Lake Allatoona Model Scenarios

Description and Results for Nutrient Criteria Revisions

Georgia Environmental Protection Division
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Table of Contents

List of Figures

List of Tables

INTRODUCTION

The Lake Allatoona Watershed is located in northern Georgia, northeast of Atlanta (Figure 1-1). The drainage area covers 1,120 square miles and is bounded on its downstream end by Lake Allatoona and upstream end by the Tennessee Valley Divide on the Blue Ridge Mountains near Dahlonega, Georgia. Although most of the watershed is within a 50-mile radius of downtown Atlanta, land cover in the drainage area is predominantly forested. However, there are dense residential and commercial areas in the watershed near Woodstock, Roswell, Marietta, and Canton (Figure 1-2). The area is located within the region of north Georgia that is experiencing rapid development and population growth from the expanding Atlanta Metropolitan Area. It is this growth that is posing a significant threat to the environmental quality and ultimate economic sustainability of the water resources of the area. There will be an ever-increasing need to balance water resources protection while allowing for smart economic development in the local communities.

The State of Georgia recently completed a draft nutrient TMDL targeting chlorophyll *a* for parts of Lake Allatoona (April 2009). In the process of developing the TMDL for Lake Allatoona, three computer models were developed for Lake Allatoona and its watershed. The models included a watershed model, an in-lake hydrodynamic model, and an in-lake water quality model. The watershed model of Lake Allatoona was developed using the Loading Simulation Program in C++ (LSPC). This model includes all point sources that have a permitted discharge of 0.1 MGD or greater within the watershed. The watershed model simulates the effects of surface runoff on both water quality and flow and was calibrated to data collected from 2001 through 2007. The results of this model were used as tributary flow inputs in the hydrodynamic model, Environmental Fluid Dynamics Code (EFDC). EFDC was used to simulate the transport of water within the lake as well as flows into and out of Lake Allatoona. The Water Quality Analysis Simulation Program (WASP), version 7 released in April 2005 by EPA Region 4, was used to simulate the fate and transport of nutrients within the lake and the uptake by phytoplankton. The growth and death of phytoplankton is measured through a surrogate parameter called chlorophyll *a*. The WASP model was calibrated to nutrient and chlorophyll *a* concentrations measured in the lake during the 2001 through 2007 growing seasons. The EFDC and WASP models include all major point sources of nutrients within the lake. The setup, calibration and validation of these computer models are documented in the following two reports:

- *Watershed Hydrology and Water Quality Modeling Report for Lake Allatoona, Georgia (Tetra Tech 2009)*
- *Hydrodynamic and Water Quality Modeling Report for Lake Allatoona, Georgia (Tetra Tech 2009)*

Once the three models were calibrated for Lake Allatoona and its watershed, various scenarios were run and analyzed. The following section describes these scenarios.

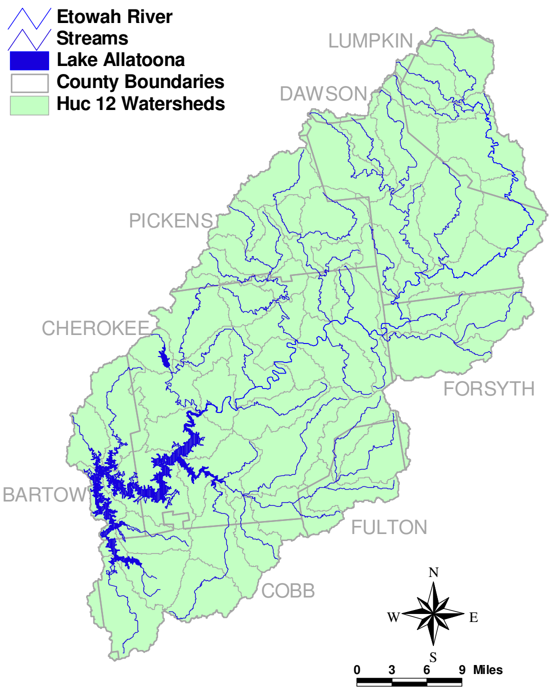

Figure 1-1 Lake Allatoona Watershed

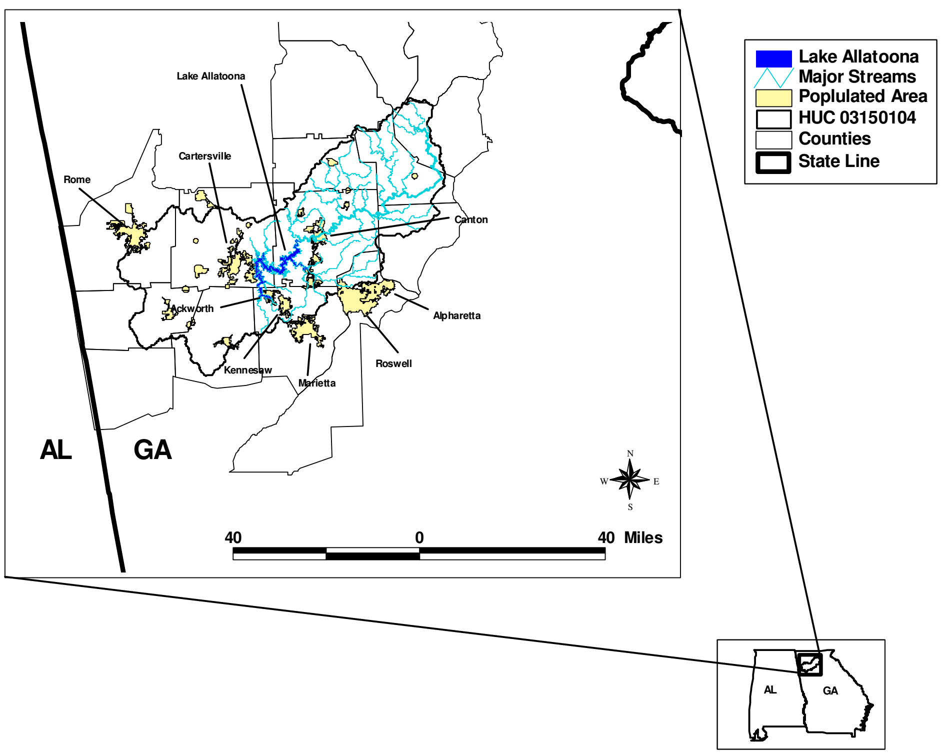

Figure 1-2 Location of Lake Allatoona

2.0 DESCRIPTION OF SCENARIOS

Seven scenarios were run using the models developed for the Lake Allatoona TMDL to explain the sources and contributions of chlorophyll *a* levels observed, and for use in establishing new nutrient criteria. For each scenario, both hydrology and water quality outputs from the LSPC model were examined at 4 tributary locations in the Lake Allatoona Watershed (Figure 2-1 and Table 2-1). The outputs were examined from January 1, 2001 through December 31, 2007. Watershed flows were evaluated based on monthly and annual average flows and percentiles of daily average flows. Watershed water quality was evaluated based on annual and monthly loading, annual and monthly concentrations, and percentiles of daily average concentrations. Watershed flows and water quality were input into the EFDC and WASP models, respectively. The outputs for the EFDC and WASP model were evaluated at five locations (Figure 2-2 and Table 2-2) around Lake Allatoona from 2001 through 2007. Results were evaluated on growing season average (April 1 through October 31). A short description of each scenario is presented below.

2.1 Scenario 1A (Calibration)

Scenario 1A was performed using the calibrated Lake Allatoona Watershed hydrology and water quality model (LSPC), the calibrated Lake Allatoona hydrodynamic model (EFDC), and the calibrated Lake Allatoona water quality model (WASP). The calibrated LSPC model was run using monthly flow data for watershed water withdrawals, as well as daily and/or monthly flow and water quality data from point source discharges. If no data were available for the point source discharges, values were input at the permitted limits, or in some cases values were assumed if no permit limit existed.

2.2 Scenario 1B (Permitted)

Scenario 1B was performed using the calibrated (Scenario 1A) Lake Allatoona Watershed hydrology and water quality model (LSPC), the calibrated Lake Allatoona hydrodynamic model (EFDC), and the calibrated Lake Allatoona water quality model (WASP) as a starting point. Point source discharges and water withdrawals were then input at their current permitted limits.

2.3 Scenario 1C (TMDL)

Scenario 1C was performed by taking Scenario 1B and reducing both the Urban nutrient loading and the Agricultural nutrient loading until all 5 lake water quality stations were in compliance with the chlorophyll *a* water quality standard.

The Allatoona Creek watershed has no point source dischargers within that arm, although it consists predominantly of forested and urban landuses. To meet the chlorophyll criteria at the Allatoona Creek station, a reduction in the nonpoint source load would be required. This was done by first reducing the Urban nutrient loading until the Allatoona Creek station (14307501, see Figure 2-2 and Table 2-2) met its water quality standard for chlorophyll *a*.

Once the Allatoona Creek station met the chlorophyll *a* standard, the same urban load reduction was applied to the rest of the Lake Allatoona watershed. Then the Agricultural nutrient loading was reduced until the Etowah River station (14302001, see Figure 2-2 and Table 2-2) met its water quality standard for chlorophyll *a*. In the end, an 85% reduction was needed in the Urban nutrient loading and a 40% reduction was needed in the Agricultural nutrient loading. In addition, failing septic tanks were reduced by 50% and the total nitrogen load from the facilities in the Little River watershed was reduced 25% based on calculated concentrations at full permit limits.

2.4 Scenario 1D (All Forested)

Scenario 1D was an all forested scenario. This scenario was performed using the calibrated (Scenario 1A) Lake Allatoona Watershed hydrology and water quality model (LSPC), the calibrated Lake Allatoona hydrodynamic model (EFDC), and the calibrated Lake Allatoona water quality model (WASP) as a starting point. Point source discharges, water withdrawals, and septic tanks were then removed and all landuse was converted to forest.

2.5 Scenario 1E (Shoal Creek Total P Load)

Scenario 1E was a Shoal Creek 12,500 lb/yr Total Phosphorus Load scenario. This scenario was performed using the Scenario 1C Lake Allatoona Watershed hydrology and water quality model (LSPC), the Lake Allatoona hydrodynamic model (EFDC), and the Lake Allatoona water quality model (WASP) as a starting point. An additional load (2,643lbs/yr) was added to Shoal Creek so that the annual Total Phosphorus load for Shoal Creek was 12,500 lbs/yr.

2.6 Scenario 1F (No Point Sources)

Scenario 1F was a No Point Source scenario. This scenario was performed using the calibrated (Scenario 1A) Lake Allatoona Watershed hydrology and water quality model (LSPC), the calibrated Lake Allatoona hydrodynamic model (EFDC), and the calibrated Lake Allatoona water quality model (WASP) as a starting point. Point source discharges and water withdrawals were then removed.

2.7 Scenario 1G (No Point Sources/No Septics)

Scenario 1G was a No Point Source or Septics scenario. This scenario was performed using the calibrated (Scenario 1A) Lake Allatoona Watershed hydrology and water quality model (LSPC), the calibrated Lake Allatoona hydrodynamic model (EFDC), and the calibrated Lake Allatoona water quality model (WASP) as a starting point. Point source discharges, water withdrawals, and septic tanks were then removed.

2.8 Scenario 1H (No Point Sources/No Septics/No Nutrient Fluxes)

Scenario 1H was a No Point Source, Septics, or Nutrient Fluxes scenario. This scenario was performed using the Scenario 1F Lake Allatoona Watershed hydrology and water quality model (LSPC), the Lake Allatoona hydrodynamic model (EFDC), and the Lake Allatoona water quality model (WASP) as a starting point. Point source discharges, water withdrawals, septic tanks, and nutrient fluxes in Lake Allatoona were then removed.

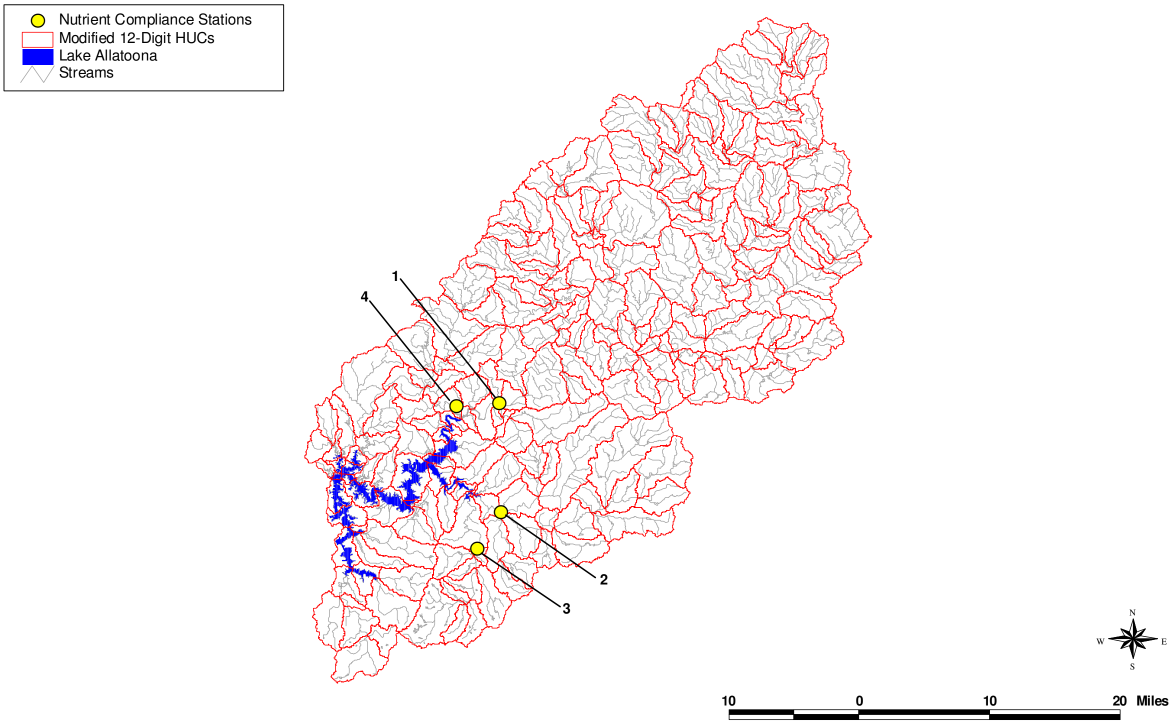

Figure 2-1 Lake Allatoona Watershed Assessment Sites

Table 2-1 Summary of Lake Allatoona Watershed Assessment Sites

Station ID	Station Name	Drainage Area (Acres)	LSPC Subbasin
1	Etowah River at State Highway 5 spur and 140, at the USGS Gage	409,685	509
2	Little River at State Highway 5 (Highway 754)	89,398	347
3	Noonday Creek at North Rope Mill Road	26,238	326
4	Shoal Creek at State Highway 108 (Fincher Road)	43,850	406

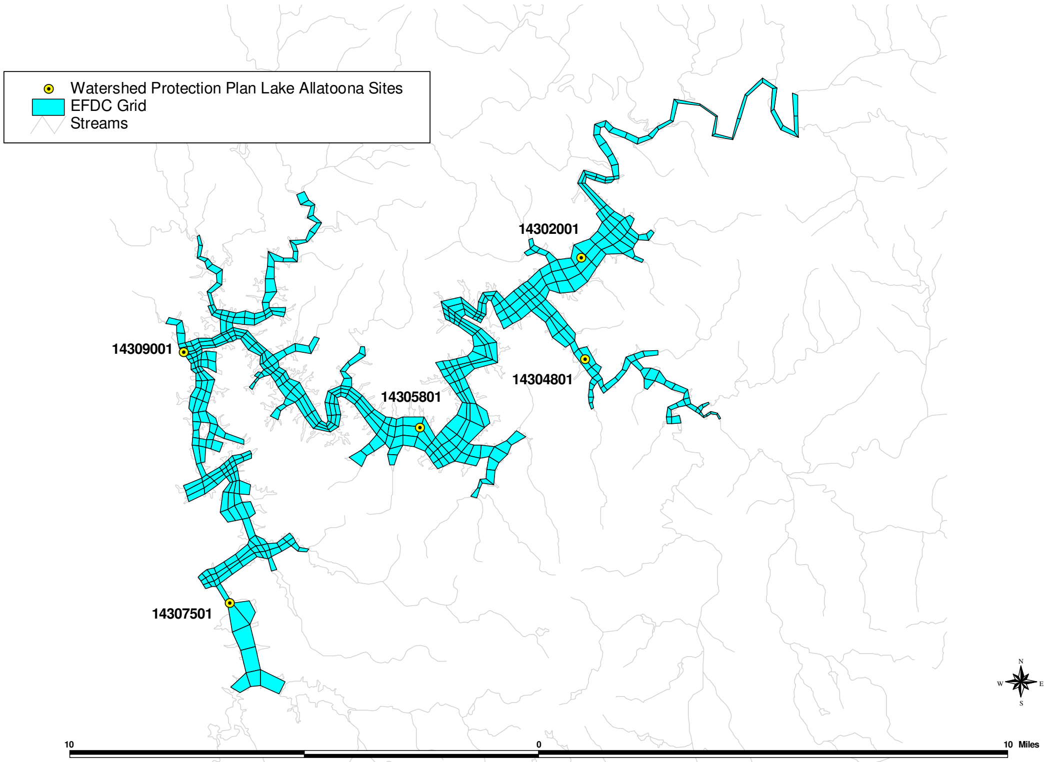

Figure 2-2 Lake Allatoona Evaluation Sites

Table 2-2 Summary of Lake Allatoona Evaluation Sites

Station Name	Station Number	EFDC Cell		WASP Segment	Layers
		I-Value	J-Value		
Etowah River Arm	14302001	17	63	420	2
Little River Embayment	14304801	23	69	463	2
Mid-Lake	14305801	31	45	266	4
Allatoona Creek Arm	14307501	58	13	28	2
Dam Pool	14309001	31	13	12	10

3.0 ANALYSIS OF SCENARIOS

3.1 Phosphorus Loading Standard

The TMDL for Lake Allatoona was based on the rate each nutrient accumulates on each landuse type. Table 3-1 provides the Total Nitrogen and Total Phosphorus accumulation loads for each landuse for the existing (Scenario 1A) and TMDL (Scenario 1C) conditions.

Table 3-1 Nutrient Landuse Accumulation Rates (lbs/day) for Scenario 1A (Calibrated) and Scenario 1C (TMDL)

		Barren	Forest	Grassland	Wetland	Pasture	Pasture Chicken	Cropland	Urban	Number of Failing Septic Tanks
Existing Condition	TN	566	51363	1600	556	12344	11659	174	13483	5090
	TP	94	8502	905	92	924	4843	13	2259	
TMDL	TN	566	51363	1600	556	7406	6996	105	2023	2545
	TP	94	8502	905	92	554	2906	8	339	
% Reduction		0%	0%	0%	0%	40%	40%	40%	85%	50%

These values are not comparable to the annual Total Phosphorus load delivered to the major tributary compliance points. To evaluate compliance with the major tributary Total Phosphorus loading standards at each compliance station, calculations are based on daily flow and monthly Total Phosphorus concentrations measured. Although the flow varies daily, the Total Phosphorus concentrations are held constant until the date of the next monthly measurement.

Table 3-2 compares the modeled calibration annual Total Phosphorus load for Scenario 1A to the actual calculated loads used for compliance for the major tributary annual Total Phosphorus load standards. In wet years (2003 and 2005), the calculated annual load is often higher than the modeled load. This may be due to the method of holding Total Phosphorus concentration constant as described above when calculating the annual major tributary load.

Table 3-2 Summary of Annual Total Phosphorus Loads (lbs/year) for Scenario 1A (Calibration) and Actual Calculated Loads (in bold)

Station	Current Standard		2001	2002	2003	2004	2005	2006	2007	Average
Etowah River @ GA 5 spur and 140	340,000	Modeled	95,306	122,157	121,631	107,972	75,762	84,926	49,396	93,879
		Calculated	**69,054**	**57,742**	**366,689**	**67,675**	**245,371**	**121,889**	**36,970**	**137,913**
Little River @ GA 5 (Hwy 754)	42,000	Modeled	20,374	27,748	31,581	25,637	23,176	22,004	15,101	23,660
		Calculated	**22,296**	**39,066**	**54,476**	**37,389**	**63,397**	**22,063**	**7,780**	**35,210**
Noonday Creek @ North Rope Mill Rd.	38,000	Modeled	36,749	38,787	42,403	37,686	36,106	25,147	15,697	33,225
		Calculated	**21,654**	**15,573**	**14,170**	**13,491**	**42,427**	**12,470**	**2,830**	**17,516**
Shoal Creek @ GA 108 (Fincher Rd.)	9,200	Modeled	5,877	11,403	12,541	9,305	6,028	6,494	3,780	7,918
		Calculated	**4,027**	**6,999**	**12,666**	**4,172**	**11,500**	**8,718**	**1,120**	**7,029**

Table 3-3 provides the modeled annual Total Phosphorus load for the major tributary compliance points for the TMDL (Scenario 1C). After the Urban, Agricultural, septic tank, and point source Total Nitrogen loading reductions were applied to the Lake Allatoona watershed, the phosphorus loading at Shoal Creek at GA 108 was still higher than the current Total Phosphorus standard of 9,200 lbs/year in 2003. It should be noted that the entire lake meets the chlorophyll *a* criteria at all five assessment sites given in Table 2-2 in this scenario. These results indicate that the original annual Total Phosphorus load standard for Shoal Creek may be too low and needs to be revised.

Table 3-3 Summary of Annual Total Phosphorus Loads for Scenario 1C (TMDL)

Station	2001	2002	2003	2004	2005	2006	2007	Average
Etowah River @ GA 5 spur and 140, at the USGS Gage	76,065	97,895	92,264	84,257	55,471	66,881	36,872	72,815
Little River @ GA 5 (Hwy 754)	13,433	18,398	19,831	16,770	13,809	13,674	10,878	15,256
Noonday Creek @ North Rope Mill Rd.	16,128	17,721	18,515	17,171	16,273	15,977	14,119	16,558
Shoal Creek @ GA 108 (Fincher Rd.)	4,128	9,085	**9,857**	7,222	4,104	4,816	2,683	5,985

The effects of various landuses on the annual Total Phosphorus load were determined by converting all landuses in the Lake Allatoona watershed to forest (Scenario 1D). Table 3-4 provides the modeled annual Total Phosphorus loads for each of the major tributaries for the all forested scenario. The all forested load for Shoal Creek in 2003 was 19% lower than the TMDL load for Shoal Creek.

Table 3-4 Summary of Annual Total Phosphorus Loads for Scenario 1D (All Forested)

Station	2001	2002	2003	2004	2005	2006	2007	Average
Etowah River @ GA 5 spur and 140, at the USGS Gage	48,121	69,914	59,999	57,130	26,066	42,243	15,830	48,121
Little River @ GA 5 (Hwy 754)	2,982	9,092	9,661	7,030	3,114	4,347	2,084	2,982
Noonday Creek @ North Rope Mill Rd.	2,792	6,390	7,202	4,665	2,406	3,153	1,192	2,792
Shoal Creek @ GA 108 (Fincher Rd.)	2,603	7,465	8,024	5,711	2,605	3,592	1,650	2,603

Table 3-5 shows that based on the 2005 landuse, the Shoal Creek watershed is approximately 83% forested. The next major landuse is agricultural making up approximately 15%. Agricultural lands have higher nutrient loading rates than forested lands; whereas, urbanized lands have increased impervious surfaces that result in higher flows during storm events. Both of these, singularly or in combination, will result in a higher annual nutrient load than an all forested scenario.

Table 3-5 Shoal Creek Watershed Landuse

Stream/Segment	Landuse Categories - Acres (Percent)													
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/Industrial/Transportation	Bare Rock/Sand/Clay	Quarries/Strip Mines/Gravel Pits	Transitional	Forest	Row Crops	Pasture/Hay	Other Grasses (Urban/Recreational; e.g. parks/lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
Shoal Creek	475 (1.1)	14 (0)	0 (0)	0 (0)	0 (0)	12 (0)	273 (0.6)	35,911 (82.9)	78 (0.2)	3,644 (8.4)	2,772 (6.4)	156 (0.4)	0 (0)	43,337 (100)

Increasing the annual Total Phosphorus Load at Shoal Creek to 12,500 lbs/year is necessary to account for the increased load due to agricultural and urban landuse changes. This new standard will be protective of the growing season average chlorophyll *a* concentrations for each assessment site in the lake (results from Model Scenario 1E) as shown in Table 3-6.

Table 3-6 Summary of Chlorophyll *a* Data (µg/L) as a result of Increasing Total P Load at Shoal Creek to 12,500 lbs/year (Scenario 1E)

Station Name	Current Standard	2001	2002	2003	2004	2005	2006	2007	Average
Etowah River Arm	12	5.2	6.4	7.4	7.8	6.3	6.0	11.2	7.2
Little River Embayment	15	5.6	9.4	4.9	6.9	4.9	6.2	14.5	7.5
Mid-Lake	10	5.2	7.3	8.3	6.4	6.0	4.3	6.4	6.3
Allatoona Creek Arm	10	3.2	5.9	10.1	5.5	5.2	3.3	6.4	5.7
Dam Pool	10	4.1	5.7	6.8	5.8	5.0	3.5	6.6	5.4

3.2 Chlorophyll *a* Standards

Scenarios 1B, 1D, 1F, 1G, and 1H were run to determine the impact of the fluxes, landuse changes, point sources, and septic tanks on the chlorophyll *a* levels. The chlorophyll *a* due to the fluxes is the results of nutrients entering the lake attached to sediment. Under anoxic conditions on the lake bottom, these nutrients are released from the bottom sediments into the water column where they can be used by algae. Deposition and build up of sediments in reservoirs is a natural process. Therefore, there will always be some nutrient fluxes in lakes. As previously mentioned, there will also be a resultant increase in chlorophyll *a* levels due to landuse changes.

Figures 3-1 through 3-5 show the level of chlorophyll *a* due to the various sources, as well as the measured chlorophyll levels, the calibrated model results, and the TMDL model results for each compliance station.

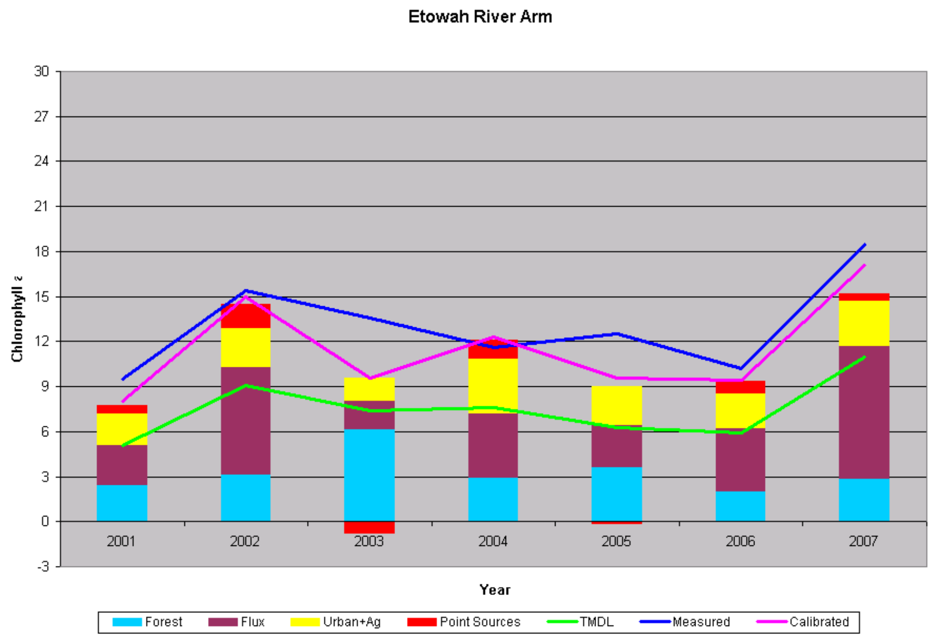

Figure 3-1 Etowah River Arm Chlorophyll *a* Contributions

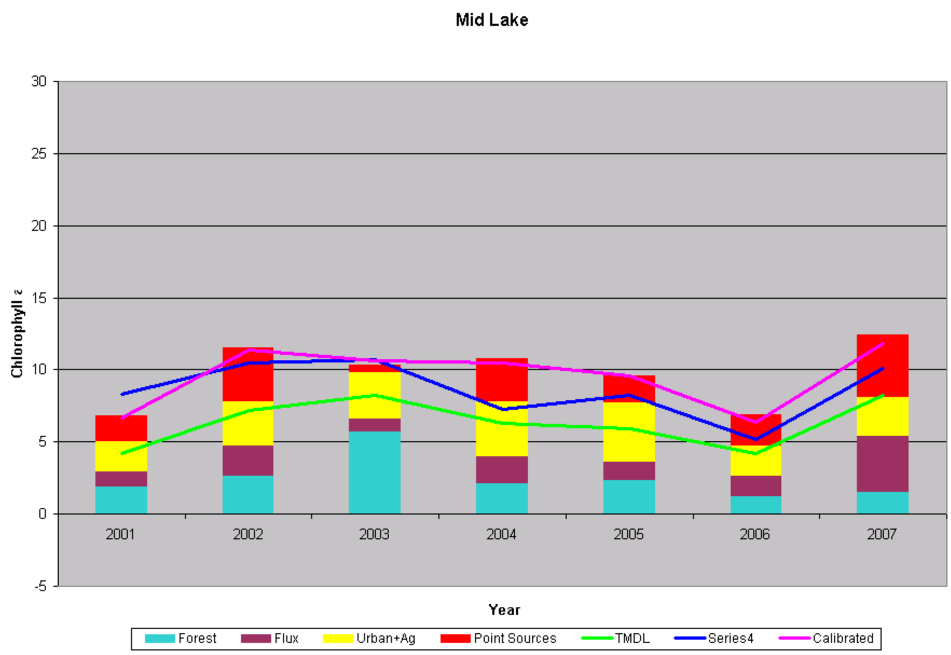

Figure 3-2 Mid Lake Chlorophyll *a* Contributions

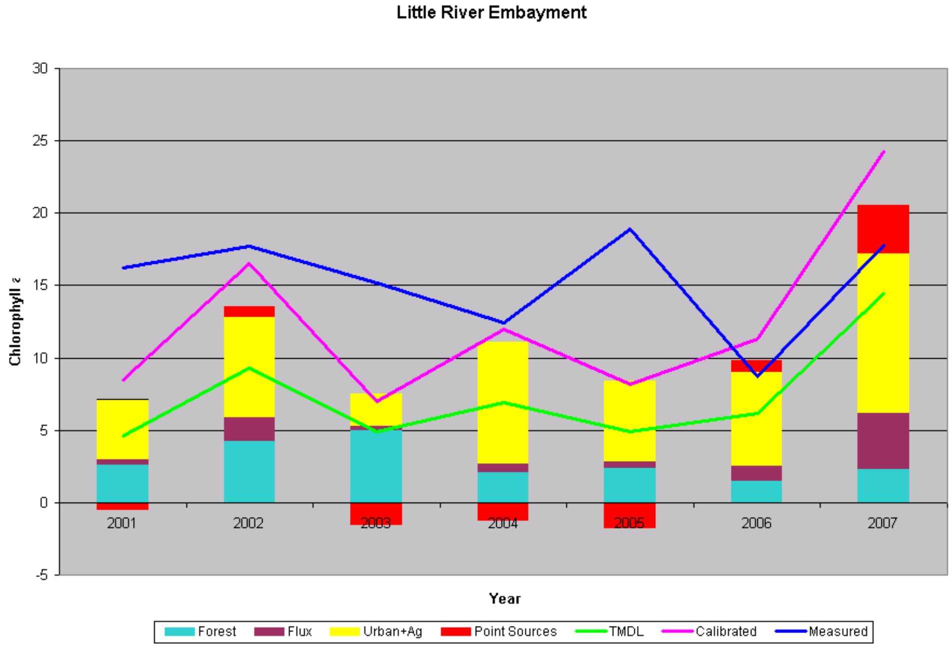

Figure 3-3 Little River Embayment Chlorophyll *a* Contributions

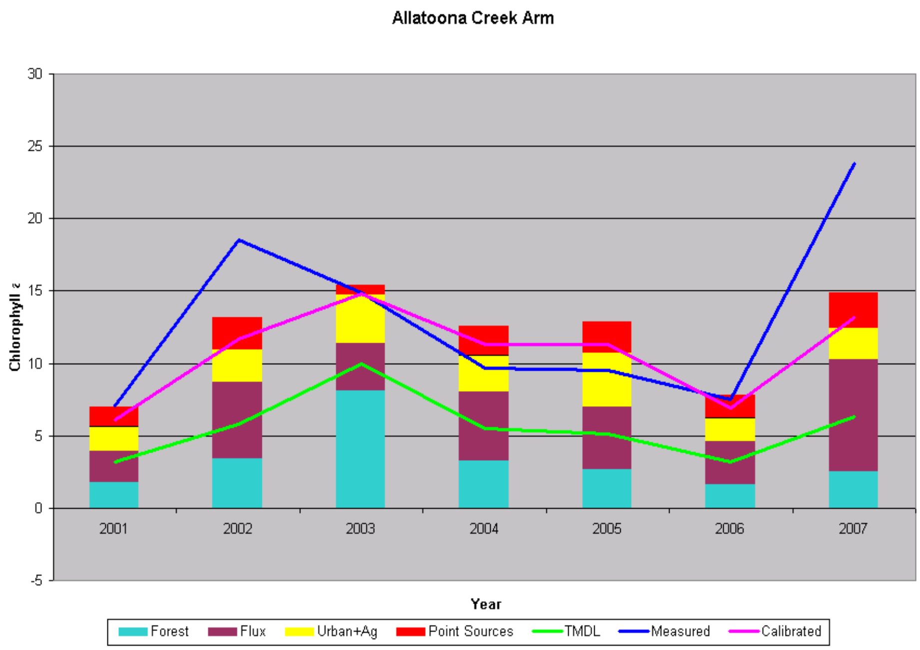

Figure 3-4 Allatoona Creek Arm Chlorophyll *a* Contributions

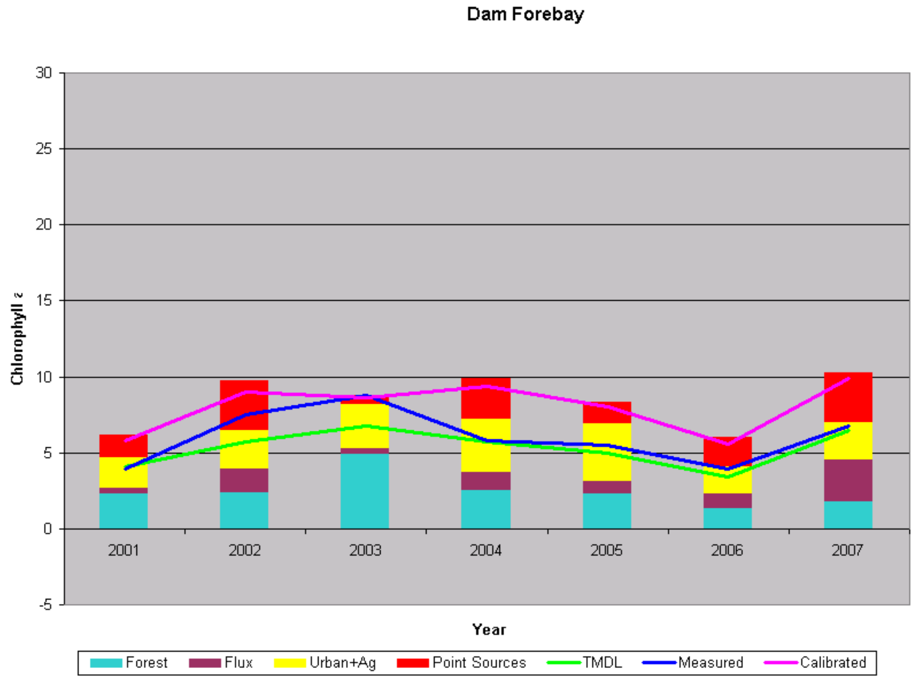

Figure 3-5 Dam Forebay Chlorophyll *a* Contributions

Watershed and lake models were used to predict the effect of various nutrient load reductions on the lake chlorophyll *a* levels. From these figures, we see that the TMDL was developed to meet the original chlorophyll *a* criteria. However, the calibrated data for several stations (i.e., Allatoona Creek, Little River, and Etowah River) is below the measured data, which may be related to model precision. Therefore, even if the TMDL reductions are applied, the chlorophyll *a* levels at these stations may still be above the predicted TMDL levels.

This model precision combined with the acknowledgment that chlorophyll *a* levels increase as a result of both landuse changes and nutrient fluxes, indicates that the current chlorophyll *a* criteria needs revised for Allatoona Creek and the Etowah River. The chlorophyll *a* criteria for Allatoona Creek upstream from I-75 should be revised to 12 µg/L and the chlorophyll *a* criteria for Etowah River upstream from Sweetwater Creek should be revised to 14 µg/L.

It should also be noted in Figures 3-1 and 3-3 that the point sources resulted in a negative effect on chlorophyll *a* levels. This is related to the extra flow that occurs during wet years resulting in a dilution of the point sources.

3.3 Total Nitrogen Standard and Nutrient Limitation

In ecosystems, rarely will all required nutrients be used up at the same rate for primary production. When one nutrient is used before other nutrients, it is called a limiting nutrient. Limiting nutrients prevent growth with their absence. When returned to the lacking environment, limiting nutrients jump-start productivity, which continues until the limiting nutrient again is depleted. Phosphorus is a limiting nutrient in many aquatic ecosystems.

The Lake Allatoona modeling indicates that the lake is phosphorus limited during the algal growing season. At most of the compliance points, the Calibration Scenario 1A model runs (exception is Etowah River, Figure 3-6) and all the TMDL Scenario 1C model runs reveal the limiting nutrient during the critical growing season is phosphorus. Figures 3-6 through 3-15 present time series of limitations in nitrogen, phosphorus, and light for algae growth during 2007. This year was chosen because it was found to be the most critical year and algal growth was highest in both the Allatoona Creek and Etowah River arms of the Lake. Values for the limitation range from 0 to 1, with the lower of the two values (nitrogen and phosphorus) being the limiting nutrient.

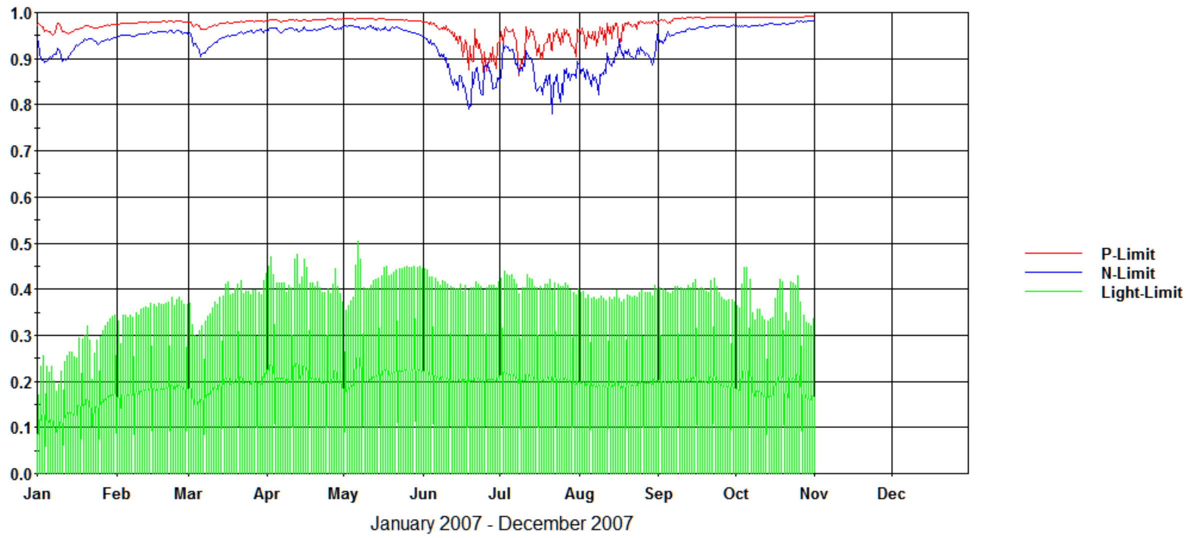

Figure 3-6 Lake Allatoona, Etowah River Station (14302001) Nutrient Limitation for Scenario 1A (Calibration)

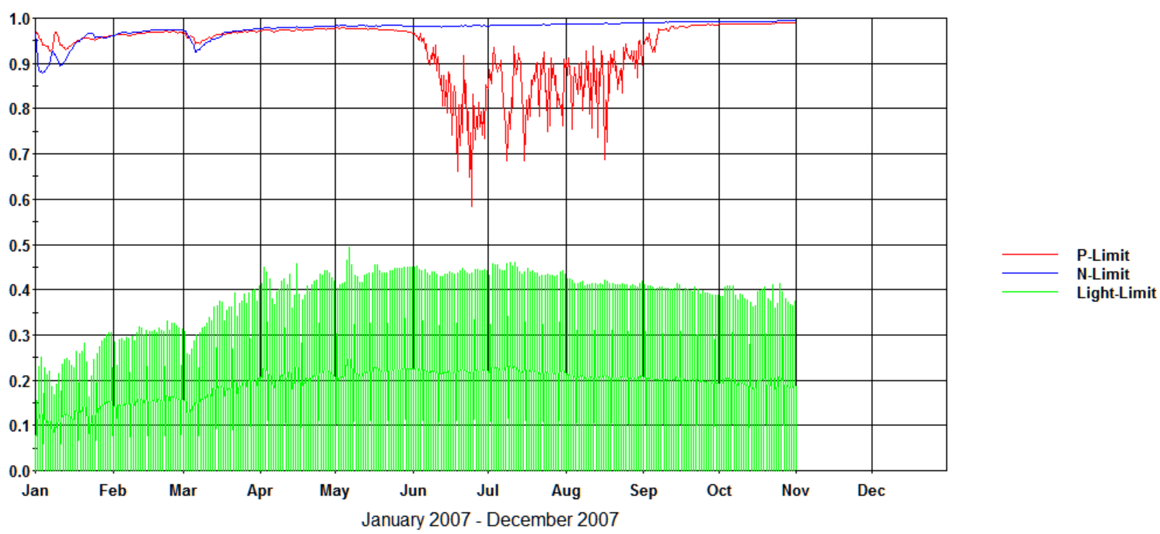

Figure 3-7 Lake Allatoona, Etowah River Station (14302001) Nutrient Limitation for Scenario 1C (TMDL)

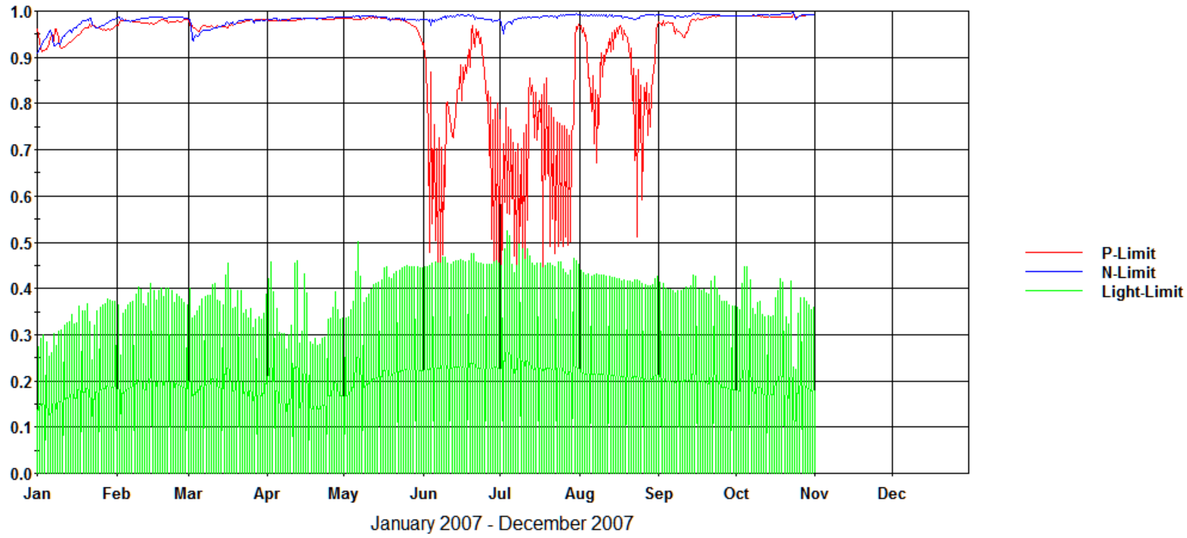

Figure 3-8 Lake Allatoona, Little River Station (14304801) Nutrient Limitation for Scenario 1A (Calibration)

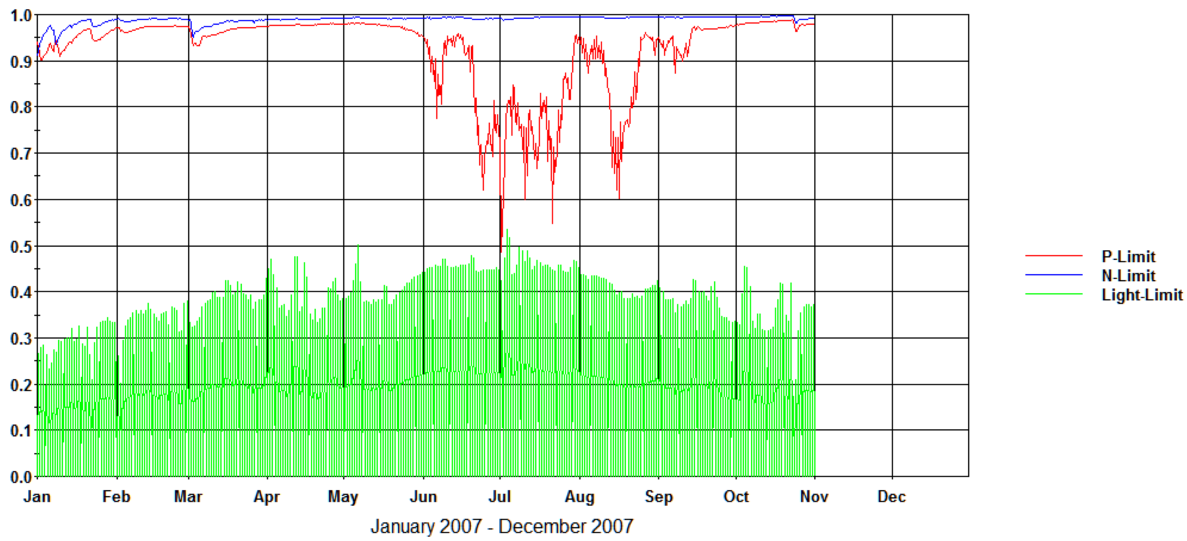

Figure 3-9 Lake Allatoona, Little River Station (14304801) Nutrient Limitation for Scenario 1C (TMDL)

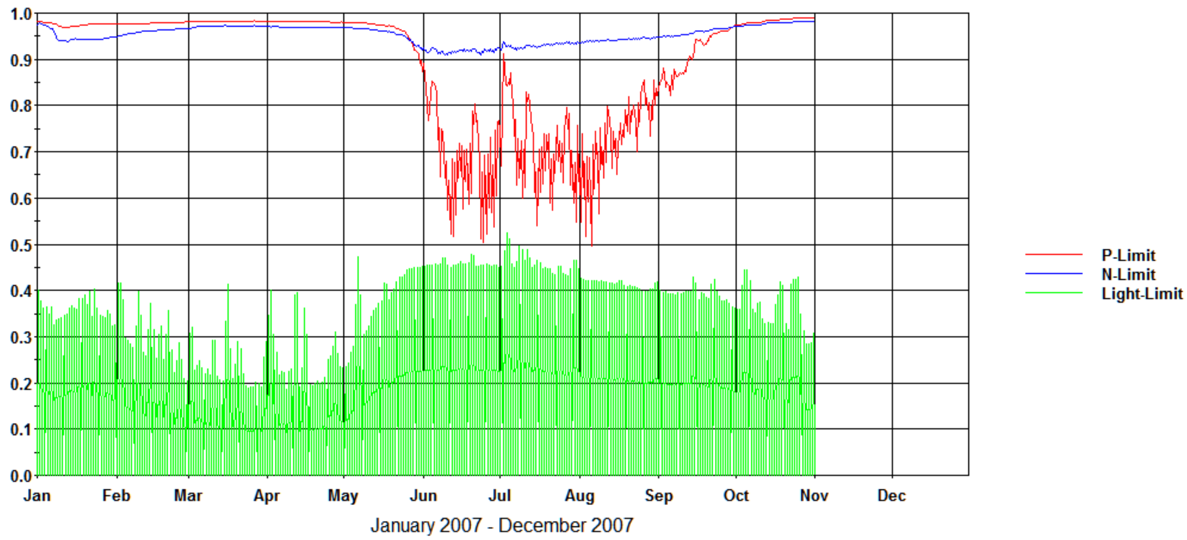

Figure 3-10 Lake Allatoona, Mid-Lake Station (14305801) Nutrient Limitation for Scenario 1A (Calibration)

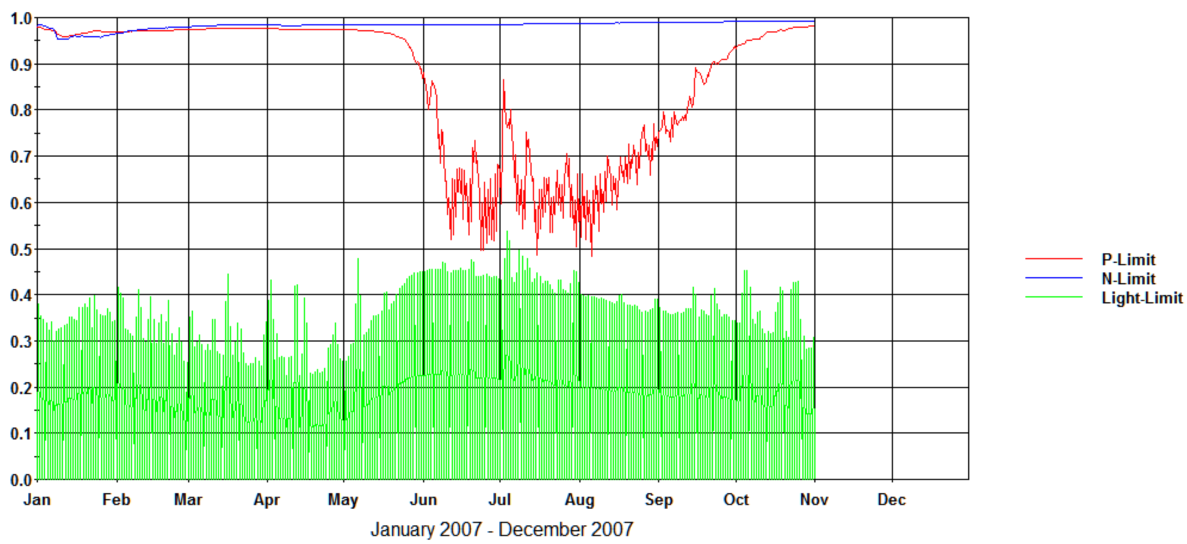

Figure 3-11 Lake Allatoona, Mid-Lake Station (14305801) Nutrient Limitation for Scenario 1C (TMDL)

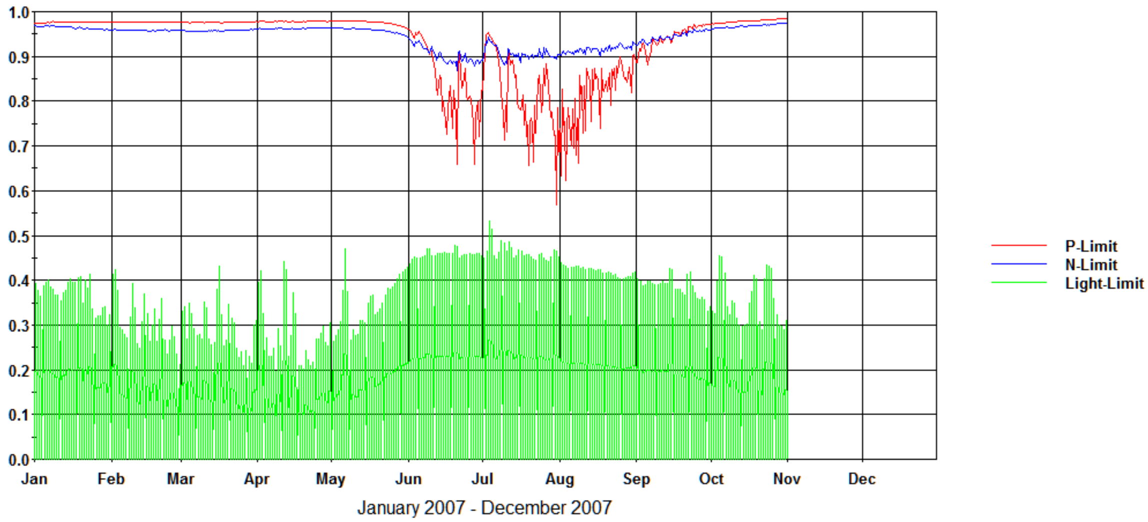

Figure 3-12 Lake Allatoona, Dam Forebay Station (14309001) Nutrient Limitation for Scenario 1A (Calibration)

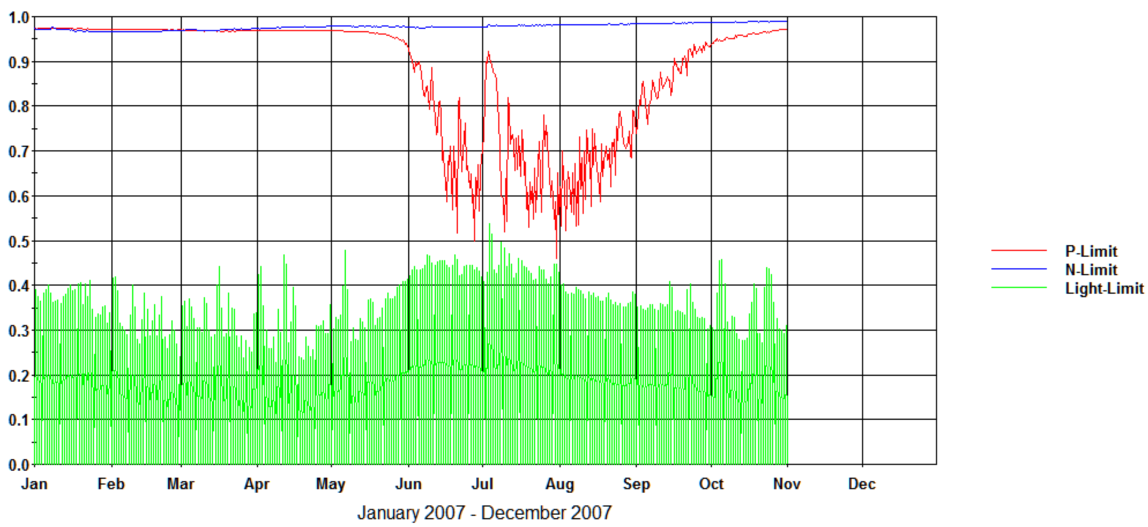

Figure 3-13 Lake Allatoona, Dam Forebay Station (14309001) Nutrient Limitation for Scenario 1C (TMDL)

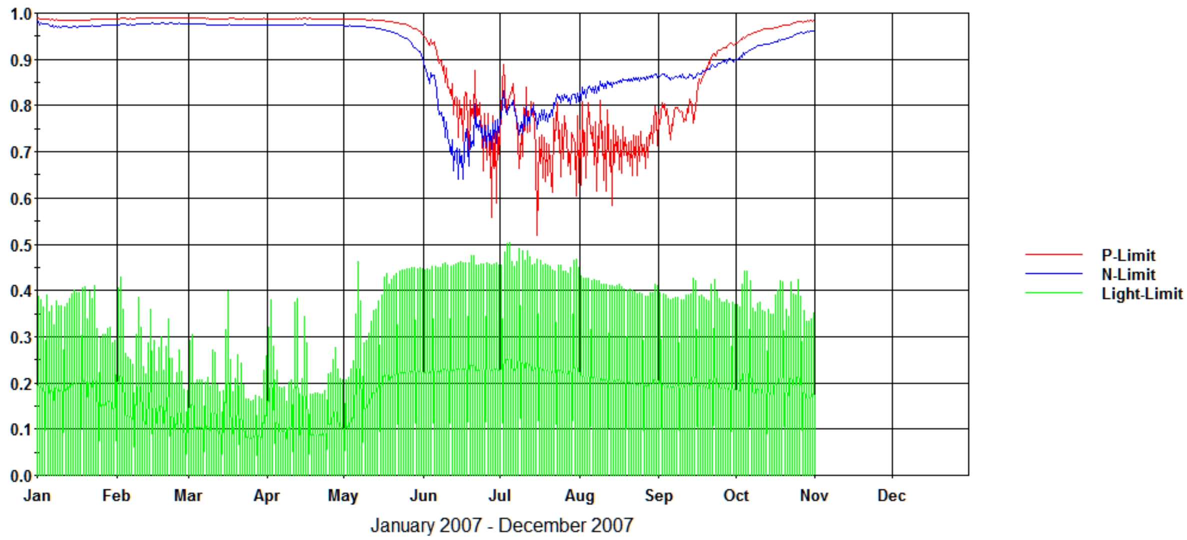

Figure 3-14 Lake Allatoona, Allatoona Creek Station (14307501) Nutrient Limitation for Scenario 1A (Calibration)

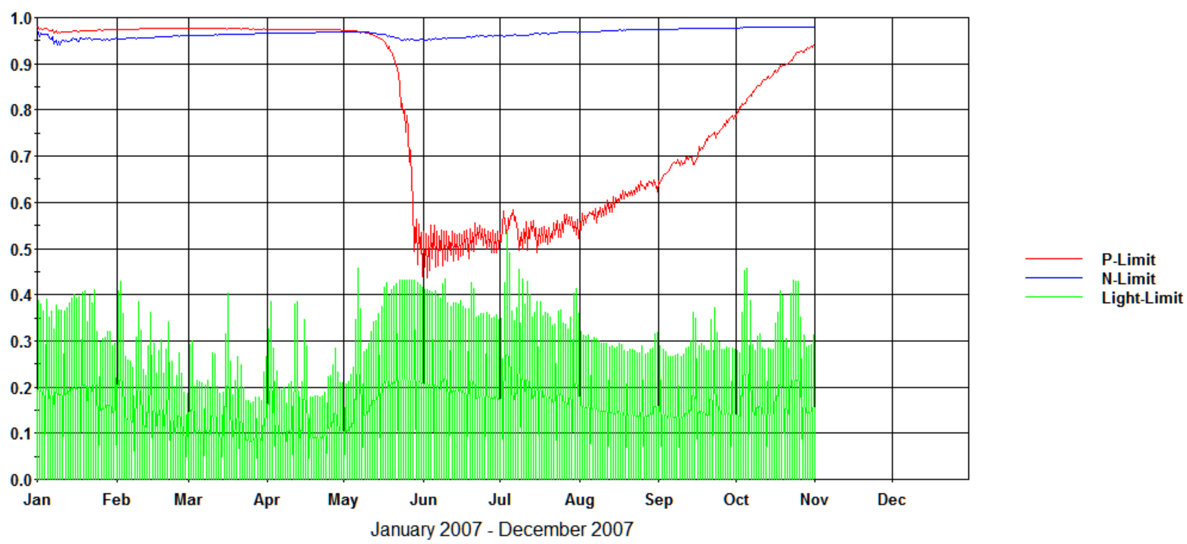

Figure 3-15 Lake Allatoona, Allatoona Creek Station (14307501) Nutrient Limitation for Scenario 1C (TMDL)

To further illustrate that Lake Allatoona is phosphorus limited, Figures 3-16 through 3-20 show the relationship between Total Nitrogen growing season average and the chlorophyll *a* growing season average at each assessment site. While the Total Nitrogen average has been increasing or level from years 2000 to 2008, the chlorophyll *a* levels have been decreasing or level during the same time period.

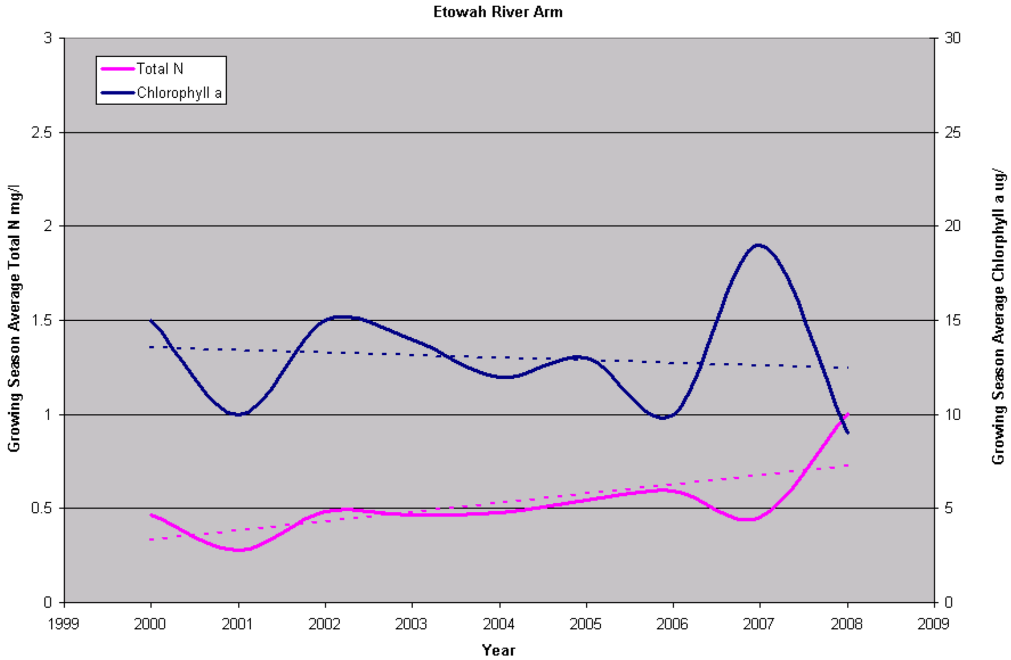

Figure 3-16 Lake Allatoona, Etowah River Arm Growing Season Chlorophyll a and Total Nitrogen Levels

Figure 3-17 Lake Allatoona, Little River Growing Season Chlorophyll a and Total Nitrogen Levels

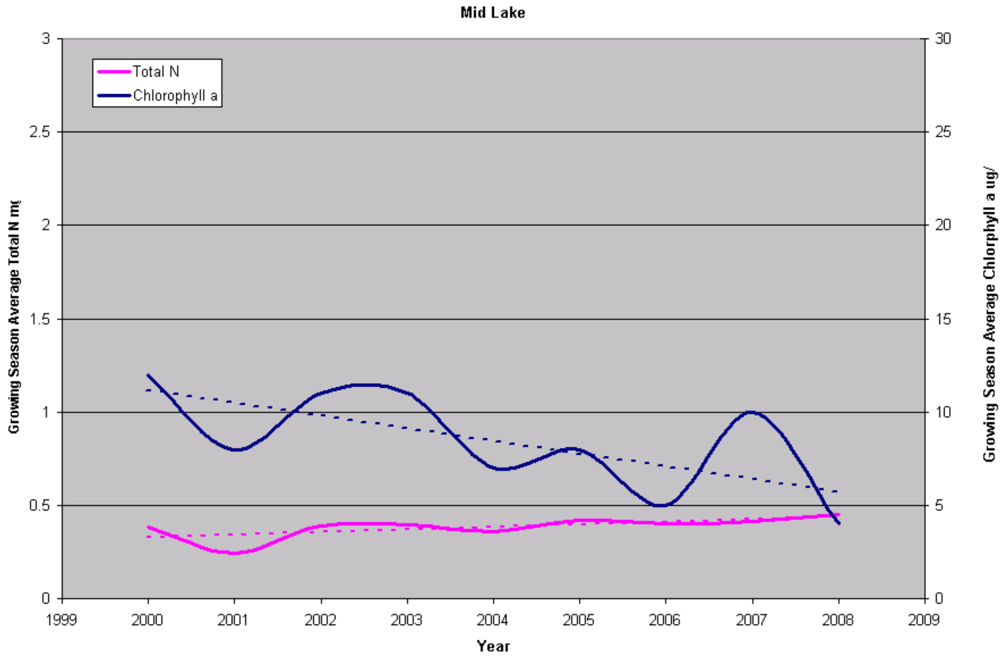

Figure 3-18 Lake Allatoona, Mid Lake Growing Season Chlorophyll a and Total Nitrogen Levels

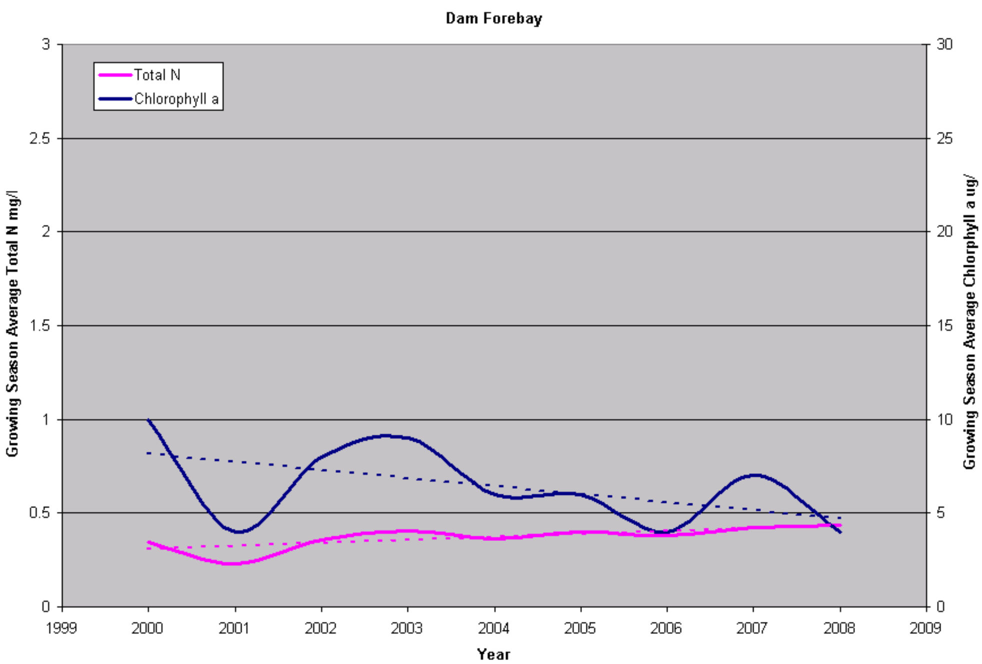

Figure 3-19 Lake Allatoona, Dam Forebay Growing Season Chlorophyll a and Total Nitrogen Levels

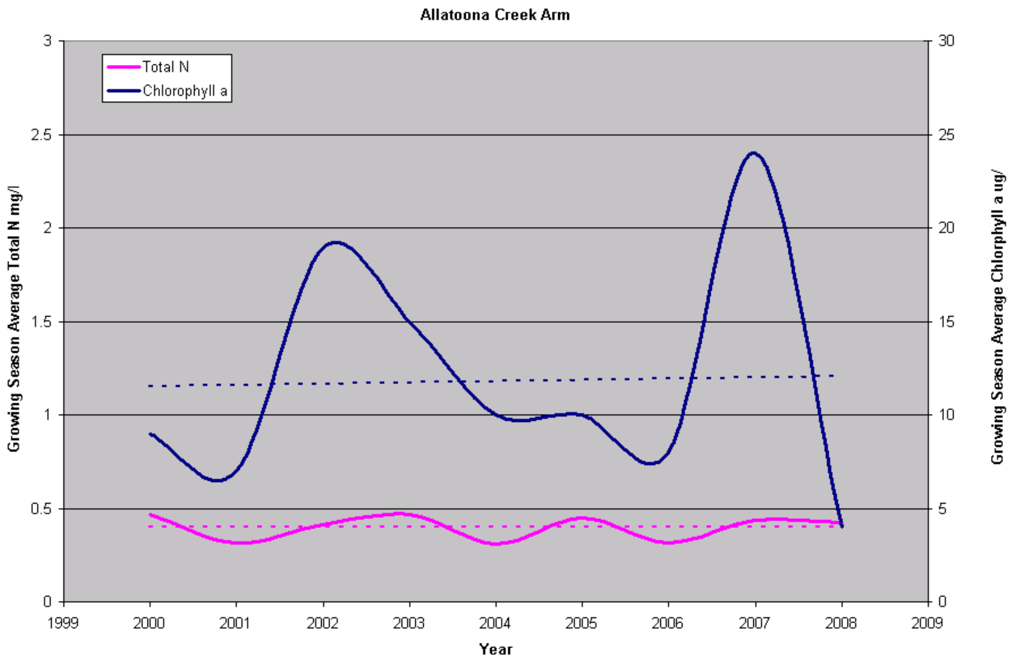

Figure 3-20 Lake Allatoona, Allatoona Creek Arm Growing Season Chlorophyll a and Total Nitrogen Levels

The fact that Lake Allatoona is phosphorus limited is supported by the Algal Growth Potential tests performed by EPA Athens in May 2010 at each compliance monitoring station. Figure 3-21 shows the results of these tests.

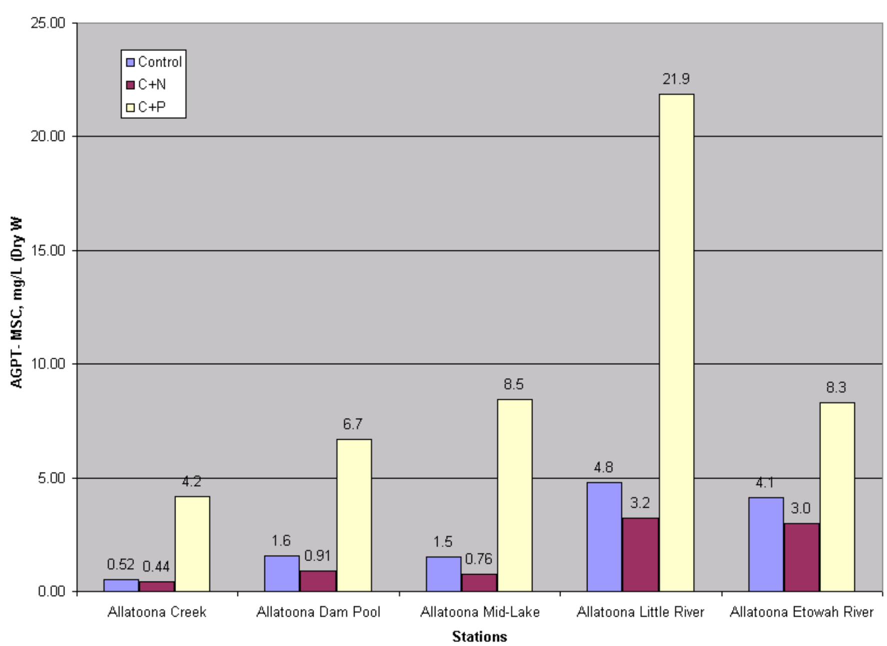

Figure 3-21 Lake Allatoona Algal Growth Potential Test Results May 25, 2010

A comparison of the Total Nitrogen loads for Scenario 1A (Calibration) and Scenario 1C (TMDL) at the four major tributaries is presented in Table 3-7. The increase in Total Nitrogen is due to future permitted flows from the point dischargers.

Table 3-7 Summary of Annual Total Nitrogen Loads (lbs/year) for Scenario 1A (Calibration) and Scenario 1C (TMDL)

Station	Scenario	2001	2002	2003	2004	2005	2006	2007	Average
Etowah River @ GA 5 spur and 140	Calibrated	813,985	850,514	1,018,991	873,052	743,795	618,676	411,309	761,475
	TMDL	1,517,156	1,550,526	1,682,857	1,558,491	1,457,385	1,334,219	1,058,872	1,451,358
Little River @ GA 5 (Hwy 754)	Calibrated	200,713	222,458	265,254	231,989	258,303	263,797	208,609	235,875
	TMDL	437,384	456,125	475,364	461,426	441,885	429,716	411,866	444,824
Noonday Creek @ North Rope Mill Rd.	Calibrated	696,676	685,545	686,013	658,209	645,718	636,300	631,861	662,903
	TMDL	661,970	665,514	675,390	668,362	662,672	656,610	644,081	662,086
Shoal Creek @ GA 108 (Fincher Rd.)	Calibrated	55,965	76,241	95,120	78,515	59,890	49,129	32,879	63,963
	TMDL	40,907	59,973	73,954	61,256	43,598	36,759	24,799	48,749

Figure 3-22 shows the lake Total Nitrogen concentrations predicted for Scenario 1C (TMDL). This figure indicates that the Total Nitrogen "not to exceed 4 mg/L" at any time, any place criteria cannot be met.

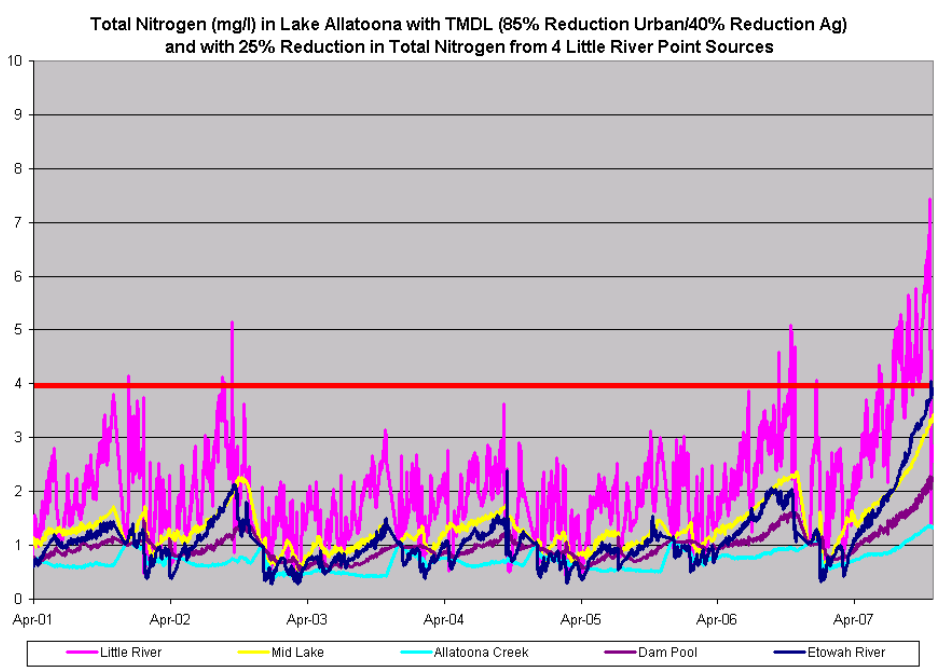

Figure 3-22 Lake Allatoona Total Nitrogen Concentration with TMDL (Scenario 1C)

Table 3-8 lists the nutrient loads from each point source used for Scenario 1C (TMDL). This is an approximate 50% increase in the existing Total Nitrogen loads from the point sources.

Table 3-8 Total Nutrient Waste Load Allocations for Scenario 1C (TMDL)

Facility Name	Number	Receiving Stream	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Goldkist Poultry Byproducts	GA0000728	Etowah River	3,000	316,586
Eastgate MHP	GA0022292	Owl Creek	472	2,774
Allatoona Campground	GA0022616	Lake Allatoona	304	1,790
Cobb County Noonday Creek WPCP	GA0024988	Noonday Creek	10,960	602,732
City of Canton WPCP	GA0025674	Etowah River	2,877	245,963
Woodstock Rubes Creek WPCP	GA0026263	Rubes Creek	760	85,615
USA FROSCOM Rec Area	GA0027456	Lake Allatoona	913	5,370
Red Top Mountain State Park	GA0029891	Lake Allatoona	46	268
Tate Housing Authority	GA0029955	Long Swamp Creek	152	895
Big Canoe WPCP	GA0030252	East Branch Long Swamp Creek	761	22,374
Jasper WPCP	GA0032204	Polecat Branch	2,435	41,400
Fulton County Little River WPCP	GA0033251	Little River	1,522	31,278
Free Home Elementary School	GA0034185	Buzzard Flapper Creek	15	89
Mountain Brook Center WPCP (R.M. Moore Elementary School)	GA0034959	Moore's Creek	91	537
Cherokee County Fitzgerald Creek	GA0038555	Little River	4,992	362,153
Hampton Reuse Facility (season discharge Nov-Apr)	GA0038903	Settingdown Creek	220	17,810
Cherokee County Rose Creek	GA0046451	Lake Allatoona	6,575	570,769
Cobb County Northwest WPCP	GA0046761	Lake Allatoona	5,845	460,268
USA COE Old Construction Site	GA0047074	Lake Allatoona	46	268
USA COE McKinney Camp Ground	GA0047465	Lake Allatoona	152	895
Tate Elementary School	GA0048518	Mud Hollow Creek	111	653
Cherokee County Northeast WPCP	Proposed	Etowah River	3,166	340,939
Etowah Water and Sewer Authority	Proposed	Etowah River	609	106,544
		TOTAL	46,024	3,217,972

Since Lake Allatoona tends to be phosphorus limited during the growing season, additional controls to meet the current Total Nitrogen "not to exceed 4 mg/L" at any time, any place criteria may be unnecessary and could lead to an economic hardship for communities who would have to reduce future Total Nitrogen loads. As a result, the current Total Nitrogen criteria should be revised to a "not to exceed the growing season average."

As part of the evaluation of revising the Total Nitrogen standard, the effect of increasing total nitrogen levels on chlorophyll *a* concentrations was examined in both Lake Allatoona and Lake Weiss. The increase in Total Nitrogen did not affect the Lake Allatoona chlorophyll *a* levels. The effect on Lake Weiss was evaluated by linking the models developed for Lake Allatoona to the models developed for the Coosa River Basin. The increase in Total Nitrogen due to future permitted flows from the point dischargers resulted in a 31% increased load coming from Allatoona Dam. This increase translated to a 7% increase in Total Nitrogen at the Georgia/Alabama state-line in the Coosa River. This 7% increase was input into EPA's Lake Weiss model, and the model showed a 0.56 µg/L chlorophyll *a* increase in the most critical year, 2005.

Figures 3-23 and 3-24 show the chlorophyll *a* levels measured in Lake Weiss that caused the impairment, as well as the Lake Weiss TMDL without an increase in Total Nitrogen from Lake Allatoona, and the Lake Weiss TMDL with the 7% increase in Total Nitrogen at the state-line due to the increase in Total Nitrogen loads from Lake Allatoona. As shown in these figures, the change in the Lake Allatoona Total Nitrogen criteria has a negligible impact on downstream conditions and the Lake Weiss chlorophyll *a* standard is protected. The WLA given in Table 3-8 will be included in the Lake Allatoona TMDL. In the future, the nutrient loads may be traded among discharges within the lake watersheds if both lake standards are met in both Allatoona and Weiss.

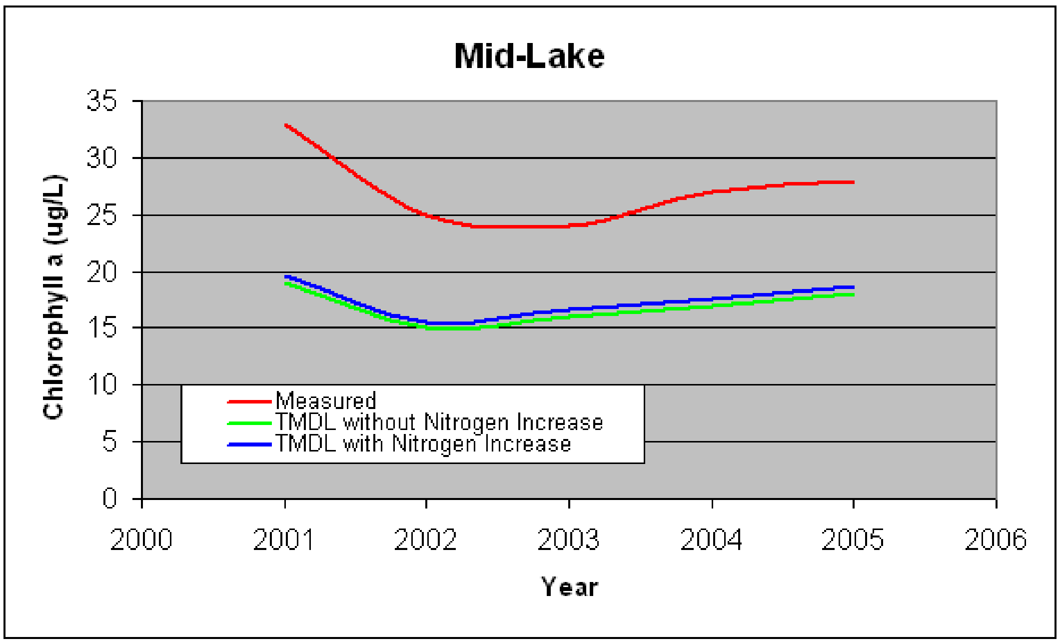

Figure 3-23 Summary of Chlorophyll *a* Data (µg/L) in Mid-Lake of Lake Weiss, including Actual Measurements, the TMDL without a Total Nitrogen increase from Lake Allatoona, and the TMDL with the 7% Total Nitrogen increase at the Stateline due to a change in the Total Nitrogen criteria in Lake Allatoona

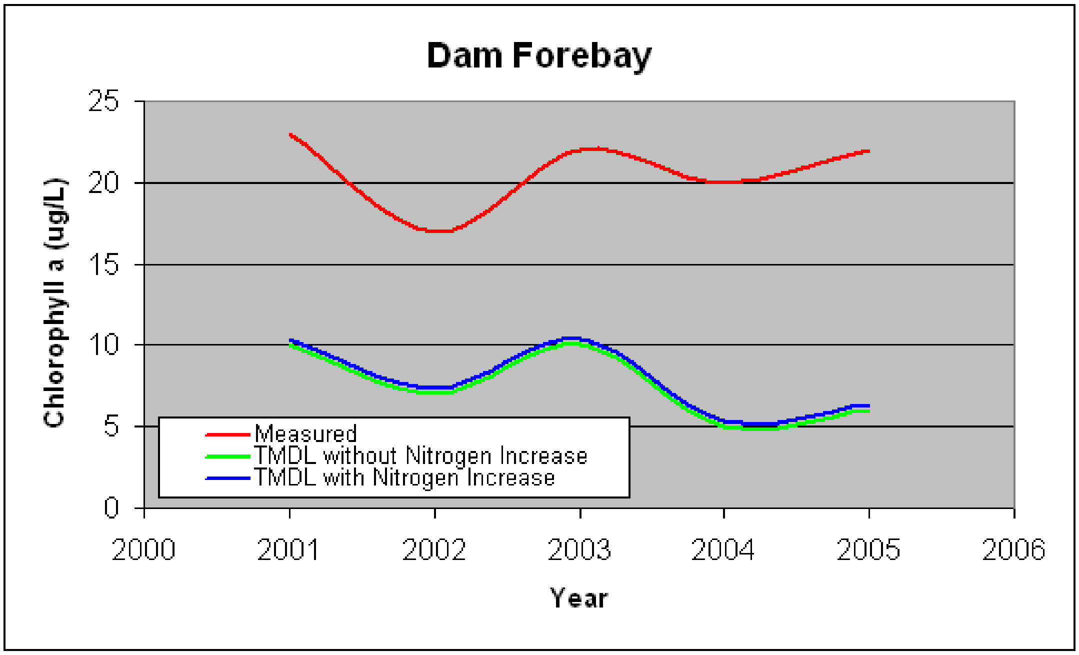

Figure 3-24 Summary of Chlorophyll *a* Data (µg/L) in Dam Forebay of Lake Weiss, including Actual Measurements, the TMDL without a Total Nitrogen increase from Lake Allatoona, and the TMDL with the 7% Total Nitrogen increase at the Stateline due to a change in the Total Nitrogen criteria in Lake Allatoona