Alabama Department of Environmental Management

FINAL
Total Maximum Daily Loads (TMDLs)

for

Neely Henry Lake
Nutrients, OE/DO & pH

Logan Martin Lake
Nutrients & OE/DO

Lay Lake
Nutrients & OE/DO

Mitchell Lake
Nutrients

Alabama Department of Environmental Management
Water Quality Branch
Water Division
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Region 4 serving the southeast

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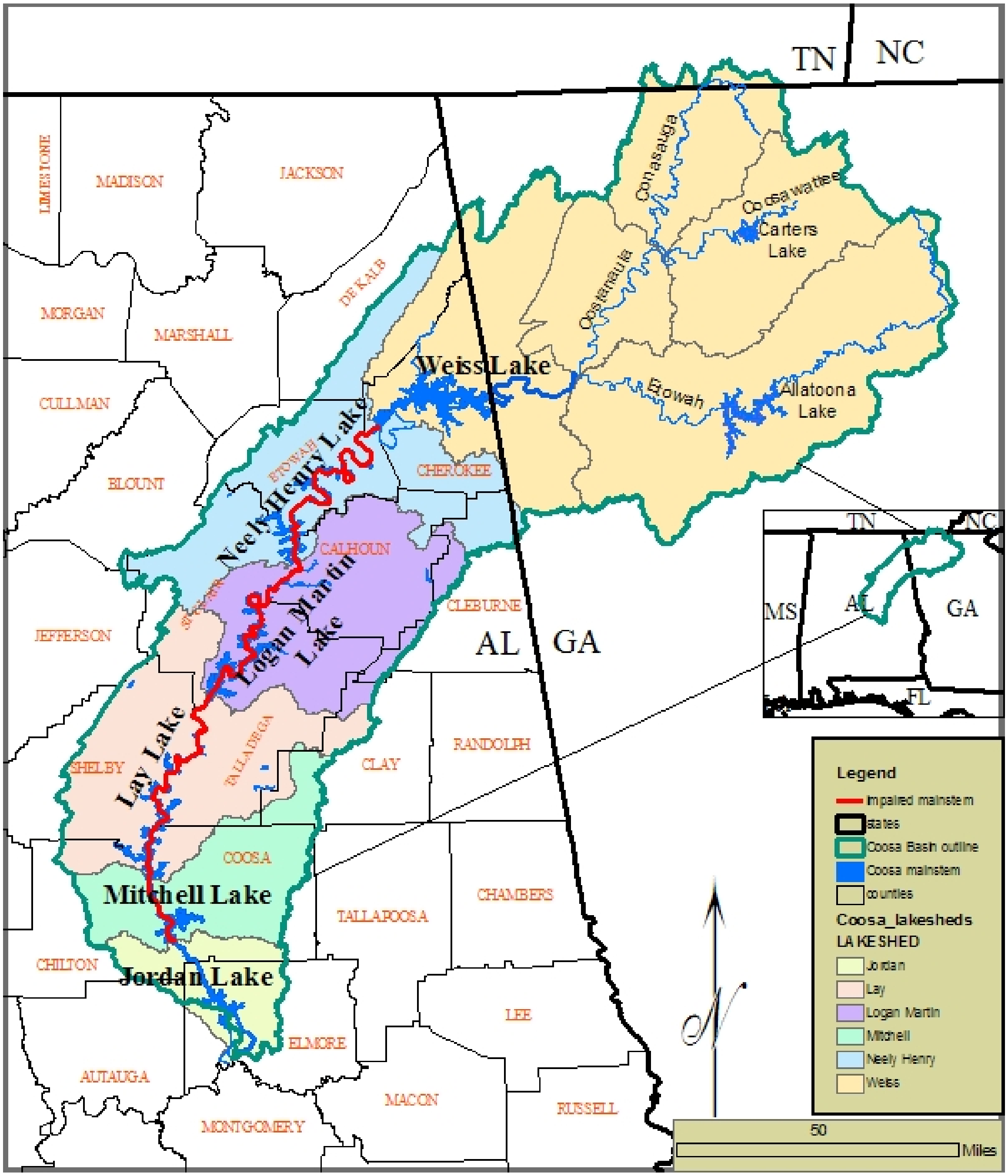


List of Abbreviations

ADEM	Alabama Department of Environmental Management
BMP	Best Management Practices
CAFO	Confined Animal Feeding Operation
CBOD	Carbonaceous Biochemical Oxygen Demand
CFS	Cubic Feet per Second
CWP	Clean Water Partnership
DEM	Digital Elevation Model
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FSA	Farm Services Agency
GAEPD	Georgia Environmental Protection Division
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOA	Memorandums of Agreements
MOS	Margin of Safety
MPN	Most Probable Number
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Stormwater System
NBOD	Nitrogenous Biochemical Oxygen Demand
NCDC	National Climatic Data Center
NHD	National Hydrography Database
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCS	Natural Resources Conservation Service
OE	Organic Enrichment
OEO	ADEM Office of Education and Outreach
RF3	Reach File 3
SOD	Sediment Oxygen Demand
SWQM	Spreadsheet Water Quality Model
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
USDA	United States Department of Agriculture
USF&WS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation

1.0 Executive Summary

In 1996, the Alabama Department of Environmental Management (ADEM) identified five of the six reservoirs on the Coosa River within the State of Alabama's borders as being impaired, namely Weiss Lake, Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake. Jordan Lake, the most downstream lake before the Coosa meets the Tallapoosa River to form the Alabama River, is the only lake not considered impaired. In 2006, Weiss Lake was removed from the 303(d) List as a result of TMDLs being completed for all causes (pollutants) by November 2004. Table 1-1 below provides a summary of the current impairment status of each of the Coosa Lakes as documented on Alabama's 2008 303(d) List.

Table 1-1 Alabama-2008§ 303(d) Listed Lakes within the Coosa River Watershed

Assessment Unit ID	Waterbody Name	Uses	Causes	Sources	Size	Downstream / Upstream Locations
AL03150106-0309-101	Coosa River (Neely Henry Lake)	Swimming Fish & Wildlife	Nutrients pH Organic Enrichment (CBOD, NBOD)	Industrial Municipal Flow regulation /modification Upstream sources	5487.94 acres	Neely Henry Dam / McCardney's Ferry
AL03150106-0309-102	Coosa River (Neely Henry Lake)	Fish & Wildlife	Nutrients pH Organic Enrichment (CBOD, NBOD)	Industrial Municipal Flow regulation /modification Upstream sources	3502.52 acres	McCardney's Ferry / Big Wills Creek
AL03150106-0104-101	Coosa River (Neely Henry Lake)	Fish & Wildlife	Nutrients pH Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Industrial Municipal Flow regulation /modification Upstream sources Contaminated Sediments	245.39 acres	Big Wills Creek / City of Gadsden water supply intake
AL03150106-0104-102	Coosa River (Neely Henry Lake)	Public Water Supply Fish & Wildlife	Nutrients pH Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Industrial Municipal Flow regulation /modification Upstream sources Contaminated Sediments	1897.43 acres	City of Gadsden water supply intake / Weiss Dam powerhouse
AL03150106-0801-100	Coosa River (Logan Martin Lake)	Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Urban runoff/storm sewers Flow regulation /modification Contaminated Sediments	14415.70 acres	Logan Martin Dam / Broken Arrow Creek
AL03150106-0501-101	Coosa River (Logan Martin Lake)	Public Water Supply Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Urban runoff/storm sewers Flow regulation /modification Contaminated Sediments	1450.26 acres	Broken Arrow Creek /Trout Creek
AL03150106-0501-102	Coosa River (Logan Martin Lake)	Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Urban runoff/storm sewers Flow regulation/modification Contaminated Sediments	820.38 acres	Trout Creek / Neely Henry Dam
AL03150107-0401-100	Coosa River (Lay Lake)	Public Water Supply Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Flow regulation/modification Upstream sources Contaminated Sediments	11806.34 acres	Lay Dam / Southern RR Bridge
AL03150107-0101-102	Coosa River (Lay Lake)	Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Flow regulation/modification Upstream sources Contaminated Sediments	862.40 acres	Southern RR Bridge / River Mile 89
AL03150106-0808-102	Coosa River (Lay Lake)	Public Water Supply Swimming Fish & Wildlife	Nutrients Organic Enrichment (CBOD, NBOD) Priority Organics (PCBs)	Flow regulation/modification Upstream sources Contaminated Sediments	698.25 acres	River Mile 89 / Logan Martin Dam
AL03150107-0601-100	Coosa River (Mitchell Lake)	Public Water Supply Swimming Fish & Wildlife	Nutrients	Urban runoff/storm sewers Flow regulation/modification	5400.33 acres	Mitchell Dam / Lay Dam

The Environmental Protection Agency (EPA) Region 4 developed a draft nutrient TMDL for Weiss Lake in July 2000, and subsequently revised and re-proposed the TMDL again for public comment in December 2002. In November 2004, EPA finalized the Nutrient TMDL for Weiss Lake. Concurrent with the TMDL proposals for Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake, EPA is proposing revisions to the Weiss Lake Nutrient TMDL for public review and comment based on extensive water quality data and information that was collected by EPA, ADEM and GAEPD for Weiss Lake and its associated watershed. The 2008 Weiss Lake Nutrient TMDL serves as a starting point for the TMDLs discussed herein. This report will therefore only address the Organic Enrichment/Dissolved Oxygen (OE/DO), Nutrient and pH issues for Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake. The priority organics (PCBs) for the listed segments of Neely Henry Lake, Logan Martin Lake and Lay Lake will be addressed under a separate report in the future.

Currently, ADEM has not established numeric nutrient criteria for Neely Henry Lake, Logan Martin Lake, Lay Lake or Mitchell Lake. Therefore, ADEM has chosen to set chlorophyll *a* targets in each of the subject lakes for purposes of developing these TMDLs. According to ADEM's Nutrient Criteria Implementation Plan (ADEM, 2007) chlorophyll *a* (response indicator) has been chosen as the primary variable for addressing cultural eutrophication and will be used as the primary tool for protecting designated uses of lakes and reservoirs from nutrient overenrichment. Chlorophyll *a* was chosen as the candidate variable because of its wide acceptance among federal/state agencies, limnologists and scientists as being a good surrogate for estimating phytoplankton biomass and because it provides the most direct indication of how nutrients are impacting a lake's designated uses. Chlorophyll *a* is also considered a good early indicator of nutrient enrichment and is relatively easy and inexpensive to collect and analyze. Table 1-2 below provides the lake specific chlorophyll *a* targets that will be used to establish Nutrient TMDLs for the Coosa Lakes. Based on readily available data and information and the approach outlined in ADEM's Nutrient Criteria Implementation Plan, the selected chlorophyll *a* targets were determined to be appropriate for these TMDLs. The readily available information includes calibrated water quality models that characterize the nutrient dynamics in the reservoirs in the Coosa River Basin, including consideration of the reductions required by the concurrently proposed Lake Weiss TMDL. ADEM's Nutrient Criteria Implementation Plan generally describes an approach for criteria development which includes best professional judgment in consideration of limnologist's recommendations and the knowledge of how chlorophyll *a* levels attenuate in a chain of reservoirs within a river basin.

Table 1-2 Lake-Specific Chlorophyll *a* Targets for TMDL Development

Lake	Station ID	Station Location	Chlorophyll *a* Target (ug/L)
Neely Henry	NEES-3	Middle Reservoir	18.0
	NEES-1	Dam Forebay	18.0
Logan Martin	LOGS-1	Upper Reservoir	17.0
	LOGS-3	Dam Forebay	17.0
Lay	LAYC-3	Middle Reservoir	17.0
	LAYC-1	Dam Forebay	17.0
Mitchell	MITC-2	Upper Reservoir	16.0
	MITC-1	Dam Forebay	14.0

A dynamic system of models was developed for the Coosa River Basin to evaluate the parameters of interest and to represent the link between watershed nutrient loads, ambient nutrient concentrations (nitrogen, phosphorus) and algal productivity (chlorophyll a). The system consists of an application of the Loading Simulation Program in C++ (LSPC) for each lakeshed (defined as all watersheds draining to a specific lake), which provided the watershed flows to each reservoir. In addition, a receiving hydrodynamic model (EFDC) and water quality model (WASP) was developed for each lake. Each of the models were setup for the 1997 and 2000 growing seasons. These time periods were chosen as they not only represent a set of critical conditions (1997 being a wet year and 2000 a dry year), but monthly data is also available for each of the lakes including chlorophyll *a*, nutrients and profile data for dissolved oxygen and temperature. In terms of overall reductions necessary meet applicable water quality standards for each lake, the 1997 hydrological conditions were found to be the most critical and therefore were used to establish the subject TMDLs.

The total phosphorus (TP) reductions necessary to meet applicable water quality standards for each of the Coosa Lakes (Neely Henry, Logan Martin, Lay and Mitchell) are presented below in Table 1-3. The TP reductions for the Coosa Lakes were developed based on the revised TP reductions for Weiss Lake as documented in the Final Weiss Lake Nutrient TMDL (EPA, 2008). The Weiss Lake TMDL, which identifies a 30% reduction to phosphorus loads in the Coosa River basin upstream from Weiss Lake, was concurrently revised and reproposed by EPA for public review and comment in August 2008.

Table 1-3 Nutrient TMDL Results for the Coosa River Basin Lakes

Lake Specific TMDL	Existing TP Loads		Allowable TP Loads			TP Reductions (per lakeshed)		
	Point sources (direct discharges)	Nonpoint Sources[2]	WLA[1] (direct discharges)	LA[2]	TMDL	WLA (direct discharges)	WLA (MS4s)[2]	LA[2]
Lake Neely Henry	621.0 lbs/day	3523.46 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 242.69 lbs/day	2466.42 lbs/day	2709.11 lbs/day	60.9%	30% (Etowah County MS4)	30.0%
Logan Martin Lake	860.8 lbs/day	5134.09 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 102.17 lbs/day	3491.69 lbs/day	3593.86 lbs/day	88.1%	NA	30.0%
Lay Lake	410.1 lbs/day	6262.04 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 293.99 lbs/day	4383.43 lbs/day	4677.42 lbs/day	28.3%	NA	30.0%
Lake Mitchell	0.0 lbs/day	8594.36 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 0.0 lbs/day	6016.05 lbs/day	6016.05 lbs/day	0.0%	NA	30.0%

1 A TP limit of 1 mg/L for majors and 8.34 lbs/day for minors is applied as a monthly average limit for the months of April through October with the exception of APCO Gaston Plant-Ash Pond which will have a TP Limit of 0.25 mg/L for the months of April through October. Refer to Table 3-3 for a specific listing of point sources that are subject to the TMDL.

2 The load allocation for the nonpoint sources that drain to Neely Henry Lake and the wasteload allocation for the Etowah County Phase II MS4 Area both require a 30% reduction. There is insufficient data and information to quantify the specific distribution between the existing nonpoint source and MS4 loads. Consequently, there is insufficient data and information to quantify the breakdown between the LA and WLA for the Etowah County MS4 in terms of pounds per day after a 30% reduction is applied. Therefore, the value of 2466.42 lbs/day includes both the allowable loads from the nonpoint sources that drain to Neely Henry Lake as well as the allowable wasteloads from the Etowah County MS4.

Based on extensive water quality modeling, the TP reductions included in the above Nutrient TMDL are shown to improve dissolved oxygen concentrations in each of the lakes by providing a more balanced algal biomass which in turn will enhance photosynthesis and respiration processes.

Based on the modeling analysis and the readily available data and information, reduction of TP loads is sufficient to result in the attainment of the applicable DO criterion of 5.0 mg/L for each of the lakes respectively. With the TP reductions, the existing point and nonpoint source loadings for Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD) are expected to achieve the applicable DO criterion of 5.0 mg/L for each of the lakes respectively. Therefore, no load reductions for CBOD and NBOD will be necessary.

The elevated pH levels in Neely Henry Lake are a direct indication of nutrient over-enrichment which can be observed during times of increased algal production and the corresponding effects on the carbonate system of the reservoir. Therefore, by lowering the nutrient loads to the lake, the pH levels are expected to fall within acceptable levels based on modeling results for Neely Henry Lake. Thus, reduction of the nutrient loads is necessary to reduce the pH levels of Neely Henry Lake to within the applicable pH criteria of 6.0-8.5 s.u.

This document presents a brief summary of the data analysis and modeling work performed in the development of the TMDLs for the listed lakes on the Coosa River. Details of the model development, calibration process, model parameters and modeling assumptions are presented in a report entitled “Hydrodynamic and Water Quality Modeling Report for the Coosa River Basin.” The report is hereinafter referred to as the Modeling Report (Tetra Tech, 2008). In developing the TMDLs for the Coosa River Basin, data was gathered from many sources. This information is presented in a report entitled “Data Summary Report for Coosa River Basin TMDLs” which will be referred to as the Data Summary Report (Tetra Tech, 2008).

2.0 Basis for the §303(d) Listing

2.1 Introduction

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987 and EPA's Water Quality Planning and Management Regulations [(Title 40 of the Code of Federal Regulations (CFR), Part 130)] require states to identify waterbodies which are not meeting water quality standards applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. Total maximum daily loads (TMDLs) for all pollutants causing violation of applicable water quality standards are required to be determined for each identified segment. Such loads are established at levels necessary to implement the applicable water quality standards with seasonal variations and margins of safety. The TMDL process establishes the allowable loading of pollutants, or other quantifiable parameters for a waterbody, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Alabama has identified 11 segments located on the Coosa River as being impaired. Table 1-1 presented the 2008 303(d) listed segments to include causes and sources of impairment, segment sizes and location as well as other pertinent data and information. All of the segments are listed as impaired for organic enrichment/dissolved oxygen (OE/DO) and nutrients, with the exception of Neely Henry Lake which is also listed as impaired for pH and Mitchell Lake is only impaired for nutrients. In addition, portions of Neely Henry Lake, Logan Martin Lake, and Lay Lake are impaired by PCBs in fish tissue. The lakes are in series and begin at the Weiss Lake Dam and end at the Mitchell Lake Dam.

All four lakes are designated Swimming and Fish & Wildlife use classification, while portions of three lakes (Neely Henry, Lay and Mitchell) also have the Public Water Supply use classification. In 1992, Lay Lake was the only lake listed as not fully supporting its designated uses. It was listed as only partially supporting. In 1994, Lay Lake was listed as partially supporting and Neely Henry Lake was listed as not-supporting its designated uses. The other lakes, Logan Martin Lake and Mitchell Lake, were listed as fully supporting. The 1996 303(d) listings for the Coosa River Lakes are shown in Table 2-1 on the following page, which is the basis for the 1998 Consent Decree TMDL schedule. All lakes were identified as partially supporting their uses. The 1998 through 2008 303(d) listings are similar to 1996, with the exception of a few additions/deletions to the causes and sources and the lakes were broken out into smaller individual segments based on a 12-digit Hydrologic Unit Code Assessment ID. The 2008 303(d) listed Coosa River segments are shown in Table 1-1.

Table 2-1 Alabama's 1996§ 303(d) Listed Reservoirs on the Coosa River

Lake	Support Status	Uses	Causes	Sources
Weiss	Partial	Public Water Supply Swimming Fish & Wildlife	Priority Organics Nutrients pH OE/DO	Industrial Municipal Flow reg/mod
Neely Henry	Partial	Public Water Supply Swimming Fish & Wildlife	Priority Organics Nutrients pH OE/DO	Industrial Municipal Flow reg/mod
Logan Martin	Partial	Swimming Fish & Wildlife	Nutrients OE/DO	Urban runoff/Storm sewers Flow reg/mod
Lay	Partial	Public Water Supply Swimming Fish & Wildlife	Priority Organics Nutrients OE/DO	Flow reg/mod
Mitchell	Partial	Public Water Supply Swimming Fish & Wildlife	Nutrients OE/DO	Urban runoff/Storm sewers Flow reg/mod

2.2 Description of Listed Lakes

For the purposes of this report, terminology of lake and reservoir will be interchangeable. The lakes addressed in this report are:

- Neely Henry Lake (from Weiss Lake Dam to Lake Neely Henry Dam)
- Logan Martin Lake (from Lake Neely Henry Dam to Logan Martin Lake Dam)
- Lay Lake (from Logan Martin Lake Dam to Lay Lake Dam)
- Mitchell Lake (from Lay Lake Dam to Lake Mitchell Dam)

General information about each lake is described below. Various information and statistics for each of the four lakes above are summarized in Table 2-2. Data is also provided in Table 2-2 for Weiss Lake (above Neely Henry Lake) and Jordan Lake (below Mitchell Lake) for informational purposes only. All six Coosa River reservoirs in Alabama have hydroelectric power operations that are owned and managed by Alabama Power Company and each project is licensed by the Federal Energy Regulatory Commission.

Table 2-2 Dam and Reservoir Statistics for Reservoirs in Coosa River Basin

	Weiss	Neely Henry	Logan Martin	Lay	Mitchell	Jordan
Dam Statistics						
Type	Gravity concrete & earth-fill	Gravity concrete & earth-fill	Gravity concrete & earth-fill	Gravity concrete	Gravity concrete	Gravity concrete
Date of Impoundment	1961	1966	1964	1914	1923	1928
Total Length (feet)	392 (concrete) 30,406 earth dikes	605 (concrete) 4,100 earth dikes	612 (concrete) 5,464 earth dikes	2,260	1,264	2,066
Maximum Height (feet)	85.5	104	97	129.6	106	125
Reservoir Statistics						
Full Pool Elevation (msl)	564	508	465	396	311.9	252
Area (acres)	30,200	11,200	15,263	12,000	5,850	6,800
Shoreline (miles)	447	339	275	289	147	188
Length (miles)	52	77.6	48.5	48.2	14	18.4
Maximum Depth at dam (feet)	62	53	69	88	90	110
Drainage Area (square miles)	5,273	6,600	7,700	9,087	9,827	10,165
Hydraulic Retention Time (days)	18	6	11	9	5	7
Average Depth (feet)	10.2	10.8	17.9	21.9	29.2	34.7
Total Storage Volume @ Full Pool (acre-feet)	306,331	120,941	273,387	262,749	170,710	236,178
Average Discharge (1940-1993) - cfs	8,770	10,505	12,756	14,150	15,850	16,971

2.2.1 Neely Henry Lake

Neely Henry Lake extends approximately 78 miles upstream from the Neely Henry Dam through Cherokee, Calhoun, Etowah and St. Clair counties in northeast Alabama. The dam is located approximately 147 miles upstream of the confluence of the Coosa and Tallapoosa Rivers, which merge to form the Alabama River (Alabama Power, 2003a).

From the Weiss Dam to the Neely Henry Dam, Neely Henry Lake has a surface area of 11,235 acres at the normal water surface elevation of 508 ft above mean sea level (msl) during summer (May 1 to October 31). The normal water surface elevation is 505 ft msl during the winter (November 5 to April 15). The lake has 339 miles of shoreline and a maximum depth of 53 feet. The lake is relatively shallow with an average depth of 10.8 ft and a total storage volume at full pool of 120,941 acre-feet. The lake drainage area is 6,600 square miles, of which 1,327 square miles comprises the local lakeshed.

It has limited capacity and typically fluctuates less than 1.5 ft in water level on a daily basis. It is primarily used for hydroelectric generation with other secondary uses such as water supply, irrigation and recreation and is operated in accordance with its Federal Energy Regulatory Commission license.

2.2.2 Logan Martin Lake

Logan Martin Lake is located in north central Alabama in Talladega, Calhoun and St. Clair counties. The Logan Martin Dam is located approximately 99 river miles above the confluence of the Coosa and Tallapoosa Rivers (Alabama Power, 2003b).

Logan Martin Lake extends approximately 48.5 miles from the Logan Martin Dam upstream to the Neely Henry Dam. It has a surface area of 15,263 acres at the normal water surface elevation of 465 ft msl. The lake has 275 miles of shoreline and a maximum depth of 69 ft at the dam and an average depth of 17.9 ft. The storage capacity of Logan Martin Lake at the normal pool elevation is 273,300 acre-ft., and 205,700 acre-ft at the minimum pool elevation of 460 ft msl. The lake drainage area is 7,700 square miles, of which 1,100 square miles comprises the local lakeshed.

The lake is primarily used for hydroelectric generation; however, its other uses include flood control, navigation flow augmentation, maintenance of downstream water quality, irrigation, and recreation. The lake also serves as an excellent habitat for fish and wildlife. Although Logan Martin Lake is used for flood control, there is a limited amount of storage that is available in the lake. Therefore the operation of the lake is coordinated with the other lakes in the Coosa River chain to minimize flooding in accordance with its Federal Energy Regulatory Commission license.

2.2.3 Lay Lake

Lay Lake is located approximately 51 river miles upstream of the confluence of the Coosa and Tallapoosa Rivers extending 48 river miles between Logan Martin Dam and Lay Dam. The reservoir was first impounded by the construction of Lay Dam by Alabama Power Company and started operation in 1914. In 1964, the normal pool elevation was raised to its present elevation (Alabama Power, 2003c).

Lay Lake has a surface area of 12,000 acres at the normal water surface elevation of 396 ft msl. The lake has 289 miles of shoreline and a maximum depth of 88 ft. The average depth of the lake is 21.9 ft with a total storage volume at full pool of 262,749 acre-feet. The lake drainage area is 9,087 square miles, of which 1,387 square miles comprises the local lakeshed.

Lay Lake has multiple uses including hydroelectric generation, water supply and recreational. It has no storage capacity and is operated in a “run-of-the-river” mode by the operation of Logan Martin and Lay Dams in accordance with its Federal Energy Regulatory Commission license.

2.2.4 Mitchell Lake

Mitchell Lake is located in central Alabama, approximately 40 miles southeast of Birmingham and 75 miles west of the state border, in Chilton and Coosa Counties. The Mitchell Lake Dam is located approximately 37 river miles above the confluence of the Coosa and Tallapoosa Rivers (Alabama Power, 2003d).

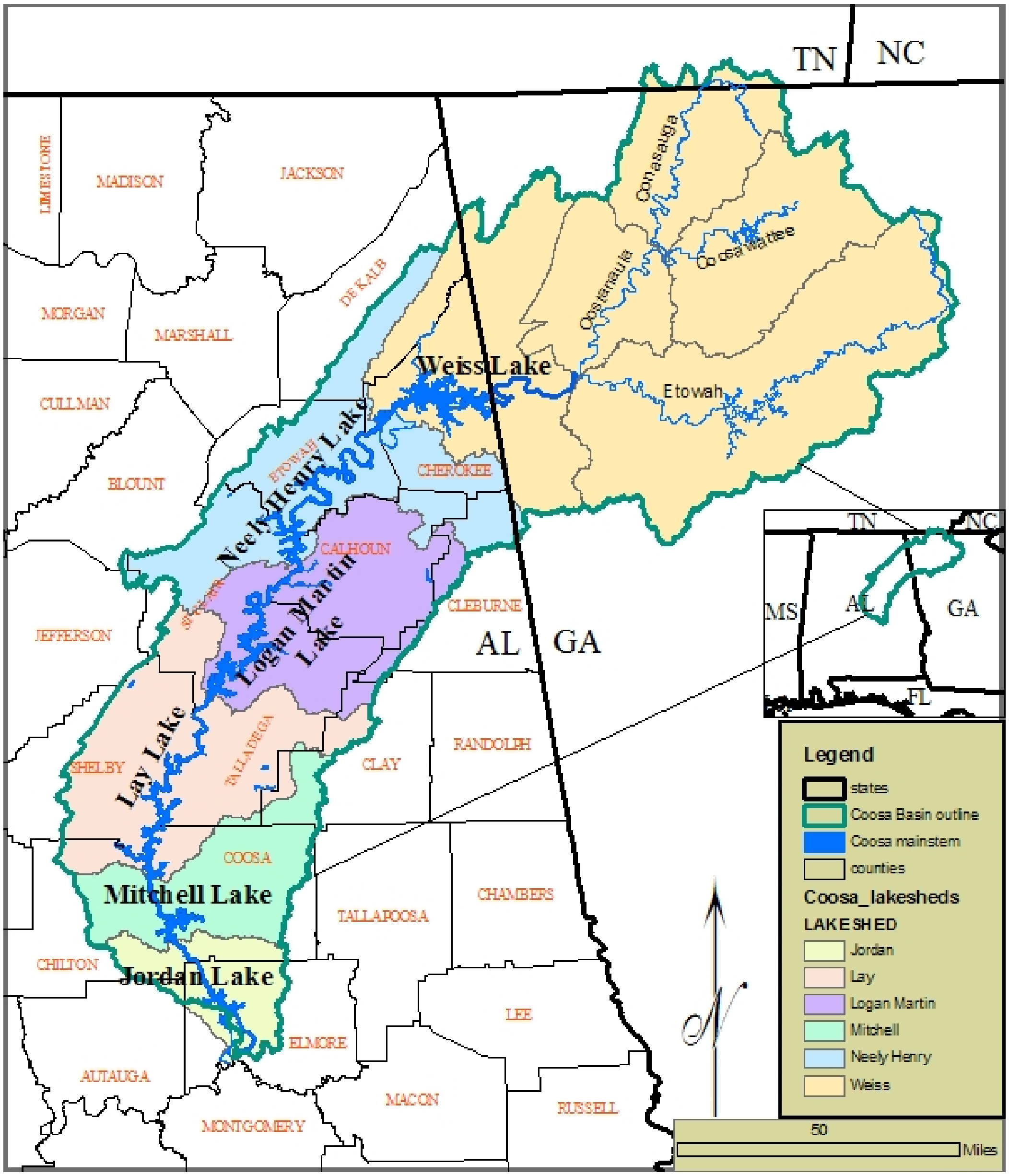
The water surface elevation is maintained at 311.9 ft msl corresponding to a lake area of 5,850 acres. The depth of water at the forebay of Mitchell Dam is approximately 100 feet. Water depths in the upper portions of Mitchell Lake near Lay Dam are approximately 20 feet. The average depth of the lake is 29.2 ft with a total storage volume at full pool of 170,710 acre-feet. The lake drainage area is 9,827 square miles, of which 725 square miles comprises the local lakeshed.

The lake is used for hydroelectric power generation, limited storage for power generation, industrial and municipal water supply, maintenance of water quality and recreational opportunities. The lake is maintained as a “run-of-the-river” lake by Alabama Power Company and is operated in accordance with its Federal Energy Regulatory Commission license.

2.3 Problem Definition

The Coosa River watershed is located within three states, Tennessee (headwaters), Georgia and Alabama. The area of interest of the Coosa River watershed for this report is from Weiss Lake Dam downstream to Lake Mitchell Dam. Figure 2-1 presents the location of the Coosa River watershed within the State of Alabama. This section of the Coosa River watershed (Weiss Lake Dam to Lake Mitchell Dam) covers approximately 4,539 square miles. All four lakes are designated Swimming and Fish & Wildlife use classification, while three lakes (Neely Henry Lake, Lay Lake and Mitchell Lake) are also designated Public Water Supply use classification.

Figure 2-1 Location Map of Coosa River Basin



The listings in this report for the lakes on the Coosa River are based on the trophic status of each lake as reported in Alabama's 305(b) reports. ADEM uses the Carlson's Trophic State Index (TSI) for determination of the trophic state of Alabama's lakes. Based on the TSI values and other data collected, ADEM determined these lakes were partially supporting or not fully supporting their designated uses due to Nutrients and OE/DO. Data collected at Neely Henry Lake also showed that more than 10% of the samples exceeded ADEM's criteria for pH. Therefore, Neely Henry Lake was also listed as not fully supporting for pH.

The purpose of this TMDL is to establish the acceptable loading of nutrients and organic material from all sources, such that the established water quality criteria outlined in Section 3.1 are attained.

3.0 Technical Basis for TMDL Development

3.1 Applicable Water Quality Criterion

3.1.1 Organic Enrichment/Dissolved Oxygen (OE/DO)

Alabama's water quality criteria regulations (ADEM Admin. Code R. 335-6-10-.09) states the following for segments classified Swimming, Fish and Wildlife and Public Water Supply:

> For a diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5.0 mg/l at all times; except under extreme conditions due to natural causes, it may range between 5.0 mg/l and 4 mg/l, provided that the water quality is favorable in all other parameters. The normal seasonal and daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5.0 mg/l dissolved oxygen where practicable and technologically possible. The Environmental Protection Agency, in cooperation with the State of Alabama and parties responsible for impoundments, shall develop a program to improve the design of existing facilities.

The dissolved oxygen criterion is established at a depth of 5 feet in water 10 feet or greater in depth; for those waters less than 10 feet in depth, the dissolved oxygen criterion is applied at mid-depth. Levels of organic materials may not deplete the daily dissolved oxygen concentration below this level, nor may nutrient loads result in algal growth and decay that violates the dissolved oxygen criterion.

The listed segments of the Coosa River are classified for Swimming, Fish and Wildlife and Public Water Supply uses. Channel depths at locations where data were sampled (which correspond to compliance points) are all greater than 10 feet for each of the lakes. Therefore, the primary water quality criterion is a DO concentration of 5.0 mg/L or greater at a depth of approximately 5 feet, except in those segments on Lay Lake and immediately below the hydroelectric impoundments where the criterion is 4 mg/l. For these TMDLs, exceedance of the dissolved oxygen criterion was determined by comparing each of the four daily outputs from the water quality model (12:00 a.m., 6:00 a.m., 12:00 p.m., and 6:00 p.m.) to the DO criterion of 5.0 mg/l.

ADEM identified organic enrichment and nutrient loads as the potential causes of low dissolved oxygen observed at the three of the four impaired reservoirs, namely Neely Henry Lake, Logan Martin Lake and Lay Lake. Nitrogen and phosphorus, in the presence of ample sunlight, support the growth of algae in a lake. Over time, the growth and decay of algae contribute organic material to the system. As this material decomposes, oxygen is consumed and nutrients stored in the biomass are released and used to support additional algal growth. In an unimpaired system, this cycle is fairly stable and oxygen levels remain high enough to support other life forms in the lake. Excessive nutrient loads that lead to algal blooms, however, disturb the equilibrium, and can cause oxygen concentrations to drop below 5.0 mg/L. As a general rule, oxygen concentrations below this level are stressful to aquatic organisms (Thomann and Mueller, 1987).

Since excessive nutrient loading and subsequent algal respiration lowers the DO level to values that are unhealthy for aquatic life, if the nutrient loading is reduced to maintain the selected chlorophyll *a* targets, DO levels in the lake are predicted to stay within acceptable levels. Thus, reduction of the nutrient (total phosphorus) loads are proposed at a level that will attain the applicable DO criterion within the listed segments.

3.1.2 Nutrients

ADEM's decision to list Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake as being impaired for nutrients was authorized under ADEM's Water Quality Standards Program, which employs both numeric and narrative criteria to ensure adequate protection of designated uses for surface waters of the State. Numeric criteria typically have quantifiable endpoints for a given parameter such as pH, dissolved oxygen, or a toxic pollutant, whereas narrative criteria are qualitative statements that establish a set of desired conditions for all State waters. These narrative criteria are more commonly referred to as "free from" criteria that enable States a regulatory avenue to address pollutants or problems that may be causing or contributing to a use impairment that otherwise cannot be evaluated against any numeric criteria. Typical pollutants that fall under this category are nutrients and sediment. Historically, in the absence of established numeric nutrient criteria, ADEM and/or EPA would use available data and information coupled with best professional judgment to determine overall use support for a given waterbody. Narrative criteria continue to serve as a basis for determining use attainability and subsequently listing/delisting of waters from Alabama's §303(d) List. ADEM's narrative criteria are shown in ADEM's Administrative Code 335-6-10-.06 are as follows:

335-6-10-.06 Minimum Conditions Applicable to All State Waters. The following minimum conditions are applicable to all State waters, at all places and at all times, regardless of their uses:

> *(a) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes that settle in forming bottom deposits which are unsightly, putrescent or interfere directly or indirectly with any classified water use.*
>
> *(b) State waters shall be free from floating debris, oil, scum, and other floating materials attributable to sewage, industrial wastes or other wastes in amounts sufficient to be unsightly, or which interfere directly or indirectly with any classified water use.*
>
> *(c) State waters shall be free from substances attributable to sewage, industrial wastes or other wastes in concentrations or combinations, which are toxic or harmful to human, animal, or aquatic life to the extent commensurate with the designated usage of such waters.*

ADEM continues its efforts to develop comprehensive numeric nutrient criteria for all surface waters throughout Alabama, including rivers/streams, lakes/reservoirs, wetlands, and coastal/estuarine waters. However, until numeric nutrient criteria or some form of quantitative interpretations of ADEM's narrative criteria are developed, the Department will continue to use all available data and information coupled with best professional judgment to make informed decisions regarding overall use support and when establishing water quality targets for TMDLs.

Lakes are complex systems influenced by morphometry, climate, and watershed characteristics. The assignment of specific nutrient criteria, to include both causal and response variables, that will protect each system and at the same time support human activities is problematic. Instead, many states use chlorophyll *a* as the primary indicator of algal biomass and reservoir health. Chlorophyll *a* is a pigment used by most plants during photosynthesis, and is therefore present in many species of algae. Each cell contains pigment, so high chlorophyll *a* concentrations observed in a lake indicate high amounts of algae in the water. Algal blooms are often associated with excess concentrations of nitrogen and/or phosphorus. Setting criteria for chlorophyll *a* concentrations indirectly limits the nutrient loads allowed to the system.

According to ADEM's Nutrient Criteria Implementation Plan (ADEM, 2007), chlorophyll *a* (response indicator) has been chosen as the primary variable for addressing cultural eutrophication and will be used as the primary tool for protecting designated uses of lakes and reservoirs from nutrient overenrichment. For purposes of establishing TMDLs for nutrients in impaired reservoirs, a calibrated and verified water quality model will be used to establish the relationship between nutrient loading (causal parameters) and chlorophyll *a* (response parameter) and will serve as the primary tool for determining the most appropriate nutrient to control. Chlorophyll *a* was chosen as the candidate variable because of its wide acceptance among federal/state agencies, limnologists and scientists as being a good surrogate for estimating phytoplankton biomass and because it provides the most direct indication of how nutrients are impacting a lake's designated uses. Chlorophyll *a* is also considered a good early indicator of nutrient enrichment and is relatively easy and inexpensive to collect and analyze. At this time, the Department does not believe it is necessary to develop numeric water quality criteria for other nutrient parameters in reservoirs, such as total phosphorus, total nitrogen, and secchi depth. However, these and many other parameters have and will continue to be routinely monitored as part of the Department's reservoir monitoring program (ADEM, May 2002) and, as necessary, will be managed to ensure compliance with established chlorophyll *a* targets or criteria.

ADEM does not specify a lake-wide criterion for chlorophyll *a*, but rather assigns site specific limits where needed [ADEM Administrative Code 335-6-10-.11]. For example, chlorophyll *a* concentrations in the Walter F. George Lake of the Chattahoochee River Basin should not exceed 15 ug/L from April to October in the dam forebay as a growing season average. On the other hand, West Point Lake in the same basin is limited to concentrations of 27 ug/L, measured at the LaGrange, Georgia water supply intake.

ADEM has established numeric chlorophyll *a* criteria for Weiss Lake shown in ADEM's Administrative Code 335-6-10-.11 as follows:

> Chlorophyll *a* (corrected, as described in *Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998*); the mean of photic-zone composite chlorophyll *a* samples collected monthly from April through October shall not exceed 20 ug/l, as measured at the deepest point, main river channel, power dam forebay; or 20 ug/l, as measured at the deepest point, main river channel, immediately upstream of causeway (Alabama Highway 9) at Cedar Bluff. If the mean of photic-zone composite chlorophyll *a* samples collected monthly from April through October is significantly less than 20 ug/l for a given year, the Department will re-evaluate the chlorophyll *a* criteria, associated nutrient management strategies, and available data and information, and recommend changes, if appropriate, to maintain and protect existing uses.

Currently, ADEM has not established lake specific numeric chlorophyll *a* criteria for Neely Henry Lake, Logan Martin Lake, Lay Lake or Mitchell Lake. Therefore, ADEM has chosen to set chlorophyll *a* targets in each of the subject lakes for purposes of developing these TMDLs. Though no site-specific criterion has been previously proposed for Neely Henry Lake, Logan Martin Lake, Lay Lake or Mitchell Lake, ADEM has identified target growing-season mean concentrations at specific locations within each of the lakes. The targets are interpreted to be the mean chlorophyll *a* concentrations of the photic-zone composite samples collected monthly from April through October. The chlorophyll *a* targets that will be used to develop TMDLs for the subject lakes are provided in Table 3-1 below. As additional data are collected and effects of the TMDL implementation are analyzed, the chlorophyll *a* targets may be re-evaluated accordingly for each lake. Data collected at the four lakes are presented in Appendix A, Appendix B, and in the Modeling Report (Tetra Tech, 2003).

The four lake segments, Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake are all listed as impaired due to nutrients. Since chlorophyll *a* is used as an indicator of algal abundance and is a direct reflection of the impact of nutrient loading, setting nutrient allocations to achieve the established chlorophyll *a* targets is expected to result in attainment of the applicable water quality standards.

Based on analysis of the readily available data and information it is anticipated that reductions in phosphorus, without concurrent reductions in nitrogen, are expected to result in the attainment of the chlorophyll *a* targets described in Table 3-1. Although total nitrogen loads were considered in the modeling analysis, reductions to the existing nitrogen loads are not necessary to address the nutrient impairment within Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake. Potential impacts of nitrogen downstream from these reservoirs were also considered as part of the TMDL analysis. Based on extensive water quality modeling and readily available data and information, there are no known nutrient or nutrient-related impairments downstream from these reservoirs.

Table 3-1 Lake-Specific Chlorophyll *a* Targets for TMDL Development

Lake	Station ID	Station Location	Chlorophyll *a* Target (ug/L)
Neely Henry	NEES-3	Middle Reservoir	18.0
	NEES-1	Dam Forebay	18.0
Logan Martin	LOGS-1	Upper Reservoir	17.0
	LOGS-3	Dam Forebay	17.0
Lay	LAYC-3	Middle Reservoir	17.0
	LAYC-1	Dam Forebay	17.0
Mitchell	MITC-2	Upper Reservoir	16.0
	MITC-1	Dam Forebay	14.0

3.1.3 pH

Neely Henry Lake is the only lake listed as being impaired due to pH. According to ADEM's Water Quality Criteria (Administrative Code 335-6-10), the pH shall not "be less than 6.0, nor greater than 8.5" in a stream classified as Public Water Supply, Fish and Wildlife and Swimming. For the purpose of this document, a minimum pH of 6.0 and maximum pH of 8.5 are established for Neely Henry Lake.

Elevated pH levels in lakes are typically a direct reflection of nutrient overenrichment. One of the biggest influences of pH in water can be plant and animal respiration and plant photosynthesis. The pH of most surface waters changes diurnally as photosynthesis and respiration of plants and animals cause changes in carbon dioxide concentrations. During daylight hours, submerged aquatic plants, including algae, remove carbon dioxide from water for use in photosynthesis. Both plants and animals continuously release carbon dioxide into water from respiration. However, during daylight hours, aquatic plants can remove carbon dioxide from water faster than it can be replaced by respiration, thus causing pH to increase. The magnitude of the fluctuation in pH depends on the buffering capacity of the water and the rates of photosynthesis and respiration. In highly eutrophic, poorly buffered waters the pH can cycle from pH 6 at dawn to pH 11 in the middle of the afternoon. (Boyd, 102)

The Department believes the elevated pH levels in Neely Henry Lake are a direct reflection of nutrient overenrichment. Therefore by lowering the nutrient loads to the lake, the pH levels are expected to fall within the acceptable range. Thus the reduction of nutrient loads is proposed at a level that will attain the applicable water quality criteria for pH.

3.2 Source Assessment

3.2.1 General Sources of Organic Enrichment/Dissolved Oxygen and Nutrients

Both point and non-point sources may contribute to organic enrichment within a given waterbody. Potential sources of organic loading are numerous and often occur in combination. In rural areas, storm runoff from row crops, livestock pastures, animal waste application sites, and feedlots can transport significant loads of organic material. Nationwide, poorly-treated municipal wastewater comprises a major source of organic matter to rivers and streams. Urban stormwater runoff, failing septic systems, sanitary sewer overflows, and combined sewer overflows can be significant sources of organic loading.

Potential sources of organic loading in the watershed were identified based on an evaluation of land use/cover information from the Multi-Resolution Landuse Classification (MRLC) datasets. The source assessment was used as the basis of development of the model and ultimate analysis of the TMDL allocations. The organic and nutrient loading within the watershed included representation of both point and non-point sources.

Nonpoint Sources

Shown in Table 3-1 is a summary of land usage in the Coosa River Basin. The landuse breakdown for each lakes individual watershed is also shown. A land use map of the watershed is presented in Figure 3-1. The predominant land use within the watershed is forest, with agriculture (cropland + pasture) comprising the next largest use. Their percentages of the total watershed are 79.2% and 14.5% respectively. There is a small portion of the watershed that is designated urban (3.1%).

Table 3-2 Land Use Distribution by Lakeshed

Landuse Type	Lake Neely Henry	Logan Martin Lake	Lay Lake	Lake Mitchell	Totals
Water	1.7%	2.3%	1.9%	1.2%	1.8%
Barren	0.0%	0.0%	0.0%	0.0%	0.0%
Cropland	6.4%	6.0%	4.6%	3.6%	5.3%
Forest	75.7%	77.9%	80.4%	85.4%	79.2%

Pasture	11.3%	9.2%	8.5%	6.4%	9.2%
Strip Mining	0.1%	0.2%	0.2%	0.0%	0.1%
Wetlands	1.4%	1.0%	2.1%	0.3%	1.3%
Urban	3.5%	3.4%	2.4%	3.2%	3.1%

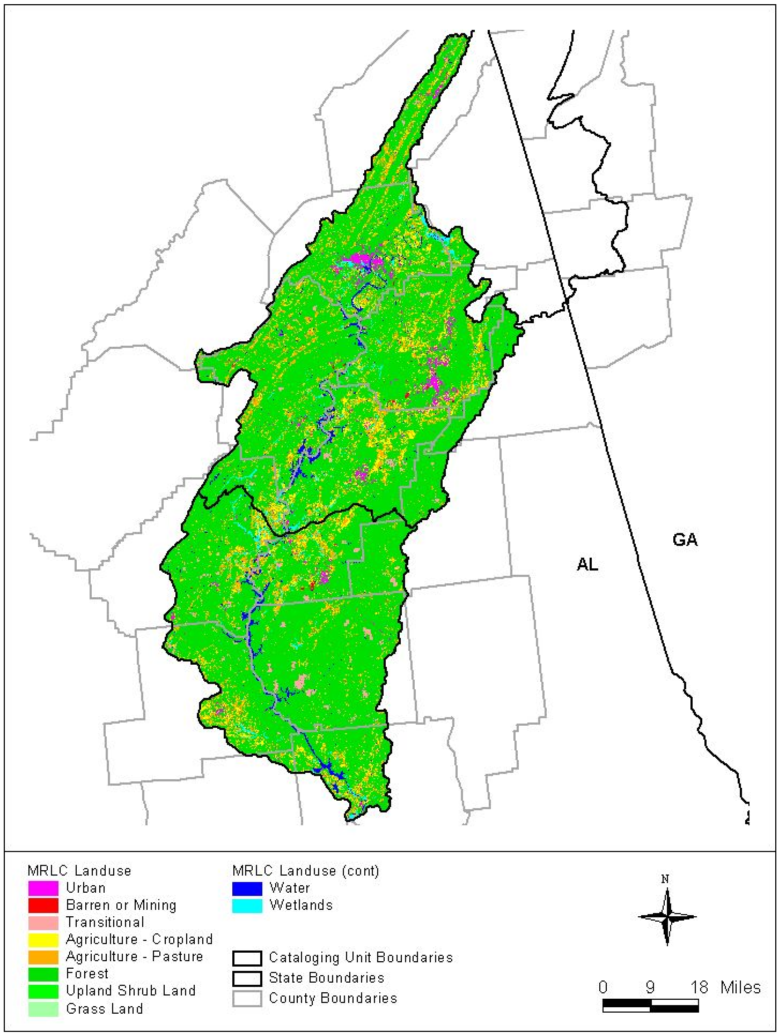


Figure 3-1 Land Use Map of Coosa River Basin from Weiss Lake Dam to confluence Tallapoosa River

Each land use has the potential to contribute to the organic loading in the watershed due to organic material on the land surface that potentially can be washed off into the receiving waters of the watershed.

The major sources of organic enrichment from non-point sources within the Coosa River watershed are nutrients and organic material from agricultural and urban lands and direct discharge to streams due to cattle. Other non-point source contributions could be failing septic systems and urban runoff. Compared to other land uses, organic enrichment from forested land is normally considered to be minimal. This is because forested land tends to serve as a filter of pollution originating within its drainage areas. Runoff from pastures, animal operations, improper land application of animal wastes, and animals with access to streams are all mechanisms that can introduce organic loading to waterbodies.

Point Sources within the Coosa River Watershed

Point source considerations typically represent discharge from wastewater treatment plants, industrial operations such as pulp and paper mills, power generation, concentrated flows and more. These operations generally result in some level of pollutant loading to the receiving water body. The loadings could be temperature, nutrients, organic matter, and others. Specific to this modeling effort the loadings of interest include the following:

- Ammonia (NH_3)
- Nitrate+nitrite (NOx)
- Organic Nitrogen (OrgN)
- Orthophosphate (PO4)
- Organic phosphorus (OrgP)
- Chlorophyll *a* (Chla)
- Biochemical oxygen demand (BOD)
- Dissolved oxygen (DO)
- Temperature (T)
- Flow (Q)

Generally, a point source discharger does not measure all of these parameters. The NPDES permit dictates what parameters are to be measured, usually based on the type of operation. When possible, parameters that are measured can be used to calculate desired parameters for model applications.

A list of the point sources recognized in the modeling effort was presented in the modeling report, Appendix F, tables D-1 through D-5. It is noted from review of the tables that some point sources were recognized with zero discharge. These were noted for completeness. With respect to the flow in the Coosa River it is worthwhile to comment on magnitudes. In the upper reach of Coosa River in this study the representative flows are approximately 10,000 cfs (6,463 mgd) and in the downstream reach the representative flows are approximately 15,000 cfs (9,695 mgd). The value in noting these flow magnitudes is realized while reviewing the flows noted in Appendix F, tables D-1 through D-5.

Point Sources Discharging Directly to the Listed Lakes

The major and minor point sources to include MS4 Areas that discharge directly to the one of the four listed lakes are presented in Table 3-3 below. The major point sources will have a total phosphorus limit of 1 mg/L applied as a monthly average limit for the months of April through October. The minor point sources will have a total phosphorus limit of 8.34 lbs/day, which will be applied as a monthly average for the months of April through October. However, the Department may impose a concentration based TP limit for a particular minor point source(s) based on site-specific conditions.

Table 3-3 Point Sources Discharging Directly to the Listed Lakes

Lake	NPDES PERMIT #	Facility Name	Facility Type	Design Flow (MGD)
Neely Henry Lake	AL0055867	Southside Lagoon	Minor Municipal	0.26
	AL0021334	Glencoe Lagoon	Minor Municipal	0.45
	AL0077976	Willow Point Marina	Minor Municipal	0.02
	AL0022659	Gadsden East WWTP	Major Municipal	6.18
	AL0053201	Gadsden West WWTP	Major Municipal	11.32
	AL0056839	Rainbow City Lagoon	Major Municipal	3.00
	AL0057657	Attalla Lagoon	Major Municipal	4.00
	AL0002119	Tyson Foods	Major Industrial	1.60
Logan Martin Lake	AL0051268	Alpine Bay	Minor Municipal	0.100
	AL0053422	Best Western Riverside Inn	Minor Municipal	0.038
	AL0052281	Harbortown Townhomes WWTP	Minor Municipal	0.050
	AL0050385	Paradise Isle Condominiums	Minor Municipal	0.020
	AL0027570	River Bend Apartments	Minor Municipal	0.070
	AL0054356	Lincoln South WWTP	Major Municipal	2.500
	AL0045993	Pell City Dye Creek WWTP	Major Municipal	4.750
Lay Lake	AL0021466	Childersburg Bailey Br Lagoon	Minor Municipal	0.830
	AL0043010	4-H Center	Minor Municipal	0.025
	AL0003140	APCO Gaston Plant Ash Pond	Major Industrial	25.0
	AL0003158	Bowater Alabama, Inc.	Major Industrial	27.0
Mitchell Lake has no direct point sources				

3.3 Data Availability and Analysis

A wide range of data and information were used to characterize the watershed and the instream conditions. The categories of data used include physiographic data that describe the physical conditions of the watershed and environmental monitoring data that identify potential pollutant sources and their contribution, and in-stream water quality monitoring data. A detailed summary of the environmental data used in the development of the model and the assessment of conditions along the listed reaches is presented within the Modeling Report (Tetra Tech, 2003).

Dissolved oxygen data were measured at lakes Neely Henry, Logan Martin, and Lay and analyzed in order to determine compliance and the percent exceedance of the dissolved oxygen criterion. The data were measured by the Alabama Department of Environmental Management (ADEM) and by the Alabama Power Company on the main channel of the Coosa River at multiple stations along the lakes. In order to determine compliance, dissolved oxygen values measured from 1995 to 2000 at a depth of 5 ft, were considered (Tables 3-4 through 3-7). Based on the analysis, Neely Henry Lake, Logan Martin Lake and Lay Lake all violate the dissolved oxygen criteria of 5.0 mg/l, at one or more locations, more than 10% of the time during the 5-year period. A detailed analysis of measured dissolved oxygen values is presented in Appendix A. In addition an analysis of measured nutrient values is presented in Appendix B.

Table 3-4 Neely Henry Lake Dissolved Oxygen Data Analysis

Neely Henry Lake					
Data Source	**Station**	**Minimum Value**	**Number of Values < than 5.0 mg/L**	**Total Number of Measurements**	**Percentage < than 5.0 mg/L**
ADEM	NEELY1	5.3	0	18	0.0%
ADEM	NEELY2	4.38	2	18	11.1%
ADEM	NEELY3	4.82	2	17	11.8%
Alabama Power	COFNH507.4	3.2	5	36	13.9%
Alabama Power	CORNH522.8	5.7	0	13	0.0%
Alabama Power	CORNH532.9	5.1	0	13	0.0%

Table 3-5 Logan Martin Lake Dissolved Oxygen Data Analysis

Logan Martin Lake					
Data Source	**Station**	**Minimum Value**	**Number of Values < than 5.0 mg/L**	**Total Number of Measurements**	**Percentage < than 5.0 mg/L**
ADEM	LOGAN1	3.35	2	18	11.1%
ADEM	LOGAN2	4.81	1	18	5.6%
ADEM	LOGAN3	4.56	1	15	6.7%
Alabama Power	COFLM458.9	2.3	5	38	13.2%
Alabama Power	CORLM470.5	6.2	0	13	0.0%
Alabama Power	CORLM480.5	6.1	0	13	0.0%
Alabama Power	CORLM490.0	5.1	0	12	0.0%

Table 3-6 Lay Lake Dissolved Oxygen Data Analysis

Lay Lake					
Data Source	**Station**	**Minimum Value**	**Number of Values < than 5.0 mg/L**	**Total Number of Measurements**	**Percentage < than 5.0 mg/L**
ADEM	LAY1	4.46	2	17	11.8%
ADEM	LAY2	4.2	1	25	4.0%
ADEM	LAY3	3.03	1	17	5.9%
Alabama Power	COFLA411.2	3.3	7	33	21.2%
Alabama Power	CORLA422.5	5.1	0	13	0.0%
Alabama Power	CORLA437.6	5.1	0	12	0.0%
Alabama Power	CORLA445.2	4.2	1	13	7.7%

4.0 Model Development

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling. In this section, the numerical modeling techniques developed to simulate the loading of organic material, nutrients, and pH and the resulting in-stream response are summarized.

For development of TMDLs in the Coosa River Basin, a system of models were developed to allow the determination of the watershed flows to the listed reaches, the instream flow and transport within the listed reaches, and the instream response of critical water quality parameters. The system of models included the following:

- Loading Simulation Program in C++ (LSPC) – used to quantify the flows to the listed reaches from the lakeshed.
- Environmental Fluid Dynamics Code (EFDC) – used to simulate the flow and transport of material through the listed reaches as well as temperature.
- Water Quality Analysis and Simulation Program (WASP) – used to simulate the instream response of critical water quality parameters.

The following presents general descriptions of each of the models along with brief discussions of the model calibrations and applications, with Logan Martin Lake used as an illustration. A complete discussion of the development, calibration, and application of the models for the other listed lakes is presented in the Modeling Report (Tetra Tech, 2003).

Watershed Model

The Loading Simulation Program C++ (LSPC) was used to represent the hydrological conditions to each specified impaired segment of the Coosa River Watershed that is addressed in this report. LSPC is a comprehensive data management and modeling system that is capable of representing loading, both flow and water quality, from nonpoint and point sources and simulating instream 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 is based on the Mining Data Analysis System (MDAS), with modifications for non-mining applications such as nutrient and fecal coliform modeling. Tetra Tech, Inc. developed LSPC for EPA Regions 3 and 4.

LSPC was configured to simulate each specified impaired segment of the Coosa River Watershed that is addressed in this report. In order to evaluate the sources contributing to an impaired waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of subwatersheds. These subwatersheds were represented using the Alabama 11-digit watershed data layer as the starting point for subwatershed delineations. Each 11-Digit HUC within the specified lakesheds in the Coosa River Watershed was further delineated for appropriate hydrological connectivity and representation. The sub-watersheds were delineated using the National Elevation Dataset (NED), BASINS GIS coverages (Reach File Version 1 and Reach File Version 3), the National Hydrography Dataset (NHD), MRLC dataset and various GIS coverages provided by ADEM.

As an example, the 11-Digit HUCs that make up the Logan Martin Lake watershed, were divided, or delineated into 32 subwatersheds. The subwatershed delineations used in LSPC for Logan Martin Lake are shown in Figure 4-1.

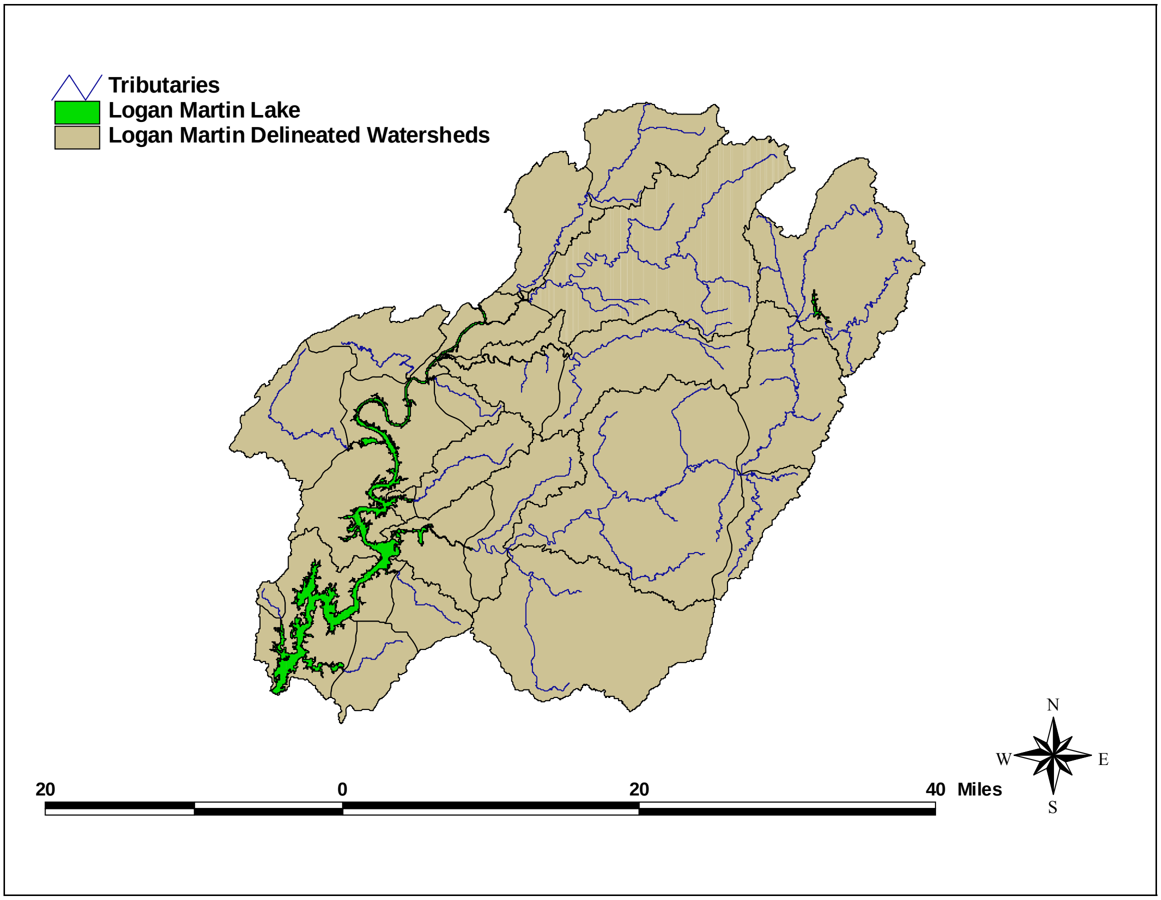


Figure 4-1 Subwatershed Delineation for Logan Martin Lake watershed

The calibration of the LSPC model was done from January 1, 1991 through December 31, 2001, and was performed by adjusting various hydrologic parameters used to represent the full hydrologic cycle. Initial values for the hydrological parameters were taken from an EPA developed default data set, that were based on watershed hydrology work performed within five Tennessee 8-Digit HUCs (Lower Tennessee-Beech, Upper Duck, Lower Duck, Buffalo, and Kentucky Lake). During the calibration process, the model parameters were adjusted, based on local knowledge of soil types and groundwater conditions, within reasonable constraints until an acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted included: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession rates, losses to the deep groundwater system, and interflow discharge.

The hydrology of the LSPC model was calibrated at the USGS flow gage #02404400 – Choccolocco Creek at Jackson Shoal near Lincoln, AL. In addition, the LSPC model was validated to six other USGS flow stations around the Coosa River watershed. These validation stations contained daily flow data for the same period as the calibration station. The calibration and validation stations are shown in Figure 4-2.

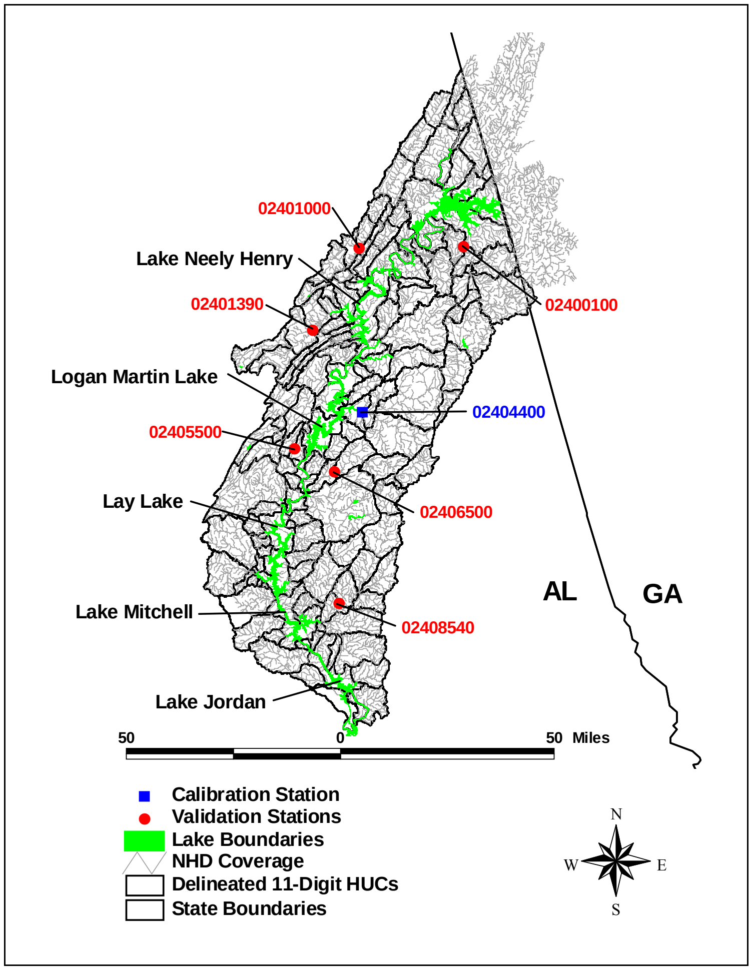


Figure 4-2 Location of USGS Flow Stations in the Coosa River Watershed used in LSPC

The watershed hydrology calibration concentrated on 1997 and 2000. Since ultimately the instream models (EFDC and WASP) will be calibrated to data that was collected during those years, the data provided by LSPC was important. Figures 4-3 and 4-4 show the calibration results for 1997 and 2000, respectively. For a more detailed discussion on the hydrologic model calibration and validation, see the modeling report (Tetra Tech, 2003).

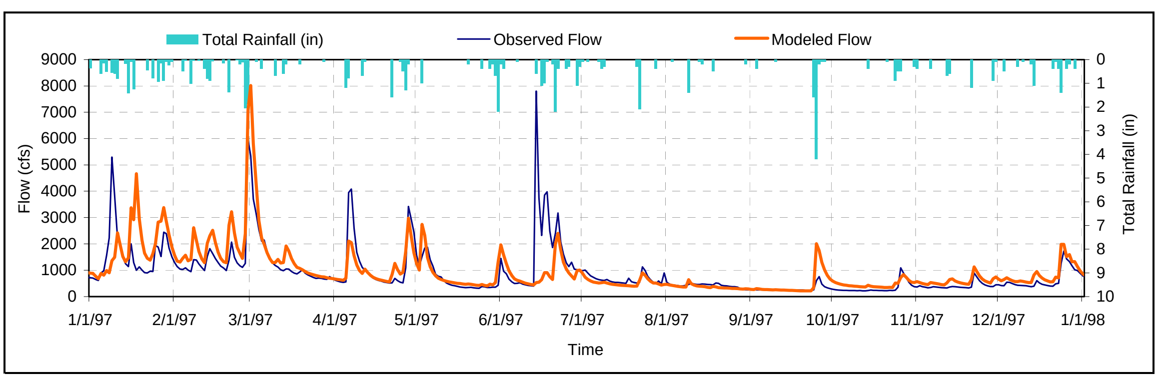


Figure 4-3 Simulated vs. Measured Flow at USGS 02404400 for 1997

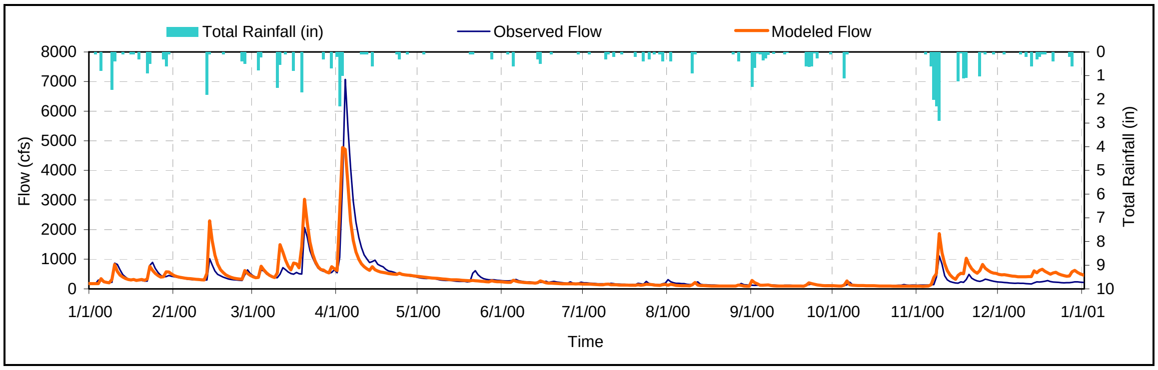


Figure 4-4 Simulated vs. Measured Flow at USGS 02404400 for 2000

Instream Hydrodynamic Model

In order to simulate the flow and transport within each listed reach, a hydrodynamic model which simulates the flow, velocity, and transport was developed. The Environmental Fluid Dynamics Code (EFDC) model was utilized with a three-dimensional simulation grid for each listed lake within the Coosa River Basin.

EFDC is a general purpose-modeling package for simulating dynamic advection and dispersion in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands and nearshore-to-shelf-scale coastal regions. The EFDC model was originally developed at the Virginia Institute of Marine Science for estuarine and coastal applications and is considered public domain software. The EFDC code has been extensively tested and documented. EFDC solves the hydrodynamic continuity, momentum, and transport equations. Specific details on the model equations, solution techniques and assumptions can be found in Hamrick (1996).

Inputs into the EFDC hydrodynamic model representing Logan Martin Lake include the following (the other lakes are similar):

- Model grid and geometry,
- Hourly upstream dam discharges (i.e., from Neely Henry dam),
- Monthly temperatures from the upstream dam,
- Hourly downstream dam discharges (i.e., for Logan Martin dam),
- Meteorological data from Birmingham, AL and Thorsby, AL, and
- Flows from the watershed model.

The model grids were developed based upon the shorelines from USGS Topographic Maps, measured cross-sectional information from ADEM and Alabama Power Company, elevation data (7.5 minute Digital Elevation Model [DEM] from USGS), and stream connectivity (from the National Hydrography Dataset stream coverage). Figure 4-5 presents the EFDC model grid for Logan Martin Lake.

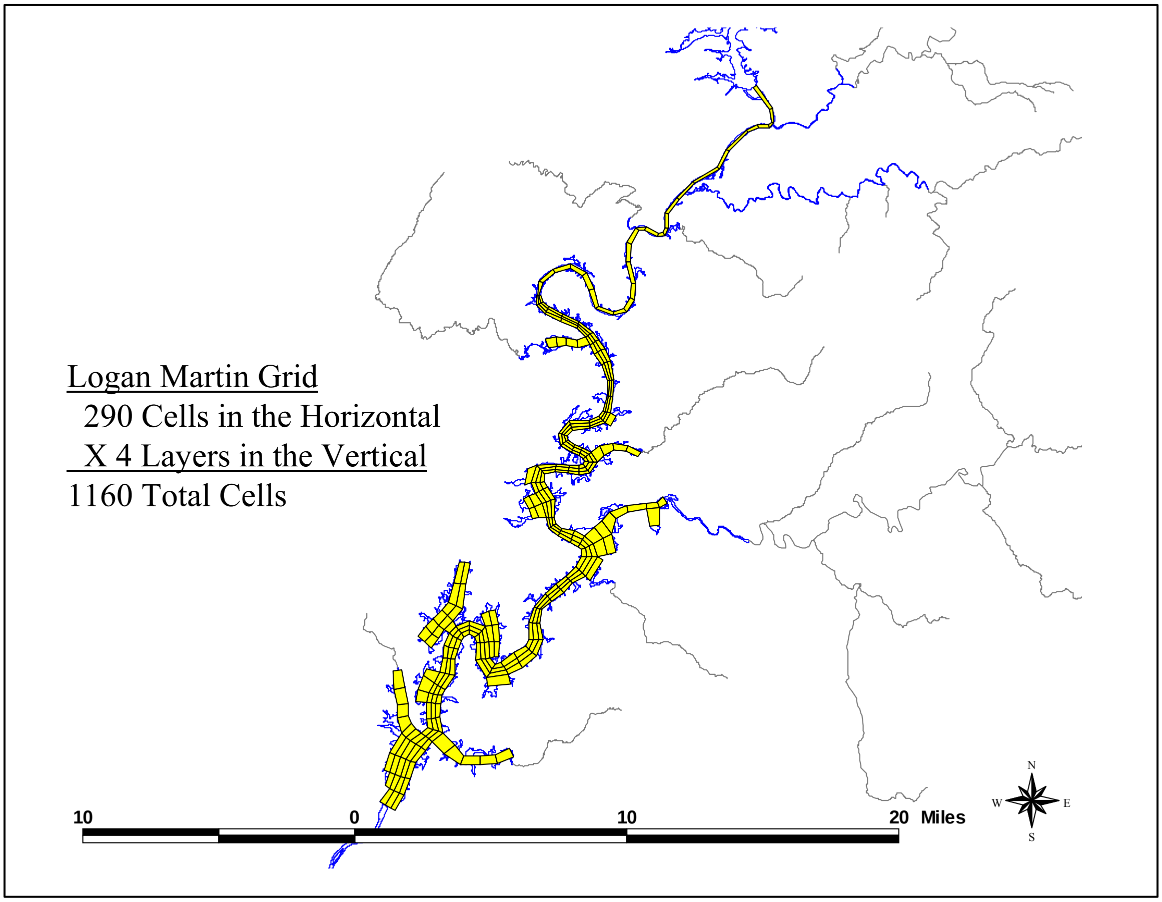


Figure 4-5 Logan Martin Lake Grid

The EFDC models were calibrated to water surface elevation during the 1997 and 2000 growing seasons (April through October). The water surface elevation was measured at the forebay of each lake. Figures 4-6 and 4-7 present the water surface elevation calibration for Logan Martin Lake. Once water surface elevation was calibrated, the model was then calibrated to water temperature (measured at multiple stations in each lake) for the corresponding years (Figure 4-8). Figures 4-9 and 4-10 present the water temperature calibration at the forebay for Logan Martin Lake. Further information about the EFDC application and calibration is detailed in the modeling report (Tetra Tech, 2003).

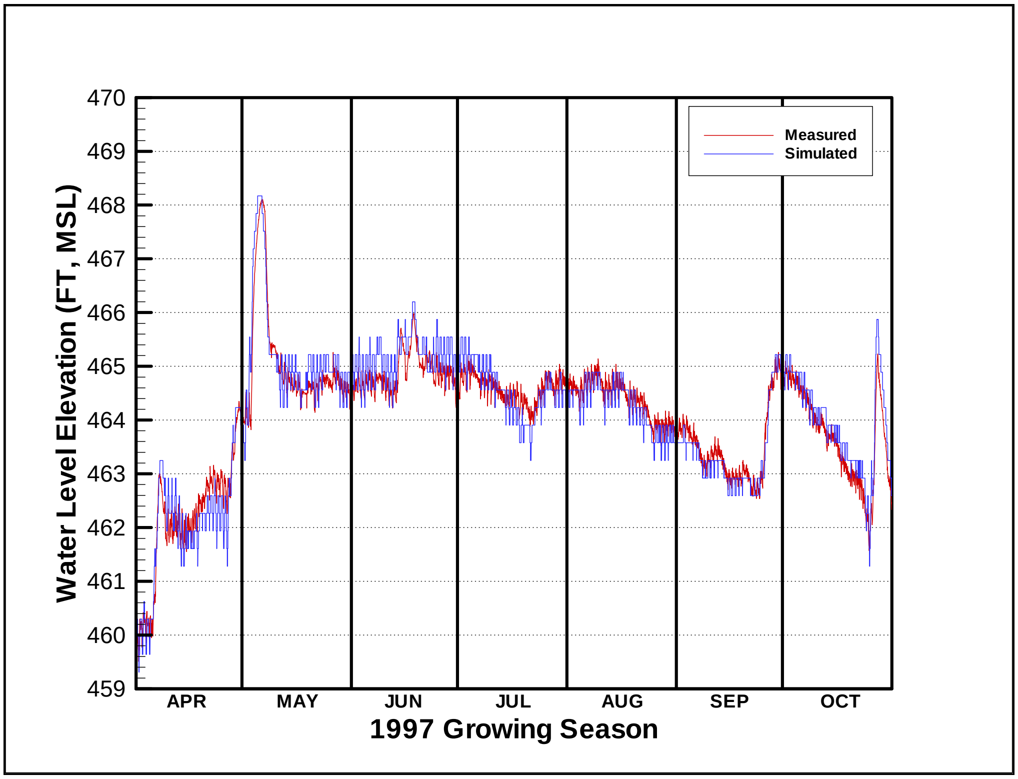


Figure 4-6 1997 Water Surface Elevation Calibration for Logan Martin Lake

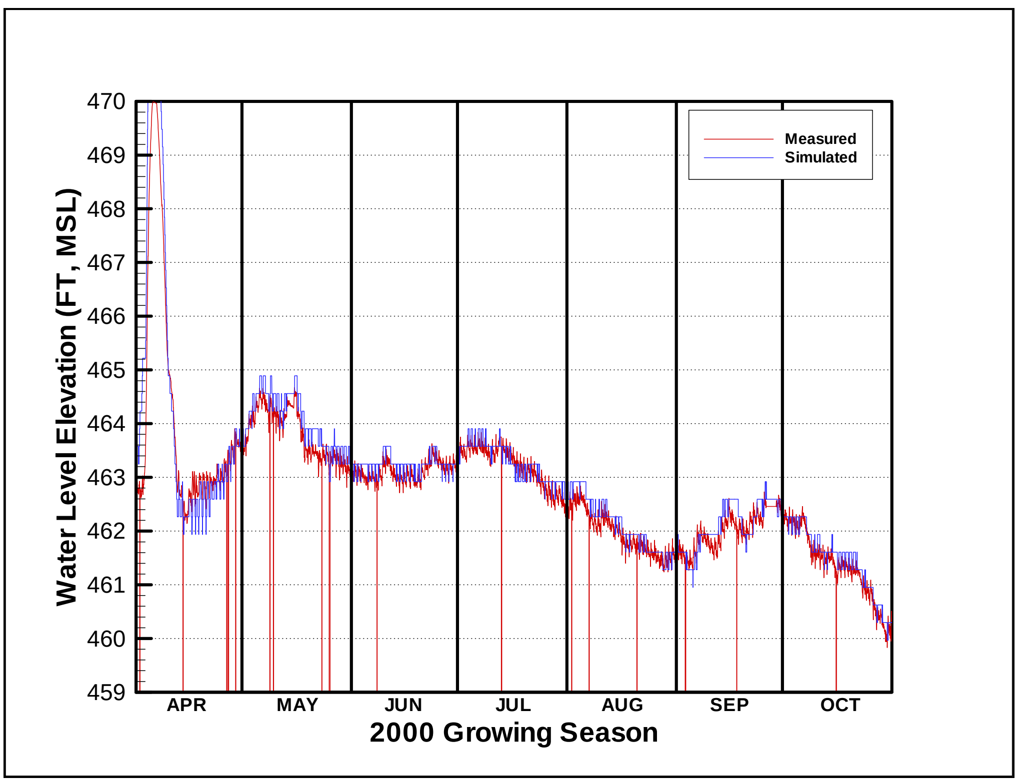


Figure 4-7 2000 Water Surface Elevation Calibration for Logan Martin Lake

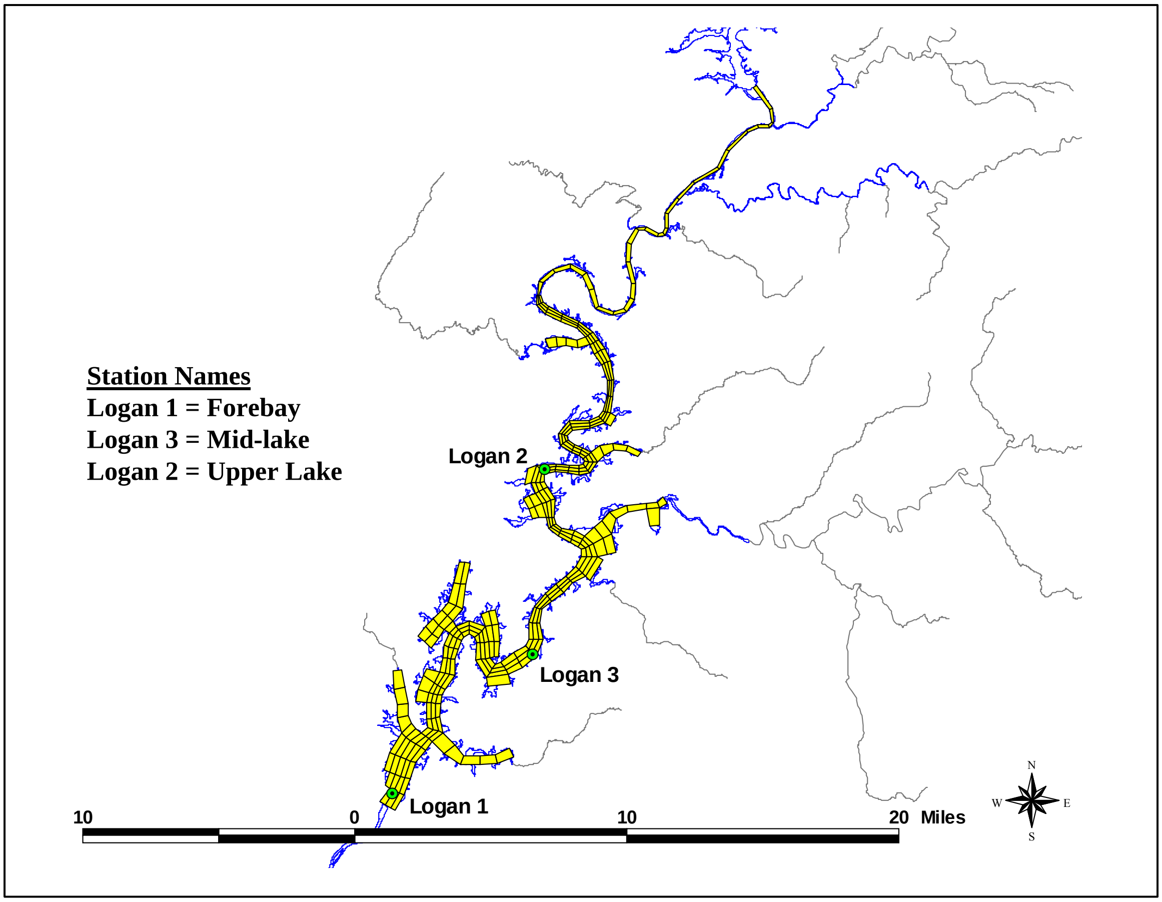


Figure 4-8 Location of Calibration Stations on Logan Martin Lake

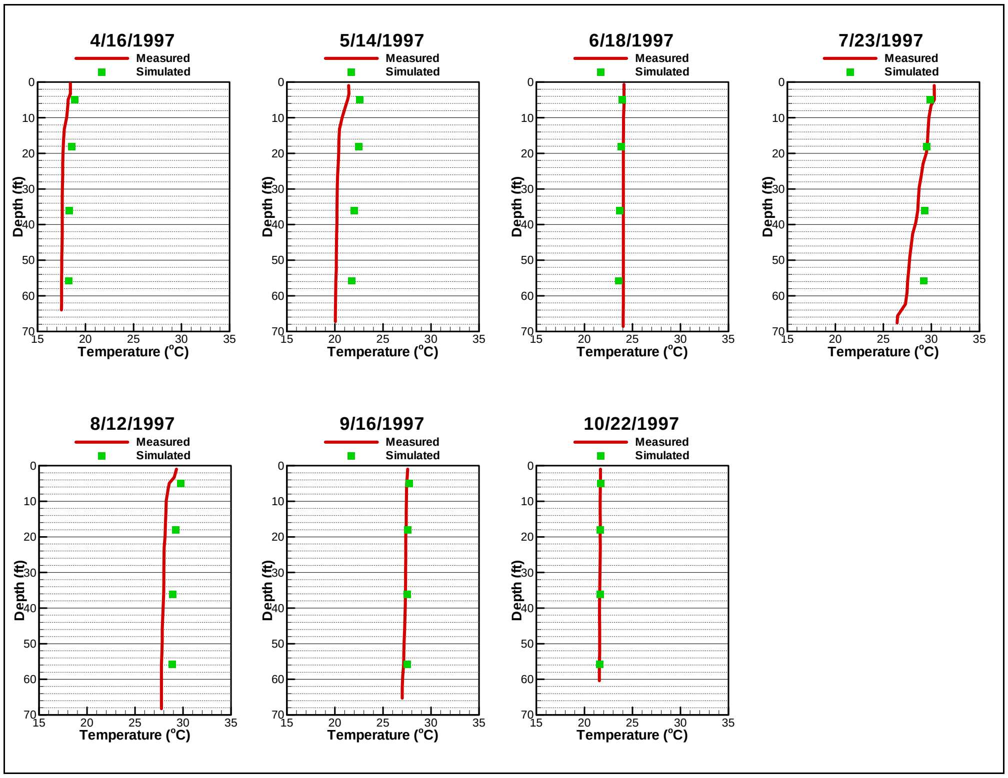


Figure 4-9 1997 Temperature Calibration at Logan Martin Lake Forebay

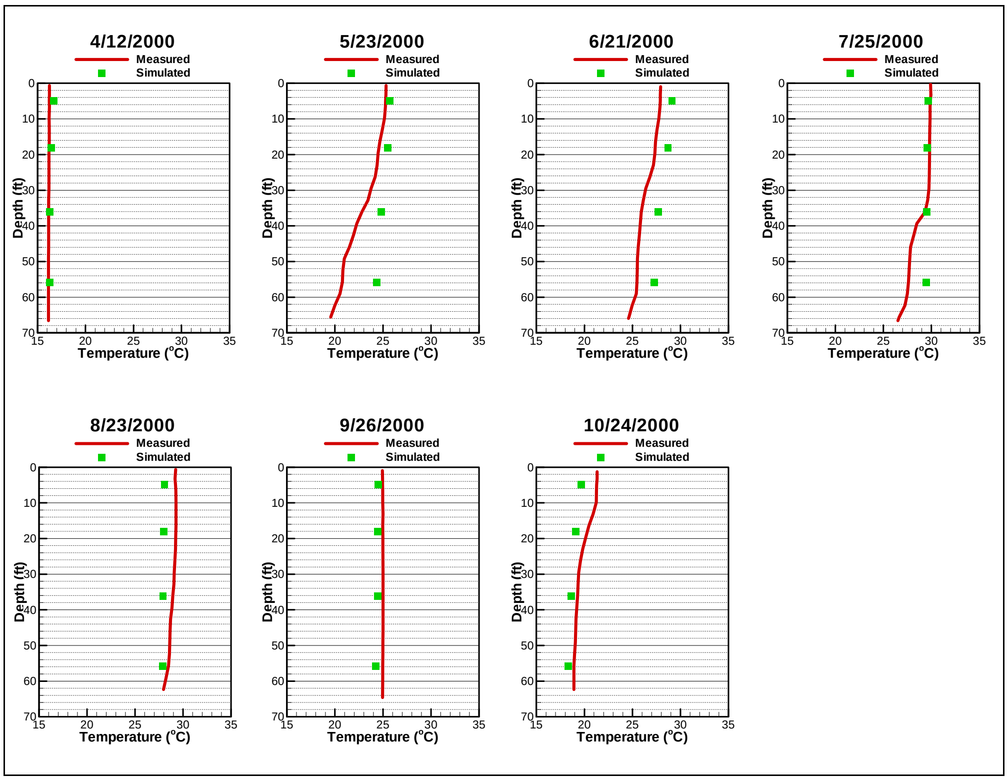


Figure 4-10 2000 Temperature Calibration at Logan Martin Lake Forebay

Instream Water Quality Model

In order to simulate the temporal and spatial concentrations of nutrients, dissolved oxygen, and chlorophyll *a*, a water quality model was utilized which simulates the full eutrophication kinetics including phosphorus and nitrogen cycling, oxidation of organic material, sediment oxygen demand, and reaeration across the water surface. The Water Quality Analysis Simulation Program (WASP) model was configured for each listed lake with a three-dimensional simulation grid identical to that developed for EFDC.

For simulation of the water quality, the EFDC model was externally linked to the WASP model through a hydrodynamic forcing file that contains the flows, volumes, and exchange coefficients between adjacent cells. WASP 6.1, an enhancement of the original WASP model (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988), is a dynamic compartment model for aquatic systems, including both the water column and the underlying benthos. The time varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program.

Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions; and permits tailored structuring of the kinetic processes, all within the larger modeling framework without having to write or rewrite large sections of computer code.

For the Coosa River watershed simulations, the WASP model was run under full eutrophication kinetics with the following state variables simulated:

- Dissolved oxygen (DO),
- Ultimate Carbonaceous Biochemical Oxygen Demand (CBODU),
- Ammonia as Nitrogen (NH_3-N),
- Nitrate/Nitrite as Nitrogen (NO_3NO_2-N),
- Organic Nitrogen (ON),
- Organic Phosphorus (OP),
- Ortho-Phosphorus (PO_4-P), and
- Chlorophyll *a*.

In order to perform the full eutrophication simulations the following general input conditions were required.

- Boundary flows and concentrations for all 8 state variables where flow enters the model (i.e., dam discharges and watershed inputs),
- Flows and concentrations for point source discharges within the receiving water domain,

- Meteorological inputs, and
- Model input coefficients.

The WASP model input coefficients reflect the best available literature values. The best fit between the WASP model simulations and the measured data was obtained by variation of critical parameters within the range of acceptable literature values.

The WASP model was calibrated to dissolved oxygen, nutrients and chlorophyll *a* during the 1997 and 2000 growing seasons (April through October). The measurements of dissolved oxygen, nutrients and chlorophyll *a* were taken at multiple stations within each lake for the corresponding years (Figure 4-8). Figures 4-11 and 4-12 present the dissolved oxygen calibration for Logan Martin Lake. Figures 4-13 and 4-14 present the chlorophyll *a* calibration for Logan Martin Lake. Further information for each lake about the WASP application, model inputs, assumptions and calibration is detailed in the modeling report (Tetra Tech, 2003).

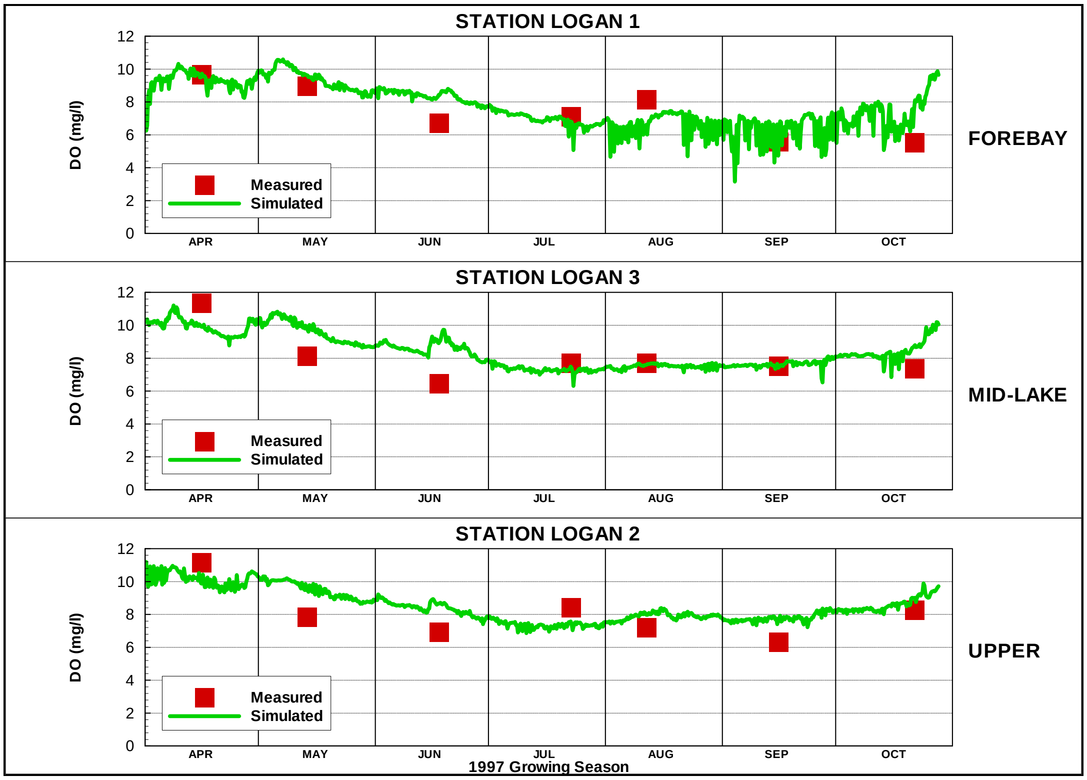


Figure 4-11 1997 Dissolved Oxygen Calibration for Logan Martin Lake

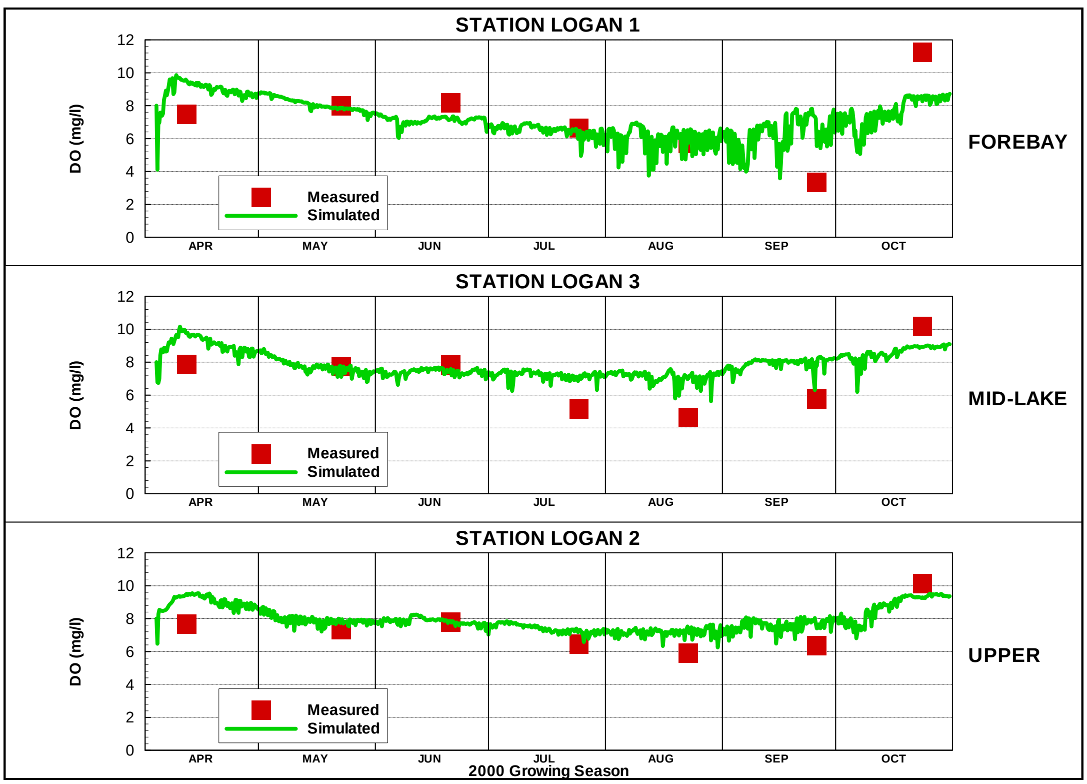


Figure 4-12 2000 Dissolved Oxygen Calibration for Logan Martin Lake

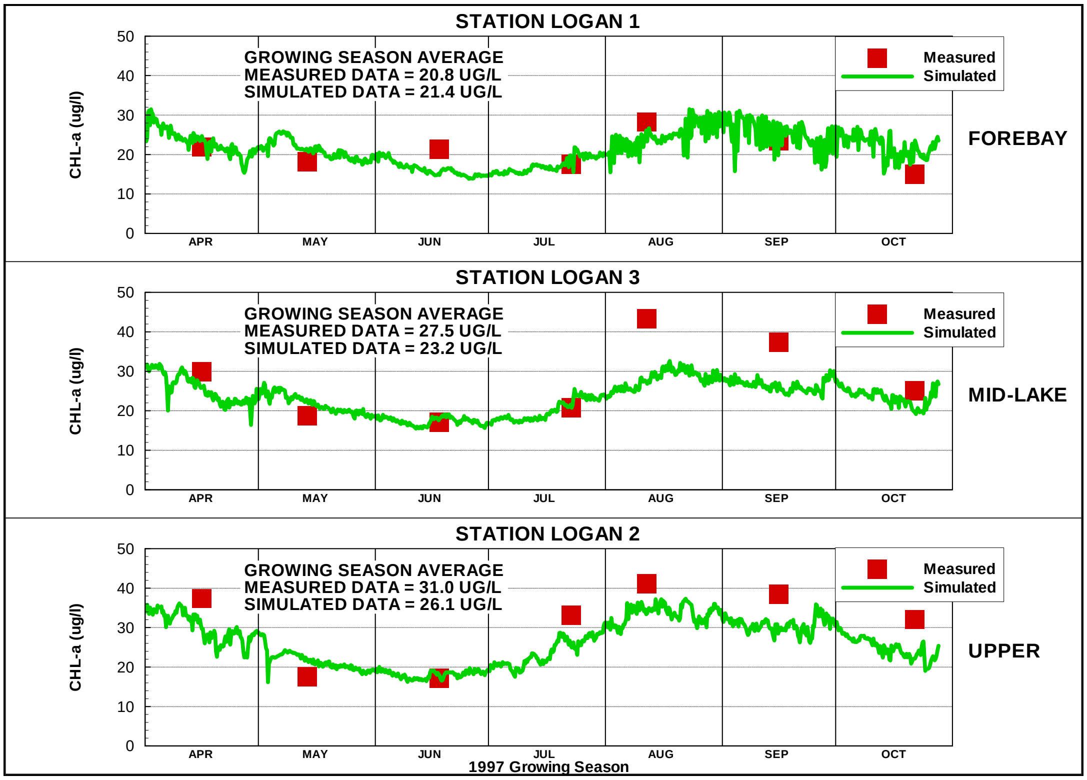


Figure 4-13 1997 Chlorophyll *a* Calibration for Logan Martin Lake

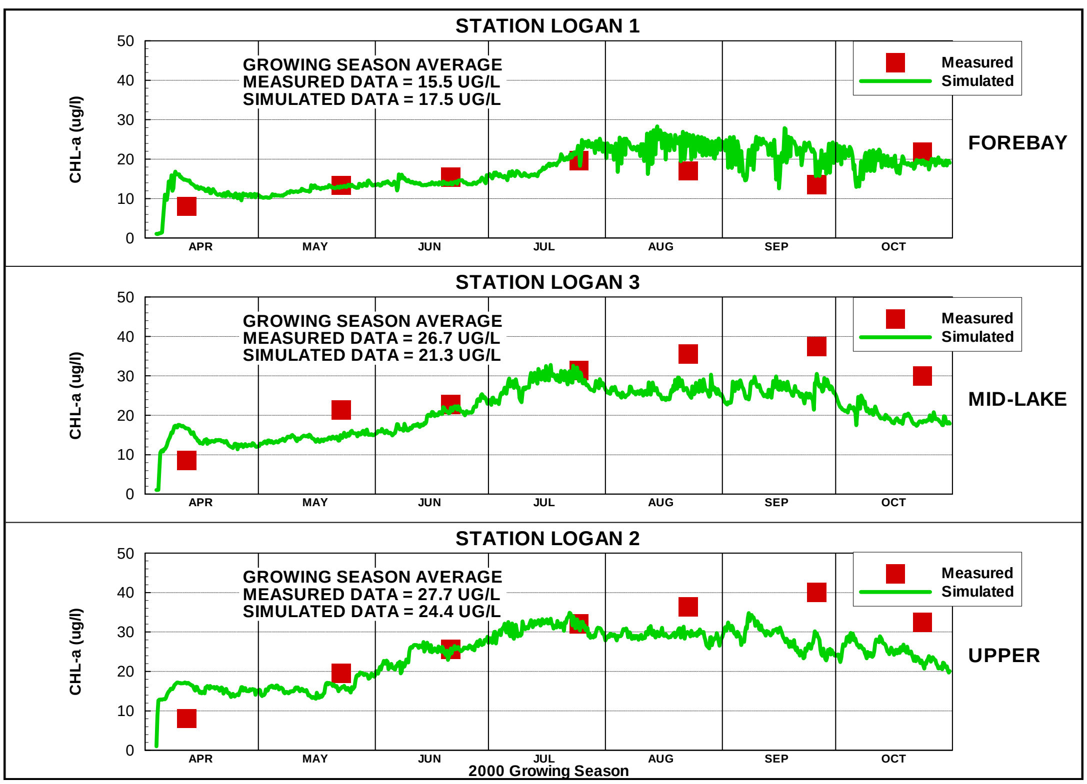


Figure 4-14 2000 Chlorophyll *a* Calibration for Logan Martin Lake

5.0 Development of the Total Maximum Daily Load

This section presents the TMDLs developed for OE/DO and Nutrients for the listed segments in the Coosa River watershed. A TMDL is the total amount of a pollutant load that can be assimilated by the receiving water while still achieving water quality criteria. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

In order to develop the TMDL, the following steps will be defined:

- Numeric Target for TMDL,
- Existing/Baseline conditions,
- Critical Conditions,
- TMDL Scenarios,
- TMDL Results
- Margin of Safety, and
- Seasonal Variation.

5.1 Numeric Targets for TMDL

The TMDL endpoints represent the instream water quality targets used in quantifying the load reduction that maintains water quality standards. The TMDL endpoints can be a combination of water quality standards, both numeric and narrative, and surrogate parameters that would ensure the standards are being met. The following presents the endpoints used for each of the parameters simulated.

5.1.1 OE/DO

The dissolved oxygen target is established at a depth of 5 feet in water 10 feet or greater in depth; for those waters less than 10 feet in depth, dissolved oxygen criteria are applied at mid-depth. Levels of organic materials may not deplete the daily dissolved oxygen concentration below this level, nor may nutrient loads result in algal growth and decay that violates the dissolved oxygen criteria.

Channel depths at locations where data were sampled (which correspond to compliance points) are all greater than 10 feet for each of the lakes. Therefore, the primary water quality target is a DO concentration of 5.0 mg/L or greater at a depth of approximately 5 feet, except in those segments on Lay Lake and immediately below the hydroelectric dams where the criterion is 4 mg/l. For these TMDLs, exceedance of the dissolved oxygen criteria was determined by comparing each of the four daily outputs from the water quality model TMDL Scenario (12:00 a.m., 6:00 a.m., 12:00 p.m., and 6:00 p.m.) to the target value of 5.0 mg/l.

Based on the modeling analysis and the readily available data and information, reduction of TP loads without concurrent reductions of Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD) is expected to be sufficient to result in the attainment of the applicable DO criterion of 5.0 mg/L for each of the lakes identified as impaired by low dissolved oxygen (i.e., Neely Henry Lake, Logan Martin Lake, and Lay Lake).

5.1.2 Nutrients

There are no site-specific criteria for nutrients in any of the listed lake segments. However, since chlorophyll *a* is used as an indicator of algal presence and is a direct reflection of the nutrient loading to the system, setting nutrient allocations to achieve of the chlorophyll *a* levels described in Table 3-1 is anticipated to result in attainment of the applicable water quality standards.

5.1.3 pH

Lake Neely Henry is the only lake listed as being impaired due to pH. According to ADEM's Water Quality Criteria (Administrative Code 335-6-10), the pH shall not "be less than 6.0, nor greater than 8.5" in a stream classified as Public Water Supply, Fish and Wildlife and Swimming. For the purpose of this document, a minimum pH of 6.0 and maximum pH of 8.5 are established for Lake Neely Henry.

The elevated pH levels in Lake Neely Henry are a direct reflection of nutrient overenrichment. Therefore by lowering the nutrient loads to the lake, the pH levels are expected to attain the applicable criteria for pH.

5.2 Existing/Baseline Conditions

The results of the calibrated models provided the existing conditions for each of the listed lakes. Existing conditions represent the existing nonpoint source loading and permitted point source discharge conditions.

The models were run during the 1997 and 2000 growing seasons to establish the existing conditions for each of the lakes. Predicted instream concentrations of chlorophyll *a* (growing season average) for the listed lakes were compared directly to the TMDL endpoints. This comparison allowed for the evaluation of each lake under its present nutrient loading (namely phosphorus) and the associated instream response of chlorophyll *a*.

For more information about the details of the calibration of each of the lakes, refer to the modeling report (Tetra Tech, 2003).

5.3 Critical Conditions

It is important when developing a TMDL that it is protective of water quality over a range of possible conditions that might occur on the listed segment. To establish this range, a set of critical conditions needs to be determined. Typically, critical conditions specify a flow that will represent an extreme low flow regime or a loading that represents a high possible value. The models are then run under these critical conditions, and the resulting instream target concentration, in this case the growing season average of chlorophyll *a*, is compared directly to the TMDL endpoint at each of the compliance points. If the growing season average concentration is smaller than the target concentration, then the loading to the system is said to be protective of water quality. On the other hand, if the growing season average concentration is larger than the target, then the loading is not protective of water quality. This loading therefore needs to be reduced until the target concentration has been met. The loading that is referred to in this system is the phosphorus loading.

For the listed segments in the Coosa River watershed, two loading conditions were defined to establish critical conditions. The 1997 and 2000 growing seasons were selected as they represent a wide range of conditions that are expected in the system. The 1997 growing season was selected because it was a wet year (the annual rainfall to the system was greater than the average annual rainfall), and the 2000 growing season was selected because it was a dry year (the annual rainfall to the system was less than the average annual rainfall).

5.4 TMDL Scenarios

If the growing season average of chlorophyll *a* did not meet the lake-specific target at each compliance point, then there were two possible TMDL scenarios that each lake was subjected to. Those scenarios were as follows:

- Run 1 – Uses the TMDL conditions from the upstream reservoir.
- Run 2 – Uses Run 1 + additional TP reductions to meet applicable water quality criteria.

5.4.1 Run 1 - Existing TMDL Conditions from Upstream Reservoir

These scenarios consisted of inputting the results from the TMDL run of the upstream reservoir into the downstream reservoir. For example, in August 2008, EPA Region 4 re-proposed the Nutrient TMDL for Weiss Lake (EPA, 2008). The TMDL called for a 30% reduction of total phosphorus. The concentrations that resulted from the Lake Weiss TMDL run were then input into Neely Henry Lake. The Neely Henry Lake model was run and the predicted chlorophyll *a* concentrations at each compliance point was compared to the target concentrations. If the predicted chlorophyll *a* concentrations met the target concentration, then there was no additional load reductions needed. If the predicted chlorophyll *a* concentrations did not meet the target concentrations, then additional load reductions were applied (see section 5.4.2). Once the predicted chlorophyll *a* concentrations met the target concentrations, then the TMDL was established for that reservoir, and the results of that scenario were then input into the downstream reservoir and the process was repeated. This scenario is also referred to as Reduction Run 1.

5.4.2 Run 2 - Additional Load Reductions

Once each of the lakes were run with the existing TMDL from the upstream reservoir, which consisted of a reduction of total phosphorus, the predicted growing season average of chlorophyll *a* was then compared to the target concentration. If the predicted chlorophyll *a* concentrations did not meet the target concentrations, then phosphorus loads from tributary watersheds were reduced to levels necessary to ensure compliance with the site-specific chlorophyll *a* targets for each reservoir. For each of the lakes, it was determined that an additional total phosphorus reduction of 30% was needed to achieve the chlorophyll *a* targets. This scenario is also referred to as Reduction Run 2.

5.5 TMDL Results

5.5.1 Nutrients

A dynamic system of models was developed for the Coosa River Basin to evaluate the parameters of interest and to represent the link between watershed nutrient loads, ambient nutrient concentrations (nitrogen, phosphorus) and algal productivity (chlorophyll a). The system consists of an application of the Loading Simulation Program in C++ (LSPC) for each lakeshed (defined as all watersheds draining to a specific lake), which provided the watershed flows to each reservoir. In addition, a receiving hydrodynamic model (EFDC) and water quality model (WASP) was developed for each lake. Each of the models were setup for the 1997 and 2000 growing seasons. These time periods were chosen as they not only represent a set of critical conditions (1997 being a wet year and 2000 a dry year), but monthly data is also available for each of the lakes including chlorophyll *a*, nutrients and profile data for dissolved oxygen and temperature. In terms of overall reductions necessary meet applicable water quality standards for each lake, the 1997 hydrological conditions were found to be the most critical and therefore were used to establish the subject TMDLs.

The total phosphorus (TP) reductions necessary to meet applicable water quality standards for each of the Coosa Lakes (Neely Henry, Logan Martin, Lay and Mitchell) are presented in Table 5-1 of the following page. The TP reductions for the Coosa Lakes were developed based on the revised TP reductions for Weiss Lake as presented in the Final Weiss Lake Nutrient TMDL (EPA, 2008). The Final Weiss Lake TMDL, which establishes a 30% reduction to phosphorus loads in the Coosa River basin upstream from Weiss Lake.

Table 5-1 Nutrient TMDL Results for the Coosa River Basin Lakes

Lake Specific TMDL	Existing TP Loads		Allowable TP Loads			TP Reductions (per lakeshed)		
	Point sources (direct discharges)	Nonpoint Sources[2]	WLA[1] (direct discharges)	LA[2]	TMDL	WLA (direct discharges)	WLA (MS4s)[2]	LA[2]

Lake Neely Henry	621.0 lbs/day	3523.46 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 242.69 lbs/day	2466.42 lbs/day	2709.11 lbs/day	60.9%	30% Etowah County MS4	30.0%
Logan Martin Lake	860.8 lbs/day	5134.09 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 102.17 lbs/day	3491.69 lbs/day	3593.86 lbs/day	88.1%	NA	30.0%
Lay Lake	410.1 lbs/day	6262.04 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 293.99 lbs/day	4383.43 lbs/day	4677.42 lbs/day	28.3%	NA	30.0%
Lake Mitchell	0.0 lbs/day	8594.36 lbs/day	Majors = 1.0 mg/L Minors = 8.34 lbs/day Total = 0.0 lbs/day	6016.05 lbs/day	6016.05 lbs/day	0.0%	NA	30.0%

1 A TP limit of 1 mg/L for majors and 8.34 lbs/day for minors is applied as a monthly average limit for the months of April through October with the exception of APCO Gaston Plant-Ash Pond which will have a TP Limit of 0.25 mg/L for the months of April through October. Refer to Table 3-3 for a specific listing of point sources that are subject to the TMDL.

2 The load allocation (LA) for the nonpoint sources that drain to Neely Henry Lake and the waste load allocation (WLA) for the Etowah County Phase II MS4 Area both require a 30% reduction. There is insufficient data and information to quantify the specific distribution between the existing nonpoint source and MS4 loads. Consequently, there is insufficient data and information to quantify the breakdown between the LA and WLA for the Etowah County MS4 in terms of pounds per day after a 30% reduction is applied. Therefore, the value of 2466.42 lbs/day includes both the allowable loads from the nonpoint sources that drain to Neely Henry Lake as well as the allowable waste loads from the Etowah County MS4.

The results of the growing season average values of chlorophyll *a* from the TMDL model runs for each of the listed segments are presented in Tables 5-2 through 5-5. The growing season average for each station were calculated by taking the four daily outputs from the model (12:00 a.m., 6:00 a.m., 12:00 p.m., and 6:00 p.m.) for the entire growing season (April 1 – October 31) and averaging all the values. Results are shown at each station within the lake. Time-series plots of the model runs are shown in Appendix C.

Table 5-2 TMDL Results of Chlorophyll *a* for Neely Henry Lake

TMDL Scenario	**1997 Growing Season Average of Chlorophyll *a* (ug/L)**			**2000 Growing Season Average of Chlorophyll *a* (ug/L)**		
Station	Neely 1	Neely 3	Neely 2	Neely 1	Neely 3	Neely 2
Existing Condition (Calibration)	26.9	26.8	28.0	32.0	32.5	32.7
Reduction Run 1 (TP Reductions from Weiss Lake TMDL only)	18.9	18.6	15.1	15.1	17.4	8.1
Reduction Run 2 (Run 1 + Additional TP Reductions from Neely Henry	15.8	15.5	14.5	10.1	11.2	7.4

Table 5-3 TMDL Results of Chlorophyll *a* for Logan Martin Lake

TMDL Scenario	**1997 Growing Season Average of Chlorophyll *a* (ug/L)**			**2000 Growing Season Average of Chlorophyll *a* (ug/L)**		
Station	Logan 1	Logan 3	Logan 2	Logan 1	Logan 3	Logan 2
Existing Condition (Calibration)	21.4	23.2	26.1	17.5	21.3	24.4
Reduction Run 1 (TP Reductions from Neely Henry Lake TMDL only)	20.4	21.5	20.4	19.1	22.0	22.8
Reduction Run 2 (Run 1 + Additional TP Reductions from Logan Martin)	16.1	15.4	15.0	11.9	11.7	10.7

Table 5-4 TMDL Results of Chlorophyll *a* for Lay Lake

TMDL Scenario	**1997 Growing Season Average of Chlorophyll *a* (ug/L)**			**2000 Growing Season Average of Chlorophyll *a* (ug/L)**		
Station	Lay 1	Lay 3	Lay 2	Lay 1	Lay 3	Lay 2
Existing Condition (Calibration)	19.3	22.9	19.0	16.9	22.6	17.2
Reduction Run 1 (TP Reductions from Logan Martin Lake TMDL only)	17.4	19.2	14.6	11.1	13.7	7.4
Reduction Run 2 (Run 1 + Additional TP Reductions from Lake Lake)	15.7	16.8	14.0	8.8	10.6	6.9

Table 5-5 TMDL Results of Chlorophyll *a* for Mitchell Lake

TMDL Scenario	**1997 Growing Season Average of Chlorophyll *a* (ug/L)**		**2000 Growing Season Average of Chlorophyll *a* (ug/L)**	
Station	Mitchell 1	Mitchell 2	Mitchell 1	Mitchell 2
Existing Condition (Calibration)	14.9	19.8	17.7	18.4
Reduction Run 1 (TP Reductions from Lay Lake TMDL only)	12.4	15.8	13.2	12.4
Reduction Run 2 (Run 1 + Additional TP Reductions from Mitchell Lake	12.3	15.8	12.7	12.4

5.5.2 Dissolved Oxygen

An analysis of dissolved oxygen data in conducted in Section 3.3 and Appendix A, confirms that ADEM has appropriately assessed Lake Mitchell as fully supporting designated uses with respect to dissolved oxygen. EPA approved ADEM's 2004 303(d) list of impaired waters, which included the removal of OE/DO as a parameter causing impairment to Lake Mitchell.

Based on extensive water quality modeling, the TP reductions included in the above Nutrient TMDL are shown to improve dissolved oxygen concentrations in each of the lakes by providing a more balanced algal biomass which in turn will enhance photosynthesis and respiration processes.

Based on the modeling analysis and the readily available data and information, reduction of TP loads is sufficient to result in the attainment of the applicable DO criterion of 5.0 mg/L for each of the lakes respectively. With the TP reductions, the existing point sources at permitted conditions and existing nonpoint source loadings for CBOD and NBOD are expected to achieve the applicable DO criterion of 5.0 mg/L for each of the lakes respectively. Therefore, no reductions for CBOD and NBOD will be necessary. See Appendix D for lake specific modeling results of the TMDL with respect to dissolved oxygen.

5.5.3 pH

Based on the modeling analysis and the readily available data and information, reduction of TP loads is sufficient to result in the attainment of the pH criteria within Neely Henry Lake.

5.6 Margin of Safety (MOS)

There are two methods for incorporating a MOS in the analysis: a) by implicitly incorporating the MOS using conservative model assumptions to develop allocations; or b) by explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

For the purposes of the listed lakes in the Coosa River watershed, the margin of safety was addressed implicitly based on conservative modeling assumptions.

5.6 Seasonal Variation

Seasonal variation is considered in the development of the TMDL because the model runs were performed during two vastly different growing seasons, 1997 and 2000. The model simulates the response of the nutrients, dissolved oxygen and chlorophyll *a* under the two hydrologic, meteorological and loading conditions, and therefore fully evaluates the potential seasonal variation.

6.0 Conclusions

The TMDLs for Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake were redeveloped by ADEM based on significant revisions to the Weiss Lake Nutrient TMDL which is the most upstream reservoir on the Coosa River. The primary revisions to the Weiss Lake TMDL were the result of extensive water quality data and information that was collected by EPA, ADEM and GAEPD for Weiss Lake and its associated watershed. The more robust data set provided EPA the ability to develop a more refined set of models for Weiss Lake and its associated watershed. As a result, ADEM was able to revise the TMDLs for the downstream reservoirs, namely Neely Henry, Logan Martin, Lay and Mitchell. This TMDL Report addresses the Organic Enrichment/Dissolved Oxygen (OE/DO), Nutrient and pH issues for Neely Henry Lake, Logan Martin Lake, Lay Lake and Mitchell Lake. The priority organics (PCBs) for the listed segments of Neely Henry Lake, Logan Martin Lake and Lay Lake will be addressed under a separate report in the future.

It was determined that reductions in total phosphorus for each of the lakes were necessary to meet the chlorophyll *a* targets established for each of the lakes. The TP reductions for the Coosa Lakes were developed based on the revised TP reductions for Weiss Lake as presented in the Final Weiss Lake Nutrient TMDL (EPA, 2008).

Based on extensive water quality modeling, the TP reductions included in the Nutrient TMDL are expected to achieve the applicable DO criterion of 5.0 mg/L for each of the lakes respectively as well as the applicable pH criteria for Neely Henry Lake.

7.0 Follow-up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's fourteen major river basins into five groups. Each year, ADEM's resources for water quality monitoring are concentrated in one of the basin groups. One goal is to continue to monitor §303(d) listed waters. Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices in the watershed. This monitoring will occur in each basin according to the schedule shown in Table 7.1.

ADEM will also monitor each impaired lake every three years once per month April – October and at least every two years during the month of August to support a trend of the critical time period for the lakes.

Table 7-1 5-Year Major Basin Rotation Sampling Schedule

River Basin Group	Schedule
Choctawhatchee, Chipola, Perdido-Escambia and Chattahoochee	2008
Tennessee	2009
Tallapoosa, Alabama and Coosa	2010
Escatawpa, Lower Tombigbee, Upper Tombigbee, Mobile	2011
Cahaba, Black Warrior	2012

8.0 Public Participation

As part of the public participation process, this TMDL was placed on public notice and made available for review and comment. The public notice was prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDL was made available on ADEM's Website: www.adem.state.al.us. The public can also request paper or electronic copies of the TMDL by contacting Mr. Chris Johnson at 334-271-7827 or cljohnson@adem.state.al.us. The public was given an opportunity to review the TMDL and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period became part of the administrative record. ADEM considered all comments received by the public prior to finalization of this TMDL and subsequent submission to EPA Region 4 for final review and approval.

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