

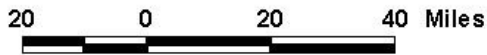
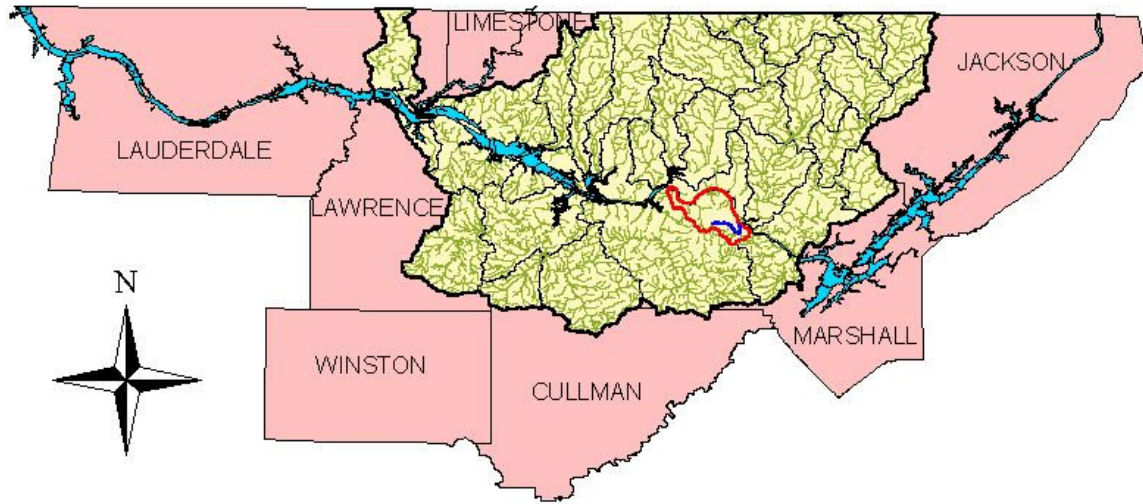









Alabama Department of Environmental Management

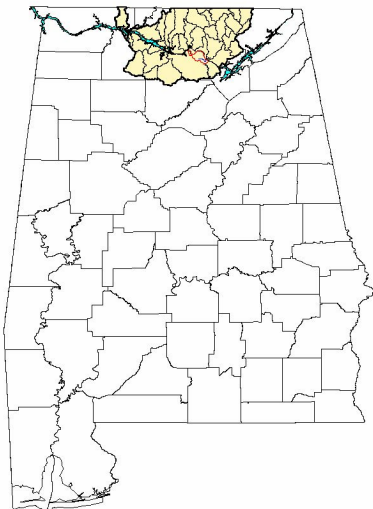
Final TMDL Development for
Cane Creek / AL06030002-220_01
Low Dissolved Oxygen/Organic Loading

Water Quality Branch
Water Division
February 2002

Cane Creek Watershed in the Tennessee River Basin



-  Cane Creek 303(d) Segment
-  USGS CU 06030002-220 Dry Creek Subwatershed
-  USGS Cataloging Unit 06030002
-  Tennessee River
-  USGS CU 06030002 Reaches
-  USGS CU 06030002 Subwatersheds
-  Counties



<i>Table of Contents</i>	<i>Page</i>
1. Executive Summary	4
2. Basis for §303(d) Listing	5
2.1. Introduction	5
2.2. Problem Definition	6
3. Technical Basis for TMDL Development	7
3.1. Water Quality Target Identification	7
3.2. Source Assessment	8
3.3. Loading Capacity - Linking Water Quality Numeric Targets and Pollutant Sources	11
3.4. Data Availability and Analysis	11
3.5. Critical Conditions	14
3.6. Margin of Safety	15
4. Water Quality Model Development	15
4.1. Water Quality Model Selection and Setup	15
4.2. Water Quality Model Summary	16
4.3. Critical Model Predictions and Graphics	19
4.4. Loading Reduction Analysis	20
4.5. Seasonal Variation	20
5. Conclusions	20
6. TMDL Implementation	20
6.1 Non-Point Source Approach	20
6.2 Point Source Approach	22
7. Follow Up Monitoring	23
8. Public Participation	23
9. Appendices	
9.1 References	24
9.2 Water Quality Data	26
9.3 Water Quality Model Input and Output Files	27
9.4 Spreadsheet Water Quality Model (SWQM) User Guide	29

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.

Cane Creek, a part of the Tennessee River Basin, is located in Marshall County near Morgan City, Al. It has been on the State of Alabama's §303(d) use impairment list since 1996 for organic enrichment/low dissolved oxygen (O.E./D.O.). Its use classification is Fish and Wildlife.

Biological data collected by TVA in 1994 and 1995 indicated impaired macroinvertebrate and fish communities. The impairment was attributed to siltation and organic enrichment/low dissolved oxygen but water column sampling was not conducted at the time to support this assumption.

Since D.O. impairments generally occur during the summer months when stream flows are low and water temperatures are high, a steady state modeling approach using the stream's 7Q10 flow (the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval) was adopted as appropriate for this TMDL analysis.

The only additional data obtained, since the TVA data collection in 1994 and 1995, was collected in 1998 by ADEM. In 1998 samples were taken from one station in May, July, and September. None of these samples showed a D.O. violation during measurable flows. Due to the fact that no violations have been recorded for Cane Creek when a measurable flow was present, no reductions were calculated for the watershed. In this report only the TMDL for the critical period was calculated. If additional data shows that Cane Creek is impaired for D.O., the TMDL will be revised to include the necessary reductions. As part of TMDL implementation additional monitoring of Cane Creek is planned for 2003.

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 below. 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 allowable pollutant loadings by source (point and non-point sources) for the summer (Critical) season (May through November).

Table 1-1. Maximum Allowable Pollutant Loads by Source (Critical)

Pollutant	Point Source Loads (lbs./day)	Non-point Source Loads (lbs./day)
CBOD _u	0	6.1
NBOD	0	3.5
Total	0	9.6

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 classification. The identified waters are prioritized based on severity of pollution with respect to designated use classification. 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 Cane Creek as being impaired by organic loading (i.e., CBOD_u and NBOD) for a length of 7.45 miles, as reported on the 1996, 1998 and Draft 2000 §303(d) list(s) of impaired waters. Cane Creek is prioritized as “low ” on the

list(s). Cane Creek is located in Marshall County and lies within the Cane Creek subwatershed of the Tennessee River Basin.

The TMDL developed for Cane 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

Cane Creek is a small headwater stream with a relatively small drainage area of 11.92 square miles. Dry weather flows for the watershed are relatively low. Information collected in 1994 and 1995 by the Tennessee Valley Authority identified dissolved oxygen impairments for Cane Creek based on the Macroinvertebrate/EPT and Fish/IBI Biological Data. There was no flow or chemical data used to support this listing. Data collected by ADEM during May-Sept 1998 did not indicate D.O. violations during measurable flows. If there are recurring depressed in-stream D.O. concentrations in Cane Creek they may be caused by several sources including the decay of oxygen demanding waste from 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 not the result of algal dynamics.

<u>Waterbody Impaired:</u>	Cane Creek from Gooch Creek to the Tennessee River
<u>Water Quality Standard Violation:</u>	Dissolved Oxygen
<u>Pollutant of Concern:</u>	Organic Enrichment (CBOD _u /NBOD)
<u>Water Use Fish and Wildlife:</u>	Fish and Wildlife

The impaired stream segment, Cane Creek, is classified as Fish and Wildlife. Usage of waters in this Fish and Wildlife 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 Fish and Wildlife 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.

Low D.O./Organic Loading Criteria:

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_t 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 CBOD_u 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 Cane 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. From a search of the database no point sources were found in the modeled portion of the Cane Creek watershed.

3.2.3. Non-Point Sources in the Cane Creek Watershed

Shown in Table 3-1, below, is a detailed summary of land usage in the Cane Creek watershed. A land use map of the watershed is presented in Figure 3-1. The predominant land uses within the watershed are forest and pasture and cropland. Their respective percentages of the total watershed are 79.8%, 10.3% and 7.3%.

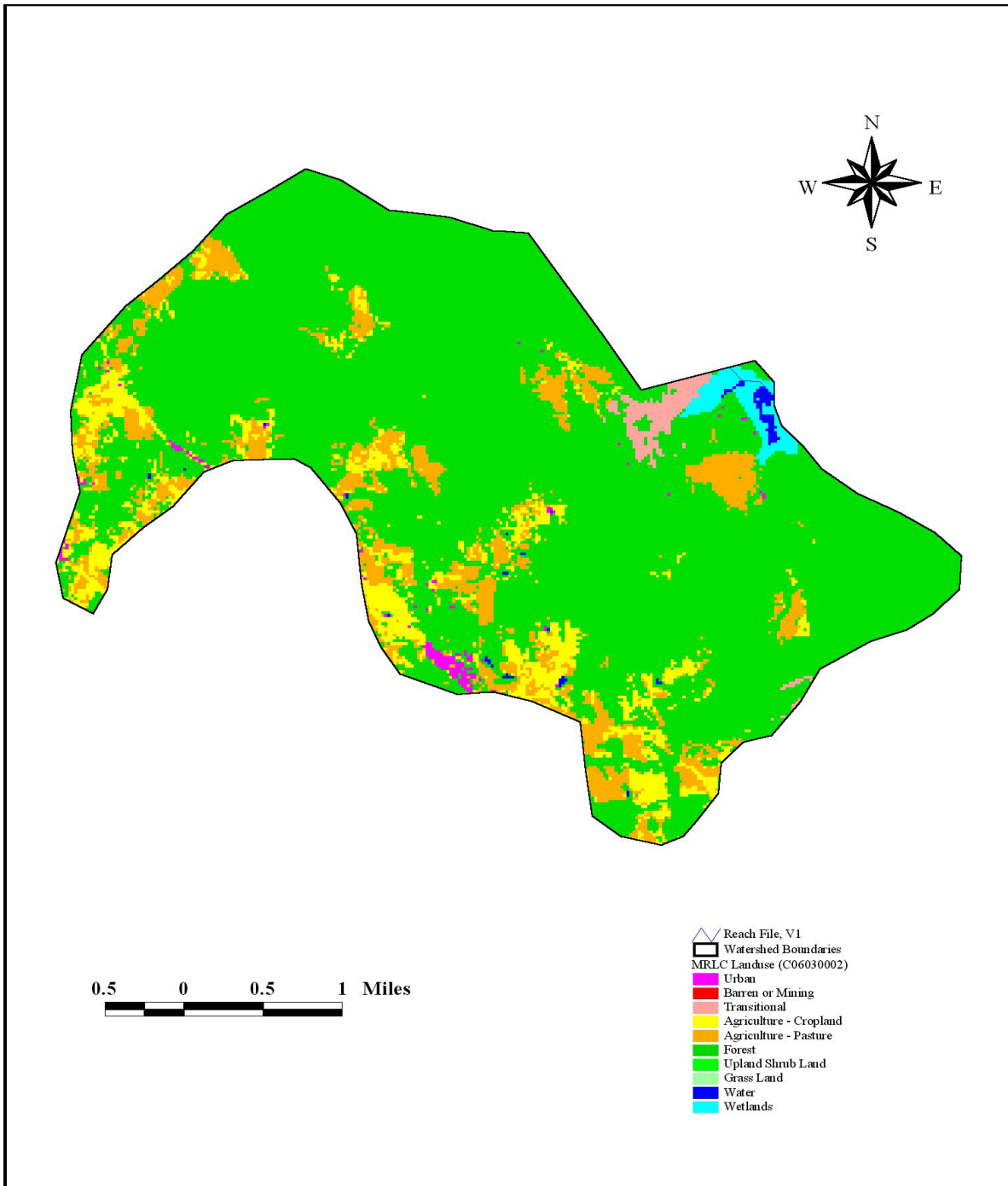
Table 3-1. Land Use in the Cane Creek Watershed

LANDUSE for Cane Creek	acres	sq miles	% of total
Cropland	559	0.87	7.3
Forest	6082	9.50	79.8
High Commercial/Industrial/Transportation	23	0.03	0.3
Residential	19	0.03	0.3
Pasture	784	1.23	10.3
Transitional	87	0.14	1.1
Open Water	18	0.03	0.2
Other	57	0.09	0.7
Total	7629	11.92	100%

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 Cane Creek watershed are the forest; cropland and pasture 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 3-1. Land Use Map for the Cane 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-(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.

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 considered to be as follows: 2 mg/l CBOD_u, 0.5 mg/l ammonia oxygen demand (NH₃OD_u), and 1 mg/l total organic nitrogen oxygen demand (TONOD_u). 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.

3.4 Data Availability and Analysis

3.4.1. Watershed Characteristics

A. **General Description**: Cane Creek, located in Marshall County, is a tributary to the Tennessee River. Cane Creek is a part of the USGS (United States Geological Survey) 06030002 cataloging unit and the NRCS (Natural Resources Conservation Service) 220 sub-watershed. Cataloging unit 06030002 represents the Wheeler Lake of the Tennessee basin. NRCS sub-watershed number 220 represents the Dry Creek subwatershed.

B. **Geological Description**: Mississippian-age limestone, chert, shale, and dolomite predominate, with springs, sinks, and caves being formed by solution of the limestone.

C. Eco-region Description: Cane Creek is primarily in the following Eco-region: The Eastern Highland Rim has more level terrain and weaker dissection than the Western Highland Rim (71f), with flat to gently rolling landforms. Mississippian-age limestone, chert, shale, and dolomite predominate, and springs, sinks, and caves have formed by solution of the limestone. Cave and spring-associated fish fauna also typify the region. In the southern part of the region, streams flow down from the Pottsville Escarpment of ecoregion 68, cutting north across the Moulton Valley and through narrow valleys of Little Mountain (71j) to the impounded Tennessee River. Natural vegetation for the region is transitional between the oak-hickory type to the west and the mixed mesophytic forests of the Appalachian ecoregions to the east. Much of the original bottomland hardwood forest has been inundated by impoundments. The flatter areas in the east and on both sides of the Tennessee River have deep, well-drained, reddish, productive soils that are intensively farmed.

D. Other Notable Characteristics: The Cane Creek modeled reach begins approximately 2.5 miles Northwest of Morgan City, Alabama in Section 24, Township 6S, and Range 1W and extends to the Wheeler Reservoir. It has a linear distance of 7.45 miles and a total drainage area of 11.92 square miles. Cane Creek has a use classification of Fish & Wildlife (F&W).

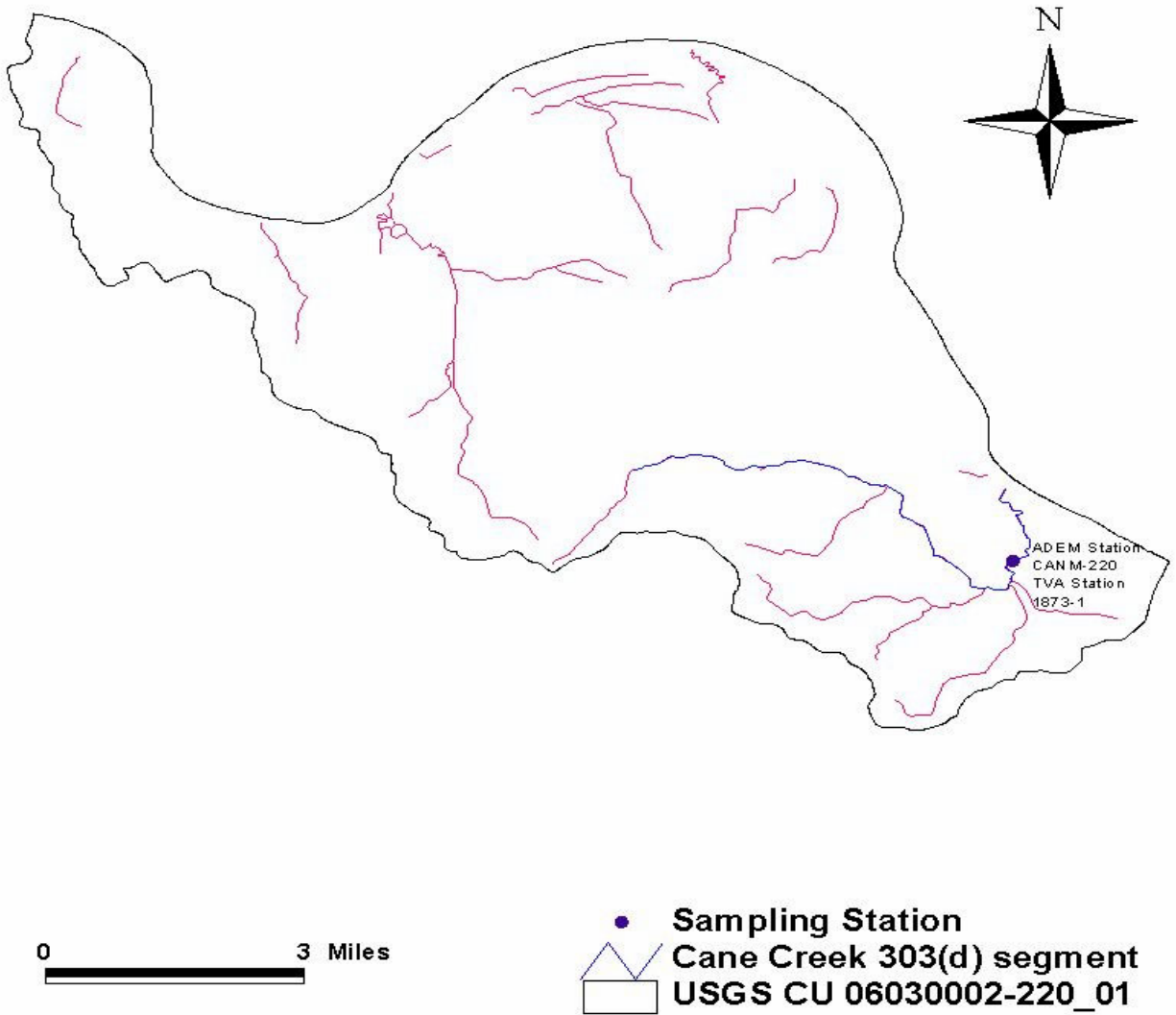
3.4.2 Available Water Quality and Biological Data

Water Quality and biological data for the Cane Creek is available for the period of 1995 and 1998. This data was collected by TVA in 1995 and by ADEM in 1998. Station 1873-1 is located at Greenbrier Road Bridge, Macroinvertebrate/EPT and Fish/IBI Biological Data was collected here. There was no flow or chemical data collected. In 1998 ADEM sampled one station, three times. This station was CANM-220 located at Greenbrier Road Bridge near Morgan City, Alabama. The data collected had no D. O. violations for any sampling event that had flow for the period of record.

Due to the fact that there was no D. O. violations during a sampling event that had flow, an existing load of pollutants to Cane Creek was not calculated at this time. In this report only the TMDL for the critical period was calculated. Additional data will be necessary to calculate the required reductions, if necessary, to achieve the TMDL. Dissolved oxygen (D.O.) data for Cane Creek was not used in this TMDL because the sampling events recorded either an unmeasurable flow or a no flow condition, see Water Quality Data Appendix 9.2.

A map indicating the location of sampling points is presented in Figure 3-2.

Figure 3-2. Map of Sampling Location for the Cane Creek Watershed.



3.4.3. Flow data

For the purpose of this TMDL, an annual 7Q₁₀ stream flow for the Critical (summer) period was employed. This flow represents worst-case scenario for the critical period model evaluation. The use of worst-case conditions, in turn, creates a margin of safety in the final results.

The 7Q₁₀ flow represents the minimum 7-day flow that occurs, on average, over a 10-year recurrence interval.

The 7Q₁₀ flow 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 7Q₁₀ flow 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, mi²), and the mean annual precipitation (P, inches):

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

The resulting Headwater 7Q₁₀ and End of Reach 7Q₁₀ flows are as follows:

Drainage Area at Headwater =	2.1	sq. miles
Drainage Area at End of Reach =	11.92	sq. miles
7Q ₁₀ at Headwater =	0.0	cfs
7Q ₁₀ at End of Reach =	0.20	cfs
G =	50	
A =	11.92	
P =	54	

The calculated flows were distributed over Cane Creek in the form of incremental inflow. The incremental flow 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 stream's 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.

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 by specifying 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 7Q₁₀ stream flows employed for this TMDL, respectively, reflect the lowest flows that would normally occur under critical conditions. 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. In addition water depths are shallow which aggravates the effect of sediment oxygen demand (SOD). Water velocities are sluggish, generally 0.5 fps or less, which intensifies the effect of BOD decay.

4.0 Water Quality Model Development

4.1 Water Quality Model Selection 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:

- D.O. concentrations for incremental flow were assumed @ 70% of the saturated value at the given temperature. (MOS)
- Incremental and tributary loading were apportioned to correlate with the land usage of the drainage basin.
- Ratios for $CBOD_u/NH_3-N$ and $CBOD_u/TON$ were calculated using water quality data for the waterbody. These ratios were assigned in the estimation of loading parameters for incremental flow and tributaries for all land uses, except forest and open water.
- $CBOD_u/CBOD_5$ ratio used for nonpoint source was 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 $CBOD_u$, 0.11-0.22 mg/l NH_3-N , 0.22-0.44 mg/l TON.

4.1.1. SOD Representation: Sediment oxygen demand (SOD) can be an important part of the oxygen demand budget in shallow streams. There was no available field SOD measurements for this waterbody; therefore SOD data was obtained from the 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 /ft²/day for a stream with similar characteristics (sand and gravel) was chosen from the database and applied to the model for Cane Creek.

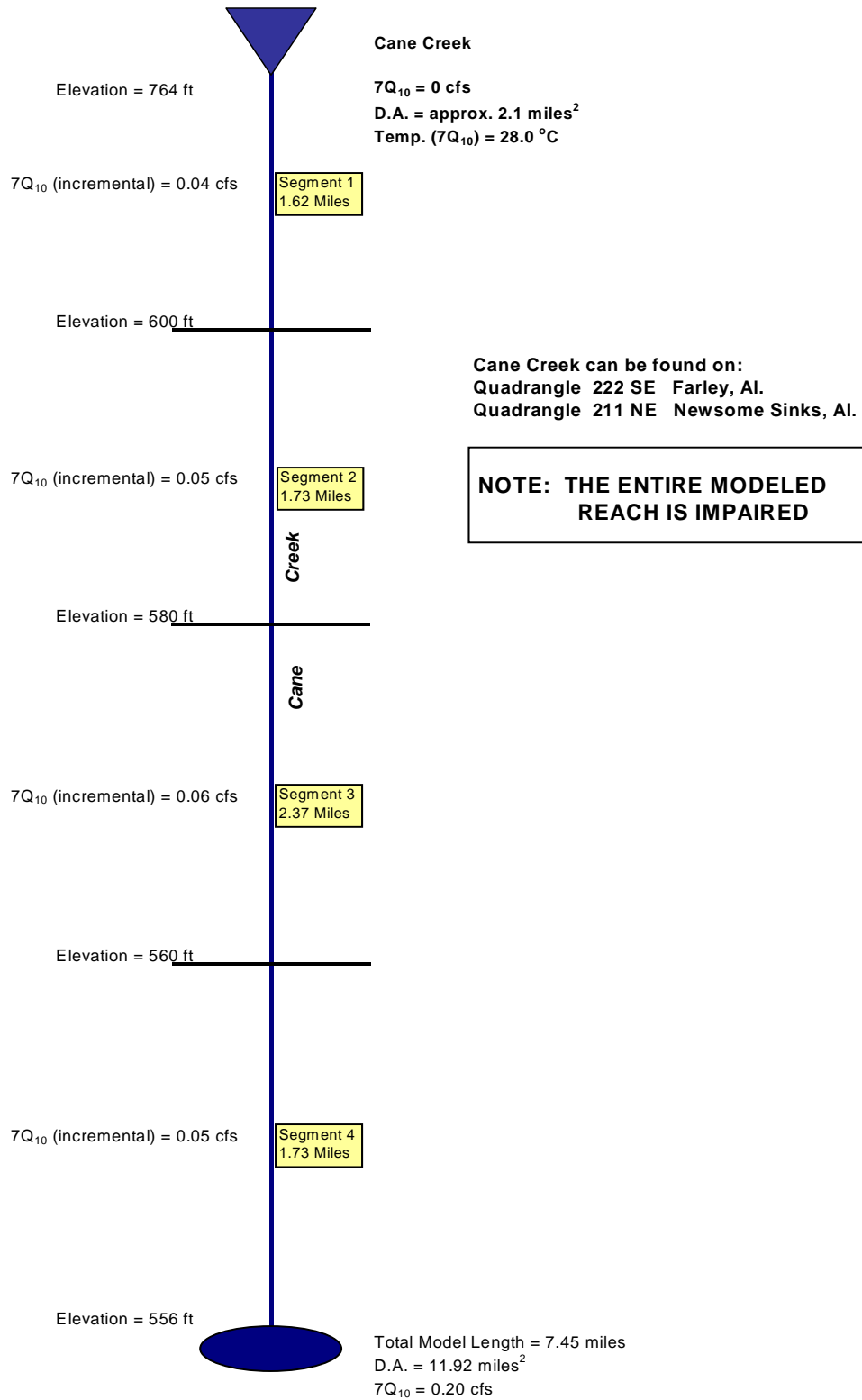
4.1.2. Calibration Data: From an examination of the available field data (ref: Appendix) it was determined that there was not sufficient data available to calibrate the model. The only D.O. violation occurred during a essentially zero flow sampling event; therefore, no calibration run was performed.

4.2 Water Quality Model Summary

The model reach consisted of 4 segments. The length of the impaired portion is 7.45 miles. A schematic diagram of the model is presented in Figure 4-1. Assumed in-stream seasonal 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

Cane Creek (Gooch Creek to Tennessee River)



4.2.1. TMDL Model

Stream Flow Parameters

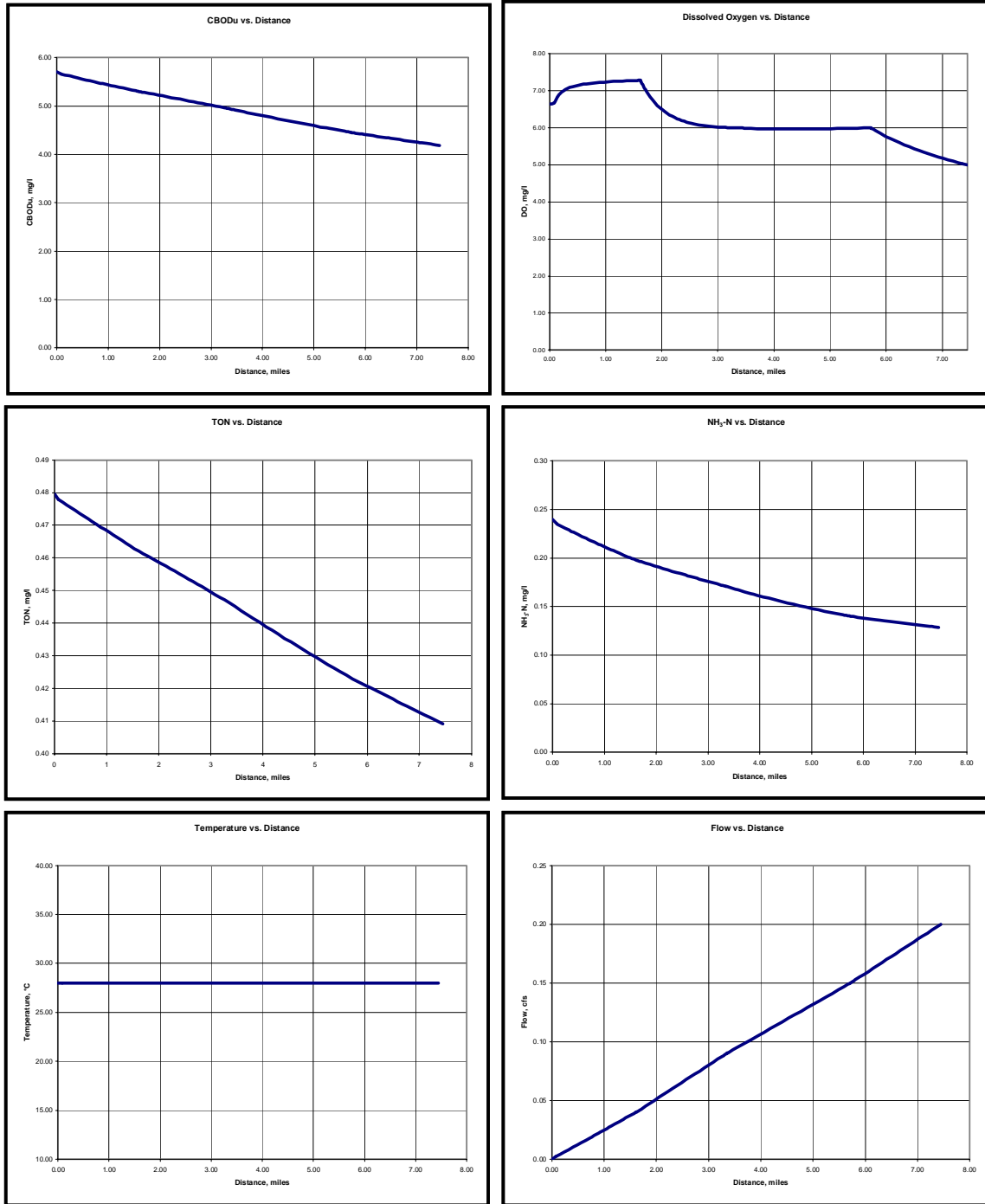
Description	Flow (cfs)	D. O. (mg/l)	CBOD _U (mg/l)	NH ₃ -N (mg/l)	TON (mg/l)	Temp (°C)
Headwaters	0.0	6.65	5.70	0.24	0.48	28
Conditions @ Lowest D.O.	0.20	5.00	4.19	0.13	0.41	28
Flow @ End of Model	0.20	5.00	4.19	0.13	0.41	28

Incremental Flow Parameters

Sections	CBOD _U (mg/l)	NH ₃ -N (mg/l)	TON (mg/l)	D. O. (mg/l)	Total Flow (cfs)	Temp. (°C)
1	5.70	0.24	0.48	5.48	0.04	28
2	5.70	0.24	0.48	5.48	0.05	28
3	5.70	0.24	0.48	5.48	0.06	28
4	5.70	0.24	0.48	5.48	0.05	28

4.3 TMDL Models Predictions and Graphics

Figure 4-2. TMDL Model Predictions.



4.4 Load Reduction Analysis

4.4.1. Required Reductions

- Currently there is not enough data to show enough confidence to calculate reductions.
- Additional data is required before reductions can be calculated.

4.5 Seasonal Variation

The regulations require that a TMDL be established with consideration of seasonal variations. Since most D.O. impairments occur during the summer months and not during other times of the year and no point sources were in the watershed, a seasonal variation in this TMDL was not necessary. It was assumed that the summer months would be the critical period.

5.0 Conclusions

A summary of the TMDL for the critical period is presented in Table 5-1.

Table 5-1. TMDL Summary

	CRITICAL TMDL
CBOD_u Loading (lbs./day)	6.1
NBOD Loading (lbs./day)	3.5
Total Loading (lbs./day)	9.6

The total loading consists only of load allocations. There are no point sources in this watershed.

6.0 TMDL Implementation

6.1 Non-Point Source Approach

Cane Creek is impacted solely by nonpoint sources. Due to the fact that there was no D.O. violations during a sampling event that had flow, an existing load of pollutants to Cane Creek was not calculated at this time. In this report only the TMDL for the critical period was calculated. Until additional data is collected that shows a D.O. violation, no reductions will be required. Collecting additional data will be a major part of the implementation plan. ADEM will be sampling in the Tennessee River Basin in 2003.

Cane Creek will be part of this sampling effort. Once adequate data is obtained the TMDL will be revised to calculate the required reductions, if applicable.

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

At the present time there are no point sources in this watershed; therefore, no permit limits will need to be revised.

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

Cane Creek will be a part of the Tennessee River Basin sampling effort in 2003. Once sufficient data is obtained the TMDL will be revised to calculate the required reductions, if applicable. 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

Adkins, J.B., Pearman, J.L.. 1994. Low-Flow and Flow-Duration Characteristics of Alabama Streams. Water-Resources Investigations Report 93-4186.

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

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

Appendix 9.2 Water Quality Data

Appendix D-1, cont. Results of physical and chemical measurements and water quality samples collected from stations included as part of the nonpoint source watershed screening and CWA §303(d) segment evaluations of the Tennessee Basin, 1998.

Sub-Watershed Number	Station Number	Date (YYMMDD)	Time (24hr)	Water Temp. (C)	Dissolved Oxygen (mg/l)	pH (s.u.)	Flow (cfs)	Fecal Coliform (col/100ml)	TSS (mg/l)	TDS (mg/l)	NO2/NO3 (mg/l)	T-PO4 (mg/l)	TKN (mg/l)	BOD-5 (mg/l)	Hardness (mg/l)
Wheeler Lake (0603-0002)															
220	CANM-220	980706	1100	26	4.8	7.0	0	>1200	90	183	0.08	0.303	2.493	4.4	140
220	CANM-220	980908	1105	24	4.0	6.5	0	220	11	227	0.007	0.066	2.008	3.9	188
220	CANM-220	980511	1030	21	5.0	7.2	High	156	4	122	0.197	0.075	0.388	1.3	

TVA Macroinvertebrate/EPT and Fish/IBI Biological Data. 1994-95

Station	Waterbody	Bug Health	EPT*	Fish Health	IBI*	Causes	Sources
1873-1	Cane Cr	Poor	3	Poor	26	silt, nutrients	Ag NPS

Appendix 9.3 Water Quality Model Input and Output Files

Summer TMDL Model

Appendix 9.4
Spreadsheet Water Quality Model
(SWQM) User Guide