FINAL
Total Maximum Daily Loads (TMDLs)

Siltation and OE/DO

Conecuh River	AL/03140301-30-01
Conecuh River	AL/03140301-40-01

Alabama Department of Environmental Management
Water Quality Branch
Water Division

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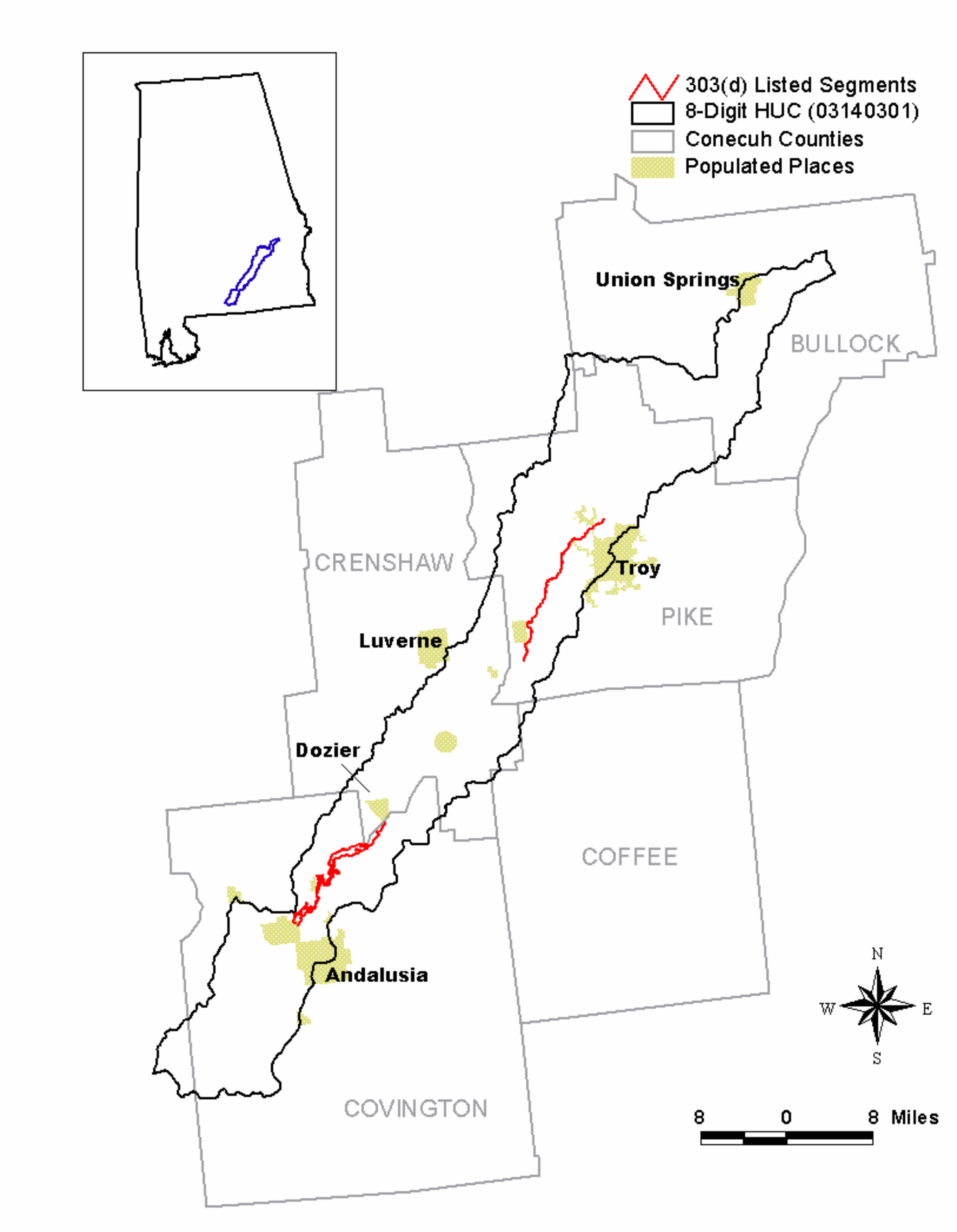

Figure I Location of Listed Segments in the Conecuh River Basin

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
FPS	Feet Per Second
FSA	Farm Services Agency
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
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

The Conecuh River is located in southeastern Alabama near the cities of Troy and Andalusia. The Conecuh watershed has an area of approximately 675 square miles from Point A Dam to the headwaters near Union Springs, Alabama. The major landuse in the watershed is forest at 76 percent and agriculture (includes row crop and pasture) at 19 percent.

There are two segments currently on the 2002-§303(d) lists in the Conecuh River Basin that require a Total Maximum Daily Load (TMDL) to address siltation and organic enrichment/dissolved oxygen (OE/DO) affecting the stream's aquatic ecosystem and habitat. In 1996, two Conecuh River segments were added to the 1996-§303(d) list based on data from the Alabama Department of Environmental Management (ADEM) 1992-§305(b) Report. AL/0314301-030_01 is the uppermost listed segment with a size of 24.7 river miles, located between Broadhead Creek and Mannings Creek. In 1996, the uppermost segment was listed for nutrients, siltation and OE/DO. Currently, this segment is listed specifically for siltation and OE/DO. Nutrients was removed as a pollutant of concern from the 1998 303(d) List.

The lowermost listed segment, AL/0314301-040_01, has a length of 18.0 river miles and is located from Hornet Creek to Point A Dam. In 1996, the lower segment was listed for nutrients, siltation, OE/DO and pathogens. The lower segment is no longer identified on the State's 303(d) List for impairment from OE/DO and pathogens. Nutrients was removed as a pollutant of concern from the 1998 303(d) List and OE/DO and pathogens were removed as pollutants of concern from the 2002 303(d) List. The delisting decision for OE/DO and pathogens was finalized and approved in April 2003 in a document titled "Final Delisting Decision for Conecuh River Waterbody ID # AL/03140301-40-01 Organic Enrichment/Dissolved Oxygen (OE/DO) Pathogens." Table 1-1 summarizes the 303(d) listing information related to TMDL development.

Table 1-1 2002-§ 303(d) Listed Segments in the Conecuh River Basin

Impaired Segments (ID)	Uses	Causes	Sources
USGS Catalog Unit 0314301 – Conecuh River Basin			
Conecuh River (upper segment) (AL/0314301-030_01)	Fish & Wildlife	Siltation OE/DO	Nonirrigated Crop Production Pasture Grazing
Conecuh River (lower segment) (AL/0314301-040_01)	Swimming Fish & Wildlife	Siltation	Nonirrigated Crop Production Pasture Grazing Flow Regulation/Modification

The following report addresses the results of the TMDL analysis for siltation and OE/DO for the two listed segments within the Conecuh River Basin. In accordance with the water quality criteria for the State of Alabama, a narrative criterion to maintain the biological integrity of the waters of the State exists and must be converted to an appropriate numerical target for sediment. The TMDL developed herein addresses this through reference watersheds where biological integrity is presently maintained and where baseline sediment loading maintains is shown to maintain biological integrity. OE/DO numeric targets are set by the State of Alabama at 5.0 mg/L at the mid-depth level if the depth is less than 10 feet and at the 5-foot level is the depth is greater than 10 feet.

The Watershed Characterization System (WCS) Sediment Tool was utilized to define baseline and impaired segment sediment loads. This tool has been developed for EPA Region 4 to provide watershed based sediment load calculations and has been utilized in the development of numerous TMDLs throughout the southeast.

The sediment TMDL summary for each of the listed segments is provided in Table 1-2. The results presented in the table include the annual average point and nonpoint source sediment loads to each listed segment.

Row cropping practices, silviculture practices and improved/unimproved roadways are the primary sources of sediment contributing to the impairment identified in the source assessment. This model application utilizes coefficients and constants that represent typical row cropping practices in place at the time of the biological assessments (ADEM 1991, 1995 and 1998). These coefficients may not represent improved farming practices implemented within the state since the initial period of the data collection. These issues were addressed within the implementation section (Section 6.0) of this report.

Table 1-2 Maximum Allowable Annual Sediment Loads for the Conecuh River

Impaired Segments	Area (acres)	Existing Loads			Allowable Loads			Reductions		TMDL (tons/yr)
		WLA Continuous sources (tons/yr)	WLA Stormwater sources (tons/acre/yr)	LA (tons/acre/yr)	WLA Continuous sources (tons/yr)	WLA Stormwater sources (tons/acre/yr)	LA (tons/acre/yr)	WLA Continuous sources (%)	WLA & LA Stormwater sources (%)	
AL/0314301-030_01	256,720	None	0.42	0.42	NA	0.16	0.16	NA	62	41,075
AL/0314301-040_01	420,847	263.9	0.81	0.81	263.9	0.16	0.16	0	80	67,599

NOTES:
1. Construction contributions are included in the WLA Stormwater sources because the runoff associated with construction sites is an NPDES regulated activity.

The point sources in the lower segment contribute less than 0.1% of the total existing sediment load to the system, and therefore, point sources alone play a negligible role in the overall cannot contribute to the impairment. Construction facilities are required by the respective National Pollutant Discharge Elimination System (NPDES) permits to implement Best Management Practices (BMPs). Ideally, if these BMPs were properly implemented, they would prevent construction activities from contributing to the sediment load. Numeric Waste Load Allocations (WLAs) were assigned to these facilities as a percent reduction because they are controlled through an NPDES permit. This allocation is shown in Table 1-2.

The data analysis and source assessment identified low dissolved oxygen levels in the upper Conecuh River associated with low flow conditions and nonpoint source runoff of ammonia. The ADEM Spreadsheet Water Quality Model (SWQM) was used to determine the dissolved oxygen scenarios for critical conditions for the upper listed segment AL/0314301-040_01. The TMDL is presented in Table 1-3.

Table 1-3 Maximum Allowable CBODu and NBODu Loads for the Conecuh River Segment AL/0314301-030_01

Constituent	Existing Load (lb/day)		TMDL (lb/day)		%WLA Reduction	%LA Reduction
	WLA	LA	WLA	LA		
CBODu	NA	3,813	NA	2,899	NA	24%
NBODu	NA	2,739	NA	2,114	NA	23%
Total	NA	6,552	NA	5,013	NA	23%

Notes: NA = no permitted NPDES point sources discharging into or upstream of the upper Conecuh River segment.

1.1 Endangered or Threatened Species

The Conecuh River Basin provides habitat for seven threatened or endangered species as reported by the Federal Register through the United States Fish and Wildlife Service (USF&WS). According to the USF&WS, the listed species are the Red-cockaded Woodpecker (*Picoides borealis*), Eastern Indigo Snake (*Drymarchon corais couperi*), Wood Stork (*Mycteria Americana),* Red Hills Salamander (*Phaeognathus hubrichti*), Relict trillium (*Trillium reliquum*), Flatwoods Salamander (*Ambystoma cinqulatum*), and Gulf Sturgeon (*Acipenser oxyrinchus desotoi*).

The endangered wood stork may be found foraging along the river or reservoirs. Freshwater prey are a significant component of the diet of the woodstork. A spawning population of the Gulf sturgeon is found downstream of the Point A Dam in the Conecuh River.

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 criteria applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. TMDLs for all pollutants resulting in violations of applicable water quality criteria are established for each identified waterbody. Such loads are established at levels necessary to implement the applicable water quality criteria with seasonal variations and margins of safety. The TMDL process establishes allowable loading of pollutants (or other quantifiable parameters for a waterbody) based on the relationship between pollution sources and instream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and to restore and maintain the quality of their water resources (USEPA, 1991).

In 1996, the EPA added two Conecuh River segments to the 1996-§303(d) and 2002-§303(d) list based on data from the 1992-§305(b) Report to Congress. The stream assessment data in the §305(b) report was collected in 1991 by ADEM. Table 1-1 describes the designated uses and causes as they appear on the 1996-§303(d) list.

The Conecuh Watershed, Hydrologic Unit Code (HUC) 03140301, is located in southeastern Alabama. Listed streams from this basin are a part of Covington and Pike counties. The watersheds are primarily within the Level IV Ecoregions of Southern Hilly Gulf Costal Plain (65d) and Southern Pine Plains and Hills (65f) as shown in Figure 2-1:

- 65d: the dissected irregular plains and gently rolling low hills of the **Southern Hilly Gulf Coastal Plain** ecoregion developed over diverse east-west trending bands of sand, clay, and marl formations. Broad cuestas with gentle south slopes and steeper north-facing slopes are common, and the heterogeneous region has a mix of clayey, loamy, and sandy soils. It has more rolling topography, higher elevations, and more relief than 65a, 65b, 65f, 65g, and streams have increased gradient. The natural vegetation of oak-hickory-pine forest grades into southern mixed forest to the south. Land cover is mostly forest and woodland, with some cropland and pasture.

- 65f: the **Southern Pine Plains and Hills** have a different mix of vegetation and landuse compared to 65d, and streams tend to be darker tea-colored and more acidic as one moves south. The oak-hickory-pine forest of the north in 65d grades into Southern mixed forest and longleaf pine forest in this region. The longleaf pine forest provided habitat Loblolly and slash pine plantations now cover wide areas. The hill summits and higher elevations are composed of the Citronelle formation, generally sandy, gravelly, and porous, and more resistant to erosion than the older underlying Miocene sandstones.

The TMDLs developed for these segments illustrate the steps that can be taken to address a waterbody impaired by siltation and OE/DO. These TMDLs are consistent with a phased-approach; estimates are made of needed pollutant reductions, load reduction controls are implemented and water quality is monitored for plan effectiveness. Flexibility is built into the plan so that load reduction targets and control actions can be reviewed if monitoring indicates continuing water quality problems.

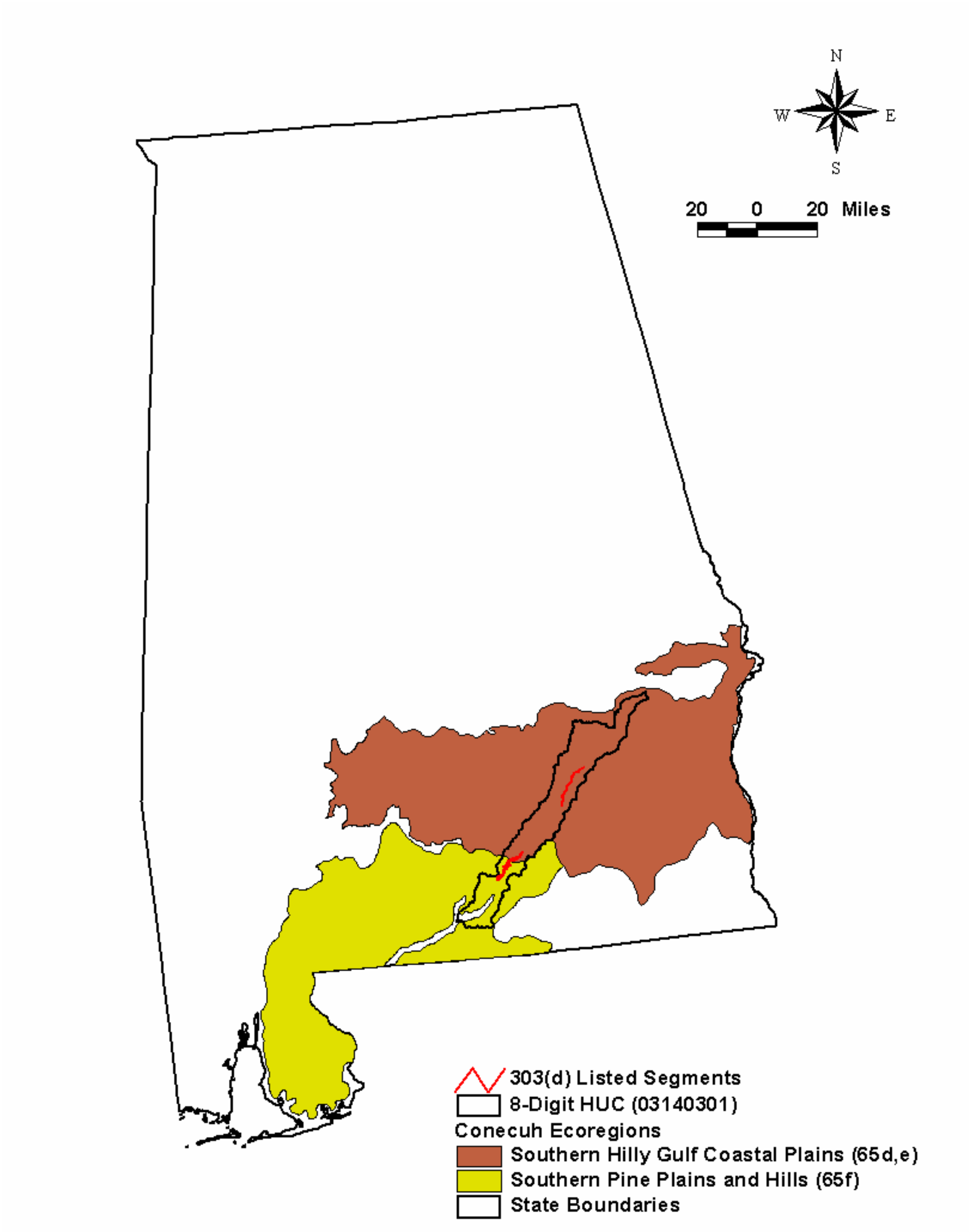

Figure 2-1 Level IV Ecoregions of Southern Alabama That Cover the Conecuh River Basin

2.2 Problem Definition

The waters for the Conecuh River were listed as impaired due to siltation and OE/DO based on habitat, chemical, and biological assessment data. Therefore, siltation and OE/DO were determined to be the cause of loss of habitat for the Conecuh River. Approaches had to be developed to address excessive sediment loads and low dissolved oxygen concentrations in the Conecuh River.

The purpose of the siltation TMDL is to establish acceptable sediment loading from all sources, such that long-term sediment loading levels in the watershed will not result in conditions where biological communities and habitat are impaired as interpreted, by EPA, for protection of aquatic life.

The purpose of the OE/DO TMDL is to establish the allowable load of nitrogenous and carbonaceous BOD to meet the State of Alabama's water quality criteria for dissolved oxygen. Hydrologic conditions that affect surface-water quality in Conecuh River include long hydraulic residence times during low flow conditions and heating of the surface waters. Increased levels of BOD and ammonia result in the depletion of dissolved oxygen levels in the Conecuh River through the decay of oxygen demanding materials and nitrification in the water column.

<u>Water Quality Criteria Violation:</u>	Excess Sediment (narrative) and OE/DO
<u>Pollutant of Concern:</u>	Sediment, Ammonia, and BOD
<u>Water Use Classification:</u>	Fish and Wildlife, Swimming (See Table 1-1 for classifications by segment)

Conecuh River (AL/0314301-030_01) is classified as Fish and Wildlife, while Conecuh River (AL/0314301-040_01) is classified as Fish and Wildlife and Swimming. Table 1-1 presents the use classifications by segment. Usages of waters in these classifications are described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), (d), and (e) for Fish and Wildlife and 335-6-10-.09(3)(a), (b), and (c) for Swimming. The usages for each are described below:

> 335-6-10-.09(5) [Fish and Wildlife]:
> (a) Best usage of waters:
> Fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water-contact sports or as a source of water supply for drinking or food-processing purposes.

(b) Conditions related to best usage:
The waters will be suitable for fish, aquatic life and wildlife propagation. The quality of salt and estuarine waters to which this classification is assigned will also be suitable for the propagation of shrimp and crabs.

(c) Other usage of waters:
It is recognized that the waters may be used for incidental water contact and recreation during June through September, except that water contact is strongly discouraged in the vicinity of discharges or other conditions beyond the control of the Department or the Alabama Department of Public Health.

(d) Conditions related to other usage:
The waters, under proper sanitary supervision by controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports.

(e) Specific criteria:
Sediment: The State of Alabama's Rules and Regulations for Water Quality Control do not include a numerical water quality criterion for aquatic life protection due to sediment. The narrative criterion is to maintain the biological integrity of the waters of the State of Alabama (ADEM 335-6-10-.06 (a) & (c)).
DO: For diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5 mg/L at all times; except under extreme conditions due to natural causes, it may range between 5 mg/L and 4 mg/L, provided that the water quality is favorable in all other parameters. The normal seasonal and fluctuations shall be maintained above these levels (ADEM 335-6-10-.09 (a) & (c)).

335-6-10-.09(3) [Swimming]:
(a) Best usage of waters:
Swimming and other whole body water-contact sports **NOTE**: In assigning this classification to waters intended for swimming and water-contact sports, the Commission will take into consideration the relative proximity of discharges of wastes and will recognize the potential hazards involved in locating swimming areas close to waste discharges. The Commission will not assign this classification to waters, the bacterial quality of which is dependent upon adequate disinfection of waste and where the interruption of such treatment would render the water unsafe for bathing.

(b) Conditions related to best usage:
Waters, under proper sanitary supervision by the controlling health authorities, will meet accepted standards of water quality for outdoor swimming places and will be considered satisfactory for swimming and other whole body water-contact sports. The quality of waters will also be suitable for the propagation of fish, wildlife and aquatic life. The quality of salt waters and estuarine waters to which this

classification is assigned will be suitable for the propagation and harvesting of shrimp and crabs.

(c) Specific criteria:
Sediment: The State of Alabama's Rules and Regulations for Water Quality Control do not include a numerical water quality criterion for aquatic life protection due to sediment. Narrative criterion is to maintain biological integrity of the waters within the State of Alabama (ADEM 335-6-10-.06 (a) & (c)).
DO: For diversified warm water biota, including game fish, daily dissolved oxygen concentrations shall not be less than 5 mg/L at all times; except under extreme conditions due to natural causes, it may range between 5 mg/L and 4 mg/L, provided that the water quality is favorable in all other parameters. The normal seasonal and fluctuations shall be maintained above these levels (ADEM 335-6-10-.09 (a) & (c)).

3.0 Technical Basis for TMDL Development

3.1 Applicable Water Quality Criterion

As stated in Section 2.0, Alabama's water quality criteria do not include numerical water quality criterion for aquatic life protection due to sediment. Narrative criterion is to maintain the biological integrity of the waters of the State of Alabama. Therefore, it is necessary to develop numerical targets based upon this narrative criterion.

Within this TMDL report, numerical targets are established through the use of reference watersheds within the State of Alabama that reflect conditions within the listed segments and that have been determined through stream assessment to be unimpaired.

The Sediment Tool (described in Section 4) uses the Universal Soil Loss Equation to determine the annual average loading conditions appropriate for developing numerical targets in reference watersheds, as well as determining existing loads and reductions in nonpoint source loads to the system. Baseline annual average loading conditions and numerical targets, are then defined using reference watersheds, presented in Section 5.1.1.

The minimum dissolved oxygen concentration in a stream classified as Fish and Wildlife and Swimming is 5.0 mg/L, except under extreme natural conditions where a 4.0 mg/L will be allowed. For the purpose of these TMDLs, a minimum dissolved oxygen level of 5.0 mg/L will be implemented within waters classified as Fish and Wildlife or Swimming for the critical summer periods. The target for lakes is established at a depth of 5 feet in waters 10 feet or greater in depth; for those waters less than 10 feet in depth, dissolved oxygen criteria are applied at mid-depth.

3.2 Source Assessment

3.2.1 General Sources of Siltation and OE/DO

Both point and nonpoint sources may contribute siltation and OE/DO to a given waterbody. Potential sources of loading are numerous and often occur in combination. In rural areas, runoff can transport significant loads of material from natural sources, while onsite wastewater (septic) systems can contribute a steady source of oxygen-consuming wastes to groundwater. Nationwide, poorly treated municipal sewage comprises a major source of organic compounds that decay and create additional organic loading and solids loading. Urban storm water runoff and agriculture practices can also be significant sources of organic and sediment loading.

All potential sources of organic loading and sedimentation in the watershed were identified based on an evaluation of current landuse/cover information on watershed activities (e.g., urban high density or forested land). The source assessment was used as the basis of development of the model and ultimate analysis of the TMDL allocations. Organic, nutrient loading and sediment loading within the watershed included both point and non-point sources.

TMDL evaluations examine the known potential sources of the pollutant in the watershed including point sources, nonpoint sources and background levels based on an evaluation of current landuse/cover information on watershed activities (e.g., urban high density or forested land). For the purpose of this TMDL, facilities permitted under the NPDES Program are considered point sources.

3.2.2 Nonpoint Sources

3.2.2.1 Nonpoint Sources of Siltation

ADEM and Tetra Tech, Inc. conducted a field visit on July 12, 2002 to identify possible non-point sources contributing to the listed segments of Conecuh River Basin. Primary sources of non-point source sediment loadings and OE/DO in the listed segments are: agriculture, silviculture, roadways (improved and unimproved), and confined animal feeding operations (CAFOs). Table 3-1 presents the biological assessment and identified non-point sources of impairment for each of the listed segments.

Table 3-1 Biological Assessment and Nonpoint Sources for Listed Waters in the Conecuh River Basin

USGS Catalog Unit 03140301Conecuh River Basin			
Impaired Segment	Biological Health	Ecoregion(s)	Identified Sources
Conecuh River (AL/0314301-030_01)	NA	65d	Non-irrigated Crop Production Pasture Grazing
Conecuh River (AL/0314301-040_01)	NA	65f	Non-irrigated Crop Production Pasture Grazing Flow reg/mod

NOTE: NA = No habitat assessments in the Conecuh River Basin

Row cropping represents the primary agricultural practice that causes or contributes the most sediment loads. Cotton, peanuts, and corn are the primary crops that utilize the practice of row cropping within the watersheds of the Conecuh River Basin. The distribution of crop production varies by county within the Conecuh River Basin, with cotton as the primary crop within Covington and Pike counties. As tillage and row cropping practices differ, the potential for sediment erosion and delivery will vary county to county and within the watersheds of the two listed segments. Sediment analyses presented in Section 4.0 account for varying agricultural practices through coefficients within the USLE and reflect present best local knowledge.

Great emphasis was placed on collecting the coefficients used in the Universal Soil Loss Equation (USLE) for row crops because they are a primary source of sediment loads.

Coefficients were collected from the Natural Resources Conservation Service (NRCS), State and District Agronomists for Covington and Pike counties.

At the time of the quantitative assessments for the 1992-§305(b) report (1991 study dates), conventional practices for the row cropping of cotton were utilized throughout most of the Conecuh River Basin. Recent improvements have taken place within various counties such that more conservative methods should provide much less potential for soil erosion. As listings were based upon conditions in place at the time of the quantitative assessment, the load determinations and the TMDL reductions may not reflect more recent practices in place.

A landuse map and elevation distribution figure of the Conecuh River watershed is presented in Figure 3-1 with landuse percentages listed in Table 3-2. The predominant landuse within the watershed is forest and agriculture (includes row crop and pasture) with 76 percent and 19 percent, respectfully. Each landuse type 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.

Table 3-2 Percentage Landuse for the Conecuh River Basin

Cataloging Unit	Forest	Row Crops	Pasture	Mining	Urban	Open Water	Other
Conecuh River	76%	11%	8%	0%	2%	1%	2%

Annual average sediment loads were calculated using the USLE (see Section 4.0) and broken down by landuse sediment sources and road erosion sediment sources. Simulated long-term area weighted watershed sediment loads calculated using the Sediment Tool (see Section 4.0) for the listed streams in the Conecuh River Basin are presented in Table 3-3. The table presents watershed acreages associated with the ecoregions: road, source, and composite sediment erosion rates; road, source, and composite sediment delivery rates; and per unit area sediment delivery rates. Within the table, erosion represents the material that directly washed off of the land surface; sediment delivery represents material that reaches the receiving stream. Composite sediment delivery rates and per acre sediment delivery rates will be targeted in the TMDL development presented in Section 5.0. Figure 3-2 is a photograph of sediment buildup in the Conecuh River.

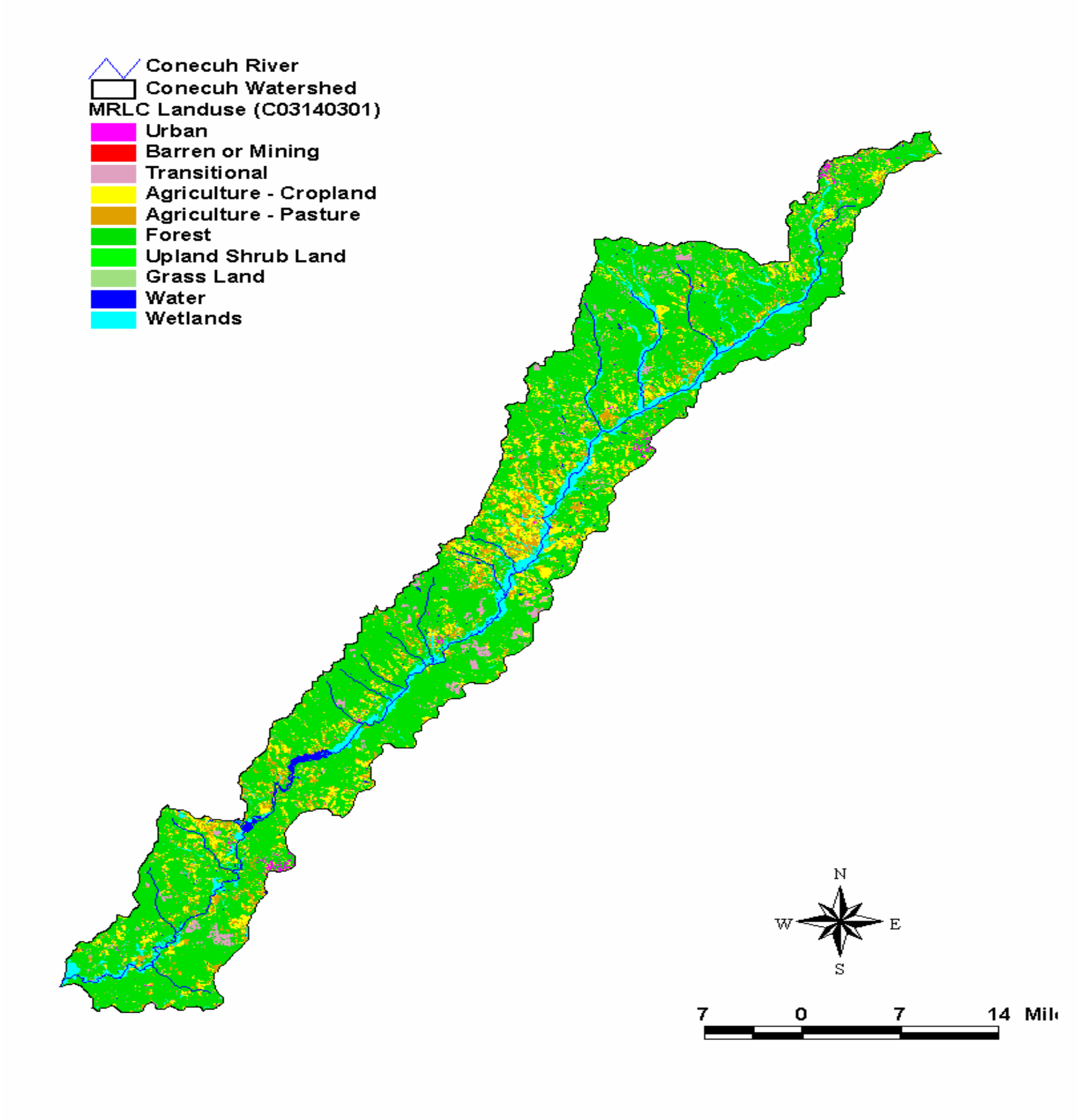

Figure 3-1 Landuse of the Conecuh River Watershed

Table 3-3 Detailed Sediment Loading Analyses

Watershed	Acres	Road Erosion (tons/yr)	Source Erosion (tons/yr)	Composite Erosion (tons/yr)	Road Sediment (tons/yr)	Source Sediment (tons/yr)	Composite Sediment (tons/yr)	Unit Sediment (tons/acre/yr)	Unit Sediment (lb/acre/yr)
AL/0314301-030_01	256,720	26,595	363,332	389,927	8,646	100,201	108,847	0.42	850
AL/0314301-040_01	420,847	47,951	583,184	631,135	15,793	155,948	171,740	0.81	1615

Figure 3-2 Evidence of Sedimentation in the Conecuh River Basin

3.2.2.2 Nonpoint Sources of OE/DO

Onsite wastewater (septic) systems are common in unincorporated portions of the watershed and may be direct or indirect sources of nutrients and organics via ground and surface waters. A high percentage of the citizens in the Conecuh River watershed rely on septic systems for wastewater treatment (Bureau of the Census 1990, 2000). Onsite septic systems have the potential to deliver loads to surface waters due to system failure and malfunction.

The number of septic systems in the Conecuh River watershed is available by tract (Bureau of the Census 1990) and from ADEM. The number of septic systems, according to ADEM, is 7,889 with ten percent of those systems listed as failing in the Conecuh River watershed.

The other predominant source contributing to low dissolved oxygen concentrations is runoff of BOD and ammonia from CAFOs. Table 3-4 lists the number of animals in the Conecuh River Basin. The data analysis shows that there are significant concentrations of ammonia, with the associated rise in nitrate-nitrites due to nitrification, and corresponding deficit of oxygen. During the field visit in July 2002, a number of active chicken houses were documented and visible from the roadway. The above-mentioned chicken houses do not have NPDES permits due to the number of birds on the property. According to ADEM, a permit is required for a chicken house with 125,000 or more birds and these permits are accounted for in Table 3-4. Those under 125,000, will not be accounted for in Table 3-4.

Table 3-4 Animal Number in the Conecuh River Basin

Total HUC	County	Major Basin	# of Cattle in Watershed	Cattle AU in Watershed	# of Swine in Watershed	Swine AU in Watershed	# of Broilers in Watershed	Broiler-Poultry AU in Watershed	# of Layers in Watershed	Layer-Poultry AU in Watershed	# of Catfish Acres in Watershed
3140301010	Bullock	Perdido-Escambia	1,000	1,000	0	0	44,000	352	15,000	120	0
3140301010	Pike	Perdido-Escambia	2,355	2,355	0	0	589,482	4,715.856	0	0	0
3140301020	Pike	Perdido-Escambia	5,148	5,148	0	0	176,844	1,414.752	15,209	121.672	0
3140301030	Crenshaw	Perdido-Escambia	1,500	1,500	600	240	519,156	4,153.248	57,000	456	24
3140301030	Pike	Perdido-Escambia	3,040	3,040	0	0	707,378	5,659.024	0	0	0
3140301040	Covington	Perdido-Escambia	648	648	22	8.8	0	0	12,648	101.184	15
3140301040	Crenshaw	Perdido-Escambia	3,100	3,100	0	0	424,764	3,398.112	0	0	0

3.2.3 Point Sources

ADEM maintains a database of current NPDES permits and Geographical Information Systems (GIS) files that locate each permitted outfall. This database includes municipal, semi-public/private, industrial, mining, industrial storm water, and CAFO permits. Table 3-5 shows the permitted point sources within the Conecuh River Basin that discharge into and upstream of the impaired segments. Table 3-6 presents the average and maximum loads along with the receiving water name and NPDES permit number, when data are available for each. Figure 3-3 shows the locations of each NPDES facility.

Although there are NPDES construction and industrial permits located in the basin, no NPDES-permitted facility discharges a significant amount of oxygen-consuming wastes or suspended solids to the Conecuh River.

In order to develop a numeric criterion that provides for the protection of the designated uses of the stream segments within the Conecuh River Basin, a target annual average loading of sediment to the listed reaches was determined. The target represents loading conditions within reference watersheds where physical conditions are similar and biological assessments have identified the waterbodies as fully supporting their designated uses. It has been determined that biological impairment of waterbodies due to excessive siltation is a long-term process and therefore the use of annual average loading conditions, as calculated through the USLE, are appropriate as the TMDL target loading conditions.

Table 3-5 Monthly Average NPDES Permit Limits for Point Sources Contributing to Impaired Segments

NPDES Permit	Facility Name	Flow (mgd)	DO (mg/L)	BOD5 (mg/L)	NH3 (mg/L)	TSS (mg/L)
AL0060518	Dozier Lagoon	0.06	NA	30	NA[2]	90
AL0022641	Brantley Lagoon	0.2	NA	30	NA[2]	90
AL0000286	River View Farms	NA	NA	NA	NA	NA
AL0002844	AL Electric Corp McWilliams Plant	1.5	NA	NA	NA	100[3]

Notes:

1. NA = No data available and/or not permitted.
2. Permit requires these facilities to report NH3, but they have not reported this data to ADEM.
3. Monthly Maximum.

Table 3-6 Contributing NPDES Permitted Point Sources for TSS. (Excluding Construction)

NPDES Permit	Facility Name	Flow (mgd)	Monthly Average Permit (mg/L)	Monthly Maximum Permit (mg/L)	Permitted Load (lb/day)	Maximum Permitted Load (tons/yr)	Receiving Stream
Conecuh River (AL/0314301-030)							
AL0000286	River View Farms	NA	NA	NA	NA	NA	Conecuh River
				Totals =	0	0	
Conecuh River (AL/03140301-040)							
AL0002844	AL Electric Corp. McWilliams Plant	1.5	NA	100	1,251	228.3	Conecuh River
AL0060518	Dozier Lagoon	0.06	90	NA	45	8.2	Conecuh River
AL0022641	Brantley Lagoon	0.2	90	NA	150	27.4	Conecuh River
				Totals =	1,446	263.9	

NOTES:

1. NA = not available and/or not permitted.
2. These permits do not include construction. These facilities are not listed as a numeric TSS number and are not assigned by the permit. TSS is addressed implicitly through BMPS.

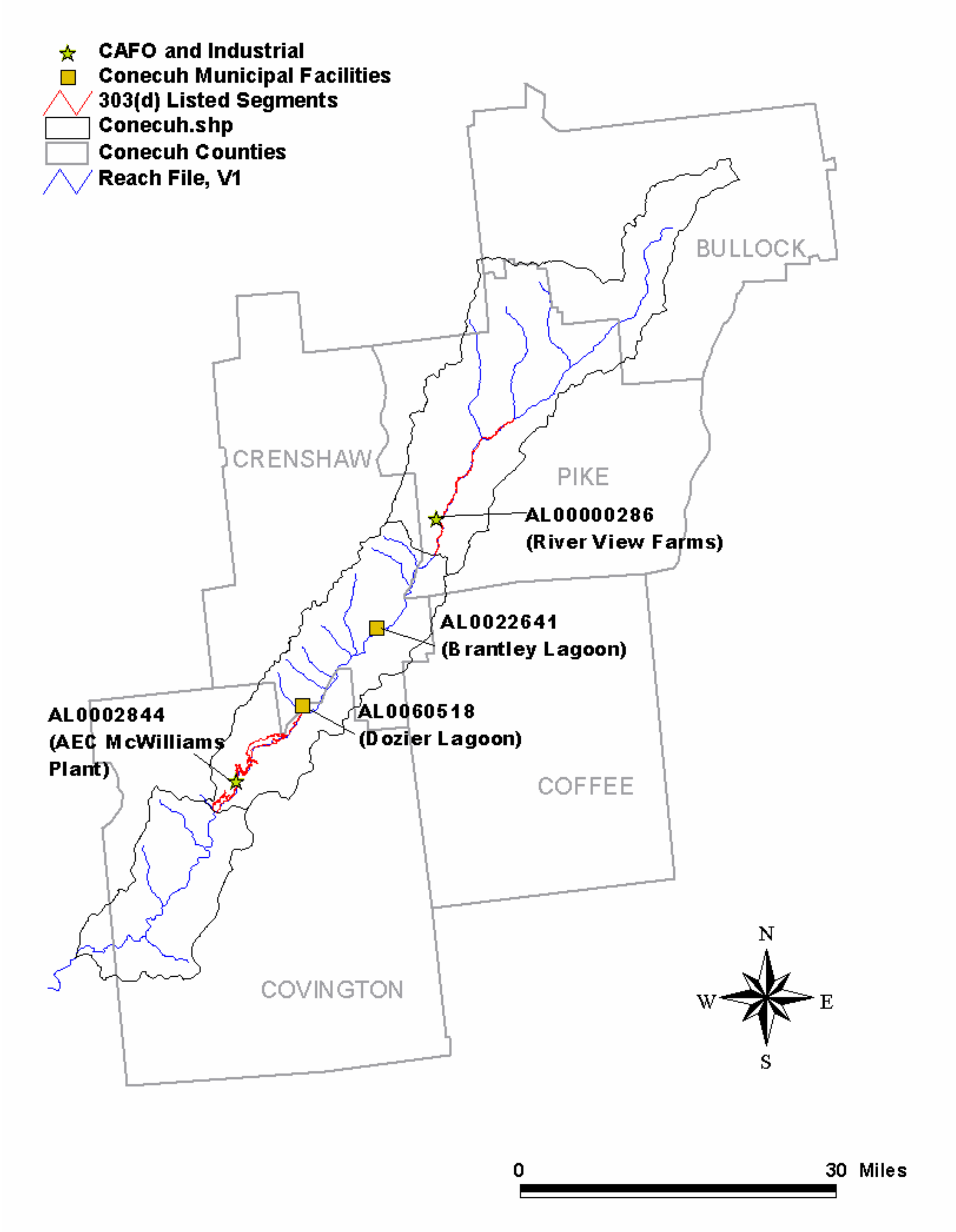

Figure 3-3 Location Maps of Point Sources

Sediment loads going to receiving streams from point source discharges are generally negligible in relation to the nonpoint sources. Point sources are generally composed more of organic material resulting in less direct impact to biological integrity (through settling and accumulation) than direct soil loss. The point sources of oxygen-consuming loads to each listed segments of the Conecuh River are listed in Tables 3-5 and 3-6. Table 3-7 summarizes the oxygen-consuming wastes in the Conecuh River watershed but these discharges are below the OE/DO impaired segment.

Table 3-7 NPDES Permitted Discharges of Oxygen-Consuming Wastes in the Conecuh River Watershed

NPDES Permit	Type of Facility	Facility Name	Significant Contributor (Yes/No)
AL0060518	Waste Water Treatment	Dozier Lagoon	NO, downstream of impaired OE/DO segment
AL0022641	Waste Water Treatment	Brantley Lagoon	NO, downstream of impaired OE/DO segment

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, environmental monitoring data that identify potential pollutant sources and their contribution, and in-stream water quality monitoring data.

The data available throughout the Conecuh River watershed include few chemical samples, which were necessary to characterize watershed-loading inputs in the watershed. The following presents the data sources and their use within the TMDL development.

3.3.1 Meteorological Data

Meteorological data are a critical component of the watershed model and the instream model. The following meteorological parameters are necessary for the watershed and in-stream water quality model:

- Rainfall,
- Air temperature,
- Solar radiation,
- Wind speed and direction,
- Relative humidity, and
- Cloud cover.

Long-term hourly data of these parameters are available at a National Climatic Data Center (NCDC) weather station located at the Troy Figure 3-4. These data were utilized to provide meteorological inputs to the model.

3.3.2 Watershed Data

Three types of spatial watershed information are utilized in the TMDLs:

1. Digital Elevation Model (DEM),
2. MLRC Landuse Coverage,
3. National Hydrography Database Reach Network (NHD).

Figure 3-4 presents the NHD stream network within the Conecuh River watershed. Figure 3-5 presents a spatial contour plot of the DEM data. This outlines the gradients seen in the system and highlights the low slope and grade of the land surface. The DEM and NHD provide the general connectivity and routing within the system for both the watershed and in-stream receiving water model.

The MLRC Landuse Coverage, shown in Figure 3-1, provided the landuse distribution utilized within the watershed model to develop the relative loads from urban, forested, agricultural, residential, and wetland uses.

3.3.3 Instream Flow Data

The Conecuh River Basin contains one continuous flow gage that has been in operation for many years and one station with current data. These stations provide an index to hydrological conditions necessary for the calibration of watershed simulations. Table 3-8 shows the United States Geological Service (USGS) flow gaging stations used in this study and the corresponding period of record. The stations listed below were the only stations with a sufficient amount of data to characterize the stream flow. Figure 3-4 shows the location of the USGS flow station used in the analysis.

Table 3-8 USGS Flow Station Employed in TMDL Development

Longitude	Latitude	USGS ID	Station Description	Period of Record
86°15’06”	31°34’24”	02371500	Conecuh River at Brantley, AL.	10/1/1937-Present
86°31’11”	31°21’40”	02372422	Conecuh River Below Point A Dam Near River Falls, AL	10/1/1999-Present

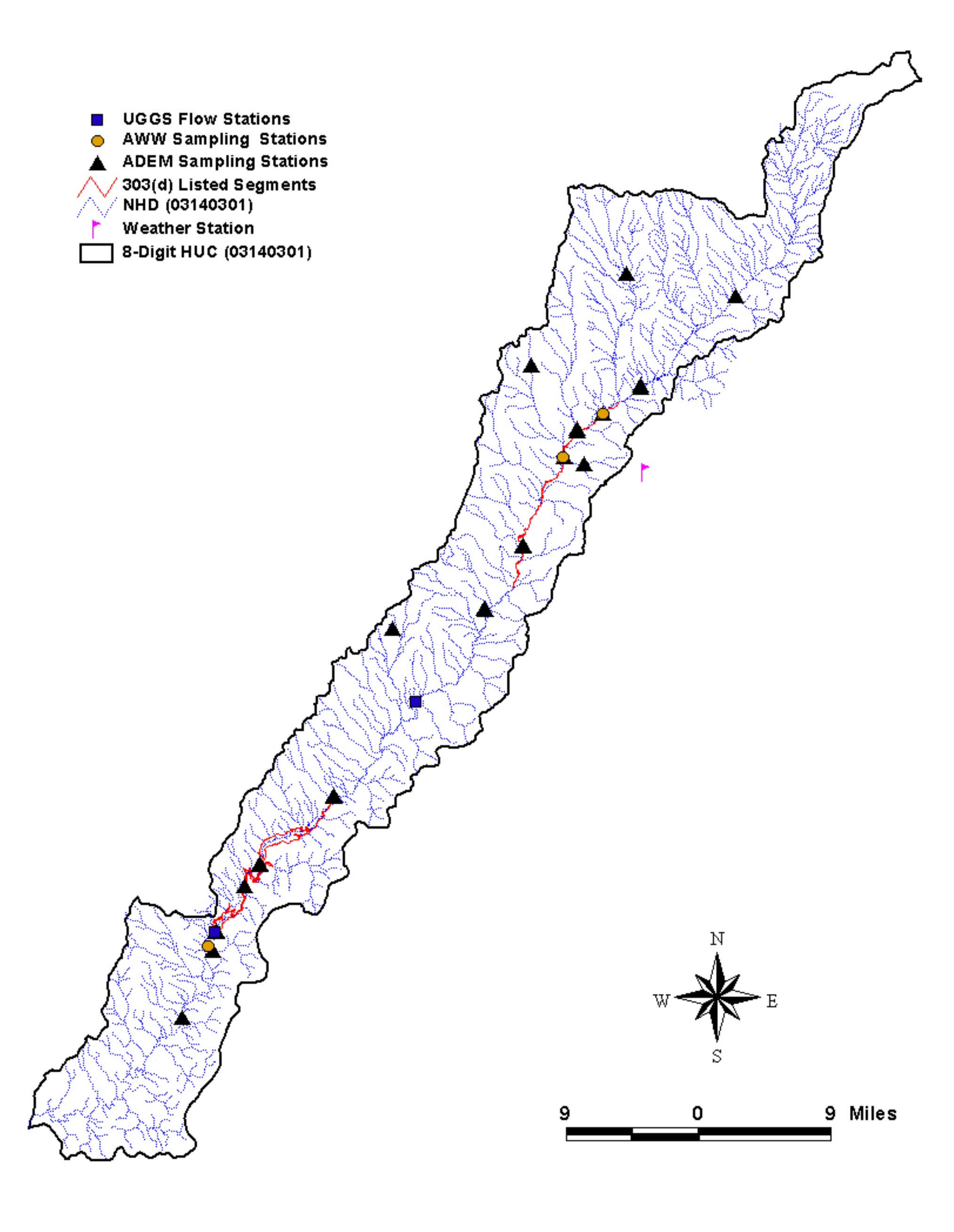

Figure 3-4 USGS Flow Stations, Water Quality Stations, Weather Station and NHDs for the Conecuh River Basin

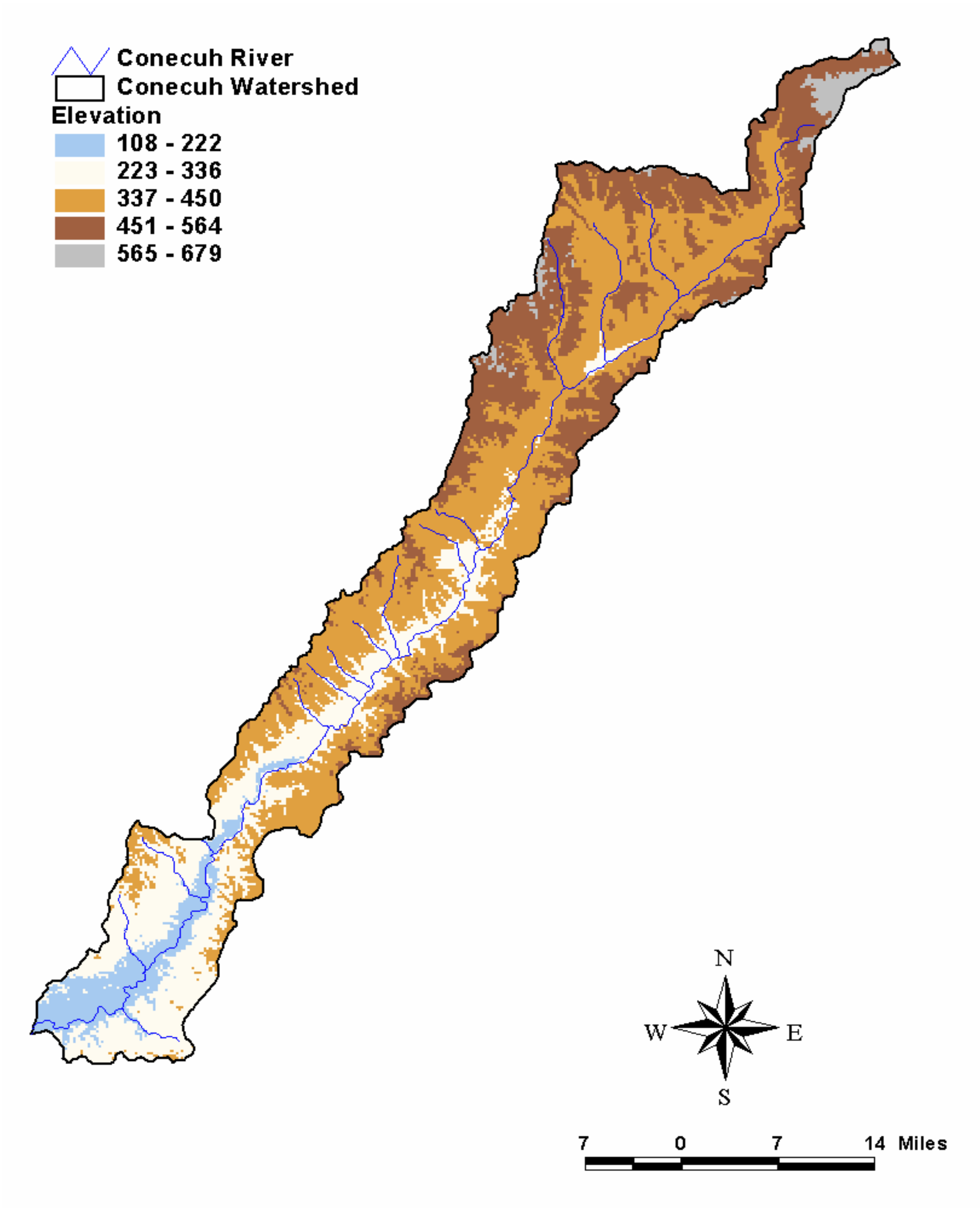

Figure 3-5 DEM of the Conecuh River Basin

3.3.4 Water Quality Data

All sampling stations and water quality data are listed in Tables A-1 thru A-3.

3.3.4.1 Dissolved Oxygen

The upper listed segment, AL/0314301-030_01, had 24 dissolved oxygen measurements collected during the summer months of 1988, 1991, 1996, 1998, and 1999. Of these 24 measurements, 38 percent (9 samples) were in violation of the criteria of 5 mg/L. The dissolved oxygen data were analyzed to determine the temporal and spatial scale of impairment (below 5.0 mg/L). Figures A-3 through A-17 show dissolved oxygen in the following manner:

- DO versus daily average flow at Brantley, AL (Figures A-3 through A-7),
- DO versus BOD5 and NH3 (Figures A-8 through A-12), and
- DO versus TKN, NO3-NO2, and TP (Figures A-13 through A-17).

Dissolved oxygen data were available from the ADEM Reservoir Ambient Study conducted from May 3, 1990 thru August 21, 2001. ADEM collected several samples within this timeframe at two separate locations in both Gantt Reservoir and Point A Reservoir. All collected samples showed levels meeting that of the Alabama Water Quality Criterion of 5.0 mg/L. Therefore, ADEM has determined that a dissolved oxygen impairment does not exist.

3.3.4.2 Sediment

The Conecuh River Basin §303(d) listing for siltation was due to visual inspection of the river and its tributaries by ADEM. The main sources of sediment to the Conecuh River are cropland, silviculture and dirt roads. The biological impairment from excessive sedimentation occurs in the both the upper and lower listed segments of the Conecuh River.

3.3.5 Special Reports

Data utilized for the development of the OE/DO and siltation TMDLs were collected under special studies, these are:

- ADEM Nonpoint Source Screening Assessment of Southeast Alabama River Basins - 1999
- ADEM 1996 Clean Water Strategy Report
- ADEM 1999 §303(d) Sampling Program
- ADEM 1997-1999 ALMAP Studies
- ADEM Reservoir Ambient Study
- Alabama Water Watch Data
- ADEM 1992 Water Quality Report to Congress

4.0 Model Development

Establishing the relationship between instream 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 and nutrients, and the resulting in-stream response of dissolved oxygen, are presented. For these TMDLs a system of models was developed to allow the determination of the watershed loads 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 includes the following:

- Sediment Tool – to quantify the loads of sediment to the Conecuh River,
- SWQM – relating DO concentrations in flowing streams to Carbonaceous Biochemical Demand (CBOD), Nitrogenous Biochemical Oxygen Demand (NBOD), Sediment Oxygen Demand (SOD) and reaeration.

The following presents general descriptions of each of the models along with brief descriptions of the model calibrations and applications.

4.1 Sediment Modeling

Watersheds of interest are first delineated. Stream grids for each delineated watershed, based on the DEM data, are created so that the stream matches the elevation (i.e. the stream corresponds to the lower elevations in the watershed). The system uses this threshold to determine whether a particular cell within the watershed area delivers load to a corresponding stream segment. Grid cells having flow accumulation values higher than the threshold will be considered as part of the stream network. The Reach File 3 (RF3) stream network is used as a reference or basis of comparison to obtain the desired stream density. Figure 4-1 presents the present RF3 stream network used throughout the Conecuh River Basin. A stream grid corresponding to a stream network that has fifty 30 x 30 meter headwater cells is the default.

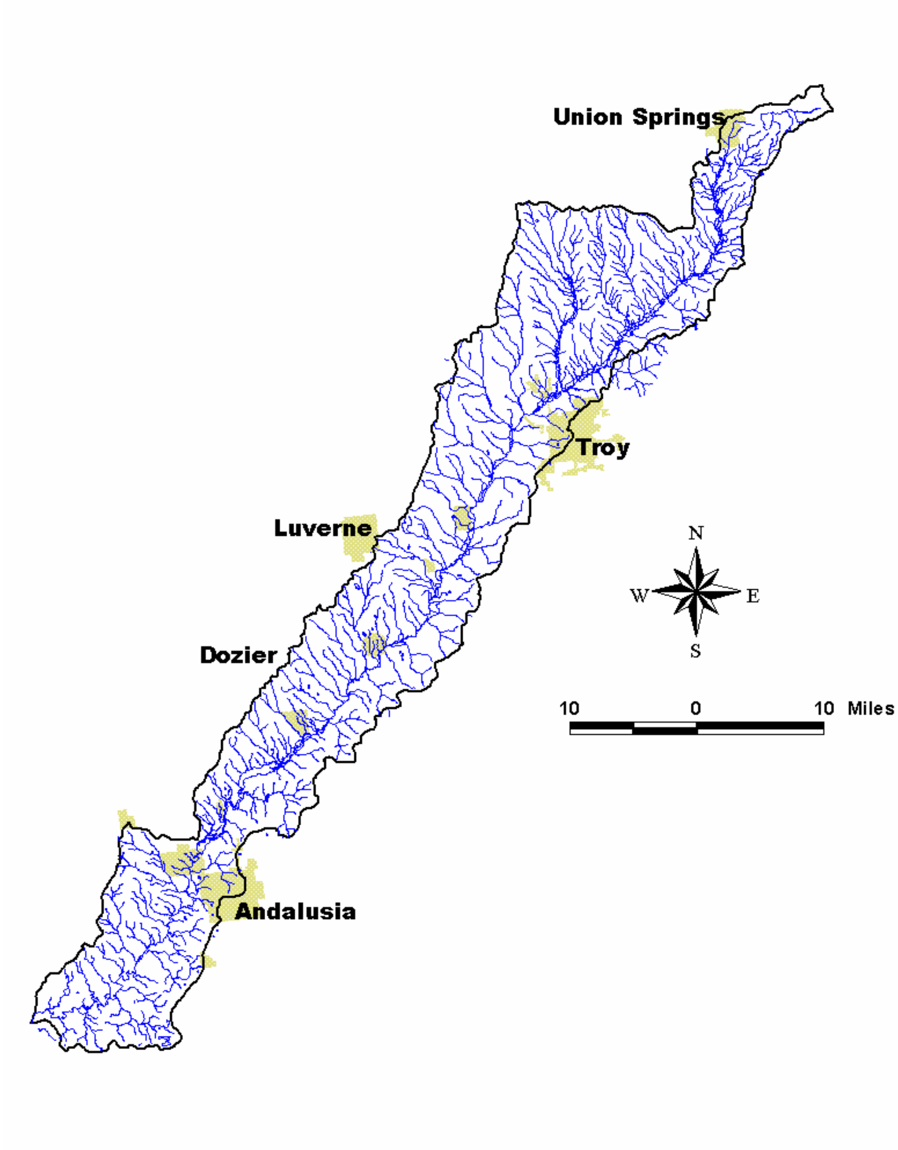

Figure 4-1 RF3 Stream Network Within the Conecuh Basin

For each 30 x 30 meter grid cell, the potential erosion based on USLE and potential sediment delivery to the stream network is estimated. The potential erosion from each cell is calculated using the USLE and the sediment delivery to the stream network is calculated using one of four available sediment delivery equations.

1) Distance-based equation (Sun and McNulty, 1998)

$$Md = M * \left(1 - 0.97 * D/L\right)$$

where: Md = mass moved (tons/acre/yr)
M = sediment mass eroded (ton)
D = least cost distance from a cell to the nearest stream grid (ft)

L = maximum distance the sediment may travel (ft)

2) Distance Slope-based equation (Yagow et al., 1998)

$$DR = \exp(-0.4233 * L * Sf)$$

$$Sf = \exp\left(-16.1 * r/L + 0.057\right) - 0.6$$

where: DR = sediment delivery ration
L = distance to the stream (m)
r = relief to the stream (m)

3) Area-based equation (USDASCS 1983)

$$DR = 0.417762 * A^{(-0.134958)} - 1.27097, \text{ DR} <= 1.0$$

where: DR = sediment delivery ratio
A = area (sq miles)

4) WEPP-based regression equation (Swift 2000)

$$Z = 0.9004 - 0.1341 * X^2 + X^3 - 0.0399 * Y + 0.0144 * Y^2 + 0.00308 * Y^3$$

where: Z = percent of source sediment passing to the next grid cell
X = cumulative distance downslope (X > 0)
Y = percent slope in the grid cell (Y > 0)

The distance slope based equation (Yagow et al., 1998) was selected to simulate sediment delivery in the Conecuh River watershed. USLE parameters applied to the Conecuh River watershed are summarized in Table 4-1.

The sediment analysis provides the calculations for the following six new parameters:

1. Source Erosion – estimated erosion from each grid cell due to the land cover,
2. Road Erosion – estimated erosion from each grid cell representing a road,
3. Composite Erosion – composite of the source and road erosion layers,
4. Source Sediment – estimated fraction of the soil erosion from each grid cell that reaches the stream (sediment delivery),
5. Road Sediment – estimated fraction of the road erosion from each grid cell that reaches the stream, and
6. Composite Sediment – composite of the source and erosion sediment layers.

The sediment delivery can be calculated based on the composite sediment, road sediment or source sediment layer. The source of sediment by each landuse type is determined showing the types of landuse, the acres of each type of landuse and the tons of sediment estimated to be generated from each landuse.

4.1.1 Sediment Analysis

Watershed sediment loads for selected watersheds were determined by use of the USLE and available GIS coverage. The Sediment Tool produces the following outputs:

- Source Erosion and Sediment Delivery
- Road Erosion and Sediment Delivery

The Sediment Tool is also able to evaluate default scenarios by, for example, changing landuses and BMPs. The following are some of the parameters that may be altered:

- C and P Lookup values
- Landuse Change Layer
- BMP Layers
- Add/Delete Roads
- Create Road Control Structure Layer

Sediment analysis can be performed for a single watershed, as well as, multiple watersheds. For TMDL development purposes, the Sediment Tool was used for developing relative impacts between impaired segments and relatively unimpaired reference watersheds.

4.1.2 Sediment Analysis Inputs

A number of data layers must be available before conducting a sediment analysis. These include the following:

<u>DEM (grid)</u> The DEM layers that come with the Watershed Characterization System (WCS) distribution system are shape files and are of coarse resolution (300 m x 300 m). The user needs to import a DEM grid layer. A higher resolution DEM grid layer (30m x 30m) was downloaded from USGS web site or from a state's GIS data clearinghouse.

<u>Road</u> The road layer is needed as a shape file and requires additional attributes such as C (road type), P (road practice) and ditch (value of either 3 or 4, indicating presence or absence of side ditch, respectively). If these attributes are not provided, the Sediment Tool automatically assigns default values of road type 2 (secondary paved roads); ditch 3 (with ditch) and road practice 1 (no practices).

<u>Soil</u> The SSURGO (1:24k) soil data may be imported into the WCS project if higher-resolution soil data are required for the estimation of potential

erosion. If the SSURGO soil database is not available, the system uses the STATSGO Soil data (1:250k) by default.

Landuse The Multi-Resolution Landuse Classification (MRLC) data are also used.

Erosivity Rainfall erosivity index is based on a rainfall index of the USA or can be calculated based on precipitation data.

Table 4-1 shows the sediment tool coefficients used in the model development.

4.1.3 Sediment Load Development Methodology

For each watershed of interest, the "existing" long–term sediment loading was estimated via the USLE sediment analysis. The USLE is designed to predict average annual soil loss caused by sheet and rill erosion. While it can estimate long-term annual soil loss and provide guidance towards proper cropping, management and conservation practices, it cannot be applied to a specific year or a specific storm event.

Resultant sediment load calculations for each watershed are therefore expressed as long-term annual soil loss expressed in tons per year calculated for the *R* - the rainfall erosivity index, a statistic calculated from the annual summation of rainfall energy in every storm (correlated to raindrop size) times its maximum 30-minute intensity.

The watershed sediment load target is based on the long-term annual soil loss expressed in tons per year calculated for relatively unimpacted watersheds with demonstrated healthy biology and habitat. For initial sediment load development, consistent default parameters and inputs were used for each watershed. These include MRLC landuse data, the USGS DEM data, STASTGO soil information and watershed average *C* and *P* values for each landuse type. The USLE coefficients utilized within each of the listed segment watersheds are presented in Table 4-1.

To refine the sediment tool and calculated sediment loads, C and P values utilized within the modeling effort represent site-specific values as defined by the various counties. The United States Department of Agriculture (USDA) and NRCS were contacted to incorporate county *C*-factors in the sediment tool. These C-factors were dependent upon the dominant crop and crop management practices in each county. For example, Covington County has predominantly cotton for row crops. Based on the county *C*-factor along with the soil properties (residue) and tillage practices, a *C*-factor was determined for use in the sediment model. Typically, high residue crops such as corn have less runoff than low residue crops such as cotton. Site-specific (county) information was important in the determination of the source erosion in the watershed. Although the use of county specific *C* and *P* values does represent use of actual data, these parameters have been developed through an evaluation of local crop management practices.

Table 4-1 USLE Coefficients Utilized in Each Subwatershed

Watershed	LS Factor			K Factor			P Factor			C Factor			R Factor		
	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean
AL/0314301-030_01	0.067	16.497	0.731	0.120	0.260	0.223	1	1	1	0	0.38	0.05	425	475	444
AL/0314301-040_01	0.076	14.685	0.521	0.120	0.263	0.212	1	1	1	0	0.38	0.039	450	525	476

4.1 Watershed Modeling –SWQM

Based on analysis of the monitoring data, review of literature, and past modeling experience; the SWQM was used to represent a source-response linkage in the Conecuh River watershed. SWQM was used to simulate dissolved oxygen concentrations for roughly 120 miles of the Conecuh River but the focus of the calibration and TMDL were in the upper listed segment, from between Broadhead Creek and Mannings Creek. The calibration plots are shown in Appendix B, Figures B-1 through B-6.

4.2.1 Water Quality Loading Model Selection, Set Up and Calibration

A Steady State model, SWQM, was selected for the OE/DO due to seasonal variations in DO levels and low flow conditions or background conditions. SWQM is based on the Streeter-Phelps DO deficit equation with modifications to account for oxygen demand resulting from nitrification of ammonia (nitrogenous oxygen demand) and organic demand fund in the waterbody sediment. The equation below shows the Streeter-Phelps relationship with additional components to account for nitrification and SOD:

$$D = \frac{K_1 L_0}{K_2 - K_1}\left(e^{-K_1 t} - e^{-K_2 t}\right) + \frac{K_3 N_0}{K_2 - K_3}\left(e^{-K_3 t} - e^{-K_2 t}\right) + \frac{SOD}{K_2 H}(1 - e^{-K_2 t}) + D_0 e^{-K_2 t}$$

where: D = DO deficit at time t, mg/l
L_0 = initial CBOD, mg/l
N_0 = initial NBOD, mg/l (NBOD = NH_3-N x 4.57)
D_0 = initial DO deficit, mg/l
K_1 = CBOD decay rate, 1/day
K_2 = reaeration rate, 1/day
K_3 = nitrification rate, 1/day
SOD=sediment oxygen demand, g O_2/ft^2/day
H=average stream depth, ft
t = time, days

The CBOD concentration, expressed as L_0 in the above equation, is the ultimate carbonaceous biochemical oxygen demand (CBODu). The CBOD concentration remaining at any time, t, can be expressed by the following first-order equation:

1) $$L = L_u e^{-K_1 t}$$

where: L = CBOD remaining at any time, t, mg/l
L_u = CBODu, mg/l = Lo
(Eqn 1)
K_1 = CBOD decay rate, 1/day
t = time, days

In the presence of nitrifying bacteria, ammonia is oxidized first to nitrite, then to nitrate. The oxidation reaction is assumed to be first order and would have the form shown in the Equation (3):

2) $$N = N_0 e^{-K_3 t}$$

where: N = NBOD remaining at any time, t, mg/l
N_0 = initial NBOD, mg/l
K_3 = nitrification rate, 1/day
t = time, days

The conversion of organic nitrogen to ammonia is assumed to follow first-order kinetics and is represented by Equation (4):

3) $$NH_3 - N = ORG\left(1 - e^{-K_4 t}\right)$$

where: NH_3-N = ammonia nitrogen produced by hydrolysis of organic nitrogen, mg/l
ORG = initial organic nitrogen concentration, mg/l
K_4 = organic nitrogen hydrolysis rate, 1/day
t = time, days

Oxygen demand by benthic sediments and organisms can represent a significant portion of oxygen consumption in surface water systems. Benthic deposits at a given location in an aquatic system are the result of the transportation and deposition of organic material. The material may be from a source outside the system, such as leaf litter or wastewater particulate CBOD, or it may be generated inside the system as occurs with plant growth. In addition to oxygen demand caused by decay of organic matter, the indigenous invertebrate population can generate significant oxygen demand through respiration. The sum of oxygen demand due to organic matter decay plus demand from invertebrate respiration is equal to the SOD. SOD is averaged over the water column depth, as indicated by the third term (to the right of the equal sign) in Equation (1).

The process by which oxygen enters a stream is known as reaeration. Equation (1) shows the net effect on DO concentration of the simultaneous processes of deoxygenation through the decay of carbonaceous organic matter, nitrification of ammonia, SOD and reaeration. The resulting pattern in DO concentration versus distance downstream from a waste source is known as the DO sag curve

Numerous equations for estimating a stream's reaeration rate have been developed and many are presented in *Rates, Constants, and Kinetic Formulations in Surface Water Quality Modeling*, 2nd edition, USEPA. Reaeration rates in the SWQM can be either entered directly or computed using the formula developed by E.C. Tsivoglou and shown in Equation (5).

4) $$K_2 = C(Slope)(Velocity)$$

where: K_2 = reaeration rate at 20°C, 1/day
C = Tsivoglou Coefficient
C = 1.8 when stream flow < 10 cfs
C = 1.3 when stream flow > 10 cfs and < 25 cfs
C = 0.88 when stream flow > 25 cfs
Slope = water surface slope, feet/mile
Velocity = water velocity, feet/second

Another commonly used method for estimating a stream's reaeration rate is the O'Conner-Dobbins formulation shown in Equation (7). This formulation generally works best for streams with a depth of greater than 5 feet and a slope of less than 2 feet/mile.

5) $$K_2 = \frac{12.9U^{0.5}}{H^{1.5}}$$

where: K_2 = reaeration rate at 20°C, 1/day
U = stream velocity, feet/second
H = stream depth, feet

Temperature affects the rate at which reactions proceed. Reaction rates are generally expressed with units of per day at 20°C. If the reactions are occurring at a temperature other than 20°C, then the reaction rates must be corrected for the new temperature. The most commonly used expression to adjust reaction rates for temperature is the modified Arrhenius relationship shown in Equation (7):

6) $$K_{T_2} = (K_{20°C})\Theta^{(T_2 - 20)}$$

where: K_{T2} = reaction rate at the new temperature, 1/day
$K_{20°C}$ = reaction rate at 20°C, 1/day

The Θ values for each of the reaction rates shown in Equation (1) vary slightly from reference to reference but those used in the SWQM are listed in the following table.

The model was calibrated to low flow conditions by extracting the historical data for low flow time periods. The data were utilized from 1988, 1991, 1996, 1998, and 1999 during the months of June through October. The data plots in Appendix A show the predominant dissolved oxygen impairment occurs between rivermiles 60 to 70 and during low flow periods. At this particular longitudinal locations there are elevated concentrations of NH_3 (Figure A-1) and an associated rise of NO_3-NO_2 downstream and a dissolved oxygen depression (Figure A-2). The following modeling parameters in Table 4-2 were used for the calibration time period.

Table 4-2 SWQM Parameters Used in Model Calibration and TMDL Allocation Scenarios for

Parameter in SWQM	Definition	Value Used in Model Calibration and TMDL	Units
K_d	CBOD Decay Rate	0.1	1/day
K_{NH3}	Nitrification rate	1.0	1/day
K_{TON}	TON Hydrolosis Rate	0.05	1/day
K_a	Reaeration Rate	0.6 to 1.5	1/day
SOD	Sediment Oxygen Demand	1.1	$gO_2/m^2/day$
$CBOD_{settling}$	CBOD Settling Rate	0.05	1/day

The dissolved oxygen calibration is shown in Figure 4-2. More calibration plots are shown in Appendix B. The $7Q_{10}$ flow, 29.9 cfs, was calculated from flow data collected at the USGS gage near Brantley, AL (USGS 02371500) with an associated drainage area of approximately 500 square miles. The daily flow data were analyzed from 1937 through 2001 to compute the log-Pearson Type III fit to the minimum 7-day average flows. The $7Q_{10}$ flow was used for the calibration and TMDL runs.

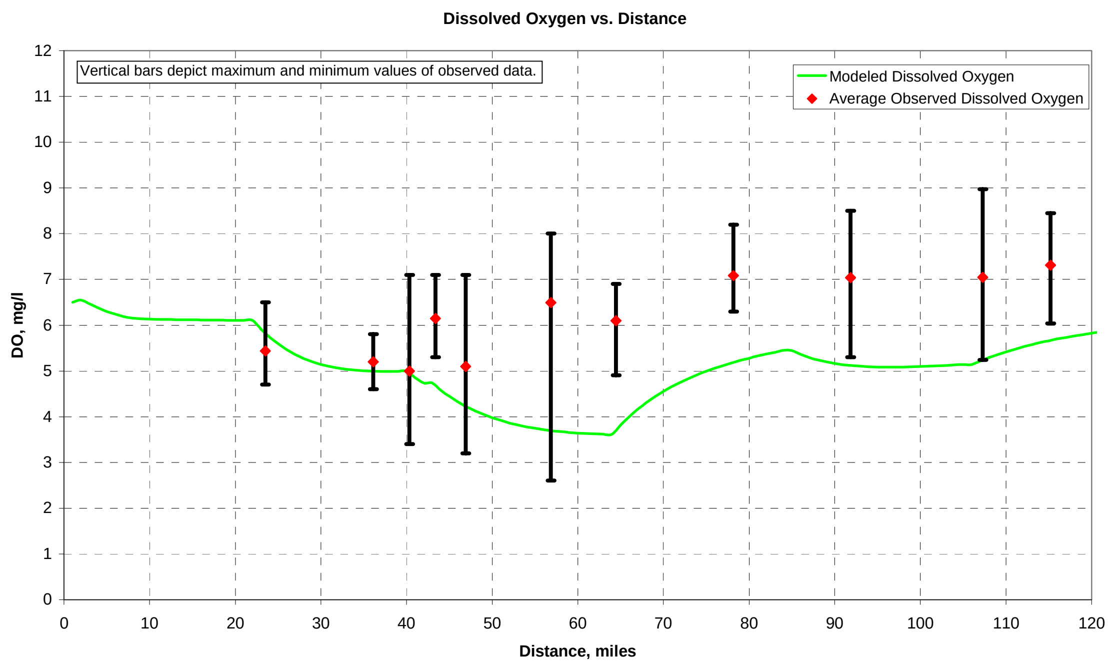

Figure 4-2 DO Calibration for the Conecuh River for an Average Low-Flow Condition based on Summer Months of Years 1988 through 1999

5.0 Development of Total Maximum Daily Load

The TMDL is the total amount of a pollutant load that can enter a waterbody (the loading capacity) and still attain the applicable water quality standard. A TMDL is expressed as WLA for point source discharges from facilities and activities regulated by the NPDES permit program and Load Allocation (LA) for all nonpoint sources. The TMDL must also incorporate an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

5.1 Numeric Targets for TMDL

5.1.1 Sediment

According to 40 CFR §130.2 (i), TMDLs can be expressed in terms of mass per unit time, toxicity, or other appropriate measure. In this case, an "other appropriate measure" is used to express the TMDL as the tons of sediment that can be discharged from an acre of a subwatershed during a year (lbs/acre/year) and still attain the applicable water quality standard. For purposes of these TMDLs, sediment loads are expressed as average annual loads per unit area. The average annual load was considered more appropriate than a daily load for representing long-term processes of accumulation of sediments in stream habitat areas and the associated effects on aquatic life.

Each subwatershed TMDL was established at a level consistent with the average annual existing sediment loading from biologically healthy reference subwatersheds located within the same ecoregion as the impaired subwatershed. An impaired subwatershed is a watershed with one or more waterbody segments listed on the State's §303(d) List. The Sediment TMDLs for impaired subwatersheds are summarized in Table 5-1. The TMDL establishes the average annual amount of sediment that may be discharged from the subwatershed into the waterbody over a year and still attain applicable water quality standards. Figure 5-2 shows the delineated watersheds for the upper and lower TMDL segments.

Table 5-1 Sediment TMDLs for the §303(d) Listed Segments of the Conecuh River Basin

Watershed	Level IV Ecoregions	TMDL (tons\acre\year)
AL/0314301-030_01 (upper segment)	65d	0.16
AL/0314301-040_01 (lower segment)	65d	0.16

EPA regulations define loading, or assimilative capacity, as the greatest amount of loading a waterbody can receive without violating water quality criteria (40 CFR Part 130.2(f)). For sedimentation, the State of Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10-06-(a)&(c)) provides a narrative criteria that establishes that biological integrity within the stream segment must be maintained.

In order to develop a numeric criterion that provides for the protection of the designated uses of the stream segments within the Conecuh River Basin, a target annual average loading of sediment to the listed reaches was determined. The target represents loading conditions within reference watersheds where physical conditions are similar and biological assessments have identified the waterbodies as fully supporting their designated uses. It has been determined that biological impairment of waterbodies due to excessive siltation is a long-term process and therefore the use of annual average loading conditions, as calculated through the USLE, are appropriate as the TMDL target loading conditions.

Determining reference watersheds for the two siltation TMDLs was based upon Ecoregion reference site monitoring data as well as other biological monitoring data. Ecoregion reference sites were established as least impacted streams with good biology and habitat within specific ecoregions. Table 5-2 presents the Ecoregion within which each of the listed segments resides. One Level III Ecoregion covers both, the Southern Plains (65).

The Level III Ecoregion is divided into two Level IV categories, the Southern Hilly Gulf Costal Plain (65d) and the Southern Pine Plains and Hills (65f) of the Southern Plains. The Southern Hilly Gulf Costal Plain (65d) has been renamed to (65e) this is why 65d and 65e as listed together in this report.

Ideally, ecoregion reference sites (or fully supporting sample sites) would be available for each of the Level IV Ecoregions in order to establish reference annual average loads that coincide with fully supporting segments. There may be more than one Level IV Ecoregions within a watershed with a listed segment; the predominant ecoregion was selected for the target.

Applicable references sites were selected for the Level IV Ecoregion site reference list from the 2000 Habitat Assessment conducted by ADEM. Ecoregion references were used because of the long-term monitoring and their habitat assessment score. Habitats in the 2000 Habitat Assessment were given a score ranging from zero to 220, with 220 being the highest or most pristine stream. ADEM determines that a waterbody with a habitat assessment score of good or better is fully supporting its designated uses in terms of habitat conditions. A good habitat assessment is determined by having an average score of at least 60 percent (132) to 70 percent (154) of the 220. Applicable reference sites were available for the Southern Hilly Gulf Costal Plain (65d,e) and Southern Pine Plains and Hills (65f). Table 5-2 lists the reference site used in developing the TMDL target.

Table 5-2 Reference Sites Used in TMDL Analyses

Reference Stream	8-Digit HUC	Level IV Ecoregion	Biological Ranking
Pineywoods Creek	Patsaliga	65d	[1]Excellent Habitat Assessment

Source: 1999 Nonpoint Source Assessment Report

Direct reference site information and fully supporting biological monitoring stations were not available for each individual ecoregion within the listed watersheds. It is important that the biological evaluations utilized in the determination of the reference site conditions coincide with the conditions upon which the site was listed in order to provide consistency with the methodology that established the §303(d) list being evaluated.

Based upon the limited data available under the 1996 listing conditions, reference site loading conditions were generalized for the Southern Hilly Gulf Coastal Plain, Level IV Ecoregion. An applicable annual average sediment load was then calculated using the methodology described in Section 4.0. The reference annual average unit loads for the Southern Hilly Gulf Costal Plain (65e) is 0.16 tons/acre/year. This became the target annual average load for the ecoregions within the Conecuh River watershed.

5.1.2 OE/DO

EPA regulations define loading, or assimilative capacity, as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 CFR Part 130.2(f)).

Using the dissolved oxygen water quality criterion of 5.0 mg/L, a TMDL model analysis was performed through a critical summer period to determine the loading capacity for the watershed. This was accomplished through a conservative model aimed at meeting the dissolved oxygen target limit by varying source contributions, either point or nonpoint sources. In the case of the nonpoint source loads, the simulations reflect the effects of nonpoint source pollution (NPS) loads on dissolved oxygen as well as background loads from failing septic systems and other upstream sources. The final acceptable simulation represents the TMDL (and loading capacity of the waterbody).

5.2 Critical Conditions

Data analysis shows that the critical conditions for OE/DO are during summer low flow periods. The low dissolved oxygen conditions within the Conecuh River watershed correspond to summer periods of low flow and high temperature. For the purpose of these TMDLs, a low flow average period of June through October was used to develop the critical conditions. From examination of the data from 1988, 1991, 1996, 1998, and 1999, a representative condition was extracted from the data to represent the calibration conditions and the critical conditions. The $7Q_{10}$ of 29.9 cfs was used to simulate flows in SWQM for the calibration and critical (TMDL) conditions.

The data analyses plots in Appendix A show that the historical dissolved oxygen impairment has occurred in the summer months (June through October) and primarily in the segment between river miles 60 and 70.

5.3 Sediment

There is no critical condition for the Conecuh River Sediment TMDL.

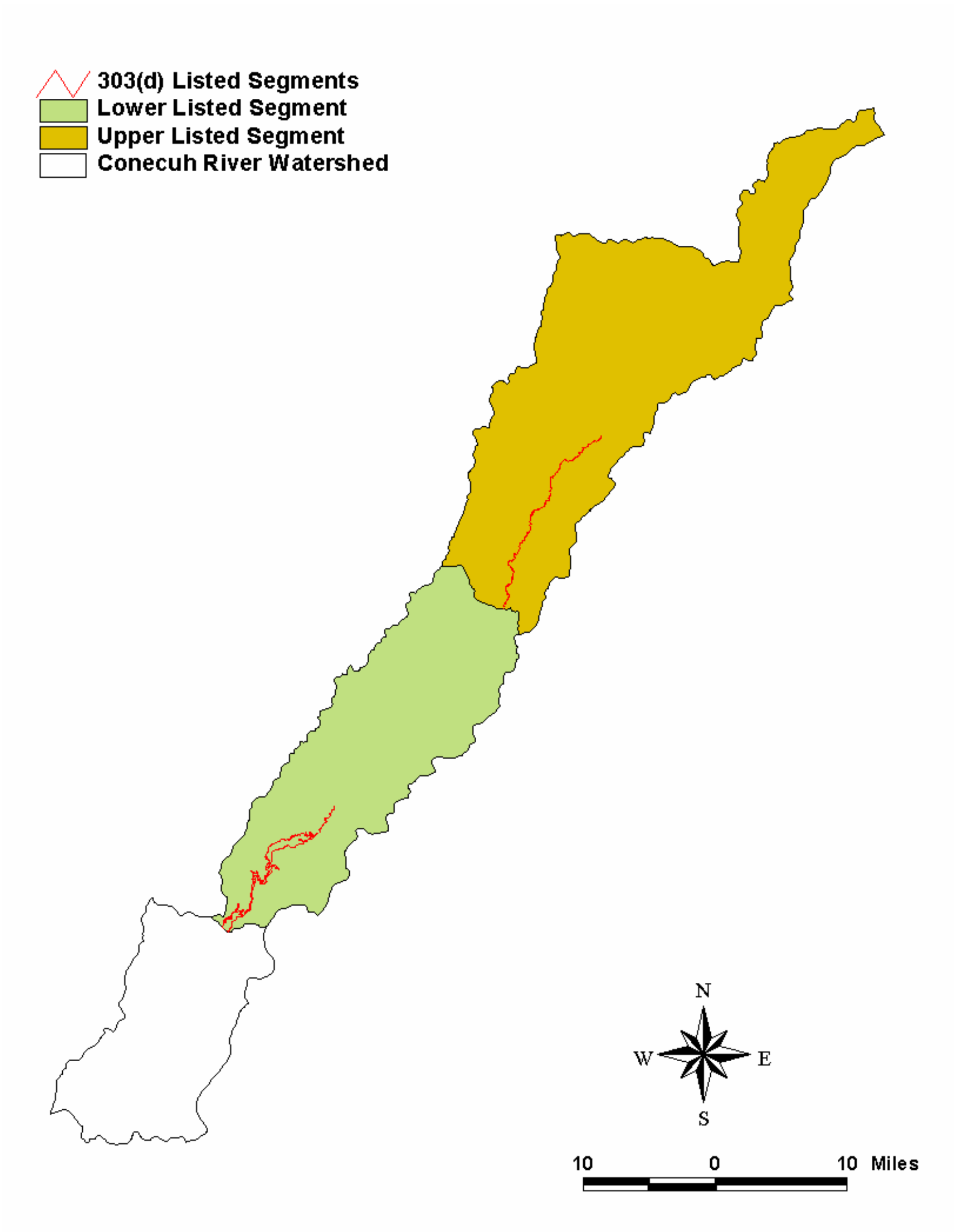

Figure 5-1 Modeled Watersheds for the Conecuh River Basin

The dissolved oxygen model was run with different allocation scenarios by reducing CBODU, NH3, and TON. Figure 5-2 shows the resultant TMDL allocation scenario to achieve the water quality target of 5.0 mg/L. The dissolved oxygen sag still occurs in nearly the same longitudinal location (see Figure 4-2), but the result is a 5.0 mg/L versus a 3.6 mg/L under the existing conditions.

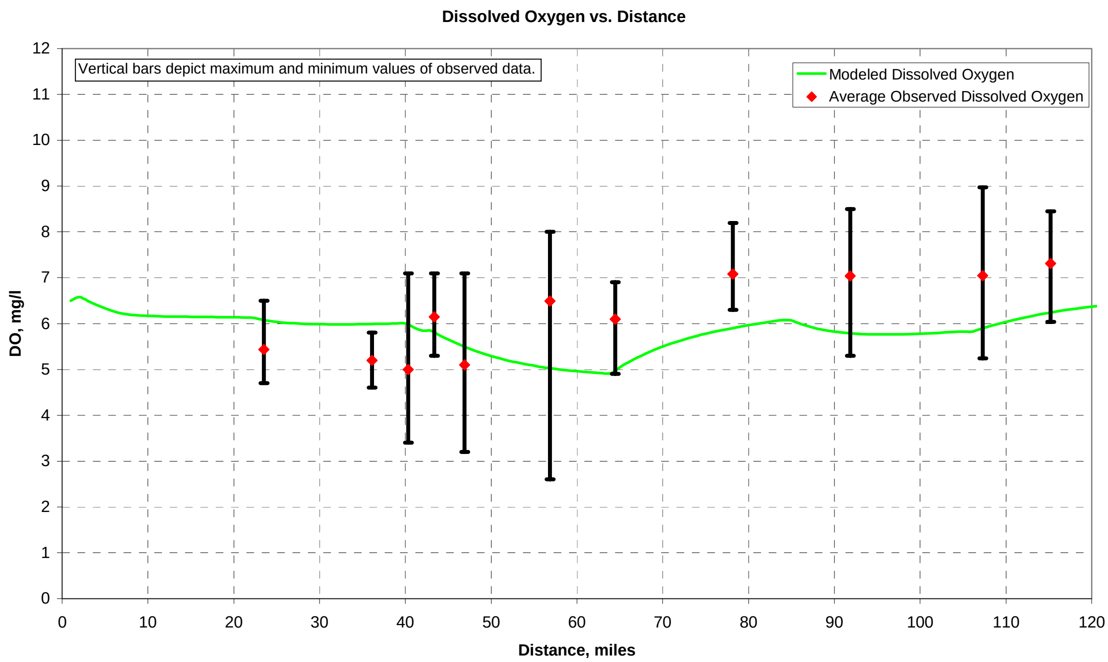

Figure 5-2 Dissolved Oxygen TMDL Allocation Simulation

5.3 Margin of Safety (MOS)

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate a MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For these TMDLs, an implicit MOS was incorporated through the use of conservative modeling assumptions. These included:

- Target values based on subecoregion reference sites, which represent the most impacted streams with good habitat/biology in the subecoregion
- The use of appropriate ecoregion reference site average annual sediment loads as target values for the calculation of needed load reductions.
- The use of the sediment delivery process that results in the most sediment transport to surface waters refers to Method 2 in Section 4.1**.**

The MOS for the OE/DO TMDL was incorporated implicitly through the use of conservative modeling assumptions as follows:

- Low streamflows persist through the critical summer months at monthly $7Q_{10}$ flow values.

- Hot summer temperatures, based on the historical record, persist for the same critical period.
- Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period. Water depths are shallow, generally less than one foot, which aggravates the effect of SOD.
- Water velocities are sluggish, generally 0.5 fps or less, which intensifies the effect of BOD decay.

5.4 Seasonal Variation

Sediment loading is expected to fluctuate according to the amount and distribution of rainfall. The determination of sediment loads on an average annual basis accounts for these differences through the rainfall erosivity index in the USLE. This is a statistic calculated from the annual summation of rainfall energy in every storm and its maximum 30-minute intensity.

Seasonal variation was considered in the OE/DO TMDL by examining the historical data from 1988 through 1999. All of the impairments, with the exception of one, occurred June through October during low flow conditions. Higher flows were examined in the model with no dissolved oxygen concentrations below 5.0 mg/L, resulting in a higher assimilative capacity.

5.5 Wasteload Allocations

5.5.1 Sediment Wasteload Allocations

There are three facilities located within the listed portions of the Conecuh River watershed with individual NPDES permits that require monitoring of TSS or turbidity. The NPDES permit limits as individual WLA for each facility is listed in Table 3-6. It is considered appropriate to provide these facilities their current discharge levels of TSS since the sediment loading from these facilities is negligible compared to other sources.

All sources of sediment loading to surface waters not regulated by the NPDES program are provided a LA in this TMDL. The approach for establishing the LA for nonpoint sources is the same approach used to establish the WLA for NPDES regulated stormwater activities. LA is provided in lbs/acre/year and represents the average annual amount (in tons) of nonpoint source sediment that can be discharged to the receiving water in a year for each acre of nonpoint source activity (see Table 5-1). A LA is established for each listed portion of the Conecuh River and the drainage areas that define those listed portions at a level equal to the estimated average annual sediment loading of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (See Table 5-2). Properly designed and well-maintained BMPs will be necessary to assure that each LA is achieved.

5.5.2 Dissolved Oxygen Waste Load Allocations

Within the Conecuh River watershed no permitted direct discharges of significant oxygen consuming wastes exist, therefore there is no WLA for the Conecuh River impaired segment. Sanitary sewer collection systems delivering waste to permitted facilities are required to eliminate unpermitted discharges.

The point sources in the lower segment contribute less than 0.1% of the total existing sediment load to the system, and therefore, point sources alone cannot alone contribute to the impairment. Construction facilities are required by the respective National Pollutant Discharge Elimination System (NPDES) permits to implement Best Management Practices (BMPs). Ideally, if these BMPs, were properly implemented, they would prevent construction activities from contributing to the sediment load. Numeric Waste Load Allocations (WLA) were assigned to these facilities because they are controlled through an NPDES permit. This allocation is shown in Table 5-3.

5.6 Load Allocations

5.6.1 Sediment Load Allocations

All sources of sediment loading to surface waters not covered by the NPDES program are provided a load LA in this TMDL. Construction activities are NOT covered in the LA portion of the TMDL. LA are provided in lbs/acre/year and represent the average annual amount (in tons) of nonpoint source sediment that can be discharged to the receiving water in a year for each acre of nonpoint source activity (see Table 5-3). LA are established for each listed segment containing a 1996-§303(d) and 2002-§303(d) listed waterbody (Table 5-3) at a level equal to the estimated average annual sediment loading of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion. Properly designed and well-maintained BMP will be necessary to assure that LA is achieved.

5.6.2 OE/DO

Significant nonpoint source loads of organic material and nutrients within the Conecuh River watershed are associated with washoff from agriculture, urban, residential, and forested lands. Loads associated with direct discharge from failing septic systems are also considered in the LA presented below.

5.7 TMDL Results

5.7.1 Sediment Results

The Sediment Tool was used to calculate the existing average annual sediment load for the impaired subwatersheds in the Conecuh River watershed. Impaired segments are those segments with one or more waterbodies on the 303(d) list of impaired waters.

These estimated existing average annual sediment loads for impaired subwatersheds were compared to the estimated existing average annual sediment loads for the appropriate biologically healthy subwatersheds to determine the percent reduction of sediment loading required to fully attain the applicable designated uses. The estimated percent reduction from current loads for each subwatershed is summarized in Table 5-3.

Table 5-3 Maximum Allowable Annual Sediment Loads for the Conecuh River

Impaired Segments	Area (acres)	Existing Loads			Allowable Loads			Reductions		TMDL (tons/yr)
		WLA Continuous sources (tons/yr)	WLA Stormwater sources (tons/acre/yr)	LA (tons/acre/yr)	WLA Continuous sources (tons/yr)	WLA Stormwater sources (tons/acre/yr)	LA (tons/acre/yr)	WLA Continuous sources (%)	WLA & LA Stormwater sources (%)	
AL/0314301-030_01	256,720	None	0.42	0.42	NA	0.16	0.16	NA	62	41,075
AL/0314301-040_01	420,847	263.9	0.81	0.81	263.9	0.16	0.16	0	80	67,599

5.7.2 OE/DO Results

Table 5-4 presents the existing and TMDL scenarios and the associated percent reductions in loads required for the upper Conecuh River. The loads are expressed as $CBOD_U$ and $NBOD_U$ for the load allocation. There are no permitted NPDES discharges in the upper Conecuh River segment.

Table 5-4 OE/DO TMDL Summary for the Upper Conecuh River Segment AL/0314301-030_01

Constituent	Existing Load (lb/day)		TMDL (lb/day)		%WLA Reduction	%LA Reduction
	WLA	LA	WLA	LA		
CBODu	NA	3,813	NA	2,899	NA	24%
NBODu	NA	2,739	NA	2,114	NA	23%
Total	NA	6,552	NA	5,013	NA	23%

Notes: NA = no permitted NPDES continuous point sources are discharging into or upstream of the upper Conecuh River segment.

6.0 Threatened and Endangered Species

The Conecuh River Basin provides habitat for seven threatened or endangered species as reported by the Federal Register through the United States Fish and Wildlife Service (USF&WS). According to the USF&WS, the listed species are the Red-cockaded Woodpecker (*Picoides borealis*), Eastern Indigo Snake (*Drymarchon corais couperi*), Wood Stork (*Mycteria Americana)*, Red Hills Salamander (*Phaeognathus hubrichti*), Relict trillium (*Trillium reliquum*), Flatwoods Salamander (*Ambystoma cinqulatum*), and Gulf Sturgeon (*Acipenser oxyrinchus desotoi*).

The endangered wood stork may be found foraging along the river or reservoirs. Freshwater prey are a significant component of the diet of the woodstork. A spawning population of the Gulf sturgeon is found downstream of the Point A Dam in the Conecuh River.

7.0 Follow-up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's 14 major river basins into five groups. Each year, the ADEM water quality resources are concentrated in one of the basin groups. One goal is to continue to monitor §303(d) listed waters to help further characterize water quality conditions resulting from the implementation of BMPs in the watershed. This monitoring will occur in each basin according to the following schedule:

River Basin Group	Scheduled Year
Choctawhatchee, Chipola, Perdido-Escambia and Chattahoochee	2004
Tallapoosa, Alabama and Coosa	2005
Escatawpa, Upper Tombigbee, Lower Tombigbee and Mobile	2006
Cahaba and Black Warrior	2007
Tennessee	2008

Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices in the watershed.

8.0 Public Participation

As part of the public participation process, these TMDLs were 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 TMDLs was made available on ADEM's Website: www.adem.state.al.us. The public can also request paper or electronic copies of the TMDLs by contacting Mr. Chris Johnson at 334-

271-7827 or clj@adem.state.al.us. The public was given an opportunity to review the TMDLs 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 these TMDLs and subsequent submission to EPA Region 4 for final review and approval.

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Appendix A Data Used In TMDL

Table A-1 Sampling Stations on Conecuh River

Year	Study	Station	Agency	Stream Section	Road Crossing	Latitude	Longitude
1996	Clean Water Strategy	PE10	ADEM	Conecuh River	AL Hwy 223	31.94889	-85.8211
1997	ALMAP Random Sampling	EB01U1	ADEM	Mannings Creek	NA	31.982875	-85.948299
1999	Southeast River Basins NPS Screening Assessment	CNR07	ADEM	Conecuh River	Pike Co Rd 7	31.982875	-85.946607
1997	ALMAP Random Sampling	EB02U1	ADEM	McQuagee Mill Creek	NA	31.899933	-86.074341
1992	Clean Water Strategy	46	ADEM	Conecuh River	US Hwy 231	31.84454	-85.99475
1999	Southeast River Basins NPS Screening Assessment	CNR06	ADEM	Conecuh River	Pike Co Rd 1	31.830949	-86.028295
1992	Clean Water Strategy	47	ADEM	Conecuh River	US Hwy 29	31.80427	-86.04664
1998	ALMAP Random Sampling	EB02U2-9	ADEM	Double Branch	NA	31.7948	-86.02436
1999	Southeast River Basins NPS Screening Assessment	CNR05	ADEM	Conecuh River	Goshen Rd	31.719587	-86.107231
1996	Clean Water Strategy	PE11	ADEM	Conecuh River	Pike Co Rd 6	31.71944	-86.1072
1999	Southeast River Basins NPS Screening Assessment	CNR04	ADEM	Conecuh River	Pike Co Rd 6	31.660326	-86.160353
1996	Clean Water Strategy	PE12	ADEM	Conecuh River	Crenshaw Co Rd 77	31.48722	-86.3611
1999	Southeast River Basins NPS Screening Assessment	CNR03	ADEM	Conecuh River	Covington Co Rd 77	31.486808	-86.361005
1999	Southeast River Basins NPS Screening Assessment	CNR02	ADEM	Conecuh River	Covington Co Rd 86	31.42583	-86.45767
1999	Southeast River Basins NPS Screening Assessment	CNR01	ADEM	Conecuh River	Point A Dam	31.36117	-86.51833
1996	Alabama Water Watch	04004001	AWW	Conecuh River	US Hwy 231	31.84454	-85.994675
1996	Alabama Water Watch	04004002	AWW	Conecuh River	US Hwy 29	31.80401	-86.04752
1996	Alabama Water Watch	04007007	AWW	Conecuh River	Covington Co Rd 84	31.34795	-86.52922
1992	Clean Water Strategy	48	ADEM	Conecuh River	Covington Co Rd 42	31.2774	-86.56845
2001	Conecuh Ambient Reservoir Data	Gantt	ADEM	Conecuh River	Gantt Reservoir	NA	NA
2001	Conecuh Ambient Reservoir Data	Point A	ADEM	Conecuh River	Point A Reservoir	NA	NA

Table A-2 All Data Collected in the Conecuh River Basin

Station ID	Study	Rivermile from Point A Dam	Date	Temp-Air °C	Temp-H_2O °C	pH Units	SpCond mmhos	DO mg/L	< 5	BOD_5 mg/L	NO_3+NO_2 mg/L	NH3 mg/L	TKN mg/L	TP mg/L	TOC mg/L	Turb NTUs	TSS mg/L	Fecal Coliform per/100 mL	Chloride mg/L	G/P Habitat Assessment	Flow cfs	Depth ft	DO %Sat
PE10	*1996 CWS*	91.69	7/24/1996	34	28	7.1	50	6.5	0	1.1	0.05	0.015K	0.61	0.08	--------	20	--------	--------	--------	--------	--------	3	--------
PE10	*1996 CWS*	91.69	8/7/1996	32	26	6.7	40	4.7	1	1.1	0.11	0.015K	0.15	0.04	--------	16	--------	--------	--------	--------	--------	4	--------
PE10	*1996 CWS*	91.69	10/3/1996	29	21	6.88	55	5.1	0	1.1	0.05	0.015K	0.006	0.11	--------	22	--------	--------	--------	--------	--------	6	--------
CNR07	§303(d) 1999	79.12	8/24/1999	28	27	7	70	5.2	0	0.8	0.09	<0.015	<0.15	0.02	6.79	20.2	9	25	--------	146	3.1	--------	--------
CNR07	§303(d) 1999	79.12	7/6/1999	36	27	6.9	75	4.6	1	1.2	0.04	<0.015	<0.15	0.06	15.79	14.8	9	70	--------	--------	--------	--------	--------
CNR07	§303(d) 1999	79.12	6/15/1999	26	26	7.32	70	5.8	0	0.8	0.12	<0.015	0.49	0.08	11.13	--------	15	83	--------	--------	48.5	--------	--------
46	*1992 CWS*	74.89	06/03/91	--------	24.20	6.5	58	4.9	1	0.7	0.13	0.18	0.62	1.2	--------	--------	--------	120	--------	--------	--------	--------	--------
46	*1992 CWS*	74.89	07/08/91	--------	24.00	6.3	40	5.1	0	0	0.03	0.04	0.52	0.04	--------	--------	--------	500	--------	--------	--------	--------	--------
46	*1992 CWS*	74.89	08/05/91	--------	27.00	6.6	50	4.4	1	0.5	0.14	0.03	0.44	0.01	--------	--------	--------	80	--------	--------	--------	--------	--------
46	*1992 CWS*	74.89	09/09/91	--------	26.00	6.6	51	4.3	1	0.2	0.16	0.06	0.45	0.02	--------	--------	--------	210	--------	--------	--------	--------	--------
46	*1992 CWS*	74.89	10/07/91	--------	17.50	7	57	4.2	1	0.6	0.08	0.08	0.46	0.01	--------	--------	--------	640	--------	--------	--------	--------	--------
CNR06	§303(d) 1999	71.83	6/15/1999	35	27	6.98	70	6.4	0	0.7	0.13	<0.015	<0.15	0.07	9.01	--------	11	100	--------	159	--------	--------	--------
CNR06	§303(d) 1999	71.83	7/6/1999	31	26	6.9	65	5.3	0	1	0.18	<0.015	<0.15	0.18	9.98	12.2	19	73	--------	--------	--------	--------	--------
CNR06	§303(d) 1999	71.83	8/24/1999	30	27	6.8	70	5.8	0	1.1	0.18	<0.015	<0.15	0.01	6.31	14.5	8	220	--------	--------	--------	--------	--------
CNR06	§303(d) 1999	71.83	9/30/1999	22	21	7.2	60	7.1	0	1.5	0.15	<0.015	<0.15	0.04	4.86	7.3	7	128	--------	--------	--------	--------	--------
47	*1992 CWS*	68.33	06/03/91	--------	25	6.7	56	4.9	1	0.5	0.12	0.09	0.46	0.04	--------	--------	--------	70	--------	--------	--------	--------	--------
47	*1992 CWS*	68.33	07/08/91		24.2	6.6	40	5.1	0	0	0.1	0.06	0.6	0.02	--------	--------	--------	340	--------	--------	--------	--------	--------
47	*1992 CWS*	68.33	08/05/91	--------	27.2	6.7	46	4.5	1	0.4	0.18	0.05	0	0.01	--------	--------	--------	50	--------	--------	--------	--------	--------
47	*1992 CWS*	68.33	09/09/91	--------	26	6.6	47	3.2	1	0.6	0.15	0.07	0.36	0.01	--------	--------	--------	20	--------	--------	--------	--------	--------
47	*1992 CWS*	68.33	10/07/91	--------	18	6.5	41	5.1	0	0.5	0.14	0.06	0.33	0	--------	--------	--------	60	--------	--------	--------	--------	--------
CNR05	§303(d) 1999	58.37	6/15/1999	37	28	7.3	80	6.5	0	0.4	0.24	<0.015	<0.15	0.03	5.18	13.7	7	113	--------	151	--------	--------	--------
CNR05	§303(d) 1999	58.37	7/6/1999	35	28	6.8	145	2.6	1	1.2	0.45	<0.015	0.78	0.02	7.98	8.5	8	80	--------	--------	--------	--------	--------

Station ID	Study	Rivermile from Point A Dam	Date	Temp-Air °C	Temp-H_2O °C	pH Units	SpCond mmhos	DO mg/L	< 5	BOD_5 mg/L	NO_3+NO_2 mg/L	NH3 mg/L	TKN mg/L	TP mg/L	TOC mg/L	Turb NTUs	TSS mg/L	Fecal Coliform per/100 mL	Chloride mg/L	G/P Habitat Assessment	Flow cfs	Depth ft	DO %Sat
CNR05	§303(d) 1999	58.37	8/24/1999	34	28	7.3	360	8	0	1.2	0.45	<0.015	0.26	<0.004	2.6	1.6	7	42	--------	--------	--------	--------	--------
CNR05	§303(d) 1999	58.37	9/30/1999	20	23	7	80	7.5	0	1.9	0.27	<0.015	<0.15	0.04	4.43	7.17	3	59	--------	--------	--------	--------	--------
PE11	*CWS 1996*	58.37	7/24/1996	34	29	7.52	100	6.4	0	0.8	0.34	0.015K	0.15K	0.02	--------	16	--------	--------	--------	--------	--------	10	--------
PE11	*CWS 1996*	58.37	8/7/1996	33	26	7.2	110	5.2	0	0.7.	0.35	0.015K	0.15K	0.03	--------	12	--------	--------	--------	--------	--------	10	--------
PE11	*CWS 1996*	58.37	10/3/1996	28	25	7.16	60	7	0	0.7	0.018	0.015K	0.23	0.07	--------	18	--------	--------	--------	--------	--------	10	--------
CNR04	§303(d) 1999	50.77	6/15/1999	31	27	7.27	90	6.4	0	0.1	0..26	<0.015 K	<0.15	0.02	4.08	--------	10	29	--------	152	--------	--------	--------
CNR04	§303(d) 1999	50.77	7/6/1999	33	26	7	75	4.9	1	1	0.2	<0.015 K	1.11	0.05	11.23	14.8	16	51	--------	--------	--------	--------	--------
CNR04	§303(d) 1999	50.77	8/24/1999	32	27	7.3	110	6.2	0	1.7	0.42	<0.015 K	<0.15	<0.004	2.6	11.2	11	67	--------	--------	--------	--------	--------
CNR04	§303(d) 1999	50.77	9/30/1999	19	21	7.1	110	6.9	0	0.6	0.35	<0.015 K	<0.15	0.04	3	7.17	6	25	--------	--------	--------	--------	--------
PE12	*CWS 1996*	23.37	7/25/1996	34	29	8.4	110	6.3	0	0.9	0.28	0.015K	0.15K	0.03	--------	38	--------	--------	--------	--------	--------	9	--------
PE12	*CWS 1996*	23.37	8/7/1996	36	27	7	90	6.4	0	0.4	0.02	0.015K	0.15K	0.02	--------	14	--------	--------	--------	--------	--------	8	--------
PE12	*CWS 1996*	23.37	10/3/1996	29	26	7.33	60	7.5	0	0.6	0.21	0.015K	0.22	0.006	--------	16	--------	--------	--------	--------	60	8	--------
CNR03	§303(d) 1999	23.37	6/28/1999	24	25.6	5.78	25	5.3	0	0.3	0.1	0.003	0.76	0.07	21.44	67.5	98	833	--------	--------	--------	--------	--------
CNR03	§303(d) 1999	23.37	7/20/1999	32	26.8	6.3	60	8.2	0	1.5	0.19	<0.015	0.32	0.06	8.19	39.3	18	467	--------	--------	--------	--------	--------
CNR03	§303(d) 1999	23.37	9/12/1999	--------	27.9	6.39	120	8.5	0	2.3	0.27	0.2	0.47	0.08	4.7	11.8	14	39	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	4/28/1999	--------	24.1	7.12	61.3	6.92	0	1	0.003	<0.015	<0.15	0.13	7.63	20.8	10	2	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	5/25/1999	--------	26.5	6.98	52.1	7.03	0	1.1	0.09	<0.015	0.15	0.02	7.19	15.5	10	<1	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	6/22/1999	--------	28	7.43	74.1	6.6	0	2.2	0.12	<0.015	7.05	0.02	5.69	13.7	1	2	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	6/29/1999	34	28.6	6.9	50	6.2	0	1.5	0.14	<0.015	0.46	0.4	7.74	30	17	77	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	7/27/1999	--------	28.2	6.8	55.6	5.24	0	0.9	0.12	<0.015	<0.15	0.03	8.2	22.4	12	15	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	8/24/1999	--------	31.1	7.77	68.9	7.39	0	1.1	<0.003	<0.015	0.2	0.004	8.18	6.17	5	3	--------	--------	--------	--------	--------
CNR02	§303(d) 1999	7.94	9/28/1999	--------	25.5	7.91	78.1	8.97	0	1.7	0.08	<0.015	0.28	0.11	4.47	2.7	2	<1	--------	--------	--------	--------	--------
CNR02	§303(d)	7.94	10/26/1999	--------	19.1	7.59	88	7.87	0	0.8	0.143	<0.015	<0.01	0.03	4.22	3.87	4	<1	--------	--------	--------	--------	--------

Station ID	Study	Rivermile from Point A Dam	Date	Temp-Air °C	Temp-H_2O °C	pH Units	SpCond mmhos	DO mg/L	< 5	BOD_5 mg/L	NO_3+NO_2 mg/L	NH3 mg/L	TKN mg/L	TP mg/L	TOC mg/L	Turb NTUs	TSS mg/L	Fecal Coliform per/100 mL	Chloride mg/L	G/P Habitat Assessment	Flow cfs	Depth ft	DO %Sat
	1999												5										
CNR01	§303(d) 1999	0.00	4/28/1999	--------	23.6	7.23	7.38	7.38	0	1	<0.003	<0.015	0.27	0.02	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	5/25/1999	--------	26	7.11	55	6.78	0	1.4	0.11	<0.015	0.77	0.02	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	6/22/1999	--------	27.2	7.28	66.7	6.68	0	0.7	0.11	<0.015	<0.15	0.02	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	7/27/1999	--------	30.4	6.88	54.3	7.56	0	1.3	0.12	<0.015	<0.15	0.03	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	8/24/1999		30.1	7.1	63	6.04	0	1.1	0.04	<0.015	0.28	0.02	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	9/28/1999		25.6	7.57	71	8.45	0	1.7	0.12	<0.015	0.53	0.06	--------	--------	--------	--------	--------	--------	--------	--------	--------
CNR01	§303(d) 1999	0.00	10/26/1999		19	7.62	83.2	7.84	0	0.9	0.125	<0.015	0.61	0.01	--------	--------	--------	--------	--------	--------	--------	--------	--------
04007002	AWW	-1.74	3/23/1996	18.20	14.00	6.50	--------	7.90	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	76.13
04014001	AWW	74.89	2/10/2000	23.50	7.50	5.50	--------	9.90	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	81.97
04014001	AWW	74.89	5/8/1998	34.50	24.50	6.25	--------	6.20	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	75.12
04014001	AWW	74.89	8/27/1998	--------	33.00	7.00	--------	6.90	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	97.17
04014002	AWW	68.33	10/29/1998	26.50	17.00	6.50	--------	7.10	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	73.26
04014002	AWW	68.33	12/8/1998	22.00	18.00	6.50	--------	6.20	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	65.42
04014002	AWW	68.33	2/23/1999	11.00	9.00	6.50	--------	9.30	0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	79.77
04014002	AWW	68.33	4/15/1999	27.00	21.00	6.00	--------	4.50	1	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	50.70
88ConRiv01	1988 CWS	74.89	6/14/1988	30	24	6.4	74	4.7	1	1	0.07	0.06	0.48	0.1	--------	18	--------	--------	--------	--------	--------	--------	55.294
88ConRiv01	1988 CWS	74.89	7/8/1988	22	23	6.7	50	4.1	1	1.6	0.08	0.1	0.5	0.04	--------	31	--------	--------	--------	--------	--------	--------	47.126
88ConRiv01	1988 CWS	74.89	8/11/1988	33	27	6.6	85	3.4	1	1.6	0.04	0.1	1.42	0.01	--------	14	--------	--------	--------	--------	--------	--------	41.975
88ConRiv01	1988 CWS	74.89	9/15/1988	35	25	6.5	61	5.9	0	1	0.06	0.03	0.39	0.03	--------	18	--------	--------	--------	--------	--------	--------	70.238
88ConRiv01	1988 CWS	74.89	10/6/1988	29	18	6.3	55	7.1	0	0.9	0.04	0.04	0.94	0.05	--------	23	--------	--------	--------	--------	--------	--------	74.737
88ConRiv02	1988 CWS	68.33	6/14/1988	29	24	6.7	61	4.7	1	1.4	0.1	0.07	0.33	0.03	--------	13	--------	--------	--------	--------	--------	--------	55.294
88ConRiv02	1988 CWS	68.33	7/8/1988	20	24	6.8	45	4.7	1	1.6	0.11	0.08	0.43	0.05	--------	22	--------	--------	--------	--------	--------	--------	55.294

Station ID	Study	Rivermile from Point A Dam	Date	Temp-Air °C	Temp-H_2O °C	pH Units	SpCond mmhos	DO mg/L	< 5	BOD_5 mg/L	NO_3+NO_2 mg/L	NH3 mg/L	TKN mg/L	TP mg/L	TOC mg/L	Turb NTUs	TSS mg/L	Fecal Coliform per/100 mL	Chloride mg/L	G/P Habitat Assessment	Flow cfs	Depth ft	DO %Sat
88ConRiv 02	1988 CWS	68.33	8/11/1988	32	27	6.9	69	3.8	1	1.8	0.05	0.27	0.62	0.03	--------	15	--------	--------	--------	--------	--------	--------	46.914
88ConRiv 02	1988 CWS	68.33	9/15/1988	35	23	6.7	66	5.9	0	1	0.09	0.02	0.32	0.02	--------	15	--------	--------	--------	--------	--------	--------	67.816
88ConRiv 02	1988 CWS	68.33	10/6/1988	24	18	6.7	50	7.1	0	0.8	0.06	0.03	0.95	0.03	--------	21	--------	--------	--------	--------	--------	--------	74.737
88ConRiv 03	1988 CWS	58.37	6/14/1988	26	22	7.4	130	6.9	0	0.2	0.56	0.02	0.1	0.14	--------	8.2	--------	--------	--------	--------	--------	--------	78.409
88ConRiv 03	1988 CWS	58.37	7/8/1988	20	23	7.1	62	6.6	0	1.1	0.28	0.05	0.48	0.08	--------	22	--------	--------	--------	--------	--------	--------	75.862
88ConRiv 03	1988 CWS	58.37	8/11/1988	32	25	7	100	6.3	0	0.3	0.37	0.03	0.2	0.02	--------	8.8	--------	--------	--------	--------	--------	--------	75
88ConRiv 03	1988 CWS	58.37	9/15/1988	30	23	6.8	73	7.1	0	0.5	0.19	0.04	0.31	0.01	--------	16	--------	--------	--------	--------	--------	--------	81.609
88ConRiv 03	1988 CWS	58.37	10/6/1988	24	18	6.6	50	7.8	0	0.8	0.07	0.04	1.17	0.04	--------	23	--------	--------	--------	--------	--------	--------	82.105
88ConRiv 04	1988 CWS	37.03	6/14/1988	27	23	7	170	7.3	0	0.1	0.36	0.01	0.15	0.13	--------	6.6	--------	--------	--------	--------	38.5	--------	83.908
88ConRiv 04	1988 CWS	37.03	7/4/1988	25	24	7	69	6.8	0	2.6	0.26	0.01	0.46	0.02	--------	57	--------	--------	--------	--------	184	--------	80
88ConRiv 04	1988 CWS	37.03	8/8/1988	31	26	7.4	168	6.3	0	1	0.37	0.03	0.14	0.01	--------	4.9	--------	--------	--------	--------	42.2	--------	76.829
88ConRiv 04	1988 CWS	37.03	9/12/1988	30	22	6.8	60	6.8	0	0.9	0.16	0.03	0.24	0.04	--------	30	--------	--------	--------	--------	462	--------	77.273
88ConRiv 04	1988 CWS	37.03	10/3/1988	25	22	7.1	76	8.2	0	1.6	0.19	0.03	0.27	0.04	--------	35	--------	--------	--------	--------	589	--------	93.182
88ConRiv 05	1988 CWS	23.37	6/14/1988	28	23	7.6	150	7.6	0	0.9	0.28	0.04	0.33	0.01	--------	5	--------	--------	--------	--------	--------	--------	87.356
88ConRiv 05	1988 CWS	23.37	7/4/1988	27	24	7.1	84	6.7	0	1.8	0.3	0.03	0.39	0.05	--------	30	--------	--------	--------	--------	--------	--------	78.823
88ConRiv 05	1988 CWS	23.37	8/8/1988	31	27	7.4	137	5.9	0	1	0.15	0.03	0.22	0.01	--------	5.4	--------	--------	--------	--------	--------	--------	72.839
88ConRiv 05	1988 CWS	23.37	9/12/1988	30	22	6.9	70	6.9	0	0.7	0.19	0.02	0.26	0.04	--------	20	--------	--------	--------	--------	--------	--------	78.409
88ConRiv 05	1988 CWS	23.37	10/3/1988	27	22	7.4	73	8.1	0	1.6	0.24	0.03	0.2	0.03	--------	33	--------	--------	--------	--------	--------	--------	92.045

Table A-3 Ambient Reservoir Data for Gantt and Point A Reservoir

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
Gantt	1		5/3/90	0.46	1.8	---	----	---	---	----	20.0	2.0	---	86.0	7.0	<0.10	0.18	---	0.05	<0.010	6.10	---	--	23
						0.3	26.1	6.7	7.1	0.062														
						1.5	24.5	6.8	7.0	0.061														
						5.0	24.2	6.7	6.3	0.062														
						8.0	23.7	6.7	5.9	0.061														
Gantt	1		8/27/90	1.51	6.0	---	----	---	---	----	7.0	30.0	---	54.0	5.0	<0.10	<0.04	---	<0.02	<0.010	8.70	4.0	44	<1
						0.3	30.9	7.2	7.4	0.077														
						1.5	30.8	7.2	6.1	0.076														
						3.0	29.6	6.8	2.7	0.080														
						4.0	29.2	6.7	2.0	0.082														
						5.0	28.9	6.7	1.0	0.083														
						6.0	28.6	6.7	0.2	0.087														
						8.0	27.8	6.7	0.1	0.100														
Gantt	1	A	4/29/93	0.76	1.93	---	----	---	---	----	22.0	23.0	53.0	59.0	3.0	<0.015	0.230	0.639	0.035	<0.004	6.35	2.4	39	2
						0.3	22.8	6.8	8.2	0.056														
						1.0	21.8	6.9	8.0	0.056														
						1.5	21.7	6.9	7.9	0.056														
						2.0	21.6	6.9	7.9	0.056														
						5.0	20.6	6.9	7.2	0.055														
						8.0	19.5	6.7	6.4	0.055														
Gantt	1	A	8/11/93	1.88	2.8	---	----	---	---	----	3.5	36.0	53.0	61.0	2.0	<0.015	0.004	0.178	0.021	<0.004	4.18	4.1	44	2
						0.3	31.4	7.3	7.3	0.072														
						1.0	30.9	7.3	7.2	0.071														
						1.5	30.4	7.3	7.2	0.071														
						2.0	30.3	6.9	7.0	0.073														
						3.0	29.9	6.8	5.4	0.070														
						4.0	29.4	6.7	4.3	0.069														
						5.0	29.2	6.7	3.7	0.075														
						6.0	28.8	6.5	1.4	0.073														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						7.0	28.1	6.6	0.1	0.094														
						9.0	25.7	6.8	0.1	0.118														
Gantt	1	A	51095	0.67	1.40	---	---	---	---	---	26.0	18	22.1	79.0	5.0	<0.015	0.230	0.300	0.80	0.013	6.26	3.5	43	157
						0.1	23.59	6.59	7.18	0.055														
						0.5	23.57	6.70	7.13	0.055														
						1	23.48	6.71	7.15	0.055														
						1.5	23.39	6.72	7.16	0.055														
						2	23.37	6.75	7.18	0.055														
						3	22.90	6.71	6.84	0.055														
						4	22.63	6.62	6.24	0.056														
						5	22.01	6.54	5.61	0.056														
						6	21.22	6.48	4.99	0.055														
						7	21.13	6.47	4.60	0.057														
						8	20.99	6.46	4.51	0.056														
						9	20.70	6.42	4.00	0.056														
						9.4	20.54	6.41	3.76	0.056														
Gantt	1	B	51095	0.67	1.31	---	---	---	---	---	26.0	19	21.0	78.0	7.0	<0.015	0.220	0.288	0.70	0.016	6.56	19.2	60	290
						0.1	23.59	6.80	7.05	0.055														
						0.5	23.55	6.81	7.14	0.055														
						1	23.50	6.80	7.15	0.055														
						1.5	23.46	6.80	7.15	0.055														
						2	23.42	6.81	7.17	0.055														
						3	23.01	6.79	6.81	0.055														
						4	22.83	6.69	6.41	0.056														
						5	21.98	6.57	5.54	0.055														
						6	21.26	6.50	5.07	0.054														
						7	21.23	6.49	4.75	0.057														
						8	21.06	6.48	4.52	0.057														
						9	20.63	6.44	3.90	0.056														
						9.4	20.56	6.43	3.80	0.056														
Gantt	1	A	83095	2.09	4.77	---	---	---	---	---	2.4	30	30.8	83.0	2.0	<0.015	0.040	<0.150	0.055	0.007	4.63	5.9	48	2
						0.1	31.85	6.99	7.45	0.073														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						1	31.47	7.44	7.68	0.072														
						1.5	31.15	7.51	7.56	0.073														
						2	31.04	7.47	7.47	0.073														
						3	30.88	7.36	7.30	0.073														
						4	30.15	7.02	5.00	0.073														
						5	29.43	6.57	3.12	0.071														
						6	28.67	6.38	0.15	0.069														
						7	27.28	6.40	0.11	0.084														
						8	26.37	6.49	0.10	0.097														
						8.4	26.09	6.56	0.09	0.101														
Gantt	1	A	82097	1.68	3.00	----	----	----	----	----	7.45	25	24.3	56.0	2.0	<0.015	0.110	0.520	0.04	<0.004	5.74	6.7	49	2
						0.3	31.51	7.38	7.47	0.062														
						1	30.73	7.35	7.42	0.063														
						1.5	30.46	7.27	7.19	0.063														
						2	30.30	7.15	6.77	0.064														
						3	29.74	6.78	4.53	0.062														
						4	28.33	6.53	2.28	0.065														
						5	27.83	6.45	1.24	0.070														
						6	27.49	6.43	0.57	0.065														
						7	27.26	6.42	0.22	0.072														
						8	26.99	6.42	0.08	0.073														
						9	26.67	6.45	0.06	0.073														
						9.7	26.52	6.46	0.06	0.066														
Gantt	1	A	42899	1.41	2.42	----	----	----	----	----	12.1	22.0	24.5	65.0	3.0	<0.015	<0.003	<0.150	0.20	0.005	6.14	4.5	45	8
						0.3	28.7	7.45	8.26	0.068														
						1	24.95	7.4	7.95	0.0675														
						1.5	24.24	7.36	7.77	0.0675														
						2	23.95	7.29	7.55	0.0671														
						3	22.25	7.11	5.91	0.0665														
						4	21.56	7.05	5.79	0.0665														
						5	21.06	6.99	5.63	0.0656														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						6	20.8	6.96	5.42	0.0659														
						7	20.42	6.94	5.4	0.0676														
						8	20.12	6.93	5.32	0.0698														
						8.3	19.98	6.92	5.16	0.0716														
Gantt	2	A	42899	1.03	1.32	----	----	----	----	----	20.8	20.0	23.1	67.0	10.0	<0.015	<0.003	<0.150	0.13	0.005	7.63	3.2	42	2
						0.3	28.41	7.25	7.74	0.0624														
						1	24.05	7.16	7.09	0.0617														
						1.5	24.08	7.12	6.92	0.0613														
						2	23.92	7.09	6.89	0.062														
						3	23.61	7.02	6.21	0.062														
						4	22.07	6.89	4.54	0.0614														
Gantt	2	B	42899	0.98	1.54	----	----	----	----	----	21.4	21.0	22.8	72.0	8.0	<0.015	<0.003	0.250	0.12	0.002	6.73	3.2	42	2
						0.3	28.48	7.3	7.71	0.0625														
						1	24.02	7.13	6.78	0.0619														
						1.5	23.96	7.08	6.73	0.062														
						2	23.92	7.07	6.73	0.0615														
						3	23.54	6.99	5.99	0.062														
						4	22.23	6.89	4.98	0.0609														
Gantt	1	A	52599	1.2	1.80	----	----	----	----	----	16.5	13.0	16.1	63.0	10.0	<0.015	0.050	0.350	0.30	<0.004	8.37	5.9	48	1
						0.3	28.23	6.96	7.6	0.0415														
						1	26.39	6.83	6.64	0.042														
						1.5	26.23	6.79	6.68	0.0423														
						2	26.12	6.74	6.39	0.0419														
						3	25.55	6.59	4.8	0.0418														
						4	24.14	6.5	3.2	0.0467														
						5	23.21	6.42	2.18	0.0461														
						6	22.72	6.38	1.75	0.0455														
						7	22.34	6.33	1.49	0.0439														
						8	21.97	6.31	1.35	0.0433														
						9	21.71	6.3	1.1	0.0441														
						9.8	21.59	6.3	1.02	0.0453														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
Gantt	2	A	52599	1.09	2.00	----	----	----	----	----	15.5	18.0	22.0	71.0	10.0	<0.015	0.090	0.150	0.02	0.003	7.19	4.8	46	<1
						0.3	30.46	7.12	7.83	0.0525														
						1	26.75	7.04	7.34	0.0521														
						1.5	26.5	6.98	7.03	0.0521														
						2	26.41	6.96	6.97	0.0539														
						3	24.97	6.77	3.96	0.0577														
						4	23.57	6.61	2.01	0.0597														
						5	23.05	6.54	1.17	0.0626														
						6	22.51	6.5	0.47	0.0628														
Gantt	1	A	62299	1.51	3.08	----	----	----	----	----	6.96	32	25.6	79	5	<0.015	0.09	<0.150	0.01	0.003	4.99	6.94	50	2*
						0.2	32.03	7.82	7.96	0.0762														
						1	31.34	7.86	7.97	0.0759														
						1.5	29.26	7.8	7.56	0.0753														
						2	28.98	7.73	7.31	0.0753														
						3	28.79	7.59	6.75	0.075														
						4	28.41	7.47	6.15	0.0746														
						5	27.72	7.26	3.95	0.0741														
						6	27.36	7.1	3.01	0.0745														
						7	26.67	6.97	1.62	0.0767														
						8	25.76	6.89	0.2	0.0813														
						9	23.85	7.01	0.17	0.1012														
						9.6	23.16	7.09	0.16	0.1081														
Gantt	2	A	62299	1.17	2.00	----	----	----	----	----	13.70	37	27.2	89	1	<0.015	0.12	7.05	0.02	0.003	5.69	8.01	51	2
						0.2	30.92	7.56	7.59	0.0743														
						1	28.41	7.49	7.11	0.0742														
						1.5	27.98	7.43	6.6	0.0741														
						2	27.82	7.37	6.26	0.0748														
						3	27.4	7.3	5.85	0.0714														
						4	27.27	7.2	5.28	0.0729														
						5	27.09	7.13	4.71	0.0733														
						5.7	26.64	7.08	4.3	0.0725														
Gantt	2	B	62299	1.17	1.90	----	----	----	----	----	13.50	32	25.2	80	7	<0.015	0.12	1.31	0.01	0.002	<0.50	7.21	50	4

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						0.3	31.23	7.44	7.48	0.0745														
						1	28.02	7.36	6.72	0.0747														
						1.5	27.92	7.33	6.52	0.0743														
						2	27.78	7.29	6.15	0.0753														
						3	27.75	7.27	6.06	0.0754														
						4	27.27	7.17	5.36	0.0727														
						5	27.09	7.11	4.85	0.0734														
						5.4	27.07	7.1	4.82	0.0735														
Gantt	1	A	72799	1.13	1.65	----	----	----	----	----	17.2	16	19.8	56	9	<0.015	0.09	<0.15	0.04	<0.004	7.63	8.54	52	20
						0.3	33.84	7.17	8.1	0.0537														
						1	31.3	7.13	7.72	0.0533														
						1.5	29.46	6.95	5.95	0.0535														
						2	28.96	6.86	5.61	0.0532														
						3	28.42	6.78	5.34	0.0535														
						4	27.99	6.7	4.88	0.0529														
						5	27.76	6.63	4.55	0.052														
						6	27.18	6.52	4.09	0.0489														
						7	26.97	6.47	4.11	0.047														
						8	26.93	6.4	3.95	0.0463														
						9	26.85	6.38	3.84	0.0466														
						9.7	26.76	6.37	2.32	0.0529														
Gantt	2	A	72799	0.87	1.5	----	----	----	----	----	22.4	15	20.5	73	12	<0.015	0.12	<0.15	0.03	<0.004	8.2	10.7	54	15
						0.3	32.3	7.17	8.09	0.0547														
						1	29.15	6.95	6.82	0.0548														
						1.5	28.24	6.8	5.24	0.0556														
						2	28.02	6.7	4.82	0.0562														
						3	26.94	6.64	4.32	0.0558														
						4	26.24	6.61	4.44	0.0554														
						5	26.15	6.56	4.32	0.0563														
						5.9	26.13	6.55	4.24	0.0562														
Gantt	1	A	82499	1.83	2.84	----	----	----	----	----	5.53	26	27.8	63	6	<0.015	<0.003	<0.15	0.01	<0.004	8.21	10.7	54	1

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						0.3	31.62	7.67	8.53	0.0683														
						1	31.21	7.61	8.18	0.0684														
						1.5	30.94	7.48	7.56	0.0681														
						2	30.76	7.3	6.56	0.0685														
						3	30.27	6.89	1.62	0.0739														
						4	30.07	6.78	0.57	0.0752														
						5	30.01	6.75	0.52	0.0757														
						6	29.79	6.73	0.47	0.0803														
						7	29.09	6.77	0.44	0.0912														
						8	28.15	6.85	0.41	0.1001														
						8.9	27	6.91	0.38	0.1049														
Gantt	2	A	82499	1.6	2.73	----	----	----	----	----	6.17	24	27.5	63	5	<0.015	<0.003	0.2	0	<0.004	8.18	11.4	54	3
						0.3	32.78	8.05	8.34	0.0692														
						1	31.79	8.05	8.34	0.0694														
						1.4	31.14	7.77	7.39	0.0689														
						2	30.65	7.48	6.46	0.069														
						3	30.17	7.13	4.12	0.0705														
						4	29.87	6.96	2.57	0.072														
						5	29.71	6.89	2.14	0.0737														
						6	29.37	6.75	0.22	0.0769														
						6.2	29.31	6.74	0.2	0.0778														
Gantt	2	B	82499	2.43	1.65	----	----	----	----	----	6.25	25	27.9	59	6	<0.015	0.02	0.19	0.01	<0.004	8.79	13.2	56	<1
						0.3	33.17	8.15	8.15	0.0694														
						1	31.53	7.89	7.92	0.0687														
						1.5	31.26	7.73	7.55	0.069														
						2	30.78	7.54	6.44	0.0688														
						3	30.27	7.24	4.41	0.0695														
						4	29.91	7.02	2.53	0.0726														
						5	29.73	6.91	2.03	0.0736														
						6	29.43	6.81	0.47	0.0771														
Gantt	1	A	92899	2.59	4.73	----	----	----	----	----	2.08	23	28.7	37	3	<0.015	0.08	<0.15	0.03	0.004	5.24	6.41	49	1

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						0.3	27.28	7.88	9	0.0652														
						1	26.92	7.88	8.86	0.0648														
						1.5	26.56	7.79	8.6	0.0646														
						2	26.05	7.69	8.25	0.0648														
						3	25.11	7.45	6.83	0.0652														
						4	24.67	7.19	5.8	0.0662														
						5	24.44	7.12	5.49	0.0682														
						6	24.18	7.1	5.75	0.0716														
						7	24.12	7.1	5.84	0.073														
						8	24.07	7.1	5.87	0.0735														
						9	24.07	7.09	5.74	0.0742														
						9.3	24.07	7.08	5.64	0.0745														
Gantt	2	A	92899	2.07	2.2	----	----	----	----	----	2.7	35	36.4	35	2	<0.015	0.08	0.28	0.11	<0.004	4.47	7.48	50	<1
						0.3	26.17	8.03	9.63	0.0755														
						1	25.73	8	9.34	0.0777														
						1.5	25.48	7.91	8.97	0.0781														
						2	25.19	7.84	8.73	0.0769														
						3	24.63	7.72	8.22	0.074														
						4	24.21	7.47	6.75	0.0761														
						5	24.05	7.42	6.93	0.0753														
						6.1	23.87	7.31	6.12	0.0771														
Gantt	1	A	102699	2.79	5.34	----	----	----	----	----	2.17	40	31.3	47	5	<0.015	0.02	0.7	0.01	0.003	3.92	3.5	43	2
						0.3	21.27	7.61	8.6	0.0906														
						1	21	7.57	8.43	0.0904														
						1.5	20.95	7.53	8.29	0.0902														
						2	20.7	7.52	8.23	0.0899														
						3	20.49	7.46	7.98	0.0903														
						4	20.42	7.41	7.8	0.0905														
						5	20.4	7.39	7.68	0.0906														
						6	20.36	7.39	7.64	0.0904														
						7	20.35	7.36	7.58	0.0907														
						8	20.31	7.36	7.52	0.0907														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						9	20.29	7.35	7.51	0.0909														
						9.4	20.29	7.33	7.4	0.0906														
Gantt	2	A	102699	1.96	3.72	----	----	----	----	----	3.87	27	25.3	39	4	<0.015	0.14	0.69	0.03	0.005	4.22	2.9	41	<1
						0.3	19.96	7.68	8.09	0.0879														
						1	19.15	7.62	7.91	0.0879														
						1.5	19.08	7.59	7.87	0.088														
						2	19.03	7.57	7.97	0.0878														
						3	18.84	7.53	7.9	0.0872														
						4	18.49	7.51	7.89	0.0869														
						5	18.47	7.48	7.87	0.0868														
						5.6	18.49	7.45	7.82	0.0868														
Gantt	2	B	102699	1.9	3.84	----	----	----	----	----	3.87	25	21.3	43	5	<0.015	0.14	0.48	0.03	0.007	4.32	2.9	41	<1
						0.3	20.42	7.66	7.88	0.0883														
						1	19.14	7.51	7.72	0.0884														
						1.5	19.07	7.5	7.72	0.0884														
						2	19.02	7.5	7.86	0.0878														
						3	18.91	7.49	7.99	0.087														
						4	18.45	7.44	7.76	0.0863														
						4.4	18.43	7.4	7.76	0.0866														
Gantt	1	A	82101	1.41	2.32	----	----	----	----	----	9.13	15	20.8		4	<0.015	0.21	<0.15	<0.004	0.013	6	7.48	50	5
						0.2	30.1	6.74	6.95	0.0526														
						1	29.75	6.71	6.9	0.0525														
						1	29.68	6.68	6.9	0.0526														
						1.5	29.14	6.67	6.77	0.0529														
						2	28.57	6.61	6.42	0.053														
						3	28.4	6.52	5.79	0.0526														
						4	28.22	6.37	4.97	0.0523														
						5	27.79	6.25	3.88	0.0518														
						6	27.46	6.14	2.97	0.0515														
						7	27.15	6.1	2.56	0.0517														
						8	26.95	6.06	2.12	0.0523														
						9.1	26.76	6.23	0.65	0.0545														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
Gantt	2	A	82101	0.82	2.15	----	----	----	----	----	13.4	13	20.1		5	<0.015	0.13	0.25	<0.004	<0.004	6.12	9.61	53	7
						0.2	29.85	6.71	6.55	0.0531														
						1	28.52	6.6	6.25	0.0531														
						1.5	28.2	6.51	5.85	0.0529														
						2	28.01	6.48	5.81	0.0531														
						3	27.94	6.4	5.53	0.0531														
						4	27.65	6.28	4.16	0.0548														
						5	27.23	6.21	3.51	0.0596														
						6	27.06	6.12	1.51	0.0596														
						6.4	27.03	6.11	0.52	0.0683														
Point A	1	A	4/29/93	0.76	1.97	---	----	---	---	-----	20.0	22.0	55.0	58.0	2.0	<0.015	0.260	0.569	0.032	<0.004	5.57	2.8	41	33
						0.3	20.9	6.8	8.2	0.057														
						1.0	20.8	6.8	8.1	0.057														
						1.5	20.6	6.9	8.0	0.057														
						2.0	20.6	6.8	7.9	0.057														
						3.0	20.3	6.9	7.9	0.059														
						5.0	19.3	6.9	7.9	0.067														
						7.0	19.2	6.9	7.8	0.068														
Point A	1	A	51095	0.76	1.53	---	---	---	---	---	23.0	20	23.0	76.0	4.0	<0.015	0.230	0.364	0.80	0.011	5.83	3.2	42	49
						0.1	23.28	6.32	7.07	0.056														
						0.5	23.28	6.40	7.06	0.056														
						1	23.27	6.52	7.07	0.056														
						1.5	23.24	6.66	7.10	0.056														
						2	23.21	6.67	7.12	0.056														
						3	22.87	6.67	6.44	0.058														
						4	22.24	6.57	5.50	0.063														
						5	21.47	6.53	4.81	0.063														
						6	20.96	6.49	4.24	0.065														
						6.2	20.84	6.49	3.88	0.066														
Point A	1	A	83095	1.6	3.52	---	---	---	---	---	3.2	27	28.9	84.0	3.0	<0.015	0.070	<0.150	0.054	0.007	5.26	8.5	52	3
						0.1	30.96	6.75	7.38	0.070														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						1	30.47	6.98	7.39	0.070														
						1.5	30.43	7.02	7.26	0.071														
						2	30.39	7.05	7.24	0.071														
						3	29.18	6.65	4.41	0.069														
						4	28.22	6.52	3.63	0.071														
						5	27.87	6.44	3.14	0.070														
						6	27.62	6.41	3.69	0.069														
						7	27.37	6.35	2.14	0.072														
						7.2	27.35	6.34	2.05	0.072														
Point A	1	A	82097	1.54	2.70	----	----	----	----	----	8.8	28	25.8	57.0	<1.0	<0.015	0.120	0.480	0.04	<0.004	5.82	5.1	47	3
						0.3	30.96	7.32	7.26	0.065														
						1	30.41	7.22	6.78	0.065														
						1.5	30.27	7.14	6.72	0.065														
						2	29.89	6.76	4.63	0.066														
						3	29.07	6.61	3.65	0.067														
						4	28.17	6.54	2.43	0.070														
						5	27.53	6.48	1.73	0.073														
						6	27.06	6.45	0.76	0.073														
						6.5	27.02	6.45	0.64	0.073														
Point A	1	A	42899	0.94	1.87	----	----	----	----	----	12.4	29.0	28.1	66.0	10.0	<0.015	<0.003	0.270	0.02	0.004	5.23	9.4	52	8
						0.2	24.65	7.34	7.48	0.076														
						1	23.78	7.27	7.53	0.0748														
						1.5	23.6	7.23	7.38	0.0738														
						2	23.49	7.2	7.3	0.0723														
						3	23.11	7.11	6.49	0.0743														
						4	22.35	7.03	5.72	0.0738														
						5	21.52	6.99	5.67	0.0723														
						6	21.19	6.96	5.44	0.0726														
						7	20.28	6.9	3.92	0.0747														
						8	20.12	6.86	3.64	0.076														
Point A	2	A	42899	1.02	1.83	----	----	----	----	----	14.3	27.0	33.1	72.0	8.0	<0.015	<0.003	0.180	0.03	0.007	5.12	2.1	38	16

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						0.2	24.66	7.3	7.34	0.0858														
						1	22.92	7.23	6.94	0.0853														
						1.5	22.6	7.22	6.91	0.0847														
						2	22.47	7.19	6.8	0.0841														
						3.1	22.28	7.16	6.66	0.0805														
Point A	1	A	52599	0.88	2.35	----	----	----	----	----	15.5	19.0	23.0	73.0	8.0	<0.015	0.110	0.770	0.02	0.005	6.29	3.5	43	1
						0.2	28.86	7.41	7.58	0.0512														
						1	26.39	7.17	6.78	0.0526														
						1.5	26.03	7.11	6.78	0.055														
						2	25.55	7.08	6.64	0.0624														
						3	24.47	7.02	6.26	0.0672														
						4	24.21	6.92	4.85	0.0588														
						5	23.79	6.76	3.56	0.053														
						6	22.98	6.6	1.93	0.0537														
						6.5	22.77	6.56	1.63	0.0556														
Point A	2	A	52599	0.77	2.31	----	----	----	----	----	14.4	25.0	31.3	71.0	13.0	<0.015	0.180	0.530	0.02	0.004	4.69	1.3	33	10
						0.2	27.65	7.32	7.1	0.0722														
						0.9	23.87	7.22	6.95	0.0709														
						1.5	23.72	7.17	6.84	0.0707														
						2	23.68	7.13	6.82	0.0707														
						3	23.63	7.09	6.6	0.0704														
						4	23.56	7.04	6.13	0.0713														
						4.3	23.57	7.02	6.04	0.0715														
Point A	1	A	62299	1.00	1.90	----	----	----	----	----	13.60	30	23.9	98	5	<0.015	0.11	<0.150	0.02	0.003	6.14	6.14	48	5
						0.2	28.35	7.48	7.37	0.0666														
						1	27.51	7.32	6.89	0.0671														
						1.5	27.17	7.28	6.68	0.0667														
						2	27.11	7.25	6.59	0.0675														
						3	26.35	7.16	5.96	0.0671														
						4	25.86	7.13	5.96	0.0687														
						5	25.45	7.07	5.57	0.0684														
						6	25.25	7	5.05	0.0678														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						6.8	25.2	6.95	4.74	0.0665														
Point A	2	A	62299	0.94	1.64	----	----	----	----	----	14.60	34	25.7	84	5	<0.015	0.15	2.81	0	0.005	5.95	3.47	43	5
						0.2	29.97	7.32	6.48	0.0734														
						1	25.44	7.24	6.52	0.0743														
						1.5	25.22	7.23	6.44	0.0743														
						2	25.13	7.22	6.29	0.0739														
						3	24.95	7.18	6.11	0.0736														
						4	24.71	7.13	5.68	0.073														
Point A	1	A	72799	0.7	1.49	----	----	----	----	----	24	20	20.1	73	11	<0.015	0.12	<0.15	0.03	<0.004	7.79	9.88	53	14
						0.2	32.22	7.02	7.85	0.054														
						1	30.47	6.91	7.62	0.0543														
						1.5	30.43	6.88	7.56	0.0543														
						2	29.63	6.86	6.87	0.0544														
						3	28.15	6.69	5.8	0.055														
						4	27.32	6.68	5.86	0.0547														
						5	26.66	6.64	5.46	0.0562														
						6	26.6	6.62	4.82	0.0603														
						6.3	26.58	6.61	4.76	0.0604														
Point A	2	A	72799	0.44	1.33	----	----	----	----	----	32.5	19	23.3	73	13	<0.015	0.17	0.27	0.02	0.003	7.26	0.8	28	213
						0.2	27.71	6.96	6.49	0.0608														
						1	26.24	6.83	6.42	0.0606														
						1.5	26.2	6.79	6.36	0.0608														
						2	26.18	6.77	6.34	0.0607														
						3	26.09	6.75	6.31	0.0609														
						4	26.09	6.73	6.22	0.0608														
						4.4	26.09	6.72	6.21	0.0608														
Point A	1	A	82499	1.25	2.8	----	----	----	----	----	7.03	23	25.7	66	3	<0.015	0.04	0.28	0.02	<0.004	7.68	7.2	50	2
						0.2	30.86	7.31	6.73	0.065														
						1	30.37	7.18	6.4	0.0638														
						1.5	30.13	7.1	6.04	0.063														
						2	30.15	7.05	5.73	0.0633														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						3	29.85	6.92	4.52	0.0691														
						4	29.45	6.88	4.28	0.0724														
						5	29.11	6.89	4.54	0.075														
						5.6	28.97	6.87	4.43	0.075														
Point A	2	A	82499	1.11	2.45	----	----	----	----	----	7.44	34	33.9	72	8	<0.015	0.15	0.2	0.01	0.002	6.63	4.6	46	41
						0.2	31.64	7.38	7.25	0.0842														
						1	29.51	7.28	7.1	0.0855														
						1.5	28.66	7.2	6.26	0.0834														
						2	27.67	7.1	5.52	0.075														
						3	27.32	7.04	5.17	0.0735														
						4	27.16	6.94	4.44	0.0699														
						4.5	27.13	6.92	4.32	0.0697														
Point A	1	A	92899	2.36	3.82	----	----	----	----	----	3.03	24	30.1	32	6	<0.015	0.12	0.53	0.06	0.002	4.8	6.41	49	3
						0.2	26.24	7.65	8.72	0.0709														
						1	25.83	7.64	8.6	0.0705														
						1.5	25.64	7.57	8.45	0.071														
						2	25.24	7.42	7.86	0.073														
						3	24.43	7.28	7.01	0.0732														
						4	23.94	7.2	6.36	0.0779														
						5	23.53	7.15	6.26	0.0831														
						6	23.36	7.14	6.35	0.0871														
						6.9	23.21	7.1	5.99	0.0875														
Point A	2	A	92899	1.92	2.87	----	----	----	----	----	5.12	40	37.2	38	6	<0.015	0.15	<0.15	0.04	0.006	3.76	4.27	45	2
						0.2	26.03	7.58	8.47	0.0734														
						1	25.69	7.56	8.39	0.0747														
						1.5	24.3	7.44	7.58	0.0921														
						2	23.16	7.41	7.58	0.0901														
						3	21.66	7.29	6.47	0.0935														
						4	21.45	7.23	6.16	0.0901														
						4.4	21.34	7.19	5.81	0.0891														
Point A	1	A	102699	1.61	3.46	----	----	----	----	----	4.15	24	19	39	7	<0.015	0.13	0.61	0.01	0.007	4.61	2.4	39	1
						0.3	19.36	7.77	7.95	0.0831														

Reservoirs	Sta	Rep	Date MMDDYY	Secchi m	Photic-zone m	Depth m	Temp degC	pH units	DO mg/l	SpCond mS/cm	Turb NTU	Alk mg/l	Hard mg/l	TDS mg/l	TSS mg/l	NH3-N mg/l	NO3+ NO2 mg/l	TKN mg/l	Total P mg/l	Ortho P mg/l	TOC mg/l	Chl.a ug/l	TSI	Fecal Colif. per 100ml
						1	19.07	7.66	7.88	0.0831														
						1.5	19.03	7.62	7.84	0.0832														
						2	19	7.56	7.78	0.0832														
						3	18.93	7.5	7.74	0.0834														
						4	18.88	7.43	7.63	0.0836														
						5	18.74	7.39	7.54	0.0838														
						6	18.4	7.32	6.95	0.0871														
						6.5	18.25	7.27	6.71	0.0882														
Point A	2	A	102699	1.09	2.58	----	----	----	----	----	8.06	26	20.1	48	6	<0.015	0.22	0.45	0.01	0.01	3.91	1.6	35	3
						0.5	16.62	7.68	7.83	0.0913														
						1	16.25	7.64	7.87	0.0905														
						1.5	16.2	7.61	7.8	0.0906														
						2	15.78	7.56	8.01	0.0961														
						3	15.35	7.5	8.11	0.0949														
						4	15.28	7.5	8.12	0.0948														
Point A	1	A	82101	0.82	2.14	----	----	----	----	----	11.9	19	21.8		6	<0.015	0.13	<0.15	0.04	<0.004	6.2	6.94	50	6
						0.2	29.68	6.58	6.27	0.0573														
						1	29.44	6.58	6.24	0.0573														
						1.5	29.01	6.56	6.21	0.0575														
						2	28.7	6.52	6.17	0.0574														
						3	27.03	6.41	5.41	0.0578														
						4	26.56	6.4	5.76	0.0579														
						4.9	26.32	6.4	6.02	0.0579														
						5.8	26.23	6.4	5.96	0.0581														
						6.8	26.16	6.39	6.05	0.0581														
						7	26.16	6.39	6.08	0.0581														
						8	26.12	6.43	5.76	0.059														
						8.4	26.13	6.41	5.75	0.059														

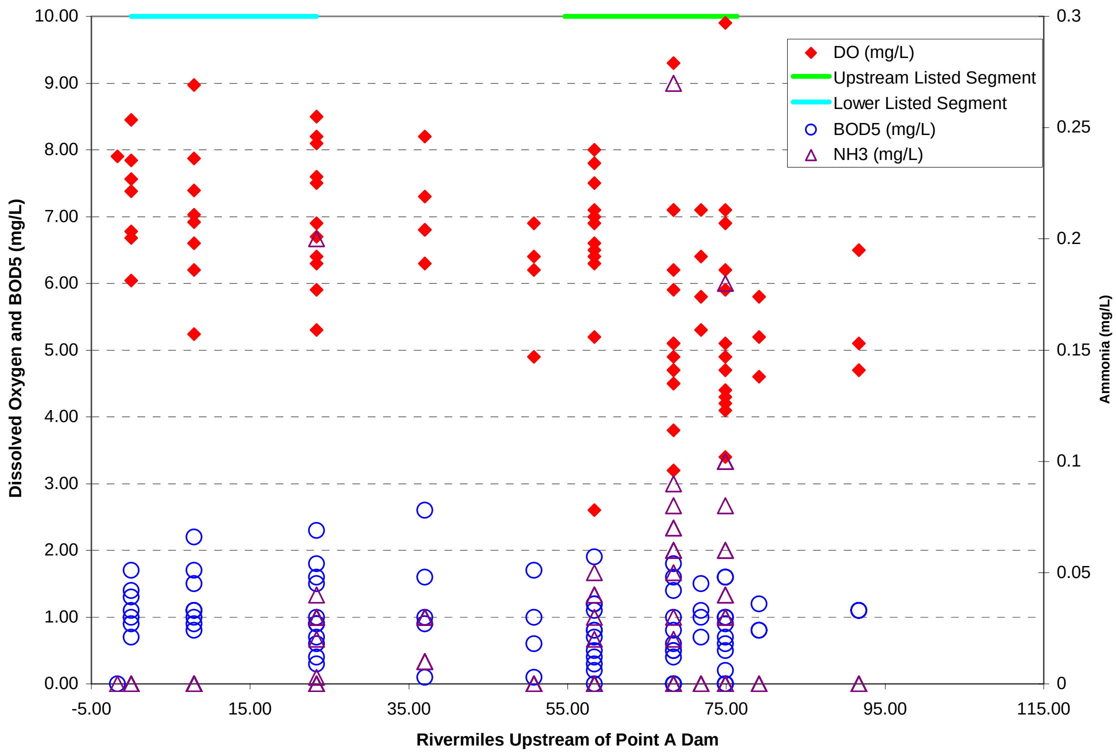

Figure A-1 DO, BOD5, and NH3 on the Conecuh River (1988-1999)

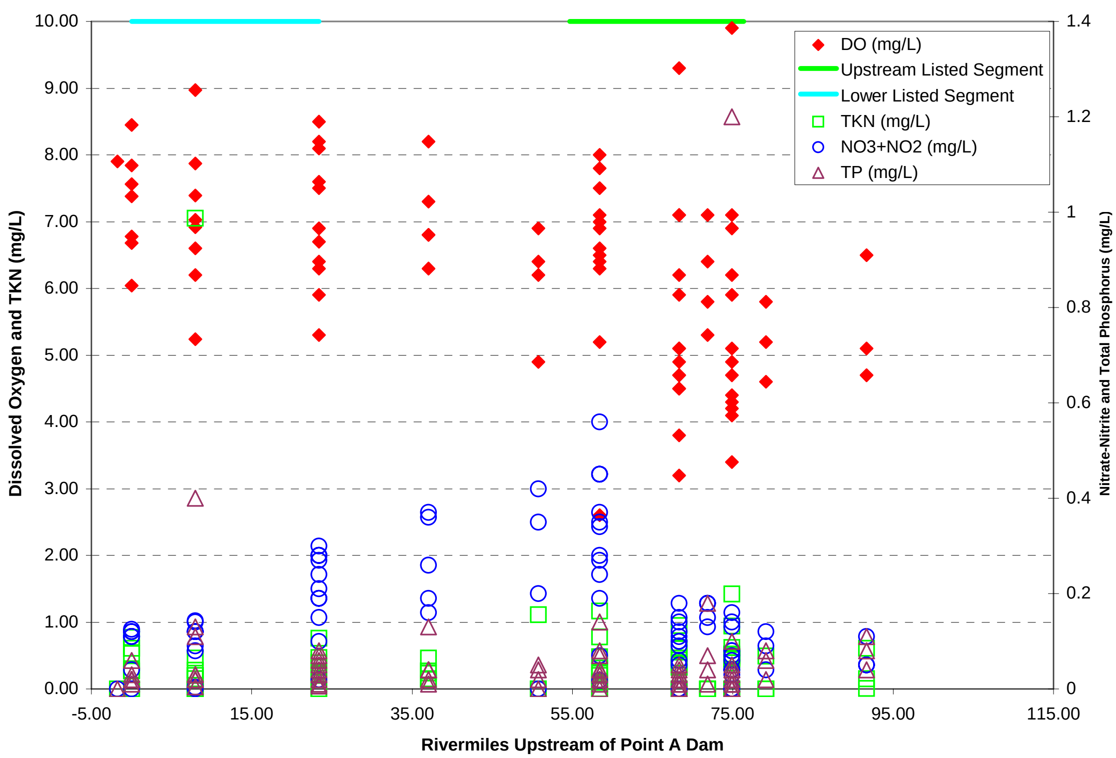

Figure A-2 DO, TKN, NO3-NO2, and TP on the Conecuh River (1988-1999)

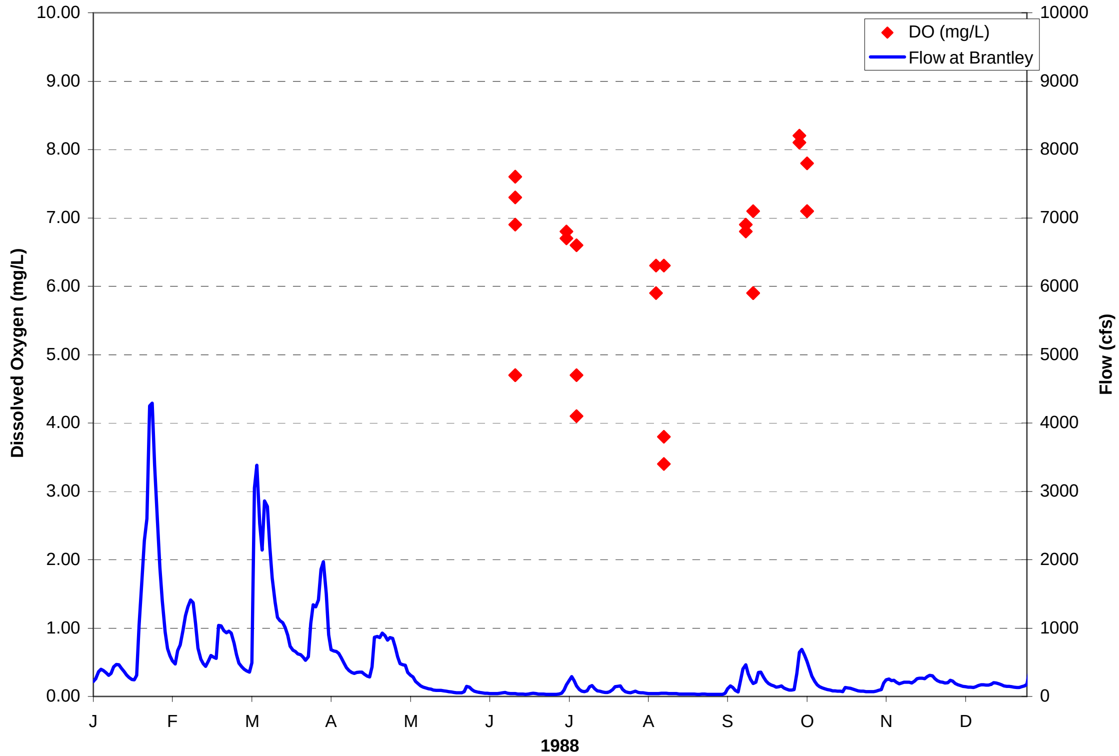

Figure A-3 DO versus USGS Daily Average Flow at Brantley, AL (1988)

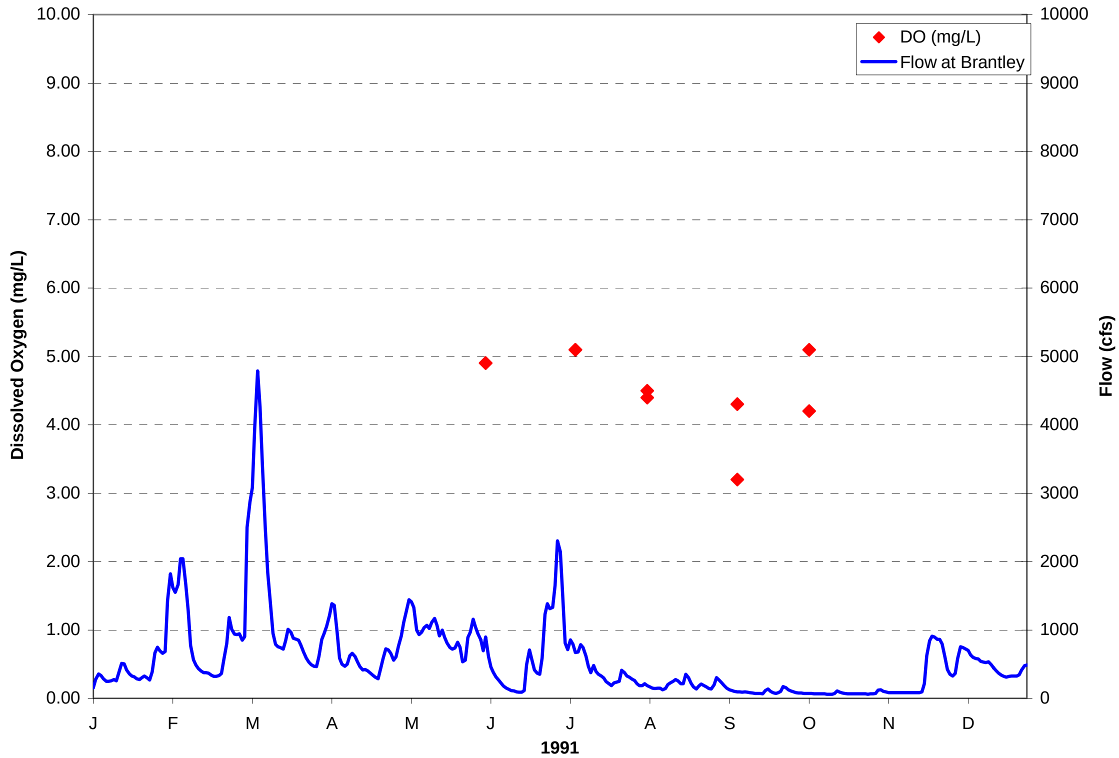

Figure A-4 DO versus USGS Daily Average Flow at Brantley, AL (1991)

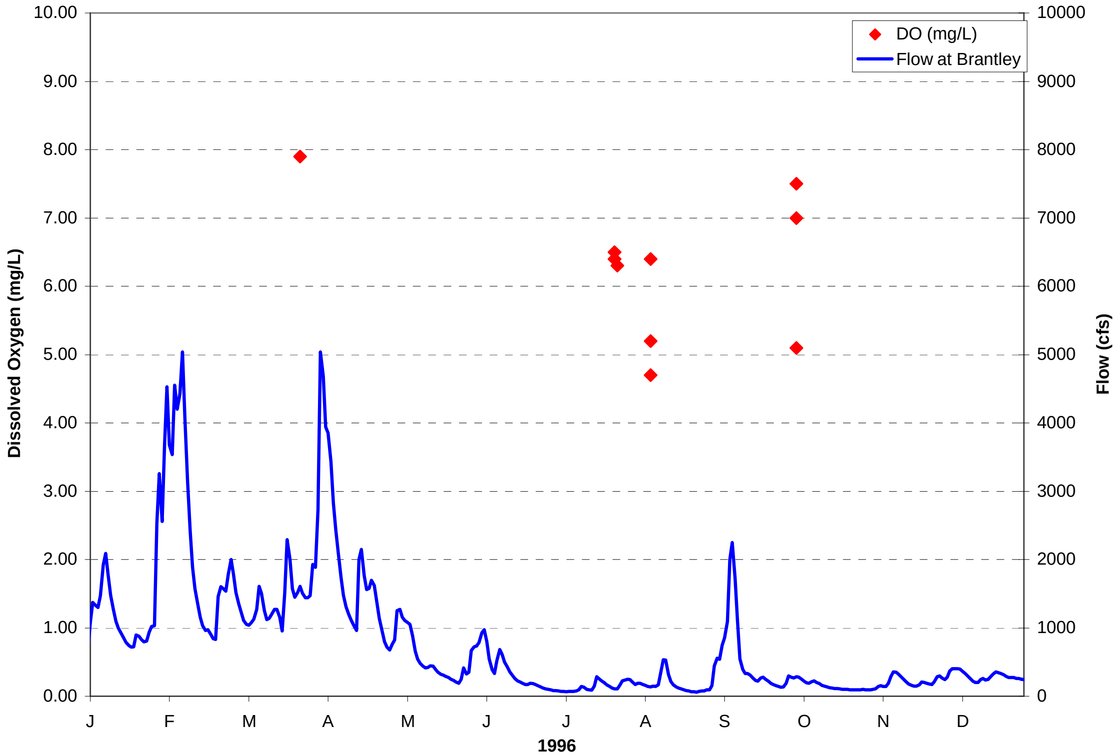

Figure A-5 DO versus USGS Daily Average Flow at Brantley, AL (1996)

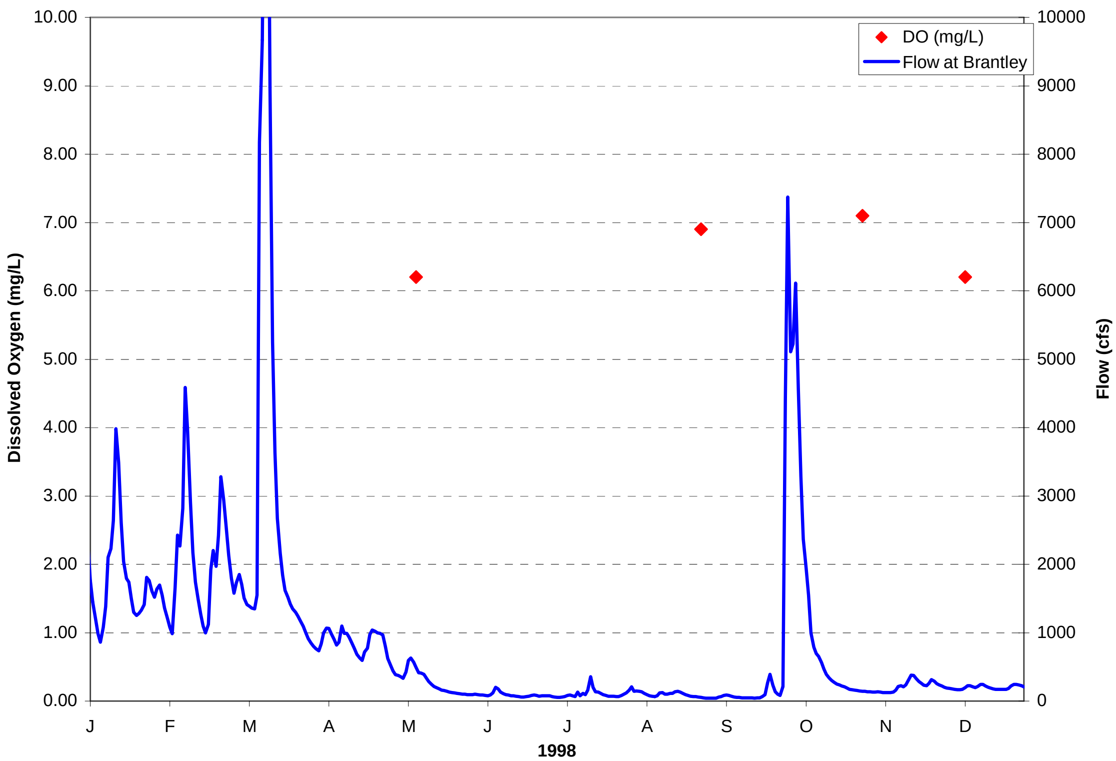

Figure A-6 DO versus USGS Daily Average Flow at Brantley, AL (1998)

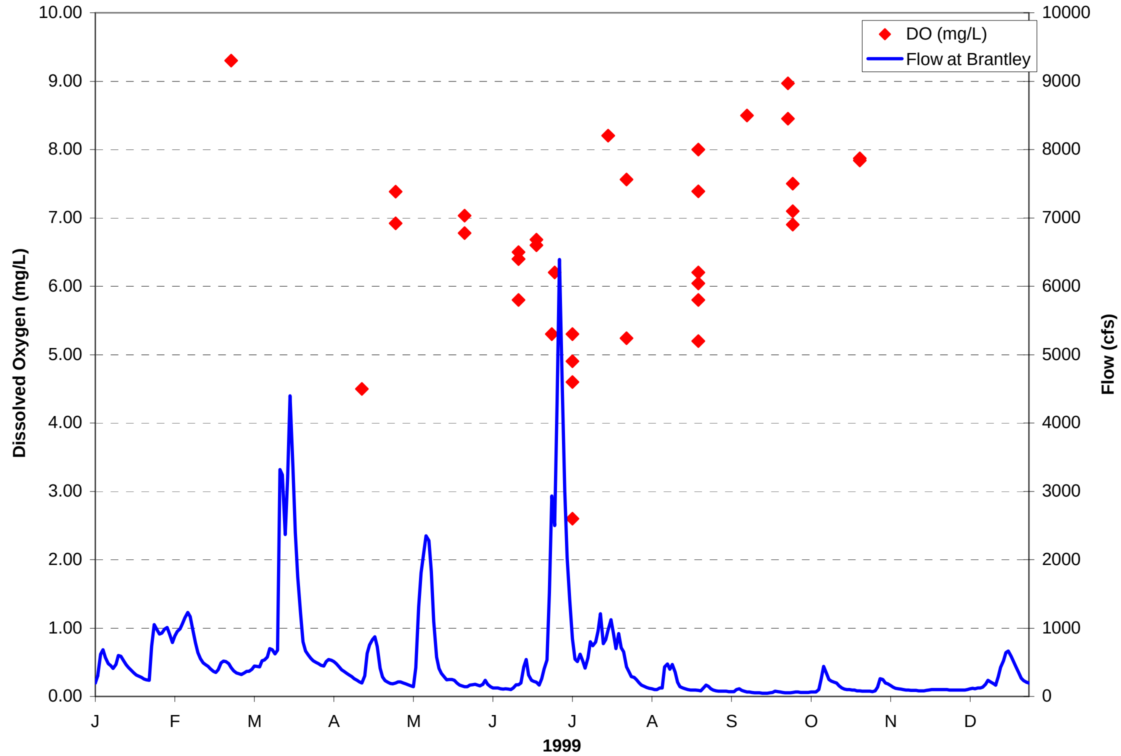

Figure A-7 DO versus USGS Daily Average Flow at Brantley, AL (1999)

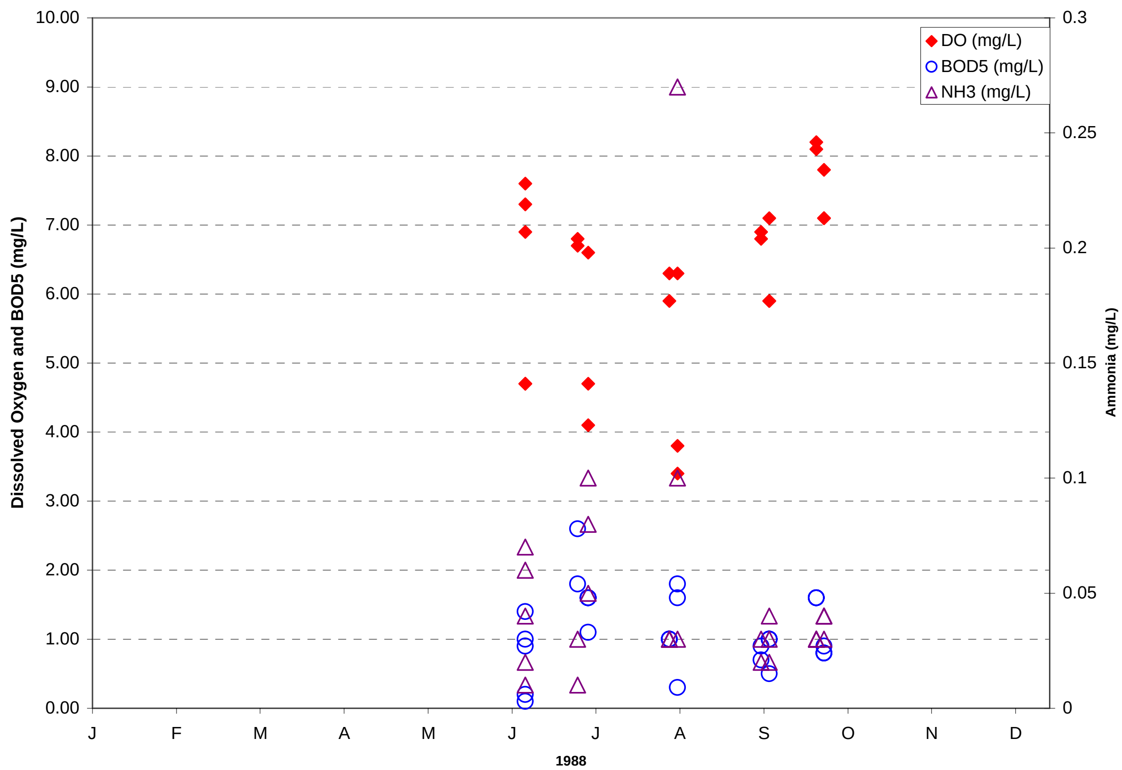

Figure A-8 DO, BOD5, and NH3 for 1988

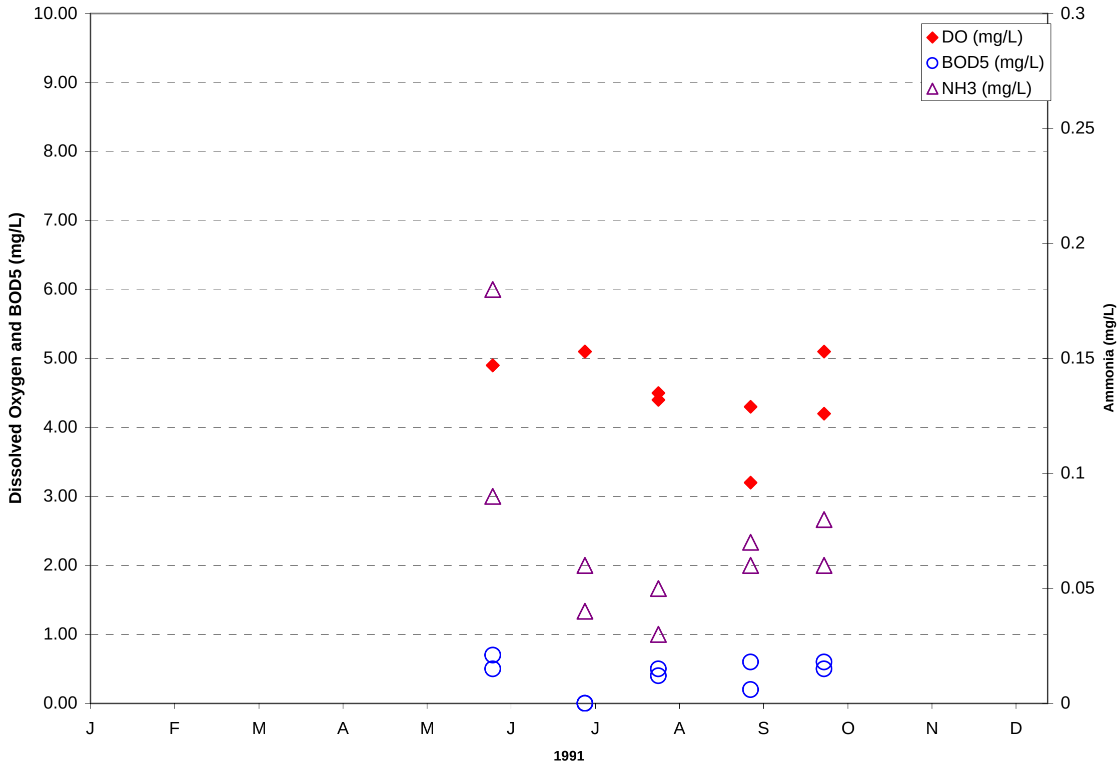

Figure A-9 DO, BOD5, and NH3 for 1991

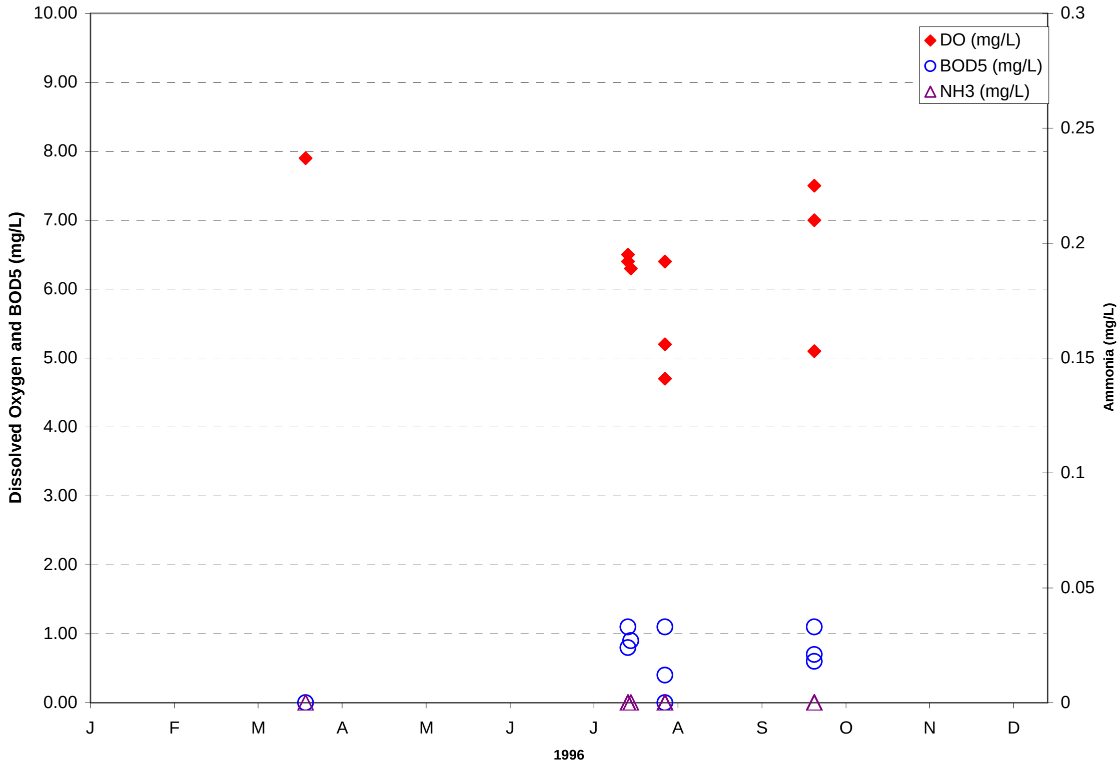

Figure A-10 DO, BOD5, and NH3 for 1996

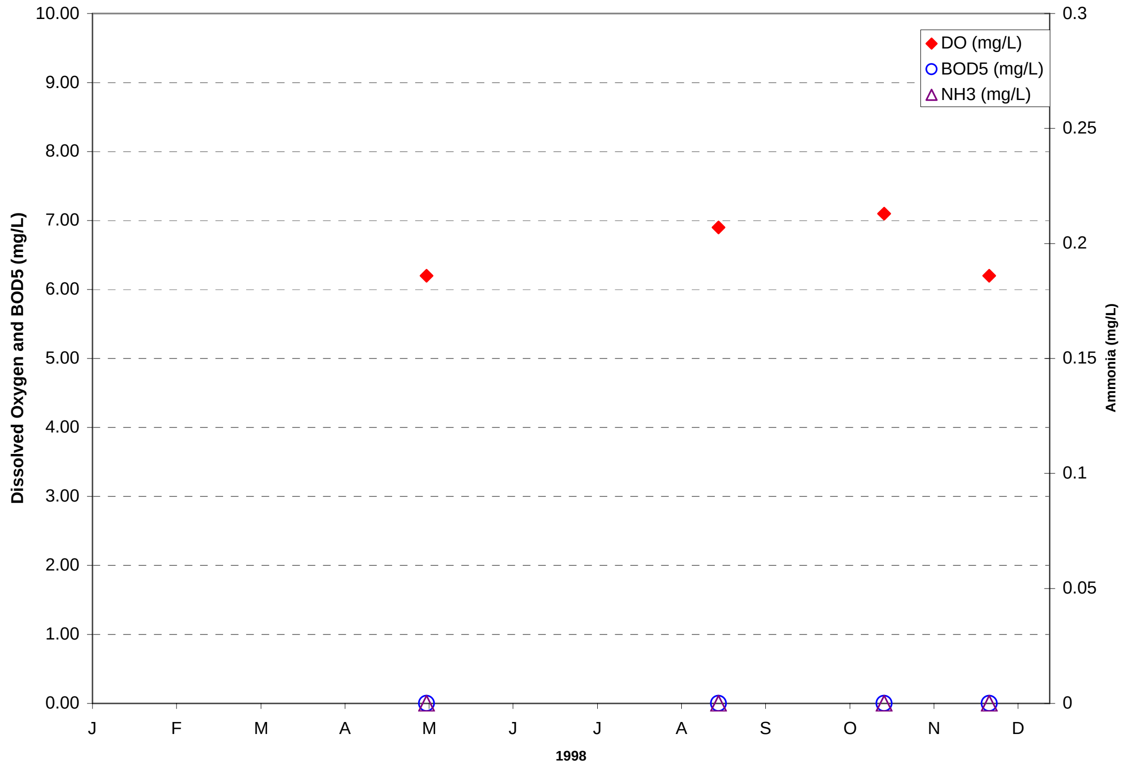

Figure A-11 DO, BOD5, and NH3 for 1998

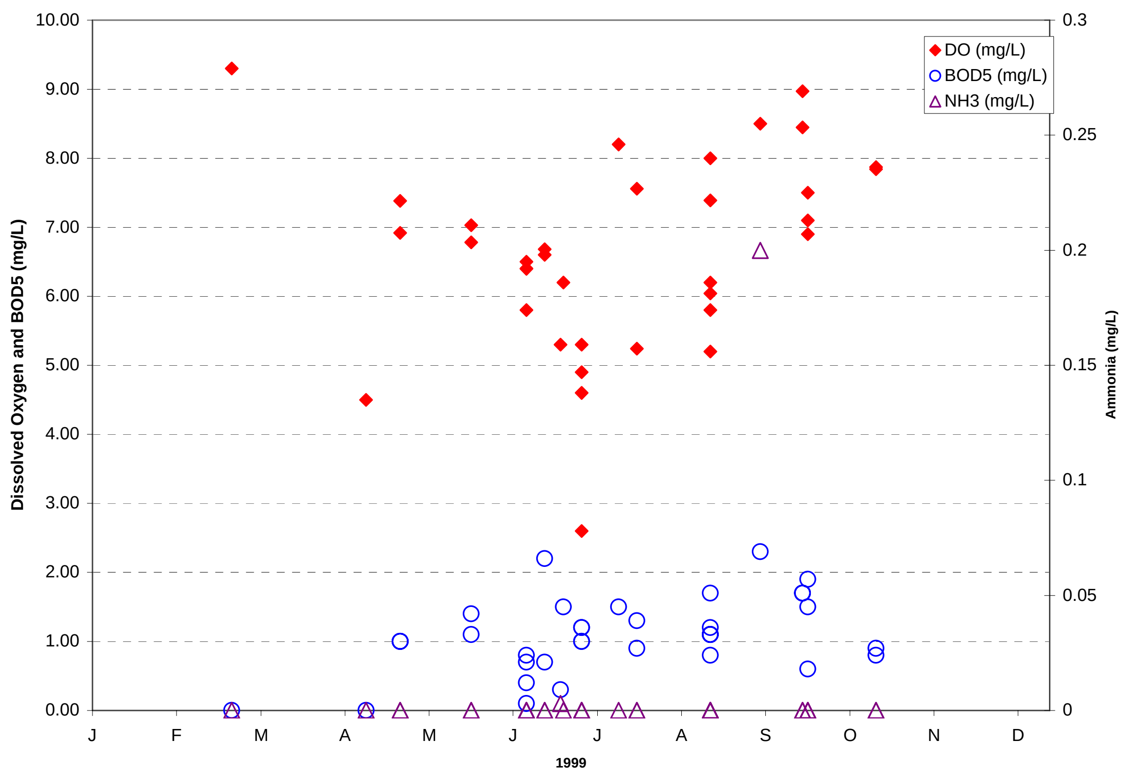

Figure A-12 DO, BOD5, and NH3 for 1999

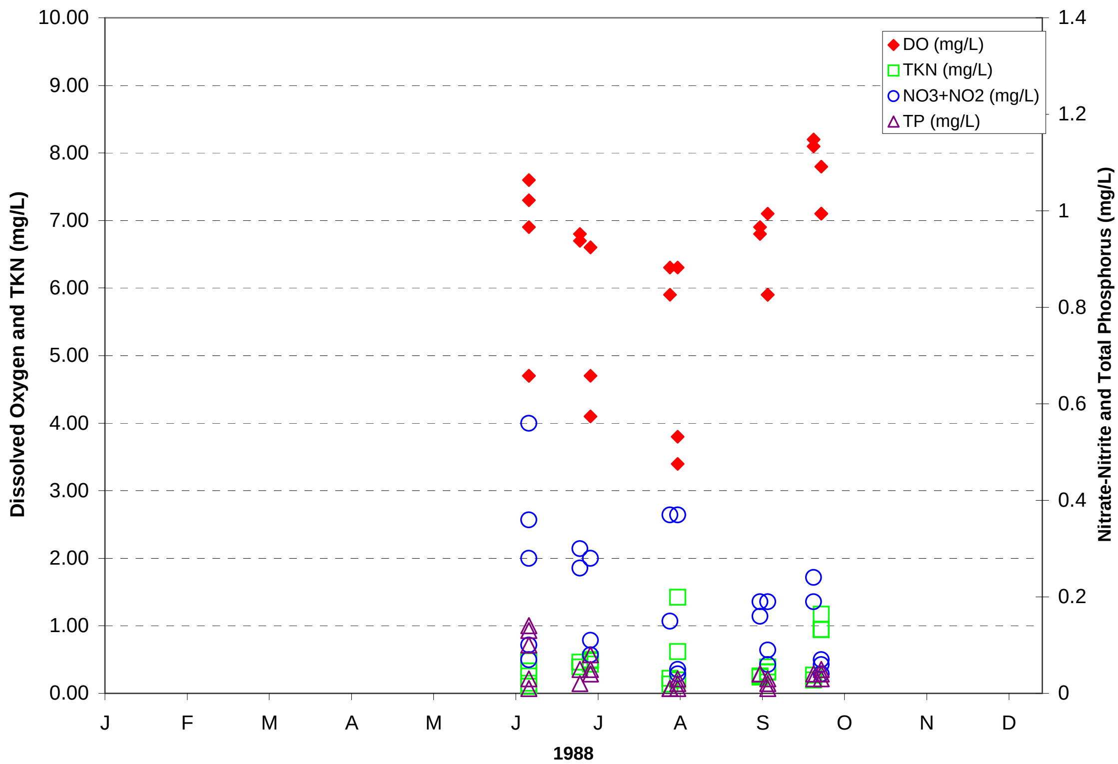

Figure A-13 DO, TKN, NO3-NO2, and TP for 1988

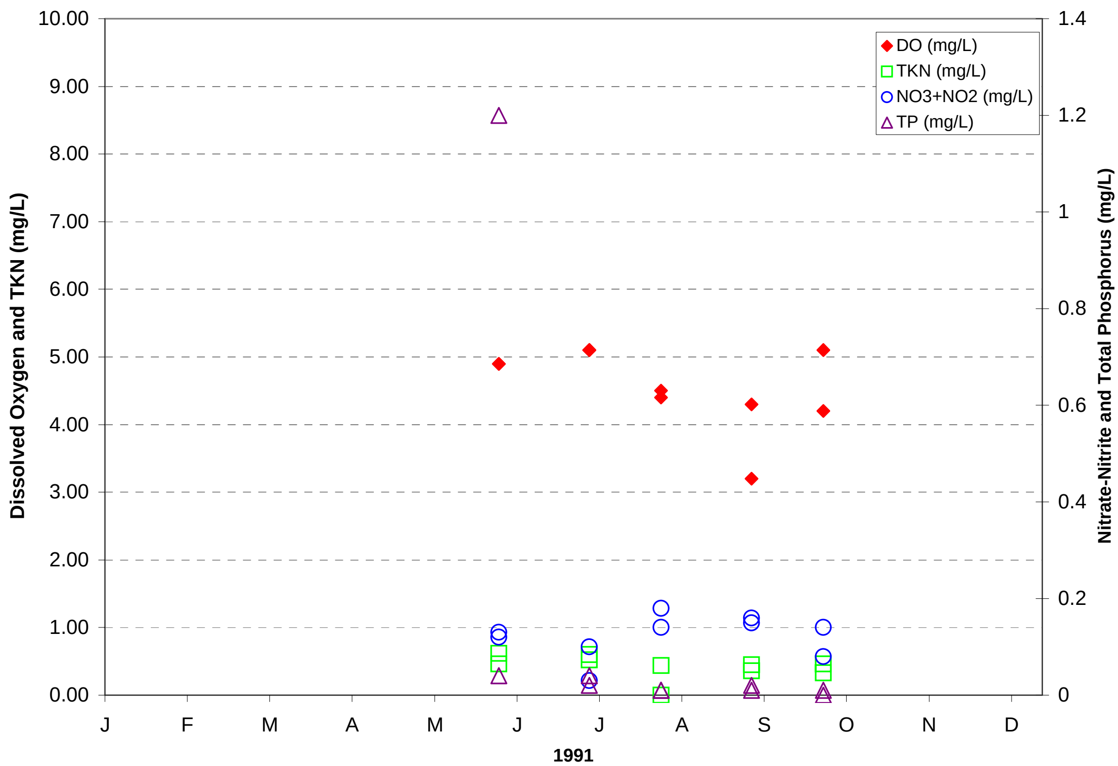

Figure A-14 DO, TKN, NO3-NO2, and TP for 1991

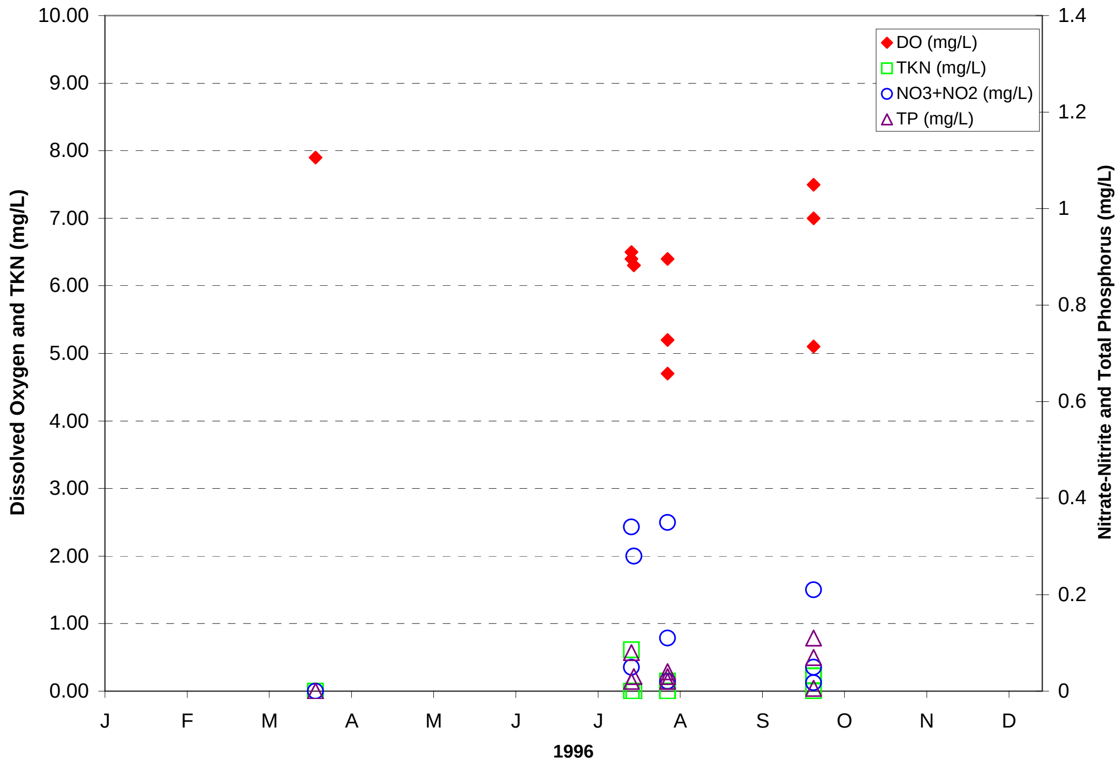

Figure A-15 DO, TKN, NO3-NO2, and TP for 1996

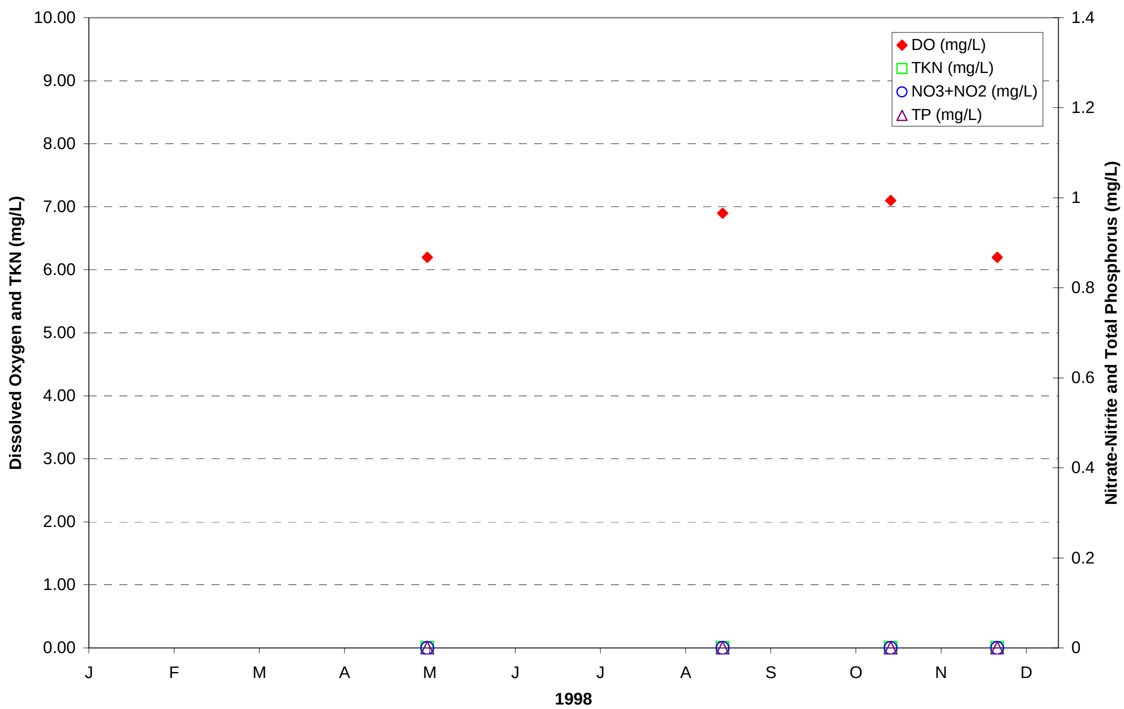

Figure A-16 DO, TKN, NO3-NO2, and TP for 1998

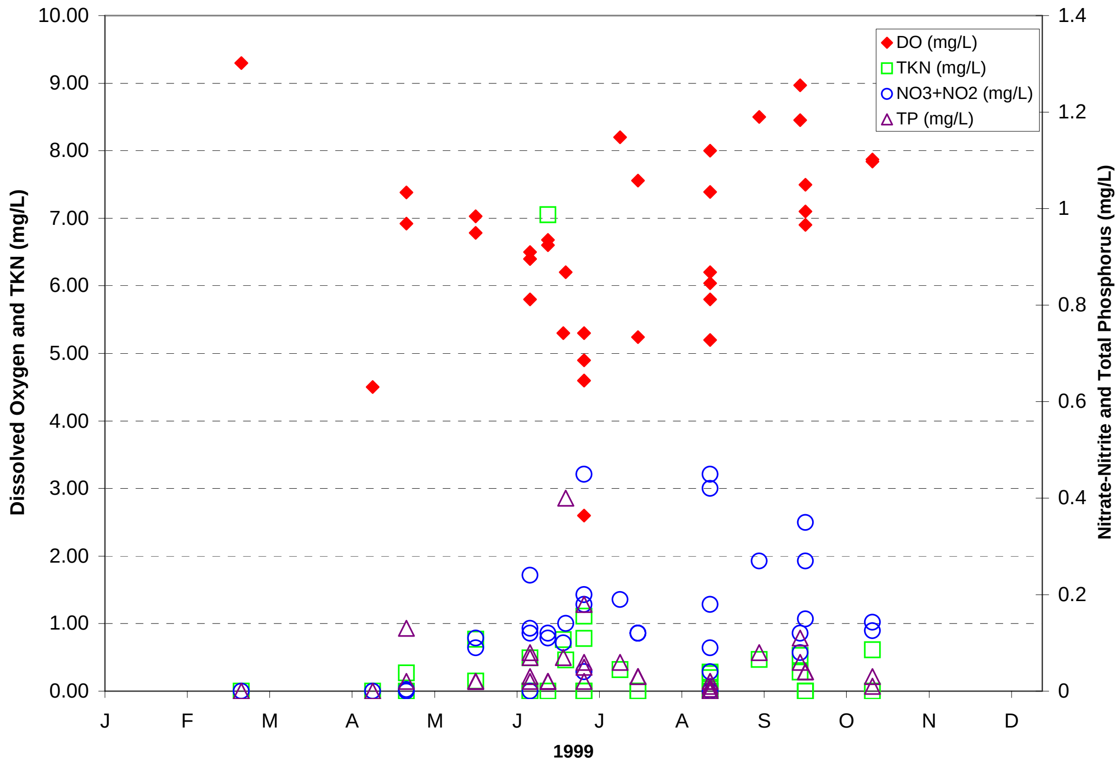

Figure A-17 DO, TKN, NO3-NO2, and TP for 1999

Appendix B Model Simulations with the SWQM

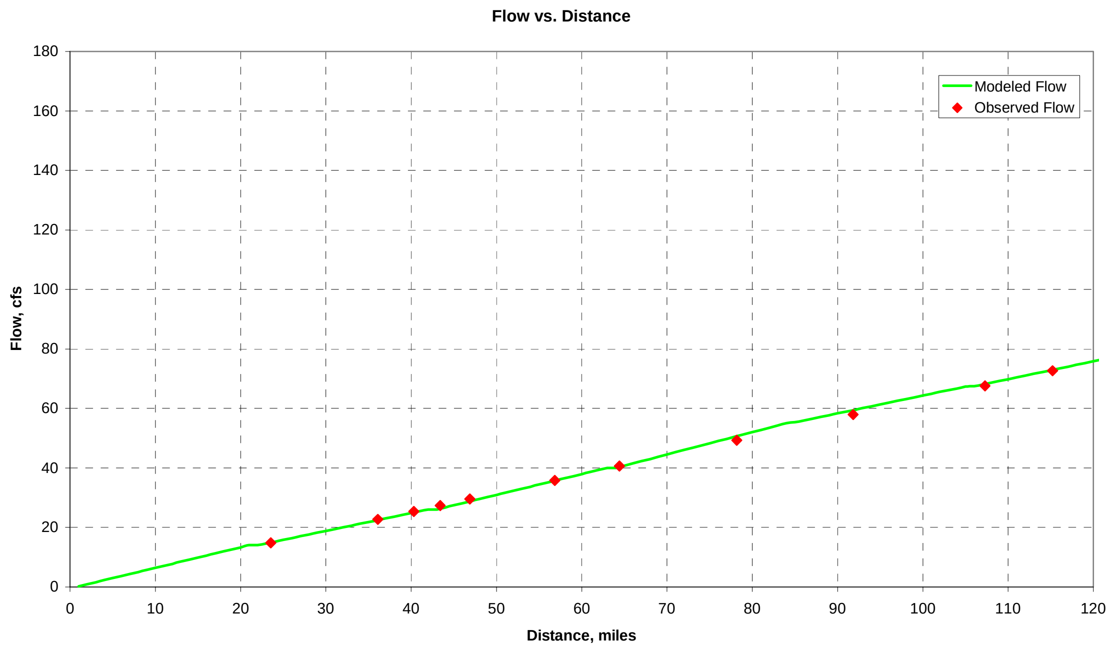

Figure B-1 Flow Calibration in the steady-state model application for Conecuh River

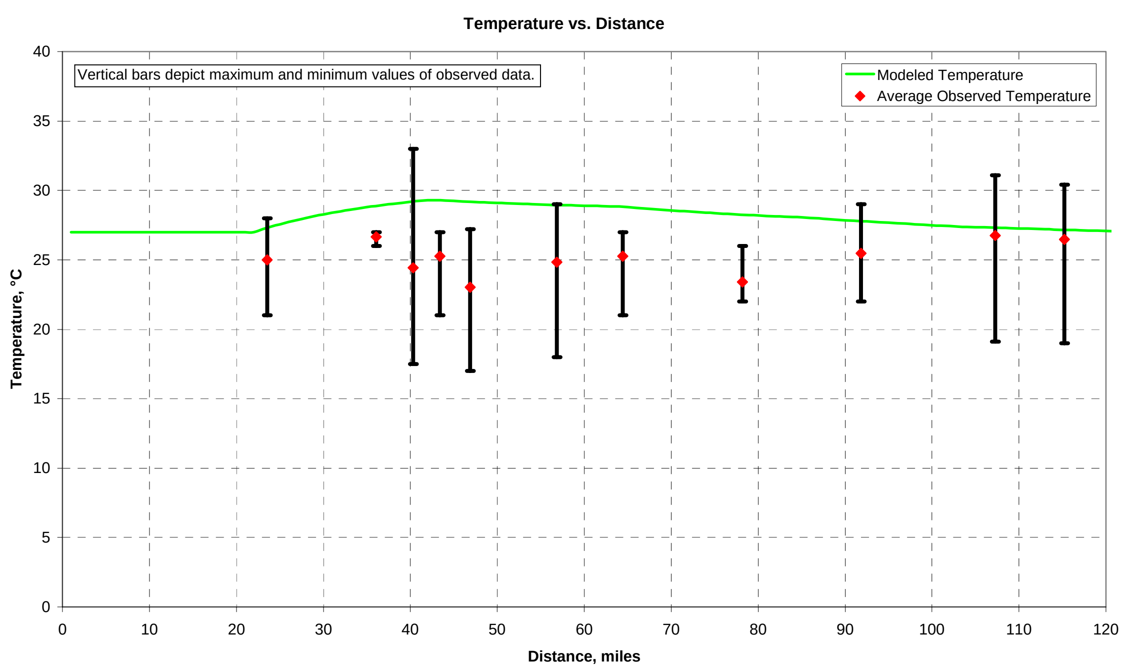

Figure B-2 Temperature Calibration in the steady-state model application for Conecuh River

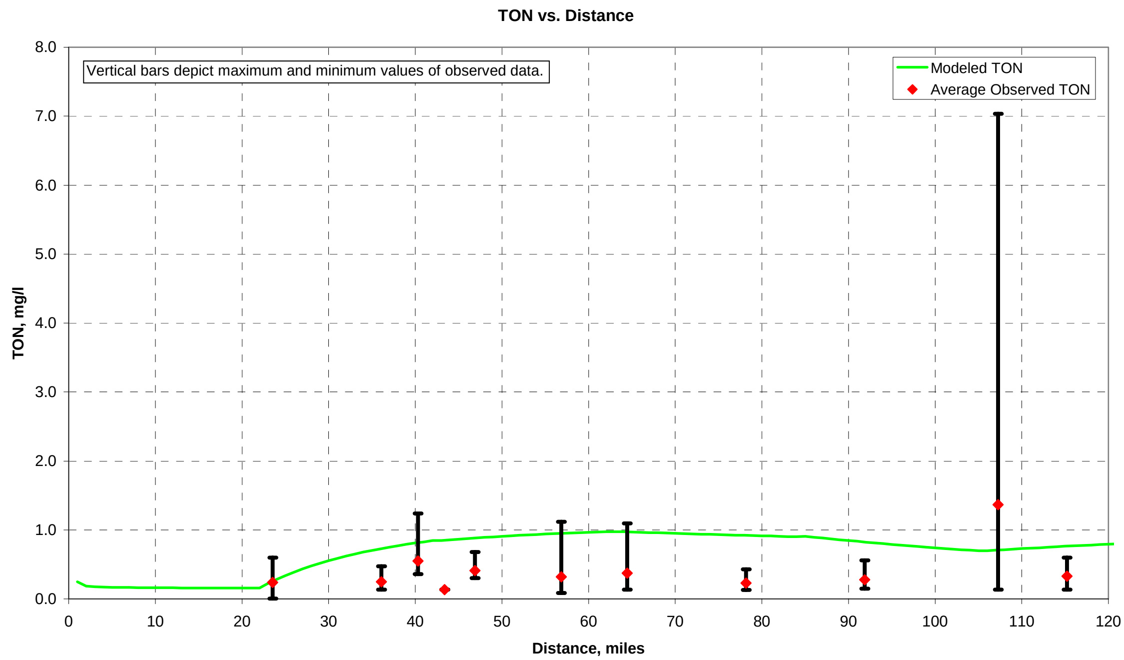

Figure B-3 TON Calibration in the steady-state model application for Conecuh River

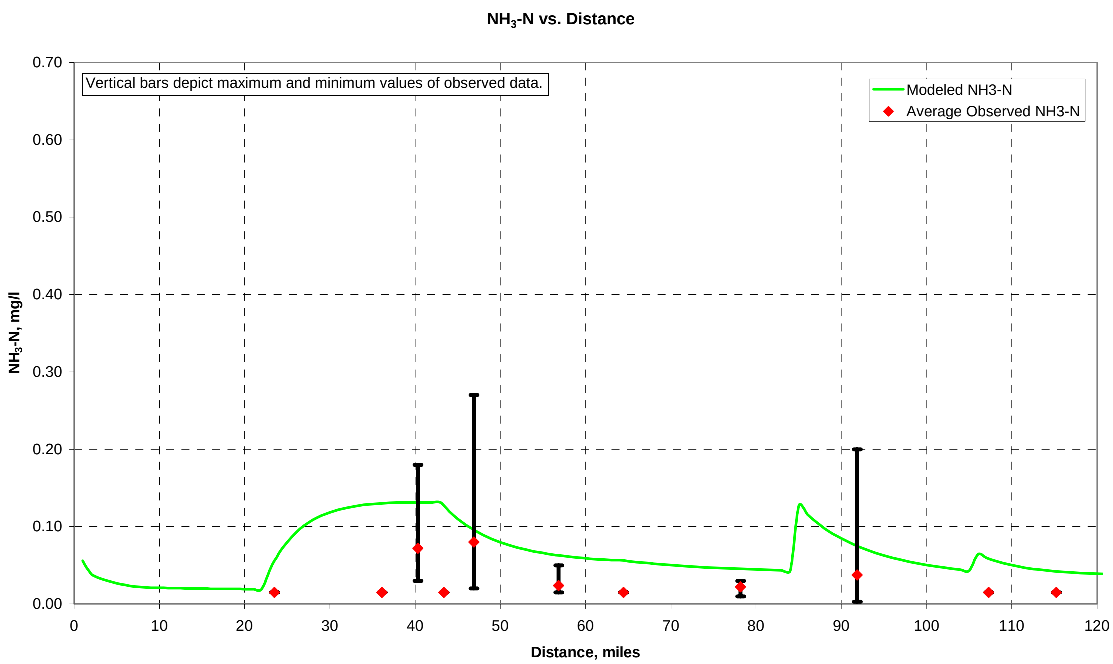

Figure B-4 NH3 Calibration in the steady-state model application for Conecuh River

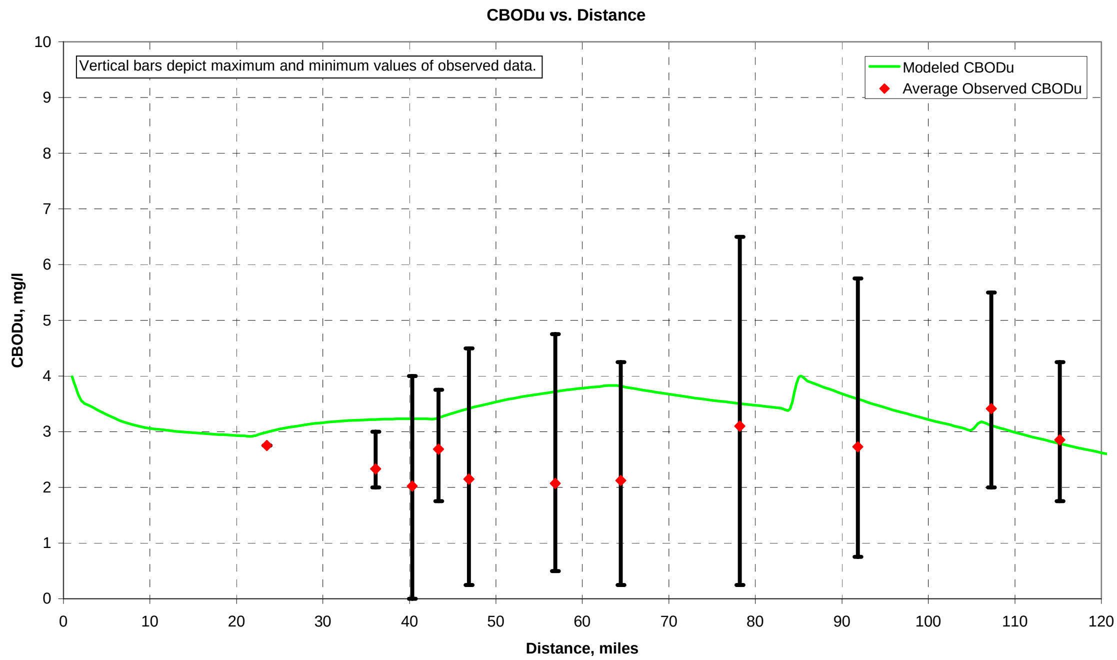

Figure B-5 CBODU Calibration in the steady-state model application for Conecuh River

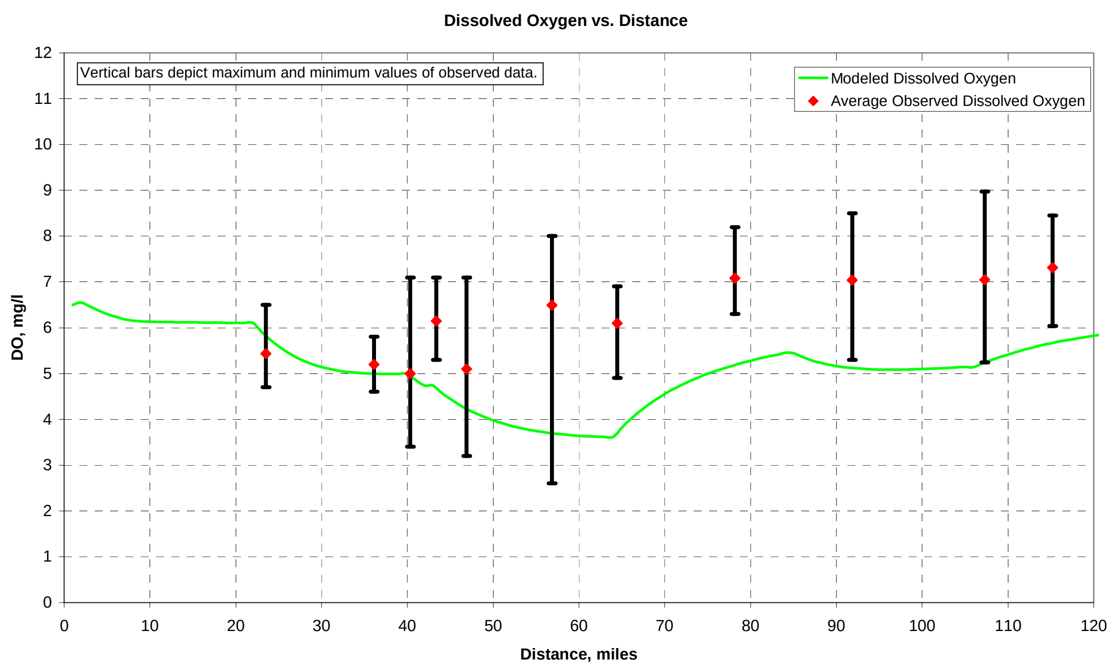

Figure B-6 DO Calibration in the steady-state model application for Conecuh River