Addendum to Synopsis Report Current Assimilative Capacity Assessment

Georgia's State Water Plan

Georgia Environmental
Protection Division

Review Draft
April 2011

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Revision History

The following table presents the revision history of the Current Assimilative Capacity Assessment Report.

Table i-1 Revision History of Current Assimilative Capacity Assessment Report

Revision Number	Release Date	Comments
0	April 2011	Initial Release of Report. **Note that the results in this document and the associated appendices are DRAFT and are subject to change.**

Acknowledgements

The Georgia Environmental Protection Division acknowledges the tremendous efforts of the Tetra Tech Team, including Tetra Tech, Wilson Engineering, and Natural Resources Engineering in the development of the models, analysis of the results, staff support, and in the preparation of this document. Without their assistance and dedication to this project, this effort could not have been completed.

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SUMMARY OF RESULTS

In support of the Georgia Comprehensive State-wide Water Management Plan (GA State Water Plan), the Surface Water Quality (or Assimilative Capacity) Resource Assessment was used to determine the capacity of Georgia's surface waters to absorb pollutants without unacceptable degradation of water quality. Assimilative Capacity is defined as the amount of contaminant load that can be discharged to a specific waterbody without exceeding water quality standards or criteria. In other words, the assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without water quality becoming impaired or aquatic life being harmed. The assimilative capacity resource assessment included developing water quality models of selected streams, rivers, lakes and estuaries throughout the State of Georgia. Results from these models were compared with applicable water quality standards.

The current assimilative capacity results focus on dissolved oxygen, nutrients, specifically nitrogen and phosphorus, and chlorophyll *a*. The water quality models were used to evaluate the impacts of current wastewater and industrial discharges and withdrawals, land use, and meteorological conditions on the waterbody. This addendum summarizes results for GA Dosag, EPDRiv1, LSPC and EFDC models in the Chattahoochee and Flint river basins.

MODELS USED FOR ASSIMILATIVE CAPACITY RESOURCE ASSESSMENT

For the Assimilative Capacity Resource Assessment, four different models were developed.

GA Dosag

Georgia Dosag (GA Dosag) was used to predict dissolved oxygen (DO) concentrations in a stream or river during critical time periods which include low flow and high temperatures.

EPDRiv1

EPDRiv1 was used to simulate both flow and water quality concentrations along the main stem rivers. EPDRiv1 was used to simulate various water quality parameters including temperature and dissolved oxygen.

LSPC

The Loading Simulation Program C++ (LSPC) was used to simulate both flow and water quality, from non-point and point sources in watersheds. LSPC was used to simulate various water quality parameters including temperature, dissolved oxygen, and nutrients.

EFDC

The Environmental Fluid Dynamics Code (EFDC) was used to simulate both flow and water quality in lakes and estuaries. EFDC was used to simulate various water quality parameters including temperature, dissolved oxygen, nutrients, and chlorophyll-a.

WATER QUALITY STANDARDS

For DO, the state cold water fishing standard that applies to Georgia's streams that have been designated as either primary or secondary trout streams is a daily average of 6.0 mg/L not less than 5.0 mg/L. The freshwater fishing standard, which applies in all areas of the state that support warm water fish species, is a daily average of 5.0 mg/L not less than 4.0 mg/L. The coastal fishing DO standard is a daily average of 5.0 mg/L not less than 4.0 mg/L unless the natural DO is less than these values and then the standard allows for a 0.1 mg/L deficit or up to a 10% deficit if the biological community is not adversely effected.

Below the fall line in the Coastal Plain, it is recognized that there can be streams with naturally low DO levels in the summertime. For these waters, EPD has allowed a 10% deficit down to 3.0 mg/L and below 3.0 mg/L, a 0.1 mg/L DO deficit.

There are six lakes in Georgia that have lake standards, Lanier, West Point, Walter F. George, Jackson, Allatoona and Carters. The 1992 Georgia Lake Law required that standards be set for growing season average chlorophyll *a* levels, major tributary annual total phosphorus loads, total lake phosphorus loading, and a total nitrogen limit for the lake. In addition, the law required standards be set for DO, temperature, pH, and fecal coliform, but only chlorophyll *a* and nutrient standards were examined. In this addendum, results are available for Lakes Lanier, West Point and Walter F. George. The associated water quality standards for these lakes can be found in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17). Results are also available for Lakes Seminole and Blackshear; however, lake standards have not been set for these.

DISSOLVED OXYGEN RESULTS

Dosag and GaEst models were developed for those waterbodies that currently have wastewater treatment plant discharges on them. For future discharges, these tools will be expanded to include additional stream segments if necessary. These models were calibrated to measured streamflow, instream DO levels, and chemical sampling data. Baseline critical, low flow (7Q10), high temperature condition models were run using 2007 discharge data. The results of these models were compared to the applicable Georgia DO standards. The following table provides a summary of the results for the Chattahoochee and Flint River basins.

River Basin	Available Assimilative Capacity (River Miles)					
	Very Good	Good	Moderate	Limited	At Assimilative Capacity	None or Exceeded
Chattahoochee	436	108	52	6	0	0
Flint	551	305	74	22	1	8
Total	987	413	126	28	1	8

NUTRIENT RESULTS

LSPC watershed models were developed for the Chattahoochee and Flint River watersheds. The watershed models were simulated for the 10-year period from January 1, 1998 through December 31, 2007. This time period was selected as it captured two drought periods (1999-2001 and 2006-2007) and several wet years including 2003 and 2005. The models were calibrated to DO, temperature, sediment and nutrients.

EFDC models were developed for lakes Lanier, West Point, Walter F. George, Seminole and Blackshear. The simulation period for the models was over a 7-year period – from January 1, 2001 through December 31, 2007. This period was chosen because it overlaps the data collection efforts by GAEPD, which occur monthly during the growing season (April through October). The models were calibrated to water level, DO, temperature, nutrients, and chlorophyll-a.

Lake Lanier

The EFDC model results show that Lake Lanier exceeded its growing season average concentration of chlorophyll *a* in 3 out of 5 stations (Flowery Branch, Browns Bridge and Lanier Bridge). The primary years of violation are 2003 and 2007. Lake Lanier is meeting its total nitrogen, annual total phosphorus loading, and its annual total phosphorus tributary loading standard, at all stations, in all years.

West Point Lake

West Point Lake is meeting its growing season average concentration of chlorophyll *a* at the Intake station every year. West Point Lake exceeded its total nitrogen standard in 2001 and 2002. West Point Lake is meeting its annual total phosphorus loading standard, and it is also meeting annual total phosphorus tributary loading for all years.

Lake Walter F. George

Lake Walter F. George is exceeding its growing season average concentration of chlorophyll *a* at the Mid-Lake station, 3 out of 7 years (2002, 2006 and 2007); however, it is meeting the growing season average concentration of chlorophyll *a* at the Forebay station. Lake Walter F. George exceeded its total nitrogen standard (3 mg/l) in 2001. Lake Walter F. George is meeting its annual total phosphorus loading standard, and it is also meeting annual total phosphorus tributary loading for all years.

Lake Seminole

There are no lake specific standards for Lake Seminole. Lake Seminole has a range of growing season average concentration of chlorophyll *a* of 2.4 to 15.1 μg/L at the Mid-Lake station and 8.3 to 11.5 μg/L at the Forebay station. Lake Seminole never exceeded a total nitrogen value of 4 mg/l and in three years exceeded 3 mg/l. The annual total phosphorus loading in Lake Seminole ranges from 4.7 to 11.1 lbs/acre-foot.

Lake Blackshear

There are no lake specific standards for Lake Blackshear. Lake Seminole has a range of growing season average concentration of chlorophyll *a* of 2.1 to 8.5 μg/L at the Mid-Lake station and 3.9 to 5.0 μg/L at the Forebay station. Lake Blackshear never exceeded a total nitrogen value of 3 mg/l. The annual total phosphorus loading in Lake Blackshear ranges from 2.3 to 6.0 lbs/acre-foot.

CONCLUSIONS

All of the results in this assessment are based on current wastewater discharges and water withdrawals. The draft results for the Assimilative Capacity Resource Assessment indicate that of the over 1,500 river miles evaluated for dissolved oxygen in the Chattahoochee and Flint River basins, 90% have Good to Very Good assimilative capacity for dissolved oxygen. This means many of these streams have greater than 0.5 mg/L of dissolved oxygen above the standard and/or natural dissolved oxygen levels and will likely be able to assimilate additional wastewater discharges in the future; although, downstream effects will still need to be evaluated using the modeling tools developed. Of the 10% of streams miles that have Moderate to No assimilative capacity, which means these streams have 0.5 mg/L or less available dissolved oxygen, most of these streams are located in South Georgia, below the fall line, where the topography is flat and reaeration is low.

Of the five lakes evaluated, only three, Lanier, West Point and Walter F. George, have nutrient and chlorophyll a standards. Model results indicate that Lake Lanier and Lake Walter F. George exceeded their growing season average concentration of chlorophyll *a* at a few stations. West Point Lake and Lake Walter F. George exceeded its maximum total nitrogen value in at least one year. All three lakes met their annual total phosphorus loading and their annual total phosphorus tributary loading. For the other two lakes in this assessment, Lake Seminole and Lake Blackshear, results indicate that the lakes are in good condition when the growing season average concentration of chlorophyll *a* and the maximum total nitrogen is evaluated.

1.0 INTRODUCTION

In support of the Georgia Comprehensive State-wide Water Management Plan (GA State Water Plan), the Surface Water Quality (or Assimilative Capacity) Resource Assessment was used to determine the capacity of Georgia's surface waters to absorb pollutants without unacceptable degradation of water quality. Assimilative Capacity is defined as the amount of contaminant load that can be discharged to a specific waterbody without exceeding water quality standards or criteria. In other words, the assimilative capacity is used to define the ability of a waterbody to naturally absorb and use a discharged substance without water quality becoming impaired or aquatic life being harmed. The assimilative capacity resource assessment included developing water quality models of selected streams, rivers, lakes and estuaries throughout the State of Georgia.

The current assimilative capacity results focus on dissolved oxygen, nutrients, specifically nitrogen and phosphorus, and chlorophyll-a, under current conditions. The water quality models were used to evaluate the impacts of current wastewater and industrial discharges and withdrawals, land use, and meteorological conditions on the waterbody.

In March 2010, a synopsis of the assimilative capacity assessment based on current conditions was released for public review and comment. Titled Review Draft: Synopsis Report Current Assimilative Capacity Assessment, the synopsis provided a basic description of the water quality models and presented current conditions results for dissolved oxygen and nutrients from the models completed as of that date. Since that time, additional modeling has been completed for the Chattahoochee and Flint river basins. This addendum summarizes those models and presents the full set of current assimilative capacity results for in the Chattahoochee and Flint basins (see Figure 1-1). This includes stream, river, watershed, and lake models.

Section 2 of this addendum presents an overview of the models developed for the resource assessment. Section 3 and 4 present the detailed results of the dissolved oxygen and nutrient analysis, respectively. Appendix A presents a detailed description of the model methodology and modeling assumptions that were made. Appendix B and C present more results from the dissolved oxygen and nutrient analysis, respectively.

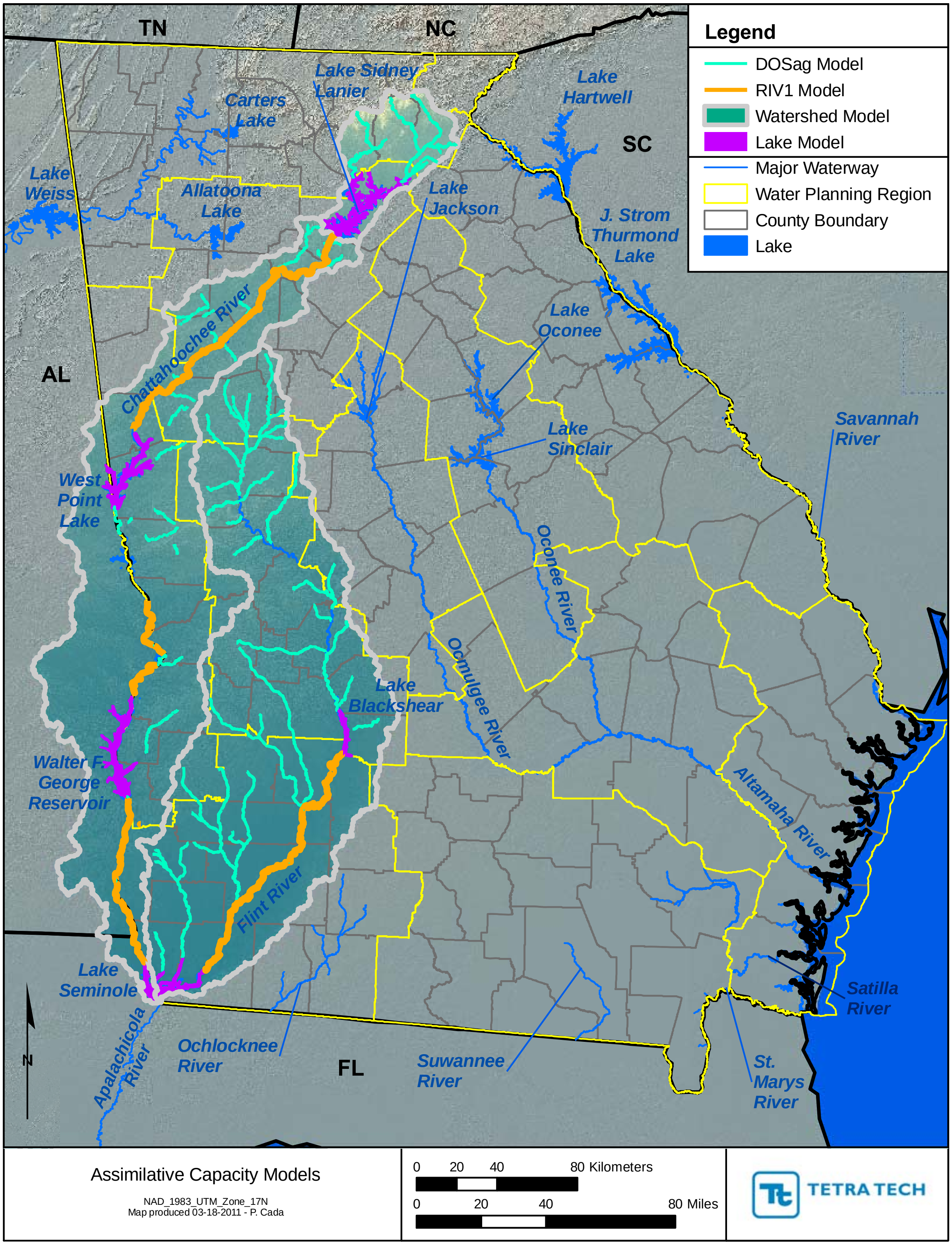

Figure 1-1 Available Assimilative Capacity Models

2.0 MODELS USED FOR RESOURCE ASSESSMENT

The following section briefly describes the models that were used for the Assimilative Capacity Resource Assessment in the Chattahoochee and Flint river basins along with a summary of how the models were calibrated. For a more detailed description of the model methodology and modeling assumptions, refer to Appendix A.

2.1 GA Dosag

Georgia Dosag is a steady-state, one-dimensional Streeter-Phelps model originally developed in 1976 by EPD in cooperation with the Georgia District of the U.S. Geological Survey. The primary purpose of the model is to predict dissolved oxygen (DO) concentrations in a branching river system, taking into account carbonaceous and nitrogenous biochemical oxygen demand (BOD) contributions from headwater inflow, tributary inflows, lateral inflows, benthic demand, and multiple wastewater discharges.

2.2 EPDRiv1

EPDRiv1 is a dynamic one-dimensional (longitudinal) water quality model for streams based on the U.S. Army Corps of Engineers' CE-QUAL-RIV1 developed by the Waterways Experiment Station. GAEPD used the original CE-QUAL-RIV1 computer code consisting of separate hydrodynamic (RIV1H) and water quality (RIV1Q) programs as the computational engine in developing a modeling system that also includes a model preprocessor, post-processor, and other model development tools.

2.3 LSPC

The Loading Simulation Program C++ (LSPC) is a comprehensive data management and modeling system that is capable of representing loading, both flow and water quality, from non-point and point sources, and simulating in-stream processes. It is capable of simulating flow, sediment, metals, nutrients, pesticides, and other conventional pollutants, as well as temperature and pH for pervious and impervious lands and waterbodies. LSPC was used to represent the hydrological and water quality conditions in the watersheds and was configured to simulate the watershed as a series of hydrologically connected sub-watersheds.

2.4 EFDC

The Environmental Fluid Dynamics Code (EFDC) is a hydrodynamic and water quality modeling package for simulating one-dimensional, two-dimensional, and three-dimensional flow and transport in surface water systems including: rivers, lakes, estuaries, reservoirs, wetlands, and nearshore to shelf scale coastal regions. The EFDC model was originally developed for estuarine and coastal applications and is considered public domain software. The three-dimensional hydrodynamics and water quality of lakes and estuaries were modeled using EFDC.

2.5 Model Calibration and Validation

Each model went through a rigorous calibration and validation process. Calibration of each of the models was performed by adjusting model parameters, within reasonable constraints, until an acceptable agreement was achieved between simulated and measured flow and water quality data. The model parameters were adjusted based on local knowledge, previous experience, literature data, and best professional judgment. Model validation is the process of taking the model parameters that have been calibrated, applying those parameters to other areas or time periods, and comparing the simulated and measured flow and water quality data. Model validation is sometimes called model verification, as essentially you are validating or verifying that model parameters calibrated in one model will produce acceptable results in another model. The measured data used in the calibration and validation process were collected from various sources including but not limited to USGS flow gages, GAEPD water quality sampling stations (both stream, river and lake), and local watershed studies.

2.6 Model Calibration Reports

The following reports present the detailed calibration and validation of the various models that were developed and used for the Assimilative Capacity Resource Assessment.

- *GA Dosag Modeling Report, January 31, 2011*
- *Watershed Hydrology and Water Quality Modeling Report for Lake Lanier, Georgia – REV3, October 31, 2010*
- *Watershed Hydrology and Water Quality Modeling Report for the Chattahoochee River Watershed, Georgia – REV0, November 30, 2010*
- *Watershed Hydrology and Water Quality Modeling Report for the Flint River Watershed, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Lake Lanier, Georgia – REV2, October 31, 2010*
- *Hydrodynamic and Water Quality Modeling Report for West Point Lake, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Lake Walter F. George, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Lake Seminole, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Lake Blackshear, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Middle Chattahoochee River, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Lower Chattahoochee River, Georgia – REV0, November 30, 2010*
- *Hydrodynamic and Water Quality Modeling Report for Flint River River, Georgia – REV0, November 30, 2010*

3.0 DISSOLVED OXYGEN RESULTS

The following section presents the dissolved oxygen results for the Current Assimilative Capacity Resource Assessment. More details results are presented in Appendix B.

3.1 Water Quality Standards

The criteria for dissolved oxygen (DO) that is applicable to all waters within the State, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(6)(ii) is: A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for water supporting warm water species of fish.

The specific criteria for dissolved oxygen in Georgia's lakes including Lanier, West Point, Walter F. George, Seminole and Blackshear as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17) is: A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times at the depth specified in 391-3-6-.03(5)(g).

GA EPD has a modeling strategy that is used for developing wasteload allocations in areas where the natural DO lower that the warm water Fishing DO criteria. It allows for a 10% deficit in waters where the natural DO is above 3.3 mg/L and 0.1 mg/L deficit in waters where the natural DO is 3.3 mg/L or below.

The following figure presents the scale that was used to show the dissolved oxygen results available above the standard or the natural DO in the streams that were modeled.

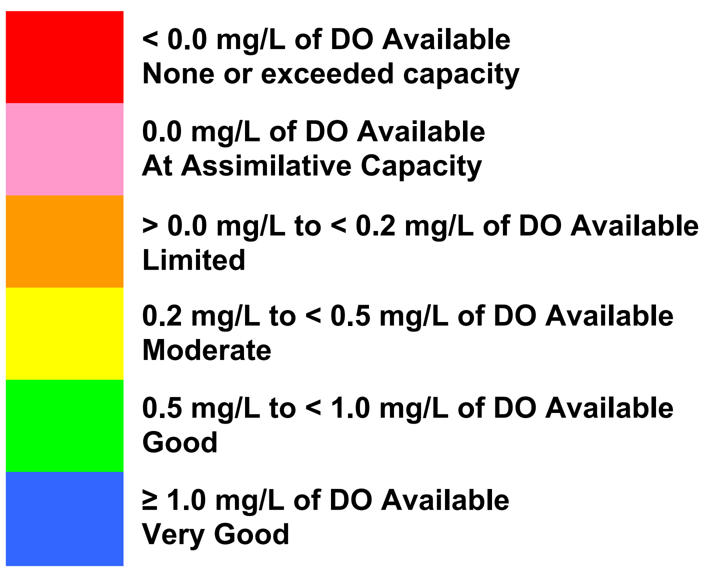

Figure 3-1 Description of Dissolved Oxygen Results

3.2 Chattahoochee River Watershed

Figure 3-2 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Chattahoochee River Basin.

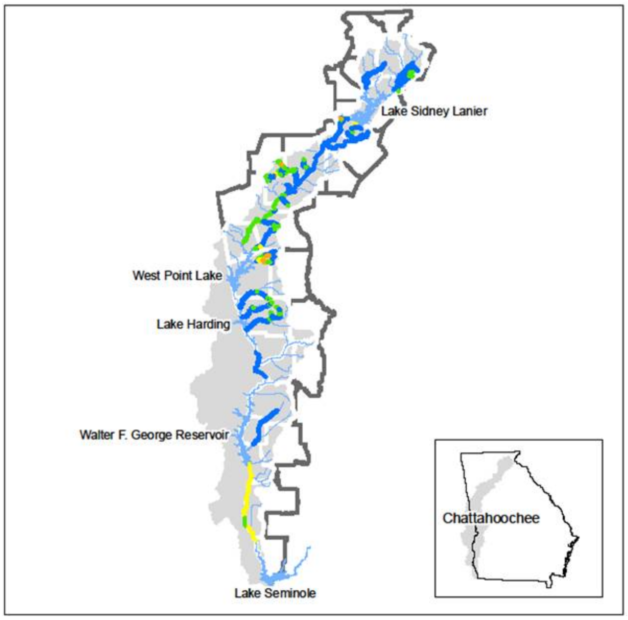

Figure 3-2 Results of Dissolved Oxygen Models in the Chattahoochee River Watershed

3.3 Flint and Ochlocknee River Watersheds

Figure 3-3 shows the results of the DO assimilative capacity analysis for all the streams that were modeled in the Flint and Ochlocknee River Basins.

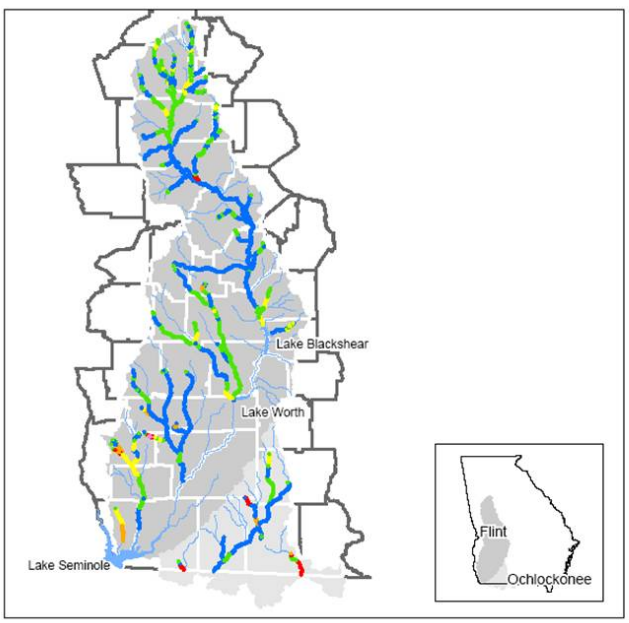

Figure 3-3 Results of Dissolved Oxygen Models in the Flint and Ochlocknee River Watersheds

4.0 NUTRIENT RESULTS

The following section presents the nutrient results for the Current Assimilative Capacity Resource Assessment. More details results, including cumulative watershed loading, are presented in Appendix C.

4.1 Water Quality Standards

The applicable water quality standards that were used for the Current Assimilative Capacity Resource Assessment are presented below.

4.1.1 Lake Lanier

The Lake (Sidney) Lanier specific criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(e) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed the chlorophyll *a* concentrations at the locations listed below more than once in a five-year period:

1.	Upstream from the Buford Dam forebay	5 μg/L
2.	Upstream from the Flowery Branch confluence	5 μg/L
3.	At Browns Bridge Road (State Road 369)	5 μg/L
4.	At Bolling Bridge (State Road 53) on Chestatee River	10 μg/L
5.	At Lanier Bridge (State Road 53) on Chattahoochee River	10 μg/L

(iii) Total Nitrogen: Not to exceed 4.0 mg/L as nitrogen in the photic zone.

(iv) Phosphorous: Total lake loading shall not exceed 0.25 pounds per acre-foot of lake volume per year.

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading to Lake Sidney Lanier shall not exceed the following:

1.	Chattahoochee River at Belton Bridge Road:	178,000 lbs/yr
2.	Chestatee River at Georgia Highway 400:	118,000 lbs/yr
3.	Flat Cree at McEver Road:	14,400 lbs/yr

4.1.2 West Point Lake

The West Point Lake specific criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(a) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed 27 μg/L at the LaGrange Water Intake more than once in a five-year period.

(iii) Total Nitrogen: Not to exceed 4.0 mg/L as nitrogen in the photic zone.

(iv) Phosphorous: Total lake loading shall not exceed 2.4 pounds per acre-foot of lake volume per year.

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading to West Point Lake shall not exceed the following:

1.	Yellow Jacket Creek at Hammet Road:	11,000 lbs/yr
2.	New River at Hwy 100:	14,000 lbs/yr
3.	Chattahoochee River at U.S. 27:	1,400,000 lbs/yr

4.1.3 Lake Walter F. George

The Lake Walter F. George specific criteria for nutrients and chlorophyll *a*, as stated in Georgia's Rules and Regulations for Water Quality Control, Chapter 391-3-6-.03(17)(b) are:

(i) Chlorophyll *a*: For the months of April through October, the average of monthly mid-channel photic zone composite samples shall not exceed 18 μg/L at mid-river at U.S. Highway 82 or 15 ug/L at mid-river in the dam forebay more than once in a five-year period.

(iii) Total Nitrogen: Not to exceed 3.0 mg/L as nitrogen in the photic zone.

(iv) Phosphorous: Total lake loading shall not exceed 2.4 pounds per acre-foot of lake volume per year.

(viii) Major Lake Tributaries: For the following major tributaries, the annual total phosphorous loading to Lake Walter F. George shall not exceed the following:

1.	Chattahoochee River at Georgia Highway 39:	2,000,000 lbs/yr

4.2 Lake Results

4.2.1 Lake Lanier

Chlorophyll *a*

Table 4-1 shows the calibrated modeled growing season average chlorophyll levels for Lake Lanier. The bolded values indicate the locations and years where the model predicted the lake did not meet its chlorophyll a standards.

Table 4-1 Lake Lanier Growing Season Average Chlorophyll a (ug/L)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Lanier Dam Pool (Station 12049001)	5	3.8	4.1	4.6	3.9	4.9	3.9	3.9
Lake Lanier Upstream of Flowery Branch (Station 12039401)	5	5.0	4.8	**6.1**	4.7	**5.9**	4.8	4.5
Lake Lanier at Browns Bridge (Station 12038001)	5	**5.3**	**5.7**	**7.0**	4.9	**7.2**	4.9	4.8
Lake Lanier at Bolling Bridge (Station 12037001)	10	6.1	6.5	8.3	5.3	8.1	5.5	5.2
Lake Lanier at Lanier Bridge (Station 12030201)	10	7.5	8.0	**10.8**	6.6	**11.1**	6.5	6.9
Lake Lanier at Little River Embayment (Station 12030161)	N/A	9.4	9.9	14.6	8.2	14.9	8.1	8.3
Lake Lanier at Flat Creek Embayment (Station 12038651)	N/A	6.4	5.8	8.4	5.7	7.8	5.6	5.1
Lake Lanier at Balus Creek Embayment (Station 12038681)	N/A	5.8	5.4	7.5	5.2	6.8	5.2	4.8
Lake Lanier at Mud Creek Embayment (Station 12038801)	N/A	6.3	5.9	8.1	5.6	7.4	5.6	5.3
Lake Lanier at Six Mile Creek Embayment (Station 12039621)	N/A	5.7	6.0	7.0	5.6	7.2	5.5	5.4

Total Nitrogen

Figure 4-1 shows the maximum simulated Total Nitrogen in Lake Lanier during 2007.

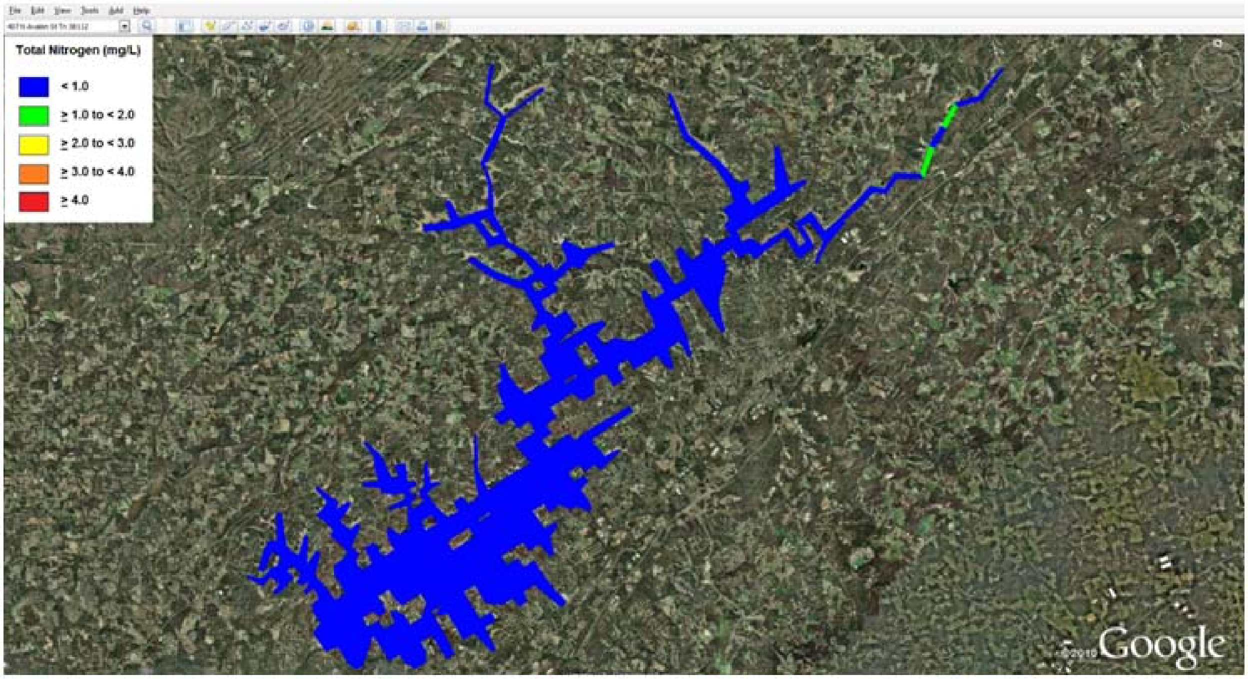

Figure 4-1 Maximum Value of Total Nitrogen (mg/L) in Lake Lanier in Photic Zone: year 2007

Total Phosphorus

Table 4-2 shows the annual Total Phosphorus loading into Lake Lanier. All years are simulating below the standard of 0.25 lbs/acre-ft.

Table 4-2 Lake Lanier Annual Total Phosphorus Loading

	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Volume (Acre-Ft)		2,232,478	2,344,835	2,642,289	2,616,349	2,623,581	2,435,960	2,330,955
Annual Load of Phosphorus (lbs)		130,903	160,677	212,971	187,740	182,855	127,650	77,237
Specific Loading (lbs/Acre-Ft)	0.25	0.06	0.07	0.08	0.07	0.07	0.05	0.03

Major Tributary Phosphorus Loading

Table 4-3 shows the annual tributary loading simulated at the three tributary compliance points. All years are simulating below the standard.

Table 4-3 Lake Lanier Watershed Annual Tributary Total Phosphorus Loads (lbs)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ Belton Bridge Road	178,000	49,100	67,000	96,700	92,200	89,500	61,900	37,500
Chestatee River @ Georgia Highway 400	118,000	23,500	32,100	42,800	32,300	29,900	27,400	13,800
Flat Creek @ McEver Road	14,400	12,000	11,900	13,400	12,300	9,100	3,500	3,400

Table 4-4 shows the calculated loading (lbs/acre) for each of the tributary compliance points, and Table 4-5 shows the simulated loading (lbs/acre/year). All years are simulating below the standard.

Table 4-4 Lake Lanier Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Standard (lbs/year)	Area (acres)	Unit Loading Rate (lbs/acre/year)
Chattahoochee River @ Belton Bridge Road	178,000	264,885	0.672
Chestatee River @ Georgia Highway 400	118,000	144,323	0.818
Flat Creek @ McEver Road	14,400	3,602	3.998

Table 4-5 Lake Lanier Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Unit Loading Rate	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ Belton Bridge Road	0.672	0.185	0.253	0.365	0.348	0.338	0.234	0.142
Chestatee River @ Georgia Highway 400	0.818	0.163	0.222	0.297	0.224	0.207	0.190	0.096
Flat Creek @ McEver Road	3.998	3.331	3.304	3.720	3.415	2.526	0.972	0.944

4.2.2 West Point Lake

Chlorophyll *a*

Table 4-6 shows the calibrated modeled growing season average chlorophyll levels for West Point Lake. All values are below the standard.

Table 4-6 Lake Jackson Growing Season Average Chlorophyll *a* (ug/L)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Intake (Station 12180001)	27	14.6	18.0	13.2	11.1	14.3	6.3	14.4
Dam Pool/Forebay (Station 12189001)	N/A	7.7	10.9	18.0	8.9	8.5	4.1	8.6

Total Nitrogen

Figure 4-2 shows the maximum simulated Total Nitrogen in West Point Lake during 2007.

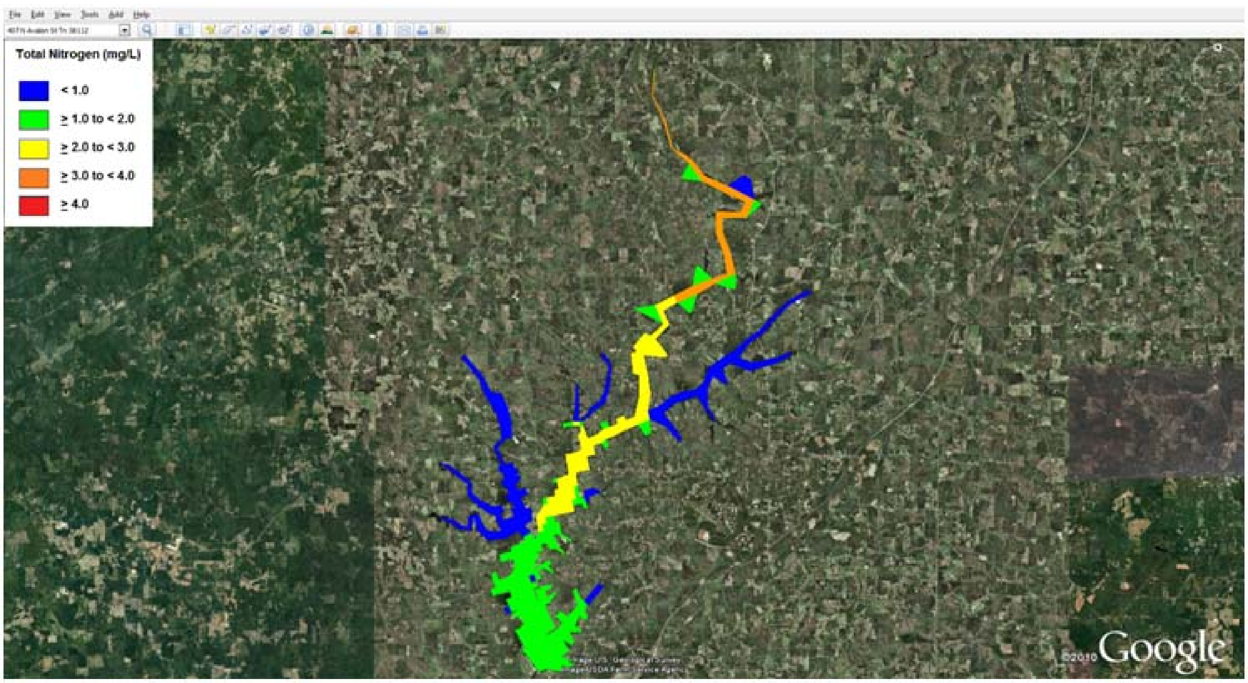

Figure 4-2 Maximum Value of Total Nitrogen (mg/L) in West Point Lake in Photic Zone: year 2007

Total Phosphorus

Table 4-7 shows the annual Total Phosphorus loading into West Point Lake. All years are simulating below the standard of 2.4 lbs/acre-ft.

Table 4-7 West Point Lake Annual Total Phosphorus Loading

	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Volume (Acre-Ft)		588,092	564,095	582,272	565,776	574,858	529,443	475,291
Annual Load of Phosphorus (lbs)		362,393	313,806	486,719	378,712	455,705	395,814	303,348
Specific Loading (lbs/Acre-Ft)	2.4	0.62	0.56	0.84	0.67	0.79	0.75	0.64

Major Tributary Phosphorus Loading

Table 4-8 shows the annual tributary loading simulated at the three tributary compliance points. All values are simulating below the standard.

Table 4-8 West Point Lake Watershed Annual Tributary Total Phosphorus Loads (lbs)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ US 27	1,400,000	341,600	298,200	447,100	356,900	424,800	382,800	299,500
New River @ GA 100	14,000	5,900	5,700	10,400	8,100	8,600	5,700	4,200
Yellow Jacket Creek downstream of Hammet Road	11,000	2,800	2,300	4,800	2,700	3,600	1,600	1,200

Table 4-9 shows the calculated loading (lbs/acre) for each of the tributary compliance points, and Table 4-10 shows the simulated loading (lbs/acre/year). All values are simulating below the standard.

Table 4-9 West Point Lake Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Standard (lbs/year)	Area (acres)	Unit Loading Rate (lbs/acre/year)
Chattahoochee River @ US 27	1,400,000	1,712,565	0.817
New River @ GA 100	14,000	80,034	0.175
Yellow Jacket Creek downstream of Hammet Road	11,000	62,025	0.177

Table 4-10 West Point Lake Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Unit Loading Rate	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ US 27	0.817	0.199	0.174	0.261	0.208	0.248	0.224	0.175
New River @ GA 100	0.175	0.074	0.071	0.130	0.101	0.107	0.071	0.052
Yellow Jacket Creek downstream of Hammet Road	0.177	0.045	0.037	0.077	0.044	0.058	0.026	0.019

4.2.3 Lake Walter F. George

Chlorophyll *a*

Table 4-11 shows the calibrated modeled growing season average chlorophyll levels for Lake Walter F. George. The bolded values indicate the locations and years where the model predicted the lake did not meet its chlorophyll a standards.

Table 4-11 Lake Walter F. George Growing Season Average Chlorophyll *a* (ug/L)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Forebay – GAEPD Station (Station 12219501)	15	7.6	7.9	5.7	7.5	8.1	9.3	9.2
Mid-Lake - GAEPD Station (Station 12219101)	18	17.0	**20.9**	4.8	13.0	5.6	**20.1**	**22.4**
Upper-Lake – ADEM Station (Station GEOH-6)	N/A	9.4	116	1.2	7.3	.9	14.0	13.7

Total Nitrogen

Figure 4-3 shows the maximum simulated Total Nitrogen in Lake Walter F. George during 2007.

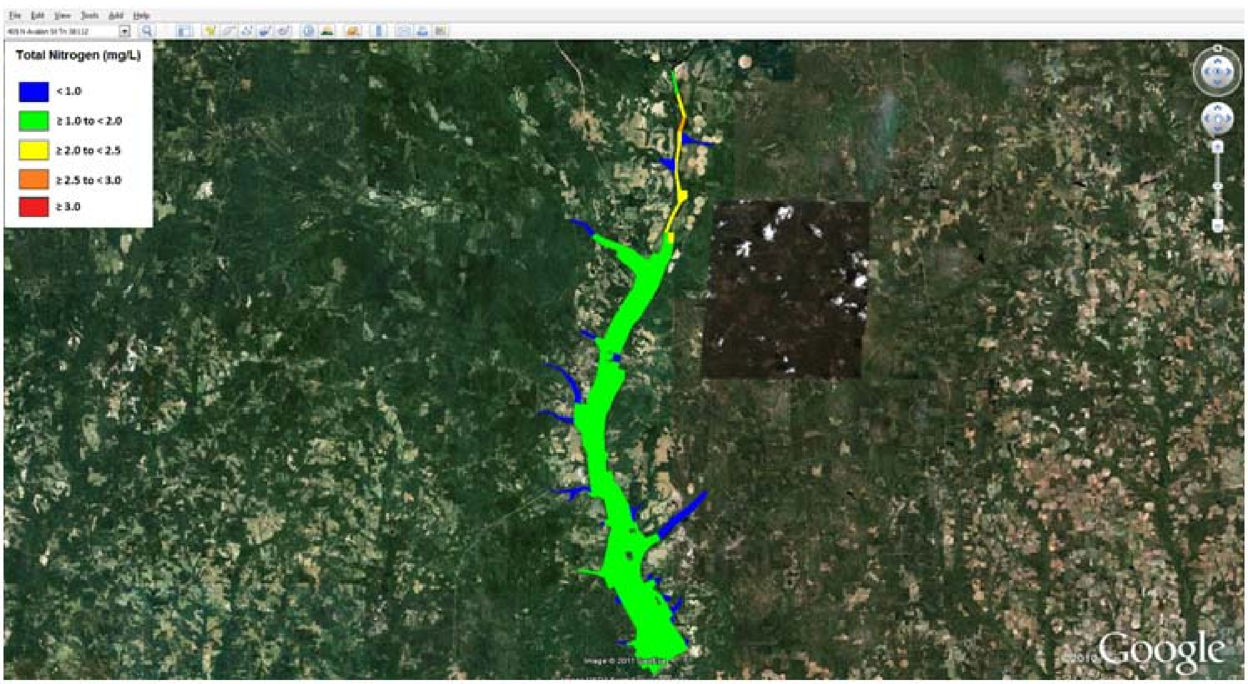

Figure 4-3 Maximum Value of Total Nitrogen (mg/L) in Lake Walter F. George in Photic Zone: year 2007

Total Phosphorus

Table 4-12 shows the annual Total Phosphorus loading into Lake Walter F. George. All years are simulating below the standard of 2.4 lbs/acre-ft.

Table 4-12 Lake Walter F. George Annual Total Phosphorus Loading

	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Volume (Acre-Ft)		879,138	847,039	907,370	890,473	898,739	857,803	819,176
Annual Load of Phosphorus (lbs)		875,061	651,551	1,248,618	945,150	1,357,315	871,123	664,309
Specific Loading (lbs/Acre-Ft)	2.4	1.00	0.77	1.38	1.06	1.51	1.02	0.81

Major Tributary Phosphorus Loading

Table 4-13 shows the annual tributary loading simulated at the tributary compliance point. All values are simulating below the standard.

Table 4-13 Lake Walter F. George Watershed Annual Tributary Total Phosphorus Loads (lbs)

Station	Standard	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ GA HWY 39	2,000,000	550,200	452,700	688,700	568,300	777,700	629,000	496,800

Table 4-14 shows the calculated loading (lbs/acre) for each of the tributary compliance points, and Table 4-15 shows the simulated loading (lbs/acre/year). All values are simulating below the standard.

Table 4-14 Lake Walter F. George Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Standard (lbs/year)	Area (acres)	Unit Loading Rate (lbs/acre/year)
Chattahoochee River @ GA HWY 39	2,000,000	3,800,689	0.526

Table 4-15 Lake Walter F. George Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Unit Loading Rate	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ GA HWY 39	0.526	0.145	0.119	0.181	0.150	0.205	0.165	0.131

4.2.3 Lake Seminole

There are no lake specific standards for Lake Seminole. The major tributary phosphorus loading was determined for four tributaries to Lake Seminole.

Chlorophyll *a*

Table 4-16 shows the calibrated modeled growing season average chlorophyll levels for Lake Seminole.

Table 4-16 Lake Seminole Growing Season Average Chlorophyll *a* (ug/L)

Station	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Forebay(Station 12900001)	11.1	10.3	10.1	11.5	9.9	8.6	8.3
Mid-Lake (Station 12650001)	9.9	15.1	2.4	6.8	3.1	11.6	14.7

Total Nitrogen

Figure 4-4 shows the maximum simulated Total Nitrogen in Lake Seminole during 2007.

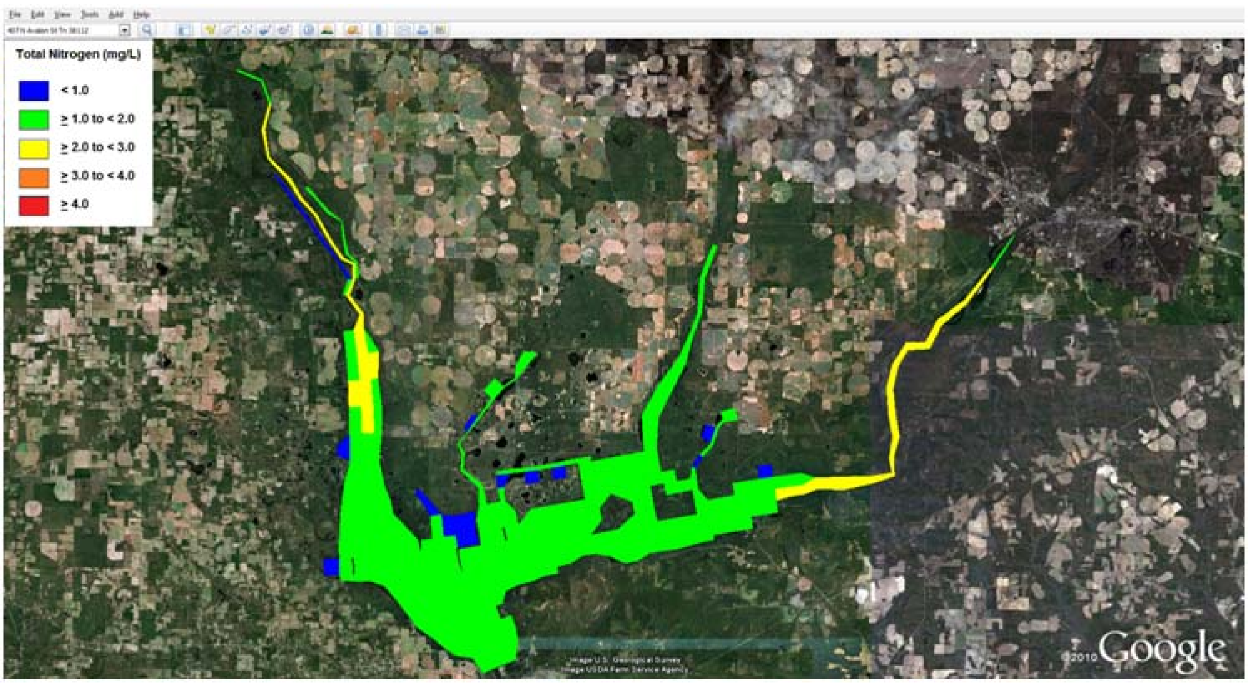

Figure 4-4 Maximum Value of Total Nitrogen (mgN/L) in Lake Seminole in Photic Zone: year 2007

Total Phosphorus

Table 4-17 shows the annual Total Phosphorus loading into Lake Seminole.

Table 4-17 Lake Seminole Annual Total Phosphorus Loading

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Volume (Acre-Ft)	353,695	351,169	368,498	356,527	364,363	348,106	347,457
Annual Load of Phosphorus (lbs)	2,452,396	1,875,031	3,556,289	2,737,601	4,042,925	2,050,884	1,632,905
Specific Loading (lbs/Acre-Ft)	6.93	5.34	9.65	7.68	11.10	5.89	4.70

Major Tributary Phosphorus Loading

Table 4-18 shows the annual tributary loading simulated at four tributaries to Lake Seminole, and Table 4-19 shows the annual loading (lbs/acre/year) at each of the tributaries.

Table 4-18 Lake Seminole Watershed Annual Tributary Total Phosphorus Loads (lbs)

Station	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ Lake Seminole	532,400	446,700	673,200	573,400	773,300	593,200	448,800
Flint River @ Lake Seminole (Bainbridge Ga)	452,500	401,500	583,400	492,400	578,800	346,100	322,600
Spring Creek @ Lake Seminole	15,300	16,900	40,100	30,900	59,900	27,300	26,100
Fishpond Drain @ Lake Seminole	6,000	7,600	12,300	9,300	18,000	7,200	5,300

Table 4-19 Lake Seminole Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Area (acres)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Chattahoochee River @ Lake Seminole	5,467,733	0.097	0.082	0.123	0.105	0.141	0.108	0.082
Flint River @ Lake Seminole (Bainbridge Ga)	4,832,538	0.094	0.083	0.121	0.102	0.120	0.072	0.067
Spring Creek @ Lake Seminole	401,713	0.038	0.042	0.100	0.077	0.149	0.068	0.065
Fishpond Drain @ Lake Seminole	60,061	0.100	0.127	0.205	0.155	0.300	0.120	0.088

4.2.4 Lake Blackshear

There are no lake specific standards for Lake Blackshear.

Chlorophyll *a*

Table 4-20 shows the calibrated modeled growing season average chlorophyll levels for Lake Blackshear.

Table 4-20 Lake Blackshear Growing Season Average Chlorophyll *a* (ug/L)

Station	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Forebay	4.3	4.5	4.0	4.8	3.9	5.0	4.9
Mid-Lake	5.9	5.9	2.1	5.8	2.2	6.0	8.5

Total Nitrogen

Figure 4-5 shows the maximum simulated Total Nitrogen in Lake Blackshear during 2007.

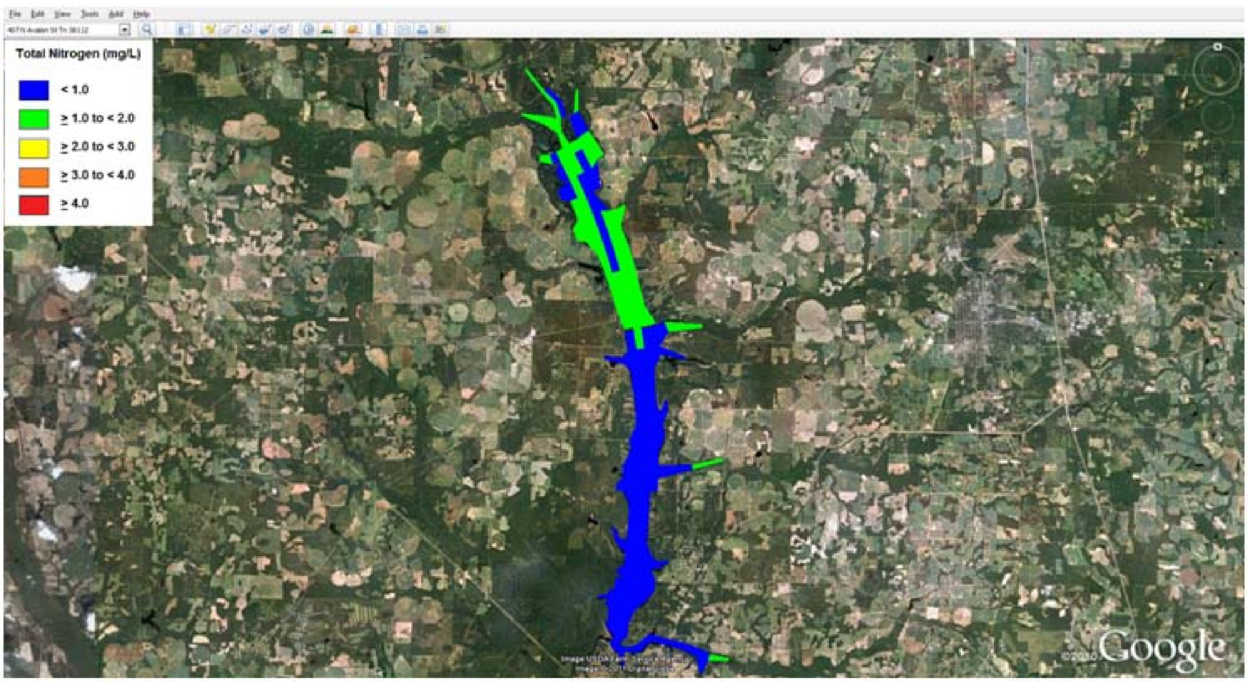

Figure 4-5 Maximum Value of Total Nitrogen (mgN/L) in Lake Blackshear in Photic Zone: year 2007

Total Phosphorus

Table 4-21 shows the annual Total Phosphorus loading into Lake Blackshear.

Table 4-21 Lake Blackshear Annual Total Phosphorus Loading

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Lake Volume (Acre-Ft)	100,934	100,733	101,368	101,017	101,429	100,712	100,690
Annual Load of Phosphorus (lbs)	341,977	286,112	573,247	457,230	604,458	252,616	233,048
Specific Loading (lbs/Acre-Ft)	3.39	2.84	5.66	4.53	5.96	2.51	2.31

Major Tributary Phosphorus Loading

Table 4-22 shows the annual tributary loading simulated at the main stem of the Flint River coming into Lake Blackshear, and Table 4-23 shows the annual loading (lbs/acre/year) at each of the tributaries.

Table 4-22 Lake Blackshear Watershed Annual Tributary Total Phosphorus Loads (lbs)

Station	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Flint River at Lake Blackshear (EFDC Input)	153,700	141,500	244,600	200,600	251,100	132,600	118,600

Table 4-23 Lake Blackshear Watershed Annual Tributary Total Phosphorus Loads (lbs/acre/year)

Station	Area (acres)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Flint River at Lake Blackshear (EFDC Input)	2,227,060	0.069	0.064	0.110	0.090	0.113	0.060	0.053

5.0 References

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