Southwest District • Tampa Bay Tributaries Basin Group

Final Report

Nutrient TMDLs for Lake Valrico (WBID 1547A) and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Lake Valrico, located in Hillsborough County.

Lake Valrico (the segment with waterbody identification [WBID] number 1547A) was identified as impaired for nutrients based on chlorophyll *a*, total nitrogen (TN), and total phosphorus (TP) because the annual geometric means for each parameter exceeded the applicable numeric nutrient criteria (NNC). The waterbody was added to the 303(d) list of impaired waters by Secretarial Order in October 2016 and confirmed in April 2020.

TMDLs for TN and TP have been developed. **Table EX-1** lists supporting information for the TMDLs. Pursuant to Paragraph 62-302.531(2)(a), Florida Administrative Code (F.A.C.), these TMDLs will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C. The TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the U.S. Environmental Protection Agency.

Table EX-1. Summary of TMDL supporting information for Lake Valrico

Type of Information	Description
Waterbody name (WBID)	Lake Valrico, Lower Segment (WBID 1547A)
Hydrologic Unit Code (HUC) 8	03100205
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
303(d) listing status	Verified List of Impaired Waters for the Group 2 basins (Tampa Bay Tributaries Basin Group) adopted via Secretarial Order dated October 2016 and April 2020
TMDL pollutants	Total nitrogen (TN) and total phosphorus (TP)
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Lake Valrico (WBID 1547A):** **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 3-year period. **TN:** 2,317 kilograms per year (kg/yr), expressed as a 7-year rolling average load not to be exceeded. **TP:** 90 kg/yr, expressed as a 7-year rolling average load not to be exceeded.
Load reductions required to meet the TMDLs	**WBID 1547A:** A 29 % TN reduction and a 78 % TP reduction to achieve the applicable AGM chlorophyll *a* criterion for low-color, high-alkalinity lakes.
Concentration-based lake restoration targets (for informational purposes only)	**WBID 1547A:** The nutrient concentrations corresponding to the applicable chlorophyll *a* numeric nutrient criterion and the loading-based criteria are a TN AGM of 0.99 milligrams per liter (mg/L) and a TP AGM of 0.028 mg/L, not to be exceeded more than once in any consecutive 3-year period.

Acknowledgments

This analysis was accomplished thanks to significant contributions from staff in the Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration, specifically, the Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, Central Regional Operations Center, and Watershed Evaluation and TMDL Section. DEP also would like to thank Hillsborough County for providing valuable information and other support.

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List of Acronyms and Abbreviations

µg/L	Micrograms Per Liter
µmhos/cm	Micromhos/Centimeter
ac-ft	Acre-Feet
ac-ft/yr	Acre-Feet Per Year
AGM	Annual Geometric Mean
AMC	Antecedent Moisture Condition
$ASRC_{wb}$	Average Stormwater Runoff Coefficient
BMAP	Basin Management Action Plan
BMP	Best Management Practice
$CaCO_3$	Calcium Carbonate
CDM	Camp Dresser McKee
CFR	Code of Federal Regulations
Chl*a*	Chlorophyll *a*
cm	Centimeter
CWA	Clean Water Act
DCIA	Directly Connected Impervious Area
DEP	Florida Department of Environmental Protection
DO	Dissolved Oxygen
EMC	Event Mean Concentration
EPA	U.S. Environmental Protection Agency
° F.	Degrees Fahrenheit
F.A.C.	Florida Administrative Code
FAWN	Florida Automated Weather Network
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FL	Florida
F.S.	Florida Statutes
FWRA	Florida Watershed Restoration Act
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HESD	Hillsborough County Environmental Service Division
hm^3/yr	Cubic Hectometers Per Year
HUC	Hydrologic Unit Code
IPaC	Information for Planning and Conservation
IWR	Impaired Surface Waters Rule
LA	Load Allocation
lbs	Pounds
kg/yr	Kilogram Per Year

m	Meter
m/yr	Meters Per Year
mg/L	Milligrams Per Liter
$mg/m^2/yr$	Milligrams Per Square Meter Per Year
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NA	Not Applicable
ND	No Data
NDCIA	Nondirectly Connected Impervious Area
NLDAS	North American Land Data Assimilation System
NMFS	National Marine Fisheries Service
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTDS	Onsite Sewage Treatment and Disposal System
PCU	Platinum Cobalt Unit
PLRG	Pollutant Load Reduction Goal
PO_4	Orthophosphate
POR	Period of Record
PRC	Proportional Runoff Coefficient
ROC	Runoff Coefficient
SJRWMD	St. Johns River Water Management District
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management (Program)
TDN	Total Dissolved Nitrogen
TDP	Total Dissolved Phosphorus
TIGER	Topologically Integrated Geographic Encoding and Referencing
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
U.S.	United States
USACE	U.S. Army Corps of Engineers
WAM	Watershed Assessment Model
WBID	Waterbody Identification (Number)
WDMutil	Watershed Data Management Utility Program
WLA	Wasteload Allocation
WQS	Water Quality Standards
WRF	Weighted Runoff Coefficient
WWTF	Wastewater Treatment Facility

Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairment of Lake Valrico, located in the Hillsborough River Basin which is part of the Tampa Bay Tributaries Basin Group. Pursuant to paragraph 62-302.531(2)(a), Florida Administrative Code (F.A.C.), the TMDLs will also constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable numeric nutrient criteria (NNC) in subsection 62-302.531(2), F.A.C. The waterbody was verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.) and was included on the Verified List of Impaired Waters for the Tampa Bay Tributaries Basin Group adopted by Secretarial Order in October 2016 and confirmed in April 2020.

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 comply 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 Valrico that would restore the waterbody so that it meets the applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Hillsborough River Basin (Hydrologic Unit Code [HUC] 8 – 03100205) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Valrico is WBID 1547A. **Figure 1.1** shows the location of the waterbody in the basin and major geopolitical and hydrologic features in the region. **Figure 1.2** contains a more detailed map of the Lake Valrico Watershed and downstream surface waters.

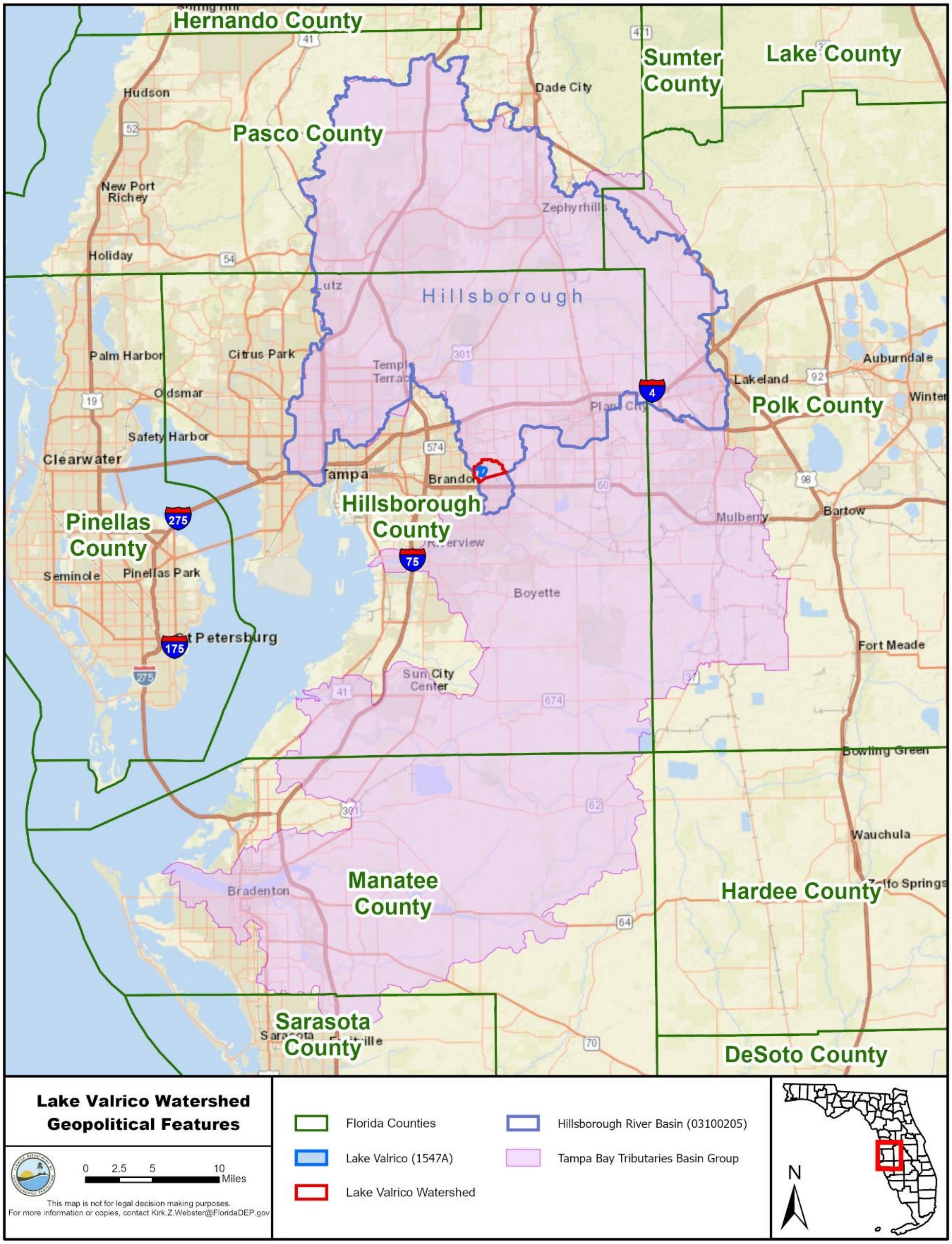


Figure 1.1. Location of the Lake Valrico (WBID 1547A) Watershed in the Tampa Bay Tributaries Basin Group and major geopolitical features in the area

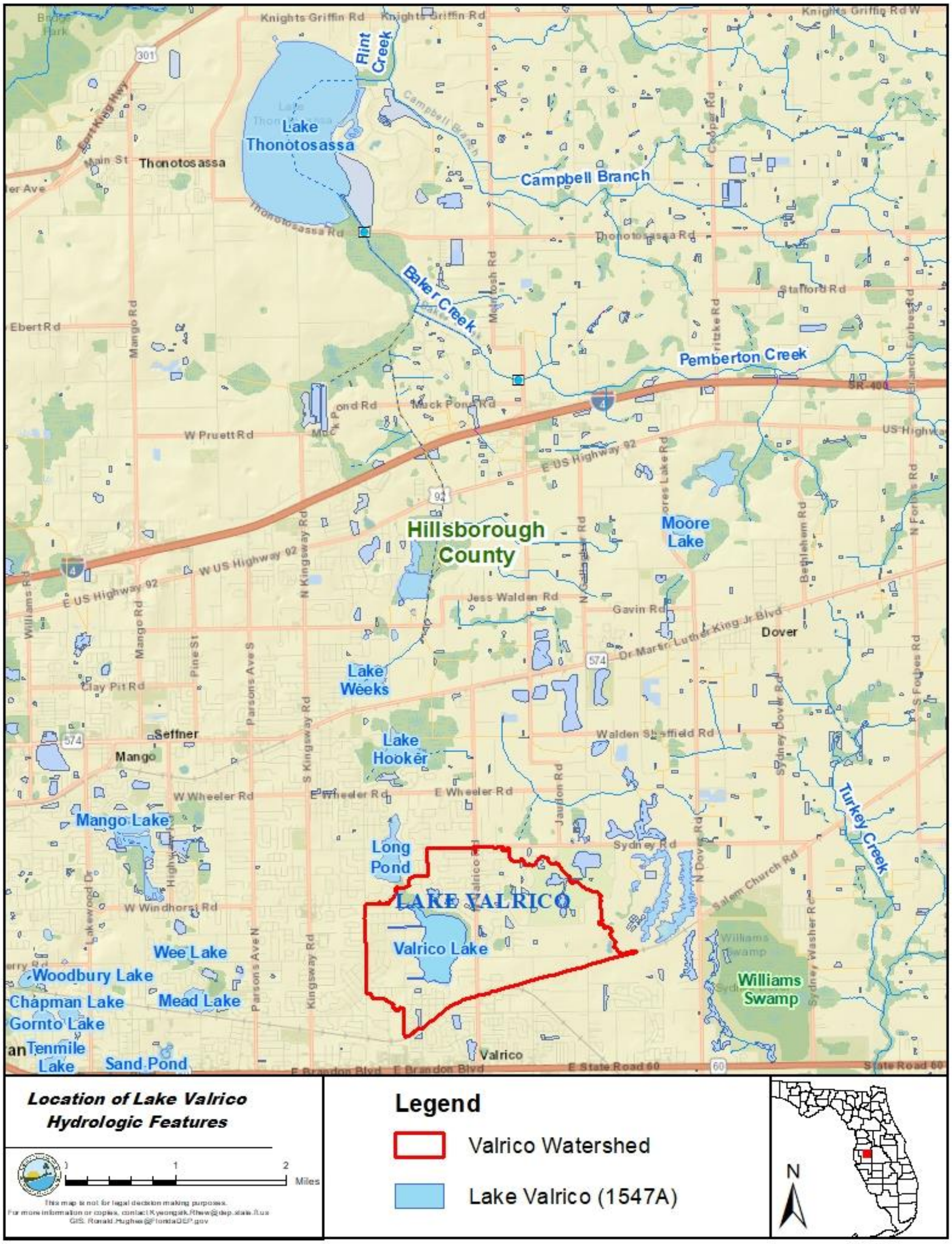


Figure 1.2. Lake Valrico (WBID 1547A) Watershed and major hydrologic and geopolitical features in the area

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

Lake Valrico and its surrounding watershed cover an area of 1,576 acres. Both the lake and watershed are located entirely in Hillsborough County between Tampa and Plant City. The county had a population of 1,471,968 as of 2019 (U.S. Census Bureau 2019). No major transportation corridors run through the watershed; however, several residential streets surround Lake Valrico. A large portion of the watershed is composed of residential land use. The watershed also includes agricultural land use, along with forests and wetlands. **Chapter 4** provides detailed summaries of land uses in the watershed.

1.3.2 Topography

Lake Valrico and the west side of its watershed are located in the Hillsborough Valley Lake Region (75-25), which includes a low-relief plain containing relatively sluggish surface drainage (Griffith et al. 1997). Many of this region's lakes are alkaline and range from moderate to high nutrients coming from urban sources (Griffith et al. 1997). The east side of the watershed is situated in the Lakeland/Bone Valley Upland Lake Region (75-30), which is covered by phosphatic sand or clayey sand. Elevation in the Lake Valrico Watershed ranges from 50 to 125 feet. The lowest elevation contour of 50 feet surrounds Lake Valrico itself in the northern portion of the watershed, while the highest elevation contours are found along the eastern edge of the watershed.

Lake Valrico flows north to Long Pond, which discharges north to Seffner Canal, ultimately contributing to Baker Creek and flowing to Lake Thonotosassa.

1.3.3 Hydrogeological Setting

The Lake Valrico Watershed is located in a humid subtropical climate zone characterized by hot and humid summers, mild winters, and a wet season between June and September. The watershed's long-term average rainfall was 54 inches per year (in/yr) from 1893 to 2020. Rainfall data were obtained from the Northeast Regional Climate Center Online Weather Data (2021) at the Plant City weather station. The annual average temperature was 72.1 degrees Fahrenheit (° F.).

The Lake Valrico Watershed comprises Hydrologic Soil Groups A, A/D, B/D, D, and unclassified lake bottom. These groups are based on the National Cooperative Soil Survey. Group A soils range from sandy to loamy in texture, characterized by low runoff potential and increased infiltration rates. Soils in Group B range from silty to loamy soil textures and have moderate drainage. Group C soils have low infiltration rates when saturated and are moderately well drained to well drained. Soils in Group D contain higher amounts of clay, often 40 % or more, and have high runoff potential. When unsaturated, Group A/D, B/D, and C/D soils are characteristic of Group A, B, and C soils, respectively, and when saturated they are more characteristic of Group D soils.

Table 1.1 lists the soil hydrologic groups in the Lake Valrico Watershed. Based on the percent acreage of these groups and the soil characteristics of the areas shown in **Figure 1.3**, soils in the watershed are mostly well drained to moderately drained. These drainage characteristics are a significant factor when calculating surface runoff and are described in more detail in **Section 4.4**.

Table 1.1. Acreage of hydrologic soil groups in the Lake Valrico Watershed

Soil Hydrologic Group	Acreage	% Acreage
A	1,095.5	69.5
A/D	205.0	13.0
B/D	113.6	7.2
D	26.6	1.7
Unclassified	135.0	8.6
Total	**1,575.7**	**100**

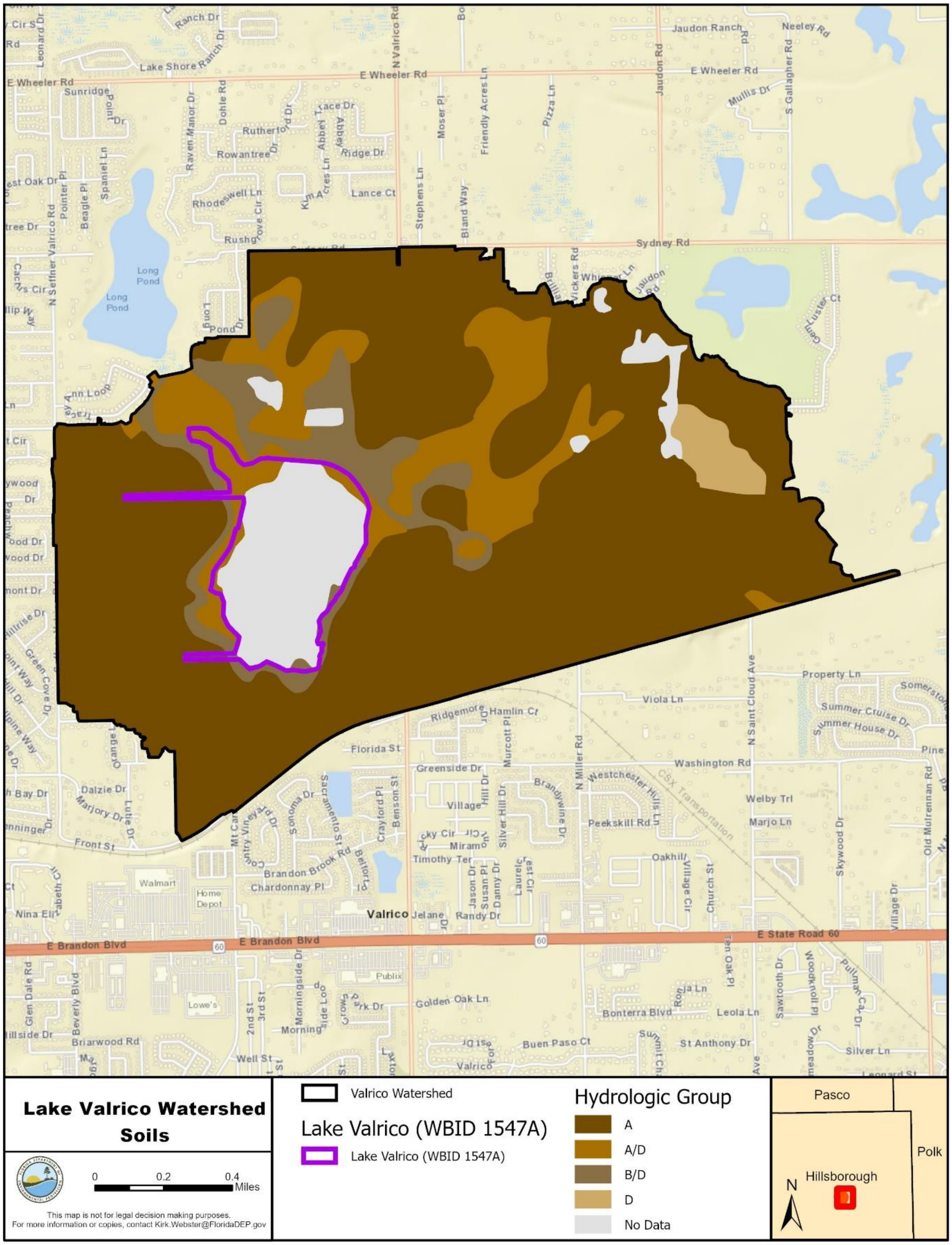


Figure 1.3. Hydrologic soil groups in the Lake Valrico Watershed

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

2.1 Statutory Requirements and Rulemaking History

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

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

The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (subsection 403.067(4), F.S.). The state's 303(d) list is amended annually to include basin updates.

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Lake Valrico is a Class III (fresh) waterbody, with a designated use of fish consumption; recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for the lake is Florida's nutrient criterion in Rule 62-302.531, F.A.C. Florida adopted numeric nutrient criteria (NNC) for lakes, spring vents, and streams in 2011. These were approved by the EPA in 2012 and became effective in 2014.

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

If insufficient alkalinity data are available, long-term geometric mean specific conductance values of all data for the POR shall be used, with a value of $\leq$100 micromhos/centimeter (µmhos/cm) used to estimate the 20 mg/L $CaCO_3$ alkalinity concentration until alkalinity data are available. Long-term geometric mean specific conductance shall be based on a minimum of 10 data points over at least 3 years with at least 1 data point in each year.

Using these thresholds and data from IWR Database Run 62, Lake Valrico is classified as a low-color (≤40 PCU), high-alkalinity (≥ 20 $CaCO_3$) lake, as shown in **Table 2.1**.

Table 2.1. Lake Valrico POR long-term geometric means for color and alkalinity

Parameter	Long-Term Geometric Mean	Number of Samples
Color (PCU)	23	50
Alkalinity (mg/L $CaCO_3$)	29	49

The chlorophyll *a* NNC for low-color, high-alkalinity lakes is an annual geometric mean (AGM) value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any consecutive 3-year period. The associated total nitrogen (TN) and total phosphorus (TP) criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the chlorophyll *a* concentrations in the lake.

If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type in **Table 2.2**, then the TN and TP numeric interpretations for that calendar year are the AGMs of lake TN and TP samples, subject to the minimum and maximum TN and TP limits in the table. If there are insufficient data to calculate the AGM for chlorophyll *a* for a given year, or if the AGM for chlorophyll *a* exceeds the values in the table for the lake type, then the applicable numeric criteria for TN and TP are the minimum values in the table. **Table 2.2** lists the NNC for Florida lakes specified in subparagraph 62-302.531(2)(b)1., F.A.C.

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

[a] 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.

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

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

Lake Valrico's data providers include DEP, Southwest Florida Water Management District (SWFWMD), and Hillsborough County Environmental Service Division (HESD). **Table 2.3** lists the data providers for Lake Valrico, including corresponding stations and monitoring beginning and ending dates. The DEP Southwest District (station prefix 21FLTPA…) was the primary data provider for the assessment that identified the nutrient impairment. **Figure 2.1** shows the lake sampling locations.

Table 2.3. Lake Valrico data provider

Sampling Station	Data Provider	Activity Beginning Date	Activity Ending Date
21FLTPA G2SW0005	DEP	2017	2020
21FLTPA 24030083	DEP	2012	2017
21FLHESDLAKE VALRICO MIDDLE	Hillsborough County	2014	2020
21FLHESDVALRICO CANAL	Hillsborough County	2019	2019
21FLSWFD17996	SWFWMD	2006	2011
21FLSWFDSTA0227	SWFWMD	1995	1996
21FLSWFDVALRICO	SWFWMD	2001	2001
21FLGW 28348	DEP	2005	2005

The individual water quality measurements discussed in this report are available in IWR Run 62 and are available on request.

2.3.2 Information on Verified Impairment

During the Group 2, Cycle 4 assessment, the NNC were used to assess Lake Valrico using data collected during the verified period (January 1, 2012–June 30, 2019) based on data from IWR Run 58. **Table 2.4** lists the AGM values for chlorophyll *a*, TN, and TP during the 2012–19 verified period for Lake Valrico. The lake was determined to be verified impaired for chlorophyll *a*, TN, and TP because the AGMs exceeded the NNC more than once in a three-year period (shaded cells with boldface type indicate exceedances in **Table 2.4**).

Table 2.4. Lake Valrico AGM values for the 2012–19 verified period

ND = No data; ID = Insufficient data
Note: Values shown in boldface type and shaded cells are greater than the NNC of 20 µg/L chlorophyll *a*, 1.05 mg/L TN, and 0.03 mg/L TP. Rule 62-302.531, F.A.C., states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive 3-year period**.**

Year	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
2012	**49**	**1.32**	**0.07**
2013	**47**	**1.18**	**0.07**
2014	ND	ND	ND
2015	ID	ID	ID
2016	ND	ND	ND
2017	**107**	**2.09**	**0.19**
2018	**70**	**1.52**	**0.09**
2019	**55**	0.63	**0.07**

Figure 2.1. Monitoring stations in Lake Valrico

2.3.3 Historical Variation in Water Quality Variables

For Lake Valrico (WBID 1547A), water quality data have been collected at eight sampling stations starting in 1995 (**Table 2.3** and **Figure 2.1**). Prior to 2012, the limited amount of data available for the lake are insufficient to calculate AGM values. **Figures 2.2** through **2.5** show the chlorophyll *a*, TN, and TP data collected at all the stations in the waterbody using (a) individual samples and (b) AGMs in the POR from the IWR Database (IWR Run 62).

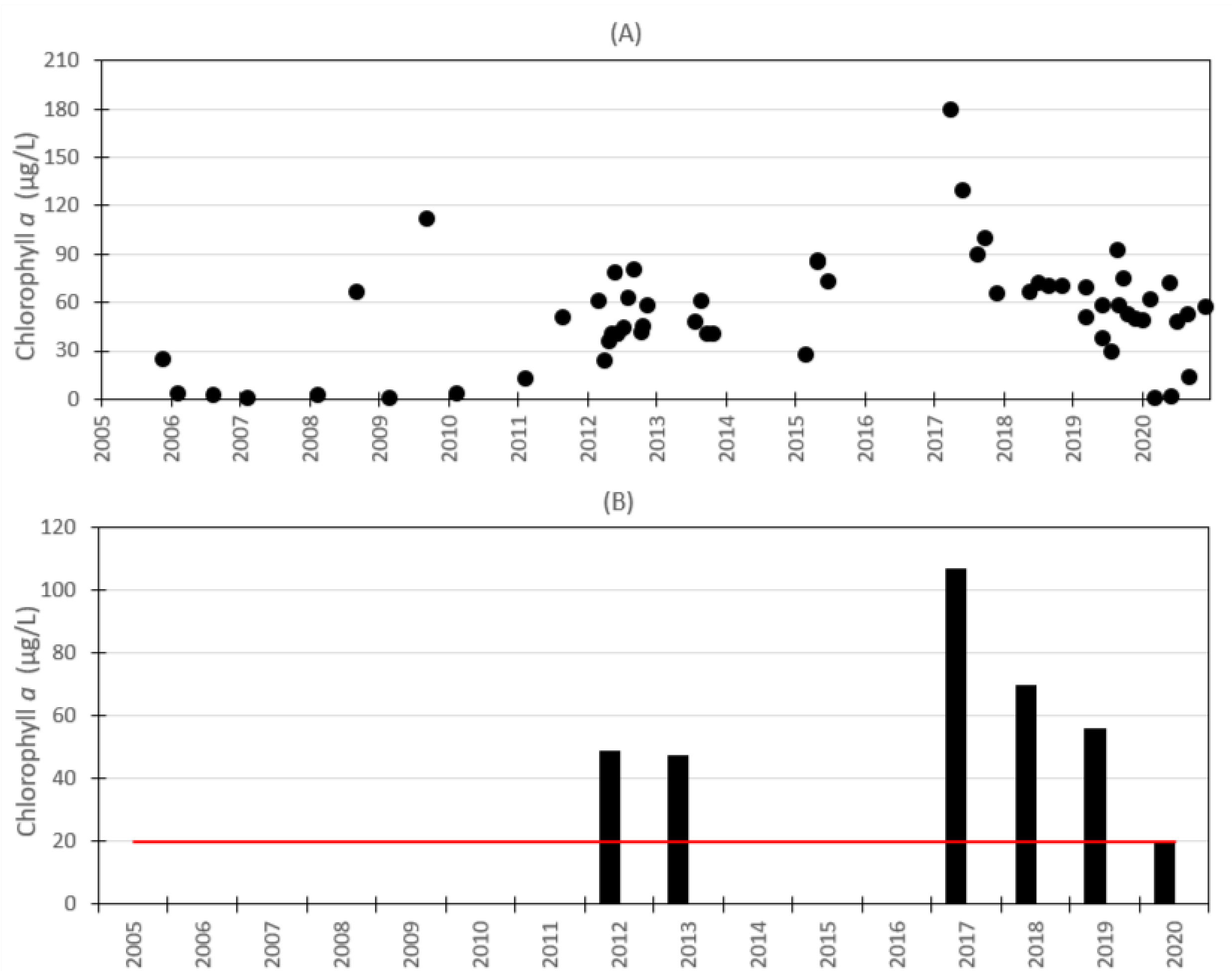


Figure 2.2. Chlorophyll *a* corrected measured in WBID 1547A: (a) individual sampling results, (b) AGMs in the POR. Red line represents the chlorophyll *a* NNC value of 20 µg/L, expressed as an AGM.

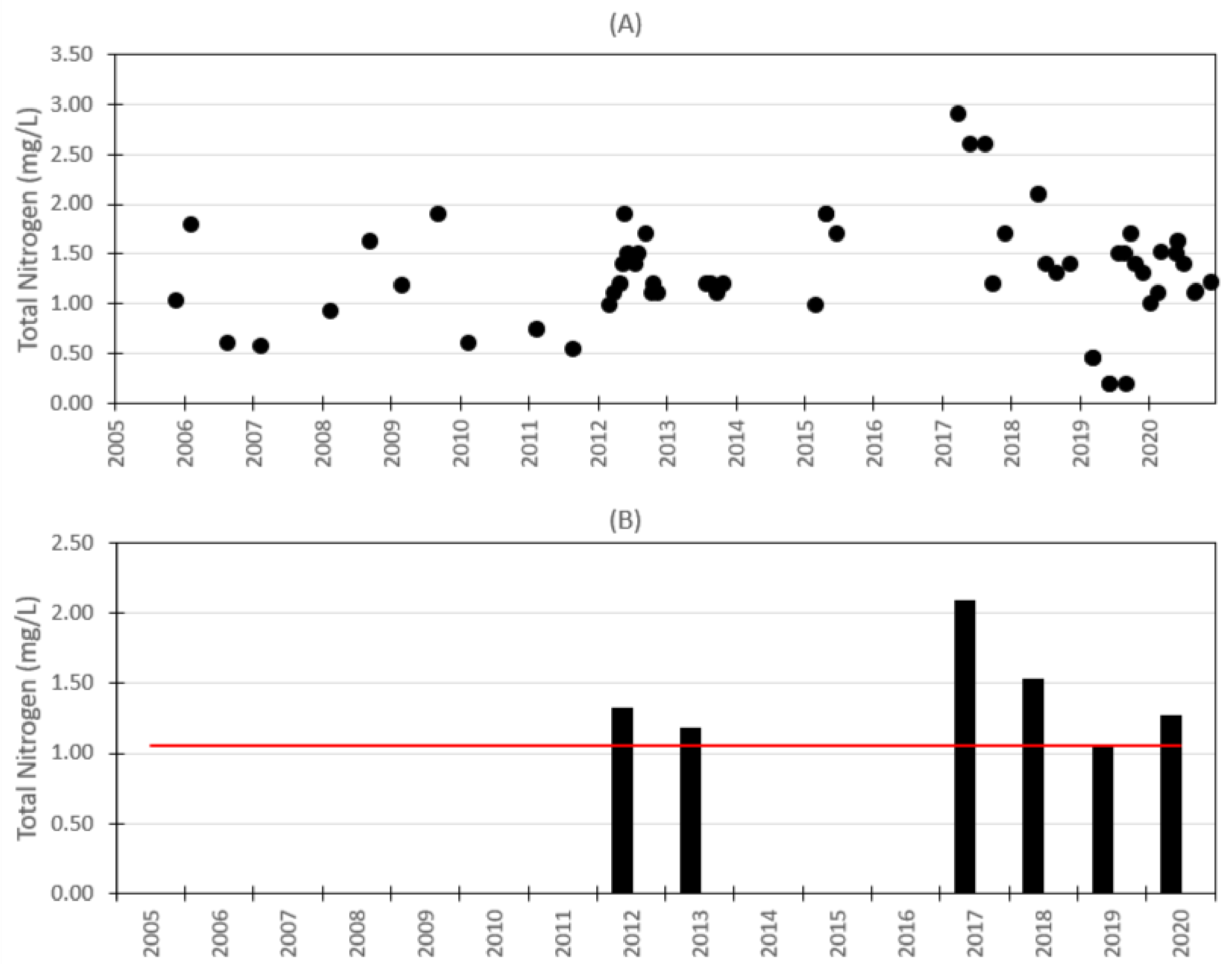


Figure 2.3. TN measured in WBID 1547A: (a) individual sampling results, (b) AGMs in the POR. Red line represents the TN minimum NNC value of 1.05 mg/L, expressed as an AGM.

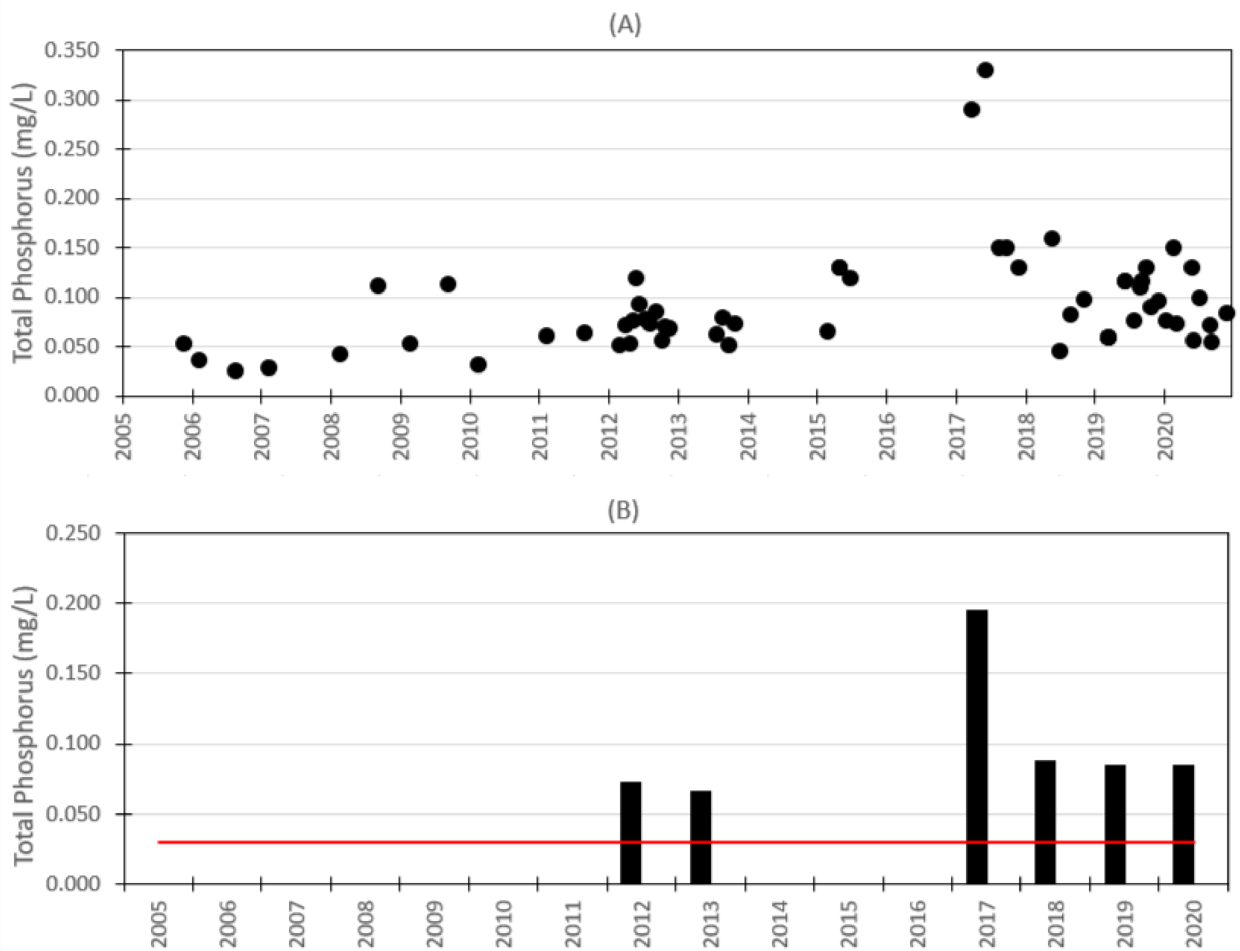


Figure 2.4. TP measured in WBID 1547A: (a) individual sampling results, (b) AGMs in the period of record. Red line represents the TP minimum NNC value of 0.03 mg/L, expressed as an AGM.

2.3.4 Relationships Between Water Quality Variables

For Lake Valrico, simple linear regression analyses were used to evaluate the relationships between the pollutant variables (TN and TP) and the response variable (chlorophyll *a*). **Figures 2.5** and **2.6** show the relationships between chlorophyll *a* and TN, and chlorophyll *a* and TP AGM values, respectively, from 2011 to 2020.

There were significant relationships between chlorophyll *a* and TN ($R^2 = 0.681$, $p = 0.043$), and chlorophyll *a* and TP ($R^2 = 0.689$, $p = 0.041$).

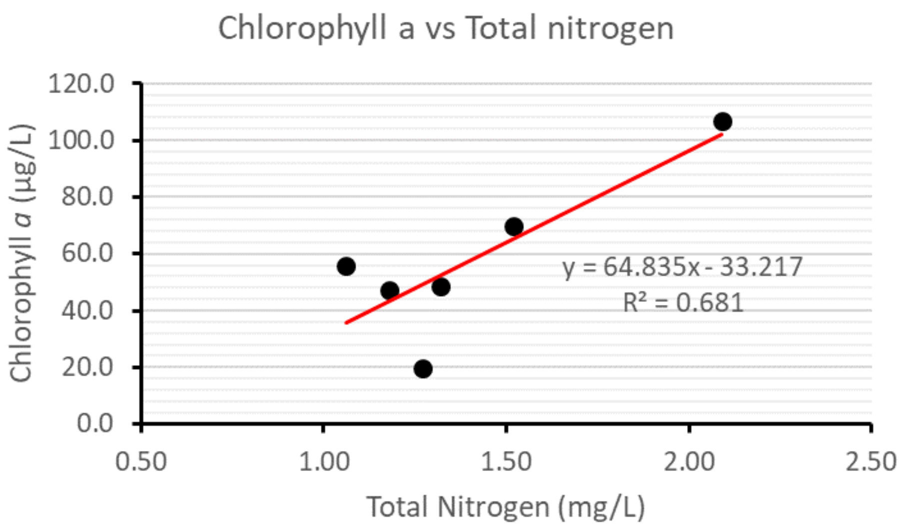


Figure 2.5. Lake Valrico chlorophyll *a* AGMs vs. TN AGMs

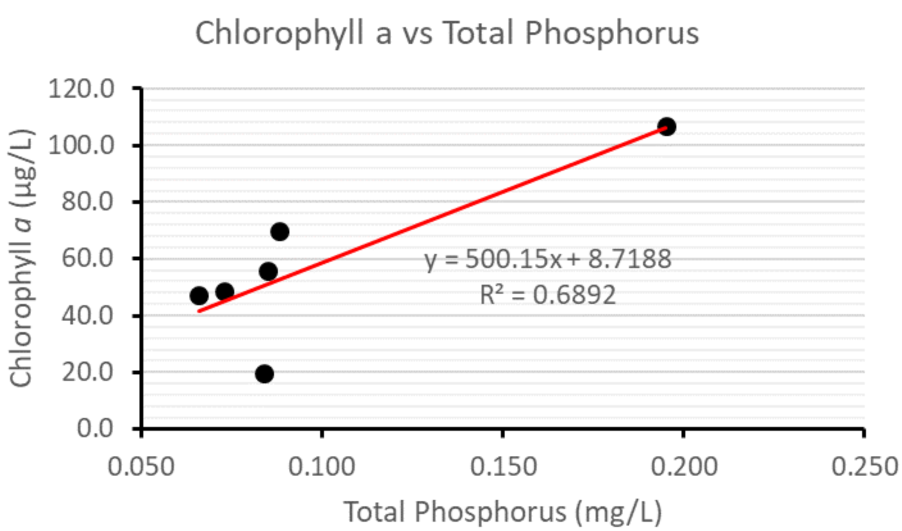


Figure 2.6. Lake Valrico chlorophyll *a* AGMs vs. TP AGMs

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

3.1 Establishing the Site-Specific Interpretation

Pursuant to paragraph 62-302.531(2)(a), F.A.C., the nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.505, F.A.C., will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in paragraph 62-302.530(48)(b), F.A.C., and will replace the otherwise applicable NNC from subparagraph 62-302.531(2)(b)1., F.A.C. **Table 3.1** lists the elements of the nutrient TMDLs that constitute the site-specific numeric interpretations of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Lake Valrico for the attainment and maintenance of water quality standards in downstream waters (pursuant to subsection 62-302.531(4), F.A.C.), and to support using the nutrient TMDLs as the site-specific numeric interpretations of the narrative nutrient criterion.

When developing TMDLs to address nutrient impairment, it is essential to address those nutrients that typically contribute to excessive plant growth. In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll *a*, and macrophytes to grow. In the past, management activities to control lake eutrophication focused on phosphorus reduction, as phosphorus was generally recognized as the limiting nutrient in freshwater systems.

Recent studies, however, have supported the reduction of both nitrogen and phosphorus as a better approach to controlling algal growth in aquatic systems (Conley et al. 2009; Paerl 2009; Lewis et al. 2011; Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC supports this idea, as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (DEP 2012).

3.2 Site-Specific Response Variable Target Selection

The generally applicable chlorophyll *a* criteria for lakes were established by taking into consideration an analysis of lake chlorophyll *a* concentrations statewide, comparisons with a smaller population of select reference lakes, paleolimnological studies, expert opinions, user perceptions, and biological responses. Based on these resources, DEP concluded that an annual average chlorophyll *a* of 20 µg/L in high-color and low-color, high-alkalinity 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. DEP developed a chlorophyll *a* criterion of 20 µg/L for both high-color (> 40 PCU) lakes and low-color (≤ 40 PCU), high-alkalinity (≥ 20 $CaCO_3$) lakes.

There are no available data suggesting that Lake Valrico differs from the reference lakes used to develop the NNC. Therefore, DEP has determined that the generally applicable chlorophyll *a* NNC for a low-color, high-alkalinity lake is the most appropriate TMDL restoration target for the lake (and will remain the applicable water quality criterion).

3.3 Expression of the Site-Specific Numeric Interpretations

Site-specific numeric interpretations of the narrative nutrient standard for Lake Valrico were determined for TN and TP using the modeling approach discussed in **Chapter 5** to determine the nutrient loads that resulted in the lake attaining the chlorophyll *a* criterion. The modeling related annual watershed TN and TP loading to in-lake chlorophyll *a*, TN, and TP concentrations. For Lake Valrico, nutrient and chlorophyll concentrations were simulated from 2010 to 2019.

The model was used to determine annual TN and TP loads necessary to attain the chlorophyll *a* target. The chlorophyll *a* target was based on the applicable criterion of 20 µg/L as an AGM not to be exceeded more than once in any consecutive 3-year period. DEP calculated a rolling 7-year average loading for each parameter. The site-specific interpretations of the narrative nutrient criterion were then set for each parameter at the maximum 7-year rolling average load for Lake Valrico. **Section 5.5** discusses in more detail the method used to determine these loading values.

Site-specific interpretations for Lake Valrico are expressed as a 7-year rolling annual average load not to be exceeded. **Table 3.1** summarizes the site-specific interpretations for TN and TP for Lake Valrico.

Table 3.1. Lake Valrico site-specific numeric interpretations of the narrative nutrient criterion

kg/yr = Kilograms per year

Waterbody	WBID	7-Year Annual Average TN (kg/yr)	7-Year Annual Average TP (kg/yr)
Lake Valrico	1547A	2,317	90

DEP also calculated the in-lake TN and TP concentrations corresponding to the load-based TN and TP site-specific interpretations of the narrative criterion that attain the target chlorophyll *a* concentration of 20 µg/L. For Lake Valrico, the TN and TP AGM concentrations of 0.99 and 0.028 mg/L, respectively, are not to be exceeded more than once in any consecutive 3-year period. These concentration-based restoration targets are provided for informational purposes only and will be used to help evaluate the effectiveness of restoration activities. The loads listed in **Table 3.1** are the site-specific interpretations of the narrative criterion for the lake.

3.4 Downstream Protection

Lake Valrico discharges into Long Pond (WBID 1547B) and then Seffner Canal (WBID 1547), which flows into Lake Thonotosassa (WBID 1522B) via Baker Creek (WBID 1522C). Based on the most recent assessment, Long Pond, Seffner Canal, and Baker Creek are not verified impaired for nutrients. As evidenced by their healthy existing condition, the existing loads from Lake Valrico to the downstream waters have not led to impairments. The restoration target nutrient concentrations associated with the nutrient TMDLs developed for Lake Thonotosassa are TN and TP values of 1.64 and 0.08 mg/L, respectively (DEP 2019). In comparison, the target concentrations of Lake Valrico for TN and TP are 0.99 and 0.028 mg/L, respectively. Since the nutrient targets for Lake Valrico are lower than those for Lake Thonotosassa, the TMDLs for Lake Valrico are protective of the downstream lake. Therefore, the reductions in nutrient loads prescribed in the TMDLs for Lake Valrico are not expected to cause nutrient impairments downstream.

3.5 Endangered Species Consideration

Section 7(a)(2) of the Endangered Species Act requires each federal agency, in consultation with the services (i.e., U.S. Fish and Wildlife Service [FWS] and National Oceanic and Atmospheric Agency [NOAA] National Marine Fisheries Service [NMFS]), to ensure that any federal action authorized, funded, or carried out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. The EPA must review and approve changes in water quality standards (WQS) such as setting site-specific criteria.

Prior to approving WQS changes for aquatic life criteria, the EPA will prepare an Effect Determination summarizing the direct or indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The EPA categorizes potential effect outcomes as either (1) "no effect," (2) "may affect, not likely to adversely affect," or (3) "may affect: likely to adversely affect."

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

The FWS online Information for Planning and Conservation (IPaC) tool (see **Appendix B**) identifies terrestrial species potentially affected by activities in the watershed. DEP is not aware of any aquatic, amphibious, or anadromous endangered species present in the Lake Valrico

Watershed. Furthermore, it is expected that restoration efforts and subsequent water quality improvements will positively affect aquatic species living in the lake and its watershed.

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. Point sources also include certain urban stormwater discharges, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs). In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from septic systems; and atmospheric deposition.

To be consistent with CWA definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1** on **Expression and Allocation of the TMDLs**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 Wastewater Point Sources

There are no NPDES-permitted wastewater facilities discharging to Lake Valrico or to its watershed.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Lake Valrico Watershed is covered by NPDES MS4 Phase I permit #FLS000006 issued to Hillsborough County and co-permittees. The NPDES stormwater wasteload allocation applies to both existing and future MS4 outfalls that discharge within the watershed or otherwise cause or contribute to the impairment. FDOT neither owns or is responsible for any roadways or outfalls within the Lake Valrico watershed.

4.3 Nonpoint Sources

Nutrient loadings to Lake Valrico are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis mainly include loadings from surface runoff based on land use, onsite sewage treatment and disposal systems (OSTDS), 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 Lake Valrico Watershed. Nutrients can be flushed into a receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human land use areas and natural land areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce. **Table 4.1** lists land uses in the watershed from 2017, based on SWFWMD data, and **Figure 4.1** shows the information graphically.

Table 4.1 and **Figure 4.1** show the breakdown of the various land use categories in the Lake Valrico Watershed. Residential land uses—including low, medium, and high density–predominate with 60 % coverage. Agriculture is the second most common land use (13 %), followed by water (9 %), forest/rangeland (7 %), and wetland (7 %).

Table 4.1. Land use in the Lake Valrico Watershed, 2017 (SWFWMD)

Land Use Type	Acreage	% Acreage
Low-density residential	144.7	9.2
Medium-density residential	477.1	30.3
High-density residential	315.4	20.0
Low-density commercial/institutional	6.1	0.4
High-density commercial	8.2	0.5
Open land/recreational	49.1	3.1
Pasture	27.8	1.8
Cropland	71.3	4.5
Other agriculture	101.0	6.4
Forest/rangeland	113.1	7.2
Water	142.3	9.0
Wetlands	119.6	7.0
Total	**1,575.7**	**100.0**

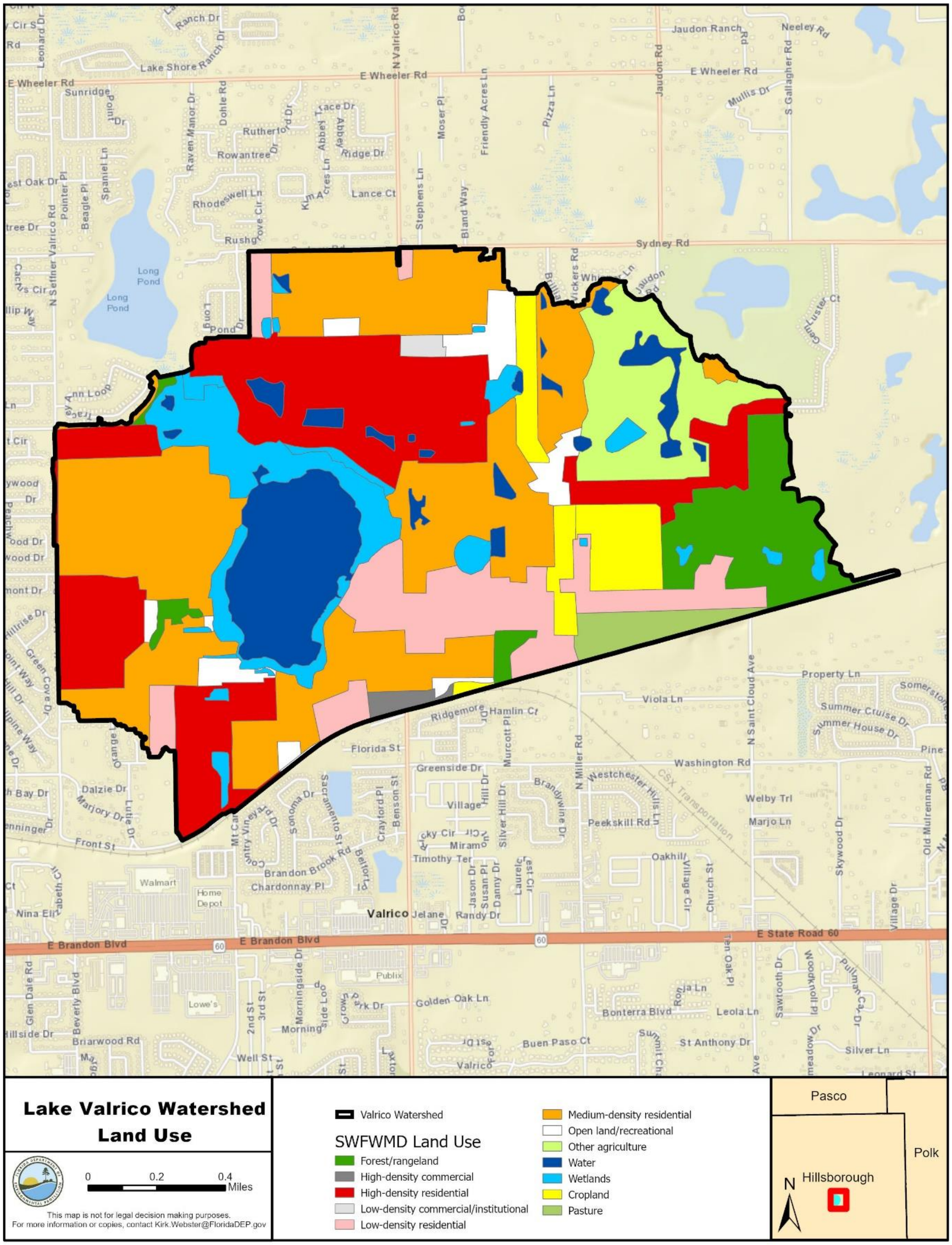


Figure 4.1. Land use in the Lake Valrico Watershed, 2017

4.3.2 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 system is comparable to secondarily treated wastewater from a sewage treatment plant. However, OSTDS can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both groundwater and surface water.

The Florida Department of Health (FDOH) maintains a list of septic tanks by county. The Hillsborough County 2018 Database was used to determine the number of septic tanks in the Lake Valrico Watershed. There are 67 known septic tanks. **Figure 4.2** shows the OSTDS locations in the watershed.

4.3.3 Atmospheric Deposition

Nutrient loadings from the atmosphere are an important component of the nutrient budget in many Florida lakes. Nutrients are delivered through two pathways: wet atmospheric deposition with precipitation and dry particulate-driven deposition. Atmospheric deposition to terrestrial portions of the Lake Valrico Watershed is assumed to be accounted for in the loading rates used to estimate the watershed loading from land. There are no known complete atmospheric deposition data for Lake Valrico. Lake Apopka, the closest deposition measuring site located about 60 miles northeast from Lake Valrico is the only site to include deposition data for both phosphorus and nitrogen. Therefore, loading from atmospheric deposition directly onto the water surface was estimated based on the St. Johns River Water Management District (SJRWMD) data collected in Lake Apopka. These included both wet and dry atmospheric deposition data.

The dry deposition portion is expressed as a per area loading rate (areal loading rate) on an annual scale. Wet deposition is delivered by precipitation, and annual wet deposition is therefore expressed as a concentration of solutes in precipitation multiplied by the total volume of precipitation. The precipitation data used in this analysis were obtained from the Florida Automated Weather Network (FAWN) Dover Weather Station. Both the wet and dry components of the calculated atmospheric nutrient deposition (**Table 4.2**) were added to the waterbody model for Lake Valrico. The table also shows annual TN and TP atmospheric loads to the lake surface.

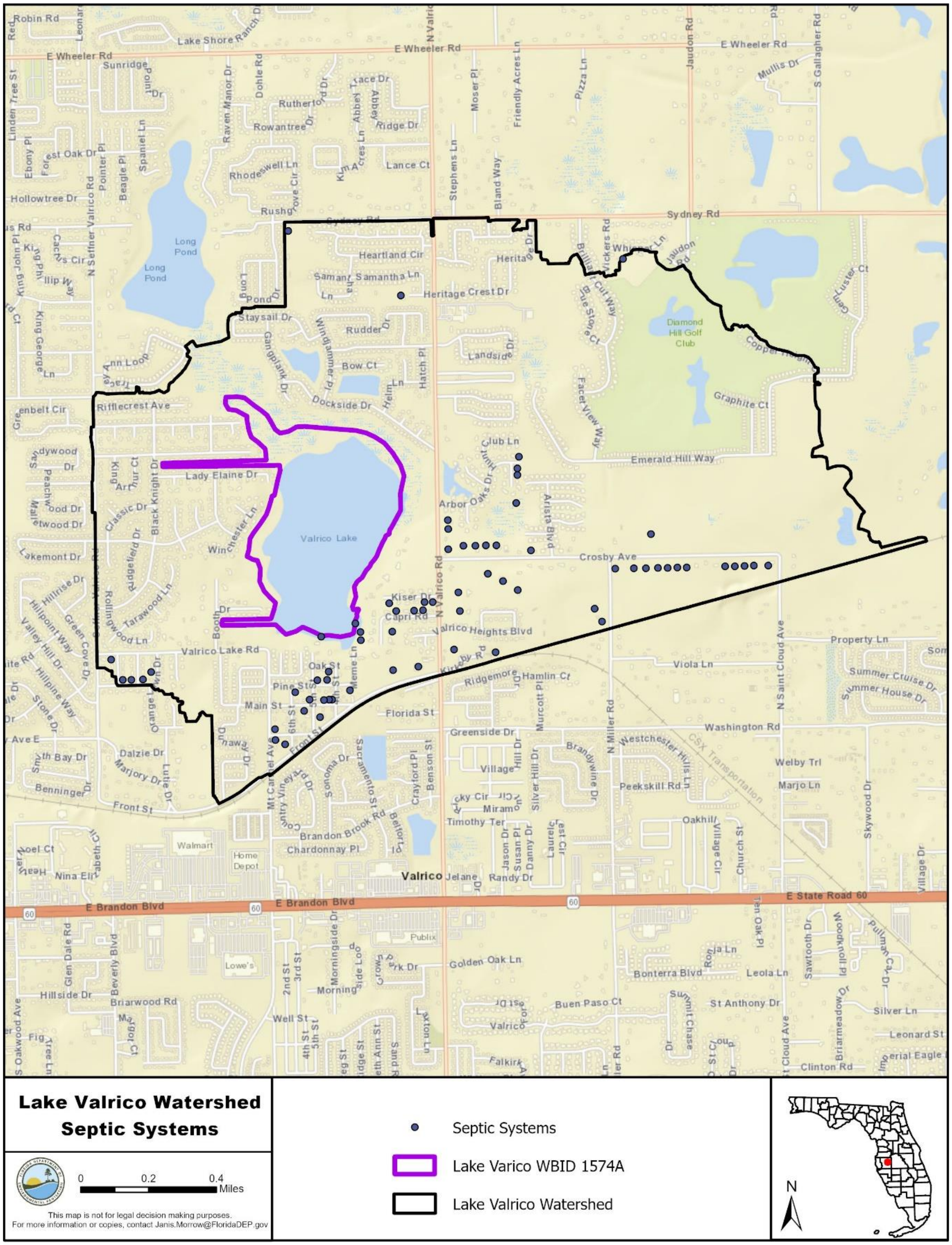


Figure 4.2. OSTDS in the Lake Valrico Watershed

Table 4.2. Calculated atmospheric deposition in Lake Valrico based on field measurements in Lake Apopka, 2011–20

$mg/m^2/yr$ = Milligrams per square meter per year
kg/yr = Kilograms per year

Year	Dry Deposition TN ($mg/m^2/yr$)	Dry Deposition TP ($mg/m^2/yr$)	Wet Deposition TN ($mg/m^2/yr$)	Wet Deposition TP ($mg/m^2/yr$)	Total Deposition TN ($mg/m^2/yr$)	Total Deposition TP ($mg/m^2/yr$)	TN loads to Lake surface (kg/yr)	TP loads to Lake surface (kg/yr)
2011	136	19	569	20	705	39	298	16
2012	296	48	864	30	1160	78	491	33
2013	146	18	809	20	956	39	404	16
2014	147	22	663	16	810	38	342	16
2015	181	29	647	28	829	58	351	24
2016	170	24	539	17	709	41	300	17
2017	244	32	446	14	690	46	292	20
2018	129	16	641	19	770	35	326	15
2019	103	14	619	22	722	36	306	15
2020	153	19	540	13	693	32	293	14

4.4 Estimating Watershed Loadings

To simulate nutrient loading from the Lake Valrico Watershed, the Natural Resources Conservation Service (NRCS) curve number model approach was used, following the SJRWMD procedure in Fulton et al. (2004) (**Appendix C**). This approach estimates runoff volume by taking into consideration the land use type, soil type, imperviousness of the watershed, and antecedent moisture condition of the soil. Curve numbers from 20 to 100 are assigned to different land use–soil combinations to represent different runoff potentials.

Rainfall is the driving force of the curve number simulation. The rainfall data used in this TMDL analysis were obtained from the FAWN weather station at Dover. The stormwater runoff volume was estimated using the same spreadsheet model created by the SJRWMD. The annual runoff volume in the Lake Valrico Watershed ranged from 1.431 to 2.811 cubic hectometers per year (hm^3/yr) from 2011 through 2020 (**Table 4.3**). The long-term average annual runoff is 2.062 hm^3/yr.

The nutrient loads from the watershed were calculated by multiplying land use specific runoff volumes by land use TN and TP event mean concentrations (EMCs), and also by taking into account the dissolved fraction of these nutrients and flow path distance to the lake (**Appendix C**). EMCs were based on general land use descriptions and spatially averaged data from studies in Florida (Harper 1994; 2012).

Table 4.3. Runoff volume (hm^3/yr) from the Lake Valrico Watershed

Year	Runoff Volume
2011	1.715
2012	1.939
2013	2.811
2014	1.958
2015	2.058
2016	1.702
2017	1.982
2018	2.387
2019	2.633
2020	1.431
Average	**2.062**

Table 4.4 list the stormwater runoff TN and TP loads from the Lake Valrico Watershed estimated using the procedures described in **Appendix C**.

Table 4.4. Runoff TP and TN annual loads (kg/yr) from the Lake Valrico Watershed

Year	TP (kg)	TN (kg)
2011	224	1,992
2012	280	2,349
2013	406	3,407
2014	248	2,245
2015	281	2,434
2016	221	1,972
2017	280	2,380
2018	315	2,782
2019	379	3,185
2020	177	1,625
Average	**281**	**2,437**

To simulate groundwater hydrology in the Lake Valrico Watershed, results from the Watershed Assessment Model (WAM) application to the Lake Thonotosassa watershed were used. Soil and Water Engineering Technology Inc. developed, calibrated, and updated the model for hydrology and water quality (modeling period 1999–2011) to evaluate the impact of various alternative watershed management practices in the watershed on water quality in Lake Thonotosassa (Soil and Water Engineering Technology Inc. 2017). The DEP has used this model in the development of nutrient TMDLs for Lake Thonotosassa (DEP 2019).

The groundwater flow calculation for the Lake Valrico Watershed, is based on the relationship between simulated surface water and groundwater flows into the WAM reach representing Lake Valrico (Reach 26). Based on the model results, the groundwater flow was about 3 % of the total inflow to the lake. The regression equation describing the relationship between the WAM simulated surface water and groundwater inflows was used to calculate the annual groundwater inflows to the lake using surface water inflow simulated by the curve number model (**Table 4.5)**.

Groundwater nutrient concentration data were obtained from 9 groundwater sampling stations from 4 WBIDs in the surrounding Lake Valrico Watershed between 2011 and 2020. Median values for TN (0.52 mg/L) and TP (0.082 mg/L) were applied in the BATHTUB model. **Table 4.5** lists the estimated nutrient loads to Lake Valrico from groundwater.

Table 4.5. Nutrient loads to Lake Valrico from groundwater

Year	Groundwater Flow (hm^3/yr)	TP Load (kg/yr)	TN Load (kg/yr)
2011	0.062	5	32
2012	0.064	5	33
2013	0.071	6	37
2014	0.064	5	33
2015	0.065	5	34
2016	0.062	5	32
2017	0.065	5	34
2018	0.068	6	35
2019	0.070	6	36
2020	0.060	5	31

4.4.1 Estimating Septic Tank Flow Rate and Nutrient Loadings

Septic tank nitrogen loadings to Lake Valrico were derived using estimates of flow rate and nitrogen concentrations from systems located within a 200-meter buffer around the lake perimeter. To estimate flow, the following equation was used:

$$S * P * W * flr * 365 = Flow\ rate\ (gallons/year)$$

Where:

S = Number of known septic tanks within 200 meters.
P = Average number of people per household.
W = Individual water consumption (70 gallons/day).
flr = Flow loss rate (15 %).

There are 8 known septic tanks within a 200-meter buffer of Lake Valrico. According to the U.S. Census Bureau, Hillsborough County averages 2.66 people per household. Each individual uses approximately 70 gallons of water per day, with a flow loss rate of 15 % (EPA 2002; Tetra Tech 2017). The number of septic tanks, the number of people per household, the individual water consumption, and a value of 0.85 were multiplied to calculate the total flow rate for septic tanks.

Flow rates were converted to cubic hectometers for input to the BATHTUB model. The average flow rate from septic tanks within the buffer area was estimated to be 0.00175 hm^3/yr.

Seepage from septic tanks may contribute nutrients to the waterbody. Inorganic nutrients, such as nitrate nitrogen and ammonia, are the main nutrients associated with septic tanks, since the majority of phosphorus loads to groundwater from septic tanks are adsorbed onto soil particles immediately or very soon after discharge. For modeling purposes, these various forms of nutrients are referred to as TN. The following flow equation was used to estimate TN loading from septic tanks in the watershed:

$$S * P * I * L = \textit{Total TN (lbs) from septic tanks}$$

Where:

S = Number of known septic tanks in groundwater zones.
P = Average number of people per household.
I = Number of pounds of TN per person per septic tank.
L = Percentage of TN lost during seepage.

The number of septic tanks was multiplied by the number of people per household. These values were then multiplied by 4.088, which is the number of kilograms of TN per person seeping from a septic tank per year (EPA 2002; Toor et al. 2019), and by 0.50, which accounts for the 50 % nitrogen loss that occurs as septic tank effluent moves through the unsaturated zone to groundwater. **Figure 4.2** shows the locations of the known septic tanks, and **Table 4.6** lists the estimated TN load from septic tank contributions.

Table 4.6. Septic tank loads from the watershed

Waterbody	Flow Rate (hm^3/yr)	TN Concentration (mg/L)	TN Load (kg/yr)
Lake Valrico	0.00175	24.862	43.5

4.4.2 Nutrient Loadings from Various Sources

Based on calculation estimates and model simulation, the long-term mean of the total annual TP loading from various sources to Lake Valrico was 305 kg/yr (**Table 4.7**). Watershed surface runoff was the largest source of phosphorus loading to Lake Valrico, representing 92 % of long-term total TP loading, followed by atmospheric deposition and groundwater (**Table 4.7**).

As shown in **Table 4.8**, the long-term mean of annual TN loading from various sources to Lake Valrico was 2,854 kg/yr. The watershed surface runoff to the lake was the largest nitrogen loading source, representing 86 % of long-term total TN loading, followed by atmospheric deposition, septic tanks, and groundwater (**Table 4.8**).

Table 4.7. Long-term mean annual TP loading from different sources into Lake Valrico, 2011–20 (kg/yr)

Value	Atmospheric Deposition	Surface Runoff	Groundwater	Total
Long-term mean annual	19	281	5	305
%	6	92	2	100

Table 4.8. Long-term mean annual TN loading from different sources into Lake Valrico, 2011–20 (kg/yr)

Value	Atmospheric Deposition	Surface Runoff	Groundwater	Septic Load	Total
Long-term mean annual	340	2,437	34	43	2,854
%	12	85	1	2	100

Chapter 5: Determination of Assimilative Capacity

5.1 Determination of Loading Capacity

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

The goal of this TMDL analysis is to determine the assimilative capacity of Lake Valrico and to identify the maximum allowable TN and TP loadings from the watershed, so that the waterbody will meet the TMDL targets and thus maintain its function and designated uses as a Class III water.

5.2 Evaluation of Water Quality Conditions

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

From 2012 to 2020, Lake Valrico chlorophyll *a* AGMs varied from 19.9 µg/L in 2020 to 106.8 µg/L in 2017 (**Figure 5.2**). TN AGMs ranged from 1.06 mg/L in 2019 to 2.09 mg/L in 2017 (**Figure 5.3**). TP AGMs ranged from 0.066 mg/L in 2013 to 0.195 mg/L in 2017 (**Figure 5.4**).

5.3 Critical Conditions and Seasonal Variation

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

5.4 Water Quality Modeling to Determine Assimilative Capacity

To represent water quality processes occurring in Lake Valrico, the U.S. Army Corps of Engineers (USACE) BATHTUB model was used (Walker 1987; 1999). The model simulates steady-state lake conditions and is set up to simulate water quality for long-term receiving water conditions. It is designed to represent reservoirs and other large waterbodies with relatively stable water levels.

5.4.1 Water Quality Model Description

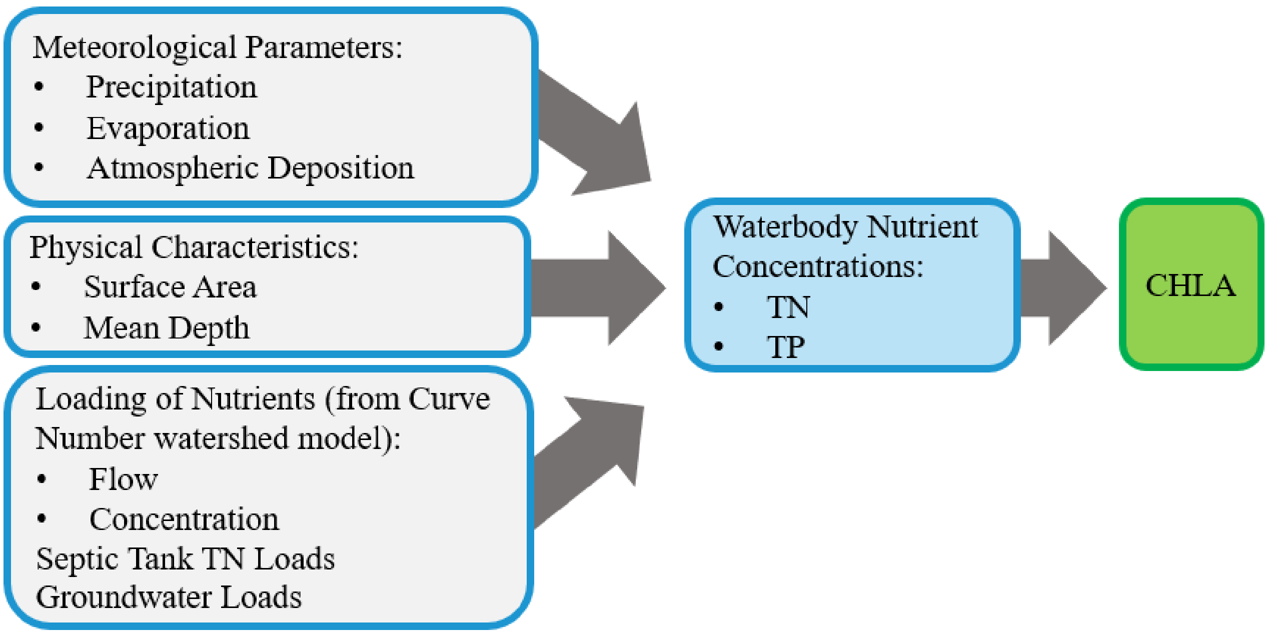
The BATHTUB model runs on a modeling framework that uses empirical relationships between nutrient loading, meteorological conditions, and physical parameters to estimate algal growth. The model's framework includes lake and lake segments morphometry, which may be directly or indirectly connected, as well as inputs of rainfall, atmospheric nutrient deposition, nutrient loads from the surrounding watershed, and internal loading of nutrients.

The primary goal of the BATHTUB model is to estimate in-lake nutrient concentrations and algal biomass (represented by chlorophyll *a* concentrations) as they relate to nutrient loadings. Walker (1999) describes methods for choosing the appropriate models for producing these nutrient estimates for different waterbodies. Two categories of models are used to empirically predict lake eutrophication, and this process usually occurs in two stages. The nutrient balance model describes the relationships between nutrient concentrations in the lake to external nutrient loadings, morphometry, and lake hydraulics. The eutrophication response model relates eutrophication indicators in the lake, including nutrient levels, chlorophyll *a*, hypolimnetic oxygen depletion, and transparency (Walker 1999).

The nutrient models in BATHTUB assume that the net accumulation of nutrients in a lake is the difference between nutrient loadings into the lake from various sources and nutrients carried out through outflow, and nutrient losses through whatever decay processes occur in the lake. BATHTUB includes a suite of phosphorus and nitrogen sedimentation, chlorophyll *a*, and Secchi depth models.

Figure 5.1 shows the scheme used to relate these various models in BATHTUB. According to this scheme, external nutrient loadings, physical characteristics, and meteorological parameters are all applied to simulate in-lake nutrient concentrations. The physical, chemical, and biological response of the lake to the level of nutrients then produces waterbody nutrient concentrations, which are used to predict algal biomass. In BATHTUB, chlorophyll models are available to account for nitrogen, phosphorus, light, or flushing, as limiting factors to algal growth.

Lake Valrico was represented as one waterbody in the BATHTUB model because the lake is relatively small and is spatially homogeneous because of its geometry. The waterbody was modeled on a yearly basis, with inputs including the watershed nutrient delivery derived from the curve number approach, atmospheric deposition, groundwater contributions, and septic tank flux (see **Sections 4.3** and **4.4**).



CHLA = Chlorophyll *a*

Figure 5.1. BATHTUB concept scheme

5.4.2 Morphologic Inputs

The physical characteristics of the lake were input for each year into BATHTUB. Two processes—residence time and nutrient fate and transport—vary based on these physical features. Lake Valrico has an average depth of 1.43 meters (m), a surface area of 0.423 square kilometers (km^2), and a lake length of 0.98 kilometers (km).

5.4.3 Meteorological Data

RAINFALL

Rainfall data (2011–20) used as input on the lake surface area were obtained from the FAWN weather station at Dover. **Table 5.1** shows annual rainfall totals for the model simulation period. The annual average rainfall in this area was 1.372 m. During the simulation period, wetter than average conditions occurred in 2013, 2018, and 2019, while drier than average conditions were present in 2012, 2017, and 2020.

Evaporation

Hamon potential evapotranspiration was computed by the Watershed Data Management Utility Program (WDMutil) using the North American Land Data Assimilation System (NLDAS) meteorological data (2011–20) (**Table 5.1**). NLDAS is currently running operationally on a 1/8th degree grid with an hourly timestep over Central North America (25-53 North). Weather Processor V 2.01 (https://www.epa.gov/ceam/basins-download-and-installation) was used to extract NLDAS meteorological data in the Lake Valrico area.

Table 5.1 lists the annual rainfall and lake evaporation values used in calibrating the BATHTUB model for Lake Valrico.

Table 5.1. Annual rainfall and lake evaporation rates for the Lake Valrico BATHTUB model calibration

m/yr = Meters per year

Year	Annual Rainfall (m/yr)	Lake Evaporation (m/yr)
2011	1.323	1.158
2012	1.229	1.156
2013	1.778	1.143
2014	1.586	1.149
2015	1.467	1.216
2016	1.324	1.193
2017	1.316	1.197
2018	1.810	1.177
2019	1.684	1.202
2020	1.201	1.212

Atmospheric Deposition

Atmospheric deposition rates (total deposition of TN and TP) to the lake surface area were applied in the BATHTUB model. These rates were calculated based on data collected by the SJRWMD in Lake Apopka (see **Section 4.3.3**) that included both wet and dry atmospheric deposition rates (see **Table 4.2**).

5.4.4 Watershed Nutrient Inputs

The curve number approach was used to simulate watershed surface runoff (see **Section 4.4**). Annual loading rates from this approach were entered as watershed tributary inputs in the BATHTUB model for simulating yearly conditions. Annual loading rates from septic tank and groundwater contributions (see **Section 4.4**) were also entered as watershed tributary inputs in the model.

5.4.5 BATHTUB Model Calibration

The BATHTUB model was set up to simulate in-lake TN, TP, and chlorophyll *a* concentrations. Lake AGMs for chlorophyll *a*, TN, and TP were input into the model as observed values from 2012 to 2020, except for the years 2014 and 2016, when no data were available. AGMs for chlorophyll *a*, TN, and TP were calculated using results from a minimum of 4 sampling events per year, with the exception of 2015 where the AGMs were calculated using results from 3 sampling events. These observed AGM values were used to calibrate the BATHTUB model and guided the selection of the appropriate nitrogen, phosphorus, and chlorophyll *a* models to apply.

For the model calibration, Model Option 08 (Canf & Bach, Lakes) was used for TP, Model Option 07 (Settling Velocity) was used for TN, and Model Option 01 (P, N, Light, Flushing) was used for chlorophyll *a*. The P. N. Light, T chlorophyll *a* model assumes that phytoplankton growth is limited by not only both phosphorus and nitrogen but also light. Model option 01 (VS. Chla & Turbidity) was also selected for transparency. Calibration factors were used to fit the Lake Valrico model predictions to the observed TN, TP, chlorophyll *a*, and Secchi depth data. Calibration factors of 1.4 and 0.85 were applied for chlorophyll *a* and Secchi depth, respectively, to fit the Lake Valrico model predictions to all modeling years.

Additionally, calibration for TN and TP was achieved by applying the internal loading rate functions for both TN and TP to approximate the measured in-lake mass. The internal loading rates account for in-lake processes that recycle nutrients from the lake bottom sediments by resuspension and inputs of nitrogen (N_2) through nitrogen fixation by cyanobacteria. The high concentrations of the measured nutrients and chlorophyll *a* and the analyses of the phytoplankton composition indicate that these internal processes may occur in the lake. DEP conducted three algal community surveys in Lake Valrico—on September 4, 1996; December 1, 2005; and July 31, 2013—and identified several major nitrogen-fixing blue-green algal taxa, including *Aphanizomenon* spp., *Cylindrospermopsis raciborskii*, *Anabaena* spp., and some non-heterocystous cyanobacteria that can fix nitrogen. In these analyses, the percent of nitrogen-fixing cyanobacteria ranged from 1 % to 59 % of the algal community by cell density in Lake Valrico (**Table 5.2**). These data support the possibility that nitrogen fixation can be a source of nitrogen within the lake.

Table 5.2. Percent of nitrogen-fixing cyanobacteria of the algal community in Lake Valrico; percent based on cell density (data from DEP Biology Laboratory)

Sampling Date	9/4/1996	12/1/2005	7/31/2013
%	1	59	39

The high lake nutrient concentrations occurred in 2017 and 2018 (**Figures 5.3** and **5.4**). As a result, the higher lake chlorophyll *a* concentrations occurred in these years (**Figures 5.2**) than those in the other years. It is hypothesized that these increased nutrient concentrations were released from resuspended sediments and facilitated algal growth. To account for these possible processes, internal loading rates of 4 and 9 milligrams per square meter per day ($mg/m^2/day$) in 2017 and 0.1 and 1 $mg/m^2/day$ in 2018 for TP and TN, respectively, were applied in the model to estimate the higher in-lake concentrations of TP, TN, and chlorophyll *a* observed in this period.

Figures 5.2 through **5.5** show the model-predicted results and observed concentrations for chlorophyll *a*, TN, TP, and Secchi depth, respectively, for Lake Valrico. To evaluate model performance, the difference between both the mean and median simulated and observed AGM values over the modeling period were calculated and are shown in **Table 5.3**. The percent differences in mean values for the modeling period of predicted and observed chlorophyll *a*, TN, TP, and Secchi depth were 5 %, 2 %, 4 %, and 3 %, respectively. The percent differences in median values for the modeling period of predicted and observed chlorophyll *a*, TN, TP, and Secchi depth were 1 %, 3 %, 3 %, and 7 %, respectively.

The model-predicted existing condition annual concentrations of TN, TP, and chlorophyll *a* are tabulated in **Table 5.4.a**.

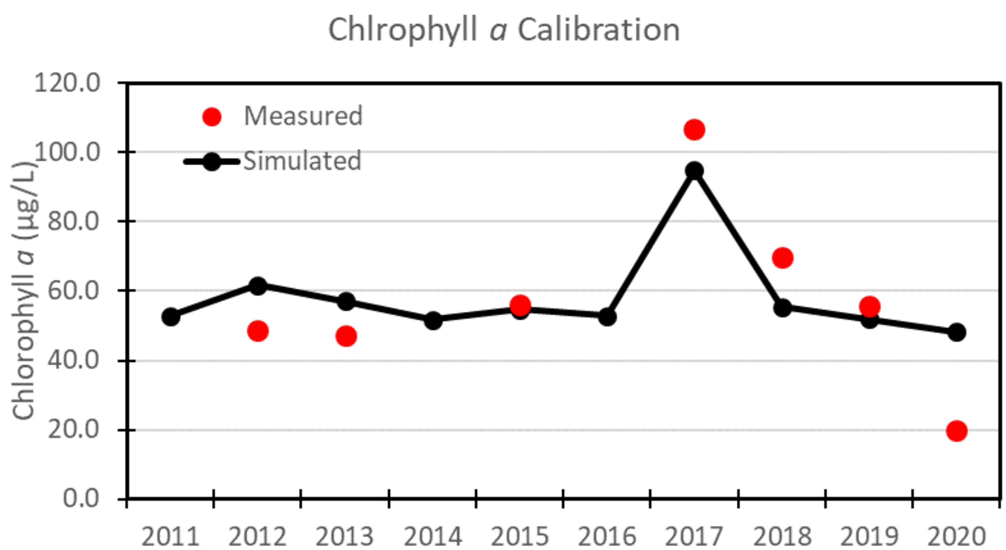


Figure 5.2. Lake Valrico chlorophyll *a* observed and BATHTUB-simulated annual average results, 2011–20

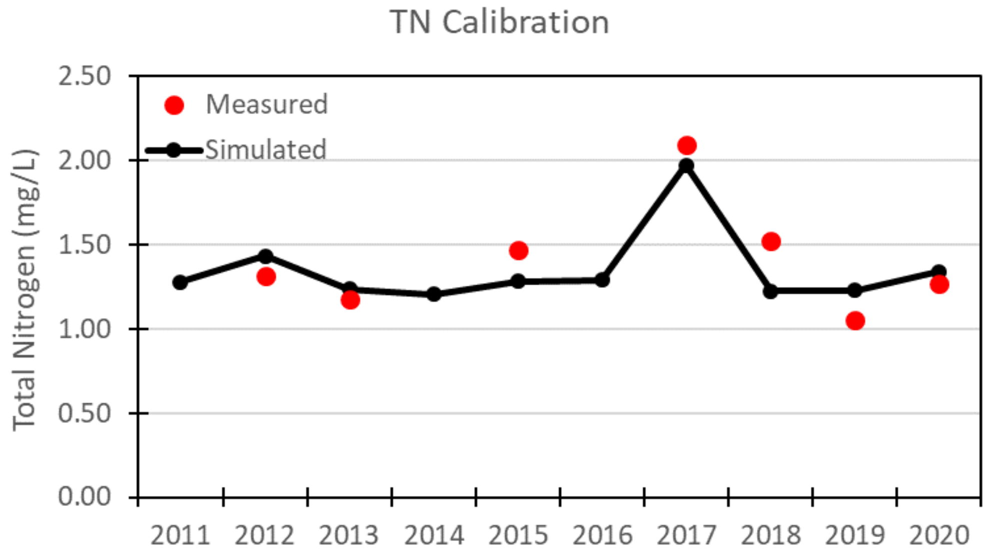


Figure 5.3. Lake Valrico TN observed and BATHTUB-simulated annual average results, 2011–20

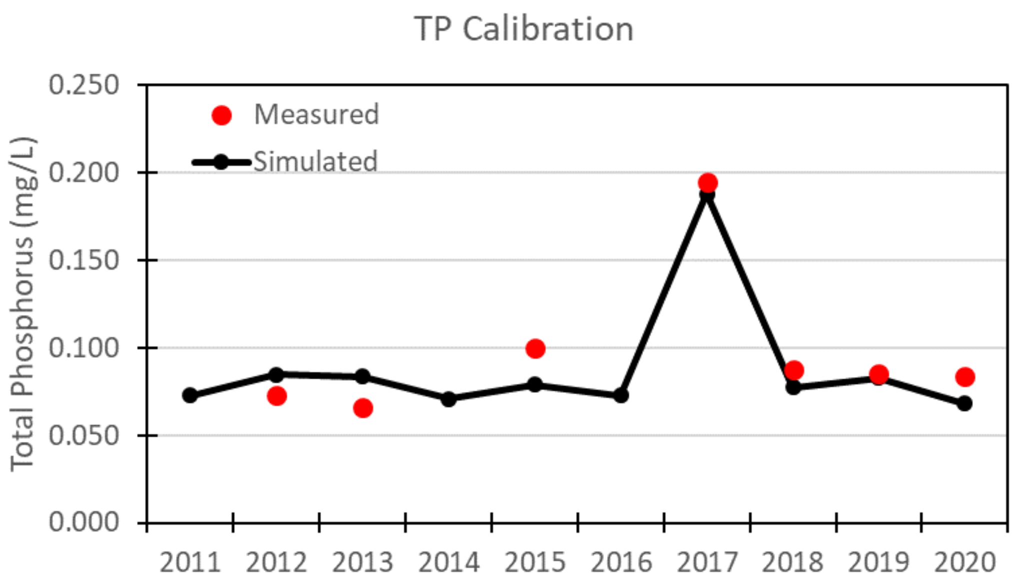


Figure 5.4. Lake Valrico TP observed and BATHTUB-simulated annual average results, 2011–20

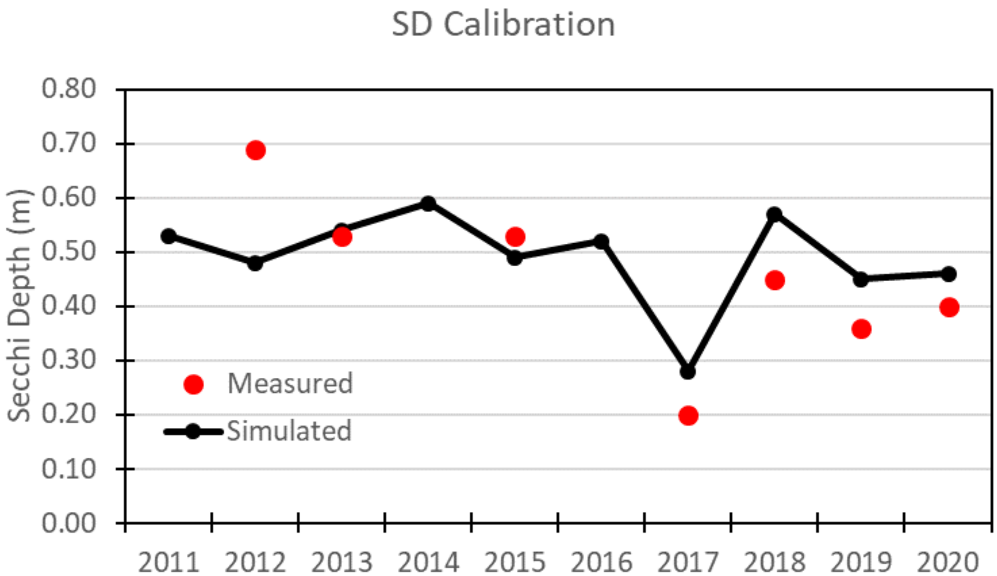


Figure 5.5. Lake Valrico Secchi depth observed and BATHTUB-simulated annual average results, 2011–20

Table 5.3. Performance statistics for model simulated parameters

Chl*a* = Chlorophyll *a*

Statistics	Measured Chl *a* (µg/L)	Simulated Chl *a* (µg/L)	Measured TN (mg/L)	Simulated TN (mg/L)	Measured TP (mg/L)	Simulated TP (mg/L)	Measured Secchi Depth (m)	Simulated Secchi Depth (m)
Mean	58	61	1.42	1.39	0.099	0.095	0.45	0.47
% Difference		-5		2		4		-3
Median	56	55	1.32	1.28	0.085	0.083	0.45	0.48
% Difference		1%		3%		3%		-7%

5.4.6 Natural Background Conditions and TMDL Scenario Run

To ensure that the site-specific restoration target would not abate natural background conditions, a Lake Valrico natural background conditions model scenario was developed. To estimate the natural background nutrient loading conditions, all anthropogenic land uses applied in the existing condition scenario were converted to forest land cover in the curve number spreadsheet. Wetland and water land cover remained unchanged in the spreadsheet for the natural background condition. The watershed background loadings were then input to the BATHTUB model file. Additionally, the septic tank loading estimates and internal loads were removed as inputs in the BATHTUB model. The atmospheric deposition and groundwater loadings in the model were kept the same as in the existing condition scenario.

For Lake Valrico, the model simulated chlorophyll *a* concentrations under the natural background loading condition were at or below the generally applicable chlorophyll *a* criterion (20 µg/L), except for 2012, when it was 24 µg/L (**Figure 5.6; Table 5.4.b**). The DEP has demonstrated that the chlorophyll *a* criterion of 20 µg/L is protective of designated uses and maintains a balanced aquatic flora and fauna for low-color, high-alkalinity lakes (DEP 2012). Therefore, 20 µg/L of chlorophyll *a* is appropriate to use as the restoration target for Lake Valrico.

The TMDL nutrient loading scenario was developed by iteratively reducing the anthropogenic loadings in the BATHTUB model until the simulated chlorophyll *a* concentrations did not exceed 20 µg/L more than once in any consecutive 3-year period. The BATHTUB simulated in-lake chlorophyll *a*, TN, and TP results for the TMDL loading scenario are presented in **Table 5.4.c**, and displayed in **Figures 5.6** to **5.8**, respectively. The in-lake TN and TP concentrations (0.99 and 0.028 mg/L, respectively) for the TMDL scenario serve as concentration-based restoration targets to assist in evaluating the effectiveness of restoration activities. These nutrient concentration targets are for informational purposes only.

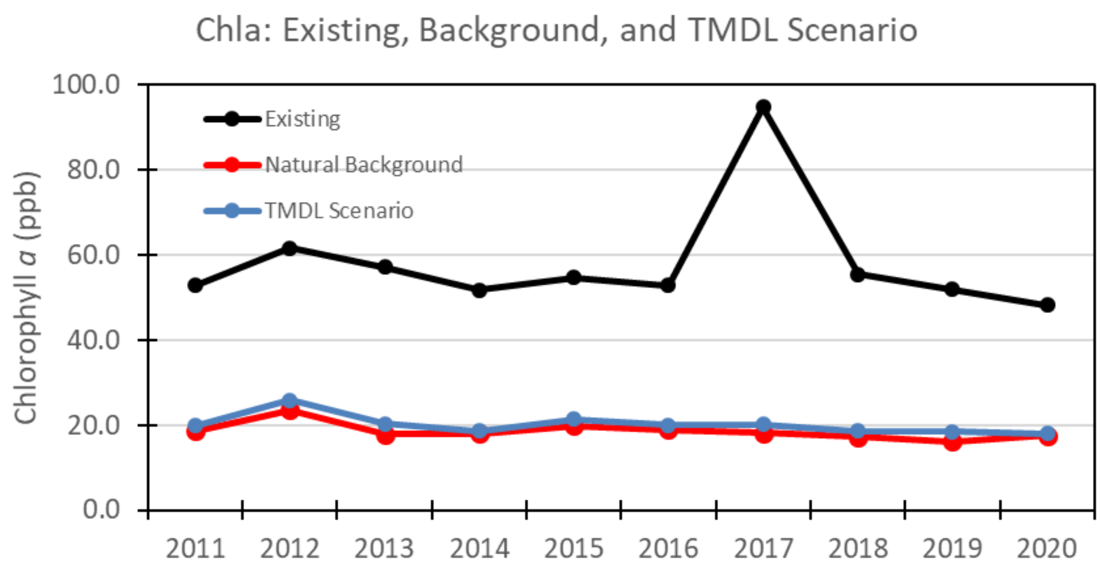


Figure 5.6. **Chlorophyll *a* concentrations in existing, natural background, and target conditions in Lake Valrico during the BATHTUB modeling period, 2011–20**

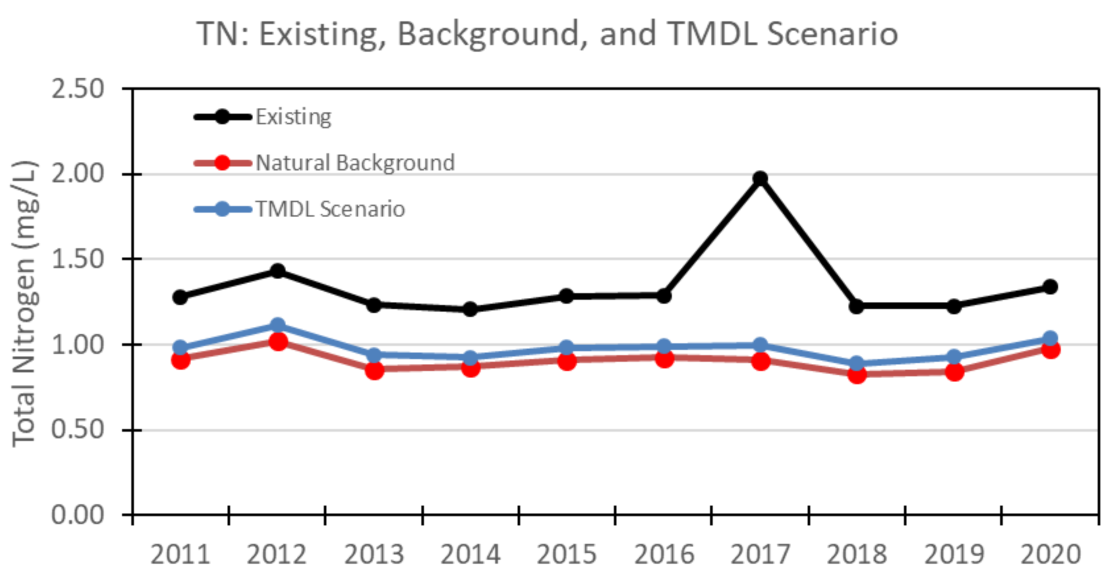


Figure 5.7. **TN concentrations in existing, natural background, and target conditions in Lake Valrico during the BATHTUB modeling period, 2011–20**

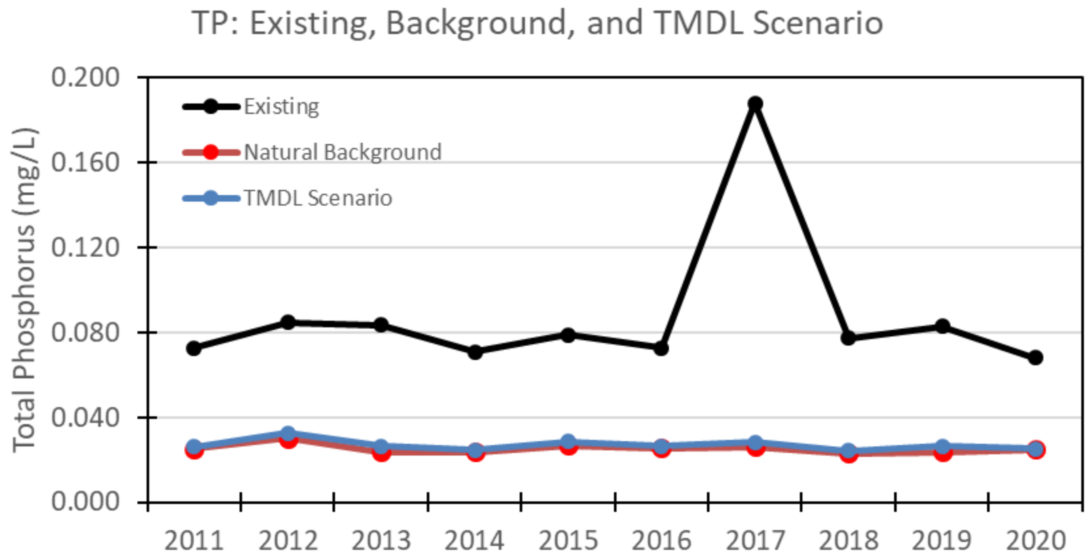


Figure 5.8. TP concentrations in existing, natural background, and target conditions in Lake Valrico during the BATHTUB modeling period, 2011–20

Table 5.4. Chlorophyll *a*, TP, and TN concentrations in (a) existing, (b) natural background, and (c) TMDL conditions during the simulation period and target concentrations

a. Existing Condition

Year	Modeled Existing Chlorophyll *a* (µg/L)	Modeled Existing TN (mg/L)	Modeled Existing TP (mg/L)
2011	53	1.28	0.073
2012	62	1.43	0.085
2013	57	1.23	0.084
2014	52	1.21	0.071
2015	55	1.28	0.079
2016	53	1.29	0.073
2017	95	1.97	0.188
2018	55	1.23	0.077
2019	52	1.23	0.083
2020	48	1.34	0.068

b. Natural Background Condition

Year	Modeled Natural Background Chlorophyll *a* (µg/L)	Modeled Natural Background TN (mg/L)	Modeled Natural Background TP (mg/L)
2011	19	0.92	0.025
2012	24	1.02	0.030
2013	18	0.86	0.024
2014	18	0.87	0.024
2015	20	0.91	0.027
2016	19	0.92	0.026
2017	18	0.91	0.026
2018	17	0.83	0.023
2019	16	0.84	0.024
2020	18	0.98	0.025

c. TMDL Condition

Year	Modeled TMDL Chlorophyll *a* (µg/L)	Modeled TMDL TN (mg/L)	Modeled TMDL TP (mg/L)
2011	20	0.98	0.026
2012	26	1.12	0.033
2013	20	0.94	0.027
2014	19	0.93	0.025
2015	21	0.98	0.029
2016	20	0.99	0.026
2017	20	1.00	0.028
2018	19	0.89	0.024
2019	19	0.93	0.026
2020	18	1.04	0.025
Target	**20.0**	**0.99**	**0.028**

5.5 Calculation of the TMDLs

The nutrient loadings for the TMDL scenario are the loadings where the annual in-lake chlorophyll *a* concentrations do not exceed 20 µg/L more than once in any consecutive 3-year time frame during the modeling period (2011–20). **Tables 5.5** lists the nutrient loads input to the BATHTUB model for Lake Valrico, including the TN and TP existing loads, the loads that achieve the criterion of 20 µg/L chlorophyll *a* (TMDL condition), and their maximum 7-year averages.

The final reductions to establish the TMDLs for Lake Valrico were calculated by using the maximum 7-year average of both the existing and TMDL condition TN and TP loads. The maximum 7-year averages for TN existing loads and TMDL condition loads for the lake are 3,245 and 2,317 kg/yr, respectively. The maximum 7-year averages for TP existing loads and TMDL condition loads for the lake are 418 and 90 kg/yr, respectively (**Table 5.5**). The general equation used to calculate the percent reductions based on maximum 7-year averages is as follows:

$$\frac{\textbf{Existing Load} - \textbf{TMDL Condition Load}}{\textbf{Existing Load}} * 100$$

To meet the TMDL loads for Lake Valrico, the required percent reductions for the TN and TP existing loads are 29 % and 78 %, respectively (**Table 5.5**). The TN and TP TMDLs of 2,317 and 90 kg/yr, respectively, which are expressed as a 7-year average load, not to be exceeded, address the anthropogenic nutrient inputs contributing to the exceedances of the chlorophyll *a* restoration target.

Table 5.5. Lake Valrico TMDL condition nutrient loads, 2011–20

Note: Values shown in boldface type and shaded cells represent the maximum 7-year averages, the 7-year loads used for the calculations, and percent reductions.

Year	Modeled Existing Condition TN Loads (kg/yr)	7-Year Rolling Average TN Loads (kg/yr)	Modeled TMDL Condition TN Loads (kg/yr)	7-Year Rolling Average TN Loads (kg/yr)	Modeled Existing Condition TP Loads (kg/yr)	7-Year Rolling Average TP Loads (kg/yr)	Modeled TMDL Condition TP Loads (kg/yr)	7-Year Rolling Average TP Loads (kg/yr)
2011	2,365		1,816		246		71	
2012	2,917		2,271		318		100	
2013	3,892		2,960		429		112	
2014	2,664		2,046		270		76	
2015	2,862		2,193		311		92	
2016	2,347		1,803		244		71	
2017	4,139	3,027	2,094	2,169	923	392	86	87
2018	3,341	3,166	2,424	2,256	351	407	90	90
2019	3,571	**3,259**	2,699	**2,317**	400	**418**	104	**90**
2020	1,993	2,988	1,543	2,115	196	385	57	82
Maximum 7-Year Average		**3,259**		**2,317**		**418**		**90**
% Reduction				29				78

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:

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

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

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

It should be noted that the various components of the 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 in 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). Stormwater reductions are included in both the MS4 WLA and LA, as applicable. However, in determining the overall stormwater reductions needed, DEP does not differentiate between the MS4 WLA and LA, and instead applies the same overall reductions to both as if the two categories were a single category source, unless otherwise specified.

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, which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure—see 40 Code of Federal Regulations (CFR) § 130.2(i).   The TMDLs for Lake Valrico are expressed in terms of kg/yr and percent reduction of TN and TP and represent the loads of TN and TP that the waterbody can assimilate while maintaining balanced communities of aquatic flora and fauna (see **Table 6.1**). These TMDLs are based on 7-year rolling averages of simulated loads from 2011 to 2020. For the TMDLs, the restoration goal is to achieve the generally applicable chlorophyll *a* criterion of 20 μg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period, thus meeting the water quality criteria and protecting designated uses for Lake Valrico.

Table 6.1 lists the TMDLs for the Lake Valrico Watershed. The TN and TP loads for the lake will constitute the site-specific numeric interpretations of the narrative nutrient criterion set forth in paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in subsection 62-302.531(2), F.A.C., for the lake. Site-specific interpretations for Lake Valrico are expressed as a 7-year rolling annual average load not to be exceeded.

Table 6.1. TMDL components for nutrients in Lake Valrico (WBID 1547A)

Note: The LA and TMDL daily load for TN is 6.4 kg/day and for TP 0.25 kg/day.
NA = Not applicable
* The required percent reductions listed in this table represent the reduction from all sources.

Waterbody (WBID)	Parameter	TMDL (kg/yr)	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)*	LA (% reduction)*	MOS
1547A	TN	2,317	NA	29	29	Implicit
1547A	TP	90	NA	78	78	Implicit

6.2 Load Allocation

To achieve the LA for Lake Valrico, 29 % and 78 % reductions in existing TN and TP loads, respectively, will be required. Load reductions were calculated from 3,259 kg/yr) and a 78 % reduction of TP (calculated from 418 kg/yr), based on the highest seven-year average load from the 2011 – 2020 period. Reductions may need to be adjusted to meet the TMDLs in the future based on future loadings.

The TMDLs are based on the percent reduction in total watershed loading of TN and TP from all anthropogenic sources. However, it is not DEP's intent to abate natural conditions. It should be noted that the LA includes loading 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

As noted in **Chapter 4**, no active NPDES-permitted facilities in the Lake Valrico Watershed discharge into either the lake or the watershed. Therefore, a WLA for wastewater discharges is not applicable.

6.3.2 NPDES Stormwater Discharges

The Lake Valrico Watershed is covered by NPDES MS4 Phase I permit #FLS000006 issued to Hillsborough County and co-permittees. The NPDES stormwater wasteload allocation applies to both existing and future MS4 outfalls that discharge within the watershed or otherwise cause or contribute to the impairment. FDOT neither owns or is responsible for any roadways or outfalls within the Lake Valrico watershed.

6.4 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)). An implicit MOS was used because the TMDLs were based on the conservative decisions associated with a number of the modeling assumptions in determining assimilative capacity (i.e., loading and water quality response). The TMDLs were developed using the maximum seven-year averages for TN and TP existing loads to calculate the percent reductions and requiring the TMDL loads not to be exceeded in any one year.

Chapter 7: Implementation Plan Development and Beyond

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation may take place through various measures, including specific requirements in NPDES wastewater and MS4 permits, and, as appropriate, local or regional water quality initiatives or basin management action plans (BMAPs).

Facilities with NPDES permits that discharge to the TMDL waterbody must implement the permit conditions that reflect target concentrations, reductions, or WLAs identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require a permit holder to prioritize and act to address a TMDL unless management actions to achieve that particular TMDL are already defined in a BMAP. MS4 Phase II permit holders must also implement the responsibilities defined in a BMAP or other form of restoration plan (e.g., a reasonable assurance plan).

7.2 BMAPs

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

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

7.3 Implementation Considerations for the Waterbody

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. Approaches for addressing these potential factors should be included in a comprehensive management plan for the lake.

Given the nature of the loading to Lake Valrico, nonpoint source reductions are required to reach the TMDL target. In the Lake Valrico Watershed, runoff from residential areas is the leading nonpoint source for nutrients. According to Hillsborough County, the Lake Valrico Nutrient

Reduction Feasibility Study is underway to identify primary sources contributing to the impairments identified in Lake Valrico. Following the completion of this study, BMPs will be identified in a manner that most efficiently addresses the impairments and will restore the waterbody to the applicable Class III surface water quality standards. Street sweeping will be conducted in the contributing drainage area surrounding Lake Valrico to reduce nutrient loading from surface runoff. The frequency and scope of the street sweeping efforts may be adjusted as additional BMPs are implemented to best fit nutrient reduction needs.

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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 Valrico
Waterbody type(s)	Lake
WBID	Lake Valrico (WBID 1547A) (see **Figure 1.1** of this report)
Description	Lake Valrico is located in Hillsborough County, between the cities of Tampa and Plant City. The lake and its surrounding watershed cover an area of 1,576 acres. Lake Valrico has a surface area of 135 acres, with an average depth of 4.7 feet. Residential land use predominates in the Lake Valrico Watershed, with 60 % coverage. **Chapter 1** of this report describes the Lake Valrico system in more detail.
Specific location (latitude/longitude or river miles)	The center of Lake Valrico is located at N: 27°57'13"/W: -82°15'29." The site-specific criteria apply as a spatial average for the lake, as defined by WBID 1547A.
Map	**Figure 1.2** shows the general location of Lake Valrico and its associated watershed, and **Figure 4.1** shows the land uses in the watershed.
Classification(s)	Class III Freshwater
Basin name (HUC 8)	Hillsborough River Basin (03100205)

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 Valrico is a low-color, high-alkalinity lake, 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:** For Lake Valrico the 7-year rolling average TN and TP loads are 2,317 and 90 kg/yr, respectively. Nutrient concentrations are provided for informational purposes only. The in-lake TN and TP AGM concentrations for Lake Valrico at the allowable TMDL loading are 0.99 and 0.028 mg/L, respectively, not to be exceeded more than once in any consecutive 3-year period. These restoration concentrations represent the in-lake concentrations that would still meet the target chlorophyll *a* concentration of 20 µg/L with a 1-in-3-year exceedance rate.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	The criteria were developed based on the application of the curve number method and the BATHTUB model, which simulated hydrology and water quality conditions from 2011 to 2020 for Lake Valrico. The primary datasets for this period include water quality data from IWR Run 62, Dover Station Weather Data, and 2017 SWFWMD land use coverage. **Sections 2.3** and **4.4** of this report provide a complete description of the data used in the derivation of the proposed site-specific criteria.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	The BATHTUB model was used to simulate lake conditions in the 2011–20 period. The period included wet and dry years. Long-term average rainfall for the Lake Valrico Watershed from 1893 to 2020 was 54 in/yr. During the simulation period, wetter than average conditions occurred in 2013, 2018, and 2019, while drier than average conditions were present in 2012, 2017, and 2020. This period captures the hydrologic variability of the system. The curve number approach model simulated loads generated in the watershed to evaluate how changes in watershed loads impact lake nutrient and chlorophyll *a* concentrations. **Figure 2.1** shows the locations of the sampling stations in Lake Valrico. Monitoring stations were located throughout the lake and represent the spatial distribution of nutrient dynamics in the lake.

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 Valrico (WBID 1547A). Firstly, the NNC were used to assess Lake Valrico during the Cycle 3, Group 2 assessment (the verified period: January 1, 2007–June 30, 2014), based on data from IWR Run 50 and later, During the Cycle 4, Group 2 assessment (the verified period: January 1, 2012–June 30, 2019), based on data from IWR Run 58. Lake Valrico was determined to be verified impaired for chlorophyll *a*, TN, and TP. **Table 2.4** lists the AGM values for chlorophyll *a*, TN, and TP during the verified period for the waterbody.
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 Valrico that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lake.
Approach used to develop criteria and how it protects uses	For the Lake Valrico nutrient TMDLs, DEP created loading-based criteria using the curve number method to simulate loading from the Lake Valrico Watershed, and this information and other loading data from atmospheric deposition, OSTDS, and groundwater to the lake were inputs into BATHTUB. DEP established the site-specific TN and TP loadings using the calibrated models to achieve an in-lake chlorophyll *a* AGM concentration of 20 µg/L. The maximum of the 7-year rolling averages of TN and TP loadings to achieve the chlorophyll *a* target was determined by decreasing TN and TP loads from anthropogenic sources into the lake until the chlorophyll *a* target was achieved. **Chapter 3** of this report describes the derivation of the TMDLs and criteria.
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	Model simulations indicated that the target chlorophyll *a* concentration (20 µg/L) in the lake will be attained at the TMDL loads for TN and TP. DEP notes that no other impairments were verified for Lake Valrico that may be related to nutrients (such as dissolved oxygen [DO] or un-ionized ammonia). Reducing the nutrient loads entering the lake will not negatively affect other water quality parameters in the lake.

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 Valrico discharges into Long Pond (WBID 1547B) and then Seffner Canal (WBID 1547), which flows into Lake Thonotosassa (WBID 1522B) via Baker Creek (WBID 1522C). Based on the most recent assessment, Long Pond, Seffner Canal, and Baker Creek are not verified impaired for nutrients. As evidenced by the healthy existing condition in Long Pond, Seffner Canal, and Baker Creek, the existing loads from Lake Valrico to the downstream waters have not led to impairments. The restoration nutrient target concentrations for Lake Thonotosassa are TN and TP values of 1.64 and 0.08 mg/L, respectively (DEP 2019). In comparison, the target concentrations of Lake Valrico for TN and TP are 0.99 and 0.028 mg/L, respectively. Since the nutrient targets for Lake Valrico are lower than those for Lake Thonotosassa, the TMDLs for Lake Valrico are protective of the downstream lake. Therefore, the reductions in nutrient loads prescribed in the TMDLs for Lake Valrico are not expected to cause nutrient impairments downstream.
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.	Hillsborough County and DEP conduct routine monitoring of Lake Valrico. The data collected through these monitoring activities will be used to evaluate the effect of BMPs implemented in the watershed on lake TN and TP loads in subsequent water quality assessment cycles.

Table B-5. Documentation of endangered species consideration

Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	DEP is not aware of any aquatic, amphibious, or anadromous endangered species present in the Lake Valrico Watershed. Furthermore, it is expected that restoration efforts and subsequent water quality improvements will positively affect aquatic species living in the lake and its watershed.

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 June 2, 2021, to initiate TMDL development for impaired waters in the Tampa Bay Tributaries Basin. A rule development public workshop for the TMDLs was held on January 21, 2022.
Hearing requirements and adoption format used; responsiveness summary	Following the publication of the Notice of Proposed Rule, DEP will provide a 21-day challenge period and a public hearing that will be noticed no less than 45 days prior.
Official submittal to EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered as site-specific interpretations of the narrative nutrient criterion and will submit these documents to the EPA.

Appendix C. Estimating the Runoff Volume and Nutrient Loads from the Lake Valrico Watershed

A. NRCS Curve Number Approach

The stormwater runoff volume for these TMDLs was estimated using the same spreadsheet model created by SJRWMD (Fulton et al. 2004). The key function of this spreadsheet model is to estimate the annual average runoff coefficient (ROC) for each land use–soil type combination for each year. Once the ROC is decided, the runoff volume can be calculated as the product of rainfall, ROC, and acreage of the land use–soil type combination.

SJRWMD's runoff volume spreadsheet model was built based on a land use classification with 15 categories. Each land use was associated with 4 soil hydrologic groups (Types A, B, C, and D), resulting in a total of 60 land use–soil type combinations. To calculate the runoff volume for the entire Lake Valrico Watershed and, at the same time, quantify the runoff contribution from each land use area, the ROC for each land use–soil type combination must be estimated. SJRWMD's runoff model achieved this goal by estimating a watershed-basin average stormwater runoff coefficient ($ASRC_{wb}$) first, and then deriving the ROC for land use–soil type combination.

The NRCS curve number approach estimates the runoff volume from a given land surface using **Equation 1**:

$$Q = \frac{\left(P - 0.2*S\right)^2}{P + 0.8*S}$$ **Equation 1**

Where,

Q = Runoff volume (inches).
P = Rainfall amount (inches).
S = Potential soil storage (inches), which can be calculated using **Equation 2**:

$$S = \frac{1000}{CN} - 10$$ **Equation 2**

Where,

CN = Curve number.

The curve number is a dimensionless value ranging from 0 to 100. It is used in the runoff equation to characterize the runoff potential for different land use–soil combinations. Specific curve numbers are assigned to different combinations. In addition, curve numbers are influenced by the antecedent moisture condition (AMC) of the soil. **Table C-1** lists the curve numbers used in developing these TMDLs. These numbers were cited in Suphunvorranop (1985) and were also used by SJRWMD in developing the nutrient PLRG for the Upper Ocklawaha Chain of Lakes.

The curve numbers listed in **Table C-1** are established for the average soil AMC, which is commonly referred to as AMC II. The low and high soil AMCs are usually referred to as AMC I and AMC III, respectively. In the curve number approach, the soil AMC status is judged by comparing the total amount of rainfall a given watershed area received for a total of five days with a set of five-day threshold rainfall values in either the dormant season or the growth season. **Table C-2** lists the five-day threshold rainfall values used to determine the soil AMC for these TMDLs. **Table C-3** lists the curve numbers under the AMC I and AMC III corresponding to each curve number value under the AMC II condition.

Table C-1. Curve numbers by hydrologic soil groups and land use types

Land Use	Soil Group A	Soil Group B	Soil Group C	Soil Group D
Low-density residential	51	68	79	84
Medium-density residential	57	72	81	86
High-density residential	77	85	90	92
Low-density commercial	77	85	90	92
High-density commercial	89	92	94	95
Industrial	81	88	91	95
Mining	32	58	72	79
Open land/recreational	49	69	79	84
Pasture	47	67	81	88
Cropland	64	75	82	84
Tree crops	32	58	72	79
Other agriculture	59	74	82	86
Forest/rangeland	36	60	73	79
Water	98	98	98	98
Wetlands	89	89	89	89

Table C-2. Threshold five-day antecedent rainfall volume (inches) for AMC classification

Soil AMC Classification	Dormant Season (November–March)	Growth Season (April–October)
I	< 0.5	< 1.4
II	0.5 – 1.1	1.4 – 2.1
III	> 1.1	> 2.1

**Table C-3.	Relationship between curve numbers under AMCs I, II, and III**

AMC I	AMC II	AMC III
0	0	0
2	5	17
4	10	26
7	15	33
9	20	39
12	25	45
15	30	50
19	35	55
23	40	60
27	45	65
31	50	70
35	55	75
40	60	79
45	65	83
51	70	87
57	75	91
63	80	94
70	85	97
78	90	98
87	95	99
100	100	100

One common practice to calculate runoff volume from a given watershed using the curve number approach is to calculate the runoff from the pervious and impervious areas, and then add the runoff volumes from these two areas together to determine total watershed runoff. To apply this method, the impervious areas are usually divided into two types: directly connected impervious area (DCIA) and nondirectly connected impervious area (NDCIA). The DCIA represents the areas that are directly connected to the stormwater drainage system. It is typically assumed that 90 % of the rainfall onto the DCIA will become runoff.

In contrast, the runoff created from the NDCIA will reach the pervious area and contributes to pervious area runoff. Therefore, the NDCIA typically is not considered as part of the impervious area but as part of the pervious area. **Table C-4** lists the percent areas occupied by DCIA, NDCIA, and pervious areas for each land use type used in developing the TMDLs. SJRWMD used these percent area values in developing the nutrient PLRG for the Upper Ocklawaha Chain of Lakes. The values included in the table were assembled by Camp Dresser and McKee (CDM) (1994).

The total runoff from a watershed can be represented using **Equation 3**:

$$Q = Q_{Pervious} + Q_{DCIA}$$ **Equation 3**

Where,

Q = Total runoff from the watershed area (centimeters [cm]).
$Q_{Pervious}$ = Runoff from the pervious area (cm).
Q_{DCIA} = Runoff from the DCIA (cm).

Table C-4. Land use–specific percent DCIA, NDCIA, and pervious area

Note: This table was cited from SJRWMD's nutrient PLRG for the Upper Ocklawaha River Basin. Data were assembled by CDM (1994).

Land Use	DCIA	NDCIA	Pervious Area	Sum of NDCIA and Pervious Area
Low-density residential	5	10	85	95
Medium-density residential	15	20	65	85
High-density residential	25	40	35	75
Low-density commercial	40	40	20	60
High-density commercial	45	35	20	55
Industrial	50	30	20	50
Mining	1	1	98	99
Open land/recreational	1	1	98	99
Pasture	1	1	98	99
Cropland	1	1	98	99
Tree crops	1	1	98	99
Other agriculture	1	1	98	99
Forest/rangeland	1	1	98	99
Water	85	15	0	15
Wetland	75	0	25	25

Q_{DCIA} can be calculated using **Equation 4**:

$$Q_{DCIA} = P * 0.9 * \left(\frac{DCIA}{TotalArea}\right)$$ **Equation 4**

Where,

P = Rainfall (cm).
$DCIA$ = Area of DCIA.
$TotalArea$ =Total watershed area.

$Q_{Pervious}$ can be calculated using **Equation 5**:

$$Q_{Pervious} = \frac{(P' - 0.2 * S)^2}{P' + 0.8 * S} * (\frac{PerviousArea}{TotalArea}) \qquad \textbf{Equation 5}$$

Where,

> *P'* = Adjusted rainfall (centimeters [cm]).
> *S* = Potential soil storage of rainfall (cm).
> *PerviousArea* = Acreage of the pervious area in the watershed.

Measured rainfall was adjusted in **Equation 5** to account for rain falling in the NDCIA. It was assumed that rainfall on these areas would reach and uniformly spread out onto the pervious area. To account for rainfall to the NDCIA, the measured rainfall was adjusted using **Equation 6**.

$$P' = \frac{P * PerviousArea + P * NDCIA}{PerviousArea} \qquad \textbf{Equation 6}$$

Where,

> *NDCIA* = Area of NDCIA.

Equation 6 can be simplified to **Equation 7**:

$$P' = P * (1 + \frac{NDCIA}{PerviousArea}) \qquad \textbf{Equation 7}$$

The potential soil storage can be calculated using **Equation 8**:

$$S = \frac{1000}{CNpervious} - 10 \qquad \textbf{Equation 8}$$

Where,

> $CN_{Pervious}$ = Curve number for the pervious area.

$CN_{Pervious}$ can be derived from the watershed average curve number, calculated using **Equation 9**:

$$CN_{Watershed} = \frac{\sum (Area * CN)}{TotalArea} \qquad \textbf{Equation 9}$$

Where,

$CN_{Watershed}$ = Watershed average curve number.
CN = Land use–soil combination specific curve number listed in **Table 4.3**.
$Area$ = Area occupied by a specific land use–soil combination.
$TotalArea$ = Total area of the entire watershed.

$CN_{Watershed}$ can also be represented using **Equation 10**:

$$CN_{Watershed} = \frac{(CN_{DCIA} * Area_{DCIA}) + (CN_{Pervious} * Area_{Pervious})}{TotalArea} \quad \textbf{Equation 10}$$

Where,

CN_{DCIA} = Curve number of the DCIA.
$Area_{DCIA}$ = Acreage occupied by the DCIA.
$Area_{Pervious}$ = Acreage of the watershed occupied by both the NDCIA and pervious area.

Equation 10 can be rewritten to solve for $CN_{Pervious}$ as **Equation 11**:

$$CN_{Pervious} = \frac{(CN_{Watershed} * TotalArea) - (CN_{DCIA} * Area_{DCIA})}{Area_{Pervious}} \quad \textbf{Equation 11}$$

With all the above equations, the watershed runoff volume Q defined in **Equation 4** can be calculated. The watershed-basin average $ASRC_{wb}$ can be calculated as the quotient between the watershed runoff volume and rainfall to the watershed.

$ASRC_{wb}$ can also be represented using **Equation 12**:

$$ASRC_{wb} = \frac{(DCIA * 0.9) + (PerviousArea * WRC_{Pervious})}{TotalArea} \quad \textbf{Equation 12}$$

Equation 12 can be rewritten to solve for the weighted runoff coefficient (WRF) for the pervious area (**Equation 13**):

$$WRC_{Pervious} = \frac{(ASRC_{wb} * TotalArea) - (DCIA * 0.9)}{PerviousArea} \quad \textbf{Equation 13}$$

When developing the nutrient PLRG for the Upper Ocklawaha Chain of Lakes, SJRWMD assumed that Type D soil would have four times the runoff compared with Type A (Fulton et al.

2004). This assumption was made based on the typical depth to groundwater and the resultant soil storage (**Table C-5**).

Table C-5. Groundwater depth and soil runoff potential

PRC = Proportional runoff coefficient

Soil Type	Depth to Groundwater (m)	Runoff Ratio	Soil Type Coefficient
A	>1.2	1	PRC
B	0.9	2	2*PRC
C	0.6	3	3*PRC
D	0.3	4	4*PRC

Based on this assumption, $WRC_{Pervious}$ can also be represented using **Equation 14**:

$$WRC_{Pervious} = \frac{PRC * Area_{Asoil} + 2PRC * Area_{Bsoil} + 3PRC * Area_{Csoil} + 4PRC * Area_{Dsoil}}{PerviousArea}$$

Equation 14

Where,

PRC = Proportional runoff coefficient.
$AreaAsoil$ = Area occupied by Type A soil.
$AreaBsoil$ = Area occupied by Type B soil.
$AreaCsoil$ = Area occupied by Type C soil.
$AreaDsoil$ = Area occupied by Type D soil.

Equation 14 can be rewritten to solve for PRC (**Equation 15**):

$$PRC = \frac{PerviousArea * WRC_{Pervious}}{Area_{Asoil} + 2 * Area_{Bsoil} + 3 * Area_{Csoil} + 4 * Area_{Dsoil}}$$ **Equation 15**

The final area WRF for each land use–soil combination ($ASRC_{LS}$) is calculated using **Equation 16**:

$$ASRC_{LS} = \frac{(DCIA_{LS} * 0.9) + (PerviousArea_{LS} * n * PRC)}{TotalArea_{LS}}$$ **Equation 16**

Where,

$DCIA_{LS}$ = DCIA occupied by a specific land use–soil type combination.

$PerviousArea_{LS}$ = Pervious area (including the NDCIA) occupied by a specific land use–soil type combination.

n = Runoff ratio listed in **Table C-5**. The n values for Type A, B, C, and D soils are 1, 2, 3, and 4, respectively.

$TotalArea_{LS}$ = Total area occupied by a specific land use–soil type combination.

Rainfall data from the Crescent City station were used in calculating the ROC and runoff volume for the TMDLs. **Table 4.3** summarizes the annual rainfall to the Lake Valrico Watershed for each year from 2010 to 2019. **Table C-6** lists the ROCs for each land use–soil type combination for each year from 2000 to 2012. **Table 4.4** lists the annual runoff volume from different land use areas in the Lake Valrico Watershed.

Table C-6. Runoff coefficient for different land use–soil type combinations for each year, 2011–20

NA = Not applicable because there is no such land use or soil type.

Land Use	Soil	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Low-density residential	A	0.075	0.110	0.111	0.068	0.089	0.074	0.102	0.078	0.109	0.062
Low-density residential	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Low-density residential	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Low-density residential	D	0.167	0.307	0.308	0.135	0.220	0.161	0.271	0.177	0.300	0.114
Medium-density residential	A	0.162	0.194	0.194	0.155	0.174	0.161	0.186	0.165	0.192	0.150
Medium-density residential	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Medium-density residential	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Medium-density residential	D	0.244	0.369	0.371	0.216	0.291	0.239	0.337	0.253	0.363	0.197
High-density residential	A	0.249	0.277	0.277	0.243	0.259	0.248	0.270	0.251	0.275	0.239
High-density residential	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
High-density residential	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
High-density residential	D	0.321	0.432	0.433	0.296	0.363	0.316	0.404	0.330	0.426	0.280
Low-density commercial	A	0.379	0.401	0.402	0.374	0.388	0.378	0.396	0.381	0.400	0.371
Low-density commercial	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Low-density commercial	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Low-density commercial	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
High-density commercial	A	0.423	0.443	0.443	0.418	0.430	0.422	0.438	0.424	0.442	0.415
High-density commercial	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
High-density commercial	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
High-density commercial	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Industrial	A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Industrial	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Industrial	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Industrial	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mining	A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mining	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mining	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mining	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Open land/recreational	A	0.041	0.077	0.078	0.033	0.054	0.039	0.068	0.043	0.075	0.027
Open land/recreational	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Open land/recreational	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Land Use	Soil	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Open land/recreational	D	0.136	0.282	0.283	0.103	0.191	0.130	0.245	0.147	0.275	0.081
Pasture	A	0.041	0.077	0.078	0.033	0.054	0.039	0.068	0.043	0.075	0.027
Pasture	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pasture	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pasture	D	0.136	0.282	0.283	0.103	0.191	0.130	0.245	0.147	0.275	0.081
Cropland	A	0.041	0.077	0.078	0.033	0.054	0.039	0.068	0.043	0.075	0.027
Cropland	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cropland	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cropland	D	0.136	0.282	0.283	0.103	0.191	0.130	0.245	0.147	0.275	0.081
Tree crop	A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tree crop	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tree crop	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tree crop	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other agriculture	A	0.041	0.077	0.078	0.033	0.054	0.039	0.068	0.043	0.075	0.027
Other agriculture	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other agriculture	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other agriculture	D	0.136	0.282	0.283	0.103	0.191	0.130	0.245	0.147	0.275	0.081
Forest/rangeland	A	0.041	0.077	0.078	0.033	0.054	0.039	0.068	0.043	0.075	0.027
Forest/rangeland	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Forest/rangeland	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Forest/rangeland	D	0.136	0.282	0.283	0.103	0.191	0.130	0.245	0.147	0.275	0.081
Water	A	0.770	0.775	0.775	0.769	0.772	0.770	0.774	0.770	0.775	0.768
Water	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Water	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Water	D	0.784	0.806	0.807	0.779	0.793	0.783	0.801	0.786	0.805	0.776
Wetland	A	0.683	0.692	0.692	0.681	0.686	0.683	0.690	0.684	0.692	0.680
Wetland	B	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetland	C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetland	D	0.707	0.744	0.744	0.699	0.721	0.705	0.735	0.710	0.742	0.693

B. Estimating Runoff Nutrient Loads

The runoff nutrient loads from a watershed are calculated by multiplying the runoff volume from the land use area by runoff TN and TP concentrations specific to the land use type. These runoff nutrient concentrations are commonly referred to as EMCs. EMCs can be determined through stormwater studies, in which both runoff volume and runoff nutrient concentrations are measured during the phases of a given stormwater event. The EMC for the stormwater event is then calculated as the mean concentration weighted for the runoff volume. The TN and TP EMCs (**Table C-7**) used in this TMDL analysis were based on general land use descriptions and were spatially averaged data in Florida (Harper 1994; 2012).

Nutrient removal by stormwater treatment facilities in urban areas was also considered in simulating watershed nutrient loads. It was assumed that all urban construction after 1984, when Florida implemented the Stormwater Rule, had some type of stormwater treatment facilities to remove TN and TP loads at certain efficiencies. To identify the construction taking place after 1984, the watershed land use distribution data from 2015 were compared with the land use distribution geographic information system (GIS) shape file of 1988, which was the earliest land use GIS shape file available in DEP's GIS DataMiner.

It was assumed that the urban land use areas included in the 1988 land use shape file did not have any stormwater treatment facilities required by the state Stormwater Rule. This assumption should be close to reality because the 1988 land use shape file was created based on 1987 land use aerial photography. Compared with the period from 1984 to 2015, the chances of missing some urban construction taking place between 1984 and 1987 were relatively small and therefore should not cause significant errors for nutrient load simulation. Any urban land areas that did not appear in the 1988 land use shape file but appeared in the 2015 land use shape files were considered new construction with stormwater treatment facilities.

When calculating watershed nutrient loads, the loads from these urban land use areas are subject to the stormwater treatment and TN and TP removal at certain percentages. Based on studies of 13 stormwater treatment systems, it was assumed that these urban stormwater facilities can remove 63 % of the phosphorus load and 42 % of the nitrogen load (Fulton et al. 2004).

Table C-7. EMCs of TN and TP for different land use types

Land Use	TP EMC (mg/L)	TN EMC (mg/L)
Low-density residential	0.178	1.51
Medium-density residential	0.301	1.87
High-density residential	0.497	2.10
Low-density commercial	0.179	1.07
High-density commercial	0.248	2.2
Industrial	0.213	1.19
Mining	0.150	1.18
Pasture	0.621	3.30
Tree crops	0.152	2.07
Cropland	0.489	2.46
Other agriculture	1.050	3.24
Open land/recreational	0.301	1.87
Forest/rangeland	0.055	1.15
Wetlands	0.055	1.15
Water	0.025	0.716

Another aspect of the nutrient load simulation was the effective delivery of nutrients to the receiving water after going through the overland transport process. In this TMDL analysis, all dissolved components of TN and TP were considered to reach the receiving water without any loss, while particulate fractions of TN and TP were considered subject to loss through the overland transport process. Therefore, the amount of nutrients eventually reaching the receiving water includes two components: the unattenuated dissolved fraction (T) and the particulate fraction that is attenuated through the overland transport process. The portion of the nutrients that eventually reaches the receiving water can be represented using **Equation 7**, which is a function established in the Reckhow et al. (1989) analyses.

$$D = (1 - T) * e^{(1.01 - 0.34 * \ln(L))} + T \qquad \textbf{Equation 17}$$

Where,

D = Amount of nutrients that eventually reaches the receiving water.
T = Dissolved fraction of the total nutrient (TN and TP) concentrations.
(1-T) = Particulate fraction of the total nutrient (TN and TP) concentrations.
The exponential portion of the equation represents the delivery ratio of the particulate nutrients.
L = Length of the overland flow path.

The percent dissolved TN and TP concentrations for different land uses used in this TMDL analysis were cited from SJRWMD's Upper Ocklawaha Chain of Lakes PLRG report (Fulton et al. 2004). These numbers were created by comparing concentrations of TN, TP, orthophosphate (PO_4), total dissolved phosphorus (TDP), and total dissolved nitrogen (TDN) from several studies on stormwater runoff conducted in Florida (Dierberg 1991; Fall 1990; Fall and Hendrickson 1988; German 1989; Harper and Miracle 1993; Hendrickson 1987; Izuno et al. 1991). **Table C-8** lists the percent concentration of dissolved phosphorus and nitrogen for different land uses.

The length of the overland flow path was estimated by randomly picking 20 transects of the watershed and measuring the distance between the boundary of the watershed and the boundary of the lake. The final length of the overland flow path was calculated as the mean values of the lengths of these 20 transect measurements. For the Lake Valrico Watershed, the average length of the overland flow path was estimated this way as 974 m.

Table 4.4 lists the stormwater runoff TN and TP loads from the Lake Valrico Watershed estimated using the procedures described above.

Table C-8. Dissolved fraction of TN and TP concentrations for different land uses

Land Use	Dissolved Phosphorus (%)	Dissolved Nitrogen (%)
Low-density residential	50.1	75.3
Medium-density residential	50.1	75.3
High- density residential	50.1	75.3
Low-density commercial	41.4	65.7
High- density commercial	76.7	76.7
Industrial	76.1	76.1
Mining	46.7	65.7
Pasture	72.2	90.8
Tree crop	62.9	90.8
Cropland	60.0	90.8
Other agriculture	68.7	90.8
Open land/recreational	50.1	75.3
Forest/rangeland	50.1	75.3
Wetlands	50.7	77.5
Water	11.8	41.3

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