Southwest District and South District • Kissimmee River Basin

Final TMDL Report

Nutrient TMDLs for Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), Hickory Lake (WBID 1730), Lake Clinch (WBID 1706), and Lake Adelaide (WBID 1730D) and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments for five lakes located in southeast Polk County and northwest Highlands County. Reedy Lake, Lake Ida, Hickory Lake, and Lake Clinch are located near the City of Frostproof, and Lake Adelaide is located near the City of Avon Park.

Reedy Lake, Hickory Lake, and Lake Clinch were originally identified as impaired for nutrients based on elevated annual average Trophic State Index values. Now all the waterbodies have exceedances of the applicable lake numeric nutrient criteria (NNC) in Subsection 62-302.531(2), Florida Administrative Code (F.A.C.). Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide 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 July 2017.

Pursuant to Paragraph 62-302.531(2)(a), F.A.C., these TMDLs will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C.

TMDLs for total nitrogen (TN) and total phosphorus (TP) have been developed. **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 Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide

Type of Information	Description
Waterbody name/ Waterbody identification (WBID) number	Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), Hickory Lake (WBID 1730), Lake Clinch (WBID 1706), and Lake Adelaide (WBID 1730D)
Hydrologic Unit Code (HUC) 8	03090101
Use classification/ Waterbody designation	Class III/Fresh
Targeted beneficial uses	Fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife
303(d) listing status	Verified List of Impaired Waters for the Kissimmee River Group 4 Basin, adopted via Secretarial Order in 2017
TMDL pollutants	TN and TP
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), and Hickory Lake (WBID 1730):** **TN:** 0.95 milligrams per liter (mg/L), expressed as an annual geometric mean (AGM) not to be exceeded **TP:** 0.03 mg/L, expressed as an AGM not to be exceeded **Lake Clinch (WBID 1706) and Lake Adelaide (WBID 1730D):** **TN:** 0.62 mg/L, expressed as an AGM not to be exceeded **TP:** 0.01 mg/L, expressed as an AGM not to be exceeded
Load reductions required to meet the TMDLs	**Reedy Lake (WBID 1685D):** A 54 % TN reduction and a 0 % TP reduction to achieve a chlorophyll *a* target of 20 micrograms per liter (µg/L) **Lake Ida (WBID 1685E):** An 87 % TN reduction and a 0 % TP reduction to achieve a chlorophyll *a* target of 20 µg/L **Hickory Lake (WBID 1730):** A 69 % TN reduction and a 0 % TP reduction to achieve a chlorophyll *a* target of 20 µg/L **Lake Clinch (WBID 1706):** An 18 % TN reduction and a 50 % TP reduction to achieve a chlorophyll *a* target of 6 µg/L **Lake Adelaide (WBID 1730D):** A 6 % TN reduction and a 50 % TP reduction to achieve a chlorophyll *a* target of 6 µg/L

Acknowledgments

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Acronyms and Additional Abbreviations Used in Report

ac	Acres
AGM	Annual Geometric Mean
BMAP	Basin Management Action Plan
BMP	Best Management Practice
CFR	Code of Federal Regulations
CWA	Clean Water Act
° F	Degrees Fahrenheit
DEP	Florida Department of Environmental Protection
DO	Dissolved Oxygen
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDOT	Florida Department of Transportation
F.S.	Florida Statutes
FSAID	Florida Statewide Agricultural Irrigation Database
ft	Feet
FWRA	Florida Watershed Restoration Act
FWS	Fish and Wildlife Service
HUC	Hydrologic Unit Code
ID	Insufficient Data
IPaC	Information for Planning and Conservation
IWR	Impaired Surface Waters Rule
LA	Load Allocation
lbs	Pounds
lbs/yr	Pounds Per Year
m	Meter
MDL	Minimum Detection Limit
µg/L	Micrograms Per Liter
m/yr	Meters Per Year
mg/L	Milligrams Per Liter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
N/A	Not Available
NMFS	National Marine Fisheries Service
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSTDS	Onsite Sewage Treatment and Disposal System
PCU	Platinum Cobalt Units
PLRGs	Pollutant Load Reduction Goals
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management

TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
U.S.	United States
WBID	Waterbody Identification
WLA	Wasteload Allocation
WQS	Water Quality Standards
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 Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide, located in the Kissimmee River Basin. The TMDLs will also constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), F.A.C., for these particular waterbodies, pursuant to Paragraph 62-302.531(2)(a), F.A.C. These lakes were verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.), and were included on the Verified List of Impaired Waters for the Kissimmee River Basin adopted by Secretarial Order in July 2017. The IWR is implemented using a 5-year basin rotation, with Florida's 52 hydrologic unit codes (HUC) basins distributed among 29 basin groups (DEP 2018).

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 loadings to Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide needed to restore these lakes and allow for the attainment of their applicable designated uses.

1.2 Identification of Waterbody

For assessment purposes, the DEP divided the Kissimmee River Basin (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. Reedy Lake is WBID 1685D; Lake Ida is WBID 1685E; Hickory Lake is WBID 1730; Lake Clinch is WBID 1706; and Lake Adelaide is WBID 1730D. **Figure 1.1** shows the location of the lake WBIDs in the basin and major geopolitical and hydrologic features in the region with arrows representing flow direction.

Lake Ida (WBID 1685E) is a small, circular lake located directly north of Reedy Lake, a large lake also located in Polk County. Lake Ida discharges into a short canal at the south end of the lake into Reedy Lake (WBID 1685D), Reedy Lake receives water from Lake Ida from the north and Lake Clinch from the west through a 72-inch control structure (concrete pipe). Reedy Lake discharges into Reedy Creek at the south end of the lake; the creek then receives water from Livingston Creek before flowing into Lake Arbuckle.

Lake Clinch (WBID 1706) is a medium-sized lake located directly west of Reedy Lake in Polk County. Lake Clinch receives water from Crooked Lake through the Crooked Clinch Canal (adjustable weir) from the northwest end of the lake and discharges into Reedy Lake from the east end of the lake (through the 72-inch control structure). The control flows to Reedy Lake is established at the Lake Clinch outfall structure by one 5-foot-wide slide gate which is affixed to the south weir only. Hickory Lake (WBID 1730) is a small, circular lake located southwest of Reedy Lake in Polk County. Lake Adelaide (WBID 1730D) is a small, bilobed lake located south of Hickory Lake in Highlands County. On the southwest side of Lake Adelaide wetlands drain into a ditch that then flows into the lake. Furthermore, during high lake elevations, Lake Adelaide drains into a ditch, on the north side, that then flows into wetlands. **Table 1.1** summarizes the lakes' general hydrologic characteristics.

Table 1.1. Characteristics of Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide

[1] Data from Polk County Water Atlas 2019.
[2] Data from Florida Fish and Wildlife Conservation Commission (FWC).
ac = Acres; ac-ft = Acre-feet; ft = Feet; N/A = Not available.

Lake Name	Lake Surface Area (ac)	Lake Volume (ac-ft)	Mean Depth (ft)	Maximum Depth (ft)	Watershed Area (ac)	Watershed
Reedy[1]	3,504	44,529	12	19	37,555	Reedy Lake, Lake Ida, and Lake Clinch
Ida[1]	85	N/A	N/A	N/A	37,555	Reedy Lake, Lake Ida, and Lake Clinch
Hickory[1]	101	N/A	N/A	N/A	18,228	Hickory Lake and Lake Adelaide
Clinch[1]	1,219	2,123	16	55	37,555	Reedy Lake, Lake Ida, and Lake Clinch
Adelaide[2]	98	686	7	N/A	18,228	Hickory Lake and Lake Adelaide

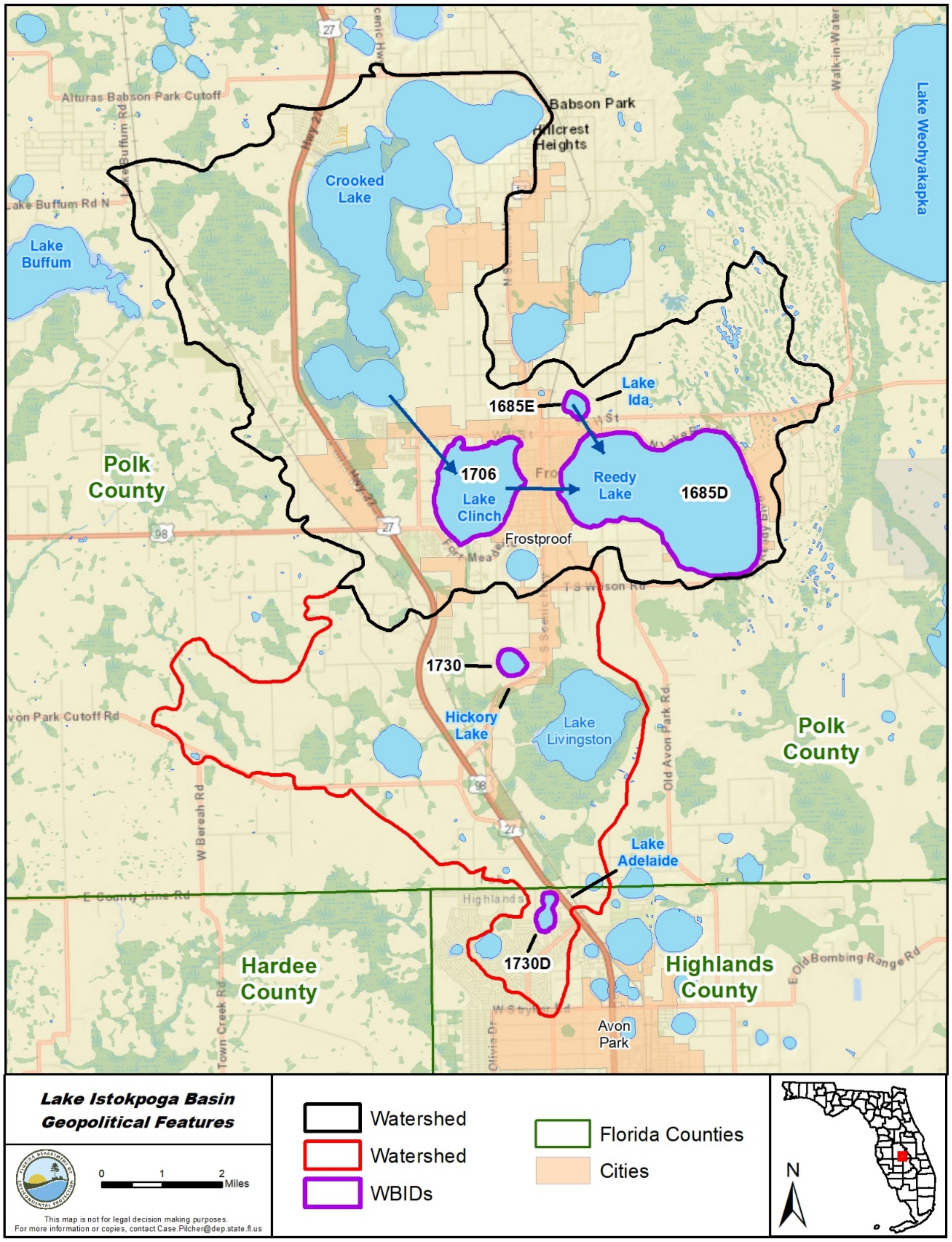

Figure 1.1. Location of Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), Hickory Lake (WBID 1730), Lake Clinch (WBID 1706), and Lake Adelaide (WBID 1730D) in the Kissimmee River Basin and major geopolitical and hydrologic features in the region with arrows representing flow direction

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

According to the data available from the U.S. Census Bureau, the population of Polk County was 686,483 with a density of 381.8 persons per square mile (U.S. Census Bureau 2017). Polk County occupies an area of 1,798 square miles, and there are 295,126 housing units in the county, with a housing density of 164.1 houses per square mile. The population of Highlands County is 102,883, with a density of 101.2 persons per square mile. Highlands County occupies an area of 1,017 square miles and there are 55,641 housing units in the county, with a housing density of 54.7 houses per square mile. Reedy Lake, Lake Ida, Hickory Lake, and Lake Clinch are located in or near the City of Frostproof, which has a population of 10,408. Lake Adelaide is located near the City of Avon Park, which has a population of 3,142.

1.3.2 Topography

The five lakes are located in the Northern Lake Wales Ridge region (75-32), which is characterized by well-drained sandy soils dominated by the Candler-Tavares-Apopka association (Griffith et al. 1997). The ridge is formed by an unnamed unit of nonmarine coarse clastic sediments of Miocene age (poorly sorted quartz sands and pebbles imbedded in kaolinitic clay) (Scott et al. 1980). Other parts of this region are classified as Pleistocene beach and dune sand and Pliocene undifferentiated sand (Brooks 1981). The area is covered by citrus groves, pasture, and urban and residential development. The lakes in this region are mostly alkaline, low-to-moderate-nutrient, clearwater lakes.

The elevation in the Reedy Lake, Lake Ida, and Lake Clinch Watershed ranges from 88 feet (ft) above North American Vertical Datum of 1988 (NAVD88) to 183 ft NAVD88, and from 77 to 302 ft NAVD88 in the Hickory Lake and Lake Adelaide Watershed.

1.3.3 Hydrogeological Setting

The hydrology of the lakes is determined in part by the topography, but also by their similar soil geology, aquifer/groundwater interactions, and climate.

The climate of the watershed areas is subtropical, with an annual average temperature of 73 degrees Fahrenheit (° F.). Annual rainfall depth in or near this part of the Kissimmee Basin averages 50 to 56 inches, with a defined rainy season occurring from June to September, and 60 % of the rainfall occurring during that period. The long-term average annual rainfall depth for Polk County is 52 inches/year (in/yr), based on data from the Southwest Florida Water Management District (SWFWMD) recorded from 1915 to 2017.

Both watersheds are located in the Cypresshead Formation (Pliocene), characterized by reddish brown to reddish orange, unconsolidated to poorly consolidated, fine to very coarse grained, clean to clayey sands (Scott 2001). The Cypresshead Formation is at or near the surface, and because of the permeable sands this region comprises a part of the surficial aquifer found in Florida and eastern Georgia.

The soils in the watersheds for the lakes contain Hydrologic Soil Groups A, A/D, B, B/D, C, and C/D. These groups are based on the National Cooperative Soil Survey. Group A type soils are typically well-drained, have deep water tables, and consist of sandy textured soils with relatively low runoff potential. Group B type soils are typically loamy with some silt component, a moderately coarse texture, and a lower infiltration rate than Group A soils and are therefore classed as moderately well-drained. Group C type soils are sand, clay, and loam with more fine textures and lower infiltration rates, especially when wet. Group D type soils are variable in texture but generally have a greater clay component and are often found at lower topography with higher water tables that generate a higher hydrologic runoff response. When Group A/D, Group B/D, and Group C/D are unsaturated, they behave like Groups A, B, and C soils and when unsaturated behave like Group D soil.

Figure 1.2 displays the distribution of soil types in the Reedy Lake, Lake Ida, and Lake Clinch Watershed and in the Hickory Lake and Lake Adelaide Watershed. A majority of soils in both watershed areas for the five lakes consists of a mix of well-drained, sandy, textured soils ("A" soils) (**Tables 1.2** and **1.3**, respectively).

Table 1.2. Soil type acreage and percent in the Reedy Lake, Lake Ida, and Lake Clinch Watershed

Note: Hybrid soil types are A/D, B/D, and C/D.

Hydrologic Group	Acres	% of Watershed
No Data	10,110	26.92
A	13,647	36.34
A/D	9,458	25.19
B	76	0.2
B/D	2,487	6.62
C	5	0.01
C/D	1,772	4.72
Total	**37,555**	**100**

Table 1.3. Soil type acreage and percent in the Hickory Lake and Lake Adelaide Watershed

Note: Hybrid soil types are A/D, B/D, and C/D.

Hydrologic Group	Acres	% of Watershed
No Data	1,805	9.9
A	8,023	44.02
A/D	7,384	40.51
B	11	0.06
B/D	839	4.6
C	31	0.17
C/D	135	0.74
Total	**18,228**	**100**

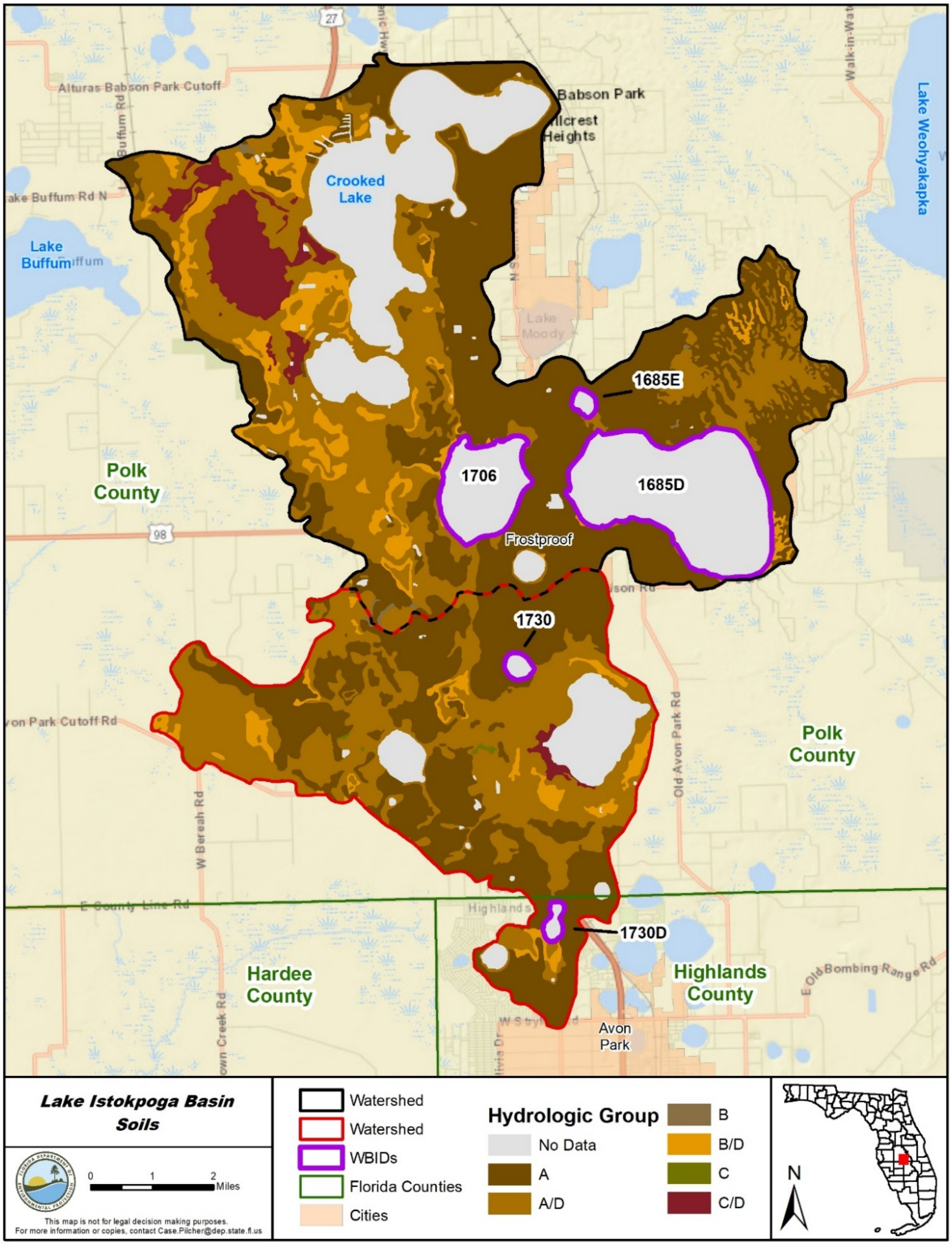

Figure 1.2. Hydrologic soil groups in the watersheds

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.). The state's 303(d) list is amended annually to include basin updates.

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide 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 impairment (nutrients) for this waterbody 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 as calcium carbonate (mg/L $CaCO_3$) and true color (color), measured in platinum cobalt units (PCU), based on long-term period of record (POR) geometric means (**Table 2.1**). Using this methodology and data from IWR Run 56, Reedy Lake, Lake Ida, and Hickory Lake are classified as low-color (< 40 PCU), high-alkalinity (> 20 mg/L $CaCO_3$) lakes. Lake Clinch and Lake Adelaide are classified as low-color (< 40 PCU), low-alkalinity (< 20 mg/L $CaCO_3$) lakes.

The chlorophyll *a* NNC for low-color, high-alkalinity lakes (Reedy Lake, Lake Ida, and Hickory Lake) is an annual geometric mean (AGM) value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any 3-year period. For low-color, low-alkalinity lakes (Lake Clinch and Lake Adelaide), the AGM for chlorophyll *a* is 6 µg/L, not to be exceeded more than once in any 3-year period.

The associated total nitrogen (TN) and total phosphorus (TP) criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the concentrations of chlorophyll *a* in the lake. If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type in **Table 2.1**, then the TN and TP numeric interpretations for the calendar year are the AGMs for lake TN and TP samples, subject to minimum and maximum limits.

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 applicable nutrient interpretations for TN and TP are the minimum values. These values are listed in **Table 2.1**, as specified in Subparagraph 62-302.531(2)(b)1., F.A.C.

Table 2.1. 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.

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 majority of lake nutrient data used in the most recent assessment period came from stations sampled and monitored by Polk County (21FLPOLK…). **Figures 2.1** and **2.2** show the lake sampling locations with the most data in the two watersheds, respectively, **Table 2.2** lists the monitoring stations for the major contributors of chlorophyll *a*, TN, and TP data from 2000 to 2016 for each lake, and **Appendix C** lists all of the monitoring stations used for the regression analysis, described in **Chapter 5**. The water quality results for this period, also described in **Chapter 5**, were used in the regression analysis.

In 1999, the county began sampling for corrected chlorophyll *a*, the form of chlorophyll *a* used to assess chlorophyll *a* in the IWR. The other sampling organizations have conducted monitoring intermittently. The individual water quality measurements discussed in this report are available in the IWR Run 56 Database and are available on request.

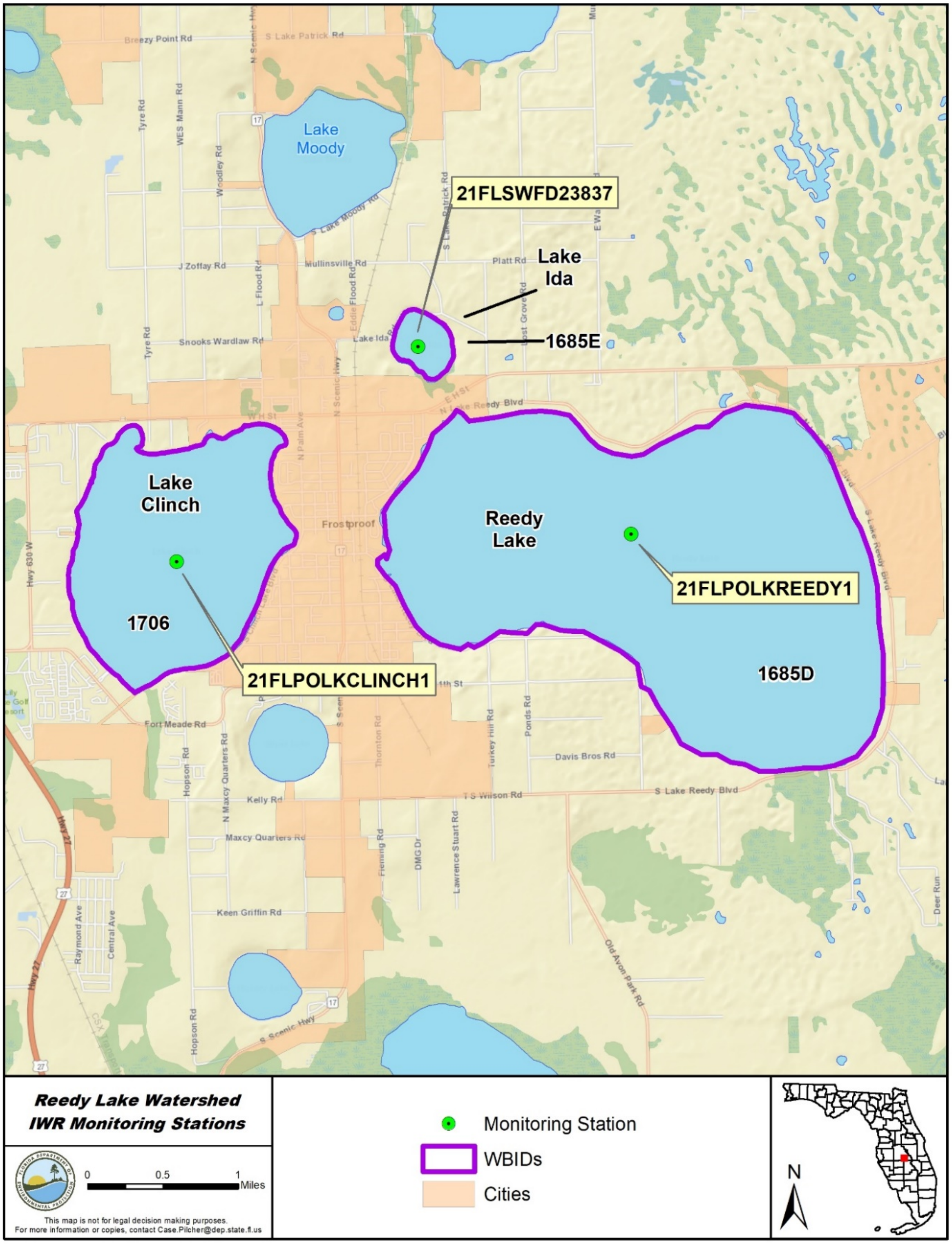

Figure 2.1. Monitoring stations in the Reedy Lake, Lake Ida, and Lake Clinch Watershed

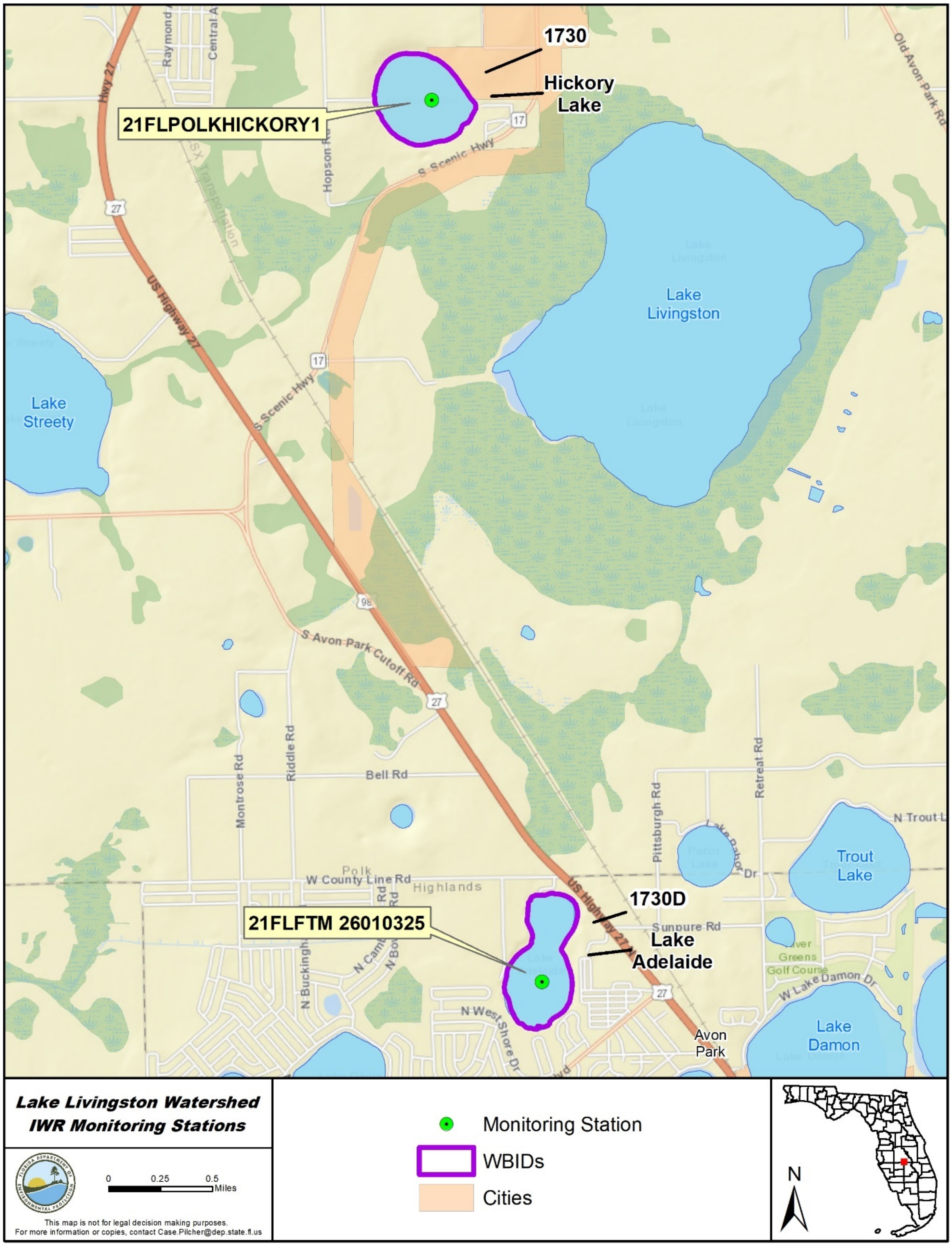

Figure 2.2. Monitoring stations in the Hickory Lake and Lake Adelaide Watershed

Table 2.2. Monitoring stations for each of the five lakes in the Kissimmee Basin

Lake	WBID	Station Identification
Reedy	1685D	21FLPOLKREEDY1
Ida	1685E	21FLSWFD23837
Hickory	1730	21FLPOLKHICKORY1
Clinch	1706	21FLPOLKCLINCH1
Adelaide	1730D	21FLFTM26010325

2.3.2 Information on Verified Impairment

For the Cycle 3 basin assessment completed in 2017, the NNC were used to assess the lakes for the verified period (January 1, 2009–June 30, 2016) based on data from the IWR Run 53 Database. Lake Clinch was assessed as impaired (Category 5) for chlorophyll *a*, TN, and TP, and the lake was added to the Verified List. Reedy Lake, Hickory Lake, and Lake Adelaide were assessed as impaired for chlorophyll *a* and TN, and the lakes were added to the Verified List. Lake Ida was assessed as impaired for TN and was added to the Verified List. **Tables 2.3**, **2.4**, and **2.5** list the chlorophyll *a*, TN, and TP AGMs, respectively, calculated using the data from 2009 to 2016 in the IWR Run 53 Database.

Table 2.3. Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide chlorophyll *a* AGM values (µg/L), 2009–16

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC of 20 µg/L chlorophyll *a* for lakes Reedy, Ida, and Hickory and 6 µg/L chlorophyll *a* for lakes Clinch and Adelaide. 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 three-year period.

Year	Reedy Lake	Lake Ida	Hickory Lake	Lake Clinch	Lake Adelaide
2009	13	ID	**66**	**17**	ID
2010	13	ID	**41**	**9**	ID
2011	17	ID	ID	**17**	ID
2012	**27**	ID	ID	**10**	ID
2013	14	1	ID	ID	ID
2014	**34**	2	ID	**9**	ID
2015	**29**	ID	ID	**12**	**8**
2016	ID	ID	ID	ID	**7**

Table 2.4. Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide TN AGM values (mg/L), 2009–16

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC of 1.05 mg/L TN for lakes Reedy, Ida, and Hickory and 0.51 mg/L TN for lakes Clinch and Adelaide. 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 three-year period.

Year	Reedy Lake	Lake Ida	Hickory Lake	Lake Clinch	Lake Adelaide
2009	**1.32**	ID	**2.62**	**0.69**	ID
2010	**1.34**	ID	**1.91**	**0.59**	ID
2011	**1.47**	ID	ID	**0.76**	ID
2012	**1.76**	ID	ID	**0.65**	ID
2013	0.95	**7.16**	ID	ID	ID
2014	**1.20**	**6.46**	ID	**0.54**	ID
2015	**1.73**	ID	ID	**0.75**	**0.66**
2016	ID	ID	ID	ID	**0.59**

Table 2.5. Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide TP AGM values (mg/L), 2009–16

ID = Insufficient data
Note: Values shown in boldface type and shaded are greater than the NNC of 0.03 mg/L TP for lakes Reedy, Ida, and Hickory and 0.01 mg/L for lakes Clinch and Adelaide. 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 three-year period.

Year	Reedy Lake	Lake Ida	Hickory Lake	Lake Clinch	Lake Adelaide
2009	0.02	ID	0.03	**0.02**	ID
2010	0.02	ID	0.02	0.01	ID
2011	0.02	ID	ID	**0.02**	ID
2012	0.02	ID	ID	0.01	ID
2013	0.02	0.01	ID	ID	ID
2014	0.03	0.01	ID	**0.02**	ID
2015	0.02	ID	ID	**0.02**	0.01
2016	ID	ID	ID	ID	**0.02**

Chapter 3: Site-Specific Numeric Interpretation of the Narrative Nutrient Criterion

3.1 Establishing the Site-Specific Interpretation

Pursuant to Paragraph 62-302.531(2)(a), F.A.C., the nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.515, F.A.C., will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C. **Table 3.1** lists the elements of the nutrient TMDLs that constitute the site-specific numeric interpretations of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide and for the attainment and maintenance of water quality standards in downstream waters (pursuant to Subsection 62-302.531[4], F.A.C.), and to support using the nutrient TMDLs as the site-specific numeric interpretations of the narrative nutrient criterion.

When developing TMDLs to address nutrient impairment, it is essential to address those nutrients that typically contribute to excessive plant growth. 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 the reduction of both nitrogen and phosphorus as a better approach to controlling 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 supports this idea, as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (DEP 2012).

3.2 Site-Specific Response Variable Target Selection

The generally applicable chlorophyll *a* criteria for lakes were established by taking into consideration multiple lines of evidence, including an analysis of lake chlorophyll *a* concentrations statewide, comparisons with a smaller population of select reference lakes, paleolimnological studies, expert opinions, user perceptions, and biological responses. Based on these lines of evidence, DEP developed a chlorophyll *a* criterion of 20 µg/L for lakes with low color (≤ 40 PCU) and high alkalinity (≥ 20 mg/L $CaCO_3$) and a chlorophyll *a* criterion of 6 µg/L for lakes with low color (≤ 40 PCU) and low alkalinity (≤ 20 mg/L $CaCO_3$) (DEP 2012). DEP demonstrated that chlorophyll *a* criteria of 20 µg/L for low-color, high-alkalinity lakes and 6 µg/L for low-color, low-alkalinity lakes are protective of designated uses and maintain the health of a balanced community of aquatic flora and fauna.

The generally applicable chlorophyll *a* criteria are assumed to be protective of individual Florida lakes, absent information that shows either (1) more sensitive aquatic life use (i.e., a more responsive floral community), or (2) a significant change in historical trophic status (i.e., a significant increasing trend in color and/or alkalinity). Long-term datasets of color, alkalinity, and nutrients in Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide suggest that they do not differ from the population of lakes used in the development of the NNC, and therefore DEP has determined that the generally applicable chlorophyll *a* criteria are the most appropriate site-specific chlorophyll *a* criteria for these lakes. As such, the chlorophyll *a* criteria were used as the water quality target for the TMDLs for all five lakes (Reedy Lake, Lake Ida, and Hickory Lake are low-color, high-alkalinity lakes with a chlorophyll *a* target of 20 µg/L, and. Lake Clinch and Lake Adelaide are low-color, low-alkalinity lakes with a chlorophyll *a* target of 6 µg/L).

The TP water quality target for Reedy Lake, Lake Ida, and Hickory Lake was derived using the predisturbance inferred water quality from paleolimnological study results measured in Whitmore and Brenner (1995 and 2002). The studies estimated predisturbance average TP levels by applying statistical models based on sedimented diatoms and calibrated using a large number of Florida lakes (Whitmore 1989; Brenner et al. 1993; Line et al. 1994). The Florida lakes researched in the paleolimnological studies are categorized as low-color, high-alkalinity lakes, located in a lake ecoregion (Trail Ridge/Lake Wales) with similar topography to the lakes discussed in the TMDL analysis (Reedy Lake, Lake Ida, and Hickory Lake). The predicted minimum average TP result from the deepest sediment core depth analyzed (90 centimeters [cm]), which equates to predisturbance conditions, was 30 µg/L (0.03 mg/L).

The TP water quality target for Lake Clinch and Lake Adelaide was derived using the predisturbance inferred water quality from paleolimnological study results measured in Quillen (2009) and Quillen et al. (2013). The studies estimated predisturbance average TP levels by applying statistical models based on sedimented diatoms and calibrated using a reference set of Florida lakes (Quillen 2009). The Florida lakes studied in Quillen (2009) and Quillen et al. (2013) were categorized as low-color, low-alkalinity lakes, located in the same lake ecoregion (Northern Lake Wales Ridge) as the lakes discussed in the TMDL analysis (Lake Clinch and Lake Adelaide). According to Quillen et al. (2013), the predicted mean predisturbance TP result was 7.2 µg/L (0.0072 mg/L).

3.3 Numeric Expression of the Site-Specific Numeric Interpretation

The TP TMDL targets also serve as the TP site-specific numeric interpretations of the narrative criterion and TMDL target (0.03 mg/L, not to be exceeded in any year for Reedy Lake, Lake Ida, and Hickory Lake, and 0.01 mg/L, not to be exceeded in any year for Lake Clinch and Lake Adelaide).

The site-specific numeric interpretations of the narrative nutrient criterion and TMDL target for TN (0.95 mg/L, not to be exceeded in any year for low-color, high-alkalinity lakes, and 0.62 mg/L, not to be exceeded in any year for low-color, low-alkalinity lakes) were determined using a regression approach, based on the relationship between nutrients (TN and TP) and chlorophyll *a*. The TN concentration, along with the lake TP concentration set at the criterion, would achieve the applicable chlorophyll *a* criteria (20 µg/L, not to be exceeded more than once in any 3-year period for low-color, high-alkalinity lakes, and 6 µg/L, not to be exceeded more than once in any 3-year period for low-color, low-alkalinity lakes). The target concentrations are then used to determine the percent reduction in in-lake concentrations necessary to meet the targets, for the period from 2000 to 2016.

The nutrient criteria are all expressed as AGM concentrations in these five lakes. The chlorophyll *a* concentration is expressed as an AGM concentration not to be exceeded more than once in any consecutive three-year period. The TN and TP concentrations are expressed as AGM concentrations not to be exceeded. **Table 3.1** summarizes the site-specific interpretations of the narrative nutrient criterion for the lakes.

Table 3.1. Site-specific interpretations of the narrative nutrient criterion

Note: Frequency refers to the time interval not to be exceeded. TN and TP are not to be exceeded.

Waterbody/ WBID	AGM TN (mg/L)	TN Frequency	AGM TP (mg/L)	TP Frequency
Reedy Lake/ 1685D	0.95	No exceedance	0.03	No exceedance
Lake Ida/ 1685E	0.95	No exceedance	0.03	No exceedance
Hickory Lake/ 1730	0.95	No exceedance	0.03	No exceedance
Lake Clinch/ 1706	0.62	No exceedance	0.01	No exceedance
Lake Adelaide/ 1730D	0.62	No exceedance	0.01	No exceedance

3.4 Downstream Protection

As discussed in **Section 1.2**, on the southwest side of Lake Adelaide wetlands drain into a ditch that then flows into the lake. Furthermore, during high lake elevations, Lake Adelaide drains into a ditch, on the north side, that then flows into wetlands. Lake Ida discharges into a canal that flows into Reedy Lake and, to ensure the downstream protection of Reedy Lake, the chlorophyll *a*, TN, and TP criteria for Reedy Lake were applied to Lake Ida. Lake Clinch discharges into Reedy Lake through a 72-inch control structure, and the TMDL for Lake Clinch is protective of Reedy Lake because the chlorophyll *a*, TN, and TP criteria for Lake Clinch are lower than the NNC for Reedy Lake. Hickory Lake has no defined drainage canals or streams connecting the lake to downstream waterbodies. Reedy Lake discharges to Reedy Creek (WBID 1685B), a Class III freshwater stream, which flows into Lake Arbuckle (WBID 1685A), a Class III freshwater lake. Reedy Creek and Lake Arbuckle are not impaired for nutrients, and therefore, nutrient reductions required under the Reedy Lake TMDL will only help to improve water quality in Reedy Creek and Lake Arbuckle.

3.5 Endangered Species Considerations

Section 7(a)(2) of the Endangered Species Act (ESA) requires each federal agency, in consultation with the services (i.e., the U.S. Fish and Wildlife Service [FWS] and the National Oceanic and Atmospheric Administration [NOAA] National Marine Fisheries Service [NMFS]), to ensure that any federal action authorized, funded, or carried out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. The EPA must review and approve changes in water quality standards (WQS) such as setting site-specific criteria. Prior to approving WQS changes for aquatic life criteria, the EPA will prepare an Effect Determination summarizing the direct or indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The EPA categorizes potential effect outcomes as either (1) "no effect," (2) "may affect, not likely to adversely affect," or (3) "may affect: likely to adversely affect."

The service(s) must concur on the Effect Determination before the EPA approves a WQS change. A finding and concurrence by the service(s) of "no effect" will allow the EPA to approve an otherwise approvable WQS change. However, findings of either "may affect, not likely to adversely affect" or "may affect: likely to adversely affect" will result in a longer consultation process between the federal agencies and may result in a disapproval or a required modification to the WQS change.

DEP is not aware of any endangered species present in the lakes discussed in this TMDL analysis. Based on the FWS online Information for Planning and Conservation (IPaC) tool, the only endangered species listed are terrestrial; there are no aquatic, amphibious, or anadromous endangered species. It is expected that water quality improvements from these restoration efforts directed towards a more natural system will positively impact any species living in the lakes and their respective watersheds.

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 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. 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.

However, the 1987 amendments to the CWA 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, 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).

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 6.1** 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.

4.2 Point Sources

4.2.1 Wastewater Point Sources

There are no NPDES-permitted domestic or industrial wastewater facilities discharging in the two watersheds discussed in this TMDL report.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Reedy Lake, Lake Ida, and Lake Clinch Watershed and a majority of the Hickory Lake and Lake Adelaide Watershed are located in Polk County and are covered by Polk County's NPDES MS4 Phase I permit (FLS000015). Florida Department of Transportation (FDOT) District 1 and the City of Frostproof are copermittees for the MS4 permit.

The Hickory Lake and Lake Adelaide Watershed is covered by a Highlands County NPDES MS4 Phase II permit (FLR04E148), an FDOT District I NPDES MS4 Phase II permit (FLR04E147), and a City of Avon Park NPDES MS4 Phase II permit (FLR04E150).

For more information on MS4s facilities in the watersheds, send an email to: npdes-stormwater@dep.state.fl.us. **Table 4.1** lists the MS4 permittees/copermittees and their MS4 permit numbers.

Table 4.1. NPDES MS4 permits with jurisdiction in the two watersheds

Permit Number	Permittee/Copermittee	Phase
FLS000015	Polk County	I
FLS000015	FDOT District 1 – Polk	I
FLS000015	City of Frostproof	I
FLR04E148	Highlands County	II
FLR04E147	FDOT District 1 – Highlands	II
FLR04E150	City of Avon Park	II

4.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater discharges are generally considered nonpoint sources. Nutrient loadings to Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide are primarily generated from nonpoint sources. Potential nonpoint sources include loadings from surface runoff, groundwater seepage entering the lake, spray fields associated with non-NPDES wastewater treatment facilities, and precipitation directly onto the lake surface (atmospheric deposition).

4.3.1 Land Uses

Land use is one of the most important factors in determining nutrient loadings from a watershed. 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 produce. **Table 4.2** lists land use in 2014 for the Reedy Lake, Lake Ida, and Lake Clinch Watershed, and **Table 4.3** lists land use in 2014 for the Hickory Lake and Lake Adelaide Watershed, based on data from SWFWMD. **Figure 4.1** shows the land use information graphically. **Appendix D** lists land use in 2019 based on the Florida Department of Agriculture and Consumer Services (FDACS) Florida Statewide Agricultural Irrigation Database (FSAID) compared to the land use in 2014 used in this TMDL report. FDACS uses different land use categories and therefore the land uses will not match directly.

The Reedy Lake, Lake Ida, and Lake Clinch Watershed covers an area of 37,559 acres (58.7 square miles). Agriculture comprises 27 % of the watershed, water 25 %, and wetlands 18 %. The Hickory Lake and Adelaide Lake Watershed covers an area of 18,228 acres (28.5 square miles). Agriculture comprises 40 % of the watershed, wetlands 22 %, and water 12 %.

Table 4.2. SWFWMD land use in the Reedy Lake, Lake Ida, and Lake Clinch Watershed in 2014

Code	Description	Acres	% of Watershed
1100	Low-Density Residential	2,339.22	6.23
1200	Medium-Density Residential	917.32	2.44
1300	High-Density Residential	588.92	1.57
1400	Commercial and Services	189.18	0.5
1500	Industrial	193.25	0.51
1600	Extractive	197.37	0.53
1700	Institutional	364.5	0.97
1800	Recreational	73.67	0.2
1900	Open Land	243.53	0.65
2000	Agriculture	10,379.77	27.64
3000	Rangeland	1,526.58	4.06
4000	Upland Forest	4,174.04	11.11
5000	Water	9,550.26	25.43
6000	Wetlands	6,616.7	17.62
8000	Transportation and Utilities	204.23	0.54
	Total	**37,558.54**	**100**

Table 4.3. SWFWMD land use in the Hickory Lake and Lake Adelaide Watershed in 2014

Code	Description	Acres	% of Watershed
1100	Low-Density Residential	1,181.38	6.48
1200	Medium-Density Residential	623.41	3.42
1300	High-Density Residential	134.65	0.74
1400	Commercial and Services	38.25	0.21
1500	Industrial	141.51	0.78
1700	Institutional	22.32	0.12
1900	Open Land	154.03	0.85
2000	Agriculture	7,326.19	40.19
3000	Rangeland	1,472.33	8.08
4000	Upland Forest	1,101.51	6.04
5000	Water	1,775.5	9.74
6000	Wetlands	4,091.18	22.44
7000	Barren Land	19.05	0.1
8000	Transportation and Utilities	146.98	0.81
	Total	**18,228.29**	**100**

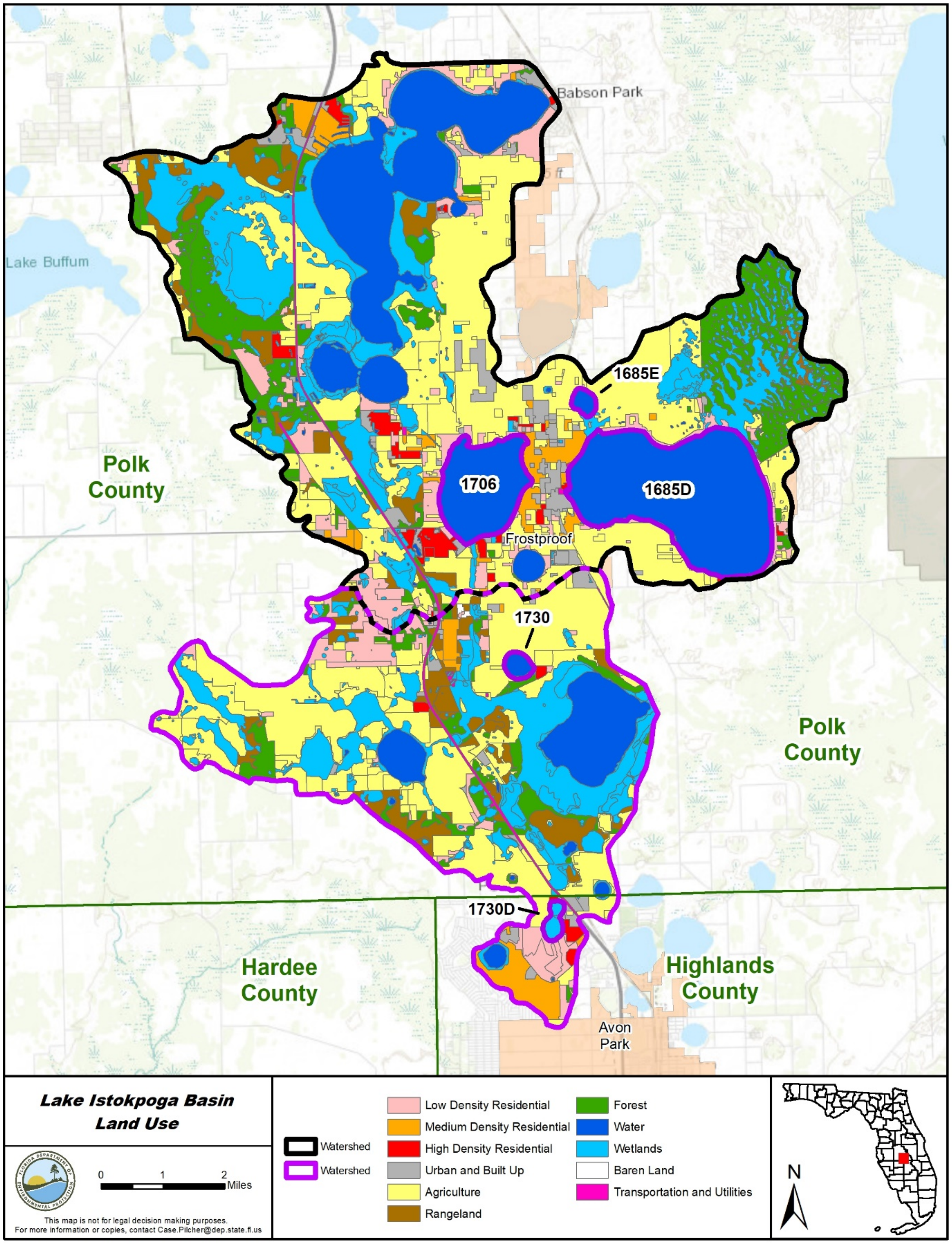

Figure 4.1. Land use in the two watersheds in 2014

4.3.2 Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, including septic tanks, are commonly used in rural areas 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. However, OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water. **Figure 4.2** shows the locations of OSTDS in the two watersheds.

Currently, there are 2,681 septic tanks in the Reedy Lake, Lake Ida, and Lake Clinch Watershed and 1,366 septic tanks in the Hickory Lake and Lake Adelaide Watershed.

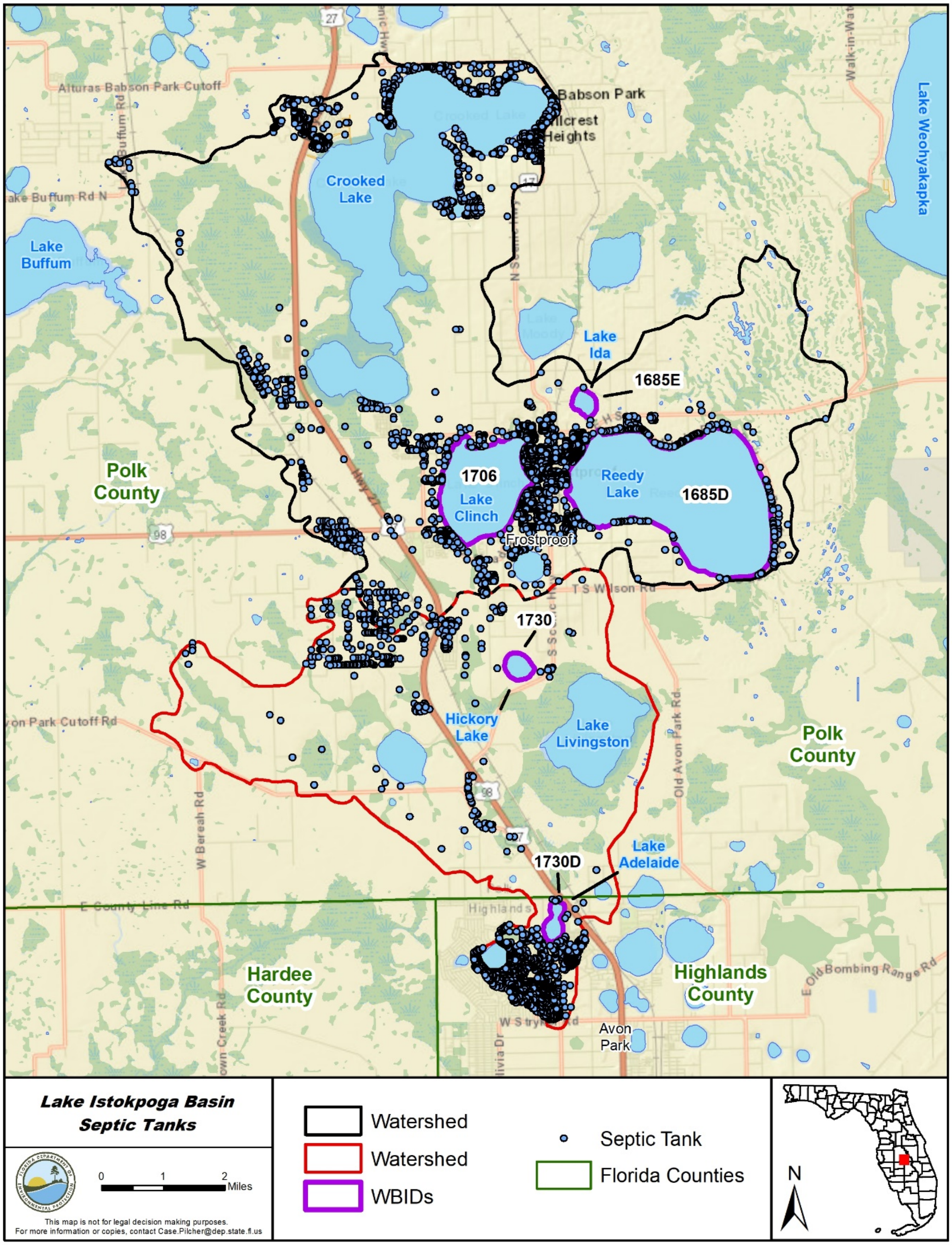

Figure 4.2. OSTDS in the two watersheds

Chapter 5: Determination of Assimilative Capacity

5.1 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 determine the assimilative capacity of Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide and to identify the maximum allowable TN and TP concentrations and the associated nutrient source reductions, so that the lakes will meet the TMDL targets and thus maintain their function and designated use as Class III waters.

5.2 Evaluation of Water Quality Conditions

As noted in **Section 2.3.1,** water quality monitoring for nutrients in the lakes was conducted primarily by Polk County (Organization Code 21FLPOLK), SWFWMD (Organization Code 21FLSWFD), and DEP.

For the water quality analysis conducted for TMDL development, AGMs were used to be consistent with the expression of the adopted NNC for lakes. For the purpose of this analysis, AGMs were calculated using a minimum of 4 sample results per year, with at least 1 sample collected in the May to September period and at least 1 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 2. Multiple sample results collected on 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 **Chapter 2** may not exactly match the AGMs used for TMDL development.

Figure 5.1 shows the chlorophyll *a* AGM values from 2000 to 2016 for Reedy Lake, Lake Ida, and Hickory Lake. Overall, Hickory Lake exhibited the highest chlorophyll *a* results, which varied from 41 to 67 µg/L. The chlorophyll *a* values for Lake Ida ranged from 2 to 4 µg/L, and the chlorophyll *a* values for Reedy Lake ranged from 13 to 39 µg/L.

Figure 5.2 shows the chlorophyll *a* AGM values from 2000 to 2016 for Lake Clinch and Lake Adelaide. Lake Clinch chlorophyll *a* values ranged from 9 to 17 µg/L, and Lake Adelaide ranged from 7 to 8 µg/L.

Figure 5.3 displays the TN AGM values from 2000 to 2016 for Reedy Lake, Lake Ida, and Hickory Lake. Overall, Lake Ida exhibited the highest TN results, varying from 6.5 to 7.2 mg/L. The TN results for Reedy Lake ranged from 0.9 to 2.0 mg/L, and the TN results for Hickory Lake ranged from 1.9 to 3.1 mg/L.

Figure 5.4 shows the TN AGM values from 2000 to 2016 for Lake Clinch and Lake Adelaide. Lake Adelaide TN values ranged from 0.6 to 0.7 mg/L, and Lake Clinch TN values ranged from 0.5 to 0.8 mg/L.

Figure 5.5 displays the TP AGM values from 2000 to 2016 for Reedy Lake, Lake Ida, and Hickory Lake. The TP results varied little from year to year, with Lake Ida TP values at 0.01 mg/L, while Reedy Lake and Hickory Lake TP values ranged from 0.02 to 0.03 mg/L.

Figure 5.6 shows the TP AGM values from 2000 to 2016 for Lake Clinch and Lake Adelaide. Lake Adelaide had slightly lower TP values than Lake Clinch, with TP values ranging from 0.01 to 0.02 mg/L in Lake Adelaide and 0.02 mg/L in Lake Clinch.

Figure 5.7 presents the color AGM results from 2000 to 2016 for Reedy Lake, Lake Ida, and Hickory Lake. The lake AGMs ranged from 2 to 24 PCU, with the exception of Hickory Lake, which had a much higher color AGM in 2009 (53 PCU).

Figure 5.8 presents the color AGM results from 2000 to 2016 for Lake Clinch and Lake Adelaide. Lake Adelaide had the highest color values, which ranged from 5 to 62 PCU. Lake Clinch color values varied from 10 to 47 PCU.

The relationships of chlorophyll *a* and TN AGMs (**Figure 5.9**) and chlorophyll *a* and TP AGMs (**Figure 5.10**) for Reedy Lake and Hickory Lake show a positive response of increased chlorophyll *a* to increased nutrient concentrations. As chlorophyll *a* responds to nutrient conditions similarly in these lakes and the applicable chlorophyll *a* target criterion appropriate for these lakes is the same (20 µg/L), the water quality results for the lakes were combined for the multiple linear regression analysis.

The relationships of chlorophyll *a* and TN AGMs (**Figure 5.11**) and chlorophyll *a* and TP AGMs (**Figure 5.12**) for Lake Clinch and Lake Adelaide show a positive response of increased chlorophyll *a* to increased nutrient concentrations. As chlorophyll *a* responds to nutrient conditions similarly in these lakes and the applicable chlorophyll *a* target criterion appropriate for these lakes is the same (6 µg/L), the water quality results for the lakes were combined for the regression analysis.

The water quality results applied in the analysis were from the 2000–16 period, which included years with both above- and below-average precipitation. The SWFWMD Polk County rainfall results (**Figure 5.13**) indicate that 2008, 2012, and 2013 were years with below-average precipitation, while 2014 to 2016 had above-average precipitation.

5.3 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, and (3) the methodology used to determine impairment is based on annual conditions (AGM values).

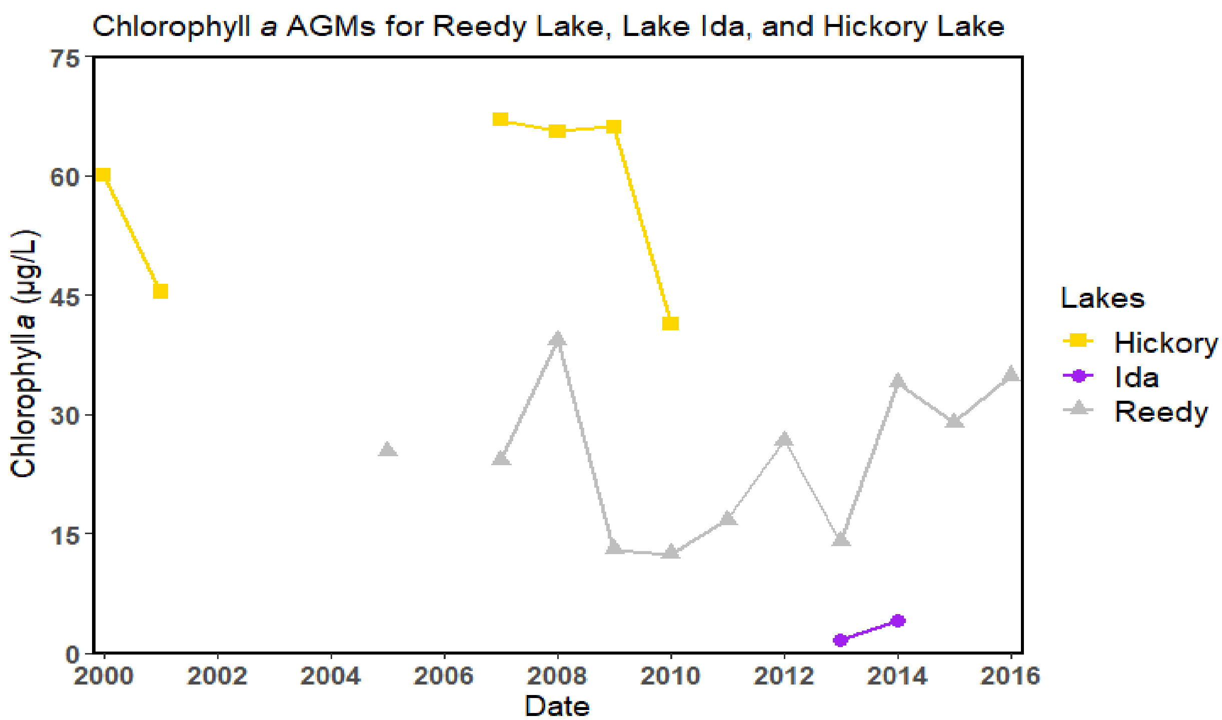

Figure 5.1. Chlorophyll a AGM values for Reedy Lake, Lake Ida, and Hickory Lake (2000–16)

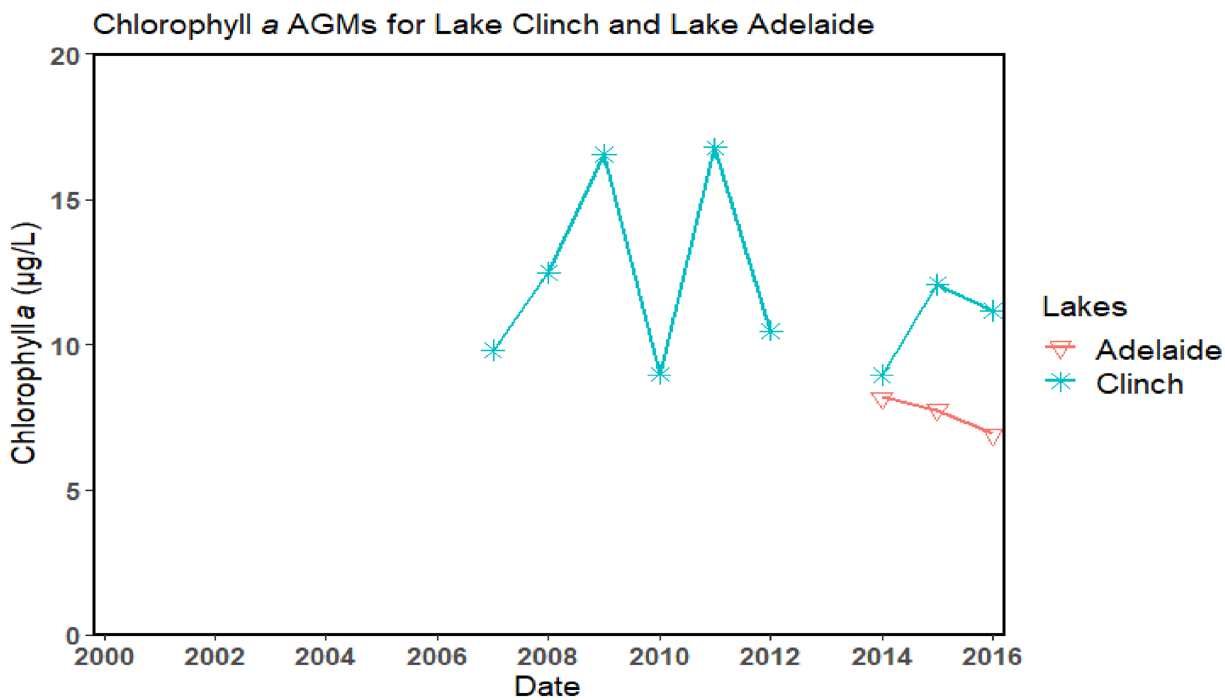

Figure 5.2. Chlorophyll *a* AGM values for Lake Clinch and Lake Adelaide (2000–16)

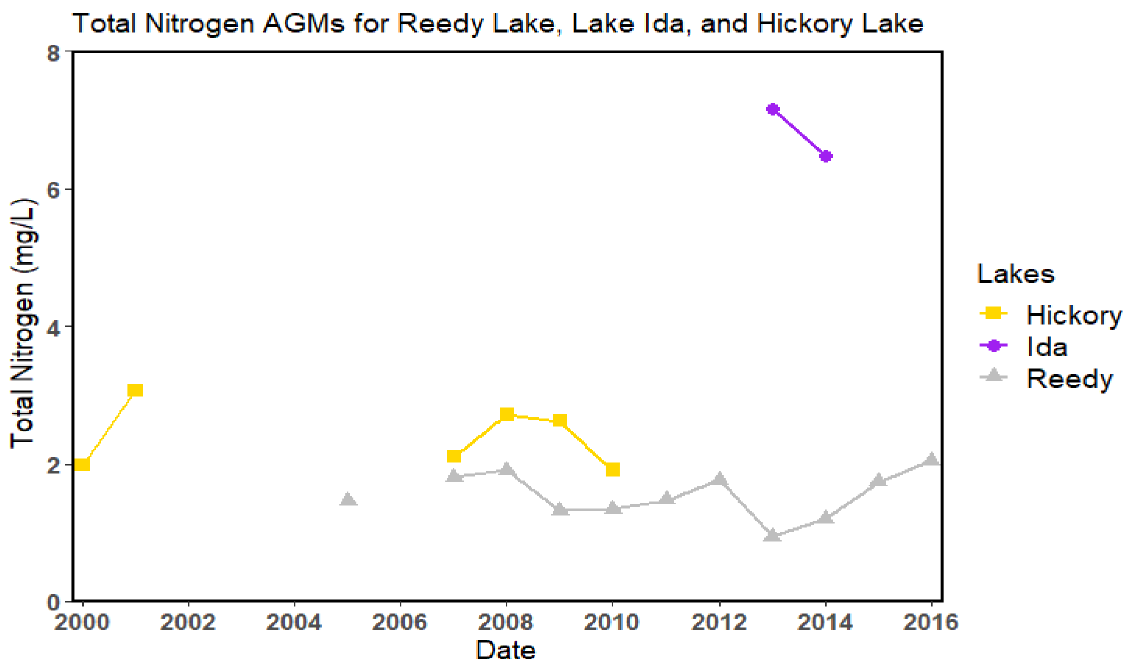

Figure 5.3. TN AGM values for Reedy Lake, Lake Ida, and Hickory Lake (2000–16)

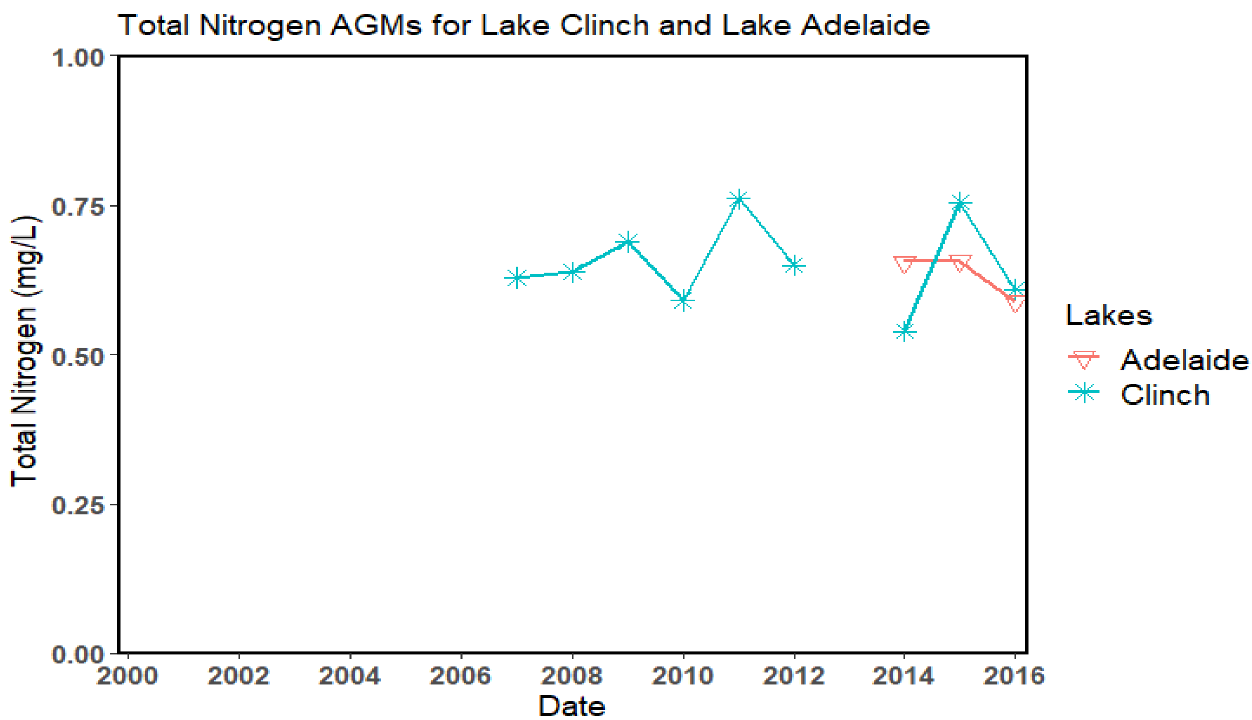

Figure 5.4. **TN AGM values for Lake Clinch and Lake Adelaide (2000–16)**

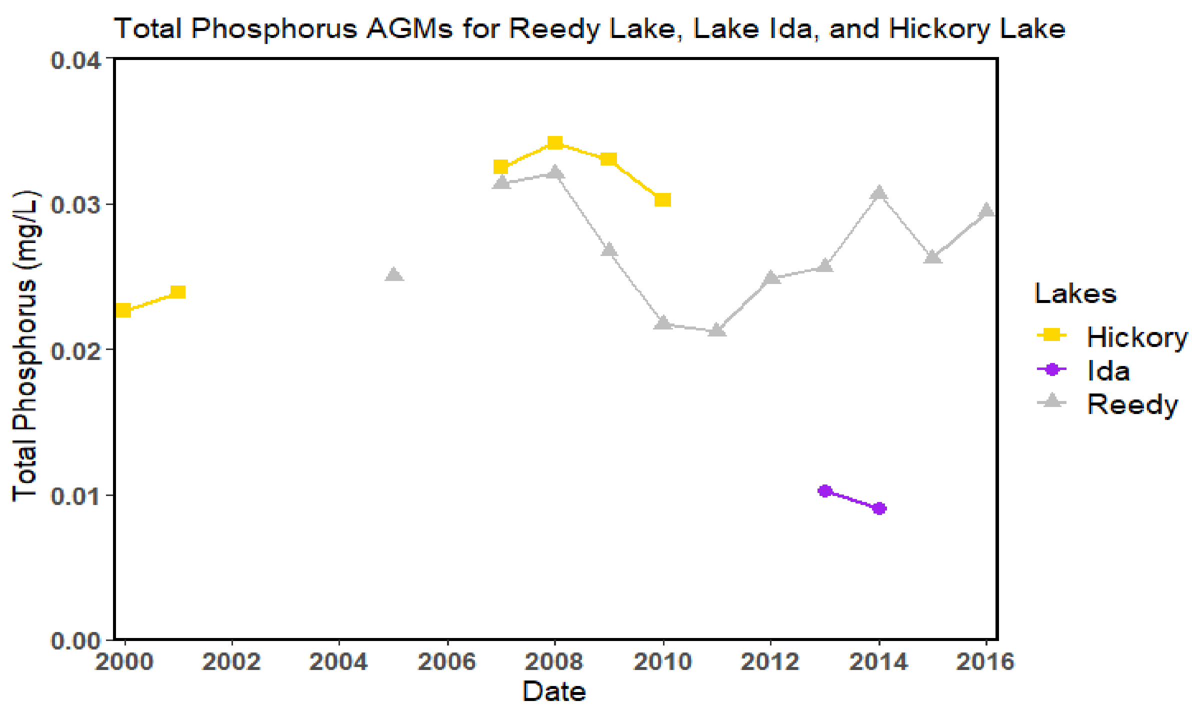

Figure 5.5. **TP AGM values for Reedy Lake, Lake Ida, and Hickory Lake (2000–16)**

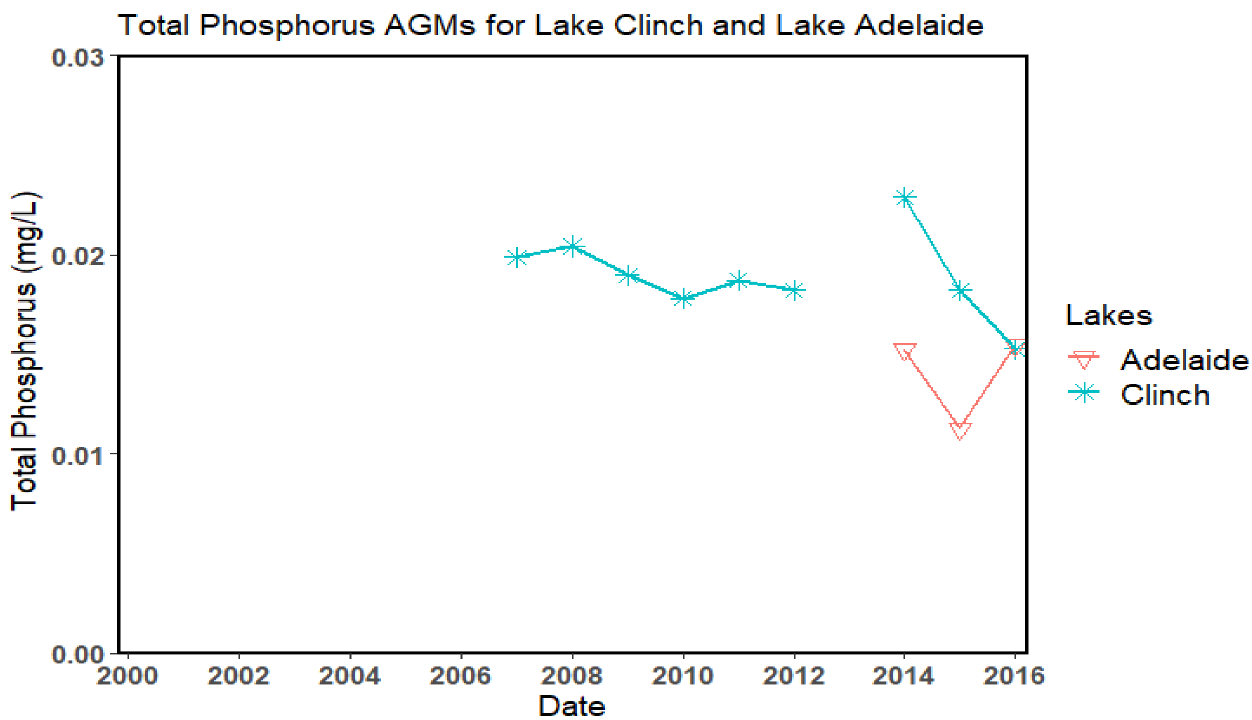

Figure 5.6. TP AGM values for Lake Clinch and Lake Adelaide (2000–16)

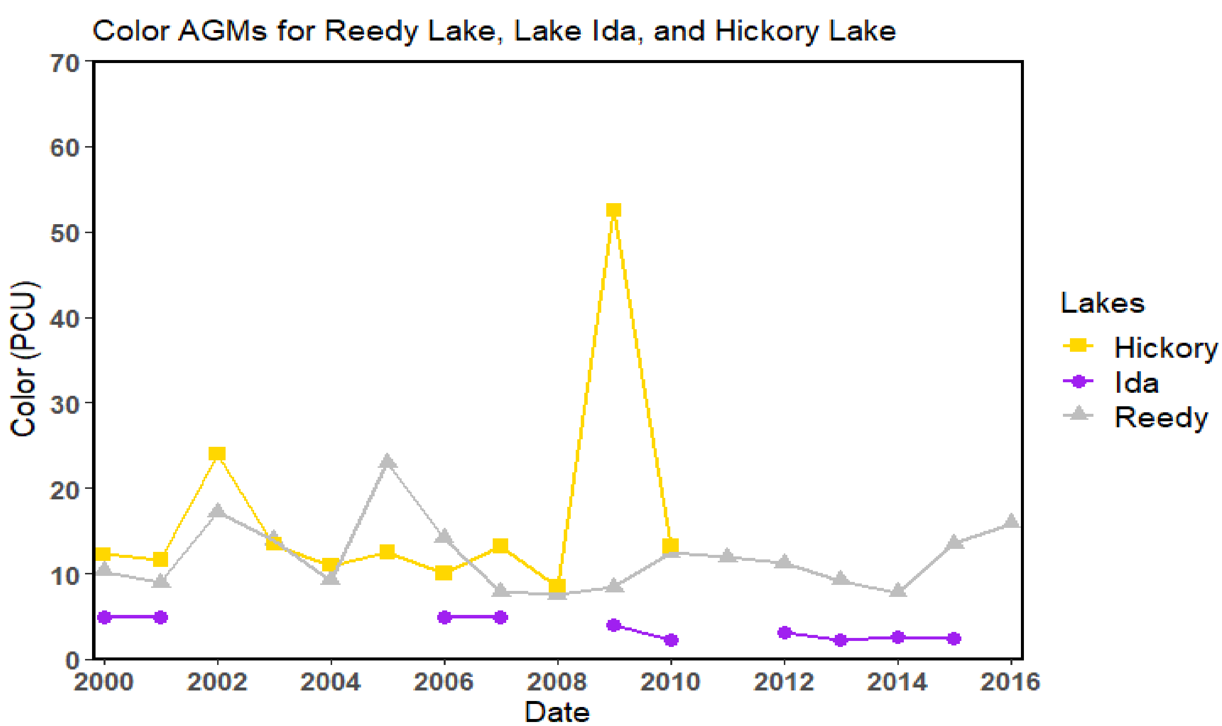

Figure 5.7. Color AGM values for Reedy Lake, Lake Ida, and Hickory Lake (2000–16)

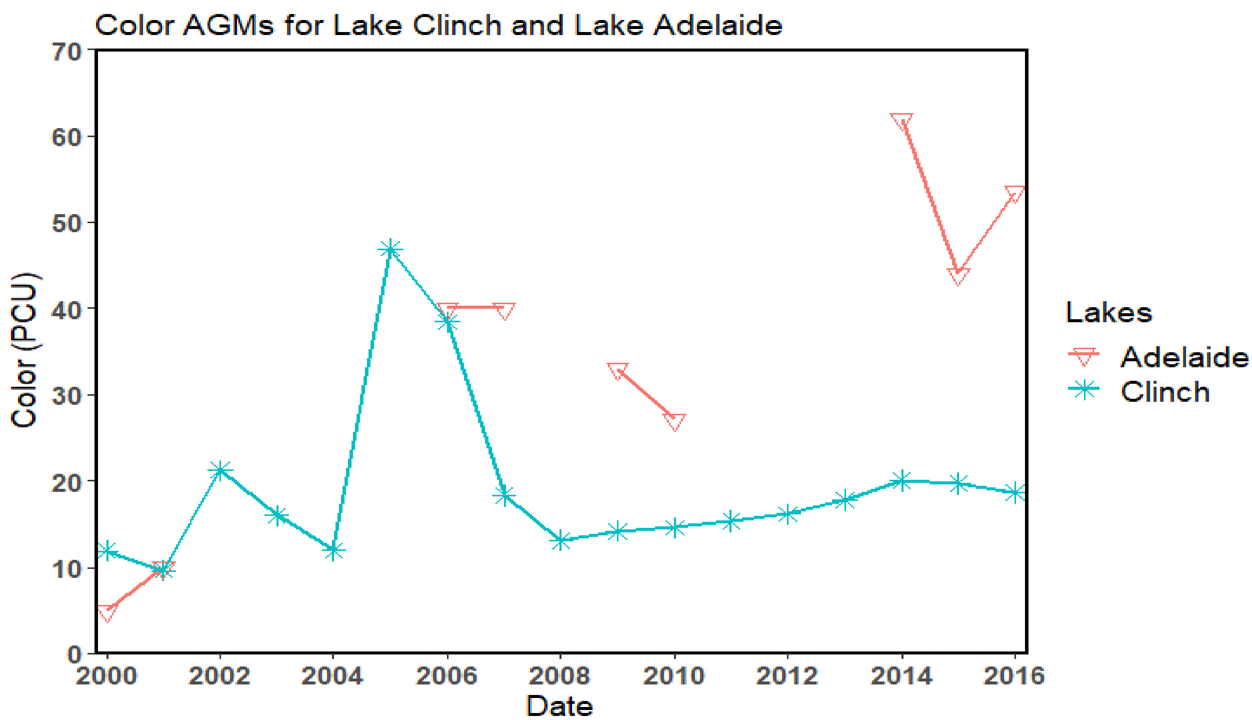

Figure 5.8. **Color AGM values for Lake Clinch and Lake Adelaide (2000–16)**

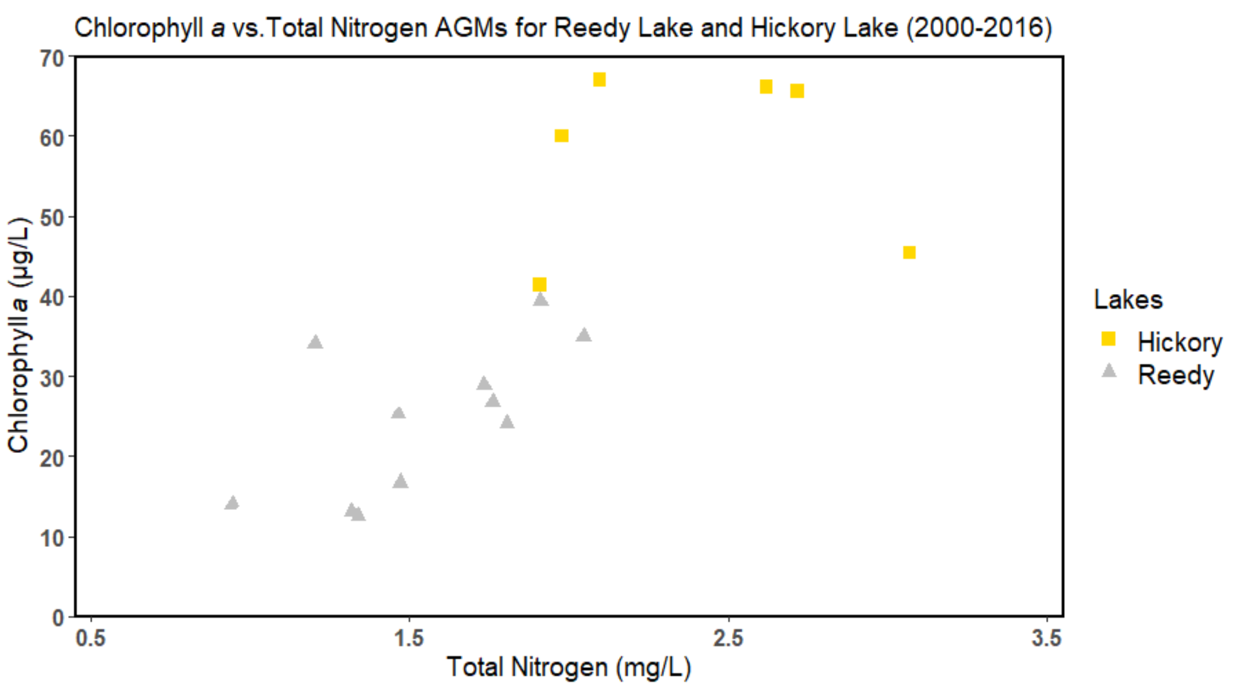

Figure 5.9. **Relationship between AGM results for chlorophyll *a* and TN for Reedy Lake and Hickory Lake (2000–16)**

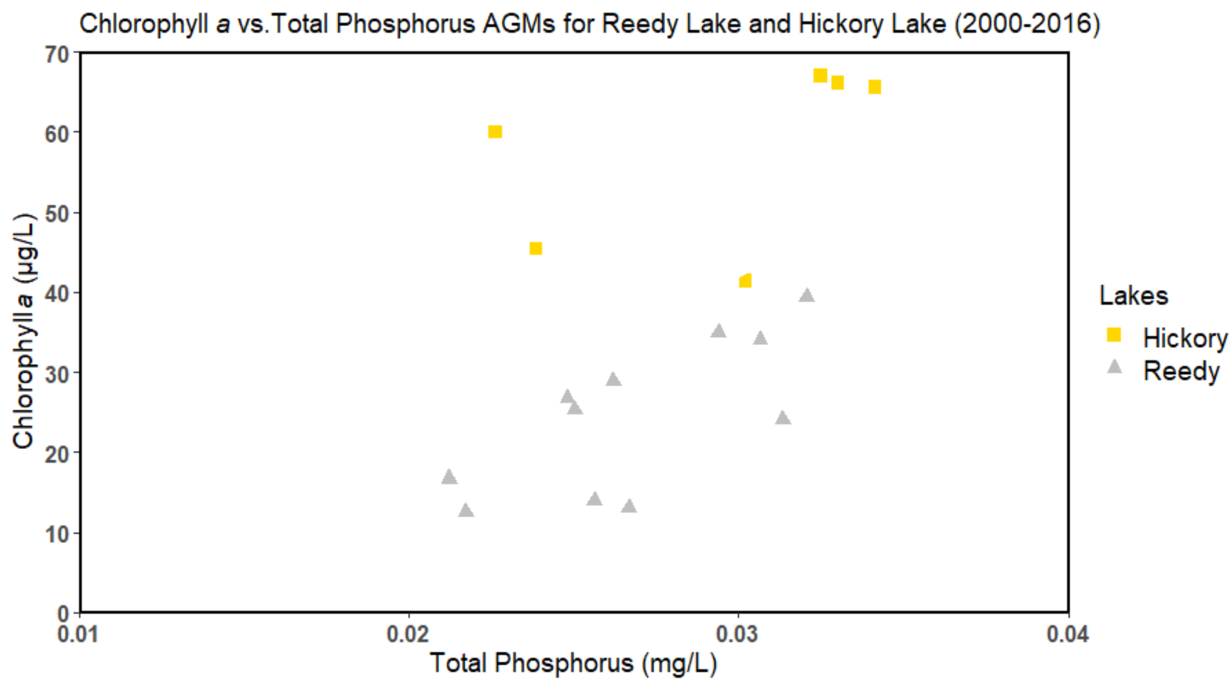

Figure 5.10. Relationship between AGM results for chlorophyll *a* and TP for Reedy Lake and Hickory Lake (2000–16)

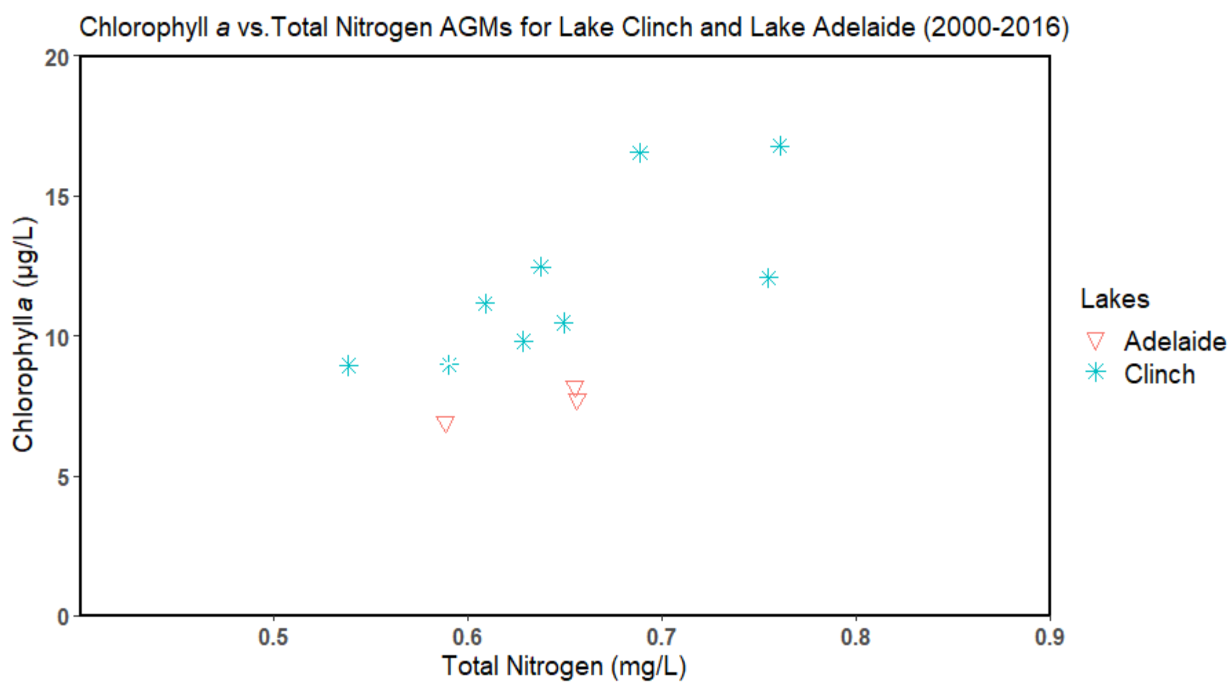

Figure 5.11. Relationship between AGM results for chlorophyll *a* and TN for Lake Clinch and Lake Adelaide (2000–16)

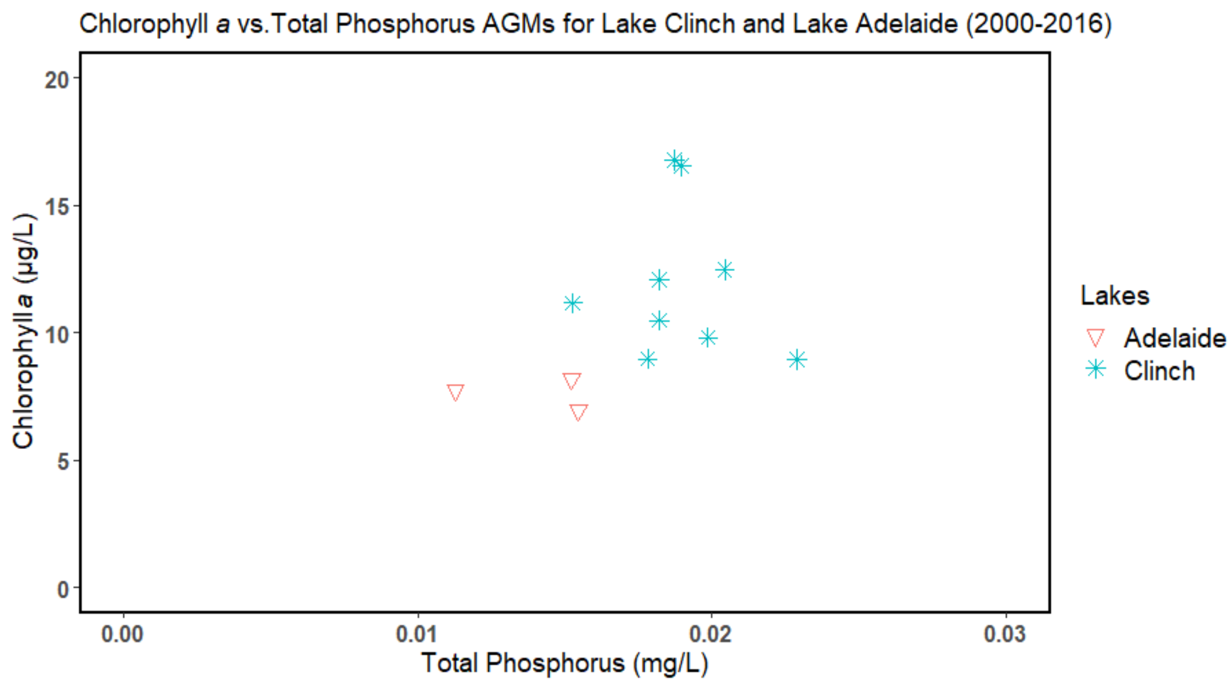

Figure 5.12. Relationship between AGM results for chlorophyll *a* and TP for Lake Clinch and Lake Adelaide (2000–16)

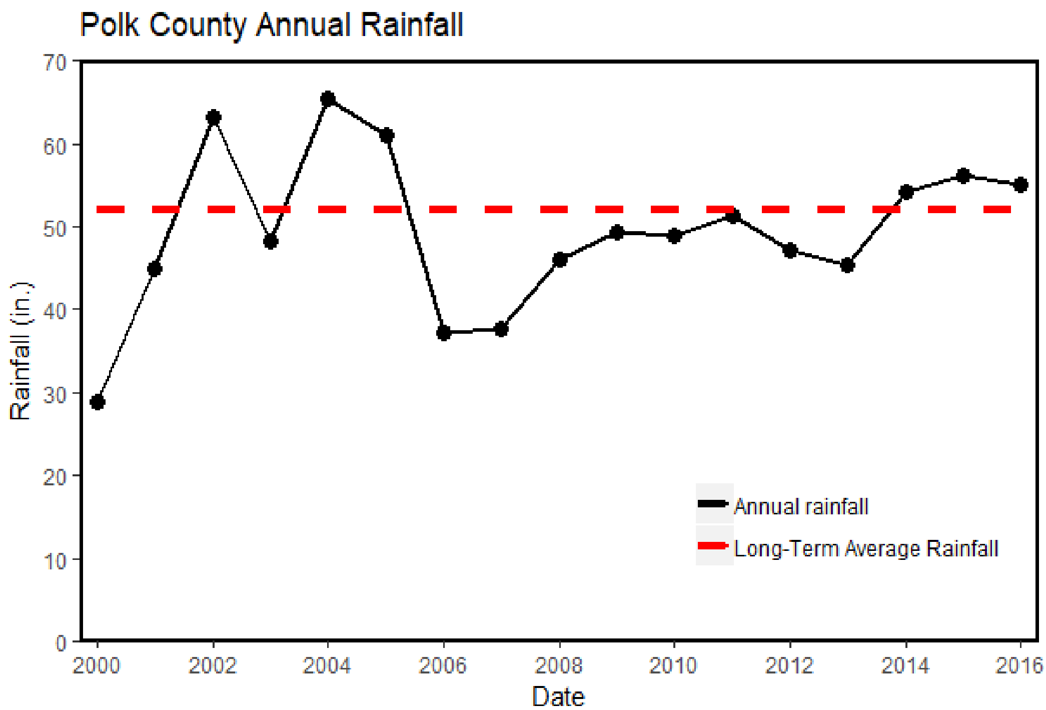

Figure 5.13. Annual rainfall in Polk County, 2000–16

5.4 Calculation of the TMDLs

The results collected in IWR Run 56 were used to evaluate the relationships between nutrient concentrations and chlorophyll *a* levels. The period from 2000 to 2016 had the most complete set of AGM values for evaluating surface water quality for Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide, as shown in **Figures 5.1** through **5.6**. The nutrient and chlorophyll *a* AGMs were used in this evaluation to be consistent with the expression of the adopted NNC for lakes.

A multiple regression model was developed for Reedy Lake and Hickory Lake, and a second multiple regression model was developed for Lake Clinch and Lake Adelaide. Although meeting the chlorophyll *a* criterion, Lake Ida was placed on the Verified List for TN impairment because it exceeded the maximum limit of TN. Again, to ensure the downstream protection of Reedy Lake, the chlorophyll *a*, TN, and TP criteria for Reedy Lake were applied to Lake Ida. Both models used nutrient results to derive an equation that relates TN and TP AGM concentrations to chlorophyll *a* AGM concentrations. The models used the chlorophyll *a*, TN, and TP AGM concentrations calculated from Polk County and DEP data from 2000 to 2016. The results of the multiple regression analysis show a significant relationship between in-lake chlorophyll *a* and nutrient concentrations. The relationship for Reedy Lake and Hickory Lake had an adjusted r squared = 0.63 and a p value < 0.05; and the relationship for Lake Clinch and Lake Adelaide had an adjusted r squared = 0.59, and a p value < 0.05 (**Appendix E**). The resultant equations are as follows:

Reedy Lake, Lake Ida, and Hickory Lake: Chlorophyll *a* AGM = **-** 45.21 + 21.81* TN AGM + 1484.33* TP AGM

Lake Clinch and Lake Adelaide: Chlorophyll *a* AGM = **-** 20.82 + 35.44* TN AGM + 493.56* TP AGM

Since the predisturbance TP results represent an estimate of average conditions, the estimated averages needed to be adjusted to geometric means to be consistent with the lake dataset used in NNC development. Using all the statewide lake TP data, which were applied in the development of lake NNC thresholds (DEP 2012), the comparison of average and geometric mean values shows a strong linear relationship (**Figure 5.14**). The expression of this relationship in the form of an equation is TP geometric mean = TP average * 0.9373. The predisturbance average TP values for Reedy Lake, Lake Ida, and Hickory Lake and for Lake Clinch and Lake Adelaide are equivalent to a geometric mean of 0.028 and 0.0067 mg/L, respectively. For TMDL development, a TP value of 0.03 mg/L expressed as a geometric mean is identified as the water quality target for Reedy Lake, Lake Ida, and Hickory Lake, and a TP value of 0.01 mg/L expressed as a geometric mean is the target for Lake Clinch and Lake Adelaide.

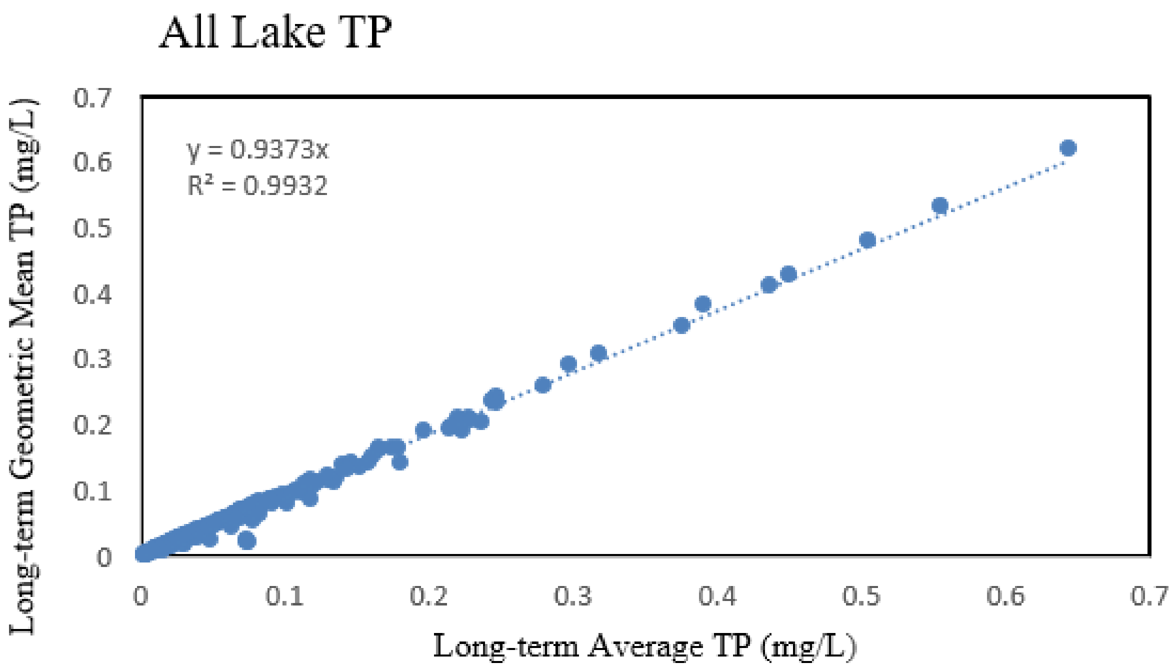

Figure 5.14. Relationship between TP AGMs and averages (arithmetic means) from lake results used in NNC development

As discussed in **Chapter 3**, the NNC chlorophyll *a* criterion of 20 µg/L, expressed as an AGM, was selected as the response variable target for TMDL development for Reedy Lake, Lake Ida, and Hickory Lake. The paleolimnological results provided a TP concentration target. The regression equation explaining the relationship of chlorophyll *a* to TN and TP was then used to determine the TN concentration necessary to meet the chlorophyll *a* target of 20 µg/L with the TP set at the TP target. A TN geometric mean of 0.95 mg/L, associated with the TP target of 0.03 mg/L, results in a chlorophyll *a* AGM of 20 µg/L.

As discussed in **Chapter 3**, the NNC chlorophyll *a* criterion of 6 µg/L, expressed as an AGM, was selected as the response variable target for TMDL development for Lake Clinch and Lake Adelaide. The paleolimnological results provided a TP concentration target. The regression equation explaining the relationship of chlorophyll *a* to TN and TP was then used to determine the TN concentration necessary to meet the chlorophyll *a* target of 6 µg/L with the TP set at the TP target. A TN geometric mean of 0.62 mg/L, associated with the TP target of 0.01 mg/L, results in a chlorophyll *a* AGM of 6 µg/L.

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 approaches used to establish the nutrient target also address meeting the chlorophyll *a* target and take into consideration the estimated predisturbance conditions in the lakes.

The method used to determine the reductions needed to attain the nutrient TMDLs is the percent reduction approach. Existing lake nutrient conditions used in the percent reduction calculations were selected by considering the nutrient concentrations measured in the 2000–16 period, which includes the Cycle 3 verified period as well as the water quality measurements in 2016 following the Cycle 3 assessment period. 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 the nutrient results available in IWR Run 56.

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

$$\frac{\underline{[\text{measured exceedance} - \text{target}]}\ \text{X}\ 100}{\text{measured exceedance}}$$

Table 5.1 and **Table 5.2** lists the percent reductions in the maximum AGMs needed to achieve a TN AGM target of 0.95 mg/L and a TP AGM of 0.03 mg/L for Reedy Lake, Lake Ida, and Hickory Lake, and the percent reductions in the maximum AGMs needed to achieve a TN AGM target of 0.62 mg/L and a TP AGM target of 0.01 mg/L for Lake Clinch and Lake Adelaide. The TN percent reductions range from a high of 87 % in Lake Ida to a low of 6 % in Lake Adelaide. Lake Clinch, the only lake with exceedances of the applicable TP NNC, requires a 50 % reduction in TP to meet the target. The nutrient AGM TMDL values and the associated percent reductions address the anthropogenic nutrient inputs contributing to the exceedances of the chlorophyll *a* criteria.

Table 5.1. Reduction required in existing TN concentrations to meet the water quality targets

ID = Insufficient data

Year	Reedy TN AGM (mg/L)	Ida TN AGM (mg/L)	Hickory TN AGM (mg/L)	Clinch TN AGM (mg/L)	Adelaide TN AGM (mg/L)
2000	ID	ID	1.98	ID	ID
2001	ID	ID	3.07	ID	ID
2002	ID	ID	ID	ID	ID
2003	ID	ID	ID	ID	ID
2004	ID	ID	ID	ID	ID
2005	1.47	ID	ID	ID	ID
2006	ID	ID	ID	ID	ID
2007	1.81	ID	2.10	0.63	ID
2008	1.91	ID	2.72	0.64	ID
2009	1.32	ID	2.62	0.69	ID
2010	1.34	ID	1.91	0.59	ID
2011	1.47	ID	ID	0.76	ID
2012	1.76	ID	ID	0.65	ID
2013	0.95	7.16	ID	ID	ID
2014	1.20	6.46	ID	0.54	0.66
2015	1.73	ID	ID	0.75	0.66
2016	2.05	ID	ID	0.61	0.59
Maximum	**2.05**	**7.16**	**3.07**	**0.76**	**0.66**
TMDL Target	**0.95**	**0.95**	**0.95**	**0.62**	**0.62**
% Reduction to Meet Target	**54**	**87**	**69**	**18**	**6**

Table 5.2. Reduction required in existing TP concentrations to meet the water quality target

ID = Insufficient data

Year	Reedy TP AGM (mg/L)	Ida TP AGM (mg/L)	Hickory TP AGM (mg/L)	Clinch TP AGM (mg/L)	Adelaide TP AGM (mg/L)
2000	ID	ID	0.02	ID	ID
2001	ID	ID	0.02	ID	ID
2002	ID	ID	ID	ID	ID
2003	ID	ID	ID	ID	ID
2004	ID	ID	ID	ID	ID
2005	0.03	ID	ID	ID	ID
2006	ID	ID	ID	ID	ID
2007	0.03	ID	0.03	0.02	ID
2008	0.03	ID	0.03	0.02	ID
2009	0.03	ID	0.03	0.02	ID
2010	0.02	ID	0.03	0.02	ID
2011	0.02	ID	ID	0.02	ID
2012	0.02	ID	ID	0.02	ID
2013	0.03	0.01	ID	ID	ID
2014	0.03	0.01	ID	0.02	0.02
2015	0.03	ID	ID	0.02	0.01
2016	0.03	ID	ID	0.02	0.02
Maximum	**0.03**	**0.01**	**0.03**	**0.02**	**0.02**
TMDL Target	**0.03**	**0.03**	**0.03**	**0.01**	**0.01**
% Reduction to Meet Target	**0**	**0**	**0**	**50**	**50**

Chapter 6: Determination of Loading Allocations

6.1 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 Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide are expressed in terms of nutrient concentration targets and the percent reductions necessary to meet the targets, and represent the lake nutrient concentrations the waterbodies can assimilate while maintaining a balanced aquatic flora and fauna (see **Table 6.1**). These TMDLs are expressed as maximum AGM values for TN and TP that are not to be exceeded.

The restoration goal for Reedy Lake, Lake Ida, and Hickory Lake is to achieve the generally applicable chlorophyll *a* criterion of 20 µg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period, thus protecting each lake's designated use. The restoration goal for Lake Clinch and Lake Adelaide is to achieve the generally applicable chlorophyll *a* criterion of 6 µg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period, thus protecting each lake's designated use.

Table 6.1 lists the TMDLs for the Reedy Lake, Lake Ida, and Lake Clinch Watershed and the Hickory Lake and Lake Adelaide Watershed. The concentration-based TMDL components will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for these particular waters.

Table 6.1. TMDL components for nutrients in Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), Hickory Lake (WBID 1730), Lake Clinch (WBID 1706), and Lake Adelaide (WBID 1730D)

NA = Not applicable
[1] Represents the AGM lake value not to be exceeded.
[2] The required percent reductions listed in this table represent the reduction from all sources.

Waterbody Name/WBID	Parameter	TMDL (mg/L)[1]	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)[2]	MOS
Reedy Lake/ 1685D	TN	0.95	NA	54	54	Implicit
Reedy Lake/ 1685D	TP	0.03	NA	0	0	Implicit
Lake Ida/ 1685E	TN	0.95	NA	87	87	Implicit
Lake Ida/ 1685E	TP	0.03	NA	0	0	Implicit
Hickory Lake/ 1730	TN	0.95	NA	69	69	Implicit
Hickory Lake/ 1730	TP	0.03	NA	0	0	Implicit
Lake Clinch/ 1706	TN	0.62	NA	18	18	Implicit
Lake Clinch/ 1706	TP	0.01	NA	50	50	Implicit
Lake Adelaide/ 1730D	TN	0.62	NA	6	6	Implicit
Lake Adelaide/ 1730D	TP	0.01	NA	50	50	Implicit

6.2 Load Allocation

To achieve the LA, the percent reductions in current TN and TP sources to the lakes, as specified in **Table 6.1**, will be required. The percent reductions represent the needed TN and TP reductions from all nonpoint sources, including stormwater runoff, groundwater contributions, and septic tanks. Although the TMDLs are based on the percent reductions from all sources to the lakes, it is not DEP's intent to abate natural conditions. 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 loading from stormwater discharges regulated by DEP and the water management districts that are not part of the NPDES stormwater program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

As noted in **Chapter 4**, no active NPDES-permitted facilities in the Reedy Lake, Lake Ida, and Lake Clinch Watershed or the Hickory Lake and Lake Adelaide Watershed discharge either into the waterbodies or watersheds. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The Reedy Lake, Lake Ida, and Lake Clinch Watershed and a majority of the Hickory Lake and Lake Adelaide Watershed are located in Polk County and are covered by a Polk County NPDES MS4 Phase I permit (FLS000015), with FDOT District 1 and the City of Frostproof as copermittees. Areas within these jurisdictions are responsible for a 54 % reduction in TN and a 0 % reduction in TP for Reedy Lake, an 87 % reduction in TN and a 0 % reduction in TP for Lake Ida, an 18 % reduction in TN and a 50 % reduction in TP for Lake Clinch, and a 69 % reduction in TN and a 0 % reduction in TP for Hickory Lake. These required reductions are from current anthropogenic loading.

The Hickory Lake and Lake Adelaide Watershed, located in Highlands County, is covered by a Highlands County NPDES MS4 Phase II permit (FLR04E148), an FDOT District I NPDES MS4 Phase II permit (FLR04E148), and a City of Avon Park NPDES MS4 Phase II permit (FLR04E150). Areas within these jurisdictions in the watershed are responsible for a 6 % reduction in TN and a 0 % reduction in TP from current anthropogenic loading.

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

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.

An implicit MOS was used in the development of the TMDLs because of the conservative assumptions that were applied. The TMDLs were developed using the highest TN and TP AGM values to calculate the percent reductions and requiring the TMDL targets not to be exceeded in any one year.

Chapter 7: Implementation Plan Development and Beyond

7.1 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 implement 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 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).

7.2 BMAPs

Information on the development and implementation of BMAPs can be found 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 Reedy Lake, Lake Ida, and Lake Clinch Watershed and the Hickory Lake and Lake Adelaide Watershed are located in the Lake Okeechobee BMAP area. The BMAP was adopted in December 2014 to address the TP TMDL, and activities are ongoing throughout the larger basin to reduce nutrient loads to Lake Okeechobee. Management strategies in the Reedy Lake, Lake Ida, and Lake Clinch Watershed and the Hickory Lake and Lake Adelaide Watershed may also address nutrient impairments for these lakes and would likely benefit them at a different level than reported in the Lake Okeechobee BMAP. More information about the adopted BMAP is available online.

7.3 Implementation Considerations for the Waterbody

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it is also 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. Approaches for addressing these other factors should be included in comprehensive management plans for the waterbodies. Additionally, the current water quality and water level monitoring of Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress.

Polk County Parks and Natural Resources Division has developed a water quality management plan for Lake Clinch. The management plan included a discussion of the current status of Lake Clinch along with recommendations for additional monitoring of lake vegetation, groundwater, in-lake processes, and sediment (Polk County Parks and Natural Resources Division 2015).

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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.

Appendix B: Information in Support of Site-Specific Interpretations of the Narrative Nutrient Criterion

Table B-1. Spatial extent of the numeric interpretation of the narrative nutrient criterion

Location	Description
Waterbody name	Reedy Lake, Lake Ida, Hickory Lake, Lake Clinch, and Lake Adelaide
Waterbody type(s)	Lake
WBID	Reedy Lake (1685D), Lake Ida (1685E), Hickory Lake (1730), Lake Clinch (1706), and Lake Adelaide (1730D) (see **Figure 1.1** of this report)
Description	Reedy Lake, Lake Ida, Hickory Lake, and Lake Clinch are located in Polk County, and Lake Adelaide is located in Highlands County. The Reedy Lake, Lake Ida, and Lake Clinch Watershed covers an area of 37,559 acres (58.7 square miles). Agriculture comprises 27 % of the watershed area, water 25 %, and wetlands 18 %. The Hickory Lake and Adelaide Lake Watershed encompasses an area of 18,228 acres (28.5 square miles). Agriculture comprises 40 % of the watershed area, wetlands 22 %, and water 12 %. **Chapter 1** of this report provides more detail on the two watershed systems.
Specific location (latitude/longitude or river miles)	The center of Reedy Lake is located at N: 27° 44' 32.7"/ W: 81° 29' 50.3." The center of Lake Ida is located at N: 27° 45' 43.8"/ W: 81° 31' 17.4." The center of Hickory Lake is located at N: 27° 42' 4.5" / W: 81° 32' 25.1." The center of Lake Clinch is located at N: 27° 44' 34.6"/ W: 81° 32' 58.4." The center of Lake Adelaide is located at N: 27° 38' 26.8"/ W: 81° 31' 54.5." The site-specific criteria apply as a spatial average for the lakes, as defined by WBIDs 1685D, 1685E, 1730, 1706, and 1730D.
Map	**Figure 1.1** shows the general location of the lakes and their watersheds, and **Figure 4.1** shows the land uses in the watersheds.
Classification(s)	Class III Freshwater
Basin name (HUC 8)	Kissimmee River Basin (03090101)

Table B-2. Description of the numeric interpretation of the narrative nutrient criterion

Numeric Interpretation of Narrative Nutrient Criterion	Information on Parameters Related to Numeric Interpretation of the Narrative Nutrient Criterion
NNC summary	Reedy Lake, Lake Ida, and Hickory Lake are classified as low-color, high-alkalinity lakes, and the generally applicable NNC, expressed as AGM concentrations not to be exceeded more than once in any 3-year period, are chlorophyll *a* of 20 µg/L, TN of 1.05 to 1.91 mg/L, and TP of 0.03 to 0.09 mg/L. Lake Clinch and Lake Adelaide are classified as low-color, low-alkalinity lakes, and the generally applicable NNC, expressed as AGM concentrations not to be exceeded more than once in any 3-year period, are chlorophyll *a* of 6 µg/L, TN of 0.51 to 0.93 mg/L, and TP of 0.01 to 0.03 mg/L.
Proposed TN and TP concentrations	Numeric interpretations of the narrative nutrient criterion (**Section 5.4**): **Reedy Lake (WBID 1685D), Lake Ida (WBID 1685E), and Hickory Lake (WBID 1730):** **TN:** 0.95 mg/L, expressed as an AGM not to be exceeded. **TP:** 0.03 mg/L, expressed as an AGM not to be exceeded. **Lake Clinch (WBID 1706) and Lake Adelaide (WBID 1730D):** **TN:** 0.62 mg/L, expressed as an AGM not to be exceeded. **TP:** 0.01 mg/L, expressed as an AGM not to be exceeded.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	Nutrient concentration (TN and TP) targets for the five lakes were selected by using empirical equations that evaluated the relationships between chlorophyll *a* and nutrient concentrations (TN and TP) with AGM data from the period from 2000 to 2016. Based on these relationships, the TN and TP targets were derived so that the chlorophyll *a* targets were achieved. The TP target was based on results from paleolimnological studies of lakes. The paleolimnological results are presented in Whitmore and Brenner (1995; 2002) and Quillen et al. (2013) (see the **References** section of this report for complete bibliographical details).
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The water quality results applied in the analysis were from the 2000–16 period, which included years with both above- and below-average precipitation. The SWFWMD Polk County rainfall database indicates that 2008, 2012, and 2013 were years with below-average precipitation, while 2014 to 2016 were years with above-average precipitation. **Figures 2.1** and **2.2** show the sampling stations in the five lakes. Monitoring stations were located across the spatial extent and represent the spatial distribution of nutrient dynamics in the lakes. The graphs in **Chapter 5** show water quality results for the variables relevant to TMDL development.

Table B-3. Summary of how designated use(s) are protected by the criterion

Designated Use Requirements	Information Related to Designated Use Requirements
History of assessment of designated use support	During the Cycle 3 assessment, the NNC were used to assess the lakes for the verified period (January 1, 2009–June 30, 2016) based on data from IWR Run 53. Lake Clinch was assessed as impaired for chlorophyll *a*, TN, and TP, and the lake was added to the 303(d) list for chlorophyll *a*, TN, and TP. Reedy Lake, Hickory Lake, and Lake Adelaide were assessed as impaired for chlorophyll *a* and TN, and the lakes were added to the 303(d) list for chlorophyll *a* and TN. Lake Ida was assessed as impaired for TN, and the lake was added to the 303(d) list for TN.
Basis for use support	The basis for use support for Reedy Lake, Lake Ida, and Hickory Lake is the NNC chlorophyll *a* concentration of 20 µg/L, which is protective of designated uses for low-color, high-alkalinity lakes. Based on the available information, there is nothing unique about these lakes that would make the use of the chlorophyll *a* criterion of 20 µg/L inappropriate. The basis for use support for Lake Clinch and Lake Adelaide is the NNC chlorophyll *a* concentration of 6 µg/L, which is protective of designated uses for low-color, high-alkalinity lakes. Based on the available information, there is nothing unique about these lakes that would make the use of the chlorophyll *a* threshold of 6 µg/L inappropriate.
Approach used to develop criteria and how it protects uses	The methods used to address the nutrient impairment included (1) the development of a regression equation that relates the lake TN and TP concentrations to the AGM chlorophyll *a* levels, and (2) the evaluation of paleolimnological results to establish a TP target consistent with predisturbance conditions. The TN and TP criteria are expressed as maximum AGM 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 (20 µg/L for low-color, high-alkalinity lakes and 6 µg/L for low-color, low-alkalinity lakes), which are protective of designated use, are achieved.
How the TMDL analysis will ensure that nutrient-related parameters are attained to demonstrate that the TMDLs will not negatively impact other water quality criteria	The methods ensures that the chlorophyll *a* concentration target of 20 µg/L for Reedy Lake, Lake Ida, and Hickory Lake, and the chlorophyll *a* concentration target of 6 µg/L for Lake Clinch and Lake Adelaide, will be attained at the TMDL in-lake TN and TP concentrations, frequency, and duration, while taking into consideration the estimated predisturbance phosphorus conditions in the lakes. There were no impairments for nutrient-related parameters (such as dissolved oxygen [DO] or un-ionized ammonia). The proposed reductions in nutrient inputs will result in further improvements in water quality.

Table B-4. Documentation of the means to attain and maintain water quality standards for downstream waters

Protection of Downstream Waters and Monitoring Requirements	Information Related to Protection of Downstream Waters and Monitoring Requirements
Identification of downstream waters	As discussed in **Section 1.2**, Lake Adelaide discharges into one canal on the north side of the lake during high lake elevations. Also, there is one canal flowing into Lake Adelaide on the west side of the lake with no upstream headwaters. Lake Ida discharges into a canal that flows into Reedy Lake and, to ensure the downstream protection of Reedy Lake, the chlorophyll *a*, TN, and TP criteria for Reedy Lake were applied to Lake Ida. Lake Clinch discharges into Reedy Lake through a 72-inch control structure, and the TMDL for Lake Clinch is protective of Reedy Lake because the chlorophyll *a*, TN, and TP criteria for Lake Clinch are lower than the NNC for Reedy Lake. Hickory Lake has no defined drainage canals or streams connecting the lake to downstream waterbodies. Reedy Lake discharges to Reedy Creek (WBID 1685B), a Class III freshwater stream, which flows into Lake Arbuckle (WBID 1685A), a Class III freshwater lake. Reedy Creek and Lake Arbuckle are not impaired for nutrients, and therefore the restoration target for Reedy Lake will meet the applicable stream nutrient thresholds and the new criteria will protect Reedy Creek and Lake Arbuckle.
Summary of existing monitoring and assessment related to the implementation of Subsection 62-302.531(4), F.A.C., and trends tests in Chapter 62-303, F.A.C.	Polk County and DEP conduct routine monitoring of the five lakes. The data collected through these monitoring activities will be used to evaluate the effect of BMPs implemented in the watersheds on lake TN and TP loads in subsequent water quality assessment cycles.

Table B-5. Documentation of endangered species consideration

Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	DEP is not aware of any endangered species present in the impaired lakes. Furthermore, it is expected that improvements in water quality resulting from these restoration efforts will positively impact aquatic species living in the lakes and their respective watersheds.

Table B-6. Documentation that administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on March 29, 2019, to initiate TMDL development for impaired waters in the Peace River Basin. A rule development public workshop for the TMDLs was held on August 27, 2019.
Hearing requirements and adoption format used; responsiveness summary	Following the publication of the Notice of Proposed Rule, DEP will provide a 21-day challenge period and a public hearing that will be noticed no less than 45 days prior.
Official submittal to EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered site-specific interpretations of the narrative nutrient criterion and will submit these documents to the EPA.

Appendix C: Monitoring Stations

Lake	WBID	Station ID
Reedy	1685D	21FLSWFDREEDY 21FLSWFDSTA0049 21FLPOLKREEDY1 21FLCEN 26011386 21FLCEN 26011384 21FLCEN 26011387 21FLCEN 26011385 21FLGW 8764 21FLGW 51024 21FLGW 51027 21FLGW 38927 21FLGW 39477 21FLGW 41631 21FLGW 43506 21FLA 26010203 21FLA 26010205 11EPALES123601 11EPALES123602 11EPALES123603 21FLA 26010201 21FLTPA 26010213 112WRD 02269400
Ida	1685E	21FLSWFDIDA (FROSTPROOF) 21FLSWFD23837 21FLSWFDSTA0199
Hickory	1730	21FLSWFDHICKORY 21FLPOLKHICKORY1 21FLSWFDSTA0038 21FLCEN 26011168 21FLCEN 26011170 21FLCEN 26011169
Clinch	1706	21FLSWFDCLINCH 21FLPOLKCLINCH1 21FLSWFDSTA0481 21FLWQSPPOL688UL 21FLGW 37013 21FLGW 38313 21FLGW 41142 21FLPOLKCLINCH2 21FLPOLKCLINCH3 112WRD 274430081330005 112WRD 02269300
Adelaide	1730D	21FLSWFDADELAIDE 21FLSWFD23774 21FLFTM 26010325 21FLSWFDSTA0377 21FLFTM KISSRV0033FTM 21FLFTM KISSRV0032FTM

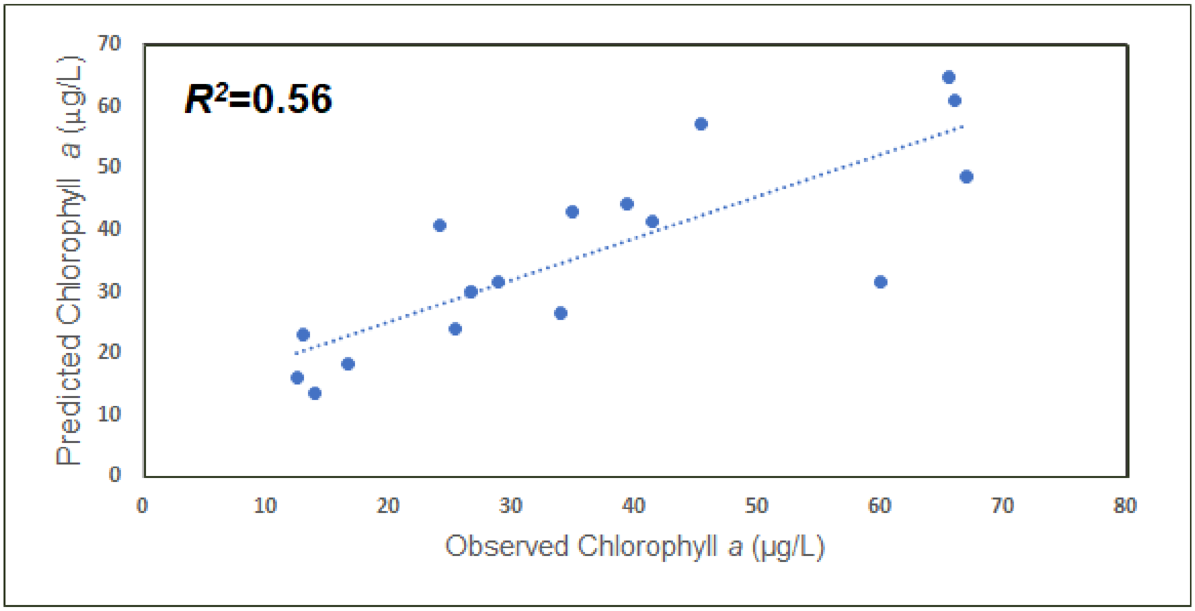
Appendix D: Land use comparison with FDACS

NA= Not Applicable

Lakes Reedy, Ida, and Clinch		
Crop	**FSAID 6**	**TMDL Report**
Fallow Crops	1,184	NA
Agriculture	5,161	10,380
Rangeland (Pasture/Brushland)	3,256	1,527
Total	9,600	11,907
Lake Hickory and Adelaide		
Crop	**FSAID 6**	**TMDL Report**
Fallow Crops	547	NA
Agriculture	4,954	7,326
Rangeland (Pasture/Brushland)	2,154	1,472
Total	7,655	8,798

Appendix E: Multiple Regression Model Results

Response chlorophyll *a* AGM: Reedy Lake and Hickory Lake
2000–16
Results
Whole Model
Actual by Predicted Plot



Summary of Fit

Calculation	Result
RSquare	0.677
RSquare Adj	0.631
Observations (or Sum Wgts)	17

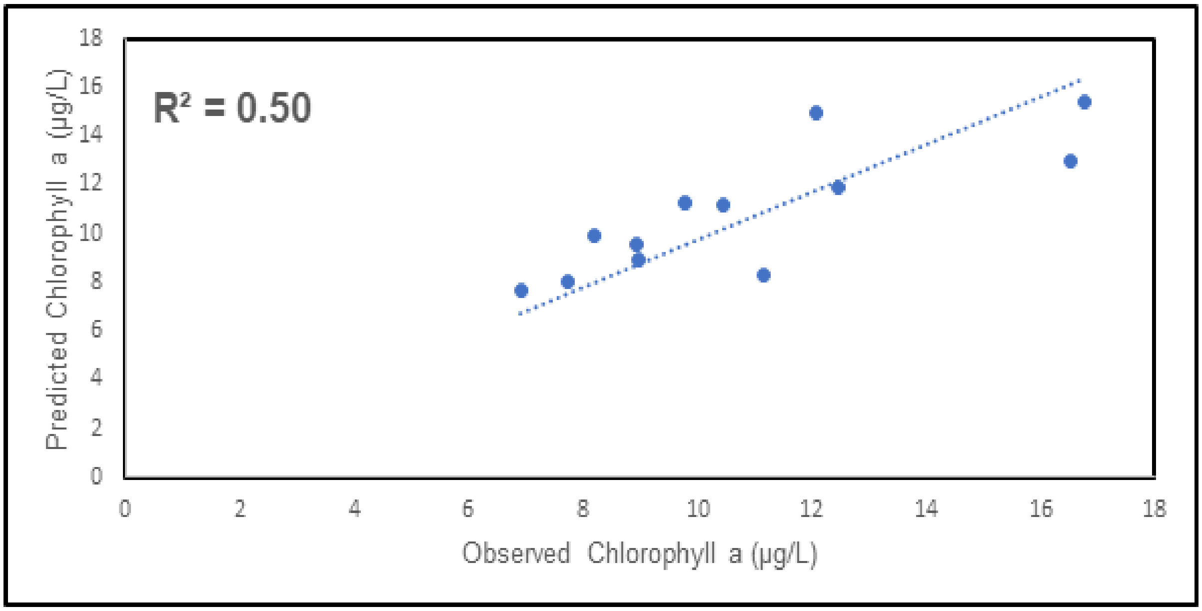
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Stat
Model	2	3907.71	1953.86	14.69
Error	14	1861.49	132.96	**Significance F**
C. Total	16	5769.20		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Stat	P-value
Intercept	-45.21	19.36	-2.33	0.035
TN	21.81	5.50	3.97	0.001
TP	1484.33	732.60	2.03	0.062

Response chlorophyll *a* AGM: Lake Clinch and Lake Adelaide
2000–16
Results
Whole Model
Actual by Predicted Plot



Summary of Fit

Calculation	Result
RSquare	0.660
RSquare Adj	0.585
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Stat
Model	2	73.98	36.99	8.74
Error	9	38.09	4.23	**Significance F**
C. Total	11	112.07		0.008

Parameter Estimates

Term	Estimate	Std Error	t Stat	P-value
Intercept	-20.82	7.59	-2.74	0.023
TN	35.44	9.58	3.70	0.005
TP	493.56	206.59	2.39	0.041