Southwest District • Peace River Basin

Final Report

Nutrient TMDLs for Lake Alfred (WBID 1488D), Lake Blue (WBID 1521Q), and Lake Marianna (WBID 1521L)

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

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Executive Summary

Lake Alfred is located in the City of Lake Alfred, in Polk County; Lake Marianna, in the City of Auburndale, in Polk County; and Lake Blue, in unincorporated Polk County. Initially, the waterbodies were identified as impaired for nutrients based on an elevated annual average Trophic State Index value and was added to the Verified list by Secretarial Order in January 2010 as the segment with waterbody identification (WBID) numbers 1488D for Lake Alfred, 1521L for Lake Marianna, and 1521Q for Lake Blue. Based on amended IWR (Rule 62-302.531, F.A.C.), these waterbodies were re-assessed using numeric nutrient criteria and added to the Verified List of Impaired Waters by Secretarial Order in October 2016. Total maximum daily loads (TMDLs) for total nitrogen (TN) and/or total phosphorus (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. These TMDLs will also constitute the site-specific numeric interpretation of the narrative nutrient criterion specified in Paragraph 62-302.530(90)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) for these waterbodies as described in Subsection 62-302.531(2), F.A.C."

Table EX-1. Summary of TMDL supporting information for Lake Alfred, Lake Blue, and Lake Marianna

Type of Information	Description
Waterbody name/ WBID number	Lake Alfred/WBID 1488D Lake Marianna/WBID 1521L Lake Blue/WBID 1521Q
Hydrologic Unit Code (HUC) 8	03100101
Use classification/ Waterbody designation	Class III/Freshwater
Targeted beneficial uses	Fish consumption; recreation; and propagation and maintenance of a healthy, well-balanced population of fish and wildlife
Verified List and 303(d) List Status	Verified List of Impaired Waters for the Group 3 basins (Sarasota-Peace-Myakka) adopted via Secretarial Order dated January 2010.
TMDL pollutants	TN and TP
TMDLs and site-specific interpretations of the narrative nutrient criterion	**WBID 1488D:** **Chlorophyll *a*:** 20 micrograms per liter (µg/L), expressed as an annual geometric mean (AGM) concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 1.69 milligrams per liter (mg/L), expressed as an AGM lake concentration not to be exceeded in any year. **TP:** 0.03 mg/L, expressed as an AGM lake concentration not to be exceeded in any year. **WBID 1521L:** **Chlorophyll a:** 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 1.00 mg/L, expressed as an AGM lake concentration not to be exceeded in any year. **TP:** 0.03 mg/L, expressed as an AGM lake concentration not to be exceeded in any year. **WBID 1521Q:** **Chlorophyll a:** 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 1.16 mg/L, expressed as an AGM lake concentration not to be exceeded in any year. **TP:** 0.03 mg/L, expressed as an AGM lake concentration not to be exceeded in any year.
Load reductions required to meet the TMDLs	**WBID 1488D:** A 16 % TN reduction and a 0% TP reduction to achieve a chlorophyll *a* target of *20* µg/L. **WBID 1521L:** A 44 % TN reduction and a 0% TP reduction to achieve a chlorophyll *a* target of *20* µg/L. **WBID 1521Q:** A 66 % TN reduction and a 67 % TP reduction to achieve a chlorophyll *a* target of 20 µg/L.

Acknowledgments

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Editorial assistance was provided by Erin Rasnake, Ansel Bubel, Kenneth Weaver, Endia Casley, Katherine Britt, Garry Payne, Kevin O'Donnell, and Linda Lord.

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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 Alfred, Lake Blue, and Lake Marianna, located in the Upper Peace River Basin. The TMDLs will also constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(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 waterbodies 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 Sarasota-Peace-Myakka Basin that was adopted by Secretarial Order on January 15, 2010.

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 Lake Alfred, Lake Blue, and Lake Marianna that would restore these waterbodies so that they meet the applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Peace River Basin (Hydrologic Unit Code [HUC] 03100101) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Alfred is WBID 1488D; Lake Blue, WBID 1521Q; and Lake Marianna, WBID 1521L. **Figure 1.1** shows the location of the WBIDs in the basin and major geopolitical and hydrologic features in the region, and **Figure 1.2** contains a more detailed map of the WBIDs.

Lake Alfred is a 726-acre lake located in the City of Lake Alfred in Polk County. The average depth of the lake is 5 feet (ft), with a maximum depth of 14 ft. The lake receives water from Lake Eva (21 acres) to the north. The average pool topographic elevation (1990–2017) of the water surface is 128 ft above mean sea level based on the National Geodetic Vertical Datum of 1929 (NGVD29) (Polk County 2017). Lake Alfred is situated in the Lake Hamilton Drainage Basin, which discharges to Peace Creek via Peace Creek Drainage Canal.

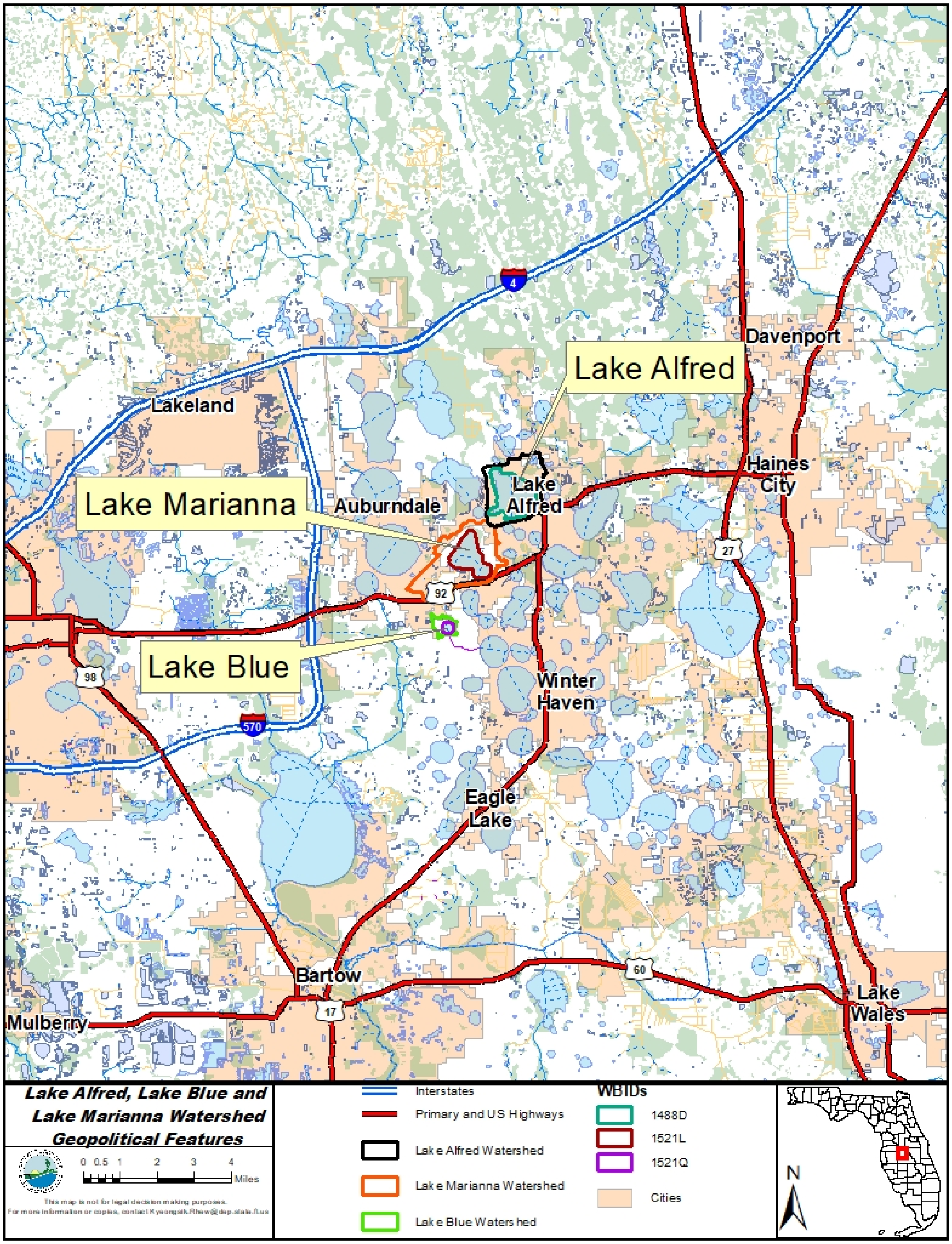


Figure 1.1. Location of Lake Alfred (WBID 1488D), Lake Marianna (WBID 1521L), and Lake Blue (WBID 1521Q) in the Peace River Basin and major hydrologic and geopolitical features in the area

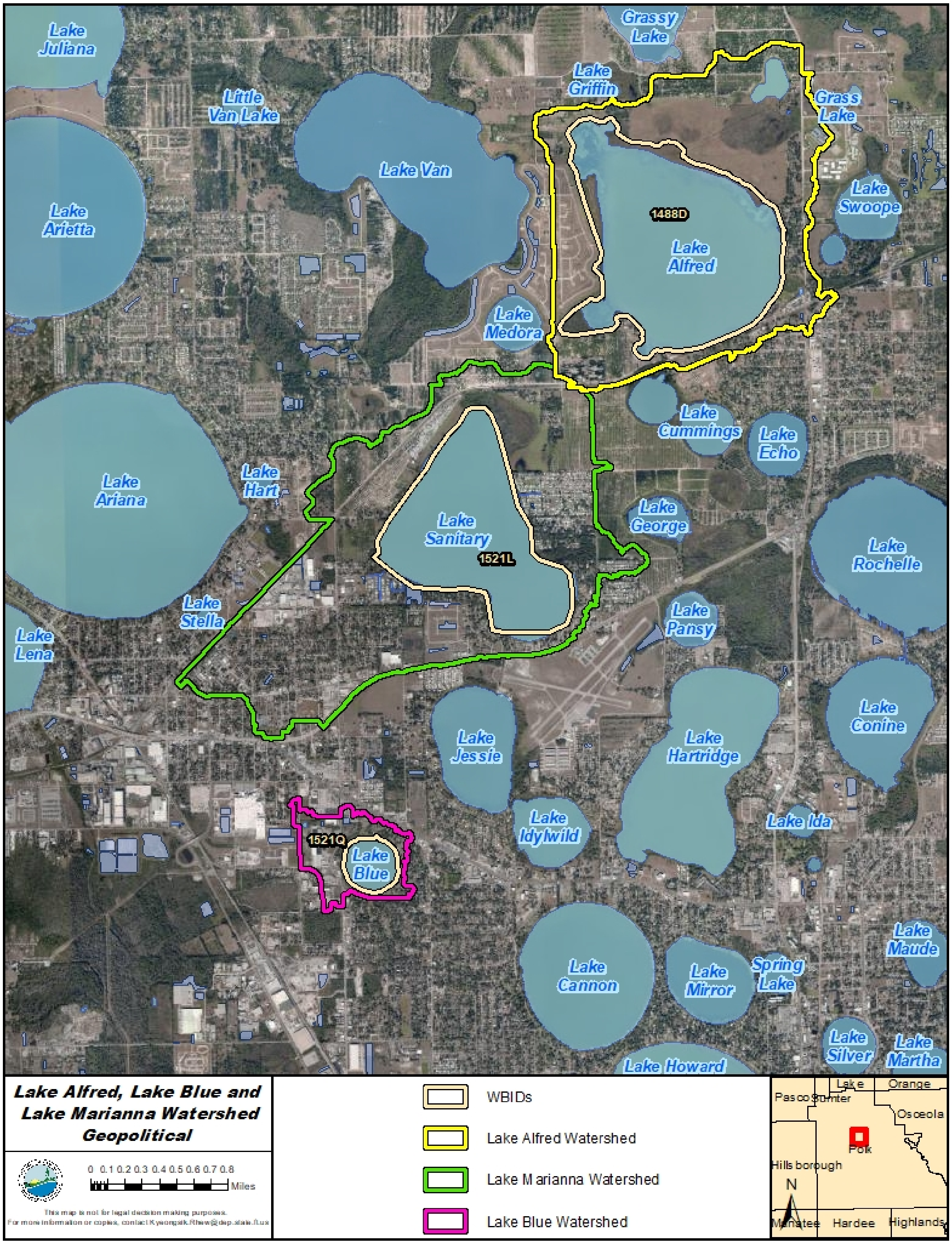


Figure 1.2. Lake Alfred (WBID 1488D), Lake Marianna (shown as Lake Sanitary) (WBID 1521L), and Lake Blue (WBID 1521Q) Watersheds

Lake Marianna is a 508-acre lake located in the City of Auburndale in Polk County. The average depth of the lake is 8 ft, with a maximum depth of 18 ft. The average pool topographic elevation (1983–2017) of the water surface is 137 ft above mean sea level, based on NGVD29 (Polk County 2017). Lake Marianna is connected to Lake Jessie, which is part of the Winter Haven Chain of Lakes which ultimately discharge to Peace Creek via Wahneta Farms Drainage Canal.

Lake Blue is a 53-acre lake located in unincorporated Polk County. The average depth of the lake is 6 ft, with a maximum depth of 10 ft. The average pool topographic elevation (1985–2017) of the water surface is 148 ft above mean sea level, based on NGVD29 (Polk County 2017). Lake Blue is connected to Lake Cannon, which is also part of the Winter Haven Chain of Lakes.

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Lake Alfred and its drainage basin span 1,619 acres; Lake Blue, 179 acres; and Lake Marianna, 1,938 acres. The watersheds of the lakes are situated in north-central Polk County. The Lake Alfred Watershed encompasses a portion of the City of Lake Alfred, the Lake Marianna Watershed covers part of the City of Auburndale, while the Lake Blue Watershed overlaps with the City of Auburndale and unincorporated Polk County. The population densities, based on 2010 U.S. Census data, are 1,002, 541, and 335 persons per square mile in the City of Auburndale, City of Lake Alfred, and Polk County, respectively (U.S. Census Bureau 2017).

1.3.2 Topography

Lake Alfred, Lake Blue, and Lake Marianna are located in the Winter Haven/Lake Henry Ridges Region (75-31), which consists primarily of upland karst area with elevations ranging from 130 to 170 ft (Griffith et al. 1997).

The lakes in the region are characterized as alkaline, moderately hard water lakes of relatively high mineral content, and are eutrophic. The elevation of the Lake Alfred Watershed ranges from 130 ft immediately adjacent to the lake to more than 190 ft on the northwestern boundary of the watershed. The elevation of the Lake Marianna Watershed ranges from 140 ft immediately adjacent to the lake to 170 ft on the watershed's western and northern boundaries. The elevation of the Lake Blue Watershed ranges from 150 ft immediately adjacent to the lake to 160 ft on the northwestern boundary of the watershed. The average slopes of the watersheds are 4.0 %, 1.2 %, and 1.0 % for Lake Alfred, Lake Marianna, and Lake Blue, respectively.

1.3.3 Hydrogeological Setting

The primary soils, based on data from the National Cooperative Soil Survey, belong in Hydrologic Soil Groups A, A/D, B/D, and C/D. Group A soils are sandy to loamy and are associated with a low runoff potential and high infiltration rates. Group B soils are silty to loamy and are moderately drained, and soils in Group C and D have high and very high runoff potentials, respectively. Soils classified in dual hydrologic groups (A/D, B/D, and C/D) have Type A, B, and C soil characteristics when unsaturated but behave like Type D soil when saturated.

Table 1.1 lists the soil hydrologic groups in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds and their corresponding acreages. Based on the soil characteristics shown in **Figure 1.3**, Group A and A/D soils coexist in the three watersheds. Unclassified (N/A) soils are most commonly used to classify soils covered by waterbodies. The hydrologic characteristics of soil can significantly influence the capability of a watershed to hold rainfall or produce surface runoff.

Table 1.1. Acreage of hydrologic soil groups in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds

Soil Hydrologic Group	Lake Alfred Acreage	Lake Alfred % Acreage	Lake Marianna Acreage	Lake Marianna % Acreage	Lake Blue Acreage	Lake Blue % Acreage
A	497.2	31	615.5	32	50.3	28
A/D	422.4	26	631.5	32	57.9	32
B/D	7.0	0	50.3	3	5.1	3
C/D	0	0	14.7	1	0	0
Unclassified (N/A)	692.0	43	625.6	32	65.7	37
Total	**1,618.6**	**100**	**1,937.6**	**100**	**179.0**	**100**

The climate of the Lake Alfred, Lake Marianna, and Lake Blue Watersheds is generally subtropical, with an annual average temperature of 73^{o} F. Annual rainfall in or near the Peace River Basin averages 50 to 56 inches, and 60 % of the rainfall occurs from June through September (Southwest Florida Water Management District [SWFWMD] 2004). The long-term average annual rainfall for Polk County, based on SWFWMD records from 1915 to 2016, is 52 inches/year (in/yr).

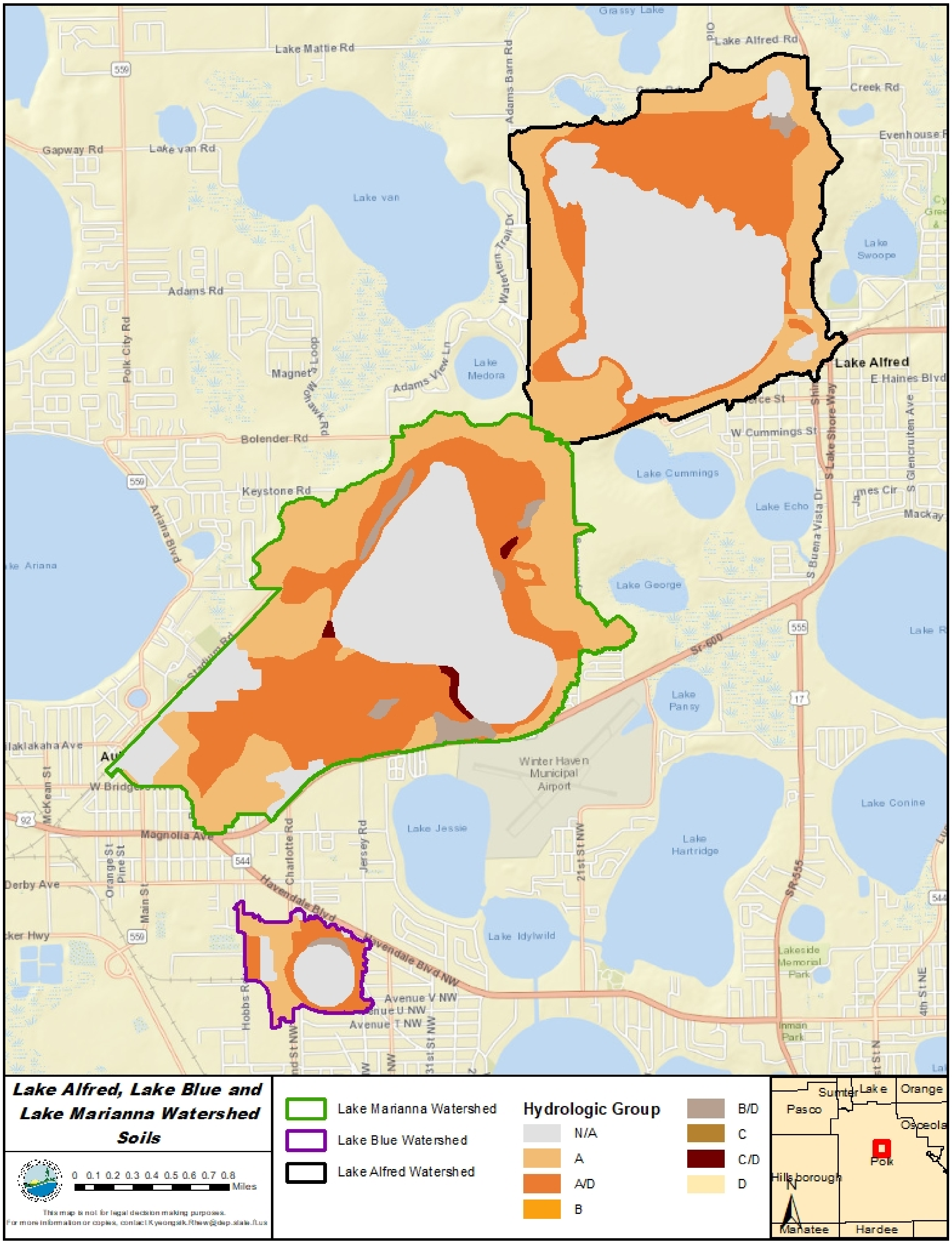


Figure 1.3. Soil hydrologic groups in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds

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 Verified List is amended annually and submitted to EPA as a basin update to the 303(d) list.

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Lake Alfred, Lake Marianna, and Lake Blue 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 standards applicable to the verified impairment (nutrients) for these waterbodies are Florida's nutrient criteria in Paragraph 62-302.530(90)(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 adopted lake NNC include criteria for chlorophyll *a*, total nitrogen (TN), and total phosphorus (TP), with the specific values depending on the color and alkalinity of a given lake. **Table 2.1** lists the NNC for Florida lakes 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.)

$CaCO_3$ = Calcium carbonate; PCU = Platinum cobalt units; µg/L = Micrograms per liter; mg/L = Milligrams per liter
[1] For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit shall be the 0.49 mg/L TP streams threshold for the region.

Lake Group Long-Term Geometric Mean Lake Color and Alkalinity	Lake Group AGM Chlorophyll *a*	Minimum NNC AGM TP	Minimum NNC AGM TN	Maximum NNC AGM TP	Maximum NNC AGM TN
> 40 PCU	20 µg/L	0.05 mg/L	1.27 mg/L	0.16 mg/L[1]	2.23 mg/L
≤ 40 PCU and > 20 mg/L $CaCO_3$	20 µg/L	0.03 mg/L	1.05 mg/L	0.09 mg/L	1.91 mg/L
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	6 µg/L	0.01 mg/L	0.51 mg/L	0.03 mg/L	0.93 mg/L

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

Data providers for Lake Alfred include Polk County (21FLPOLK…), U.S. Geological Survey (USGS) (112WRD…), Bream Fisherman Association (21FLBRA…), DEP (21FLGW…), DEP Southwest District Office (21FLTPA…), and SWRWMD (21FLSWFD…).

Data providers for Lake Marianna include Polk County, USGS, DEP Southwest District Office, SWFWMD, and Florida LakeWatch (21FLKWAT…).

Data providers for Lake Blue include Polk County, DEP Southwest District Office, and Florida LakeWatch (21FLKWAT…).

The majority of the available data comes from Polk County monitoring for Lake Alfred, Lake Marianna, and Lake Blue. **Figure 2.1** shows the sampling locations in the WBIDs. The individual water quality measurements discussed in this report are available in IWR Database Run IWR 53.

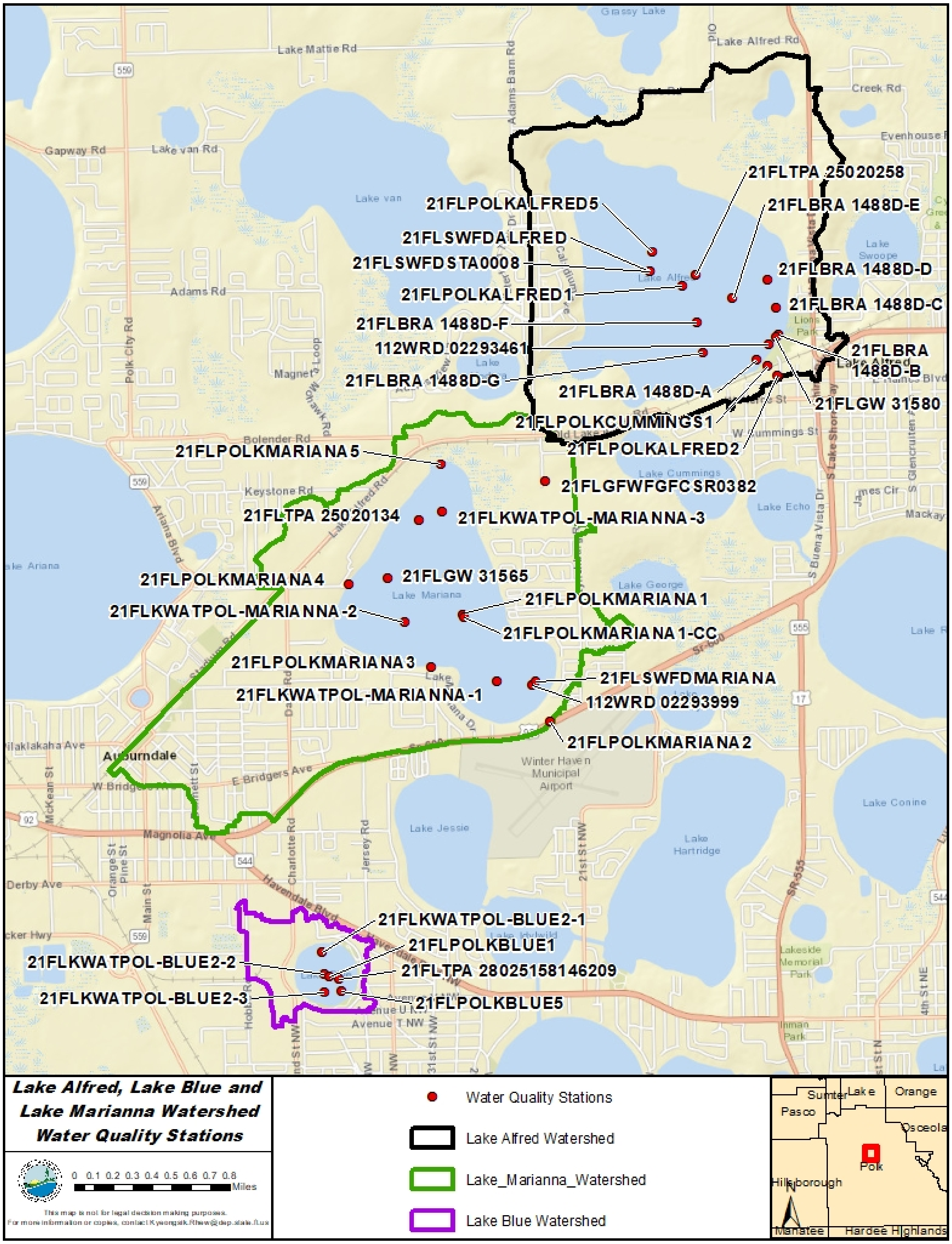


Figure 2.1. Monitoring stations in Lake Alfred, Lake Marianna, and Lake Blue

2.3.2 Water Quality Variables in the Lakes

Table 2.2 lists statistical summaries of key water quality parameters for Lake Alfred (WBID 1488D), Lake Marianna (WBID 1521L), and Lake Blue (WBID 1521Q). **Figures 2.2** through **2.7** also show the water quality data collected at all the stations in each lake from 1990 to 2016.

Table 2.2. Summary statistics of key water quality parameters for Lake Alfred (WBID 1488D), Lake Marianna (WBID 1521L), and Lake Blue (WBID 1521Q), 1990–2016

WBID	Statistics	Corrected Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)	Alkalinity (mg/L)	Color (PCU)
Lake Alfred	N of Sample	86	120	117	53	121
Lake Alfred	Minimum	3	0.06	0.001	5	10
Lake Alfred	Maximum	45	2.96	0.094	84	55
Lake Alfred	Median	24	1.80	0.031	63	25
Lake Alfred	Mean	23	1.78	0.033	63	25
Lake Marianna	N of Sample	81	370	365	103	190
Lake Marianna	Minimum	11	0.41	0.006	46	5
Lake Marianna	Maximum	58	4.00	0.310	72	40
Lake Marianna	Median	26	1.12	0.033	51	15
Lake Marianna	Mean	30	1.19	0.043	54	15
Lake Blue	N of Sample	69	272	267	102	102
Lake Blue	Minimum	6	0.27	0.007	13	4
Lake Blue	Maximum	153	7.49	0.364	82	38
Lake Blue	Median	69	1.88	0.081	53	25
Lake Blue	Mean	75	2.05	0.100	52	26

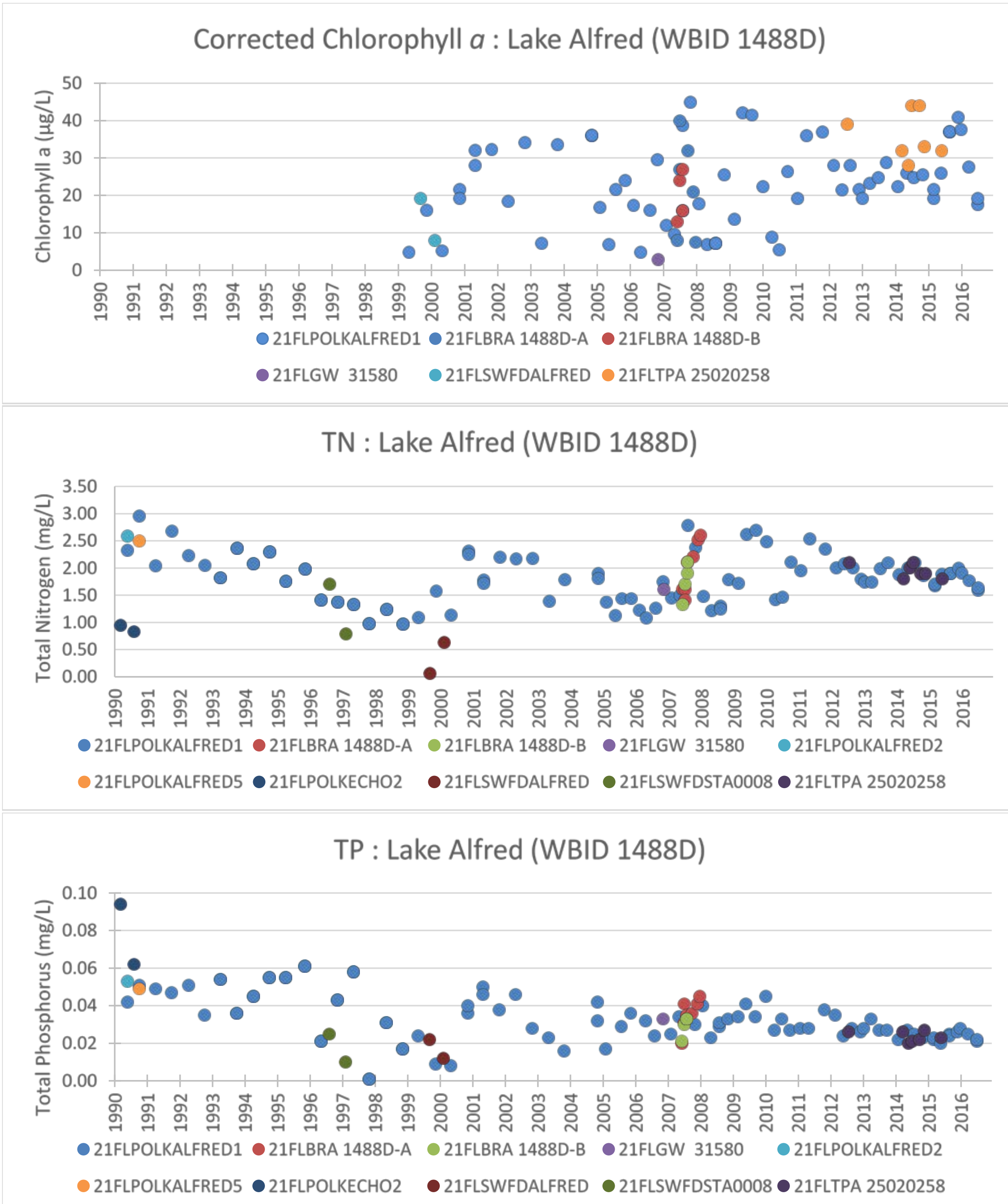


Figure 2.2. Chlorophyll *a*, TN, and TP concentrations measured in Lake Alfred, 1990–2016

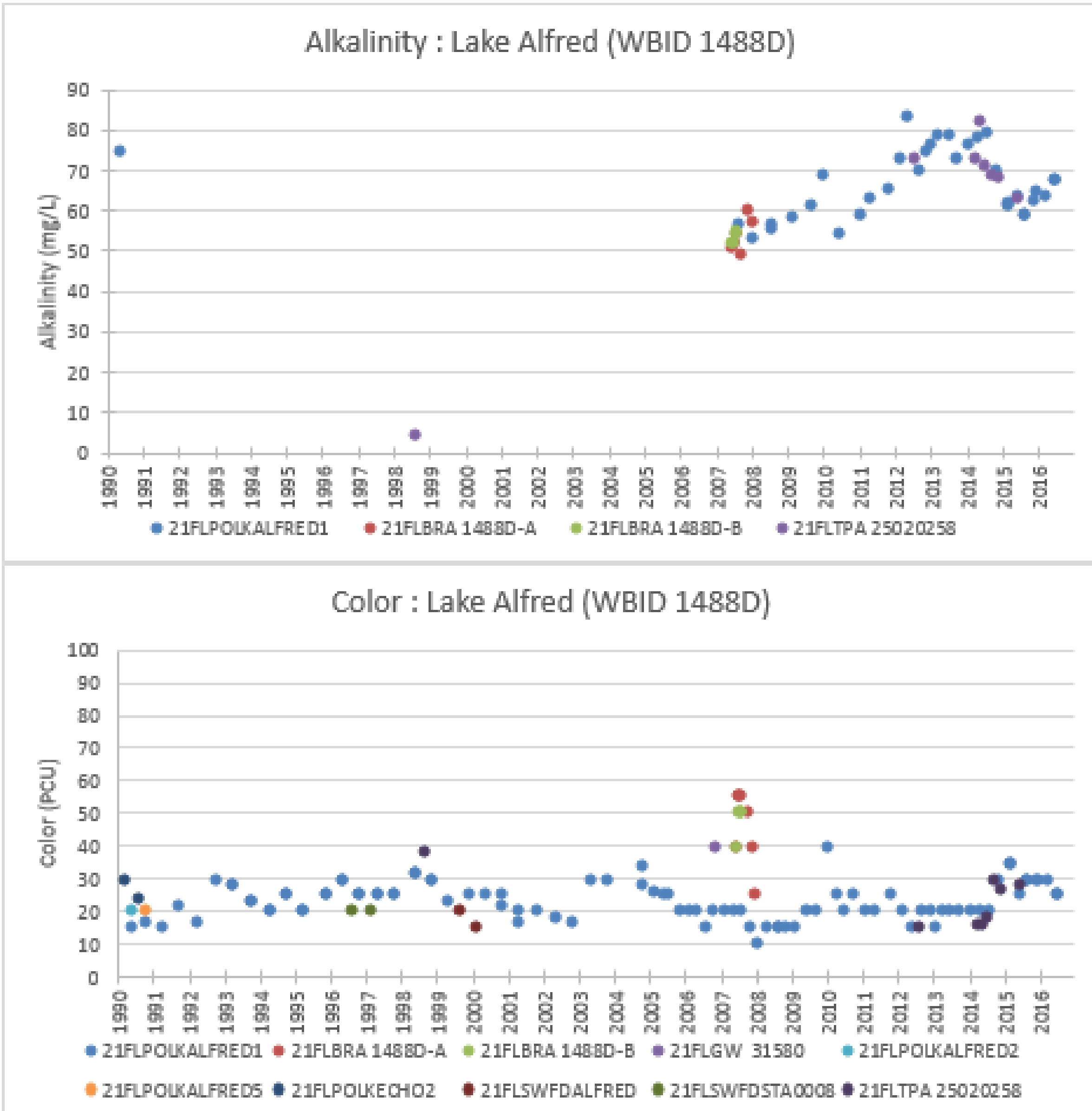


Figure 2.3. Alkalinity and color measured in Lake Alfred, 1990–2016

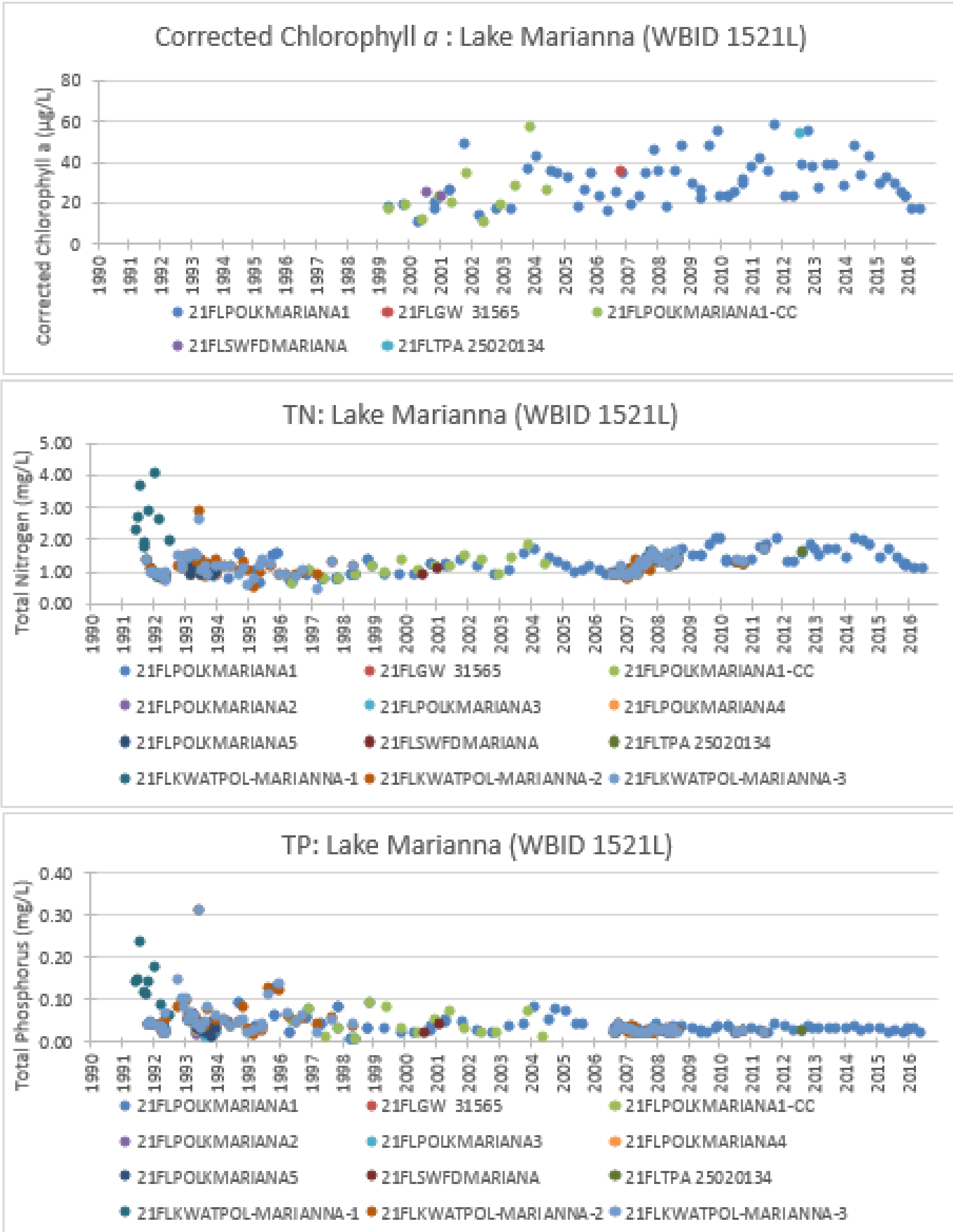


Figure 2.4. Chlorophyll a, TN, and TP concentrations measured in Lake Marianna, 1990–2016

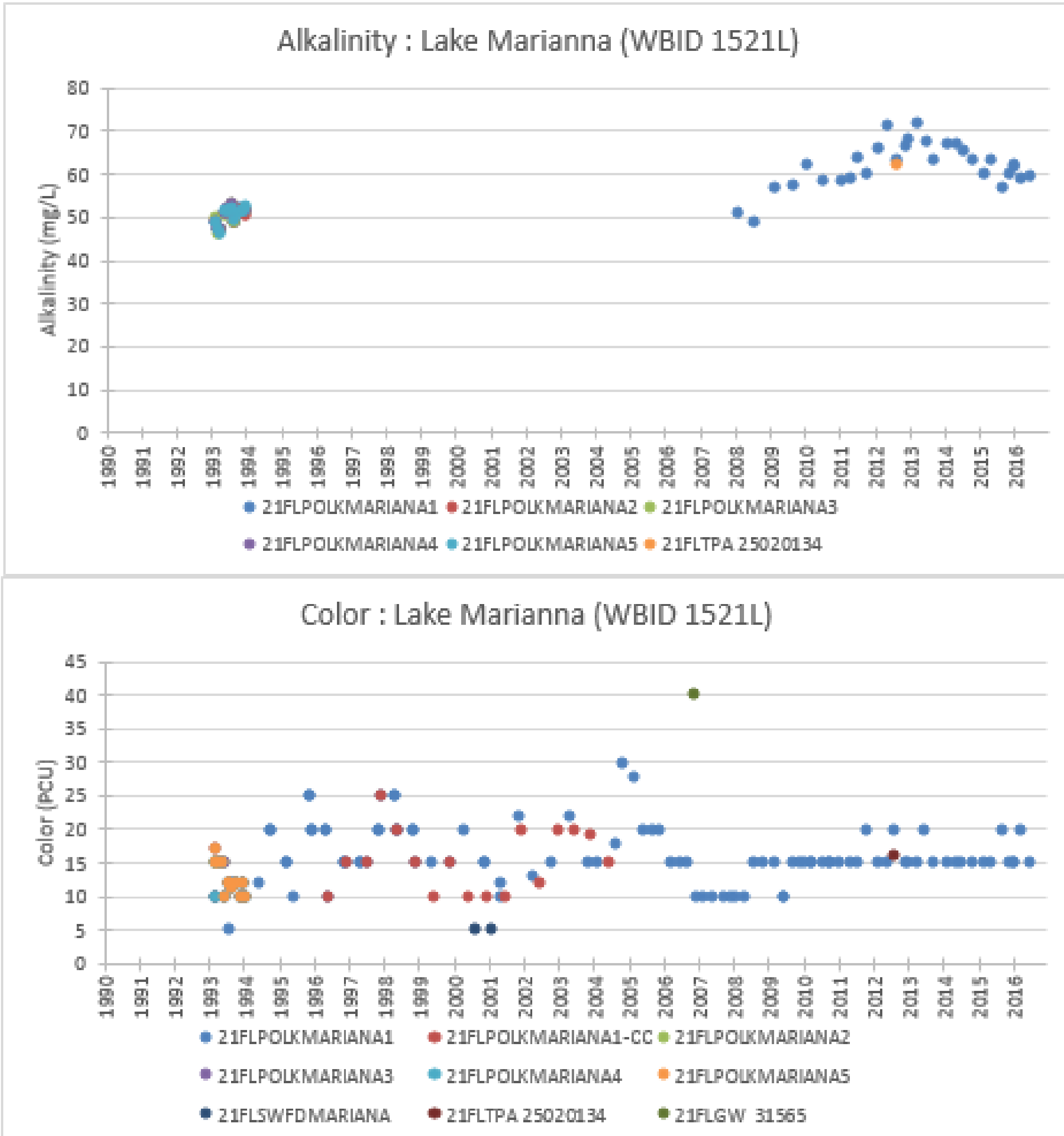


Figure 2.5. Alkalinity and color measured in Lake Marianna, 1990–2016

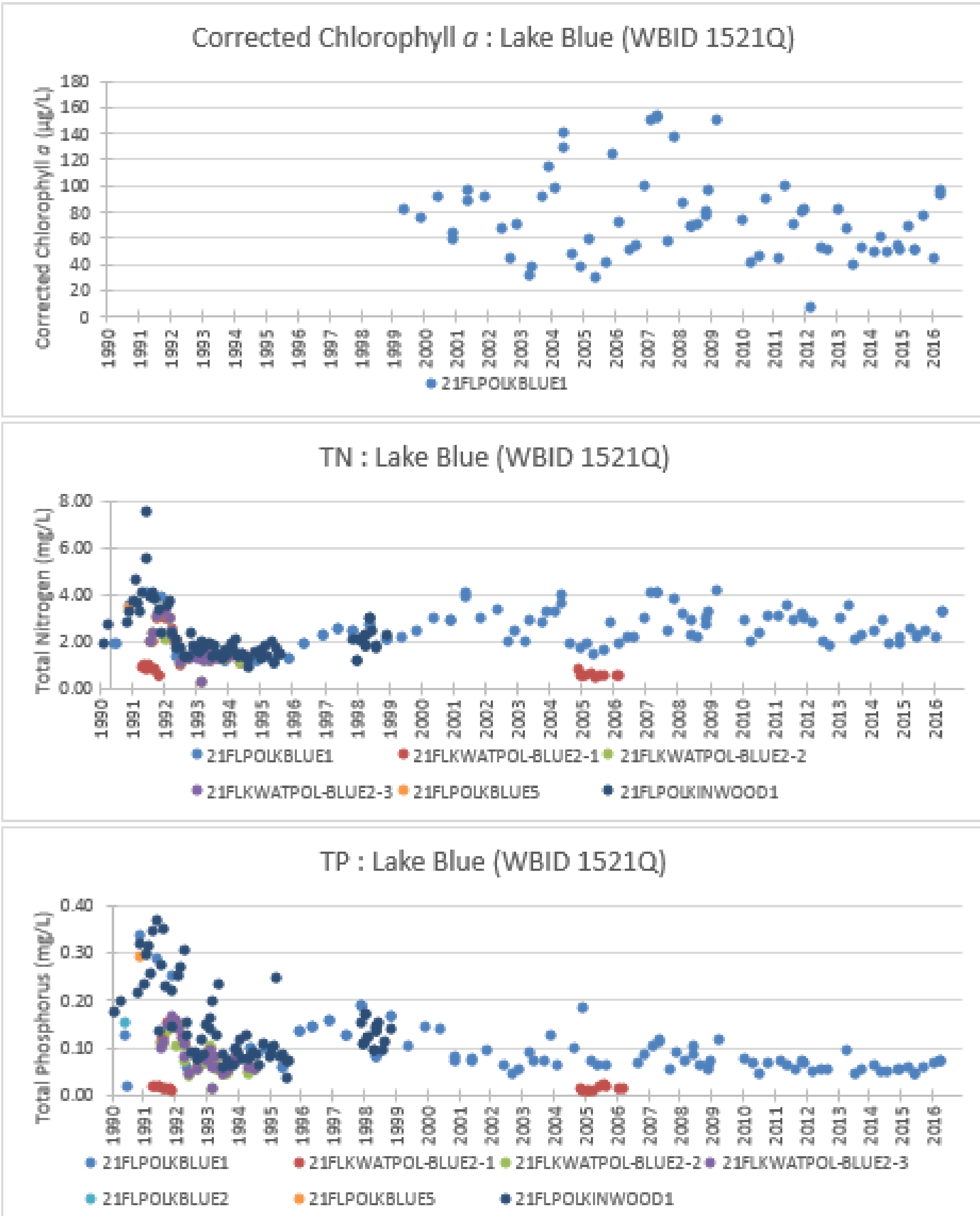
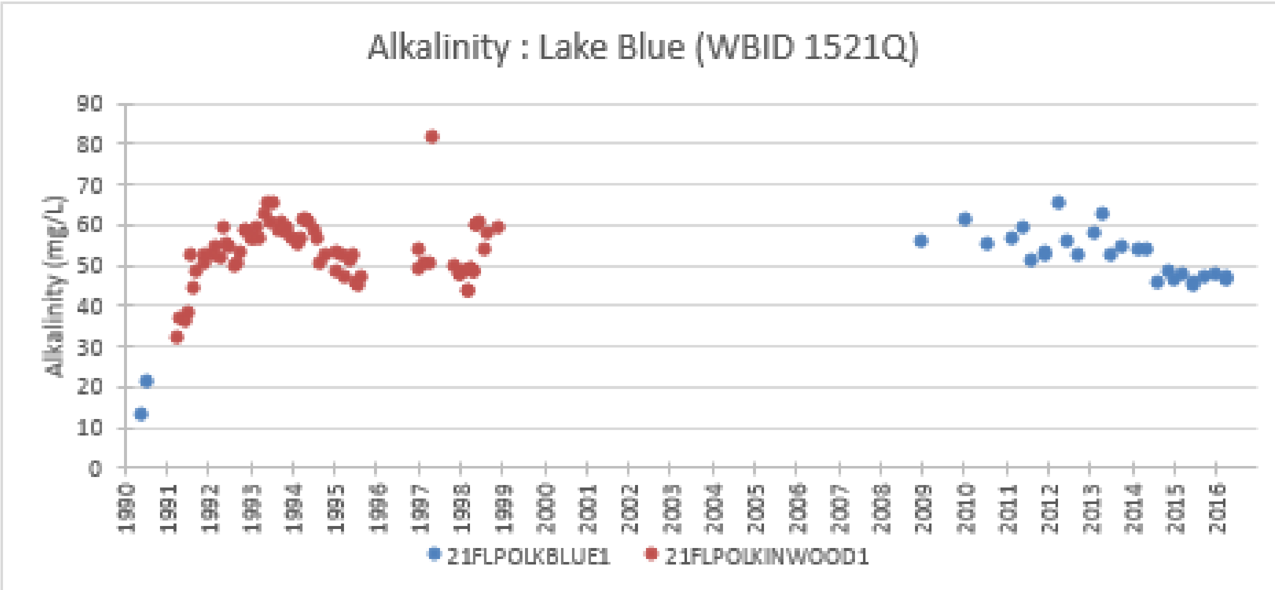


Figure 2.6. Chlorophyll *a*, TN, and TP concentrations measured in Lake Blue, 1990–2016



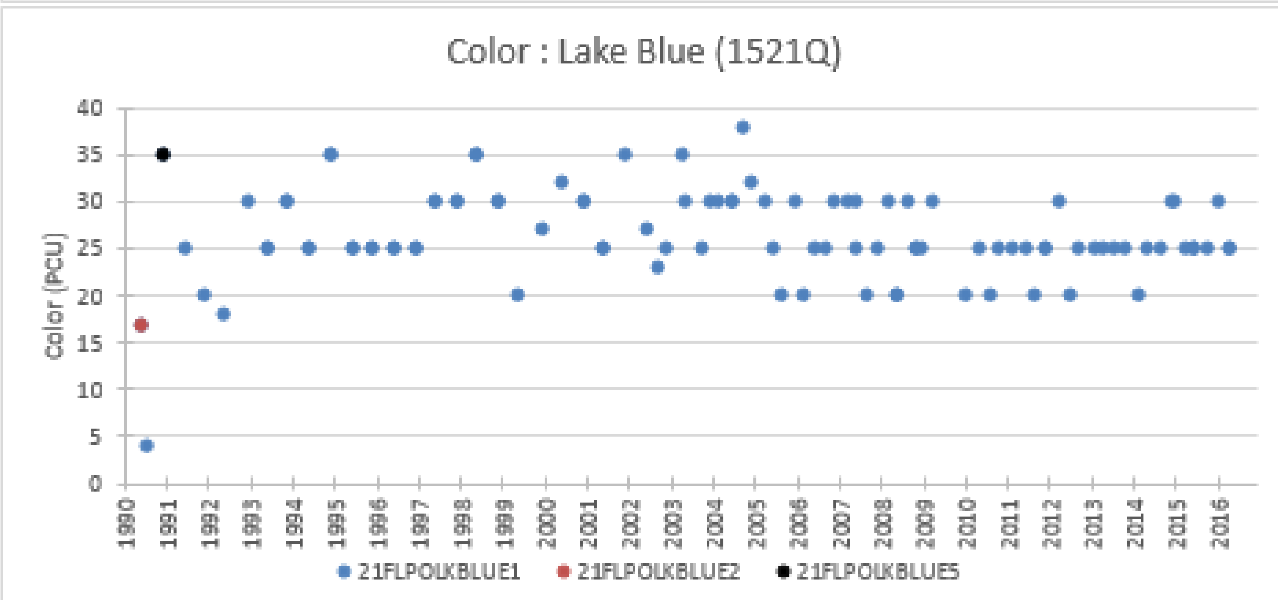


Figure 2.7. Alkalinity and color measured in Lake Blue, 1990–2016

2.3.3 Information on Verified Impairment

DEP used the assessment process described in the IWR (Chapter 62-302, F.A.C.) to assess water quality impairments in Lake Alfred, Lake Marianna, and Lake Blue. These lakes were verified as impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 2 verified period (the Cycle 2 verified period for the Group 3 basins was January 2002 to June 2009). At the time, the Cycle 2 assessment was performed, the IWR methodology used the water quality variables TN, TP, and chlorophyll *a* (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values and in interpreting Florida's narrative nutrient threshold.

The TSI is calculated based on concentrations of TP, TN, and chlorophyll *a*. The TSI thresholds were set based on annual mean color, where high-color lakes (> 40 PCU) had a TSI threshold of 60, and lower color lakes (≤ 40 PCU) had a TSI threshold of 40. Exceeding the TSI threshold in any single year of the verified period was sufficient to identify a lake as impaired for nutrients. For the Cycle 2 assessment, Lake Alfred was classified as a low-color lake and was assessed against the TSI threshold of 40. Annual mean TSI values exceeded the impairment threshold of 40 in 2007 and 2008.

Lake Marianna and Lake Blue are part of the Winter Haven Chain of Lakes. They were assessed against an alternative site-specific TSI threshold (TSI < 60) TSI to determine their impairment status. These alternative thresholds are based on paleolimnological research (Whitmore and Brenner 1995). Historical water quality assessments of selected lakes in the Winter Haven Chain indicate that the natural background condition of the lake is a TSI above 40, even though mean annual color values are frequently less than 40 PCU. For Lake Marianna, TSI annual means were above 60 in 2004, 2007, and 2008 in the Cycle 2 verified period. For Lake Blue, TSI annual means were above 60 in 2007 and 2008 in the Cycle 2 verified period.

In 2012, the IWR was amended to incorporate the numeric interpretations of Florida's narrative criterion (Rule 62-302.531, F.A.C.) (**Table 2.1**). Under the revised methodology, lakes are assessed for chlorophyll *a*, TN, and TP as individual parameters and the TSI is no longer used. The IWR assessment methodology utilized during Cycle 3 reflected this rule amendment. Each lake was determined to be a low-color, high-alkalinity lake and was assessed using an AGM corrected chlorophyll *a* criterion of 20 µg/L, a TN criterion range of 1.05 to 1.91 mg/L and a TP criterion range of 0.03 to 0.93 mg/L. These numeric interpretations vary annually depending on chlorophyll *a* data.

At the time of the Group 3 Cycle 3 assessments (January 1, 2008, to June 30, 2015), waterbodies previously impaired for TSI were delisted per Paragraph 62-303.720(2)(l), F.A.C., and reevaluated using the NNC for lakes. Lake Alfred was found to be impaired for chlorophyll *a* (exceeding the AGM of 20 µg/L from 2012 to 2015) and TN (exceeding the AGM of 1.05 mg/L from 2012 to 2015). Lake Marianna was also found to be impaired for chlorophyll *a* (exceeding the AGM of 20 µg/L from 2008 to 2015) and TN (exceeding the AGM of 1.05 mg/L from 2008 to 2015). No TP impairment was found in either lake (**Tables 2.3 and 2.4**). Lake Blue was found to be impaired for chlorophyll *a* (exceeding the AGM of 20 µg/L in 2008 and 2010–15), TN (exceeding the AGM of 1.05 mg/L in 2008 and 2010–15), and TP (exceeding the AGM of 0.03 mg/L in 2008, 2010–12, 2014, and 2015 (**Table 2.5**). **Tables 2.3, 2.4, and 2.5** show the most recent data using the IWR methodology.

Table 2.3. Lake Alfred (WBID 1488D) AGM values (2003–16)

ID = Insufficient data
Note: Values shown in shaded cells and boldface type 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 three-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2003	ID	ID	ID
2004	ID	ID	ID
2005	16	1.33	ID
2006	9	1.36	ID
2007	20	1.87	0.02
2008	11	1.61	0.02
2009	ID	ID	ID
2010	13	1.82	0.02
2011	ID	ID	ID
2012	**27**	**2.00**	0.02
2013	**24**	**1.89**	0.02
2014	**30**	**1.95**	0.02
2015	**30**	**1.85**	0.02
2016	**28**	**1.72**	0.02

Table 2.4. Lake Marianna (WBID 1521L) AGM values (2003–16)

ID = Insufficient data
Note: Values shown in shaded cells and boldface type 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 three-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2003	**31**	**1.44**	ID
2004	**34**	**1.39**	**0.04**
2005	**27**	**1.08**	ID
2006	**26**	1.03	ID
2007	**29**	**1.25**	0.02
2008	**32**	**1.48**	0.02
2009	**37**	**1.69**	0.02
2010	**25**	**1.47**	0.02
2011	**42**	**1.73**	0.02
2012	**36**	**1.48**	0.02
2013	**35**	**1.64**	0.02
2014	**37**	**1.79**	0.02
2015	**29**	**1.44**	0.02
2016	**21**	**1.19**	0.02

Table 2.5. Lake Blue (WBID 1521Q) AGM values (2003–16)

ID = Insufficient data
Note: Values shown in shaded cells and boldface type 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 three-year period.

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2003	**60**	**2.66**	**0.09**
2004	**69**	**2.48**	ID
2005	**54**	**1.84**	ID
2006	**67**	**2.24**	ID
2007	**116**	**3.45**	**0.09**
2008	**75**	**2.63**	**0.07**
2009	ID	ID	ID
2010	**59**	**2.51**	**0.06**
2011	**71**	**3.16**	**0.06**
2012	**34**	**2.31**	**0.06**
2013	**58**	**2.63**	ID
2014	**52**	**2.28**	**0.05**
2015	**60**	**2.21**	**0.05**
2016	**60**	**2.36**	**0.06**

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

3.1 Establishing the Site-Specific Interpretation

The nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.625, F.A.C., will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for this particular waterbody, pursuant to Paragraph 62-302.531(2)(a), F.A.C. **Table 3.1** lists the elements of the nutrient TMDLs that constitute the site-specific numeric interpretation of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Lake Alfred, Lake Marianna, and Lake Blue 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.

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

Note: Chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period. TN and TP are not to be exceeded.

WBID	AGM Chlorophyll *a* (µg/L)	TMDL TN Concentration (mg/L)	TMDL TP Concentration (mg/L)
1488D	20	1.69	0.03
1521L	20	1.00	0.03
1521Q	20	1.16	0.03

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 that the reduction of both nitrogen and phosphorus is necessary to control algal growth in aquatic systems (Conley et al. 2009, Paerl 2009, Lewis et al. 2011, Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC support this idea as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (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 to a smaller population of select reference lakes, paleolimnological studies, expert opinions, user perceptions, and biological responses. Based upon these lines of evidence, DEP concluded that annual average chlorophyll *a* of 20 µg/L in colored or high alkalinity clear and 6 µg/L in low alkalinity clear lakes is protective of the designated uses of recreation and aquatic life support (DEP 2012).

Color and alkalinity were used as morphoedaphic factors to predict the natural trophic status of lakes. Colored (≥40 PCU), and high alkalinity lakes (≥ 20 mg $CaCO_3$/L) are mesotrophic[1] or eutrophic, while low-color (<20 PCU) with low alkalinity (<20 $CaCO_3$/L) tend to be oligotrophic. 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*., more responsive floral community); or, 2) a significant historic change in trophic status (*i.e*., significant increasing trend in color and/or alkalinity).

As low-color, high-alkalinity lakes, a target of 20 µg/L will apply to Lake Alfred, Lake Marianna, and Lake Blue. Long-term datasets of color and alkalinity in these lakes (**Figures 2.3**, **2.5** and **2.7**) consistently show low color and high alkalinity and 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 NNC criteria are the most appropriate site-specific chlorophyll *a* criteria.

3.3 Numeric Expression of the Site-Specific Numeric Interpretation

The TN and TP criteria for Lake Alfred, Lake Marianna, and Lake Blue were established using the regression approach discussed in detail in **Chapter 5**. This approach relates the lake TN and/or TP concentrations to the annual geometric mean (AGM) chlorophyll *a* levels. The TN and TP criteria are expressed as maximum AGM concentrations not to be exceeded in any year. The frequency of the chlorophyll *a* NNC (20 µg/L) is established as not to be exceeded more than once in any consecutive 3-year period which is unchanged in the generally applicable criterion and ensures protection of the designated use while accounting for year to year variability.

The site-specific numeric interpretations of the narrative nutrient criterion for TN in Lake Alfred, Lake Marianna, and Lake Blue are 1.69, 1.00, and 1.16 mg/L, respectively (**Table 3.1**), expressed as an AGM lake concentration not to be exceeded in any year. The site-specific numeric interpretation of the narrative nutrient criterion for TP in Lake Alfred, Lake Marianna,

[1] The 20 µg/L chlorophyll *a* criterion was set to be protective of a mesotrophic condition. However, many Florida lakes may naturally be eutrophic or even hypertrophic; therefore, the department may use paleolimnological evidence to establish appropriate chlorophyll *a* targets for these lakes.

and Lake Blue is 0.03 mg/L (**Table 3.1**), expressed as an AGM lake concentration not to be exceeded in any year.

3.4 Downstream Protection

Lake Alfred is a closed system, with no connection to downstream surface waters.

Lake Marianna discharges into Lake Jessie (WBID 1521K), which is part of the Winter Haven Chain of Lakes and is classified as a low-color (<40 PCU), high-alkalinity (> 20 mg/L $CaCO_3$) lake. The generally applicable NNCs for Lake Jessie are 1.05 mg/L for TN, 0.03 mg/L for TP, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in a 3-year period. During the Cycle 3 (Group 3) assessment period when Lake Marianna was listed as impaired for nutrients, Lake Jessie was delisted as category 4A (TMDLs developed) for TP, but was assessed as impaired for chlorophyll *a* and TN.

To evaluate whether the Lake Marianna TMDL is protective of Lake Jessie, the department conducted a simple regression analysis of the relationship between the TN AGMs (1999 – 2016) in Lake Marianna and those in Lake Jessie (**Figure 3.1**). This analysis suggests that flow from the Lake Marianna has an influence on the water quality in Lake Jessie ($R^2 = 0.4288$, and $p = 0.0043$). When the TN target (1.00 mg/L) for Lake Marianna is applied to the regression equation, the resulting TN concentration in Lake Jessie is 0.94 mg/L. The Department then developed a multiple regression analysis of data within Lake Jessie from 1999 to 2016 to establish a predictive relationship for lake chlorophyll a, with TN and TP as the independent variables (**Appendix D**). The equation indicates a TN AGM of 0.94 mg/L and a TP AGM of 0.03 mg/L (the target TP concentration allowed under the Lake Marianna TMDL) will achieve the chlorophyll *a* criterion of 20 µg/L. Therefore, the Lake Marianna TMDL will be protective of water quality in Lake Jessie.

Lake Blue discharges into Lake Cannon (WBID 1521H) through a gated control structure when seasonal high waters exceed the lake operational levels. Lake Cannon is classified as a low-color (<40 PCU), high-alkalinity (> 20 mg/L $CaCO_3$) lake. The generally applicable NNCs for lake Cannon are 1.05 mg/L for TN, 0.03 mg/L for TP, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in a 3-year period. During the Cycle 3 (Group 3) assessment period when Lake Blue was listed as impaired for nutrients, Lake Cannon was delisted as category 4A (TMDLs developed) for TP, but was assessed as impaired for chlorophyll *a* and TN.

There are two pieces of evidence indicating that the Lake Blue has minimal impacts on Lake Cannon. First, according to the Winter Haven Chain of Lakes Water Quality Management Plan prepared by PBS&J (2010), "Due to the hydrologic isolation of Lake Blue from the Southern Chain by a gated structure, improvements in water quality of the lake would result in little benefit farther downstream."

Second, the department conducted a simple regression analyses of the relationships between the TN and TP AGMs (1999 – 2015) in Lake Blue and those in Lake Cannon (**Figures 3.2** and **3.3**). The low R^2 and high P values of these analyses suggest that flow from the Lake Marianna has very little or no influence on the water quality in Lake Cannon. This supports the hydrologic isolation between these two lakes. Therefore, the Lake Blue TMDL will be protective of water quality in Lake Cannon.

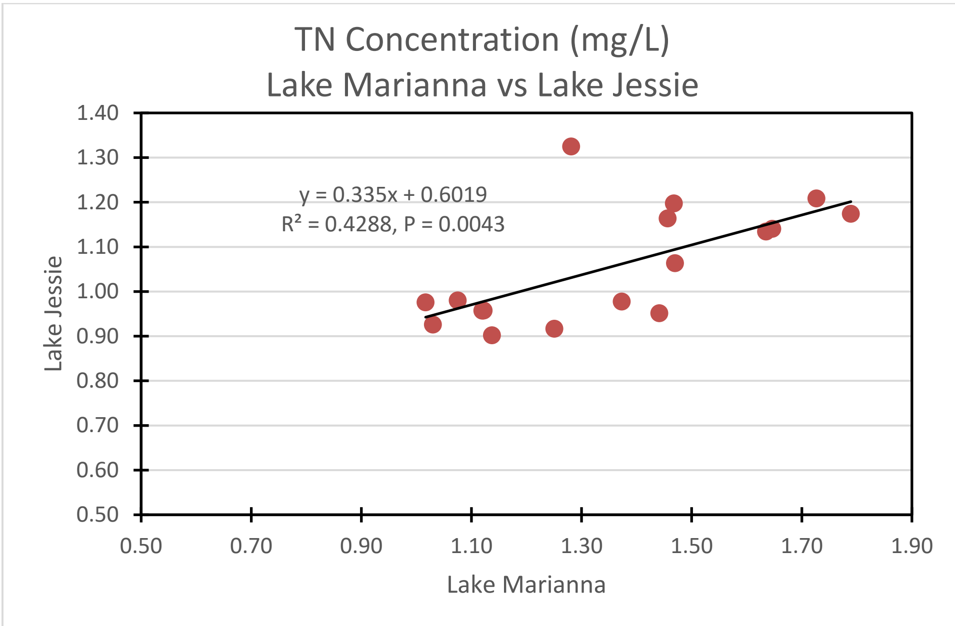


Figure 3.1. Relationship of AGMs (1999 - 2016) for TN Concentration between Lake Marianna and Lake Jessie

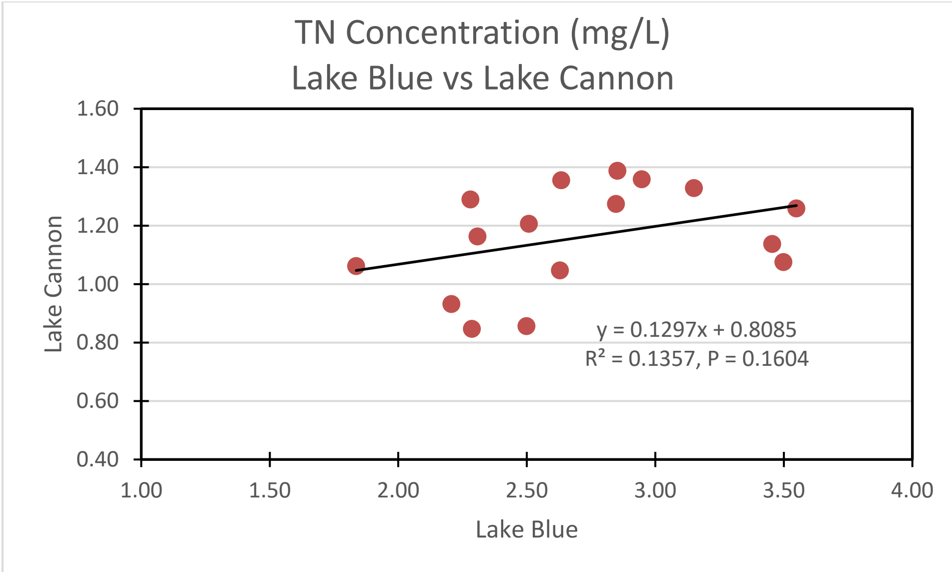


Figure 3.2. Relationship of AGMs (1999 - 2015) for TN Concentration between Lake Blue and Lake Cannon

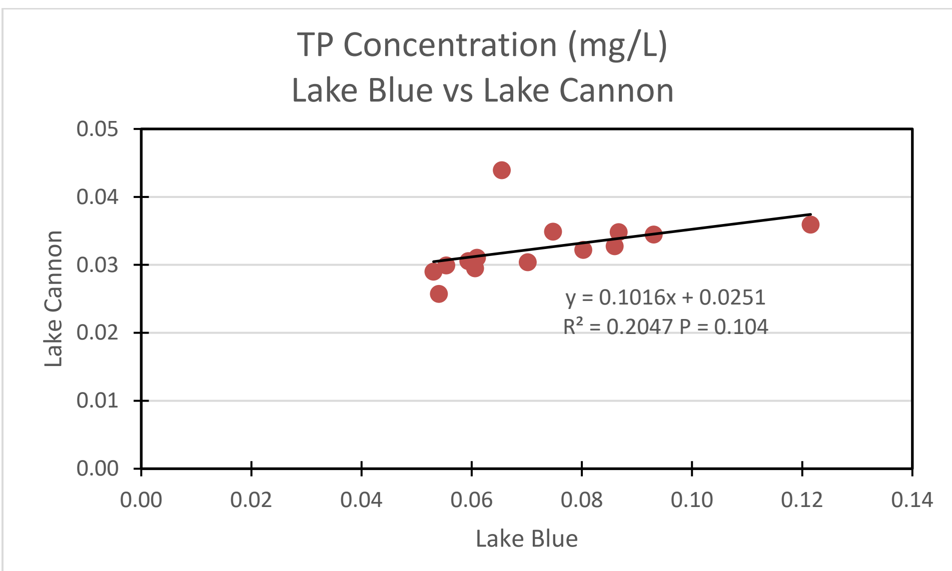


Figure 3.3. Relationship of AGMs (1999 - 2015) for TP Concentration between Lake Blue and Lake Cannon

3.5 Endangered Species Consideration

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 U.S. National Oceanic and/or Atmospheric Administration [NOAA], National Marine Fisheries Service [NMFS]), to ensure that any 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 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 the presence of any endangered aquatic species or critical habitat present in the Northern Chain of Lakes that could potentially be adversely affected by these TMDLs. Furthermore, it is expected that improvements in water quality from these restoration efforts will positively impact aquatic 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 two NPDES-permitted wastewater facilities in the Lake Marianna Watershed: UFP Auburndale, LLC (FL0133132) and Florida Brewery Inc. (FLA013273). UFP Auburndale, LLC is authorized to discharge effluent and stormwater from Outfall D-001 to Lake Ariana Drain (WBID 1501F) and Lake Ariana (WBID 1501B), not to Lake Marianna. Florida Brewery Inc. is not authorized to discharge effluent to surface water.

No NPDES-permitted wastewater facilities that discharge directly to surface waters were identified in the Lake Alfred and Lake Blue Watersheds.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The stormwater collection systems in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds, which are owned and operated by Polk County in conjunction with the Florida Department of Transportation (FDOT) District 1, are covered by an NPDES Phase I MS4 permit (FLS000015). The City of Lake Alfred is a co-permittee in the MS4 permit for the Lake Alfred Watershed, and the City of Auburndale is a co-permittee in the MS4 permit for the Lake Marianna and Lake Blue Watersheds. For more information on MS4s in the watersheds, email NPDES-stormwater@dep.state.fl.us. **Table 4.1** lists the permittees/co-permittees and their MS4 permit numbers.

Table 4.1. NPDES MS4 permits with jurisdiction in the watersheds of Lake Alfred, Lake Marianna, and Lake Blue

* Represents co-permittee.

Permit Number	Permittee/Co-Permittees	Phase
FLS000015	Polk County	I
FLS266701	City of Lake Alfred*	I
FLS266604	City of Auburndale*	I
FLS266779	FDOT District 1 – Polk*	I

4.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater dischargers are generally considered nonpoint sources. Nutrient loadings to Lake Alfred, Lake Marianna, and Lake Blue are primarily generated from nonpoint sources, mainly loadings from surface runoff, groundwater seepage entering the lake, 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 the 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. The spatial distribution of different land use categories in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds was identified using the SWFWMD 2011 land use coverage contained in DEP's geographic information system (GIS) library.

Land use categories in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds were aggregated using the Florida Land Use Code and Classification System (FLUCCS) (FDOT 1999) expanded Level 1 codes (including Level 2 codes for urban and built-up) and are tabulated in

Tables 4.2, **4.3**, and **4.4**, respectively. **Figure 4.1** shows the spatial distribution of the principal land uses in the watersheds.

The total area of the Lake Alfred Watershed is 1,619 acres, including the lake itself and other lakes, which cover 601 acres and account for 36 % of the total watershed area (**Table 4.2**). Wetland occupies 461 acres and accounts for 29 % of the total watershed. The largest wetland area is located on the north side of Lake Alfred. All urban land uses—including residential, commercial, industrial, recreational, and open land—occupy 313 acres and account for 19 % of the total watershed. Agricultural land occupies 13 % of the total watershed area.

The total area of the Lake Marianna Watershed is 1,938 acres, including the lake itself, which covers 520 acres and accounts for 27 % of the total watershed area (**Table 4.3**). Medium-density residential covers 412 acres and accounts for 21 % of the total watershed area. Agriculture occupies 382 acres and accounts for 20 % of the total watershed. Overall, human land uses—including all urban, agricultural, and communication and transportation areas—occupy 1,327 acres and account for 69 % of the total watershed.

The total area of the Lake Blue Watershed is 179 acres, including the lake itself, which covers 54 acres and accounts for 30 % of the total watershed area (**Table 4.4**). The dominant land use type, urban and built-up, covers 107 acres and accounts for 60 % of the total watershed area. Within the urban and built-up category, industrial land use occupies 60 acres and accounts for 33% of the total watershed. Residential land, including medium- and high-density residential, covers 17 acres and accounts for 10 % of the total watershed area. There are no agricultural areas in the watershed. Overall, human land uses, including medium- and high-density residential and urban and built-up occupy 124 acres and account for 69 % of the total watershed area.

Table 4.2. 2011 SWFWMD land use in the Lake Alfred Watershed

FLUCCs Code	Land Use Classification	Acres	% of Watershed
1000	Urban and Built-Up	156.3	10
1100	Low-Density Residential	64.1	4
1200	Medium-Density Residential	86.6	5
1300	High-Density Residential	5.7	0
2000	Agriculture	207.5	13
4000	Forest	22.3	1
5000	Water	600.8	37
6000	Wetland	461.1	29
8000	Communication and Transportation	14.2	1
Total	**All Combined**	**1,618.6**	**100**

Table 4.3. 2011 SWFWMD land use in the Lake Marianna Watershed

FLUCCs Code	Land Use Classification	Acres	% of Watershed
1000	Urban and Built-Up	299.8	15
1100	Low-Density Residential	17.9	1
1200	Medium-Density Residential	411.9	21
1300	High-Density Residential	171.5	9
2000	Agriculture	381.5	20
5000	Water	519.7	27
6000	Wetland	90.6	5
8000	Communication and Transportation	44.7	2
Total	**All Combined**	**1,937.6**	**100**

Table 4.4. 2011 SWFWMD land use in the Lake Blue Watershed

FLUCCs Code	Land Use Classification	Acres	% of Watershed
1000	Urban and Built-Up	107.0	60
1200	Medium-Density Residential	13.4	8
1300	High-Density Residential	3.8	2
5000	Water	54.0	30
6000	Wetland	0.6	0
Total	**All Combined**	**178.8**	**100**

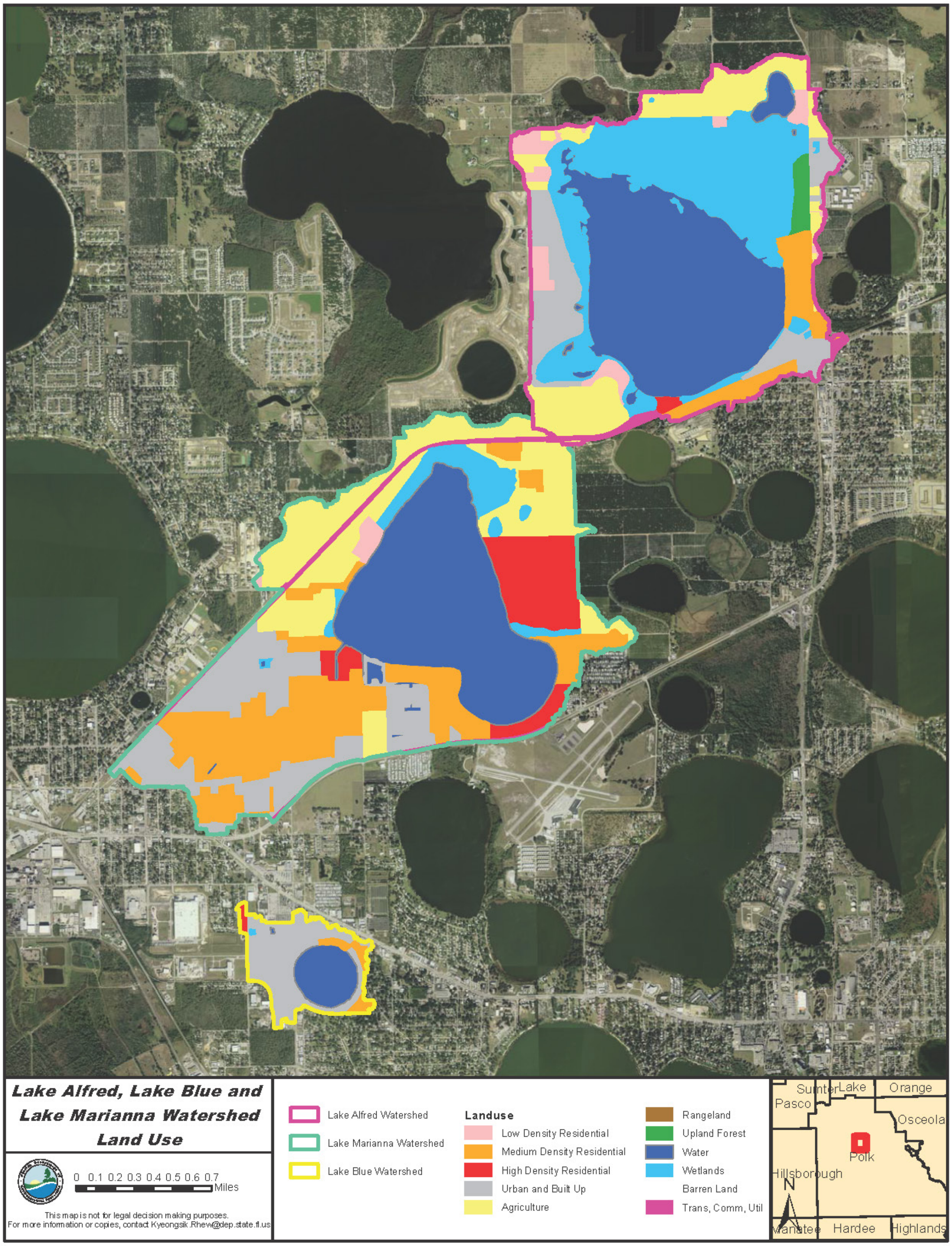


Figure 4.1. Land use in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds in 2011

4.3.2 Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, including septic tanks, are commonly used where providing central sewer service is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, 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. When not functioning properly, however, OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water. Information on the location of septic systems was obtained from Florida Department of Health (FDOH) OSTDS GIS coverage dated November 2012.

Figure 4.2 shows the locations of OSTDS in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds. Currently the number of septic tanks is calculated at 117, 1437, and 61 in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds, respectively.

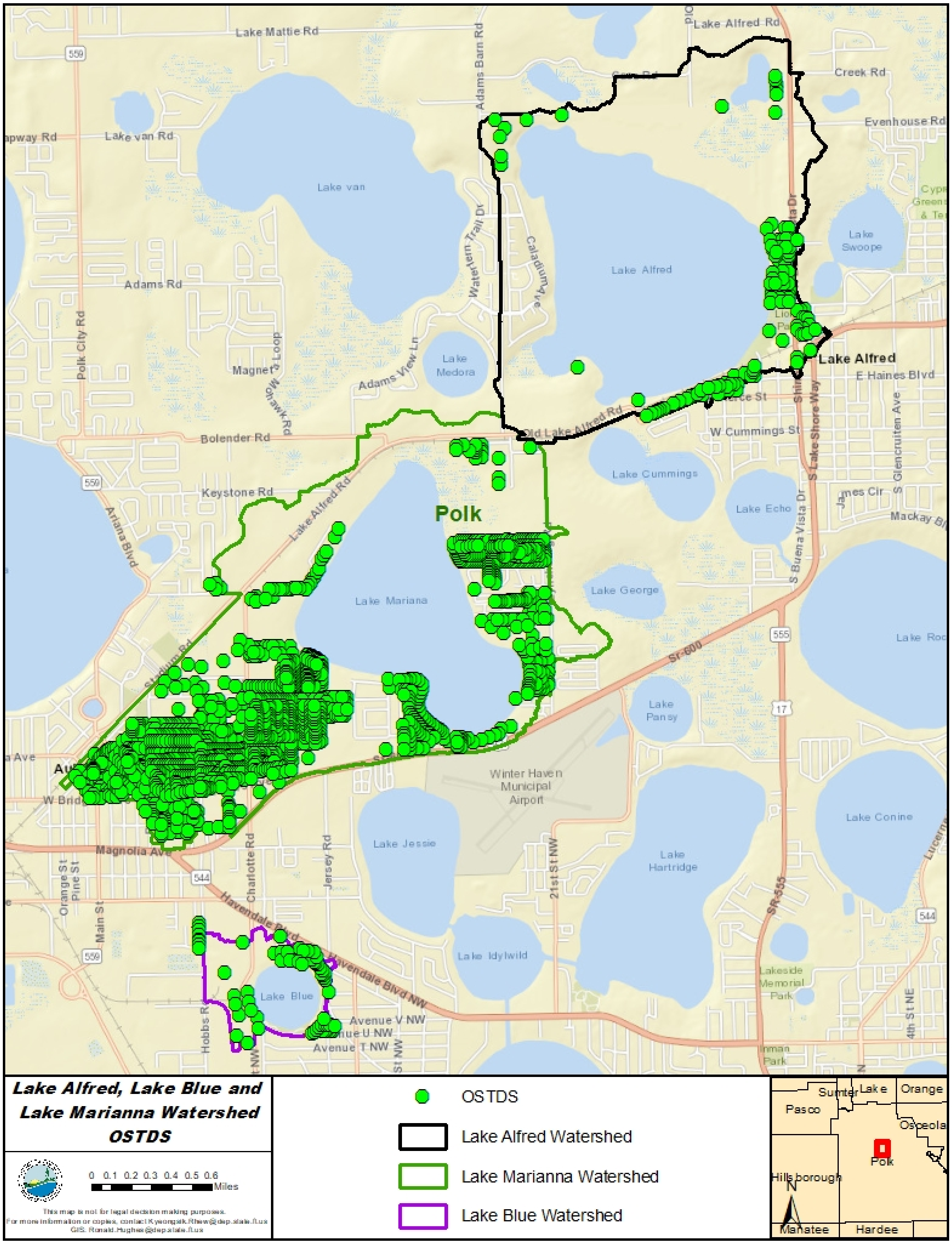


Figure 4.2. OSTDS in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds

Chapter 5: Determination of Assimilative Capacity

5.1 Determination of Loading Capacity

The TMDL development process identifies nutrient target concentrations and nutrient reductions for Lake Alfred, Lake Marianna, and Lake Blue necessary for the waterbodies to achieve the applicable nutrient water quality criteria, and to maintain their function and designated use as a Class III fresh water. The methods used to address the nutrient impairment included the development of regression equations that relate lake nutrient concentrations to the AGM chlorophyll *a* levels and/or the evaluation of paleolimnological results to establish a water quality target for TP. For addressing nonpoint sources (both NPDES stormwater discharges and non-NPDES stormwater discharges), the TMDLs are expressed as percent reductions in the existing lake TN and TP concentrations necessary to meet the applicable chlorophyll *a* target, while taking into consideration the estimated predisturbance conditions in the lake.

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

5.2 Evaluation of Water Quality Conditions

The results collected at the Polk County sampling locations near the center of each lake were evaluated to determine if relationships exist between nutrient concentrations and chlorophyll *a* levels. The county monitoring near the lake center provides a consistent dataset for evaluating surface water quality. The county is the only organization that has routinely sampled the lakes over an extended period. The nutrient and corrected chlorophyll *a* AGMs were used in this evaluation to be consistent with the expression of the adopted NNC for lakes.

In 1999, the county began sampling for corrected chlorophyll *a*, which is the more common form of chlorophyll *a* used in assessing surface water quality. For this analysis, the geometric means for each year were calculated using a minimum of two Polk County sample results per year, collected in different quarters, with at least one of the results collected in the May to September time frame. From 1999 to 2016, sufficient results were collected in most years to calculate AGM values for corrected chlorophyll *a* and nutrients for all three lakes.

In Lake Alfred, AGM values were calculated for TN, TP, and corrected chlorophyll *a* results measured at the center of the lake (21FLPOLKALFRED1). TN annual means ranged from 1.31 to 2.30 mg/L, and TP annual means ranged from 0.015 to 0.043 mg/L from 1999 to 2016. TN concentrations fluctuated throughout the period, increasing from 1999 to 2002, decreasing through 2006, increasing again through 2011, and decreasing through 2016 (**Figure 5.1**). In general, TP concentrations showed no decreasing or increasing trend (P= 0.7890) during this period.

Figure 5.2 plots chlorophyll *a* AGM values along with annual total rainfall. Chlorophyll *a* AGM values in Lake Alfred were above 20 µg/L in 7 of the 8 years between 2009 and 2016 (the verified period and more recently), with the exception of 2010, when the mean was 13 µg/L. Geometric means above the target ranged from 24 µg/L in 2009 and 2013 to 30 µg/L in 2015. A comparison of AGM chlorophyll *a* results with annual rainfall in **Figure 5.3** indicates that the relationship between these variables is not significant (P = 0.164). The results suggest that factors in addition to external nutrient loadings, such as lake residence time and the internal cycling of nutrients, may have some influence on lake nutrient and chlorophyll *a* levels.

Figures 5.4 and **5.5** show the relationships between chlorophyll *a* and TN and TP AGM values, respectively. Chlorophyll *a* exhibits a significant positive relationship with TN (R^2 = 0.492, P = 0.004). The results indicate a relationship between AGM chlorophyll *a* and TP (R^2 = 0.36, P = 0.023).

In Lake Marianna, AGM values were calculated for TN, TP, and corrected chlorophyll *a* results measured at the center of the lake (21FLPOLKMARIANA1 and 21FLPOLKMARIANA1-CC). TN annual means ranged from 1.02 to 1.76 mg/L, and TP annual means ranged from 0.024 to 0.050 mg/L from 1999 to 2016. TN concentrations fluctuated throughout the period, increasing from 1999 to 2004, decreasing through 2006, increasing again through 2014, and decreasing through 2016. In general, TN concentrations showed an increasing statistical trend (P = 0.012) but TP concentrations showed a decreasing trend (P = 0.047) during the 1999 to 2016 period (**Figure 5.6**).

Figure 5.7 shows chlorophyll *a* AGM values along with annual total rainfall. Chlorophyll *a* AGM values in Lake Marianna were above 20 µg /L in 7 of the 8 years between 2008 and 2016 (the verified period and more recently), with the exception of 2016, when the mean was 18 µg/L. Geometric means above the target ranged from 25 µg/L in 2010 to 42 µg/L in 2011. A comparison of AGM chlorophyll *a* results with annual rainfall in **Figure 5.8** indicates no relationship between these variables (P = 0.647). The results suggest that factors in addition to external nutrient loads, such as lake residence time and the internal cycling of nutrients, may have some influence on lake nutrient and chlorophyll *a* levels.

Figures 5.9 and **5.10** show the relationships between chlorophyll *a* and TN and TP AGM concentrations, respectively. Chlorophyll *a* exhibits a strong positive relationship with TN (R^2 =

0.719, P < 0.000). The results indicate no apparent relationship between AGM chlorophyll *a* and TP (P = 0.957). These observations suggest that with a lowering of the in-lake nitrogen concentrations, chlorophyll *a* concentrations will decrease.

In Lake Blue, AGM values were calculated for TN, TP, and corrected chlorophyll *a* results measured at the center of the lake (21FLPOLKBLUE1). TN annual means ranged from 1.84 to 3.55 mg/L, and TP annual means ranged from 0.053 to 0.122 mg/L from 1999 to 2015. TN concentrations fluctuated throughout the period, increasing from 1999 to 2001, decreasing through 2005, increasing again through 2007, and decreasing through 2015. TP concentrations fluctuated throughout the period, decreasing from 1999 to 2002, increasing through 2005, and decreasing through 2015. In general, TP concentrations showed a decreasing trend (P = 0.001), but TN concentrations showed no statistical trend (P = 0.457) during the 1999 to 2015 period (**Figure 5.11**).

Figure 5.12 shows chlorophyll *a* AGM values along with annual total rainfall. Chlorophyll *a* AGM values in Lake Blue were above 20 µg/L in every year between 2008 and 2015 (the verified period) with the exception of 2009, when data were insufficient to calculate an AGM. Geometric means above the target ranged from 34 µg/L in 2012 to 75 µg/L in 2008. A comparison of AGM chlorophyll *a* results with annual rainfall (**Figure 5.13)** indicates no relationship between these variables (P = 0.771). The results suggest that factors in addition to external nutrient loadings, such as lake residence time and the internal cycling of nutrients, may have some influence on lake nutrient and chlorophyll *a* levels.

Figures 5.14 and **5.15** show the relationships between chlorophyll *a* and TN and TP AGM concentrations, respectively. Chlorophyll *a* exhibits a significant positive relationship with TN (R^2 = 0.612, P = 0.000). The results also indicate that there is a weaker relationship between annual geometric mean chlorophyll *a* and TP (R^2 = 0.415, P = 0.013). These observations suggest that with a lowering of in-lake nitrogen and phosphorus concentrations, chlorophyll *a* concentrations will decrease.

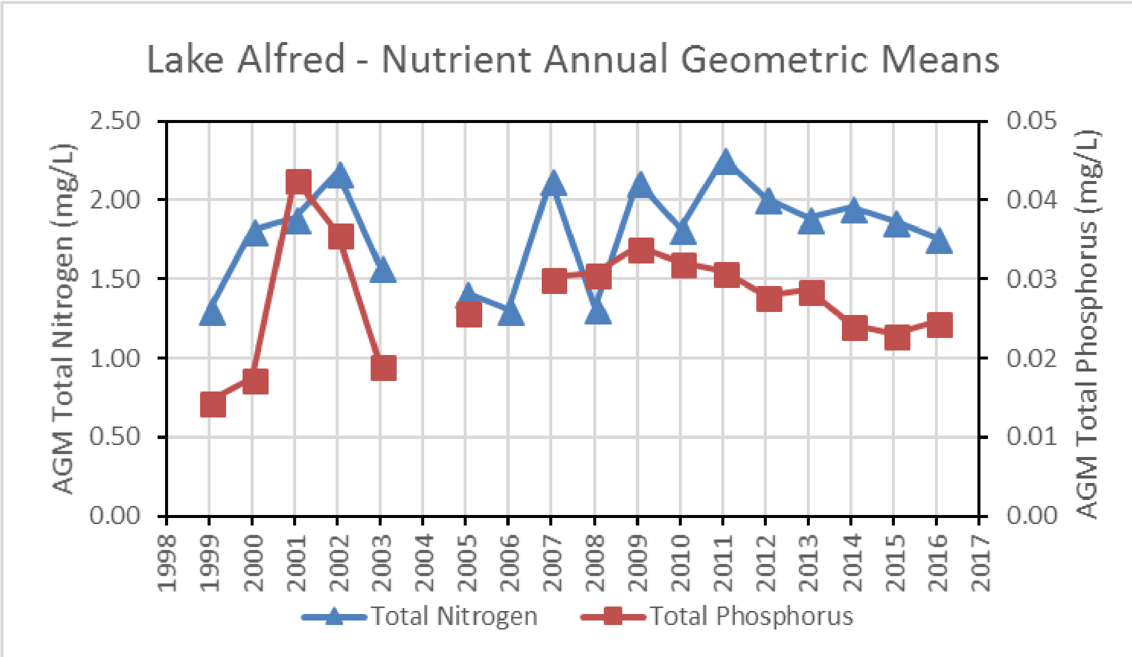


Figure 5.1. **TN and TP AGMs in Lake Alfred**

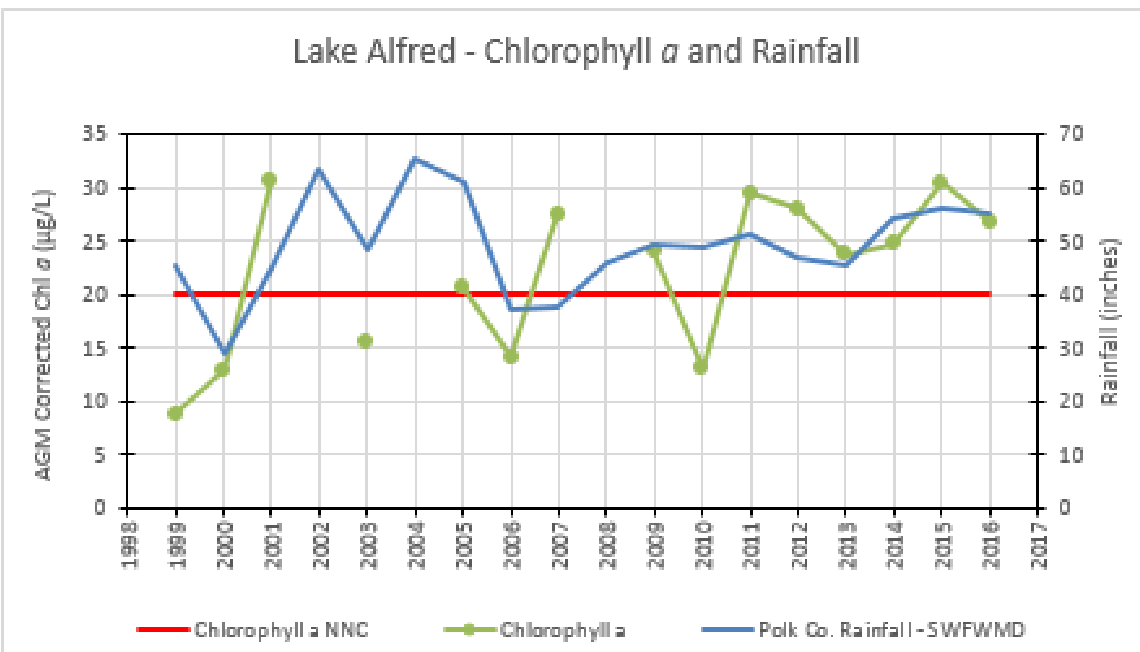


Figure 5.2. **Chlorophyll *a* AGMs and annual rainfall in Lake Alfred**

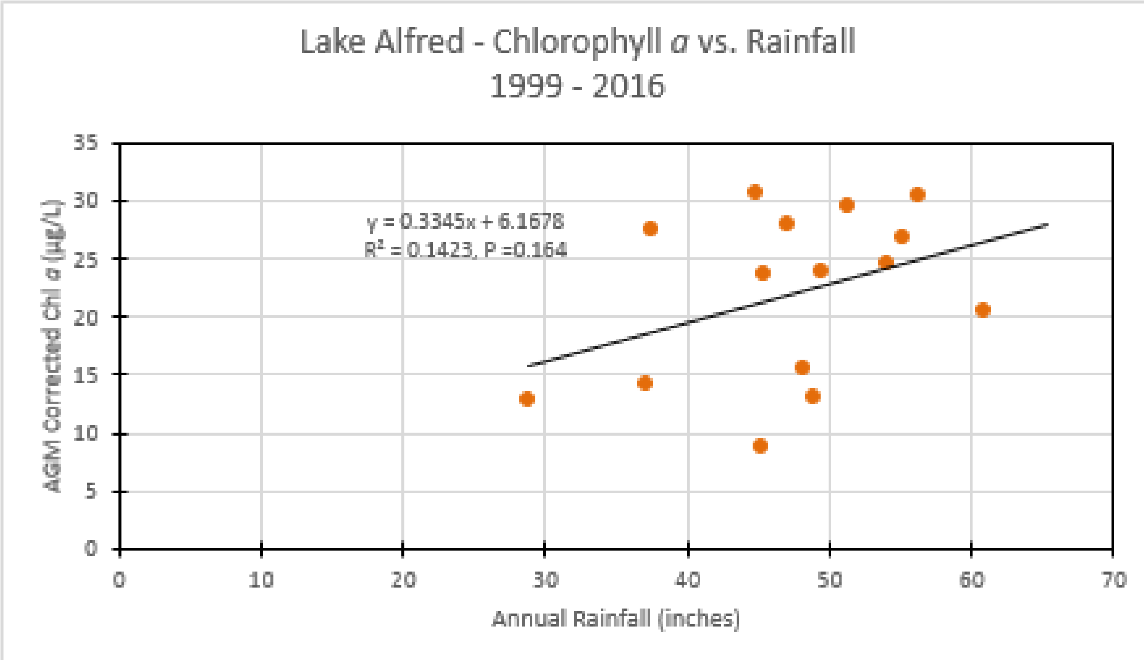


Figure 5.3. **Relationship between chlorophyll *a* AGMs and annual rainfall in Lake Alfred**

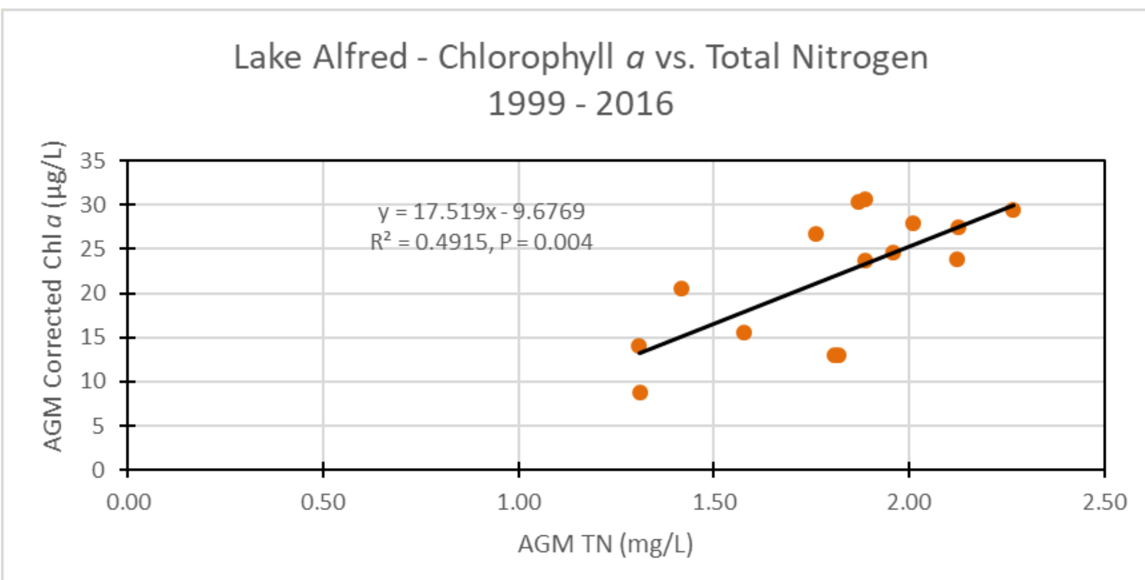


Figure 5.4. **Relationship between AGMs for chlorophyll *a* and TN in Lake Alfred**

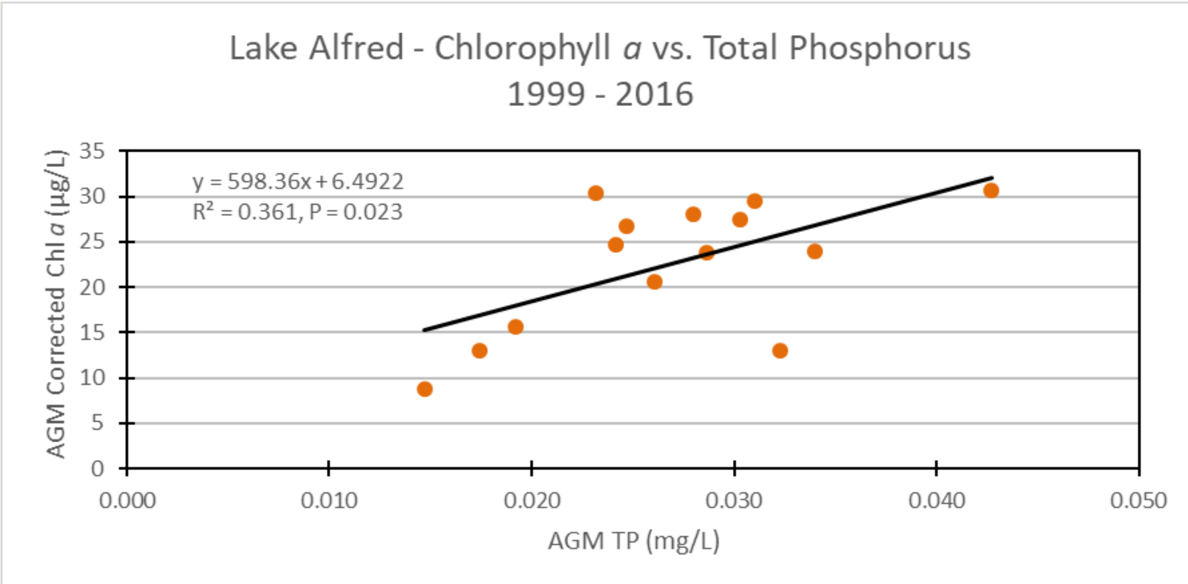


Figure 5.5. Relationship between AGMs for chlorophyll *a* and TP in Lake Alfred

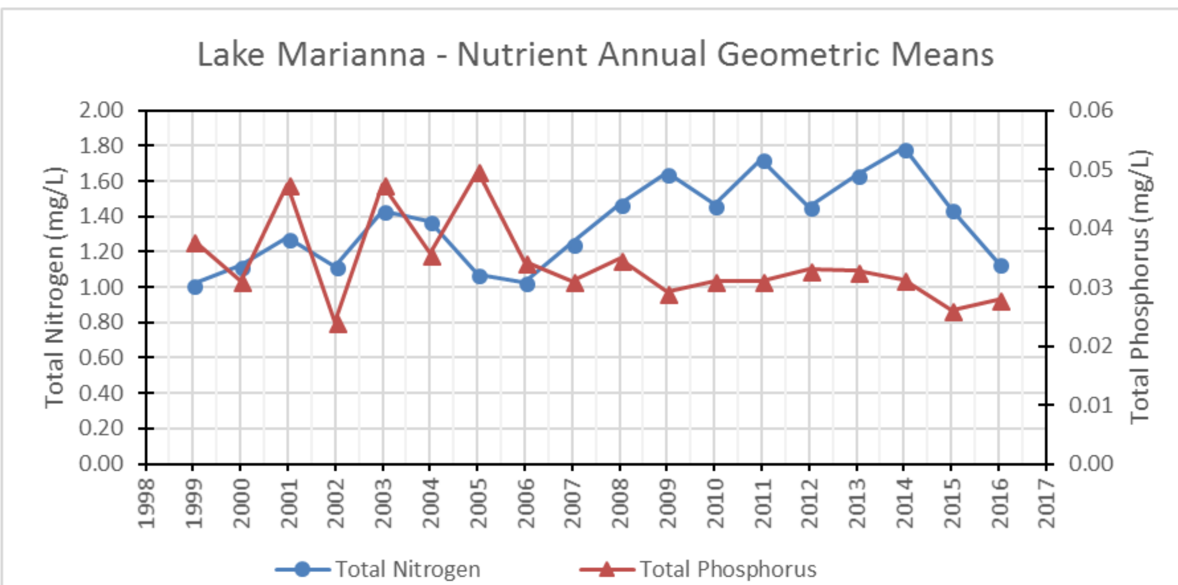


Figure 5.6. TN and TP AGMs in Lake Marianna

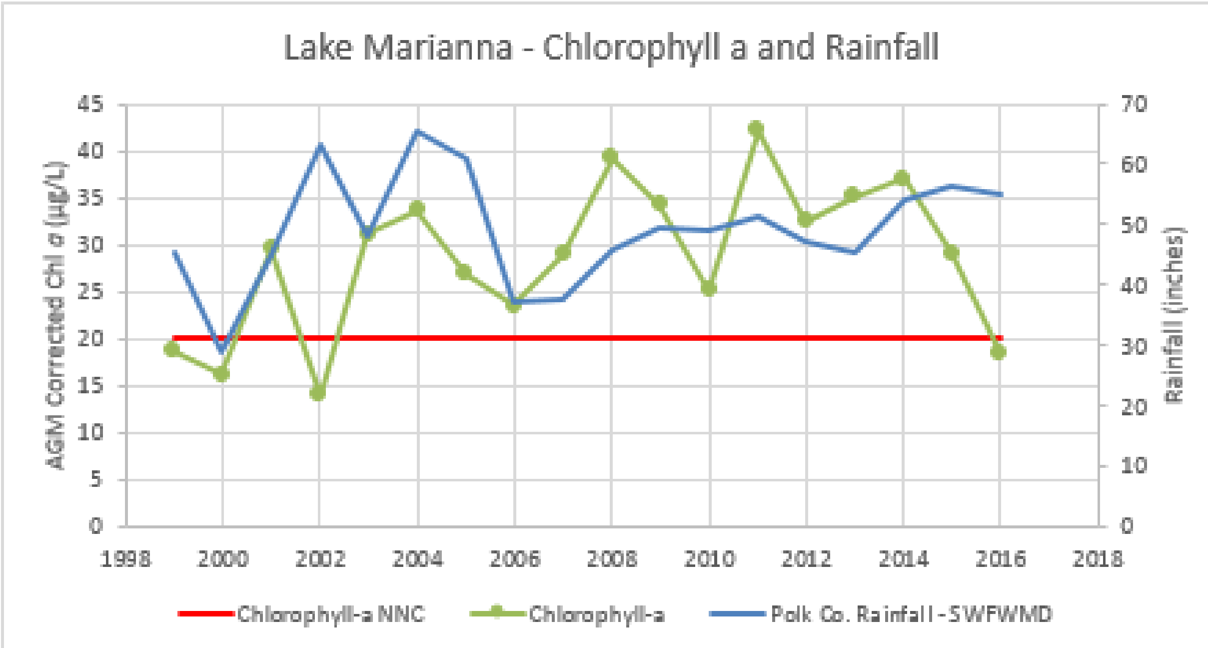


Figure 5.7. Chlorophyll *a* AGMs and annual rainfall in Lake Marianna

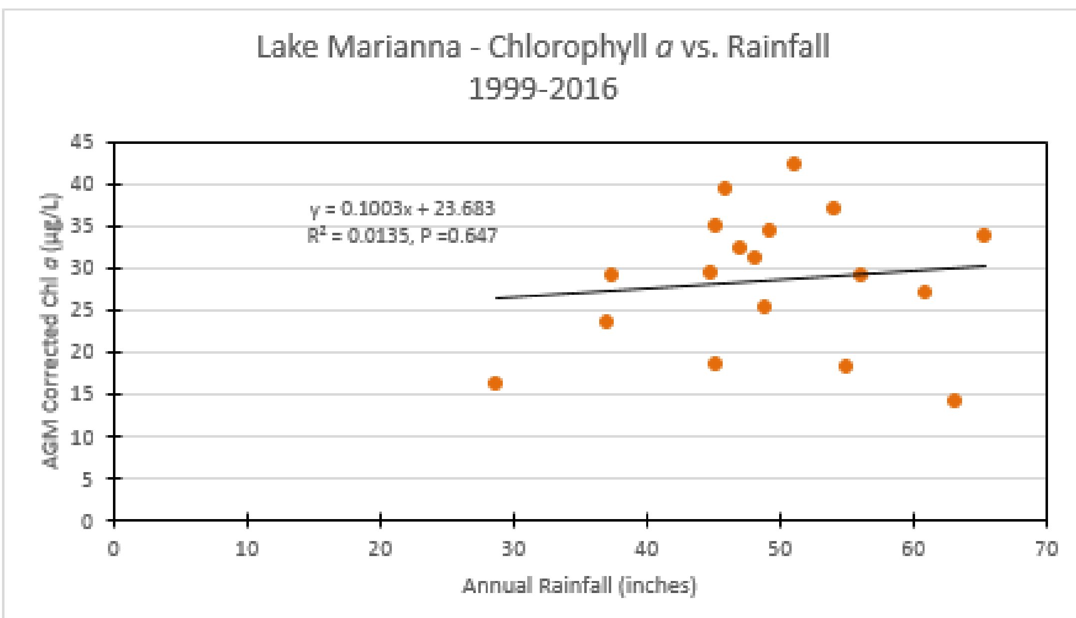


Figure 5.8. Relationship between chlorophyll *a* AGMs and annual rainfall in Lake Marianna

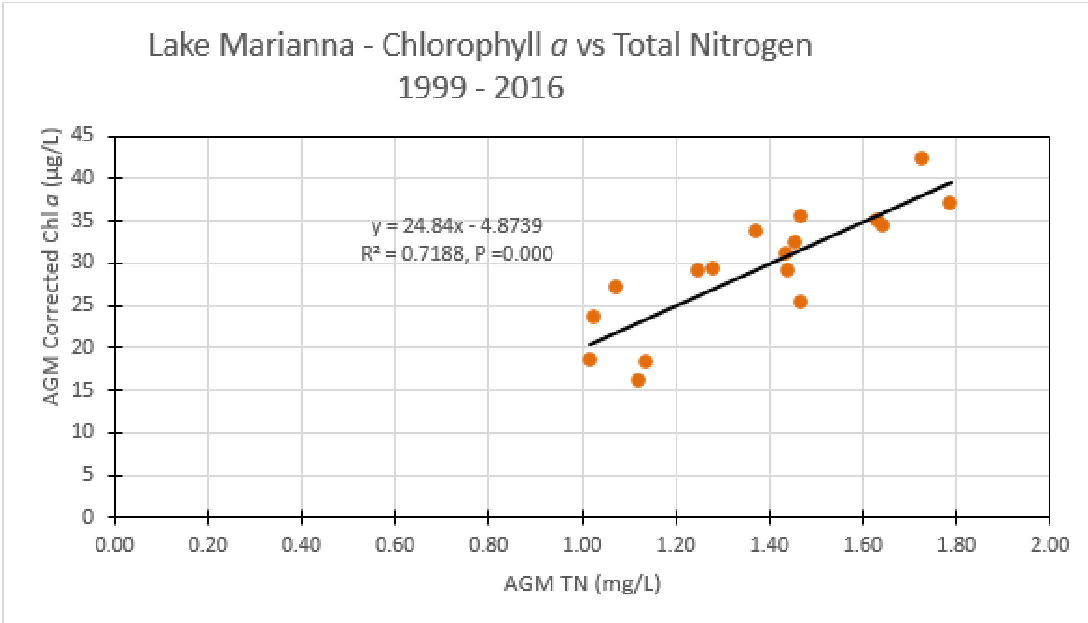


Figure 5.9. **Relationship between AGMs for chlorophyll *a* and TN in Lake Marianna**

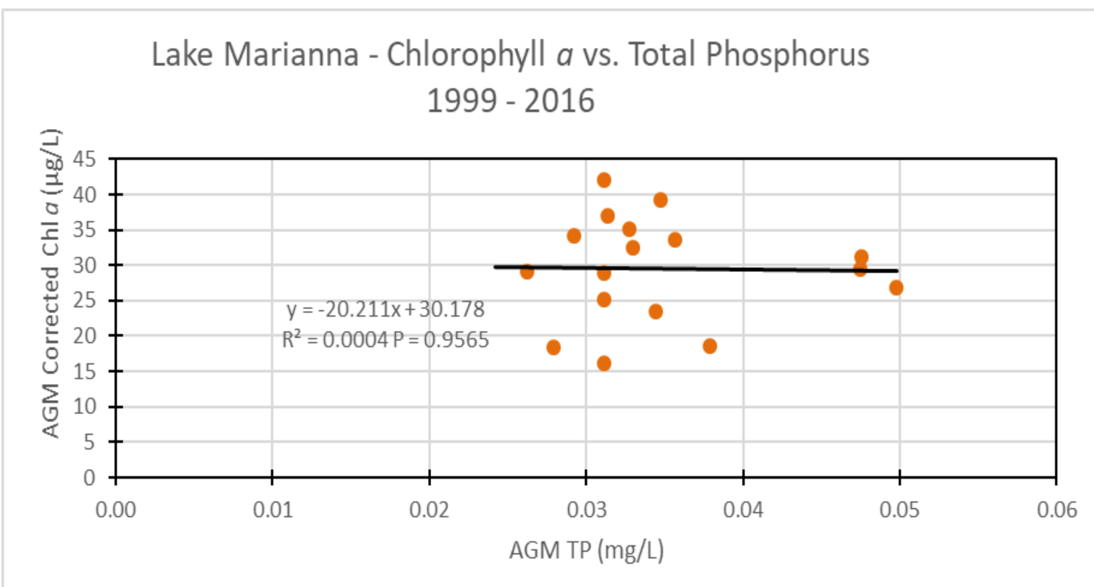


Figure 5.10. **Relationship between AGMs for chlorophyll *a* and TP in Lake Marianna**

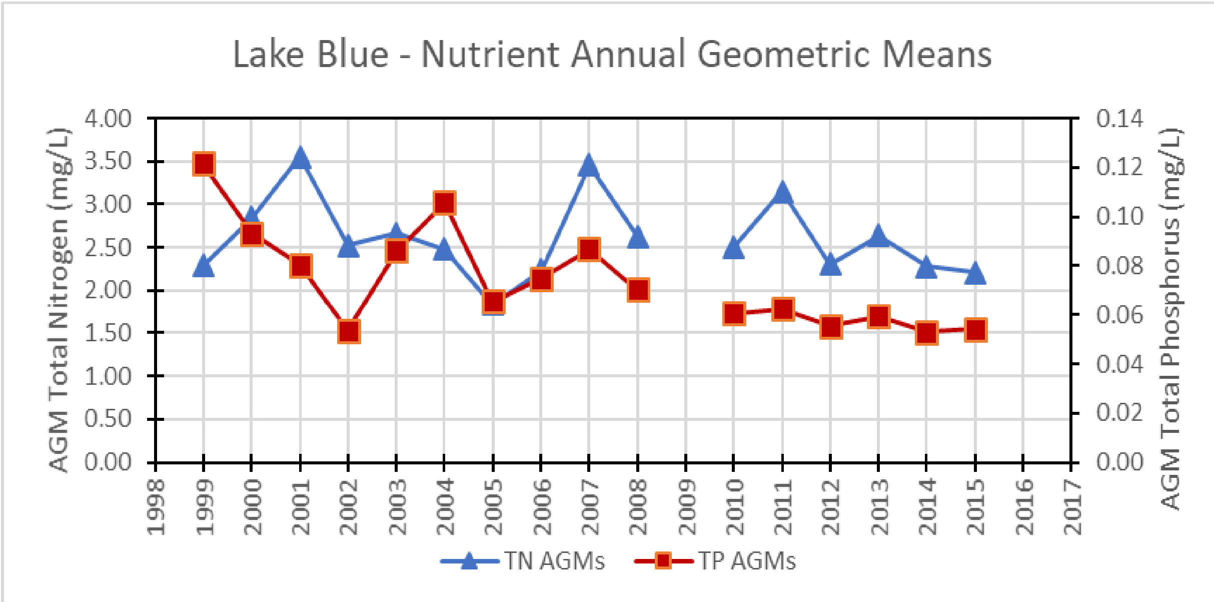


Figure 5.11. TN and TP AGMs in Lake Blue

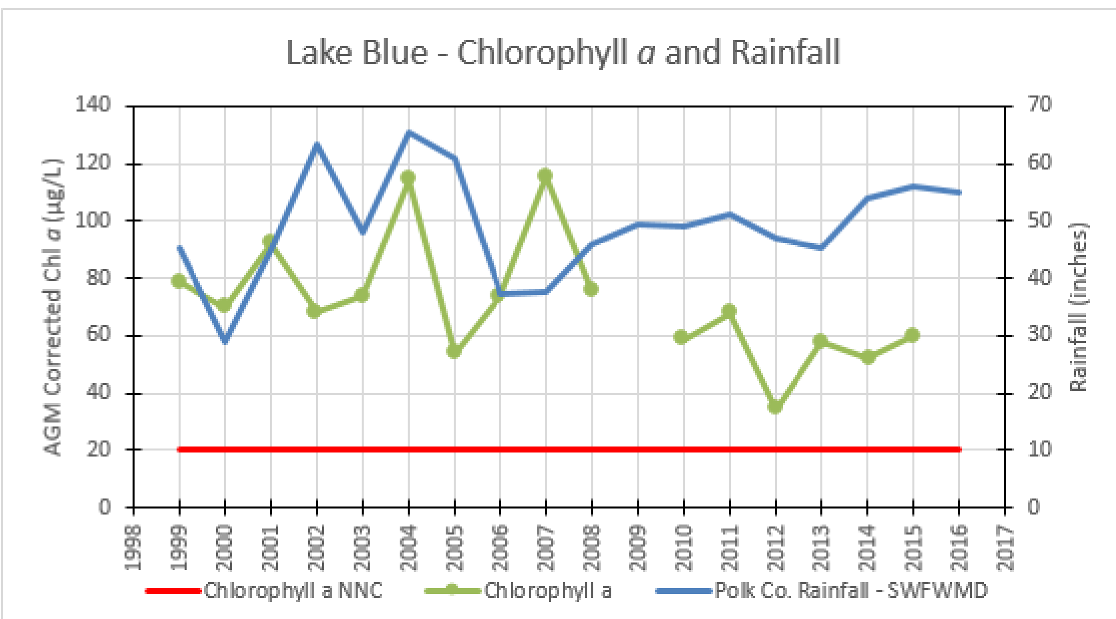


Figure 5.12. Chlorophyll *a* AGMs and annual rainfall in Lake Blue

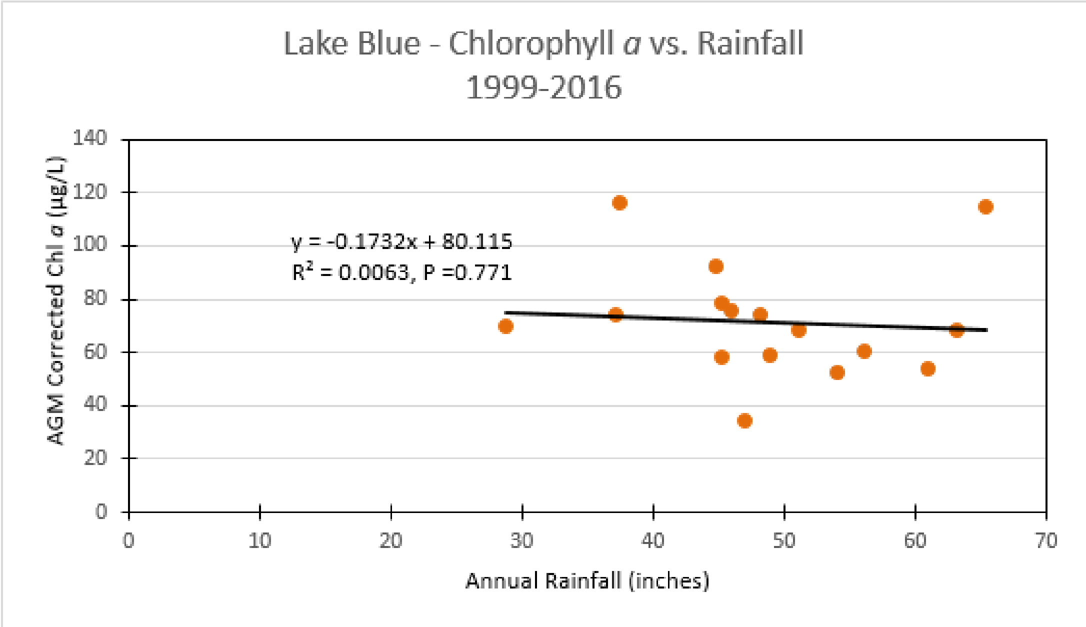


Figure 5.13. Relationship between chlorophyll *a* AGMs and annual rainfall in Lake Blue

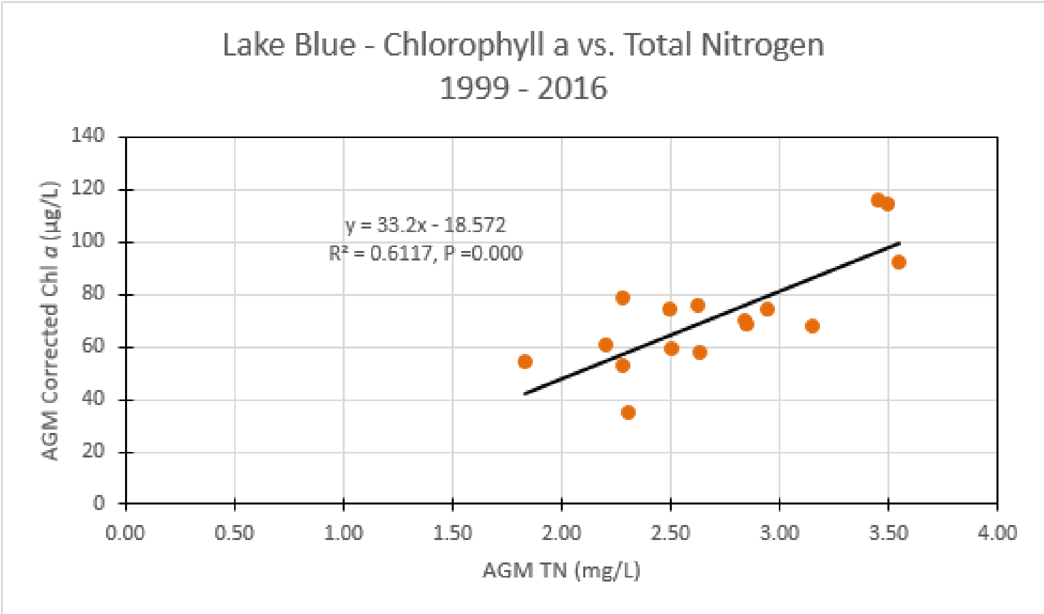


Figure 5.14. Relationship between AGMs for chlorophyll *a* and TN in Lake Blue

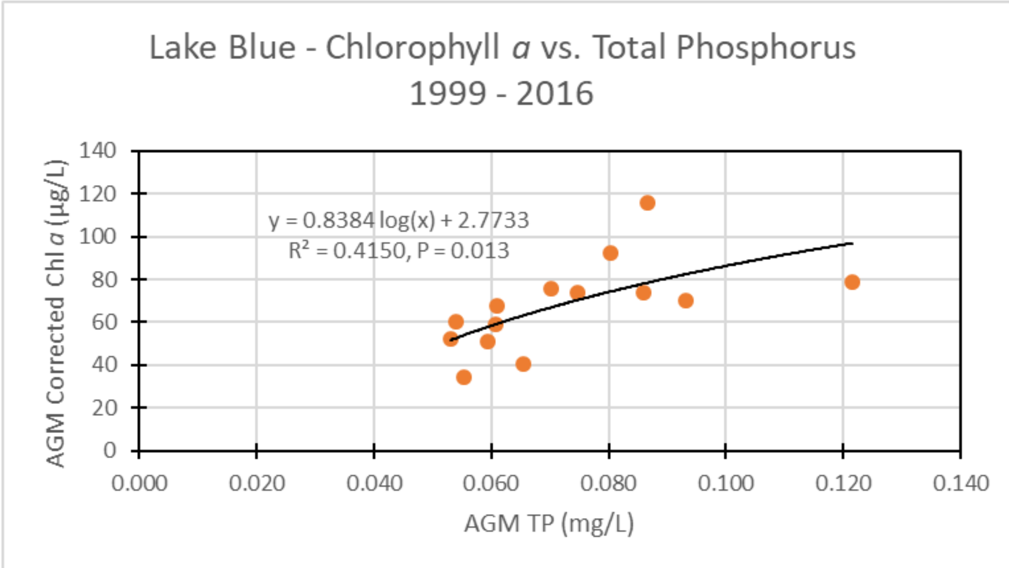


Figure 5.15. Relationship between AGMs for chlorophyll *a* and TP in Lake Blue

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 the assimilative capacity for nutrient 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 (AGMs or arithmetic means).

5.4 Water Quality Analysis to Determine Assimilative Capacity

The method used for developing the nutrient TMDL is a percent reduction approach, where the percent reduction in the existing lake TN concentration was calculated to meet the TN target. As discussed in **Chapter 3**, the NNC chlorophyll *a* threshold of 20 µg/L, expressed as an AGM, was selected as the response variable target for TMDL development. To identify the TN water quality target, the regression equation explaining the relationship between AGM chlorophyll *a* and TN, **Figures 5.4**, **5.9**, and **Appendix C** were used to determine the TN concentration necessary to meet the chlorophyll *a* target of 20 µg/L for Lake Alfred, Lake Marianna, and Lake Blue, respectively. The TN AGMs of 1.69 mg/L for Lake Alfred, 1.00 mg/L for Lake Marianna, and 1.16 mg/L for Lake Blue result in a chlorophyll *a* AGM of 20 µg/L.

The TP water quality target was derived using the predisturbance inferred water quality from paleolimnological studies conducted in lakes located in the area of Lakes Alfred, Marianna, and Blue. The median value of the TP paleolimnological results (0.03 mg/L) from studies conducted in Lake Conine, Lake Hartridge, Lake Howard, Lake Lucerne, Lake Marianna, and Lake May

(Whitmore and Brenner 2002) was selected as the target. These lakes are located in the same lake region as Lakes Alfred, Marianna, and Blue (the Winter Haven/Lake Henry Ridges Region, 75-31).

For Lake Alfred and Lake Marianna, based on an assessment of the lake results listed in **Tables 2.2** and **2.3**, the TP AGMs did not exceed the applicable target of 0.03 mg/L in any year for the former and exceeded only once, in 2003, for the latter. The available data indicate that the lake TP results are meeting the applicable target which suggests that the existing lake phosphorus concentrations and TP loads to the lakes are not having a detrimental effect on surface water quality. The TP water quality target is the same as the lower end of the range of NNC values, which is 0.03 mg/L for low-color, high-alkalinity lakes.

For Lake Blue, the approach used to establish the nutrient targets takes into consideration the estimated TP predisturbance conditions from the paleolimnological results and the generally applicable NNC in the lake. A multiple regression model relating TN and TP concentrations to chlorophyll *a* concentrations in Lake Blue shows that the selected nutrient targets can achieve the chlorophyll *a* target of 20 µg/L. The model was developed using log-transformed AGMs of corrected chlorophyll *a*, TN, and TP concentrations calculated from Polk County measurements recorded in Lake Blue from 1999 to 2016. **Appendix C** presents the results of the multiple regression analyses, and the resulting equation is as follows:

*Log of Annual Geo Mean Chl a = 2.16 + 0.8 * Polk Co. Sta. 1 Log of TN Annual Geo Mean + 0.6 * Polk Co. Sta. 1 Log of TP Annual Geo Mean*

Applying the TN (1.16 mg/L) and TP (0.03 mg/L) AGM TMDL targets in the equation results in a chlorophyll *a* value of 20 µg/L.

5.5 Calculation of the TMDLs

Lake Alfred, Lake Marianna, and Lake Blue are expected to meet the applicable nutrient criteria and maintain their function and designated use as Class III waters when surface water nutrient concentrations are reduced to the target concentrations, addressing anthropogenic contributions to the water quality impairment. The approaches used to establish the nutrient target and the TMDL address meeting the chlorophyll *a* target, which is protective of the lakes' designated use.

For Lake Alfred, Lake Marianna, and Lake Blue, the existing lake nutrient conditions evaluated for establishing the TMDL were TN and TP concentrations measured from 2003 to 2016. This period includes the Cycle 2 and Cycle 3 verified periods, and more recent years. The geometric means were calculated from TN results available in IWR Database Run 53. For the purpose of establishing the TMDL, the existing TN condition used in the percent reduction calculation is the maximum TN AGM value from 2003 to 2016 (**Table 5.1**). The use of the maximum geometric mean value in setting the TMDL is considered a conservative assumption for establishing reductions, as this will ensure that all exceedances of the TN target are addressed.

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

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

In the equation, the measured exceedance is the maximum TN AGM value. For Lake Alfred, to achieve the target concentration of 1.69 mg/L from the maximum TN value of 2.00 mg/L, a 16 % reduction in the lake TN concentration is necessary. For Lake Marianna, to achieve the target concentration of 1.00 mg/L from the maximum TN value of 1.79 mg/L, a 44 % reduction in the lake TN concentration is necessary. Since no TP impairment was found in Lake Alfred and Lake Marianna, the TP reduction was assigned as 0 %.

For Lake Blue, to achieve the target concentration of 1.16 mg/L from the maximum TN value of 3.45 mg/L, a 66 % reduction in the lake TN concentration is necessary. To achieve the target concentration of 0.03 mg/L from the maximum TP value of 0.09 mg/L, a 67 % reduction in the lake TP concentration is necessary. The nutrient TMDL value, which is expressed as an AGM, addresses the anthropogenic nutrient inputs contributing to the exceedances of the chlorophyll *a* restoration target.

Table 5.1. Lake Alfred, Lake Marianna, and Lake Blue nutrient AGMs used to calculate the percent reductions needed to meet the water quality targets

ID = Insufficient data

Year	Lake Alfred AGM TN (mg/L)	Lake Marianna AGM TN (mg/L)	Lake Blue AGM TN (mg/L)	Lake Blue AGM TP (mg/L)
2003	ID	1.44	2.66	0.09
2004	ID	1.39	2.48	ID
2005	1.33	1.08	1.84	ID
2006	1.36	1.03	2.24	ID
2007	1.87	1.25	3.45	0.09
2008	1.61	1.48	2.63	0.07
2009	ID	1.69	ID	ID
2010	1.82	1.47	2.51	0.06
2011	ID	1.73	3.16	0.06
2012	2.00	1.48	2.31	0.06
2013	1.89	1.64	2.63	ID
2014	1.95	1.79	2.28	0.05
2015	1.85	1.44	2.21	0.05
2016	1.72	1.19	2.36	0.06
Maximum	**2.00**	**1.79**	**3.45**	**0.09**

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 Lake Alfred, Lake Marianna, and Lake Blue are expressed in terms of nutrient concentration targets and the percent reductions for nonpoint sources necessary to meet the targets (**Table 6.1**), and represent the maximum lake nutrient concentrations these surface waters can assimilate to meet the applicable nutrient criteria. The TMDLs will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for these particular waters, pursuant to Paragraph 62-302.531(2)(a) F.A.C.

Table 6.1 lists the TMDLs for the Lake Alfred, Lake Marianna, and Lake Blue Watersheds. The TMDLs constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), F.A.C., that 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 Lake Alfred (WBID 1488D), Lake Marianna (WBID 1521L), and Lake Blue (WBID 1521Q)

[1] Represents the AGM lake value that is not to be exceeded.
[2] As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.
NA = Not applicable

Waterbody (WBID)	Parameter	TMDL (mg/L)[1]	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)[2]	MOS
1488D	TN	1.69	NA	16	16	Implicit
1488D	TP	0.03	NA	NA	NA	Implicit
1521L	TN	1.00	NA	44	44	Implicit
1521L	TP	0.03	NA	NA	NA	Implicit
1521Q	TN	1.16	NA	66	66	Implicit
1521Q	TP	0.03	NA	67	67	Implicit

6.2 Load Allocation

To achieve the lake nutrient targets, a 16% reduction in the current TN load is required for Lake Alfred (WBID 1488D), a 44 % reduction in current TN load is needed for Lake Marianna (WBID 1521L), and reductions in current TN and TP loads of 66 % and 67 %, respectively, are required for Lake Blue (WBID 1521Q). The percent reductions represent the generally needed total nitrogen and total phosphorus reductions from all 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 may include loads from stormwater discharges regulated by DEP and the water management district that are not part of the NPDES Stormwater Program **(**see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

No NPDES-permitted wastewater discharges were identified in the Lake Alfred, Lake Marianna, and Lake Blue Watersheds.

6.3.2 NPDES Stormwater Discharges

The stormwater collection systems in the watersheds, which are owned and operated by Polk County in conjunction with FDOT District 1, are covered by an NPDES Phase I MS4 permit (FLS000015). The City of Lake Alfred is a co-permittee in the MS4 permit for the Lake Alfred Watershed. The City of Auburndale is a co-permittee in the MS4 permit for the Lake Marianna and Lake Blue Watersheds. The MS4 permittees may be responsible for a 16 % reduction in TN from the current anthropogenic loading in the Lake Alfred Watershed, and a 44 % reduction in the current TN anthropogenic loading in the Lake Marianna Watershed. Likewise, the MS4 permittees may be responsible for a 66 % reduction in TN and a 67 % reduction in TP from the current loading in the Lake Blue Watershed.

It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety (MOS)

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.

Percent reductions were determined by using the maximum AGMs of TN concentrations as existing condition, which is considered a conservative assumption for establishing reductions as this will address all exceedances of the TN target.

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 respond to the permit conditions that reflect target concentrations, reductions, or wasteload allocations identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require 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).

As outlined in Subsection 403.9337(2), F.S., all county and municipal government located within a waterbody listed as impaired by nutrients pursuant to s. 403.067, shall, at a minimum, adopt DEP's *Model Ordinance for Florida-Friendly Fertilizer Use on Urban Landscapes.* The Model Ordinance contains numerous best management practices (BMPs) addressing setbacks from water bodies, recommended fertilizer blends and slow release application rates, and proper irrigation practices. Municipal governments may adopt additional or more stringent standards if deemed necessary to better address the impairment.

7.2 BMAPs

Section 403.067, F.S. (the FWRA), contains information on the development and implementation of BMAPs. 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 usually implement these strategies, such as wastewater facilities, industrial sources, agricultural producers, county and city stormwater systems, military bases, water control districts, state agencies, and individual property owners. BMAPs can also identify mechanisms to address potential pollutant loading from future growth and development.

Additional information about BMAPs in available at https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps.

7.3 Implementation Considerations

DEP is working with Polk County Public Works, the City of Lake Alfred, the City of Auburndale, businesses, and other stakeholders to undertake reductions in the discharge of pollutants and achieve the established TMDLs for Lake Alfred, Lake Marianna, and Lake Blue. Polk County, Southwest Florida Water Management District (SWFWMD), LakeWatch, and DEP have already been actively involved in data collection and analysis.

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources (e.g., sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. In the case of Lake Alfred, Lake Marianna, and Lake Blue, the lake water quality management plan (PBS&J 2010) and the previous phytoplankton monitoring (**Appendix D**) suggest that other factors besides external loading inputs, such as sediment nutrient fluxes and/or nitrogen fixation, are also influencing the lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the lake.

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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	Lake Alfred, Lake Marianna, and Lake Blue
Waterbody type(s)	Lake
WBID	WBID 1488D, WBID 1521L, and WBID 1521Q (see **Figure 1.1** of this report)
Description	Lake Alfred, Lake Marianna, and Lake Blue are located in Polk County. The surface area of Lake Alfred is 726 acres. The lake receives runoff from a watershed of 1,619 acres occupied by wet-land and urban land uses. There is no obvious surface inflow to the lake other than flow from Lake Eva. Lake Alfred is predominantly a low-color, high-alkalinity eutrophic lake. The surface area of Lake Marianna is 508 acres. The lake receives runoff from a watershed area of 1,938 acres occupied by urban and agricultural land uses. There is no obvious surface inflow to the lake. Lake Marianna is predominantly a low-color, high-alkalinity eutrophic lake. The surface area of Lake Blue is 53 acres. The lake receives runoff from a watershed area of 179 acres predominantly occupied by urban land uses. There is no obvious surface inflow to the lake. Lake Blue is predominantly a low-color, high-alkalinity eutrophic lake.
Specific location (latitude/longitude or river miles)	The center of Lake Alfred is located at Latitude N: 28.09919, Longitude W: - 81.74225. The center of Lake Marianna is located at Latitude N: 28.07481, Longitude W: - 81.76142 The center of Lake Blue is located at Latitude N: 28.04786, Longitude W: - 81.77325
Map	**Figures 1.1 and 1.2** show the general locations of Lake Alfred, Lake Marianna, and Lake Blue and their watersheds, and **Figure 4.1** shows land use in the watersheds.
Classification(s)	Class III Freshwater
Basin name (HUC 8)	Peace River Basin (03100101)

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: Generally applicable lake classification (if applicable) and corresponding NNC	Lake Alfred, Lake Marianna, and Lake Blue are 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.
Proposed TN, TP, chlorophyll *a*, and/or nitrate + nitrite concentrations (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: The NNC for chlorophyll *a* in Lake Alfred is 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.TN and TP NNC are expressed as an AGM lake concentration not to be exceeded in any year. The Lake Alfred TN and TP concentrations are 1.69 and 0.03 mg/L, respectively. The NNC for chlorophyll *a* in Lake Marianna is 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.TN and TP NNC are expressed as AGM lake concentrations not to be exceeded in any year. The Lake Marianna TN and TP concentrations are 1.00 and 0.03 mg/L, respectively. The NNC for chlorophyll *a* in Lake Blue is 20 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.TN and TP NNC are expressed as an AGM lake concentration not to be exceeded in any year. The Lake Blue TN and TP concentrations are 1.16 and 0.03 mg/L, respectively.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	Numeric interpretations of the narrative nutrient criterion for TN and TP criteria: The TN criterion is based on the application of an empirical model developed using data from 1999 to 2016. The primary dataset for this period is the IWR Run 53. The results of a paleolimnological study of Lake Blue were used to derive a TP concentration target because the empirical model relating chlorophyll *a* to TP resulted in a TP concentration less than background conditions. The paleolimnological results are presented in the following document: Whitmore, T.J., and M. Brenner. 2002. *Paleolimnological characterization of pre-disturbance water quality conditions in EPA-defined Florida lake regions.* Final report to the Florida Department of Environmental Protection. Gainesville, FL: University of Florida, Department of Fisheries and Aquatic Sciences.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The water quality results applied in the analysis spanned the 1999–2016 period, which included both wet and dry years. The annual average rainfall for 1999 to 2016 was 49.2 inches/year. The years 2000, 2006, and 2007 were dry years; 2009 to 2011 were average years; and 2002, 2004, 2005, and 2015 were wet years. **Figure 2.1** shows the sampling stations in Lake Alfred, Lake Marianna, and Lake Blue. The Polk County data collected near the center of the lake at Stations 21FLPOLKAlFRED1, 21FLPOLKMARIAJA1, and 21FLPOLKBLUE1 for each lake were used to develop the regression equations relating nutrient concentrations to chlorophyll *a* levels. The majority of data were collected at this Polk County monitoring station; results collected at other lake sampling locations were similar to the results observed there.

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	DEP used the IWR Database to assess water quality impairments in Lake Alfred (WBID 1488D), Lake Marianna (WBID 1521L), and Lake Blue (WBID 1521Q). The lakes were verified as impaired for nutrients based on an elevated annual average TSI during the Cycle 2 verified period for the Group 3 basins (January 1, 2002–June 30, 2009). During the Cycle 3 assessment, the NNC were used to assess the lakes during the verified period (January 1, 2008–June 30, 2015) using data from IWR Database Run 53. Lake Alfred was found to be impaired for chlorophyll *a* (years when the AGM of 20 µg/L was exceeded: 2012–15) and TN (years when the AGM of 1.05 mg/L was exceeded: 2012–15) but was not impaired for TP. Lake Marianna was found to be impaired for chlorophyll *a* (years when the AGM of 20 µg/L was exceeded: 2008–15), TN (years when the AGM of 1.05 mg/L was exceeded: 2008–15) but was not impaired for TP. Lake Blue was found to be impaired for chlorophyll *a* (years when the AGM of 20 µg/L was exceeded: 2008 and 2010–15), TN (years when the AGM of 1.05 mg/L was exceeded: 2008 and 2010–15), and TP (years when the AGM of 0.03 mg/L was exceeded: 2008, 2010–12, 2014, and 2015). See **Section 2.3.2** of this report for a detailed discussion.
Basis for use support	The basis for use support 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 Lake Alfred, Lake Marianna, and Lake Blue that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lakes.
Approach used to develop criteria and how it protects uses	For Lake Alfred and Lake Marianna, the method used to address the nutrient impairment is a regression equation that relates the lake TN concentrations to the AGM chlorophyll *a* levels. For Lake Blue, the method used consists of (a) the development of regression equations that relate the lake TN and TP concentrations to AGM chlorophyll *a* levels, and (b) the evaluation of paleolimnological results to refine the water quality target for TP consistent with predisturbance conditions. The criterion is expressed as a maximum AGM concentration not to be exceeded in any year. Establishing the frequency as not to be exceeded in any year ensures that the chlorophyll *a* NNC, which is protective of the designated use, is 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 method indicated that the chlorophyll *a* concentration target for the lakes will be attained at the TMDL in-lake TN concentration, frequency, and duration, while taking into consideration the estimated predisturbance phosphorus condition in the lakes. DEP notes that there were no impairments for nutrient-related parameters (such as DO or un-ionized ammonia). The proposed reductions in nutrient inputs will result in further improvements in water quality. Regression approaches indicated that the target chlorophyll *a* concentration (20 µg/L) in the lakes will be attained at the TMDL loads for TN and TP. DEP notes that no other impairments were verified for Lake Alfred, Lake Marianna, and Lake Blue that may be related to nutrients (such as DO or un-ionized ammonia). Reducing the nutrient loads entering the lakes will not negatively impact other water quality parameters.

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: List receiving waters and identify technical justification for concluding downstream waters are protected	Lake Alfred is a closed system, with no connection to downstream surface waters. Lake Marianna discharges into Lake Jessie (WBID 1521K), which is part of the Winter Haven Chain of Lakes and is classified as a low-color, high-alkalinity lake. The generally applicable NNCs for Lake Jessie are 1.05 mg/L for TN, 0.03 mg/L for TP, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in a 3-year period. During the Cycle 3 (Group 3) assessment period when Lake Marianna was listed as impaired for nutrients, Lake Jessie was delisted as category 4A (TMDLs developed) for TP, but was assessed as impaired for chlorophyll *a* and TN. To evaluate whether the Lake Marianna TMDL is protective of Lake Jessie, the department conducted a simple regression analysis of the relationship between the TN AGMs (1999 – 2016) in Lake Marianna and those in Lake Jessie (**Figure 3.1**). This analysis suggests that flow from the Lake Marianna has an influence on the water quality in Lake Jessie (R^2 = 0.4288, and p = 0.0043). When the TN target (1.00 mg/L) for Lake Marianna is applied to the regression equation, the resulting TN concentration in Lake Jessie is 0.94 mg/L. The Department then developed a multiple regression analysis of data within Lake Jessie from 1999 to 2016 to establish a predictive relationship for lake chlorophyll a, with TN and TP as the independent variables (**Appendix D**). The equation indicates a TN AGM of 0.94 mg/L and a TP AGM of 0.03 mg/L (the target TP concentration allowed under the Lake Marianna TMDL) will achieve the chlorophyll *a* criterion of 20 µg/L. Therefore, the Lake Marianna TMDL will be protective of water quality in Lake Jessie. Lake Blue discharges into Lake Cannon (WBID 1521H) through a gated control structure when seasonal high waters exceed the lake operational levels. Lake Cannon is classified as a low-color (<40 PCU), high-alkalinity (> 20 mg/L $CaCO_3$) lake. The generally applicable NNCs for lake Cannon are 1.05 mg/L for TN, 0.03 mg/L for TP, and 20 µg/L of chlorophyll *a*, expressed as AGMs not to be exceeded more than once in a 3-year period. During the Cycle 3 (Group 3) assessment period when Lake Blue was listed as impaired for nutrients, Lake Cannon was delisted as category 4A (TMDLs developed) for TP, but was assessed as impaired for chlorophyll *a* and TN. There are two pieces of evidence indicating that the Lake Blue has minimal impacts on Lake Cannon. First, according to the Winter Haven Chain of Lakes Water Quality Management Plan prepared by PBS&J (2010), "Due to the hydrologic isolation of Lake Blue from the Southern Chain by a gated structure, improvements in water quality of the lake would result in little benefit farther downstream." Second, the department conducted a simple regression analyses of the relationships between the TN and TP AGMs (1999 – 2015) in Lake Blue and those in Lake Cannon (**Figures 3.2** and **3.3**). The low R^2 and high P values of these analyses suggest that flow from the Lake Marianna has very little or no influence on the water quality in Lake Cannon. This supports the hydrologic isolation between these two lakes. Therefore, the Lake Blue TMDL will be protective of water quality in Lake Cannon.
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, SWFWMD, and DEP conduct routine monitoring of Lake Alfred, Lake Marianna, and Lake Blue. 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 the presence of any endangered aquatic species or critical habitat present in the Northern Chain of Lakes that could potentially be adversely affected by these TMDLs. 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.

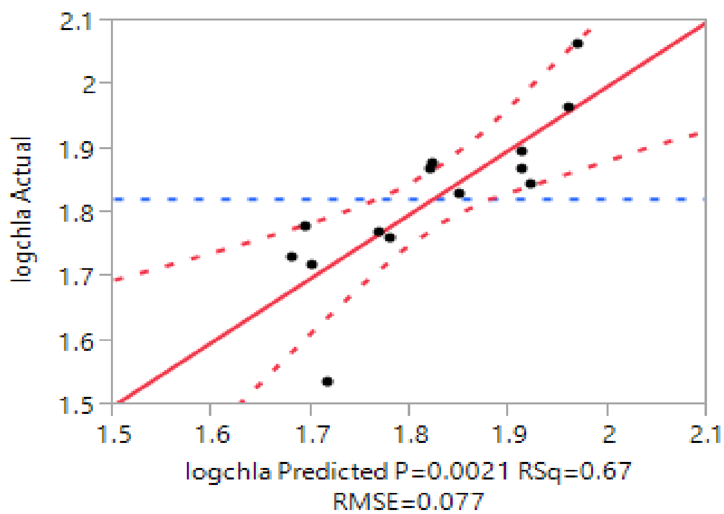
Table B-6. Documentation that administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on February 21, 2018, to initiate TMDL development for impaired waters in the Peace River Basin. Technical workshops for the Lake Alfred, Lake Marianna, and Lake Blue TMDLs were held on November 8, 2017, to present the general TMDL approach to local stakeholders. A rule development public workshop for the TMDLs was held on March 6, 2018.
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. Hearing held on June 29, 2018
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 a site-specific interpretation of the narrative nutrient criterion, and will submit these documents to the EPA.

Appendix C: Lake Blue Multiple Regression Model Results

Response Polk County Station 1 CHLAC Log of Annual Geometric Mean: Lake Blue 1999-2015 Results
Whole Model

Actual by Predicted Plot



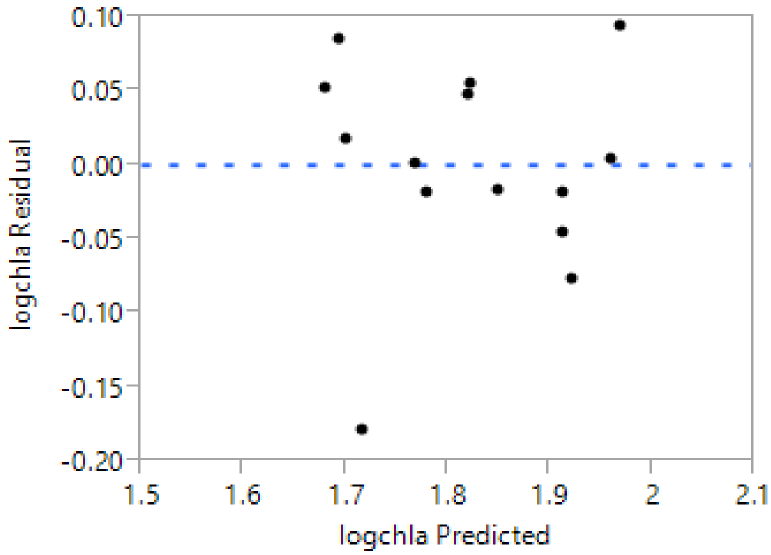
Summary of Fit	Result
Rsquare	0.674642
Rsquare Adj	0.615486
Root Mean Square Error	0.077
Mean of Response	.821965
Observations (or Sum Wgts)	14

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	0.13523500	0.067617	11.4044
Error	11	0.06521955	0.005929	Prob > F
C. Total	13	0.20045455		0.0021*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	2.1623109	0.306652	7.05	<.0001*	.
TN Log Annual Geo Mean	0.7994694	0.283504	2.82	0.0167*	1.1173
TP Log Annual Geo Mean	0.5861007	0.214471	2.73	0.0195*	1.1173

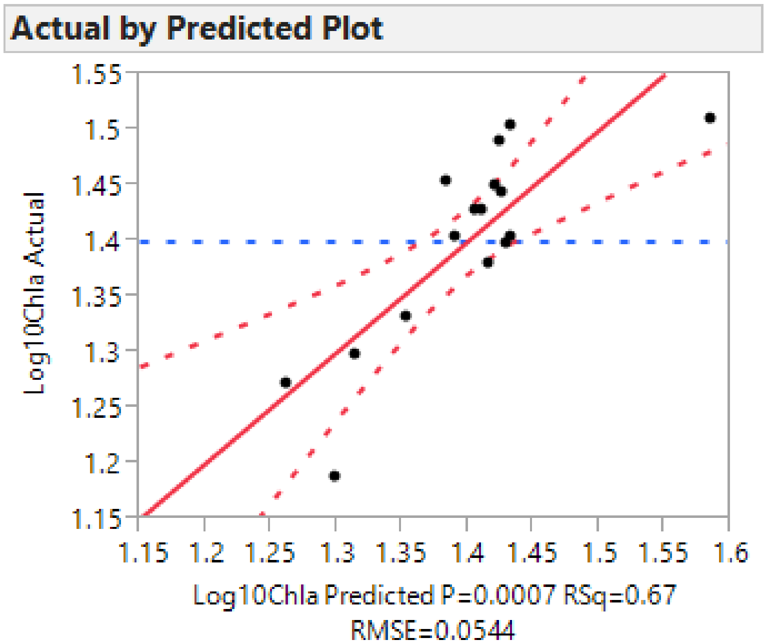


Lake Blue Annual Geometric Means Used in the Multiple Regression Model

Year	Chla AGMs	TN AGMs	TP AGMs
1999	78.5	2.29	0.122
2000	69.9	2.85	0.093
2001	92.1	3.55	0.080
2002	68.1	2.85	
2003	73.7	2.95	0.086
2004	114.4	3.50	
2005	53.8	1.84	0.065
2006	73.8	2.50	0.075
2007	115.8	3.45	0.087
2008	75.4	2.63	0.070
2009			
2010	58.8	2.51	0.061
2011	67.8	3.15	0.061
2012	34.4	2.31	0.055
2013	57.7	2.63	0.059
2014	52.3	2.28	0.053
2015	60.1	2.21	0.054

Appendix D: Lake Jessie Multiple Regression Model Results

Response Polk County Station 1 CHLAC Log of Annual Geometric Mean: Lake Jessie 1999-2016 Results Whole Model



Summary of Fit

Calculation	Result
RSquare	0.671137
RSquare Adj	0.620543
Root Mean Square Error	0.054369
Mean of Response	1.399013
Observations (or Sum Wgts)	16

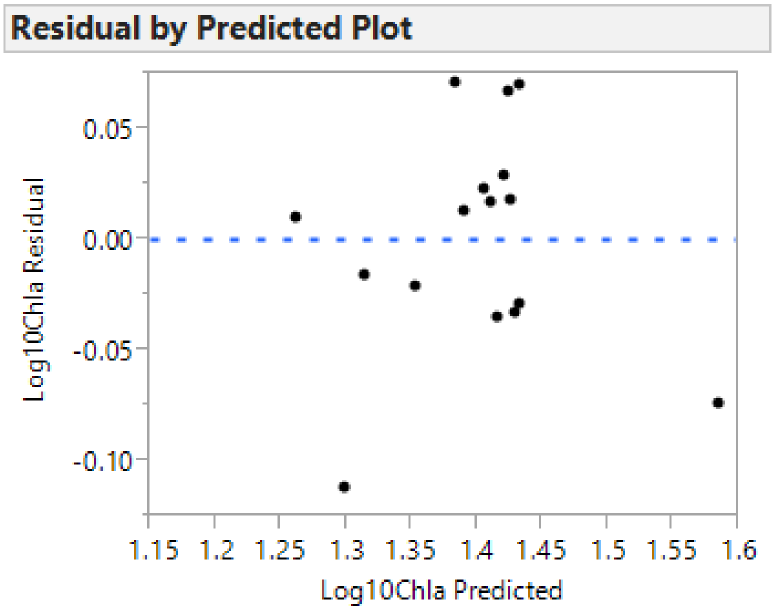
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	0.07842266	0.039211	13.2651
Error	13	0.03842780	0.002956	**Prob > F**
C. Total	15	0.11685045		<.0007*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	1.946004	0.170121	11.44	<.0001*	.
TN Log Annual Geo Mean	0.8531845	0.271841	3.14	<.0078*	1.0425212
TP Log Annual Geo Mean	0.4031139	0.119758	3.37	<.0051*	1.0425212

Log Chl a = 1.946 + 0.853* log TN + 0.403*log TP



Lake Jessie Annual Geometric Means Used in the Multiple Regression Model

Year	Chla AGMs	TN AGMs	TP AGMs
1999	27.8	0.98	0.054
2000	25.3	0.96	0.046
2001	32.4	1.32	0.070
2002	18.7	0.96	0.022
2003			
2004	23.7	0.98	
2005	28.2	0.98	0.052
2006	28.4	0.93	0.047
2007	21.5	0.92	0.040
2008	25.4	1.06	0.047
2009	30.9	1.14	0.038
2010	31.9	1.20	0.037
2011	25.0	1.21	0.035
2012	24.0	1.16	0.035
2013	26.8	1.13	0.036
2014	26.8	1.17	0.032
2015	19.8	0.95	0.030
2016	15.4	0.90	0.031

Appendix E: Lake Phytoplankton Monitoring Results

Lake Alfred Phytoplankton Composition – Collected by DEP on August 1, 2012

Taxon Name	Phylum	# counted	# per mL
Ankistrodesmus falcatus	Chlorophycota	2	2,761
Aphanothece microscopica	Cyanophycota	1	1,381
Aphanothece nidulans	Cyanophycota	1	1,381
Bacillariophyta	Bacillariophyta	3	4,142
Botryococcus braunii	Chlorophycota	1	1,381
Chlamydomonas	Chlorophycota	1	1,381
Chlorella	Chlorophycota	4	5,522
Chlorococcum humicola	Chlorophycota	2	2,761
Cosmarium emarginatum	Chlorophycota	1	1,381
Crucigenia tetrapedia	Chlorophycota	1	1,381
Cryptomonas	Cryptophycophyta	2	2,761
Cyanobium parvum	Cyanophycota	5	6,903
Cylindrospermopsis raciborskii	Cyanophycota	63	86,974
Euglena	Euglenophycota	1	1,381
Glenodinium	Pyrrophycophyta	1	1,381
Jaaginema gracile	Cyanophycota	84	115,966
Limnothrix mirabilis	Cyanophycota	1	1,381
Merismopedia tenuissima	Cyanophycota	1	1,381
Merismopedia warmingiana	Cyanophycota	2	2,761
Microcystis aeruginosa	Cyanophycota	2	2,761
Microcystis wesenbergii	Cyanophycota	1	1,381
Planktolyngbya contorta	Cyanophycota	2	2,761
Planktolyngbya limnetica	Cyanophycota	16	22,089
Planktolyngbya microspira	Cyanophycota	1	1,381
Pseudanabaena	Cyanophycota	1	1,381
Pseudanabaena biceps	Cyanophycota	19	26,230
Rhabdoderma lineare	Cyanophycota	3	4,142
Rhabdogloea	Cyanophycota	6	8,283
Romeria leopoliensis	Cyanophycota	3	4,142
Scenedesmus quadricauda	Chlorophycota	2	2,761
Schroederia judayi	Chlorophycota	1	1,381
Spirulina laxissima	Cyanophycota	1	1,381
Staurastrum curviceps	Chlorophycota	1	1,381
Synechococcus	Cyanophycota	3	4,142
Synechocystis	Cyanophycota	65	89,735

Lake Marianna Phytoplankton Composition – Collected by DEP on August 30, 2012

Taxon Name	Phylum	# counted	# per mL
Aphanizomenon	Cyanophycota	2	1,140
Aphanocapsa planctonica	Cyanophycota	2	1,140
Bacillariophyta	Bacillariophyta	4	2,281
Chlamydomonas	Chlorophycota	1	570
Chlorella	Chlorophycota	5	2,851
Chlorococcum humicola	Chlorophycota	1	570
Cosmarium emarginatum	Chlorophycota	1	570
Cryptomonas	Cryptophycophyta	1	570
Cylindrospermopsis raciborskii	Cyanophycota	81	46,181
Euastrum denticulatum	Chlorophycota	1	570
Glaucospira	Cyanophycota	3	1,710
Glenodinium	Pyrrophycophyta	1	570
Jaaginema gracile	Cyanophycota	103	58,724
Merismopedia tenuissima	Cyanophycota	1	570
Merismopedia warmingiana	Cyanophycota	3	1,710
Microcystis aeruginosa	Cyanophycota	2	1,140
Microcystis wesenbergii	Cyanophycota	3	1,710
Peridinium	Pyrrophycophyta	1	570
Planktolyngbya limnetica	Cyanophycota	2	1,140
Pseudanabaena biceps	Cyanophycota	21	11,973
Pseudanabaena limnetica	Cyanophycota	1	570
Rhabdogloea	Cyanophycota	7	3,991
Scenedesmus bijuga	Chlorophycota	1	570
Scenedesmus quadricauda	Chlorophycota	2	1,140
Synechococcus	Cyanophycota	3	1,710
Synechocystis	Cyanophycota	46	26,226
Tetraedron caudatum	Chlorophycota	1	570
Tetraedron minimum	Chlorophycota	1	570