Alabama Department of Environmental Management

Final TMDL Development for

Rock Creek AL/03160110-080_01

Low Dissolved Oxygen/Organic Loading

Water Quality Branch

Water Division

February 2002

Rock Creek Watershed in the Black Warrior Basin

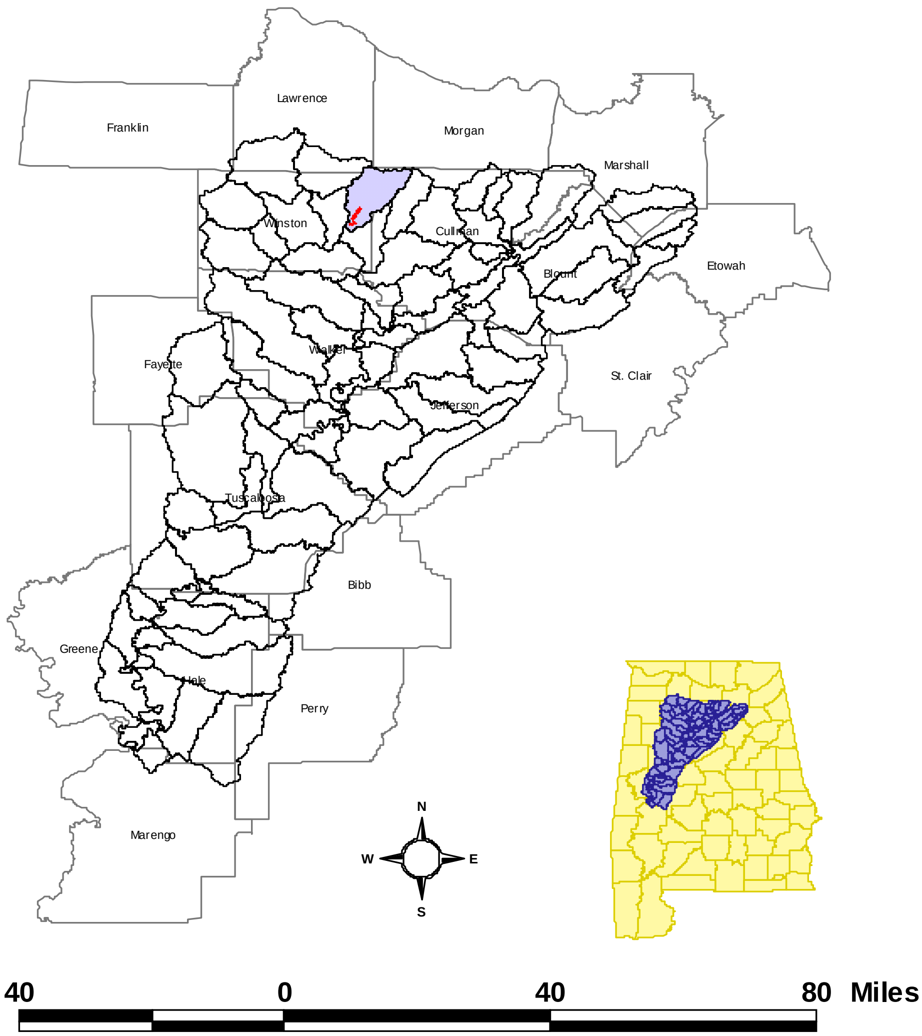


Table of Contents *Page*

1.0 Executive Summary

This report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Alabama's 1996 and/or 1998 Section 303(d) List(s) of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The implementation of the TMDLs contained herein will be prioritized within Alabama's rotating basin approach.

The amount and quality of data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in land use within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Rock Creek, a part of the Black Warrior basin, is located in Winston County near Addison Alabama. It has been on the State of Alabama's §303(d) use impairment list since 1992 for organic enrichment/low dissolved oxygen (O.E./D.O.). Its use classification is Fish and Wildlife.

Water quality data or information collected in 1988, 1991, and 1997 identified dissolved oxygen impairments for Rock Creek. The stream flows during periods of impairment were typically at, or below, the $7Q_{10}$ (the minimum 7-day average flow that occurs once in 10 years on average). Since the D.O. impairments were clearly driven by low flows and high temperatures, occurring during the summer months, a steady state modeling approach was adopted as appropriate for the TMDL analysis.

The following report addresses the results of the TMDL analysis for O.E./D.O. In accordance with ADEM water quality standards, the minimum dissolved oxygen concentration in a stream classified as Fish and Wildlife is 5.0 mg/l. For the purpose of this TMDL, a minimum dissolved oxygen level of 5.0 mg/l will be implemented allowing for an implicit margin of safety resulting from conservative assumptions used in the dissolved oxygen model.

A summary of the TMDL for the watershed is provided in the table presented on the next page. The pollutants shown in the table include ultimate carbonaceous biochemical oxygen demand ($CBOD_u$) and nitrogenous biochemical oxygen demand (NBOD), the principle causes for observed low dissolved oxygen concentrations. $CBOD_u$ is a measure of the total amount of oxygen required to degrade the carbonaceous portion of the organic matter present in the water. NBOD is the amount of oxygen utilized by bacteria as they convert ammonia to nitrate. Because organic nitrogen can be converted to ammonia, its potential oxygen demand is included in the NBOD component of the TMDL. The table lists maximum allowable pollutant loadings by source (point and non-point sources).

Table 1-1. Maximum Allowable Pollutant Loads by Source

Pollutant	Point Source Loads (lbs./day)	Non-point Source Loads (lbs./day)
$CBOD_u$	1.58	56.42
NBOD	0.16	76.84
Total	1.74	133.26

Note: Addison High School discharges to an unnamed tributary of Boone Creek that is, in turn, a tributary of Rock Creek. Figures under the "Point Source Loads" column above represent pollutant loading impacts from Addison High School at the mouth of Boone Creek. Two Boone Creek simulations were preformed to calculate Addison High School's impacts. Addison High School was included as a point source in the first simulation. In the second simulation, it was removed. The difference in pollutant loadings at Boone Creek's mouth between simulations 1 and 2 results in the values listed in the "Point Source Loads" column above.

2.0 Basis for §303(d) Listing

2.1 Introduction

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

The State of Alabama has identified Rock Creek as being impaired by organic loading (i.e., $CBOD_u$ and NBOD) for a length of 5.0 miles, as reported on the 1992, 1994, 1996, 1998, and the draft 2000 §303(d) list(s) of impaired waters. Rock Creek has a priority ranking of "medium" on the list(s). Rock Creek is located in Winston County and lies within the Sipsey Fork watershed of the Black Warrior basin.

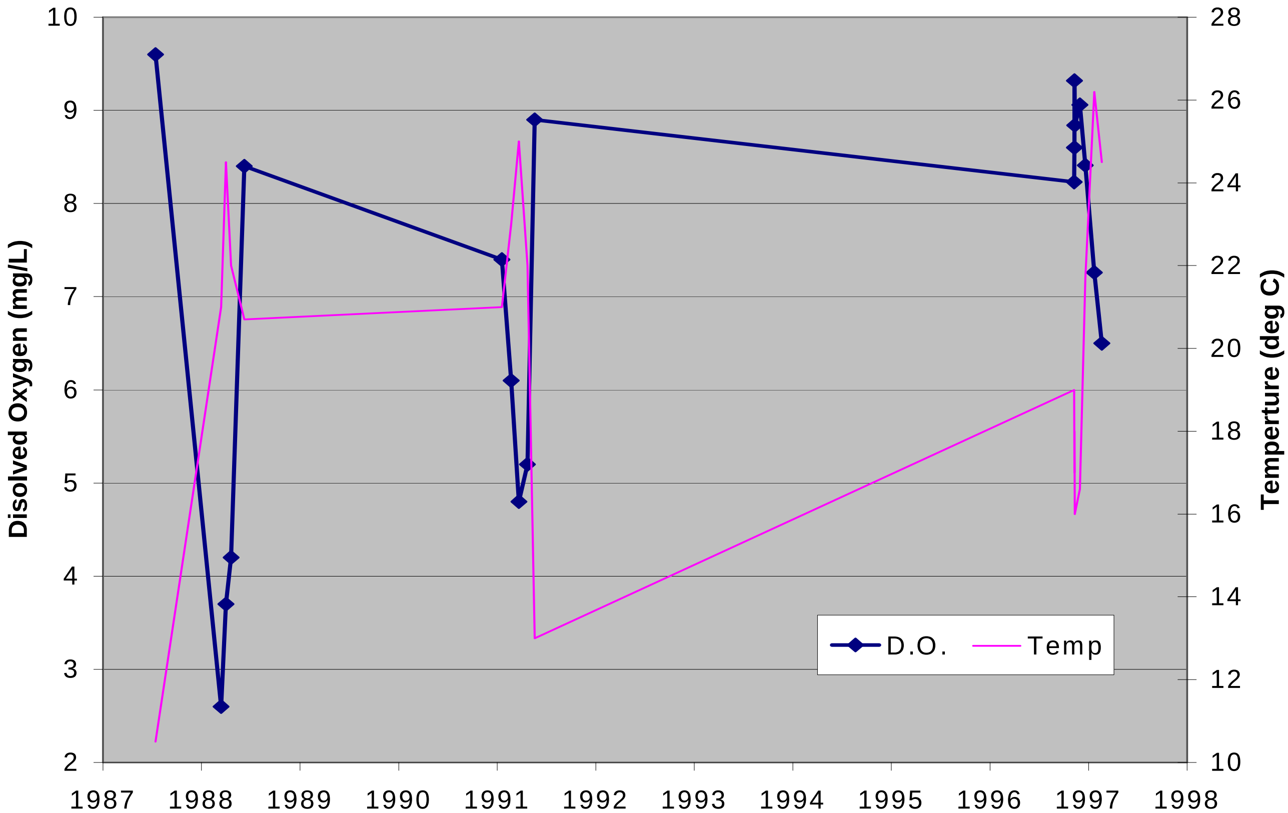
The TMDL developed for Rock Creek illustrates the steps that can be taken to address a waterbody impaired by low dissolved oxygen levels. The TMDL is consistent with a phased-approach: estimates are made of needed pollutant reductions, load reduction controls are implemented, and water quality is monitored 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.

2.2 Problem Definition

Rock Creek is a small, headwater stream with a relatively small drainage area of 84.5 sq miles. Dry weather flows for the watershed are relatively low, or zero. Water quality data collected for the watershed during 1997, 1991, and 1988 indicates that dissolved oxygen impairments occurred primarily during the summer months (May through November). The percentage of the dissolved oxygen data not meeting the minimum water quality standard is 12.0%. Generally, depressed in-stream D.O. concentrations may be caused by several sources including the decay of oxygen demanding waste from both point and non-point sources, algal respiration, sediment oxygen demand or other sources. It is believed based on available data that the low dissolved oxygen concentrations observed in this watershed are due to due to nonpoint source run off combined with persistent flow conditions at or below the $7Q_{10}$ and high temperatures, occurring during summer months, and are not the result of algal dynamics.

Figure 2.1 below illustrates the dissolved oxygen versus temperature data available for Rock Creek.

Figure 2.1 Dissolved Oxygen vs. Temperature Data



<u>Waterbody Impaired:</u>	Rock Creek – form Smith Lake to Blevens Creek
<u>Water Quality Standard Violation:</u>	Dissolved Oxygen
<u>Pollutant of Concern:</u>	Organic Enrichment ($CBOD_u$/NBOD)
<u>Water Use Classification:</u>	Fish and Wildlife

The impaired stream segment, Rock Creek, is classified as Fish and Wildlife. Usage of waters in this classification is described in ADEM Admin. Code R. 335-6-10-.09(5)(a), (b), (c), and (d).

(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 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.

<u>Low D.O./Organic Loading Criteria:</u>

Alabama’s water quality criteria document (ADEM Admin. Code R. 335-6-10-.09-(5)(e)(4.)) states that for a 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 daily fluctuations shall be maintained above these levels. In no event shall the dissolved oxygen level be less than 4 mg/l due to discharges from existing hydroelectric generation impoundments. All new hydroelectric generation impoundments, including addition of new hydroelectric generation units to existing impoundments, shall be designed so that the discharge will contain at least 5 mg/l dissolved oxygen where practicable and technologically possible. The Environmental Protection Agency, in cooperation with the State of Alabama and parties responsible for impoundments, shall develop a program to improve the design of existing facilities.

3.0 Technical Basis for TMDL Development

3.1 Water Quality Target Identification

The minimum dissolved oxygen concentration in a stream classified as Fish and Wildlife is 5.0 mg/l. For the purpose of this TMDL, a minimum dissolved oxygen level of 5.0 mg/l will be implemented allowing for an implicit margin of safety resulting from conservative assumptions used in the dissolved oxygen model. The target $CBOD_u$ and NBOD concentrations are concentrations that, in concert with the nitrification of ammonia, will not deplete the dissolved oxygen concentration below this level as a result of the decaying process.

3.2 Source Assessment

3.2.1. General Sources of CBODu and NBOD

Both point and non-point sources may contribute $CBOD_u$ and NBOD (i.e., organic loading) to a given waterbody. Potential sources of organic loading are numerous and often occur in combination. In rural areas, storm runoff from row crops, livestock pastures, animal waste application sites, and feedlots can transport significant loads of organic loading. Nationwide, poorly treated municipal sewage comprises a major source of organic compounds that are hydrolyzed to create additional organic loading. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows can be significant sources of organic loading.

All potential sources of organic loading in the watershed were identified based on an evaluation of current land use/cover information on watershed activities (e.g., agricultural management activities). The source assessment was used as the basis of development of the model and ultimate analysis of the TMDL allocations. The organic loading assessment within the watershed included both point and non-point sources.

3.2.2. Point Sources in the Rock Creek Watershed

ADEM maintains a database of current NPDES permits and GIS files that locate each permitted outfall. This database includes municipal, semi-public/private, industrial, mining, industrial storm water, and concentrated animal feeding operations (CAFOs) permits. Table 3-1, below, shows the permitted point sources in the watershed that discharge into or upstream of the impaired segment. Included in Table 3-1 is the percent of the facility wastewater flow of the $7Q_{10}$. Table 3-2 contains the permit limitations for the point sources that were considered in the model development. Only point sources with NPDES permits for process wastewater discharges are included in the model. Stormwater discharge are not included since they do not contribute organic loads during critical stream flow conditions. Figure 3-1 shows the location of each facility considered a significant source relative to the impaired segment.

Table 3-1. Contributing Point Sources in the Rock Creek Watershed.

NPDES Permit	Type of Facility (e.g., CAFO, Industrial, Municipal, Semi-Public/Private, Mining, Industrial Storm Water)	Facility Name	Significant Contributor (Yes/No) (% of $7Q_{10}$)
AL0051811	Municipal	Addison High School	Yes 3%
AL0058373	Industrial Storm Water	Hyche Landfill	No 0%
ALA000125	CAFO	R&R Gil Farm	No 0%

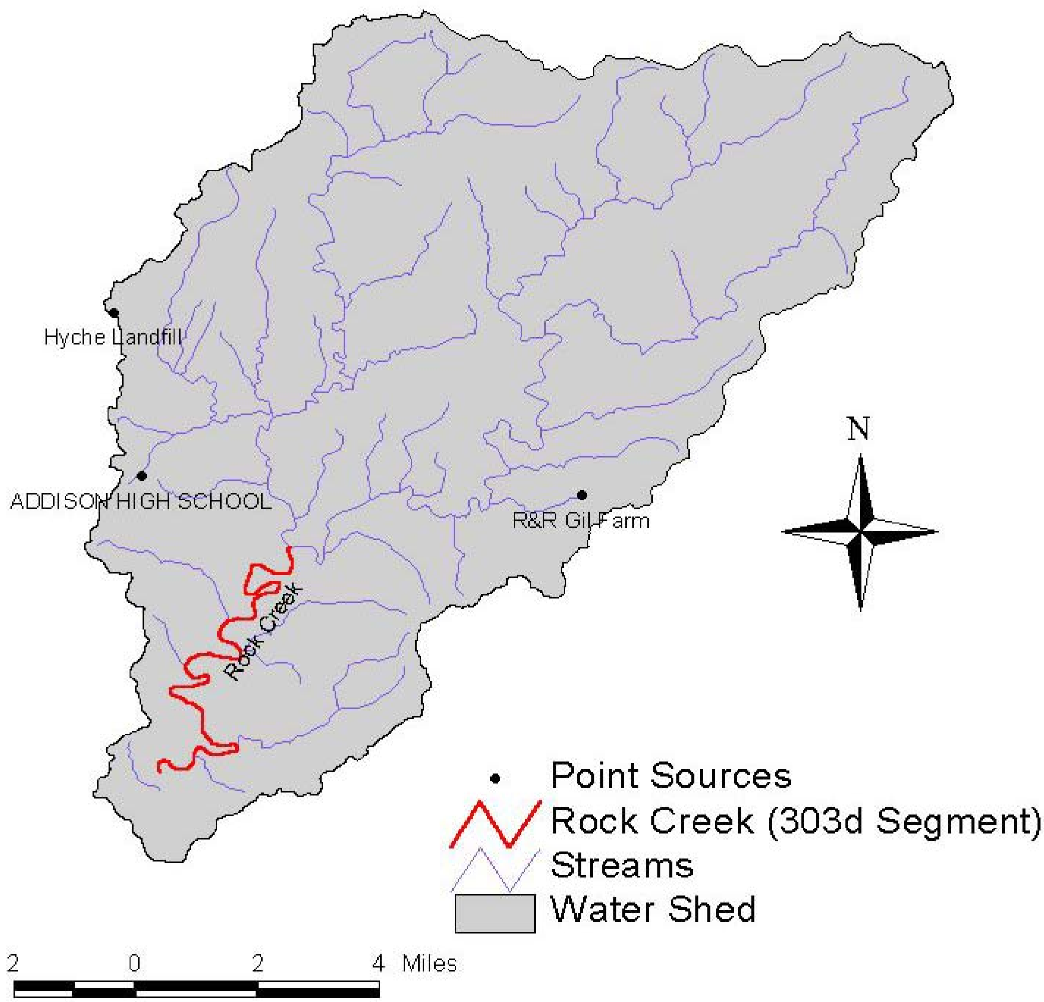
Note: Storm water discharges listed in the above table were marked as not being significant contributors since the discharge would not occur during low flow conditions. Construction storm water discharges are not listed as these discharges do not occur during low flow and generally do not contribute directly to the organic loading. CAFOs were not listed as significant contributors due to the fact they are not permitted to discharge.

Table 3-2. NPDES Permit Limits for Significant Contributing Point Sources

NPDES Permit	Facility Name	Permit Limtations - Summer							Permit Limtations – Winter						
		Flow (MGD)		BOD_5 (MG/L)		NH_3-N (MG/L)		DO (MG/L)	Flow (MGD)		BOD_5 (MG/L)		NH_3-N (MG/L)		DO (MG/L)
		Max	Avg	Avg weekly	Avg monthly	Avg weekly	Avg monthly	Min	Max	Avg	Avg weekly	Avg monthly	Avg weekly	Avg monthly	Min
AL0051811	Addison High School	na	0.016	45	30	1.8	1.2	6	na	0.016	45	30	3.1	2.1	6

Notes: n/a = not applicable. Flows listed for municipal and industrial permits are design flow and long term average flows, respectively. The flows listed for industrial permits may or may not be limited by the permit, but are included for the purpose of calculating the percent of the $7Q_{10}$.

Figure 3-1. Location Map of Significant Point Sources



3.2.3. Non-Point Sources in the Rock Creek Watershed

Shown in Table 3-3, below, is a detailed summary of land usage in the Rock Creek watershed. A land use map of the watershed is presented in Figure 3-2. The predominant land uses within the watershed are pasture/hay, row crops, and forest. Their respective percentages of the total watershed are 18%, 8%, and 73%.

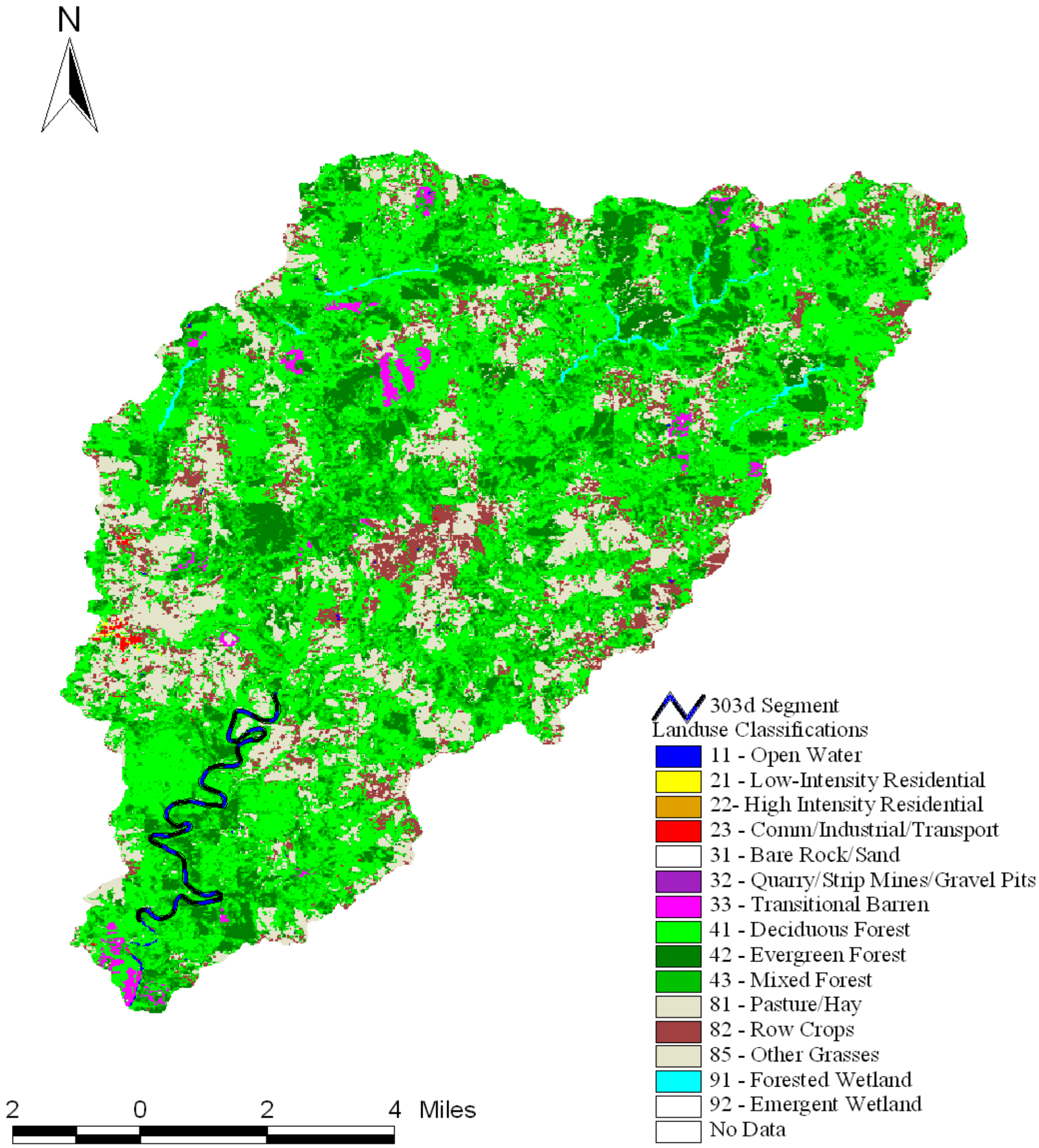
Table 3-3. Land Use in the Rock Creek Watershed.

LAND USE	PERCENTAGE
Open Water	0.13
Low-Intensity Industrial Residential	0.07
Commercial/Industrial/Transport	0.23
Quarry/Strip Mine/Gravel Pits	0.00
Transitional Barren	1.01
Deciduous Forest	41.42
Evergreen Forest	11.39
Mixed Forest	19.78
Pasture/Hay	18.00
Row Crops	7.51
Forest Wetland	0.46

The predominant land uses of pasture/hay, row crops, and forest make up 99% of the watershed. The other 1% of the land uses, except open water, was combined into one category (other) for modeling purposes. Each land use has the potential to contribute to the organic loading in the watershed due to organic material on the land surface that potentially can be washed off into the receiving waters of the watershed. Information on agricultural and management activities and watershed characteristics were obtained through coordination with the ADEM Mining and Non-Point Section, the Alabama Cooperative Extension System, and the USDA-Natural Resources Conservation Service (NRCS).

The major sources of organic enrichment from non-point sources within the Rock Creek watershed are the pasture/hay, row crops, and forest land uses. Compared to other land uses organic enrichment from forested land is normally considered to be small. This is because forested land tends to serve as a filter of pollution originating within its drainage areas. However, organic loading can originate from forested areas due to the presence of wild animals such as deer, raccoons, turkeys, waterfowl, etc. Control of these sources is usually limited to land management best management practices (BMPs) and may be impracticable in most cases. In contrast to forested land, agricultural land can be a major source of organic loading. Runoff from pastures, animal operations, improper land application of animal wastes, and animals with access to streams are all mechanisms that can introduce organic loading to waterbodies.

Figure 3-2. Land Use Map for the Rock Creek Watershed.



3.3 Loading Capacity – Linking Numeric Water Quality Targets and Pollutant Sources

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)).

Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10-.09-(4)(e)(4.)) states that for a 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 daily fluctuations shall be maintained above these levels.

Using the D.O. water quality criterion of 5.0 mg/l as the numerical target, a TMDL model analysis was performed at critical conditions (i.e., summer) to determine the loading capacity for the watershed. This was accomplished through a series of simulations aimed at meeting the dissolved oxygen target limit by varying source contributions. The final acceptable simulation represented the TMDL (and loading capacity of the waterbody). If point sources were identified in the watershed, an additional model analysis was performed for the winter to determine the loading capacity during higher flow conditions.

In the TMDL model analysis, the pollutant concentrations from forestland were assumed to be at normal background concentrations. Specific values for background pollutant concentrations are as follows: 2 mg/l $CBOD_u$, 0.11 mg/l ammonia as nitrogen (NH_3N), and 0.22 mg/l total organic nitrogen (TON). Pollutant concentrations for the other land uses in the watershed were assigned in proportion to measured concentrations and were set in the TMDL model at levels necessary to maintain dissolved oxygen concentrations greater than, or equal to, 5 mg/l. The model predictions for in-stream pollutant concentrations were then compared to actual field data. The model velocities and reaeration coefficients were adjusted in those cases where the field data indicated significant discrepancies from the model predictions.

3.4 Data Availability and Analysis

3.4.1. Watershed Characteristics

A. General Description: Rock Creek, located in Winston County, is a tributary to the Lewis Smith Lake. The Rock Creek is a part of the Black Warrior River basin. Rock Creek is a part of the USGS (United States Geological Survey) AL/03160110 cataloging unit and the NRCS (Natural Resources Conservation Service) 080 sub-watershed.

Rock Creek begins approximately 0.5 miles south west of Corinth (3/4 mile from the Morgan County line) in Section 5, T. 9 s, and R. 5 w. It has a linear distance of 22.3

miles and a total drainage area of 84.5 square miles. Rock Creek has a use classification of Fish & Wildlife (F&W).

B. Geological Description: The main rock type in the region is sand, conglomerate, shale, siltstone, and coal. The Pottsville Formation occurs in the lower part of the region.

C. Eco-region Description: The Dissected Plateau is so strongly dissected that it no longer has a typical plateau appearance such as in 68a or d. The rugged, mostly forested region contains predominantly strongly sloping land, some steep-sided gorges and sandstone cliffs, and relief of 300-400 feet. The cool canyons and valleys often contain plant and animal species usually found further north. The Bankhead National Forest occupies a large portion of 68e, providing public recreation, wilderness, and forestry areas. Most of the region is drained by the Sipsey Fork of the Black Warrior River. The Sipsey Fork is a National Wild and Scenic River and is designated as Outstanding National Resource Water in its headwaters, and downstream is impounded to form Lewis Smith Lake, a hydroelectric generating reservoir, also popular for bass fishing.

D. Other Notable Characteristics: None

3.4.2 Available Water Quality and Biological Data

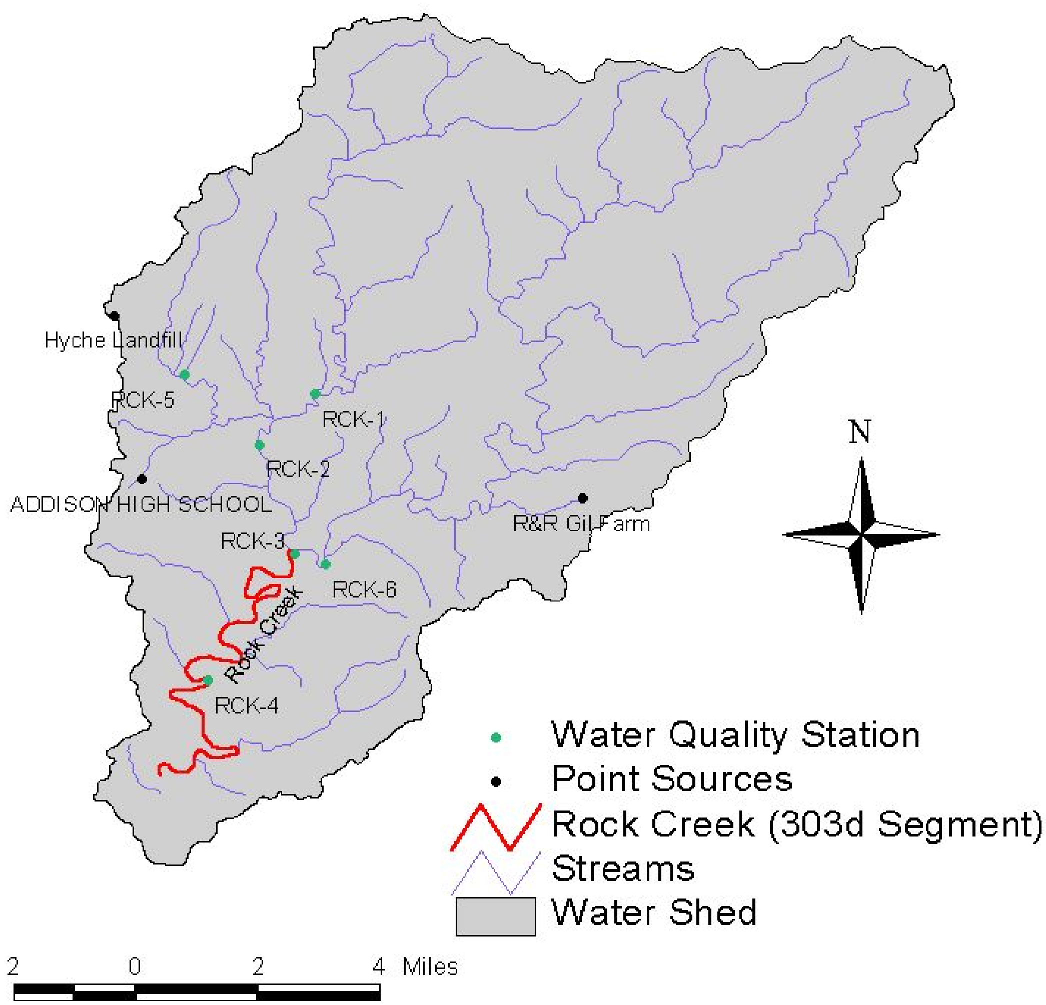
Water quality and biological data for Rock Creek are available from five different studies. The first set of data was acquired as a part of the state's 1988 Clean Water Strategy study. The second set is derived from the state's second Clean Water Strategy study in 1991. The third and fourth studies took place in 1997 as a result of Rock Creek's placement on the 1996 303(d) list. One of the studies consisted of monthly sampling from June through September 1997. The other study was an intensive water quality survey of the creek in May 1997. The fifth (and final) study also took place in 1997, and was a part of ADEM's Nonpoint Source (NPS) Screening Assessment of the Black Warrior River Basin. Biological data was acquired in the final study in the form of three types of assessments – habitat, macroinvertebrate and fish IBI (Index of Biotic Integrity). Shown in Table 3-4 is a summary of sampling station location descriptions for each study. Only one station was sampled from the 1991 Clean Water Stategy study. It was the same as RCK-1 from the 1988 Clean Water Strategy study.

A complete listing of the available data can be found in the appendix of this report. A map listing 1997 sampling station locations, as well as point source discharges, can be found in Figure 3-3.

Table 3-4. Sampling Stations in the Rock Creek Watershed.

Study	Station ID	Description	Comments
1988 Clean Water Strategy (CWS) Study	RCK-1	Rock Creek @ County Rd. at bridge NW 1/4 Sec. 35, T9S, R6W	Same as RCK - 1 1997
	RCK-2	Rock Creek @ AL Hwy 74 at bridge Se 1/4 Sec. 10, T10S, R6W	Same as RCK - 3 1997
	RCK-3	Rock Creek @County Rd. 66 at bridge SE 1/4 Sec. 21, T10S, R6W	Same as RCK - 4 1997
1997 Studies	RCK-1	Rock Creek @ County Rd. at bridge NW 1/4 Sec. 35, T9S, R6W	Same as RCK - 1 1988 CWS
	RCK-2	Rock Creek @ County Rd. at Bridge SW 1/4 Sec. 34, T9S, R6W	Same as ROCW - 52a
	RCK-3	Rock Creek @ AL Hwy 74 at bridge Se 1/4 Sec. 10, T10S, R6W	Same as RCK - 2 1988 CWS
	RCK-4	Rock Creek @County Rd. 66 at bridge SE 1/4 Sec. 21, T10S, R6W	Same as RCK - 3 1988 CWS
	RCK-5	Boone Creek @ County Rd. at bridge SW 1/4 sec. 28, T9S, R6W	No counterpart
	RCK-6	Blevens Creek @ County Rd. at Bridge SW 1/4 Sec. 11, T10S, R6W	No counterpart
1997 NPS Screening Assessment Study	ROCW-52a	Rock Creek @ County Rd. at Bridge SW 1/4 Sec. 34, T9S, R6W	Same as RCK - 2 1997
	ROCW-52b	Rock Creek @ Winston Co. Rd. 80 S 1/2 Sec. 23, T9S, R6W	No counterpart

Figure 3-3. Map of 1997 Studies Sampling Locations and Point Source Discharges for the Rock Creek Watershed.



3.4.3. Flow data

For the purpose of this TMDL, annual $7Q_{10}$ stream flows for the summer season and annual $7Q_2$ stream flows for the winter season are employed. These flows represent worst-case scenarios for seasonal model evaluations. The use of worst-case conditions, in turn, creates a margin of safety in the final results.

The $7Q_{10}$ flow represents the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval. Likewise, the $7Q_2$ is the minimum 7-day flow that occurs, on average, over a 2-year period.

Both flows (i.e., $7Q_{10}$ and $7Q_2$) can be calculated for the model using gage data from the United States Geological Survey (USGS) or by using the Bingham Equation. The Bingham Equation can be found on page 3 of a publication from the Geological Survey of Alabama entitled, **Low-Flow Characteristics of Alabama Streams, Bulletin 117**.

The equations used to calculate the $7Q_{10}$ and $7Q_2$ flows based on continuous USGS gaging records for the stream and any associated tributaries are as follows:

$$7Q_{10}\ (\text{cfs}) = \frac{(7Q_{10}\ @\ \text{USGS Station (cfs)})}{(\text{Drainage Area @ USGS Station (mi}^2))} * (\text{Watershed Drainage Area (mi}^2))$$

$$7Q_{2}\ (\text{cfs}) = \frac{(7Q_{2}\ @\ \text{USGS Station (cfs)})}{(\text{Drainage Area @ USGS Station (mi}^2))} * (\text{Watershed Drainage Area (mi}^2))$$

The $7Q_{10}$ and $7Q_2$ flows can also be estimated using the Bingham equation. Low flow estimates employing this equation are based on the stream's recession index (G, no units), the stream's drainage area (A, mi^2), and the mean annual precipitation (P, inches):

$$7Q_{10}\ (\text{cfs}) = 0.15\text{x}10^{-5}(G-30)^{1.35}(A)^{1.05}(P-30)^{1.64}$$

$$7Q_{2}\ (\text{cfs}) = 0.24\text{x}10^{-4}(G-30)^{1.07}(A)^{0.94}(P-30)^{1.51}$$

The method used to determine the $7Q_{10}$ and $7Q_2$ flows for the Rock Creek was the Bingham equation. The resulting $7Q_{10}$ and $7Q_2$ flows are 1.74 and 3.5 cfs, respectively.

The calculated flows were distributed over Rock Creek in the form of tributary flow or incremental inflow (identified on the modeled reach schematic as IF). The IF was distributed in proportion to the length of each segment.

3.5 Critical Conditions

Summer months (May – November) are generally considered critical conditions for dissolved oxygen in streams. This can be explained by the nature of storm events in the summer versus the winter. Periods of low precipitation allow for slower in-stream velocity, which increases the organic loading residence time and decreases stream re-aeration rates. This increased time permits more decay to occur which depletes the streams dissolved oxygen supply. Reaction rates for $CBOD_u$ and NBOD (i.e., organic loading) are temperature dependent and high summertime temperatures increase the decay process, which depletes the dissolved oxygen even further.

In winter, frequent low intensity rain events are more typical and do not allow for the build-up of organic loading on the land surface, resulting in a more uniform loading rate. Higher flows and lower temperatures create less residence time and lower decay rates. This pattern is evidenced in the output data of the model where the highest allowable loading achieved was for winter stream flows.

3.6 Margin of Safety (MOS)

There are two basic methods of incorporating the MOS (USEPA, 1991): 1) implicitly, using conservative model assumptions, or 2) explicitly specify a portion of the TMDL as the MOS.

The MOS is implicit in this TMDL process through the use of conservative model input parameters (temperature, flow and D.O. concentrations). Conservative temperature values are employed through the use of the highest average maximum temperature that would normally occur under critical stream flow conditions. The $7Q_{10}$ stream flow employed for the critical season reflects the lowest flow that would normally occur under critical conditions. All point source discharges were assumed to be continuous at current NPDES permit limits. Finally, the D.O. concentration for incremental flow was set at 70% of the saturation concentration at the given temperature, which is 15% lower than the 85% normally assumed in a typical waste load allocation.

4.0 Water Quality Model Development

4.1 Water Quality Model Selections and Setup

Since the impairment noted by the available data occurred during periods of low flows, a steady-state modeling approach was adopted as appropriate to represent the relevant conditions in the impaired waterbody. The steady state TMDL spreadsheet water quality model (SWQM) developed by the ADEM was selected for the following reasons:

- It is a simplified approach without unnecessary complexity.
- It conforms to ADEM standard practices for developing wasteload allocations.
- It lends itself to being developed with limited data, which is the present situation for this waterbody.
- It has the ability to handle tributary inputs and both point and non-point source inputs.

The TMDL spreadsheet model also provides a complete spatial view of a stream, upstream to downstream, giving differences in stream behavior at various locations along the model reach. The model computes dissolved oxygen using a modified form of the Streeter-Phelps equation. The modified Streeter-Phelps equation takes into account the oxygen demand due to carbonaceous decay plus the oxygen demand generated from the nitrification process (ammonia decay). Each stream reach is divided into twenty elements, with each element assumed to be the functional equivalent of a completely mixed reactor.

The following assumptions were used in the spreadsheet TMDL model***:***

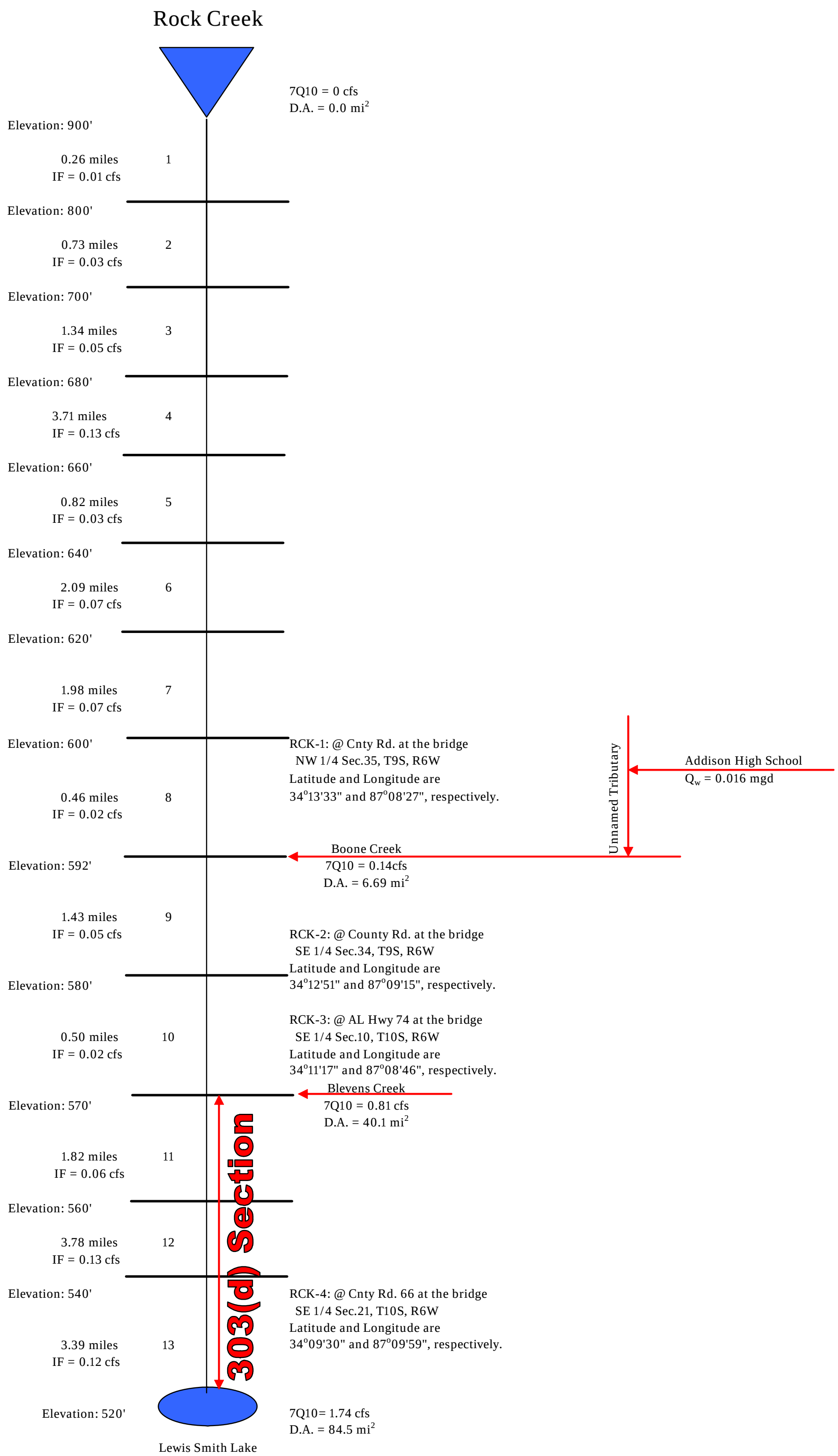
- For the calibration model the D.O. concentration for incremental flow was set at 4.5, and for the reduction and summer model the D.O. concentration for incremental flow was set at 70% of the saturation concentration at the given temperature
- Incremental and tributary loading were apportioned to correlate with the land usage of the drainage basin.
- Ratios for $CBOD_U/NH_3OD_U$ and $CBOD_U/TONOD_U$ were calculated using water quality data for the waterbody or estimated during the calibration process. These ratios were assigned in the estimation of loading parameters for incremental flow and tributaries for all land uses, except forest and open water.
- $CBOD_u/CBOD_5$ ratios used for point sources were assumed to be 1.5.
- $CBOD_u/CBOD_5$ ratios used for non-point sources were assumed to be 1.5.
- NH_3OD_u is equal to 4.57 times the ammonia nitrogen concentration.
- $TONOD_u$ is equal to 4.57 times the organic nitrogen concentration.
- Background conditions were assumed for forest incremental flow.
  Background conditions are typically the following ranges: 2-3 mg/l $CBOD_u$, 0.2-1 mg/l NH_3OD_u, 1-2 mg/l $TONOD_u$.

4.1.1. <u>SOD Representation</u>: Sediment oxygen demand (SOD) can be an important part of the oxygen demand budget in shallow streams. However, for shallow streams with steep slopes and rocky substrate, the SOD component is generally small. These hydrogeological conditions are representative of the Rock Creek. It is believed, therefore, that the SOD for this stream is minimal. In the absence of available field SOD measurements for the waterbody, SOD data was obtained from EPA Region IV's SOD database. The EPA SOD database represents mixed land uses and varying degrees of point source activity. A SOD value of 0.05 gm-O_2 ft^2/day was chosen based on similar bottom characteristics of sand, conglomerate, shale, siltstone, and coal.

4.2 Water Quality Model Summary

The model reach consists of 13 segments and extends from Rock Creek's source to its mouth at Lewis Smith Lake. The impaired portion of Rock Creek extends from Blevens Creek to its mouth (segments 11-13). The length of the impaired portion is 8.98 miles. Total distance of the modeled reach is 22.3 miles. A schematic diagram of the modeled reach is presented in Figure 4-1. Assumed in-stream temperatures are based on historical model development. A guide for use of ADEM's TMDL water quality model can be found in the appendix. The guide also explains the theoretical basis for the physical/chemical mechanisms and principles that form the foundation of the model.

Figure 4-1. Schematic of the Modeled Reach.



4.3 TMDL Model Predictions and Graphics

4.3.1. TMDL Model

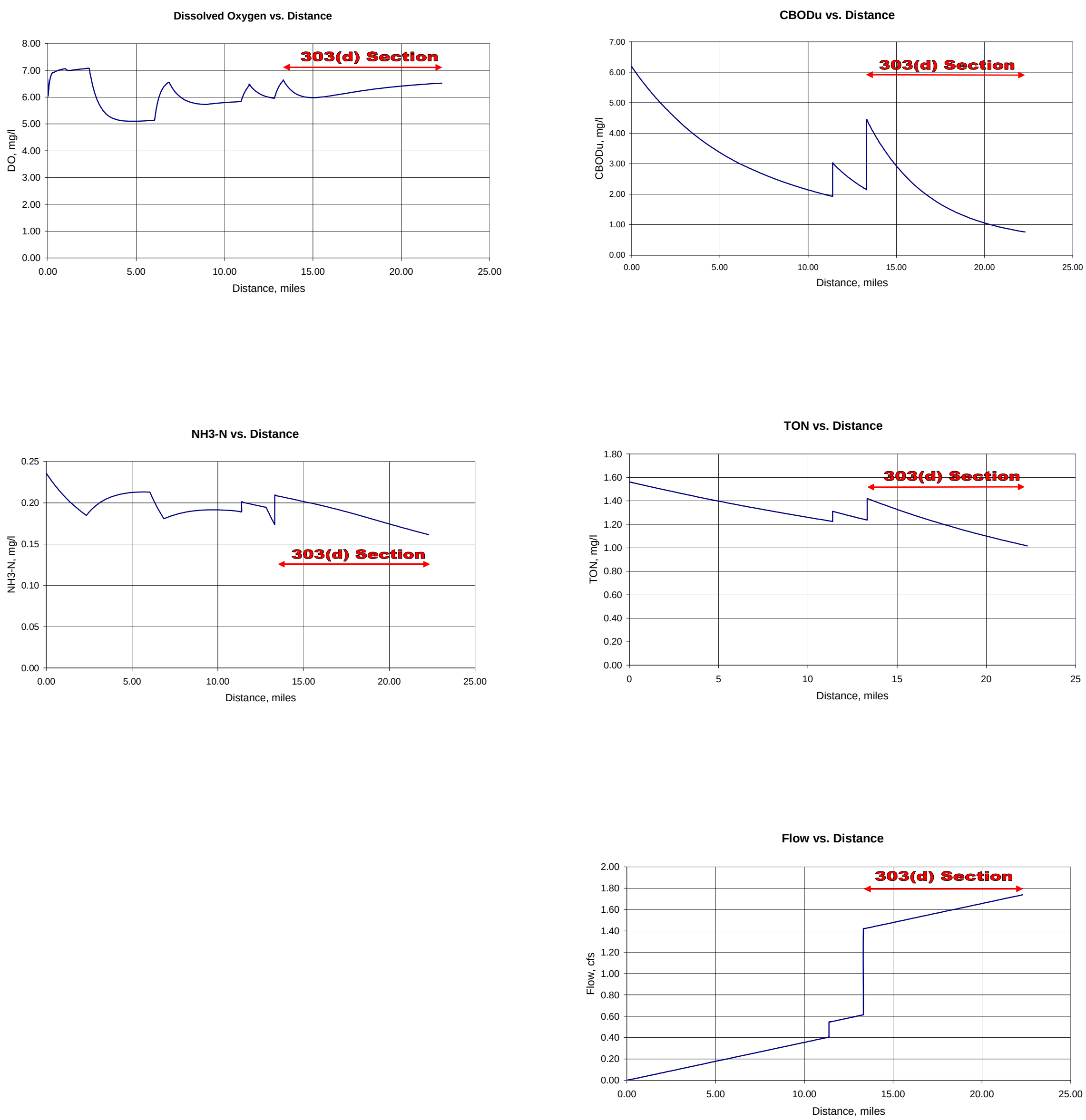
TMDL Stream Flow Parameters

Description	**Flow (cfs)**	**DO (mg/l)**	**$CBOD_U$ (mg/l)**	**NH_3N (mg/l)**	**TON (mg/l)**	**Temp (^oC)**
Headwaters	0.00	6.65	6.19	0.24	1.56	28
Boone Creek	0.14	6.65	6.19	0.24	1.56	28
Blevens Creek	0.81	6.65	6.19	0.24	1.56	28
Conditions @ Lowest D.O.	0.17	5.10	3.46	0.21	1.41	28
Flow @ End of Model	1.74	6.52	0.76	0.16	1.02	28

TMDL Incremental Flow Parameters

Sections	**$CBOD_U$ (mg/l)**	**NH_3N (mg/l)**	**TON (mg/l)**	**DO (mg/l)**	**Total Flow (cfs)**	**Temp. (^oC)**
1	6.19	0.24	1.56	5.48	0.01	28
2	6.19	0.24	1.56	5.48	0.03	28
3	6.19	0.24	1.56	5.48	0.05	28
4	6.19	0.24	1.56	5.48	0.13	28
5	6.19	0.24	1.56	5.48	0.03	28
6	6.19	0.24	1.56	5.48	0.07	28
7	6.19	0.24	1.56	5.48	0.07	28
8	6.19	0.24	1.56	5.48	0.02	28
9	6.19	0.24	1.56	5.48	0.05	28
10	6.19	0.24	1.56	5.48	0.02	28
11	6.19	0.24	1.56	5.48	0.06	28
12	6.19	0.24	1.56	5.48	0.13	28
13	6.19	0.24	1.56	5.48	0.12	28

Figure 4-2. TMDL Model Predictions.



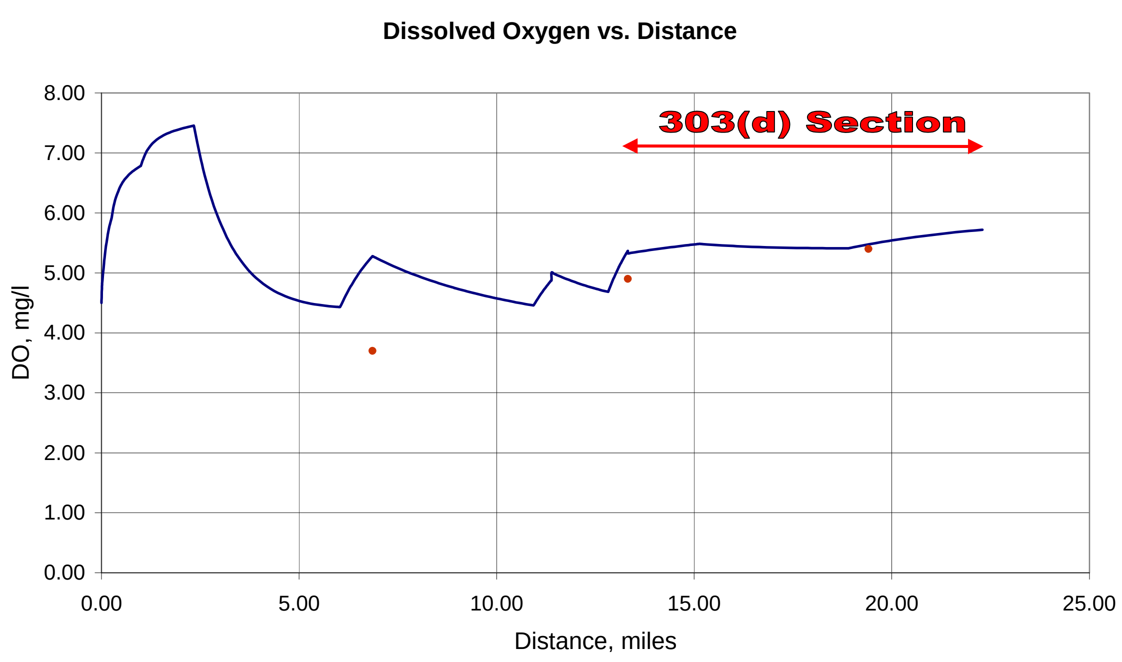
4.4 Loading Reduction Analysis

4.4.1. Calibrated Model

All of the D.O. violations from available field data occurred at sampling stations RCK-1, RCK-2, and RCK-3. Field data from the July 19, 1988 sampling event were used as input into a TMDL model to perform a second simulation referred to as the calibrated model (the first simulation is referred to as the TMDL). Non-point source loading was adjusted so that model predictions simulated the measured D.O. value as closely as possible at all stations, while still providing a reasonable representation of water quality in the stream at the time of the sampling event.

Shown in Figure 4-4, below, is a plot of D.O. calibrated model predictions vs. actual D.O. field data.

Figure 4-4. Calibrated Model D.O. Predictions vs. Actual D.O. Field Data.



Calibrated Model Flow Parameters

Description	Flow (cfs)	DO (mg/l)	CBOD (mg/l)	NH_3N (mg/l)	TON (mg/l)	Temp (^oC)
Headwaters	0.00	4.50	5.14	0.08	0.90	23
Boone Creek	18.9	5.30	5.14	0.08	0.90	28
Blevens Creek	109.86	5.30	5.14	0.08	0.90	28
Conditions @ Low D.O	23.71	4.43	2.84	0.11	0.81	23
Flow @ End of Model	216.31	5.72	3.03	0.10	0.82	27

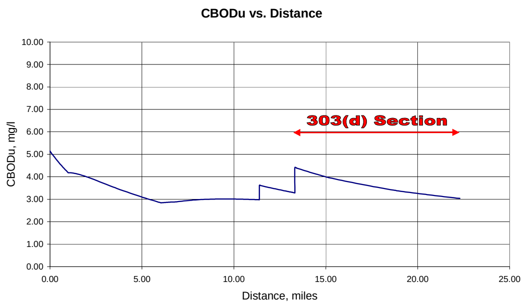
Calibrated Model Incremental Flow Parameters

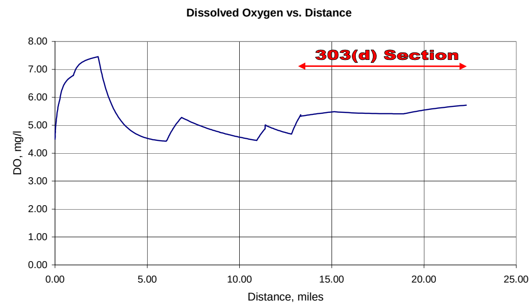
Sections	$CBOD_U$ (mg/l)	NH_3N (mg/l)	TON (mg/l)	DO (mg/l)	Total Flow (cfs)	Temp. (^oC)
1	5.14	0.085	0.90	4.50	1.01	23
2	5.14	0.085	0.90	4.50	2.90	23
3	5.14	0.085	0.90	4.50	5.27	23
4	5.14	0.085	0.90	4.50	14.53	23
5	5.14	0.085	0.90	4.50	3.23	26
6	5.14	0.085	0.90	4.50	8.20	26
7	5.14	0.085	0.90	4.50	7.79	26
8	5.14	0.085	0.90	4.50	1.79	27
9	5.14	0.085	0.90	4.50	5.62	27
10	5.14	0.085	0.90	4.50	1.96	28
11	5.14	0.085	0.90	4.50	7.13	28
12	5.14	0.085	0.90	4.50	14.83	28
13	5.14	0.085	0.90	4.50	13.30	28

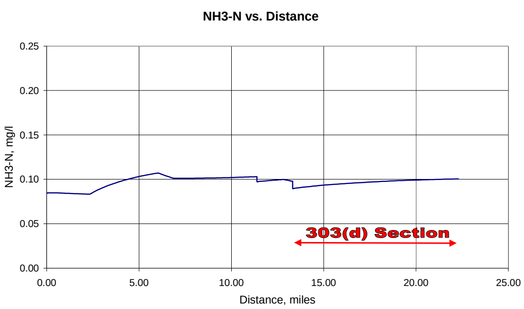
Comparison of Calibrated Model Flow Parameters to Actual Data

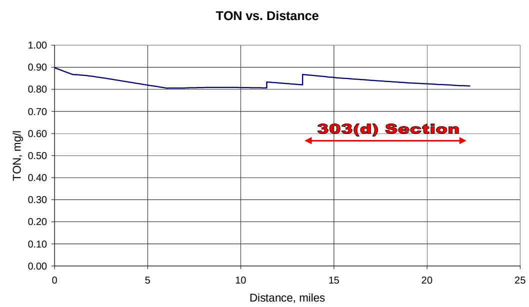
Description	Flow (cfs)	DO (mg/l)	$CBOD_U$ (mg/l)	NH_3N (mg/l)	TON (mg/l)	Temp (^oC)
Actual Conditions @ Calibrated Point	No Data	4.9	1.8	0.1	0.8	25.3
Model Conditions @ Calibrated Point	71.20	5.37	3.28	0.10	0.82	25.7

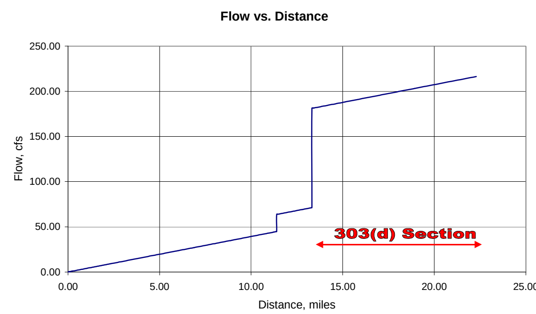
Figure 4-4. Calibrated Model Predictions and Graphics.











4.4.2. Load Reduction Model

The third simulation is referred to as the load reduction model. In this simulation, non-point and point source loadings in the calibrated model were adjusted to bring the waterbody into compliance with the 5 mg/l D.O. Fish & Wildlife water quality standard.

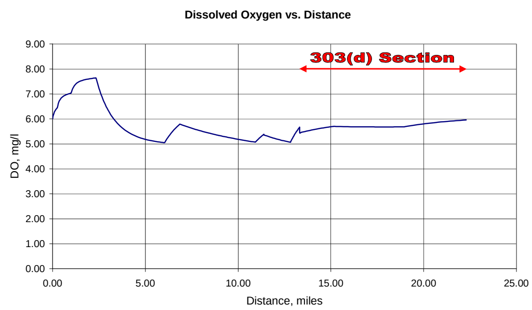
Load Reduction Model Flow Parameters

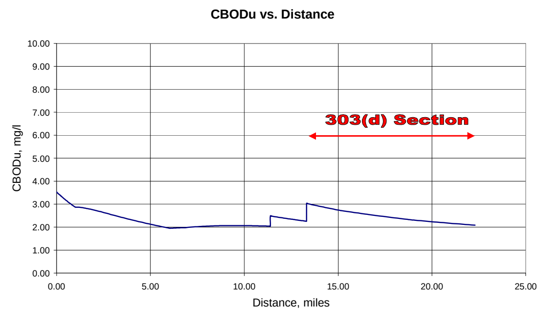
Description	**Flow (cfs)**	**DO (mg/l)**	**$CBOD_U$ (mg/l)**	**NH_3N (mg/l)**	**TON (mg/l)**	**Temp (^oC)**
Headwaters	0.00	6.00	3.53	0.04	0.50	23
Boone Creek	18.90	5.30	3.53	0.04	0.50	28
Blevens Creek	109.86	5.30	3.53	0.04	0.50	28
Conditions @ Calibrated Point	71.20	5.67	2.25	0.05	0.45	25.7
Flow @ End of Model	216.31	5.96	2.08	0.05	0.45	27.24

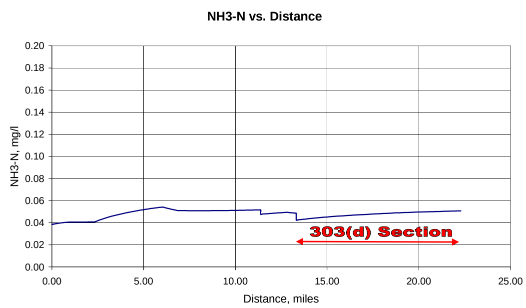
Load Reduction Model Incremental Flow Parameters

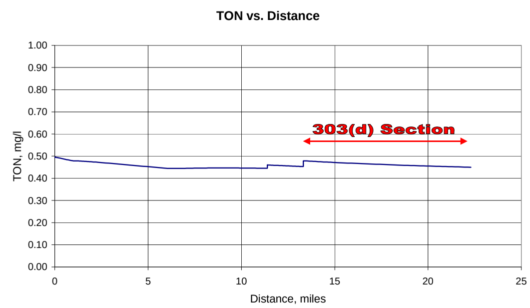
Sections	**$CBOD_U$ (mg/l)**	**NH_3N (mg/l)**	**TON (mg/l)**	**DO (mg/l)**	**Total Flow (cfs)**	**Temp. (^oC)**
1	3.53	0.04	0.50	6.00	1.01	23
2	3.53	0.04	0.50	6.00	2.90	23
3	3.53	0.04	0.50	6.00	5.27	23
4	3.53	0.04	0.50	6.00	14.53	23
5	3.53	0.04	0.50	5.70	3.23	26
6	3.53	0.04	0.50	5.70	8.20	26
7	3.53	0.04	0.50	5.70	7.79	26
8	3.53	0.04	0.50	5.60	1.79	27
9	3.53	0.04	0.50	5.60	5.62	27
10	3.53	0.04	0.50	5.50	1.96	28
11	3.53	0.04	0.50	5.50	7.13	28
12	3.53	0.04	0.50	5.50	14.83	28
13	3.53	0.04	0.50	5.50	13.30	28

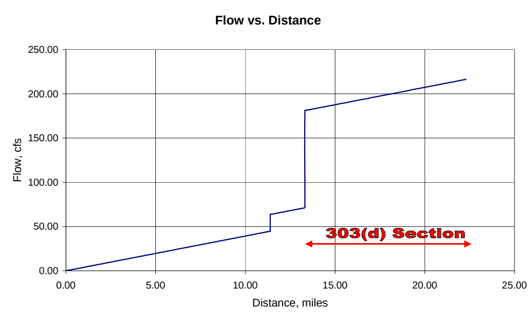
Figure 4-5. Load Reduction Model Predictions and Graphics.











4.3. Required Reductions

Total organic loading (i.e., $CBOD_u$ and NBOD) was calculated at the end of the model for both the calibrated model and the load reduction model. Based on these model analyses in order to bring the stream into compliance with the D.O. standard, there would require a theoretical total organic loading reduction of 0% for point source loads and 38% reduction for non-point source loads to bring Rock Creek into compliance with the Fish & Wildlife D.O. water quality standard of 5.0 mg/l. The necessary reductions are being sought from existing non-point sources since the point source load is adequately assimulated in the tributary prior to the confluence with Rock Creek.

A summary of the required reductions for point and non-point source loads is presented in Table 4-1.

Table 4-1. Required Load Reductions for Point and Non-Point Sources.

Existing Point Source Load[1]	Existing Non-Point Source Load[1]	Total Existing Load [1]	Reduced Load[1]	% Reduction	% Reduction	% Reduction
(lbs./day)	(lbs./day)	(lbs./day)	(lbs./day)	Point Sources	Non-Point Sources	Non Forest Land use
1.7	11233.2	11234.9	6968.8	0%	38%	55%

Notes: 1 = $CBOD_u$ + NBOD

The required reductions will be sought through TMDL implementation with follow up monitoring to determine the effectiveness of implementation. Follow up monitoring as discussed further in this document will be conducted according to basin rotation.

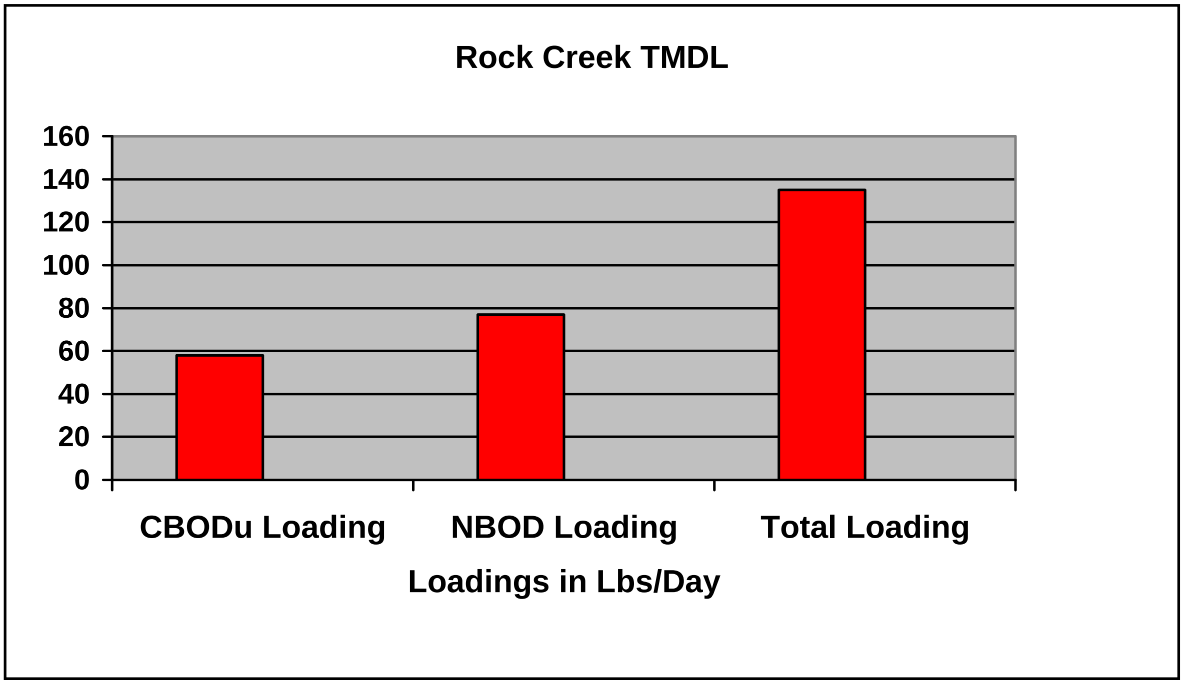
5.0 Conclusions

A summary of the TMDL is presented in Table 5-1 and Figure 5-1.

Table 5-1. TMDL Summary

	TMDL
$CBOD_u$ Loading (lbs./day)	58.0
NBOD Loading (lbs./day)	77.0
Total Loading (lbs./day)	135.0

Figure 5-1. TMDL Loading



Within the impaired segment, the point source allocations used in development of the summer TMDL will be addressed by the NPDES permit program during permit renewals and modifications. Based on the summer TMDL analysis the revised NPDES permit limitations are necessary for the point sources.

6.0 TMDL Implementation

6.1 Non-Point Source Approach

Rock Creek is impaired solely by nonpoint sources. For 303(d) listed waters impaired solely or primarily by nonpoint source (NPS) pollutants, necessary reductions will be sought during TMDL implementation using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired water. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. Therefore, TMDL implementation activities will be coordinated through interaction with local entities in conjunction with Clean Water Partnership efforts.

The primary TMDL implementation mechanism used will employ concurrent education and outreach, training, technology transfer, and technical assistance with incentive-based pollutant management measures. The ADEM Office of Education and Outreach (OEO) will assist in the implementation of TMDLs in cooperation with public and private stakeholders. Planning and oversight will be provided by or coordinated with the Alabama Department of Environmental Management's (ADEM) Section 319 nonpoint source grant program in conjunction with other local, state, and federal resource management and protection programs and authorities. The CWA Section 319 grant program may provide limited funding to specifically ascertain NPS pollution sources and causes, identify and coordinate management programs and resources, present education and outreach opportunities, promote pollution prevention, and implement needed management measures to restore impaired waters.

Depending on the pollutant of concern, resources for corrective actions may be provided, as applicable, by the Alabama Cooperative Extension System (education and outreach); the USDA-Natural Resources Conservation Service (NRCS) (technical assistance) and Farm Services Agency (FSA) (federal cost-share funding); and the Alabama Soil and Water Conservation Committee (state agricultural cost share funding and management measure implementation assistance) through local Soil and Water Conservation Districts, or Resource Conservation and Development Councils (funding, project implementation, and coordination). Additional assistance from such agencies as the Alabama Department of Public Health (septic systems), Alabama Department of Agriculture and Industries (pesticides), and the Alabama Department of Industrial Relations and Dept of Interior - Office of Surface Mining (abandoned minelands), Natural Heritage Program and US Fish and Wildlife Service (threatened and endangered species), may also provide practical TMDL implementation delivery systems, programs, and information. Land use and urban sprawl issues will be addressed through the Nonpoint Source for Municipal

Officials (NEMO) education and outreach program. Memorandums of Agreements (MOAs) may be used as a tool to formally define roles and responsibilities.

Additional public/private assistance is available through the Alabama Clean Water Partnership (CWP) Program. The CWP program uses a local citizen-based environmental protection approach to coordinate efforts to restore and protect the state's resources in accordance with the goals of the Clean Water Act. Interaction with the state or river basin specific CWP will facilitate TMDL implementation by providing improved and timely communication and information exchange between community-based groups, units of government, industry, special interest groups, and individuals. The CWP can assist local entities to plan, develop, and coordinate restoration strategies that holistically meet multiple needs, eliminate duplication of efforts, and allow for effective and efficient use of available resources to restore the impaired waterbody or watershed.

Other mechanisms that are available and may be used during implementation of this TMDL include local regulations or ordinances related to zoning, land use, or storm water runoff controls. Local governments can provide funding assistance through general revenues, bond issuance, special taxes, utility fees, and impact fees. If applicable, reductions from point sources will be addressed by the NPDES permit program. The Alabama Water Pollution Control Act empowers ADEM to monitor water quality, issue permits, conduct inspections, and pursue enforcement of discharge activities and conditions that threaten water quality. In addition to traditional "end-of-pipe" discharges, the ADEM NPDES permit program addresses animal feeding operations and land application of animal wastes. For certain water quality improvement projects, the State Clean Water Revolving Fund (SRF) can provide low interest loans to local governments.

Long-term physical, chemical, and biological improvements in water quality will be used to measure TMDL implementation success. As may be indicated by further evaluation of stream water quality, the effectiveness of implemented management measures may necessitate revisions of this TMDL. The ADEM will continue to monitor water quality according to the rotational river basin monitoring schedule as allowed by resources. In addition, assessments may include local citizen-volunteer monitoring through the Alabama Water Watch Program and/or data collected by agencies, universities, or other entities using standardized monitoring and assessment methodologies. Core management measures will include, but not be limited to water quality improvements and designated use support, preserving and enhancing public health, enhancing ecosystems, pollution prevention and load reductions, implementation of NPS controls, and public awareness and attitude/behavior changes.

6.2 Point Source Approach

Point source reduction is not necessary to meet the TMDL for Rock Creek
.

7.0 *Follow Up Monitoring*

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

River Basin Group	Schedule
Cahaba / Black Warrior	2002
Tennessee	2003
Choctawhatchee / Chipola / Perdido-Escambia / Chattahoochee	2004
Tallapoosa / Alabama / Coosa	2005
Escatawpa / Upper Tombigbee / Lower Tombigbee / Mobile	2006

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

8.0 *Public Participation*

A sixty-day public notice was provided for this TMDL. During this time, the availability of the TMDL was public noticed, a copy of the TMDL was provided as requested, and the public was invited to provide comments on the TMDL.

Appendix 9.1
References

References

Bingham, R.H.. 1982. Low-Flow Characteristics of Alabama Streams. Geological Survey Water-Supply Paper 2083

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-00

Alabama Department of Environmental Management. 1992. Alabama Clean Water Strategy Water Quality Assessment Report. Alabama Department of Environmental Management

United States Environmental Protection Agency Region IV Sediment Oxygen Demand (SOD) Database

1997 Rock Creek Monthly Sampling Data

STATION	DATE	TIME	T/A °C	T/W °C	pH	DO	F. COLI.	COND.	TURB.	HARD	$CBOD_5$	TSS	TDS	ORTHO P	NO_2+NO_3-N	TKN	PO_4-P	DEPTH	WIDTH	FLOW
RCK-1	06/11/1997	10:45	20	16.6	6.42	9.06	175	30	8.6	30	0.6	4	44	<.005	0.988	0.42	0.067	2	54	77.8 cfs
RCK-2	06/11/1997	11:15	24	19.4	6.5	9.1	169	39	10.7	22	0.5	6	48	0.006	1.083	0.406	0.032	3	50	117.6 cfs
RCK-3	06/11/1997	12:35	23	17.7	6.56	8.53	150	38	10	22	0.6	9	44	<.005	1.115	0.317	0.05	1	50	
RCK-4	06/11/1997	12:00	24	19.4	6.71	9	181	39	12.9	20	0.6	12	48	0.006	1.109	1.445	0.036	5.5	66	
RCK-5	06/11/1997	10:15	20	17.2	6.5	8.7	220	45	13.2	22	0.6	7	52	0.009	1.357	0.438	0.065	2.4	20	16.6 cfs
RCK-6	06/11/1997	13:00	24	18.9	6.57	8.5	194	36	9.7	16	0.3	7	45	<.005	1.114	0.203	0.026	3	50	143.2 cfs

STATION	DATE	TIME	T/A °C	T/W °C	pH	DO	F. COLI.	COND.	TURB.	HARD	$CBOD_5$	TSS	TDS	ORTHO P	NO_2+NO_3-N	TKN	PO_4-P	DEPTH	WIDTH	FLOW
RCK-1	07/01/1997	10:30	27	21.7	7	8.41	1760	33	16.5	14	1.5	24	35	0.028	0.733	0.497	0.065			185 cfs
RCK-2	07/01/1997		ROAD OUT COULD NOT GET TO SAMPLE SITE																	236 cfs
RCK-3	07/01/1997	12:05	30	22.9	6.93	7.98	1660	32	28	14	1.8	101	40	0.031	0.723	0.621	0.114			
RCK-4	07/01/1997	11:30	27	20.7	6.93	8.27	1120	34.9	44	24	1.2	84	48	0.05	0.707	0.84	0.148			
RCK-5	07/01/1997	10:55	27	22.7	6.59	8.21	3740	40	46	24	1.6	48	51	0.069	0.943	0.752	0.156			
RCK-6	07/01/1997	10:10	27	21	6.77	8.46	1980	32	29	24	1.3	70	42	0.036	0.722	0.725	0.113			fast

STATION	DATE	TIME	T/A °C	T/W °C	pH	DO	F. COLI.	COND.	TURB.	HARD	$CBOD_5$	TSS	TDS	ORTHO P	NO_2+NO_3-N	TKN	PO_4-P	DEPTH	WIDTH	FLOW
RCK-1	08/05/1997	14:20	33	26.2	7.08	7.26	200	47.5	1.5	40	1.9	1	49	<.005	0.192	0.62	0.051	0.7	43	0.2 cfs
RCK-2	08/05/1997	10:50	27.5	23.5	6.37	6.73	45	74	15.7	42	1.5	6	70	0.007	0.072	0.548	0.052	0.2	14	0.6 cfs
RCK-3	08/05/1997	12:10	33	26.7	7.01	6.42	47	44.8	3.5	34	1.2	4	48	<.005	0.205	0.356	0.045	0.5	40	
RCK-4	08/05/1997	15:10	33.5	28.5	7.17	7.67	52	41.9	2.1	38	1.2	1	44	<.005	0.15	0.449	0.044	0.8	43	
RCK-5	08/05/1997	13:55	32	26.6	7.04	4.81	10	48.4	15.6	32	1.6	6	60	0.006	0.124	0.5	0.077	1.1	20	0.1 cfs
RCK-6	08/05/1997	11:20	32	25.9	7.35	7.57	132	52.8	16.6	34	1.6	12	57	0.005	0.262	0.579	0.058	0.35	42.5	1.5 cfs

STATION	DATE	TIME	T/A °C	T/W °C	pH	DO	F. COLI.	COND.	TURB.	HARD	$CBOD_5$	TSS	TDS	ORTHO P	NO_2+NO_3-N	TKN	PO_4-P	DEPTH	WIDTH	FLOW
RCK-1	09/02/1997	13:30	35	24.5	6.6	6.5	not coll	60.9	2	44	1.8	<1	50	<.005	0.039	0.368	0.035	1	50	none
RCK-2	09/02/1997	13:50	35	30.5	6.47	6.05	not coll	98.8	750	58	1.6	484	93	<.005	0.256	1.741	0.555	0.4	10	none
RCK-3	09/02/1997	11:00	33	24.5	6.62	7.12	not coll	52.3	6.1	50	1.9	1	56	0.006	0.282	0.474	0.055	0.5	30	very slow
RCK-4	09/02/1997	11:40	30	25.3	6.69	6.9	not coll	59	3.7	54	1.6	<1	60	<.005	0.099	0.478	0.032	0.7	43	very slow
RCK-5	09/02/1997	13:00	30	26.2	6.84	6.8	not coll	126.1	87	80	2.7	28	140	<.005	0.155	0.845	0.106	1.5	20	none
RCK-6	09/02/1997	14:20	33	27.5	6.9	7.9	not coll	48.9	5.4	30	2.1	2	49	0.008	0.371	0.507	0.105	0.2	45	slow

1997 Rock Creek Intensive Survey

Station	Date	Time	T/A C	T/W C	pH	DO mg/l	F. Coli org/100ml	Cond umho/cm	Turb NTUs	Hard mg/L	CBOD5 mg/L	TSS mg/L	TDS mg/L	Ortho P mg/L	PO4-P mg/L	Depth M	Flow cfs
RCK-1	05/20/1997	19:49	21	19	6	8.23		46	3.14							0.2	
RCK-2	05/20/1997	18:36	21	19	7	8.65		52	4.98							0.2	
RCK-3	05/20/1997	18:05	22						3.33								
RCK-4	05/20/1997	16:47	25	21	6	8.33		49	3.63							0.4	18.6
RCK-5	05/20/1997	19:24	20	20	6	7.6		56	13.9							0.1	
RCK-6	05/20/1997	17:18	25	19	6	8.34		47	2.83							0.3	
RCK-1	05/21/1997	11:05	21	17	6	8.6	40	51	3.35	18	1.7	1k	59	0.005	0.038	0.3	3.43
RCK-2	05/21/1997	10:43	19	17	6	8.33	56	53	5.23	22	1.6	1	58	0.008	0.038	0.3	6.19
RCK-3	05/21/1997	10:13	18	18	6	8.69	33	51	3.12	20	1.7	1k	63	0.005	0.038	0.3	
RCK-4	05/21/1997	9:32	17	19	6	8.26	28	51	3.42	22	1.7	1k	60	0.005	0.038	0.6	
RCK-5	05/21/1997	11:24	24	18	6	7.87	77	56	21.7	22	1.6	8	59	0.003	0.049	0.2	
RCK-6	05/21/1997	9:56	18	18	6	8.16	24	48	3.06	22/24	2.0/2.2	6/1k	72/66	0.009	0.035/0.036	0.7	9.71
RCK-1	05/21/1997	18:29	23	18	6	9.32		50	3.75							0.3	
RCK-2	05/21/1997	19:02	26	19	7	9.6		51	5.58							0.2	
RCK-3	05/21/1997	20:13	25	20	7	9.33		51	3.55							0.1	
RCK-4	05/21/1997	20:29	23	20	7	8.92		51	3.64							0.6	20.1
RCK-5	05/21/1997	19:25	21	19	6	8.45		56	17.1							0.2	1.17
RCK-6	05/21/1997	19:09	26	19	6	8.83		48	3.19							0.3	
RCK-1	05/22/1997	16:07	21	16	6	8.84	58	49	3.14	22/20	1.7/1.8	1	1.7/1.8	0.004k	0.0350.035	0.2	2.91
RCK-2	05/22/1997	15:28	19	15	6	8.49	72	51	5.18	20	1.7	1	1.7	0.005	0.038	0.3	5.27
RCK-3	05/22/1997	17:13	18	17	6	8.95	34	50	3.44	16	2	1	2	0.005	0.037	0.1	
RCK-4	05/22/1997	17:16	16	17	6	8.22	58	50	3.33	16	1.9	1	1.9	0.005	0.038	0.3	18.6
RCK-5	05/22/1997	17:40	19	17	6	8.16	192	55	32.7	40	1.9	4	1.9	0.004	0.058	0.1	0.8
RCK-6	05/22/1997	16:45	17	16	6	8.28	176	48	2.91	20	2	2	2	0.015	0.035	0.3	8.31

1988 Clean Water Strategy Study

STATION	DATE	TIME	T/W °C	pH	DO	$CBOD_5$	NO_2+NO_3-N	PO_4-P	FLOW
			°C	SU	mg/l	mg/l	mg/l	mg/l	cfs
RCK-1	06/30/1988	9:00 AM	21	5.7	2.6	1.8	0.08	0.04	
RCK-2	06/30/1988	8:30 AM	23	5.4	4.5	1.6	0.08	0.04	
RCK-3	06/30/1988	9:50 AM	23	5.6	5.4	1.6	0.02	0.04	103.8

STATION	DATE	TIME	T/W °C	pH	DO	$CBOD_5$	NO_2+NO_3-N	PO_4-P	FLOW
			°C	SU	mg/l	mg/l	mg/l	mg/l	cfs
RCK-1	07/19/1988	10:45 AM	24.5	6.7	3.7	1.7	0.74	0.6	25.1
RCK-2	07/19/1988	10:00 AM	25.3	6.8	4.9	1.2	0.48	0.03	
RCK-3	07/19/1988	1:25 PM	27.8	6.7	5.4	3.6	0.46	0.03	2.05.4

STATION	DATE	TIME	T/W °C	pH	DO	$CBOD_5$	NO_2+NO_3-N	PO_4-P	FLOW
			°C	SU	mg/l	mg/l	mg/l	mg/l	cfs
RCK-1	08/08/1988	11:00 AM	22	6.7	4.2	1	0.05	0.02	
RCK-2	08/08/1988	11:30 AM	23	6.2	5	1.2	0.06	0.02	
RCK-3	08/08/1988	12:15 PM	23	6.4	5.4	1	0.04	0.02	

STATION	DATE	TIME	T/W °C	pH	DO	$CBOD_5$	NO_2+NO_3-N	PO_4-P	FLOW
			°C	SU	mg/l	mg/l	mg/l	mg/l	cfs
RCK-1	09/27/1988	12:30 PM	20.7	6.6	8.4	1	1.06	0.04	
RCK-2	09/27/1988	2:15 PM	22.5	7	8.2	1	1	0.02	
RCK-3	09/27/1988	1:20 PM	22.3	6.8	8	1	1.18	0.02	

STATION	DATE	TIME	T/W °C	pH	DO	$CBOD_5$	NO_2+NO_3-N	PO_4-P	FLOW
			°C	SU	mg/l	mg/l	mg/l	mg/l	cfs
RCK-1	10/25/1887	11:25 AM	10.5	6.8	9.6	1.1	0.02	0.74	
RCK-2	10/25/1887	10:15 AM	11	6.7	10.6	1	0.2	0.49	
RCK-3	10/25/1887	12:00 PM	12	7.6	9.6	1	0.2	0.02	

Data from
Alabama Clean Water Strategy
Water Quality Assessment Report
December 1992

The samples were taken in 1991
Location: at Count Road 39 bridge, north east of Addison

BLACK WARRIOR RIVER BASIN SAMPLING DATA

Station	Date	Time	H_2O Temp. (deg. C)	pH (S.U.)	D.O. (mg/l)	Cond.	$CBOD_5$ (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	NO_2+NO_3-N (mg/l)	PO_4-P (mg/l)	T-PO_4 (mg/l)	bacteria org/100ml
Rock	June 4	07:10	21.0	8.1	7.4	45	0.8	0.28	0.38	0.81		0.03	17000
Creek	July 9	09:45	23.0	7.2	6.1	56	1.4	0.00	0.46	0.24		0.01	860
(F&W)	August 8	10:30	25.0	7.2	4.8	60	2.0	0.02	0.57	0.01		0.01	10
	Sept 9	11:30	22.0	8.3	5.2	51	2.2	0.06	0.72	1.10		0.08	1300
	Oct 7	11:30	13.0	7.1	8.9	68	2.4	0.06	0.59	0.27		0.02	90

1997 Black Warrior NPS Screening Assessment

Table 3b. Habitat quality and aquatic macroinvertebrate assessments from the Sipsey Fork cataloging unit. In order to compare levels of habitat degradation between stations, values each of three major habitat parameters are presented as percent of maximum score.

Parameter	Station										
	WHOC-16a	WHEC-17a	ROCW-52b	SANW-12a	CRK-3	CANW-13a	MILW-18a	CLCW-53b	CLCW-53c	CROC-54a	TPSL-1
Habitat assessment form	RR	RR	RR	RR	GP	RR	RR	RR	RR	GP	RR
Instream habitat quality	92	85	93	75	70	38	53	25	22	77	75
Sediment deposition	93	78	90	35	37	40	25	8	10	74	69
% Sand	14	20	10	45	39	45	43	70	88	39	20
% Silt	10	8	5	2	5	10	10	2	3	5	2
Sinuosity	90	80	75	65	35	75	25	10	3	34	68
Bank and vegetative stability	65	65	48	75	68	50	15	60	43	68	67
Riparian zone measurements	65	65	48	75	68	50	15	60	43	80	93
% Canopy cover	70	90	50	50	30	50	20	50	70	30	30
% Maximum Score	78	73	73	66	63	49	42	34	28	72	74
Habitat Assessment Category	Excellent	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Excellent
EPT Taxa Collected	13	14	12	14	----	11	3	8	8	9	16
Aq. Macroinvertebrate Assess.	Unimp.	Unimp.	Unimp.	Unimp.	----	Unimp.	Sev. Imp	Sl. Imp.	Sl. Imp.	Sl. Imp.	Unimp.

	BRUW-14f	CPSY-1	RUSW-1	BEEW-1	BRSH-1	SF-1	SF-2	Ryan-Aub	Crooked-Aub	Rock-Aub	Blevens-Aub
Habitat assessment form	RR	RR	RR	GP	GP	Original	Original	Original	Original	Original	Original
Instream habitat quality	79	85	61	62	68	31	73	83	83	83	83
Sediment deposition	70	80	63	55	60	52	45	96	100	90	92
% Sand	30	15	35	53	45	80	73	4	2	12	15
% Silt	5	5	2	5	2	1	2	2	0	2	2
Sinuosity	85	75	40	40	40	63	63	67	67	73	80
Bank and vegetative stability	48	70	65	68	60	78	80	100	100	100	100
Riparian zone measurements	93	90	93	90	88	80	80	100	100	100	90
% Canopy cover	90	90	90	30	70	70	30	30	50	10	30
% Maximum Score	73	80	64	66	65	53	63	80	91	81	90
Habitat Assessment Category	Good	Excellent	Good	Good	Good	Good	Good	Excellent	Excellent	Excellent	Excellent
EPT Taxa Collected	16	13	14	13	12	9	15	10	10	12	
Aq. Macroinvertebrate Assess.	Unimp.	Unimp	Unimp	Unimp	Unimp	Sl. Imp	Unimp.	Sl. Imp.	Unimp	Unimp.	Sl. Imp.

* 'original' from Plafkin et al (1989); RR (Riffle Run) or GP (Glide Pool) assessment from Barbour and Stribling (1994).
"-Aub" station data from Webber et al. (1994)

1997 Black Warrior NPS Screening Assessment

Table 4b. Results of fish IBI assessments conducted within the Sipsey Fork cataloging unit by the GSA and the ADEM in September 1997 (O'Neil & Shepard 1998) and Auburn in 1993.

	Assessment Sites									
	ROCW-52a	CROC-54b	CLCW-53b	CLCW-53c	SANW-12a	Ryan-Aub*	Crooked-Aub*	Rock-Aub*	Blevens-Aub*	Rush-Aub*
Collection time (min.)	30	30	30	30	30					
Collection Date	09/09/1997	09/09/1997	09/10/1997	09/10/1997	09/10/1997	1993	1993	1993	1993	1993
Area (sq mi)	27	23	20	23	16					
Richness measures										
# total species	12	10	9	11	12	19	16	21	17	21
# darter species	1	1	1	1	3	2	2	3	3	4
# minnow species	5	4	4	4	4					
# sunfish species	3	2	1	1	2	4	4	4	3	3
# sucker species	0	0	2	1	1	2	1	2	1	3
Tolerance/ intolerance										
# intolerant species	0	0	0	0	0	0	0	2	2	2
Trophic measures										
# individuals	303	404	91	69	45	1684	896	1162	1035	151
% omnivores and herbivores	16	7	0	0	11	0	0	3	0	0
% top carnivores	18	3	6	13	2	2	4	2	3	7
Composition measures										
% insectivorous cyprinids	59	75	77	43	47	8	38	27	40	39
% sunfish	2	8	4	1	4					
Community health measures										
# collected/ hour	606	808	182	138	90					
% with disease/ anomalies	8	0	0	0	31	0	0	0	0	0
IBI Score	38	42	39	37	40	46	44	50	46	54
Assessment	Poor-Fair	Fair	Poor-Fair	Poor-Fair	Fair	Good-Fair	Fair	Good	Good-Fair	Excel-Good

* Webber et al (1994)

Appendix 9.3
Water Quality Model
Input and Output Files

SUMMER TMDL MODEL

CALIBRATED MODEL

LOAD REDUCTION MODEL

9.4
Spreadsheet Water Quality Model (SWQM) User Guide