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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

SOUTHWEST DISTRICT • LAKE HANCOCK BASIN • PEACE RIVER PLANNING UNIT

TMDL Report

Nutrient TMDL For Lake Parker

WBID 1497B

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October 2005

Acknowledgments

This study could not have been accomplished without significant contributions from staff in the Florida Department of Environmental Protection's (the Department) Watershed Assessment Section. The Department also recognizes the substantial support and assistance from the Department's Tampa District Office, the Southwest Florida Water Management District (SWFWMD), the Polk County Natural Resource Division, Soil and Water Engineering Technology, Inc. (SWET), and Quantitative Environmental Analysis (QEA), LLC, and their contributions towards understanding the issues, history, and processes at work in the Lake Parker watershed.

Editorial assistance provided by Daryll Joyner and Jan Mandrup-Poulsen.

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the TMDL for nutrients for Lake Parker. Lake Parker is located in the Lake Hancock Basin which contributes to the Lower Saddle Creek watershed, the Peace River and ultimately Charlotte Harbor and the Gulf of Mexico. The lake was verified as impaired by nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR, Rule 62-303, Florida Administrative Code), and was included on the Verified List of impaired waters for the Lake Hancock Basin that was adopted by Secretarial Order on June 17, 2005. The TMDL establishes the allowable loadings to the lake that would restore the waterbody so that it meets its applicable water quality criteria for nutrients.

1.2 Identification of Waterbody

Lake Parker is located inside the City of Lakeland, Polk County, Florida (**Figure 1.1**). The estimated surface area of the Lake is 2,272 acres, with an average lake volume of 15,080,984 m^3 (3,984,393,331 gal). Average depth is 5.3 ft (1.6 m) with a maximum depth of 10 ft. The surface water drainage area of the Lake Parker watershed which enters Middle/Upper Saddle Creek and eventually Lake Hancock is approximately 23.8 square miles or 15,231 acres. The normal pool topographic elevation of the water surface is 130.3 feet National Geodetic Vertical Datum (NGVD) (Polk County Natural Resources Division, 2002).

For assessment purposes, the Department has divided the Lake Hancock Basin into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Lake Parker has been given the WBID number of 1497B. The Lake Parker WBID and its sampling/monitoring stations are illustrated in **Figure 1.2.**

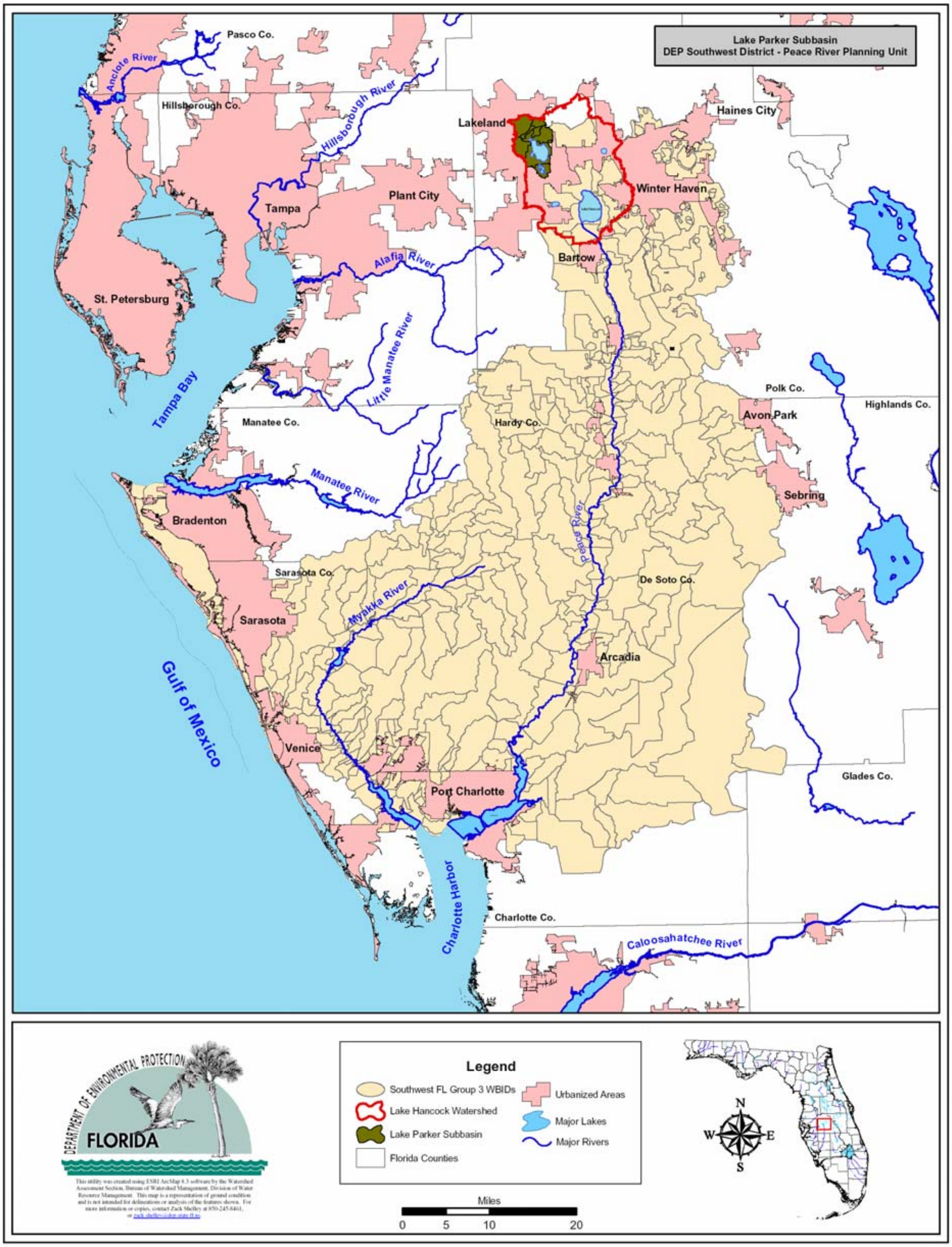

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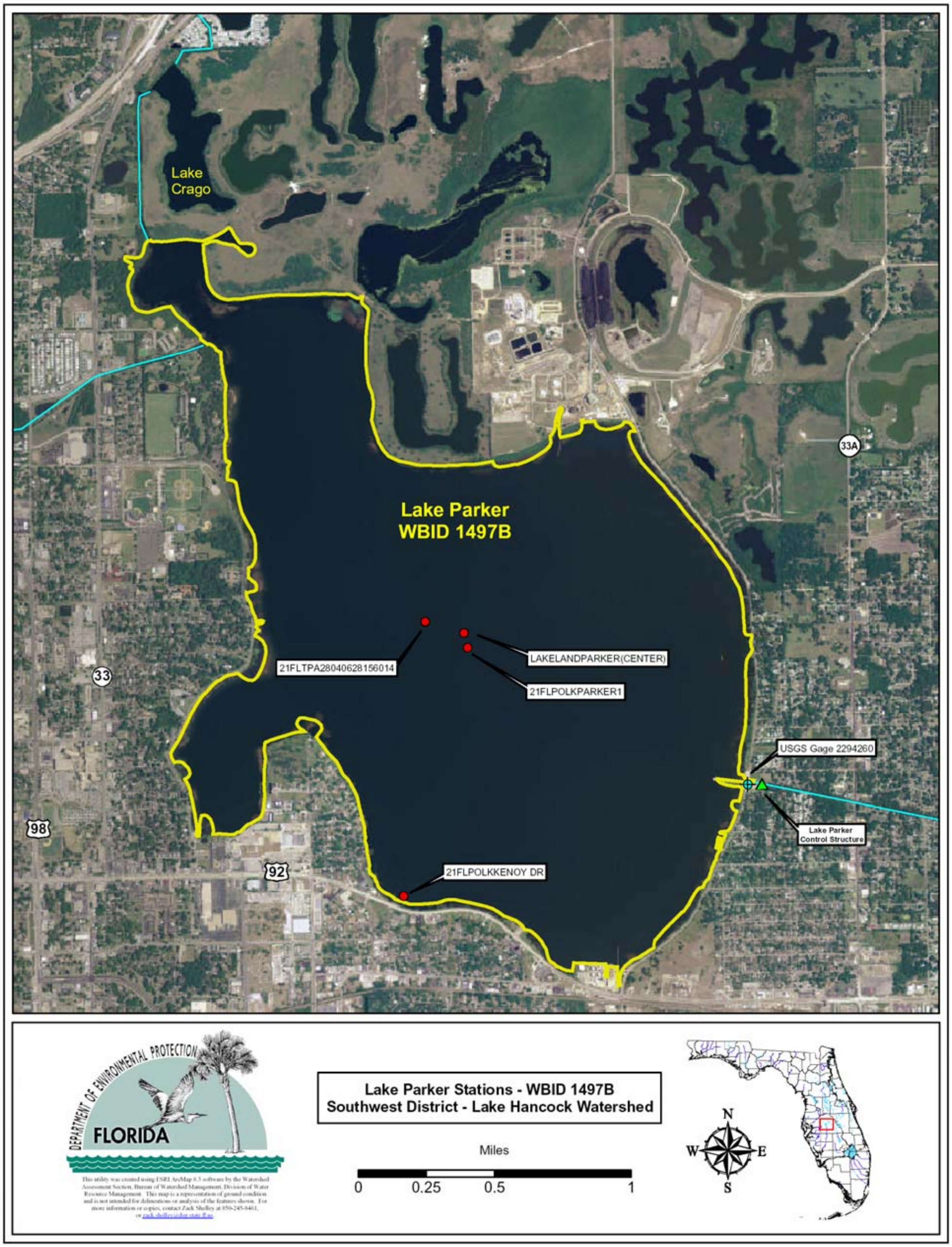
Figure 1.1 Southwest Florida Group 3 WBIDs and Major Metropolitan Areas Surrounding the Lake Hancock Watershed and the Lake Parker Sub-basin



Lake Parker Stations - WBID 1497B
Southwest District - Lake Hancock Watershed

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Figure 1.2 Lake Parker WBID 1497B and Monitoring Stations

1.3 Background Information

Lake Parker is the largest lake in the City of Lakeland. The lake receives water from lakes Bonny, Crago, Gibson, Garden, and Mirror and outflows to Middle/Upper Saddle Creek and thence to Lake Hancock, Lower Saddle Creek and the Peace River. A canal connects Lakes Parker and Crago. Crago is connected via a canal to Lake Gibson. Lake Mirror discharges to Lake Parker through a piped conveyance. The Lake Parker sub-basin is one of nine major sub-basins delineated for modeling the Lake Hancock Basin. Included in the Lake Parker TMDL modeling process are lakes Gibson and Crago. Lake Bonny is addressed in a separate TMDL report. **Figure 1.3** provides an overview of Lake Parker and the Lake Parker sub-basin modeled for the TMDL. Two fossil fuel power generation facilities (Lakeland Electric McIntosh Plant and Lakeland Larson Memorial Plant) are located on the banks of Lake Parker which use the lake for re-circulating cooling water. Lake Parker has three parks, three boat ramps and two fishing piers. In the past, phosphate was mined along the north shore of the lake and herbicides were used to control Hydrilla. Parker has a large migratory bird community in the winter months, where several species of wintering ducks and geese have been observed.

The TMDL Report for Lake Parker is part of the implementation of the Department's watershed management approach for restoring and protecting water resources and addressing Total Maximum Daily Load (TMDL) Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's fifty-two river basins over a five-year cycle, provides a framework for implementing the requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet the waterbody's designated uses. A waterbody that does not meet its designated uses is defined as impaired. TMDLs must be developed and implemented for each of the state's impaired waters, unless the impairment is documented to be a naturally occurring condition that cannot be abated by a TMDL or unless a management plan already in place is expected to correct the problem.

The development and implementation of a Basin Management Action Plan, or BMAP, to reduce the amount of pollutants that caused the impairment will follow this TMDL Report. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), Polk County, local governments, local businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDL for Lake Parker.

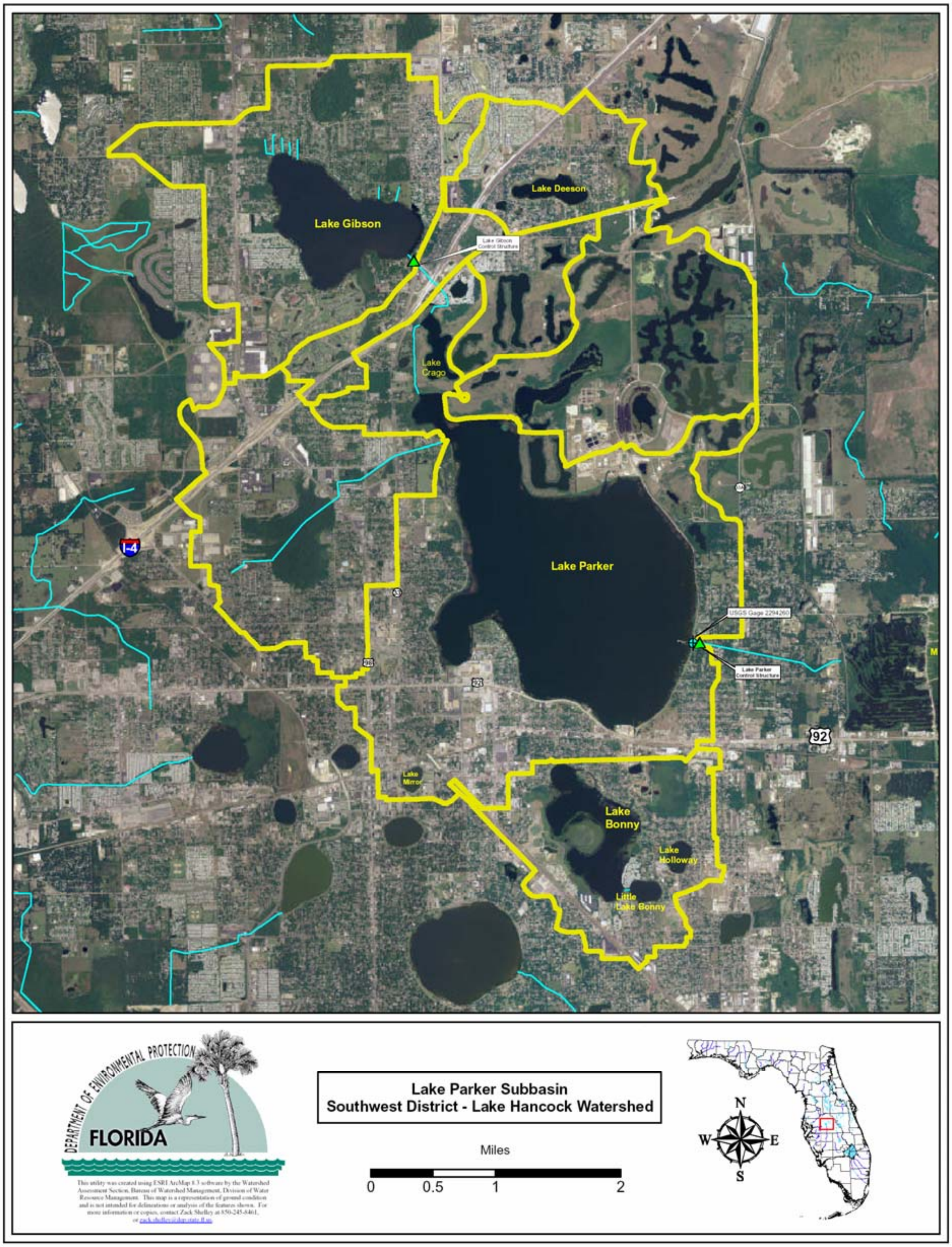

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Figure 1.3 Overview of Lake Parker and the Lake Parker Sub-basin

Chapter 2: STATEMENT OF WATER QUALITY PROBLEM

2.1 Legislative and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the EPA a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of the listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the Florid Watershed Restoration Act (Subsection 403.067[4)] Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 52 waterbodies in the Peace River Planning Unit, with 11 of those waterbodies in the Lake Hancock Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department 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, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Lake Parker. The lake was verified as impaired for nutrients based on elevated annual average Trophic State Index (TSI) values over the verification period (the Verified Period for the Group 3 basins is from January 1, 1997 to June 30, 2004). The IWR methodology uses the water quality variables total nitrogen (TN), total phosphorus (TP), and chlorophyll a (a measure of algal mass, corrected and uncorrected) in calculating annual TSI values and in interpreting Florida's narrative nutrient threshold. Annual average TSI values for the verified period for Lake Parker were 83.1 (1997), 80.3 (1998), 86.6 (1999), 88.8 (2000), 85.5 (2001), 83.4 (2002), and 77.4 (2003). The annual average TSI value for years in the verified period was 83.6. Exceeding 60 in any one year of the verified period is sufficient in determining the impairment for a lake for nutrients. Annual average color values for the verified period for the lake were 48.6 (1997), 82 (1998), 32 (1999), 32 (2000), 55.3 (2001), 34 (2002), and 53.8 (2003). The annual average color value for years in the verified period was 48.2.

The TSI is calculated based on concentrations of TP, TN, and chlorophyll a as follows:

TSI Formula

$\mathrm{CHLA}_{\mathrm{TSI}} = 16.8 + 14.4 * \mathrm{LN}(\mathrm{Chl}\ a)$ Chlorophyll a in µg/L
$\mathrm{TN}_{\mathrm{TSI}} = 56 + 19.8 * \mathrm{LN}(\mathrm{N})$ Nitrogen in mg/L
$\mathrm{TN2}_{\mathrm{TSI}} = 10 * [5.96 + 2.15 * \mathrm{LN}(\mathrm{N} + 0.0001)]$ Phosphorus in mg/L
$\mathrm{TPTSI} = 18.6 * \mathrm{LN}(\mathrm{P} * 1000) – 18.4$
$\mathrm{TP2}_{\mathrm{TSI}} = 10 * [2.36 * \mathrm{LN}(\mathrm{P} * 1000) – 2.38]$

If $\mathrm{N/P} > 30$, *then* $\mathrm{NUTR}_{\mathrm{TSI}} = \mathrm{TP2}_{\mathrm{TSI}}$
If $\mathrm{N/P} < 10$, *then* $\mathrm{NUTR}_{\mathrm{TSI}} = \mathrm{TN2}_{\mathrm{TSI}}$
if $10 < \mathrm{N/P} < 30$, *then* $\mathrm{NUTR}_{\mathrm{TSI}} = (\mathrm{TP}_{\mathrm{TSI}} + \mathrm{TN}_{\mathrm{TSI}})/2$

$\mathrm{TSI} = (\mathrm{CHLA}_{\mathrm{TSI}} + \mathrm{NUTR}_{\mathrm{TSI}})/2$ Note: TSI has no units

For modeling purposes, the analysis of the eutrophication-related data for Lake Parker used "all" of the available data from 1993 – 2004 for which records of TP, TN, and Chlorophyll a were sufficient to calculate seasonal annual average conditions. However, to calculate the TSI for a given year under the IWR, there must be at least one sample of TN, TP, and Chlorophyll a taken at the same time period in each season of the year. The absence of data from all four seasons for the planning and verified periods caused the elimination of the years 1993-1995, and 2004 from the analysis of TSI for Lake Parker.

Figure 2.1 displays annual average TSI values for all data from 1993 to 2004 (includes Lakewatch data) and IWR planning and verified period TSI values from 1996 to 2003 (does not include Lakewatch data). Additionally, as the verified period ends in June of 2004, annual averages were not calculated for 2004 but are displayed in **Figure 2.1** for review. For Lake Parker, all annual mean TSI values exceeded 60 in the verified period.

Monthly and annual average TN results for Lake Parker from 1993 to 2004 are displayed in **Figures 2.2 a**nd **2.3**, respectively. Monthly and annual average TP results from 1993 to 2004 are displayed in **Figures 2.4** and **2.5**. Monthly and annual average chlorohphyll a results from 1993 to 2004 are displayed in **Figures 2.6** and **2.7**. Values from all stations for TN for Lake Parker from 1993 to 2004 were typically highest during the months of May, June, September, and November. Values for TP were highest during the months of May, June, and September. Values for Chlorophyll a were highest during the months of March, May, June, September, and November.

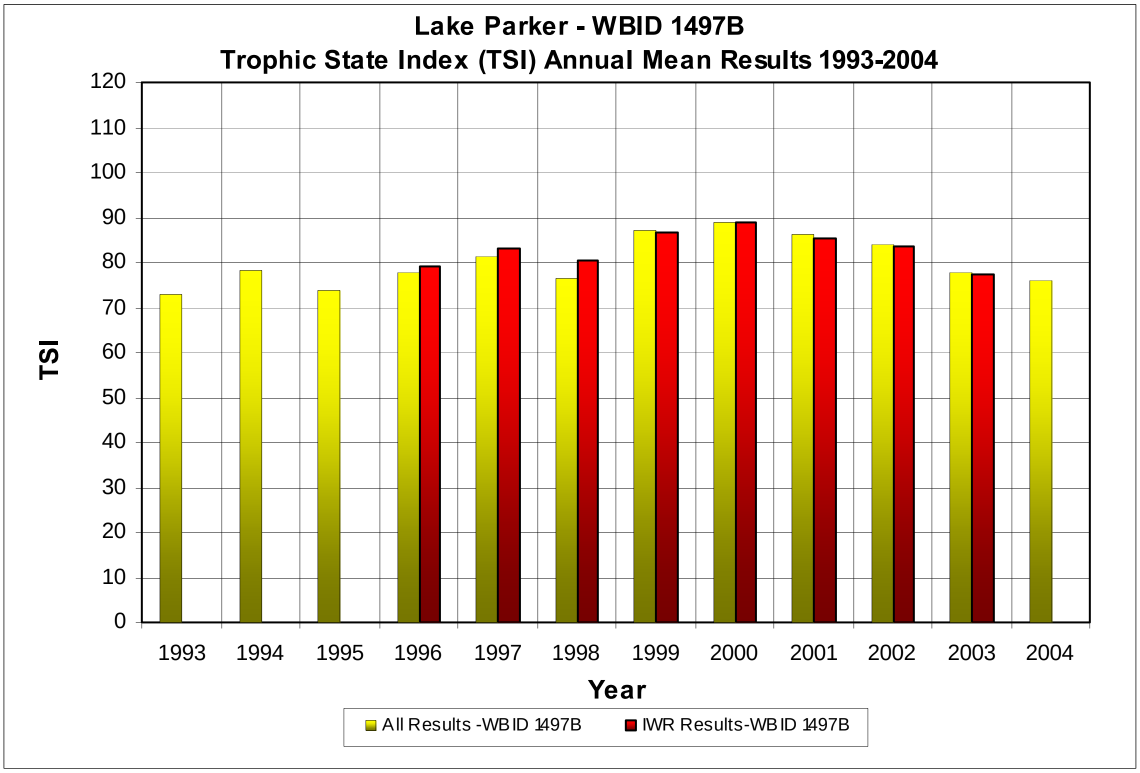

Figure 2.1 TSI Results for Lake Lena Calculated from Annual Average Concentrations of TP, TN, and Chlorophyll *a* from 1993 to 2004

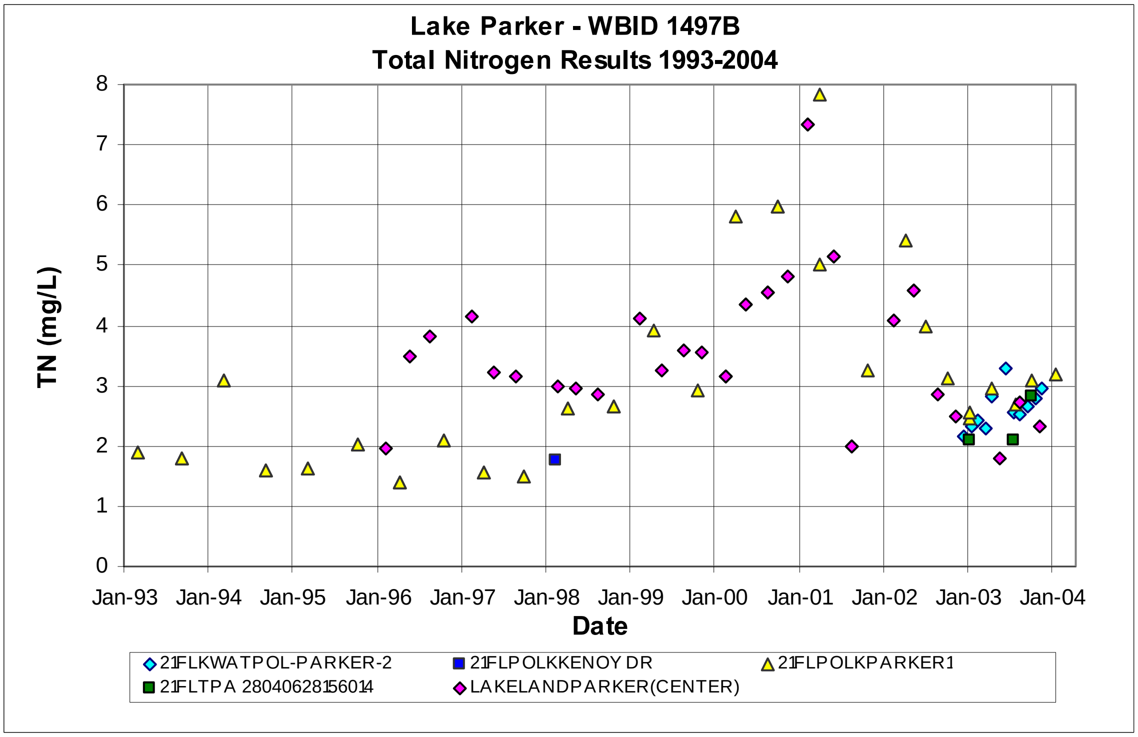

Figure2.2 Total Nitrogen Monthly Results for Lake Parker from 1993 to 2004

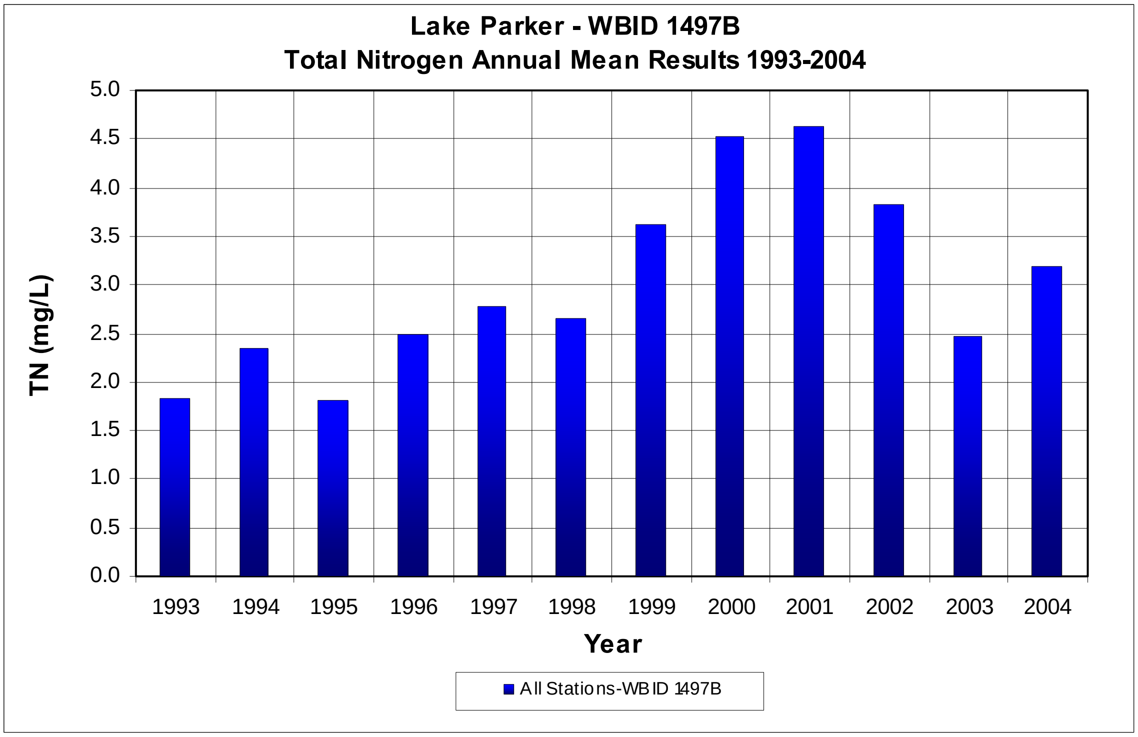

Figure 2.3 Total Nitrogen Annual Mean Results for Lake Parker from 1993 to 2004

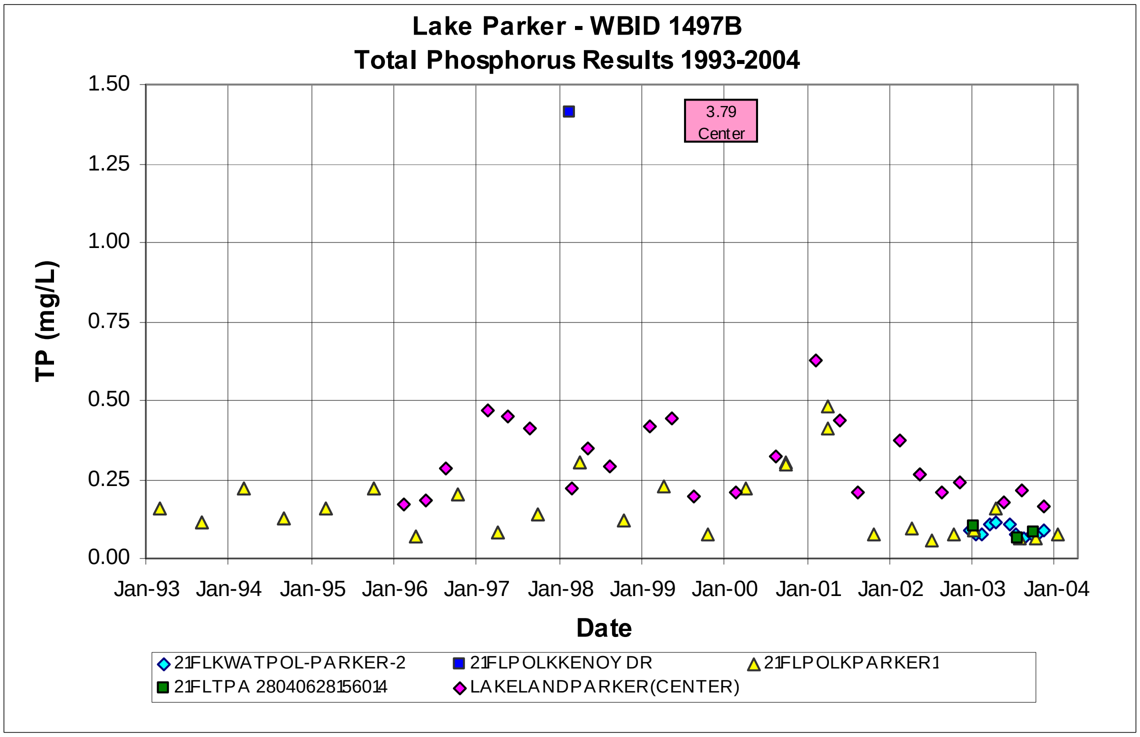

Figure 2.4 Total Phosphorus Monthly Results for Lake Parker from 1993 to 2004

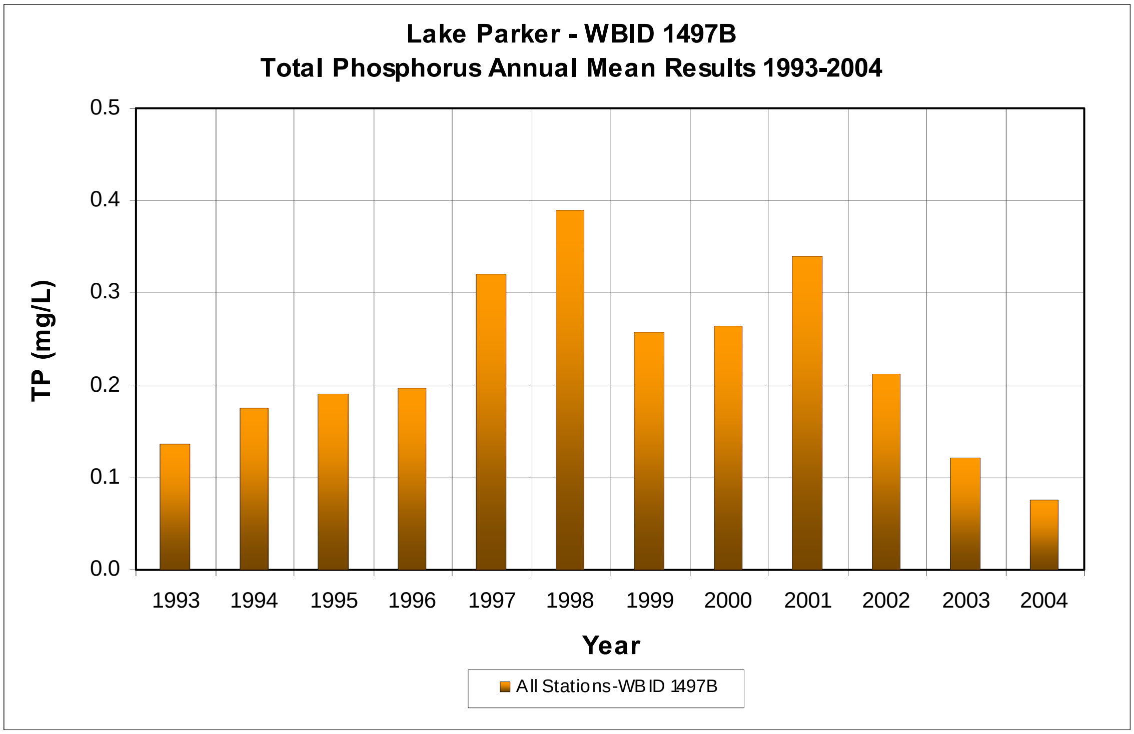

Figure 2.5 Total Phosphorus Annual Mean Results for Lake Parker from 1993 to 2004

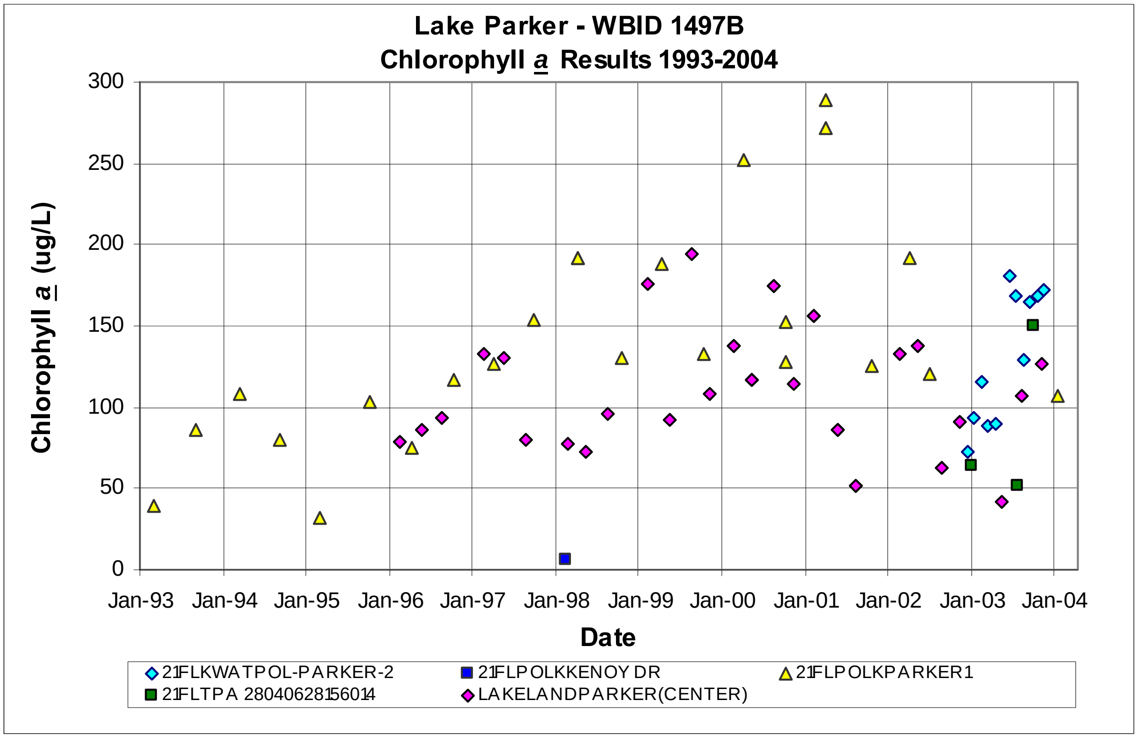

Figure 2.6 Chlorophyll *a* Monthly Results for Lake Parker from 1993 to 2004

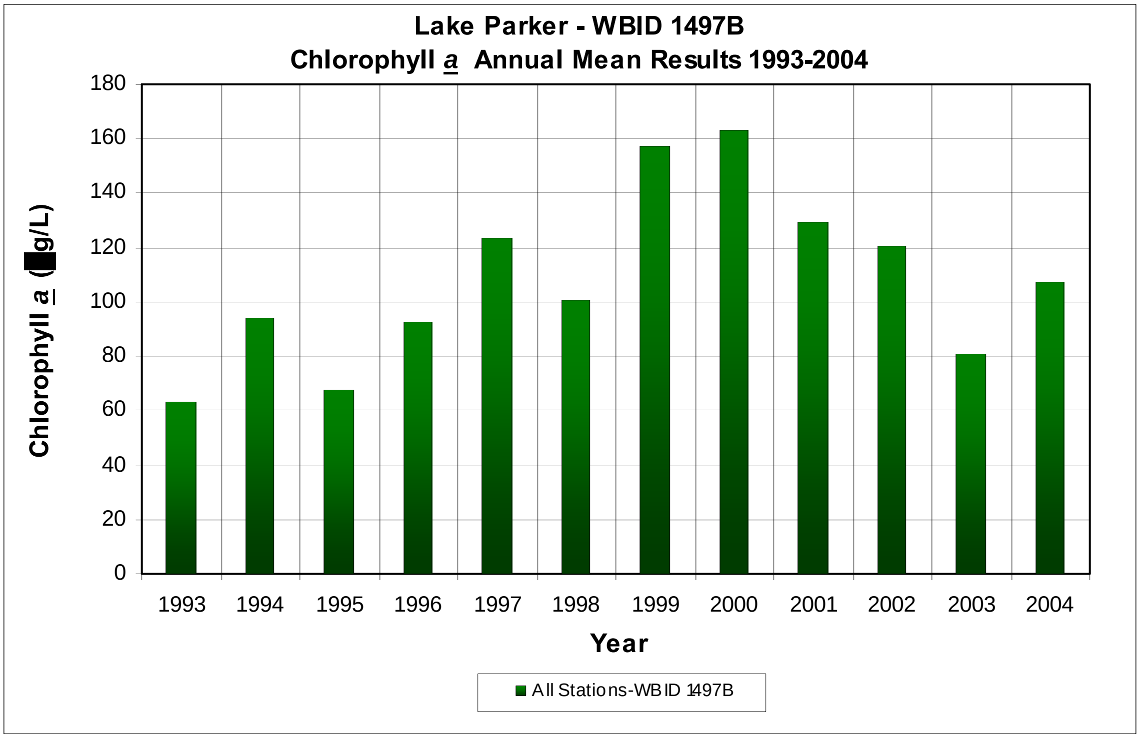

Figure 2.7 Chlorophyll a Annual Mean Results for Lake Parker from 1993 to 2004

Table 2.1 provides summary statistics for Lake Parker for TN, TP and chlorophyll a from 1993 to 2004. Individual water quality measurements for TN, TP, chlorophyll a used in the assessment are provided in **Appendix G.**

Table 2.1 Water Quality Summary Statistics for TN, TP, and Chlorophyll a from 1993 to 2004 for Lake Parker (WBID 1497B)

Waterbody	Water Quality Variable	# of Samples	Minimum	Mean	Median	Maximum
Lake Parker	Total Nitrogen (mg/L)	59	1.38	3.23	2.97	7.82
Lake Parker	Total Phosphorus (mg/L)	55	0.06	0.30	0.21	3.79
Lake Parker	Chlorophyll a (µg/L)	52	6.58	115.57	111.00	280.40

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface water is protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced 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 Parker is classified as Class III freshwater waterbody, with a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the observed impairment for Lake Parker is the state of Florida's narrative nutrient criterion [Rule 62-302.530(48) (b), FAC].

3.2 Interpretation of the Narrative Nutrient Criterion for Lakes

To place a waterbody segment on the Verified List for nutrients, the Department checks against the appropriate impairment threshold identified in the IWR. In addition, the limiting nutrient or nutrients causing impairment must also be identified. The following method is used to identify the limiting nutrient(s) in streams and lakes:

The individual ratios over the entire verified period (i.e., January 1997 to June 2004) are evaluated to determine the limiting nutrient(s). If all the sampling event ratios are less than 10, nitrogen is identified as the limiting nutrient, and if all the ratios are greater than 30, phosphorus is identified as the limiting nutrient. Both nitrogen and phosphorus are identified as limiting nutrients if the ratios are between 10 and 30. A TN/TP ratio median of 14.86 mg/L for the verified period was recorded for Lake Parker suggesting that TN and TP are co-limiting for the lake.

Florida's nutrient criterion is narrative only — nutrient concentrations of a body of water shall not be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Accordingly, a nutrient-related target was needed to represent levels at which an imbalance in flora or fauna is expected to occur. While the IWR provides a threshold for nutrient impairment for lakes based on annual average TSI levels, these thresholds are not standards and are not required to be used as the nutrient-related water quality target for TMDLs. In recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Subsection 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

The TSI originally developed by R. E. Carlson (1977) was calculated based on Secchi depth, chlorophyll concentration, and total phosphorus concentration and was used to describe a lake's trophic state. Carlson's TSI was developed based on the assumption that the lakes were all phosphorus limited. In Florida, because the local geology produced a phosphorus rich soil, nitrogen can be the sole or co-limiting factor for phytoplankton population in some lakes. In addition, because of the existence of dark-water lakes in the state, using Secchi depth as an index to represent lake trophic state can produce misleading results.

Therefore, the TSI was revised to be based on total nitrogen, total phosphorus, and chlorophyll a concentrations. This revised calculation for TSI now contains a TN -TSI, TP -TSI, and Chlorophyll a -TSI. As a result, there are three different ways of calculating a final in-lake TSI. If the TN to TP ratio is equal to or greater than 30, the lake is considered phosphorus limited and the final TSI is the average of the TP -TSI and the Chlorophyll a -TSI. If the TN to TP ratio is 10 or less, the lake is considered nitrogen limited and the final TSI is the average of the TN -TSI and the Chlorophyll a -TSI. If the TN to TP ratio is between 10 and 30, the lake is considered co-limited and the final TSI is the result of averaging the Chlorophyll a -TSI with the average of the TN and TP TSI's.

The Florida-specific TSI was determined based on the analysis of data from 313 Florida lakes. The index was adjusted so that a chlorophyll a concentration of 20 μg/L was equal to a Chlorophyll a -TSI value of 60. The final TSI for any lake may be higher or lower than 60 depending on the TN -TSI and the TP -TSI values. A TSI of 60 was then set as the threshold for nutrient impairment for most lakes (for those with a color higher than 40 platinum cobalt units) because, generally, the phytoplankton may switch to communities dominated by blue-green algae at chlorophyll a levels above 20 μg/L. These blue-green algae are often an unfavorable food source to zooplankton and many other aquatic animals. Some blue-green algae may even produce toxins, which could be harmful to fish and other animals. In addition, excessive growth of phytoplankton and the subsequent death of these algae may consume large quantities of dissolved oxygen and result in anaerobic condition in lakes, which makes conditions in the impacted lake unfavorable for fish and other wildlife. All of these processes may negatively impact the health and balance of native fauna and flora.

Because of the amazing diversity and productivity of Florida lakes, some lakes have a natural background TSI that is different from 60. In recognition of this natural variation, the IWR allows for the use of a lower TSI (40) in very clear lakes, a higher TSI if paleolimnological data indicate the lake was naturally above 60, and the development of site-specific thresholds that better represent the levels at which nutrient impairment occurs.

For the Lake Hancock Basin and Lake Parker TMDL, the Department applied the Watershed Assessment Model (WAM) (Soil and Water Engineering Technology, Inc., 2005) and the BATHTUB model (Quantitative Environmental Analysis, LLC, 2005) to simulate water quality discharges and eutrophication processes to determine the appropriate nutrient target. The WAM model was used to estimate the natural background TSI by setting land uses to natural or forested land, and then compared the resulting TSI to the IWR thresholds. If the natural background TSI can be determined, then an increase of 5 TSI units above natural background will be used as the water quality target for the TMDL. Otherwise, the IWR threshold TSI of 60 will be established as the target for TMDL development. The estimated natural background TSI for Lake Parker is 68.4 with a target TMDL TSI of 72.9.

3.3 Narrative Nutrient Criteria Definitions

Chlorophyll *a*

Chlorophyll is a green pigment found in plants and is an essential component in the process of converting light energy into chemical energy. Chlorophyll is capable of channeling the energy of sunlight into chemical energy through the process of photosynthesis. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide and water into carbohydrates and oxygen. The chemical energy stored by photosynthesis in carbohydrates drives biochemical reactions in nearly all living organisms. Thus, chlorophyll is at the center of the photosynthetic oxidation-reduction reaction between carbon dioxide and water.

There are several types of chlorophyll; however, the predominant form is chlorophyll *a*. The measurement of chlorophyll *a* in a water sample is a useful indicator of phytoplankton biomass, especially when used in conjunction with analysis concerning algal growth potential and species abundance. The greater the abundance of chlorophyll *a*, typically the greater the abundance of algae. Algae are the primary producers in the aquatic food web, and thus are very important in characterizing the productivity of lakes and streams. As noted earlier, chlorophyll *a* measurements are also used to estimate the trophic conditions of lakes and lentic waters.

Nitrogen Total as N (TN)

Total nitrogen is the combined measurement of nitrate (NO^3), nitrite (NO^2), ammonia, and organic nitrogen found in water. Nitrogen compounds function as important nutrients to many aquatic organisms and are essential to the chemical processes that exist between land, air, and water. The most readily bio-available forms of nitrogen are ammonia and nitrate. These compounds, in conjunction with other nutrients, serve as an important base for primary productivity.

The major source of excessive amounts of nitrogen in surface water are the effluent from municipal treatment plants and runoff from agricultural sites. When nutrient concentrations consistently exceed natural levels, the resulting nutrient imbalance can cause undesirable changes in a waterbody's biological community and drive an aquatic system into an accelerated rate of eutrophication. Usually, the eutrophication process is observed as a change in the structure of the algal community and includes severe algal blooms that may cover large areas for extended periods. Large algal blooms are generally followed by a depletion in dissolved oxygen concentrations as a result of algal decomposition.

Phosphorus Total as P (TP)

Phosphorus is one of the primary nutrients that regulates algal and macrophyte growth in natural waters, particularly in fresh water. Phosphate, the form in which almost all phosphorus is found in the water column, can enter the aquatic environment in a number of ways. Natural processes transport phosphate to water through atmospheric deposition, ground water percolation, and terrestrial runoff. Municipal treatment plants, industries, agriculture, and domestic activities also contribute to phosphate loading through direct discharge and natural transport mechanisms. The very high levels of phosphorus in some of Florida's streams and estuaries are usually caused by phosphate mining and fertilizer processing activities.

High phosphorus concentrations are frequently responsible for accelerating the process of eutrophication, or accelerated aging, of a waterbody. Once phosphorus and other important nutrients enter the ecosystem, they are extremely difficult to remove. They become tied up in biomass or deposited in sediments. Nutrients, particularly phosphates, deposited in sediments generally are redistributed to the water column. This type of cycling compounds the difficulty of halting the eutrophication process.

3.4 Paleolimnological Conditions of Lake Parker

Paleolimnological methods can be used to identify baseline limnological conditions and to assess anthropogenic changes in lakes that lack historical limnological data. The lack of historical water quality data makes it difficult to document past changes in the trophic status of numerous Florida lakes including Lake Parker. The absence of long-term limnological data makes it difficult to document the timing and magnitude of anthropogenic changes in most of Florida's lakes. Thus, paleolimnological studies are very important in yielding information on historical trophic conditions.

Results from a case study conducted by Brenner, Whitmore, Flannery, and Binford (1993) show that Lake Parker has displayed statistically significant increases in limnetic total phosphorus and chlorophyll a concentrations since the 1920s. The study evaluated sediment diatom assemblages to infer former water quality. Sediment diatoms are powerful bio-indicators of historic and current nutrient concentrations. They are ubiquitous, well preserved, and sensitive to even subtle environmental shifts (Dixit, et al., 1992)

Although Lake Parker overlies phosphatic deposits, the paleolimnological record from the study indicates that the lake was naturally mesotrophic. Several lines of quantitative evidence (diatom transfer rates and nutrient accumulation rates) suggest progressive increases in total phosphorus and chlorophyll a in the lake between 1920 and 1980. Net accumulation rates of phosphorus have increased more than 10-fold in this century. In addition, there is no evidence of substantial macrophyte presence in the lake (Brenner, Whitmore, Flannery, and Binford, 1993). As a result of human disturbances that affected both the watershed and surrounding airshed, the authors estimate that the lake underwent substantial cultural eutrophication during this time period.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Overview of Modeling Process

The Lake Parker sub-basin is a part of a larger network of lakes and streams that drain to Lake Hancock, which discharges to Lower Saddle Creek, the Peace River, and ultimately, Charlotte Harbor and the Gulf of Mexico. As there are several other lakes in the network for which TMDLs are being developed, the Department modeled the entire Lake Hancock Basin. A primary basin setup was used to create an ArcView project file for Lake Hancock, which was designated the primary basin. The term ‘primary basin’ in the Watershed Assessment Model (WAM), refers to a collection of sub-basins or basins that discharge to a single receiving water body. The primary basin setup procedure used to model Lake Parker, and ultimately, Lake Hancock is described in detail in “The WAM Watershed Assessment Final Report of the Lake Hancock Basin” (see **Appendix H**). The WAM model was then linked to the BATHTUB model. The BATHTUB model simulates nutrients in reservoirs and lakes based on annual average inputs. The BATHTUB model is described in detail in “The BATHTUB Framework for the Lake Hancock Basin, Florida, Final Report” (see **Appendix I**).

The external load assessment conducted by the WAM and BATHTUB models was intended to determine the loading characteristics of the various sources of pollutants to the Lake Parker watershed, and eventually Lake Hancock and Lower Saddle Creek. Assessing the external load entailed assessing land use patterns, soils, topography, hydrography, point sources, service area coverages, climate, and rainfall to determine the volume, concentration, timing, location, and underlying nature of the point, nonpoint, and atmospheric sources of nutrients to the lake and its watershed.

WAM is a tool that has been shown to be useful in the assessment of watershed-related properties. WAM was developed to allow engineers and planners to assess the water quality of both surface water and ground water. The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. The model assesses the hydrology of the watershed using imbedded models including “Ground Water Loading Effects of Agricultural Management Systems” (GLEAMS; Knisel, 1993), “Everglades Agricultural Area Model” (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning’s flow equation based technique (Jacobson et al., 1998). BATHTUB is a U. S. Army Corps of Engineers steady-state model. The model incorporates several empirical equations of nutrient settling and algal growth to predict steady-state nutrient and chlorophyll a concentrations based on waterbody characteristics, hydraulic characteristics, and nutrient loadings. BATHTUB is capable of predicting concentrations of chlorophyll a, total nitrogen (TN), total phosphorus (TP) and transparency in a waterbody under different loading conditions (QEA, LLC, 2005).

4.2 Potential Sources of Nutrients in the Lake Parker Watershed

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 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 Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term “point source” will be 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**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2.1 Point Sources

There are no permitted wastewater treatment facilities discharging nutrient loads into Lake Parker or the Lake Parker sub-basin. However, two active permitted fossil fuel power generation facilities are located on the banks of Lake Parker; the Lakeland Larson Memorial Plant (NPDES FL0026298) and the Lakeland Electric McIntosh Plant (NPDES FL0026301).

The Larsen facility has a design capacity of 115 MGD for unit #001 and 115 MGD for unit #002. The McIntosh facility has a design capacity of 115.2 MGD for unit #1. Unit #2 ceased operations in 1988. The plants withdraw water from Lake Parker to use as once through cooling water and cooling tower make up water and return the water to the lake through outfalls for the once through cooling water and for the cooling tower blowdown. The McIntosh plant typically operates only in times of additional energy demands (i.e., energy demands are close to or beyond the capabilities of the Larson plant).

For both facilities, water is removed from the lake, used for cooling and then returned to the lake with an insignificant volumetric loss or pollutant contribution. As a result, the Larsen and Mcintosh facility discharges were not considered significant enough, in terms of volumes and concentrations, to affect modeling results and were not incorporated into the WAM model and in determining TMDL point source loads. However, once through cooling water and cooling tower blowdown water discharges may be a contributing factor in the re-suspension of nutrients from lake sediments.

Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003.

Regulated Phase II MS4s, which are defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters.

The stormwater collection systems in the Lake Parker sub-basin, which are owned and operated by Polk County in conjunction with the Florida Department of Transportation (FDOT), are covered by a NPDES Phase I MS4 permit. The Lake Parker sub-basin is located within the Lake Hancock watershed. The Lake Hancock watershed is situated between the cities of Lakeland, Winterhaven, Auburndale, and Bartow. All of theses cities are Phase I MS4 co-permittees with City of Lakeland having portions of their jurisdiction located within the segment. At this time, it is unknown if local governments in the Lake Parker sub-basin have applied for coverage under the Phase II NPDES MS4 permit.

As a note, numerous Polk County stormwater Capital Improvement Projects (CIPs) are currently under construction or are anticipated in the near future in an attempt to reduce nutrient and sediment loadings to lakes and watersheds that contribute water quantity and quality to Lake Hancock. Current and future projects in the Lake Parker sub-basin involve lakes Gibson, Mirror, and Parker.

4.2.2 Nonpoint Sources and Land Uses

Unlike traditional point source effluent loads, nonpoint source loads enter at so many locations and exhibit such large temporal variation that a direct monitoring approach is often infeasible. For the Lake Parker TMDL, all nonpoint sources were evaluated by use of a watershed and lake modeling approach. **Table 4.1** shows the existing area of the various land use categories examined and modeled for the Lake Parker sub-basin. **Figure 4.1** shows the drainage basin of the lake and the spatial distribution of the land uses shown in **Table 4.1**.

The predominant land coverages include low, medium, and high density residential (28.4%), followed by commercial, industrial, and transportation (13.8%), and recreation (10.4%). These coverages account for 57.6 percent of the land use in the sub-basin. The lake and interconnected waterways/streams/wetlands etc. account for 30.5 percent of the sub-basin. The areas occupied by anthropogenic land uses account for approximately 63.4 percent of the watershed.

Land use coverages in the sub-basin were aggregated using the Florida Land Use, Cover and Forms Classification System (FLUCCS, 1999). The spatial distribution and acreage of different land use categories for WAM were identified using the 1999 land use coverage (scale 1:24,000) provided by the Southwest Florida Water Management District (SWFWMD) contained in the Lake Hancock Basin WAM model developed by Soil and Water Engineering Technology, (2005).

Table 4.1 Lake Parker Sub-basin Existing Land Use Description

FLUCCS ID	Lake Parker Sub-basin Existing Land Use Coverage	Acres	Sq Miles	Percent
5201	Interconnected Lakes	3167.87	4.950	20.80%
1200	Medium Density Residential, Fixed Single Family Units	2935.60	4.587	19.27%
1800	Recreation	1588.88	2.483	10.43%
1400	Commercial and Services	1482.62	2.317	9.73%
1300	High Density Residential, Fixed Single Family Units	1003.24	1.568	6.59%
5300	Reservoirs	691.89	1.081	4.54%
1700	Educational Facilities	533.74	0.834	3.50%
2100	Pastures and Fields	496.68	0.776	3.26%
8300	Utilities	467.03	0.730	3.07%
8100	Transportation	434.90	0.680	2.86%
6150	Stream and Lake Swamps (Bottomland)	425.02	0.664	2.79%
1100	Low Density Residential, Fixed Single Family Units	383.01	0.598	2.51%
6410	Freshwater Marshes	308.88	0.483	2.03%
1900	Undeveloped Land	252.05	0.394	1.65%
1500	Industrial	185.33	0.290	1.22%
4340	Hardwood - Conifer Mixed	182.86	0.286	1.20%
2210	Citrus Groves	121.08	0.189	0.79%
4200	Upland Hardwood Forest	113.67	0.178	0.75%
2600	Old Field	111.20	0.174	0.73%
6440	Emergent Aquatic Vegetation	96.37	0.151	0.63%
3200	Prairies	84.02	0.131	0.55%
4100	Upland Coniferous Forests	46.95	0.073	0.31%
6300	Wetland Forested Mixed	37.07	0.058	0.24%
5200	Lakes	27.18	0.042	0.18%
6530	Inland Shores/Ephemeral Ponds	14.83	0.023	0.10%
3300	Mixed Rangeland	12.36	0.019	0.08%
6430	Wet Prairies	12.36	0.019	0.08%
8200	Communications	9.88	0.015	0.06%
6200	Wetland Coniferous Forest	4.94	0.008	0.03%
Sum		**15,231.5**	**23.8**	**100%**

FLUCCS: Florida Land Use, Cover, and Forms Classification System, 1999.

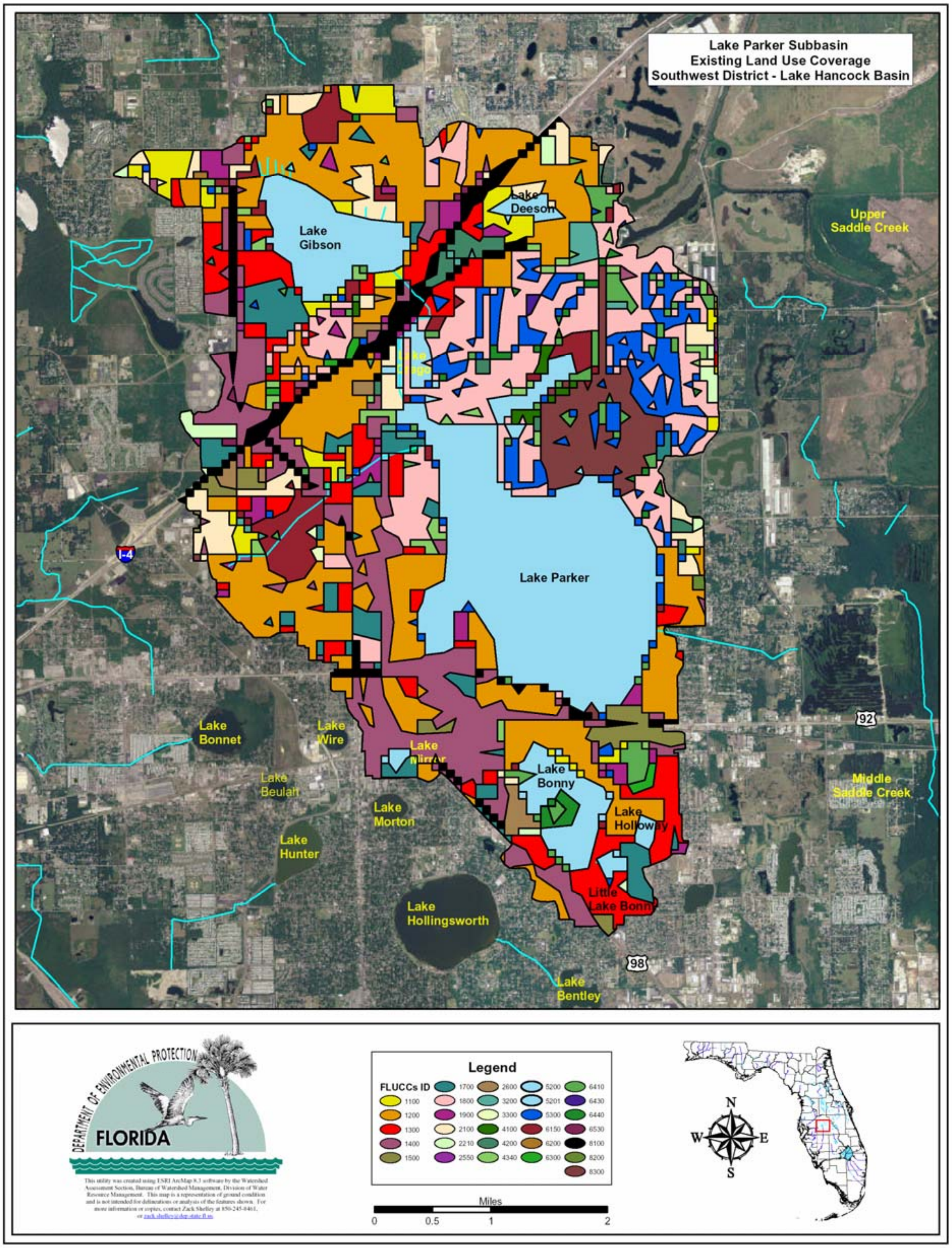

Figure 4.1 Lake Parker Sub-basin Existing Land Use Coverage

Polk County Population

According to the U.S Census Bureau, the population density in Polk County, in the year 2000, was at or less than 258.2 people per square mile. The Census Bureau reports that the total population in 2000 for Polk County, which includes (but is not exclusive to) the Lake Parker sub-basin, was 483,924, with 226,376 housing units. Polk County occupies an area of approximately 2,009 square miles. For all of Polk County, the Bureau reported a housing density of 120.8 houses per square mile. Polk County is just below the average housing density for Florida counties with 134.3 housing units per square mile. (U. S. Census Bureau Web site, 2004).

Polk County Septic Tanks

Onsite sewage treatment and disposal systems (OSTDSs), including septic tanks, are commonly used where providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDSs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, however, OSTDSs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

As of 2001, Polk County had a cumulative registry of 112,848 septic systems. Data for septic tanks are based on 1970 – 2001 census results, with year-by-year additions based on new septic tank construction. The data do not reflect septic tanks that have been removed going back to 1970. From fiscal years 1993–2004, 1,151 permits for repairs were issued in Polk County (Florida Department of Health, 2004). Based on the number of permitted septic tanks and housing units (226,376) located in the county, approximately 50 percent of the housing units are connected to a central sewer line (i.e., wastewater treatment facility), with the remaining 50 percent utilizing septic tank systems.

4.3 Estimating Point and Nonpoint Source Loadings

Model Approach

The Watershed Assessment Model (WAM) was utilized to estimate the nutrient loads within and discharged from the Lake Hancock Basin. WAM is a Geographic Information System (GIS) based model that allows the Department to interactively simulate and assess the environmental effects of various land use changes and associated land use practices.

WAM utilizes ESRI^{TM} ArcView 3.2 with Spatial Analyst 2.0 to analyze and display model input and output using grids. Grid datasets, as opposed to polygon datasets, spatially represent geographic data as a collection of raster cells. Each cell contains attributes of the dataset, e.g. land use code numbers that can be overlaid with cells of other grids. The benefits of using grids over polygons include computational speed and output resolution. Output can be displayed by grid cell as opposed to by sub-basin polygon. The cell size is dependant on the desired resolution. A grid cell size of one hectare was chosen with the intent that this would adequately characterize the land use and capture linear features such as highways (SWET, 2005).

The water quality parameters (impact parameters) simulated within the model for Lake Parker included: Water quantity, soluble nitrogen (N) forms (ammonia, soluble organic, nitrate), particulate N, ground water N, soluble phosphorus (P), particulate P, ground water P, sediment, 5-day biochemical oxygen demand (BOD_5), and dissolved oxygen. GIS datasets of land use, soils and rainfall are used to calculate the combined impact of the watershed characteristics for a given grid cell. Once the combined impact for each unique cell within a watershed is determined, the cumulative impact for the entire watershed is determined by attenuating the constituent to the sub-basin outlets. Constituents are attenuated based upon the flow distances (overland to nearest water body, through wetlands or depressions and within streams to the sub-basin outlet), flow rates in each related flow path and the type of wetland or depression encountered. **Figure 4.2** shows the conceptual routing schemes and flow distances that are calculated for each cell (SWET, 2005).

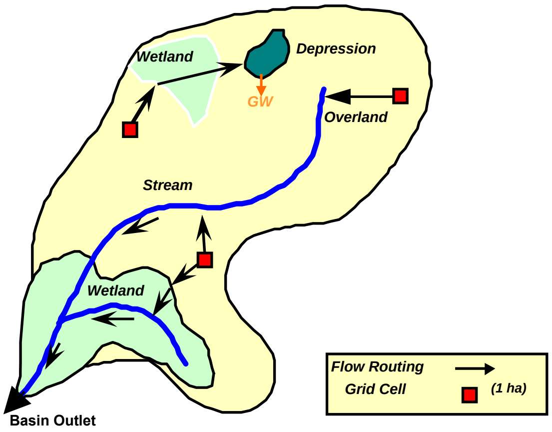

Figure 4.2 WAM Conceptual Routing Diagram (SWET, 2005)

A portion of the flow in each cell is converted to ground water based on the soil type and amount of imperviousness estimated for each land use. Surface flow that enters depressions is also converted to ground water. Ground water is routed to the nearest stream unless directed otherwise.

The hydrologic contaminant transport modeling is accomplished by first simulating all of the unique grid cell combinations of land use, soils, and rainfall by using one of several source cell models including GLEAMS (Knisel, 1993), EAAMOD (Bottcher et al., 1998; SWET, 1999), a wetland module, and an urban module. The time series outputs for each grid cell is then routed and attenuated to the nearest stream and then through the entire stream network of the watershed. Dynamic routing of flows is accomplished through the use of an algorithm, BLASROUTE.exe, that uses a non-linear reservoir technique (Jacobson et al., 1998). **Figure 4.3** shows a flow diagram of the hydrologic contaminant transport modeling component of the overall WAM model.

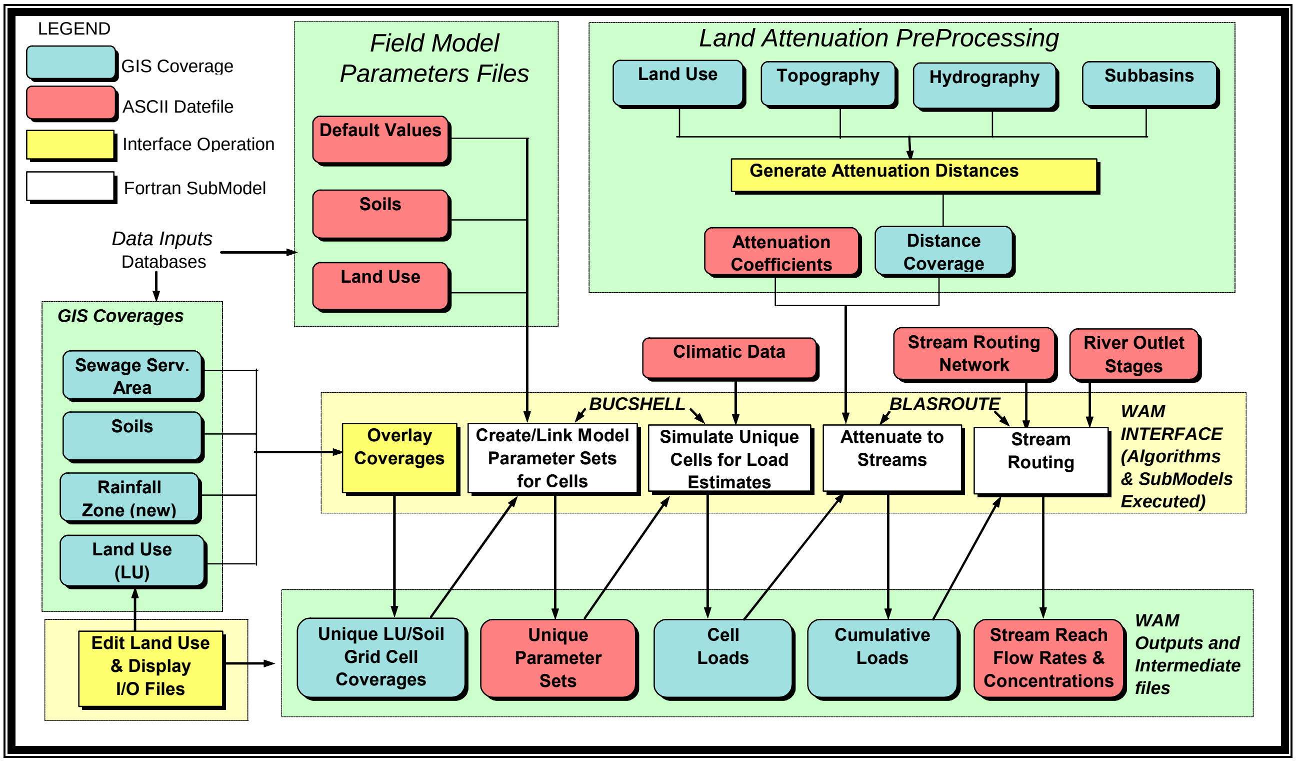

Figure 4.3 Dynamic Modeling Approach (SWET, 2005)

While BATHTUB has the capability to simulate large, sinuous reservoirs and lakes using multiple model cells, the size and nature of the eleven lakes evaluated supported the designation of one BATHTUB segment for each lake. However, because of the interconnectedness of the eleven lakes, all eleven lakes, including Lake Parker were incorporated into a single BATHTUB model framework containing eleven linked segments. The outflow from each lake enters the next lake downstream. Surface water and ground water inputs are designated as tributaries in the model (one set to each lake). These inputs are provided by WAM, which was explicitly set up to output the incremental surface water and ground water quantity and quality flowing into each of the BATHTUB-simulated lakes. That is, the tributaries designated in the BATHTUB model have flows and concentrations that reflect their local upstream (between lakes) sources only. Ground water seepage from each lake is simulated using BATHTUB's channels. A schematic of the model framework is shown in **Figure 4.4**. All flows that do not point to a lake represent flows that are lost to the system. Daily WAM results were computed for he time period 1994 to 2003. The WAM results were averaged on annual basis to develop eleven separate BATHTUB model scenarios, one for each year (QEA, LLC, 2005).

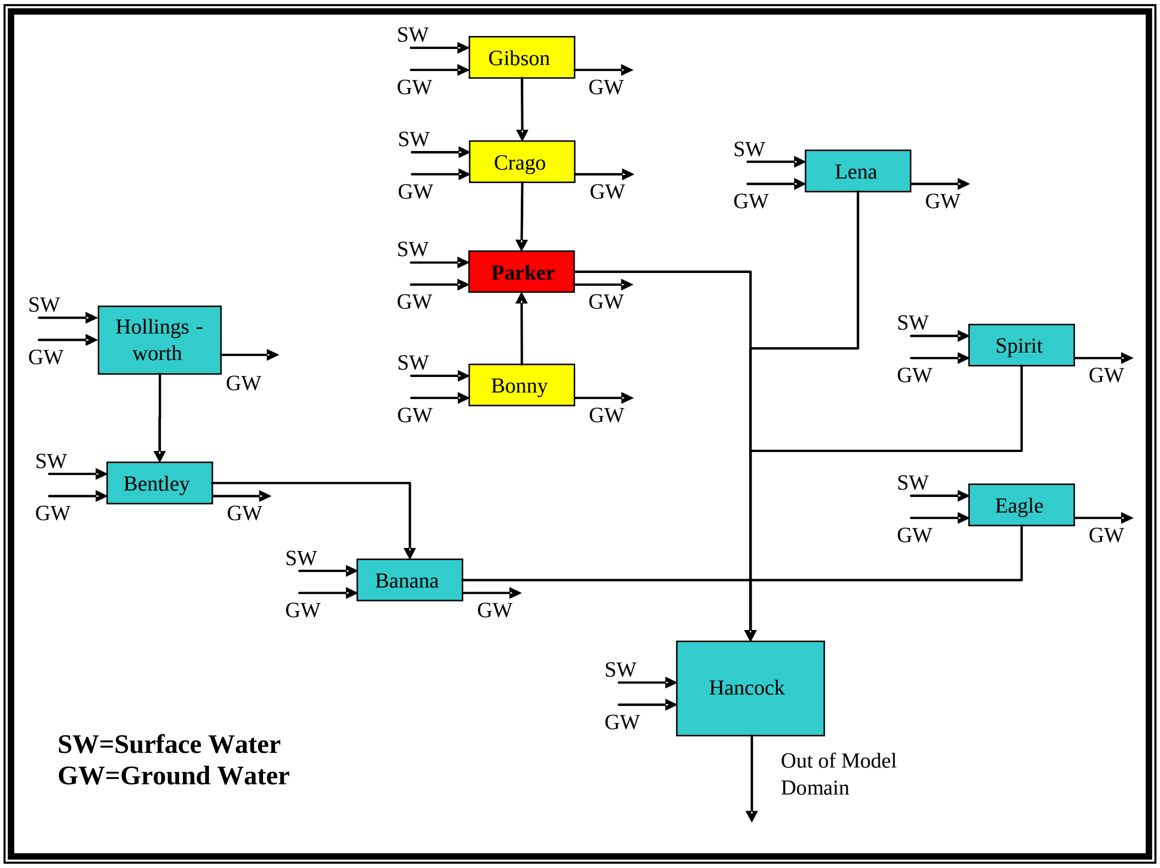

Figure 4.4 Model Schematic Depicting the Interconnected Eleven Lakes Modeled for The Lake Hancock Watershed (QEA, 2005)

GIS and model data set inputs for WAM included land use, soils, topography and depressions, hydrogaphy, USGS gage and flow data, septic tanks, water use pumpage, point sources, rainfall, ground water, atmospheric deposition, solar radiation, control structures, attenuation distances, and stream reaches.

Inputs required for the BATHTUB model included annual data for rainfall (amount and TN and TP concentrations), evaporation, surface water inflow volumes and TN and TP loads, ground water inflow volumes and TN and TP loads, and leakage volume. Because BATHTUB is unable to vary the rainfall rate between lakes, it was decided that WAM would include rain inputs as part of its surface reach loads, so that the rain zones could be represented. Therefore, BATHTUB inputs show no rainfall. BATHTUB has been set up to simulate Lake Parker and its upstream watershed and lakes in the watershed. The flow routing to and between lakes is built into both WAM and BATHTUB. Bathtub will route flow and constituents between lakes, but requires WAM to provide all flow and constituents generated above and between lakes (SWET, 2005).

Lake Parker Existing Land Use Loadings

The total loadings of nitrogen and phosphorus for Lake Parker were estimated using the WAM and BATHTUB models. Modeling frameworks were designed to simulate the period 1994 through 2003. This time period had the best available seasonal data for the lake and also represented the verified period for Group 3 waterbodies located in the Lake Hancock Basin.

Based on the hydrology, and lake and stream interconnected reaches, nine major sub-basins were delineated in making up the Lake Hancock watershed. The nine sub-basins include Banana Lake and Banana Lake Canal, Cabbage Branch, Eagle Lake, K-Ville Branch, Lake Lena and Lake Lena Run/Creek, Lake Parker, Lower Saddle Creek, Middle Saddle Creek, and Upper Saddle Creek. Within the nine sub-basins making up the Lake Hancock watershed, eleven lakes were targeted and modeled based on nutrient impairment and the interconnected nature of the waterbodies contributing runoff and loadings to Lake Hancock. The eleven lakes are Lake Gibson, Lake Crago, Lake Bonny, Lake Parker, Lake Lena, Lake Hollingsworth, Lake Bentley, Banana Lake, Spirit Lake, Eagle Lake, and Lake Hancock.

The eleven lakes are impaired for nutrients based on the Department's Impaired Waters Rule methodology. Each lake was modeled separately to determine individual contributions to Lake Hancock. **Table 4.2** illustrates the total water volume and loadings for TN and TP going into Lake Parker from 1994 to 2003 based on the WAM and BATHTUB model results under current/existing land use coverages. Loads were estimated based on lake surface rainfall, surface water inflow, ground water inflow and septic inflow. Ground water loss/leakage from each lake was also calculated and subtracted from the total inflow volume.

Table 4.2 Lake Parker Existing Land Use Water Volume and Loadings for TN and TP from 1994 to 2003

Lake Parker Loadings					
Year	**Water** (hm^3)	**TN** (kg)	**TN** (lbs)	**TP** (kg)	**TP** (lbs)
1994	28.470	23,624.175	52,082.399	3,330.821	7,343.204
1995	29.569	30,685.817	67,650.658	3,408.686	7,514.869
1996	22.465	16,120.843	35,540.381	2,649.782	5,841.769
1997	35.289	39,650.413	87,414.212	4,436.551	9,780.923
1998	28.364	27,585.262	60,815.103	3,253.249	7,172.187
1999	19.535	16,428.250	36,218.098	2,343.845	5,167.295
2000	14.965	15,148.670	33,397.106	1,790.876	3,948.207
2001	19.697	22,304.743	49,173.548	2,485.395	5,479.360
2002	34.832	29,299.021	64,593.296	4,136.224	9,118.814
2003	28.583	32,376.762	71,378.553	3,201.457	7,058.005
94-03 Mean	26.2	25,322.4	55,826.3	3,103.7	6,842.5
94-03 Totals	261.8	253,224.0	558,263.4	31,036.9	68,424.6

hm^3: Cubic Hectometers
kg: Kilograms
lbs: Pounds

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 source. Addressing eutrophication involves relating water quality and biological effects (such as photosynthesis, decomposition, and nutrient recycling), as acted upon by hydrodynamic factors (including flow, wind, tide, and salinity) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. The assimilative capacity should be related to some specific hydro-meteorological condition such as an 'average' during a selected time span or to cover some range of expected variation in these conditions.

As discussed in Chapter 4, the WAM model was selected as the watershed model. It was run dynamically through the ten-year period of record with all the lakes linked together in their current configuration. BATHTUB was selected as the lake model. It was set up with all the lakes linked together and the model calibrated based on the annual average output from WAM and run year by year (1994 – 2003) for all eleven lakes.

5.1.1 Rainfall

The long-term average for the two rainfall gages used in the model [Bartow (COOP: 080478) and Lakeland (COOP: 084797 and COOP: 084802) National Weather Service stations] was 52.01 inches/year. The 10-year average rainfall for the study period (1994 – 2003) was 55.23 inches for Lakeland (60th percentile of the Lakeland long-term record) and 55.19 inches for Bartow (71st percentile of the Bartow long-term record) (see **Table 5.1**). Therefore, the study period represented a wetter than average period. However, it contained a very dry year, the year 2000, that was the driest year with 38.3 inches of rain recorded in Lakeland (10th percentile of the long-term record) and with 35.9 inches recorded at Bartow (~ the 1st percentile of the long-term record). For the year 2000, evaporation exceeded rainfall. This created a year with very high in-lake concentrations in both the current condition and natural land use background scenario.

Table 5.1 Bartow and Lakeland, Florida, Rainfall Stations Used for Model Loading and Calibration

Rainfall from Bartow and Lakeland		
Bartow	1900-2004 average = 53.7”	
Lakeland	1949-2004 average = 50.33”	
Year	**Lakeland**	**Bartow**
1994	67.13	60
1995	48.47	60.31
1996	52.85	46.1
1997	58.14	60.2
1998	54.41	62.33
1999	48.66	42.29
2000	38.26	35.87
2001	57.67	49.56
2002	66.58	71.44
2003	60.13	63.83
94-03 Average	55.23”	55.19”

Note: Lakeland stations missing data from September and October 1995.

5.1.2 Model Calibration

Watershed Assessment Model (WAM)

WAM was calibrated by consultants for conditions in the years 1994 – 2003. Calibration consisted of a water balance approach to match the measured in-lake stages and flows at flow measuring points. An Access database tool was created to aggregate the daily predictions for surface water and ground water (flows and TN, TP concentrations) up to annual average conditions in a format compatible with the requirements of the BATHTUB model. For details on the WAM model see “WAM Watershed Assessment Model, Model Documentation and Users Manual,” Soil and Water Engineering Technology, Inc., 2005 (**Appendix J**). For details on model calibration see the WAM Final Report, September, 2005 (**Appendix H**).

BATHTUB Model

The consultant provided the Department with copies of ten BATHTUB input decks (one for each year 1994 – 2003) set up for current conditions but not calibrated. The Department calibrated the BATHTUB model which, consisted of running each model year through all of the model options in BATHTUB to determine which set of models provided the best un-calibrated fit to the measured data. As a result of running through these models it became apparent that for many of the lake/year combinations the watershed model was not delivering enough mass to match the measured data for either TN or TP. However, in other lake/year combinations there was too much mass. Once a set of models was selected the primary calibration for TN and TP was achieved by invoking BATHTUB’s internal loading rate functions for both TN and TP to match the measured in-lake mass. This Internal Loading rate (IL) integrates all of the missing mass. It is not proposed that the IL rate represents only those in-lake processes that either recycle mass within the lake or fix nitrogen from the atmosphere; it also includes all other missing mass. As such, it will be referred to as the ‘missing mass.’ Chlorophyll *a* was calibrated using the

BATHTUB calibration coefficient. Each lake/year combination was calibrated individually, but once the chlorophyll a calibration was set, it remained unchanged for all other BATHTUB simulations (background and TMDL development).

The phosphorous model that best fit Lake Parker was Model 1, Second-Order, Available P model. The nitrogen model selected was Model 1, Second-Order, Available N model. The chlorophyll a model selected was Model 1, for P, N, Light and Flushing. Details regarding the selected models can be found in the BATHTUB Users Manual (U.S. Army Corps of Engineers, 1999; Walker, W.W., 2004). **Figures 5.1** – **5.4** illustrate the measured, un-calibrated, and calibrated data for TN, TP, Chlorophyll a, and TSI for the ten-year modeled period (1994 – 2003) for Lake Parker. The figures for measured, un-calibrated, and calibrated data for Lakes Bonny, Gibson, and Crago are displayed in **Appendix B**.

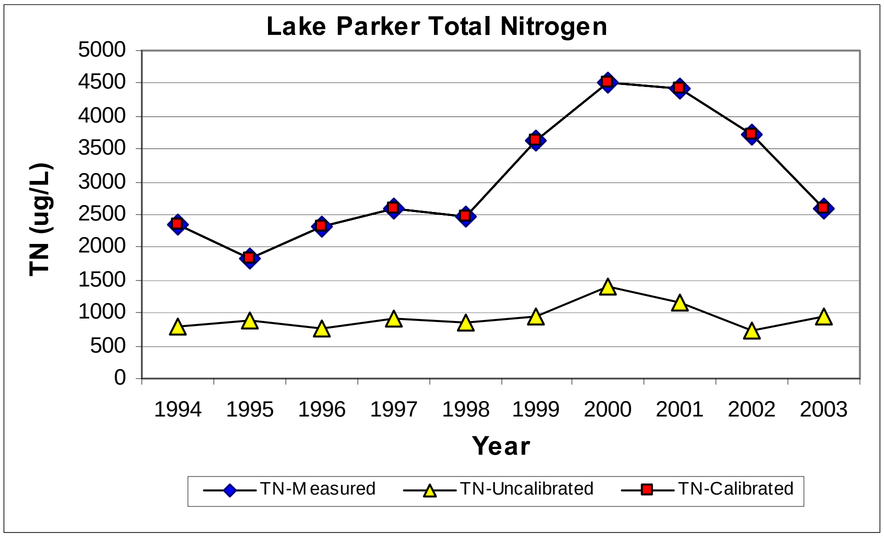

Figure 5.1 **Lake Parker Total Nitrogen Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003**

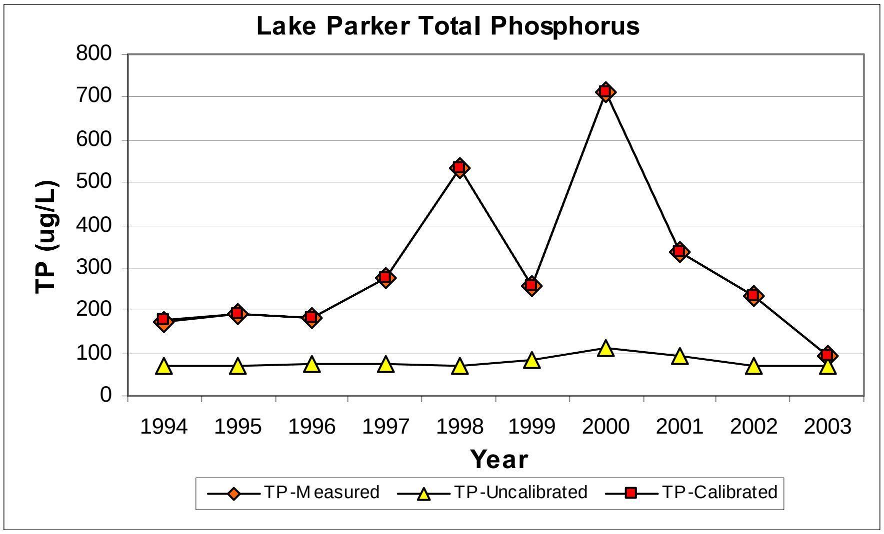

Figure 5.2 Lake Parker Total Phosphorus Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

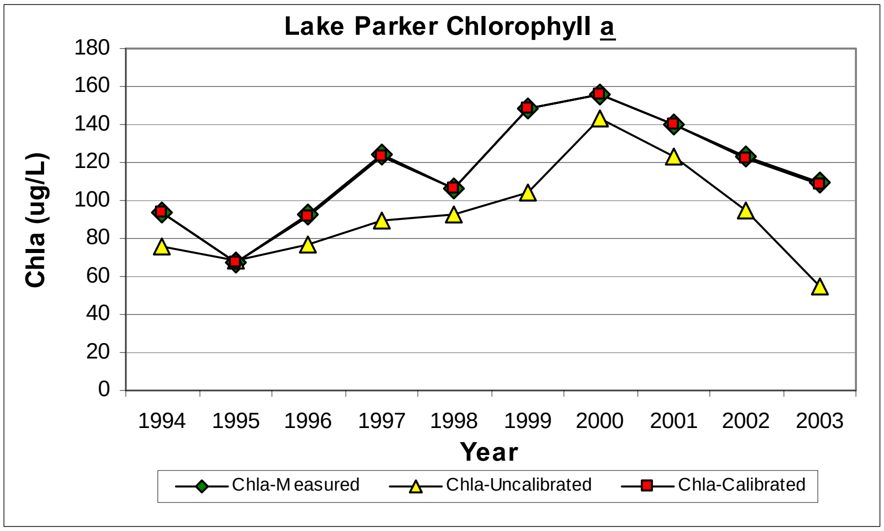

Figure 5.3 Lake Parker Chlorophyll a Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

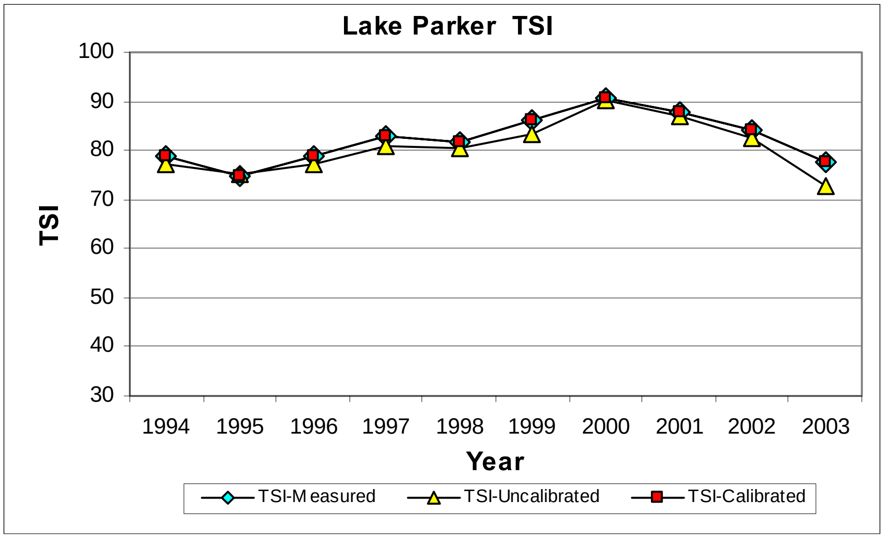

Figure 5.4 Lake Parker TSI Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

5.1.3 Background Conditions

WAM Model

WAM was used to describe and evaluate the “natural land use background condition” for the entire Lake Hancock watershed, including Lake Parker. For this simulation, all current land uses were ‘reassigned’ to a mixture of Herbaceous, Prairies, Other Shrubs and Brush, Upland Coniferous Forest, Pine Flatwoods, Upland Hardwoods Forest, Hardwood Conifer Mix (the majority), Lakes, Interconnected Lakes, Reservoirs, Mixed Wetland Hardwoods, Streams and Lakes Swamps (bottomlands), Wetland Coniferous Forest, Cypress, Wetland Forested Mix, Freshwater Marshes, Wet Prairies, Emergent Aquatic Vegetation, Inland Shores and Ephemeral Ponds. The current condition was maintained for all waterbody physical characteristics. From this point forward, the natural land use background will be referred to as “background.”

At first, the WAM was run with current rates of seepage around waterbodies and leakance from inside waterbodies. This resulted in such a large reduction in the total water flowing into the lakes that even with the significant reduction in external watershed loading, several lake/year combinations had higher concentrations of TN, TP, and chlorophyll a than under current conditions as the evaporation of 1.32 meters nearly exceeded inflow and the lakes dried up. To account for this water loss in the background condition, seepage around the lakes was adjusted back to background conditions in the model and leakance was adjusted down (50 percent of current rate) until the lake stages and surface areas approximated current conditions. Even under this scenario the total water inflowing to the lakes under the background scenario was less than current conditions, particularly in the drier years (1996 and 2000). Again, this resulted in concentrations for some lake/year combinations being as great as they are under current conditions. In other words, the watershed model is indicating that under ‘natural landuse’ dry conditions the lakes would have a trophic state similar to that today. Conversely, under average or wet conditions the natural land use trophic states were significantly less than current conditions.

BATHTUB Model

After achieving acceptable WAM background results, the BATHTUB model was run with no reduction in the total amount of missing mass (internal loading rate). As expected with the reduction in total flow for the background condition and with no attenuation of the missing mass, many of the lake/year combinations did not improve. In fact, for the dry years the background condition was still worst than the current condition. In an effort to find the natural background, reductions in the missing mass were made. First, the BATHTUB model was used to identify the total external load of TN and TP under both the current condition and the background condition. Then the ratio of the change in external load between the background condition and the current condition (background/current) was applied to the missing mass (internal loading rate). This was called the attenuated case (A). This brought the in-lake trophic states down in the average and wet years, but many of the dry year lake trophic states remained higher in the background condition than in the current condition. As a result, the remaining missing mass was reduced until the worst case dry year trophic state was below the current conditions. This required an additional 75 percent reduction in the missing mass remaining after attenuation. The modeling abbreviations used in the tables, figures and report are explained below:

Abbreviations Used

L 100 = leakance at current conditions (calibrated model)
L50 = leakance reduced from current conditions by 50 percent
L0 = leakance reduced to near zero (0.01 m)
PC = results from calibrated BATHTUB model
IL = missing mass (used internal loading rate to achieve mass balance in model calibration)
ILA = missing mass changed by the ratio of the change in external mass of background/current condition.
IL50 = ILA plus an additional 50 percent reduction in missing mass
IL75 = ILA plus an additional 75 percent reduction in missing mass
ILNIL = all missing mass eliminated (loading rate = 0.0)

5.2 Selection of the TMDL Threshold

It should be recognized that the direct application of natural background as the target TSI would not allow for any assimilative capacity. The IWR uses as one measure of impairment in lakes, a 10 unit change in TSI from “historical” levels. This 10 unit increase is assumed to represent the transition of a lake from one trophic state (say mesotrophic) to another nutrient enriched condition (eutrophic). The Department has assumed that allowing a 5 unit increase in TSI over the natural background condition would prevent a lake from becoming impaired (changing trophic states) and reserve 5 TSI units to allow for future changes in the basin and as part of the implicit margin of safety in establishing the assimilative capacity.

After examining all of the background runs for lakes Bonny, Gibson, Crago, and Parker, it was decided that the scenario with leakance set at 50 percent of the current condition and the attenuated missing mass reduced by an additional 75 percent represented the natural land use background condition. These conditions resulted in a TSI of 68.4. As has been Department practice, when acceptable background conditions can be established the target for TMDL development becomes the background TSI plus 5 TSI units. However, for the year 2000, the Department used the natural land use (IL75) as the TMDL target because natural background plus 5 TSI units was greater than the existing (measured) condition. Based on annual average results, this raises the target TSI for Lake Parker to 72.9.

Based on achieving the TMDL targets for each year of the ten-year period of record, a long-term annual average TMDL for TSI was set at 72.8. The range in TSI TMDL targets was between 62.1 and 89.8. Once the target TSI was established (a TSI of 72.9), BATHTUB was rerun with decreasing loads until the target TSI was met.

The required annual average percent reduction for TN coming into Lake Parker was 57.4 percent with an allowable long-term annual average loading of 68,802.5 kg/year (151,683.6 lbs/year). The required annual average percent reduction for TP coming into the lake was 57.1 with an allowable long-term annual average loading of 13,825.8 kg/year (30,480.7 lbs/year). The annual percent reductions ranged between 11.2 and 77.8 for TN and between 10.4 and 77.6 for TP. These reductions correspond to a range in loadings of 34,635.0 kg/year (76,357.1 lbs/year) to 104,882.1 kg/year (231,225.5 lbs/year) for TN and between 2,096.3 kg/year (4,621.6 lbs/year) to 46,620.0 kg/year (102,779.5 lbs/year) for TP. Maintaining the long-term annual average loadings for TN and TP established in this TMDL should result in attaining the annual average TSI of 72.8.

Tables 5.2 shows the TSI for the calibrated model (PC), the background model (IL75), the TMDL Target TSI, TMDL-TSI, and the percent reduction for Lake Parker. The TSI for the calibrated model (PC), the background model (IL75), the TMDL Target TSI, TMDL-TSI, and the percent reduction for Lakes Bonny, Gibson, and Crago are displayed in **Appendix C**. **Table 5.3** shows the mass for TN and TP for the calibrated model, TMDL, and percent reductions for Lake Parker. The mass for TN and TP for Lakes Bonny, Gibson, and Crago are displayed in **Appendix D**. **Table 5.4** shows the annual average concentrations for TN, TP, and chlorophyll a for Lake Parker. Annual average concentrations for Lakes Bonny, Gibson, and Crago are displayed in **Appendix E**. **Figures 5.5** – **5.8** show the TMDL target, calibrated data, and L50-IL75 for TN, TP, Chlorophyll a, and TSI for the ten-year modeled period (1994 – 2003) for Lake Parker. The TMDL target, calibrated data, and L50-IL75 for Lakes Bonny, Gibson, and Crago are displayed in **Appendix F**.

Table 5.2 Lake Parker TSI for PC, Background, TMDL Target, and TSI-Unit Reduction

Lake Parker
TSI for Measured, PC, Background, TMDL Target, TMDL, and TSI-unit Percent Reduction Based on Background L50-IL75

Year	PCU Color	Measured	PC	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994	23.5	78.8	78.7	65.1	70.1	69.9	61
1995	25	74.9	75	57.1	62.1	62	67.5
1996	27.4	78.7	78.7	70.5	75.5	75.5	28
1997	48.6	83.1	83.1	61.3	66.3	66.2	78.5
1998	82	81.5	81.5	61.2	66.2	66	76.8
1999	32	86	86	74.3	79.3	79.4	54.6
2000*	32	90.7	90.7	89.8	89.8	89.8	10
2001	55.3	87.8	87.8	76.2	81.2	81.1	58
2002	34	84.3	84.3	67.1	72.1	71.9	75.1
2003	53.8	77.4	77.4	61.3	66.3	66.3	66.2
Minimum	23.5	74.9	75	57.1	62.1	62	10
Maximum	82	90.7	90.7	89.8	89.9	89.8	78.5
Average	38.2	82.3	82.3	68.4	72.9	72.8	57.6

* Used natural land use (IL75) as TMDL target because background plus 5 TSI units was greater than the existing condition (measured condition).

Table 5.3 Lake Parker Mass for TN and TP for Calibrated Model, TMDL, and Percent Reduction

Lake Parker
Mass for TN and TP for Calibrated Model and TMDL, with Mass Percent Reductions (kg/year)

Year	TN-MASS Calibrated	TN-MASS TMDL	TN-MASS % Reduction	TP-MASS Calibrated	TP-MASS TMDL	TP-MASS % Reduction
1994	147,935.2	59,825.4	59.6	16,314.2	6,628.2	59.4
1995	103,119.6	34,635.3	66.4	20,010.6	6,680.1	66.6
1996	103,530.0	72,696.3	29.8	12,270.2	8,578.1	30.1
1997	224,461.3	49,839.9	77.8	47,919.0	10,747.1	77.6
1998	161,813.0	38,516.0	76.2	127,686.9	29,837.5	76.6
1999	161,928.1	72,991.8	54.9	16,154.1	7,289.3	54.9
2000*	116,177.3	103,220.2	11.2	52,033.6	46,620.0	10.4
2001	217,593.1	91,996.3	57.7	25,250.8	10,750.2	57.4
2002	416,935.2	104,882.1	74.8	35,839.4	9,031.3	74.8
2003	173,894.3	59,421.4	65.8	5,768.9	2,096.3	63.7
Minimum	103,119.6	34,635.3	11.2	5,768.9	2,096.3	10.4
Maximum	416,935.2	104,882.1	77.8	127,686.9	46,620.0	77.6
Average	182,738.7	68,802.5	57.4	35,924.8	13,825.8	57.1

* Used natural land use (IL75) as TMDL target because background plus 5 TSI units was greater than the existing condition (measured condition).

Table 5.4 Lake Parker Annual Average Concentrations for TN, TP, and Chlorophyll *a*

Lake Parker Annual Average Concentrations for TN, TP, and Chlorophyll *a* (µg/L)									
Year	Measured TN	Calibrated TN	TMDL TN	Measured TP	Calibrated TP	TMDL TP	Measured Chl *a*	Calibrated Chl *a*	TMDL Chl *a*
1994	2349.8	2350.3	1318.8	175	175.5	103.3	94	93.4	57.6
1995	1815	1815.7	872.6	190	190.4	100.3	67.6	67.8	33.5
1996	2316	2316.7	1865.8	182.3	182	148.4	92.3	92	78
1997	2586.5	2586.8	952.8	275	275.6	116.6	123.8	123	52.8
1998	2469	2468.9	976.5	532.3	532.3	244.3	106.4	106	49.5
1999	3629	3629.5	2269.1	256.5	255.9	163.8	148.4	148.7	109.1
2000*	4507.5	4507	4216.6	709.9	710.5	671	155.7	155.5	151.5
2001	4428.5	4428.8	2685.6	337.3	337.3	210.7	139.9	139.9	104.9
2002	3729.1	3729.7	1591.1	233.4	233.4	104.6	122.9	122.1	66.3
2003	2584.5	2584.4	1314.3	94.4	94.8	49.4	109.1	108.6	56.3

* Used natural land use (IL75) as TMDL target because background plus 5 TSI units was greater than the existing condition (measured condition).

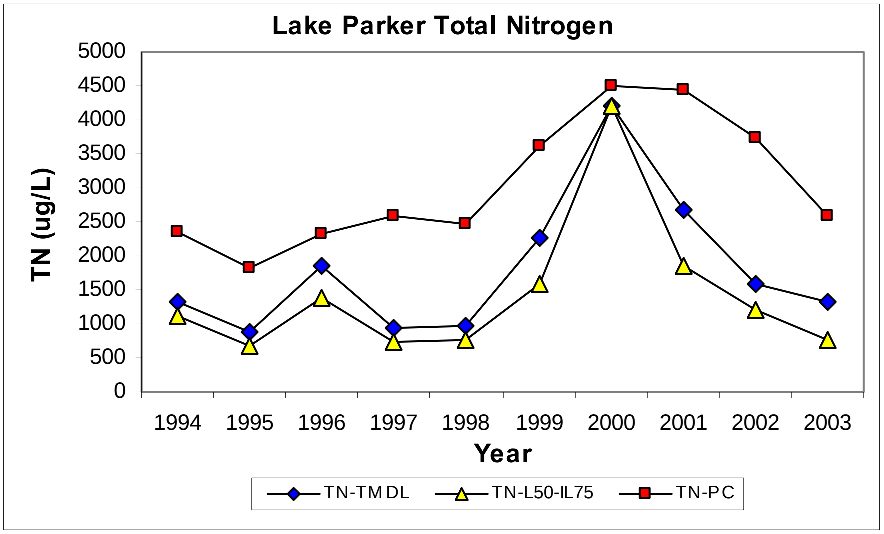

Figure 5.5 Lake Parker Total Nitrogen Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

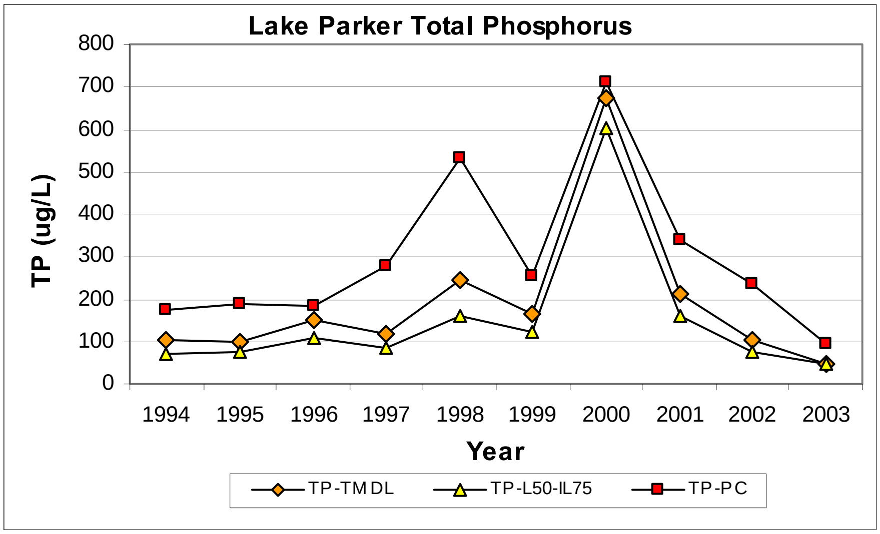

Figure 5.6 Lake Parker Total Phosphorus Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

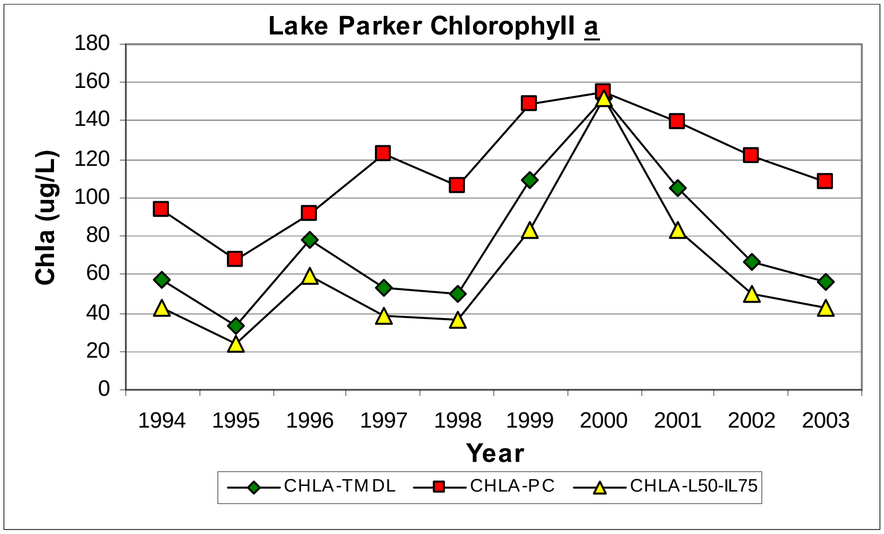

Figure 5.7 Lake Parker Chlorophyll a Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

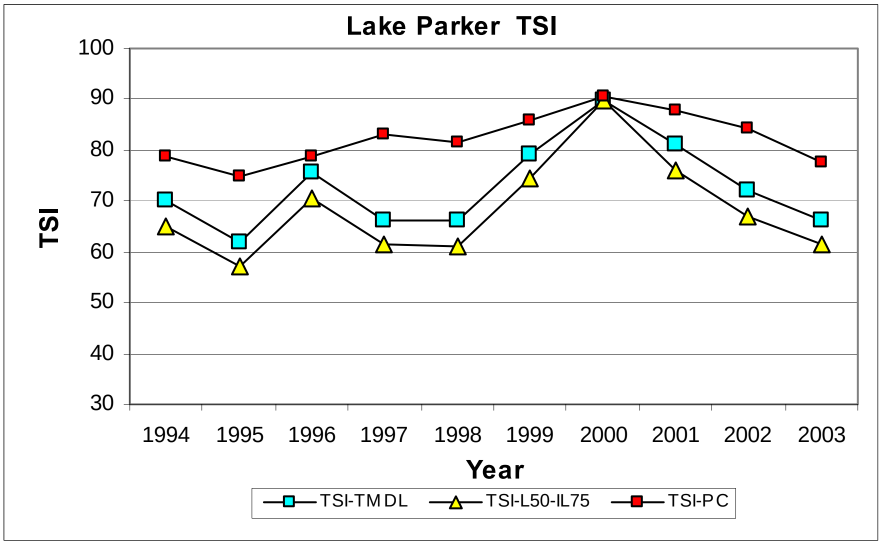

Figure 5.8 Lake Parker TSI Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

5.3 Critical Conditions

The estimated assimilative capacity was based on annual average conditions (i.e., values from all four seasons in a calendar year) rather than critical/seasonal conditions because (a) the methodology used to determine the assimilative capacity does not lend itself very well to short-term assessments, (b) the Department is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, and (c) the methodology used to determine impairment is based on an annual average and requires data from all four quarters of a calendar year.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

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:

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

It should be noted that the various components of the TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and b) 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 a mass per day].

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges is also different than 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.

This approach is consistent with federal regulations [40 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 TMDL for Lake Parker is expressed in terms of pounds (lbs) per year (converted from kilograms per year as shown in Chapter 5) and percent reductions, and represent the long-term annual average load of TN and TP Lake Parker can assimilate and maintain the Class III narrative nutrient criterion (see **Table 6.1**).

Table 6.1 Lake Parker TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1497B	TN	NA	57.4	151,683.6	Implicit	151,683.6	57.4
1497B	TP	NA	57.1	30,480.7	Implicit	30,480.7	57.1

6.2 Load Allocation (LA)

The required long-term annual average allowable LA is 151,683.6 lbs/year for TN and 30,480.7 lbs/year for TP. This corresponds to reductions from the existing loadings of 57.4 percent for TN and 57.1 percent for TP. Maintaining the long-term annual average loadings for TN and TP established as this TMDL should result in attaining the target annual average TSI of 72.8. It should be noted that the LA may include loading from stormwater discharges regulated by the Department and the Water Management District that are not part of the NPDES Stormwater Program **(see Appendix A).**

6.3 Wasteload Allocation (WLA)

NPDES Wastewater Discharges

There are no wastewater NPDES facilities that discharge directly to Lake Parker or its watershed. As noted in Chapter 4 (Section 4.2.1), two active NPDES permitted fossil fuel power generation facilities are located on the banks of Lake Parker; the Lakeland Larson Memorial Plant (NPDES FL0026298) and the Lakeland Electric McIntosh Plant (NPDES FL0026301). However, the Larsen and McIntosh facility discharges were not considered significant enough, in terms of volumes and concentrations of nutrients, to affect modeling results and were not incorporated into the WAM model and in determining TMDL point source loads. As a result, the $WLA_{wastewater}$ for the Lake Parker TMDL is not applicable.

NPDES Stormwater Discharges

The wasteload allocation for stormwater discharges is a 57.4 percent reduction in loading for TN and 57.1 percent for TP, which is the required percent reduction in nonpoint sources. It should be noted that any MS4 permittee will only be responsible for reducing the loads associated with stormwater outfalls for which it owns or otherwise has responsible control, and is not responsible for reducing other nonpoint source loads within its jurisdiction.

6.4 Margin of Safety (MOS)

TMDLs must address uncertainty issues by incorporating a MOS into the analysis. 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 [Clean Water Act, 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 (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of the Lake Parker TMDL. An implicit MOS was used because the TMDL was based on the conservative decisions associated with a number of the modeling assumptions and allowing for a10 TSI unit increase (5 TSI units above natural background conditions and an additional 5 TSI units to allow for future changes in the watershed) in determining the assimilative capacity (i.e., loading and water quality response) for the lake.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan for Lake Parker and the Lake Parker sub-basin. This document will be developed in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished.

The Basin Management Action Plan (BMAP) will include:

- Appropriate allocations among the affected parties.
- A description of the load reduction activities to be undertaken.
- Timetables for project implementation and completion.
- Funding mechanisms that may be utilized.
- Any applicable signed agreements.
- Local ordinances defining actions to be taken or prohibited.
- Local water quality standards, permits, or load limitation agreements.
- Monitoring and follow-up measures.

It should be noted that TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent Watershed Management cycles. The Department acknowledges the uncertainty associated with TMDL development and allocation, particularly in estimates of nonpoint source loads and allocations for NPDES stormwater discharges, and fully expects that it may be further refined or revised over time. If any changes in the estimate of the assimilative capacity AND/OR allocation between point and nonpoint sources are required, the rule adopting this TMDL will be revised, thereby providing a point of entry for interested parties.

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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 that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

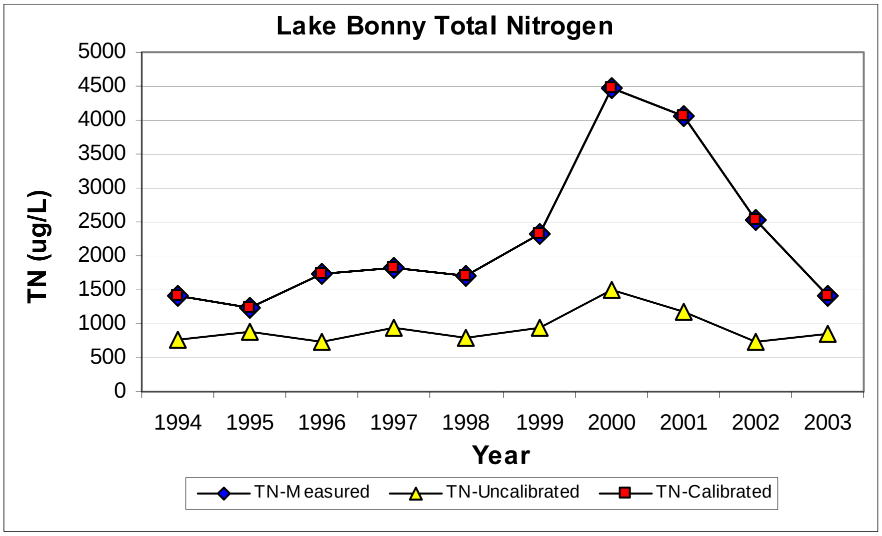
The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka. At this time, no PLRG has been developed for Lake Parker.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act 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 implementation of the Phase I NPDES stormwater program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific Standard Industrial Classification (SIC) codes, construction sites disturbing five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the fifteen counties meeting the population criteria. The Department received authorization to implement the NPDES stormwater program in 2000.

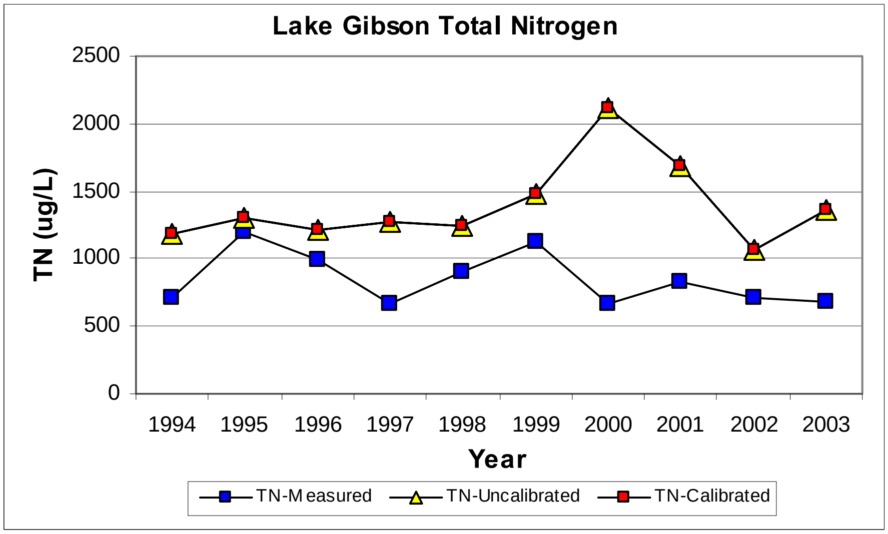
An important difference between the NPDES and other state stormwater permitting programs is that the NPDES program covers both new and existing discharges, while the other state programs focus on new discharges. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between one and five acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now 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 similar to other point sources of pollution, such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a re-opener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Lakes Bonny, Gibson, and Crago TN, TP, Chlorophyll a, and TSI Measured, Un-Calibrated, and Calibrated Data for the TMDL Modeling Period 1994 to 2003

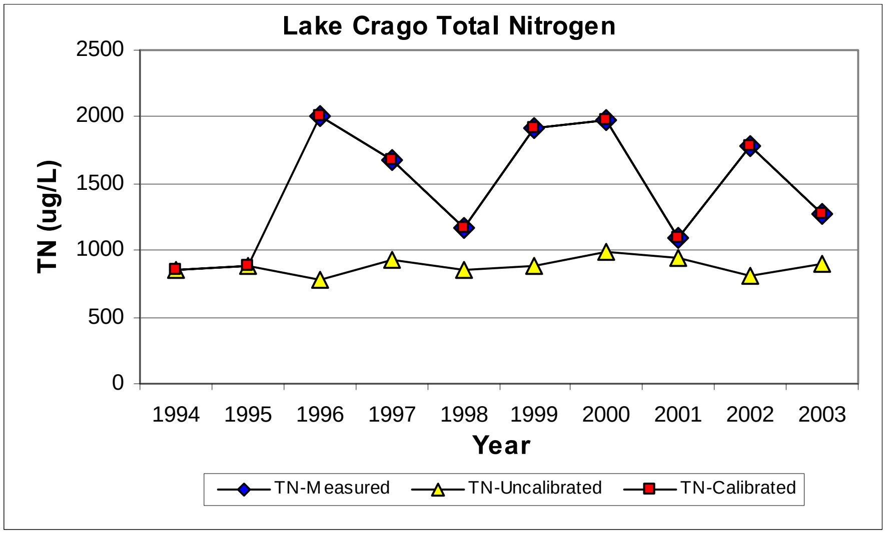
Lake Bonny TN



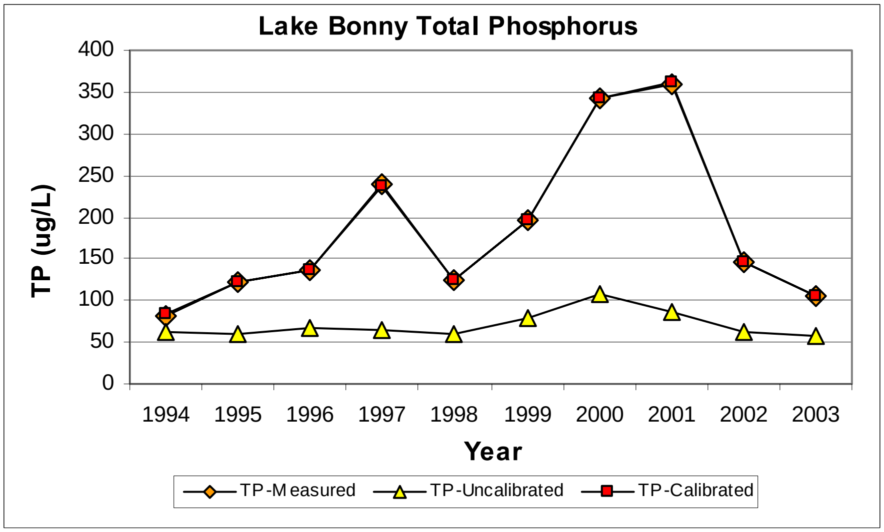
Lake Gibson TN



Lake Crago TN



Lake Bonny TP



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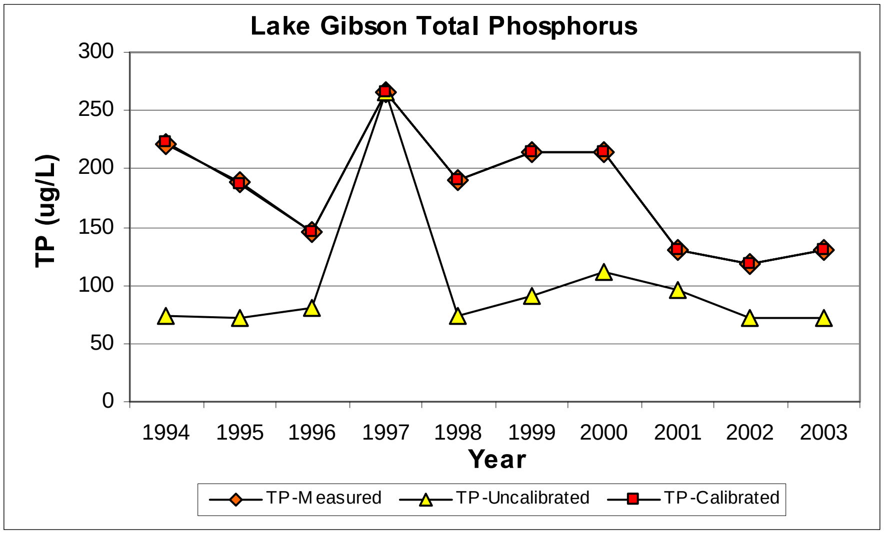
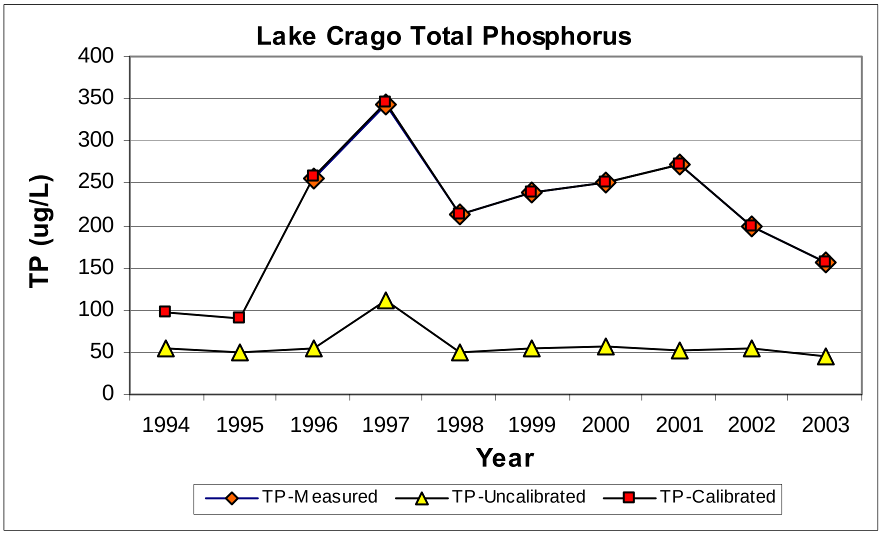
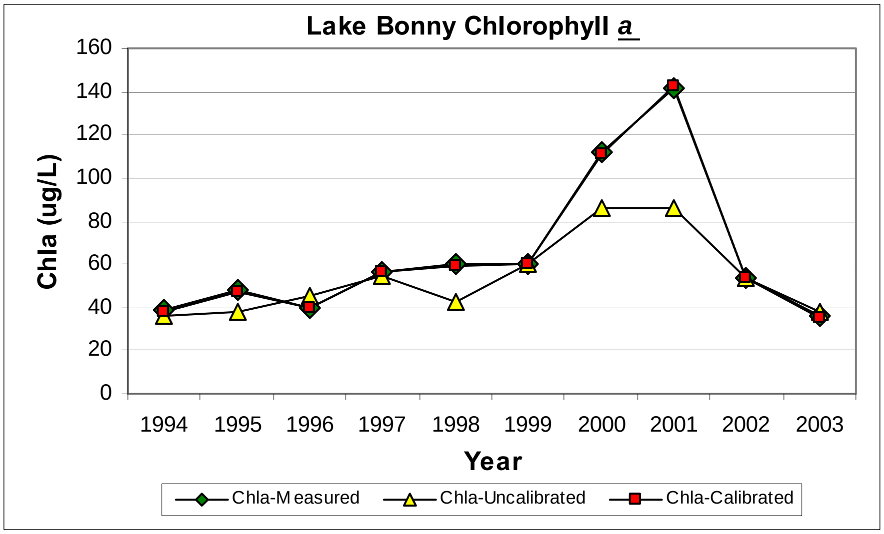


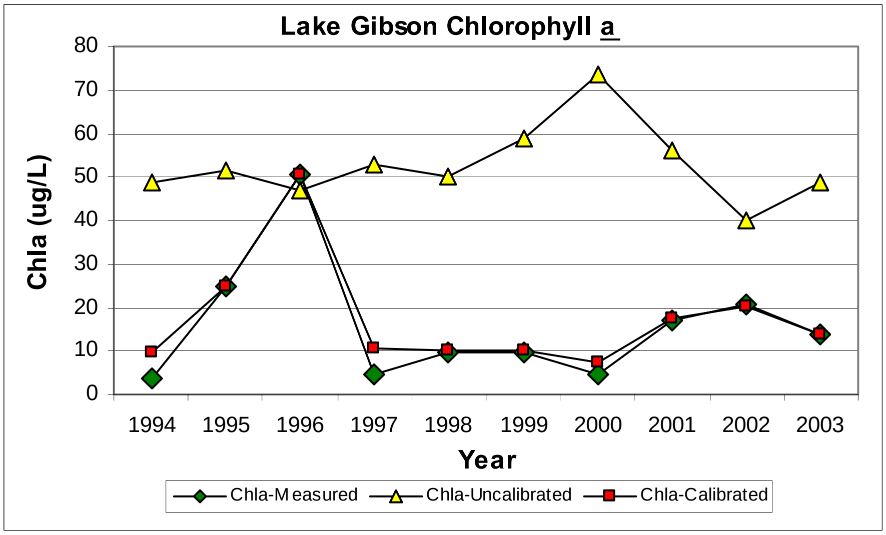
Lake Crago TP



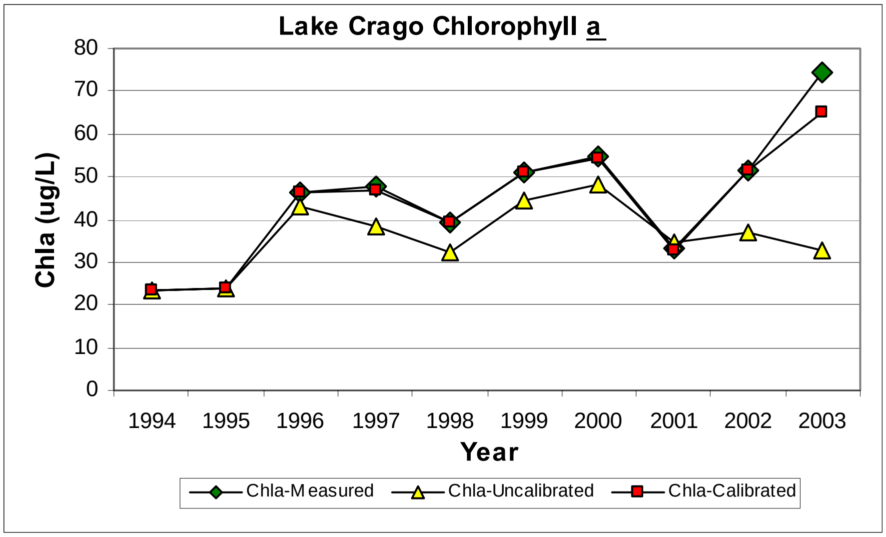
Lake Bonny Chlorophyll *a*



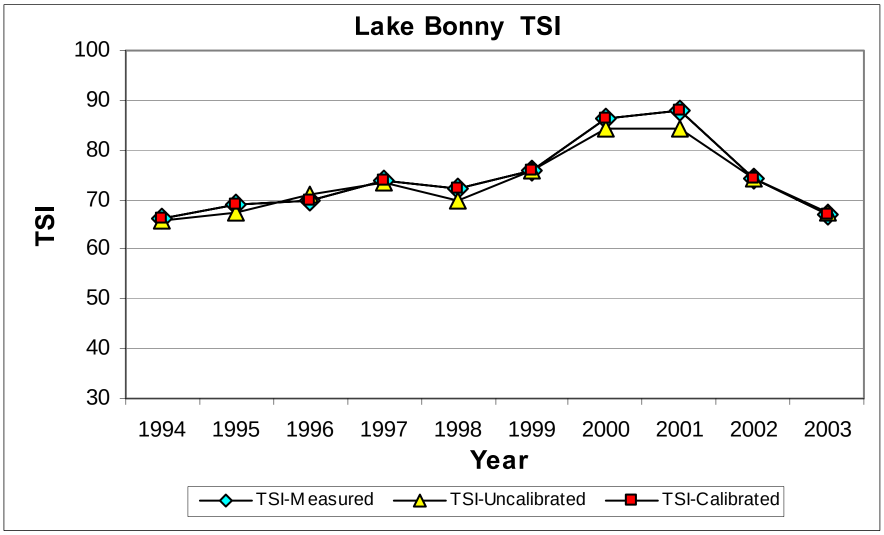
Lake Gibson Chlorophyll *a*



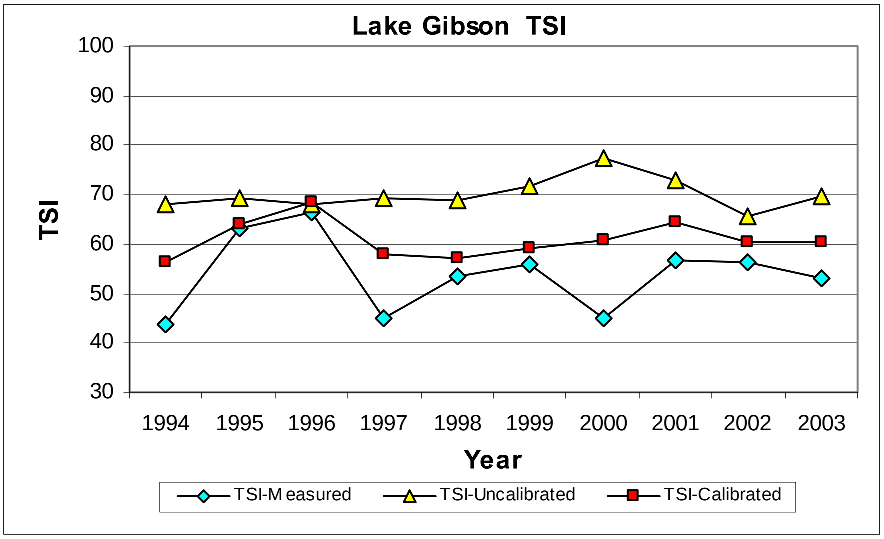
Lake Crago Chlorophyll *a*



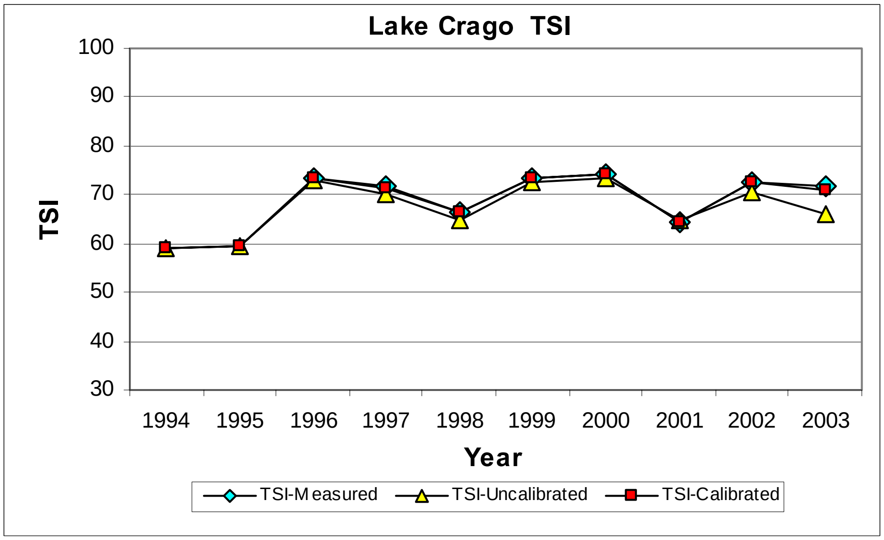
Lake Bonny TSI



Lake Gibson TSI

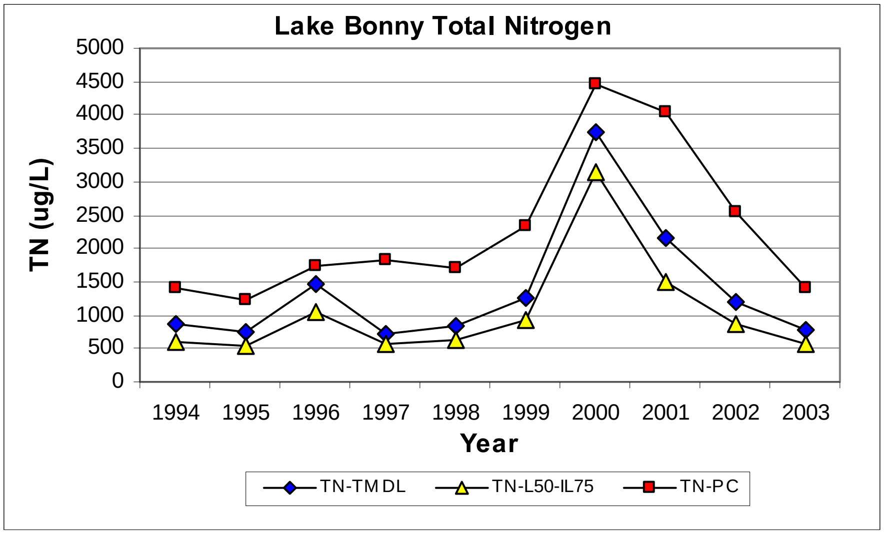


Lake Crago TSI

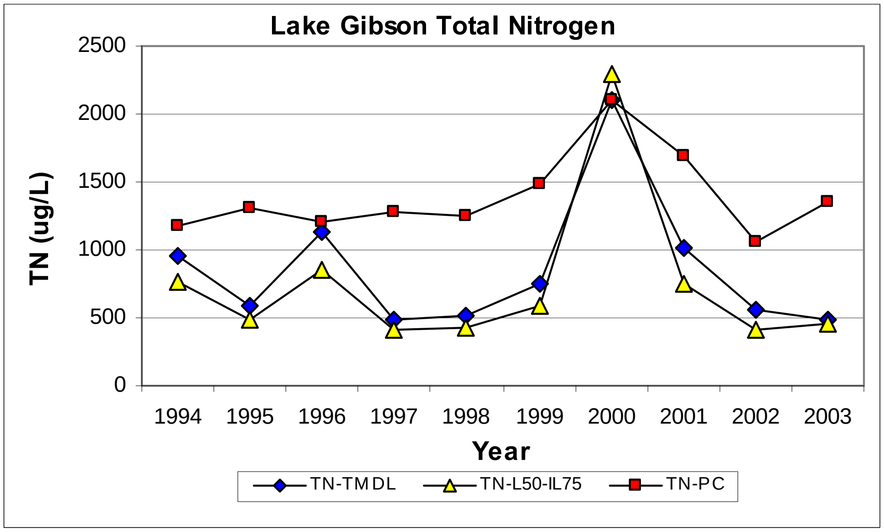


Appendix C: Lakes Bonny, Gibson, and Crago TN, TP, Chlorophyll a, and TSI TMDL Target, L50-IL75, and Background Calibration for the TMDL Modeling Period 1994 to 2003

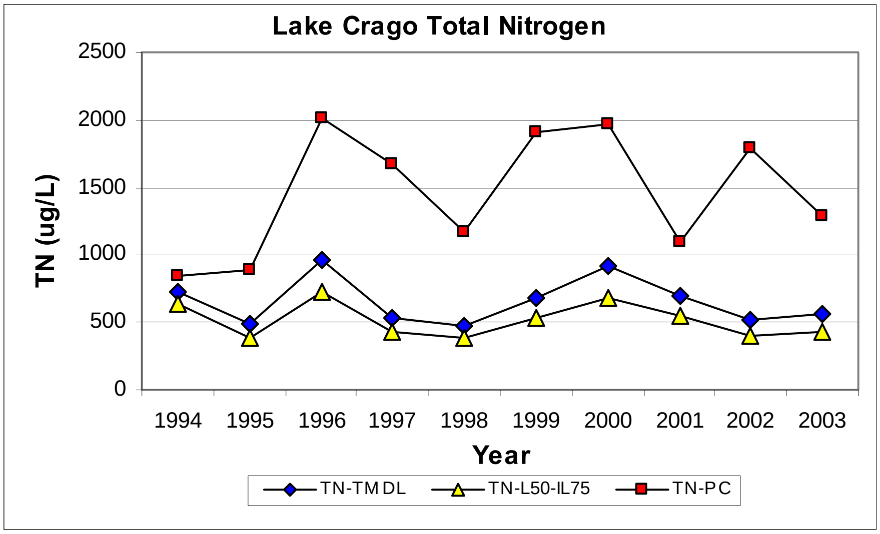
Lake Bonny TN



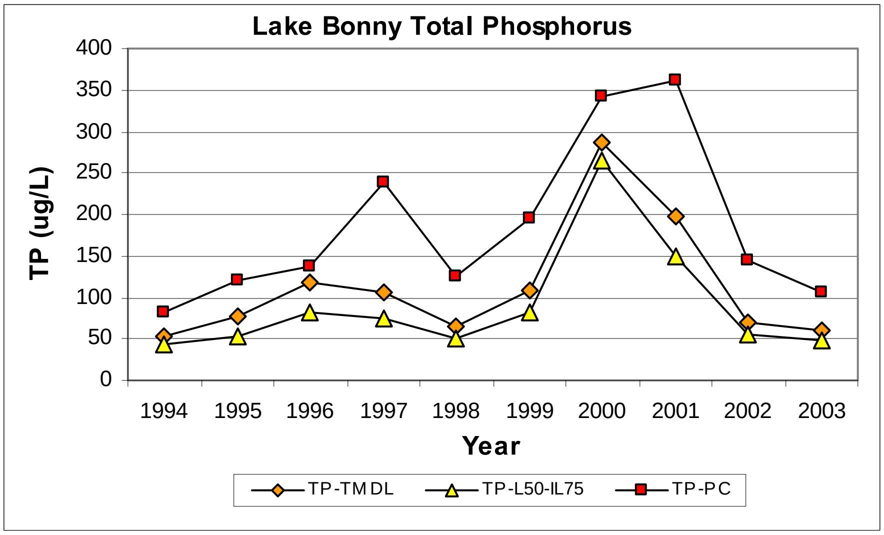
Lake Gibson TN



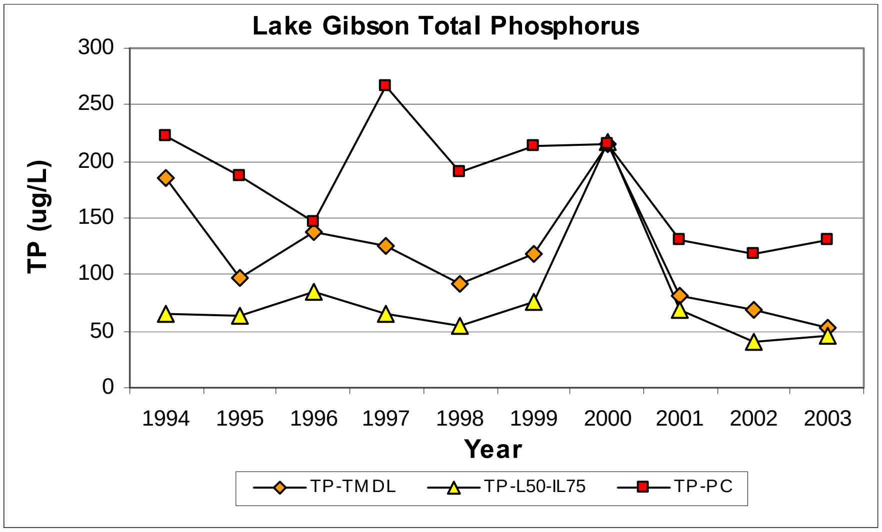
Lake Crago TN



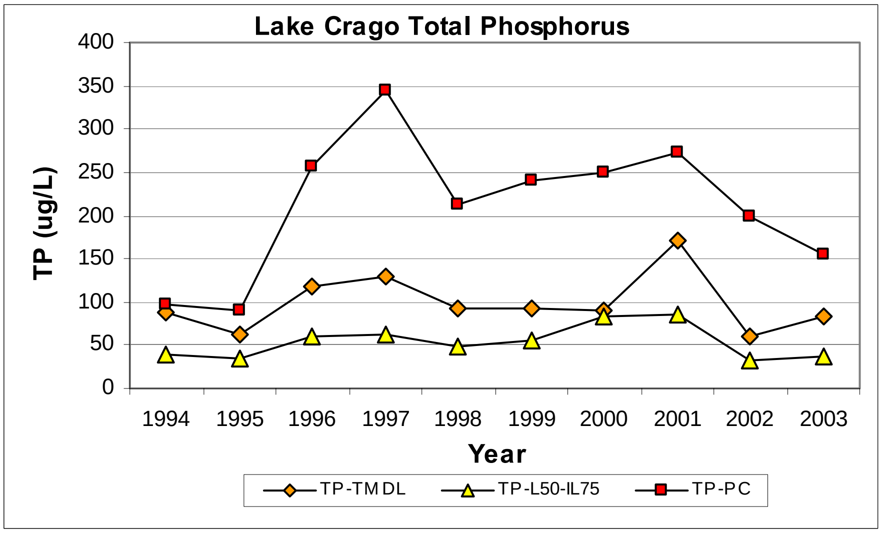
Lake Bonny TP



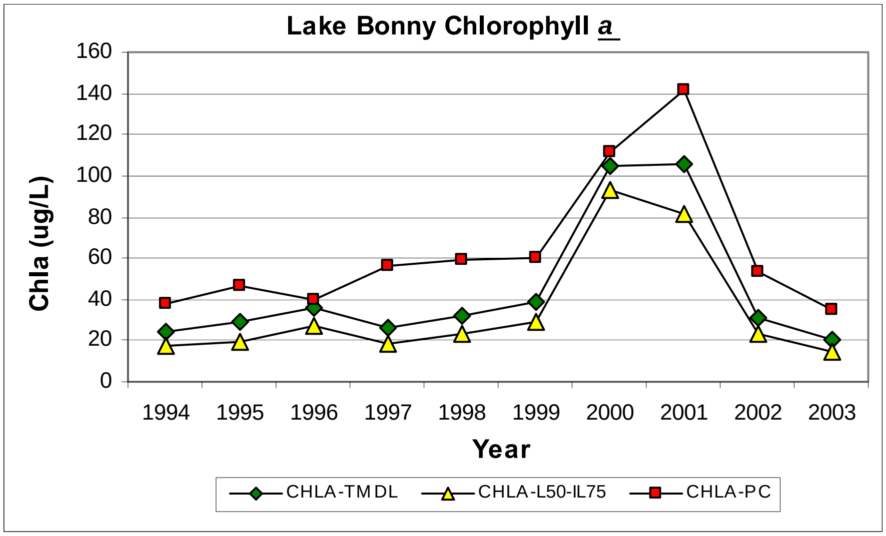
Lake Gibson TP



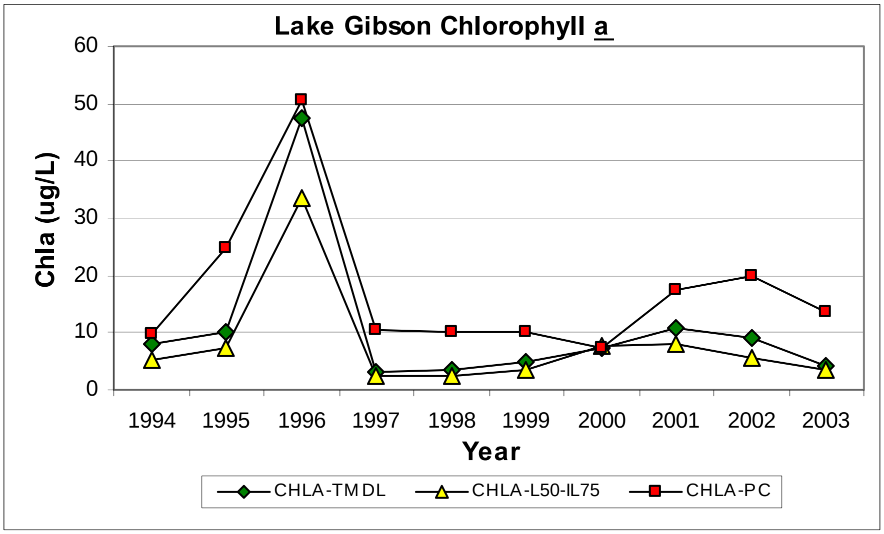
Lake Crago TP



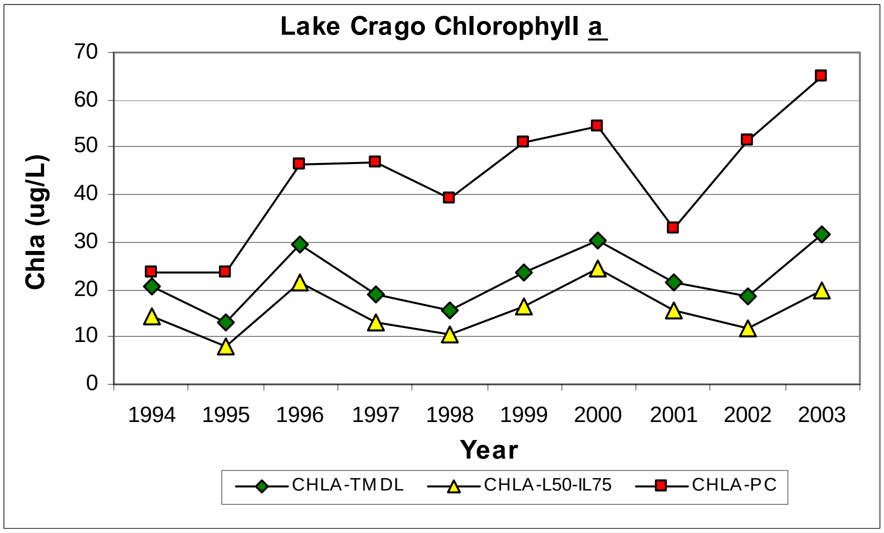
Lake Bonny Chlorophyll a



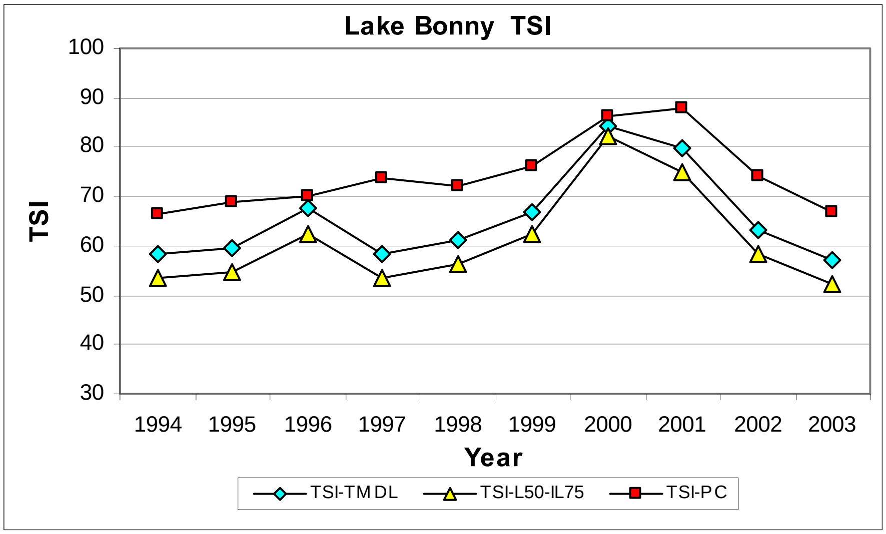
Lake Gibson Chlorophyll a



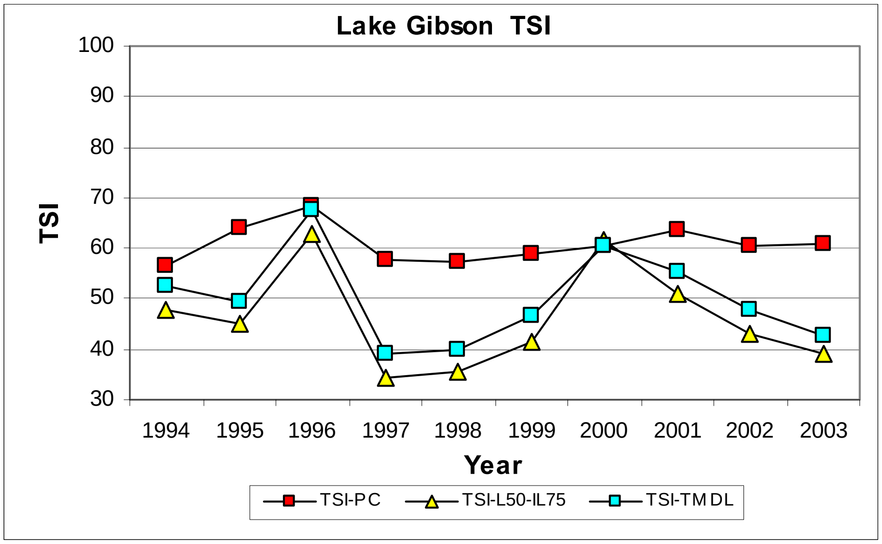
Lake Crago Chlorophyll *a*



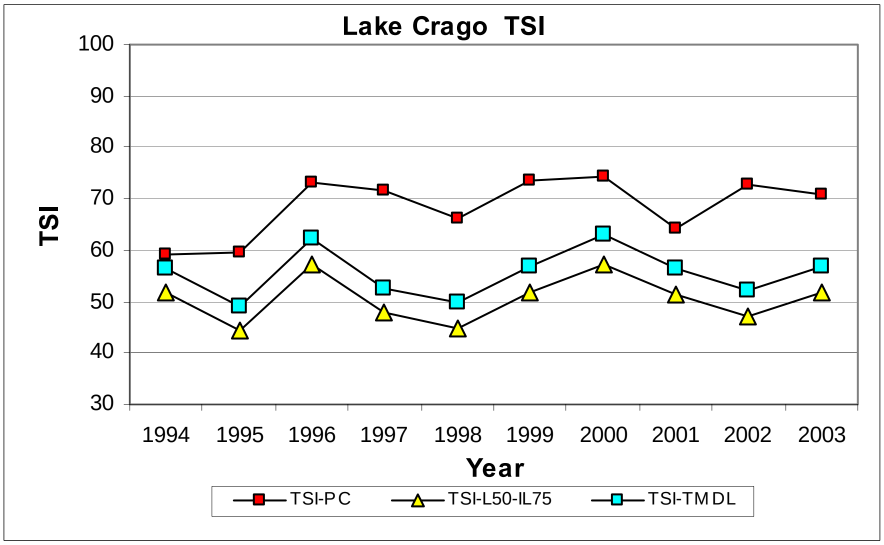
Lake Bonny TSI



Lake Gibson TSI



Lake Crago TSI



Appendix D: Lakes Bonny, Gibson, and Crago TSI for PC, Background, TMDL Target, and TSI-Unit Percent Reduction

Lake Bonny

Lake Bonny
TSI for Measured, PC, Background, TMDL Target, TMDL, and
TSI-unit Percent Reduction Based on Background L50-IL75

Year	Measured	PC	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994	66.4	66.2	53.3	58.3	58.3	54.5
1995	69.0	68.9	54.7	59.7	59.5	54.5
1996	69.9	70.0	62.4	67.4	67.6	25.0
1997	73.7	73.7	53.4	58.4	58.2	77.0
1998	72.3	72.2	56.4	61.4	61.3	69.0
1999	76.0	76.0	62.2	67.2	67.0	66.0
2000*	86.3	86.3	82.1	84.2	84.1	28.0
2001	87.8	87.8	74.8	79.8	79.7	68.0
2002	74.2	74.2	58.3	63.3	63.1	72.0
2003	67.0	66.9	52.2	57.2	57.1	63.0
Minimum	66.4	66.2	52.2	57.2	57.1	25.0
Maximum	87.8	87.8	82.1	87.1	84.1	77.0
Average	74.3	74.2	61.0	66.0	65.6	57.7

* Target for 2000 was set at half the difference between IL75 and PC due to a dry year in the background condition.

Lake Gibson

Lake Gibson
TSI for Measured, PC, Background, TMDL Target, TMDL, and
TSI-unit Percent Reduction Based on Background L50-IL75

Year	Measured	PC	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994	43.6	56.4	47.6	52.6	52.5	28
1995	63.2	64.1	44.9	49.9	49.3	68
1996	66.4	68.5	63	68	67.4	9
1997	44.8	57.8	34.4	39.4	39.1	74
1998	53.4	57.2	35.6	40.6	39.9	72
1999	55.8	59	41.4	46.4	46.6	65
2000*	44.9	60.6	61.7	66.7	60.6	
2001	56.5	63.6	51.1	56.1	55.4	55
2002	56.3	60.5	43	48	47.7	60
2003	53	60.8	39	44	42.8	77
Minimum	43.6	56.4	34.4	39.4	39.1	9
Maximum	66.4	68.5	63	68	67.4	77
Average	53.8	60.8	46.2	51.2	50.1	56.4

* Year 2000 not included as the lake in the background condition had higher concentrations than the current condition.

Lake Crago

Lake Crago
TSI for Measured, PC, Background, TMDL Target, TMDL, and TSI-unit Percent Reduction Based on Background L50-IL75

Year	Measured	PC	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994		59.2	51.9	56.9	56.5	10
1995		59.6	44.5	49.5	49.1	20
1996	73.3	73.3	57.4	62.4	62.1	80
1997	71.6	71.5	47.8	52.8	52.7	85
1998	66.3	66.3	44.9	49.9	49.7	80
1999	73.5	73.5	51.7	56.7	56.8	85
2000	74.3	74.3	57.1	62.1	62.9	90
2001	64.4	64.3	51.4	56.4	56.5	58
2002	72.8	72.8	47	52	52.1	91.5
2003	71.9	70.9	51.9	56.9	57	65
Minimum	64.4	59.2	44.5	49.5	49.1	10
Maximum	74.3	74.3	57.4	62.4	62.9	91.5
Average	71	68.6	50.6	55.6	55.5	66.5

Appendix E: Lakes Bonny, Gibson, and Crago Mass for TN and TP for Calibrated Model, TMDL, and Percent Reduction

Lake Bonny

Lake Bonny
Mass for TN and TP for Calibrated Model and TMDL,
with Mass Percent Reductions (kg/year)

Year	TN-MASS Calibrated	TN-MASS TMDL	TN-MASS % Reduction	TP-MASS Calibrated	TP-MASS TMDL	TP-MASS % Reduction
1994	10,059.0	4,576.8	54.5	719.2	327.2	54.5
1995	9,062.8	4,123.6	54.5	1,605.6	730.5	54.5
1996	10,031.4	7,523.5	25.0	1,241.1	930.8	25.0
1997	20,827.0	4,790.2	77.0	6,615.3	1,521.5	77.0
1998	15,320.9	4,749.5	69.0	1,706.9	529.1	69.0
1999	11,479.9	3,903.2	66.0	1,568.9	533.4	66.0
2000*	17,405.3	12,531.7	28.0	2,030.3	1,461.8	28.0
2001	29,067.4	9,301.6	68.0	4,604.5	1,473.4	68.0
2002	35,883.1	10,047.3	72.0	2,597.4	727.3	72.0
2003	11,699.1	4,328.5	63.0	1,287.9	476.5	63.0
Minimum	9,062.8	3,903.2	25.0	719.2	327.2	25.0
Maximum	35,883.1	12,531.7	77.0	6,615.3	1,521.5	77.0
Average	17,083.6	6,587.6	57.7	2,397.7	871.2	57.7

* Target for the year 2000 was set at half the difference between IL75 and PC due to a dry year in the background condition.

Lake Gibson

Lake Gibson
Mass for TN and TP for Calibrated Model and TMDL,
with Mass Percent Reductions (kg/year)

Year	TN-MASS Calibrated	TN-MASS TMDL	TN-MASS % Reduction	TP-MASS Calibrated	TP-MASS TMDL	TP-MASS % Reduction
1994	10,815.4	7,787.1	28	5,622.7	4,048.3	28
1995	13,422.2	4,295.1	68	4,428.9	1,417.3	68
1996	8,323.0	7,573.9	9	1,948.3	1,772.9	9
1997	16,079.5	4,180.7	74	10,354.5	2,692.2	74
1998	12,176.4	3,409.4	72	4,401.6	1,232.5	72
1999	8,676.8	3,036.9	65	2,882.7	1,008.9	65
2000*	8,950.2	8,950.2		1,652.0	1,652.0	
2001	10,787.6	4,854.4	55	1,197.1	538.7	55
2002	12,066.5	4,829.2	60	2,414.0	965.6	60
2003	13,944.7	3,207.3	77	2,248.5	517.5	77
Minimum	8,323.0	3,036.9	9	1,197.1	517.5	9
Maximum	16,079.5	8,950.2	77	10,354.5	4,048.3	77
Average	11,524.2	5,212.4	56.4	3,715.0	1,584.6	56.4

* Year 2000 not included as the lake in the background condition had higher concentrations than the current condition.

Lake Crago

Lake Crago
Mass for TN and TP for Calibrated Model and TMDL,
with Mass Percent Reductions (kg/year)

Year	TN-MASS Calibrated	TN-MASS TMDL	TN-MASS % Reduction	TP-MASS Calibrated	TP-MASS TMDL	TP-MASS % Reduction
1994	6,181.7	5,114.2	17.3	1,191.9	1,015.4	14.8
1995	6,354.0	3,162.7	50.2	1,033.6	601.8	41.8
1996	16,026.3	5,648.0	64.8	5,224.1	1,342.3	74.3
1997	17,612.7	4,329.9	75.4	11,090.6	2,146.9	80.6
1998	8,963.0	2,879.1	67.9	4,267.7	1,074.6	74.8
1999	12,199.9	2,846.4	76.7	3,875.0	749.3	80.7
2000	8,841.5	2,741.4	69.0	2,955.7	484.7	83.6
2001	4,945.7	2,698.4	45.4	4,521.1	1,952.9	56.8
2002	19,639.6	4,233.6	78.4	4,385.2	693.6	84.2
2003	9,748.1	3,460.9	64.5	2,444.3	887.3	63.7
Minimum	4,945.7	2,698.4	17.3	1,033.6	484.7	14.8
Maximum	19,639.6	5,648.0	78.4	11,090.6	2,146.9	84.2
Average	11,051.3	3,711.5	61.0	4,098.9	1,094.9	65.5

Appendix F: Lakes Bonny, Gibson, and Crago Annual Average Concentrations for TN, TP, and Chlorophyll a

Lake Bonny

Lake Bonny
Annual Average Concentrations for TN, TP, and Chlorophyll a (µg/L)

Year	Measured TN	Calibrated TN	TMDL TN	Measured TP	Calibrated TP	TMDL TP	Measured Chl a	Calibrated Chl a	TMDL Chl a
1994	1,417.8	1,418.0	869.9	82.5	82.9	51.9	38.7	35.7	23.8
1995	1,238.5	1,238.9	754.7	121.5	121.4	77.7	47.7	37.8	29.4
1996	1,723.9	1,724.5	1,459.4	137.3	137.2	117.1	40.0	45.6	35.7
1997	1,834.5	1,834.3	729.4	238.5	238.1	106.4	56.3	54.7	25.9
1998	1,692.5	1,692.7	831.4	125.3	125.4	64.5	59.9	43.0	32.3
1999	2,331.3	2,331.4	1,244.8	195.8	195.3	108.1	60.2	60.0	38.9
2000*	4,471.3	4,470.8	3,744.1	341.4	341.8	287.6	111.8	86.4	104.4
2001	4,053.8	4,053.8	2,145.7	359.9	360.6	196.7	141.5	86.1	105.3
2002	2,542.5	2,542.0	1,197.6	145.6	145.4	70.3	53.2	53.6	30.8
2003	1,420.1	1,420.6	767.7	105.9	105.5	59.5	35.7	37.9	20.1

* Target for the year 2000 was set at half the difference between IL75 and PC due to a dry year in the background condition.

Lake Gibson

Lake Gibson
Annual Average Concentrations for TN, TP, and Chlorophyll a (µg/L)

Year	Measured TN	Calibrated TN	TMDL TN	Measured TP	Calibrated TP	TMDL TP	Measured Chl a	Calibrated Chl a	TMDL Chl a
1994	714.3	1,181.9	949.9	221.5	222.1	185.3	3.5	9.8	7.9
1995	1,196.7	1,302.2	594.2	188.0	187.6	97.7	24.7	24.7	10.2
1996	997.3	1,209.5	1,137.9	146.5	145.9	138.3	50.7	50.4	47.6
1997	666.4	1,274.9	489.2	266.3	266.0	125.2	4.6	10.6	3.3
1998	900.1	1,249.3	513.4	190.8	190.6	91.7	9.6	10.0	3.4
1999	1,123.9	1,486.0	746.3	213.8	213.6	118.6	9.7	10.0	4.9
2000*	658.6	2,108.9	2,108.9	215.1	214.8	214.8	4.8	7.4	7.4
2001	823.3	1,686.4	1,013.8	130.0	130.0	81.2	17.0	17.4	10.7
2002	712.5	1,065.4	554.3	118.5	118.7	68.1	20.5	20.0	9.1
2003	685.0	1,359.4	487.6	130.4	130.3	53.2	13.8	13.7	4.1

* Year 2000 not included as the lake in the background condition had higher concentrations than the current condition.

Lake Crago

Lake Crago
Annual Average Concentrations for TN, TP, and Chlorophyll *a* (µg/L)

Year	Measured TN	Calibrated TN	TMDL TN	Measured TP	Calibrated TP	TMDL TP	Measured Chl *a*	Calibrated Chl *a*	TMDL Chl *a*
1994		847.9	726.9		97.0	87.4		23.5	20.5
1995		880.8	494.7		89.1	62.0		23.6	13.0
1996	2,010.3	2,009.9	960.1	256.3	257.0	117.3	46.4	46.5	29.5
1997	1,674.7	1,674.9	537.3	344.0	345.1	130.5	47.9	47.0	19.0
1998	1,168.7	1,168.9	466.3	212.8	212.6	92.3	39.1	39.2	15.4
1999	1,910.0	1,909.8	679.7	240.0	239.6	92.7	51.1	51.1	23.6
2000	1,972.5	1,971.5	913.5	250.7	250.8	90.5	54.7	54.4	30.3
2001	1,092.0	1,092.7	697.7	272.0	272.8	171.2	33.2	32.8	21.6
2002	1,784.0	1,784.6	514.8	199.6	199.7	60.0	51.3	51.2	18.5
2003	1,279.3	1,279.7	565.8	155.6	156.0	83.3	74.5	64.9	31.7

Appendix G: TN, TP, and Chlorophyll a Monitoring Data Used in the TMDL Analysis for Lake Parker

Lake Parker Total Nitrogen Data

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1497B	21FLPOLKPARKER1	3/31/1993	1027	1.40	600	1.89	
1497B	21FLPOLKPARKER1	10/6/1993	1302	1.30	600	1.79	
1497B	21FLPOLKPARKER1	4/12/1994	835	1.40	600	3.1	
1497B	21FLPOLKPARKER1	10/5/1994	920	1.50	600	1.6	
1497B	21FLPOLKPARKER1	4/5/1995	835	1.40	600	1.61	
1497B	21FLPOLKPARKER1	11/8/1995	1110	1.40	600	2.02	
1497B	LAKELANDPARKER(CENTER)	3/13/1996	1015	0.5	600	1.96	
1497B	21FLPOLKPARKER1	5/8/1996	853	1.40	600	1.38	
1497B	21FLPOLKPARKER1	5/8/1996	853	4.59	600	1.38	
1497B	LAKELANDPARKER(CENTER)	6/19/1996	1000	0.5	600	3.5	
1497B	LAKELANDPARKER(CENTER)	9/18/1996	940	0.5	600	3.82	
1497B	21FLPOLKPARKER1	11/13/1996	900	1.20	600	2.1	
1497B	LAKELANDPARKER(CENTER)	3/18/1997	1015	0.5	600	4.15	
1497B	21FLPOLKPARKER1	5/7/1997	855	1.40	600	1.56	
1497B	LAKELANDPARKER(CENTER)	6/18/1997	1050	0.5	600	3.2	
1497B	LAKELANDPARKER(CENTER)	9/23/1997	1041	0.5	600	3.1	
1497B	21FLPOLKPARKER1	10/30/1997	833	1.60	600	1.5	
1497B	21FLPOLKKENOY DR	3/18/1998	1210	0.10	600	1.77	
1497B	LAKELANDPARKER(CENTER)	3/24/1998	1012	0.5	600	2.97	
1497B	21FLPOLKPARKER1	5/5/1998	820	1.40	600	2.61	
1497B	LAKELANDPARKER(CENTER)	6/10/1998	1020	0.5	600	2.93	
1497B	LAKELANDPARKER(CENTER)	9/14/1998	1021	0.5	600	2.83	
1497B	21FLPOLKPARKER1	11/17/1998	830	1.30	600	2.65	
1497B	LAKELANDPARKER(CENTER)	3/9/1999	926	0.5	600	4.1	
1497B	21FLPOLKPARKER1	5/10/1999	1000	1.30	600	3.91	
1497B	LAKELANDPARKER(CENTER)	6/15/1999	1125	0.5	600	3.22	
1497B	LAKELANDPARKER(CENTER)	9/22/1999	1015	0.5	600	3.57	
1497B	21FLPOLKPARKER1	11/15/1999	1100	1.50	600	2.934	
1497B	LAKELANDPARKER(CENTER)	12/7/1999	1055	0.5	600	3.54	
1497B	LAKELANDPARKER(CENTER)	3/21/2000	1030	0.5	600	3.12	
1497B	21FLPOLKPARKER1	5/2/2000	955	1.20	600	5.8	
1497B	LAKELANDPARKER(CENTER)	6/13/2000	1015	0.5	600	4.34	
1497B	LAKELANDPARKER(CENTER)	9/18/2000	1008	0.5	600	4.53	
1497B	21FLPOLKPARKER1	11/2/2000	927	1.25	600	5.98	
1497B	LAKELANDPARKER(CENTER)	12/12/2000	1020	0.5	600	4.81	
1497B	LAKELANDPARKER(CENTER)	3/13/2001	924	0.5	600	7.332	
1497B	21FLPOLKPARKER1	5/3/2001	930	1.10	600	5.01	
1497B	21FLPOLKPARKER1	5/3/2001	935	0.50	600	7.82	
1497B	LAKELANDPARKER(CENTER)	6/26/2001	840	0.5	600	5.13	
1497B	LAKELANDPARKER(CENTER)	9/11/2001	1015	0.5	600	1.967	
1497B	21FLPOLKPARKER1	11/20/2001	1010	0.50	600	3.24	
1497B	LAKELANDPARKER(CENTER)	3/18/2002	1000	0.5	600	4.082	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1497B	21FLPOLKPARKER1	5/9/2002	900	0.50	600	5.42	
1497B	LAKELANDPARKER(CENTER)	6/11/2002	916	0.5	600	4.577	
1497B	21FLPOLKPARKER1	8/1/2002	1215	0.50	600	3.99	
1497B	LAKELANDPARKER(CENTER)	9/19/2002	923	0.5	600	2.842	
1497B	21FLPOLKPARKER1	11/7/2002	1320	0.50	600	3.13	
1497B	LAKELANDPARKER(CENTER)	12/10/2002	900	0.5	600	2.473	
1497B	21FLTPA 28040628156014	2/5/2003	1230	0.20	600	2.104	+
1497B	21FLPOLKPARKER1	2/11/2003	940	0.50	600	2.49	
1497B	21FLPOLKPARKER1	5/13/2003	845	0.50	600	2.95	
1497B	LAKELANDPARKER(CENTER)	6/17/2003	935	0.5	600	1.77	
1497B	21FLTPA 28040628156014	8/18/2003	1140	0.20	600	2.104	+
1497B	21FLPOLKPARKER1	8/26/2003	1250	0.50	600	2.691	
1497B	LAKELANDPARKER(CENTER)	9/11/2003	1020	0.5	600	2.688	
1497B	21FLTPA 28040628156014	11/3/2003	1210	0.20	600	2.805	+
1497B	21FLPOLKPARKER1	11/6/2003	855	0.50	600	3.09	
1497B	LAKELANDPARKER(CENTER)	12/9/2003	940	0.5	600	2.301	
1497B	21FLPOLKPARKER1	2/11/2004	1200	0.50	600	3.176	+

+ : Calculated value.

Lake Parker Total Phosphorus Data

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1497B	21FLPOLKPARKER1	3/31/1993	1027	1.40	665	0.158	
1497B	21FLPOLKPARKER1	10/6/1993	1302	1.30	665	0.114	
1497B	21FLPOLKPARKER1	4/12/1994	835	1.40	665	0.221	
1497B	21FLPOLKPARKER1	10/5/1994	920	1.50	665	0.129	
1497B	21FLPOLKPARKER1	4/5/1995	835	1.40	665	0.16	
1497B	21FLPOLKPARKER1	11/8/1995	1110	1.40	665	0.22	
1497B	LAKELANDPARKER(CENTER)	3/13/1996	1015	0.50	665	0.174	
1497B	21FLPOLKPARKER1	5/8/1996	853	1.40	665	0.072	
1497B	LAKELANDPARKER(CENTER)	6/19/1996	1000	0.50	665	0.183	
1497B	LAKELANDPARKER(CENTER)	9/18/1996	940	0.50	665	0.282	
1497B	21FLPOLKPARKER1	11/13/1996	900	1.20	665	0.201	
1497B	LAKELANDPARKER(CENTER)	3/18/1997	1015	0.50	665	0.469	
1497B	21FLPOLKPARKER1	5/7/1997	855	1.40	665	0.084	
1497B	LAKELANDPARKER(CENTER)	6/18/1997	1050	0.50	665	0.45	
1497B	LAKELANDPARKER(CENTER)	9/23/1997	1041	0.50	665	0.41	
1497B	21FLPOLKPARKER1	10/30/1997	833	1.60	665	0.137	
1497B	21FLPOLKKENOY DR	3/18/1998	1210	0.10	665	1.412	
1497B	LAKELANDPARKER(CENTER)	3/24/1998	1012	0.50	665	0.22	
1497B	21FLPOLKPARKER1	5/5/1998	820	1.40	665	0.305	
1497B	LAKELANDPARKER(CENTER)	6/10/1998	1020	0.50	665	0.35	
1497B	LAKELANDPARKER(CENTER)	9/14/1998	1021	0.50	665	0.29	
1497B	21FLPOLKPARKER1	11/17/1998	830	1.30	665	0.122	
1497B	LAKELANDPARKER(CENTER)	3/9/1999	926	0.50	665	0.417	
1497B	21FLPOLKPARKER1	5/10/1999	1000	1.30	665	0.231	
1497B	LAKELANDPARKER(CENTER)	6/15/1999	1125	0.50	665	0.443	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1497B	LAKELANDPARKER(CENTER)	9/22/1999	1015	0.50	665	0.199	
1497B	21FLPOLKPARKER1	11/15/1999	1100	1.50	665	0.073	
1497B	LAKELANDPARKER(CENTER)	3/21/2000	1030	0.50	665	0.21	
1497B	21FLPOLKPARKER1	5/2/2000	955	1.20	665	0.222	
1497B	LAKELANDPARKER(CENTER)	6/13/2000	1015	0.50	665	3.79	
1497B	LAKELANDPARKER(CENTER)	9/18/2000	1008	0.50	665	0.324	
1497B	21FLPOLKPARKER1	11/2/2000	929	0.50	665	0.30	
1497B	LAKELANDPARKER(CENTER)	3/13/2001	924	0.50	665	0.628	
1497B	21FLPOLKPARKER1	5/3/2001	935	0.50	665	0.45	
1497B	LAKELANDPARKER(CENTER)	6/26/2001	840	0.50	665	0.435	
1497B	LAKELANDPARKER(CENTER)	9/11/2001	1015	0.50	665	0.211	
1497B	21FLPOLKPARKER1	11/20/2001	1010	0.50	665	0.075	
1497B	LAKELANDPARKER(CENTER)	3/18/2002	1000	0.50	665	0.374	
1497B	21FLPOLKPARKER1	5/9/2002	900	0.50	665	0.095	
1497B	LAKELANDPARKER(CENTER)	6/11/2002	916	0.50	665	0.268	
1497B	21FLPOLKPARKER1	8/1/2002	1215	0.50	665	0.06	
1497B	LAKELANDPARKER(CENTER)	9/19/2002	923	0.50	665	0.208	
1497B	21FLPOLKPARKER1	11/7/2002	1320	0.50	665	0.077	
1497B	LAKELANDPARKER(CENTER)	12/10/2002	900	0.50	665	0.238	
1497B	21FLTPA 28040628156014	2/5/2003	1230	0.20	665	0.1	
1497B	21FLPOLKPARKER1	2/11/2003	940	0.50	665	0.09	
1497B	21FLPOLKPARKER1	5/13/2003	845	0.50	665	0.161	
1497B	LAKELANDPARKER(CENTER)	6/17/2003	935	0.50	665	0.177	
1497B	21FLTPA 28040628156014	8/18/2003	1140	0.20	665	0.066	
1497B	21FLPOLKPARKER1	8/26/2003	1250	0.50	665	0.061	
1497B	LAKELANDPARKER(CENTER)	9/11/2003	1020	0.50	665	0.215	
1497B	21FLTPA 28040628156014	11/3/2003	1210	0.20	665	0.084	
1497B	21FLPOLKPARKER1	11/6/2003	855	0.50	665	0.061	
1497B	LAKELANDPARKER(CENTER)	12/9/2003	940	0.50	665	0.166	
1497B	21FLPOLKPARKER1	2/11/2004	1200	0.50	665	0.076	

Lake Parker Chlorophyll *a* Data

WBID	Station	Date	Time	Depth	Storet Code	Chl *a* (µg/L)	R-Code
1497B	21FLPOLKPARKER1	3/31/1993	1027	4.59	32210	39.6	
1497B	21FLPOLKPARKER1	10/6/1993	1302	4.26	32210	86.5	
1497B	21FLPOLKPARKER1	4/12/1994	835	4.59	32210	107.8	
1497B	21FLPOLKPARKER1	10/5/1994	920	4.92	32210	80.2	
1497B	21FLPOLKPARKER1	4/5/1995	835	4.59	32210	32.1	
1497B	21FLPOLKPARKER1	11/8/1995	1110	4.59	32210	103.1	
1497B	LAKELANDPARKER(CENTER)	3/13/1996	1015	0.50	32210	79.1	
1497B	21FLPOLKPARKER1	5/8/1996	853	4.59	32210	75.4	
1497B	LAKELANDPARKER(CENTER)	6/19/1996	1000	0.50	32210	86.0	
1497B	LAKELANDPARKER(CENTER)	9/18/1996	940	0.50	32210	93.1	
1497B	21FLPOLKPARKER1	11/13/1996	900	3.94	32210	116.3	
1497B	LAKELANDPARKER(CENTER)	3/18/1997	1015	0.50	32210	133.0	

WBID	Station	Date	Time	Depth	Storet Code	Chl a (µg/L)	R-Code
1497B	21FLPOLKPARKER1	5/7/1997	855	4.59	32210	126.8	
1497B	LAKELANDPARKER(CENTER)	6/18/1997	1050	0.50	32210	130.0	
1497B	LAKELANDPARKER(CENTER)	9/23/1997	1041	0.50	32210	80.4	
1497B	21FLPOLKPARKER1	10/30/1997	833	5.25	32210	153.3	
1497B	21FLPOLKKENOY DR	3/18/1998	1210	0.33	32210	6.6	
1497B	LAKELANDPARKER(CENTER)	3/24/1998	1012	0.50	32210	77.8	
1497B	21FLPOLKPARKER1	5/5/1998	820	1.40	32210	192.3	
1497B	LAKELANDPARKER(CENTER)	6/10/1998	1020	0.50	32210	72.9	
1497B	LAKELANDPARKER(CENTER)	9/14/1998	1021	0.50	32210	95.9	
1497B	21FLPOLKPARKER1	11/17/1998	830	4.26	32210	130.7	
1497B	LAKELANDPARKER(CENTER)	3/9/1999	926	0.50	32210	175.7	
1497B	21FLPOLKPARKER1	5/10/1999	1000	1.30	32223	188.2	
1497B	LAKELANDPARKER(CENTER)	6/15/1999	1125	0.50	32210	92.2	
1497B	LAKELANDPARKER(CENTER)	9/22/1999	1015	0.50	32210	194.0	
1497B	21FLPOLKPARKER1	11/15/1999	1100	1.50	32223	132.2	
1497B	LAKELANDPARKER(CENTER)	12/7/1999	1055	0.00	32210	108.2	
1497B	LAKELANDPARKER(CENTER)	3/21/2000	1030	0.50	32210	137.1	
1497B	21FLPOLKPARKER1	5/2/2000	955	1.20	32223	252.3	
1497B	LAKELANDPARKER(CENTER)	6/13/2000	1015	0.50	32210	116.2	
1497B	LAKELANDPARKER(CENTER)	9/18/2000	1008	0.50	32210	174.6	
1497B	21FLPOLKPARKER1	11/2/2000	929	0.50	32223	140.2	
1497B	LAKELANDPARKER(CENTER)	12/12/2000	1020	0.00	32210	113.8	
1497B	LAKELANDPARKER(CENTER)	3/13/2001	924	0.50	32210	156.7	
1497B	21FLPOLKPARKER1	5/3/2001	935	0.50	32223	280.4	
1497B	LAKELANDPARKER(CENTER)	6/26/2001	840	0.50	32210	85.6	
1497B	LAKELANDPARKER(CENTER)	9/11/2001	1015	0.50	32210	51.5	
1497B	21FLPOLKPARKER1	11/20/2001	1010	0.50	32223	125.5	
1497B	LAKELANDPARKER(CENTER)	3/18/2002	1000	0.50	32210	132.6	
1497B	21FLPOLKPARKER1	5/9/2002	900	0.50	32223	192.2	
1497B	LAKELANDPARKER(CENTER)	6/11/2002	916	0.50	32210	137.4	
1497B	21FLPOLKPARKER1	8/1/2002	1215	0.50	32223	121.0	
1497B	LAKELANDPARKER(CENTER)	9/19/2002	923	0.50	32210	63.0	
1497B	LAKELANDPARKER(CENTER)	12/10/2002	900	0.50	32210	91.4	
1497B	21FLTPA 28040628156014	2/5/2003	1230	0.20	32209	64.0	A
1497B	LAKELANDPARKER(CENTER)	6/17/2003	935	0.50	32210	41.7	
1497B	21FLTPA 28040628156014	8/18/2003	1140	0.20	32209	52.0	
1497B	LAKELANDPARKER(CENTER)	9/11/2003	1020	0.50	32210	107.2	
1497B	21FLTPA 28040628156014	11/3/2003	1210	0.20	32209	150.0	
1497B	LAKELANDPARKER(CENTER)	12/9/2003	940	0.50	32210	126.9	
1497B	21FLPOLKPARKER1	2/11/2004	1200	0.50	32210	107.1	

A: Value reported is the mean of two or more determinations.

Appendix H: SWET Watershed Assessment Model (WAM) Final Report for the Lake Hancock and Saddle Creek Basin (available upon request)

Appendix I: QEA, LLC, BATHTUB Model Final Report for the Lake Hancock and Saddle Creek Basin (available upon request)

Appendix J: WAM Watershed Assessment Model, Model Documentation and Users Manual, Soil and Water Engineering Technology, Inc., May, 2005 (available upon request)