Total Maximum Daily Load

Evaluation

for

McFarland Branch

in

Tennessee River Basin

for

Dissolved Oxygen

Submitted to:

The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years (GA EPD, 2000-2001).

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and to restore and maintain water quality.

The State of Georgia has identified one stream segment, McFarland Branch, located in the Tennessee River Basin, as water quality limited due to dissolved oxygen (DO). This waterbody was included in the State's 2002 303(d) list. This report presents the dissolved oxygen TMDL for this segment.

Part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of oxygen demanding substances on land surfaces that wash off as a result of storm events.

The process of developing the dissolved oxygen TMDL for McFarland Branch included developing a computer model for the impaired segment. Georgia DOSAG, a steady state water quality model developed by Georgia Environmental Protection Division (GAEPA), was used. The model was run for critical conditions (i.e., low flow and high temperatures).

Management practices may be used to help reduce and/or maintain the Ultimate Oxygen Demand (UOD) loads. These include:

- Compliance with the requirements of the NPDES permit program,
- Application of Best Management Practices (BMPs) appropriate to nonpoint sources.

The amount of oxygen demanding substances delivered to a stream is difficult to determine. However, by requiring and monitoring the implementation of these practices, their effects will improve stream water quality, and represent a beneficial measure of TMDL implementation.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories with respect to designated uses: 1) supporting, 2) partially supporting, or 3) not supporting. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years (GA EPD, 2000-2001).

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The State of Georgia has identified one stream segment, McFarland Branch, located in the Tennessee River Basin, as water quality limited due to dissolved oxygen (DO). This waterbody was included in the State's 2002 303(d) list. This report presents the dissolved oxygen TMDL loads for the listed segment in the Tennessee River Basin identified in Table 1.

Table 1. Waterbody Listed For Dissolved Oxygen in the Tennessee River Basin

LISTED STREAM	LOCATION	SEGMENT LENGTH (Miles)	STATUS
McFarland Branch	City of Rossville (Walker County)	1	Not Support

1.2 Watershed Description

McFarland Branch is located in the Tennessee River Basin in northwest Georgia. McFarland Branch originates in western Walker County, within the Lookout Mountain range. The stream flows northwest into Tennessee, through the City of Rossville, Georgia, where it joins with Chattanooga Creek, which flows into the Tennessee River after crossing the Georgia-Tennessee state line. McFarland Branch is located in the portion of the Tennessee River Basin contained in the Southern Appalachian Ridge and Valley Ecoregion.

The USGS has divided the Tennessee River Basin into three sub-basins, or Hydrologic Unit Codes (HUCs). McFarland Branch is located in the Tennessee River Bain HUC 06020001. Figure 1 shows the location of this listed dissolved oxygen segment within this HUC.

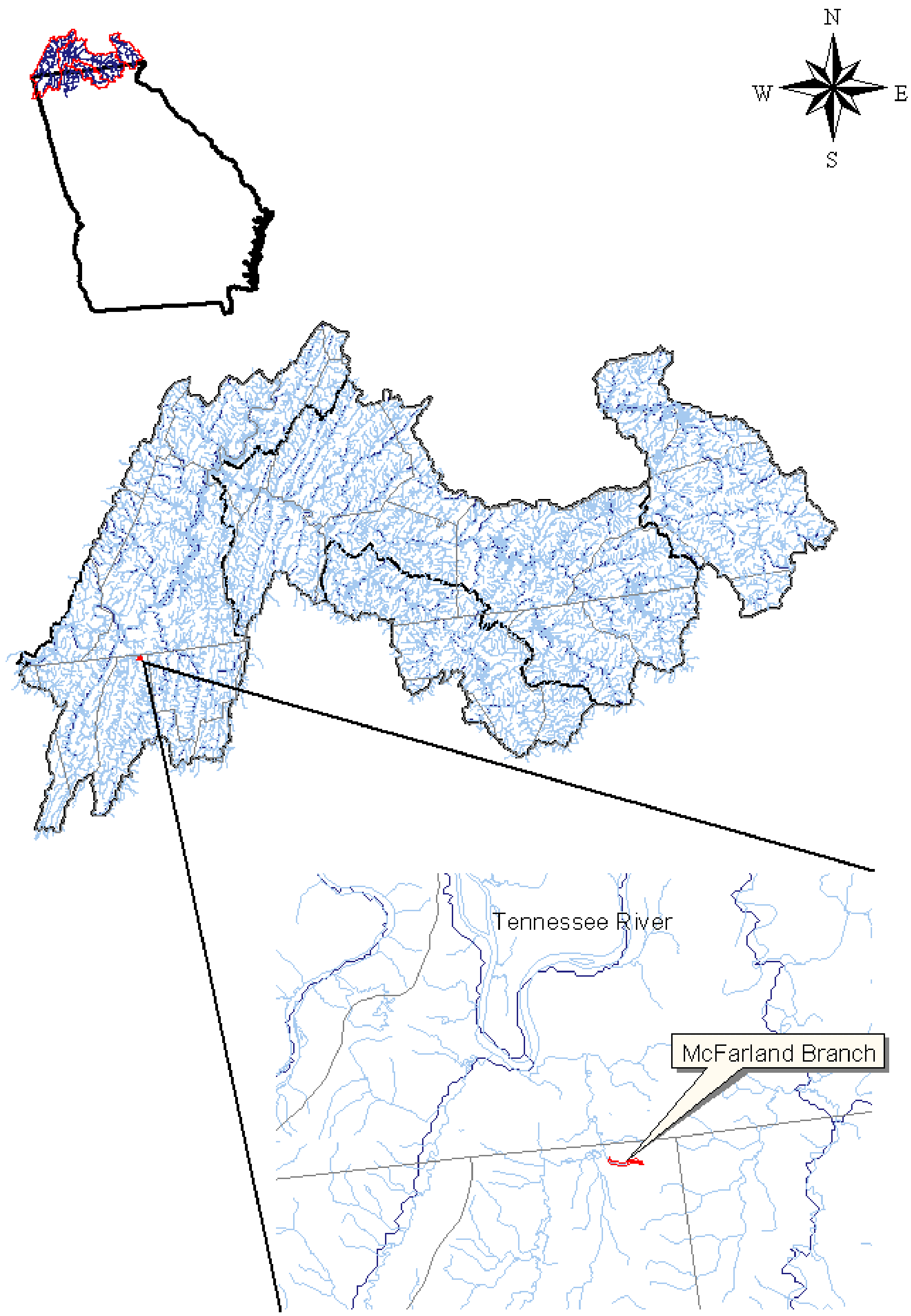

Figure 1. 303(d) Listed Segment for Dissolved Oxygen in the Tennessee River Basin

The land use characteristics of the Tennessee River Basin watersheds were determined using data from Georgia's National Land Cover Dataset (NLCD). This coverage is based on Landsat Thematic Mapper digital images developed in 1995. The classification is based on a modified Anderson level one and two system. Table 2 lists the land cover distribution and associated percent land cover for McFarland Branch.

Table 2. Land Cover Distribution

Land Use	Area (acres)	Percent
Open Water	2	0.4
Low Intensity Residential	161	28.4
High Intensity Residential	53	9.4
High Intensity Commercial/Industrial/Transportation	111	19.6
Bare Rock/Sand/Clay	0	0.0
Quarries/Strip Mines/Gravel Pits	0	0.0
Transitional	0	0.0
Forest	181	32.0
Row Crops	12	2.1
Pasture/Hay	10	1.8
Other Grasses (Urban/Recreational; e.g., parks/lawns)	27	4.8
Woody Wetlands	9	1.6
Emergent Herbaceous Wetlands	0	0.0
Total	566	100

1.3 Water Quality Standard

The water use classification for the McFarland Branch is Fishing and McFarland Branch is not classified as a trout stream. The criterion violated is listed as dissolved oxygen. The potential cause of listed segment is urban runoff. The associated water quality standards for dissolved oxygen, as stated in *Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03 (c) (i), is:

> A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

2.0 WATER QUALITY ASSESSMENT

2.1 Historical Water Quality Assessment

In the early 1980s, numerous complaints were filed reporting illicit discharges in the McFarland Branch watershed from Rossville Development Corporation (RDC), Burlington Industrial (currently Owens Illinois), Standard-Coosa-Thatcher (currently Coats American), failing septic systems, broken sewer lines, and other unknown sources. GA EPD join with the Chattanooga Task Force to conduct various investigations, and enforcement actions, including consent orders involving monetary fines. Since these actions, water quality in McFarland Branch has improved.

Standard-Coosa-Thatcher (Coats American) had an NPDES permit to discharge its cooling process water to McFarland Branch. This permit expired on May 31, 1998. Standard-Coosa-Thatcher subsequently went out of business, and their permit was never reissued.

The United States Geological Survey (USGS) has been collecting water quality data at USGS Station 03568595 (GA EPD Station 15300001) – McFarland Spring Branch at Stateline Road in Rossville, Georgia, since 1983. In 2001, a total of nineteen dissolved oxygen measurements were taken at this station. Two of these measurements (DO values of 1.1 mg/L on May 5 and 1.7 mg/L on June 12) violated the instantaneous water quality standard of 4.0 mg/l and resulted in this segment being listed. The water quality data collected at McFarland Branch in 2001 are provided in Appendix A.

Figure 2 is a plot of the dissolved oxygen concentrations and water temperatures measured at this monitoring station during 2001. Low dissolved oxygen concentrations (below 5 mg/L) occurred during the period from May to July. This plot shows that these dissolved oxygen violations did not occur when the water temperatures were at their highest levels (July and August).

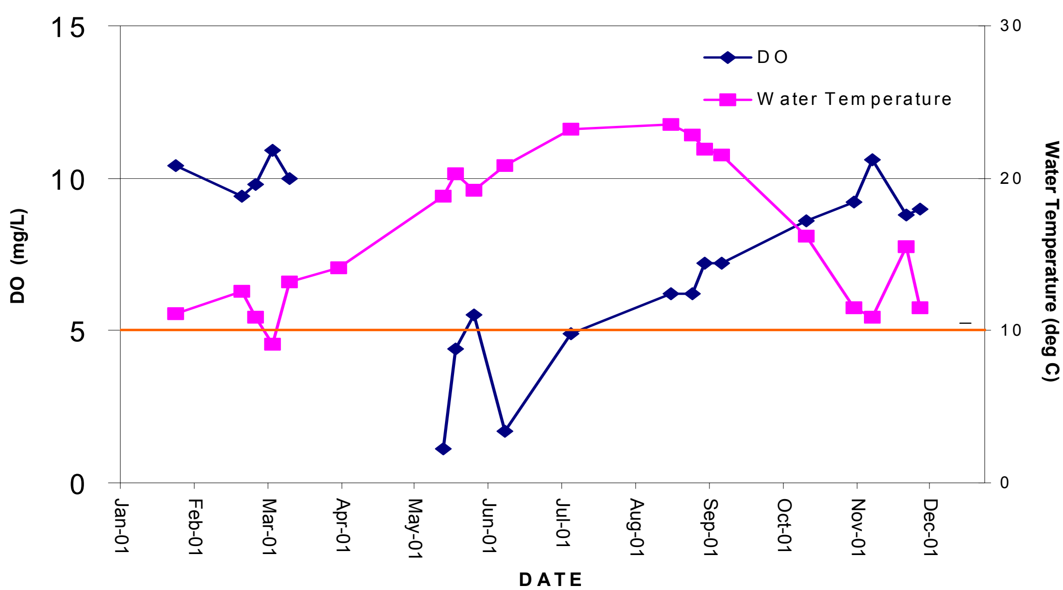

Figure 2. Dissolved Oxygen versus Water Temperature, McFarland Branch at Stateline Road

Figure 3 is a plot of the dissolved oxygen concentration and stream flows measured in McFarland Branch during 2001. This plot indicates the dissolved oxygen violations did not occur when the stream flows were a their lowest levels (March and November). In fact, the stream flows remained relatively constant (1 cfs) throughout the period of low dissolved oxygen measurements.

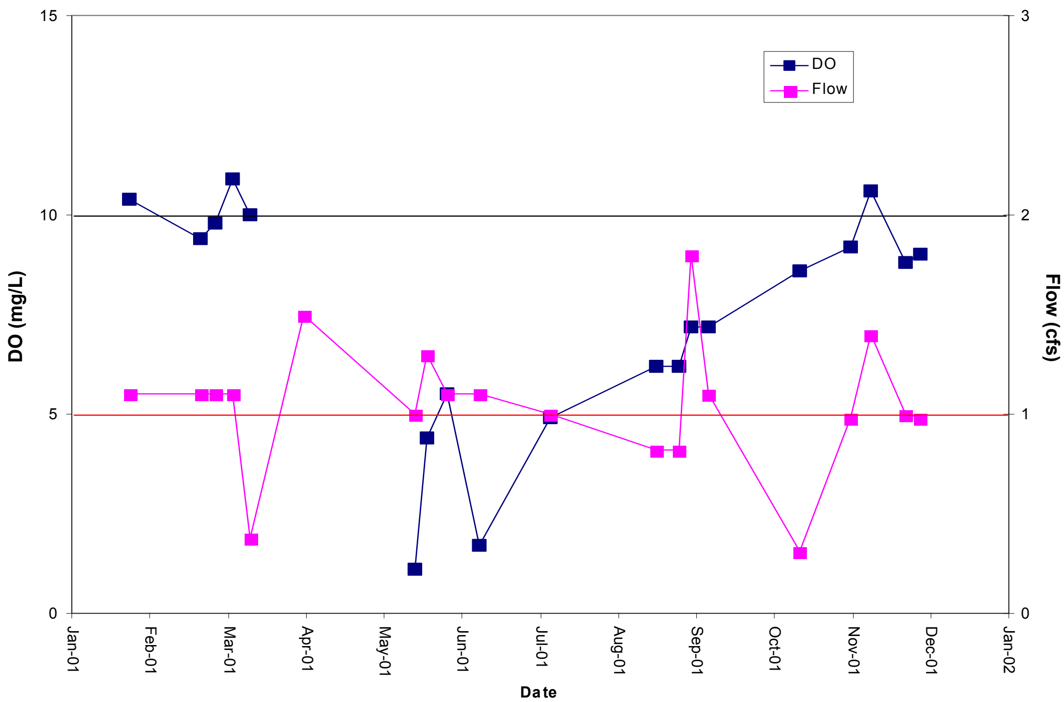

Figure 3. Dissolved Oxygen versus Stream Flow, McFarland Branch at Stateline Road

McFarland Branch is a spring fed stream. Therefore, the stream flow usually fluctuates with rainfall duration and the underground water table levels. In general, seasonal variation for spring fed streams is not clearly defined.

The fact that the dissolved oxygen violations in McFarland Branch did not correlate with high temperatures and low stream flows indicates that these violations were not a natural phenomena. As shown in Figures 4 and 5, the 2001 dissolved oxygen violations occurred when 5-day Biochemical Oxygen Demand (BOD_5) and ammonia concentrations were high. This would indicate that the dissolved oxygen violations in McFarland Branch were caused by illicit discharges with poorly treated or untreated sanitary wastewater.

GA EPD compiled all field data from 1983 to 2001, including historic trend monitoring data from 1983 through 1997, and the 2001 GA EPD/USGS water quality monitoring data, collected in McFarland Branch at Stateline Road. The measured dissolved oxygen concentrations always met the minimum instantaneous dissolved oxygen standard of 4.0 mg/L and usually met the daily average dissolved oxygen standard of 5.0 mg/L. Periods of low dissolved oxygen concentration occurred prior to 1998, but these data should not be considered for modeling verification purposes, as the permitted discharge (Standard-Coosa-Thatcher) is no longer discharging to this stream and since that time, most of the potential pollutants have been removed from the stream due to the on-going efforts of GA EPD and the Chattanooga Task Force.

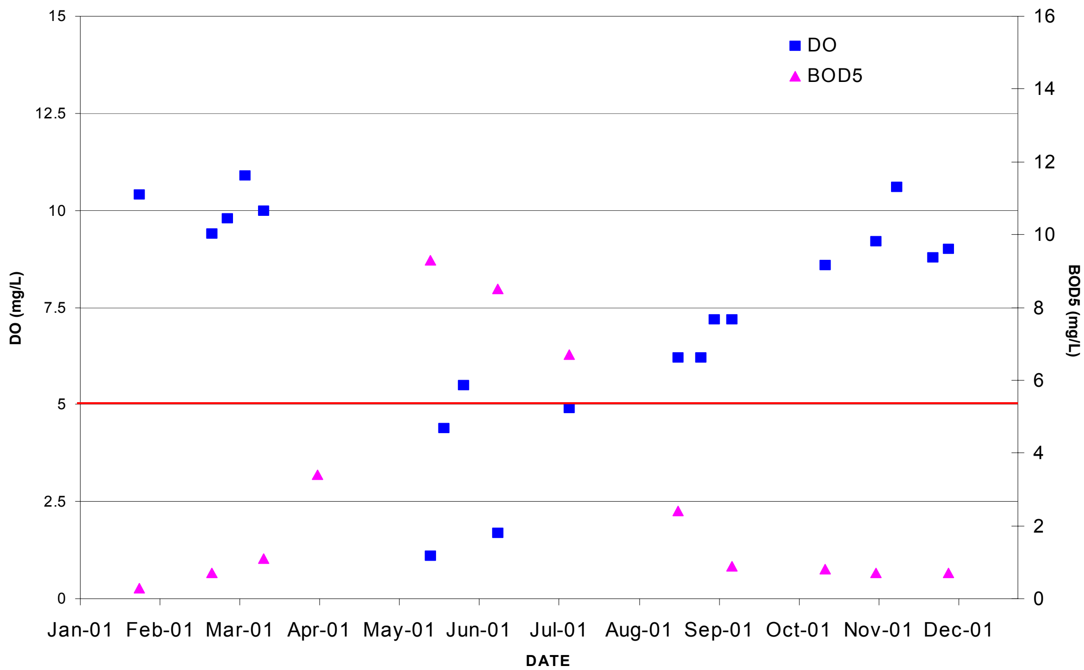

Figure 4. Dissolved Oxygen versus BOD_5 , McFarland Branch at Stateline Road

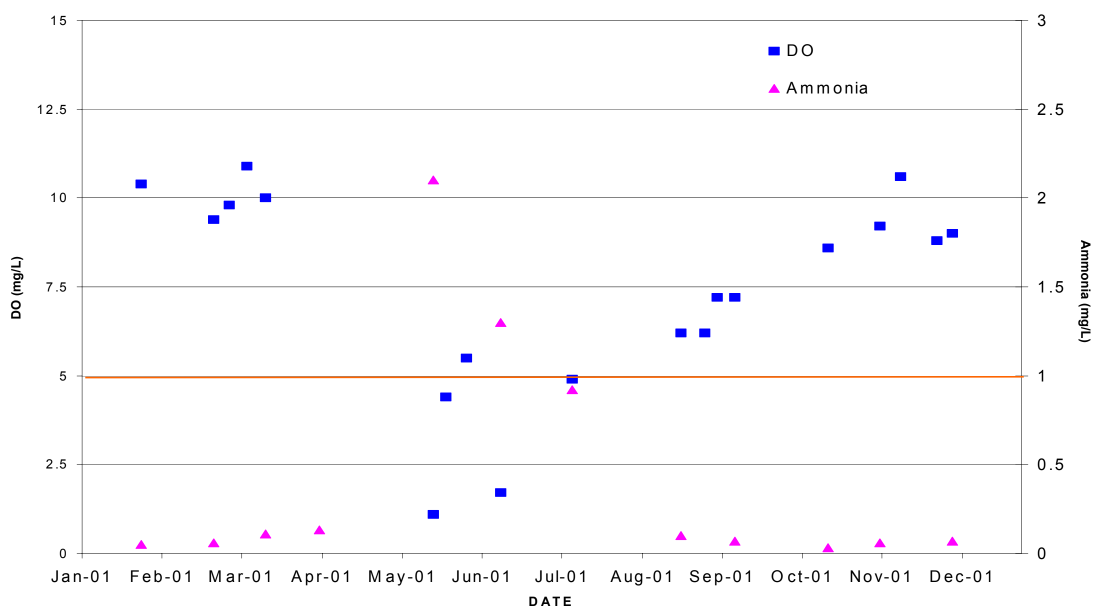

Figure 5. Dissolved Oxygen versus Ammonia, McFarland Branch at Stateline Road

The relationship between the dissolved oxygen concentrations and water temperature measured at this trend monitoring station is plotted in Figure 6. The instream dissolved oxygen concentrations in McFarland Branch follow the general trend that as dissolved oxygen concentrations increased, water temperatures decreased.

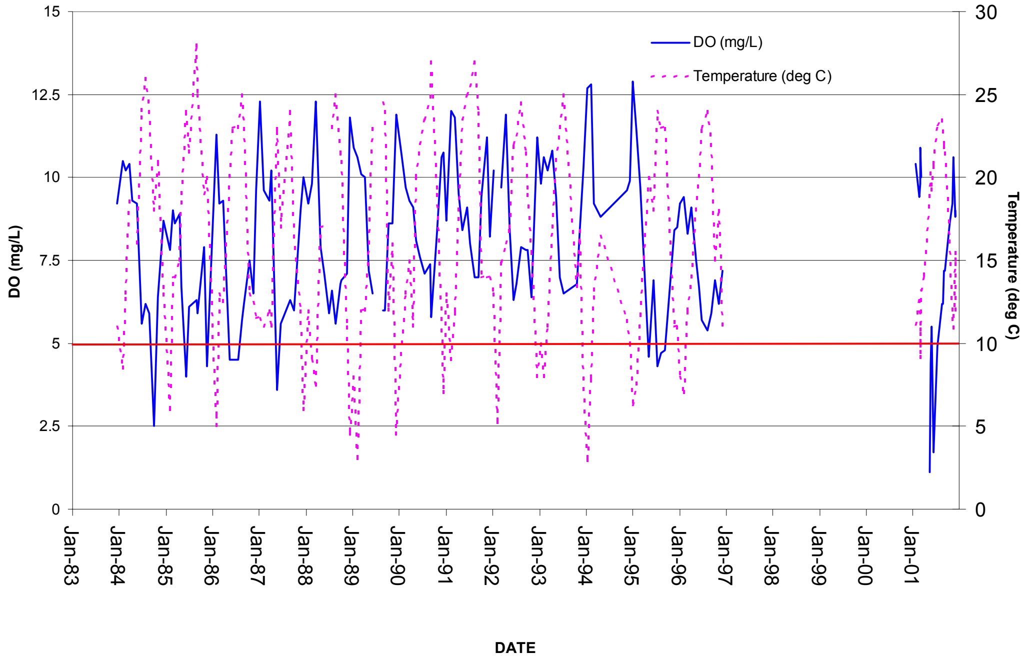

Figure 6. Trend Monitoring Data, McFarland Branch at Stateline Road

Based upon the historical data assessment at McFarland Branch, it is concluded that the dissolved oxygen violations in 2001 were incidental and were caused by illicit discharges with poorly treated or untreated sanitary wastewater. Currently, there are no permitted (NPDES) discharges in the McFarland Branch. Wastewater from the City of Rossville is discharged to the City of Chattanooga sewer system, which after treatment is discharged at Moccasin Bend in the Tennessee River.

2.2 Current Water Quality Assessment

Since the impacted segment is approximately one mile long, instream sample collection is the most direct approach of identifying the sources of these dissolved oxygen violations. GA EPD TMDL Modeling and Development Unit conducted a special field study on McFarland Branch on March 27, 2003, to determine the causes of the violations. Water quality samples relating to instream dissolved oxygen concentration were collected along McFarland Branch and its tributary in order to identify any illicit discharges. The field data are listed in Table 3.

Table 3. Field Data from March 27, 2003

27-Mar-03	Time of Collection	Temp (deg F)	DO (mg/L)	BOD5 (mg/L)	COD (mg/L)	Ammonia (mg/L)	Nitrite-Nitrate (mg/L)	TKN (mg/L)	P (mg/L)
(Detection Limits)				(2)	(10)	(0.03)	(0.04)	(0.1)	(0.02)
Tributary									
HW at W. Peachtree Rd	10:35 AM	13.8	6.6	n/d	n/d	n/d	2.4	n/d	n/d
at Richmond Road	10:45 AM	15	7.6						
near Glenn and Oak Road	10:50 AM	14.9	9	n/d	n/d	n/d	1	n/d	0.04
upstream of Cherry St	11:55 AM	15.7	8.3	n/d	n/d	n/d	1	n/d	0.03
Downstream Coats American	12:10 AM	15.7	8.8	n/d	n/d	n/d	0.02	n/d	0.02
HW at East Oak	5:55 PM	16	7.6	n/d	n/d	n/d	0.9	n/d	0.04
McFarland Branch									
City Lake	2:30 PM	20.6	6.8	n/d	n/d	n/d	0.88	n/d	n/d
48" pipe	1:15 PM	16.9	9	n/d	n/d	n/d	1	n/d	0.04
at Railroad	12:50 PM	17.7	8.5	n/d	n/d	n/d	0.9	n/d	0.03
Us of Owens Illinois	12:34 AM			n/d	n/d	n/d	0.88	n/d	0.04
Ds of Owens Illinois	12:20 PM	15	9.6	n/d	n/d	n/d	0.86	n/d	0.04
UP of Rossville Middle	3:05 PM	20.6	8.4	n/d	n/d	n/d	0.82	n/d	0.04
Stateline Road	3:35 PM	19.4	8.1	n/d	n/d	n/d	0.71	0.1	0.02

During this study, there were neither water quality violations, nor any indications of potential pollutants in the water quality samples collected. The study results indicated that the sources causing the dissolved oxygen violations in 2001were not present at time of the study.

A conversation with staff of the City of Rossville, revealed the instance of the sewer line repair in August 2001. Further investigation found that the sewer line repaired was adjacent to McFarland Branch near Rossville Middle School. Raw sewerage flowed into the stream for a period of four months in 2001 (according to monitoring data). The broken sewer line was not discovered and reported until mid-August.

It appears that the source of the dissolved oxygen violations was the broken sewer line. According to the 2001 monitoring data, it appears that the pipe broke during April. Raw sewerage was then discharged to McFarland Branch for a period of four months. The broken sewer line was fixed on August 20, 2001. No dissolved oxygen violations have been recorded since this time in McFarland Branch.

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of oxygen demanding substances on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. There are two categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated storm water discharges.

3.1.1 Wastewater Treatment Facilities

In general, industrial and municipal wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on federal and state effluent guidelines (technology-based limits) or on water quality standards (water quality-based limits).

The EPA has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges without regard for the quality of the receiving waters. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

The EPA and the states have also developed numeric and narrative water quality standards. Typically, these standards are based on the results of aquatic toxicity tests and/or human health criteria, and include a margin of safety. Water quality-based effluent limits are set to protect the receiving stream. These limits are based on water quality standards that have been established for a stream based on its intended use and the prescribed biological and chemical conditions that must be met to sustain that use.

Municipal and industrial wastewater treatment facilities' discharges may contribute oxygen demanding substances to receiving waters. There are no NPDES permitted discharges identified in the McFarland Branch watershed. Wastewater from the City of Rossville is discharged to the City of Chattanooga sewer system, which after treatments is discharged at Moccasin Bend in the Tennessee River.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no permitted CSO outfalls in the McFarland Brach watershed.

3.1.2 Regulated Storm Water Discharges

Some storm water runoff is covered under the NPDES Permit Program. It is considered a diffuse source of pollution. Unlike other NPDES permits that establish end-of-pipe limits, storm water NPDES permits establish controls “to the maximum extent practicable” (MEP). Currently, regulated storm water discharges that may contain oxygen demanding substances consist of those associated with industrial activities, including construction sites five acres or greater, and large and medium municipal separate storm sewer systems (MS4s) that serve populations of 100,000 or more.

Storm water discharges associated with industrial activities are currently covered under a General Storm Water Permit NPDES permit. This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping.

Storm water discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. All cities and counties within the state of Georgia that had a population of greater than 100,000 at the time of the 1990 Census, are permitted for their storm water discharge under Phase I. Phase I MS4 permits require the prohibition on non-storm water discharges (i.e., illicit discharges) into the storm sewer systems, and controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, design and engineering methods (Federal Register, 1990). A site-specific Storm Water Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. There are no Phase I MS4 permits in the Tennessee River Basin.

In March 2003, small MS4s serving urbanized areas were required to obtain a storm water permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. It is estimated that 56 communities will be permitted under the Phase II regulations. Table 4 lists those counties and communities located in the Tennessee River Basin that will be covered by the Phase II General Storm Water Permit, GAG610000.

Table 4. Phase II Permitted MS4s in the Tennessee River Basin

Name	Watershed
Catoosa County	Tennessee
Chickamauga	Tennessee
Fort Oglethorpe	Tennessee
Lookout Mountain	Tennessee
Ringgold	Tennessee
Rossville	Tennessee
Tunnel Hill	Tennessee
Walker County	Tennessee, Coosa
Whitfield County	Tennessee, Coosa

Source: Nonpoint Source Permitting Program, GA DNR, 2003

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources can enter a waterbody randomly, discretely, or even continuously, and usually involve runoff being carried through the river system.

3.2.1 Illicit Discharges

Illicit discharges exist in various forms. There are illegal, unpermitted discharges, separate or broken joints in the sewer system, illicit sanitary sewer connections to the storm sewer system, failed septic systems, and infiltration from sanitary sewer systems.

Illegal, unpermitted discharges do exist under various conditions. Sometimes, there are caused by unpredictable conditions in treatment plants, such as mechanical malfunction or careless operation. Other times, violators simply discharge their wastewater without a permit to avoid the cost of the treatment and the permit process.

As the age of the municipal and industrial sewer system increases, pipes may collapse or the joints may sag or separate. This results leaks in the sewer system, as was the case in the City of Rossville system.

In addition, illicit sanitary sewer connections to the storm sewer system may occur. As part of the MS4 permitting program, municipalities are required to conduct dry-weather monitoring to identify and then eliminate these illicit discharges. Oxygen demanding substances may also enter streams from leaky sewer pipes or during storm events when the combined sewer overflows discharge.

3.2.2 Septic System

Instream low DO problems may also be attributed to failed septic systems. The total number of septic systems in the McFarland Branch watershed is unknown. However, based on Georgia Department of Human Resources, Division of Public Health data, there are a total 19,097 septic systems in Walker County, and approximately 600 of these septic systems were repaired during the eleven-year period from 1990 to 2001.

In some cases, the soil, saturated with water after several rainy days will exert tremendous pressure to underground sewer pipes. In these cases, the pressure can be so great as to force water into the sewer pipes and created sewer overflow.

3.2.3 Urban Development

In urban areas, a large portion of storm water runoff may be collected in storm sewer systems and discharged through distinct outlet structures. For large urban areas, these storm sewer discharge points are regulated.

Urban runoff can contain high concentrations of oxygen demanding substances from domestic animals and urban wildlife. These substances enter streams by direct wash off from the land surface, or the runoff may be diverted to a storm water collection system and discharged through a discrete outlet structure. For larger urban areas (population greater than 100,000), the storm water outlets are regulated under MS4 permits (see Section 3.1.2). For smaller urban areas, the storm water discharge outlets currently remain unregulated.

3.2.4 Leaf Litterfall

Leaf litterfall is a possible contributor of oxygen demanding substances in the stream water column and may affect the amount of sediment oxygen demand being SOD exerted. The effects of leaf litterfall are characterized reflected by increased SOD as vegetation decay on stream channel bottom in increased.

4.0 MODELING APPROACH

Since McFarland Branch was listed on the 2002 303(d) List as not supporting its designated use as a "fishing" stream, a Total Maximum Daily Load (TMDL) must to be developed regardless of the fact that the broken sewer pipe has been repaired. The TMDL is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard; in this case the dissolved oxygen standard, under critical conditions, for nonpoint source pollution control. A DOSAG model was developed to represent McFarland Branch in the Tennessee River Basin to determine the DO TMDL load.

4.1 Model Selection and Setup

As noted in Figure 6, instream dissolved oxygen concentration decreased as instream temperature increased. Therefore, the steady-state Georgia DOSAG model, developed by the GA EPD, was selected for the following reasons:

- It conforms to GA EPD standard practices for developing wasteload allocations.
- It works well for low flow and high temperature conditions.
- It can be developed with a limited dataset.
- It is able to handle branching tributaries and both point and nonpoint source inputs.

Georgia DOSAG computes dissolved oxygen using an enhanced form of the Streeter-Phelps equation (Thomann and Mueller, 1987). The model applies the equation to each stream reach over small incremental distances. The model also provides a complete spatial view of a system, upstream to downstream. This allows the modeler to understand the important differences in stream behavior at various locations throughout a basin.

USGS quadrangle maps along with Arcview and MapInfo spatial graphics files were used to develop drainage areas, stream lengths, bed slopes, and other physical input data for each model.

4.2 Model Calibration

The tabletop model was calibrated based on water quality data collected on a special study conducted by EPD on March 27, 2003 at McFarland Branch and its tributary. DO measurements were collected on every major road intersection along McFarland Branch and its tributary. In this way, a DO profile was created for McFarland Branch and its tributary. The monitoring data used in the calibration process includes dissolved oxygen, water temperature, BOD_5, and ammonia. The 2001 USGS monitoring data that listed McFarland Branch were not suitable for model calibration purposes.

There are no field SOD measurements in the Tennessee River basin. However, there were several SOD measurements from the South 4 Basins. The values ranged from 0.9 to 1.9 $g/m^2/day$. SOD in North Georgia streams is relative low in comparison with the streams in South Georgia. It is necessary to be reasonable in the development and application of SOD values in the McFarland Branch model. An examination of the South 4 SOD results was performed and an average value of SOD in McFarland Branch was estimated to be 0.5 $g/m^2/day$.

Monitoring data from March 2003 was used as instream targets to calibrate the models. A profile was created along McFarland Branch and its tributary. Water temperatures were varied across the basin in accordance with the sampling data. Headwater and tributary water quality boundaries were developed from instream field data, expected dissolved oxygen saturation values (Meyer, 1992), and GA EPD standard modeling practices. The SOD was set to 0.5 g/m^2/day to reflect mixed land uses. Figure 7 depicts the longitudinal dissolved oxygen calibration curve for the McFarland Branch developed using this approach. Figure 8 depicts the longitudinal dissolved oxygen calibration curve for the tributary of McFarland Branch.

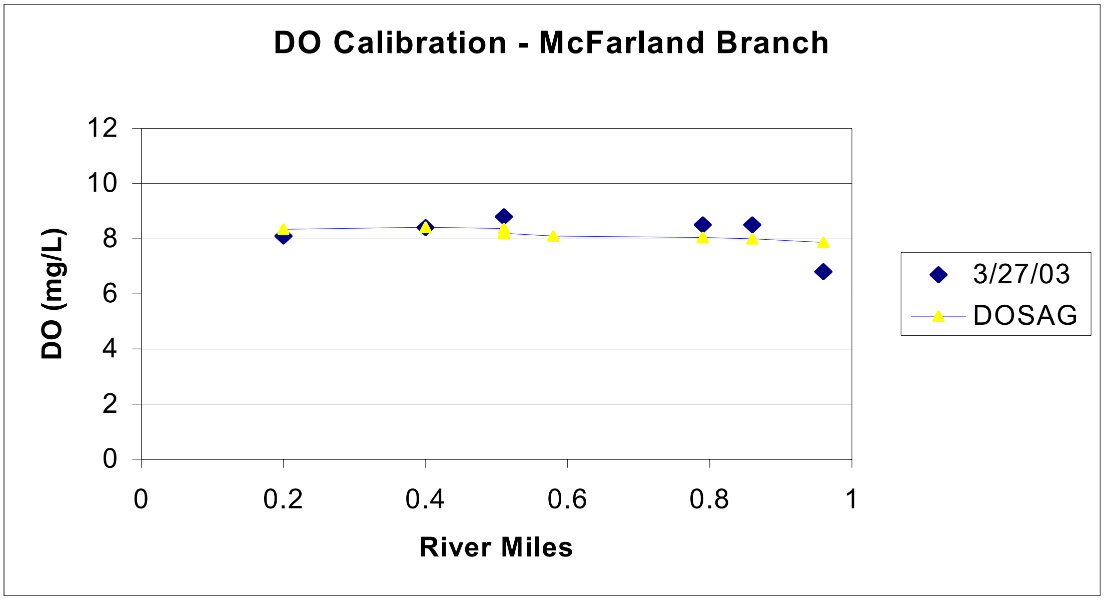

Figure 7. Dissolved Oxygen Calibration for McFarland Branch

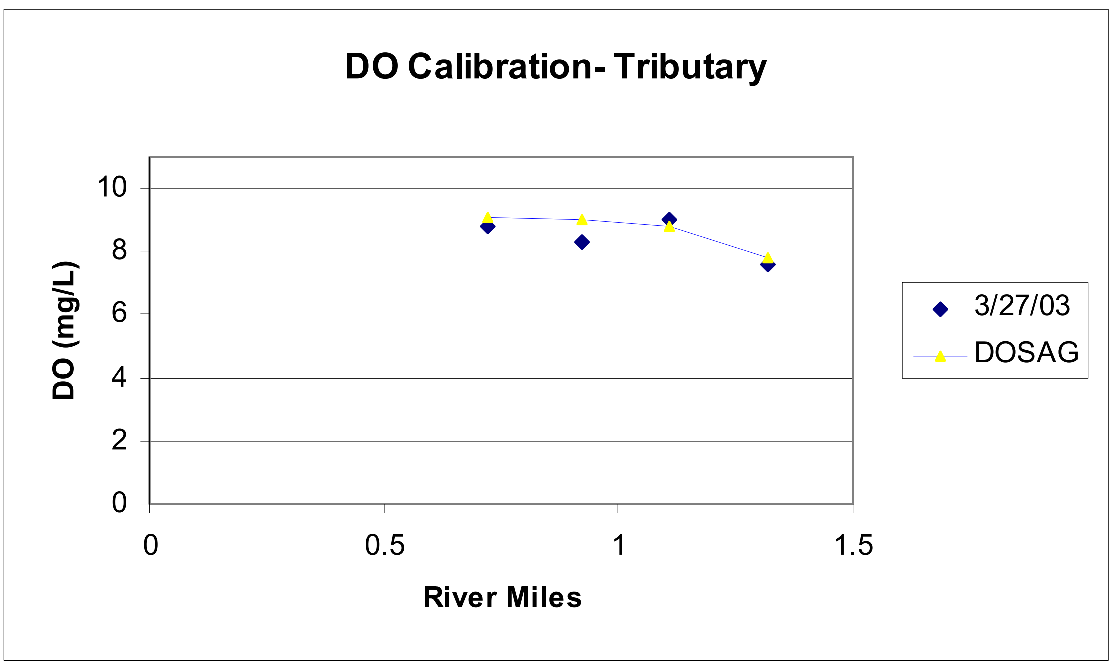

Figure 8. Dissolved Oxygen Calibration for the tributary to McFarland Branch

Additional calibration on the McFarland Branch tabletop model was also performed using data from September 4, 2001 to ensure the accuracy of the model. At the time, the broken sewer line had been repaired for over a half month. Headwater and tributary water quality boundaries were developed from instream field data collected on September 4, 2001. The McFarland Branch model predicted the instream DO at Stateline Road to be 7.8 mg/L and the recorded dissolved oxygen at Stateline Road on September 4, 2001was 7.2 mg/L. Considering daily variation on instream-dissolved oxygen concentrations, limited field data, and some modeling assumptions, the model prediction was satisfactory**.**

4.3 Critical Conditions

The combination of the lowest, steady flow period with the lowest dissolved oxygen, and highest BOD concentrations, defined the critical modeling period. Since raw sewerage was discharged to McFarland Branch for a period of four months, extreme low DO readings were recorded in the 2001 monitoring data. This situation would not be considered a critical condition.

Model critical conditions were developed, in accordance with GA EPD standard practices. Critical conditions are used to assess dissolved oxygen standards, to determine if a problem exists requiring regulatory intervention, and to establish a level of protection if necessary. To do this, each calibrated model was modified. Productivity factors were calculated from the revised 7Q10 values and applied uniformly throughout the basin. Critical water temperatures were developed by examining the long-term trend monitoring data and fitting a harmonic sine function to all of the historical data at a given station.

4.3.1 Low-Flow Analysis

A productivity factor was computed by dividing the 7Q10 by the watershed area of the USGS gage. The units of the productivity factor are cubic feet per second (cfs) per square mile. A weighting 7Q10 was then computed by multiplying the listed segment watershed drainage area by the calculated productivity factor.

The McFarland Branch drainage area is relatively small and its stream flow is mainly fed by springs from Missionary Ridge. According to *the Low-Flow Profiles of the Tennessee River and tributaries in Georgia, (USGS, 1988)*, the 7Q10 in McFarland Branch is estimated to be 0.03 cfs. However, the estimation of the 7Q10 flow from the productivity factor in the USGS flow book is not feasible because McFarland Branch is a spring fed stream, and compared with other streams, its 7Q10 flow is relatively stable throughout the year as long as the underground water aquifer is stable. Therefore, a 7Q10 flow of 0.3 cfs at the Stateline Road was used since it was the lowest flow recorded during the 2001and 2003 studies.

4.3.2 Temperature Analysis

Critical water temperatures are determined by examining the long-term trend monitoring data and fitting a harmonic sine function to all of the historical data at a given (reference) station in the *Stream-Temperature Characteristics in Georgia (USGS, 1997)*. Critical temperatures in the McFarland Branch basin were adjusted on the basis of USGS monitoring data for McFarland Branch taken from November 16, 1993 to December 12, 2001. Water quality boundaries, the SOD rate, and all other modeling rates and constants were the same as those in the calibrated models. A critical temperature of 25 degrees Fahrenheit was chosen in the model predictions.

5.0 TOTAL MAXIMUM DAILY LOAD

A Total Maximum Daily Load (TMDL) is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard; in this case the warm water dissolved oxygen standard. A TMDL is the sum of the individual waste load allocations (WLAs) from point sources and load allocations (LAs) for nonpoint sources and natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For oxygen demanding substances, the TMDLs are expressed as pounds/day (lbs/day).

A TMDL can be expressed as follows:

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

This TMDL determines the allowable oxygen demanding loads to McFarland Branch. It is based on the hypothesis that an impaired watershed has a natural dissolved oxygen concentration above 5.0 mg/L during critical conditions. The following sections describe the various oxygen demanding substances TMDL components.

5.1 Waste Load and Load Allocations

The partitioning of allocations between point (WLA) and nonpoint (LA) sources as shown in Table 5 is based on modeling results and professional judgment. The model was used to account for instream kinetic processes within the listed segment.

The WLA is the portion of the receiving water's loading capacity that is allocated to existing or future point sources. Waste load allocations are provided to the point sources from municipal and industrial wastewater treatment systems. There are no NPDES permitted facilities in the McFarland Branch watershed at this time. According to the DOSAG model, 92 percent (83 lbs/day) of the LA may be allocated to point sources (WLA). If necessary, GA EPD may modify the WLA during the NPDES permitting process and this TMDL will be used to assess any new permits.

State and Federal Rules define storm water discharges covered by NPDES permits as point sources. However, storm water discharges are from diffuse sources and there are multiple storm water outfalls. Storm water sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge, 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control, 3) the activities contributing to the pollutant loading may include various allowable activities of others, and control of these activities is not solely within the discretion of the permittee, and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

The intent of storm water NPDES permits is not to treat the water after collection, but to reduce the exposure of storm water to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to try to control pollutant discharges from each storm water outfall. Therefore, storm water NPDES permits require the establishment of controls or BMPs to reduce pollutants entering the environment.

The Georgia DOSAG McFarland Branch model was run under critical conditions assuming 7Q10 flows and dry weather conditions. Because the critical conditions occur when there are no storm events, no numeric allocation is given to the waste load allocations from storm water discharges associated with MS4s (WLAsw). The nonpoint source loads for the existing LA and TMDL were computed from the model boundary conditions, which include the stream, tributary, and headwater model boundaries.

Table 5. TMDL Load for McFarland Branch

Stream	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL * (lbs/day)	Reduction WLA	Reduction LA
McFarland Branch	NA	NA	90	90	0%	0%

NOTE: * TMDL expressed as Ultimate Oxygen Demand (UOD), which includes Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD).
NA = no permitted point sources currently exist in this watershed and storm water runoff is not applicable because the model predictions were based on critical conditions

Currently, no reduction in TMDL load is needed to correct the dissolved oxygen violations documented in the 2001 monitoring data for the listed McFarland Branch segment since the broken sewer line had been repaired. According to the rest of 2001 monitoring data after the sewer line was repaired and 2003 special study at McFarland Branch, no violations were recorded. Monitoring for dissolved oxygen is recommended. The details of the monitoring will be addressed in the TMDL implementation Plan. If violations occur, reductions in LA and WLA may be needed.

5.2 Seasonal Variation

The low flow critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions and to provide year-round protection of water quality. This TMDL is expressed as a total load during the critical low flow period.

5.3 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety must account for any lack of knowledge concerning the relationship between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

For this TMDL, the MOS was implicitly incorporated in the use of the following conservative modeling assumptions:

- Hot summer temperatures, based on the historical record, that persist for the same critical period.
- The model was predicted to meet a minimum instream DO of 5.2 mg/L (instead of 5.0 mg/L) at every reach in the McFarland Branch watershed.
- DO saturations, for all flows entering the system, were equal to those measured during the low DO period in the summer of 2001.

6.0 RECOMMENDATIONS

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the State each year. GA EPD has adopted a basin approach to water quality management that divides Georgia's major river basins into five groups. This approach provides for additional sampling work to be focused on one of the five basin groups each year and offers a five-year planning and assessment cycle. The Coosa, Tallapoosa, and Tennessee River Basins were the basins of focused monitoring in 2001 and will again receive focused monitoring in 2006.

The TMDL Implementation Plan will outline an appropriate water quality-sampling program for the listed streams in the Tennessee River Basin. The monitoring program will be developed to help identify the various oxygen demanding sources. This will be especially valuable for those segments where no data or old data that resulted in the listing.

6.2 Reasonable Assurance

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities that have a bearing on nonpoint source pollution include establishing water quality standards and use classifications, assessing and reporting water quality conditions, and regulating land-use activities, which may affect water quality. Georgia is working with local governments, agricultural, and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission to foster the implementation of Best Management Practices (BMPs) that address nonpoint source pollution. In addition, public education efforts are being targeted to individual stakeholders to provide information regarding the use of BMPs to protect water quality.

6.3 Public Participation

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

7.0 INITIAL TMDL IMPLEMENTATION PLAN

GA EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. GA EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. GA EPD and EPA have executed a Memorandum of Understanding that documents the schedule for developing the more comprehensive plans. This Initial TMDL Implementation Plan includes a list of BMPs and provides for an initial implementation demonstration project to address one of the major sources of pollutants identified in this TMDL, while State and/or local agencies work with local stakeholders to develop a revised TMDL implementation plan. It also includes a process whereby GA EPD and/or Regional Development Centers (RDCs), or other GA EPD contractors (hereinafter, "GA EPD Contractors"), will develop expanded plans (hereinafter, "Revised TMDL Implementation Plans").

This Initial TMDL Implementation Plan, written by GA EPD and for which GA EPD and/or the GA EPD Contractor are responsible, contains the following elements.

1. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some best management practices. The "Management Measure Selector Table" shown below identifies these management strategies by source category and pollutant. Nonpoint sources are the primary cause of excessive pollutant loading in most cases. Any wasteload allocations in this TMDL will be implemented in the form of water-quality based effluent limitations in NPDES permits issued under CWA Section 402. [See 40 C.F.R. § 122.44(d)(1)(vii)(B)]. NPDES permit discharges are a secondary source of excessive pollutant loading, where they are a factor, in most cases.

2. GA EPD and the GA EPD Contractor will select and implement one or more BMP demonstration projects for each River Basin. The purpose of the demonstration projects will be to evaluate by River Basin and pollutant parameter the site-specific effectiveness of one or more of the BMPs chosen. GA EPD intends that the BMP demonstration project be completed before the Revised TMDL Implementation Plan is issued. The BMP demonstration project will address the major pollutant categories of concern for the respective River Basin as identified in the TMDLs. The demonstration project need not be of a large scale, and may consist of one or more measures from the Table or equivalent BMP measures proposed by the GA EPD Contractor and approved by GA EPD. Other such measures may include those found in EPA's "Best Management Practices Handbook," the "NRCS National Handbook of Conservation Practices," or any similar reference, or measures that the volunteers, etc., devise that GA EPD approves. If for any reason the GA EPD Contractor does not complete the BMP demonstration project, GA EPD will take responsibility for doing so.

3. As part of the Initial TMDL Implementation Plan the GA EPD brochure entitled "Watershed Wisdom -- Georgia's TMDL Program" will be distributed by GA EPD to the GA EPD Contractor for use with appropriate stakeholders for this TMDL. Also, a copy of the video of that same title will be provided to the GA EPD Contractor for its use in making presentations to appropriate stakeholders on TMDL Implementation Plan development.

4. If for any reason the GA EPD Contractor does not complete one or more elements of a Revised TMDL Implementation Plan, GA EPD will be responsible

for getting that (those) element(s) completed, either directly or through another contractor.

5. The deadline for development of a Revised TMDL Implementation Plan is the end of December 2005.

6. The GA EPD Contractor helping to develop the Revised TMDL Implementation Plan, in coordination with GA EPD, will work on the following tasks involved in converting the Initial TMDL Implementation Plan to a Revised TMDL Implementation Plan:

   A. Generally characterize the watershed;
   B. Identify stakeholders;
   C. Verify the present problem to the extent feasible and appropriate, (e.g., local monitoring);
   D. Identify probable sources of pollutant(s);
   E. For the purpose of assisting in the implementation of the load allocations of this TMDL, identify potential regulatory or voluntary actions to control pollutant(s) from the relevant nonpoint sources;
   F. Determine measurable milestones of progress;
   G. Develop monitoring plan, taking into account available resources, to measure effectiveness; and
   H. Complete and submit to GA EPD the Revised TMDL Implementation Plan.

7. The public will be provided an opportunity to participate in the development of the Revised TMDL Implementation Plan and to comment on it before it is finalized.

8. The Revised TMDL Implementation Plan will supersede this Initial TMDL Implementation Plan when GA EPD approves the Revised TMDL Implementation Plan.

Management Measure Selector Table

Land Use	Management Measures	*Fecal Coliform*	*Dissolved Oxygen*	*pH*	*Oxygen demanding substances*	*Temperature*	*Toxicity*	*Mercury*	*Metals (copper, lead, zinc, cadmium)*	*PCBs, toxaphene*
Agriculture	1. Oxygen demanding substances & Erosion Control	–	–		–	–				
	2. Confined Animal Facilities	_	_							
	3. Nutrient Management	_	_							
	4. Pesticide Management		_							
	5. Livestock Grazing	_	_		_	_				
	6. Irrigation		_		_	_				
Forestry	1. Preharvest Planning				_	_				
	2. Streamside Management Areas	_	_		_	_				
	3. Road Construction & Reconstruction		–		–	–				
	4. Road Management		_		_	_				
	5. Timber Harvesting		_		_	_				
	6. Site Preparation & Forest Regeneration		–		–	–				
	7. Fire Management	_	_	_	_	_				
	8. Revegetation of Disturbed Areas	_	_	_	_	_				
	9. Forest Chemical Management		_			_				
	10. Wetlands Forest Management	–	–	–		–		–		
Urban	1. New Development	_	_		_	_			_	
	2. Watershed Protection & Site Development	–	–		–	–		–	–	

Land Use	**Management Measures**	*Fecal Coliform*	*Dissolved Oxygen*	*pH*	*Oxygen demanding substances*	*Temperature*	*Toxicity*	*Mercury*	*Metals (copper, lead, zinc, cadmium)*	*PCBs, toxaphene*
	3. Construction Site Erosion and Sediment Control		–		–	–				
	4. Construction Site Chemical Control		–							
	5. Existing Developments	–	–		–	–			–	
	6. Residential and Commercial Pollution Prevention	–	–							
Onsite Wastewater	1. New Onsite Wastewater Disposal Systems	–	–							
	2. Operating Existing Onsite Wastewater Disposal Systems	–	–							
Roads, Highways and Bridges	1. Siting New Roads, Highways & Bridges	–	–		–	–			–	
	2. Construction Projects for Roads, Highways and Bridges		–		–	–				
	3. Construction Site Chemical Control for Roads, Highways and Bridges		–							
	4. Operation and Maintenance- Roads, Highways and Bridges	–	–			–			–	

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APPENDIX A

Water Quality Data

Water Quality Data Collected in McFarland Branch during 2001

Date	BOD_5 (mg/L)	Discharge (cfs)	DO (mg/L)	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C	Fecal Coliform (counts/100ml)	NH_3 (mg/L)	NO_2-NO_3 (mg/L)	pH	TP (mg/L)	Water Temp (deg C)	TOC (mg/L)	Turbidity (NTU)
01/24/2001	0.3	1.1	10.4	418		0.05	1.1	8.1	0.04	11.1	1.6	
02/21/2001	0.7	1.1	9.4	414	1700	0.06	0.93	7.9	0.04	12.6	2	0.7
02/27/2001		1.1	9.8		3100			7.9		10.9		
03/06/2001		1.1	10.9	424	790			8		9.1		
03/13/2001	1.1	0.4	10.0	325	54000	0.11	0.89	7.9	0.1	13.2	2.6	8
04/03/2001	3.4	1.5		273		0.13	0.84	7.9	0.06	14.1	2	3.1
05/17/2001	9.3	1.0	1.1	427	24000	2.1	0.08	7.5	1.7	18.8	4.1	11
05/22/2001		1.3	4.4	311	24000			7.4		20.3	4.1	5.5
05/30/2001		1.1	5.5	394	24000			7.5		19.2		
06/12/2001	8.5	1.1	1.7	449	24000	1.3	0.15	7.5	1.7	20.8	24	20
07/10/2001	6.7	1.0	4.9	391	0.92	0.92	0.33	7.7	0.49	23.2	2.1	5.2
08/21/2001	2.4	0.8	6.2	383	4900	0.1	0.23	8	0.1	23.5	1.9	1.3
08/30/2001		0.8	6.2	372	2200			7.9		22.8		
09/04/2001		1.8	7.2	408	4900			7.7		21.9		
09/11/2001	0.9	1.1	7.2	374	330	0.07	0.31	8	0.04	21.5	1.7	0.9
10/17/2001	0.8	0.3	8.6	413		0.03	0.36	8	0.04	16.2	2.1	2
11/06/2001	0.7	1.0	9.2	377	490	0.06	0.28	8	0.05	11.5	2.3	0.6
11/14/2001		1.4	10.6	383	40			8		10.9		
11/28/2001		1.0	8.8	387	20			7.8		15.5		
12/04/2001	0.7	1.0	9.0	399	490	0.07	0.77		0.05	11.5	3.8	4.4

APPENDIX B

Daily Oxygen Demanding Substances Load Summary Memorandum

SUMMARY MEMORANDUM
Annual Average Oxygen Demanding Substances Load
McFarland Branch

1. 303(d) Listed Waterbody Information

State: Georgia
County: Walker

Major River Basin: Tennessee
8-Digit Hydrologic Unit Code(s): 06020001

Waterbody Name: McFarland Branch
Location: Rossville to Stateline
Stream Length: 1 mile
Watershed Area: 1.2 square miles
Tributary to: Chattanooga Creek
Ecoregion: Ridge and Valley

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standard:
A daily average of 6.0 mg/L and no less than 5.0 mg/L at all times for waters designated as trout streams by the Wildlife Resources Division. A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

2. TMDL Development

Analysis/Modeling: Georgia DOSAG – Steady state water quality model developed by Georgia Environmental Protection Division.

Calibration Data: McFarland Branch – 2003 DO TMDL Study field data.

Critical Conditions:
(1) 7Q10 flows based on *Low-Flow Profiles of the Tennessee River and Tributaries in Georgia (USGS, 1988*), and 2001 monitoring data.
(2) Temperatures were derived from historic trend monitoring data in *Stream-Temperature Characteristics in Georgia (USGS, 1997).*
(3) No Point source discharges at current conditions.
(4) Velocities, kinetic rates, reaeration rates, and boundary conditions as per the guidance provided in the Georgia's DOSAG Modeling Procedures Manual.
(5) Same depths, velocities, kinetic rates, reaeration rates, and boundary conditions as calibration conditions.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): NA
Wasteload Allocations (WLAsw): NA

Load Allocation (LA): 90 lbs/day*

*** TMDL expressed as Ultimate Oxygen Demand (UOD), which includes Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD).**

Margin of Safety (MOS): **Implicit, based on the following conservative assumptions:**

(1) Drought streamflows persist through the critical summer months at monthly 7Q10 flow values.
(2) Hot summer temperatures, based on the historical record, persist for the same critical period.
(3) DO saturation, for all flows entering the system, equal those measured during the low DO period in the summer of 2001.
(4) Water depths are shallow, generally less than one foot, which increases the effect of SOD

Total Maximum Daily Load (TMDL): 90 lbs/day*