkaline, but almost all are clear with low color and low nutrients (Griffith et al. 1997).

The elevations in the Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds range from 75 to 210 feet (ft) North American Datum 1983 (NAD). The elevation in the Lake Glenada Watershed ranges from 120 to 160 ft NAD, in the Huckleberry Lake Watershed from 105 to 120 ft NAD, in the Red Water Lake Watershed from 75 to 140 ft NAD, and in the Lake Placid Watershed from 95 to 210 ft NAD.

1.3.3 Hydrogeological Setting

The greater hydrogeological context in which these lakes function is determined in part by the topography, but also by their similar soil geology, aquifer/groundwater interactions, and climate. The most prominent topographic feature of the Highlands County area is the Lake Wales Ridge (White 1970; Spechler 2010). The Lake Wales Ridge is characterized by numerous surface depressions and closed basin lakes, and its valley was formed by the dissolution of the underlying limestone and contains numerous karst features (Spechler 2010).

The climate of these watersheds is classified as subtropical and is characterized by hot, wet summers and relatively dry winters. During the summer months, daily maximum air temperatures usually exceed 90° F, with an annual average temperature of 73° F. (World Media Group, LLC 2021). The long-term average annual rainfall in Highlands County is 51 inches/year (in/yr), based on South Florida Water Management District (SFWMD) records from 1991 to 2020. There is a defined rainy season from June to September, with 55 % to 60 % of the rainfall occurring in that period (SFWMD 2021).

The hydrologic characteristics of soil can significantly influence the capability of a watershed to hold rainfall or produce surface runoff. Soils are generally classified as one of four major types based on their hydrologic characteristics (Viessman et al. 1989). Type A soils have high infiltration rates even if thoroughly wetted. They consist chiefly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission. Type B soils have moderate infiltration rates if thoroughly wetted. They consist chiefly of moderately deep to deep, moderately well-drained to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. Type C soils have slow infiltration rates if thoroughly wetted. They consist chiefly of soils with a layer that impedes the downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission. Type D soils have very slow infiltration rates if thoroughly wetted. They consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

Tables 1.1 through **1.4** show that Type A and A/D soils are predominant in each of the watersheds. Type A/D soil has Type A soil characteristics when unsaturated but behaves like Type D soil when saturated. **Figures 1.6** through **1.9** contain detailed maps of the soil hydrologic groups in each watershed. The maps are based on the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) 2010 dataset developed by the National Cooperative Soil Survey.

Table 1.1. Hydrologic soil groups and acreages in the Lake Glenada Watershed

Lake Glenada Watershed		
Hydrologic Soil Group	Area (acres)	%
A	1,307	55
A/D	730	31
B/D	145	6
Unspecified	201	8
Total	2,383	100

Table 1.2. Hydrologic soil groups and acreages in the Huckleberry Lake Watershed

Huckleberry Lake Watershed		
Hydrologic Soil Group	Area (acres)	%
A	20	6
A/D	205	61
Unspecified	110	33
Total	335	100

Table 1.3. Hydrologic soil groups and acreages in the Red Water Lake Watershed

Red Water Lake Watershed		
Hydrologic Soil Group	Area (acres)	%
A	1,119	75
A/D	130	9
B/D	45	3
Unspecified	192	13
Total	1,486	100

Table 1.4. Hydrologic soil groups and acreages in the Lake Placid Watershed

Lake Placid Watershed		
Hydrologic Soil Group	Area (acres)	%
A	4,111	32
A/D	5,224	40
B/D	131	1
Unspecified	3,571	27
Total	13,037	100

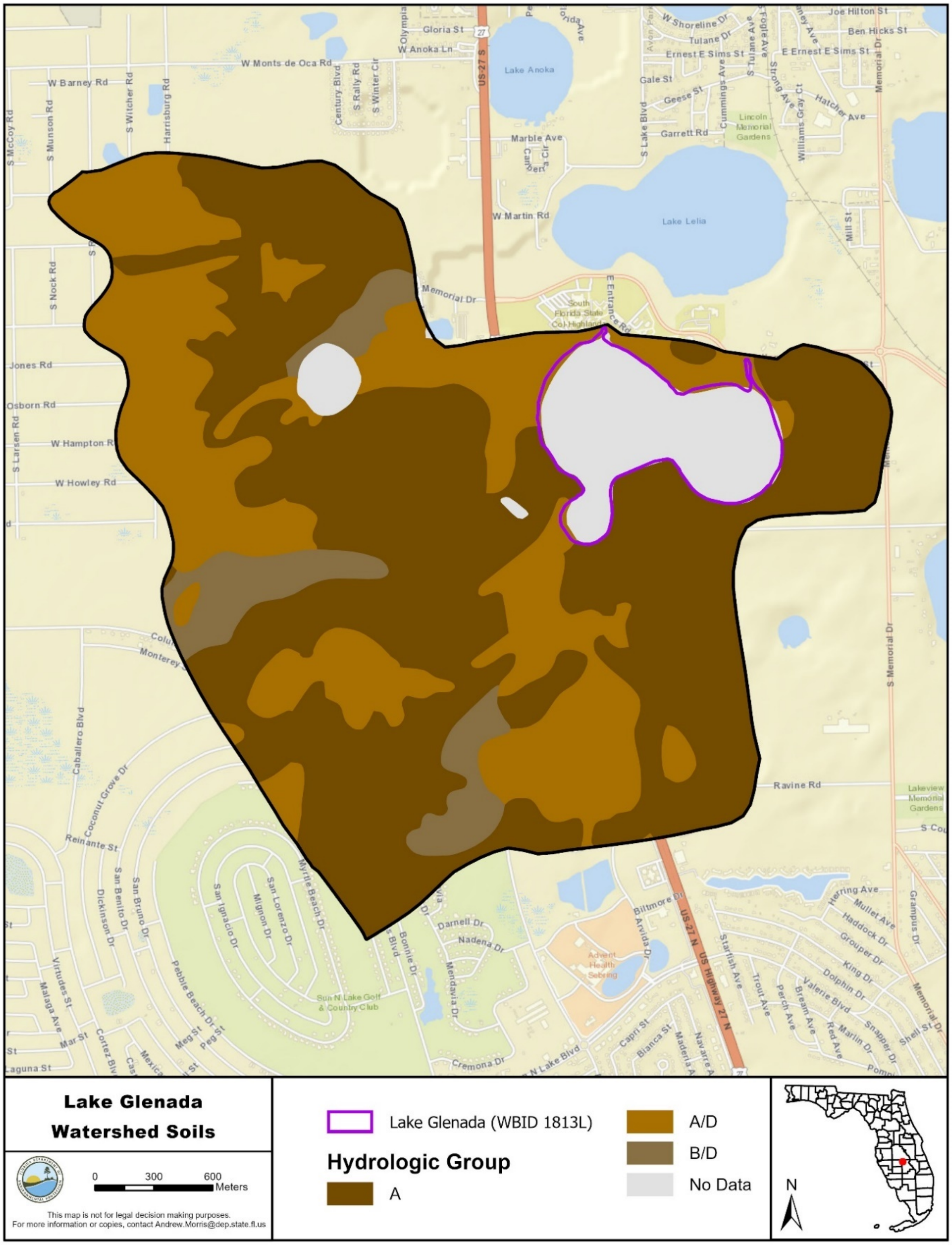

Figure 1.6. Hydrologic soil groups in the Lake Glenada Watershed

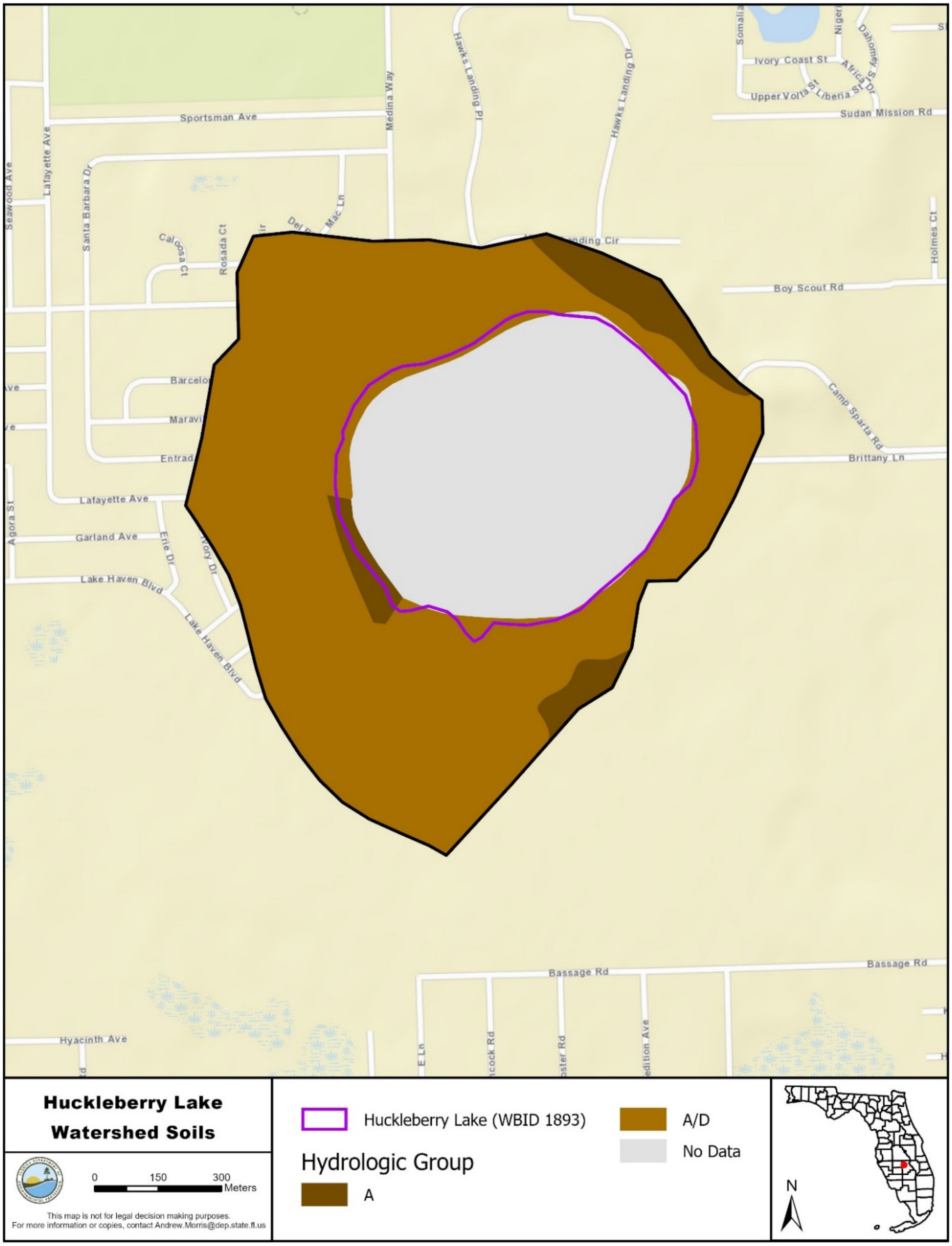

Figure 1.7. Hydrologic soil groups in the Huckleberry Lake Watershed

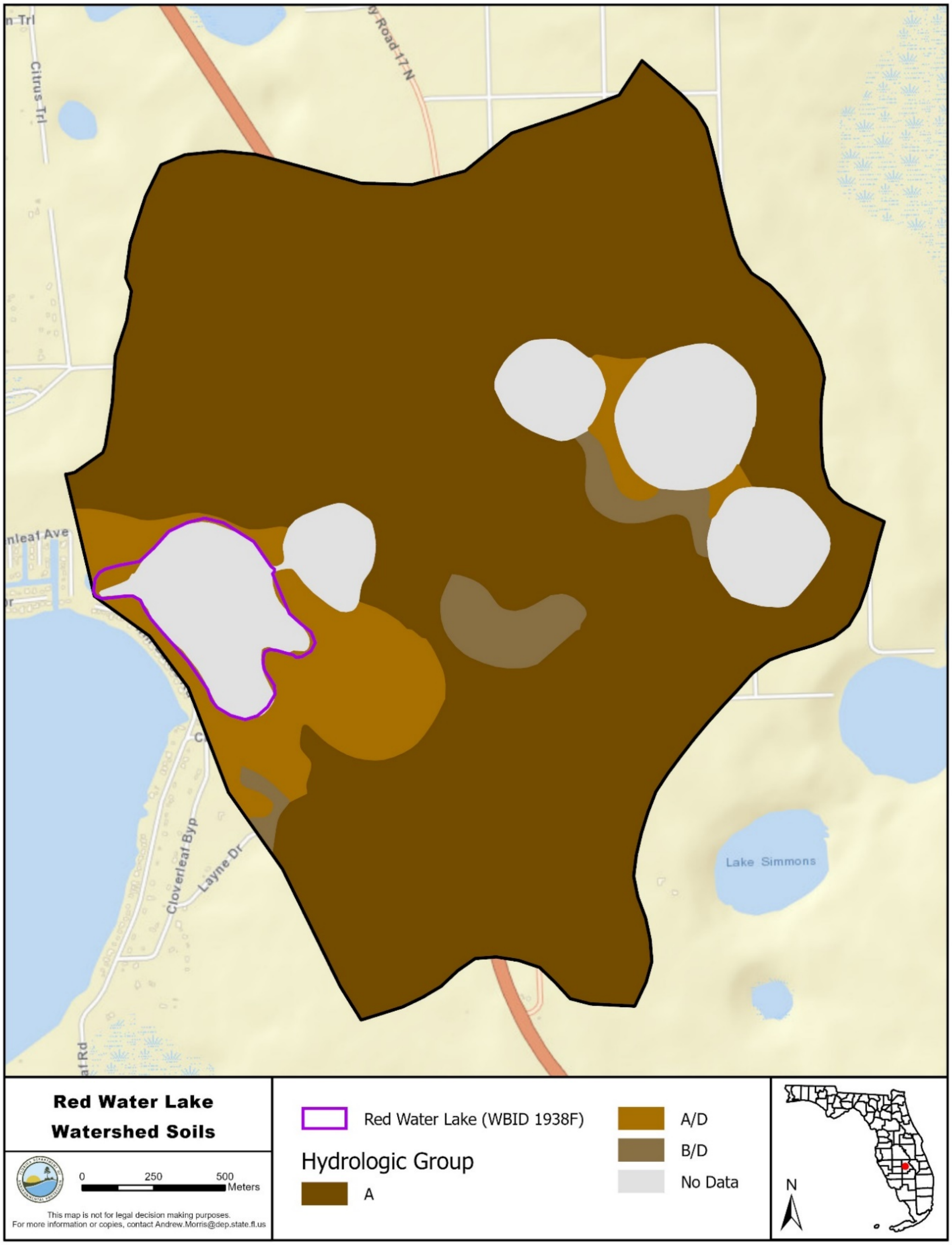

Figure 1.8. Hydrologic soil groups in the Red Water Lake Watershed

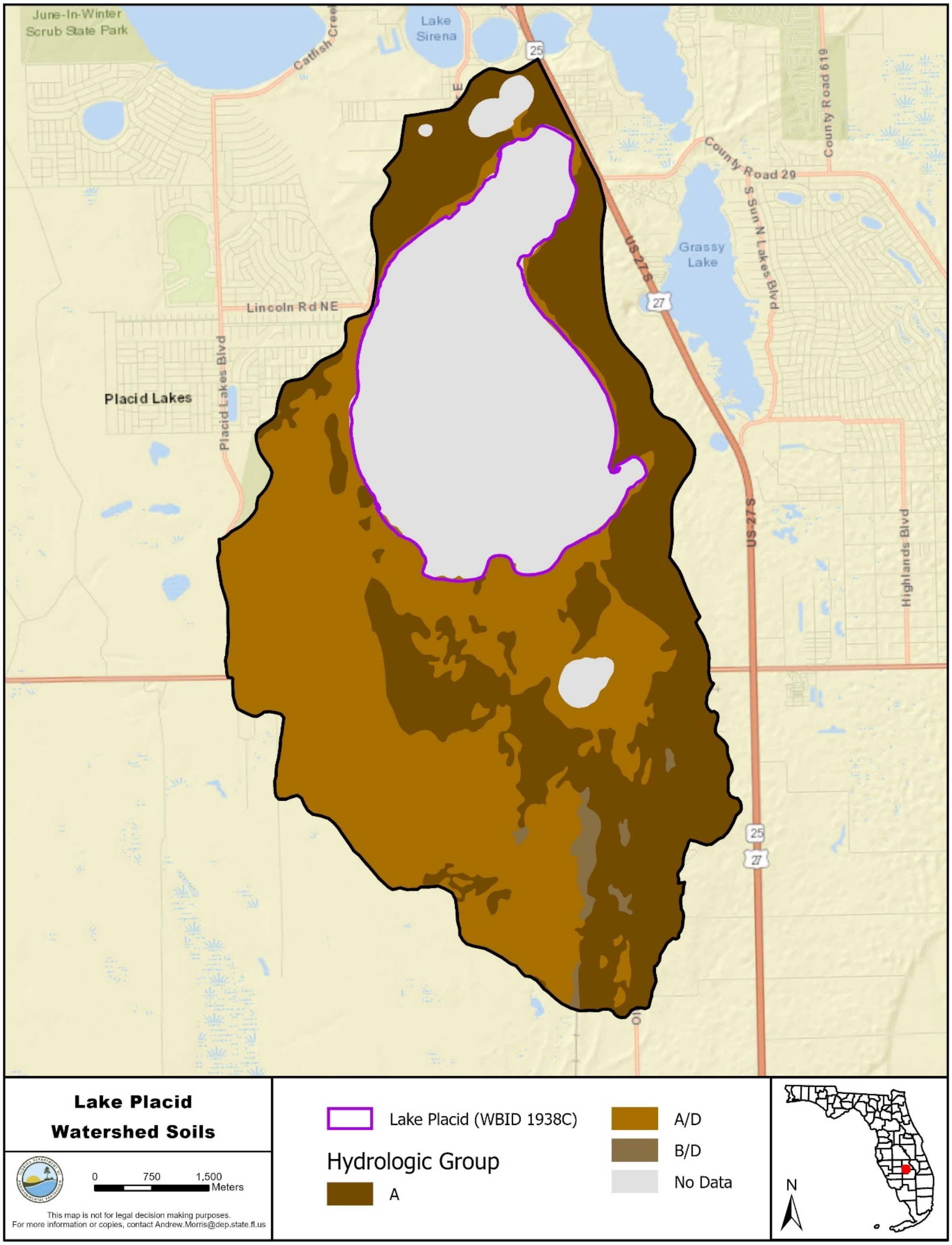

Figure 1.9. **Hydrologic soil groups in the Lake Placid Watershed**

Chapter 2: Water Quality Assessment and Identification of Pollutants of Concern

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act (CWA) requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. DEP has developed such lists, commonly referred to as 303(d) lists, since 1992.

The Florida Watershed Restoration Act (FWRA) (Section 403.067, Florida Statutes [F.S.]) directed DEP to develop, and adopt by rule, a science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the methodology as Chapter 62-303, F.A.C. (the IWR), in 2001. The rule was amended in 2006, 2007, 2012, 2013, and 2016.

The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], F.S.). In the past, the state's 303(d) list has been amended annually to include basin updates for 20% of the state every year, conducted as part of a rotating basin approach to cover the whole state every five years. However, the state's 303(d) list will soon be amended biennially and consist of a statewide assessment every two years, beginning with the 2022 biennial assessment.

2.2 Classification of the Waterbodies and Applicable Water Quality Standards

Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid are Class III (fresh) waterbodies, with a designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairments for these waterbodies is Florida's nutrient criterion in Paragraph 62-302.530(48)(b), F.A.C. Florida adopted NNC for lakes, spring vents, and streams in 2011. These were approved by the EPA in 2012 and became effective in 2014.

The applicable lake NNC are dependent on alkalinity, measured in milligrams per liter (mg/L) as calcium carbonate ($CaCO_3$), and true color (color), measured in platinum cobalt units (PCU), based on long-term period of record (POR) geometric means. For the purpose of Subparagraph 62-302.531(2)(b)1., F.A.C., color is assessed as true color and should be free from turbidity. Lake color and alkalinity are based on a minimum of 10 data points over at least 3 years with at least 1 data point in each year.

Using this threshold for data sufficiency from the POR, Lake Glenada and Huckleberry Lake are classified as high-color (> 40 PCU) lakes. Red Water Lake and Lake Placid are classified as low-color (≤ 40 PCU), low-alkalinity (≤ 20 mg/L $CaCO_3$) lakes, as shown in **Table 2.1**. The POR data for Lake Glenada, Red Water Lake, and Lake Placid were taken from IWR Database Run 53, while the POR data for Huckleberry Lake were taken from IWR Database Run 60.

Table 2.1. Long-term geometric means for color and alkalinity for the POR

Waterbody	POR for Color	Long-Term Geometric Mean Color (PCU)	POR for Alkalinity	Long-Term Geometric Mean Alkalinity (mg/L $CaCO_3$)
Lake Glenada	1984–2014	49	1973–2014	37
Huckleberry Lake	1984–2020	92	2004–2020	24
Red Water Lake	1984–2016	26	2004–2016	16
Lake Placid	1966–2015	10	1968–2012	6

Table 2.2 lists the NNC for Florida lakes specified in Subparagraph 62-302.531(2)(b)1., F.A.C. The relevant row for Lake Glenada and Huckleberry Lake is the top row corresponding to high-color lakes (color > 40 PCU). The relevant row for Lake Placid and Red Water Lake is the bottom row corresponding to low-color, low-alkalinity lakes (color ≤ 40 PCU; alkalinity ≤ 20 mg/L $CaCO_3$). The chlorophyll *a* NNC for high-color lakes is an annual geometric mean (AGM) value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any consecutive 3-year period. The chlorophyll *a* NNC for low-color, low-alkalinity lakes is an AGM value of 6 µg/L, not to be exceeded more than once in any consecutive 3-year period.

The TN and TP criteria for a lake can vary annually. If there are sufficient data to calculate an AGM for chlorophyll *a* and the AGM does not exceed the chlorophyll a criterion for the lake type listed in **Table 2.2**, then the corresponding numeric interpretations for TN and TP are the maximum values. If there are insufficient data to calculate the AGM for chlorophyll *a* for a given year, or the AGM for chlorophyll *a* exceeds the values in the table for the lake type, then the corresponding numeric interpretations for TN and TP are the minimum values.

Table 2.2. Chlorophyll *a*, TN, and TP criteria for Florida lakes (Subparagraph 62-302.531[2][b]1., F.A.C)

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

Note: Values shown in boldface type and shaded represent the relevant NNC for Lake Glenada and Huckleberry Lake (top) and Red Water Lake and Lake Placid (bottom)

Long-Term Geometric Mean Lake Color and Alkalinity	AGM Chlorophyll *a* (µg/L)	Minimum Calculated AGM TP NNC (mg/L)	Minimum Calculated AGM TN NNC (mg/L)	Maximum Calculated AGM TP NNC (mg/L)	Maximum Calculated AGM TN NNC (mg/L)
>40 PCU	**20**	**0.05**	**1.27**	0.16*	2.23
≤ 40 PCU and > 20 mg/L $CaCO_3$	20	0.03	1.05	0.09	1.91
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	**6**	**0.01**	**0.51**	0.03	0.93

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

The sources of lake nutrient data used in the verified assessment periods for Lake Glenada, Red Water Lake, and Lake Placid (2009–16), and for Huckleberry Lake (2013–20), are stations sampled by the Southwest Florida Water Management District (SWFWMD) (21FLSWFD) and DEP (21FLFTM, 21FLGW). **Figures 2.1** through **2.4** show these sampling locations in Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid, respectively.

More than 40 % of the data used in the assessment of Lake Glenada come from SWFWMD Station 21FLSWFD25512. The rest of the data come from 7 DEP stations located throughout Lake Glenada.

The data used in the assessment of Huckleberry Lake come from DEP Stations 21FLFTM 26010669FTM and 21FLFTM G4SD0166, located at the center of Huckleberry Lake.

The majority of the data used in the assessment of Red Water Lake come from SWFWMD Station 21FLSWFD23712 and DEP Station 21FLFTM 26010694FTM. Additional data come from 3 other DEP stations. The stations are located throughout Red Water Lake.

The majority of the data used in the assessment of Lake Placid come from SWFWMD Stations 21FLSWFD23832 and 21FLSWFD23833. Additional data come from 3 DEP stations. The stations are located throughout Lake Placid.

The individual water quality measurements discussed in this report for the verified assessment period from 2009 through 2016 are available in IWR Database Run 53. The individual water quality measurements discussed in this report for the verified assessment period from 2013 through 2020 are available in IWR Database Run 60. These water quality measurements are available on request.

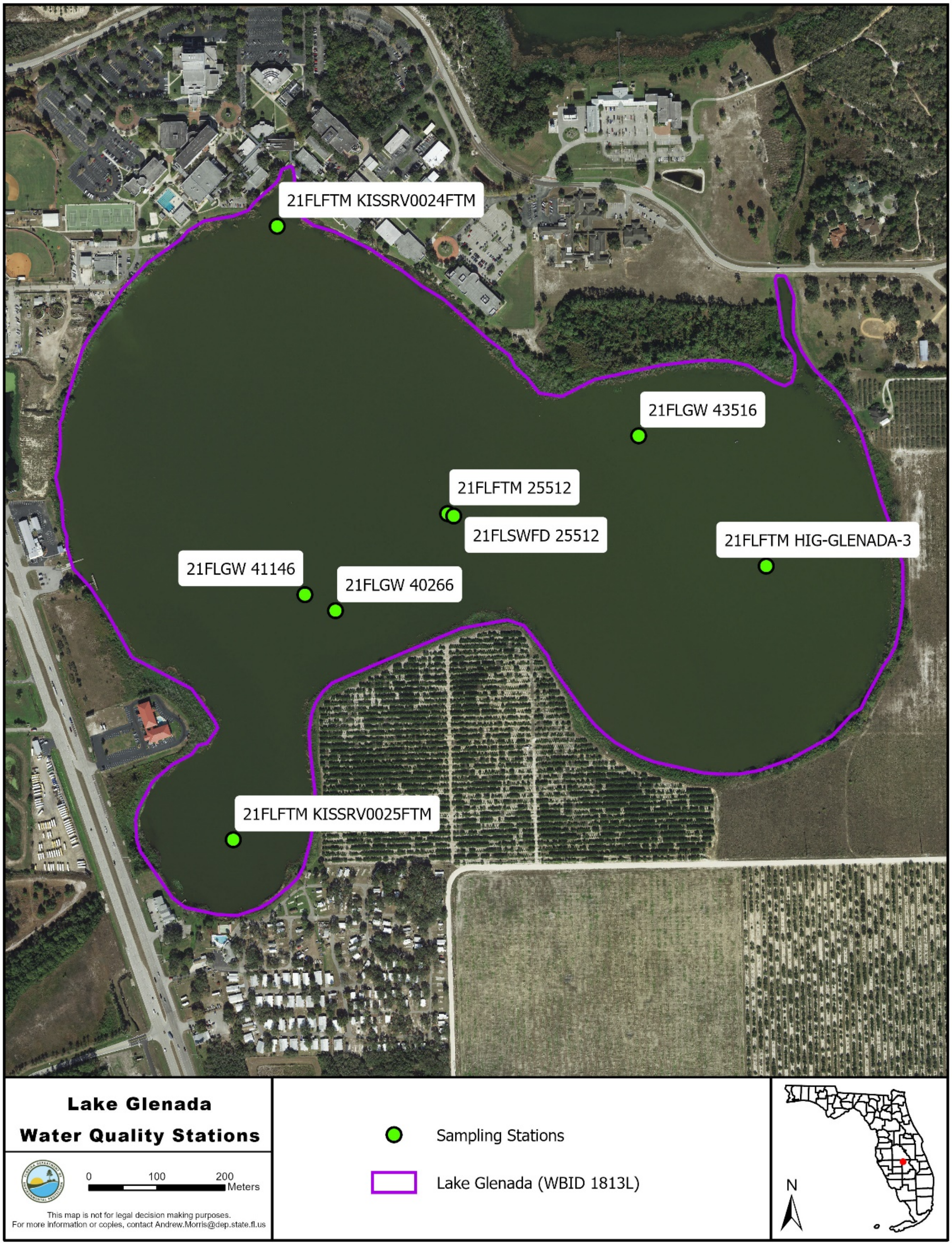

Figure 2.1. Water quality monitoring stations in Lake Glenada

Figure 2.2. Water quality monitoring stations in Huckleberry Lake

Figure 2.3. Water quality monitoring stations in Red Water Lake

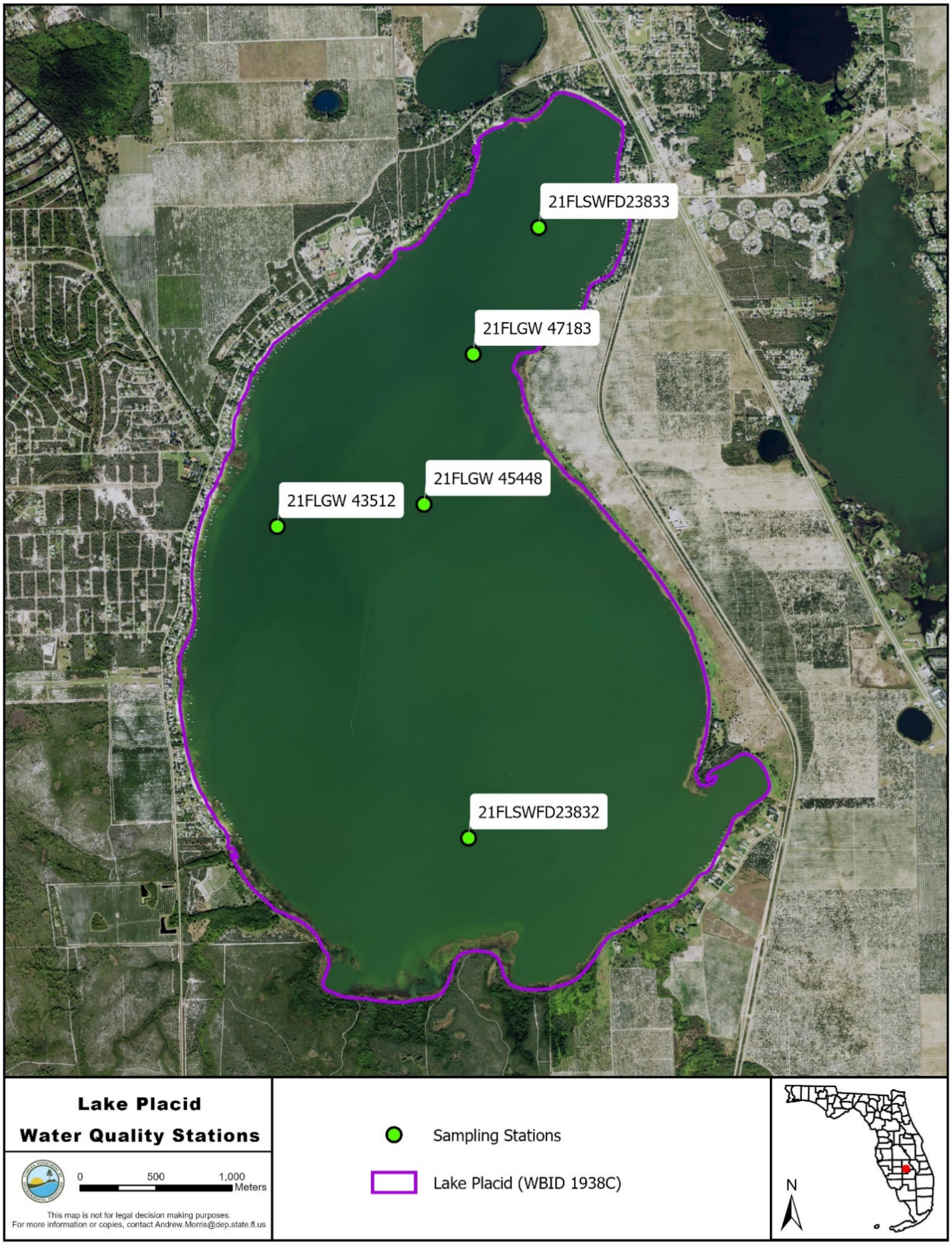

Figure 2.4. Water quality monitoring stations in Lake Placid

2.3.2 Information on Verified Impairment

Lake Glenada (WBID 1813L), Red Water Lake (WBID 1938F), and Lake Placid (WBID 1938C) were assessed for lake NNC as part of the Group 4, Cycle 3 IWR assessment. The verified period was January 1, 2009, through June 30, 2016. Data for the Group 4, Cycle 3 IWR assessment are stored in the IWR Run 53 Access database.

Huckleberry Lake (WBID 1893) was assessed for lake NNC as part of the first statewide biennial IWR assessment. The verified period was January 1, 2013, through June 30, 2020. Data for the statewide biennial IWR assessment are stored in the IWR Run 60 Access database.

Tables 2.3 through **2.5** list the AGM values for chlorophyll *a*, TN, and TP during the 2009–16 verified period for Lake Glenada, Red Water Lake, and Lake Placid. **Table 2.6** lists the AGM values for chlorophyll *a*, TN, and TP during the 2013–20 verified period for Huckleberry Lake. To be assessed as impaired (Category 5) for nutrients, AGMs for a particular nutrient had to have exceeded the NNC more than once in a 3-year period.

Lake Glenada was assessed as impaired for chlorophyll *a* because the AGMs exceeded 20 µg/L in 2009 and 2011. Huckleberry Lake was assessed as impaired for chlorophyll *a*, TN, and TP because chlorophyll *a* AGMs exceeded 20 µg/L from 2017 to 2019, TN AGMs exceeded 1.27 mg/L from 2017 to 2019, and TP AGMs exceeded 0.05 mg/L from 2017 to 2019. Red Water Lake was assessed as impaired for chlorophyll *a*, TN, and TP because chlorophyll *a* AGMs exceeded 6 µg/L from 2013 to 2016, TN AGMs exceeded 0.51 mg/L from 2014 to 2016, and TP AGMs exceeded 0.01 mg/L in 2015 and 2016. Lake Placid was assessed as impaired for chlorophyll *a* because the AGMs exceeded 6 µg/L in 2010 and 2011.

Table 2.3. Lake Glenada (WBID 1813L) AGM values for the 2009–16 verified period

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, 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 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	**39**	**1.66**	**0.07**
2010	ID	ID	ID
2011	**35**	0.94	0.05
2012	ID	ID	ID
2013	ID	ID	ID
2014	ID	ID	ID
2015	ID	ID	ID
2016	ID	ID	ID

Table 2.4. Red Water Lake (WBID 1938F) AGM values for the 2009–16 verified period

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, 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 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	ID	ID	ID
2010	ID	ID	ID
2011	ID	ID	ID
2012	ID	ID	ID
2013	**15**	0.49	0.01
2014	**31**	**0.89**	0.01
2015	**32**	**1.19**	**0.02**
2016	**23**	**1.55**	**0.02**

Table 2.5. Lake Placid (WBID 1938C) AGM values for the 2009–16 verified period

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, 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 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2009	6	0.36	0.01
2010	**8**	0.29	0.01
2011	**9**	ID	0.01
2012	ID	ID	ID
2013	ID	ID	ID
2014	ID	ID	ID
2015	ID	ID	ID
2016	ID	ID	ID

Table 2.6. Huckleberry Lake (WBID 1893) AGM values for the 2013–20 verified period

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC for lakes. Rule 62-302.531, 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 3-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2013	ID	ID	ID
2014	ID	ID	ID
2015	ID	ID	ID
2016	ID	ID	ID
2017	**42**	**1.34**	**0.09**
2018	**54**	**1.68**	**0.11**
2019	**49**	**1.5**	**0.1**
2020	ID	ID	ID

Chapter 3: Assessment of Sources

3.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern in the target 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. Point sources also include certain urban stormwater discharges, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs). 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 septic systems; and atmospheric deposition.

To be consistent with CWA 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 (see **Section 5.1** on **Expression and Allocation of the TMDL**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

3.2 Point Sources

3.2.1 Wastewater Point Sources

No NPDES-permitted wastewater facilities discharge to Lake Glenada, Huckleberry Lake, Red Water Lake, or Lake Placid, or to surface waters in the Lake Glenada, Huckleberry, Red Water or Placid Watersheds.

3.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

There are currently no Phase I MS4 permits in the Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds. These watersheds are covered by Highlands County's NPDES MS4 Phase II permit (FLR04E148) and Florida Department of Transportation (FDOT) District 1 – Highlands County NPDES MS4 Phase II Permit (FLR04E147). In addition, a portion of the Huckleberry Lake Watershed is covered by the City of Sebring's NPDES MS4 Phase II permit (FLR04E149). For more information on MS4s in the watersheds, send an email to

NPDES-stormwater@dep.state.fl.us. **Table 3.1** lists the MS4 permittees and their permit numbers.

Table 3.1. NPDES MS4 permittees with jurisdiction in the watersheds

Permittee	Permit Number	Phase
Highlands County	FLR04E148	II
FDOT District 1 – Highlands County	FLR04E147	II
City of Sebring	FLR04E149	II

3.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater dischargers are generally considered nonpoint sources. Nutrient loadings to Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis primarily include loadings from surface runoff, baseflow, and precipitation directly onto the lake surface (atmospheric deposition).

3.3.1 Land Use

Land use is one of the most important factors in determining nutrient loadings from the Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds. Nutrients can be flushed into a receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human land use areas and natural land areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce. **Tables 3.2** through **3.5** list land use in the watersheds, based on the statewide land use land cover dataset (including the land use dataset from SWFWMD 2014 and SFWMD 2014–16). **Figures 3.1** through **3.4** show the information graphically.

Table 3.2. Land use in the Lake Glenada Watershed, 2014–16

FLUCCS = Florida Land Use, Cover and Forms Classification System

FLUCCS Codes	Land Use Description	Lake Glenada (acres)	% of Watershed
260	Agricultural General	36	1
221	Agricultural Tree Crop	353	15
411, 434	Upland Forest	383	16
130	High Density Residential	92	4
140, 170, 182, 1888	Industrial and Commercial	236	10
110	Low Density Residential	20	1
120	Medium Density Residential	142	6
190, 192	Open Land	354	15
211	Pasture	48	2
320	Rangeland	281	12
520, 530	Water	187	8
615, 641, 643, 644, 652, 653	Wetland	221	9
830	Utilities	30	1
Total		**2,383**	**100**

Table 3.3. Land use in the Huckleberry Lake Watershed, 2014–16

FLUCCS = Florida Land Use, Cover and Forms Classification System

FLUCCS Codes	Land Use Description	Huckleberry Lake (acres)	% of Watershed
411, 434	Upland Forest	61	18
140, 170, 182, 1888	Industrial and Commercial	15	5
110	Low Density Residential	18	5
120	Medium Density Residential	63	19
180	Recreational	17	5
320	Rangeland	18	6
520, 530	Water	111	33
615, 641, 643, 644, 652, 653	Wetland	17	5
740	Disturbed	15	4
Total		**335**	**100**

Table 3.4. Land use in the Red Water Lake Watershed, 2014–16

FLUCCS = Florida Land Use, Cover and Forms Classification System

FLUCCS Codes	Land Use Description	Red Water Lake (acres)	% of Watershed
260, 240	Agricultural General	124	8
221, 224	Agricultural Tree Crop	886	60
434	Upland Forest	22	1
150	Industrial and Commercial	9	1
110	Low Density Residential	24	2
120	Medium Density Residential	63	4
190	Open Land	8	1
211	Pasture	59	4
520, 530	Water	200	13
615, 641, 643, 644, 653	Wetland	47	3
810	Transportation, Utilities	44	3
Total		**1,486**	**100**

Table 3.5. Land use in the Lake Placid Watershed, 2014–16

FLUCCS = Florida Land Use, Cover and Forms Classification System

FLUCCS Codes	Land Use Description	Lake Placid (acres)	% of Watershed
260, 241, 243	Agriculture General	507	4
221, 224	Agriculture Tree Crop	1,896	14
411, 434, 421	Upland Forest	627	5
150, 140, 170, 1888	Industrial and Commercial	250	2
118, 110	Low Density Residential	383	3
120	Medium Density Residential	179	1
190, 192	Open Land	115	1
212, 211, 213	Pasture	680	5
320, 310	Rangeland	3,606	28
520, 530	Water	3,469	27
615, 641, 643, 652, 617, 6172, 621, 630	Wetland	905	7
740	Barren Land	274	2
810, 830	Transportation, Utilities	146	1
Total		**13,037**	**100**

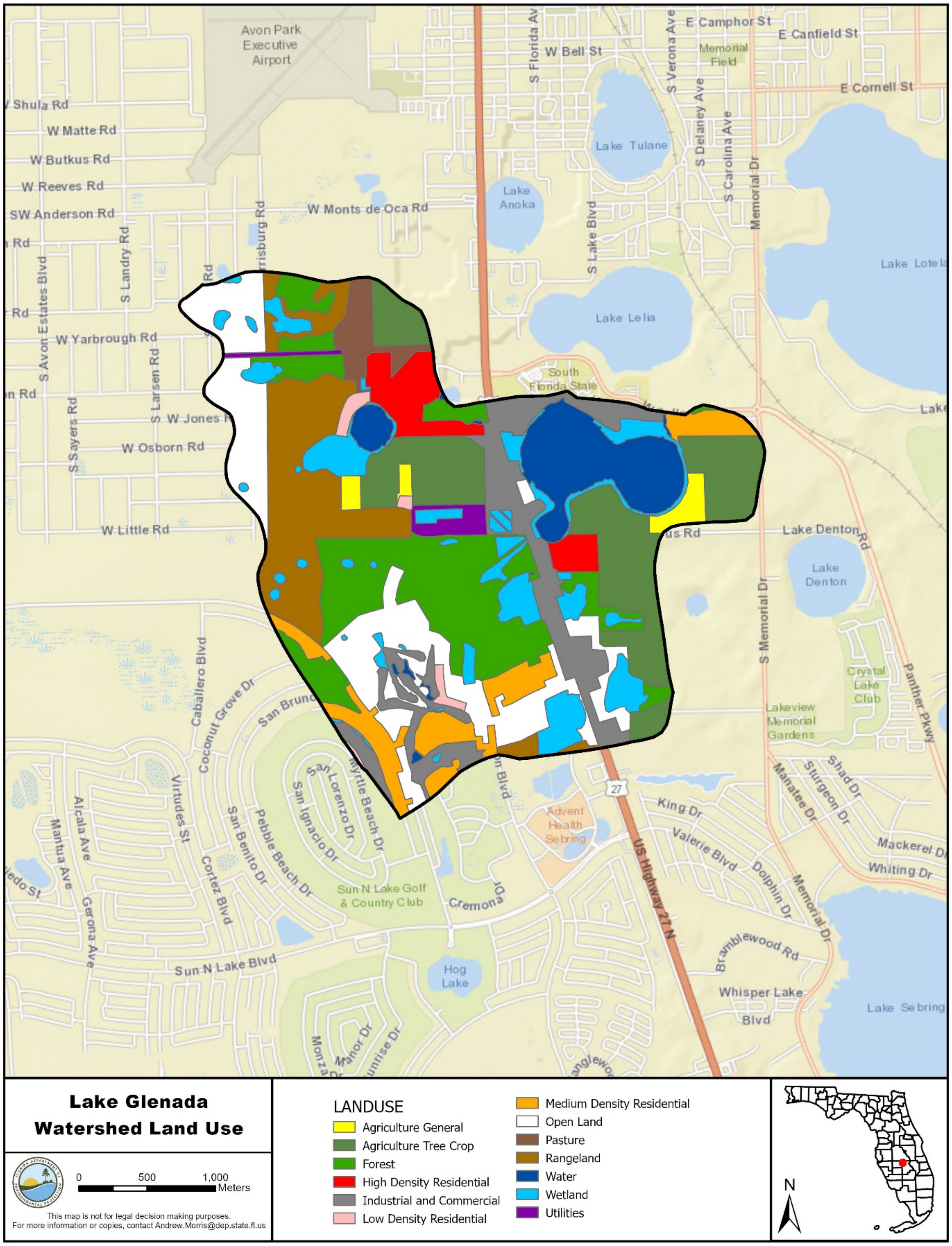

Figure 3.1. Land use in the Lake Glenada Watershed, 2014–16

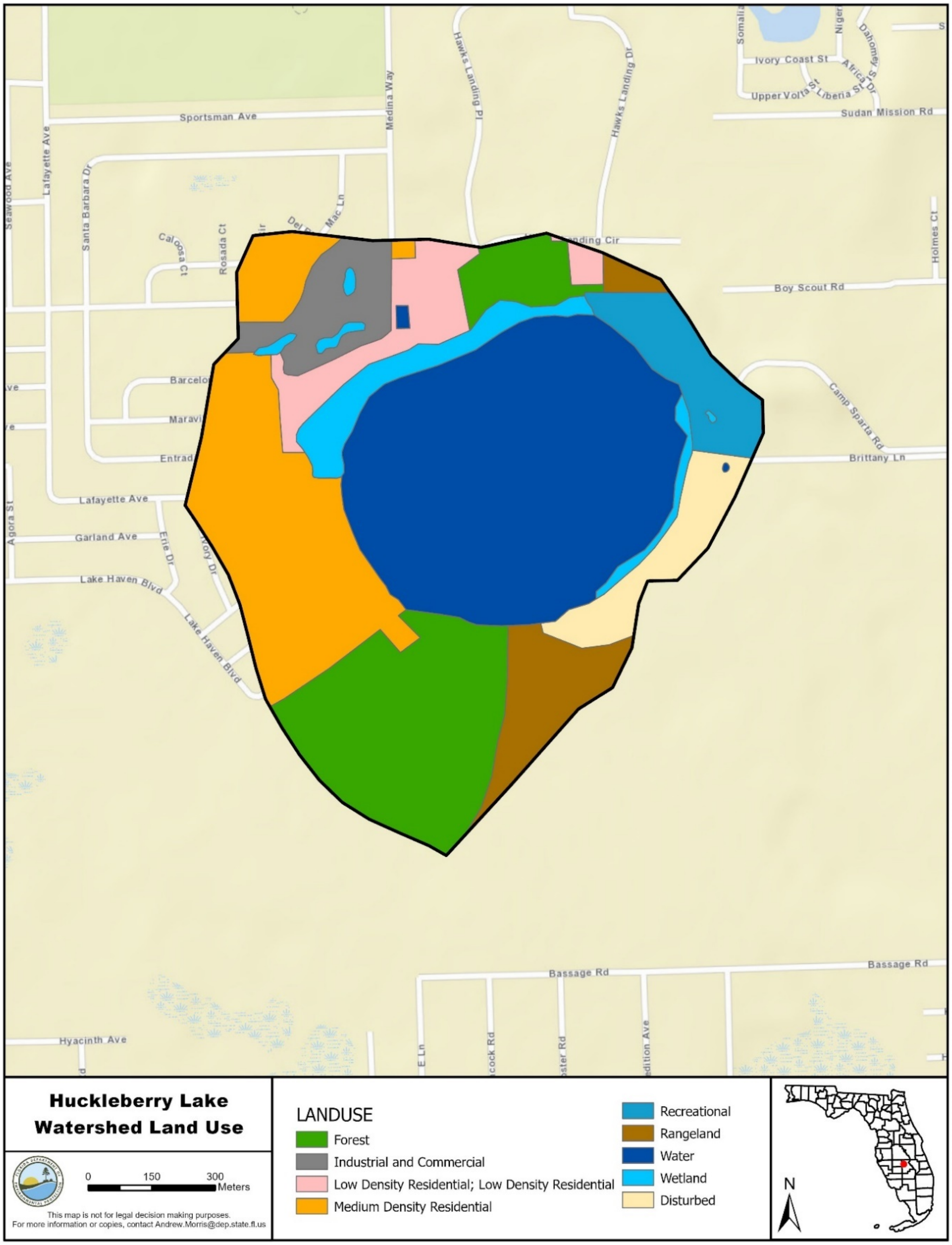

Figure 3.2. Land use in the Huckleberry Lake Watershed, 2014–16

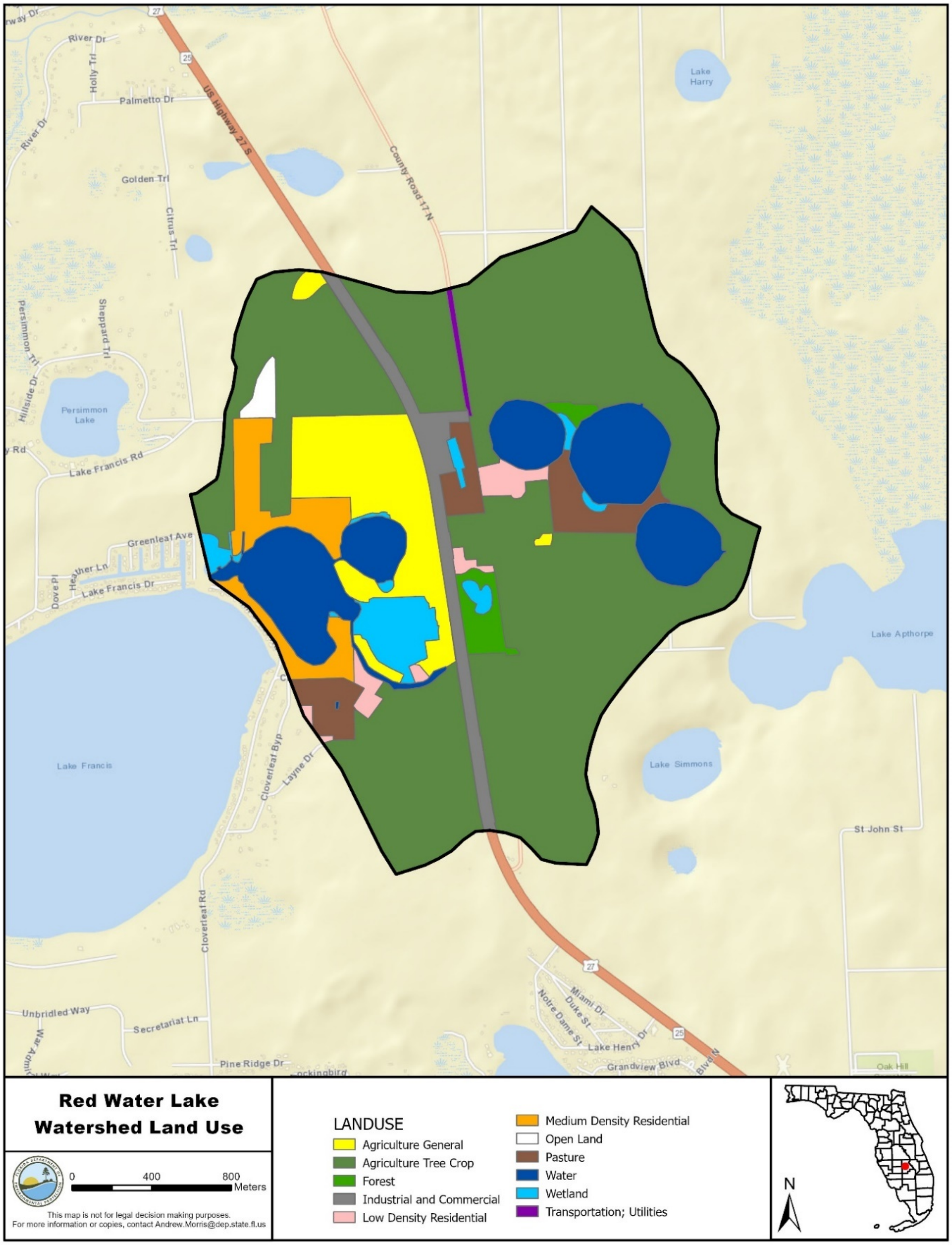

Figure 3.3. Land use in the Red Water Lake Watershed, 2014–16

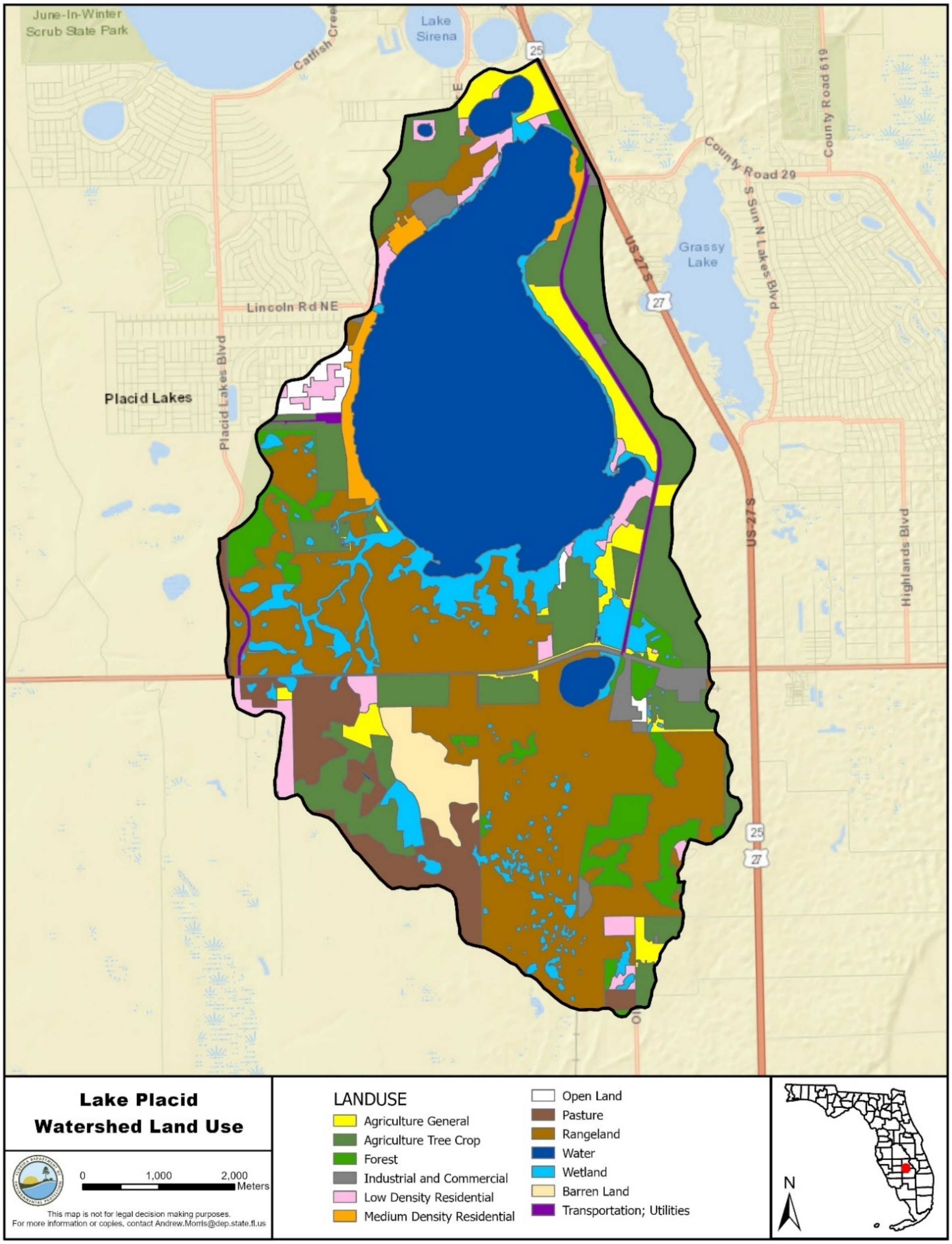

Figure 3.4. Land use in the Lake Placid Watershed, 2014–16

3.3.2 Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, including septic systems, are commonly used where providing central sewer service 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 OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water. **Figures 3.5** through **3.8** show the approximate locations of OSTDS in the watersheds based on centroids of parcels with known septic systems.

The Florida Department of Health (FDOH) maintains a list of septic systems by county, and the FDOH Florida Water Management Inventory dataset was used to determine the number of "known" and "likely" septic systems in the area. As listed in **Table 3.6**, there are 601 "known" and "likely" septic systems in the combined Lake Glenada, Huckleberry, Red Water, and Placid Watersheds. The largest number, 333, is found in the Lake Placid Watershed, followed by 143 in the Red Water Lake Watershed, 77 in the Huckleberry Lake Watershed, and 48 in the Lake Glenada Watershed. Generally, the highest concentrations occur in the residential areas of each watershed.

Table 3.6. Number of "known" and "likely" OSTDS in the individual lake watersheds

Watershed	Number of "Known" and "Likely" OSTDS
Lake Glenada	48
Huckleberry Lake	77
Red Water Lake	143
Lake Placid	333
Total	**601**

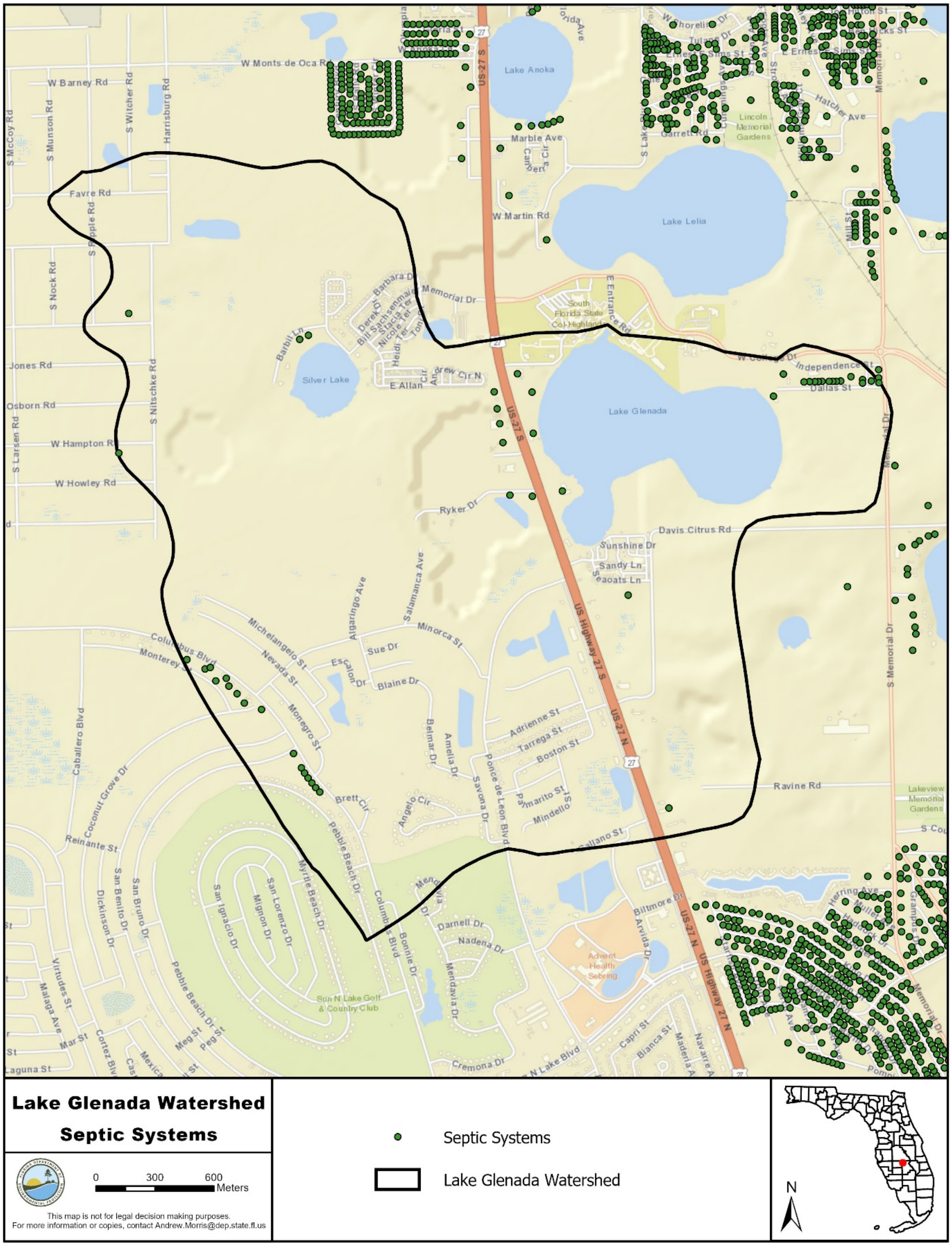

Figure 3.5. "Known" and "likely" OSTDS in the Lake Glenada Watershed

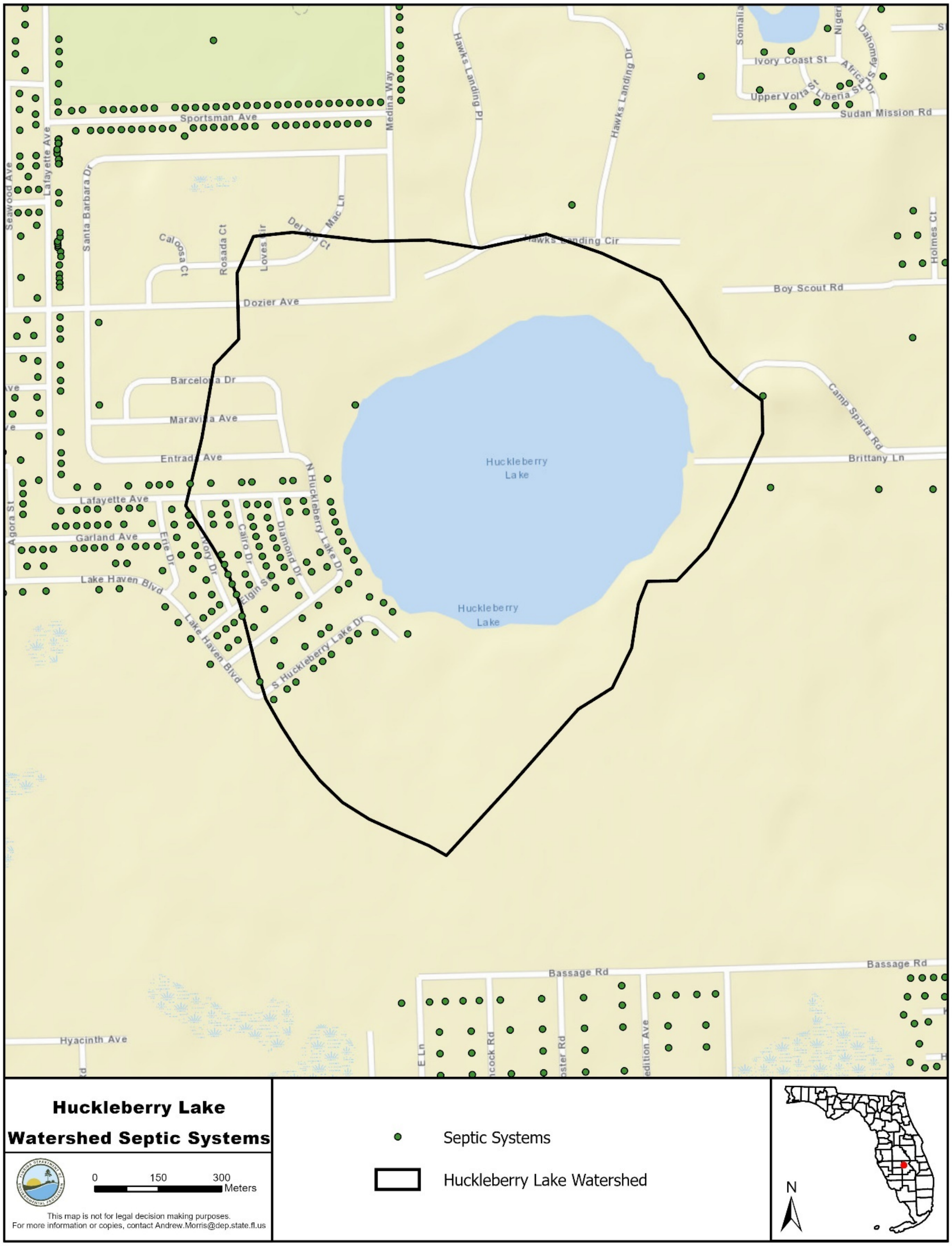

Figure 3.6. “Known” and “likely” OSTDS in the Huckleberry Lake Watershed

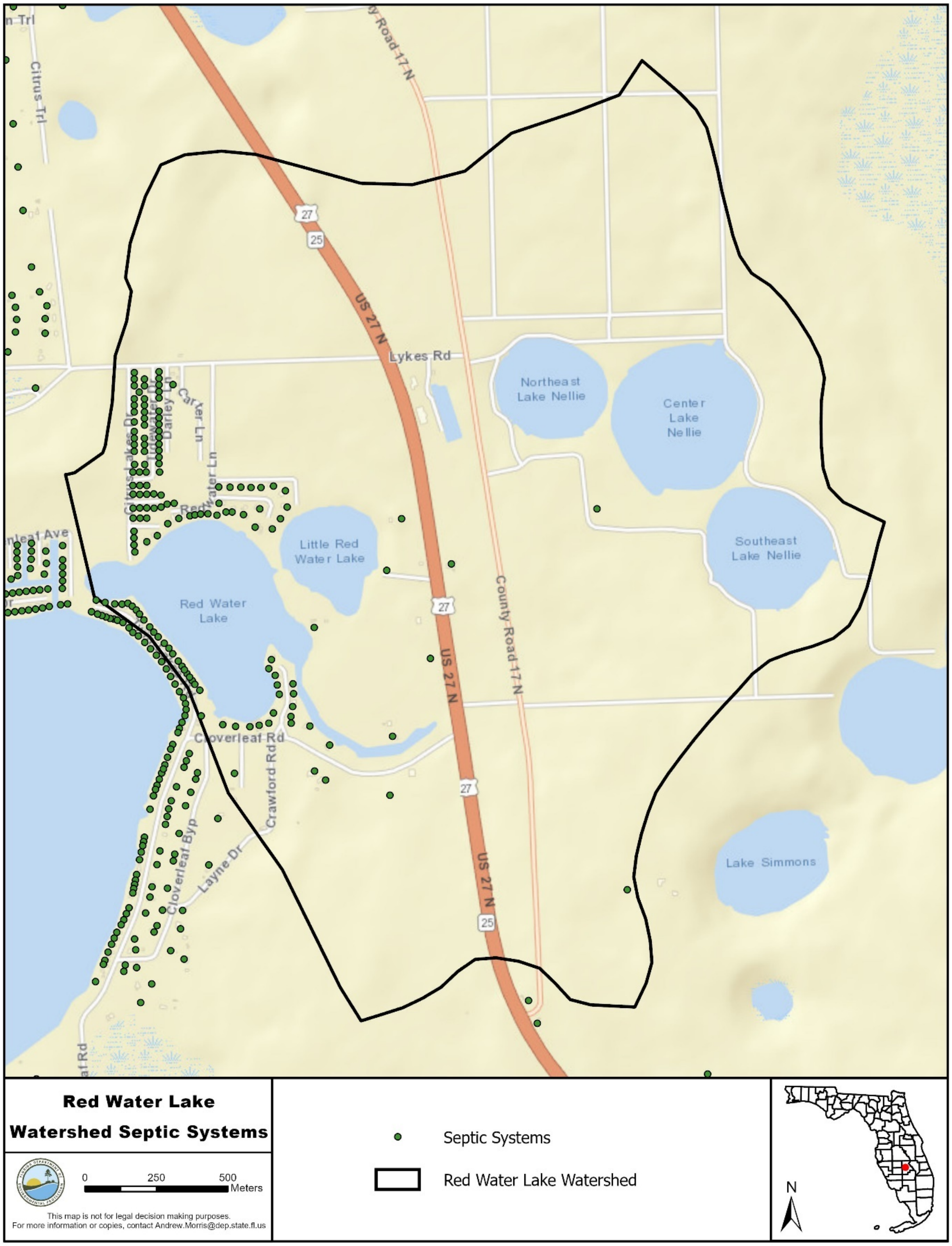

Figure 3.7. "Known" and "likely" OSTDS in the Red Water Lake Watershed

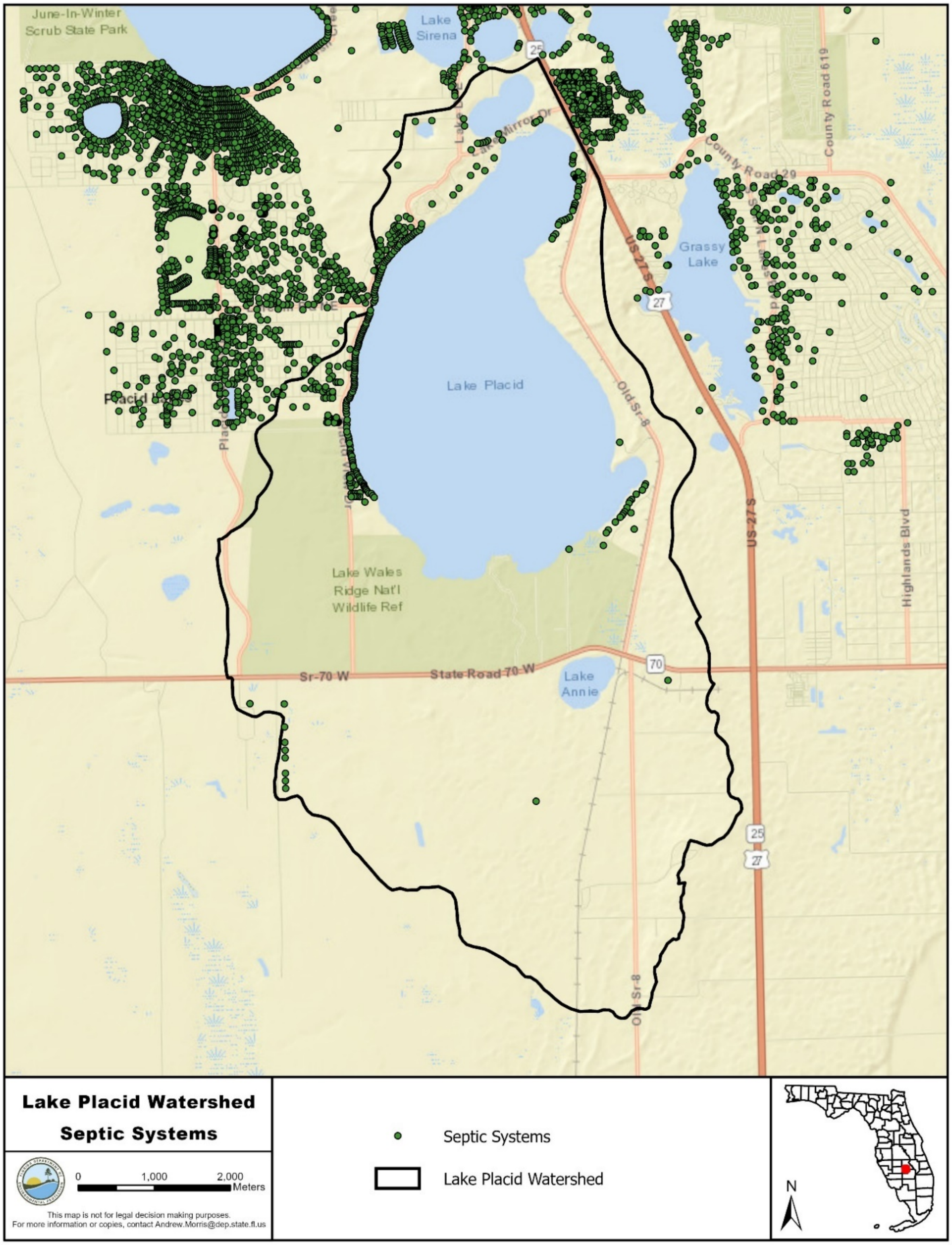

Figure 3.8. "Known" and "likely" OSTDS in the Lake Placid Watershed

Chapter 4: Determination of Assimilative Capacity

4.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication tend to be widespread and are frequently manifested far (in both time and space) from their sources. Addressing eutrophication involves relating water quality and biological effects such as photosynthesis, decomposition, and nutrient recycling as acted on by environmental factors (rainfall, point source discharge, etc.) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. Assimilative capacity should be related to some specific hydrometeorological condition during a selected period or to some range of expected variation in these conditions.

The goal of this TMDL analysis is to identify the maximum allowable in-lake TN and TP concentrations, and the reductions in the in-lake nutrient concentrations, so that the lakes will meet the TMDL targets for chlorophyll *a* and thus maintain their function and designated use as Class III freshwaters.

4.2 Evaluation of Water Quality Conditions

For the water quality analyses conducted for TMDL development, AGMs were used in order to be consistent with the expression of the adopted NNC for lakes. AGMs were calculated using a minimum of four sample results per year, with at least one of the samples collected in the May to September period and at least one sample collected from other months. Values with an "I" qualifier code were used as reported. Values with "U" or "T" qualifier codes were changed to the minimum detection limit (MDL) divided by the square root of two. Values with "G" or "V" qualifier codes were removed from the analysis for quality control purposes. Negative values and zero values were also removed. Multiple sample results collected in the same day at the same station were averaged. The AGM calculation method for this purpose is somewhat different than the one used to calculate AGMs for performing water quality assessments, following the methodology in Chapter 62-303, F.A.C. Therefore, the AGMs listed in **Tables 2.3** through **2.6** in **Chapter 2** may not exactly match the AGMs used in these analyses and for TMDL development.

4.3 Critical Conditions and Seasonal Variation

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions, because (1) the methodology used to determine assimilative capacity does not lend itself very well to short-term assessments, (2) DEP is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, (3) the methodology used to determine impairment is based on annual conditions, and (4) the chlorophyll *a* criterion used as the TMDL target is expressed as an AGM.

4.4 Relationships Between Water Quality Variables

Water quality monitoring for nutrients in all four lakes has been conducted by SWFWMD, DEP, and Florida LakeWatch. The majority of the available data are from monitoring conducted by Florida LakeWatch. Data collection in Lake Glenada extends back to 1973, with more routine data collection beginning in the mid- to late 1990s. Data collection in Huckleberry Lake extends back to 1994, with more routine data collection beginning in 1999. Data collection in Red Water Lake extends back to 1991. Data collection in Lake Placid began in 1968, with more routine data collection beginning in the mid-1990s. **Figures 4.1** through **4.12** show the water quality AGMs used for developing TMDLs based on the IWR Run 61 Database. Standard data quality assurance practices were followed when evaluating the data and developing the TMDLs.

Chlorophyll *a* AGM values from 2009 to 2020 for Lake Glenada (**Figure 4.1**) have consistently been above the NNC AGM of 20 µg/L and have risen to over 60 µg/L, ranging from 24.8 to 68.3 µg/L over this period.

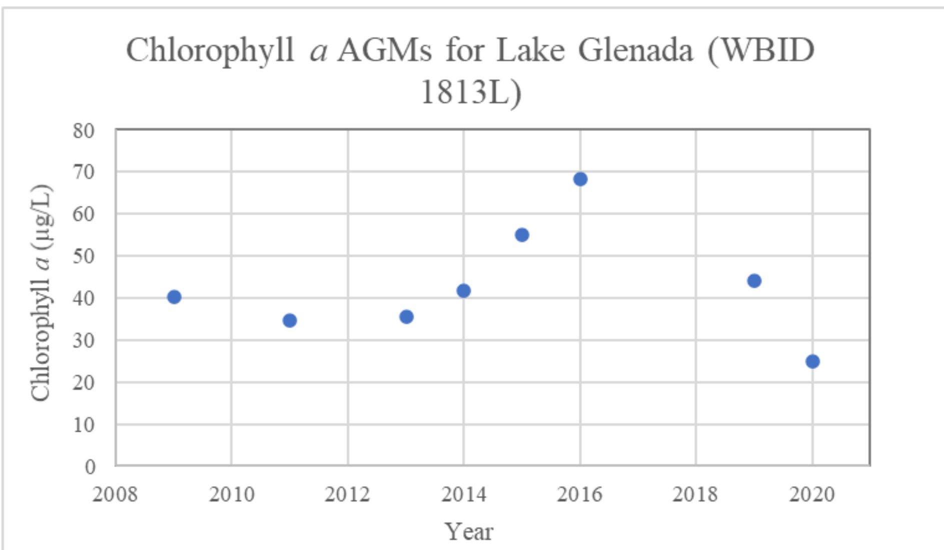

Figure 4.1. Chlorophyll *a* AGM values for Lake Glenada, 2009–20

TN AGM values from 2009 to 2020 for Lake Glenada (**Figure 4.2**) show a pattern of fluctuating concentrations above and below the NNC AGM of 1.27 mg/L. Values over this period range from 1.0 to 1.53 mg/L.

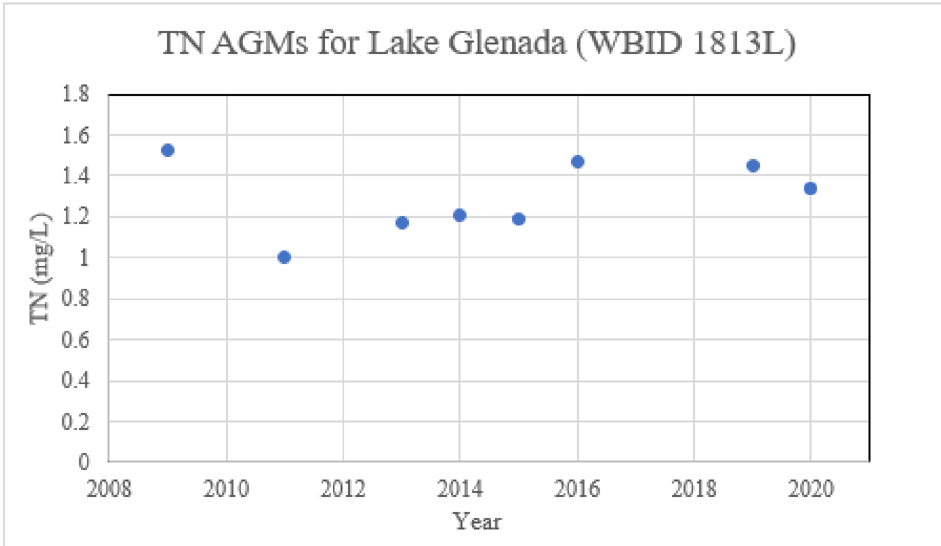

Figure 4.2. TN AGM values for Lake Glenada, 2009–20

TP AGM values from 2009 to 2020 for Lake Glenada (**Figure 4.3**) are similar to those of TN and chlorophyll *a,* ranging from 0.046 to 0.072 mg/L, with values above the NNC AGM of 0.05 mg/L in all except one instance.

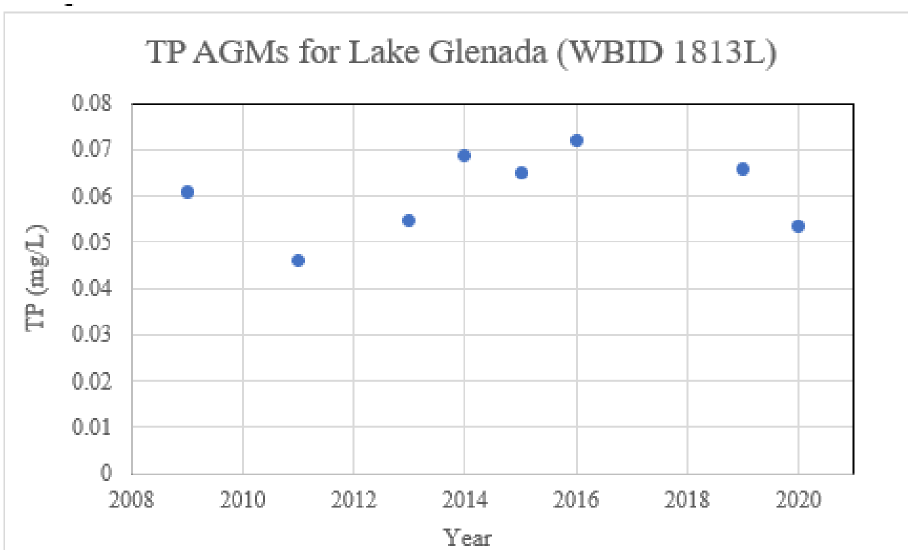

Figure 4.3. TP AGM values for Lake Glenada, 2009–20

Chlorophyll *a* AGM values from 2017 to 2019 for Huckleberry Lake (**Figure 4.4**) have consistently been well above the NNC AGM of 20 mg/L, ranging from 42.2 to 53.5 mg/L over this period.

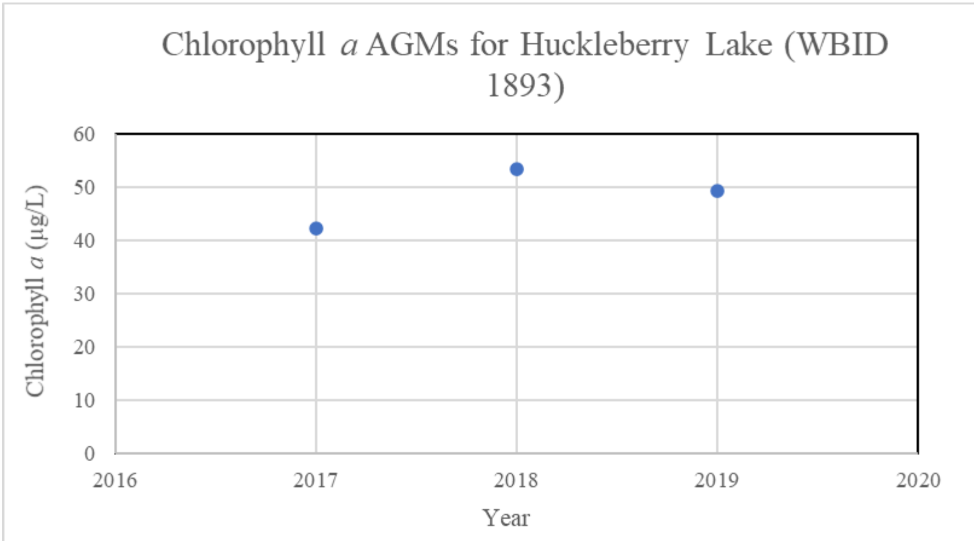

Figure 4.4. Chlorophyll *a* AGM values for Huckleberry Lake, 2017–19

TN AGM values from 2017 to 2019 for Huckleberry Lake (**Figure 4.5**) have surpassed the NNC AGM of 1.27 mg/L, ranging from 1.3 to 1.7 mg/L over this period.

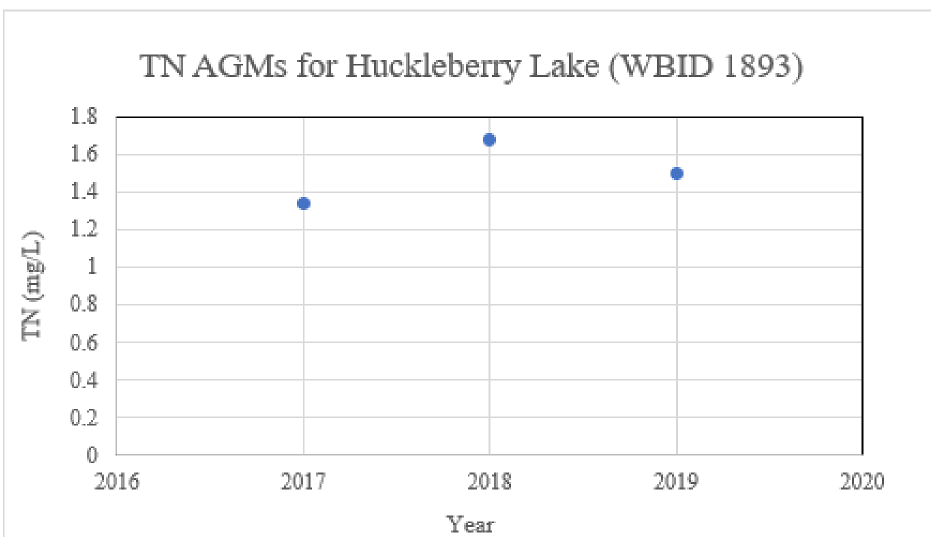

Figure 4.5. TN AGM values for Huckleberry Lake, 2017–19

TP AGM values from 2017 to 2019 for Huckleberry Lake (**Figure 4.6**) are similar to those of TN and chlorophyll *a*. They have consistently been well above the NNC AGM of 0.05 mg/L, ranging from 0.091 to 0.11 mg/L over this period.

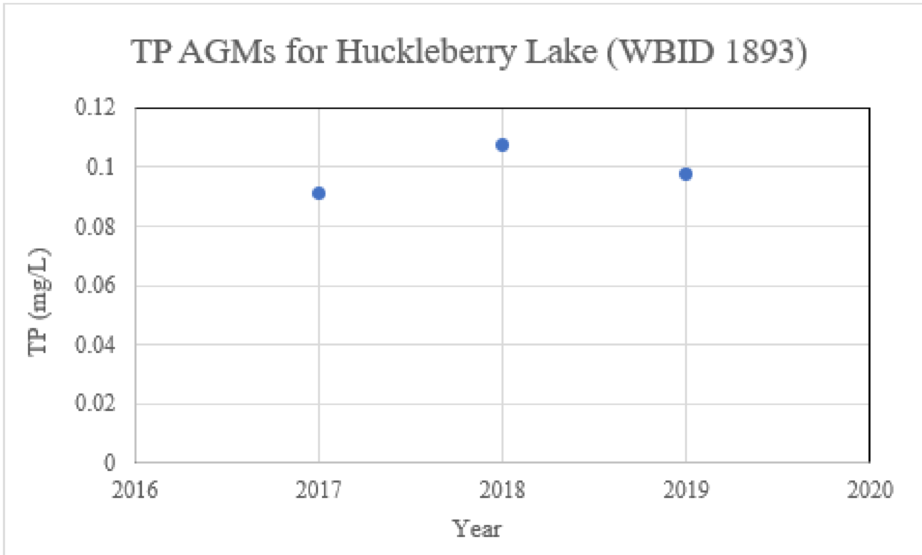

Figure 4.6. TP AGM values for Huckleberry Lake, 2017–19

Chlorophyll *a* AGM values from 2013 to 2019 for Red Water Lake (**Figure 4.7**) have consistently been above the NNC AGM of 6 µg/L and have risen to over 29 µg/L, ranging from 13.4 to 29.4 µg/L over this period.

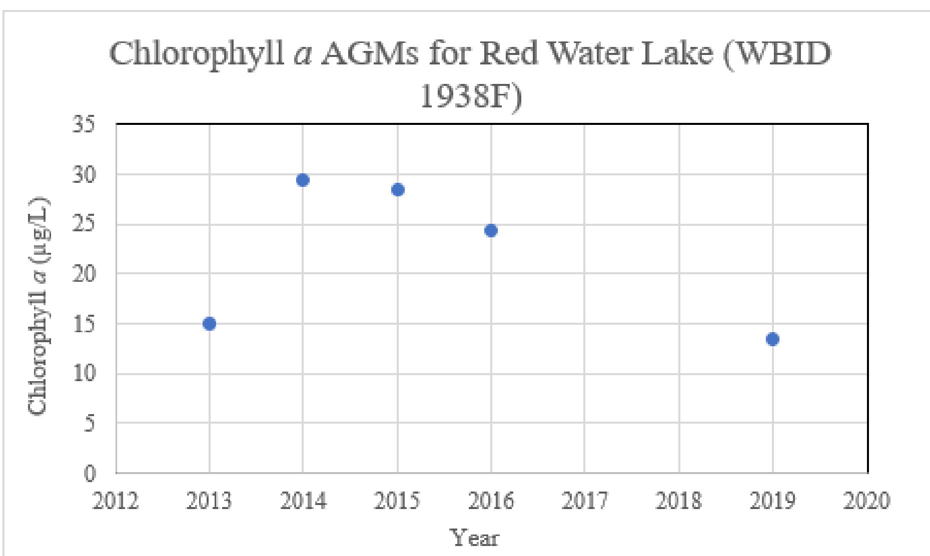

Figure 4.7. Chlorophyll *a* AGM values for Red Water Lake, 2013–19

TN AGM values from 2013 to 2019 for Red Water Lake (**Figure 4.8**) have generally surpassed the NNC AGM of 0.51 mg/L, with values ranging from 0.49 to 1.43 mg/L over this period.

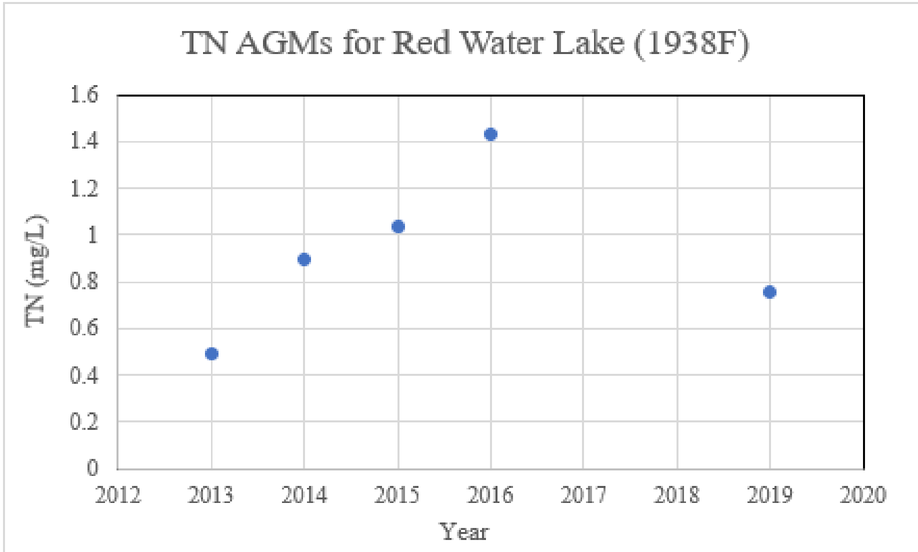

Figure 4.8. TN AGM values for Red Water Lake, 2013–19

TP AGM values from 2013 through 2019 for Red Water Lake (**Figure 4.9**) have been consistently above the NNC AGM of 0.01 mg/L, ranging from 0.014 to 0.020 mg/L over this period.

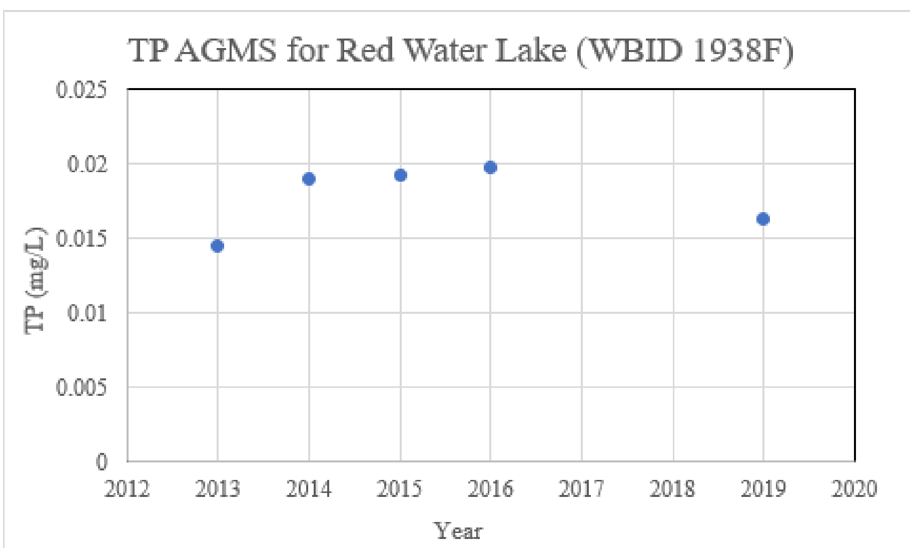

Figure 4.9. TP AGM values for Red Water Lake, 2013–19

Chlorophyll *a* AGM values from 2005 through 2020 for Lake Placid (**Figure 4.10**) show a pattern of generally increasing concentrations, with most values above the NNC AGM of 6 µg/L. Values over this period range from 2.2 to 18.4 µg/L.

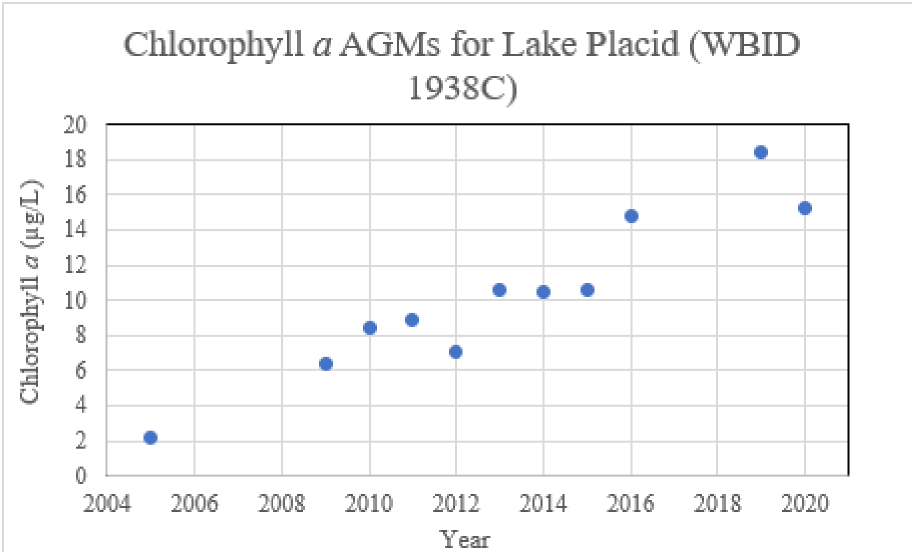

Figure 4.10. Chlorophyll *a* AGM values for Lake Placid, 2005–20

TN AGM values from 2005 through 2020 for Lake Placid (**Figure 4.11**) show a pattern of generally increasing concentrations similar to chlorophyll *a* AGMs. More recent measurements show TN AGMs surpassing the NNC AGM of 0.51 mg/L. Values over this period range from 0.37 to 0.73 mg/L.

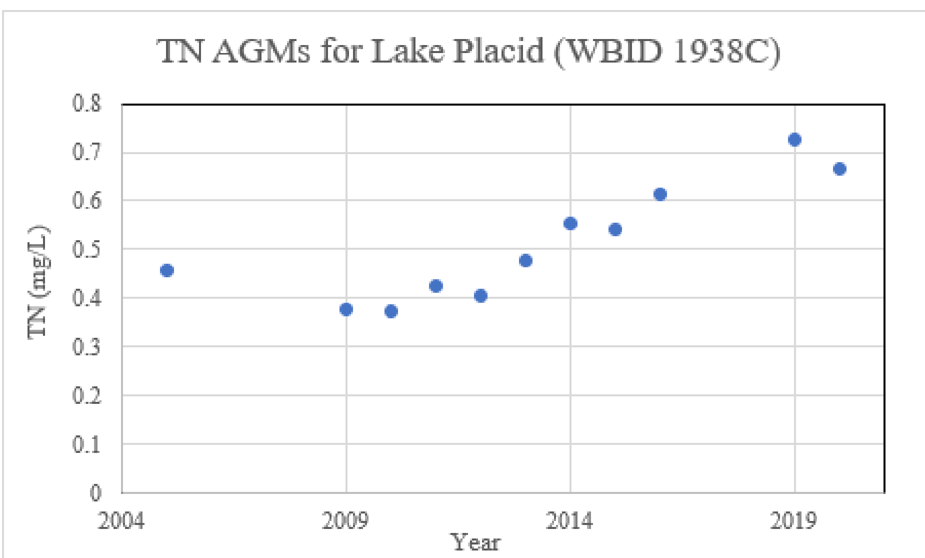

Figure 4.11. TN AGM values for Lake Placid, 2005–20

TP AGM values from 2005 through 2020 for Lake Placid (**Figure 4.12**) have consistently been above the NNC AGM of 0.01 mg/L, ranging from 0.012 to 0.017 mg/L over this period.

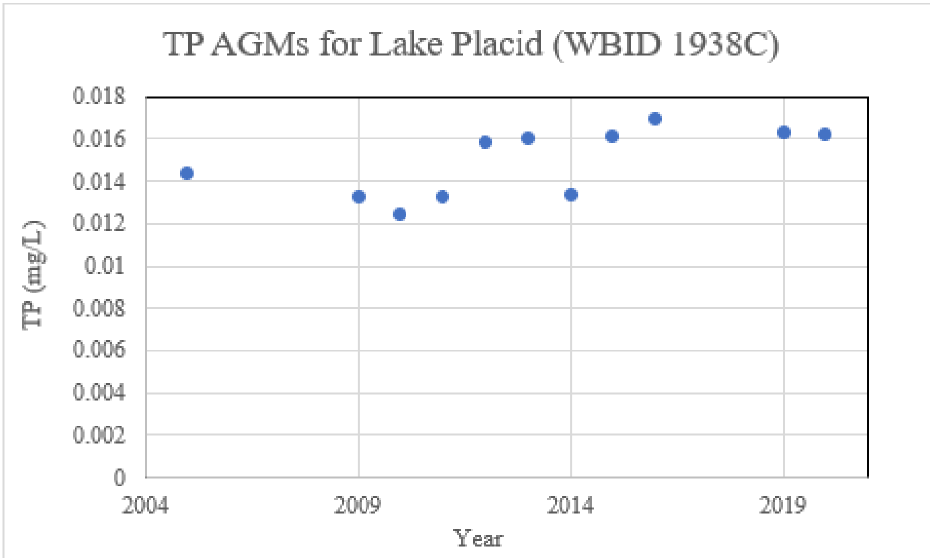

Figure 4.12. TP AGM values for Lake Placid, 2005–20

4.5 Basis of the TMDLs

The data collected by DEP and SWFWMD were used in evaluating the in-lake concentrations of nutrients and chlorophyll *a*. The period from 2005 to 2020 had the most complete long-term set of AGM values for evaluating surface water quality for the four lakes. This analysis used nutrient and corrected chlorophyll *a* AGMs to be consistent with the expression of the adopted NNC for lakes.

The state of Florida developed the generally applicable statewide NNC based on robust empirical relationships between nutrients and chlorophyll *a* derived from a large dataset of lakes statewide, and an evaluation of the relationships between chlorophyll *a* and TN and TP in those lakes (DEP 2012). The dataset consists of paired nutrient and chlorophyll *a* data for 195 low-color lakes and 129 high-color lakes. DEP developed a chlorophyll *a* criterion of 20 µg/L for both high color (> 40 PCU) lakes and low color (< 40 PCU) high alkalinity (> 20 mg/L CaCO3) lakes, and a chlorophyll *a* criterion of 6 µg/L for low color (< 40 PCU), low alkalinity (< 20 mg/L CaCO3) lakes. DEP (2012) demonstrated that these chlorophyll *a* criteria are protective of designated uses and maintains the health of a balanced community of aquatic flora and fauna.

The generally applicable TN and TP criteria are subject to a range of AGMs based on whether there are sufficient data to calculate an AGM for chlorophyll *a*, and whether the AGM chlorophyll *a* exceed the criteria for the particular lake type in subparagraph 62-302.531(2)(b)1., F.A.C. If there are insufficient data to calculate the AGM chlorophyll *a* for a given year or the AGM chlorophyll *a* exceeds the criterion for the lake type, then the applicable numeric interpretations for TN and TP are the minimum values. If there are sufficient data to calculate the AGM chlorophyll *a* and the AGM does not exceed the chlorophyll *a* value for the lake type (e.g., 20 µg/L in a high-color lake), then the TN and TP AGMs for that calendar year may not exceed the maximum TN and TP limits for the particular lake type.

For the high-color lakes, including Lake Glenada and Huckleberry Lake, the criteria range for TN is 1.27–2.23 mg/L, and is 0.05–0.16 mg/L for TP and have an exceedance frequency of no more than once in any three-year period. For the low-color, low-alkalinity lakes, including Red Water Lake and Lake Placid, the criteria range for TN is 0.51–0.93 mg/L, and is 0.01–0.03 mg/L for TP and have an exceedance frequency of no more than once in any three-year period. AGMs for chlorophyll *a* concentrations within Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid all exceeded the NNC values for the applicable lake types; therefore, the applicable numeric interpretations for TN and TP are the minimum values in the criteria ranges, which ensures attainment of the applicable chlorophyll *a* targets.

The individual nutrient data for these four lakes were compared with the larger statewide nutrient datasets to see if they fell within the range of the data used to establish the generally applicable NNC. This was done to verify that these lakes are operating like the NNC lakes and are exhibiting the same nutrient responses to determine if site-specific criteria were needed. **Figures 4.13** and **4.14** show the TN and TP data, respectively, for Lake Glenada plotted against the statewide population of high-color lakes. **Figures 4.15** and **4.16** show the TN and TP data, respectively, for Huckleberry Lake plotted against the statewide population of high-color lakes. **Figures 4.17** and **4.18** show the TN and TP data for Red Water Lake, respectively, plotted against the statewide population of low-color lakes, and **Figures 4.19** and **4.20** show the same comparison for Lake Placid.

These graphs demonstrate that the relationship of TN and TP to chlorophyll *a* in the lakes does not fall outside the range used to develop the generally applicable NNC. For these four lakes, the TN values are indicated with red triangles and the TP values with green circles. The statewide populations are represented by the gray x's. The dashed line shown on these graphs bounds the distributions at the 90 % prediction intervals. Lakes that plot within these intervals are characteristic of the majority of lakes in the dataset, while lakes that plot outside those bounds are not functioning in a manner consistent with the majority of lakes in the statewide dataset.

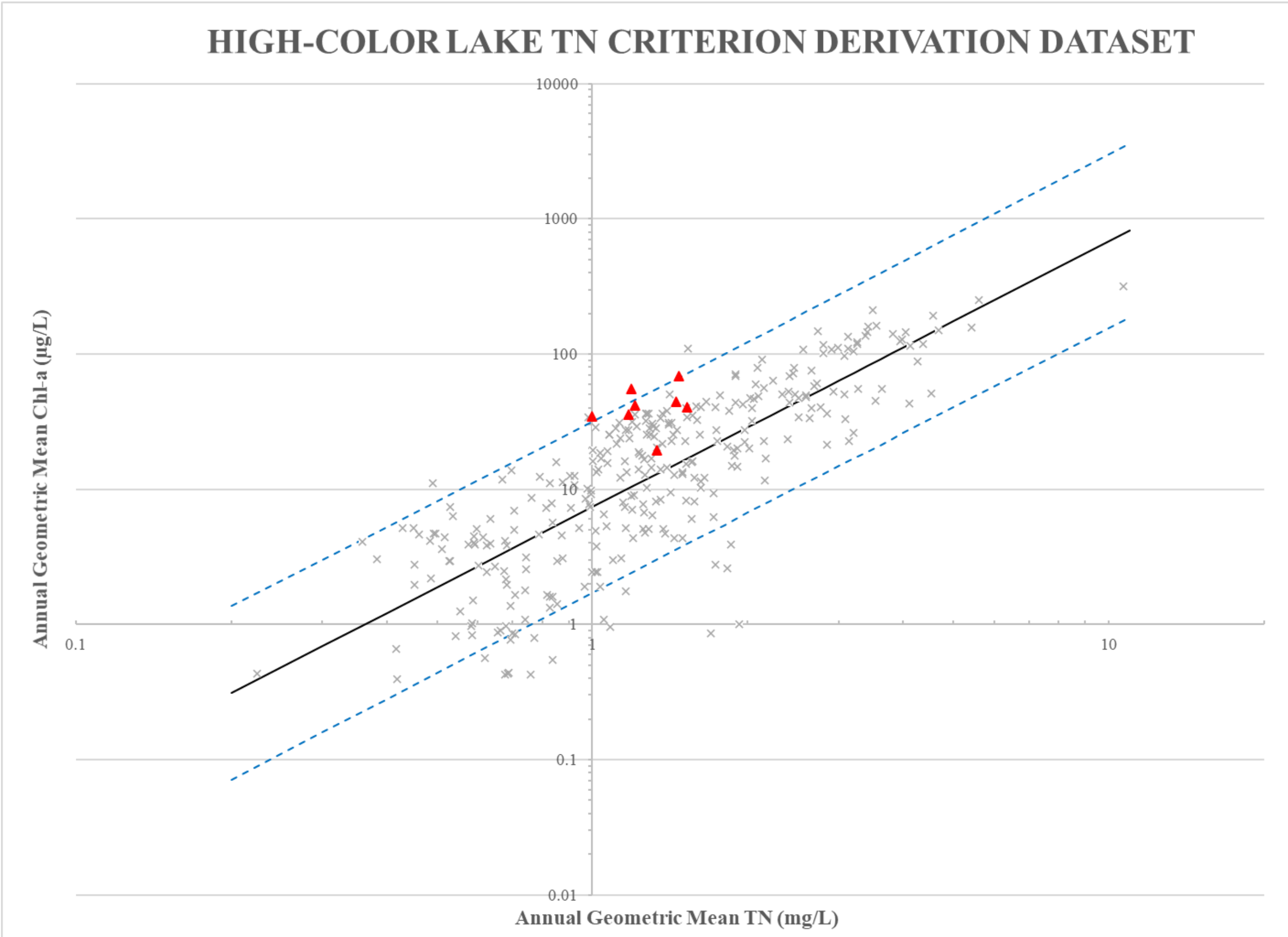

Figure 4.13. Lake Glenada TN AGMs (red triangles) plotted against the statewide dataset used to derive the NNC for high-color lakes

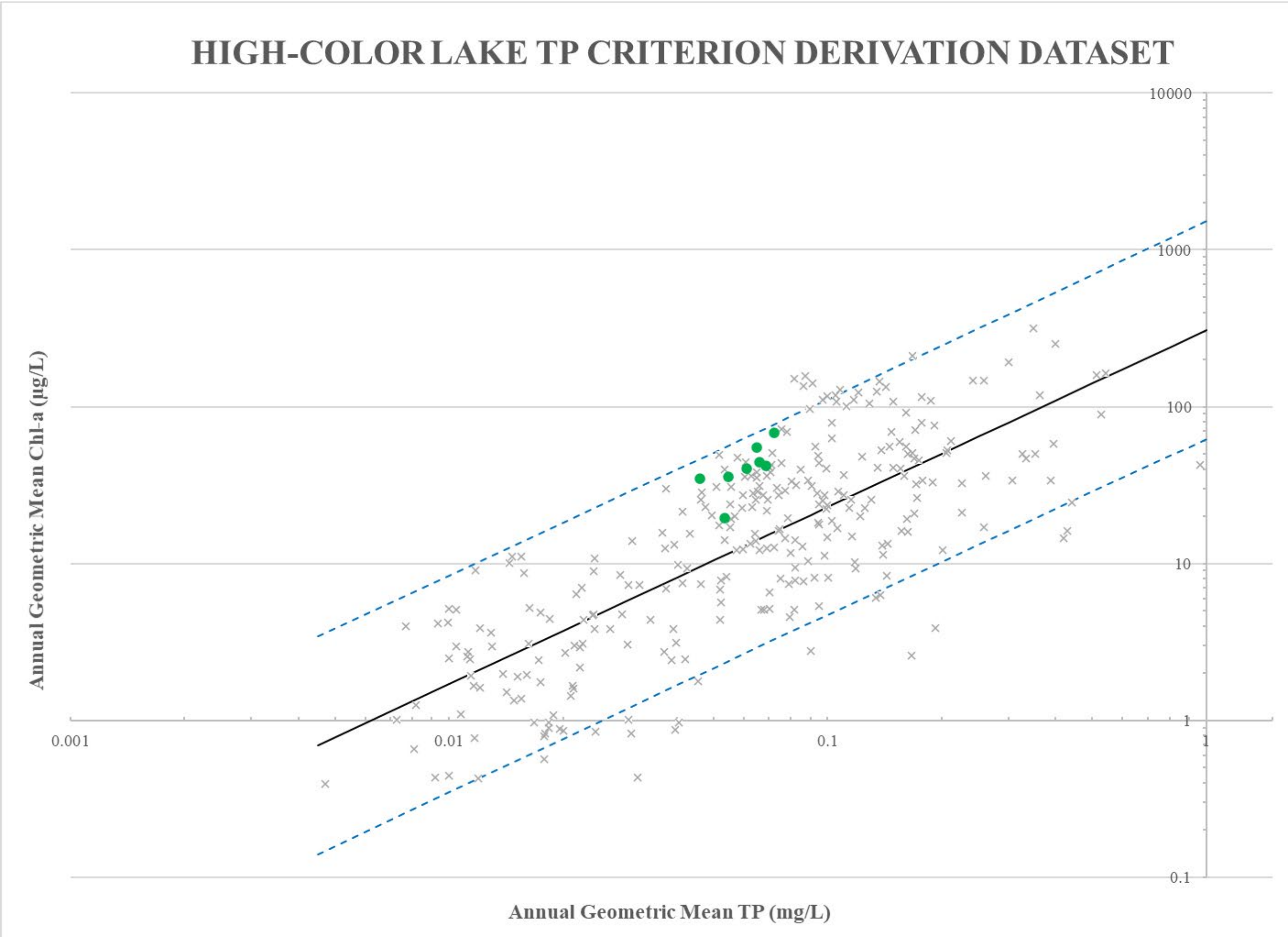

Figure 4.14. Lake Glenada TP AGMs (green circles) plotted against the statewide dataset used to derive the NNC for high-color lakes

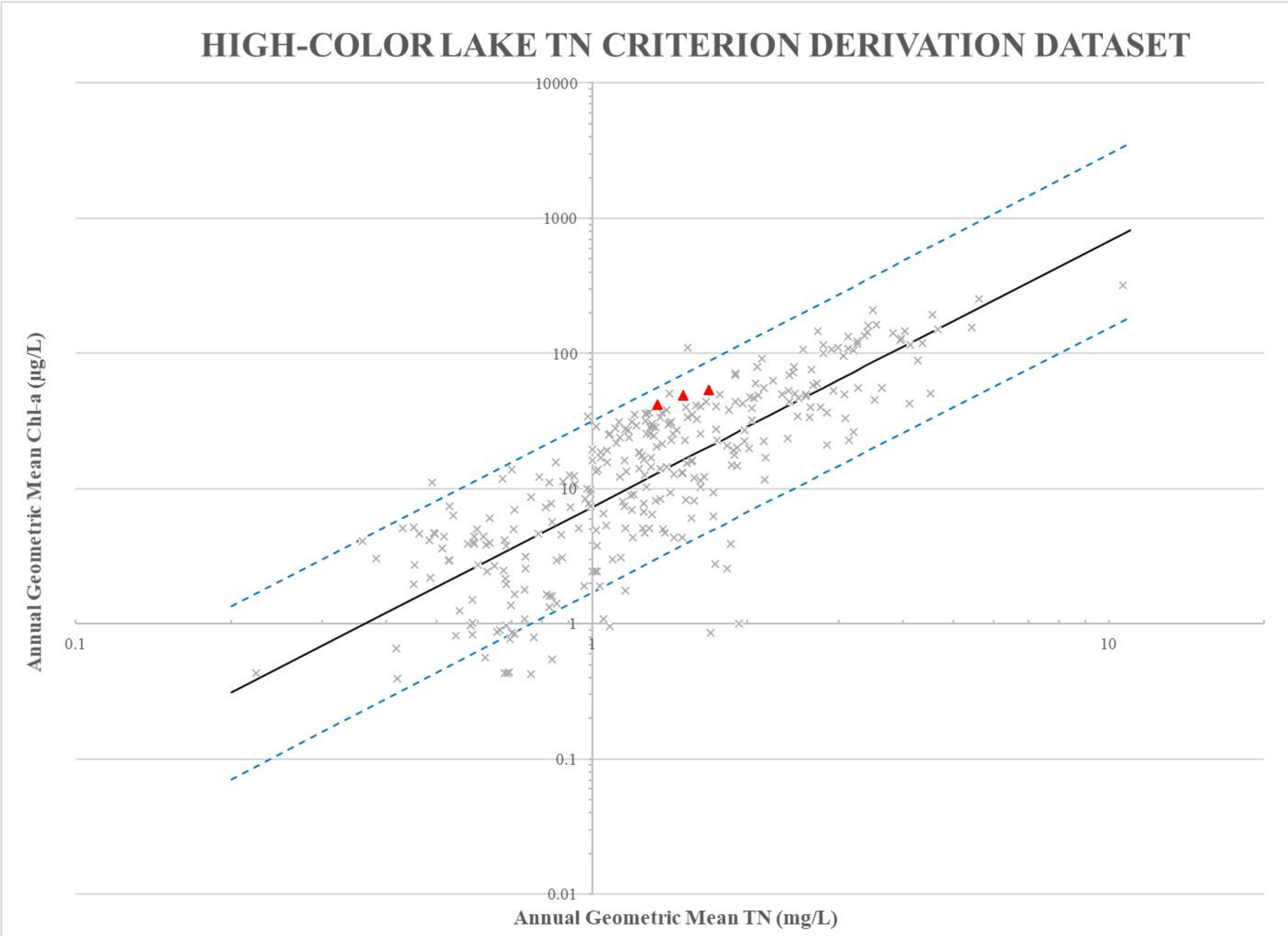

Figure 4.15. Huckleberry Lake TN AGMs (red triangles) plotted against the statewide dataset used to derive the NNC for high-color lakes

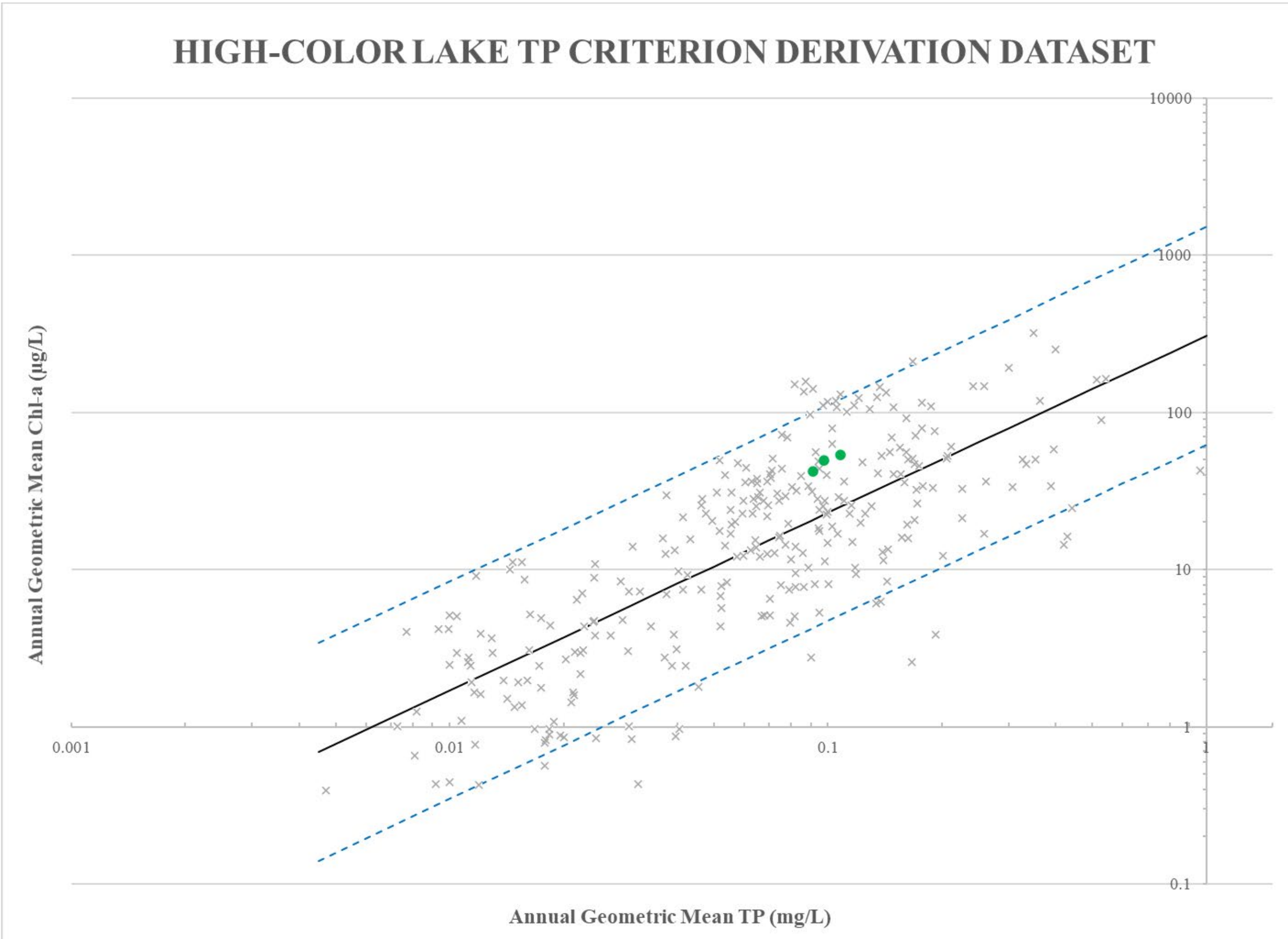

Figure 4.16. Huckleberry Lake TP AGMs (green circles) plotted against the statewide dataset used to derive the NNC for high-color lakes

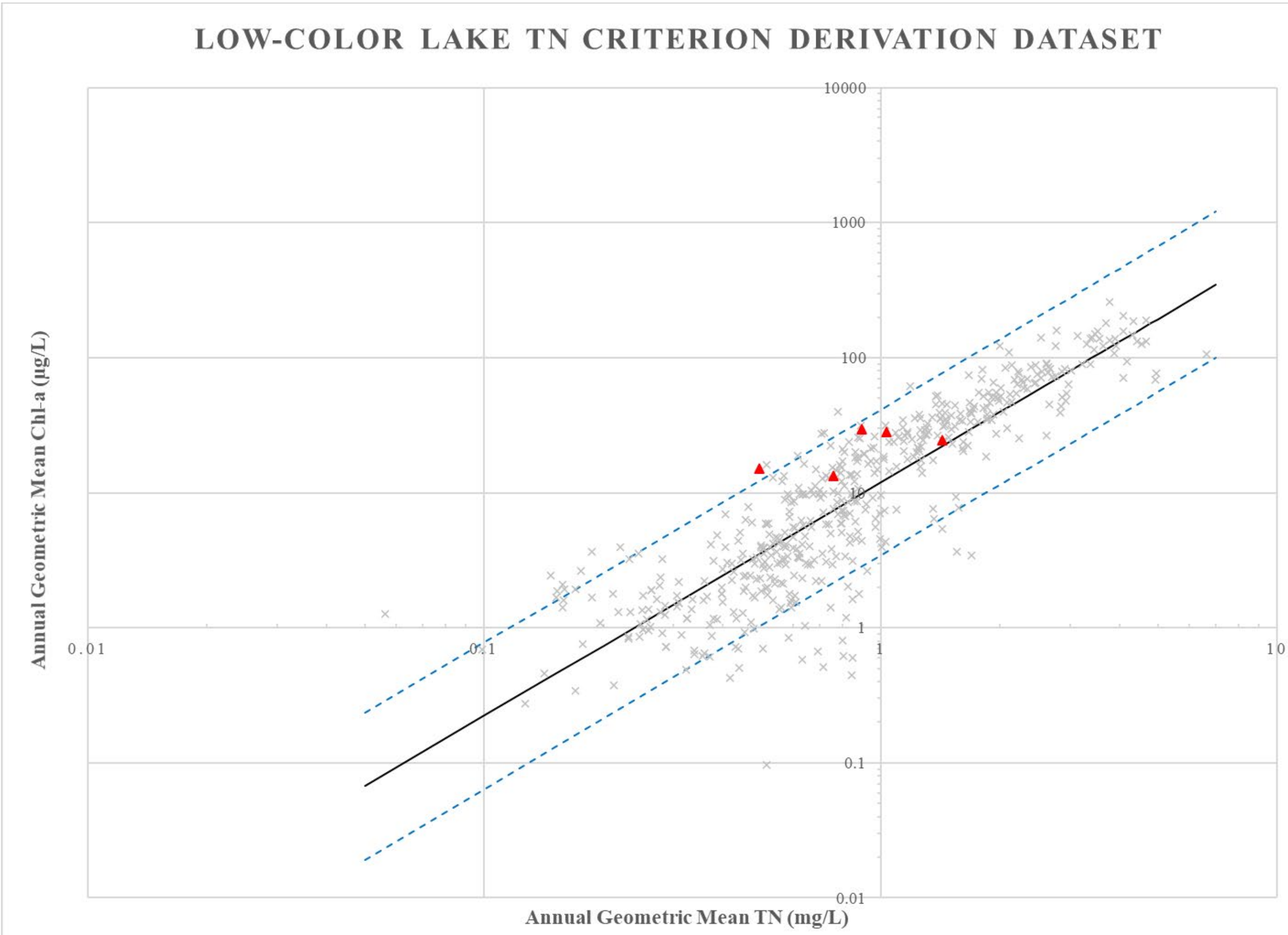

Figure 4.17. Red Water Lake TN AGMs (red triangles) plotted against the statewide dataset used to derive the NNC for low-color lakes

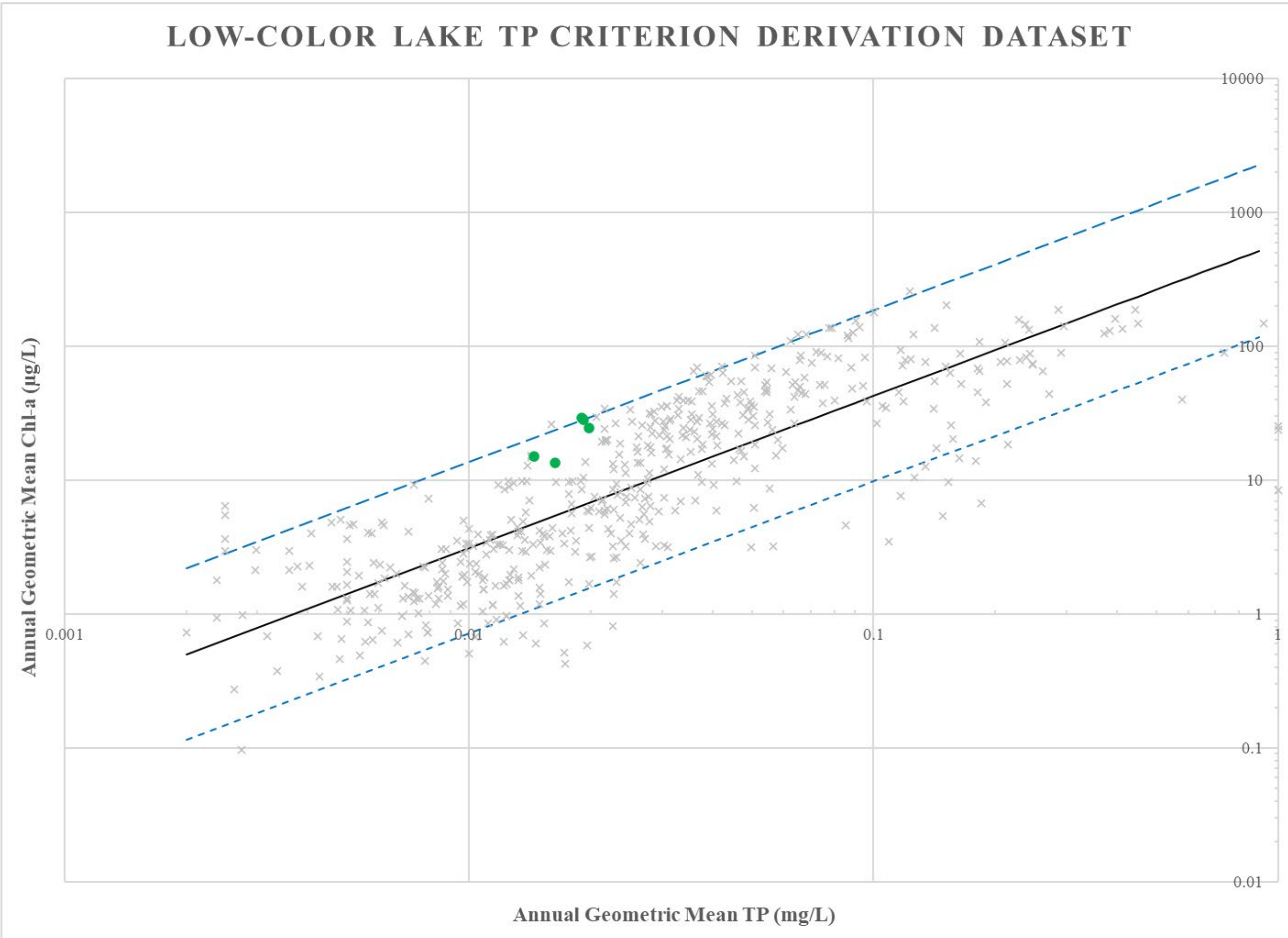

Figure 4.18. Red Water Lake TP AGMs (green circles) plotted against the statewide dataset used to derive the NNC for low-color lakes

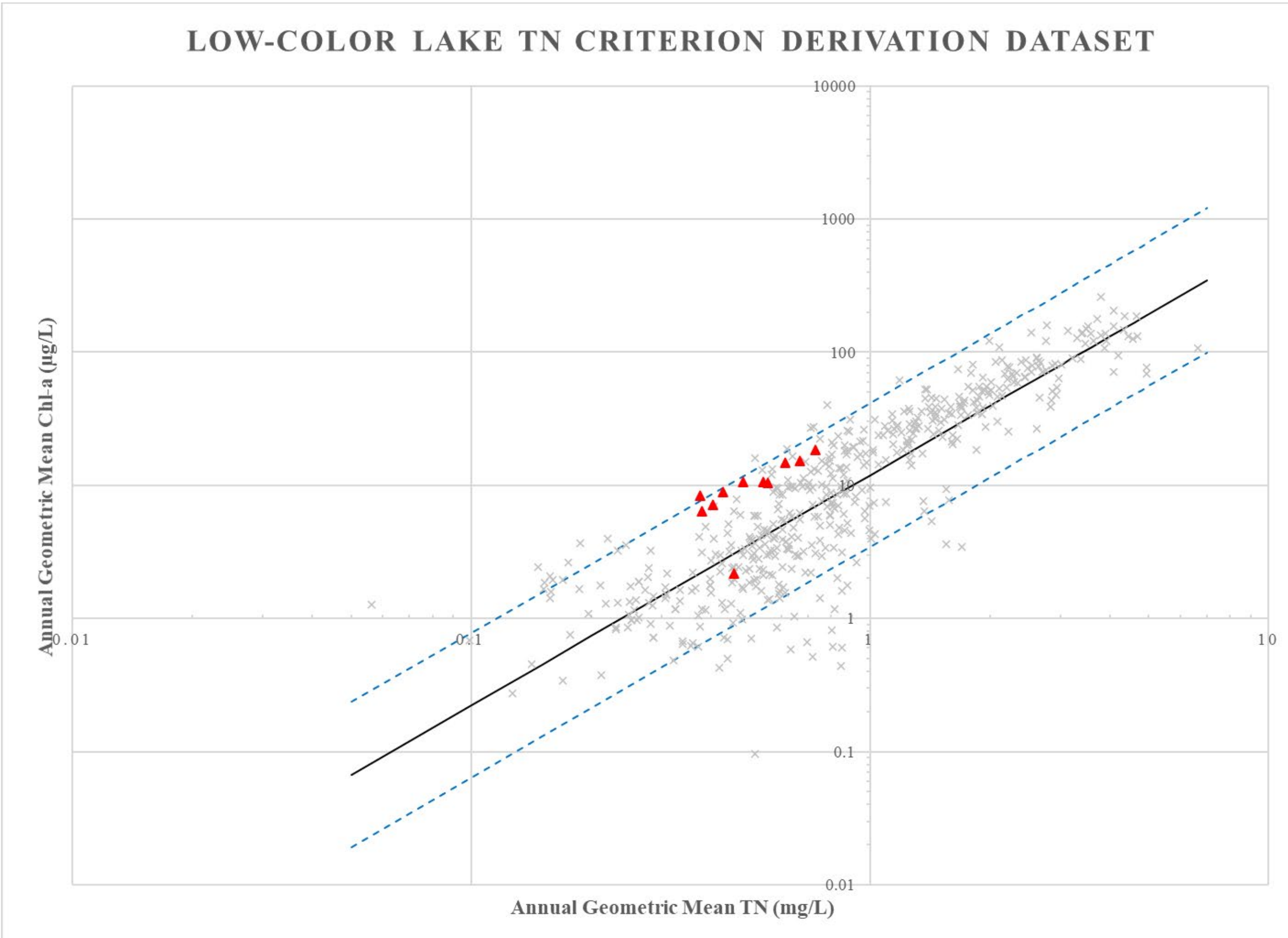

Figure 4.19. Lake Placid TN AGMs (red triangles) plotted against the statewide dataset used to derive the NNC for low-color lakes

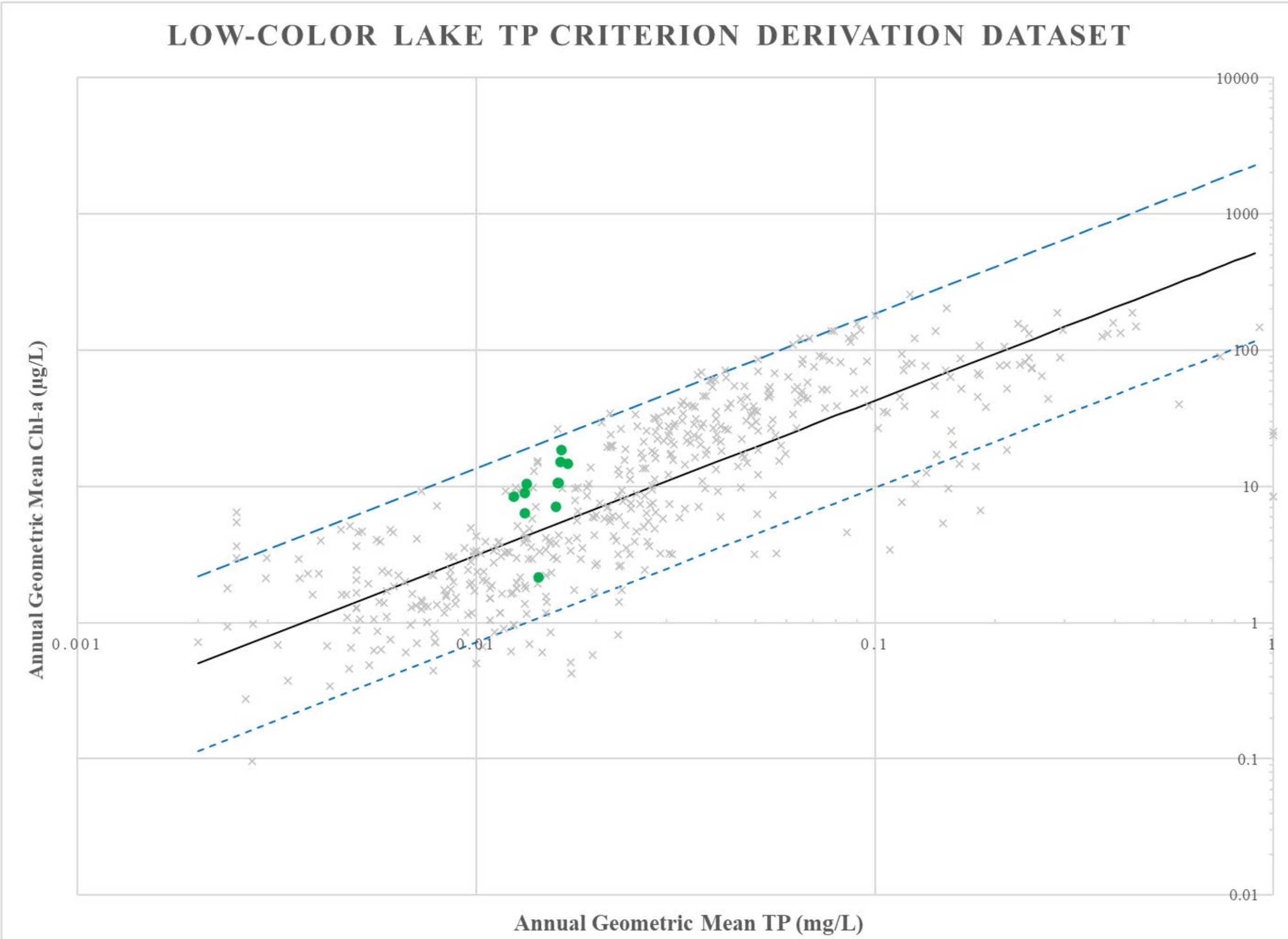

Figure 4.20. Lake Placid TP AGMs (green circles) plotted against the statewide dataset used to derive the NNC for low-color lakes

Based on the available information, there is nothing unique about Lake Glenada and Huckleberry Lake that would either make the use of the chlorophyll *a* threshold of 20 µg/L unprotective, or suggest that the lakes respond differently from the statewide generally applicable relationships shown in **Figures 4.13** through **4.16**. Nutrient concentrations less than or equal to lower lake NNC threshold are unlikely to exceed the chlorophyll *a* criteria (DEP 2012). Therefore, it can be concluded that basing the TMDL targets on the low-end generally applicable NNC (TN of 1.27 mg/L and TP of 0.05 mg/L) will meet the TMDL targets for chlorophyll *a* and fully protect designated uses in these lakes. Additionally, the TMDL targets do not need to be adopted as Hierarchy 1 site-specific interpretations of the NNC because the generally applicable NNC for high-color lakes fully protect designated uses.

Similarly, based on the available information, there is nothing unique about Red Water Lake and Lake Placid that would either make the use of the chlorophyll *a* threshold of 6 µg/L unprotective, or suggest that the lakes respond differently from the statewide generally applicable relationships shown in **Figures 4.17** through **4.20**. Therefore, it can be concluded that basing the TMDL targets on the low-end generally applicable NNC (TN of 0.51 mg/L and TP of 0.01 mg/L) will fully protect designated uses in these lakes.

The lakes are expected to meet the applicable nutrient criteria and maintain their function and designated use as Class III freshwater lakes when surface water nutrient concentrations are reduced to the target concentrations, addressing the anthropogenic contributions to the water quality impairments.

The method used to determine the reductions needed to attain the nutrient TMDLs is the percent reduction approach. Existing lake nutrient condition calculations were selected by considering the nutrient concentrations measured in the 2005–20 period, which includes the Cycle 3 verified period (2009–16) for Lake Glenada, Red Water Lake, and Lake Placid, and the 2022 biennial assessment verified period (2013–20) for Huckleberry Lake. The existing nutrient conditions used to calculate the required reductions were the maximum values of the TN and TP AGMs in each lake that exceeded the water quality targets. The geometric means were calculated from nutrient results available in the IWR Run 61 Database.

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

$$\frac{\text{[measured exceedance – target]}}{\text{measured exceedance}} \times 100$$

Table 4.1 lists the percent reductions in the maximum AGMs needed to achieve the TN AGM target of 1.27 mg/L and the TP AGM target of 0.05 mg/L for Lake Glenada and Huckleberry Lake. The TN percent reductions are 14 % in Lake Glenada and 24 % in Huckleberry Lake. The TP percent reductions are 31 % in Lake Glenada and 54 % in Huckleberry Lake.

Table 4.2 lists the percent reductions in the maximum AGMs needed to achieve the TN AGM target of 0.51 mg/L and the TP AGM target of 0.01 mg/L for Red Water Lake and Lake Placid. The TN percent reductions are 64 % in Red Water Lake and 30 % in Lake Placid. The TP percent reductions are 50 % in Red Water Lake and 41 % in Lake Placid. The nutrient AGM TMDL values and the associated percent reductions address the anthropogenic nutrient inputs contributing to the exceedances of the chlorophyll *a* criterion.

Table 4.1. Reductions required in existing TN and TP concentrations to meet water quality targets for Lake Glenada and Huckleberry Lake

ID = Insufficient data

Year	Lake Glenada TN AGMs (mg/L)	Lake Glenada TP AGMs (mg/L)	Huckleberry Lake TN AGMs (mg/L)	Huckleberry Lake TP AGMs (mg/L)
2011	0.998	0.046	ID	ID
2012	ID	ID	ID	ID
2013	1.175	0.055	ID	ID
2014	1.208	0.069	ID	ID
2015	1.187	0.065	ID	ID
2016	1.473	0.072	ID	ID
2017	ID	ID	1.339	0.091
2018	ID	ID	1.680	0.108
2019	1.455	0.066	1.500	0.097
2020	1.335	0.053	ID	ID
Maximum	**1.473**	**0.072**	**1.680**	**0.108**
TMDL Target	**1.27**	**0.05**	**1.27**	**0.05**
% Reduction	**14**	**31**	**24**	**54**

Table 4.2. Reductions required in existing TN and TP concentrations to meet water quality targets for Lake Glenada and Huckleberry Lake

ID = Insufficient data

Year	Red Water Lake TN AGMs (mg/L)	Red Water Lake TP AGMs (mg/L)	Lake Placid TN AGMs (mg/L)	Lake Placid TP AGMs (mg/L)
2011	ID	ID	0.427	0.013
2012	ID	ID	0.404	0.016
2013	0.494	0.014	0.479	0.016
2014	0.895	0.019	0.555	0.013
2015	1.036	0.019	0.540	0.016
2016	1.432	0.020	0.614	0.017
2017	ID	ID	ID	ID
2018	ID	ID	ID	ID
2019	0.758	0.016	0.728	0.016
2020	ID	ID	0.667	0.016
Maximum	**1.432**	**0.020**	**0.728**	**0.017**
TMDL Target	**0.51**	**0.01**	**0.51**	**0.01**
% Reduction	**64**	**50**	**30**	**41**

Chapter 5: Determination of Loading Allocations

5.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating loads to all 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 (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which accounts for uncertainty in the relationship between effluent limitations and water quality:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

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

This approach is consistent with federal regulations (40 Code of Federal Regulations [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 Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid are expressed in terms of in-lake nutrient concentration targets and the percent reductions of existing in-lake concentrations necessary to meet the targets (see **Table 5.1**). These TMDLs are expressed as maximum AGM values for TN and TP not to be exceeded. The restoration goal is to achieve the generally applicable chlorophyll *a* criterion of 20 µg/L for Lake Glenada and Huckleberry Lake and 6 µg/L for Red Water Lake and Lake Placid, expressed as an AGM not to be exceeded more than once in any consecutive 3-year period. This threshold protects each lake's designated use.

Table 5.1 lists the TMDLs for Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid. They are based on the generally applicable NNC in Subsection 62-302.531(2), F.A.C.

Table 5.1. TMDL components for nutrients in Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid (WBIDs 1813L, 1893, 1938F, and 1938C)

Note: The TMDL represents the AGM lake concentration (mg/L) not to be exceeded.
NA = Not applicable; margin of safety is implicit.
* The required percent reductions listed in this table represent the reductions of in-lake concentrations and do not directly reflect reductions in source loading.

Waterbody (WBID)	Parameter	TMDL (mg/L)	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)*
Lake Glenada (1813L)	TN	1.27	NA	14	14
Lake Glenada (1813L)	TP	0.05	NA	31	31
Huckleberry Lake (1893)	TN	1.27	NA	24	24
Huckleberry Lake (1893)	TP	0.05	NA	54	54
Red Water Lake (1938F)	TN	0.51	NA	64	64
Red Water Lake (1938F)	TP	0.01	NA	50	50
Lake Placid (1938C)	TN	0.51	NA	30	30
Lake Placid (1938C)	TP	0.01	NA	41	41

5.2 Load Allocation

To achieve the LA in Lake Glenada, a 14 % reduction in current TN in-lake concentration and a 31 % reduction in current TP in-lake concentration have been identified. To achieve the LA in Huckleberry Lake, a 24 % and 54 % reduction in current TN and TP in-lake concentrations, respectively, will be required. To achieve the LA in Red Water Lake, a 64 % and 50 % reduction in current TN and TP in-lake concentrations, respectively, have been identified. To achieve the LA in Lake Placid, a 30 % and 41 % reduction in current TN and TP in-lake concentrations, respectively, have been identified.

The TMDLs are based on the percent reduction in in-lake concentrations. The needed reduction from anthropogenic inputs will be calculated based on more detailed source information when a restoration plan is developed. The reductions in nonpoint source nutrient loads are expected to result in reduced sediment nutrient flux, which is commonly a factor in lake eutrophication.

It should be noted that the LA includes nutrient sources from stormwater discharges regulated by DEP and the water management districts that are not part of the NPDES stormwater program (see **Appendix A**).

5.3 Wasteload Allocation

5.3.1 NPDES Wastewater Discharges

As noted in **Chapter 4**, no active NPDES-permitted wastewater facilities in the Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds discharge either into the waterbodies or their watersheds. Therefore, a WLA for wastewater discharges is not applicable.

5.3.2 NPDES Stormwater Discharges

The MS4 permittees in the Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds are Highlands County, FDOT District 1 – Highlands County, and the City of Sebring. The Phase II NPDES MS4 permits are FLR04E148 (Highlands County), FLR04E147 (FDOT District 1 – Highlands County), and FLR04E149 (City of Sebring). Areas within these jurisdictions in the Lake Glenada Watershed are responsible for a 14 % and 31 % reduction in TN and TP, respectively, from in-lake concentrations. Areas within these jurisdictions in the Huckleberry Lake Watershed are responsible for a 24 % and 54 % reduction in TN and TP, respectively, from in-lake concentrations. Areas within these jurisdictions in the Red Water Lake Watershed are responsible for a 64 % and 50 % reduction in in TN and TP, respectively, from in-lake concentrations. Areas within these jurisdictions in the Lake Placid Watershed are responsible for a 30 % and 41 % reduction in TN and TP, respectively, from in-lake concentrations. The stormwater reductions for the TMDLs are those necessary (along with other sources) to meet the applicable NNC criteria for the lakes.

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.

5.4 Margin of Safety (MOS)

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 (DEP 2001), an implicit MOS was used in the development of these TMDLs. 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 (CWA, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as in predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

Consistent with the recommendations of the Allocation Technical Advisory Committee (DEP 2001), an implicit MOS was used in the development of the TMDLs because of the conservative assumptions that were applied. The conservative elements are that reductions were calculated from the highest measured AGM TN and TP values to achieve the low end of the TN and TP criteria range within the generally applicable NNC to calculate the percent reductions. However, it should be noted that these conservative measures are only components of the MOS and are not intended to change the frequency or duration of the applicable NNC.

Chapter 6: Implementation Plan Development and Beyond

6.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation takes place through various measures. The implementation of TMDLs may occur through specific requirements in NPDES wastewater and 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 WLAs 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 a permit holder to prioritize and act to address a TMDL unless management actions to achieve that particular TMDL are already defined in a BMAP. MS4 Phase II permit holders must also implement the responsibilities defined in a BMAP or other form of restoration plan (e.g., a reasonable assurance plan).

6.2 BMAPs

Information on the development and implementation of BMAPs is contained in Section 403.067, F.S. (the FWRA). DEP or a local entity may initiate and develop a BMAP that addresses some or all of the contributing areas to the TMDL waterbody. BMAPs are adopted by the DEP Secretary and are legally enforceable.

BMAPs describe the fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed, as well as the management strategies that will be implemented to meet those responsibilities, funding strategies, mechanisms to track progress, and water quality monitoring. Local entities, such as wastewater facilities, industrial sources, agricultural producers, county and city stormwater systems, military bases, water control districts, state agencies, and individual property owners usually implement these strategies. BMAPs can also identify mechanisms to address potential pollutant loading from future growth and development.

The Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid Watersheds are located in the Lake Okeechobee BMAP area, specifically in the Lake Istokpoga Subwatershed. Lake Glenada is located in the Arbuckle Creek Basin, and Huckleberry Lake, Red Water Lake, and Lake Placid are situated in the Josephine Creek Basin. The BMAP was adopted in December 2014 to implement the TP TMDL in the Lake Okeechobee Watershed, and activities are ongoing throughout the larger basin to reduce nutrient loads to Lake Okeechobee. An updated BMAP was adopted in February 2020. Management strategies in the Lake Glenada, Lake Huckleberry, Red Water Lake, and Lake Placid Watersheds will address nutrient impairments for these lakes and will also likely benefit Lake Okeechobee. In the Josephine Creek and Arbuckle Creek Basins, BMPs and other projects have been conducted to reduce nutrient loading to lakes, including these four. Highlands County, the City of Sebring, the City of Avon Park, SFWMD, and the Spring Lake Improvement District have conducted projects and educational and outreach efforts in these basins to help reduce nutrient loading. Projects include online retention BMPs, street sweeping, dispersed water management (DWM), and stormwater treatment areas (STAs). Educational and outreach efforts include the Florida Yards and Neighborhoods Program, landscaping and irrigation ordinances, public service announcements, and pamphlets. These projects and others in the Lake Istokpoga Subwatershed are further described in the Lake Okeechobee BMAP (DEP 2020) and Florida Statewide Annual Report (DEP 2021).

Additional information about BMAPs is available online.

6.3 Implementation Considerations for the Waterbody

Existing nutrient reduction and management infrastructure and plans should be included in any future pollutant mitigation strategies. 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 additional associated remediation projects on surface water quality. Approaches for addressing these other factors should be included in comprehensive management plans for the waterbodies.

Additionally, the current water quality monitoring of the lakes should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress. According to SWFWMD, the City of Lake Placid, the City of Avon Park, and Highlands County currently have no restoration projects associated with Lake Glenada, Huckleberry Lake, Red Water Lake, and Lake Placid. However, the impacts of any future projects should be monitored to track progress.

The goal of this TMDL is to achieve the generally applicable NNC. Stakeholders should focus on nutrient concentration targets that help reduce nutrient and chlorophyll levels. Once the lake is consistently meeting the NNC over the assessment period, it can be assumed that the TMDL is being met.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, DEP stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations, as authorized under Part IV of Chapter 373, F.S.

Chapter 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) Program plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal CWA Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in 1990 to address stormwater discharges associated with industrial activity, including 11 categories of industrial activity, construction activities disturbing 5 or more acres of land, and large and medium MS4s located in incorporated places and counties with populations of 100,000 or more.

However, because the master drainage systems of most local governments in Florida are physically interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 special districts; community development districts, water control districts, and FDOT throughout the 15 counties meeting the population criteria. DEP received authorization to implement the NPDES stormwater program in 2000. The authority to administer the program is set forth in Section 403.0885, F.S.

The Phase II NPDES stormwater program, promulgated in 1999, addresses additional sources, including small MS4s and small construction activities disturbing between 1 and 5 acres, and urbanized areas serving a minimum resident population of at least 1,000 individuals. While these urban stormwater discharges are technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that Phase I MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.