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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 Banana Lake and Banana Lake Canal

WBID 1549B & WBID 1549A

Zack Shelley
Douglas Gilbert
Kevin Petrus

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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 Banana Lake watershed.

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

For additional information on the watershed management approach and impaired waters in The Peace River, Myakka River, and Sarasota Bay Planning Units, contact:

Tom Singleton
Florida Department of Environmental Protection
Bureau of Watershed Management
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
tom.singleton@dep.state.fl.us
Phone: (850) 245-8561; Suncom: 205-8561
Fax: (850) 245-8434

Access to all data used in the development of this report can be obtained by contacting:

Kevin Petrus, Environmental Manager
Florida Department of Environmental Protection
Bureau of Watershed Management
Watershed Assessment Section
2600 Blair Stone Road, Mail Station 3555
Tallahassee, FL 32399-2400
Kevin.petrus@dep.state.fl.us
Phone: (850) 245-8459; Suncom: 205-8459
Fax: (850) 245-8536

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the TMDL for nutrients for Banana Lake and Banana Lake Canal (also known as Banana Creek) located in the Lake Hancock Basin. Banana Lake and Banana Lake Canal were verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR, Rule 62-303, Florida Administrative Code). The lake and canal were included on the Verified List of impaired waters that was adopted by Secretarial Order on June 17, 2005. This TMDL establishes the allowable loadings to Banana Lake that would restore the lake and the canal so that they meet their applicable water quality criteria for nutrients.

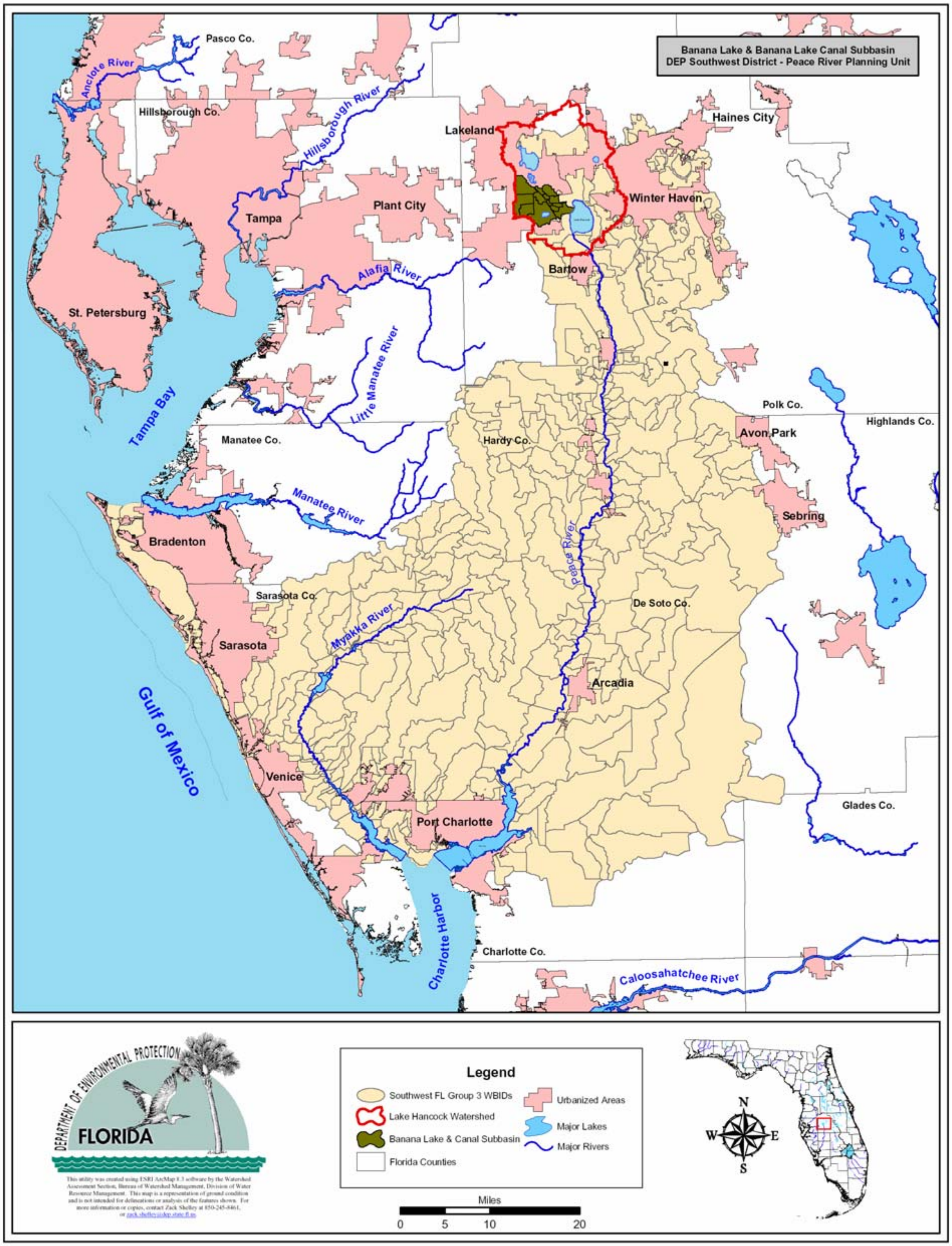
1.2 Identification of Waterbody

Banana Lake is located 3.5 miles southeast of the City of Lakeland, in Polk County, Florida (Figure 1.1). The estimated surface area of the lake is approximately 0.53 square miles or 342 acres, and the average depth of the lake is 4 ft (1.2 m).. The surface water drainage area of the lake is approximately 16.1 square miles or 10,289 acres.

The Banana Lake and Banana Lake Canal sub-basin is a contributing drainage area to Lake Hancock. Additional lakes in the sub-basin include lakes Bentley, Hollingsworth, Horney, John, Mirror, Morton, and Somerset. The surface water drainage basin of the lake and Banana Lake Canal sub-basin that enters Lake Hancock is approximately 21.5 square miles or 13,788 acres. . The watershed's land use designations are primarily urban, commercial, and abandoned phosphate mine lands. The normal pool topographic elevation of the water surface is 104.08 feet National Geodetic Vertical Datum (NGVD) (Polk County Natural Resources Division, 2002).

Lake Stahl (also known as Banana North Pit) and Little Banana Lake (also known as Banana South Pit) are connected to Banana Lake via canals and located directly to the west of the lake.. Lake Stahl, approximately 30 acres in size, and Little Banana Lake, approximately 62 acres in size, are former phosphate mining pits**.** Lake Stahl receives runoff from a relatively small drainage area. The majority of flow into Stahl Lake comes from Stahl Creek/Canal, which receives runoff and inflow from Lake Somerset. Lake Somerset receives inflow from Lake Bentley, and Bentley receives inflow from Lake Hollingsworth. Lake Somerset is also connected to Lake John by a culvert under New Jersey Road. Lakes Somerset and Bentley were created during phosphate mining (City of Lakeland, Lakes and Stormwater Division, 2001).

Another inflow source to Banana Lake is the Holloway Canal, which enters the lake from the north and has a relatively small and constant flow. The primary outfall of Banana Lake is Banana Lake Canal, located on the east shore of the lake which flows directly into Lake Hancock. The canal is approximately five miles in length and is one of three primary tributary inputs into Lake Hancock.



This utility was created using ESRI ArcMap 8.3 software by the Watershed Assessment Section, Bureau of Watershed Management, Division of Water Resource Management. This map is a representation of ground condition and is not intended for delineations or analysis of the features shown. For more information or copies, contact Zack Shelley at 850-245-8461, or zack.shelley@dep.state.fl.us.

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

The dominant land use categories in the Banana Lake Canal watershed are agricultural, residential, open water, lakes and wetlands. The canal passes through the Circle B-Bar Ranch and then enters the west side of Lake Hancock. The Circle B-Bar Ranch property is approximately 1,200 acres in area and is owned and managed by Polk County and SWFWMD. This property contains areas that were formerly grasslands and wetlands. In March 2004, survey sites in the canal had channel bottom elevations in the range of 99 to 101 NGVD feet, with the stream flowing at a rate of about 3 to 5 cfs (BCI Engineers and Scientist, Inc., 2005).

For assessment purposes, the Department has divided the Lake Hancock Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Banana Lake has been given the WBID number of 1549B and Banana Lake Canal is 1549A. The Banana Lake WBID and its sampling/monitoring stations are illustrated in **Figure 1.2.** The Banana Lake Canal WBID and its sampling/monitoring stations are illustrated in **Figure 1.3.**

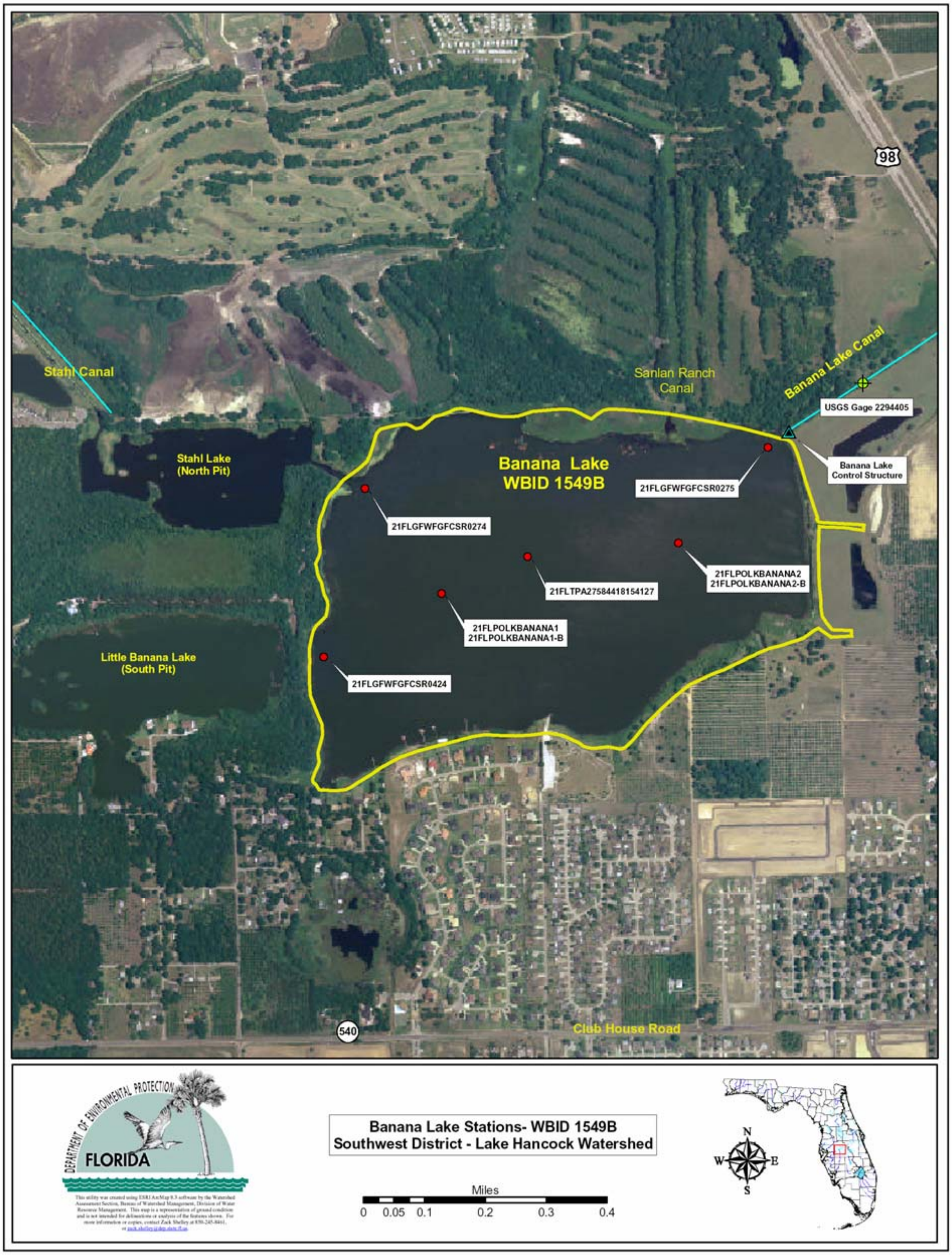


Figure 1.2 Banana Lake WBID 1549B and Monitoring Stations

Figure 1.3 Banana Lake Canal WBID 1549A and Monitoring Stations

1.3 Historic Water Quality Problems

Historic water quality problems have been largely attributed to the highly nutrient rich sediment that built up in the lake from the direct discharge of the City of Lakeland's 10 million gallons a day (mgd) wastewater treatment plant (WWTP) that began discharging to Stahl Creek/Canal in 1926. Between January 1975 and April 1987, the plant discharged on average 6.4 mgd. The City of Lakeland's WWTP effluent discharge was diverted away from Banana Lake in 1987. However, the Stahl Creek/Canal watershed is dominated by urban infrastructure with significant areas of impervious surfaces that support nonpoint source runoff.

Another contributing factor to poor water quality is the control structure at the outfall of Banana Lake to Banana Lake Canal, which was constructed to retain the lake's water levels. The structure was designed to maintain an artificially elevated water level in the lake for agricultural withdrawals. Discharges of lake water to Banana Lake Canal were limited to extreme high water conditions resulting from extensive rainfall and to reduce flooding during the wet season. The natural seasonal lake level fluctuations were interrupted, which would have promoted the flushing of excessive nutrients out of the lake. As a result, the lake was temporarily impounded for extended periods of time, which contributed significantly to the eutrophication of the system (Polk County Natural Resources Division, 2001; SWFWMD, 2005). The accumulated sediment were high in nutrients, and the re-suspension of the sediments by wind and wave action continually caused nutrients to be reintroduced in the lake's water column. Muck deposits in some locations of Banana Lake were estimated to be over 7 feet thick and average 2.8 feet throughout the lake (SWFWMD, 1989).

In 1989-1990, a cooperative effort by state, county, and local agencies developed a restoration plan to hydraulically dredge the entire lake to remove the sediments. An estimated one million cubic yards (cy) of organic sediment had accumulated since 1926. Dredging began in August 1990 and was completed in August 1991. Slightly less than one million cy of sediment was estimated to have been removed by the dredging (Bromwell and Carrier, Inc., 1991).

1.4 Background Information

The TMDL Report for Banana Lake and Banana Lake Canal is part of the implementation of the Florida Department of Environmental Protection's (Department) 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 Banana Lake and Banana Lake Canal.

Because Banana Lake discharges to Banana Lake Canal, which flows into Lake Hancock, the water quality in Banana Lake directly affects water quality of the canal and Lake Hancock. The Banana Lake and Banana Lake Canal sub-basin is one of nine major sub-basins delineated for modeling the Lake Hancock Basin. Included in the Banana Lake sub-basin TMDL modeling process are Lakes Hollingsworth and Bentley. See **Figure 1.4** for an overview of the Banana Lake and Banana Lake Canal sub-basin (including Lakes Hollingsworth and Bentley) modeled for the TMDL.

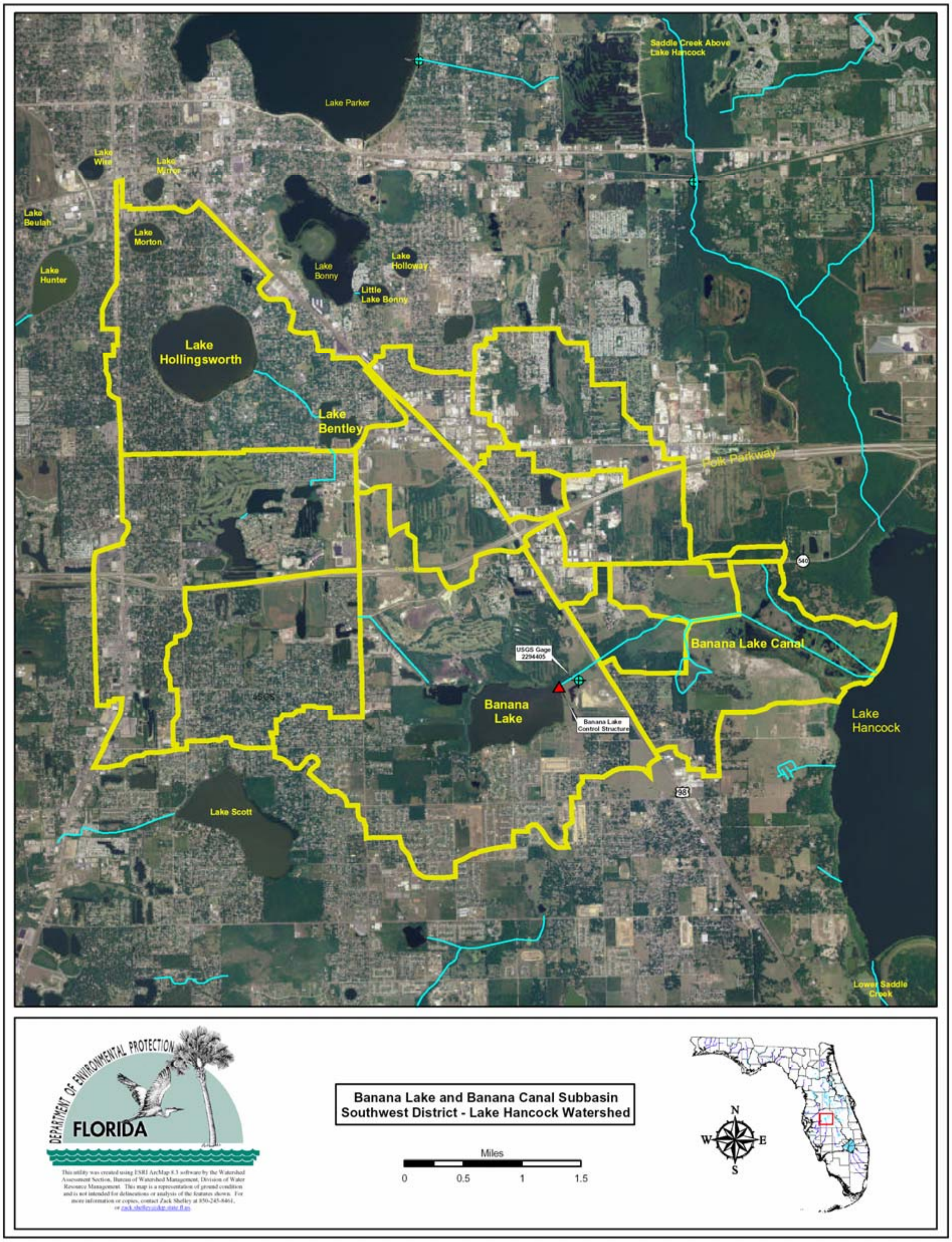


Figure 1.4 Overview of the Banana Lake and Banana Lake Canal Sub-basin

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. After a long rulemaking process, 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 Banana Lake and Banana Lake Canal. The lake and the canal were both verified impaired for nutrients. 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 Trophic State Index (TSI) values for lakes used in interpreting Florida's narrative nutrient criteria.

Banana Lake and Banana Lake Canal were also listed as being impaired for dissolved oxygen (DO) during the Verified Period for Group 3 waterbodies. However, based on a re-evaluation of the WBID boundaries and the location of the existing monitoring stations that led to the conclusion that the waters were impaired for DO, several stations from both the lake and canal were reassigned to other water segments to accurately reflect the waterbodies in which they are located. Stations 21FLPOLKBANANA 3, 4, and 5 were removed from the Banana Lake WBID, and stations 21FLPOLKBANANA 7, 8, 9, 10, and 11 were removed from the Banana Lake Canal WBID. As a result of the station reassignments, a reassessment of water quality showed that the lake and canal are not impaired for DO.

Banana Lake was verified as impaired for nutrients based on elevated annual average TSI values during the verification period (the Verified Period for the Group 3 basins is from January 1, 1997 to June 30, 2004). Annual average TSI values for the verified period for the lake were 81.9 (1997), 82 (1998), 82.4 (1999), and 91.8 (2001). The annual average TSI value for years in the verified period was 84.5. Annual average color values for the verified period for the lake were 35.1 (1997), 50.5 (1998), and 33.5 (1999). The annual average color value for years in the verified period was 39.7.

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

TSI Formula

$CHLA_{TSI} = 16.8 + 14.4 * LN(Chl\ a)$ Chlorophyll a in µg/L
$TN_{TSI} = 56 + 19.8 * LN(N)$ Nitrogen in mg/L
$TN2_{TSI} = 10 * [5.96 + 2.15 * LN(N + 0.0001)]$ Phosphorus in mg/L
$TPTSI = 18.6 * LN(P * 1000) – 18.4$
$TP2_{TSI} = 10 * [2.36 * LN(P * 1000) – 2.38]$

If $N/P > 30$, *then* $NUTR_{TSI} = TP2_{TSI}$
If $N/P < 10$, *then* $NUTR_{TSI} = TN2_{TSI}$
if $10 < N/P < 30$, *then* $NUTR_{TSI} = (TP_{TSI} + TN_{TSI})/2$

$TSI = (CHLA_{TSI} + NUTR_{TSI})/2$ Note: TSI has no units

For modeling purposes, the analysis of the eutrophication-related data for Banana Lake used "all" of the available data from 1984 – 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 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 1994, 2000, 2001, and 2002 from the analysis of TSI for Banana Lake.

Figure 2.1 displays annual average TSI values for all data from 1984 to 2004 (includes Lakewatch data) and IWR planning and verified period TSI values from 1992 to 2001 (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. Planning and verified period seasonal annual average TSI values exceeded the IWR threshold level of 60 in 1992, 1993, 1995 to 1999, and in 2001 and averaged 81.6 for those eight years. Exceeding 60 in any one year of the verified period is sufficient in determining the impairment for a lake for nutrients. For Banana Lake, all annual mean TSI values (where data were available for all four seasons) for the planning and verified periods (years 1992, 1993, 1995 to 1999, and 2001) exceeded 60.

The canal was listed for nutrients because, in 2003, the annual average chlorophyll a value (87.8 µ/g/L) was greater than the chlorophyll a threshold of 20 µ/g/L for freshwater streams. Based on the new station realignment for the canal, data were available for the years 1992, 2003, and 2004. Only the year 2003 had data from all four seasons to calculate an annual average value per IWR methodology. Annual average chlorophyll a values for 1992 and 2004 were 48.7 and 149.8 µ/g/L, respectively.

Monthly and annual average TN results for Banana Lake from 1992 to 2004 are displayed in **Figures 2.2** and **2.3,** respectively. Monthly and annual average TP results from 1992 to 2004 are displayed in **Figures 2.4** and **2.5**. Monthly and annual average chlorophyll a results from 1992 to 2004 are displayed in **Figures 2.6** and **2.7**. Monthly and annual average TN results for Banana Lake Canal from 1992 to 2004 are displayed in **Figures 2.8** and **2.9**, respectively. Monthly and annual average TP results from 1992 to 2004 are displayed in **Figures 2.10** and **2.11**. Monthly and annual average chlorophyll a results from 1992 to 2004 are displayed in **Figures 2.12** and **2.13.** Values from all stations for TN for Banana Lake from 1992 to 2004 were typically highest during the months of February and May. Values for TP were highest during the months of February, April, and May. Values for Chlorophyll a were highest during the months of February, May, August, and November. Values from all stations for TN for Banana Lake Canal from 1993, 2003 and 2004 were typically highest during the months of May and November. Values for TP were highest during the months of February, May, and November. Values for Chlorophyll a were high through-out each year with the highest values occurring in May. The months of February, May, and November appear to show the strongest relationship in terms of consistently having high monthly values for all three water quality variables between the lake and canal.

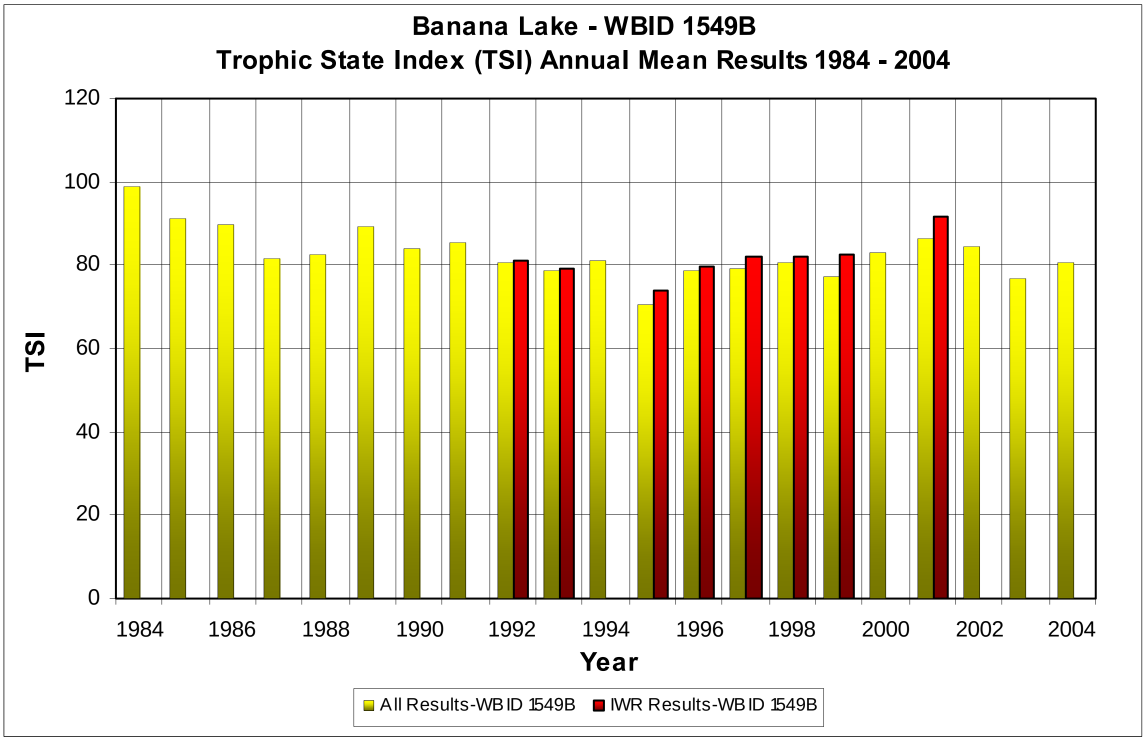


Figure 2.1 TSI Results for Banana Lake Calculated from Seasonal Annual Average Concentrations of TP, TN, and Chlorophyll a from 1984 to 2004.

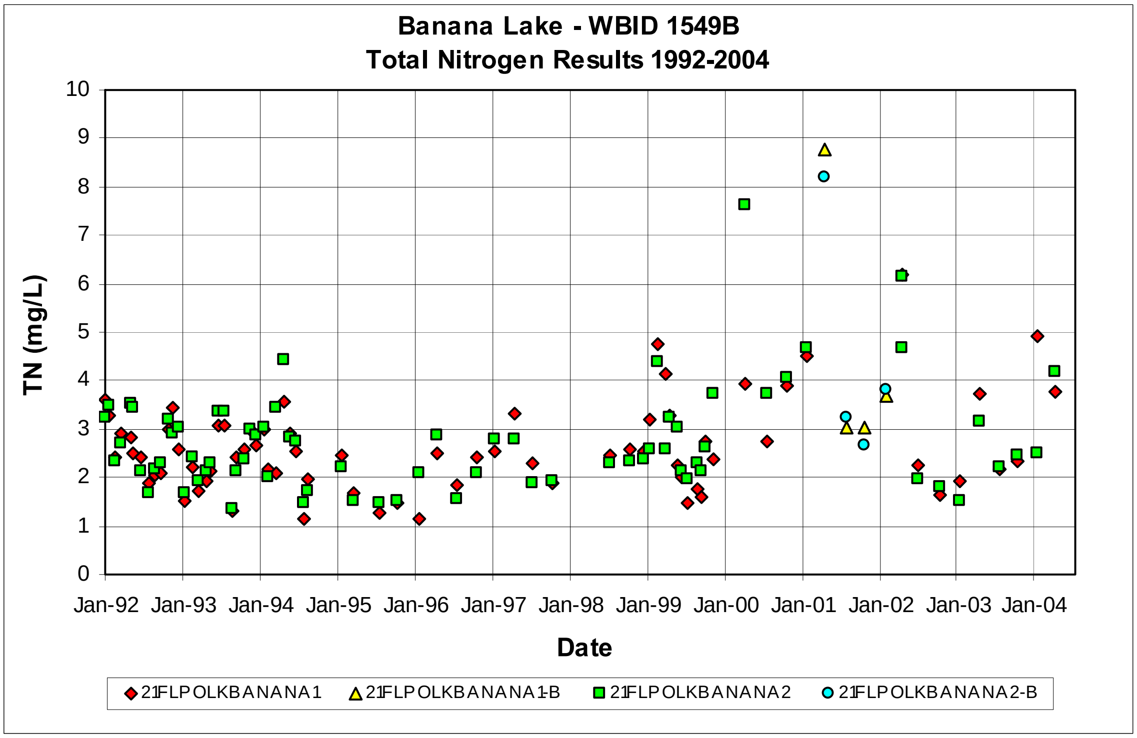


Figure 2.2 Total Nitrogen Monthly Results for Banana Lake from 1992 to 2004

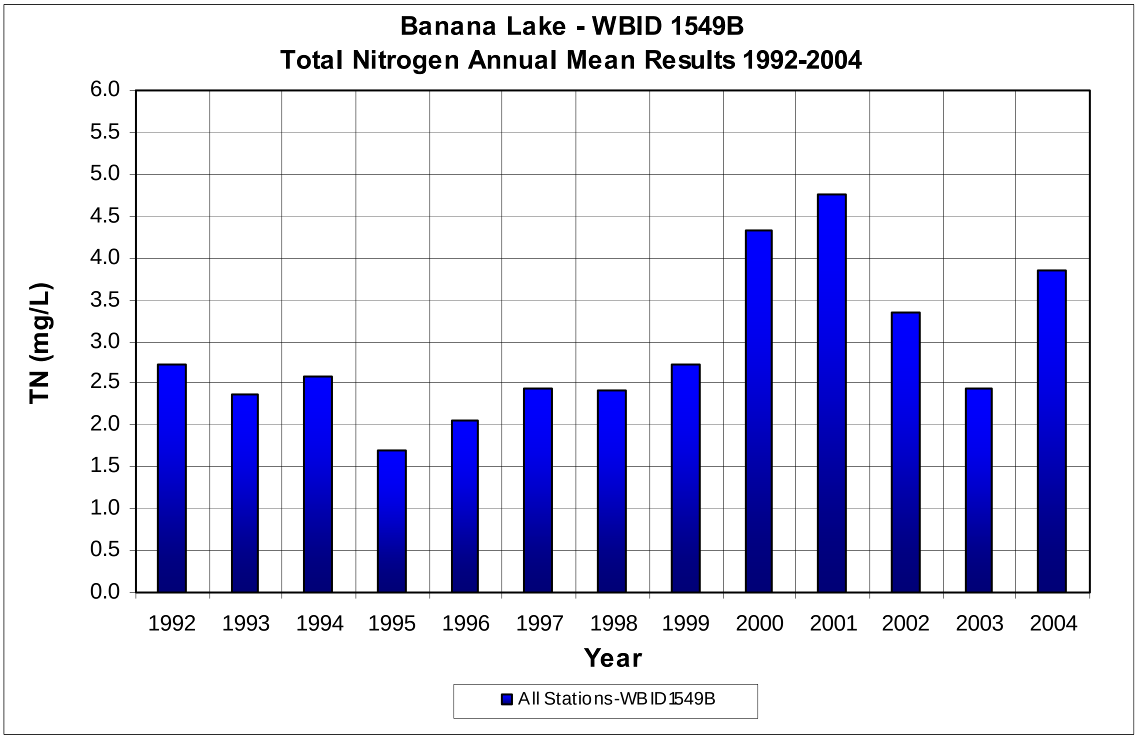


Figure 2.3 Total Nitrogen Annual Mean Results for Banana Lake from 1992 to 2004

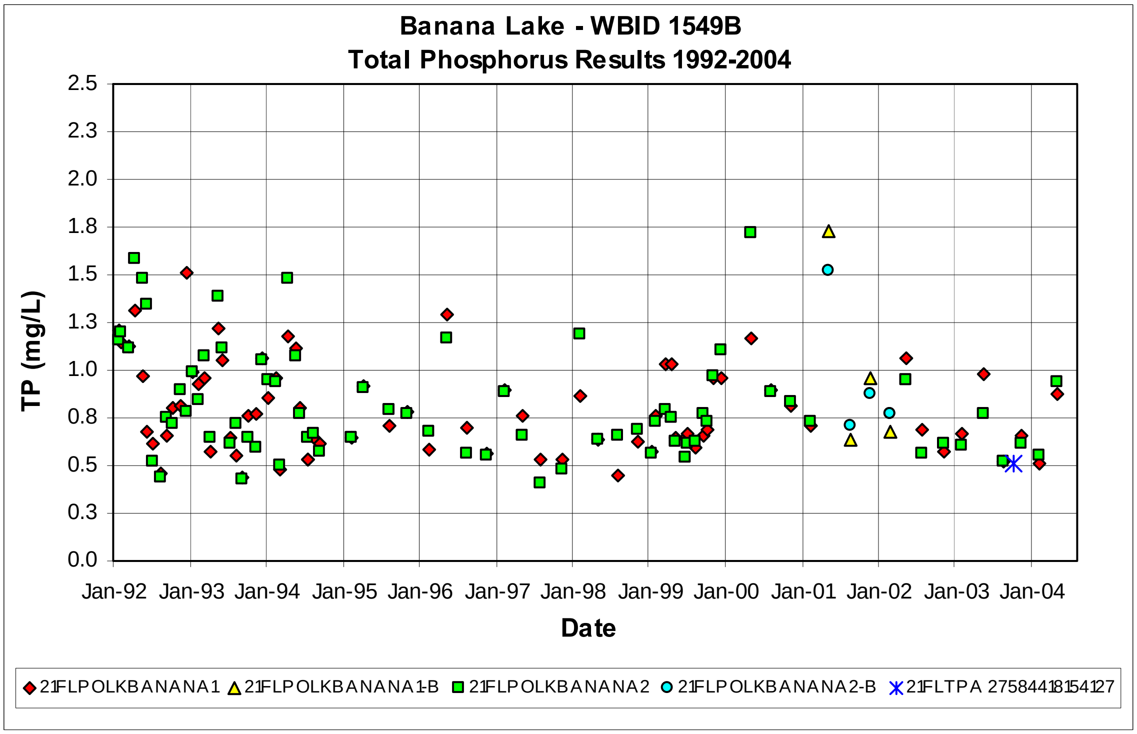


Figure 2.4 Total Phosphorus Monthly Results for Banana Lake from 1992 to 2004

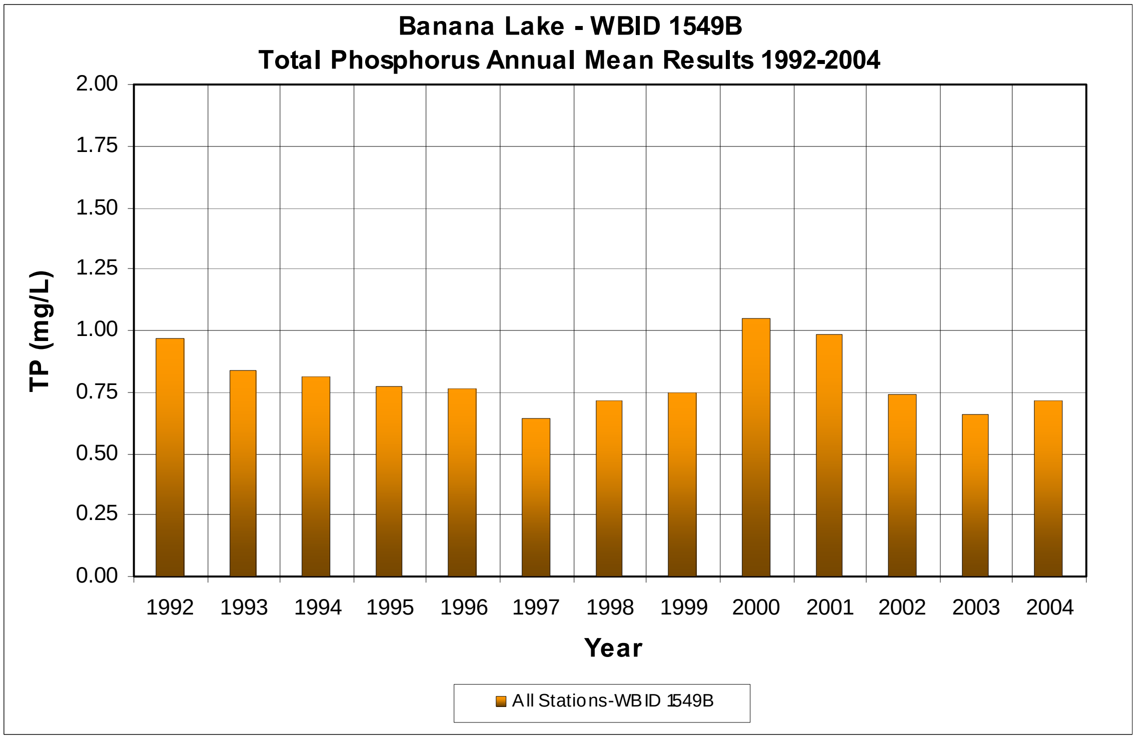


Figure 2.5 Total Phosphorus Annual Mean Results for Banana Lake from 1992 to 2004

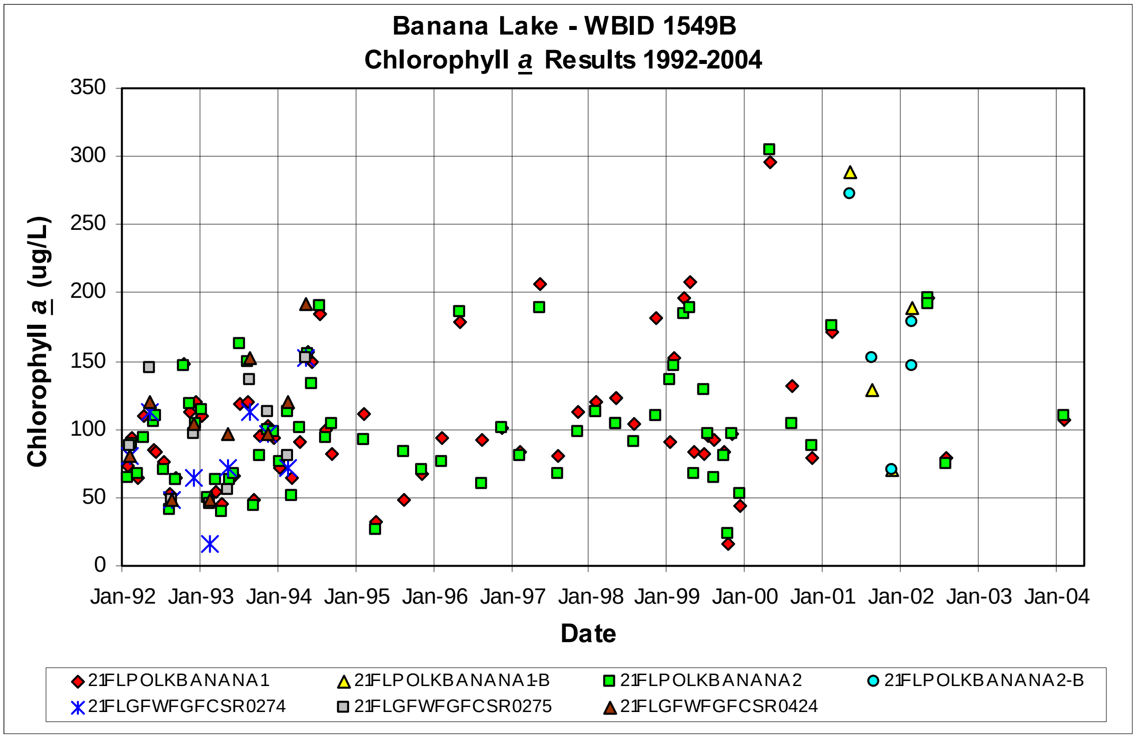


Figure 2.6 Chlorophyll a Monthly Results for Banana Lake from 1992 to 2004

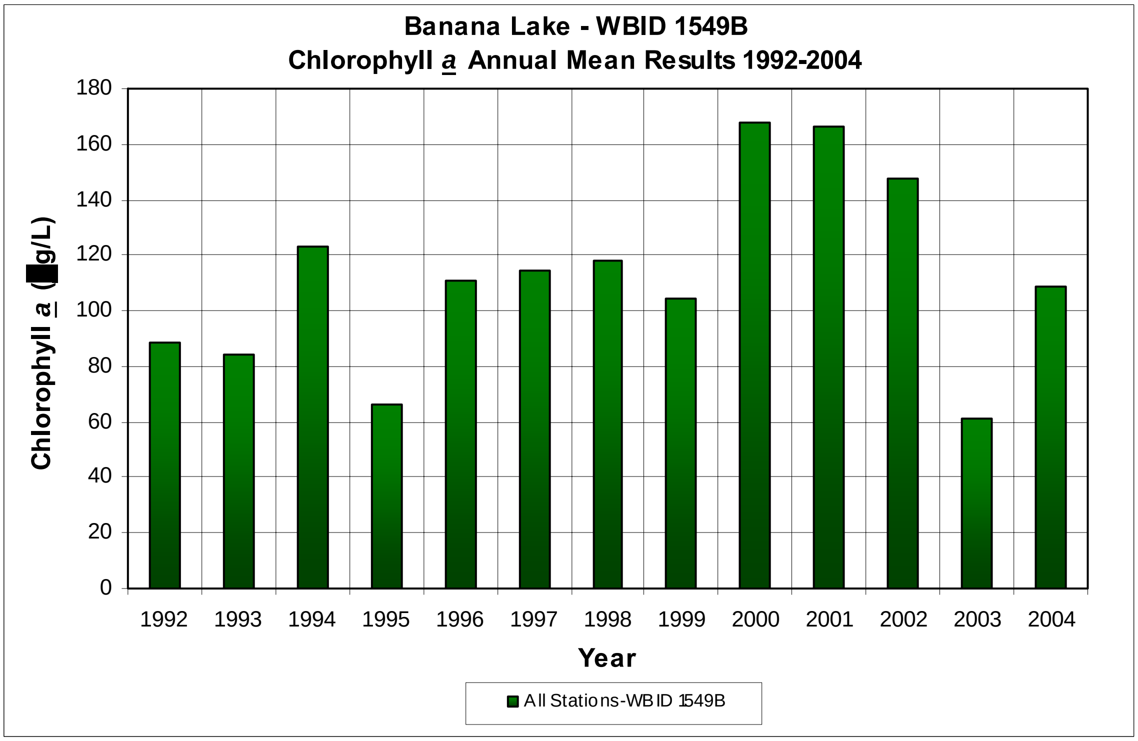


Figure 2.7 Chlorophyll a Annual Mean Results for Banana Lake from 1992 to 2004

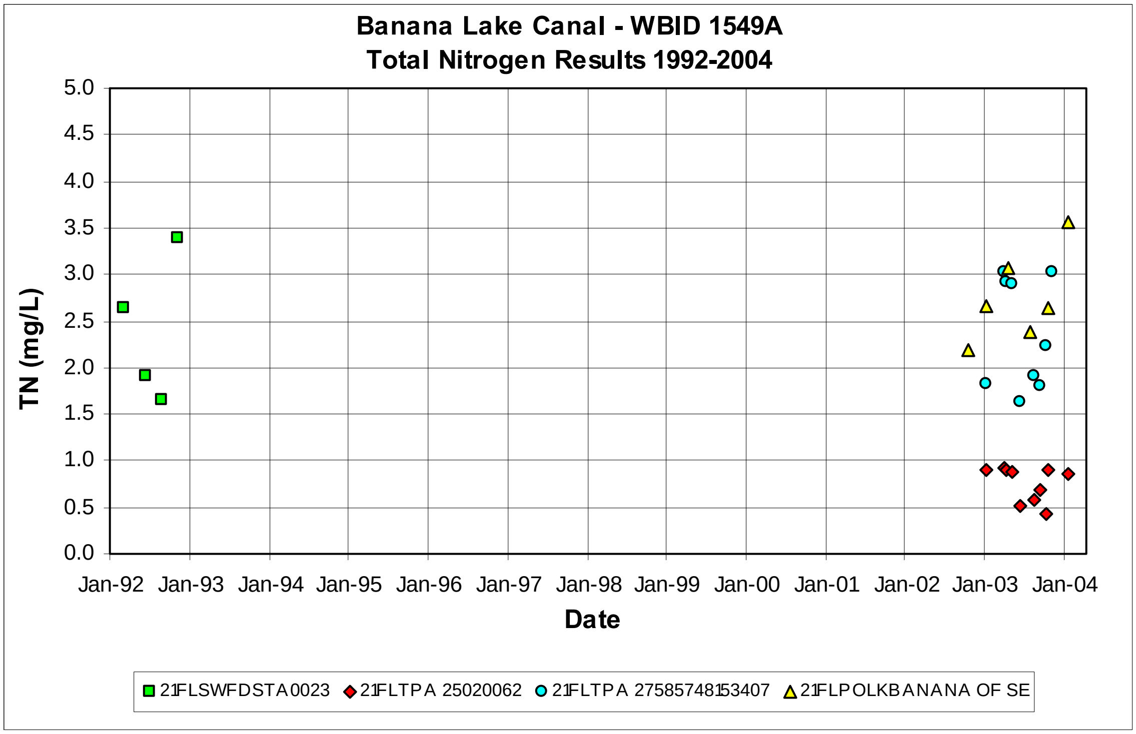


Figure 2.8 Total Nitrogen Monthly Results for Banana Lake Canal from 1992 to 2004

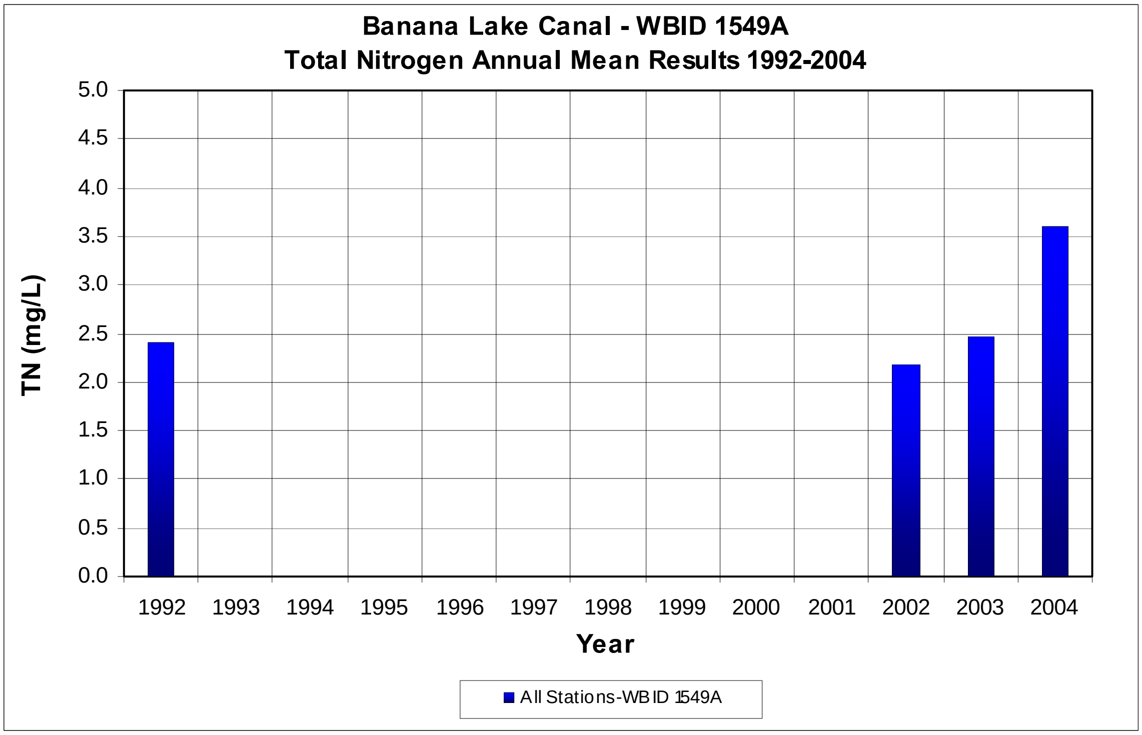


Figure 2.9 Total Nitrogen Annual Mean Results for Banana Lake Canal from 1992 to 2004

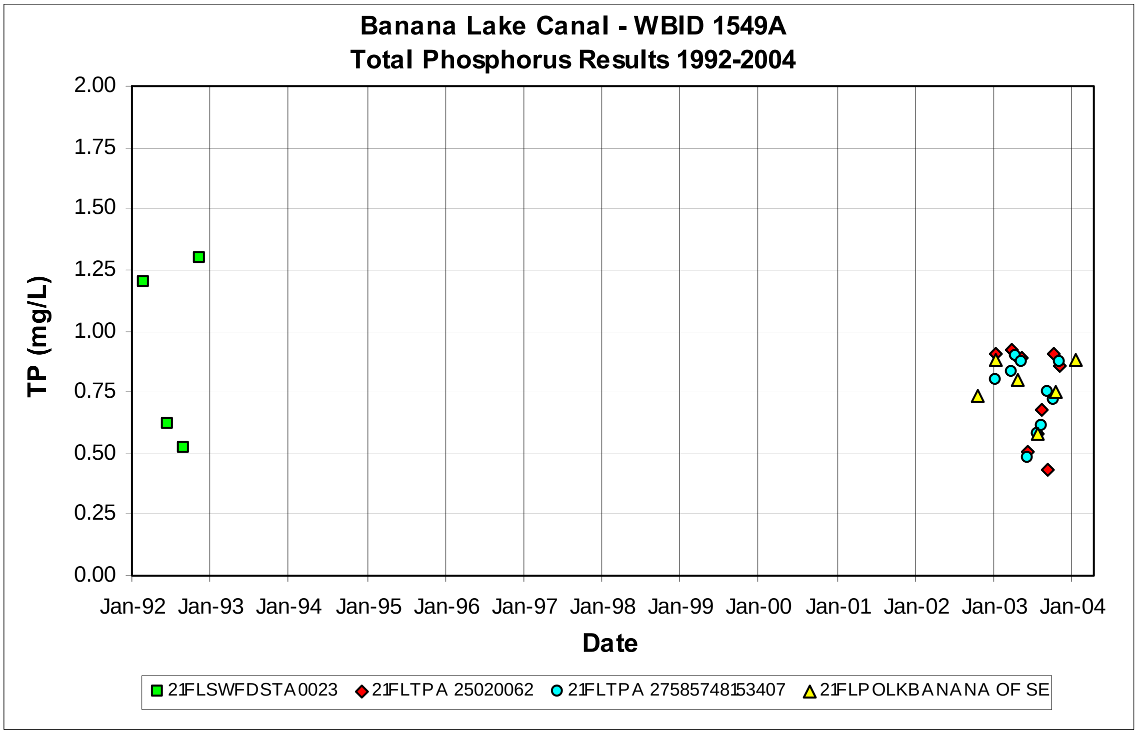


Figure 2.10 Total Phosphorus Monthly Results for Banana Lake Canal from 1992 to 2004

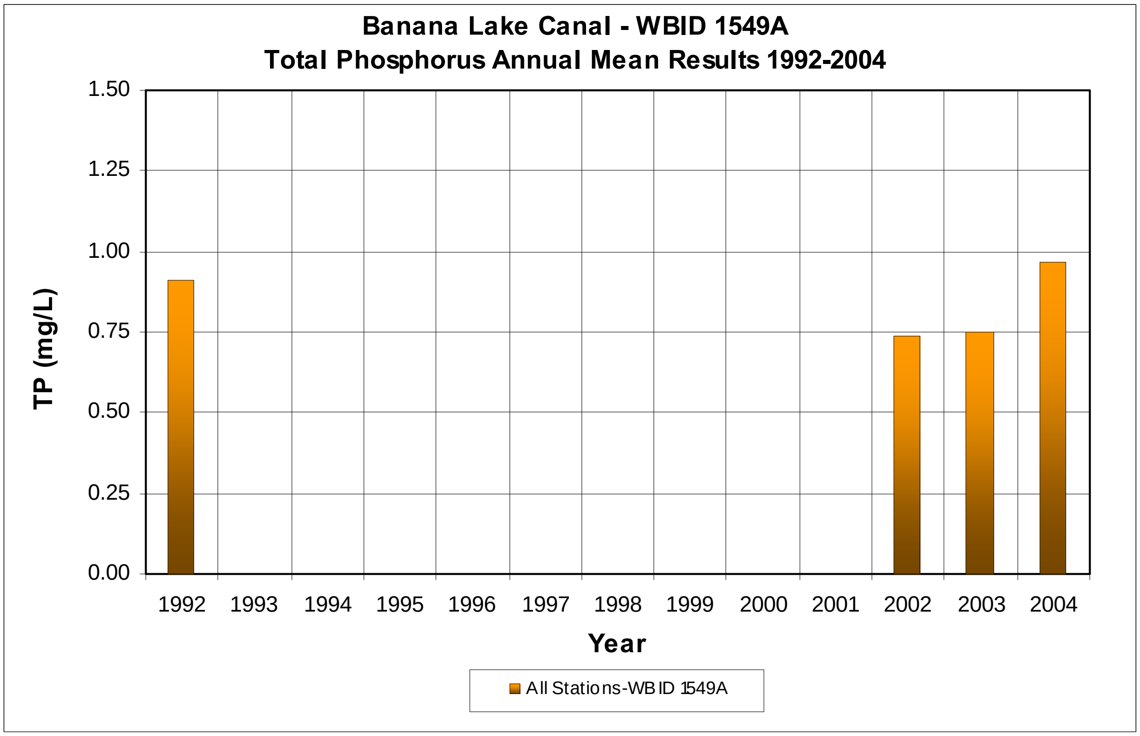


Figure 2.11 Total Phosphorus Annual Mean Results for Banana Lake Canal from 1992 to 2004

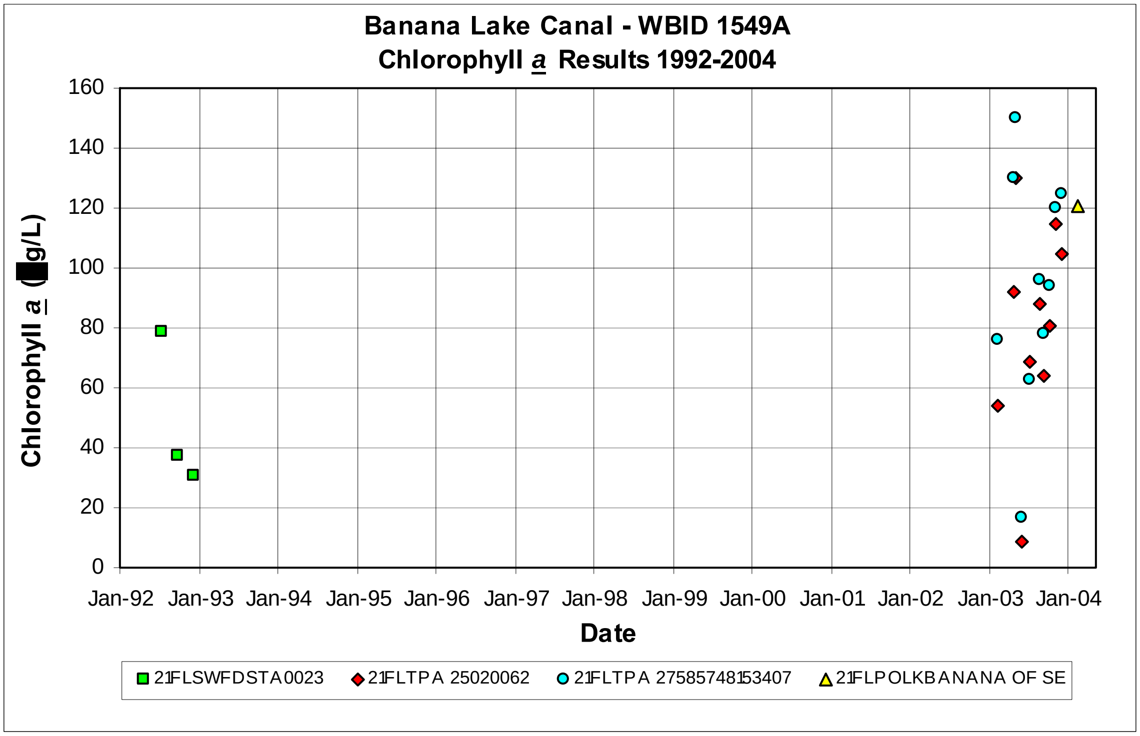


Figure 2.12 Chlorophyll *a* Monthly Results for Banana Lake Canal from 1992 to 2004

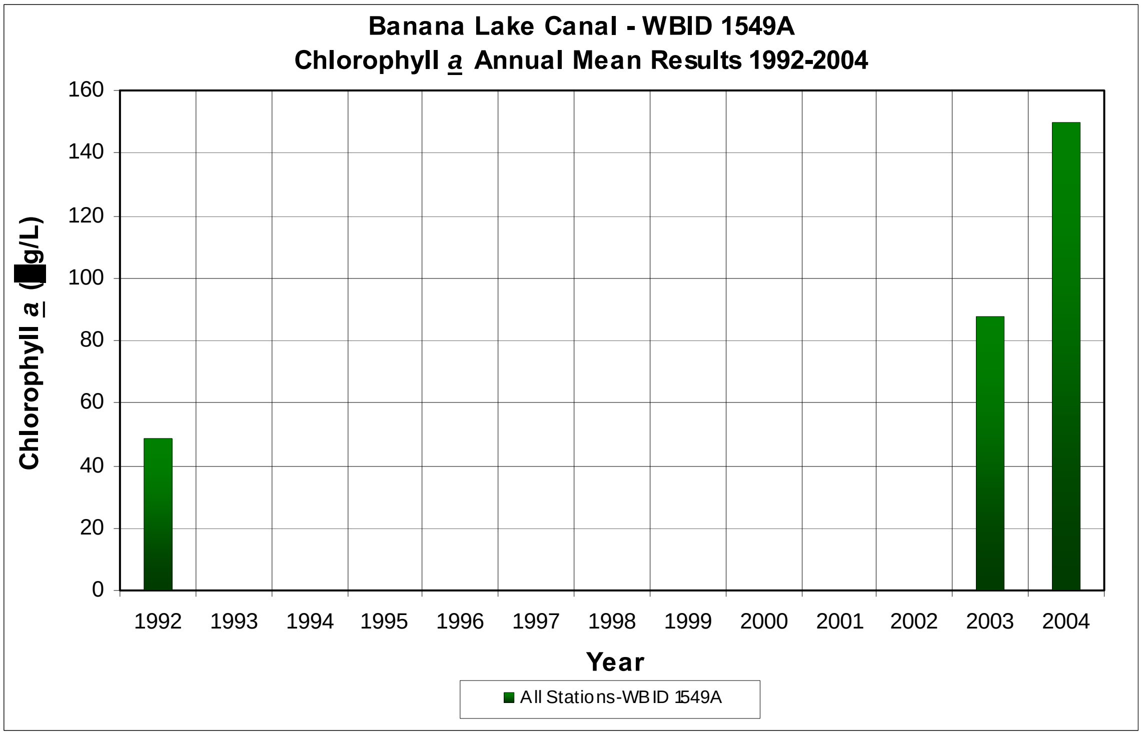


Figure 2.13 Chlorophyll *a* Annual Mean Results for Banana Lake Canal from 1992 to 2004

Table 2.1 provides summary statistics for the lake and canal for TN, TP, and chlorophyll a from 1992 to 2004. Individual water quality measurements for TN, TP, and chlorophyll a used in the assessment for the lake and canal are provided in **Appendix G.**

Table 2.1 Water Quality Summary Statistics for TN, TP, and Chlorophyll a from 1992 to 2004 for Banana Lake (WBID 1549B) and Banana Lake Canal (WBID 1549A)

Waterbody	Water Variable	# of Samples	Minimum	Mean	Median	Maximum
Banana Lake	Total Nitrogen (mg/L)	157	1.15	2.75	2.52	8.78
Banana Lake	Total Phosphorus (mg/L)	160	0.40	0.81	0.76	1.73
Banana Lake	Chlorophyll a (µg/L)	183	16.02	106.65	96.20	304.40
Banana L. Canal	Total Nitrogen (mg/L)	29	1.63	2.52	2.64	3.64
Banana L. Canal.	Total Phosphorus (mg/L)	31	0.43	0.78	0.80	1.3
Banana L. Canal	Chlorophyll a (µg/L)	25	8.50	88.04	88.00	178.90

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)**

Banana Lake and Banana Lake Canal are classified as Class III freshwater waterbodies, 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 impairments for Banana Lake and Banana Lake Canal are 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 and Streams

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. For Banana Lake, the median TN/TP ratio was 3.3 for the verified period, clearly indicating that TN is the limiting nutrient 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 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 for Lakes 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 Banana Lake and Banana Lake Canal TMDLs, 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 in Banana Lake to determine the appropriate nutrient target. The WAM model was used to estimate the natural background nutrient loadings by setting land uses to a mixture of natural land cover. The loadings were then input to the BATHTUB lake model to calculate a natural background TSI value. Once the natural background TSI was determined, an increase of 5 TSI units above natural background was used as the water quality target for the TMDL. The estimated natural background TSI for Banana Lake is 57.8 with a target TMDL TSI of 62.8.

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 (CO_2) and water (H_2O) into carbohydrates and oxygen (O_2). 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 (NH_3 + NH_4^+), and organic nitrogen (NH_2) 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 bioavailable 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.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Overview of Modeling Process

The Banana Lake and Banana Lake Canal sub-basin are 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 WAM refers to a collection of sub-basins or basins that discharge to a single receiving waterbody. The primary basin setup procedure used to model Banana Lake, the canal, 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 Watershed Assessment Model (WAM) and BATHTUB models was intended to determine the loading characteristics of the various sources of pollutants to Banana Lake, Banana Lake Canal, and eventually to Lake Hancock. 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 the canal.

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 Banana Lake and Banana Lake Canal 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 or industrial facilities that discharge nutrient loads into the sub-basin. However, in 1926, the City of Lakeland’s WWTP began to discharge effluent into Stahl Creek/Canal, which flows downstream to Banana Lake. Between January 1975 and April 1987, the plant discharged on average 6.4 mgd. In 1987, discharge was diverted away from Stahl Canal and Banana Lake.

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 Transportation (FDOT), are covered by a NPDES Phase I MS4 permit. The Banana Lake and Banana Lake Canal sub-basin is located within the Lake Hancock watershed. The Lake Hancock watershed is situated between the cities of Lakeland, Winterhaven, Auburndale, and Bartow. The City of Lakeland has areas in it’s jurisdiction located within the Banana Lake watershed. Note, that a portion of Banana Lake and Banana Lake Canal proper is not located within the MS4 permit area. At this time, it is unknown if any local governments in the Banana Lake and the Banana Lake Canal 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 projects in the Banana Lake and Banana Lake Canal sub-basin include lakes Hollingsworth, John, and Morton.

4.2.2 Nonpoint Sources and Land Use

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 Banana Lake and Banana Lake Canal TMDLs, 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 Banana Lake and Banana Lake Canal sub-basin. **Figure 4.1** shows the drainage basin of the lake and canal, and the spatial distribution of the land uses is shown in **Table 4.1.**

The predominant land coverages in the Banana Lake and Banana Lake Canal sub-basin include low, medium, and high density residential (36.2%), followed by extractive post phosphorus mining (15.9%), and commercial, industrial, and transportation (11.9%). These coverages account for 64 percent of the land use in the sub-basin. The lake, canal, and interconnected waterways/streams/wetlands etc. account for 12.5 percent of the sub-basin. The areas occupied by anthropogenic land uses account for 74.4 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, Inc. (2005). 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 discharges into Class I or Class II waters, or Outstanding Florida Waters.

The stormwater collection systems in the Banana Lake and Banana Lake Canal sub-basin, which are owned and operated by Polk County in conjunction with the Florida Department of

Table 4.1 Banana Lake and Banana Lake Canal Sub-basin Existing Land Use Description

FLUCCS ID	Banana Lake and Banana Lake Canal Sub-basin Existing Land Use Coverage	Acres	Sq Miles	Percent
1200	Medium Density Residential, Fixed Single Family Units	4,094.5	6.398	29.70%
1600	Extractive-Phosphorus Mining	2,204.2	3.444	15.99%
2100	Pastures and Fields	1,203.4	1.880	8.73%
5201	Interconnected Lakes	963.7	1.506	6.99%
1400	Commercial and Services	906.9	1.417	6.58%
2210	Citrus Groves	711.7	1.112	5.16%
1300	High Density Residential, Fixed Single Family Units	533.7	0.834	3.87%
1800	Recreation	395.4	0.618	2.87%
6150	Stream and Lake Swamps (Bottomland)	380.5	0.595	2.76%
1100	Low Density Residential, Fixed Single Family Units	365.7	0.571	2.65%
1500	Industrial	358.3	0.560	2.60%
8100	Transportation	345.9	0.541	2.51%
1700	Educational Facilities	279.2	0.436	2.03%
5300	Reservoirs	200.2	0.313	1.45%
4340	Hardwood - Conifer Mixed	190.3	0.297	1.38%
1900	Undeveloped Land	170.5	0.266	1.24%
6410	Freshwater Marshes	116.1	0.181	0.84%
4200	Upland Hardwood Forest	106.3	0.166	0.77%
2600	Old Field	71.7	0.112	0.52%
8300	Utilities	66.7	0.104	0.48%
6430	Wet Prairies	49.4	0.077	0.36%
6440	Emergent Aquatic Vegetation	32.1	0.050	0.23%
5200	Lakes	19.8	0.031	0.14%
2410	Tree Nurseries	17.3	0.027	0.13%
6300	Wetland Forested Mixed	4.9	0.008	0.04%
Sum		**13,788.4**	**21.5**	**100%**

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

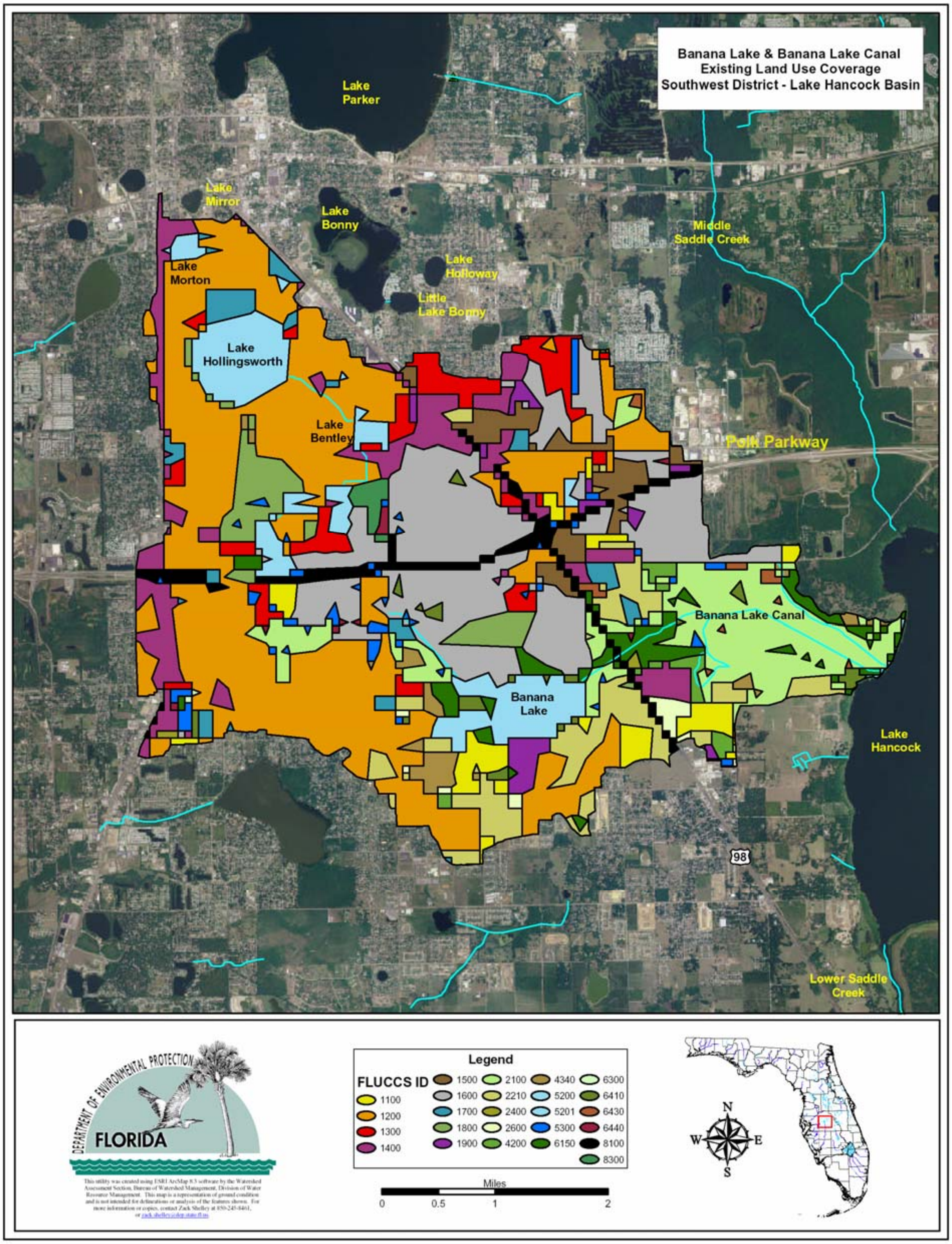


Figure 4.1 **Banana Lake and Banana Lake Canal Sub-basin Existing Land Use Coverage**

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 Banana Lake and Banana Lake Canal 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 Banana Lake 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).

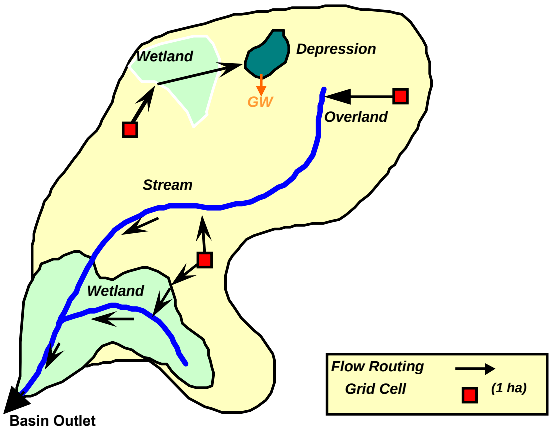


Figure 4.2 WAM Conceptual Routing Diagram (SWET, 2005)

A portion of the flow in each cell is converted to ground water based on the soil type and the 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.

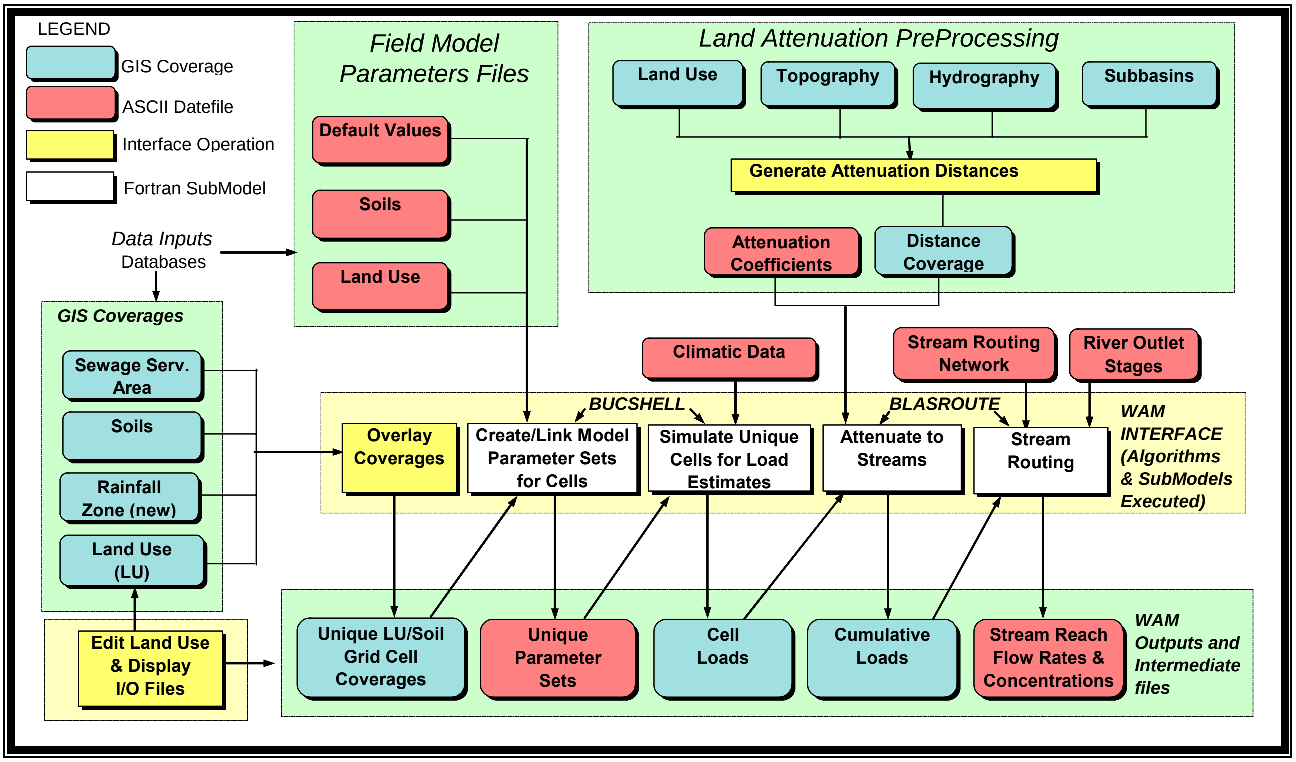


Figure 4.3 Dynamic Modeling Approach (SWET, 2005)

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 Banana Lake 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 (QEA, LLC, 2005).

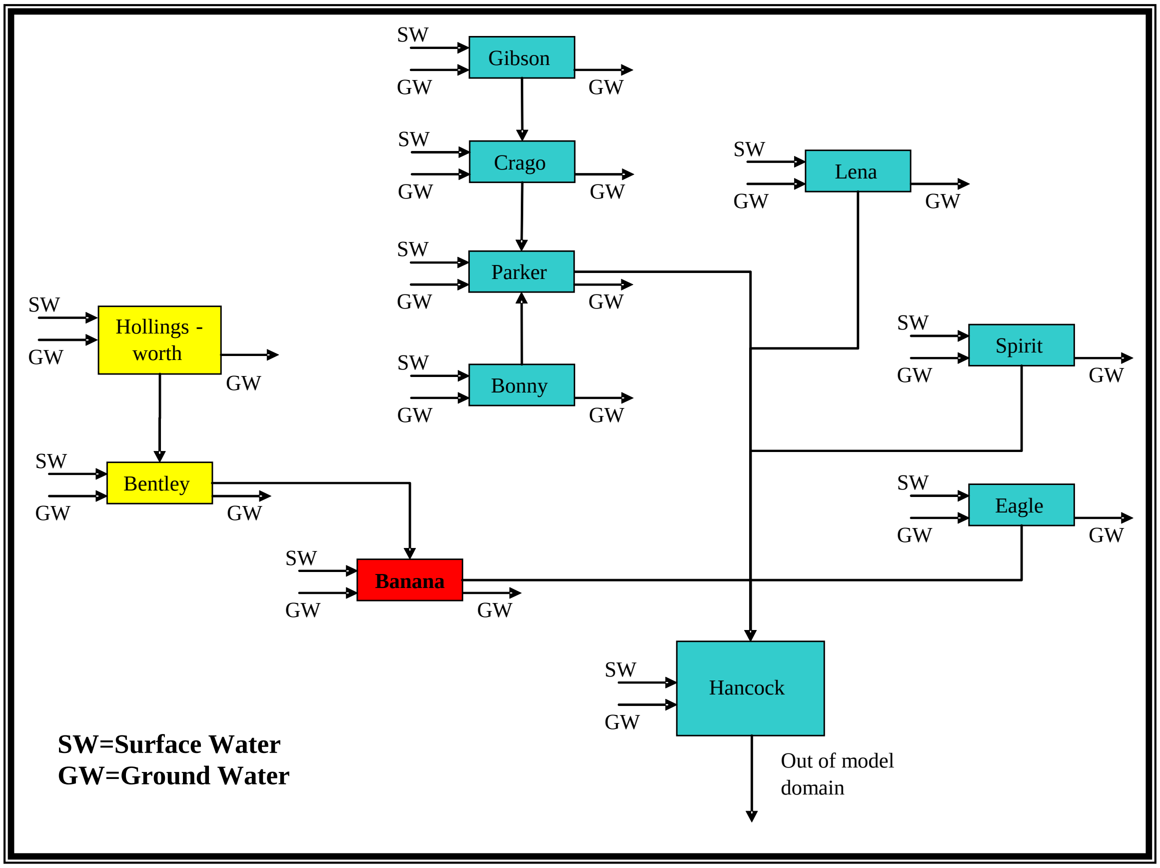


Figure 4.4 Model Schematic Depicting the Interconnected Eleven Lakes Modeled for the Lake Hancock Watershed (QEA, 2005)

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.

The 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 rainzones could be represented. Therefore, BATHTUB inputs show no rainfall. BATHTUB has been set up to simulate Banana Lake and its upstream lakes and 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).

Banana Lake Existing Land Use Loadings

The total loadings of nitrogen and phosphorus for Banana Lake 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 canal 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.

All of these lakes are impaired for nutrients based on the Department's Impaired Waters Rule (IWR) 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 Banana Lake from 1994 to 2003 based on the WAM and BATHTUB model results under current/existing land use conditions. 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 Banana Lake Existing Land Use Water Volume and Loadings for TN and TP from 1994 to 2003

Banana Lake Loadings					
Year	**Water** (hm^3)	**TN** (kg)	**TN** (lbs)	**TP** (kg)	**TP** (lbs)
1994	11.757	19,178.615	42,281.615	1,846.296	4,070.387
1995	13.054	21,642.245	47,712.992	2,048.170	4,515.443
1996	9.040	13,498.432	29,758.953	1,459.635	3,217.945
1997	16.814	29,160.410	64,287.710	3,015.341	6,647.690
1998	14.421	17,896.841	39,455.787	2,342.609	5,164.570
1999	7.476	12,011.806	26,481.505	1,261.537	2,781.213
2000	5.755	12,030.551	26,522.829	1,003.382	2,212.080
2001	8.418	16,435.450	36,233.970	1,553.886	3,425.732
2002	15.485	25,754.704	56,779.412	2,566.756	5,658.729
2003	14.532	19,000.511	41,888.963	2,247.636	4,955.189
94-03 Mean	11.7	18,661.0	41,140.4	1,934.5	4,264.9
94-03 Totals	116.8	186,609.6	411,403.7	19,345.2	42,649.0

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 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.

5.1.2Model Calibration

Watershed Assessment Model (WAM)

WAM was calibrated by consultants to conditions for 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 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 (IL) rate integrates all 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 Banana Lake 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 Banana Lake. The figures for measured, un-calibrated, and calibrated data for Lakes Hollingsworth and Bentley are displayed in **Appendix B**.

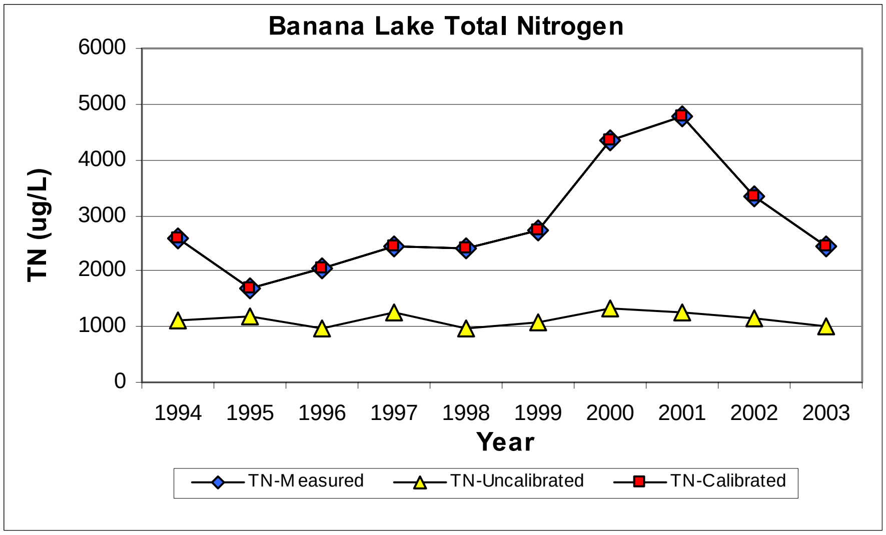


Figure 5.1 Banana Lake Total Nitrogen Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

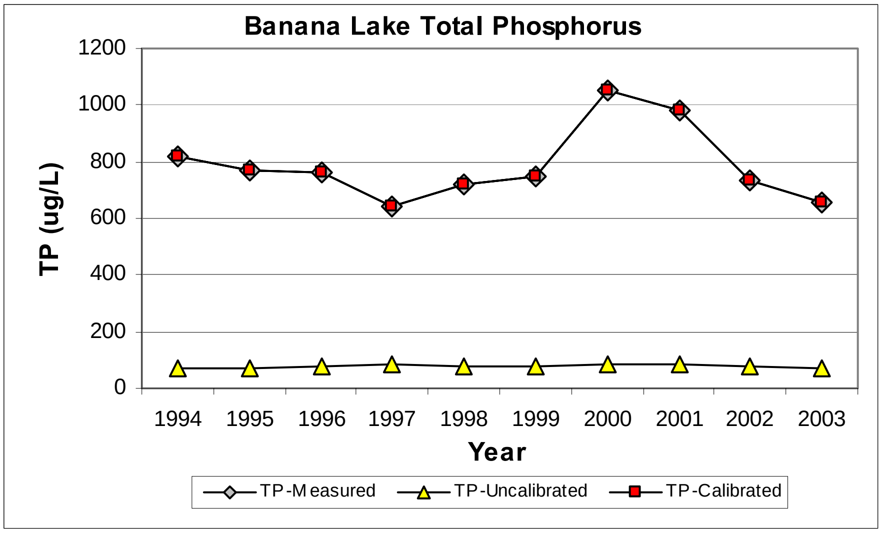


Figure 5.2 Banana Lake Total Phosphorus Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

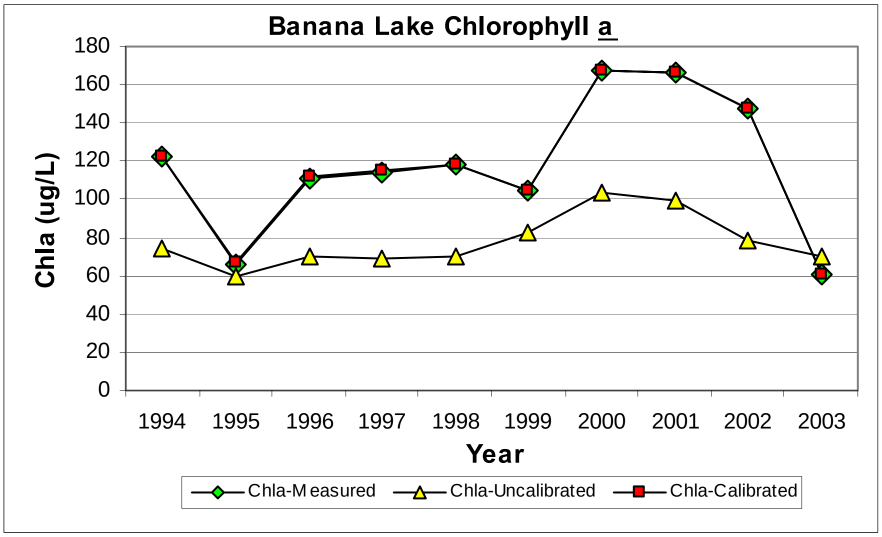


Figure 5.3 Banana Lake Chlorophyll a Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003

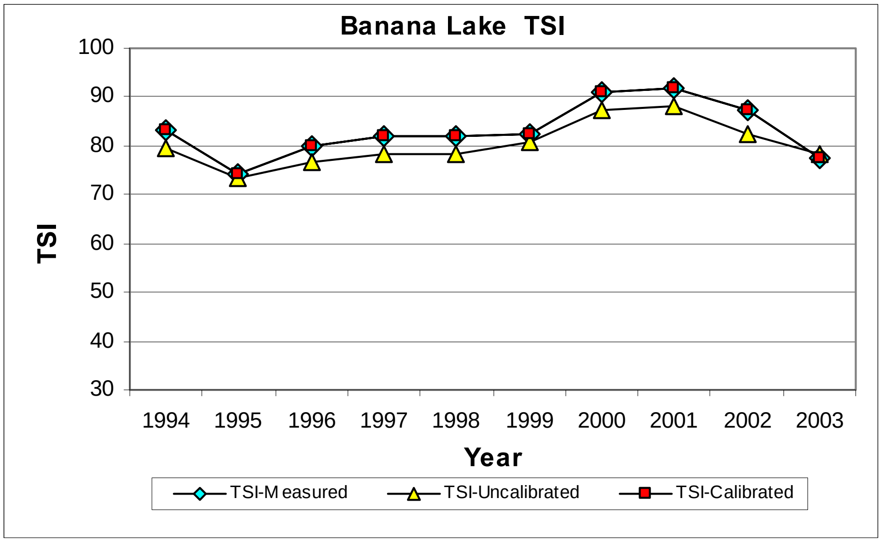


Figure 5.4 **Banana Lake TSI Measured, Un-Calibrated, and Calibrated Data from 1994 to 2003**

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 Banana Lake. 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 m 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 land use’ dry conditions the lakes would have a trophic state similar to that of 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 worse 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 the background runs for Lakes Hollingsworth, Bentley, and Banana, 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 57.8 units. 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. This raises the target TSI for Banana Lake to 62.8 (57.8 + 5 TSI units).

In order to complete the TMDL for Banana Lake and Banana Lake Canal, load reductions had to be proposed for Lake Hollingsworth as it discharges into Lake Bentley, which flows into Banana Lake. In addition, water quality in Banana Lake Canal is directly influenced by the water quality in Banana Lake. As a result of this direct influence, it is anticipated that achieving the TMDL for the Lake will result in achieving water quality standards in Banana Lake Canal.

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 62.8. The range in TSI TMDL targets was between 52.9 and 78.9. Once the target TSI was established (a TSI of 62.8), BATHTUB was rerun with decreasing loads until the target TSI was met. The required annual average percent reduction for TN coming into Banana Lake was 79.4 percent with an allowable long-term annual average loading of 15,744.6 kg/year (34,716.8 lbs/year). The required annual average percent reduction for TP coming into the lake was 79.5 with an allowable long-term annual average loading of 25,627.9 kg/year (56,509.5 lbs/year).

The annual percent reductions for TN ranged between 36.4 and 89.7 and between 34.0 and 90.3 for TP. These reductions correspond to a range in loadings of 6,283.2 kg/year (13,852.1 lbs/year) to 50,039.7 kg/year (110,318.7 lbs/year) for TN and between 8672.1 kg/year (19,118.7 lbs/year) to 93,190.9 kg/year (205,450.8 lbs/year) for TP. Maintaining the long-term annual average loadings for TN and TP established in this TMDL should result in attaining the target long-term annual average TSI of 62.8 (the model TMDL target is 62.8).

For Lake Hollingsworth for the years 1994, 1995, 1997, 1998, 1999, 2000, 2002, and 2003, as the TP and TN concentrations were reduced by equal percentages, the TP input concentrations approached the background concentrations before the target TMDL was achieved. As a result, for these years, reductions in the TP concentration was stopped before the concentration fell below background. Reductions in the TN concentration continued until the target TMDL was achieved. Additionally, for the year 2000, as a TSI of background plus 5 was greater than the existing condition, the TMDL target was set at half the difference between the background TSI and the current condition TSI.

For Lake Bentley (as noted with Hollingsworth) for the years 1994, 1995, and 2002, as the TP and TN concentrations were reduced by equal percentages, the TP input concentrations approached the background concentrations before the target TMDL was achieved. As a result, for these years, reductions in the TP concentration was stopped before the concentration fell below background. Reductions in the TN concentrations continued until the target TMDL was achieved.

Table 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 Banana Lake**.** The TSI for the calibrated model (PC), the background model (IL75), the TMDL Target TSI, TMDL-TSI, and the percent reduction for Lakes Hollingsworth and Bentley are displayed in **Appendix D**. **Table 5.3** shows the mass for TN and TP for the calibrated model, TMDL, and percent reductions for Banana Lake. The mass for TN and TP for Lakes Hollingsworth and Bentley are displayed in **Appendix E**. **Table 5.4** shows the annual average concentrations for TN, TP, and chlorophyll a for Banana Lake. Annual average concentrations for Lakes Hollingsworth and Bentley are displayed in **Appendix F**. **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 Banana Lake. The TMDL target, calibrated data, and L50-IL75 for Lakes Hollingsworth and Bentley are displayed in **Appendix C**.

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

Banana Lake TSI for Measured, PC, Background, TMDL Target, TMDL, and TSI-unit Percent Reduction Based on Background L50-IL75							
Year	Color (PCU)	Measured	Calibrated	Background IL75	Target IL75+5	TMDL	Percent Reduction
1994	34.23	83	83	73.9	78.9	78.9	34
1995	48.93	74.1	74.2	57.5	62.5	62.3	60.5
1996	39.64	79.9	80	57.4	62.4	62.3	80.3
1997	35.71	81.9	81.9	48.4	53.4	53.5	89.1
1998	52.62	82	82	51.2	56.2	56.2	87.7
1999	33.5	82.4	82.4	53.3	58.3	58.3	88.5
2000		90.8	90.8	66.2	71.2	71.2	88.7
2001		91.8	91.8	66.1	71.1	71.1	89.9
2002	42	87.2	87.2	56.3	61.3	61.2	90.4
2003	50	77.4	77.3	47.8	52.8	52.9	86.8
Minimum	33.5	74.1	74.2	47.8	52.8	52.9	34
Maximum	52.6	91.8	91.8	73.9	78.9	78.9	90.4
Mean	42.1	83.1	83.1	57.8	62.8	62.8	79.6

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

Banana Lake 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	78,712.1	50,039.7	36.4	141,282.7	93,190.9	34.0
1995	45,448.0	17,227.0	62.1	135,638.2	53,593.0	60.5
1996	42,615.2	9,373.2	78.0	97,385.7	19,276.7	80.2
1997	94,168.5	11,160.9	88.1	111,217.9	12,286.5	89.0
1998	81,718.7	10,616.6	87.0	125,292.0	15,516.4	87.6
1999	53,454.0	6,283.2	88.2	75,148.4	8,672.1	88.5
2000	88,872.9	10,175.7	88.6	104,952.1	11,886.2	88.7
2001	152,977.7	15,734.1	89.7	139,287.0	14,120.9	89.9
2002	147,416.3	15,170.1	89.7	139,618.9	13,504.6	90.3
2003	83,547.1	11,665.8	86.0	106,314.2	14,231.5	86.6
Minimum	42,615.2	6,283.2	36.4	75,148.4	8,672.1	34.0
Maximum	152,977.7	50,039.7	89.7	141,282.7	93,190.9	90.3
Mean	86,893.0	15,744.6	79.4	117,613.7	25,627.9	79.5

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

Banana Lake Annual Average Concentrations for TN, TP, and Chlorophyll a (µg/L)												
Year	Measured TN	Calibrated TN	TMDL TN	Background TN	Measured TP	Calibrated TP	TMDL TP	Background TP	Measured Chl a	Calibrated Chl a	TMDL Chl a	Background Chl a
1994	2585	2584.8	1928	1443.3	816.6	816.9	657.6	189.9	122.8	122.7	106.7	82.8
1995	1702.5	1703.8	841.4	660.6	770.9	770.6	472.4	158.6	66.3	66.7	37	27
1996	2065	2065.2	726.1	570.6	762.4	762.6	324.7	187.2	111.1	111.8	45.7	33.4
1997	2433.8	2433.3	476.6	385.9	643.4	643.1	189.5	115.5	114.6	114.7	25.1	17.1
1998	2411.3	2410.2	534.6	430.9	717.3	717.1	231.3	127.2	118.2	118.2	30.8	21.3
1999	2719.3	2719.7	645.3	512.9	751.4	751.3	238.8	152.5	104.2	104.6	31.2	22.2
2000	4334.5	4333.9	1149.5	870.9	1051.2	1051	337.5	269.8	167.5	167.3	78.9	60.2
2001	4762.5	4761.6	1147	864.5	983	984.2	294.8	219.5	166.4	165.9	78.4	60.1
2002	3355.8	3354.9	656.8	519.7	736	736.7	205.2	144	147.5	147.4	45.6	32.6
2003	2438	2438.4	574.8	457.8	657.5	657	219.8	125.2	61	60.7	17.5	12.1
Minimum	1702.5	1703.8	476.6	385.9	643.4	643.1	189.5	115.5	61	60.7	17.5	12.1
Maximum	4762.5	4761.6	1928	1443.3	1051.2	1051	657.6	269.8	167.5	167.3	106.7	82.8
Mean	2880.8	2880.6	868	671.7	789	789.1	317.1	168.9	118	118	49.7	36.9

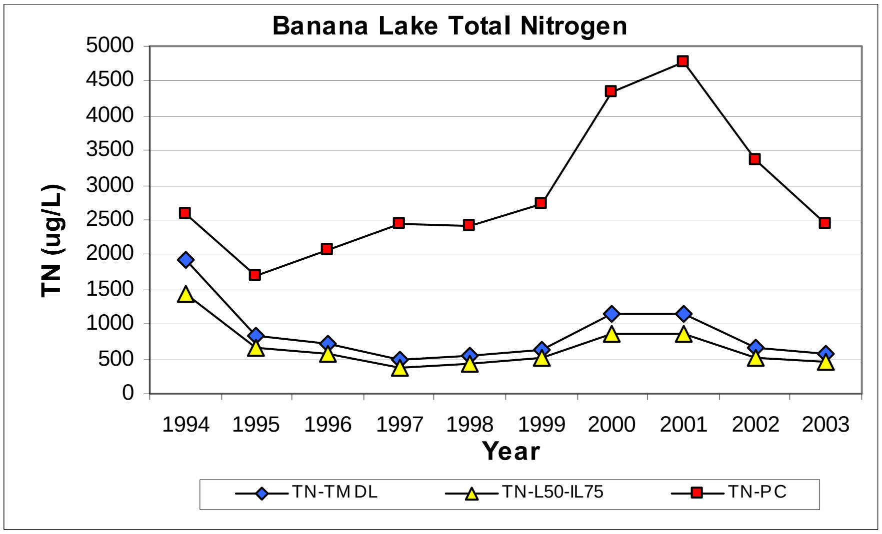


Figure 5.5 Banana Lake Total Nitrogen Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

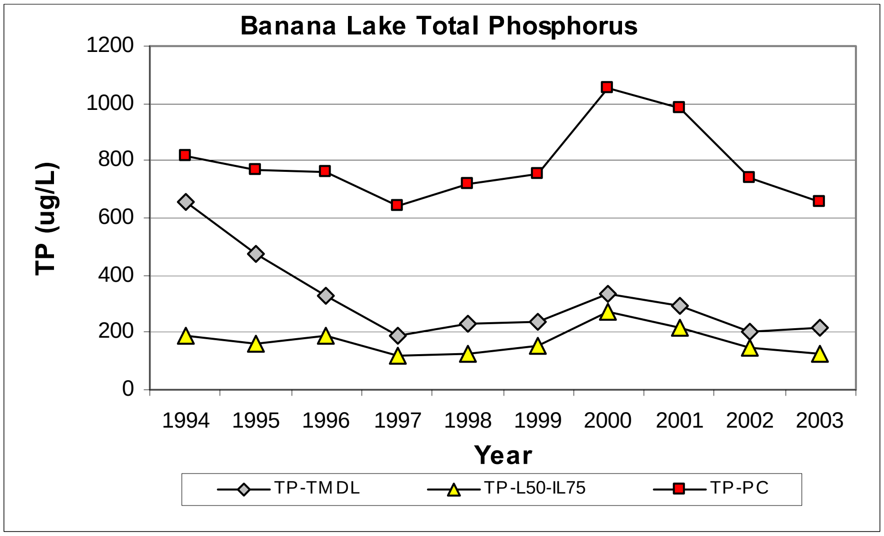


Figure 5.6 Banana Lake Total Phosphorus Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

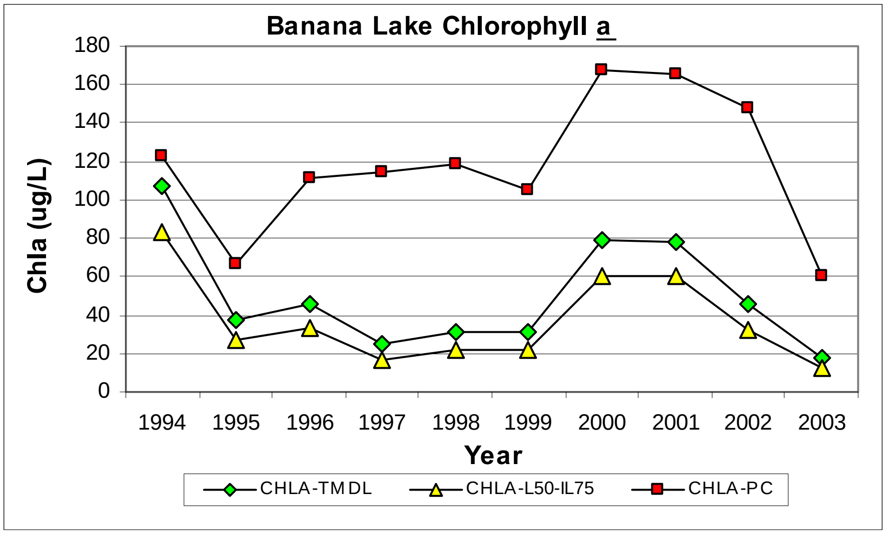


Figure 5.7 Banana Lake Chlorophyll *a* Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

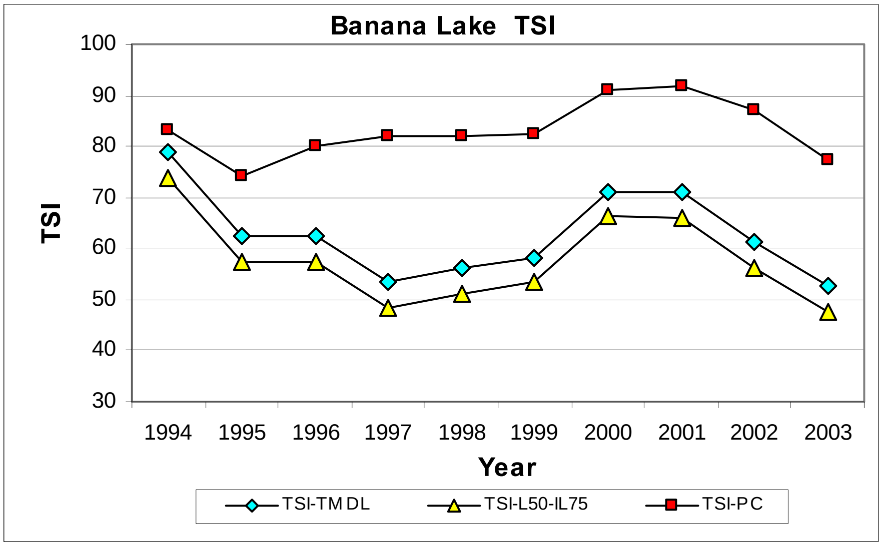


Figure 5.8 Banana Lake TSI Target TMDL, L50-IL75, and Background Calibration from 1994 to 2003

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 Banana Lake 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 Banana Lake can assimilate and maintain the Class III narrative nutrient criterion (see **Table 6.1**).

Table 6.1 Banana Lake TMDL Load Allocations

WBID	Parameter	WLA		LA (lbs/year)	MOS	TMDL (lbs/year)	Percent Reduction
		Wastewater (lbs/year)	Stormwater (% reduction)				
1549B	TN	NA	79.4	34,717	Implicit	34,717	79.4
1549B	TP	NA	79.5	56,510	Implicit	56,510	79.5

6.2 Load Allocation (LA)

The required long-term annual average allowable LA is 34,717 lbs/year for TN and 56,510 lbs/year for TP. This corresponds to reductions from the existing loadings of 79.4 percent for TN and 79.5 percent for TP. Maintaining the long-term annual average loadings for TN and TP established as this TMDL should result in attaining the target lake annual average TSI of 62.8 and maintain water quality standards in the canal. 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 or industrial NPDES facilities that discharge directly to Banana Lake, Banana Lake Canal, or their watersheds. As a result, the $WLA_{wastewater}$ for the Banana Lake and Banana Lake Canal TMDL is not applicable.

NPDES Stormwater Discharges

The wasteload allocation for stormwater discharges is a 79.4 percent reduction in loading for TN and 79.5 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 Banana Lake and Banana Lake Canal 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 determining the assimilative capacity (i.e., loading and water quality response) for the lake.

6.5 Banana Lake Canal

Because Banana Lake Canal serves mainly as a conveyance system connecting Banana Lake with Lake Hancock, loadings to the canal from Banana Lake are believed to be the primary cause of the impairments to the canal. The canal is expected to attain water quality standards following implementation of the Banana Lake TMDL because the lake TMDL will require a 79.4 percent reduction in TN and a 79.5 percent reduction in TP loadings (see **Table 6.1**).

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 the Banana Lake and Banana Lake Canal 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 (B-MAP) 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.

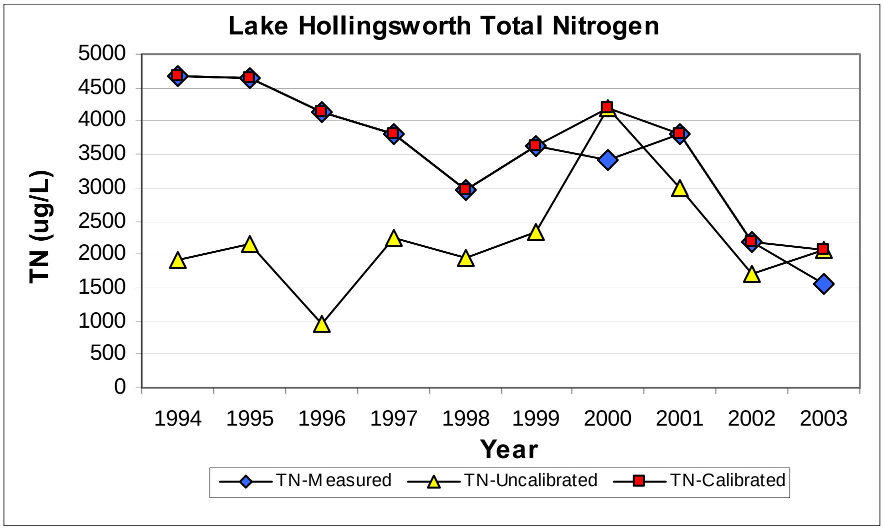
The rule requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a SWIM plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs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

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.

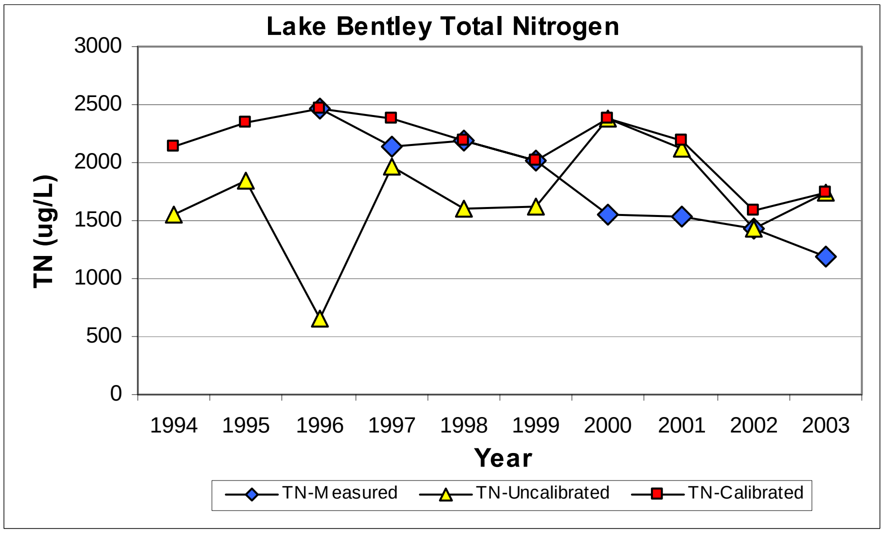
An important difference between the NPDES and other state stormwater permitting programs is that the NPDES program covers both new and existing discharges, while the other state programs focus on new discharges. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these 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 Hollingsworth and Bentley TN, TP, Chlorophyll a, and TSI Measured, Un-Calibrated, and Calibrated Data for the TMDL Modeling Period 1994 to 2003

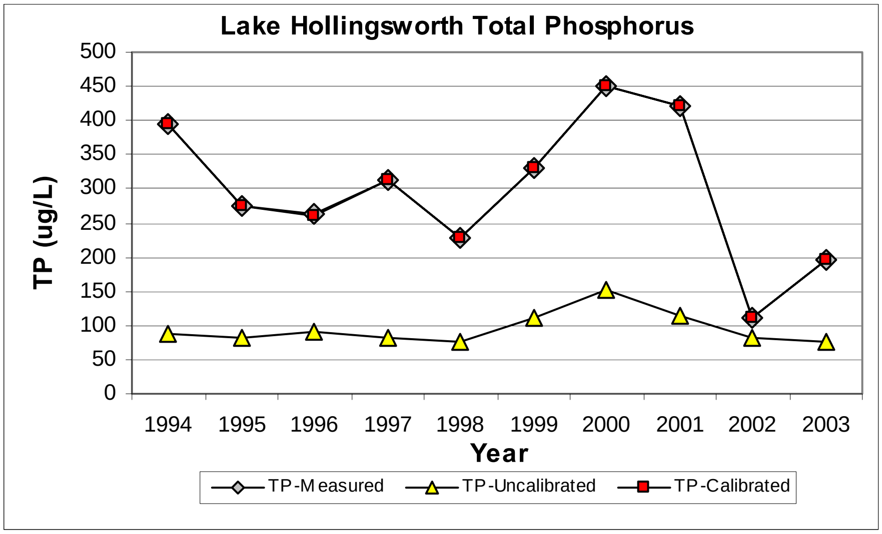
Lake Hollingsworth TN



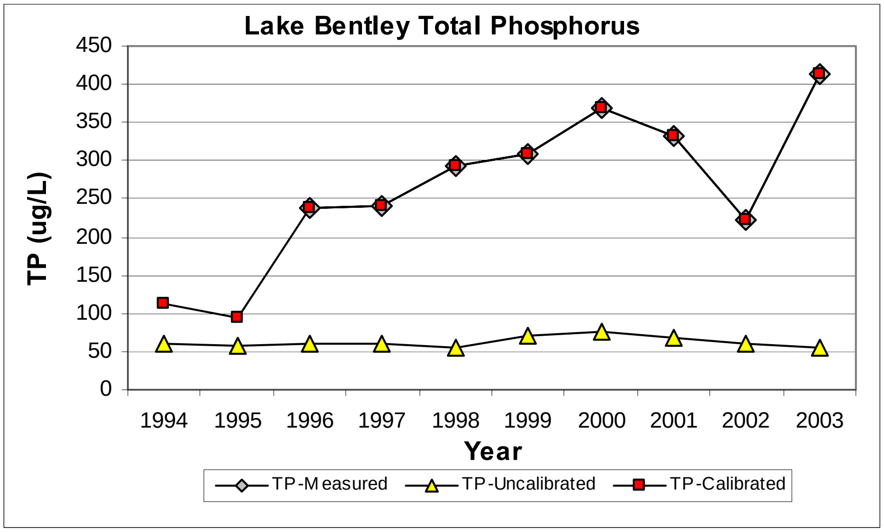
Lake Bentley TN



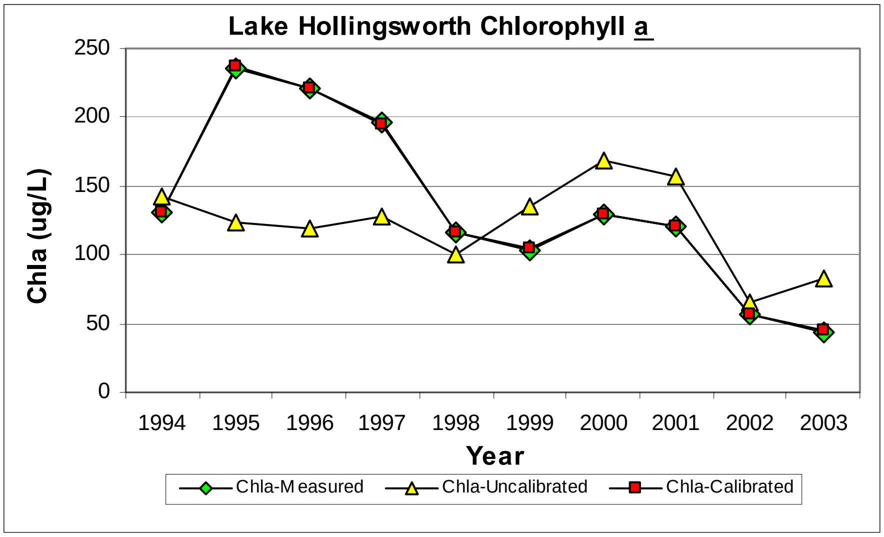
Lake Hollingsworth TP



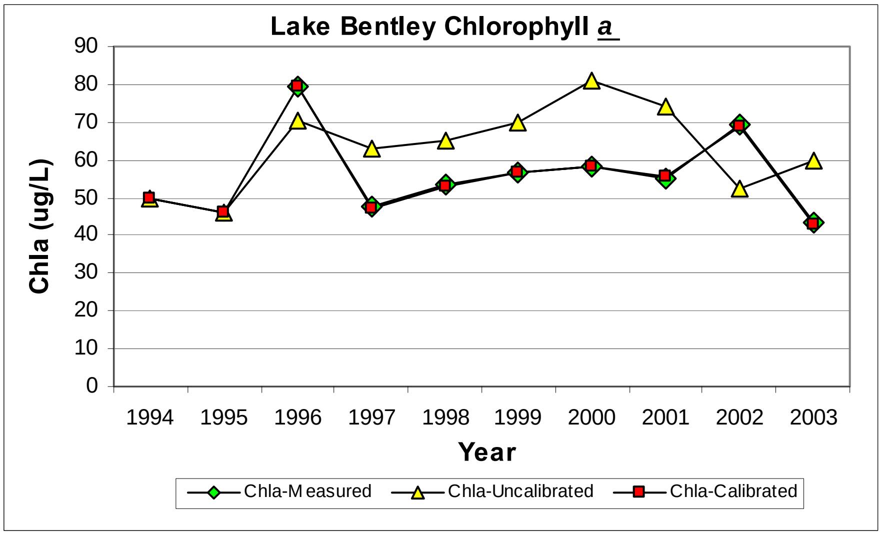
Lake Bentley TP



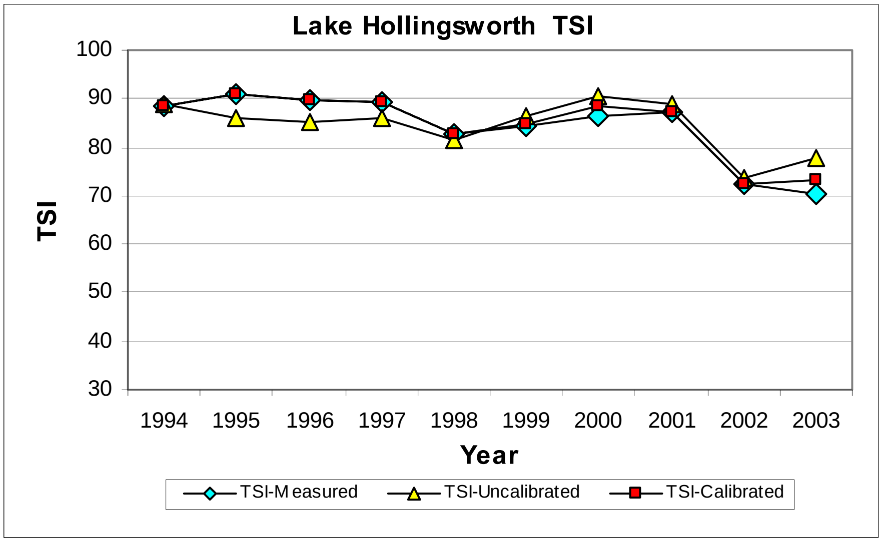
Lake Hollingsworth Chlorophyll *a*



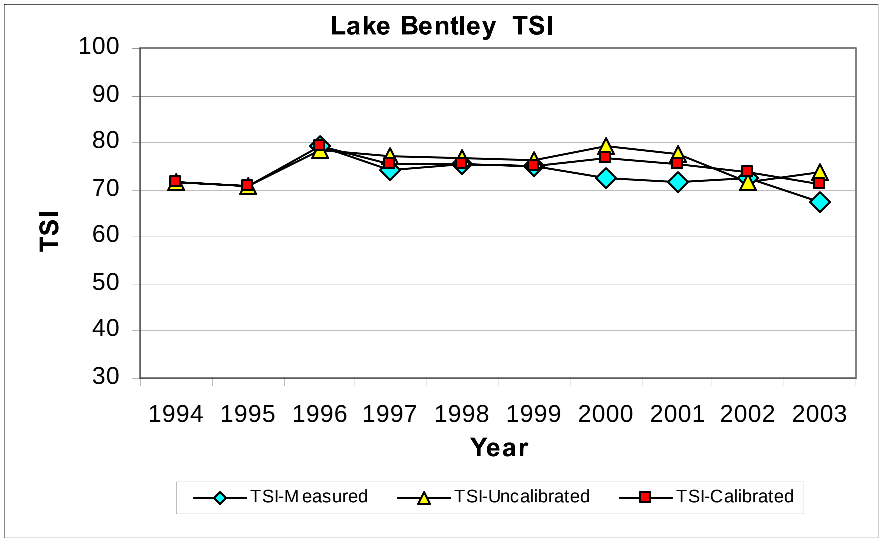
Lake Bentley Chlorophyll *a*



Lake Hollingsworth TSI

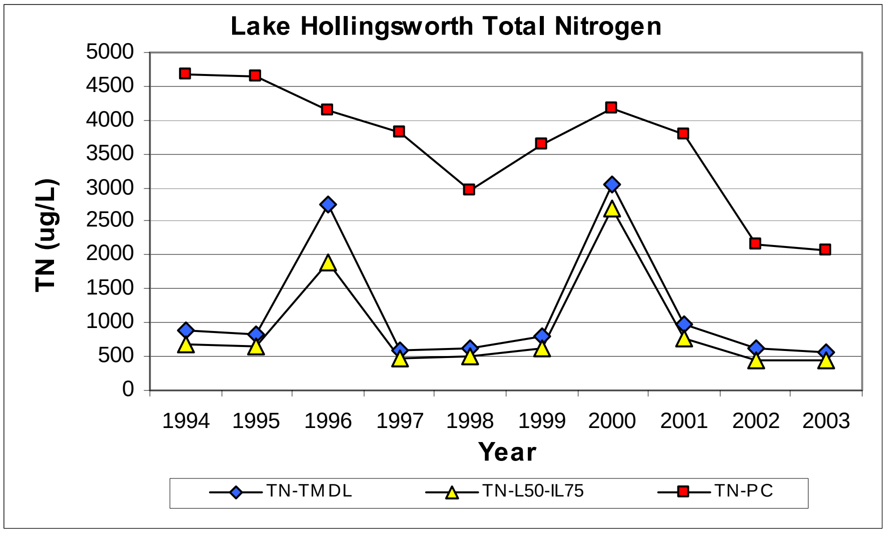


Lake Bentley TSI

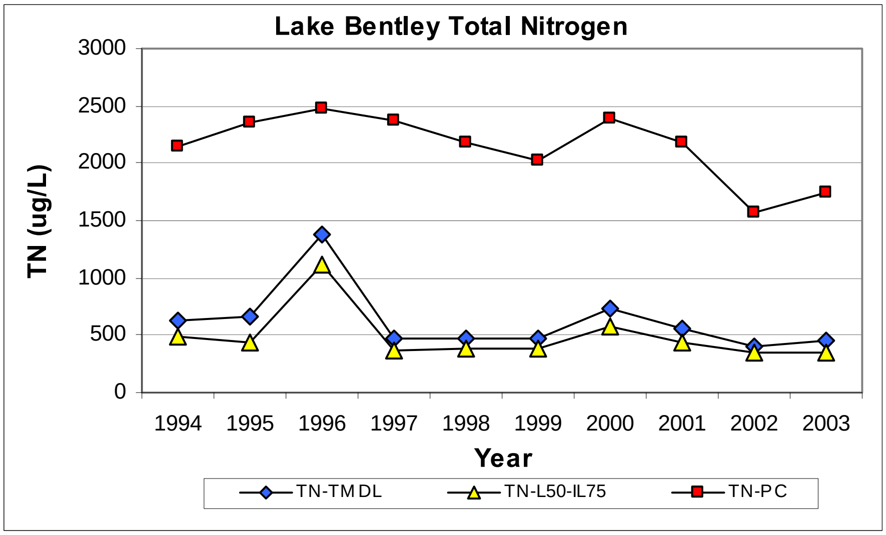


Appendix C: Lakes Hollingsworth and Bentley TN, TP, Chlorophyll a, and TSI TMDL Target, L50-IL75, and Background Calibration for the TMDL Modeling Period 1994 to 2003

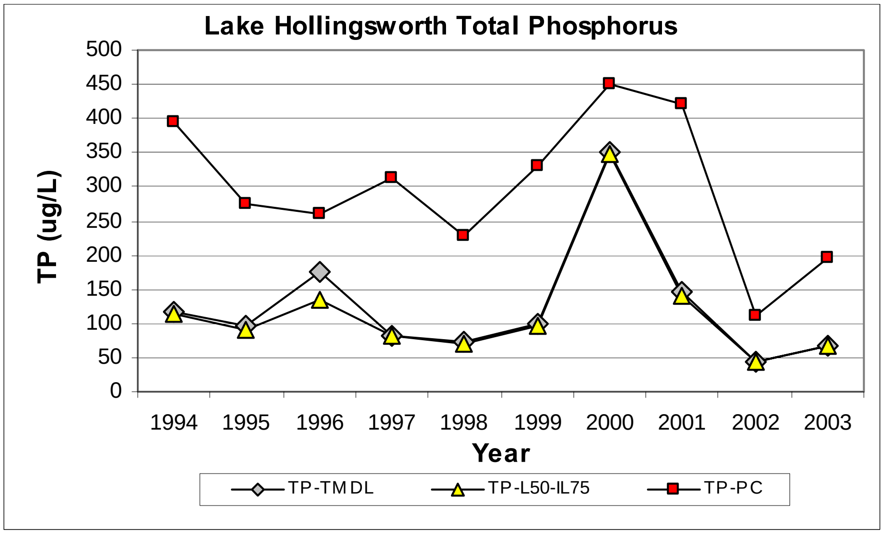
Lake Hollingsworth TN



Lake Bentley TN



Lake Hollingsworth TP



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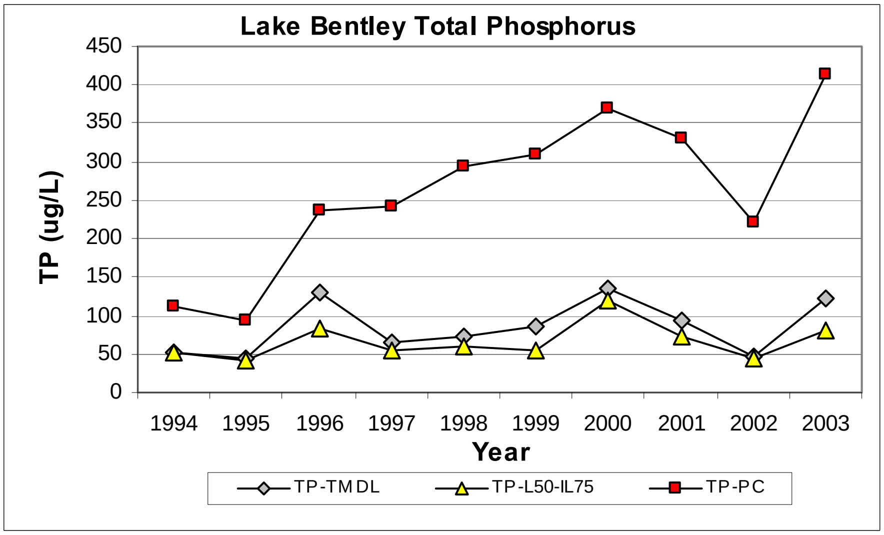
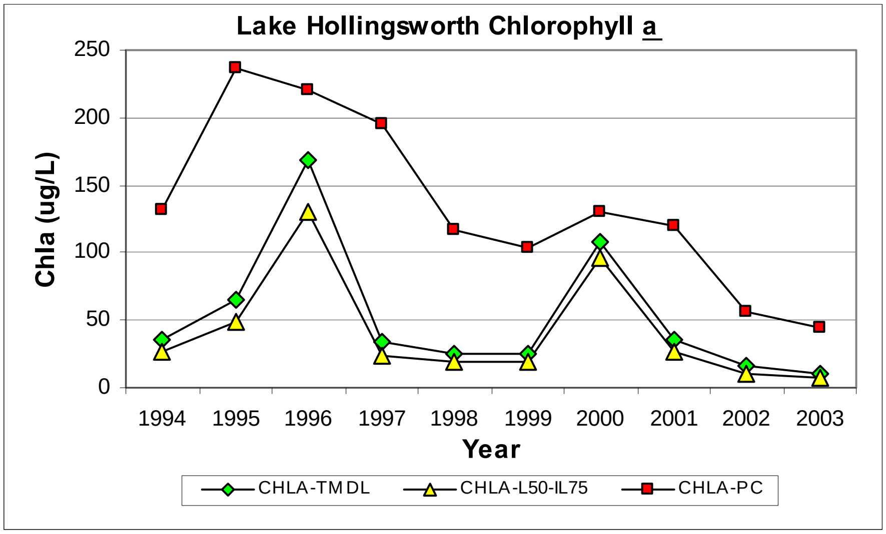
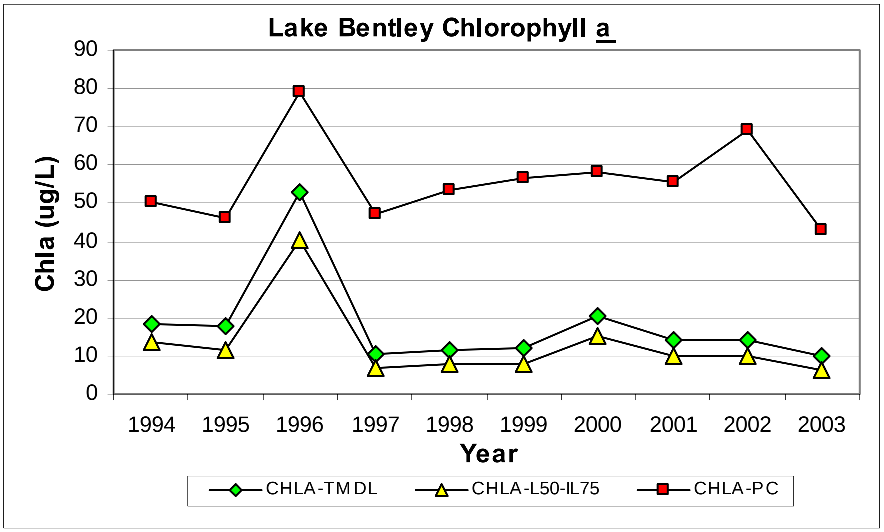


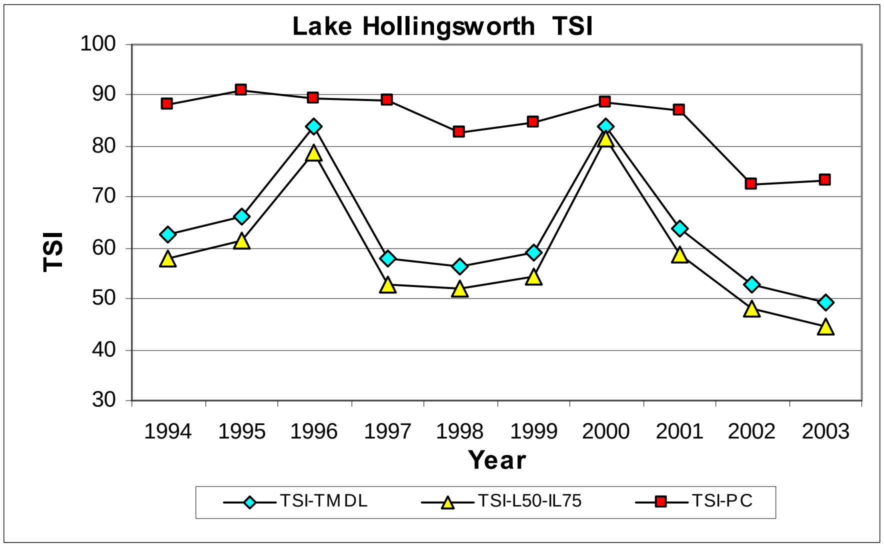
Lake Hollingsworth Chlorophyll *a*



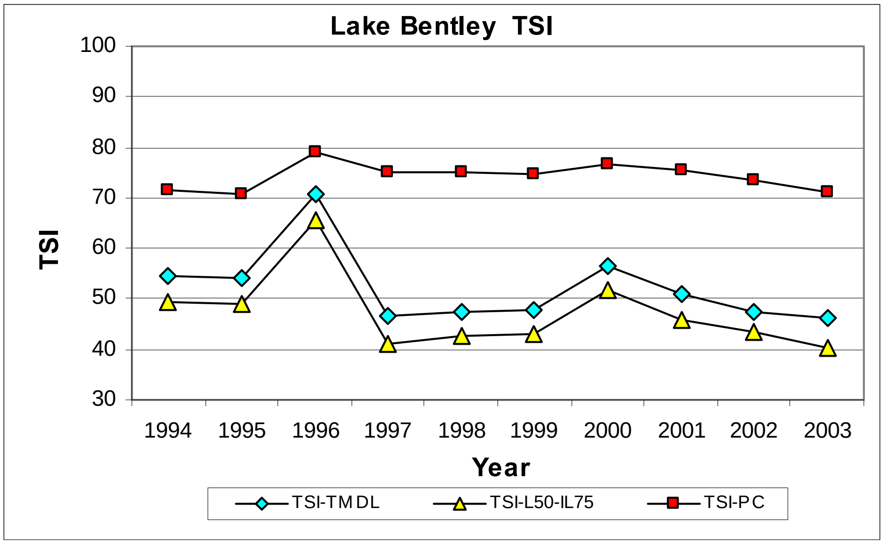
Lake Bentley Chlorophyll *a*



Lake Hollingsworth TSI



Lake Bentley TSI



Appendix D: Lakes Hollingsworth and Bentley TSI for PC, Background, TMDL Target, and TSI-Unit Percent Reduction

Lake Hollingsworth

Lake Hollingsworth
TSI for Measured, PC, Background, TMDL Target, TMDL, and TN and TP Mass Percent Reduction

Year	Measured	Calibrated	Background IL75	Target IL75+5	TMDL	TN Mass Percent Reduction	TP Mass Percent Reduction
1994*	88.4	88.3	57.7	62.7	62.8	92.2	88
1995*	90.8	90.9	61.4	66.4	66.3	93	83
1996	89.6	89.6	78.8	83.8	83.8	50	50
1997*	89.1	89.1	52.9	57.9	57.8	93.2	89
1998*	82.7	82.7	52	57	56.4	90	85
1999*	84.5	84.6	54.2	59.2	58.9	90	87
2000**	86.4	88.6	81.7	84.1	83.9	40.5	37
2001	87.1	87	58.8	63.8	63.8	88	88
2002*	72.6	72.6	47.9	52.9	52.8	82.5	75
2003*	70.3	73.3	44.5	49.5	49.1	84	82
Minimum	70.3	72.6	44.5	49.5	49.1	40.5	37
Maximum	90.8	90.9	81.7	84.1	83.9	93.2	89
Mean	84.2	84.7	59	63.7	63.6	80.3	76.4

* Reductions in TP limited by background concentrations.
** Used 1/2 of the difference between PC and Background as target for TMDL due to background concentrations greater than existing.

Lake Bentley

Lake Bentley
TSI for Measured, PC, Background, TMDL Target, TMDL, and TN and TP Mass Percent Reduction

Year	Measured	Calibrated	Background IL75	Target IL75+5	TMDL	TN Mass Percent Reduction	TP Mass Percent Reduction
1994*		71.7	49.3	54.3	54.5	84	69
1995*		70.8	48.9	53.9	54	83	81
1996	79.2	79.2	65.6	70.6	70.6	68	68
1997	74.2	75.2	41.2	46.2	46.8	93	93
1998	75.3	75.2	42.5	47.5	47.6	92.3	92.3
1999	74.8	74.8	42.9	47.9	47.8	90	90
2000	72.2	76.8	51.8	56.8	56.6	84.9	84.4
2001	71.7	75.5	45.7	50.7	50.8	90.7	90.7
2002*	72.6	73.6	43.5	48.5	47.5	95	94
2003	67.3	71.3	40.5	45.5	46.2	89	89
Minimum	67.3	70.8	40.5	45.5	46.2	68	68
Maximum	79.2	79.2	65.6	70.6	70.6	95	94
Mean	73.4	74.4	47.2	52.2	52.2	87	85.1

* Reductions in TP limited by background concentrations.

Appendix E: Lakes Hollingsworth and Bentley Mass for TN and TP for Calibrated Model, TMDL, and Percent Reduction

Lake Hollingsworth

Lake Hollingsworth
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*	52,471.0	4,092.7	92.2	7,376.5	885.2	88
1995*	59,081.4	4,135.7	93.0	4,380.1	744.6	83
1996	31,496.1	15,748.1	50.0	2,581.2	1,290.6	50
1997*	49,304.1	3,352.5	93.2	6,633.2	729.7	89
1998*	28,281.7	2,828.2	90.0	3,286.4	493.2	85
1999*	16,565.5	1,656.6	90.0	2,505.4	325.6	87
2000**	9,500.9	5,653.1	40.5	1,927.6	1,214.2	37
2001	16,898.6	2,196.6	87.0	3,611.2	587.4	83.7
2002*	19,806.3	3,466.1	82.5	1,113.7	278.4	75
2003*	15,868.4	2,538.9	84.0	2,477.6	445.8	82
Minimum	9,500.9	1,656.6	40.5	1,113.7	278.4	37
Maximum	59,081.4	15,748.1	93.2	7,376.5	1,290.6	89
Mean	29,927.4	4,566.8	80.2	3,589.3	699.5	76

* Reductions in TP limited by background concentrations.

** Used 1/2 of the difference between PC and Background as target for TMDL due to background concentrations greater than existing.

Lake Bentley

Lake Bentley
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*	11718.3	2110.6	82	777.6	231.5	70.2
1995*	14857.2	2598.2	82.5	658	204.8	68.9
1996	8935.3	3549.6	60.3	1678.7	582.3	65.3
1997	19613	2426	87.6	3979.1	492.8	87.6
1998	13588.2	1720.5	87.3	4592	449.1	90.2
1999	4153.5	478.6	88.5	1728.4	182.7	89.4
2000	3372.5	526.1	84.4	1443.4	225.2	84.4
2001	5950.3	784.1	86.8	2480.2	270.7	89.1
2002*	10424.6	1940.8	81.4	3293.5	298.5	90.9
2003	9710.4	1662.8	82.9	8596.9	1027.5	88
Minimum	3372.5	478.6	60.3	658	182.7	65.3
Maximum	19613	3549.6	88.5	8596.9	1027.5	90.9
Mean	10232.3	1779.7	82.4	2922.8	396.5	82.4

* Reductions in TP limited by background concentrations.

Appendix F: Lakes Hollingsworth and Bentley Annual Average Concentrations for TN, TP, and Chlorophyll a

Lake Hollingsworth

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

Year	Measured TN	Calibrated TN	TMDL TN	Background TN	Measured TP	Calibrated TP	TMDL TP	Background TP	Measured Chl a	Calibrated Chl a	TMDL Chl a	Background Chl a
1994*	2585	4682.5	897.6	688.7	816.6	394	116.1	115	122.8	131.2	35.8	26.3
1995*	1702.5	4655.2	831.4	648.8	770.9	274	96.1	89.3	66.3	236.5	64.9	48.1
1996	2065	4130.6	2745.3	1907.7	762.4	261.7	176.6	133.8	111.1	220.7	168.1	130.4
1997*	2433.8	3802.5	588.2	468.6	643.4	313.9	82.9	81.6	114.6	195.3	33.6	23.9
1998*	2411.3	2965.5	616.3	496.9	717.3	229	72.6	70.9	118.2	116.5	25.9	19.2
1999*	2719.3	3626	786.3	621.2	751.4	329.5	99.2	96.3	104.2	103.9	25.4	18.8
2000**	4334.5	4183.7	3062	2678.3	1051.2	450.8	349.7	347.8	167.5	130	107.3	96.5
2001	4762.5	3795	977.5	756.4	983	419.7	147.5	140.6	166.4	120.5	36.1	26.4
2002*	3355.8	2171.2	619.8	430.6	736	110.4	43	42.8	147.5	56.4	15.8	10.3
2003*	2438	2075	565.8	454.9	657.5	195.3	67.9	66.8	61	44.4	10.7	7.7
Minimum	1702.5	2075	565.8	430.6	643.4	110.4	43	42.8	61	44.4	10.7	7.7
Maximum	4762.5	4682.5	3062	2678.3	1051.2	450.8	349.7	347.8	167.5	236.5	168.1	130.4
Mean	2880.8	3608.7	1169	915.2	789	297.8	125.2	118.5	118	135.6	52.4	40.8

* Reductions in TP limited by background concentrations.

** Used 1/2 of the difference between PC and Background as target for TMDL due to background concentrations greater than existing.

Lake Bentley

Lake Bentley Annual Average Concentrations for TN, TP, and Chlorophyll *a* (μg/L)												
Year	Measured TN	Calibrated TN	TMDL TN	Background TN	Measured TP	Calibrated TP	TMDL TP	Background TP	Measured Chl *a*	Calibrated Chl *a*	TMDL Chl *a*	Background Chl *a*
1994*		2136.8	619.5	484		112	50.9	50.8		50	18.1	13.8
1995*		2347.7	667.1	443.4		94.9	43.1	42.8		46.1	17.7	11.7
1996	2472	2472.5	1383.8	1111	237.3	237	130.6	84	79.6	79.3	52.7	40.4
1997	2138	2373.3	467.3	367.6	241	241.5	64.4	53.9	47.5	47.1	10.2	6.7
1998	2186.7	2186.8	467.2	375.6	293.3	293.8	73.1	58.6	53.7	53.2	11.5	7.8
1999	2018.8	2018.7	465.9	383.2	308	308.3	87.1	55.8	56.8	56.6	11.8	8.1
2000	1553.8	2387.7	729.5	576.6	369	369.7	134	119	58.3	58.3	20.6	15.1
2001	1531.4	2187.6	549.4	437.7	331.9	331	94.8	72.4	55.2	55.5	14.1	9.8
2002*	1437.3	1577.6	408.5	344.4	221.1	221.6	46.8	43.3	69.4	69.1	13.9	10.2
2003	1192.3	1740.8	451.5	357.1	413	413.4	123.4	79.6	43.5	43.1	10	6.4
Minimum	1192.3	1577.6	408.5	344.4	221.1	94.9	43.1	42.8	43.5	43.1	10	6.4
Maximum	2472	2472.5	1383.8	1111	413	413.4	134	119	79.6	79.3	52.7	40.4
Mean	1816.3	2143	621	488.1	301.8	262.3	84.8	66	58	55.8	18	13

* Reductions in TP limited by background concentrations.

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

Banana Lake Total Nitrogen Data

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1549B	21FLPOLKBANANA1	1/27/1992	940	1.00	600	3.60	
1549B	21FLPOLKBANANA2	1/27/1992	1004	1.00	600	3.24	
1549B	21FLPOLKBANANA1	2/12/1992	1211	1.00	600	3.27	
1549B	21FLPOLKBANANA2	2/12/1992	1224	0.70	600	3.47	
1549B	21FLPOLKBANANA1	3/16/1992	1012	1.00	600	2.43	
1549B	21FLPOLKBANANA2	3/16/1992	1033	1.00	600	2.34	
1549B	21FLPOLKBANANA1	4/13/1992	830	1.00	600	2.89	
1549B	21FLPOLKBANANA2	4/13/1992	917	1.20	600	2.71	
1549B	21FLPOLKBANANA1	5/26/1992	850	1.85	600	2.82	
1549B	21FLPOLKBANANA2	5/26/1992	935	0.40	600	3.51	
1549B	21FLPOLKBANANA1	6/8/1992	835	1.10	600	2.52	
1549B	21FLPOLKBANANA2	6/8/1992	910	0.60	600	3.45	
1549B	21FLPOLKBANANA1	7/13/1992	910	1.10	600	2.40	
1549B	21FLPOLKBANANA2	7/13/1992	925	1.20	600	2.13	
1549B	21FLPOLKBANANA1	8/17/1992	1220	1.20	600	1.90	
1549B	21FLPOLKBANANA2	8/17/1992	1240	1.00	600	1.68	
1549B	21FLPOLKBANANA1	9/14/1992	855	1.10	600	2.06	
1549B	21FLPOLKBANANA2	9/14/1992	915	1.10	600	2.19	
1549B	21FLPOLKBANANA1	10/13/1992	856	1.15	600	2.10	
1549B	21FLPOLKBANANA2	10/13/1992	915	0.80	600	2.30	
1549B	21FLPOLKBANANA1	11/18/1992	910	1.00	600	2.99	
1549B	21FLPOLKBANANA2	11/18/1992	932	0.90	600	3.18	
1549B	21FLPOLKBANANA1	12/14/1992	844	0.80	600	3.43	
1549B	21FLPOLKBANANA2	12/14/1992	852	0.70	600	2.90	
1549B	21FLPOLKBANANA1	1/11/1993	845	0.90	600	2.59	
1549B	21FLPOLKBANANA2	1/11/1993	857	0.90	600	3.04	
1549B	21FLPOLKBANANA1	2/9/1993	910	1.00	600	1.52	
1549B	21FLPOLKBANANA2	2/9/1993	935	0.80	600	1.66	
1549B	21FLPOLKBANANA1	3/15/1993	1208	1.00	600	2.20	
1549B	21FLPOLKBANANA2	3/15/1993	1230	1.00	600	2.42	
1549B	21FLPOLKBANANA1	4/13/1993	1108	1.00	600	1.71	
1549B	21FLPOLKBANANA2	4/13/1993	1122	1.00	600	1.92	
1549B	21FLPOLKBANANA1	5/17/1993	928	0.90	600	1.93	
1549B	21FLPOLKBANANA2	5/17/1993	945	1.00	600	2.13	
1549B	21FLPOLKBANANA1	6/7/1993	830	0.90	600	2.13	
1549B	21FLPOLKBANANA2	6/7/1993	848	0.80	600	2.30	
1549B	21FLPOLKBANANA1	7/12/1993	910	1.00	600	3.06	
1549B	21FLPOLKBANANA2	7/12/1993	924	0.90	600	3.37	
1549B	21FLPOLKBANANA1	8/10/1993	900	1.00	600	3.06	
1549B	21FLPOLKBANANA2	8/10/1993	915	1.10	600	3.35	
1549B	21FLPOLKBANANA1	9/13/1993	1115	1.20	600	1.33	
1549B	21FLPOLKBANANA2	9/13/1993	1125	1.10	600	1.36	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1549B	21FLPOLKBANANA1	10/11/1993	835	1.00	600	2.41	
1549B	21FLPOLKBANANA2	10/11/1993	850	1.00	600	2.14	
1549B	21FLPOLKBANANA1	11/15/1993	842	0.80	600	2.58	
1549B	21FLPOLKBANANA2	11/15/1993	856	0.80	600	2.36	
1549B	21FLPOLKBANANA1	12/14/1993	835	0.80	600	2.99	
1549B	21FLPOLKBANANA2	12/14/1993	855	0.80	600	3.01	
1549B	21FLPOLKBANANA1	1/10/1994	855	0.80	600	2.66	
1549B	21FLPOLKBANANA2	1/10/1994	908	0.80	600	2.85	
1549B	21FLPOLKBANANA1	2/15/1994	840	0.80	600	2.98	
1549B	21FLPOLKBANANA2	2/15/1994	855	0.90	600	3.02	
1549B	21FLPOLKBANANA1	3/7/1994	1103	0.90	600	2.18	
1549B	21FLPOLKBANANA2	3/7/1994	1115	1.00	600	2.00	
1549B	21FLPOLKBANANA1	4/13/1994	825	0.90	600	2.07	
1549B	21FLPOLKBANANA2	4/13/1994	840	0.70	600	3.46	
1549B	21FLPOLKBANANA1	5/18/1994	1000	0.80	600	3.56	
1549B	21FLPOLKBANANA2	5/18/1994	1012	0.80	600	4.43	
1549B	21FLPOLKBANANA1	6/14/1994	1018	1.00	600	2.90	
1549B	21FLPOLKBANANA2	6/14/1994	1035	1.00	600	2.82	
1549B	21FLPOLKBANANA1	7/14/1994	850	1.20	600	2.56	
1549B	21FLPOLKBANANA2	7/14/1994	902	1.00	600	2.75	
1549B	21FLPOLKBANANA1	8/17/1994	1050	1.00	600	1.15	
1549B	21FLPOLKBANANA2	8/17/1994	1100	1.10	600	1.47	
1549B	21FLPOLKBANANA1	9/12/1994	1130	1.00	600	1.96	
1549B	21FLPOLKBANANA2	9/12/1994	1145	0.90	600	1.71	
1549B	21FLPOLKBANANA1	2/13/1995	1010	0.80	600	2.46	
1549B	21FLPOLKBANANA2	2/13/1995	1020	1.00	600	2.22	
1549B	21FLPOLKBANANA1	4/10/1995	1150	0.90	600	1.70	
1549B	21FLPOLKBANANA2	4/10/1995	1200	1.00	600	1.50	
1549B	21FLPOLKBANANA1	8/14/1995	1057	1.00	600	1.26	
1549B	21FLPOLKBANANA2	8/14/1995	1105	1.00	600	1.47	
1549B	21FLPOLKBANANA1	11/8/1995	928	1.00	600	1.48	
1549B	21FLPOLKBANANA2	11/8/1995	931	1.00	600	1.53	
1549B	21FLPOLKBANANA1	2/15/1996	1145	0.90	600	1.16	
1549B	21FLPOLKBANANA2	2/15/1996	1155	0.80	600	2.07	
1549B	21FLPOLKBANANA1	5/9/1996	1015	0.90	600	2.52	
1549B	21FLPOLKBANANA2	5/9/1996	1028	0.80	600	2.85	
1549B	21FLPOLKBANANA1	8/12/1996	1103	0.90	600	1.84	
1549B	21FLPOLKBANANA2	8/12/1996	1112	1.10	600	1.57	
1549B	21FLPOLKBANANA1	11/18/1996	1025	0.80	600	2.43	
1549B	21FLPOLKBANANA2	11/18/1996	1033	0.70	600	2.08	
1549B	21FLPOLKBANANA1	2/10/1997	1040	0.60	600	2.56	
1549B	21FLPOLKBANANA2	2/10/1997	1055	0.70	600	2.80	
1549B	21FLPOLKBANANA1	5/12/1997	1025	0.80	600	3.33	
1549B	21FLPOLKBANANA2	5/12/1997	1035	0.70	600	2.80	
1549B	21FLPOLKBANANA1	8/6/1997	945	1.00	600	2.29	
1549B	21FLPOLKBANANA2	8/6/1997	955	0.80	600	1.87	
1549B	21FLPOLKBANANA1	11/10/1997	1045	0.90	600	1.90	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1549B	21FLPOLKBANANA2	11/10/1997	1110	0.90	600	1.92	
1549B	21FLPOLKBANANA1	2/5/1998	1150	0.80	600	2.53	
1549B	21FLPOLKBANANA2	2/5/1998	1025	0.80	600	2.62	
1549B	21FLPOLKBANANA1	5/7/1998	1138	0.80	600	2.08	
1549B	21FLPOLKBANANA2	5/7/1998	1155	0.70	600	2.37	
1549B	21FLPOLKBANANA1	8/3/1998	1020	0.80	600	2.46	
1549B	21FLPOLKBANANA2	8/3/1998	1030	0.80	600	2.31	
1549B	21FLPOLKBANANA1	11/9/1998	1140	0.80	600	2.60	
1549B	21FLPOLKBANANA2	11/9/1998	1148	0.90	600	2.32	
1549B	21FLPOLKBANANA1	1/13/1999	1255	0.30	600	2.55	
1549B	21FLPOLKBANANA2	1/13/1999	1050	0.30	600	2.39	
1549B	21FLPOLKBANANA1	2/4/1999	1130	0.40	600	3.20	
1549B	21FLPOLKBANANA2	2/4/1999	1135	0.40	600	2.58	
1549B	21FLPOLKBANANA1	3/22/1999	1155	0.50	600	4.75	
1549B	21FLPOLKBANANA2	3/22/1999	1210	0.50	600	4.40	
1549B	21FLPOLKBANANA1	4/20/1999	1050	0.55	600	4.13	
1549B	21FLPOLKBANANA2	4/20/1999	1130	0.50	600	2.59	
1549B	21FLPOLKBANANA1	5/12/1999	1020	0.80	600	3.29	
1549B	21FLPOLKBANANA2	5/12/1999	1030	0.90	600	3.25	
1549B	21FLPOLKBANANA1	6/21/1999	1155	0.75	600	2.27	
1549B	21FLPOLKBANANA2	6/21/1999	1200	0.80	600	3.04	
1549B	21FLPOLKBANANA1	7/9/1999	1045	0.90	600	2.02	
1549B	21FLPOLKBANANA2	7/9/1999	1050	0.70	600	2.14	
1549B	21FLPOLKBANANA1	8/9/1999	950	0.50	600	1.48	
1549B	21FLPOLKBANANA2	8/9/1999	1000	0.60	600	1.98	
1549B	21FLPOLKBANANA1	9/23/1999	1050	0.60	600	1.75	
1549B	21FLPOLKBANANA2	9/23/1999	1100	0.60	600	2.28	
1549B	21FLPOLKBANANA1	10/11/1999	1415	0.60	600	1.60	
1549B	21FLPOLKBANANA2	10/11/1999	1425	0.60	600	2.11	
1549B	21FLPOLKBANANA1	11/1/1999	1105	0.60	600	2.73	
1549B	21FLPOLKBANANA2	11/1/1999	1115	0.60	600	2.61	
1549B	21FLPOLKBANANA1	12/9/1999	1022	0.50	600	2.40	
1549B	21FLPOLKBANANA2	12/9/1999	1030	0.60	600	3.72	
1549B	21FLPOLKBANANA1	5/4/2000	1015	0.70	600	3.95	
1549B	21FLPOLKBANANA2	5/4/2000	1130	0.80	600	7.63	
1549B	21FLPOLKBANANA1	8/10/2000	1140	0.50	600	2.76	
1549B	21FLPOLKBANANA2	8/10/2000	1150	0.50	600	3.73	
1549B	21FLPOLKBANANA1	11/13/2000	1430	0.60	600	3.90	
1549B	21FLPOLKBANANA2	11/13/2000	1445	0.50	600	4.04	
1549B	21FLPOLKBANANA1	2/15/2001	1140	0.70	600	4.49	
1549B	21FLPOLKBANANA2	2/15/2001	1120	0.70	600	4.66	
1549B	21FLPOLKBANANA1-B	5/9/2001	1030	0.70	600	8.78	
1549B	21FLPOLKBANANA2-B	5/9/2001	1015	0.60	600	8.20	
1549B	21FLPOLKBANANA1-B	8/21/2001	915	0.50	600	3.03	
1549B	21FLPOLKBANANA2-B	8/21/2001	925	0.50	600	3.24	
1549B	21FLPOLKBANANA1-B	11/20/2001	1245	0.50	600	3.03	
1549B	21FLPOLKBANANA2-B	11/20/2001	1255	0.50	600	2.67	

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1549B	21FLPOLKBANANA1-B	2/25/2002	1000	0.50	600	3.70	
1549B	21FLPOLKBANANA2-B	2/25/2002	1010	0.50	600	3.88	
1549B	21FLPOLKBANANA2-B	2/25/2002	1015	0.50	600	3.76	
1549B	21FLPOLKBANANA1	5/14/2002	1145	0.50	600	6.20	
1549B	21FLPOLKBANANA2	5/14/2002	1130	0.50	600	5.41	
1549B	21FLPOLKBANANA1	8/1/2002	830	0.50	600	2.27	
1549B	21FLPOLKBANANA2	8/1/2002	835	0.50	600	1.97	
1549B	21FLPOLKBANANA1	11/12/2002	1200	0.50	600	1.64	
1549B	21FLPOLKBANANA2	11/12/2002	1215	0.50	600	1.80	
1549B	21FLPOLKBANANA1	2/6/2003	805	0.50	600	1.92	
1549B	21FLPOLKBANANA2	2/6/2003	820	0.50	600	1.52	
1549B	21FLPOLKBANANA1	5/14/2003	855	0.50	600	3.73	
1549B	21FLPOLKBANANA2	5/14/2003	905	0.50	600	3.16	
1549B	21FLPOLKBANANA1	8/19/2003	1040	0.50	600	2.18	
1549B	21FLPOLKBANANA2	8/19/2003	1050	0.50	600	2.23	
1549B	21FLPOLKBANANA1	11/13/2003	850	0.50	600	2.33	
1549B	21FLPOLKBANANA2	11/13/2003	900	0.50	600	2.44	
1549B	21FLPOLKBANANA1	2/12/2004	950	0.50	600	4.92	
1549B	21FLPOLKBANANA2	2/12/2004	1000	0.50	600	2.52	
1549B	21FLPOLKBANANA1	5/6/2004	925	0.5	600	3.79	
1549B	21FLPOLKBANANA2	5/6/2004	935	0.5	600	4.17	

Banana Lake Total Phosphorus Data

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549B	21FLPOLKBANANA1	1/27/1992	940	1.00	665	1.211	
1549B	21FLPOLKBANANA2	1/27/1992	1004	1.00	665	1.160	
1549B	21FLPOLKBANANA1	2/12/1992	1211	1.00	665	1.149	
1549B	21FLPOLKBANANA2	2/12/1992	1224	0.70	665	1.200	
1549B	21FLPOLKBANANA1	3/16/1992	1012	1.00	665	1.129	
1549B	21FLPOLKBANANA2	3/16/1992	1033	1.00	665	1.116	
1549B	21FLPOLKBANANA1	4/13/1992	830	1.00	665	1.317	
1549B	21FLPOLKBANANA2	4/13/1992	917	1.20	665	1.587	
1549B	21FLPOLKBANANA1	5/26/1992	850	1.85	665	0.970	
1549B	21FLPOLKBANANA2	5/26/1992	935	0.40	665	1.476	
1549B	21FLPOLKBANANA1	6/8/1992	835	1.10	665	0.679	
1549B	21FLPOLKBANANA2	6/8/1992	910	0.60	665	1.345	
1549B	21FLPOLKBANANA1	7/13/1992	910	1.10	665	0.613	
1549B	21FLPOLKBANANA2	7/13/1992	925	1.20	665	0.524	
1549B	21FLPOLKBANANA1	8/17/1992	1220	1.20	665	0.460	
1549B	21FLPOLKBANANA2	8/17/1992	1240	1.00	665	0.434	
1549B	21FLPOLKBANANA1	9/14/1992	855	1.10	665	0.656	
1549B	21FLPOLKBANANA2	9/14/1992	915	1.10	665	0.750	
1549B	21FLPOLKBANANA1	10/13/1992	855	7.54	665	0.800	
1549B	21FLPOLKBANANA2	10/13/1992	915	0.80	665	0.723	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549B	21FLPOLKBANANA1	11/18/1992	910	1.00	665	0.816	
1549B	21FLPOLKBANANA2	11/18/1992	932	0.90	665	0.901	
1549B	21FLPOLKBANANA1	12/14/1992	844	0.80	665	1.509	
1549B	21FLPOLKBANANA2	12/14/1992	852	0.70	665	0.782	
1549B	21FLPOLKBANANA1	1/11/1993	845	0.90	665	0.987	
1549B	21FLPOLKBANANA2	1/11/1993	857	0.90	665	0.994	
1549B	21FLPOLKBANANA1	2/9/1993	910	1.00	665	0.930	
1549B	21FLPOLKBANANA2	2/9/1993	935	0.80	665	0.846	
1549B	21FLPOLKBANANA1	3/15/1993	1208	1.00	665	0.963	
1549B	21FLPOLKBANANA2	3/15/1993	1230	1.00	665	1.076	
1549B	21FLPOLKBANANA1	4/13/1993	1108	1.00	665	0.574	
1549B	21FLPOLKBANANA2	4/13/1993	1122	1.00	665	0.647	
1549B	21FLPOLKBANANA1	5/17/1993	928	0.90	665	1.217	
1549B	21FLPOLKBANANA2	5/17/1993	945	1.00	665	1.389	
1549B	21FLPOLKBANANA1	6/7/1993	830	0.90	665	1.055	
1549B	21FLPOLKBANANA2	6/7/1993	848	0.80	665	1.116	
1549B	21FLPOLKBANANA1	7/12/1993	910	1.00	665	0.646	
1549B	21FLPOLKBANANA2	7/12/1993	924	0.90	665	0.618	
1549B	21FLPOLKBANANA1	8/10/1993	900	1.00	665	0.555	
1549B	21FLPOLKBANANA2	8/10/1993	915	1.10	665	0.714	
1549B	21FLPOLKBANANA1	9/13/1993	1115	1.20	665	0.434	
1549B	21FLPOLKBANANA2	9/13/1993	1125	1.10	665	0.428	
1549B	21FLPOLKBANANA1	10/11/1993	835	1.00	665	0.764	
1549B	21FLPOLKBANANA2	10/11/1993	850	1.00	665	0.646	
1549B	21FLPOLKBANANA1	11/15/1993	842	0.80	665	0.775	
1549B	21FLPOLKBANANA2	11/15/1993	856	0.80	665	0.594	
1549B	21FLPOLKBANANA1	12/14/1993	835	0.80	665	1.066	
1549B	21FLPOLKBANANA2	12/14/1993	855	0.80	665	1.052	
1549B	21FLPOLKBANANA1	1/10/1994	855	0.80	665	0.852	
1549B	21FLPOLKBANANA2	1/10/1994	908	0.80	665	0.948	
1549B	21FLPOLKBANANA1	2/15/1994	840	0.80	665	0.962	
1549B	21FLPOLKBANANA2	2/15/1994	855	0.90	665	0.934	
1549B	21FLPOLKBANANA1	3/7/1994	1103	0.90	665	0.483	
1549B	21FLPOLKBANANA2	3/7/1994	1115	1.00	665	0.502	
1549B	21FLPOLKBANANA1	4/13/1994	825	0.90	665	1.180	
1549B	21FLPOLKBANANA2	4/13/1994	840	0.70	665	1.479	
1549B	21FLPOLKBANANA1	5/18/1994	1000	0.80	665	1.116	
1549B	21FLPOLKBANANA2	5/18/1994	1012	0.80	665	1.078	
1549B	21FLPOLKBANANA1	6/14/1994	1018	1.00	665	0.804	
1549B	21FLPOLKBANANA2	6/14/1994	1035	1.00	665	0.767	
1549B	21FLPOLKBANANA1	7/14/1994	850	1.20	665	0.527	
1549B	21FLPOLKBANANA2	7/14/1994	902	1.00	665	0.644	
1549B	21FLPOLKBANANA1	7/15/1994	850	3.94	665	0.527	
1549B	21FLPOLKBANANA1	8/17/1994	1050	1.00	665	0.649	
1549B	21FLPOLKBANANA2	8/17/1994	1100	1.10	665	0.662	
1549B	21FLPOLKBANANA1	9/12/1994	1130	1.00	665	0.614	
1549B	21FLPOLKBANANA2	9/12/1994	1145	0.90	665	0.570	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549B	21FLPOLKBANANA1	2/13/1995	1010	0.80	665	0.643	
1549B	21FLPOLKBANANA2	2/13/1995	1020	1.00	665	0.644	
1549B	21FLPOLKBANANA1	4/10/1995	1150	0.90	665	0.919	
1549B	21FLPOLKBANANA2	4/10/1995	1200	1.00	665	0.908	
1549B	21FLPOLKBANANA1	8/14/1995	1057	1.00	665	0.712	
1549B	21FLPOLKBANANA2	8/14/1995	1105	1.00	665	0.788	
1549B	21FLPOLKBANANA1	11/8/1995	928	1.00	665	0.781	
1549B	21FLPOLKBANANA2	11/8/1995	931	1.00	665	0.772	
1549B	21FLPOLKBANANA1	2/15/1996	1145	0.90	665	0.579	
1549B	21FLPOLKBANANA2	2/15/1996	1155	0.80	665	0.680	
1549B	21FLPOLKBANANA1	5/9/1996	1015	0.90	665	1.295	
1549B	21FLPOLKBANANA2	5/9/1996	1028	0.80	665	1.167	
1549B	21FLPOLKBANANA1	8/12/1996	1103	0.90	665	0.701	
1549B	21FLPOLKBANANA2	8/12/1996	1112	1.10	665	0.563	
1549B	21FLPOLKBANANA1	11/18/1996	1025	0.80	665	0.559	
1549B	21FLPOLKBANANA2	11/18/1996	1033	0.70	665	0.555	
1549B	21FLPOLKBANANA1	2/10/1997	1040	0.60	665	0.901	
1549B	21FLPOLKBANANA2	2/10/1997	1055	0.70	665	0.882	
1549B	21FLPOLKBANANA1	5/12/1997	1025	0.80	665	0.763	
1549B	21FLPOLKBANANA2	5/12/1997	1035	0.70	665	0.661	
1549B	21FLPOLKBANANA1	8/6/1997	945	1.00	665	0.532	
1549B	21FLPOLKBANANA2	8/6/1997	955	0.80	665	0.403	
1549B	21FLPOLKBANANA1	11/10/1997	1045	0.90	665	0.530	
1549B	21FLPOLKBANANA2	11/10/1997	1110	0.90	665	0.475	
1549B	21FLPOLKBANANA1	2/5/1998	1150	0.80	665	0.867	
1549B	21FLPOLKBANANA2	2/5/1998	1025	0.80	665	1.184	
1549B	21FLPOLKBANANA1	5/7/1998	1138	0.80	665	0.632	
1549B	21FLPOLKBANANA2	5/7/1998	1155	0.70	665	0.637	
1549B	21FLPOLKBANANA1	8/3/1998	1020	0.80	665	0.450	
1549B	21FLPOLKBANANA2	8/3/1998	1030	0.80	665	0.659	
1549B	21FLPOLKBANANA1	11/9/1998	1140	0.80	665	0.623	
1549B	21FLPOLKBANANA2	11/9/1998	1148	0.90	665	0.686	
1549B	21FLPOLKBANANA1	1/13/1999	0	0.30	665	0.574	
1549B	21FLPOLKBANANA2	1/13/1999	0	0.30	665	0.563	
1549B	21FLPOLKBANANA1	2/4/1999	1130	0.40	665	0.756	
1549B	21FLPOLKBANANA2	2/4/1999	1135	0.40	665	0.731	
1549B	21FLPOLKBANANA1	3/22/1999	1155	0.50	665	1.033	
1549B	21FLPOLKBANANA2	3/22/1999	1210	0.50	665	0.795	
1549B	21FLPOLKBANANA1	4/20/1999	1050	0.55	665	1.031	
1549B	21FLPOLKBANANA2	4/20/1999	1130	0.50	665	0.755	
1549B	21FLPOLKBANANA1	5/12/1999	1020	0.80	665	0.641	
1549B	21FLPOLKBANANA2	5/12/1999	1030	0.90	665	0.624	
1549B	21FLPOLKBANANA1	6/21/1999	1155	0.75	665	0.648	
1549B	21FLPOLKBANANA2	6/21/1999	1200	0.80	665	0.538	
1549B	21FLPOLKBANANA1	7/9/1999	1045	0.90	665	0.668	
1549B	21FLPOLKBANANA2	7/9/1999	1050	0.70	665	0.619	
1549B	21FLPOLKBANANA1	8/9/1999	950	0.50	665	0.591	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549B	21FLPOLKBANANA2	8/9/1999	1000	0.60	665	0.629	
1549B	21FLPOLKBANANA1	9/23/1999	1050	0.60	665	0.656	
1549B	21FLPOLKBANANA2	9/23/1999	1100	0.60	665	0.772	
1549B	21FLPOLKBANANA1	10/11/1999	1415	0.60	665	0.691	
1549B	21FLPOLKBANANA2	10/11/1999	1425	0.60	665	0.726	
1549B	21FLPOLKBANANA1	11/1/1999	1105	0.60	665	0.961	
1549B	21FLPOLKBANANA2	11/1/1999	1115	0.60	665	0.969	
1549B	21FLPOLKBANANA1	12/9/1999	1022	0.50	665	0.954	
1549B	21FLPOLKBANANA2	12/9/1999	1030	0.60	665	1.109	
1549B	21FLPOLKBANANA1	5/4/2000	1015	0.70	665	1.169	
1549B	21FLPOLKBANANA2	5/4/2000	1130	0.80	665	1.716	
1549B	21FLPOLKBANANA1	8/10/2000	1140	0.50	665	0.895	
1549B	21FLPOLKBANANA2	8/10/2000	1150	0.50	665	0.881	
1549B	21FLPOLKBANANA1	11/13/2000	1430	0.60	665	0.812	
1549B	21FLPOLKBANANA2	11/13/2000	1445	0.50	665	0.834	
1549B	21FLPOLKBANANA1	2/15/2001	1140	0.70	665	0.706	
1549B	21FLPOLKBANANA2	2/15/2001	1120	0.70	665	0.733	
1549B	21FLPOLKBANANA1-B	5/9/2001	1030	0.70	665	1.728	
1549B	21FLPOLKBANANA2-B	5/9/2001	1015	0.60	665	1.519	
1549B	21FLPOLKBANANA1-B	8/21/2001	915	0.50	665	0.639	
1549B	21FLPOLKBANANA2-B	8/21/2001	925	0.50	665	0.704	
1549B	21FLPOLKBANANA1-B	11/20/2001	1245	0.50	665	0.960	
1549B	21FLPOLKBANANA2-B	11/20/2001	1255	0.50	665	0.875	
1549B	21FLPOLKBANANA1-B	2/25/2002	1000	0.50	665	0.675	
1549B	21FLPOLKBANANA2-B	2/25/2002	1010	0.50	665	0.771	
1549B	21FLPOLKBANANA2-B	2/25/2002	1015	0.50	665	0.770	
1549B	21FLPOLKBANANA1	5/14/2002	1145	0.50	665	1.064	
1549B	21FLPOLKBANANA2	5/14/2002	1130	0.50	665	0.931	
1549B	21FLPOLKBANANA2	5/14/2002	1135	0.50	665	0.970	
1549B	21FLPOLKBANANA1	8/1/2002	830	0.50	665	0.690	
1549B	21FLPOLKBANANA2	8/1/2002	835	0.50	665	0.564	
1549B	21FLPOLKBANANA1	11/12/2002	1200	0.50	665	0.570	
1549B	21FLPOLKBANANA2	11/12/2002	1215	0.50	665	0.610	
1549B	21FLPOLKBANANA1	2/6/2003	805	0.50	665	0.670	
1549B	21FLPOLKBANANA2	2/6/2003	820	0.50	665	0.608	
1549B	21FLPOLKBANANA1	5/14/2003	855	0.50	665	0.974	
1549B	21FLPOLKBANANA2	5/14/2003	905	0.50	665	0.771	
1549B	21FLPOLKBANANA1	8/19/2003	1040	0.50	665	0.526	
1549B	21FLPOLKBANANA2	8/19/2003	1050	0.50	665	0.520	
1549B	21FLTPA 27584418154127	10/7/2003	1350	0.80	665	0.510	
1549B	21FLPOLKBANANA1	11/13/2003	850	0.50	665	0.658	
1549B	21FLPOLKBANANA2	11/13/2003	900	0.50	665	0.619	
1549B	21FLPOLKBANANA1	2/12/2004	950	0.50	665	0.514	
1549B	21FLPOLKBANANA2	2/12/2004	1000	0.50	665	0.551	
1549B	21FLPOLKBANANA1	5/6/2004	925	0.50	665	0.870	
1549B	21FLPOLKBANANA2	5/6/2004	935	0.50	665	0.940	

Banana Lake Chlorophyll a Data

WBID	Station	Date	Time	Depth	Storet Code	Chl *a* (µg/L)	R-Code
1549B	21FLPOLKBANANA1	1/27/1992	940	3.28	32210	73.9	
1549B	21FLPOLKBANANA2	1/27/1992	1004	3.28	32210	64.6	
1549B	21FLGFWFGFCSR0274	2/10/1992	1010	0.00	32211	80.2	
1549B	21FLGFWFGFCSR0275	2/10/1992	1020	0.00	32211	88.2	
1549B	21FLGFWFGFCSR0424	2/10/1992	1000	0.00	32211	80.2	
1549B	21FLPOLKBANANA1	2/12/1992	1211	3.28	32210	93.4	
1549B	21FLPOLKBANANA2	2/12/1992	1224	2.30	32210	90.0	
1549B	21FLPOLKBANANA1	3/16/1992	1012	3.28	32210	64.4	
1549B	21FLPOLKBANANA2	3/16/1992	1033	3.28	32210	66.6	
1549B	21FLPOLKBANANA1	4/13/1992	830	3.28	32210	109.8	
1549B	21FLPOLKBANANA2	4/13/1992	917	3.94	32210	94.4	
1549B	21FLGFWFGFCSR0274	5/12/1992	845	0.00	32211	112.3	
1549B	21FLGFWFGFCSR0275	5/12/1992	855	0.00	32211	144.3	
1549B	21FLGFWFGFCSR0424	5/12/1992	905	0.00	32211	120.3	
1549B	21FLPOLKBANANA1	5/26/1992	850	6.07	32210	84.4	
1549B	21FLPOLKBANANA2	5/26/1992	935	3.12	32210	105.4	
1549B	21FLPOLKBANANA1	6/8/1992	835	6.89	32210	83.0	
1549B	21FLPOLKBANANA2	6/8/1992	910	4.10	32210	110.2	
1549B	21FLPOLKBANANA1	7/13/1992	910	7.22	32210	76.8	
1549B	21FLPOLKBANANA2	7/13/1992	925	7.87	32210	70.8	
1549B	21FLPOLKBANANA1	8/17/1992	1220	7.87	32210	52.2	
1549B	21FLPOLKBANANA2	8/17/1992	1240	6.56	32210	41.7	
1549B	21FLGFWFGFCSR0274	8/25/1992	955	0.00	32211	48.1	
1549B	21FLGFWFGFCSR0275	8/25/1992	1005	0.00	32211	48.1	
1549B	21FLGFWFGFCSR0424	8/25/1992	1015	0.00	32211	48.1	
1549B	21FLPOLKBANANA1	9/14/1992	855	7.54	32210	64.5	
1549B	21FLPOLKBANANA2	9/14/1992	915	7.54	32210	63.0	
1549B	21FLPOLKBANANA1	10/13/1992	855	7.54	32210	148.1	
1549B	21FLPOLKBANANA2	10/13/1992	915	5.25	32210	146.5	
1549B	21FLPOLKBANANA1	11/18/1992	910	6.56	32210	113.2	
1549B	21FLPOLKBANANA2	11/18/1992	932	2.95	32210	119.2	
1549B	21FLGFWFGFCSR0274	11/30/1992	1015	0.00	32211	64.1	
1549B	21FLGFWFGFCSR0275	11/30/1992	1030	0.00	32211	96.2	
1549B	21FLGFWFGFCSR0424	11/30/1992	1000	0.00	32211	104.3	
1549B	21FLPOLKBANANA1	12/14/1992	844	5.58	32210	119.4	
1549B	21FLPOLKBANANA2	12/14/1992	852	4.59	32210	104.0	
1549B	21FLPOLKBANANA1	1/11/1993	845	2.95	32210	110.2	
1549B	21FLPOLKBANANA2	1/11/1993	857	2.95	32210	114.7	
1549B	21FLPOLKBANANA1	2/9/1993	910	3.28	32210	50.0	
1549B	21FLPOLKBANANA2	2/9/1993	935	2.62	32210	49.4	
1549B	21FLGFWFGFCSR0274	2/15/1993	2500	0.00	32211	16.2	
1549B	21FLGFWFGFCSR0275	2/15/1993	2500	0.00	32211	44.9	
1549B	21FLGFWFGFCSR0424	2/15/1993	2500	0.00	32211	48.1	
1549B	21FLPOLKBANANA1	3/15/1993	1208	3.28	32210	54.6	
1549B	21FLPOLKBANANA2	3/15/1993	1230	3.28	32210	62.3	
1549B	21FLPOLKBANANA1	4/13/1993	1108	3.28	32210	45.7	
1549B	21FLPOLKBANANA2	4/13/1993	1122	3.28	32210	40.1	

WBID	Station	Date	Time	Depth	Storet Code	Chl a (µg/L)	R-Code
1549B	21FLGFWFGFCSR0274	5/10/1993	1035	0.00	32211	72.2	
1549B	21FLGFWFGFCSR0275	5/10/1993	1045	0.00	32211	56.1	
1549B	21FLGFWFGFCSR0424	5/10/1993	1025	0.00	32211	96.2	
1549B	21FLPOLKBANANA1	5/17/1993	928	2.95	32210	63.4	
1549B	21FLPOLKBANANA2	5/17/1993	945	3.28	32210	63.6	
1549B	21FLPOLKBANANA1	6/7/1993	830	2.95	32210	66.6	
1549B	21FLPOLKBANANA2	6/7/1993	848	2.62	32210	67.3	
1549B	21FLPOLKBANANA1	7/12/1993	910	3.28	32210	119.0	
1549B	21FLPOLKBANANA2	7/12/1993	924	2.95	32210	163.0	
1549B	21FLPOLKBANANA1	8/10/1993	900	3.28	32210	120.7	
1549B	21FLPOLKBANANA2	8/10/1993	915	3.61	32210	148.8	
1549B	21FLGFWFGFCSR0274	8/23/1993	1030	0.00	32211	112.3	
1549B	21FLGFWFGFCSR0275	8/23/1993	1035	0.00	32211	136.3	
1549B	21FLGFWFGFCSR0424	8/23/1993	1030	0.00	32211	152.4	
1549B	21FLPOLKBANANA1	9/13/1993	1115	3.94	32210	47.8	
1549B	21FLPOLKBANANA2	9/13/1993	1125	3.61	32210	44.5	
1549B	21FLPOLKBANANA1	10/11/1993	835	3.28	32210	95.7	
1549B	21FLPOLKBANANA2	10/11/1993	850	3.28	32210	80.6	
1549B	21FLPOLKBANANA1	11/15/1993	842	2.62	32210	102.5	
1549B	21FLPOLKBANANA2	11/15/1993	856	2.62	32210	99.2	
1549B	21FLGFWFGFCSR0274	11/15/1993	2500	0.00	32211	96.2	
1549B	21FLGFWFGFCSR0275	11/15/1993	2500	0.00	32211	112.3	
1549B	21FLGFWFGFCSR0424	11/15/1993	2500	0.00	32211	96.2	
1549B	21FLPOLKBANANA1	12/14/1993	835	2.62	32210	93.8	
1549B	21FLPOLKBANANA2	12/14/1993	855	2.62	32210	98.2	
1549B	21FLPOLKBANANA1	1/10/1994	855	2.62	32210	71.5	
1549B	21FLPOLKBANANA2	1/10/1994	908	2.62	32210	76.8	
1549B	21FLPOLKBANANA1	2/15/1994	840	2.62	32210	115.5	
1549B	21FLPOLKBANANA2	2/15/1994	855	2.95	32210	113.0	
1549B	21FLGFWFGFCSR0274	2/21/1994	1415	0.00	32211	72.2	
1549B	21FLGFWFGFCSR0275	2/21/1994	1345	0.00	32211	80.2	
1549B	21FLGFWFGFCSR0424	2/21/1994	1400	0.00	32211	120.3	
1549B	21FLPOLKBANANA1	3/7/1994	1103	2.95	32210	63.7	
1549B	21FLPOLKBANANA2	3/7/1994	1115	3.28	32210	51.6	
1549B	21FLPOLKBANANA1	4/13/1994	825	2.95	32210	90.3	
1549B	21FLPOLKBANANA2	4/13/1994	840	2.30	32210	100.4	
1549B	21FLGFWFGFCSR0274	5/9/1994	1024	0.00	32211	152.4	
1549B	21FLGFWFGFCSR0275	5/9/1994	1031	0.00	32211	152.4	
1549B	21FLGFWFGFCSR0424	5/9/1994	1018	0.00	32211	192.5	
1549B	21FLPOLKBANANA1	5/18/1994	1000	2.62	32210	156.2	
1549B	21FLPOLKBANANA2	5/18/1994	1012	2.62	32210	155.0	
1549B	21FLPOLKBANANA1	6/14/1994	1018	3.28	32210	149.5	
1549B	21FLPOLKBANANA2	6/14/1994	1035	3.28	32210	133.3	
1549B	21FLPOLKBANANA1	7/14/1994	850	3.94	32210	184.6	
1549B	21FLPOLKBANANA2	7/14/1994	902	3.28	32210	190.4	
1549B	21FLPOLKBANANA1	7/15/1994	850	3.94	32210	184.6	
1549B	21FLPOLKBANANA2	7/15/1994	902	3.28	32210	190.4	

WBID	Station	Date	Time	Depth	Storet Code	Chl a (µg/L)	R-Code
1549B	21FLPOLKBANANA1	8/17/1994	1050	3.28	32210	99.0	
1549B	21FLPOLKBANANA2	8/17/1994	1100	3.61	32210	93.5	
1549B	21FLPOLKBANANA1	9/12/1994	1130	3.28	32210	81.3	
1549B	21FLPOLKBANANA2	9/12/1994	1145	2.95	32210	104.6	
1549B	21FLPOLKBANANA1	2/13/1995	1010	2.62	32210	112.0	
1549B	21FLPOLKBANANA2	2/13/1995	1020	3.28	32210	91.6	
1549B	21FLPOLKBANANA1	4/10/1995	1150	2.95	32210	32.4	
1549B	21FLPOLKBANANA2	4/10/1995	1200	3.28	32210	25.7	
1549B	21FLPOLKBANANA1	8/14/1995	1057	3.28	32210	48.0	
1549B	21FLPOLKBANANA2	8/14/1995	1105	3.28	32210	83.6	
1549B	21FLPOLKBANANA1	11/8/1995	928	3.28	32210	67.1	
1549B	21FLPOLKBANANA2	11/8/1995	931	3.28	32210	69.9	
1549B	21FLPOLKBANANA1	2/15/1996	1145	2.95	32210	93.3	
1549B	21FLPOLKBANANA2	2/15/1996	1155	2.62	32210	76.9	
1549B	21FLPOLKBANANA1	5/9/1996	1015	2.95	32210	178.8	
1549B	21FLPOLKBANANA2	5/9/1996	1028	2.62	32210	185.4	
1549B	21FLPOLKBANANA1	8/12/1996	1103	2.95	32210	91.8	
1549B	21FLPOLKBANANA2	8/12/1996	1112	3.61	32210	60.6	
1549B	21FLPOLKBANANA1	11/18/1996	1025	2.62	32210	100.8	
1549B	21FLPOLKBANANA2	11/18/1996	1033	2.30	32210	100.8	
1549B	21FLPOLKBANANA1	2/10/1997	1040	1.97	32210	83.1	
1549B	21FLPOLKBANANA2	2/10/1997	1055	2.30	32210	79.9	
1549B	21FLPOLKBANANA1	5/12/1997	1025	2.62	32210	205.8	
1549B	21FLPOLKBANANA2	5/12/1997	1035	2.30	32210	189.2	
1549B	21FLPOLKBANANA1	8/6/1997	945	3.28	32210	80.0	
1549B	21FLPOLKBANANA2	8/6/1997	955	2.62	32210	67.2	
1549B	21FLPOLKBANANA1	11/10/1997	1045	2.95	32210	112.7	
1549B	21FLPOLKBANANA2	11/10/1997	1110	2.95	32210	98.8	
1549B	21FLPOLKBANANA1	2/5/1998	1150	0.80	32210	119.6	
1549B	21FLPOLKBANANA1	2/5/1998	1150	2.62	32210	119.6	
1549B	21FLPOLKBANANA2	2/5/1998	1025	0.80	32210	112.2	
1549B	21FLPOLKBANANA2	2/5/1998	1025	2.62	32210	112.2	
1549B	21FLPOLKBANANA1	5/7/1998	1138	0.80	32210	122.5	
1549B	21FLPOLKBANANA1	5/7/1998	1138	2.62	32210	122.5	
1549B	21FLPOLKBANANA2	5/7/1998	1155	0.70	32210	104.6	
1549B	21FLPOLKBANANA2	5/7/1998	1155	2.30	32210	104.6	
1549B	21FLPOLKBANANA1	8/3/1998	1020	2.62	32210	104.3	
1549B	21FLPOLKBANANA2	8/3/1998	1030	2.62	32210	91.1	
1549B	21FLPOLKBANANA1	11/9/1998	1140	2.62	32210	181.4	
1549B	21FLPOLKBANANA2	11/9/1998	1148	2.95	32210	110.3	
1549B	21FLPOLKBANANA1	1/13/1999	1255	0.30	32223	90.1	
1549B	21FLPOLKBANANA2	1/13/1999	1050	0.30	32223	136.2	
1549B	21FLPOLKBANANA1	2/4/1999	1130	0.40	32223	152.2	
1549B	21FLPOLKBANANA2	2/4/1999	1135	0.40	32223	146.2	
1549B	21FLPOLKBANANA1	3/22/1999	1155	.	32223	196.0	
1549B	21FLPOLKBANANA2	3/22/1999	1210	.	32223	184.0	
1549B	21FLPOLKBANANA1	4/20/1999	1050	0.55	32223	208.3	

WBID	Station	Date	Time	Depth	Storet Code	Chl a (µg/L)	R-Code
1549B	21FLPOLKBANANA2	4/20/1999	1130	0.50	32223	188.2	
1549B	21FLPOLKBANANA1	5/12/1999	1020	0.80	32223	84.1	
1549B	21FLPOLKBANANA2	5/12/1999	1030	0.90	32223	68.1	
1549B	21FLPOLKBANANA1	6/21/1999	1155	0.75	32223	81.4	
1549B	21FLPOLKBANANA2	6/21/1999	1200	0.80	32223	128.2	
1549B	21FLPOLKBANANA1	7/9/1999	1045	0.90	32223	94.8	
1549B	21FLPOLKBANANA2	7/9/1999	1050	0.70	32223	96.1	
1549B	21FLPOLKBANANA1	8/9/1999	950	0.50	32223	92.1	
1549B	21FLPOLKBANANA2	8/9/1999	1000	0.60	32223	64.1	
1549B	21FLPOLKBANANA1	9/23/1999	1050	0.60	32223	84.1	
1549B	21FLPOLKBANANA2	9/23/1999	1100	0.60	32223	80.1	
1549B	21FLPOLKBANANA1	10/11/1999	1415	0.60	32223	16.0	
1549B	21FLPOLKBANANA2	10/11/1999	1425	0.60	32223	22.7	
1549B	21FLPOLKBANANA1	11/1/1999	1105	0.60	32223	96.1	
1549B	21FLPOLKBANANA2	11/1/1999	1115	0.60	32223	96.1	
1549B	21FLPOLKBANANA1	12/9/1999	1022	0.50	32223	44.1	
1549B	21FLPOLKBANANA2	12/9/1999	1030	0.60	32223	52.1	
1549B	21FLPOLKBANANA1	5/4/2000	1015	0.70	32223	296.4	
1549B	21FLPOLKBANANA2	5/4/2000	1130	0.80	32223	304.4	
1549B	21FLPOLKBANANA1	8/10/2000	1140	0.50	32223	132.2	
1549B	21FLPOLKBANANA2	8/10/2000	1150	0.50	32223	104.1	
1549B	21FLPOLKBANANA1	11/13/2000	1430	0.60	32223	79.7	
1549B	21FLPOLKBANANA2	11/13/2000	1445	0.50	32223	88.1	
1549B	21FLPOLKBANANA1	2/15/2001	1140	0.70	32223	172.0	
1549B	21FLPOLKBANANA2	2/15/2001	1120	0.70	32223	176.0	
1549B	21FLPOLKBANANA1-B	5/9/2001	1030	0.70	32223	288.4	
1549B	21FLPOLKBANANA2-B	5/9/2001	1015	0.60	32223	272.3	
1549B	21FLPOLKBANANA1-B	8/21/2001	915	0.50	32223	129.5	
1549B	21FLPOLKBANANA2-B	8/21/2001	925	0.50	32223	152.2	
1549B	21FLPOLKBANANA1-B	11/20/2001	1245	0.50	32223	70.8	
1549B	21FLPOLKBANANA2-B	11/20/2001	1255	0.50	32223	70.1	
1549B	21FLPOLKBANANA1-B	2/25/2002	1000	0.50	32223	189.4	
1549B	21FLPOLKBANANA2-B	2/25/2002	1010	0.50	32223	146.9	
1549B	21FLPOLKBANANA2-B	2/25/2002	1015	0.50	32223	178.0	
1549B	21FLPOLKBANANA1	5/14/2002	1145	0.50	32223	196.3	
1549B	21FLPOLKBANANA2	5/14/2002	1130	0.50	32223	196.3	
1549B	21FLPOLKBANANA2	5/14/2002	1135	0.50	32223	191.5	
1549B	21FLPOLKBANANA1	8/1/2002	830	0.50	32223	78.8	
1549B	21FLPOLKBANANA2	8/1/2002	835	0.50	32223	74.0	
1549B	21FLTPA27584418154127	10/7/2003	1350	0.8	32223	61.0	
1549B	21FLPOLKBANANA1	2/12/2004	950	0.50	32210	107.2	
1549B	21FLPOLKBANANA2	2/12/2004	1000	0.50	32210	110.4	

Banana Lake Canal Total Nitrogen Data

WBID	Station	Date	Time	Depth	Storet Code	TN (mg/L)	R-Code
1549A	21FLSWFDSTA0023	3/26/1992	915	8.00	600	2.64	U
1549A	21FLSWFDSTA0023	7/8/1992	815	1.00	600	1.92	U
1549A	21FLSWFDSTA0023	9/22/1992	1015	2.20	600	1.66	A
1549A	21FLSWFDSTA0023	12/7/1992	1050	1.20	600	3.39	
1549A	21FLPOLKBANANA OF SE	11/12/2002	1500	0.25	600	2.18	
1549A	21FLTPA 25020062	2/5/2003	945	0.20	600	2.05	
1549A	21FLTPA 27585748153407	2/5/2003	915	0.20	600	1.83	
1549A	21FLPOLKBANANA OF SE	2/6/2003	1045	0.20	600	2.67	
1549A	21FLTPA 25020062	4/22/2003	1125	0.20	600	2.76	
1549A	21FLTPA 27585748153407	4/22/2003	1100	0.20	600	3.04	
1549A	21FLTPA 25020062	5/7/2003	1125	0.20	600	3.12	
1549A	21FLTPA 27585748153407	5/7/2003	1110	0.20	600	2.92	
1549A	21FLPOLKBANANA OF SE	5/14/2003	805	0.20	600	3.07	
1549A	21FLTPA 25020062	6/4/2003	1030	0.30	600	2.90	
1549A	21FLTPA 27585748153407	6/4/2003	1015	0.20	600	2.90	
1549A	21FLTPA 25020062	7/8/2003	1130	0.20	600	1.71	
1549A	21FLTPA 27585748153407	7/8/2003	1115	0.20	600	1.63	
1549A	21FLPOLKBANANA OF SE	8/19/2003	1155	0.25	600	2.38	
1549A	21FLTPA 25020062	9/9/2003	1005	0.20	600	2.02	
1549A	21FLTPA 27585748153407	9/9/2003	945	0.20	600	1.91	
1549A	21FLTPA 25020062	10/6/2003	1120	0.20	600	1.90	
1549A	21FLTPA 27585748153407	10/6/2003	1105	0.20	600	1.81	
1549A	21FLTPA 25020062	11/3/2003	1005	0.20	600	2.64	
1549A	21FLTPA 27585748153407	11/3/2003	950	0.20	600	2.22	
1549A	21FLPOLKBANANA OF SE	11/13/2003	930	0.30	600	2.64	
1549A	21FLTPA 25020062	12/2/2003	1045	0.20	600	2.95	
1549A	21FLTPA 27585748153407	12/2/2003	1110	0.20	600	3.03	
1549A	21FLPOLKBANANA OF SE	2/12/2004	1105	0.25	600	3.56	
1549A	21FLPOLKBANANA OF SE	5/6/2004	835	0.15	600	3.64	

A: Value reported is the mean of two or more determinations.
U: Material was analyzed for but not detected

Banana Lake Canal Total Phosphorus Data

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549A	21FLSWFDSTA0023	3/26/1992	915	8.00	665	1.200	
1549A	21FLSWFDSTA0023	7/8/1992	815	1.00	665	0.620	
1549A	21FLSWFDSTA0023	9/22/1992	1015	2.20	665	0.520	A
1549A	21FLSWFDSTA0023	12/7/1992	1050	1.20	665	1.300	
1549A	21FLPOLKBANANA OF SE	11/12/2002	1500	0.25	665	0.738	
1549A	21FLTPA 25020062	2/5/2003	945	0.20	665	0.910	
1549A	21FLTPA 27585748153407	2/5/2003	915	0.20	665	0.800	
1549A	21FLPOLKBANANA OF SE	2/6/2003	1045	0.20	665	0.884	
1549A	21FLTPA 25020062	4/22/2003	1125	0.20	665	0.920	
1549A	21FLTPA 27585748153407	4/22/2003	1100	0.20	665	0.830	
1549A	21FLTPA 25020062	5/7/2003	1125	0.20	665	0.900	

WBID	Station	Date	Time	Depth	Storet Code	TP (mg/L)	R-Code
1549A	21FLTPA 27585748153407	5/7/2003	1110	0.20	665	0.900	
1549A	21FLPOLKBANANA OF SE	5/14/2003	805	0.20	665	0.803	
1549A	21FLTPA 25020062	6/4/2003	1030	0.30	665	0.890	
1549A	21FLTPA 27585748153407	6/4/2003	1015	0.20	665	0.870	
1549A	21FLTPA 25020062	7/8/2003	1130	0.20	665	0.510	
1549A	21FLTPA 27585748153407	7/8/2003	1115	0.20	665	0.480	
1549A	21FLPOLKBANANA OF SE	8/19/2003	1155	0.25	665	0.576	
1549A	21FLTPA 25020062	8/19/2003	1057	0.20	665	0.580	
1549A	21FLTPA 27585748153407	8/19/2003	1040	0.20	665	0.580	
1549A	21FLTPA 25020062	9/9/2003	1005	0.20	665	0.680	
1549A	21FLTPA 27585748153407	9/9/2003	945	0.20	665	0.610	
1549A	21FLTPA 25020062	10/6/2003	1120	0.20	665	0.430	
1549A	21FLTPA 27585748153407	10/6/2003	1105	0.20	665	0.750	
1549A	21FLTPA 25020062	11/3/2003	1005	0.20	665	0.910	
1549A	21FLTPA 27585748153407	11/3/2003	950	0.20	665	0.720	
1549A	21FLPOLKBANANA OF SE	11/13/2003	930	0.30	665	0.751	
1549A	21FLTPA 25020062	12/2/2003	1045	0.20	665	0.860	
1549A	21FLTPA 27585748153407	12/2/2003	1110	0.20	665	0.870	
1549A	21FLPOLKBANANA OF SE	2/12/2004	1105	0.25	665	0.884	
1549A	21FLPOLKBANANA OF SE	5/6/2004	835	0.15	665	1.055	

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

Banana Lake Canal Chlorophyll *a* Data

WBID	Station	Date	Time	Depth	Storet Code	Chla (µg/L)	R-Code
1549A	21FLSWFDSTA0023	7/8/1992	815	1.00	32211	78.4	
1549A	21FLSWFDSTA0023	9/22/1992	1015	2.20	32211	37.1	A
1549A	21FLSWFDSTA0023	12/7/1992	1050	1.20	32211	30.5	
1549A	21FLTPA 25020062	2/5/2003	945	0.20	32209	54.0	
1549A	21FLTPA 27585748153407	2/5/2003	915	0.20	32209	76.0	
1549A	21FLTPA 25020062	4/22/2003	1125	0.20	32209	92.0	
1549A	21FLTPA 27585748153407	4/22/2003	1100	0.20	32209	130.0	
1549A	21FLTPA 25020062	5/7/2003	1125	0.20	32209	130.0	
1549A	21FLTPA 27585748153407	5/7/2003	1110	0.20	32209	150.0	
1549A	21FLTPA 25020062	6/4/2003	1030	0.30	32209	8.5	
1549A	21FLTPA 27585748153407	6/4/2003	1015	0.20	32209	17.0	
1549A	21FLTPA 25020062	7/8/2003	1130	0.20	32209	69.0	
1549A	21FLTPA 27585748153407	7/8/2003	1115	0.20	32209	63.0	
1549A	21FLTPA 25020062	8/19/2003	1057	0.20	32209	88.0	
1549A	21FLTPA 27585748153407	8/19/2003	1040	0.20	32209	96.0	
1549A	21FLTPA 25020062	9/9/2003	1005	0.20	32209	64.0	
1549A	21FLTPA 27585748153407	9/9/2003	945	0.20	32209	78.0	
1549A	21FLTPA 25020062	10/6/2003	1120	0.20	32209	81.0	
1549A	21FLTPA 27585748153407	10/6/2003	1105	0.20	32209	94.0	
1549A	21FLTPA 25020062	11/3/2003	1005	0.20	32209	115.0	
1549A	21FLTPA 27585748153407	11/3/2003	950	0.20	32209	120.0	

WBID	Station	Date	Time	Depth	Storet Code	Chla (µg/L)	R-Code
1549A	21FLTPA 25020062	12/2/2003	1045	0.20	32209	105.0	
1549A	21FLTPA 27585748153407	12/2/2003	1110	0.20	32209	125.0	
1549A	21FLPOLKBANANA OF SE	2/12/2004	1105	0.25	32210	120.7	
1549A	21FLPOLKBANANA OF SE	5/6/2004	835	0.15	32210	178.9	

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)