West Point Lake Model Scenarios

Description and Results for Nutrient Criteria Revisions

Georgia Environmental Protection Division
Atlanta, Georgia

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INTRODUCTION

West Point Lake is a 25,864-acre impoundment on the mainstream of the Chattahoochee River, located just north of I-85, an hour southwest of Atlanta (Figure 1-1). West Point Lake extends 35 miles southwest along the Chattahoochee River, just north of West Point, Georgia. The lake has a shoreline of more than 500 miles. The Flood Control Act of 1962 authorized the construction of West Point Dam. Congress authorized the project for flood control, hydroelectric power, navigation, fish and wildlife development, and general recreation. Construction of West Point Dam began in December 1965 and was completed in October 1974. West Point Dam controls flooding of the river by managing seasonal variations in water flow. West Point Dam is 7,250 feet long and has a drainage area of approximately 3,400 sq. mile (Figure 1-2).

Water quality standards for West Point Lake were established in 1995. Its designated uses are Recreation and Drinking Water and the chlorophyll *a* criteria for the lake is as follows:

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

Since the establishment of the lake standards, chlorophyll *a* levels in the lake have been decreasing over time, as evidenced by monitoring data collected at the LaGrange Intake (see Figure 1-3). This reduction is due to the enactment of the phosphorus detergent ban, as well as upgraded technology in removal of nutrients from point sources in the Atlanta metro area. The decrease in the lake chlorophyll *a* levels led to a request to review the existing criteria to determine if it warrants reduction, since currently West Point Lake has the highest chlorophyll *a* standard than any other lake in Georgia. This review was performed in light of the need to balance water resources protection with future economic development in the West Point Lake watershed, which includes metro Atlanta.

The State of Georgia recently completed the modeling of the Chattahoochee River Basin that looked at nutrient and the chlorophyll *a* dynamics for the Chattahoochee River Watershed, including Lake Lanier and West Point Lake. The watershed model of Lake Lanier and West Point Lake were developed using the Loading Simulation Program in C++ (LSPC). This model includes all major point sources (permitted discharge of 0.1 MGD or greater) of nutrients 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 the watershed models were used as tributary flow inputs in the hydrodynamic model, Environmental Fluid Dynamics Code (EFDC). EFDC was used to simulate the transport and flow of water within the lake, the fate and transport of nutrients within the lakes, and the uptake by phytoplankton. The growth and death of phytoplankton is measured through a surrogate parameter called chlorophyll *a*. The EFDC models were calibrated to nutrient and chlorophyll *a* concentrations measured in Lake Lanier and West Point Lake during the 2001 through 2007 growing seasons, and include all major point sources of nutrients within the lakes. Model outputs from the upstream watershed and lake models for Lake Lanier (above Buford Dam) were linked with the watershed and lake models for West Point Lake. Thus, the model results for Lake Lanier at Buford Dam are the upper boundary of the watershed model developed for West Point Lake.

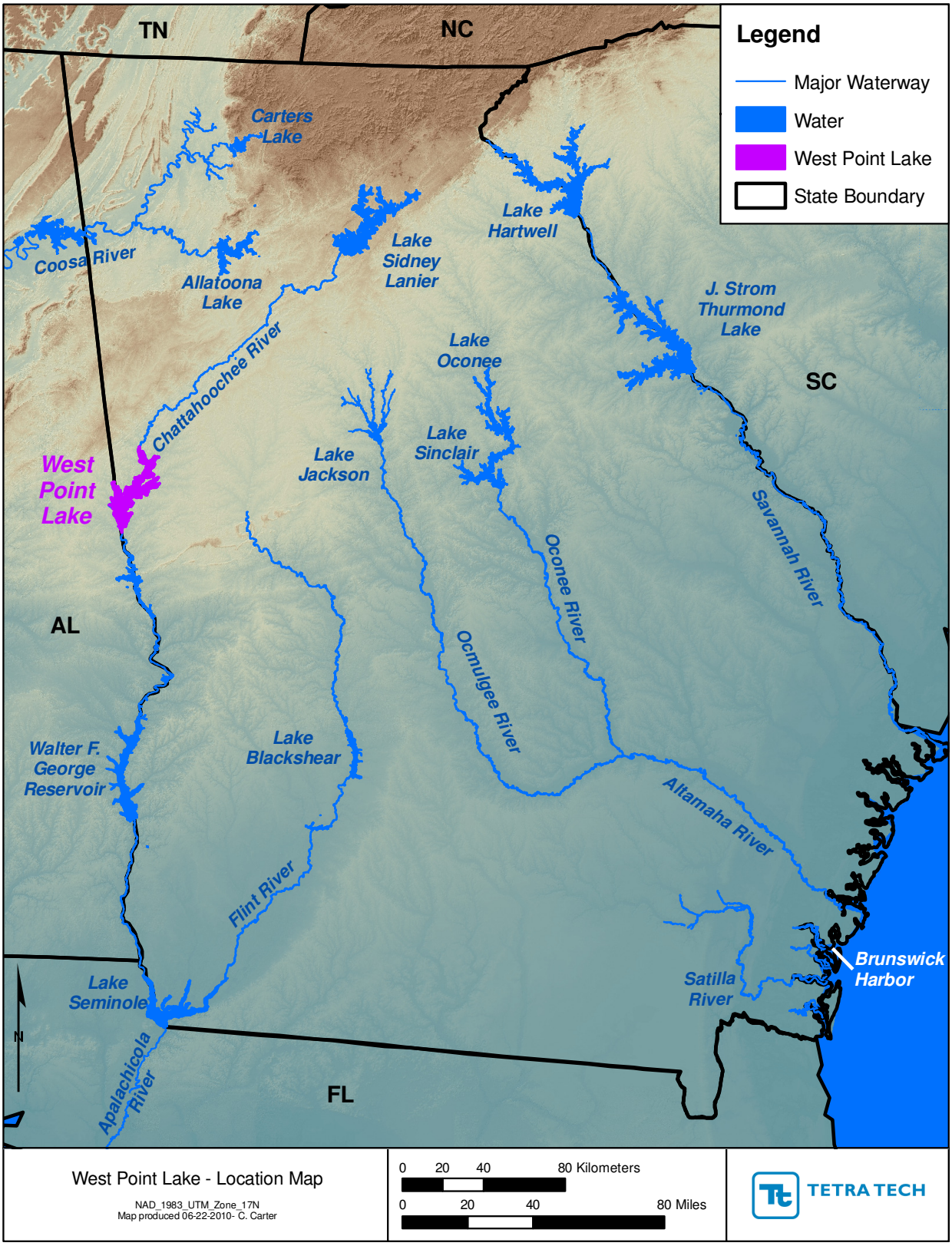

Figure 1-1 Location of West Point Lake

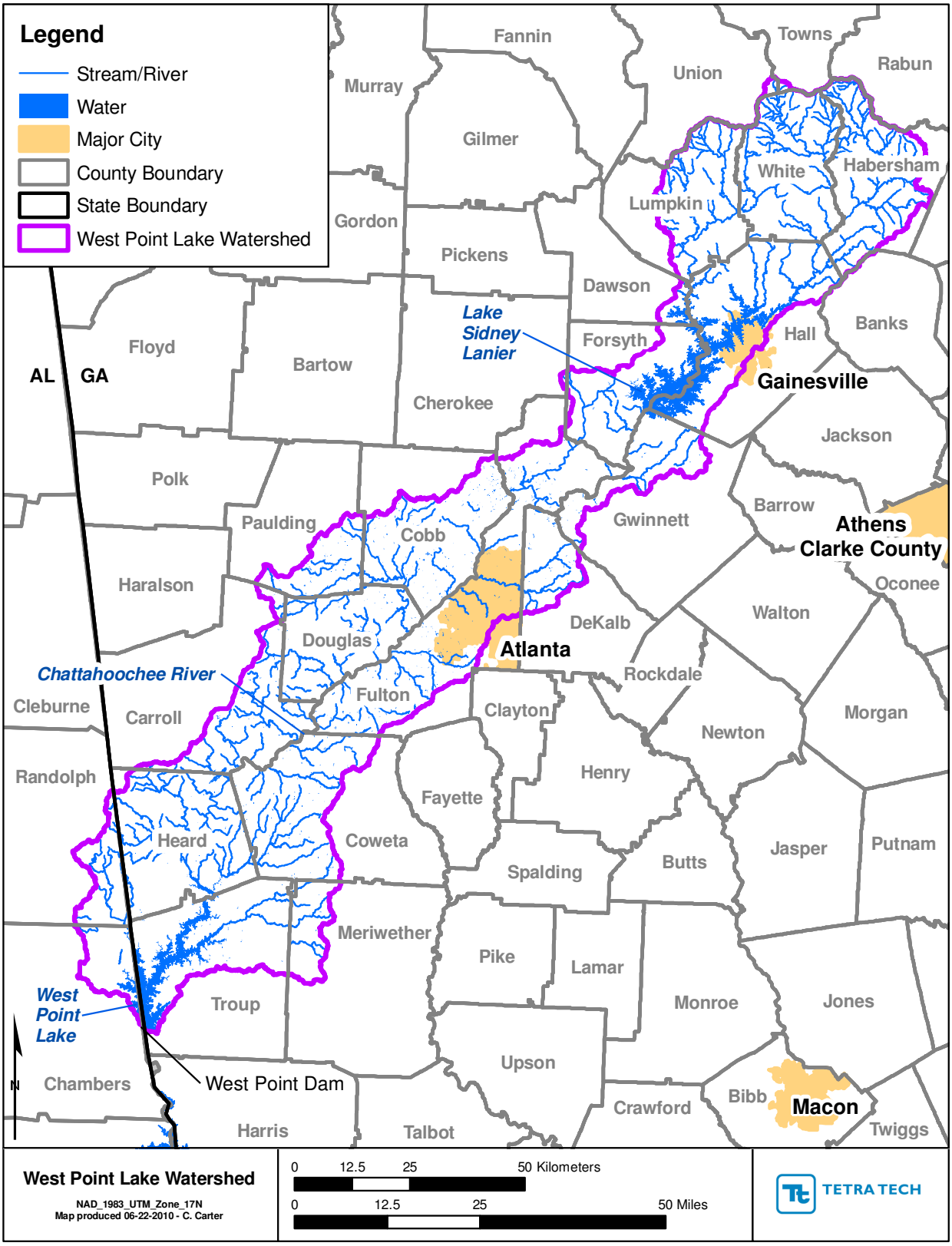

Figure 1-2 West Point Lake Watershed

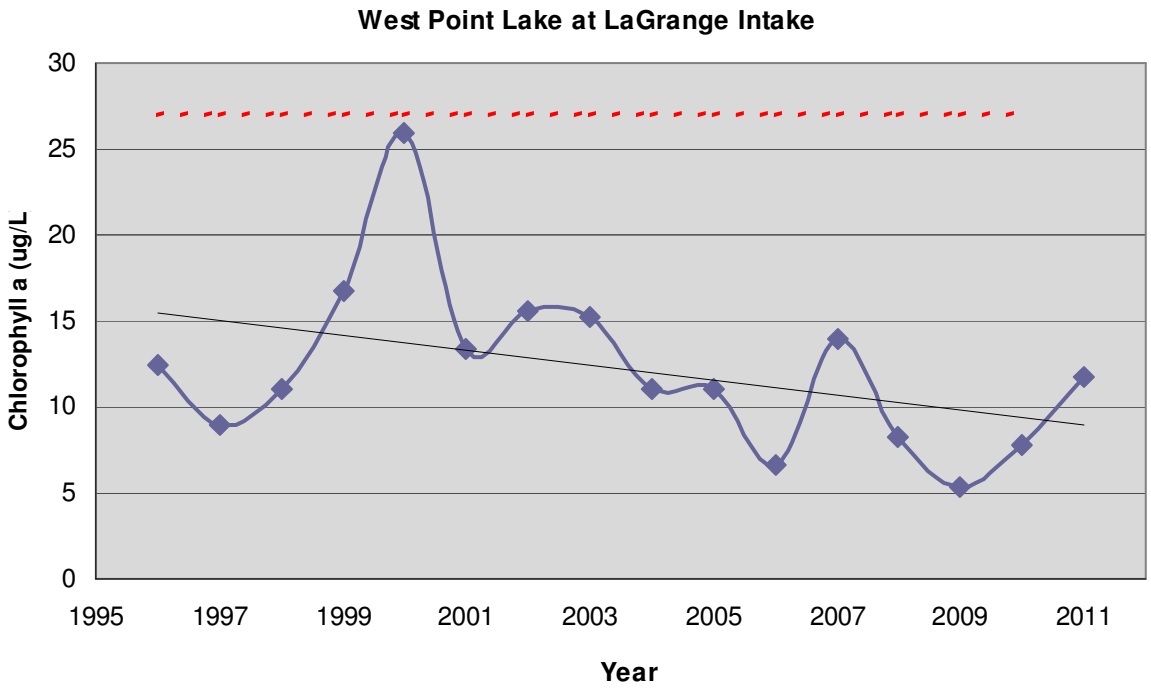

Figure 1-3 Long-term Growing Season Average Chlorophyll Levels at the LaGrange Intake in Relation to the Current Criteria

The setup, calibration and validation of these computer models are documented in the following reports:

- *Watershed Hydrology and Water Quality Modeling Report for the Chattahoochee River Watershed, Georgia – REV2 (Tetra Tech 2011)*
- *Hydrodynamic and Water Quality Modeling Report for West Point Lake, Georgia – REV2 (Tetra Tech 2011)*

Once the models were calibrated for West Point Lake and its watershed, various scenarios were run and analyzed to evaluate the nutrient sources. The following section describes these scenarios.

2.0 DESCRIPTION OF SCENARIOS

Five scenarios were run using the models developed for the West Point Lake to explain the sources and contributions of chlorophyll *a* levels observed, and for use in establishing new or revised chlorophyll *a* criteria. For each scenario, both hydrology and water quality was calibrated and validated at thirty-four locations within the watershed (Figure 2-1) from the LSPC model, however, only three tributary locations were evaluated for purposes of assessment in the West Point Lake watershed (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 model. The outputs for the EFDC model were evaluated at five locations (Figure 2-2 and Table 2-2) in West Point Lake from 2001 through 2007. Results were evaluated based on growing season averages (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 West Point Lake Watershed hydrology and water quality model (LSPC) and the calibrated West Point Lake model (EFDC). 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 (Current Permit)

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

2.3 Scenario 1C (All Forested)

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

2.4 Scenario 1D (No Point Sources – Current Landuse)

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

2.5 Scenario 1E (2035 Permit and Landuse)

Scenario 1E was a 2035 Point Source and Landuse scenario. This scenario was performed using the calibrated (Scenario 1A) West Point Lake Watershed hydrology and water quality model (LSPC) and the West Point Lake model (EFDC), but with landuse projected for year 2040. The 2040 Georgia Landuse Trends (GLUT) dataset was obtained from the University of Georgia. Point source discharges, withdrawals, and septic tanks were set at either the 2035 flows outlined in the Metro District Plan or 2040 flows forecasted for the State Water Plan.

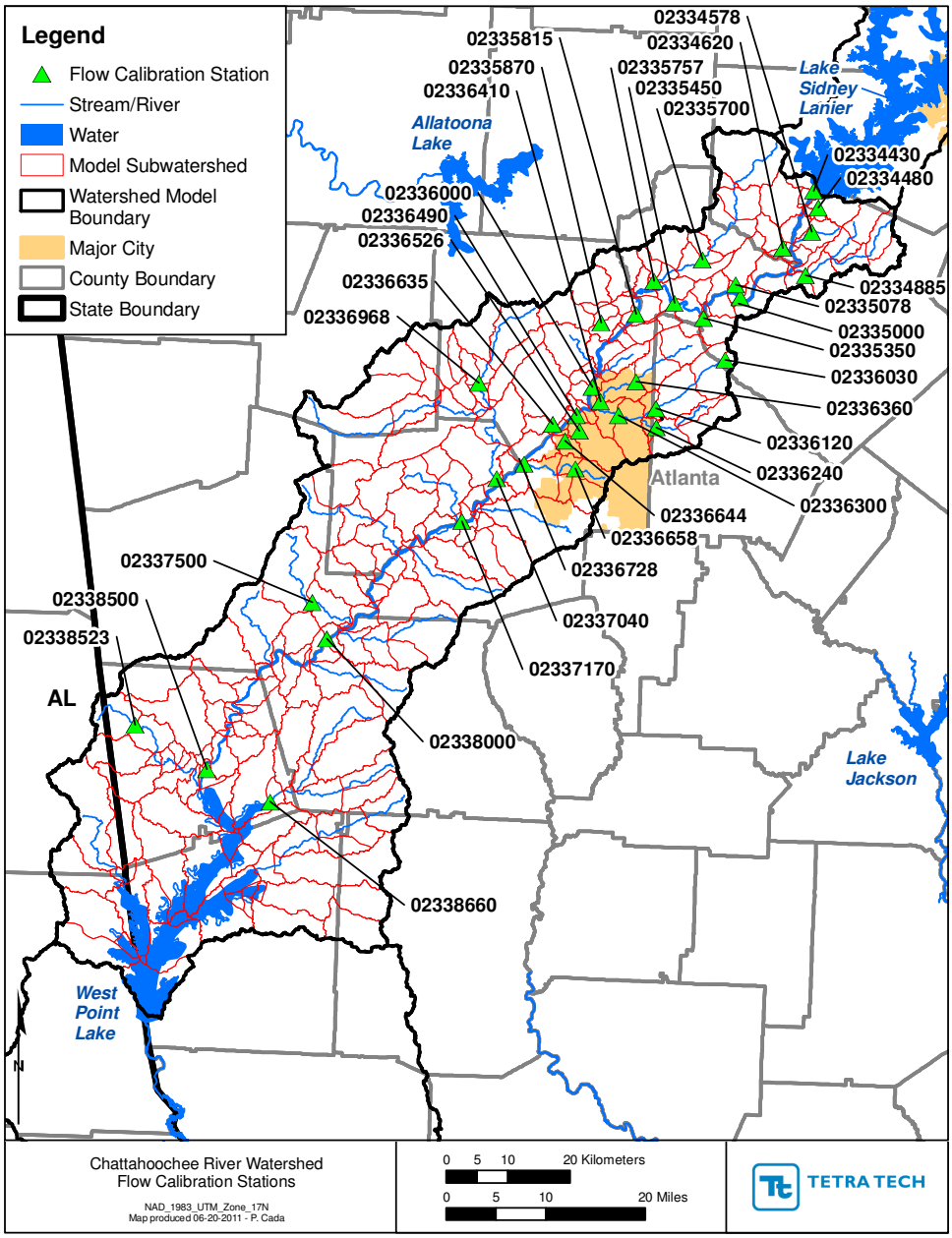

Figure 2-1 West Point Lake Watershed Sites

Table 2-1 Summary of West Point Lake Assessment Sites

Station Name	Station Number	Drainage Area (Acres)	LSPC Subbasin
Chattahoochee River @ US 27	12170001	1,715,200	276
New River @ GA 100	12174301	81,280	474
Yellow Jacket Creek downstream of Hammet Road	12181801	58,240	483

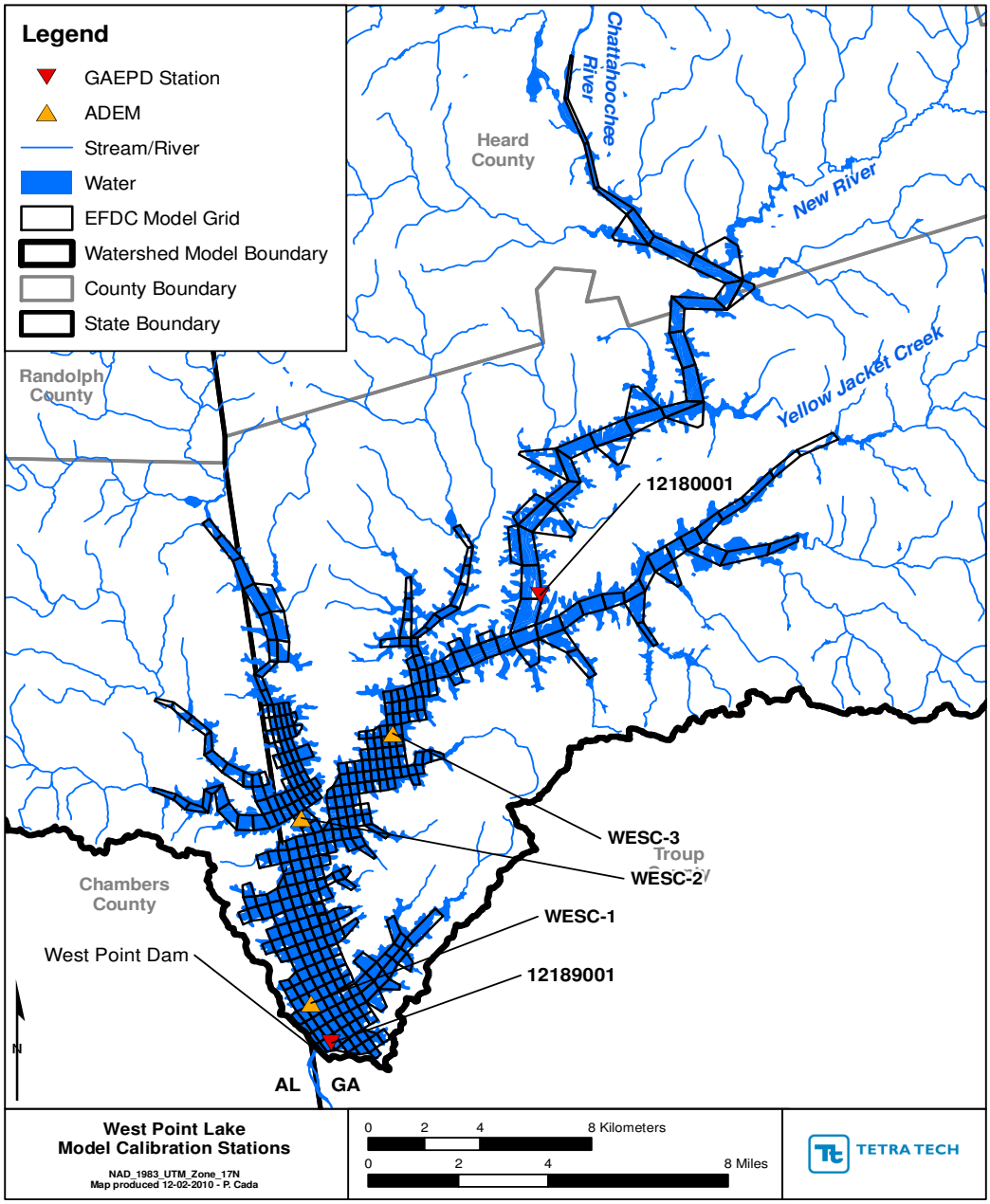

Figure 2-2 West Point Lake Evaluation Sites

Table 2-2 Summary of West Point Lake Evaluation Sites

Station Name	Station Number	EFDC Cell		Layers
		I-Value	J-Value	
LaGrange Intake	12180001	36	37	2
Dam Pool	12189001	4	5	5
ADEM-1	WESC-1	5	9	4
ADEM-2	WESC-2	11	24	3
ADEM-3	WESC-3	23	31	2

3.0 ANALYSIS OF SCENARIOS

3.1 Chlorophyll *a* Standards

The current chlorophyll *a* standard for West Point Lake was adopted in 1995 at 27 µg/L at the LaGrange Intake based on a limited dataset. Since the standard was adopted, more data has been collected and EPD has determined that chlorophyll *a* concentrations in the lake are far more complex than previously thought. A number of factors, such as nutrient concentrations, rainfall patterns, lake hydrology, and the amount of sunlight can influence chlorophyll levels. This greater knowledge obtained from analysis of the monitoring data combined with newly developed watershed and lake models has provided EPD the tools and information needed to reevaluate the lake standards.

Watershed and lake models were used to predict the effect of various nutrient loads on the West Point Lake chlorophyll *a* levels. The models were calibrated to existing hydraulic and water quality data from 2001 (Year 1) through 2007 (Year 7). The models were then run at full permitted loads (Scenario 1B) to predict the chlorophyll *a* levels in the lake. Results from the calibration and current permit runs are given in Figures 3-1 and 3-2 for the LaGrange Intake and Dam Pool, respectively. These results indicate that the current standard of 27 µg/L at the LaGrange Intake could be lowered, along with a related standard to be established at the Dam Pool.

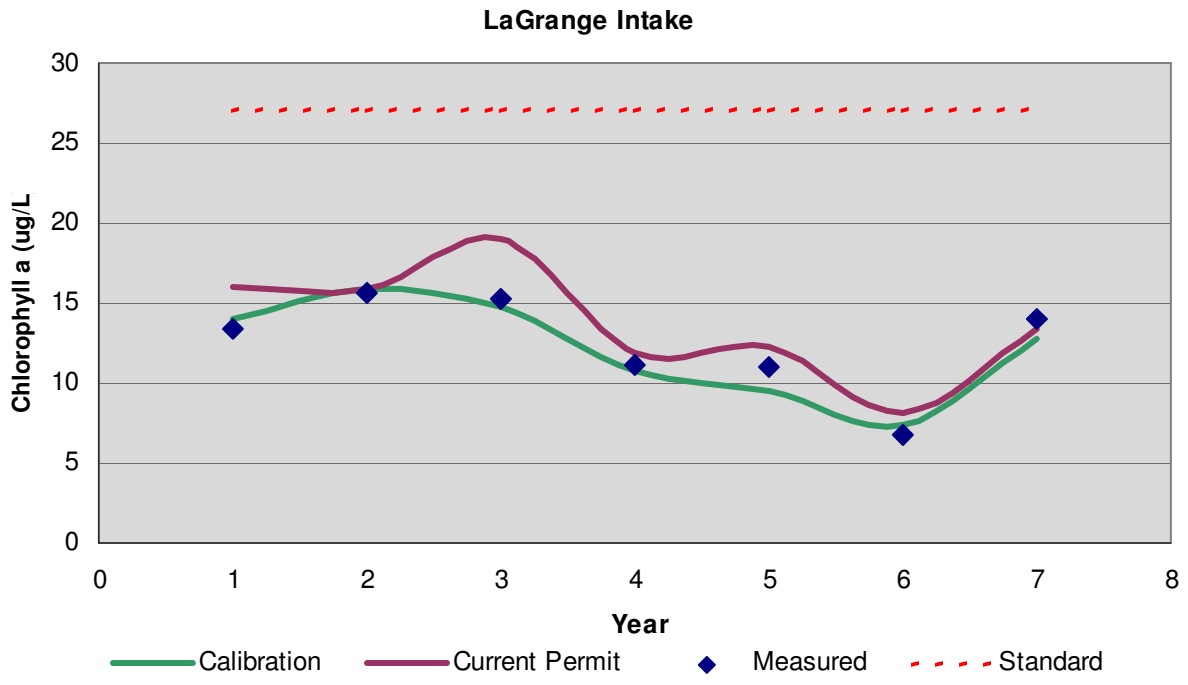

Figure 3-1: LaGrange Intake Calibration (Scenario 1A) and Current Permit (Scenario 1B) Model Results in Relation to Measured Data

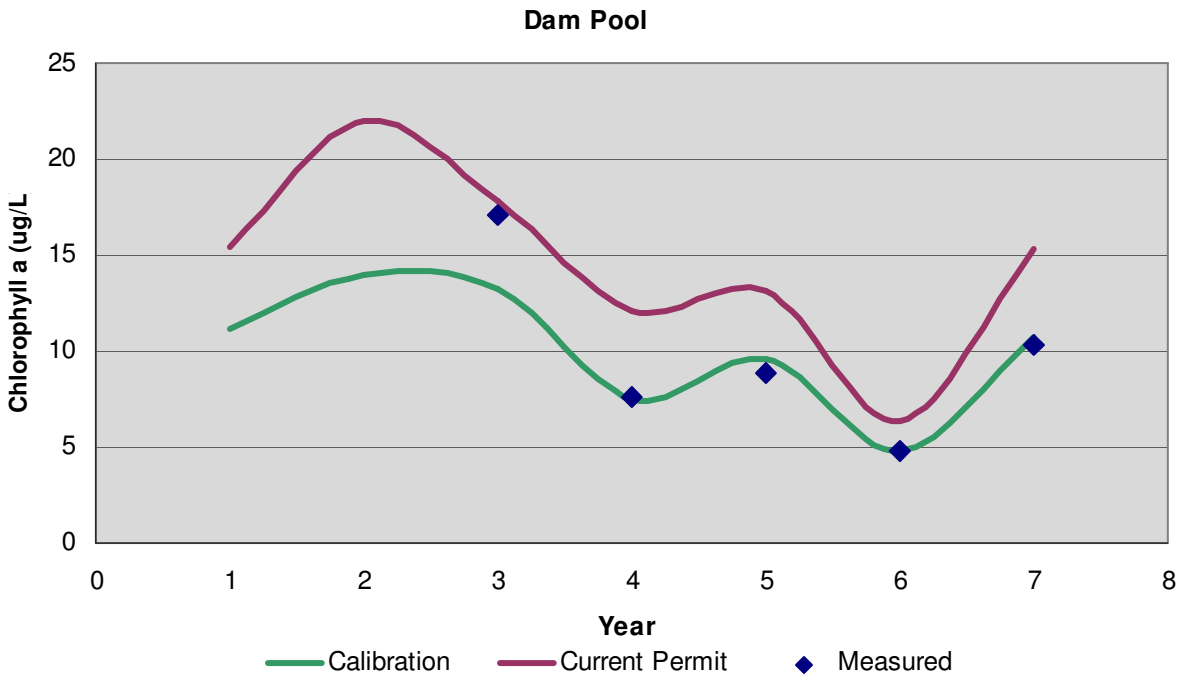

Figure 3-2: Dam Pool Calibration (Scenario 1A) and Current Permit (Scenario 1B) Model Results in Relation to Measured Data

Figures 3-3 and 3-4 breakdown the sources that contribute to the chlorophyll levels observed for the LaGrange Intake and the Dam Pool based on the results of the current permitted run (Model Scenario 1B). Landuse, which corresponds to non-point source loads, is the leading cause of chlorophyll *a* levels at the LaGrange Intake in most years. However, it is interesting to note that point sources are the leading source of chlorophyll *a* levels at the Dam Pool. The LaGrange Intake is located in the shallower, upper portion of the lake (Figure 2-2) where higher non-point source loads from the sizeable upstream watershed can have a greater effect on chlorophyll *a* levels. The deeper Dam Pool location can dilute the lower non-point source loads that arrive here from the minor watershed downstream of the LaGrange Intake. Thus, non-point source contributions are a major factor, especially in the upper portions of the mainstem of the lake.

These results, however, did not take into account future loads from point sources outlined in the 2035 Metro District Plan, as well as future landuse. Model scenario 1E (2035 Permit and Landuse) was then run to determine the effect these future loads and landuse changes would have on the West Point Lake chlorophyll *a* levels (Figures 3-5 and 3-6). These results indicate that the chlorophyll *a* criteria for the LaGrange Intake can be lowered to 24 µg/L and the chlorophyll *a* criteria for the Dam Pam can be established at 22 µg/L.

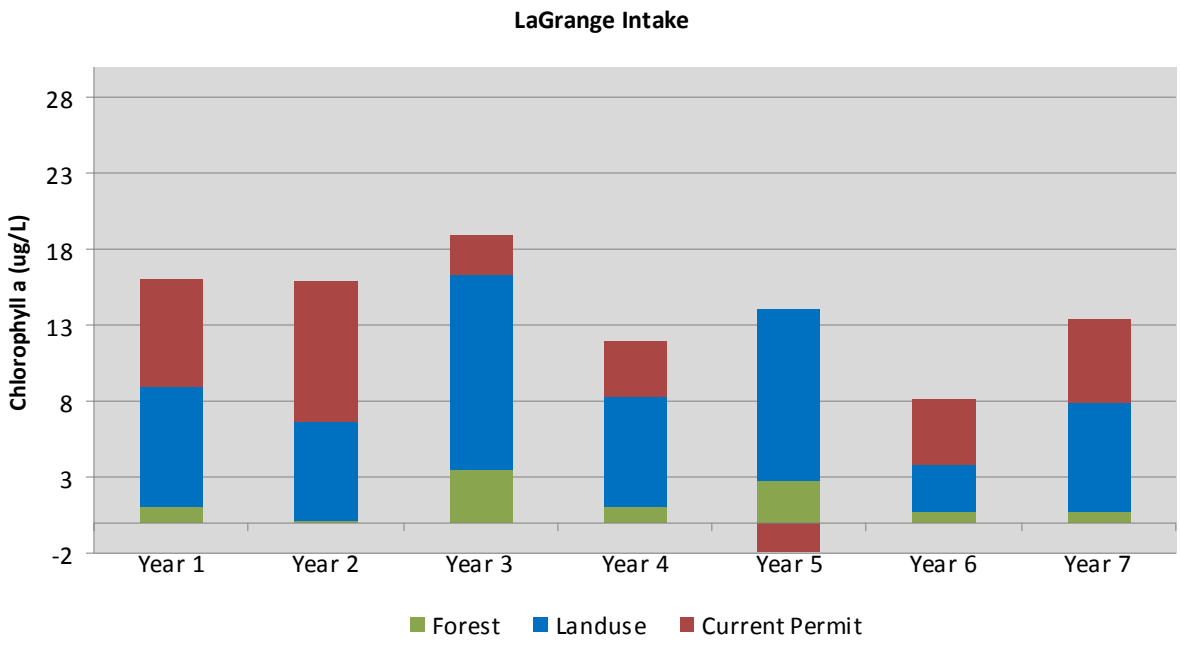

Figure 3-3 Source Contributions to Observed Chlorophyll at LaGrange Intake

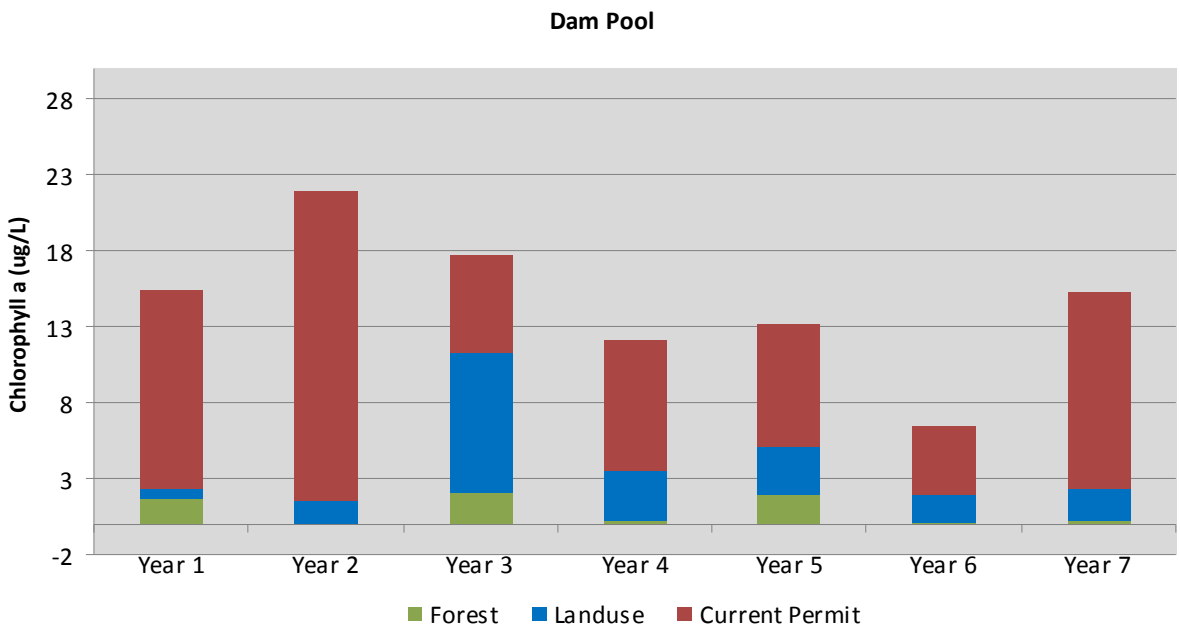

Figure 3-4 Source Contributions to Observed Chlorophyll at Dam Pool

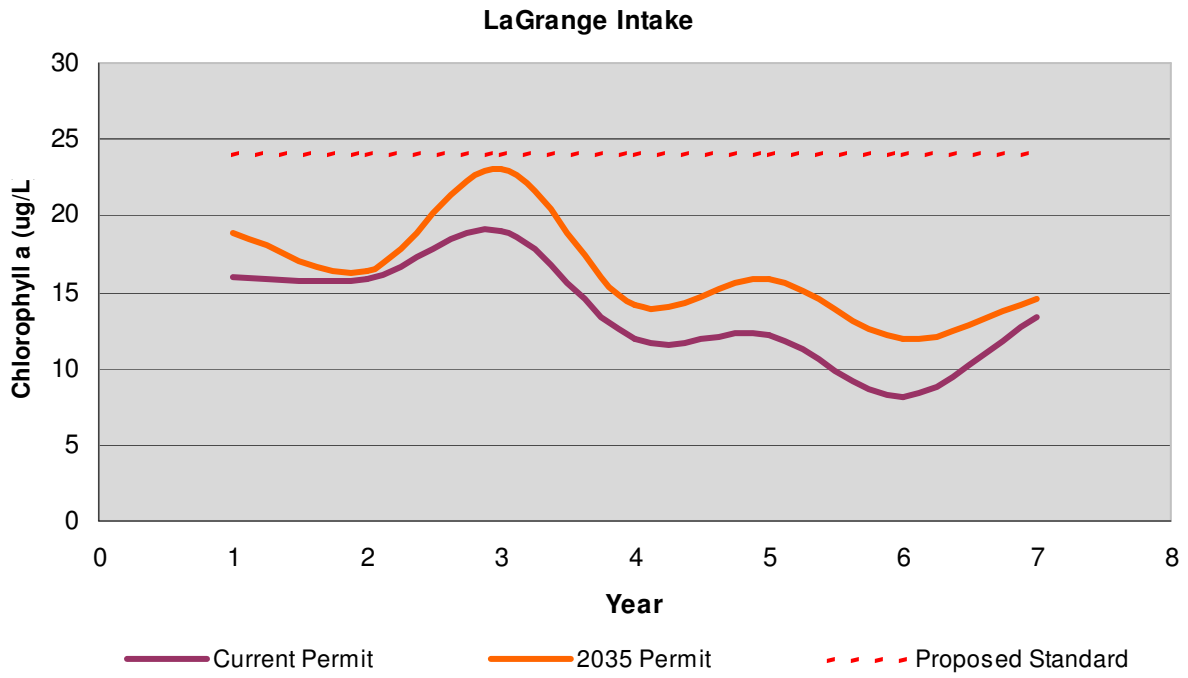

Figure 3-5: LaGrange Intake Current Permit (Scenario 1B) and 2035 Permit (Scenario 1E) Model Results *(Differences are due to future growth)*

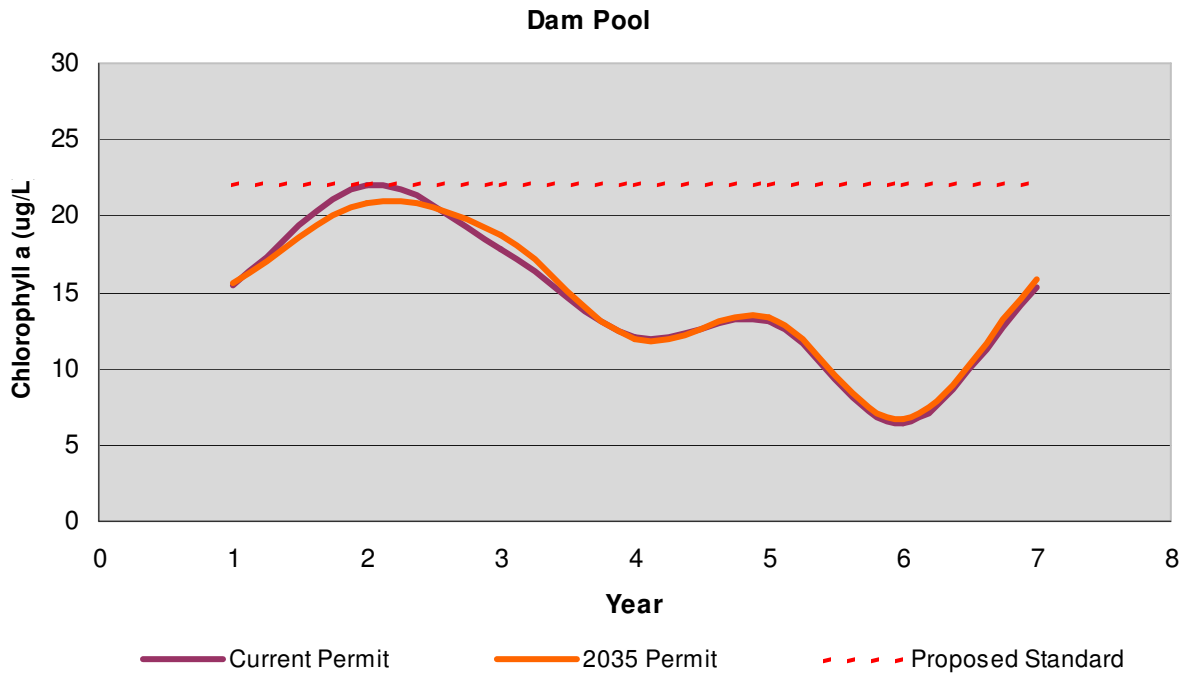

Figure 3-6: Dam Pool Current Permit (Scenario 1B) and 2035 Permit (Scenario 1E) Model Results *(Differences are due to future growth)*

In summary, the revision of the chlorophyll *a* criteria for the LaGrange Intake to 24 µg/L and the establishment of the Dam Pool chlorophyll *a* criteria of 22 µg/L are supported by the modeling work presented here. These criteria will still be protective of the Recreation and Drinking Water designated uses, and will not result in any economic burden on point or non-point sources within the watershed now or within the foreseeable future due to their continued attainment.

3.2 Major Tributary Annual Phosphorus Loading Standard

The major tributary annual phosphorus loading standard was also evaluated for West Point Lake to ensure these criteria were being met. The model results for each scenario are presented in Table 3-1. These results indicate that under all conditions evaluated the phosphorus loading standard will be met.

Table 3-1 Evaluation of West Point Lake Major Tributary Annual Phosphorus Loading Standard for Each Model Scenario

Model Scenario	Tributary Station	Standard (lbs/year)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Calibration (1A)	**Chattahoochee River @ US 27**	1400000	323100	304300	422200	324900	397700	365200	275900
	New River @ Hwy 100	14000	5700	6100	11000	6500	7600	4100	2900
	Yellow Jacket Creek @ Hammet Road	11000	3900	3000	7100	3300	5000	1600	1300
Current Permit (1B)	**Chattahoochee River @ US 27**	1400000	522700	526400	667400	578200	634700	550100	502300
	New River @ Hwy 100	14000	5000	6000	10600	5600	7700	3800	2500
	Yellow Jacket Creek @ Hammet Road	11000	3900	3000	7100	3300	5000	1600	1300
All Forest (1C)	**Chattahoochee River @ US 27**	1400000	30400	25200	105300	61500	93700	49400	30800
	New River @ Hwy 100	14000	800	900	3200	800	1800	500	300
	Yellow Jacket Creek @ Hammet Road	11000	1200	700	3100	900	1700	400	300
No Point Sources, Current Landuse (1D)	**Chattahoochee River @ US 27**	1400000	122300	129500	241700	166700	213700	145800	104800
	New River @ Hwy 100	14000	4000	4900	9200	4500	6400	3000	2000
	Yellow Jacket Creek @ Hammet Road	11000	3900	3000	7100	3300	5000	1700	1300
2035 Permit and Landuse (1E)	**Chattahoochee River @ US 27**	1400000	493000	505300	648300	558700	614700	526300	475700
	New River @ Hwy 100	14000	7600	8600	13000	8100	10100	6500	5500
	Yellow Jacket Creek @ Hammet Road	11000	4000	3200	7300	3600	5200	1900	1500

4.0 DESIGNATED USE SUPPORT

4.1 Recreational Use Support

West Point beaches, operated by the U.S. Army Corps of Engineers (COE), are located in the lower half of the lake. There have been no recreational closures due to algal blooms at any of the COE operated beaches (personal communication, COE).

4.2 Fisheries Use Support

There have not been any fish kills in West Point Lake associated with oxygen deficiency since standards were adopted. Following the phosphate detergent ban and phosphorus limits in NPDES permits in the early 1990's, algal productivity declined in the lake and resulted in increased water clarity. WRD Fisheries Biologists subsequently documented during standardized monitoring a shift in the dominant black bass species from largemouth bass to spotted bass. Spotted bass seem to have a competitive advantage over largemouth bass in clear, more infertile waters. The decline in the largemouth bass fishery is reflected in decreased growth and recruitment of the fish, and a reduction in angler satisfaction. A local lake advocacy group, the West Point Lake Coalition, has sponsored spotted bass fishing tournaments to offset the impact from the species shift, providing an alternative to largemouth bass tournaments. WRD has also removed the minimum length limit to encourage anglers to harvest more spotted bass.

The WRD began stocking Gulf race striped bass in West Point Lake as part of their native species restoration efforts. Striped bass, especially adults over 11 pounds, are a temperate cool water species that require at a minimum habitat having temperatures of less than 25 ℃ and with greater than 3 mg/L of dissolved oxygen. Water temperatures of 22 ℃ or less with dissolved oxygen concentrations of 5 mg/L or more are optimal for this species. Whereas the decreased algal productivity has had a negative effect on the largemouth bass sport fishery, a positive impact is expected for the restoration of the Gulf race striped bass fishery. The establishment of the Dam Forebay chlorophyll a criteria and lowering of the LaGrange Intake chlorophyll a criteria can be seen as further protecting the native fisheries in West Point Lake.

4.3 Drinking Water Source Use Support

The original City of LaGrange water intake was in the Chattahoochee River channel at an elevation of 618 feet above mean sea level (msl), and was replaced in subsequent years following lake impoundment with intakes constructed at elevations of 628, 625 and 623 feet msl. The design summer operating pool of West Point is 635 feet msl. The City has found that the depth of the epilimnion layer containing the majority of algal biomass is confined within the top 10 feet at their intake facility, and withdrawals are made using the intake below this layer when possible. With declining water levels during the summer of 2007 and somewhat higher chlorophyll a levels (as shown in Figure 4-1), the City was forced to withdraw water in the epilimnion. Water treatment costs increased and taste and odor complaints to the City became more numerous. The City has had similar problems in past dry years (e.g., 2000 and 2012) when summer lake levels were well below the design summer pool elevation and chlorophyll levels were elevated. The proposed reduction in the chlorolphyll *a* criteria should help reduce the potential for taste and odor problems due to algae in the future.

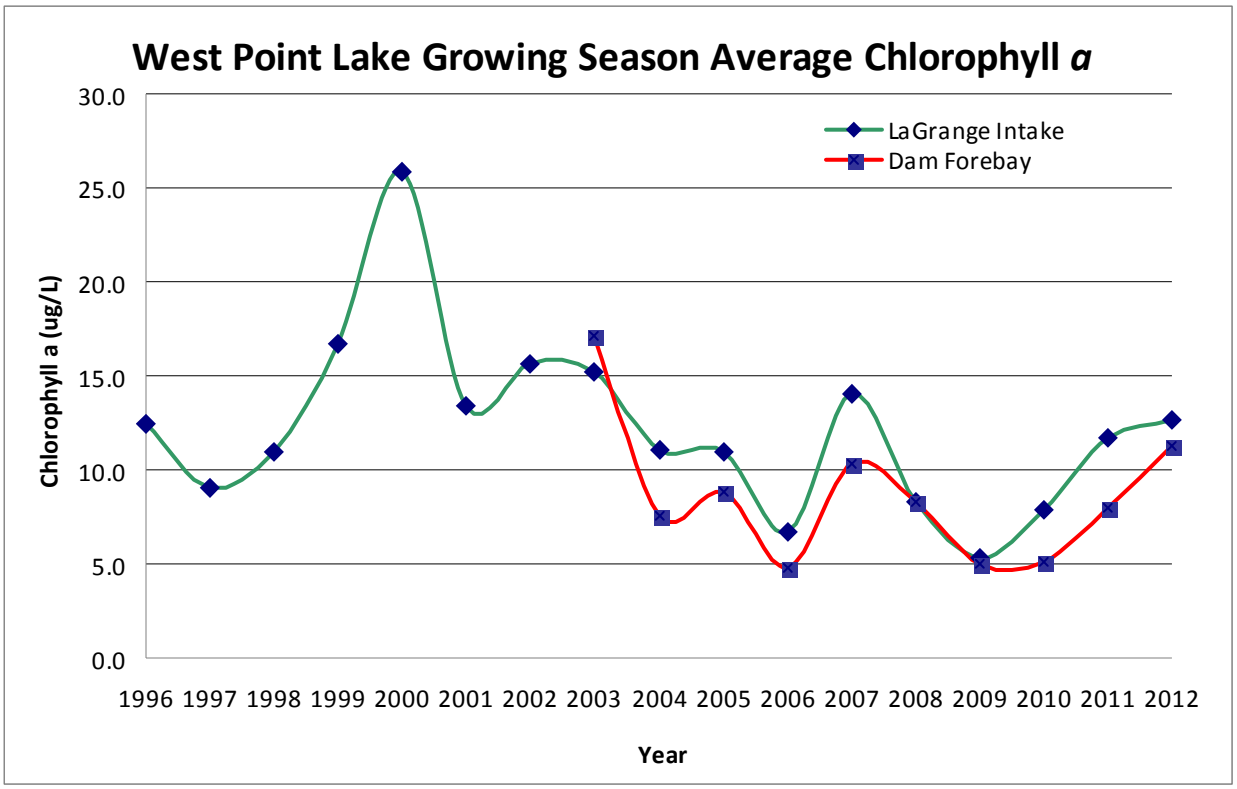

Figure 4-1 Historic West Point Lake Growing Season Average Chlorophyll a