Final TMDL Report

Nutrient TMDLs for Lake Adair (WBID 2997R)

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

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Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) for nutrients for Lake Adair in the Middle St. Johns River Basin. The TMDLs will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(90)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), F.A.C., for this particular water. The lake 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 initially included on the Verified List of impaired waters for the Middle St. Johns River Basin that was adopted by Secretarial Order on May 27, 2004.

According to the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida), once a waterbody is included on the Verified List, a TMDL must be developed. The purpose of these TMDLs is to establish the allowable loadings of pollutants to Lake Adair that would restore the waterbody so that it meets its applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

Lake Adair is located near downtown Orlando in the Middle St. Johns River Basin and the Lake Jesup Planning Unit (**Figure 1.1**). A 25-acre lake with a mean depth of 2.9 meters (m) is situated in the urbanized Orlando area (Lake Region 75-21) where a karst area consists primarily of Miocene-age quartz sands and pebbles imbedded in kaolinitic clay (Griffith et al. 1997).

Lake Adair receives upstream flow from Spring Lake, located west of Orange Blossom Trail (U.S. Highway 441). Spring Lake overflows at an elevation of 88.1 feet via a culvert under Highway 441 to the Overbrook Creek Canal, which connects to the southwest corner of Lake Adair. The natural hydrologic connection between Spring Lake and Lake Adair was altered over 100 years ago by the construction of a railroad (McCann et al. 1997). Lake Adair discharges to Lake Concord via drainage pipes under Edgewater Drive. Water levels in Lake Adair are also controlled by a drainage well located in the northeast corner of the lake, which connects to the Upper Floridan aquifer. These lakes are part of the Howell Branch Chain of Lakes, which ultimately flows to Lake Jesup.

The elevation of the Lake Adair watershed ranges from 80 feet immediately adjacent to the lake to 100 feet along the watershed boundary. The main sources of water to the lake include surface runoff from the watershed, stormwater from conveyance systems, seepage flow from groundwater, and direct rainfall onto the lake surface. Based on lake stage data collected for the period from August 2, 2008, to September 4, 2013, the average lake elevation is 76 feet National Geodetic Vertical Datum (NGVD).

Long-term average annual rainfall obtained from the National Climatic Data Center at the Orlando International Airport weather station for the period from 1942 to 2005 is 50 inches/year (in/yr), with monthly rainfall values ranging from 1.97 inches during November to 7.76 inches during July. The annual average air temperature, based on data collected from 2000 through 2012 from the Orlando International Airport weather station, is 23^{o} C. The summer maximum temperature ranges between 35^{o} and 37^{o} C.

For assessment purposes, the Florida Department of Environmental Protection (DEP) has divided the Middle St. Johns River Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Lake Adair is WBID 2997R.

1.3 Background

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

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

This TMDL report will be followed by the development and implementation of a restoration plan to reduce the amount of nutrients that caused the verified impairment of Lake Adair. Restoration activities will depend on the active participation of the City of Orlando, Orange County, residents and businesses in the watershed, and other stakeholders. DEP will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for the impaired waterbody.

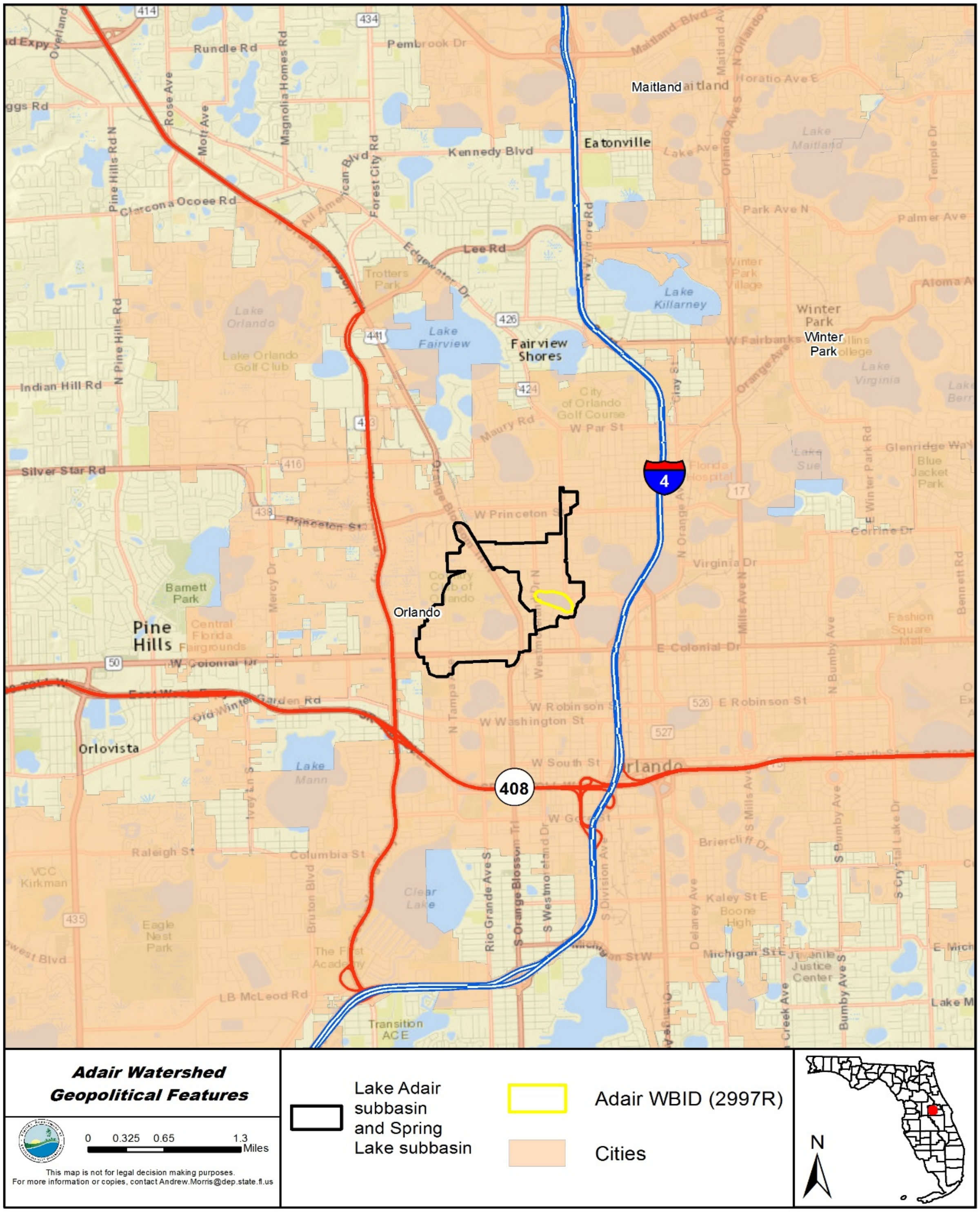


Figure 1.1. Geographic location of Lake Adair in Central Florida and major geopolitical features in the area

Chapter 2: Description of Water Quality Problem

2.1 Statutory Requirements and Rulemaking History

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

The FWRA (Section 403.067, Florida Statutes [F.S.]) stated that all previous Florida 303(d) lists were for planning purposes only and directed DEP to develop, and adopt by rule, a new science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the new methodology as Chapter 62-303, F.A.C. (Identification of Impaired Surface Waters Rule, or 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 updates for each basin statewide.

2.2 Information on Verified Impairment

DEP used the IWR to assess water quality impairments in the Middle St. Johns River Basin and verified that Lake Adair was impaired for nutrients based on elevated annual average Trophic State Index (TSI) values during the Cycle 1 verified period (January 1, 1996–June 30, 2003) for the Group 2 Middle St. Johns River Basin. At the time, the Cycle 1 assessment was performed, the IWR methodology used the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll *a* to calculate annual TSI values and to interpret Florida's narrative nutrient criterion.

The TSI thresholds were set based on annual mean color, where high-color lakes (> 40 platinum cobalt units [PCU]) had a TSI threshold of 60, and lower color lakes (≤ 40 PCU) had a TSI threshold of 40. Exceeding the TSI threshold in any single year of the verified period was sufficient for identifying a lake as impaired for nutrients. For the Cycle 1 assessment, Lake Adair was classified as a high-color lake and had annual mean TSI values exceeding the impairment threshold of 60 from 1996 to 2001.

On July 2, 2012, the IWR was amended to incorporate the numeric interpretations of Florida's narrative nutrient criterion (Rule 62-302.531, F.A.C.). Under the revised IWR methodology, lakes are assessed for chlorophyll *a*, TN, and TP as individual parameters, and the TSI is no longer used. In Cycle 3, the IWR methodology reflected this rule amendment. For each lake, the methodology used an annual geometric mean (AGM) corrected chlorophyll *a* criterion of 20 micrograms per liter (µg/L), and a TN criterion that ranged from 1.05 to 1.91 milligrams per liter [mg/L]) and a TP criterion that ranged from 0.03 to 0.09 mg/L. These numeric interpretations vary annually, depending on the chlorophyll *a* data. At the time of the Group 2 Cycle 3 assessments (planning period, January 1, 2002–December 31, 2011; verified period, January 1, 2007–June 30, 2014), all waterbodies previously determined to be impaired for TSI were placed into Category NA Delist (Not Applicable) per Rule 62-303.720(2)(l), F.A.C.

Under the revised methodology, Lake Adair was found to be impaired for chlorophyll *a* (exceeding the criterion in 2002, 2005–07, and 2012–14), TN (exceeding the criterion each year an AGM could be calculated, 2005–07, and 2012), and TP (exceeding the criterion in 2002, 2005–07 and 2012–14). The lake was submitted to EPA as an addition to the 303(d) list for these parameters.

Chapter 3. Description of Applicable Water Quality Standards and Targets

3.1 Classification of the Waterbody and Criteria Applicable to the TMDLs

Florida's surface waters are protected for six designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Fish consumption; recreation; and/or propagation and maintenance of a healthy, well-balanced population of fish and wildlife**
Class III–Limited	**Fish consumption; recreation or limited recreation; and/or propagation and maintenance of a limited population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Lake Adair 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 criteria applicable to the verified impairment (nutrients) for this water are Florida's numeric nutrient criteria (NNC) in Subparagraph 62-302.531(2)(b)1, F.A.C., Florida adopted NNC for lakes in 2011. These were approved by the EPA in 2012 and became effective on October 27, 2014.

3.2 Generally Applicable Numeric Interpretation of the Narrative Nutrient Criterion

The lake NNC are expressed as AGM values for chlorophyll *a*, TN, and TP, and are dependent on alkalinity and true color (color), based on long-term period of record (POR) geometric means. For the purpose of Subparagraph 62-302.531(2)(b)1., F.A.C., color is assessed as true color and should be free from turbidity. Lake color and alkalinity are based on a minimum of 10 data points over at least 3 years with at least 1 data point in each year.

Based on the long-term geometric mean color and alkalinity for the lake (26 PCU and 60.7 mg/L, respectively), Lake Adair is classified as low color (<40 PCU) and high alkalinity (>20 mg/L $CaCO_3$), as shown in **Table 3.1.**

Table 3.1. Lake Adair long-term geometric means for color and alkalinity for the period of record

N	Long-Term Geometric Mean	Number of Samples
Color (PCU)	26	18
Alkalinity (mg/L $CaCO_3$)	60.7	68

The chlorophyll *a* NNC for low-color, high-alkalinity lakes is an AGM value of 20 µg/L, not to be exceeded more than once in any consecutive three-year period. The associated TN and TP criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the concentrations of nutrients and chlorophyll *a* in the lake. If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type, 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. If there are insufficient data to calculate the AGM chlorophyll *a* for a given year, or if the AGM chlorophyll *a* exceeds the applicable value for the lake type, then the applicable numeric interpretations for TN and TP are the minimum values. **Table 3.2** lists the NNC for Florida lakes specified in Subparagraph 62-302.531(2)(b)1., F.A.C.

Table 3.2. Applicable NNC for lakes in Florida

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

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

Lake Adair does not meet the generally applicable NNC for low color, high alkalinity lakes based on a preliminary analysis of the available data and therefore remains impaired for nutrients. The nutrient TMDLs presented in this report, upon adoption into Rule 62-304, F.A.C., will constitute site-specific numeric interpretations of the narrative nutrient criterion in Paragraph 62-302.530(90)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for this particular water, pursuant to Paragraph 62-302.531(2)(a), F.A.C.

Appendix A summarizes the relevant details to support the determination that the TMDLs provide for the protection of Lake Adair, and 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.

TMDL targets and water quality criteria are generally very similar, as both measures are used to protect the designated uses of surface waters. In fact, for many non-nutrient TMDLs, the TMDL target is the applicable water quality criterion, and the TMDL identifies the load that will attain the concentration-based criteria. This is the case for some nutrient TMDLs in which the target is to attain the generally applicable NNC (for a lake, for example), and the TMDL establishes the allowable nutrient load. Under Florida's nutrient standard in Rule 62-302.531, F.A.C., the allowable load becomes the applicable NNC for a lake when the TMDL is adopted.

3.3 Site-Specific Interpretations of the Narrative Nutrient Criterion for Lake Adair

The development of the generally applicable lake NNC was based on the selection of a protective chlorophyll *a* criterion and then evaluation of the relationship between chlorophyll *a* and TN and TP to develop the TN and TP loads as the site-specific TN and TP interpretations of the narrative nutrient criterion protective of designated uses. Based on several lines of evidence, DEP developed a chlorophyll *a* criterion of 20 μg/L for low-color lakes (below 40 PCU) and clear lakes with alkalinity above 20 mg/L $CaCO_3$ (DEP 2012). The chlorophyll *a* criteria were established by taking into consideration results from paleolimnological studies, expert opinions, biological responses, user perceptions, and chlorophyll *a* concentrations in a set of carefully selected reference lakes (DEP 2012).

DEP 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. Based on the best available scientific information, there are no data suggesting that a chlorophyll *a* criterion different from 20 μg/L is necessary to protect the designated uses of Lake Adair, and DEP concluded that the chlorophyll *a* criterion of 20 μg/L is appropriate to address the nutrient impairment of Lake Adair.

The TN and TP loads identified as the site-specific TN and TP interpretations of the narrative nutrient criterion were determined by using watershed and waterbody models to find watershed TN and TP loadings that will achieve the chlorophyll *a* criterion of 20 μg/L. The simulated chlorophyll *a* corresponding to the simulated TN and TP loads were also compared against the model-simulated natural background chlorophyll *a* to avoid abating the natural background condition. Based on the model simulation, as described in **Chapter 5**, the modeled chlorophyll *a* concentration under the natural background condition did not exceed the chlorophyll *a* criterion of 20 µg/L for Lake Adair. Therefore, the 20 µg/L chlorophyll *a* NNC was used as the site-specific chlorophyll *a* criterion and TMDL target.

Chapter 5 contains details on the simulation of the TN and TP loads that achieved the AGM chlorophyll *a* of 20 μg/L, and selected as the site-specific TN and TP interpretations of the narrative nutrient criterion for Lake Adair. **Table 3.3** summarizes the chlorophyll *a* target and the TMDL loads for TN and TP.

Table 3.3. Site-specific interpretations of the narrative nutrient criterion

WBID	AGM Chlorophyll *a* (µg/L)	7-Year Annual Average TN (lbs/yr)	7-Year Annual Average TP (lbs/yr)
2997R	20	1,201	72

Chapter 4: Assessment of Sources

4.1 Types of Sources

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

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

To be consistent with CWA definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) **and** stormwater systems requiring an NPDES stormwater permit when allocating the 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 Potential Nutrient Sources in the Lake Adair Watershed

4.2.1 Point Sources

4.2.1.1 Wastewater Point Sources

When these TMDLs were being developed, no NPDES-permitted wastewater facilities directly discharging to Lake Adair were identified in the watershed.

4.2.1.2 Municipal Separate Storm Sewer System (MS4) Permittees

In the entire Lake Adair Subbasin and some of the Spring Lake Subbasin, the stormwater collection systems owned and operated by the City of Orlando are covered by an NPDES Phase I MS4 permit (FLS000014). For a portion of the Spring Lake Subbasin, the stormwater collection systems are operated by Orange County and co-permittees in the MS4 permit (FLS000011). **Figure 4.1** shows the MS4 permit coverage in the Lake Adair Watershed.

4.2.2 Nonpoint Sources

Nutrient loadings to Lake Adair are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis primarily include loadings from surface runoff, groundwater seepage entering the lake, and precipitation directly onto the lake surface.

4.2.2.1 Land Uses

Land use is one of the most important factors in estimating nutrient loadings from the Lake Adair Watershed. Nutrients can be flushed into the receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human and natural land use areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce.

The SJRWMD's 2009 land use and land cover were used for the Lake Adair Hydrologic Simulation Program – FORTRAN (HSPF) model updated from the Lake Jesup HSPF model (Tetra Tech 2017b). The land use classes in this coverage were grouped into 13 major categories, which were aggregated based on similarities in hydrologic properties and nutrient loads. **Figure 4.2** shows the aggregated land use categories and their distribution in the Lake Adair Watershed, including the Spring Lake Subbasin.

The Lake Adair Watershed covers an area of 781 acres, consisting of 504 acres of the Spring Lake Subbasin and 277 acres of the Lake Adair Subbasin (**Table 4.1**). Medium-density residential is predominant in the watershed, accounting for 51 % of the total area. Industrial and commercial is the second leading land use type, covering 20.4 %. Overall, human land use areas occupied 707 acres of the watershed, accounting for 90.5 % of the total watershed area. Natural land uses, including forest/rangeland, water, and wetlands, occupied 74 acres, or 9.5 %.

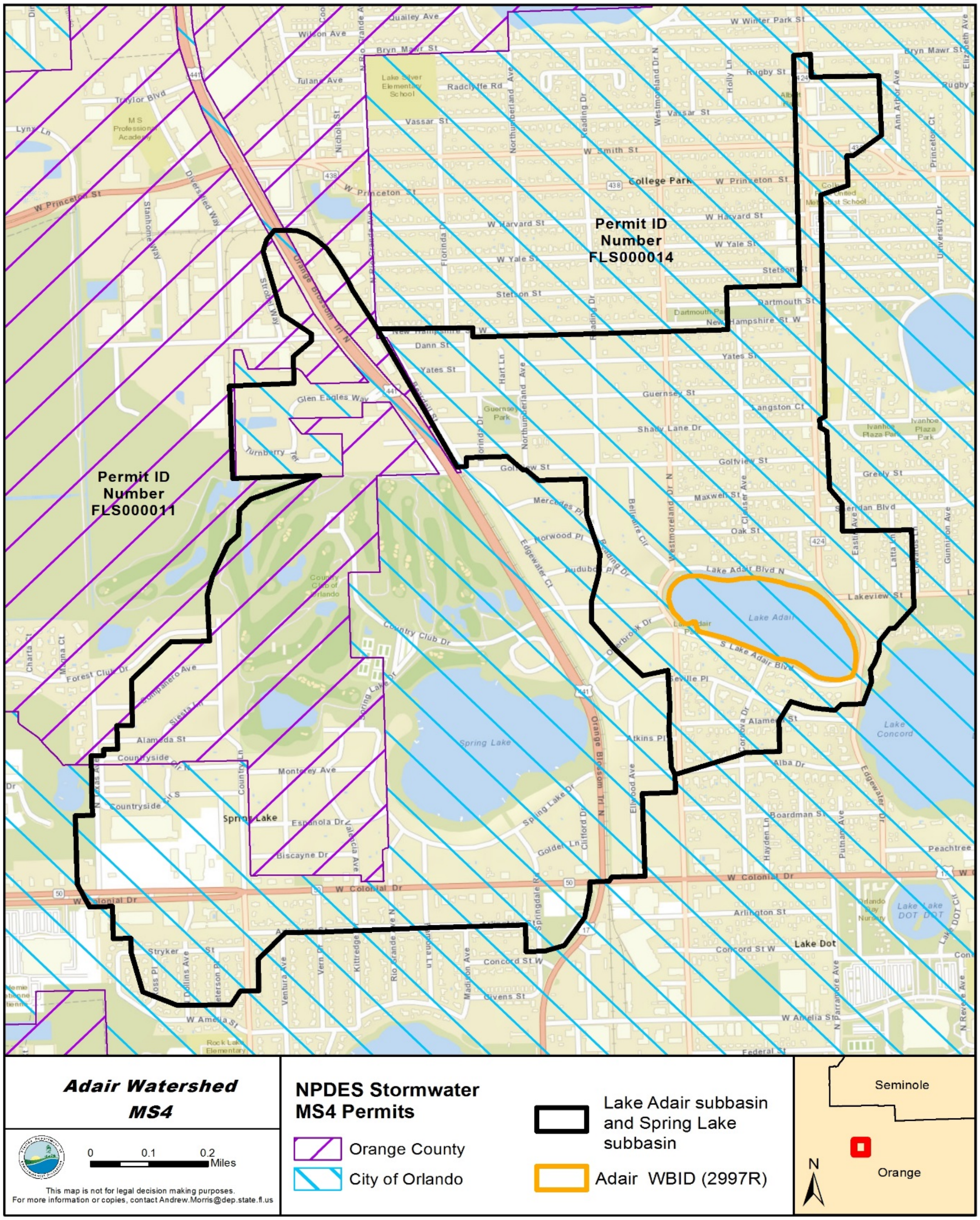


Figure 4.1. MS4 permits in the Spring Lake and Lake Adair Subbasins

Table 4.1. Land uses and their corresponding acreage in the Lake Adair Watershed

Land Use	Spring Lake Subbasin Land Use (acres)	% of Subbasin Area	Lake Adair Subbasin Land Use (acres)	% of Subbasin Area	Total Area of Lake Adair Watershed (acres)	% of Total Watershed Area
High-Density Residential	26	5	10	4	36	4.6
Industrial and Commercial	126	25	34	12	159	20.4
Medium-Density Residential	193	38	205	74	397	50.8
Agriculture General (Golf Course)	110	22	0	0	110	14.1
Forest	4	1	0	0	4	0.5
Water	43	8	24	9	67	8.6
Open Land	0	0	5	2	5	0.6
Wetland	3	1	0	0	3	0.4
Total	**504**	**100**	**277**	**100**	**781**	**100.0**

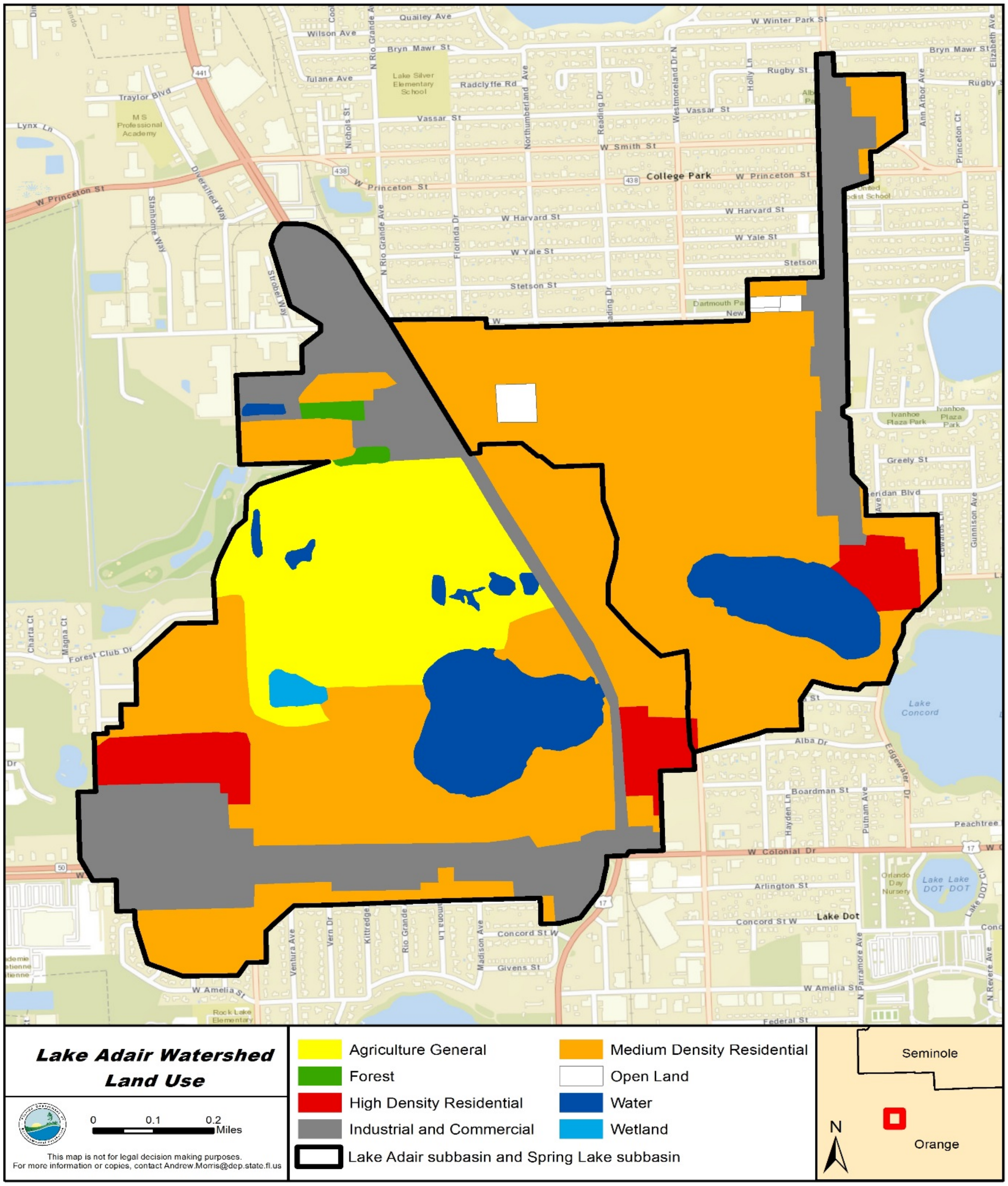


Figure 4.2. Spatial distribution of land uses in the Spring Lake and Lake Adair Subbasins

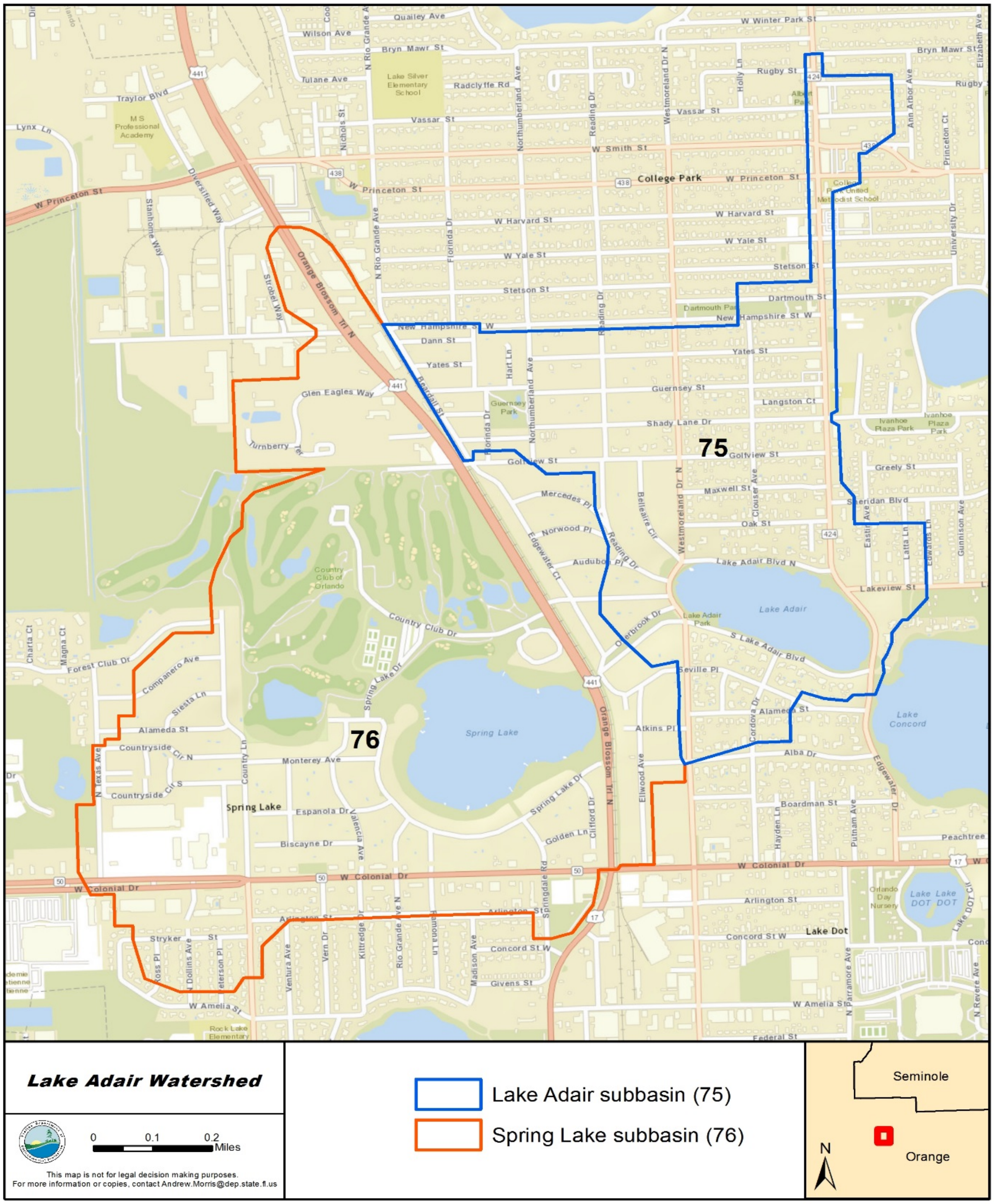


Figure 4.3. Boundaries of the Spring Lake and Lake Adair Subbasins

4.2.3 Estimating Point and Nonpoint Source Loadings

4.2.3.1 Hydrologic Simulation Program – FORTRAN (HSPF) Model Approach

The HSPF model was used to estimate the nutrient loads within and discharged from the Lake Adair Watershed. The updates made to the Lake Jesup HSPF model are described in detail in the Lake Jesup modeling report (Tetra Tech 2017b).

Several modifications were made to the HSPF model specifically for use in developing the TMDLs for Lake Adair. Tetra Tech, contractor for DEP, refined the existing model into additional subwatersheds, including delineations for each of the impaired lakes in the basin. The updated model delineation for the Lake Adair Watershed was based on information provided by the City of Orlando (**Figure 4.3**). In the HSPF model, Lake Adair is located in Lake Adair Subbasin 75 and receives discharges from Spring Lake Subbasin 76 through Overbrook Ditch. There is a weir on the outfall from Spring Lake, with an elevation of 88.1 feet. Discharges from Spring Lake to Lake Adair through the ditch only occur when the Spring Lake elevation is greater than 88.1 feet.

The HSPF model allows DEP to interactively simulate and assess the environmental effects of various land use changes and associated land use practices. The model parameters (impact parameters) simulated for the Lake Adair Watershed include water quantity (surface runoff, interflow, and baseflow), and water quality (TN, organic nitrogen, ammonia nitrogen, nitrogen oxides [NO_X], TP, organic phosphorus, orthophosphorus, phytoplankton as biologically active chlorophyll *a*, temperature, total suspended solids [TSS], dissolved oxygen [DO], and ultimate carbonaceous biological oxygen demand [CBOD]). Datasets of land use, soils, topography and depressions, hydrography, flow data, septic tanks, water use pumpage, point sources, groundwater, atmospheric deposition, solar radiation, control structures, and rainfall (Tetra Tech 2017a) are used to calculate the combined impact of the watershed characteristics for a given modeled area on a waterbody represented in the model as a reach. Data from the Lake Jesup Watershed HSPF model (Subbasins 75 and 76) were used as inputs to the Lake Adair EFDC and WASP models as described in **Chapter 5**.

4.2.3.2 Meteorological Data

The meteorological data for the HSPF model include precipitation, potential evaporation, air temperature, wind speed, solar radiation, dewpoint temperature, and cloud cover. Precipitation data were obtained from the SJRWMD's next-generation radar (NEXRAD) Doppler radar rainfall database, and these data are collected on a 2 x 2 kilometer (km) grid. Potential evapotranspiration data and solar radiation data are from Geostationary Operational Environmental Satellites (GOES) datasets maintained by the U.S. Geological Survey (USGS). The GOES data are collected daily. Other meteorological data were obtained from the Orlando International Airport weather station and were downloaded from the Integrated Surface Database maintained by the National Oceanic and Atmospheric Administration (NOAA). **Table 4.2** summarizes the meteorological data used in the HSPF model.

Table 4.2. Meteorological data for the HSPF model

Data Type	Data Source	Description
Precipitation	SJRWMD	Doppler 2 x 2 km radar grid data
Potential Evaporation	USGS	GOES 2 x 2 km satellite grid data
Solar Radiation	USGS	GOES 2 x 2 km satellite grid data
Air Temperature	NOAA	Orlando International Airport gauge data
Wind Speed	NOAA	Orlando International Airport gauge data
Dew Point Temperature	NOAA	Orlando International Airport gauge data
Cloud Cover	NOAA	Orlando International Airport gauge data

4.2.3.3 Pervious Land Segments (PERLND) Module

The PERLND module of HSPF accounts for surface runoff, interflow, and groundwater flow (baseflow) from pervious land areas. For the purposes of modeling, the total amount of pervious tributary area was estimated as the total tributary area minus the impervious area.

HSPF uses the Stanford Watershed Model methodology as the basis for hydrologic calculations. This methodology calculates soil moisture and water flow between a number of different types of storage, including surface storage, interflow storage, upper soil storage zone, lower soil storage zone, active groundwater zone, and deep storage. Rain that is not converted to surface runoff or interflow infiltrates into the soil storage zones. Part of the infiltrated water is lost by evapotranspiration, discharged as baseflow, or lost to deep percolation (e.g., deep aquifer recharge).

In the HSPF model, water and wetland land uses were generally modeled as pervious land (PERLND) elements. Since these land use types are expected to generate more flow as surface runoff than other pervious lands, the PERLND elements representing water and wetlands were assigned lower values for infiltration rate (INFILT), upper zone nominal storage (UZSN), and lower zone nominal storage (LZSN).

The hydrology for large waterbodies (e.g., lakes) and rivers and streams that connect numerous lakes throughout the area was modeled in reaches (RCHRES). For each subbasin containing a main stem reach, a number of acres were removed from the land use in PERLND that were modeled explicitly in RCHRES.

4.2.3.4 Impervious Land Segments (IMPLND) Module

The IMPLND module of HSPF accounts for surface runoff from impervious land areas (e.g., parking lots and highways). For the purposes of this model, each land use was assigned a typical percentage of impervious area, as shown in **Table 4.3,** based on the Lake Jesup HSPF model (Jia 2015).

Table 4.3. Percentage of imperviousness

Land Use Category	% Imperviousness
Low-Density Residential	5
Medium-Density Residential	10
High-Density Residential	35
Industrial Commercial	50

4.2.3.5 Waterbody (RCHRES) Module

The RCHRES module of HSPF conveys flows input from the PERLND and IMPLND modules, accounts for direct water surface inflow (rainfall) and direct water surface outflow (evaporation), and routes flows based on a rating curve supplied by the modeler. Within each subbasin of each planning unit model, a RCHRES element was developed that defines the depth-area-volume relationships for the modeled waterbody.

The depth-area-volume relationships for Lake Adair were obtained from the survey conducted by DEP on October 22, 2015. The survey was performed using depth readings and position information from designated points along lake transects. Satellite-based positioning information determined using a global positioning system (GPS) (Trimble GeoXT GPS unit) were used to develop bathymetric contour maps and morphologic characteristics for the lake (**Figure 4.4**). A depth-surface area relationship was then computed using the bathymetric maps, and surface area as a function of stage was obtained using a best-fit polynomial equation based on the relationship (Environmental Consulting and Technology [ECT] 1989). In addition, Tetra Tech created site-specific F-Tables for Lake Adair using the bathymetric data and outfall structure elevation data. The detailed F-Tables, in combination with the revised subwatershed delineations, allowed for a more refined water quantity and quality calibration for the lake.

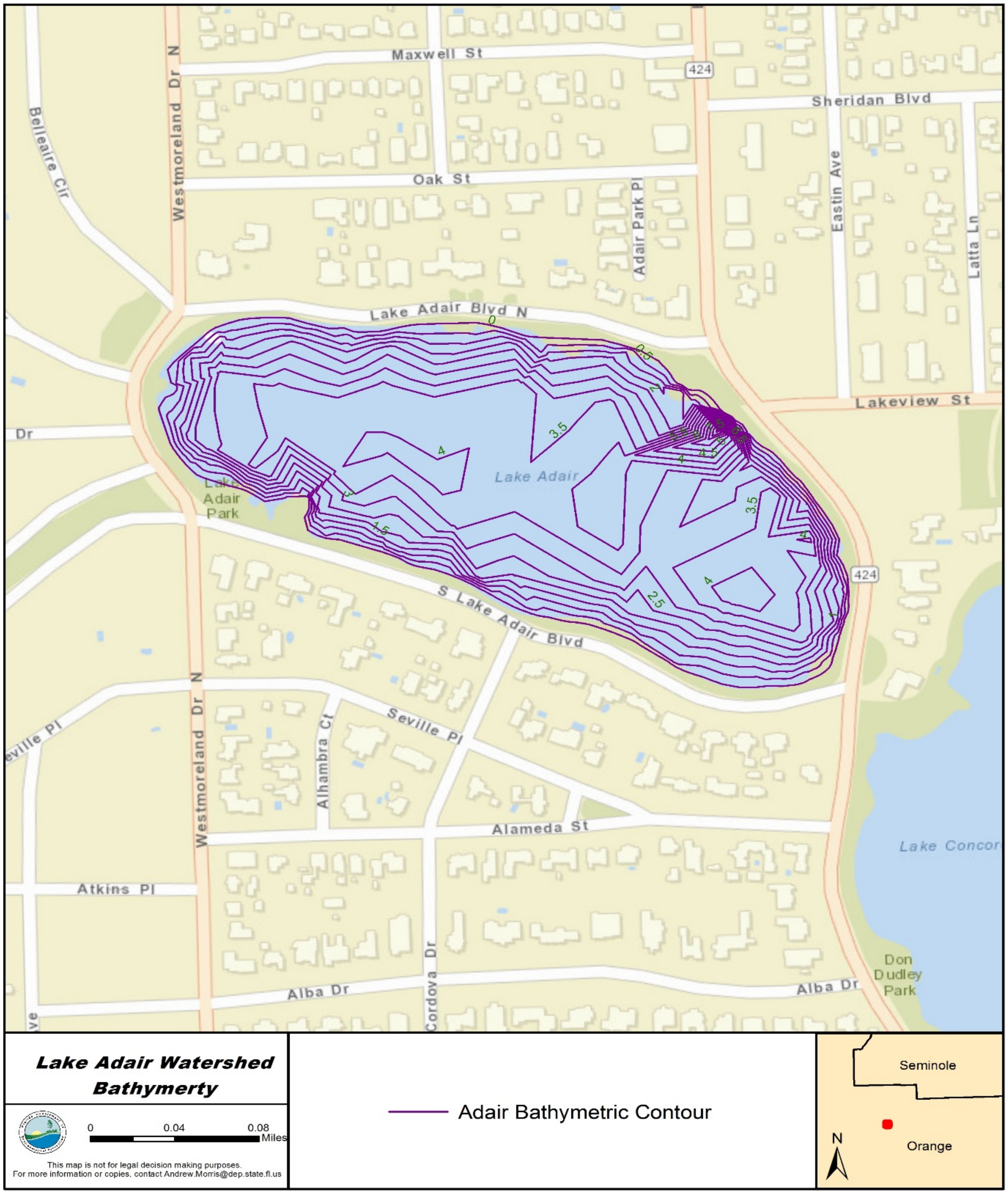


Figure 4.4. Lake Adair bathymetric contour map (depth shown in meters)

4.2.3.6 Hydrologic Soil Groups

The hydrologic characteristics of soil can significantly influence the capability of a watershed to hold rainfall or produce surface runoff. Soils are generally classified as one of four major types, as follows, based on their hydrologic characteristics (Viessman et al. 1989):

- **Type A soil (low runoff potential):** Soils having high infiltration rates even if thoroughly wetted and consisting chiefly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

- **Type B soil:** Soils having moderate infiltration rates if thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well-drained to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

- **Type C soil:** Soils having slow infiltration rates if thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

- **Type D soil (high runoff potential):** Soils having very slow infiltration rates if thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

The soil hydrologic characteristics of the Lake Adair Watershed used in this TMDL analysis were based on the soil hydrologic classifications in the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) 2010 Soil Survey Geographic (SSURGO) Database GIS shapefile. **Figure 4.5** shows the spatial distribution of soil hydrologic groups in the Lake Adair Watershed. Type A and A/D soils were predominant. Type A/D, B/D, and C/D soils have Type A, B, and C soil characteristics when unsaturated but behave like Type D soil when saturated. **Table 4.4** lists the soil hydrologic groups in the watershed and their corresponding acreages.

Table 4.4. Acreage of hydrologic soil groups in the Lake Adair Watershed

Soil Hydrologic Group	Acreage	% Acreage
A	584	74.8
A/D	35	4.5
B/D	0.6	0.1
C/D	16	2.1
No Data	145	18.5
Total	**780.6**	**100**

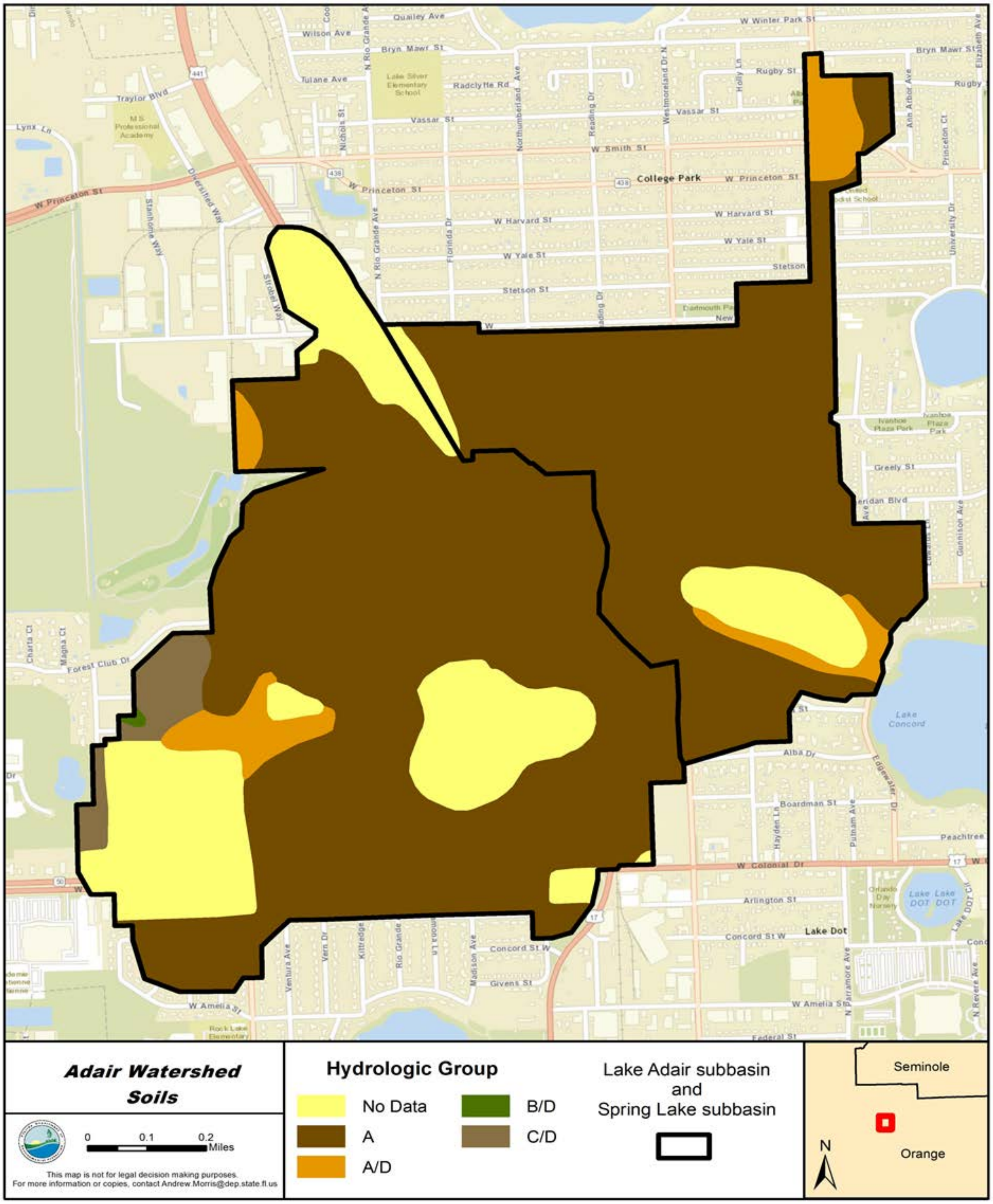


Figure 4.5. **Lake Adair soil hydrologic groups (NRCS 2010)**

4.2.3.7 Best Management Practice (BMP) Coverage

The BMP coverage used in the updated Lake Jesup HSPF model includes urban structural BMPs in the Lake Jesup Basin Management Action Plan (BMAP) from 2006 through May 31, 2013 (the end of the 2013 BMAP annual progress report period). The BMPs in the model include baffle boxes, inlet baskets, continuous deflective separation (CDS) units, swales, dry detention ponds, wet detention ponds, City of Orlando 100 % onsite retention, City of Orlando private BMPs, and lake drainage wells. For modeling purposes, these BMPs were grouped into eight categories based on their pollutant removal efficiencies.

BMPs are used to treat 243 acres, or 88 %, of the Lake Adair Watershed (227 acres) in the HSPF model. For the Spring Lake Watershed, 425 acres, or 82 %, are treated by BMPs. The Lake Jesup BMAP projects in the Lake Adair Watershed include the Ivanhoe Plaza Park exfiltration, Reading Drive baffle box, Guernsey Park expansion of wet pond, Overbrook stormwater improvements, Westmoreland baffle box, Lake Adair inlet baskets, and drainage well. The Lake Jesup BMAP projects in the Spring Lake Watershed include the Overbrook stormwater improvements, Spring Lake baffle box at Springdale, Spring Lake baffle box at Rio Grande, Spring Lake inlet baskets, Florida Department of Transportation (FDOT) pond west of Spring Lake, and drainage well.

4.2.3.8 Lake Adair Nonpoint Source Loadings

Nonpoint source loads of TN and TP from different types of land uses were estimated for the existing conditions in the Lake Adair Watershed based on the HSPF PERLND and IMPLND flows and the corresponding simulated concentrations of each land use category. The estimated TN and TP loading coefficients for land use types were compared with literature values to make sure that the calibrated loading rates of TN and TP from each land use were reasonable (Tetra Tech 2017b; Environmental Research and Design [ERD] 2008; McCann et al. 1997).

Tables 4.5 and **4.6** list the annual average TN and TP loads from various sources to Lake Adair. The averaged total incoming loads were 1,968 pounds per year (lbs/yr) for TN and 141 lbs/yr for TP for the 12-year simulated period. Spring Lake discharged to Lake Adair a 12-year averaged annual TN load of 822 lbs/yr and a TP load of 67 lbs/yr, accounting for 41 % of the total TN loads and 48 % of the total TP loads to the lake during the simulation period (**Figures 4.6** and **4.7**). Contributions from the immediate Lake Adair Subbasin accounted for only 45 % of the TN and 43 % of the TP total loads.

Table 4.5. Simulated annual TN loads (lbs/yr) to Lake Adair by source. Note that loads in the BMPs category represent the portion of the loads via the surface runoff and baseflow treated by BMPs.

Year	Spring Lake Subbasin (lbs/yr)	Lake Adair Subbasin Surface Runoff (lbs/yr)	Lake Adair Subbasin Baseflow (lbs/yr)	Lake Adair Subbasin BMPs (lbs/yr)	Atmospheric Deposition (lbs/yr)	Total Incoming TN Load (lbs/yr)
2003	437	91	9.9	631	252	1,401
2004	1,416	163	12.5	982	354	2,872
2005	1,361	264	14.7	1,080	366	2,945
2006	383	101	6.2	621	228	1,313
2007	329	62	5.6	549	230	1,178
2008	1,560	114	9.1	934	324	2,927
2009	896	93	8.4	772	293	2,054
2010	766	92	8.8	858	268	1,992
2011	745	87	5.9	833	268	1,942
2012	307	64	4.2	571	221	1,170
2013	741	74	5.3	687	253	1,764
2014	924	83	5.4	762	282	2,059
Average	**822**	**107**	**8.0**	**773**	**278**	**1,968**

Table 4.6. Simulated annual TP loads (lbs/yr) to Lake Adair by source. Note that loads in the BMPs category represent the portion of the loads via the surface runoff and baseflow treated by BMPs.

Year	Spring Lake Subbasin (lbs/yr)	Lake Adair Subbasin Surface Runoff (lbs/yr)	Lake Adair Subbasin Baseflow (lbs/yr)	Lake Adair Subbasin BMPs (lbs/yr)	Atmospheric Deposition (lbs/yr)	Total Incoming TP Load (lbs/yr)
2003	37	6.2	0.5	44	11	99
2004	115	10.2	0.7	68	16	210
2005	108	15.0	0.8	71	16	211
2006	31	7.0	0.3	47	10	95
2007	27	4.7	0.3	39	10	82
2008	128	7.8	0.5	66	15	217
2009	73	6.5	0.5	53	13	146
2010	63	6.7	0.5	59	12	142
2011	62	6.4	0.3	58	12	139
2012	25	4.7	0.2	40	10	80
2013	61	5.3	0.3	47	11	125
2014	76	6.3	0.3	57	13	152
Average	**67**	**7.2**	**0.4**	**54**	**12**	**141**

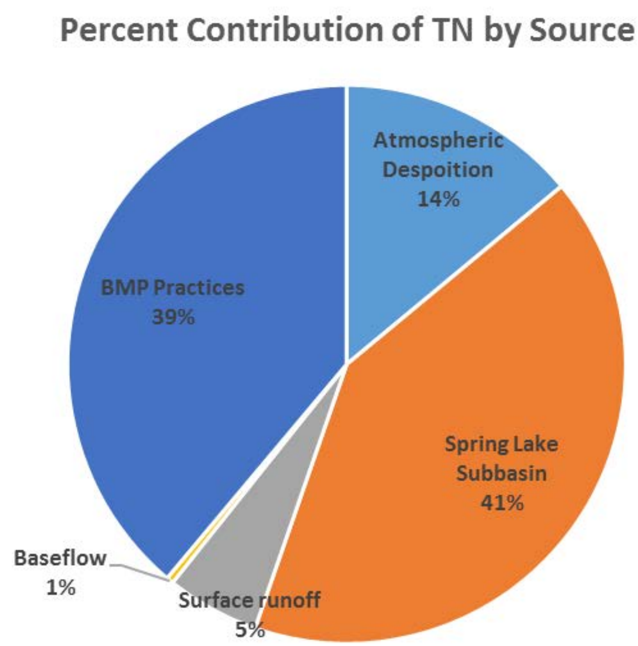


Figure 4.6. Percent TN contribution to Lake Adair under the existing condition

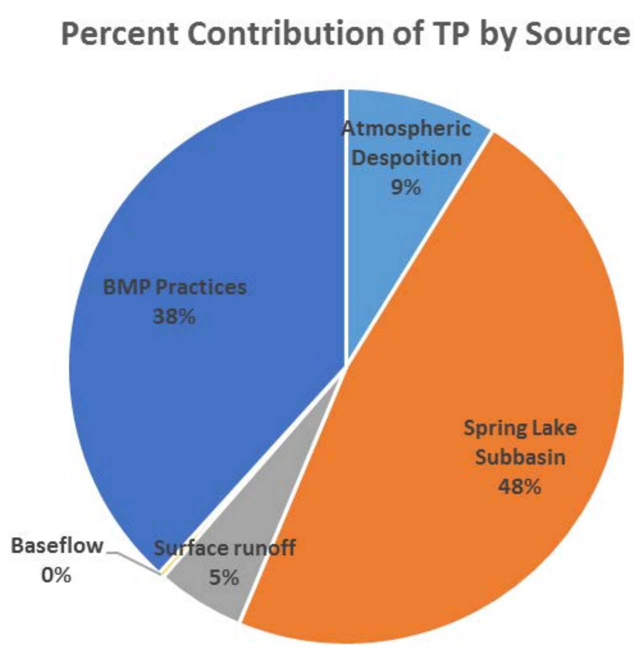


Figure 4.7. Percent TP contribution to Lake Adair under the existing condition

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 (i.e., 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 development is to determine the assimilative capacity of Lake Adair and to identify the maximum allowable TN and TP loadings from the watershed, so that Lake Adair will meet the TMDL targets and thus maintain its function and designated use as a Class III water. To achieve the goal, DEP used a combination of HSPF for watershed simulation, and EFDC and WASP for waterbody simulation, focusing on the in-lake processes and the water and nutrient budgets of the lakes. These models were updated or set up by Tetra Tech, and detailed model inputs and configuration were addressed in the final report (Tetra Tech 2017a).

5.2 Water Quality Trends for Lake Adair

Temporal water quality patterns of chlorophyll *a*, TN, and TP were examined using the water quality data retrieved from the IWR Run 52 for Lake Adair. Several water quality stations in the lake were identified for the period of observation between 1990 and 2014 (**Table 5.1**; **Figure 5.1**). A water quality station (112WRD 02234205) was not included in this analysis since it appeared that only one sampling event was conducted over the period (in 2001).

Table 5.1. Water quality monitoring stations in Lake Adair

Sampling Entity	Station Name	Station Location
DEP – Central District	21FLCEN 20011193	Lake Adair @ 250m W of Center
DEP – Central District	21FLCEN 20011194	Lake Adair @ 100m N of Center
DEP – Central District	21FLCEN 20011195	Lake Adair @ 100m S of Center
DEP – Central District	21FLCEN 20011196	Lake Adair @ 250m E of Center
Florida LakeWatch	21FLKWATORA-ADAIR-1	Orange-Adair-1
Florida LakeWatch	21FLKWATORA-ADAIR-2	Orange-Adair-2
Florida LakeWatch	21FLKWATORA-ADAIR-3	Orange-Adair-3
City of Orlando Stormwater Division	21FLORL ADAIR	Lake Adair in Orlando, Florida

Figure 5.2 shows temporal trends of daily averaged concentrations of chlorophyll *a*, TN, and TP and the TN/TP ratio during the period. The long-term average for TN was 1.13 ± 0.41 mg/L (n = 229) during the period, with a coefficient of variance (CV) of 36 %. The average TP concentration was 0.091 ± 0.062 mg/L (n = 227), with a CV of 69 %. The average ratio of TN/TP was 16 (n = 225), indicating the lake is co-limited. The long-term average for chlorophyll *a* during the period was 40 ± 30 µg/L (n = 107), with a CV of 76 %. The peak concentrations of chlorophyll *a*, TN, and TP were 202 µg/L, 3.72 mg/L, and 0.399 mg/L, respectively, between 1995 and 1996. However, the 13-year daily averaged concentrations during the planning and verified periods (January 1, 2002–June 30, 2014) of the Group 2 Cycle 3 assessments were 30 ± 16 µg/L (n = 53) for chlorophyll *a*, 1.05 ± 0.33 mg/L (n = 80) for TN, and 0.067 ± 0.036 mg/L (n = 79) for TP, remaining relatively constant over the 13-year period.

Table 5.2 summarizes the annual average concentrations of chlorophyll *a*, TN, and TP and TN/TP ratio observed during the planning and verified periods from 2002 to 2014. The annual concentrations of TN and TP ranged from 0.82 mg/L in 2014 to 1.49 mg/L in 2009, and from 0.040 mg/L in 2002 to 0.132 mg/L in 2013, respectively. The 13-year average concentrations of TN and TP were 1.12 ± 0.20 mg/L (n = 13) with a CV of 18 % and 0.072 ± 0.022 mg/L (n = 13), with a CV of 31 %, respectively. Annual average chlorophyll *a* concentrations ranged from 19.4 µg/L in 2002 to 43.1 µg/L in 2013, with a long-term average concentration of 28.4 ± 7.4 µg/L (CV = 26 %, n = 13). Based on the statistical summary, there was no significant change in annual concentrations during the period.

Table 5.2. Summary of statistics of annual chlorophyll *a*, TN, and TP and TN/TP ratios in Lake Adair observed during the assessment (planning and verified) period (January 1, 2002–June 30, 2014)

Water Quality Variables	Unit	Median	Mean	Standard Deviation	Minimum	Maximum	CV (%)
Chlorophyll *a*	µg/L	28	28	7	19	43	26
TN	mg/L	1.15	1.12	0.20	0.82	1.49	18
TP	mg/L	0.070	0.072	0.022	0.040	0.132	31
TN/TP Ratio	No unit	16.0	16.5	3.8	9.4	22.6	23

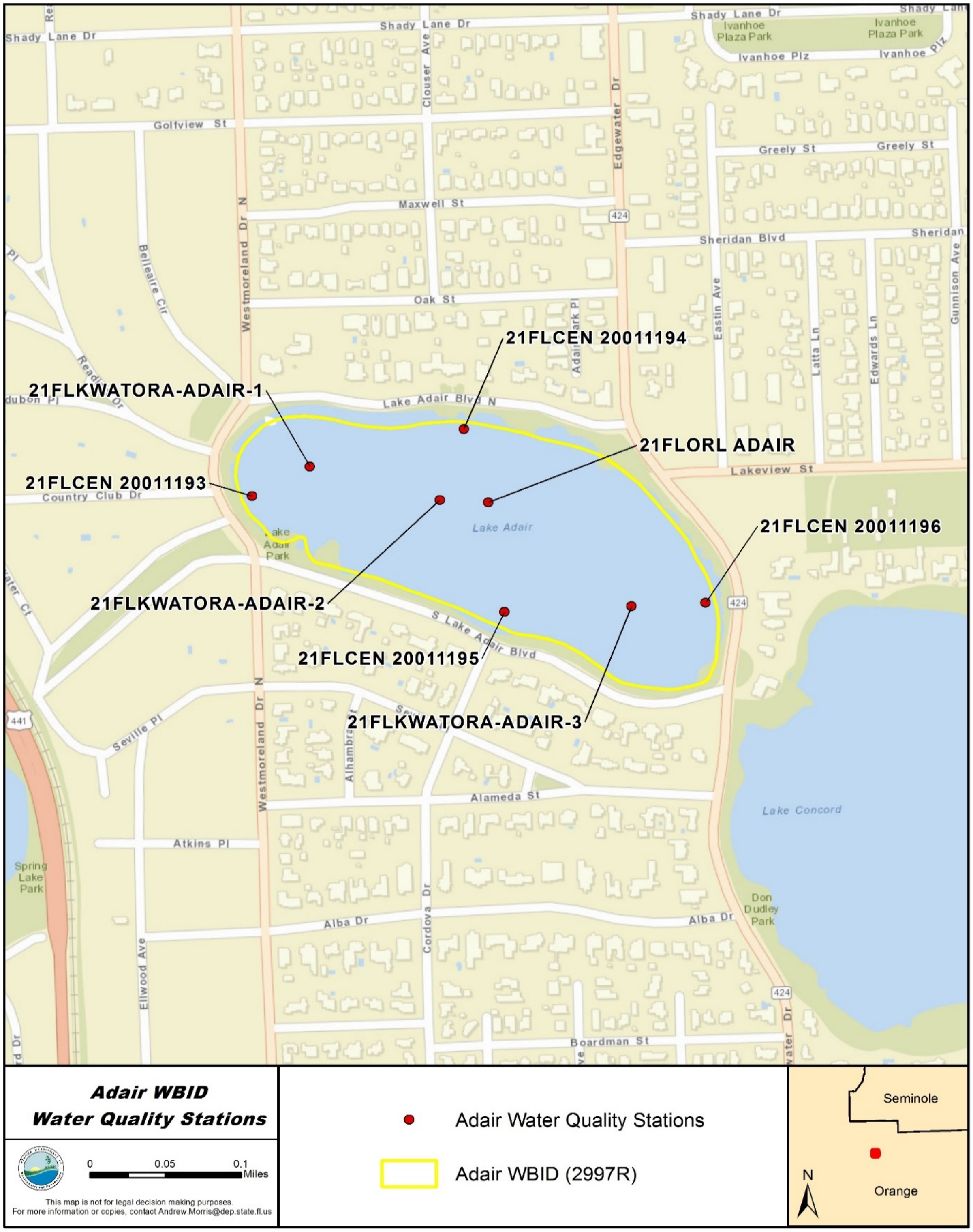


Figure 5.1. Location of water quality stations in Lake Adair

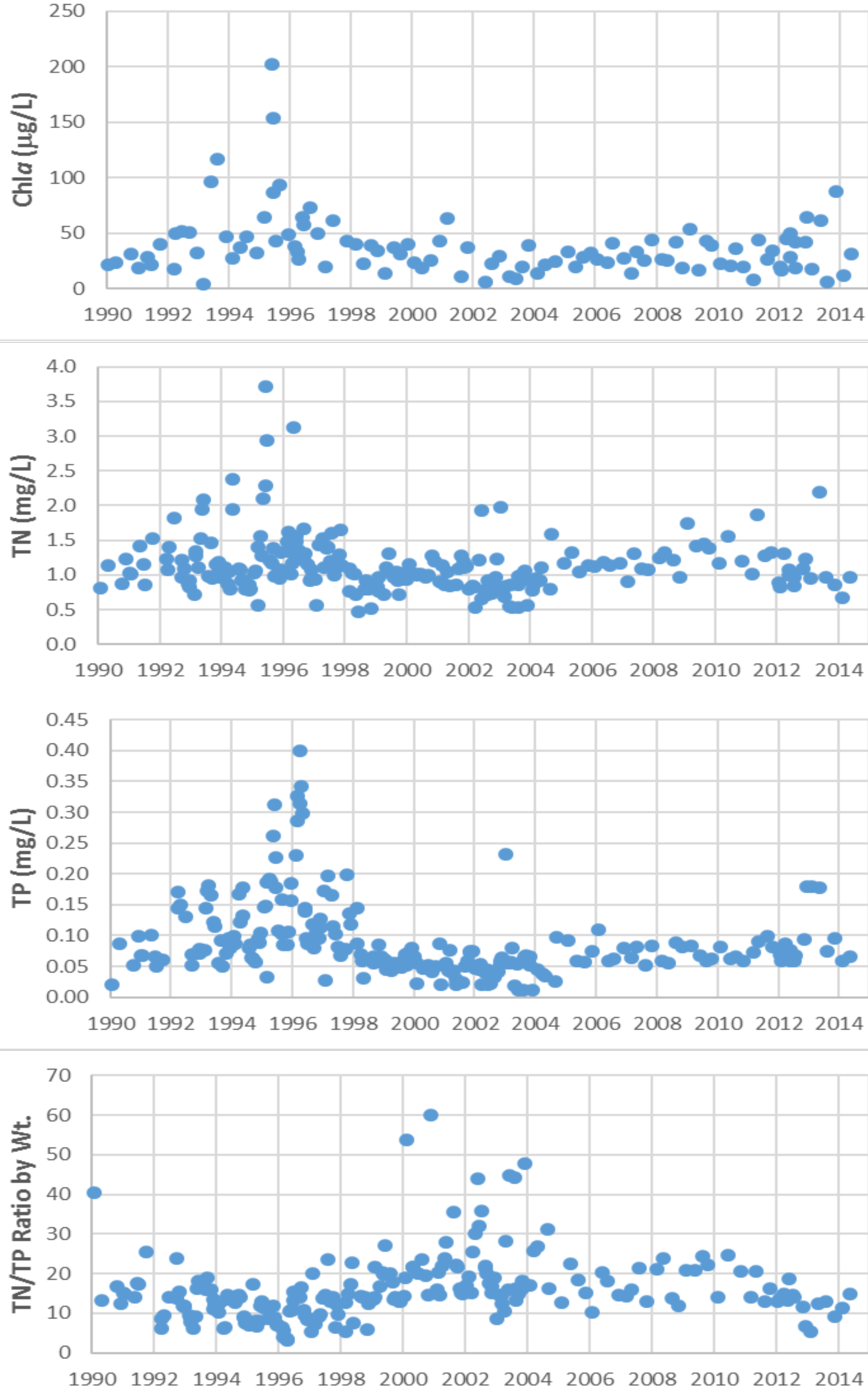


Figure 5.2. Long-term trends of daily concentrations of chlorophyll *a*, TN, and TP and TN/TP ratio in Lake Adair

DEP conducted a water quality sampling event on October 21, 2015, at the Overbrook Canal station located in the middle of the canal and at the Lake Adair Inlet station where Overbrook Canal meets the southwest corner of Lake Adair. Following this event, the monthly sample collection continued in order to evaluate the chemical behavior and transport of nutrients coming into Lake Adair via Overbrook Canal from January 27, 2016, to January 30, 2017.

Figures 5.3 and **5.4** show monthly variations of inorganic nutrients (i.e., ammonium [NH_4], nitrite+nitrate [NO_{2+3}], and phosphate [PO_4]) and total nutrients (i.e., TN and TP) at the Overbrook Canal and Lake Adair Inlet stations during the survey, along with the monthly rainfall data retrieved from the city's database. The rainfall data indicate a typical pattern of wet months (May through October) and dry months (November through April), with unusually heavy rainfall recorded in January 2016. The average monthly rainfall during the wet months (7.2 ± 1.8 inches) was much greater than the average monthly rainfall during the dry months (1.3 ± 0.9 inches), excluding January 2016.

Different flow regimes with varying amounts of rainfall during the wet and dry months may characterize a delivery pattern of inorganic and total nutrients to Lake Adair. Concentrations of NO_{2+3} in the Overbrook Canal and Lake Adair Inlet were much higher in the dry months than in the wet months, showing a distinctive pattern of carrying more NO_{2+3} to Lake Adair during a low-flow regime (**Figure 5.3**). As a result, there is a strong inverse relationship between rainfall and NO_{2+3} concentrations, with a correlation coefficient of $r^2 = 0.52$ ($n = 13$). In addition, a higher inorganic nitrogen portion (42 % to 89 %, averaging 76 %) of the total nitrogen was observed during the dry months, suggesting that more inorganic and total nitrogen were delivered to the lake during a lower flow regime (**Figure 5.4**).

A relatively weak correlation between rainfall and PO_4 was observed. A peak concentration of PO_4 was recorded during the dry month, and elevated PO_4 levels were also observed during the wet months (**Figure 5.3**). Similarly, TP concentrations were relatively constant over the months of the survey, with higher levels of inorganic nutrients entering the lake during the low-flow regime (**Figure 5.4**). Overall, there may no distinctive difference in nutrient TN and TP loadings over the dry and wet months. However, the elevated levels of inorganic nitrogen and phosphorus coming into the lake during the dry months may increase bioavailability and result in elevated biological productivity during those months.

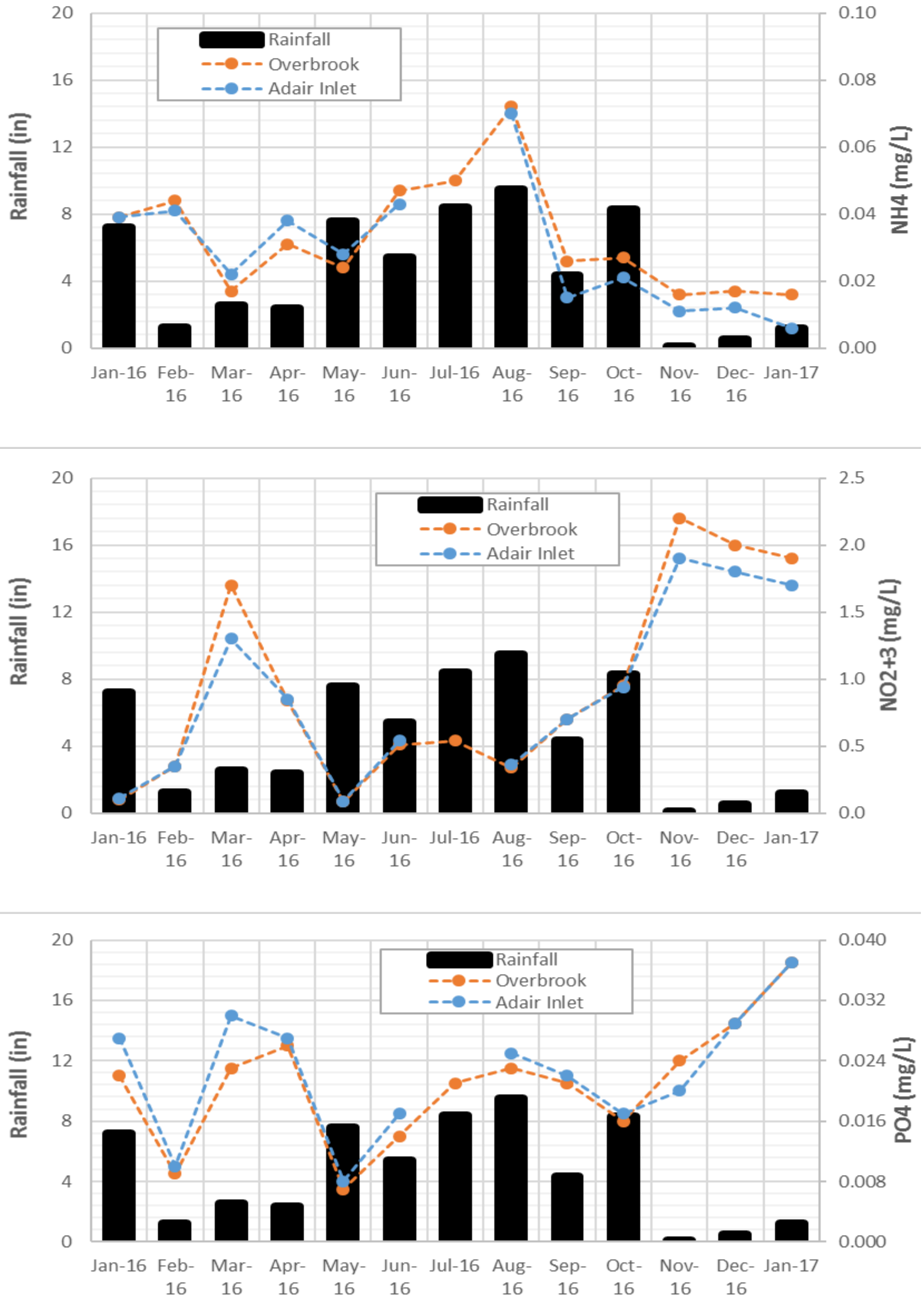
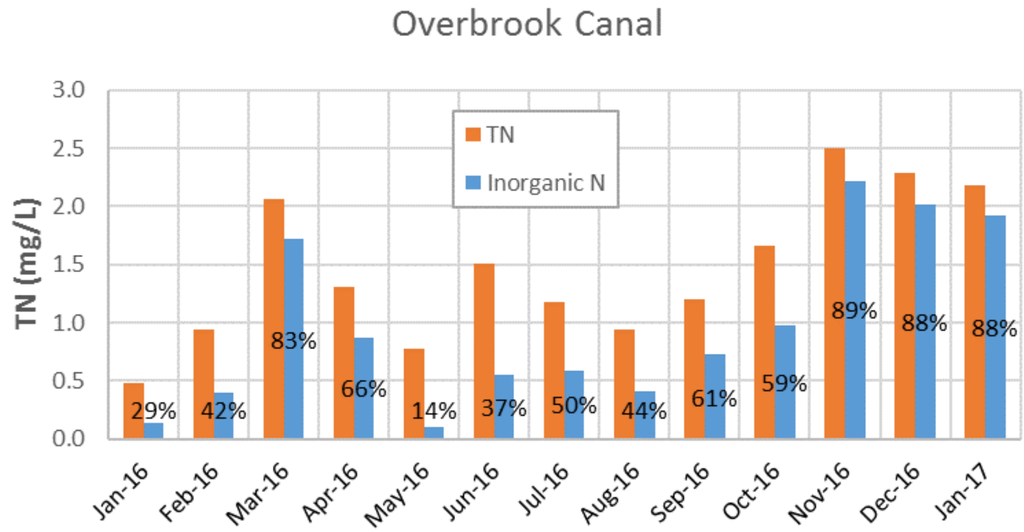


Figure 5.3. Monthly variations of inorganic nutrients in Overbrook Canal and Lake Adair Inlet during the survey period, January 27, 2016–January 30, 2017



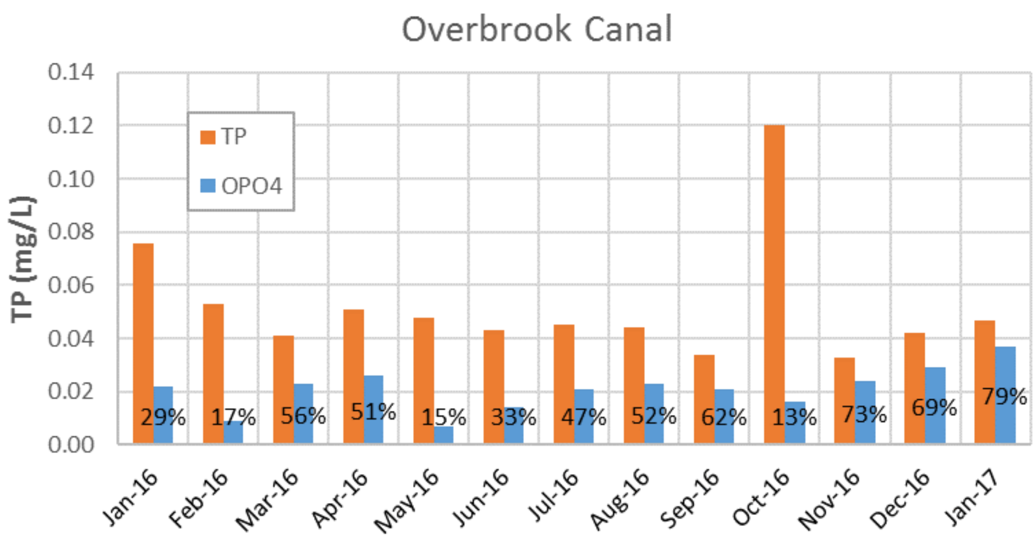


Figure 5.4. Monthly variations of total and inorganic nutrients in Overbrook Canal during the survey period, January 27, 2016–January 30, 2017. Values represent the inorganic portion of TN and TP in percent.

5.3 Lake Adair Water Quality Modeling

5.3.1 EFDC Model

The Lake Adair EFDC model grid is based on the contour map from the City of Orlando and the bathymetry data collected by DEP in October 2015. Depths in the lake ranged from 1 to 5 m. To account for the various depths, the EFDC model was divided into 30 cells (a 5-cell-by-6-cell grid), with an average cell size of 100 by 50 m. Each cell is one layer, which is assigned the appropriate depth. **Figure 5.5** illustrates the grid and the average cell depth, in meters. More details about EFDC inputs, and the model calibrations for hydrodynamics (i.e., flow and lake elevation) and stable variables (i.e., temperature), can be found in the Lake Adair final report (Tetra Tech 2017a).

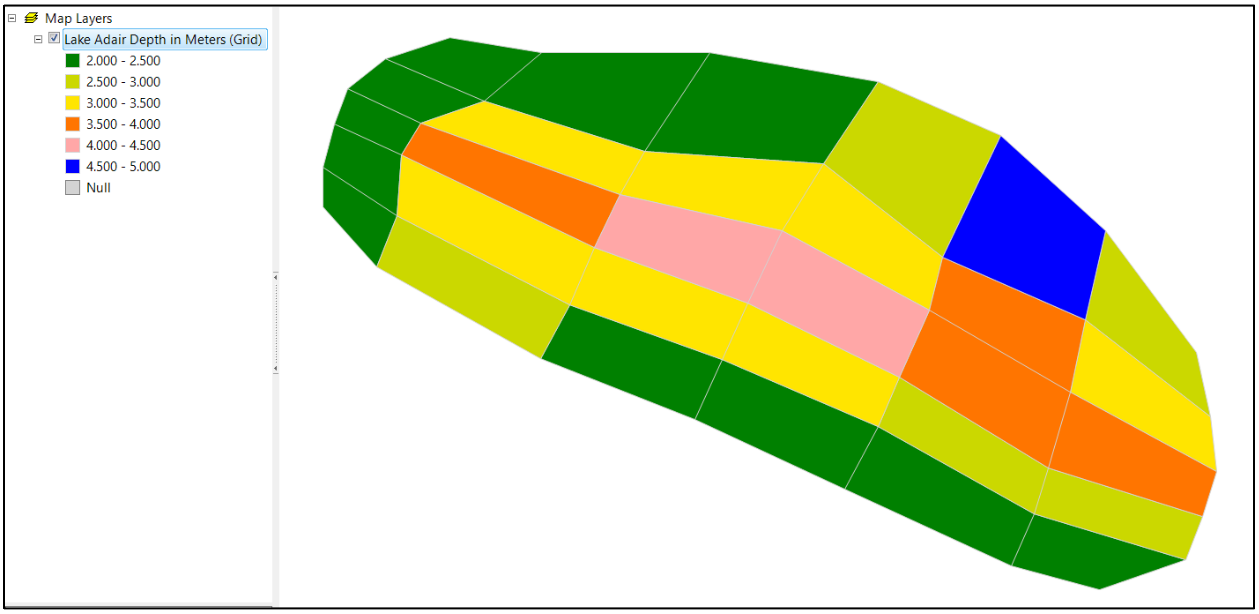


Figure 5.5. Bathymetric map generated for Lake Adair using ArcGIS. Each contour line represents a 0.5-m depth interval.

5.3.2 WASP Model

The Lake Adair EFDC model hydrodynamic results (flows, velocities, volumes, and temperatures) were used to drive the Lake Adair WASP model. The advanced eutrophication module of WASP 8.1 was used to simulate water quality in Lake Adair. The same approach was used for the Lake Jesup WASP model. The Lake Jesup model report (Tetra Tech 2017b) contains additional details about the Lake Jesup EFDC and WASP models.

The Lake Adair water quality inputs were provided by the Lake Jesup Watershed HSPF model (Subwatershed 75) and were input into the WASP model as kilograms per day (kg/day) at a daily time step. The inputs to the WASP model for Lake Adair included the Spring Lake Watershed (Subwatershed 76) loading. The total organic nitrogen (OrgN) loads were divided between dissolved organic nitrogen (DON) and detrital nitrogen (DN) at a 4:6 ratio. The total organic phosphorus (OrgP) loads were divided between dissolved organic phosphorus (DOP) and detrital phosphorus (DP) at a 2:8 ratio. Detrital carbon was set at a constant of 5 milligrams (mg) carbon per liter (mg C/L).

The initial WASP model kinetic rates were from the Lake Jesup WASP model, with nutrient uptake rates and chlorophyll growth rates adjusted during calibration. The final Lake Adair model report (Tetra Tech 2017a) provides the kinetic rates used in the Lake Adair WASP model. Time series for solar radiation, fraction of the day with daylight, wind speed, and air temperature are from the Lake Jesup WASP model. The WASP model uses daily solar radiation and fraction of daylight hours for simulating phytoplankton growth, as well as daily water temperature for the modification of chemical reaction rates and the growth and respiration of phytoplankton.

5.3.2.1 WASP Model Calibration and Validation

Water quality data collected in Lake Adair from 2003 through 2013 were used for in-lake water quality calibration, since there was a model spin-up time in 2002, and insufficient data were available to calculate the observed AGMs for 2014. As shown in **Table 5.1**, several water quality monitoring stations were available for model calibration purposes, and data from each station were examined as part of data quality control processes to compare with the WASP model simulation results.

Most of the water quality data were collected from Station 21FLORL ADAIR, which was sampled by the City of Orlando during the entire simulation period from 2003 through 2013. The lake is relatively small and completely mixed. Therefore, the data from the monitoring stations were combined and compared with the WASP model simulation results averaged over the entire lake. The final Lake Adair modeling report (Tetra Tech 2017a) provided detailed time-series comparisons between observed versus simulated results for DO, NH_4, NO_3, TSS, chlorophyll *a*, TN, and TP.

The general calibration/validation targets or tolerances from Donigian (2002) and McCutcheon et al. (1990) were used to evaluate the WASP model calibration. The differences in the median values of the observed data compared with the model-simulated results indicated that the WASP model performs very well in simulating the measured water quality data for Lake Adair (Tetra Tech 2017a).

Figures 5.6 through **5.8** show box and whisker plots for observed versus simulated annual concentrations of TN, TP, and chlorophyll *a* from 2003 to 2013. **Table 5.3** lists the annual averaged data for observed and simulated TN, TP, and chlorophyll *a*. Annual average concentrations of TN, TP, and chlorophyll *a* simulated by WASP are comparable to the annual concentrations observed for Lake Adair, within the CV over the simulated period. Long-term averages of annual TN and TP were simulated to be 1.18 ± 0.07 and 0.076 ± 0.006 mg/L, respectively. The simulated 11-year averages are similar to those of observed TN (1.17 ± 0.17 mg/L) and TP (0.076 ± 0.020 mg/L). The long-term average of chlorophyll *a* was simulated at 34 ± 4 µg/L, comparable to the observed value of 30 ± 7 µg/L, indicating that the simulated chlorophyll *a* concentrations are also consistent with observed chlorophyll *a* concentrations.

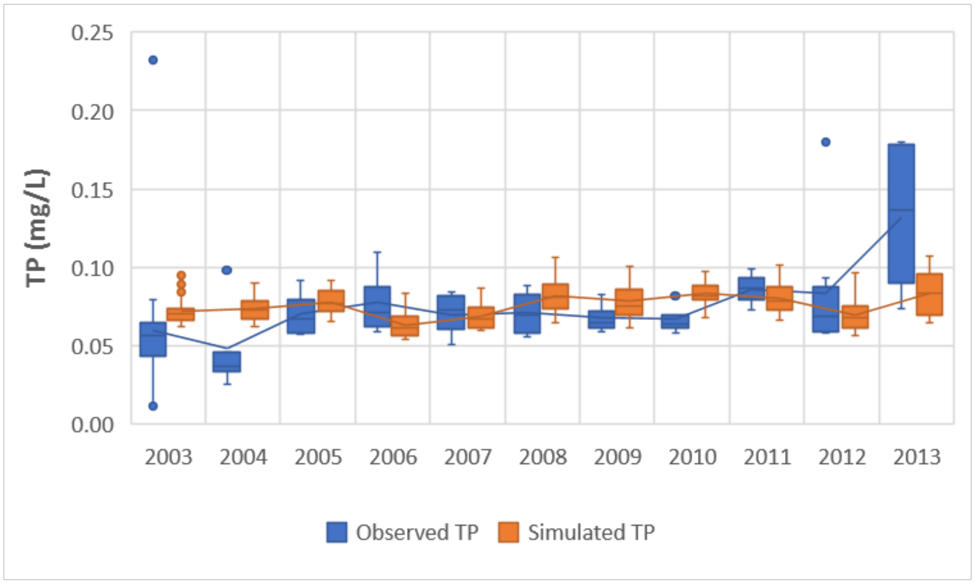


Figure 5.6. Box and whisker plot of observed annual TP (blue bars) and simulated annual TP (orange bars) in Lake Adair. The blue and orange lines represent annual average concentrations of observed and simulated TP, respectively.

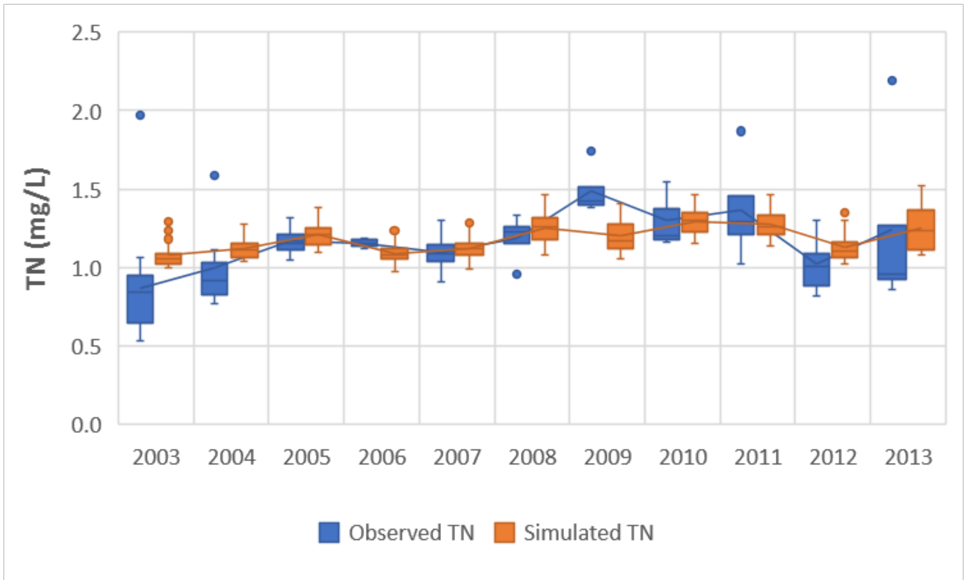


Figure 5.7. Box and whisker plot of observed annual TN (blue bars) and simulated annual TN (orange bars) in Lake Adair. The blue and orange lines represent annual average concentrations of observed and simulated TN, respectively.

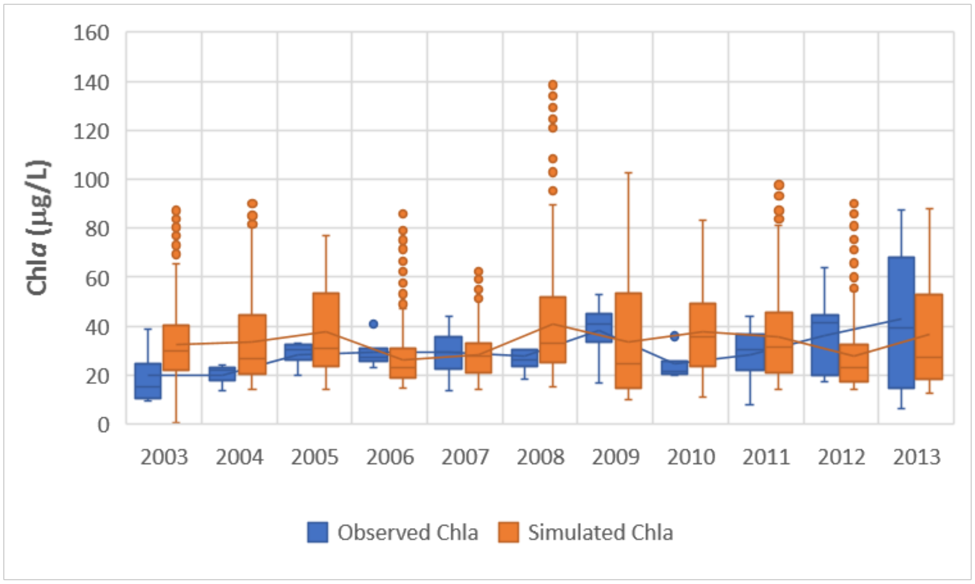


Figure 5.8. **Box and whisker plot of observed annual chlorophyll *a* (blue bars) and simulated annual chlorophyll *a* (orange bars) in Lake Adair. The blue and orange lines represent annual average concentrations of observed and simulated chlorophyll *a*, respectively.**

Table 5.3. **Observed and simulated annual average concentrations of chlorophyll *a*, TN, and TP for Lake Adair. Std represents standard deviation with a 1-sigma standard error.**

Year	Chlorophyll *a* (µg/L)		TN (mg/L)		TP (mg/L)	
	Observed	Simulated	Observed	Simulated	Observed	Simulated
2003	20	33	0.87	1.08	0.060	0.072
2004	20	34	1.00	1.12	0.048	0.074
2005	28	38	1.17	1.21	0.071	0.078
2006	30	26	1.16	1.09	0.078	0.063
2007	29	28	1.10	1.12	0.070	0.068
2008	28	41	1.19	1.25	0.071	0.082
2009	38	34	1.49	1.20	0.068	0.078
2010	25	38	1.30	1.29	0.067	0.083
2011	28	36	1.37	1.27	0.086	0.080
2012	36	28	1.02	1.13	0.083	0.070
2013	43	37	1.24	1.25	0.132	0.084
Average	**30**	**34**	**1.17**	**1.18**	**0.076**	**0.076**
Std	**7**	**4**	**0.17**	**0.07**	**0.020**	**0.006**

5.3.2.2 WASP Sediment Nutrient Benthic Flux

The sediment diagenesis module was turned on in the calibrated model, and the results from this simulation were reported in the final Lake Adair modeling document (Tetra Tech 2017a). The report summarizes the total simulated nutrient fluxes. The total nutrient flux from sediment was a median of 0.02 milligrams per square meter per day (mg/m^2/day) for TN and 0.02 mg/m^2/day for TP, corresponding to the nutrient loads of 2.7 lbs/yr for TN and 2.8 lbs/yr for TP. These loads accounted only for 0.1 % of the total TN loads and 1.9 % of the total TP loads from all sources to Lake Adair, suggesting that the sediment nutrient flux is an insignificant source of nutrients to the lake.

5.3.3 Natural Background Conditions To Determine Natural Levels of Chlorophyll a, TN, and TP

The natural land use background conditions for the Lake Adair Watershed were established to ensure that the proposed restoration target of chlorophyll a 20 µg/L will not abate the natural background condition. For this simulation, the wetland and water land uses in the current condition model were kept the same but all anthropogenic land uses in the current condition model were converted into forest and wetland land uses based on the hydrologic soil group classification. Anthropogenic land uses with Class A and B soils were converted to forests, and anthropogenic land uses with Class C, D, and dual category soils were converted to wetlands. The resulting land use coverage and background simulation results are provided in the final modeling report for Lake Adair (Tetra Tech 2017a). The loading from the watershed in the natural background simulation is 722 lbs/yr of TN and 35 lbs/yr of TP.

Simulated daily average concentrations of chlorophyll *a*, TN, and TP for the natural background condition from 2003 to 2013 were converted to AGMs for each year and compared with simulated AGMs for the existing condition (**Table 5.4**). Based on the background model run results, the predevelopment lake is expected to have AGM TP concentrations ranging from 0.007 to 0.035 mg/L, with a long-term average of 0.016 mg/L. Predevelopment AGM TN concentrations range from 0.11 to 0.56 mg/L, with a long-term average of 0.26 mg/L. Predevelopment AGM chlorophyll *a* ranges from 3 to 14 µg/L, showing that application of the 20 µg/L chlorophyll *a* criterion as the TMDL target for Lake Adair will not abate the natural background condition and thereby the chlorophyll a 20 µg/L target should be used as the TMDL target for Lake Adair.

Table 5.4. Simulated AGMs for chlorophyll a, TN, and TP for the existing and natural background conditions

Year	Existing AGM Chlorophyll *a* (µg/L)	Existing AGM TN (mg/L)	Existing AGM TP (mg/L)	Natural AGM Chlorophyll *a* (µg/L)	Natural AGM TN (mg/L)	Natural AGM TP (mg/L)
2003	27	1.08	0.072	14	0.56	0.023
2004	30	1.12	0.073	14	0.56	0.035
2005	34	1.21	0.078	5	0.20	0.012
2006	25	1.09	0.063	3	0.11	0.007
2007	27	1.12	0.068	6	0.22	0.015
2008	35	1.25	0.081	9	0.40	0.032
2009	27	1.20	0.078	6	0.24	0.015
2010	34	1.29	0.083	4	0.16	0.009
2011	32	1.27	0.080	3	0.14	0.007
2012	25	1.13	0.069	4	0.15	0.007
2013	31	1.24	0.083	4	0.14	0.012
Average	**30**	**1.18**	**0.075**	**6**	**0.26**	**0.016**

5.3.4 Load Reduction Scenarios To Determine the TMDLs

As discussed in **Section 3.3**, the chlorophyll *a* target of 20 µg/L was selected as the TMDL target for Lake Adair. The TN and TP loads as the site-specific TN and TP interpretations of the narrative nutrient criterion for Lake Adair were then determined as the watershed TN and TP loads were reduced iteratively until simulated AGM chlorophyll *a* in Lake Adair met the chlorophyll *a* target of 20 µg/L in each year of the simulation.

For the TP and TN load reduction scenarios, the existing TP and TN loads were iteratively reduced until the simulated AGM chlorophyll *a* under the reduction scenario conditions met the chlorophyll *a* target in each year (**Figures 5.9** and **5.10**). When the existing total TP and TN loads were reduced by 54 % and 45 %, respectively, the AGMs of simulated chlorophyll *a* did not exceed the target (20 µg/L) in any single year (**Figure 5.11**). Therefore, the model scenario with a 54 % reduction for TP and 45 % for TN from the existing total loads would be protective of the designated use of Lake Adair.

Under the TMDL condition with a 54 % reduction in TP and a 45 % reduction in TN that meets the chlorophyll *a* target, the AGMs of simulated in-lake TP concentration range from 0.035 to 0.044 mg/L, with a long-term (11-year) average AGM of 0.040 mg/L. For TN, simulated AGMs range from 0.60 to 0.71 mg/L, with a long-term (11-year) average AGM of 0.66 mg/L. For lake information purposes, the restoration TP and TN concentrations are set as the AGMs of TP and

TN at 0.044 and 0.71 mg/L, respectively, not to be exceeded in any year to allow the lake to achieve the chlorophyll *a* target in every year of the model simulation (**Figures 5.12** and **5.13**).

All incoming TN and TP loads from the Spring Lake and Lake Adair Subbasin surface runoff, Lake Adair Subbasin baseflow, Lake Adair Subbasin BMPs, and direct atmospheric loads, as listed in **Tables 4.5** and **4.6**, should be included to calculate the allowable TMDLs for Lake Adair. However, the direct atmospheric deposition of TN and TP on the lake surface is not regulated by the CWA and was kept the same for the TMDL load calculation as the existing atmospheric TN and TP deposition.

Tables 5.5 and **5.6** list the annual allowable loads of TN and TP for Lake Adair. The final TMDLs for TN and TP, calculated as the maximum annual average loads of TN and TP from 7-year average loads, are 1,201 lbs/yr for TN and 72 lbs/yr for TP from all sources, not to be exceeded in any year, to protect the designated use of Lake Adair.

5.3.5 Identification of Downstream Water Protection

The TMDL target and the site-specific TN and TP loads for Lake Adair also protect the downstream lake, Lake Concord (WBID 2997P), located at the northeast corner of Lake Adair. Lake Adair discharges directly to Lake Concord through drainage pipes under Edgewater Drive. **Table 5.7** lists the annual average concentrations of chlorophyll *a*, TN, and TP in Lake Concord observed during the planning and verified periods from 2000 to 2014. The Group 2 Cycle 3 assessment listed Lake Concord as not impaired for chlorophyll *a*, TN, or TP. Annual average concentrations of TN ranged from 0.61 mg/L in 2004 to 0.99 mg/L in 2010, with an average of 0.80 mg/L, indicating that the TN restoration concentration of 0.71 mg/L for Lake Adair, not to be exceeded in any year, is well within the range of observed TN in Lake Concord.

Similarly, annual average TP concentrations in Lake Concord ranged from 0.029 mg/L in 2014 and 0.047 mg/L in 2005, with a 15-year average of 0.037 mg/L. The TP restoration concentration of 0.044 mg/L, not to be exceeded in any single year, is well in the range of the observed annual TP and lower than the maximum annual TP in Lake Concord. Therefore, the proposed target loads of TN and TP for Lake Adair associated with the lake restoration TN and TP concentrations, not to be exceeded in any year, should improve the water quality in Lake Concord.

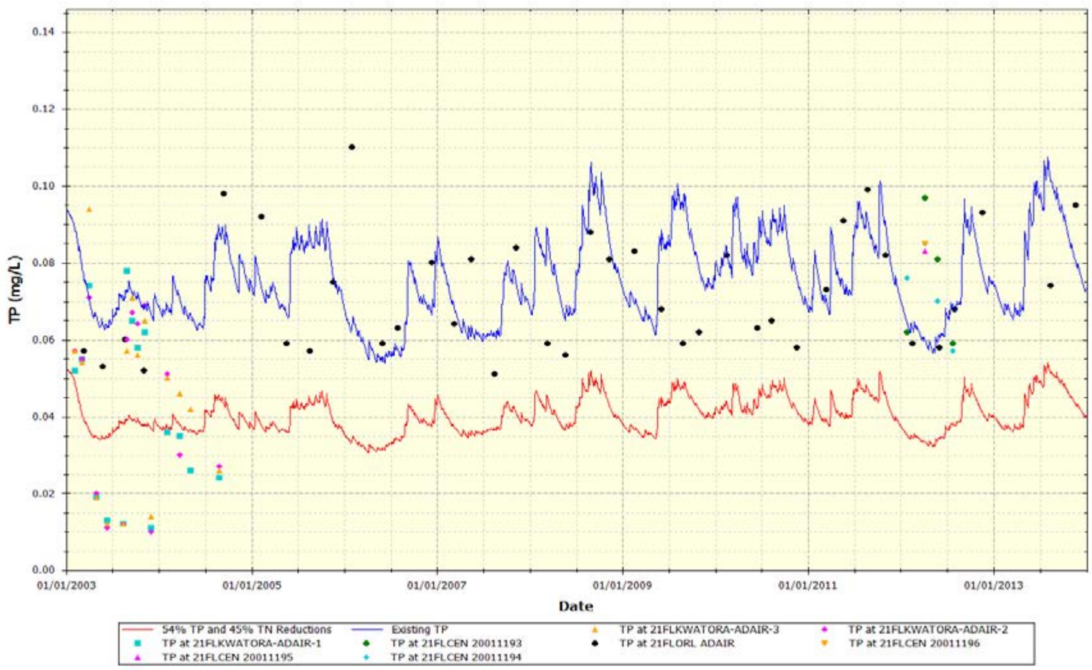


Figure 5.9. Simulated TP for existing (blue line), and 54 % TP and 45 % TN reductions (red line). Symbols represent the observed data for TP.

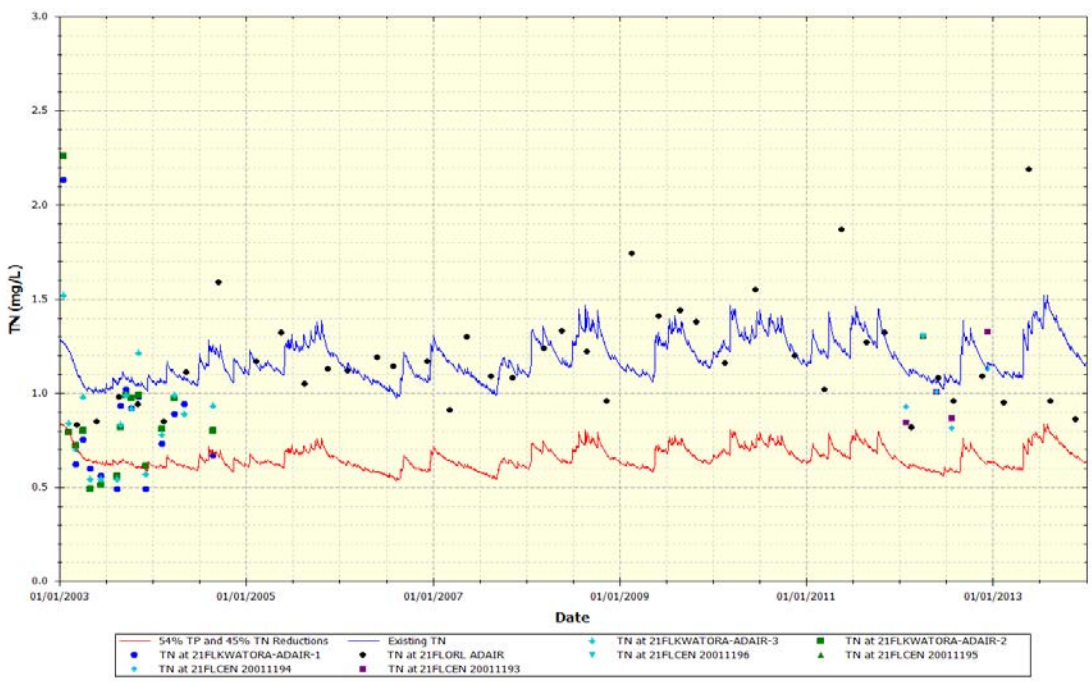


Figure 5.10. Simulated TN for existing (blue line), and 54 % TP and 45 % TN reductions (red line). Symbols represent the observed data for TN.

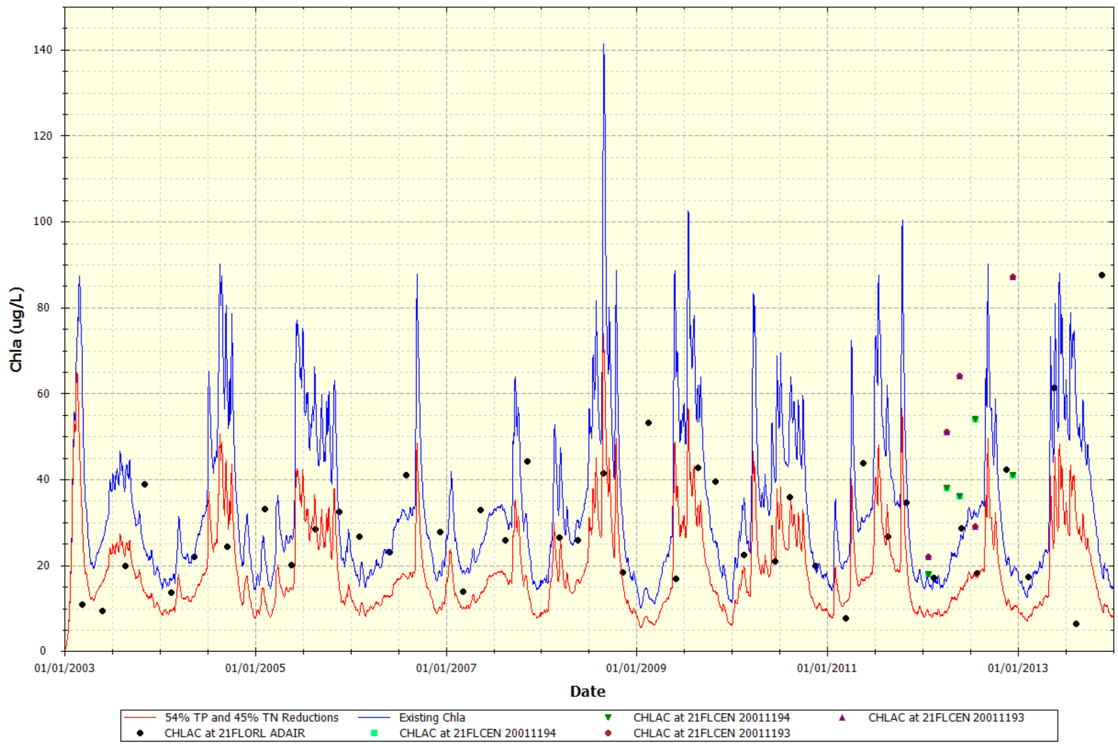


Figure 5.11. Simulated chlorophyll *a* for existing (blue line), and 54 % TP and 45 % TN reductions (red line). Symbols represent the observed data for chlorophyll *a*.

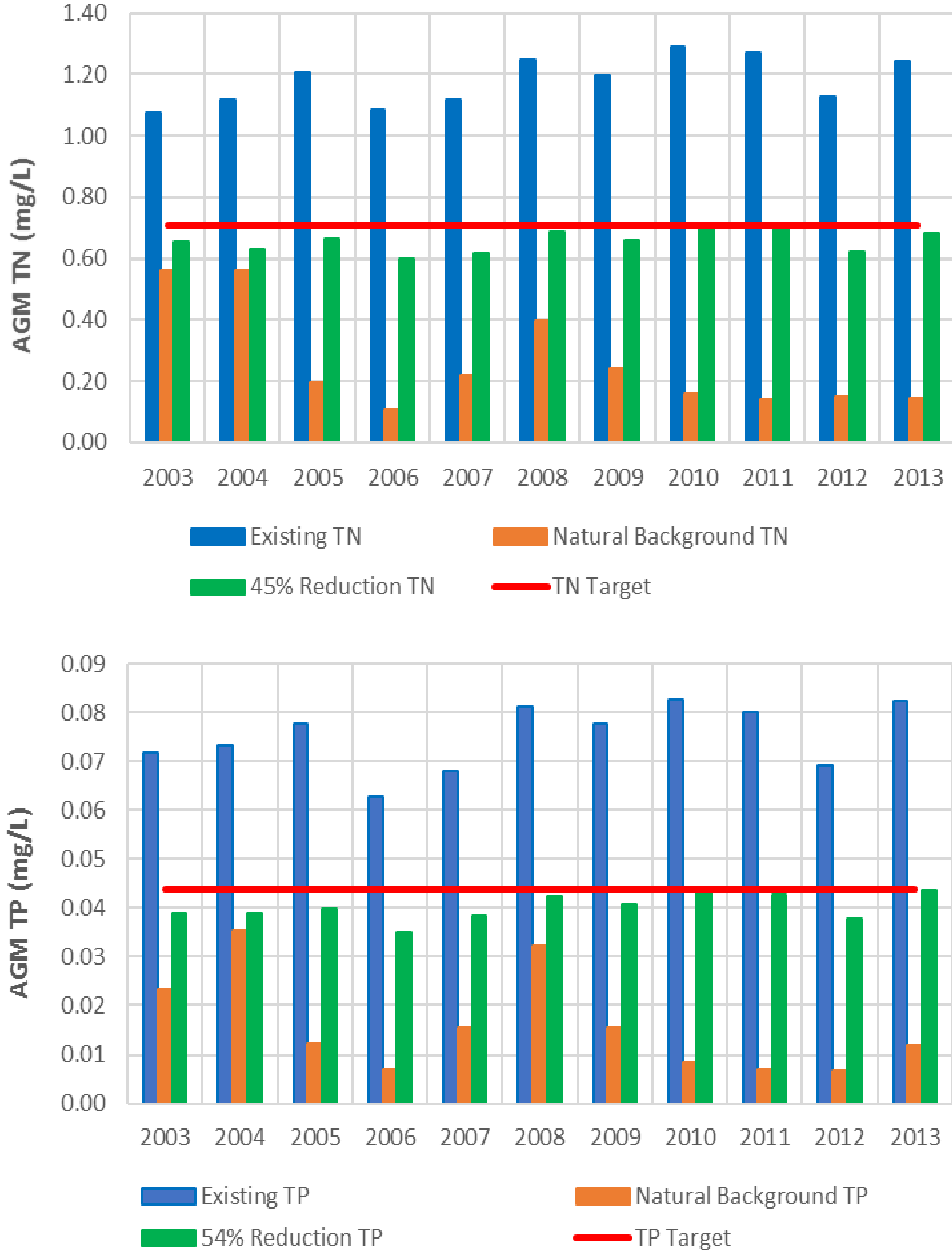


Figure 5.12. AGMs of TN (top) and TP (bottom) for existing (blue bars), natural background (orange bars), and TMDL conditions (green bars). The red lines represent the TN and TP targets of 0.71 and 0.044 mg/L, respectively.

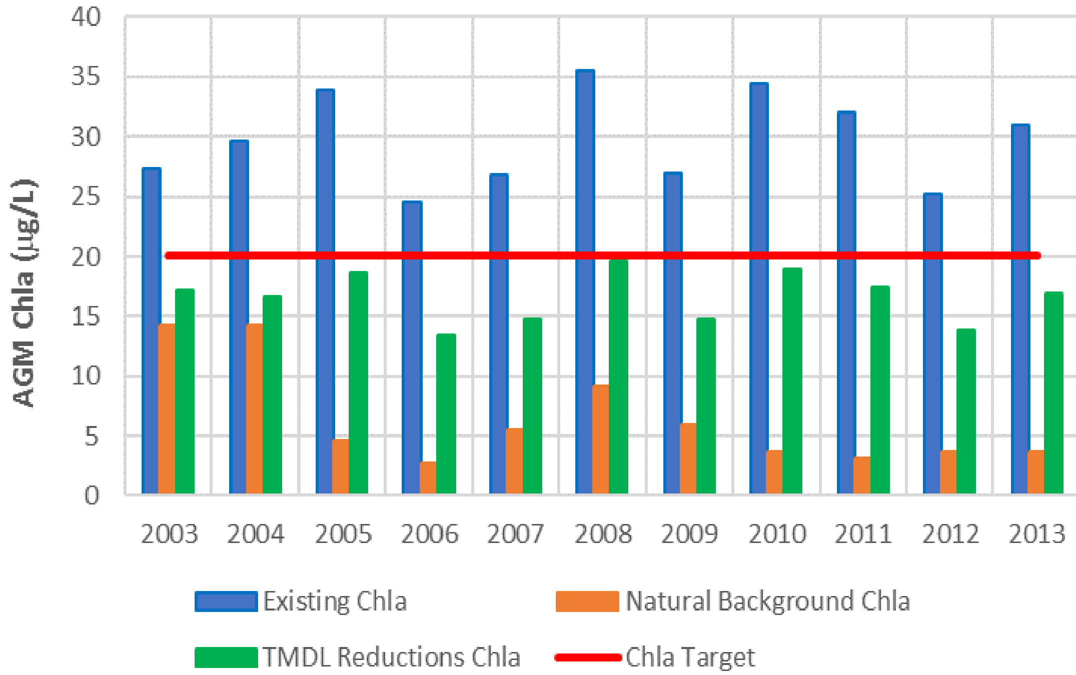


Figure 5.13. AGMs of chlorophyll *a* for existing (blue bars), natural background (orange bars), and TMDL conditions (green bars). The red line represents the chlorophyll *a* target of 20 µg/L for Lake Adair.

Table 5.5. Allowable TP loads under the existing and TMDL condition (54 % reduction)

Year	Existing Total TP Loads (lbs/yr)	Allowable Total TP Loads under 54 % Reduction (lbs/yr)	Atmospheric TP Deposition (lbs/yr)	Allowable Watershed TP Loads under 54 % Reduction (lbs/yr)	7-Year Rolling Average To Determine TP TMDL (lbs/yr)
2003	99	46	11	35	
2004	210	97	16	81	
2005	211	97	16	81	
2006	95	44	10	34	
2007	82	38	10	28	
2008	217	100	15	85	
2009	146	67	13	54	70
2010	142	65	12	53	72
2011	139	64	12	52	68
2012	80	37	10	27	59
2013	125	58	11	47	61
2014	152	70	13	57	66
Average	**141**	**65**	**12**	**53**	**66**

Table 5.6. Allowable TN loads under the existing and TMDL condition (45 % reduction)

Year	Existing Total TN Loads (lbs/yr)	Allowable Total TN Loads under 45 % Reduction (lbs/yr)	Atmospheric TN Deposition (lbs/yr)	Allowable Watershed TN Loads under 45 % Reduction (lbs/yr)	7-Year Rolling Average To Determine TN TMDL (lbs/yr)
2003	1,401	771	252	519	
2004	2,872	1,580	354	1,226	
2005	2,945	1,620	366	1,254	
2006	1,313	722	228	494	
2007	1,178	648	230	418	
2008	2,927	1,610	324	1,286	
2009	2,054	1,130	293	837	1,154
2010	1,992	1,096	268	828	1,201
2011	1,942	1,068	268	800	1,128
2012	1,170	644	221	423	988
2013	1,764	970	253	717	1,024
2014	2,059	1,132	282	850	1,093
Average	**1,968**	**1,082**	**278**	**804**	**1,098**

Table 5.7. Annual average concentrations of chlorophyll *a*, TN, and TP in Lake Concord from the planning and verified periods

General Statistics	Chlorophyll *a* (µg/L)	TN (mg/L)	TP (mg/L)
Count	15	15	15
Average	20	0.80	0.037
Median	19	0.80	0.036
Standard Deviation	7	0.12	0.005
Minimum	10	0.61	0.029
Maximum	37	0.99	0.047

Chapter 6: Determination of the TMDLs

6.1 Expression and Allocation of the TMDLs

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

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

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

It should be noted that the various components of the 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 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).

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 nonpoint sources (given the nature of stormwater transport). The permitting of MS4 stormwater discharges is also different than the permitting of most wastewater point sources. Because MS4 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 BMPs.

This approach is consistent with federal regulations (40 Code of Federal Regulations [CFR] § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The NPDES stormwater WLA is expressed as a percent reduction in the stormwater from MS4 areas. The load allocation and TMDLs for Lake Adair are expressed as loads and percent reductions, and represent the seven-year average load of TN and TP from all sources that the waterbody can assimilate and maintain the Class III NNC (**Table 6.1**). The expression and allocation of the TMDLs in this report are based on the loadings necessary to achieve the water quality criteria and designated uses of the surface waters.

These TMDLs are based on simulated 11-year data from 2003 through 2013. The restoration goal is to restore the lake with the AGM 20 µg/L chlorophyll *a* concentration, never to be exceeded more than once in any consecutive three-year period.

Table 6.1. TMDL components for Lake Adair

NA = Not applicable
*The TMDL daily load is 3.3 lbs/day for TN and 0.20 lbs/day for TP, and corresponding in-lake AGM concentrations for information purposes only are 0.71 mg/L for TN and 0.044 mg/L for TP, not to be exceeded in any single year.
** The required percent reductions listed in this table represent the reduction from all incoming sources.

WBID	Parameter	TMDL (lbs/yr)*	WLA Wastewater (lbs/yr)	WLA Stormwater (% reduction)**	LA (% reduction)**	MOS
2997R	TN	1,201	NA	45	45	Implicit
2997R	TP	72	NA	54	54	Implicit

6.2 Load Allocation (LA)

Because the exact boundaries between those areas of the watershed covered by the WLA allocation for stormwater and the LA allocation are unknown, both the LA and the WLA for stormwater will receive the same percent reduction. The LA is a 54 % reduction in TP and a 45 % reduction in TN of the total nonpoint source loadings, based on the period from 2003 to 2014.

As the LAs are based on the percent reduction in total loading and reductions from natural land uses are not required, the percent reductions for anthropogenic sources may be greater. It should be noted that the LA may include loading from stormwater discharges regulated by DEP and the water management district that are not part of the NPDES Stormwater Program (see **Appendix B**).

6.3 Wasteload Allocation (WLA)

6.3.1 NPDES Wastewater Discharges

As noted in **Chapter 4**, there are no active NPDES-permitted facilities in the Lake Adair Watershed that discharge into the lake or its watershed. Therefore, the $WLA_{wastewater}$ for the Lake Adair TMDLs is not applicable.

6.3.2 NPDES Stormwater Discharges

The stormwater collection systems in the Lake Adair Subbasin that are owned and operated by the City of Orlando are covered by an NPDES Phase I MS4 permit (FLS000014). For a portion of the Spring Lake Subbasin, the stormwater collection systems are operated by Orange County and co-permittees in the MS4 permit (FLS000011). The wasteload allocations for stormwater discharges are a 54 % reduction in TP and a 45 % reduction in TN, which are the required percent reductions for the total TN and TP loads from all sources.

It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction. As the TMDLs are based on the percent reduction in total watershed loading and any natural land uses are held harmless, the percent reduction for only anthropogenic sources may be greater.

6.4 Margin of Safety (MOS)

The MOS is a required component of a TMDL analysis and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (CWA, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty. The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings.

Consistent with the recommendations of the Allocation Technical Advisory Committee (DEP 2001), an implicit MOS was used in the development of the Lake Adair TMDLs because the TMDLs are based on the conservative decisions associated with a number of the modeling assumptions in determining assimilative capacity (i.e., watershed loading and water quality response). For example, the model calibration and validation period was extended to the 11-year simulation to include a worst-case condition and associated model scenarios represented that water quality variables responded to the condition. In addition, the TMDL target attaining the chlorophyll *a* NNC in all years and the maximum annual average loads of TN and TP from 7-year average loads was determined as the site-specific TN and TP interpretations of the narrative nutrient criterion for Lake Adair.

Chapter 7: Next Steps: Implementation Plan Development and Beyond

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation takes place through various measures. The implementation of TMDLs may occur through specific requirements in NPDES wastewater and MS4 permits, and, as appropriate, through local or regional water quality initiatives or BMAPs.

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

7.2 Basin Management Action Plans

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

The FWRA (Section 403.067, F.S.) provides for the development and implementation of BMAPs. BMAPs are adopted by the DEP Secretary and are legally enforceable. They describe the management strategies that will be implemented, as well as funding strategies, project tracking mechanisms, water quality monitoring, and the fair and equitable allocations of pollution reduction responsibilities to sources in the watershed. They also identify mechanisms to address potential pollutant loading from future growth and development.

The most important component of a BMAP is the list of management strategies to reduce pollution sources, as these are the activities needed to implement the TMDL. The local entities that will conduct these management strategies are identified and their responsibilities are enforceable. Management strategies may include wastewater treatment upgrades, stormwater improvements, and agricultural BMPs.

The ongoing BMAP has been developed for the entire Lake Jesup watershed that also requires implementation of restoration strategies to the Lake Adair watershed. Additional information about BMAPs for the Lake Jesup watershed is available on the DEP website.

7.3 Implementation Considerations for Lake Adair

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 any associated remediation projects on surface water quality. In the case of Lake Adair, other factors such as changing inflow and outflow may be also influencing lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the lake.

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Appendices

Appendix A: Summary of Information Supporting the TMDLs as Site-Specific Interpretations of the Narrative Nutrient Criterion for Lake Adair

Table A-1. Spatial extent of the waterbody where site-specific numeric interpretations of the narrative nutrient criterion will apply

Location	Description
Waterbody name	Lake Adair
Waterbody type(s)	Lake
Waterbody ID (WBID)	WBID 2997R
Description	Lake Adair is located near downtown Orlando, FL. The average surface area of the lake is 25 acres, with an average depth of 2.9 m. Lake Adair receives the upstream flow from Spring Lake, located west of Orange Blossom Trail (U.S. Highway 441). Lake Adair discharges to Lake Concord from the southeast corner of Lake Adair via drainage pipes under Edgewater Drive, and its water levels are also controlled by a drainage well located in the northeast corner of Lake Adair that conveys to the Upper Floridan aquifer. These lakes are part of the Howell Branch Chain of Lakes, which ultimately flows to Lake Jesup.
Specific location (latitude/longitude or river miles)	The center of Lake Adair is located at Latitude N: 28°33'37", Longitude W: - 81°23'28".
Map	**Figure 1.1** and **Figure 4.2** show the general location of Lake Adair and land uses in the watershed, respectively. Land uses include urban and residential (75.8 %), forest/rangeland (0.5 %), golf course (14.1 %), open land (0.6%), and water and wetlands (9.0 %).
Classification(s)	Class III Freshwater
Basin name (Hydrologic Unit Code [HUC] 8)	Middle St. Johns River Basin (03080101)

Table A-2. Default NNC, site-specific interpretations of the narrative criterion developed as TMDL targets, and data used to develop the site-specific interpretation of the narrative criterion

Narrative Nutrient Criterion	Description
NNC summary: Default nutrient watershed region or lake classification (if applicable) and corresponding NNC	Lake Adair 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 1.27 to 2.23 mg/L, and TP of 0.05 to 0.16 mg/L.
Proposed TN, TP, Chlorophyll *a*, and/or nitrate+nitrite (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: TN load of 1,201 lbs/yr and TP load of 72 lbs/yr are both expressed as 7-year averages of annual loads not to be exceeded, which are intended to achieve a chlorophyll *a* of 20 µg/L never to be exceeded more than once in any consecutive three-year period. This approach establishes lake-specific NNC that are more representative of conditions in Lake Adair than the generally applicable NNC. The TMDL loads will be considered the site-specific interpretation of the narrative criterion. Nutrient concentrations are provided for informational purposes only. The TP and TN restoration concentrations are set as the AGMs of TP and TN at 0.044 and 0.71 mg/L, respectively, not to be exceeded in any year to allow the lake to achieve the chlorophyll *a* target.
Period of record used to develop the numeric interpretations of the narrative nutrient criterion for TN and TP criteria	The criteria were developed based on the application of the HSPF model and the receiving water EFDC and WASP models that simulated hydrology and water quality conditions over the 2003 to 2014 period. The primary datasets for this period include water quality data from the IWR Database (Run 52) rainfall, and evapotranspiration data from 2002 to 2014. Land use data from the SJRWMD 2009 land use were used to establish watershed nutrient loads.
Indicate how criteria developed are spatially and temporally representative of the waterbody or critical condition.	The model simulated the 2003 to 2014 period, which included both wet and dry years. During the simulation period, total annual average rainfall varied from 36.1 to 68.6 inches and averaged 51.4 inches. A comparison with the long-term average rainfall data indicated that 2006, 2007, and 2010 were dry years, while 2005, 2008, and 2014 were wet years. NEXRAD rainfall data that the SJRWMD received from the National Weather Service were used as the model input for estimating nutrient loads from the watershed. These rainfall datasets have a spatial resolution of 2 km^2, which properly represents the spatial heterogeneity of rainfall in the watershed. The model simulated the entire watershed to evaluate how changes in watershed loads impact lake nutrient and chlorophyll *a* concentrations. **Figure 5.1** of this report shows the location of a water quality sampling station used in the Lake Adair model calibration process. The water quality stations properly represents a well-mixed lake.

Table A-3. History of nutrient impairment, quantitative indicators of use support, and methodologies used to develop the site-specific interpretation of the narrative criterion

Designated Use	Description
History of assessment of designated use support.	DEP used the IWR to assess water quality for Lake Adair. The lake was verified as impaired for nutrients during the Cycle 3 assessment (verified period January 1, 2007–June 30, 2014) using the methodology in the IWR (Chapter 62-302, F.A.C.), and was included on the Cycle 3 Verified List of impaired waters for the Middle St. Johns River Basin adopted by Secretarial Order. Chlorophyll *a* data from 2007 to 2014 were used to assess the nutrient impairment based on the NNC. There were sufficient chlorophyll *a* data from 2007 through 2014 to meet the data sufficiency requirements of Subsection 62-302.531(6), F.A.C., to calculate the AGM of chlorophyll *a* concentrations. The AGM chlorophyll *a* concentration exceeded the 20 µg/L criterion in several years (2007, 2012, 2013, and 2014), indicating that the lake is impaired for chlorophyll *a*.
Quantitative indicator(s) 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 Adair that would make the use of the chlorophyll *a* threshold of 20 µg/L inappropriate for the lake.
Summarize approach used to develop criteria and how it protects uses	For the Lake Adair nutrient TMDLs, DEP established the site-specific TN and TP concentrations and loadings using a set of calibrated models to achieve an in-lake chlorophyll *a* AGM concentration of 20 µg/L. Because the 20 µg/L chlorophyll *a* target was demonstrated in the NNC development document to be protective of the designated use for low-color, high-alkalinity lakes, the TN and TP concentrations and loading targets established to achieve the 20 µg/L concentration target will also be protective of the designated use.
Discuss how the TMDLs 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 Adair that may be related to nutrients (such as DO or un-ionized ammonia). Reducing the nutrient loads entering the lake will not negatively impact other water quality parameters of the lake.

Table A-4. Site-specific interpretation of the narrative criterion and protection of designated use of downstream segments

Downstream Protection and Monitoring	Description
Identification of downstream waters: List receiving waters and identify the technical justification for concluding downstream waters are protected.	When water levels are high, Lake Adair drains to Lake Concord via a structure located at the northeast corner of the lake. The outlet discharges to a residential stormwater pond through an underground pipe. The restoration targets of TN and TP in Lake Adair were well within the range of annual concentrations of TN and TP observed in downstream, nonimpaired Lake Concord.
Summarize 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.	DEP and the City of Orlando collected water quality data in Lake Adair. These entities will continue to evaluate future water quality trends in the lake. The data collected through their monitoring activities will be used to evaluate the effect of BMPs implemented in the watershed on the lake's TN and TP concentrations in subsequent water quality assessment cycles.

Table A-5. Public participation and legal requirements of rule adoption

Administrative Requirements	Descriptive Information
Notice and comment notifications	DEP published a Notice of Development of Rulemaking on April 6, 2015, to initiate TMDL development for impaired waters in the Middle St. Johns River Basin. Technical workshops for the Lake Adair TMDLs were held on September 23, 2016, and April 13, 2017, to present the general TMDL approach to local stakeholders. A rule development public workshop for the TMDLs was held on September 28, 2017. A 30-day public comment period was provided to the stakeholders. Public comments were received for the TMDLs, and DEP has prepared a responsiveness summary for these comments. DEP published an updated Notice of Development of Rulemaking on January 17, 2017, covering the Middle St. Johns River Basin, to address the need for TMDLs to be adopted within 1 year after the Notice of Development of Rulemaking is published.
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 the EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered a site-specific interpretation of the narrative nutrient criterion, and submit these documents to the EPA.

Appendix B: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, DEP's 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 (ERP) 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 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, stormwater PLRGs 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 the FDOT throughout the 15 counties meeting the population criteria. DEP received authorization to implement the NPDES stormwater program in October 2000. Its authority to administer the program is set forth in Section 403.0885, F.S.

The Phase II NPDES stormwater program, promulgated in1999, addresses additional sources, including small MS4s and small construction activities disturbing 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.