

Total Maximum Daily Load
Evaluation
for
Bear Creek

Submitted to:

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

Submitted by:

The Georgia Department of Natural Resources
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EXECUTIVE SUMMARY

The State of Georgia assesses its waters for compliance with water quality standards established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed waters are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality data assessment results. These waters are referred to as 305(b) waters after the section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years. A subset of the 305(b) partially and not supporting waters is assigned to the 303(d) list, also named after the section of the CWA. In accordance with U.S. Environmental Protection Agency (USEPA) guidelines, waters are placed on the 303(d) list if actions to achieve water quality standards will take more than two years to implement.

Waters on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for that water quality constituent in violation of the water quality standard. Implementation of a TMDL is one tool for addressing water quality limited waters, and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the allowable loadings or percent load reductions to the stream, thereby providing the basis for addressing the water quality impairment.

The State of Georgia has identified a segment of Bear Creek downstream from the City of Lavonia, Georgia, as a 305(b) not supporting stream segment, and has placed the stream segment on the 303(d) list of waters. Bear Creek is an approximately 6.5 square mile watershed located in the headwaters of the Broad River watershed of the northern Savannah River basin. Bear Creek and Little Bear Creek join to form Unawatti Creek, which drains into the North Fork Broad River. The North Fork Broad River flows into the Broad River which is a tributary to the Savannah River. A portion of the City of Lavonia is located in the headwaters of Bear Creek. The two mile segment of Bear Creek identified on the 303(d) list is located downstream from the City of Lavonia waste water treatment facility (WWTF). This segment has a water use classification of fishing and a daily average dissolved oxygen concentration standard of 5.0 milligrams per liter (mg/l) and no less than 4.0 mg/l at all times.

The Bear Creek segment was identified as potentially not supporting water quality standards during the permit reissuance process in 1992. This segment was listed based on water quality modeling results, and not for measured dissolved oxygen concentrations below the water quality standard. Just prior to 1992, Georgia adopted a new annual low flow value for Bear Creek based on new streamflow statistics for the Savannah River basin developed by the U.S. Geological Survey. The revised low flow was approximately 50 percent lower than the low flow previously used. Using the revised low flow, the updated water quality model predicted a dissolved oxygen concentration below water quality standards due to the Lavonia WWTF discharge. At that time, the National Pollutant Discharge Elimination System (NPDES) permit was reissued with a clause regarding a model calibration stream study, as well as a clause to reopen the permit to require more stringent effluent limitations based on the water quality modeling results.

The potential dissolved oxygen concentration standard violation shown by the water quality modeling was attributed to the permitted discharge from the City of Lavonia WWTF. The facility was permitted for a monthly average flow of 1.32 million gallons per day (MGD) and effluent limits for BOD₅, ammonia, and dissolved oxygen of 30, 17.4, and 6 mg/l, respectively. The primary constituents responsible for lowering the instream dissolved oxygen concentration are ultimate carbonaceous biochemical oxygen demand (CBOD_u) and ultimate nitrogenous oxygen demand (NBOD_u). The nitrogenous oxygen demand is represented by ammonia. Other sources of these constituents are nonpoint sources such as background stream concentrations.

Field studies were performed in 1993 to collect data for Bear Creek to improve the selection of parameters in the water quality model. Using the field study data, a critical conditions water quality model was developed to determine the effluent limits for the City of Lavonia WWTF that would be protective of the dissolved oxygen concentration standard. The critical conditions model incorporates those severe hydrologic and meteorologic conditions in which the water quality standard would be protected. Revised effluent limits for BOD₅, ammonia, and dissolved oxygen of 15, 5, and 6 mg/l, respectively, were developed and required in a compliance schedule in the City of Lavonia WWTF's National Pollutant Discharge Elimination System (NPDES) permit in June 1997. The average monthly flow rate of 1.32 MGD remained the same. These effluent limits represent a 62 percent reduction in the oxygen demanding constituents permitted to be discharged from the plant.

A review of the available data and the water quality model was performed for the purpose of developing this TMDL. During this review it was found that some assumptions made in the latest water quality model were not conservative enough. This led to a revision of the water quality model which indicated that more stringent effluent limits were necessary to protect water quality standards. Consequently, new effluent concentration limits were developed for BOD₅, ammonia, and dissolved oxygen and are 10, 2, and 6 mg/l, respectively, while the flow rate remained unchanged. These effluent limits represent a 77 percent reduction in the oxygen demanding constituents permitted to be discharged from the plant, and will be incorporated in a revised permit. TMDLs for CBOD_u and ammonia (NBOD_u) for the Bear Creek watershed were developed based on the critical conditions water quality modeling results using these effluent limits.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its waters for compliance with water quality standards established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed waters are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality data assessment results. These waters are referred to as 305(b) waters after the section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years. A subset of the 305(b) partially and not supporting waters is assigned to the 303(d) list, also named after the section of the CWA. In accordance with U.S. Environmental Protection Agency (USEPA) guidelines, waters are placed on the 303(d) list if actions to achieve water quality standards will take more than two years to implement.

Waters on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for that water quality constituent in violation of the water quality standard. The implementation of a TMDL is one tool for addressing water quality limited waters, and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the allowable loadings or percent load reductions to the stream, thereby providing the basis for addressing the water quality impairment.

The State of Georgia has identified a segment of Bear Creek downstream from the City of Lavonia, Georgia, as a 305(b) not supporting stream segment, and has placed the stream segment on the 303(d) list of waters. A portion of the City of Lavonia is located in the headwaters of Bear Creek. The two mile segment of Bear Creek identified on the 303(d) list is located downstream from the City of Lavonia waste water treatment facility (WWTF). This segment has a water use classification of fishing and a daily average dissolved oxygen concentration standard of 5.0 milligrams per liter (mg/l) and no less than 4.0 mg/l at all times. This document describes the analyses used to develop the TMDL(s) and the resulting wastewater treatment permit limits that will be protective of the dissolved oxygen concentration standard.

1.2 Watershed Description

Bear Creek is located in the Broad River watershed of the northern Savannah River basin, U.S. Geological Survey (USGS) hydrologic unit code 03060104. Bear Creek and Little Bear Creek join to form Unawatti Creek which drains into the North Fork Broad River. The North Fork Broad River flows into the Broad River which is a tributary to the Savannah River (see Figure 1). The two mile segment of Bear Creek identified on the 303(d) list is located downstream from the City of Lavonia wastewater treatment facility (see Figure 2).

The Bear Creek watershed (to its confluence with Little Bear Creek) is a 6.4 square mile (sqmi) watershed (see Figure 2). Bear Creek and some of its tributaries drain areas of the City of Lavonia which is located on the watershed divide between the Broad River

hydrologic unit and the Tugaloo River hydrologic unit. Other than the City of Lavonia, there is little development in the remainder of the Bear Creek watershed. Other areas of the watershed are either forested, pasture or open land. There is a Natural Resource Conservation Service (NRCS) lake located on Bear Creek upstream from Little Bear Creek approximately one mile downstream from the Lavonia WWTF outfall.

1.3 Water Quality Standards

As described in section 1.1 the water quality standard for the dissolved oxygen concentration in Bear Creek is a daily average of 5.0 mg/l and no less than 4.0 mg/l at all times. This standard will be used to determine the TMDLs for Bear Creek. An explicit TMDL for dissolved oxygen was not developed since it is not a pollutant, but rather an indicator of water quality. Therefore, TMDLs were developed for those constituents responsible for depleting dissolved oxygen.

2.0 WATER QUALITY ASSESSMENT

There are very little water quality monitoring data available for the Bear Creek stream segment. This segment was listed based on water quality modeling results, and not for measured dissolved oxygen concentrations below the water quality standard. The data that are available were collected during the September and December 1993, calibration field studies. Table 1 shows water quality monitoring data from the field studies. During the September 1993 field study, one dissolved oxygen concentration (0.6 mg/l) was measured below the minimum instantaneous water quality standard of 4.0 mg/l, and one approaching this water quality standard (4.5 mg/l) was also observed.

Bear Creek is a sluggish stream with beaver dams located downstream from the Lavonia WWTF discharge and the low streamflow velocities and long times of travel adversely affect dissolved oxygen concentrations. The 0.6 mg/l dissolved oxygen concentration measurement was made near the backwater of the NRCS lake and may not have been representative of the free flowing stream dissolved oxygen concentration. Dissolved oxygen concentrations observed during the December 1993, field study were all greater than the water quality standard.

3.0 SOURCE ASSESSMENT

3.1 Point Source Assessment

There is one National Pollutant Discharge Elimination System (NPDES) permitted wastewater treatment facility discharging to the Bear Creek watershed. The City of Lavonia operates this wastewater treatment facility (NPDES permit number GA0047589).

The 2 mile segment of Bear Creek was identified as potentially not supporting water quality standards during the permit reissuance process in 1992. Just prior to 1992, Georgia adopted a new 7-day average low flow with a recurrence interval of 10 years (7Q10) for the Bear Creek watershed. The new low flow was based on streamflow statistics developed by the USGS (USGS 1988). The new low flow yield of 0.21 cubic feet per square mile (cfs/sqmi) is more than 50 percent less than the previously used low flow yield of 0.46 cfs/sqmi. Using the revised low flow, the updated water quality model predicted a dissolved oxygen sag concentration below water quality standards due to the Lavonia WWTF discharge. At that time, the NPDES permit was reissued with a clause regarding a model calibration stream study, and a clause to reopen the permit to require more stringent limitations based on the water quality modeling results.

The Lavonia WWTF was previously permitted for a monthly average flow of 1.32 million gallons per day (MGD) and effluent limits for BOD₅, ammonia, and dissolved oxygen of 30, 17.4, and 6 mg/l, respectively. These effluent limits were later revised to 15, 5, and 6 mg/l as a result of the field studies and revised water quality model. The primary constituents responsible for lowering the instream dissolved oxygen concentration are carbonaceous biochemical oxygen demand (CBOD_u) and ammonia (NBOD_u). These effluent limits represent a 62 percent reduction in the oxygen demanding constituents permitted to be discharged from the plant. Other sources of these constituents are nonpoint sources such as background stream concentrations which are discussed in the following section.

Further review of the available data and the water quality model was performed for the purpose of developing this TMDL. During this review it was found that some assumptions made in the latest water quality model were not conservative enough. This led to a revision of the water quality model which now indicated that more stringent effluent limits were necessary to protect water quality standards. TMDLs for CBOD_u and ammonia (NBOD_u) for the Bear Creek watershed were developed based on the critical conditions water quality modeling results. New effluent concentration limits of 10, 2, and 6 mg/l were developed for BOD₅, ammonia, and dissolved oxygen, respectively, while the flow rate remained unchanged. These effluent limits represent a 15 percent further reduction in the oxygen demanding constituents permitted to be discharged from the plant.

3.2 Nonpoint Source Assessment

Other constituent loadings include nonpoint source loads representing background streamflow concentrations. These are represented in the water quality model as headwaters, tributary, and lateral inflows.

4.0 MODELING APPROACH

4.1 Model Selection

Water quality modeling was used to assess the cause and effect relationship between pollutant sources and stream water quality. A one-dimensional steady-state conventional pollutant water quality model was applied to Bear Creek. This modeling approach was chosen based on the nature of the waterbody, pollutant sources and constituents, critical conditions, and the water quality standard involved. The Georgia DOSAG conventional pollutant and dissolved oxygen computer model was chosen to develop the Bear Creek TMDL for dissolved oxygen related constituents. The following sections describe the justification for this modeling approach.

4.1.1 Waterbody

The modeled stream segment is approximately 8.4 miles long and includes Bear and Unawatti Creeks, as well as the inflows from other streams. A small lake constructed by the Natural Resource Conservation Service (NRCS) is located on Bear Creek downstream from the Lavonia WWTF discharge. During the field study, beaver dams were also observed downstream from the discharge. Although the presence of the lake and beaver dams modifies the hydraulic and water quality characteristics of the waterbody, the steady-state and one-dimensional, as well as other DOSAG modeling assumptions, were still considered appropriate.

4.1.2 Pollutant Sources and Constituents

The primary pollutant source is the City of Lavonia WWTF. The primary pollutants affecting the dissolved oxygen concentration in Bear Creek are the oxygen demanding constituents in the facility's effluent and local streamflows. These include the carbonaceous biochemical oxygen demanding materials (CBOD_u) and the nitrogenous oxygen demanding materials like ammonia (NBOD_u). The DOSAG model simulates the dissolved oxygen kinetics of both CBOD_u and NBOD_u.

4.1.3 Critical Conditions

The steady-state critical conditions selected for developing the TMDL for Bear Creek are low-flow and high temperature conditions in which the primary pollutant source, the discharge from the wastewater treatment facility, has a more severe impact on the stream's dissolved oxygen concentration. Low-flow conditions are defined by streamflows equivalent to the estimated 7-day average low flow with a 10 year recurrence interval, referred to as the 7Q10. Dilution of the wastewater is at a minimum during low flow conditions, and higher water temperatures reduce dissolved oxygen solubility. These are severe environmental conditions affecting the dissolved oxygen concentration. The potential minimum instream dissolved oxygen concentration can be determined using these critical conditions along with the allowable wastewater treatment facility effluent limits. The DOSAG model is capable of simulating these steady-state critical conditions.

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4.1.4 Water Quality Standard

The DOSAG model computes dissolved oxygen concentrations using the dissolved oxygen kinetics for $CBOD_u$ and $NBOD_u$ and other processes. An explicit TMDL for dissolved oxygen will not be determined, but rather TMDLs for oxygen consuming substances, $CBOD_u$ and $NBOD_u$, will be determined. Consequently, DOSAG will be used to predict dissolved oxygen concentrations and the TMDLs will be developed from the corresponding loadings used in the model.

4.2 Calibration Model

Field studies were conducted in September and December 1993, to collect data and information to calibrate the water quality model. These field studies collected data including streamflow, instream dissolved oxygen concentrations, and time of travel. The September 1993 data were used for model calibration. Section 4.4 describes the model setup in more detail and Appendix A contains the DOSAG model input and results for the 1993 calibration model.

4.3 Critical Conditions Model

The critical conditions model was developed from the calibration model by modifying the model input parameters to represent the selected critical conditions. The model parameters modified to represent the critical conditions included streamflow, water temperature, and wastewater treatment facility effluent limits. Streamflow velocities in the upper reaches of the model were reduced from 0.3 feet per second (fps) in the original model to 0.1 fps in the new critical conditions model to reflect the influence of the beaver dams. Section 4.4 describes the model setup in more detail and Appendix B contains the DOSAG model input and results for the critical conditions model.

4.4 Model Setup

4.4.1 General

The Bear Creek water quality model consists of one branch with 20 stream reaches. Stream reaches were chosen based on features such as roads, tributary confluences, point source discharges, and dams. The model included one wastewater treatment facility and four tributaries.

4.4.2 Point Source Representation

The City of Lavonia WWTF was represented in the critical conditions model as a point source with effluent limits for BOD_5 , ammonia, and dissolved oxygen of 10, 2, and 6 mg/l, respectively. A $CBOD_u$ to BOD_5 f-ratio of 2.0 was applied to the wastewater treatment facility BOD_5 effluent limit concentration in both the calibration and critical conditions model.

4.4.3 Nonpoint Source Representation

The water quality constituent concentrations assigned to headwaters, tributaries, and lateral inflows were estimated using typical values. A dissolved oxygen concentration equal to 80 percent of saturation was used for headwaters, tributaries, and lateral inflows unless field study data indicated otherwise.

4.4.4 Stream Characteristics

Streamflows used in the critical conditions model were determined using the annual 7Q10 streamflow yield factor of 0.21 cfs/sqmi. This factor was derived from the nearby USGS Toms Creek near Martin streamflow gage (USGS 02190500) (USGS 1988). Streamflows used in the calibration model were equivalent to those measured during the field study.

Except in the upper reaches of the critical conditions model, streamflow velocities were computed in the water quality models using the equation:

$$v = cQ^n$$

where v is the streamflow velocity, Q is the streamflow rate, c is a coefficient, and n is an exponent. Time of travel data collected during the field studies were used to determine the values for c and n . A velocity of 0.1 fps was used in the upper reaches of the critical conditions model.

The *water temperature* throughout the critical conditions model was set to 24.6 degrees Celsius based on U.S. Geological Survey water temperature estimates (USGS, 1996) for this area. This is the expected highest water temperature for this area. Water temperatures in the calibration model were equivalent to those measured during the field study.

Kinetic rates for $CBOD_u$ and $NBOD_u$ are used in the DOSAG model to compute the decay of these substances and the corresponding oxygen consumption. The decomposition of $CBOD_u$ and $NBOD_u$ was modeled using a first-order decay rate. No data were available to compute the first-order decay rates. As a result, literature values were used in both the critical conditions and calibration models. The kinetic rates at 20 degrees Celsius used for $CBOD_u$ and $NBOD_u$ were 0.35 and 0.2 per day, respectively. These kinetic rates were temperature adjusted in the model.

Reaeration was computed in both models using the Tsivoglou reaeration formulation with escape coefficients of 0.08 in the calibration model and 0.11 in the critical conditions model.

Photosynthesis/respiration and sediment oxygen demand were not considered significant components of the dissolved oxygen deficit and were not represented in the water quality model.

5.0 MODEL RESULTS

Model input and results for both the calibration model and the critical conditions model are contained in Appendix A and B.

5.1 Calibration Model

The calibration model (see Appendix A) was developed using data from the September, 1993, field study. Data from this study were also used to compare with model results to calibrate the water quality model. Figure 3 compares the measured dissolved oxygen data to the calibration model results.

5.2 Critical Conditions Model

The critical conditions model (see Appendix B) was developed using parameters from the calibration model, and streamflow and water temperature representing the critical condition. High water temperature and low streamflow represent the selected critical or design conditions for protecting the dissolved oxygen concentration standard, and is considered the condition in which the treatment facility will have a severe impact. The resulting dissolved oxygen concentration profile is shown in Figure 4. The results show a minimum dissolved oxygen concentration in Bear Creek of 5.2 mg/l. The loadings in the critical conditions model will be used as the basis for computing the TMDLs for the various constituents.

6.0 ALLOCATION

6.1 Total Maximum Daily Load

A TMDL is the sum of the individual wasteload allocations (WLA) for point sources, and load allocations (LA) for nonpoint sources including background. The sum of these components may not result in an exceedence of water quality standards for that waterbody. To protect against exceedences, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality of the receiving waterbody. Conceptually, a TMDL can be expressed as follows:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while maintaining water quality standards. TMDLs establish allowable waterbody loadings that provide the basis for water quality based controls. For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For dissolved oxygen the TMDLs for the oxygen consuming constituents CBOD_u and NBOD_u are expressed as mass loading rates.

The total maximum daily loads of oxygen demanding constituents was determined by adding the WLA and the LA. The MOS (as described in Section 4.5) was implicitly included in the TMDL analysis and does not factor directly in the TMDL equation as shown above. Tables 2 and 3 show the computation of the total maximum daily load using the WLAs and the LAs for the critical condition. The TMDLs for CBOD_u and NBOD_u are 242 and 102 pounds, respectively, and were determined by rounding the computed results to the next pound.

6.2 Wasteload Allocations

The only permitted point source discharge in the Bear Creek watershed is the City of Lavonia WWTF. The critical conditions model was used to set the wasteload allocation for this plant that protects the dissolved oxygen standard. At a flow rate of 1.32 MGD (2.04 cfs), the plant's effluent concentration limits for BOD₅, ammonia, and dissolved oxygen must be 10, 2, and 6 mg/l, respectively, to protect the downstream dissolved oxygen concentration standard. Using a CBOD_u/BOD₅ f-ratio of 2.0 and an ammonia to NBOD_u conversion factor of 4.57, the corresponding loadings for CBOD_u and NBOD_u are 220 and 100 pounds per day, respectively. These are the allowable waste load allocations (WLA) for the Lavonia WWTF for the critical conditions and are shown in Tables 2 and 3. These revised limits represent a 77 percent reduction in the permitted ultimate oxygen demanding substance loading to Bear Creek (see Table 4).

6.3 Load Allocations

Load allocations include constituents originating from nonpoint sources and natural background concentrations for the watershed, and were included in the critical

conditions model to determine the TMDLs. For the Bear Creek steady-state low flow critical condition, these load allocations represent the background concentrations for the watershed and were included in the water quality model. Background tributary concentrations of CBOD_u and NBOD_u are estimated at 3.0 mg/l and 0.3 mg/l, respectively.

The loadings from the headwaters, tributaries, and local inflows were computed to determine the load allocation (LA) for background loadings. Tables 2 and 3 show the background loadings by headwater and stream reach. The total load allocation was computed by adding all the loads associated with background concentrations upstream from Little Bear Creek. This point was chosen as the downstream extent of the potential water quality impairment.

The resulting load allocation for the Bear Creek watershed upstream from the Little Bear Creek confluence was 22 pounds per day of CBOD_u and 2 pounds per day of NBOD_u. These load allocations were computed based on the low flow critical conditions and apply only to these conditions. Therefore, it should be recognized that during wet weather and other higher streamflow conditions these load allocations could be exceeded. However, these conditions are not considered critical to the dissolved oxygen concentration.

6.4 Seasonal Variation

The high temperature and low-flow conditions represent the selected design condition for protecting the dissolved oxygen standard, and is considered the condition in which the treatment facility will have a severe impact. This design condition is expected to occur during the summer/fall seasons of the year when low streamflows and higher ambient water temperatures would be expected to occur. Other times of the year are expected to be less severe with higher streamflows and lower temperatures.

To demonstrate this conclusion, an analysis of minimum dissolved oxygen concentration changes with changing streamflows and water temperature was performed. The analysis used average monthly 7Q10 streamflows (USGS 1982) and computed monthly water temperatures (USGS 1996) based on historic measured data.

Monthly minimum (7Q10) streamflows for Bear Creek were based on the USGS average monthly minimum streamflow data for Panther Creek near Toccoa (02182000) (USGS 1982). Monthly minimum streamflow yields for the Panther Creek gage watershed were computed by dividing the minimum streamflow rate by the gaged watershed area (see Table 5). The average monthly minimum streamflow yield for Bear Creek was computed by multiplying the ratio of the annual 7Q10 streamflow rates for Bear Creek and Panther Creek (0.21 [USGS 88] and 0.43 [USGS 77], respectively) by the average monthly minimum streamflow yield for Panther Creek (see Table 5). The table shows that the minimum streamflow yield is 0.24 cfs/sqmi, slightly higher than the 0.21 used in the water quality critical conditions model. This minimum streamflow yield occurred during the month of September.

These monthly minimum streamflows and water temperatures were used in individual model simulations to compute the resulting minimum dissolved oxygen concentrations for each month (see Table 5). The results show that the minimum dissolved oxygen concentration is affected more by water temperature than minimum instream flow. Minimum dissolved oxygen concentrations for all months were greater than the minimum dissolved oxygen concentration computed in the critical conditions model. This supports the use of the selected critical conditions.

6.5 Margin of Safety

The MOS is part of the TMDL development process and there are two basic methods for incorporating the MOS:

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations, or
- Explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

A combination of these two MOS approaches was used in developing the TMDL for dissolved oxygen for Bear Creek. First, the MOS is implicitly incorporated into the modeling process by selecting critical conditions of combined high temperature and low streamflow with a low recurrence interval. Secondly, the minimum dissolved oxygen concentration was maintained at 5.2 mg/l which is above the 4.0 and 5.0 mg/l standard concentrations in order to provide another margin of safety in the analysis.

6.6 Monitoring Recommendations

It is recommended that the City of Lavonia conduct monitoring for dissolved oxygen concentration and water temperature both upstream and downstream from the water pollution control plant discharge once per week. In addition, it is recommended that total phosphorus, organic nitrogen, ammonia, and $\text{NO}_2 + \text{NO}_3$ be added to the monitoring parameter list at the downstream monitoring site with a sampling frequency sufficient to characterize seasonal tributary loadings. This additional sampling is recommended due to the potential for eutrophication in the downstream NRCS impoundment. Monitoring downstream from the discharge should be done in the flowing stream just upstream from the NRCS impoundment backwaters.

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USGS 1996, Stream Temperature Characteristics, U.S. Geological Survey Water Resources Investigations Report 96-4203, Dyar T.R., Alhadeff S.J.

Table 1: Water Quality Data from Field Studies

September 14-16, 1993 Field Study						
	Location	Date	Time	Flow (cfs)	Temperature (C)	DO (mg/l)
BC1	Upstream from Lavonia WWTF	09/14/1993	15:47	1.0	22.0	7.4
	WWTF Lavonia WWTF	09/14/1993	15:45	0.3	26.5	7.9
BC2	Upstream NRCS Lake	09/14/1993	13:19		23.0	0.6
BC3A	NRCS Lake Discharge	09/14/1993	12:05		24.0	6.2
BC3B	Downstream from NRCS Lake Discharge	09/14/1993	11:30		24.5	5.4
BC4	McGee Road	09/14/1993	18:00	2.7	24.0	4.5
LBC1	Little Bear Creek Tributary	09/15/1993	9:07	1.2	20.0	7.6
UC1	Brady School Road	09/15/1993	8:50		22.0	5.5
UC2	South Fairview Road	09/15/1993	11:04		21.0	7.4

December 13-14, 1993 Field Study						
	Location	Date	Time	Flow (cfs)	Temperature (C)	DO (mg/l)
BC1	Upstream from Lavonia WWTF	12/13/1993	11:10	1.7	5.5	11.3
	WWTF Lavonia WWTF	12/13/1993	11:12	1.3	8.0	11.3
BC2	Upstream NRCS Lake	12/13/1993	16:35		8.0	10.7
BC3A	NRCS Lake Discharge	12/13/1993	16:45		8.0	10.8
BC3B	Downstream from NRCS Lake Discharge	12/13/1993	17:00		8.0	11.4
BC4	McGee Road	12/13/1993	14:50	5.4	8.0	11.0
LBC1	Little Bear Creek Tributary	12/13/1993	14:00	1.8	9.0	10.6
UC1	Brady School Road	12/13/1993	14:12		8.0	10.8
UC2	South Fairview Road	12/13/1993	15:25		8.0	10.6

Table 2: CBODu Total Maximum Daily Load

Reach/Headwater	Wasteload Allocation			Load Allocation		
	Flow (cfs)	Concentration (mg/l)	Load (lbs/day)	Flow (cfs)	Concentration (mg/l)	Load (lbs/day)
Headwater				0.42	3.0	6.8
City of Lavonia WWTF	2.04	20	219.9			
WWTF to Tributary				0.28	3.0	4.5
Tributary to Impoundment Headwater				0.08	3.0	1.3
Impoundment Headwater to Outfall				0.37	3.0	6.0
Outfall to BC3B				0.02	3.0	0.3
BC3B to McGee Road				0.08	3.0	1.3
McGee Road to Little Bear Creek				0.08	3.0	1.3
Total:	2.04		220	1.33		22

Total Maximum Daily Load: 242 pounds

Table 3: NBODu Total Maximum Daily Load

Reach/Headwater	Wasteload Allocation			Load Allocation		
	Flow (cfs)	Concentration (mg/l)	Load (lbs/day)	Flow (cfs)	Concentration (mg/l)	Load (lbs/day)
Headwater				0.42	0.3	0.7
City of Lavonia WWTF	2.04	9.14	100.5			
WWTF to Tributary				0.28	0.3	0.5
Tributary to Impoundment Headwater				0.08	0.3	0.1
Impoundment Headwater to Outfall				0.37	0.3	0.6
Outfall to BC3B				0.02	0.3	0.0
BC3B to McGee Road				0.08	0.3	0.1
McGee Road to Little Bear Creek				0.08	0.3	0.1
Total:	2.04		100	1.33		2

Total Maximum Daily Load: 102 pounds

Table 4: Percent Permitted Load Reduction for City of Lavonia WWTF

f-Ratio(1):	1.5								
f-Ratio(2):	2.0								
NBODu Stoichiometric Constant:	4.57								
	Flow (MGD)	Flow (cfs)	BOD5 (mg/l)	BODu (mg/l)	Load (lbs/day)	Ammonia (mg/l)	NBODu (mg/l)	Load (lbs/day)	
Previous Effluent Limits	1.32	2.04	30	45	495	17.4	80	875	
Revised Effluent Limits	1.32	2.04	10	20	220	2	9.14	101	
			BODu percent reduction:		56%	NBODu percent reduction:		89%	
Total Reduction:	77%								

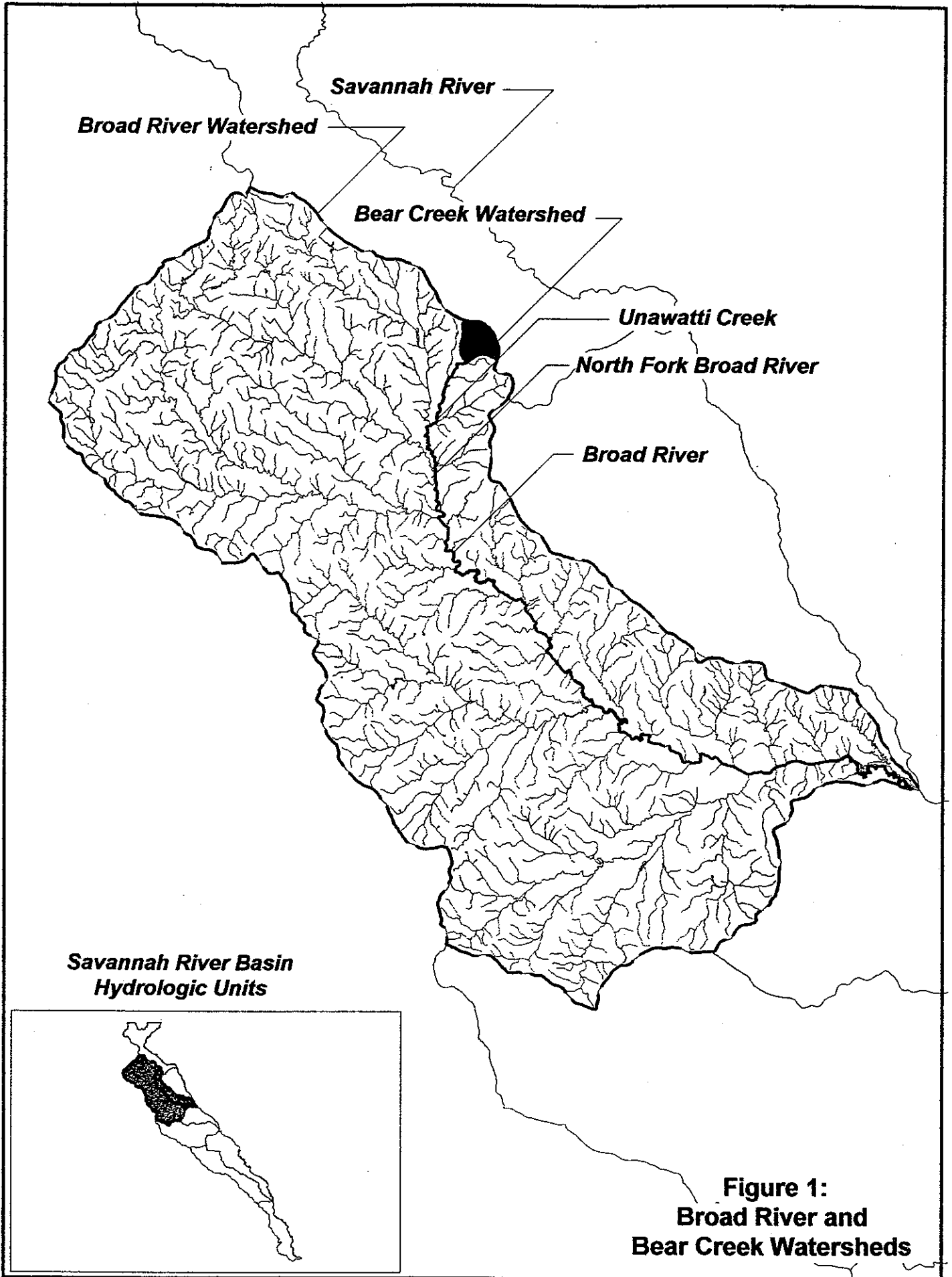
Note: To compute BODu f-ratio(1) was used for previous effluent limits and f-ratio(2) was used for revised effluent limits.

Table 5: Seasonal Dissolved Oxygen Analysis Data and Results

Month	(1) Average Monthly Minimum Discharge (cfs)	Average Monthly Minimum Discharge Yield (Panther Creek) (cfs/sqmi)	(2) Average Monthly Minimum Discharge Yield (Bear Creek) (cfs/sqmi)	Monthly Temperature (Celsius)	Dissolved Oxygen Concentration (mg/l)
January	27	0.83	0.41	7	7.13
February	36	1.11	0.54	7	7.36
March	46	1.42	0.69	9	7.39
April	49	1.51	0.74	13	7.10
May	44	1.35	0.66	17	6.75
June	32	0.98	0.48	22	6.37
July	26	0.80	0.39	25	5.56
August	20	0.62	0.30	25	5.36
September	16	0.49	0.24	23	5.60
October	18	0.55	0.27	18	6.36
November	21	0.65	0.32	14	6.58
December	20	0.62	0.30	10	6.73

(1) Monthly 7 consecutive day average low flow with 10 year recurrence interval (7Q10) based on U.S. Geological Survey streamflow gage Panther Creek near Toccoa, Georgia (02182000).

(2) Average monthly minimum (7Q10) discharge yield for Bear Creek is computed using the ratio of the annual 7Q10 values for Bear Creek and Panther Creek (0.21 and 0.43 respectively) multiplied by the average monthly minimum discharge yield for Panther Creek.



**Figure 1:
Broad River and
Bear Creek Watersheds**



Figure 2:
Bear Creek Watershed Features

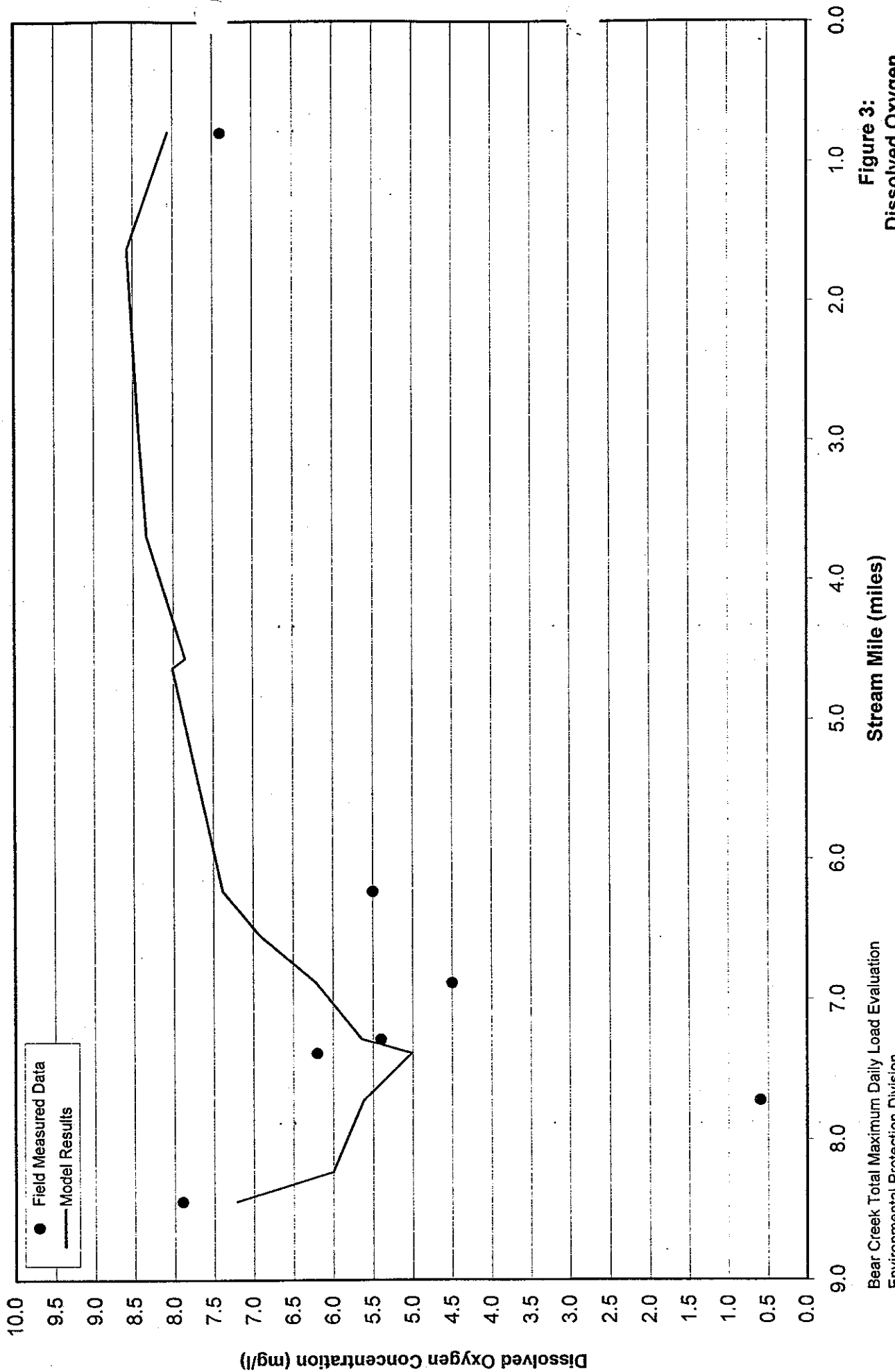


Figure 3:
Dissolved Oxygen
Model Calibration Results

Bear Creek Total Maximum Daily Load Evaluation
Environmental Protection Division
Atlanta, Georgia

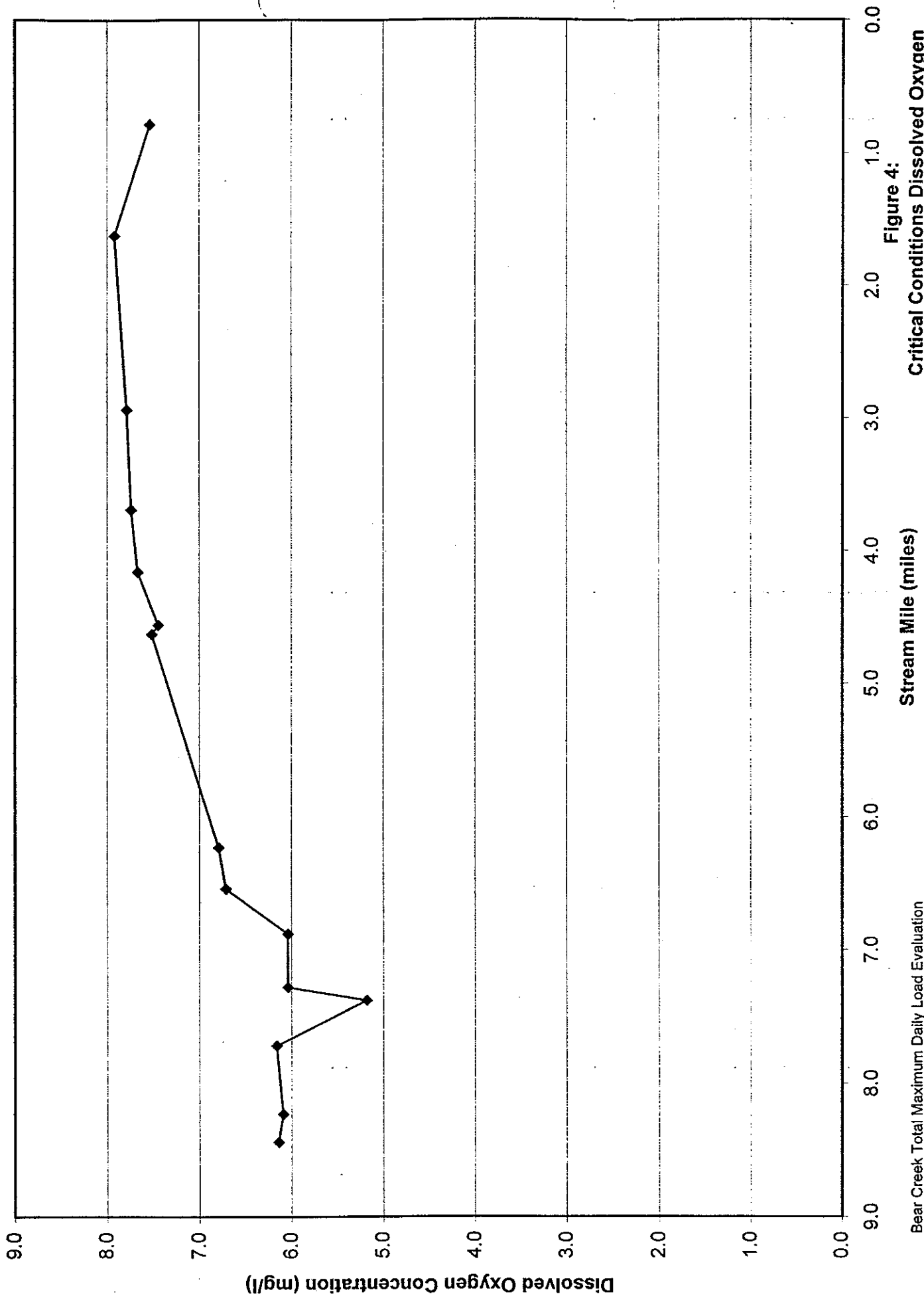


Figure 4:
Critical Conditions Dissolved Oxygen
Concentration Profile

APPENDIX A
Calibration Model

City of Lavonia WWTF, GA0047589
Calibration Model
Bear Creek, WQMU 0103
Paul Lamarre, 05/26/99

* * * SYSTEM DATA AND SELECTED RUN PARAMETERS * * *

=====

PROJ:	Bear Creek Calibration Mo	Reaches	=	20	Ints	=	0
Date:	06-23-1999.....	Branches	=	0	Wtfs	=	1
File:	BCRCAL.....	Sub-Branches	=	0	Dams	=	0

SOD Variable: ON. Net P/R Variable: ON.
Substance No. 1: ON --> TNH3 expressed in mg/l
Substance No. 2: ON --> Sub#2 expressed in ---

Georgia Soil Type --> No. 4: Southern Piedmont
Soil Vel Eqn = $0.137 * (Q^{0.522}) * (S^{0.264}) * (A^{-0.333}) * (L^{0.348})$

=====

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * BRANCH OPTIONS AND SELECTED HEADWATER DATA * * *

```

=====
***** BRANCH DESCRIPTIONS ***** <---- CALC OPTIONS ---->
No.      Type                Name                Depth  Vel      Reaer
=====
  1  MAIN STEM  Bear Creek.....    ON  v=c*Q^n  Tsivoglou
=====
  
```

```

=====
BRAN ***** HEADWATER GEOMETRY ***** <----- FLOW PARAMETERS ----->
No. Rch  RivMile  Elev      drAREA      Fixed  Opt  Prod      Used
=====
  1    1    8.44    734.0      2.000    1.00  INPUT  0.210    1.00
=====
  
```

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * HEADWATERS DATA AND SELECTED BRANCH RESULTS * * *

```

=====
BRAN  CBODu  NBODu  <----- DO PARAMETERS ----->  TNH3  Sub#2
No.   mg/l   mg/l   Fixed Opt  %Sat DoSat Used  mg/l   ---
=====
  1    3.0    0.3    7.4 INPUT 75.0  8.52 7.40  0.1  0.000E+00
=====
  
```

```

=====
BRANCH hwTEMP ***** END-OF-BRANCH RESULTS *****
No.    degC  Reach  RivMile  Elev  SumArea  SumFlow  SumTOT
=====
  1    22.0  EOM    0.00    609.0  32.648  11.27  3.987
=====
  
```

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * MODEL REACH STRUCTURE * * *

06-23-1999

10:10 am

```

=====
RCH   RIVER   ELEV   REACH   REACH DESCRIPTION
#     Mile    ft     Type
=====
-(br 1) MAIN STEM:  Bear Creek
  1     8.44    734.0  Dischg  City of Lavonia WPCP,discharge.....
  2     8.44    734.0  stream  discharge to Unnamed Trib.....
  3     8.23    730.0  stream  Unnamed trib. to Head of Impoundmen
  4     7.72    720.0  stream  Head of Imp. to Outfall.....
  5     7.38    719.0  stream  Outfall to BC3B.....
  6     7.28    715.0  stream  BC3B to McGee Road.....
  7     6.88    710.0  stream  McGee Road to Little Bear Creek....
  8     6.54    705.0  -trib-  Little Bear Creek.....
  9     6.54    705.0  stream  lbc to Brady school rd. (UC1).....
 10     6.23    703.0  stream  UC1 to Muddy Branch.....
 11     4.63    682.0  -trib-  Muddy Branch.....
 12     4.63    682.0  stream  Muddy Branch to Unnnamed Trib.....
 13     4.56    680.0  -trib-  Unnamed Trib.....
 14     4.56    680.0  stream  Unnamed Trib to S Fairview Rd. (UC1
 15     4.16    674.0  stream  Fairview to County rd.....
 16     3.69    668.0  stream  county rd. to 660' contour.....
 17     2.94    660.0  stream  660' to 640' Contour.....
 18     1.63    640.0  stream  640' Contour to Double Branch.....
 19     0.79    624.0  -trib-  Double Branch.....
 20     0.79    624.0  stream  Double Branch to NFB River.....
=====
  
```

```

DS = 0.00 609.0 ---- DISCHARGES 1; INTAKES 0; DAMS 0
RiverMiles and Elevations represent 'Head-of-Reach' Values.
Model File Name: BCRCAL
  
```


City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * STREAM DEPTH & REACH PHYSICAL DATA * * *

06-23-1999

10:10 am

```

=====
RCH  LENGTH  dLELV  SLOPE  drAREA  <----- DEPTH PARAMETERS ----->
#    mi      ft    ft/mi   mi2     fixed  coeff  exp  Opt -used
=====
- (br 1) MAIN STEM:  Bear Creek
  1  Dischg   --    --      --      -      -      -      -      -
  2  0.203    4.00   19.704  1.320  0.0    0.000  0.000  C    0.0
  3  0.513   10.00   19.493  0.387  0.0    0.000  0.000  C    0.0
  4  0.346    1.00    2.890  1.752  0.0    0.000  0.000  C    0.0
  5  0.100    4.00   40.000  0.100  0.0    0.000  0.000  C    0.0
  6  0.400    5.00   12.500  0.400  0.0    0.000  0.000  C    0.0
  7  0.335    5.00   14.925  0.400  0.0    0.000  0.000  C    0.0
  8  -trib-   --     --      1.974  -      -      -      -      -
  9  0.307    2.00    6.515  0.180  0.0    0.000  0.000  C    0.0
 10  1.600   21.00   13.125  1.002  0.0    0.000  0.000  C    0.0
 11  -trib-   --     --      2.419  -      -      -      -      -
 12  0.076    2.00   26.316  0.037  0.0    0.000  0.000  C    0.0
 13  -trib-   --     --      3.839  -      -      -      -      -
 14  0.402    6.00   14.925  0.321  0.0    0.000  0.000  C    0.0
 15  0.468    6.00   12.821  1.156  0.0    0.000  0.000  C    0.0
 16  0.746    8.00   10.724  0.460  0.0    0.000  0.000  C    0.0
 17  1.307   20.00   15.302  0.981  0.0    0.000  0.000  C    0.0
 18  0.848   16.00   18.868  0.320  0.0    0.000  0.000  C    0.0
 19  -trib-   --     --     12.460  -      -      -      -      -
 20  0.786   15.00   19.084  1.140  0.0    0.000  0.000  C    0.0
=====

```

SF = -- 1.00 1.00 1.00 -- --- --- 1.00

(*) means Depth variable has been turned OFF for THAT Branch.
 NOTE: 'used' - shows the Depth value 'used' in calculations.
 'fixed' - identifies the Depth value fixed-by-user Input.
 I or C - Depth 'used' is INPUT (I), or CALCULATED (C).

Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * REACH FLOW AND VELOCITY DATA * * *

06-23-1999

10:10 am

```
=====
RCH  <---- FLOW PARAMETERS ---->  <--- VELOCITY PARAMETERS --->
#    fixed  Prod  Opt   used  fixed  coeff  exp  Opt  used
=====
```

-(br 1) MAIN STEM: Bear Creek

#	fixed	Prod	Opt	used	fixed	coeff	exp	Opt	used
1	Dischg	--		--	--	--	--		--
2	0.00	0.300	C	0.40	0.10	0.020	0.400	Q	0.025
3	0.00	0.300	C	0.12	0.10	0.020	0.400	Q	0.026
4	0.00	0.300	C	0.53	0.10	0.020	0.400	Q	0.028
5	0.00	0.300	C	0.03	0.10	0.020	0.400	Q	0.029
6	0.00	0.300	C	0.12	0.00	0.020	1.390	Q	0.075
7	0.00	0.300	C	0.12	0.00	0.100	0.890	Q	0.243
8	1.20	0.300	I	1.20	--	----trib----			--
9	0.00	0.300	C	0.05	0.00	0.100	0.890	Q	0.343
10	0.00	0.300	C	0.30	0.00	0.220	0.400	Q	0.390
11	0.00	0.300	C	0.73	--	----trib----			--
12	0.00	0.300	C	0.01	0.00	0.220	0.400	Q	0.421
13	0.00	0.300	C	1.15	--	----trib----			--
14	0.00	0.300	C	0.10	0.00	0.220	0.400	Q	0.458
15	0.00	0.300	C	0.35	0.00	0.220	0.400	Q	0.465
16	0.00	0.300	C	0.14	0.00	0.220	0.400	Q	0.472
17	0.00	0.300	C	0.29	0.00	0.220	0.400	Q	0.478
18	0.00	0.300	C	0.10	0.00	0.220	0.400	Q	0.483
19	0.00	0.300	C	3.74	--	----trib----			--
20	0.00	0.300	C	0.34	0.00	0.220	0.400	Q	0.576

```
=====
SF =   ---   1.00           1.00   --   1.00   1.00           1.00
NOTE: 'used' - shows the Value actually 'used' in calculations.
      'fixed' - identifies the Value fixed-by-user Input.
      I or C - Value 'used' is INPUT (I), or CALCULATED (C).
      S or Q - Velocity from Soil (S), or V=c*Q^n (Q) equation.
Model File Name:  BCRCAL
```

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * RATES: BOD, TNH3, Sub#2 (Base e @ 20 Deg.C) * *
 06-23-1999 10:10 am

```

=====
RCH  TEMP  Kr,CBOD  Kd,CBOD  Kd,NBOD  Kx,TNH3  Kz,Sub#2
#    degC  /day      /day      /day      /day      /day
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg  --        --        --        --        --
  2  23.0    0.350    0.350    0.200    0.000    0.000
  3  23.0    0.350    0.350    0.200    0.000    0.000
  4  23.0    0.350    0.350    0.200    0.000    0.000
  5  24.0    0.350    0.350    0.200    0.000    0.000
  6  24.5    0.350    0.350    0.200    0.000    0.000
  7  24.0    0.350    0.350    0.200    0.000    0.000
  8  -trib-  --        --        --        --        --
  9  22.0    0.350    0.350    0.200    0.000    0.000
 10  22.0    0.350    0.350    0.200    0.000    0.000
 11  -trib-  --        --        --        --        --
 12  22.0    0.350    0.350    0.200    0.000    0.000
 13  -trib-  --        --        --        --        --
 14  22.0    0.350    0.350    0.200    0.000    0.000
 15  21.0    0.350    0.350    0.200    0.000    0.000
 16  21.0    0.350    0.350    0.200    0.000    0.000
 17  21.0    0.350    0.350    0.200    0.000    0.000
 18  21.0    0.350    0.350    0.200    0.000    0.000
 19  -trib-  --        --        --        --        --
 20  21.0    0.350    0.350    0.200    0.000    0.000
=====

```

```

=====
SF = 0.0  1.00  1.00  1.00  1.00  1.00
Current Variable Status -->                ON      ON
TNH3 and Sub#2 are independent AND have no effect on DO.
CAUTION:  Kd for CBOD should NEVER exceed Kr for CBOD.
NOTE:  Nitrification Inhibition switch now turned OFF, thus
       Kd,NBOD rates are NOT inhibited in the Calculations.
Model File Name:  BCRCAL
=====

```

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * RATES: REAER, SOD, P/R (Base e @ 20 Deg.C) * * *

06-23-1999

10:10 am

```
=====
RCH  BOTTOM    SOD  nP/R  <----- REAERATION PARAMETERS ----->
#    fract    gsmd mgld  fixed  ESC   dE/TOT  Depth  Opt   -used
=====
```

-(br 1) MAIN STEM: Bear Creek

RCH #	BOTTOM fract	SOD gsmd	nP/R mgld	fixed	ESC	dE/TOT	Depth	Opt	-used
1	Dischg	--	-	--	--	--			---
2	1.00	0.00	0.0	0.000	0.080	7.90	-on-	T	0.632
3	1.00	0.00	0.0	0.000	0.080	8.28	-on-	T	0.662
4	1.00	0.00	0.0	0.000	0.080	1.31	-on-	T	0.104
5	1.00	0.00	0.0	0.000	0.080	18.94	-on-	T	1.515
6	1.00	0.00	0.0	0.000	0.080	15.37	-on-	T	1.230
7	1.00	0.00	0.0	0.000	0.080	59.35	-on-	T	4.748
8	-trib-	--	-	--	--	--			---
9	1.00	0.00	0.0	0.000	0.080	36.60	-on-	T	2.928
10	1.00	0.00	0.0	0.000	0.080	83.70	-on-	T	6.696
11	-trib-	--	-	--	--	--			---
12	1.00	0.00	0.0	0.000	0.080	181.18	-on-	T	14.494
13	-trib-	--	-	--	--	--			---
14	1.00	0.00	0.0	0.000	0.080	111.93	-on-	T	8.954
15	1.00	0.00	0.0	0.000	0.080	97.49	-on-	T	7.799
16	1.00	0.00	0.0	0.000	0.080	82.75	-on-	T	6.620
17	1.00	0.00	0.0	0.000	0.080	119.59	-on-	T	9.567
18	1.00	0.00	0.0	0.000	0.080	149.10	-on-	T	11.928
19	-trib-	--	-	--	--	--			---
20	1.00	0.00	0.0	0.000	0.080	179.90	-on-	T	14.392

```
=====
SF = 1.00  1.00  1.00  ---  1.00  --  1.00
STATUS -->  ON    ON
```

If PhotoSynthesis > Respiration, then Net P/R is (+).
 NOTE: 'used' - shows the Value actually 'used' in calculations.
 'fixed' - identifies the K2 value fixed-by-user Input.
 I - means K2 'used' is INPUT (I), fixed by user.
 T or O - K2 is CALCULATED, Tsivoglou (T) or O'Connor (O).
 *T - O'Connor selected, DEPTH disabled, Tsivoglou used.

Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * REACH WATER QUALITY INPUT DATA * * *

06-23-1999

10:10 am

```
=====
```

RCH #	TEMP degC	CBODu mg/l	NBODu mg/l	<---- fixed	DO %Sat	PARAMS Opt	----> -used	*pH	TNH3 mg/l	Sub#2

-(br 1) MAIN STEM: Bear Creek										
1	Dischg	--	--	--	--	--	--	-	--	---
2	23.0	3.0	0.3	0.00	80.0	C	6.68	7.0	0.00	0.000E+00
3	23.0	3.0	0.3	0.00	80.0	C	6.69	7.0	0.00	0.000E+00
4	23.0	3.0	0.3	0.00	80.0	C	6.69	7.0	0.00	0.000E+00
5	24.0	3.0	0.3	0.00	80.0	C	6.56	7.0	0.00	0.000E+00
6	24.5	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
7	24.0	3.0	0.3	0.00	80.0	C	6.56	7.0	0.00	0.000E+00
8	20.0	3.0	0.3	7.60	80.0	I	7.60	trib	0.00	0.000E+00
9	22.0	3.0	0.3	0.00	80.0	C	6.82	7.0	0.00	0.000E+00
10	22.0	3.0	0.3	0.00	80.0	C	6.82	7.0	0.00	0.000E+00
11	22.0	3.0	0.3	0.00	80.0	C	6.82	trib	0.00	0.000E+00
12	22.0	3.0	0.3	0.00	80.0	C	6.83	7.0	0.00	0.000E+00
13	22.0	3.0	0.3	0.00	80.0	C	6.83	trib	0.00	0.000E+00
14	22.0	3.0	0.3	0.00	80.0	C	6.83	7.0	0.00	0.000E+00
15	21.0	3.0	0.3	0.00	80.0	C	6.96	7.0	0.00	0.000E+00
16	21.0	3.0	0.3	0.00	80.0	C	6.96	7.0	0.00	0.000E+00
17	21.0	3.0	0.3	0.00	80.0	C	6.97	7.0	0.00	0.000E+00
18	21.0	3.0	0.3	0.00	80.0	C	6.97	7.0	0.00	0.000E+00
19	21.0	3.0	0.3	0.00	80.0	C	6.97	trib	0.00	0.000E+00
20	21.0	3.0	0.3	0.00	80.0	C	6.98	7.0	0.00	0.000E+00

```
=====
```

SF = 0.0 1.00 1.00 -- 1.00 1.00 1.00 1.00 1.00 1.00
 Current Variable Status --> ON ON

TNH3 and Sub#2 are independent AND have no effect on DO.
 *pH is SET-by-user, ONLY used for Ammonia Toxicity calculations.
 DO Saturation is based on the STANDARD METHODS equation.
 Elevation Correction for DO Saturation has been turned ON.
 NOTE: 'used' - shows the Value actually 'used' in calculations.
 'fixed' - identifies the DO value fixed-by-user Input.
 I or C - reach DO 'used' is INPUT (I), or CALCULATED (C).
 Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
Calibration Model
Bear Creek, WQMU 0103
Paul Lamarre, 05/26/99

* * * WATER INTAKE, WASTE DISCHARGE SUMMARY * * *

06-23-1999

10:10 am

```
=====
RCH  STREAM  FLOW  CBODu  NBODu  DO  TNH3  Sub#2
#    Mile    MGD   mg/l   mg/l   mg/l mg/l   ---
=====
- (br 1) MAIN STEM:  Bear Creek
  1 Dischg Name:  City of Lavonia WPCP, discharge
    8.44    0.30    24.00    2.8    6.8    0.60    0.000E+00
=====
```

NOTE: Discharge DO less than zero will become IOD (mg/l).
Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * FIELD CALIBRATION DATA * * *

06-23-1999

10:10 am

```
=====
```

RCH #	RIVER Mile	CBODu mg/l	NBODu mg/l	DoDEF mg/l	DO mg/l	TNH3 mg/l	Sub#2

-(br 1) MAIN STEM: Bear Creek							
2	8.44	-1.00x	-1.00x	-1.00x	7.90	-1.00x	-1.000E+00x
4	7.72	-1.00x	-1.00x	-1.00x	0.60	-1.00x	-1.000E+00x
5	7.38	-1.00x	-1.00x	-1.00x	6.20	-1.00x	-1.000E+00x
6	7.28	-1.00x	-1.00x	-1.00x	5.40	-1.00x	-1.000E+00x
7	6.88	-1.00x	-1.00x	-1.00x	4.50	-1.00x	-1.000E+00x
10	6.23	-1.00x	-1.00x	-1.00x	5.50	-1.00x	-1.000E+00x
20	0.79	-1.00x	-1.00x	-1.00x	7.40	-1.00x	-1.000E+00x

```
=====
```

Current Variable Status --> ON ON

NOTE: Field Data MUST represent 'Head-of-Reach' RiverMiles.
 (-1.00x) means 'No Field Data' for that location.

Calibration File Name: CALDAT
 Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * CALCULATED REACH RESULTS * * *

06-23-1999

10:18 am

RCH #	TYPE	CBODu mg/l	NBODu mg/l	DO mg/l	***DO MIN*** mg/l	RM	TNH3 mg/l	Sub#2 ---
-(br 1) MAIN STEM: Bear Creek								
1	Dischg	3.0	0.3	7.40	7.21	8.44	0.06	0.000E+00
2	stream	9.7	1.1	7.21	6.00	8.23	0.23	0.000E+00
3	stream	6.7	0.8	6.00	5.62	7.72	0.18	0.000E+00
4	stream	4.0	0.6	5.62	5.01	7.38	0.17	0.000E+00
5	stream	2.8	0.4	5.01	4.87	7.38	0.14	0.000E+00
6	stream	2.6	0.4	5.64	5.61	7.28	0.13	0.000E+00
7	stream	2.2	0.4	6.21	6.21	6.88	0.13	0.000E+00
8	-trib-	2.2	0.4	6.91	6.91	6.54	0.12	0.000E+00
9	stream	2.4	0.3	6.92	6.92	6.54	0.09	0.000E+00
10	stream	2.4	0.3	7.38	7.35	6.23	0.08	0.000E+00
11	-trib-	2.2	0.3	8.21	8.01	4.63	0.08	0.000E+00
12	stream	2.3	0.3	8.01	8.01	4.63	0.07	0.000E+00
13	-trib-	2.3	0.3	8.08	7.85	4.56	0.07	0.000E+00
14	stream	2.4	0.3	7.85	7.84	4.56	0.05	0.000E+00
15	stream	2.4	0.3	8.07	8.07	4.16	0.05	0.000E+00
16	stream	2.4	0.3	8.33	8.31	3.69	0.05	0.000E+00
17	stream	2.3	0.3	8.43	8.38	2.94	0.05	0.000E+00
18	stream	2.2	0.3	8.57	8.55	1.63	0.05	0.000E+00
19	-trib-	2.1	0.3	8.62	8.06	0.79	0.05	0.000E+00
20	stream	2.4	0.3	8.06	8.03	0.79	0.03	0.000E+00
eBr	----	2.4	0.3	8.47	--	--	0.03	0.000E+00

Current Variable Status -->

ON

ON

TNH3 and Sub#2 are independent AND have no effect on DO.

All Results (except DO Min) represent the 'Head-of-Reach'.

DO Saturation is based on the STANDARD METHODS equation.

Elevation Correction for DO Saturation has been turned ON.

Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * PROCESSED REACH DATA * * *

06-23-1999

10:18 am

RCH #	RIVER Mile	WIDTH ft	CUM Flow	VEL fps	TOT days	K2@T /day	TEMP degC	rDO mg/l
- (br 1) MAIN STEM: Bear Creek								
1	Dischg	-	1.00	--	--	--	--	--
2	8.44	0.0	1.46	0.02	0.506	0.679	23.0	6.68
3	8.23	0.0	1.86	0.03	1.208	0.711	23.0	6.69
4	7.72	0.0	1.98	0.03	0.766	0.112	23.0	6.69
5	7.38	0.0	2.50	0.03	0.211	1.666	24.0	6.56
6	7.28	0.0	2.53	0.08	0.325	1.368	24.5	6.50
7	6.88	0.0	2.65	0.24	0.084	5.220	24.0	6.56
8	-trib-	-	2.77	--	--	--	20.0	7.60
9	6.54	0.0	3.97	0.34	0.055	3.070	22.0	6.82
10	6.23	0.0	4.03	0.39	0.251	7.021	22.0	6.82
11	-trib-	-	4.33	--	--	--	22.0	6.82
12	4.63	0.0	5.05	0.42	0.011	15.198	22.0	6.83
13	-trib-	-	5.06	--	--	--	22.0	6.83
14	4.56	0.0	6.21	0.46	0.054	9.389	22.0	6.83
15	4.16	0.0	6.31	0.46	0.062	7.986	21.0	6.96
16	3.69	0.0	6.66	0.47	0.097	6.779	21.0	6.96
17	2.94	0.0	6.80	0.48	0.167	9.797	21.0	6.97
18	1.63	0.0	7.09	0.48	0.107	12.214	21.0	6.97
19	-trib-	-	7.19	--	--	--	21.0	6.97
20	0.79	0.0	10.92	0.58	0.083	14.737	21.0	6.98
eBr	0.00	-	11.27	--	3.987	--	--	--

SF = -- --- -- 1.00 --- 1.00 0.0 1.00
 (?) - means Width cannot be calculated (Depth turned OFF).
 Cumulative FLOW represents the inflow to 'Head-of-Reach'.
 rDO is the DO concentration of Reach Incremental Flows.
 Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

*** RATES: BOD, TNH3, Sub#2 (Base e @ T Deg.C) ***
 06-23-1999 10:18 am

RCH #	TEMP degC	Kr,CBOD /day	Kd,CBOD /day	INHIB Factor	Kd,NBOD /day	K,TNH3 /day	K,Sub#2 /day
-(br 1) MAIN STEM: Bear Creek							
1	Dischg	--	--	--	--	--	--
2	23.0	0.402	0.402	1.000	0.252	0.000	0.000
3	23.0	0.402	0.402	1.000	0.252	0.000	0.000
4	23.0	0.402	0.402	1.000	0.252	0.000	0.000
5	24.0	0.421	0.421	1.000	0.272	0.000	0.000
6	24.5	0.430	0.430	1.000	0.283	0.000	0.000
7	24.0	0.421	0.421	1.000	0.272	0.000	0.000
8	-trib-	--	--	--	--	--	--
9	22.0	0.384	0.384	1.000	0.233	0.000	0.000
10	22.0	0.384	0.384	1.000	0.233	0.000	0.000
11	-trib-	--	--	--	--	--	--
12	22.0	0.384	0.384	1.000	0.233	0.000	0.000
13	-trib-	--	--	--	--	--	--
14	22.0	0.384	0.384	1.000	0.233	0.000	0.000
15	21.0	0.366	0.366	1.000	0.216	0.000	0.000
16	21.0	0.366	0.366	1.000	0.216	0.000	0.000
17	21.0	0.366	0.366	1.000	0.216	0.000	0.000
18	21.0	0.366	0.366	1.000	0.216	0.000	0.000
19	-trib-	--	--	--	--	--	--
20	21.0	0.366	0.366	1.000	0.216	0.000	0.000

SF = 0.0 1.00 1.00 --- 1.00 1.00 1.00
 Current Variable Status --> ON ON

TNH3 and Sub#2 are independent AND have no effect on DO.
 CAUTION: Kd for CBOD should NEVER exceed Kr for CBOD.
 NOTE: Nitrification Inhibition switch now turned OFF, thus
 Kd,NBOD rates are NOT inhibited in the Calculations.
 Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * RATES: REAER, SOD, P/R (Base e @ T Deg.C) * * *
 06-23-1999 10:18 am

```
=====
```

RCH #	TEMP degC	nP/R mgld	BOTTOM fract	SOD gsmd	DEPTH m	rSOD mg/l	K2, REAERATION Opt	/day
-(br 1) MAIN STEM: Bear Creek								
1	Dischg	--	--	--	--	--		--
2	23.0	0.00	1.00	0.00	0.00	0.00	T	0.679
3	23.0	0.00	1.00	0.00	0.00	0.00	T	0.711
4	23.0	0.00	1.00	0.00	0.00	0.00	T	0.112
5	24.0	0.00	1.00	0.00	0.00	0.00	T	1.666
6	24.5	0.00	1.00	0.00	0.00	0.00	T	1.368
7	24.0	0.00	1.00	0.00	0.00	0.00	T	5.220
8	-trib-	--	--	--	--	--		--
9	22.0	0.00	1.00	0.00	0.00	0.00	T	3.070
10	22.0	0.00	1.00	0.00	0.00	0.00	T	7.021
11	-trib-	--	--	--	--	--		--
12	22.0	0.00	1.00	0.00	0.00	0.00	T	15.198
13	-trib-	--	--	--	--	--		--
14	22.0	0.00	1.00	0.00	0.00	0.00	T	9.389
15	21.0	0.00	1.00	0.00	0.00	0.00	T	7.986
16	21.0	0.00	1.00	0.00	0.00	0.00	T	6.779
17	21.0	0.00	1.00	0.00	0.00	0.00	T	9.797
18	21.0	0.00	1.00	0.00	0.00	0.00	T	12.214
19	-trib-	--	--	--	--	--		--
20	21.0	0.00	1.00	0.00	0.00	0.00	T	14.737

```
=====
```

SF = 0.0 1.00 1.00 1.00 --- --- 1.00
 STATUS --> ON ON ON

If PhotoSynthesis > Respiration, then Net P/R is (+).
 rSOD = 'Reach SOD', the value actually used in DOsag calcs.
 NOTE: I - means Reaeration is INPUT (I), fixed-by-user.
 T or O - K2 is CALCULATED, Tsivoglou (T) or O'Connor (O).
 *T - O'Connor chosen, Depth disabled, Tsivoglou used.
 Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * AMMONIA TOXICITY RESULTS * * *

06-23-1999

10:18 am

```

=====
Rch  pH  TEMP  TNH3-N  un-NH3  **COLD-WATER**  **WARM-WATER**
#    degC  mg/l   mg/l     acute chronic  acute chronic
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg  --    --    ---    ---    ---    ---
  2  7.0    23.0  0.23  0.001  0.093  0.007  0.114  0.010
  3  7.0    23.0  0.18  0.001  0.093  0.007  0.114  0.010
  4  7.0    23.0  0.17  0.001  0.093  0.007  0.114  0.010
  5  7.0    24.0  0.14  0.001  0.093  0.007  0.122  0.010
  6  7.0    24.5  0.13  0.001  0.093  0.007  0.126  0.010
  7  7.0    24.0  0.13  0.001  0.093  0.007  0.122  0.010
  8  -trib-  --    --    ---    ---    ---    ---    ---
  9  7.0    22.0  0.09  0.000  0.093  0.007  0.106  0.010
 10  7.0    22.0  0.08  0.000  0.093  0.007  0.106  0.010
 11  -trib-  --    --    ---    ---    ---    ---    ---
 12  7.0    22.0  0.07  0.000  0.093  0.007  0.106  0.010
 13  -trib-  --    --    ---    ---    ---    ---    ---
 14  7.0    22.0  0.05  0.000  0.093  0.007  0.106  0.010
 15  7.0    21.0  0.05  0.000  0.093  0.007  0.099  0.010
 16  7.0    21.0  0.05  0.000  0.093  0.007  0.099  0.010
 17  7.0    21.0  0.05  0.000  0.093  0.007  0.099  0.010
 18  7.0    21.0  0.05  0.000  0.093  0.007  0.099  0.010
 19  -trib-  --    --    ---    ---    ---    ---    ---
 20  7.0    21.0  0.03  0.000  0.093  0.007  0.099  0.010
eBr  -      --    0.03  ---    ---    ---    ---    ---
=====

```

SF = 1.00 0.0

BASIS FOR LIMITS: USEPA Revision (30 July 1992) to 1985 Criteria.

NOTE: Valid pH should lie between 6.5 and 9; accordingly,
 (#) means that pH is out-of-bounds for that Reach.

Valid Temperature should lie between 0 and 30 degC;
 likewise, (*) means that Temp is out-of-bounds.

Model File Name: BCRCAL

City of Lavonia WWTF, GA0047589
 Calibration Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 05/26/99

* * * DO RESULTS & CALIBRATION SUMMARY * * *

06-23-1999

10:18 am

```

=====
RCH  RIVER  DoSat   %SAT   DoSTD   <--- DO, mg/l --->  DoDEF
#    Mile  River   River  mg/l    Calc - Field = Diff  mg/l
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg  8.52   86.9   5.00   7.40   --   --   1.12
  2   8.4    8.52   84.7   5.00   7.21   7.90  -0.69  1.31
  3   8.2    8.35   71.9   5.00   6.00   --   --   2.35
  4   7.7    8.36   67.3   5.00   5.62   0.60   5.02  2.73
  5   7.4    8.36   59.9   5.00   5.01   6.20  -1.19  3.35
  6   7.3    8.20   68.8   5.00   5.64   5.40   0.24  2.56
  7   6.9    8.13   76.5   5.00   6.21   4.50   1.71  1.91
  8  -trib-  8.21   84.2   5.00   6.91   --   --   1.30
  9   6.5    8.21   84.3   5.00   6.92   --   --   1.29
 10   6.2    8.52   86.6   5.00   7.38   5.50   1.88  1.14
 11  -trib-  8.53   96.3   5.00   8.21   --   --   0.32
 12   4.6    8.53   94.0   5.00   8.01   --   --   0.52
 13  -trib-  8.53   94.8   5.00   8.08   --   --   0.45
 14   4.6    8.53   92.0   5.00   7.85   --   --   0.68
 15   4.2    8.53   94.6   5.00   8.07   --   --   0.46
 16   3.7    8.70   95.7   5.00   8.33   --   --   0.37
 17   2.9    8.70   96.9   5.00   8.43   --   --   0.27
 18   1.6    8.71   98.4   5.00   8.57   --   --   0.14
 19  -trib-  8.71   98.9   5.00   8.62   --   --   0.09
 20   0.8    8.71   92.4   5.00   8.06   7.40   0.66  0.66
eBr   0.0    8.72   97.2   --   8.47   --   --   0.25
=====

```

NOTE: RiverMiles are 'Head-of-Reach' values, thus 'Field' data MUST correspond to Head-of-Reach RiverMiles. DO Saturation is based on the STANDARD METHODS equation. Elevation Correction for DO Saturation has been turned ON. The DO Standard is a FIXED Minimum value. Calibration File Name: CALDAT Model File Name: BCRCAL

APPENDIX B
Critical Conditions Model

City of Lavonia WWTF, GA0047589
Critical Conditions Model
Bear Creek, WQMU 0103
Paul Lamarre, 06/03/99

* * * SYSTEM DATA AND SELECTED RUN PARAMETERS * * *

=====

PROJ: Bear Creek Calibration Mo Reaches = 20 Ints = 0
Date: 06-21-1999..... Branches = 0 Wtfs = 1
File: BCRCRIT..... Sub-Branches = 0 Dams = 0

SOD Variable: ON. Net P/R Variable: ON.
Substance No. 1: ON --> TNH3 expressed in mg/l
Substance No. 2: ON --> Sub#2 expressed in ---

Georgia Soil Type --> No. 4: Southern Piedmont
Soil Vel Eqn = $0.137 * (Q^{0.522}) * (S^{0.264}) * (A^{-0.333}) * (L^{0.348})$

=====

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * BRANCH OPTIONS AND SELECTED HEADWATER DATA * * *

```

=====
***** BRANCH DESCRIPTIONS ***** <---- CALC OPTIONS ---->
No.      Type                Name                Depth  Vel      Reaer
=====
1  MAIN STEM  Bear Creek.....  ON  v=c*Q^n  Tsivoglou
=====
  
```

```

=====
BRAN ***** HEADWATER GEOMETRY ***** <----- FLOW PARAMETERS ----->
No. Rch  RivMile  Elev      drAREA      Fixed  Opt  Prod  Used
=====
1    1    8.44    734.0      2.000    0.00  CALC  0.210  0.42
=====
  
```


City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * HEADWATERS DATA AND SELECTED BRANCH RESULTS * * *

```

=====
BRAN  CBODu  NBODu  <----- DO PARAMETERS ----->  TNH3   Sub#2
No.   mg/l   mg/l   Fixed  Opt   %Sat  DoSat  Used  mg/l   ---
=====
  1     3.0   0.3    0.0   CALC  84.0   8.11  6.81   0.1   0.000E+00
=====
  
```

```

=====
BRANCH hwTEMP ***** END-OF-BRANCH RESULTS *****
No.    degC  Reach  RivMile  Elev  SumArea  SumFlow  SumTOT
=====
  1     24.6  EOM    0.00    609.0  32.648  8.90    1.954
=====
  
```

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * MODEL REACH STRUCTURE * * *

06-22-1999

3:09 pm

```

=====
RCH   RIVER   ELEV   REACH   REACH DESCRIPTION
#     Mile    ft     Type
=====
- (br 1) MAIN STEM:  Bear Creek
  1     8.44    734.0  Dischg  City of Lavonia WPCP, discharge.....
  2     8.44    734.0  stream  discharge to Unnamed Trib.....
  3     8.23    730.0  stream* Unnamed trib. to Head of Impoundmen
  4     7.72    720.0  stream  Head of Imp. to Outfall.....
  5     7.38    719.0  stream  Outfall to BC3B.....
  6     7.28    715.0  stream  BC3B to McGee Road.....
  7     6.88    710.0  stream  McGee Road to Little Bear Creek....
  8     6.54    705.0  -trib-  Little Bear Creek.....
  9     6.54    705.0  stream  lbc to Brady school rd. (UC1).....
 10     6.23    703.0  stream  UC1 to Muddy Branch.....
 11     4.63    682.0  -trib-  Muddy Branch.....
 12     4.63    682.0  stream  Muddy Branch to Unnnamed Trib.....
 13     4.56    680.0  -trib-  Unnamed Trib.....
 14     4.56    680.0  stream  Unnamed Trib to S Fairview Rd. (UC1
 15     4.16    674.0  stream  Fairview to County rd.....
 16     3.69    668.0  stream  county rd. to 660' contour.....
 17     2.94    660.0  stream  660' to 640' Contour.....
 18     1.63    640.0  stream  640' Contour to Double Branch.....
 19     0.79    624.0  -trib-  Double Branch.....
 20     0.79    624.0  stream  Double Branch to NFB River.....
=====

```

DS = 0.00 609.0 ---- DISCHARGES 1; INTAKES 0; DAMS 0
 RiverMiles and Elevations represent 'Head-of-Reach' Values.
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * STREAM DEPTH & REACH PHYSICAL DATA * * *

06-22-1999

3:09 pm

```

=====
RCH  LENGTH  dLELV  SLOPE  drAREA  <----- DEPTH PARAMETERS ----->
#    mi      ft    ft/mi   mi2     fixed  coeff  exp  Opt -used
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg   --    --      --      -      --    --    --    -
  2  0.203   4.00   19.704  1.320  0.0    0.000  0.000  C    0.0
  3  0.513  10.00   19.493  0.387  0.0    0.000  0.000  C    0.0
  4  0.346   1.00    2.890   1.752  0.0    0.000  0.000  C    0.0
  5  0.100   4.00   40.000  0.100  0.0    0.000  0.000  C    0.0
  6  0.400   5.00   12.500  0.400  0.0    0.000  0.000  C    0.0
  7  0.335   5.00   14.925  0.400  0.0    0.000  0.000  C    0.0
  8  -trib-   --     --      1.974  -      --    --    --    -
  9  0.307   2.00    6.515  0.180  0.0    0.000  0.000  C    0.0
 10  1.600  21.00   13.125  1.002  0.0    0.000  0.000  C    0.0
 11  -trib-   --     --      2.419  -      --    --    --    -
 12  0.076   2.00   26.316  0.037  0.0    0.000  0.000  C    0.0
 13  -trib-   --     --      3.839  -      --    --    --    -
 14  0.402   6.00   14.925  0.321  0.0    0.000  0.000  C    0.0
 15  0.468   6.00   12.821  1.156  0.0    0.000  0.000  C    0.0
 16  0.746   8.00   10.724  0.460  0.0    0.000  0.000  C    0.0
 17  1.307  20.00   15.302  0.981  0.0    0.000  0.000  C    0.0
 18  0.848  16.00   18.868  0.320  0.0    0.000  0.000  C    0.0
 19  -trib-   --     --      12.460  -      --    --    --    -
 20  0.786  15.00   19.084  1.140  0.0    0.000  0.000  C    0.0
=====
SF =  --    1.00  1.00  1.00  --    ---    ---    1.00

```

(*) means Depth variable has been turned OFF for THAT Branch.
 NOTE: 'used' - shows the Depth value 'used' in calculations.
 'fixed' - identifies the Depth value fixed-by-user Input.
 I or C - Depth 'used' is INPUT (I), or CALCULATED (C).

Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * REACH FLOW AND VELOCITY DATA * * *

06-22-1999

3:09 pm

```

=====
RCH  <---- FLOW PARAMETERS ---->  <--- VELOCITY PARAMETERS --->
#    fixed  Prod  Opt   used  fixed  coeff  exp  Opt used
=====
-(br 1) MAIN STEM:  Bear Creek
  1    Dischg  --    --    --    --    --    --    --
  2    0.00   0.210  C    0.28  0.10  0.020  0.400  I  0.100
  3    0.00   0.210  C    0.08  0.10  0.020  0.400  I  0.100
  4    0.00   0.210  C    0.37  0.10  0.020  0.400  I  0.100
  5    0.00   0.210  C    0.02  0.10  0.020  0.400  I  0.100
  6    0.00   0.210  C    0.08  0.00  0.020  1.390  Q  0.103
  7    0.00   0.210  C    0.08  0.00  0.100  0.890  Q  0.292
  8    0.00   0.210  C    0.41  --    ----trib----  --
  9    0.00   0.210  C    0.04  0.00  0.100  0.890  Q  0.329
 10    0.00   0.210  C    0.21  0.00  0.220  0.400  Q  0.381
 11    0.00   0.210  C    0.51  --    ----trib----  --
 12    0.00   0.210  C    0.01  0.00  0.220  0.400  Q  0.403
 13    0.00   0.210  C    0.81  --    ----trib----  --
 14    0.00   0.210  C    0.07  0.00  0.220  0.400  Q  0.432
 15    0.00   0.210  C    0.24  0.00  0.220  0.400  Q  0.437
 16    0.00   0.210  C    0.10  0.00  0.220  0.400  Q  0.442
 17    0.00   0.210  C    0.21  0.00  0.220  0.400  Q  0.447
 18    0.00   0.210  C    0.07  0.00  0.220  0.400  Q  0.451
 19    0.00   0.210  C    2.62  --    ----trib----  --
 20    0.00   0.210  C    0.24  0.00  0.220  0.400  Q  0.525
=====

```

```

SF =    ---    1.00    1.00    --    1.00    1.00    1.00
NOTE:  'used' - shows the Value actually 'used' in calculations.
       'fixed' - identifies the Value fixed-by-user Input.
       I or C - Value 'used' is INPUT (I), or CALCULATED (C).
       S or Q - Velocity from Soil (S), or V=c*Q^n (Q) equation.
Model File Name:  BCRCRIT

```

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * RATES: BOD, TNH3, Sub#2 (Base e @ 20 Deg.C) * *
 06-22-1999 3:09 pm

```

=====
RCH  TEMP  Kr,CBOD  Kd,CBOD  Kd,NBOD  Kx,TNH3  Kz,Sub#2
#    degC  /day      /day      /day      /day      /day
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg  --        --        --        --        --
  2  24.6    0.350    0.350    0.200    0.000    0.000
  3  24.6    0.350    0.350    0.200    0.000    0.000
  4  24.6    0.350    0.350    0.200    0.000    0.000
  5  24.6    0.350    0.350    0.200    0.000    0.000
  6  24.6    0.350    0.350    0.200    0.000    0.000
  7  24.6    0.350    0.350    0.200    0.000    0.000
  8  -trib-  --        --        --        --        --
  9  24.6    0.350    0.350    0.200    0.000    0.000
 10  24.6    0.350    0.350    0.200    0.000    0.000
 11  -trib-  --        --        --        --        --
 12  24.6    0.350    0.350    0.200    0.000    0.000
 13  -trib-  --        --        --        --        --
 14  24.6    0.350    0.350    0.200    0.000    0.000
 15  24.6    0.350    0.350    0.200    0.000    0.000
 16  24.6    0.350    0.350    0.200    0.000    0.000
 17  24.6    0.350    0.350    0.200    0.000    0.000
 18  24.6    0.350    0.350    0.200    0.000    0.000
 19  -trib-  --        --        --        --        --
 20  24.6    0.350    0.350    0.200    0.000    0.000
=====

```

SF = 0.0 1.00 1.00 1.00 1.00 1.00
 Current Variable Status --> ON ON

TNH3 and Sub#2 are independent AND have no effect on DO.

CAUTION: Kd for CBOD should NEVER exceed Kr for CBOD.

NOTE: Nitrification Inhibition switch now turned OFF, thus
 Kd,NBOD rates are NOT inhibited in the Calculations.

Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

*** RATES: REAER, SOD, P/R (Base e @ 20 Deg.C) ***
 06-22-1999 3:09 pm

```

=====
RCH  BOTTOM    SOD  nP/R  <----- REAERATION PARAMETERS ----->
#    fract    gsmd mgld  fixed  ESC  dE/TOT  Depth  Opt  -used
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg    --    -    --    --    --    ---
  2  1.00    0.00  0.0  0.000  0.110  32.24  -on-  T    3.547
  3  1.00    0.00  0.0  0.000  0.110  31.90  -on-  T    3.509
  4  1.00    0.00  0.0  0.000  0.110   4.73  -on-  T    0.520
  5  1.00    0.00  0.0  0.000  0.110  65.45  -on-  T    7.200
  6  1.00    0.00  0.0  0.000  0.110  21.07  -on-  T    2.318
  7  1.00    0.00  0.0  0.000  0.110  71.36  -on-  T    7.850
  8  -trib-    --    -    --    --    --    ---
  9  1.00    0.00  0.0  0.000  0.110  35.07  -on-  T    3.858
 10  1.00    0.00  0.0  0.000  0.110  81.73  -on-  T    8.991
 11  -trib-    --    -    --    --    --    ---
 12  1.00    0.00  0.0  0.000  0.110 173.71  -on-  T   19.108
 13  -trib-    --    -    --    --    --    ---
 14  1.00    0.00  0.0  0.000  0.110 105.45  -on-  T   11.600
 15  1.00    0.00  0.0  0.000  0.110  91.62  -on-  T   10.078
 16  1.00    0.00  0.0  0.000  0.110  77.56  -on-  T    8.532
 17  1.00    0.00  0.0  0.000  0.110 111.84  -on-  T   12.302
 18  1.00    0.00  0.0  0.000  0.110 139.17  -on-  T   15.309
 19  -trib-    --    -    --    --    --    ---
 20  1.00    0.00  0.0  0.000  0.110 163.81  -on-  T   18.019
=====
SF = 1.00  1.00  1.00  ---  1.00  --  1.00
STATUS -->  ON  ON
  
```

If PhotoSynthesis > Respiration, then Net P/R is (+).
 NOTE: 'used' - shows the Value actually 'used' in calculations.
 'fixed' - identifies the K2 value fixed-by-user Input.
 I - means K2 'used' is INPUT (I), fixed by user.
 T or O - K2 is CALCULATED, Tsivoglou (T) or O'Connor (O).
 *T - O'Connor selected, DEPTH disabled, Tsivoglou used.

Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * REACH WATER QUALITY INPUT DATA * * *

06-22-1999

3:09 pm

```
=====
```

RCH #	TEMP degC	CBODu mg/l	NBODu mg/l	<---- fixed	DO %Sat	PARAMS Opt	----> -used	*pH	TNH3 mg/l	Sub#2
- (br 1) MAIN STEM: Bear Creek										
1	Dischg	--	--	--	--	--	--	-	--	---
2	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
3	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
4	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
5	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
6	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
7	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
8	24.6	3.0	0.3	0.00	80.0	C	6.49	trib	0.00	0.000E+00
9	24.6	3.0	0.3	0.00	80.0	C	6.49	7.0	0.00	0.000E+00
10	24.6	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
11	24.6	3.0	0.3	0.00	80.0	C	6.50	trib	0.00	0.000E+00
12	24.6	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
13	24.6	3.0	0.3	0.00	80.0	C	6.50	trib	0.00	0.000E+00
14	24.6	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
15	24.6	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
16	24.6	3.0	0.3	0.00	80.0	C	6.50	7.0	0.00	0.000E+00
17	24.6	3.0	0.3	0.00	80.0	C	6.51	7.0	0.00	0.000E+00
18	24.6	3.0	0.3	0.00	80.0	C	6.51	7.0	0.00	0.000E+00
19	24.6	3.0	0.3	0.00	80.0	C	6.51	trib	0.00	0.000E+00
20	24.6	3.0	0.3	0.00	80.0	C	6.51	7.0	0.00	0.000E+00

```
=====
```

SF = 0.0 1.00 1.00 -- 1.00 1.00 1.00 1.00 1.00
 Current Variable Status --> ON ON

TNH3 and Sub#2 are independent AND have no effect on DO.
 *pH is SET-by-user, ONLY used for Ammonia Toxicity calculations.
 DO Saturation is based on the STANDARD METHODS equation.
 Elevation Correction for DO Saturation has been turned ON.
 NOTE: 'used' - shows the Value actually 'used' in calculations.
 'fixed' - identifies the DO value fixed-by-user Input.
 I or C - reach DO 'used' is INPUT (I), or CALCULATED (C).
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
Critical Conditions Model
Bear Creek, WQMU 0103
Paul Lamarre, 06/03/99

* * * WATER INTAKE, WASTE DISCHARGE SUMMARY * * *

06-23-1999

8:54 am

```
=====
RCH  STREAM  FLOW  CBODu  NBODu  DO  TNH3  Sub#2
#    Mile    MGD   mg/l   mg/l   mg/l mg/l   ---
=====
-(br 1) MAIN STEM:  Bear Creek
  1 Dischg Name:  City of Lavonia WPCP,discharge
      8.44      1.32  20.00   9.1    6.0    2.00  0.000E+00
=====
```

NOTE: Discharge DO less than zero will become IOD (mg/l).
Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * CALCULATED REACH RESULTS * * *

06-23-1999

8:55 am

RCH #	TYPE	CBODu mg/l	NBODu mg/l	DO mg/l	***DO MIN*** mg/l	RM	TNH3 mg/l	Sub#2 ---
- (br 1) MAIN STEM: Bear Creek								
1	Dischg	3.0	0.3	6.81	6.14	8.44	0.06	0.000E+00
2	stream	17.1	7.6	6.14	6.09	8.23	1.67	0.000E+00
3	stream	14.9	6.7	6.09	6.09	8.23	1.50	0.000E+00
4	stream	12.7	5.9	6.16	5.18	7.38	1.46	0.000E+00
5	stream	10.5	5.0	5.18	5.18	7.38	1.29	0.000E+00
6	stream	10.2	4.8	6.04	6.03	7.08	1.28	0.000E+00
7	stream	9.1	4.4	6.04	6.04	6.88	1.25	0.000E+00
8	-trib-	8.6	4.2	6.74	6.71	6.54	1.22	0.000E+00
9	stream	8.0	3.8	6.71	6.71	6.54	1.08	0.000E+00
10	stream	7.8	3.7	6.79	6.78	6.23	1.07	0.000E+00
11	-trib-	6.7	3.3	7.65	7.52	4.63	1.02	0.000E+00
12	stream	6.3	2.9	7.52	7.52	4.63	0.90	0.000E+00
13	-trib-	6.3	2.9	7.62	7.45	4.56	0.90	0.000E+00
14	stream	5.8	2.5	7.45	7.44	4.56	0.77	0.000E+00
15	stream	5.6	2.5	7.67	7.62	4.16	0.76	0.000E+00
16	stream	5.4	2.3	7.74	7.72	3.69	0.72	0.000E+00
17	stream	5.1	2.2	7.79	7.75	2.94	0.71	0.000E+00
18	stream	4.6	2.1	7.92	7.91	1.63	0.69	0.000E+00
19	-trib-	4.4	2.0	7.98	7.54	0.79	0.68	0.000E+00
20	stream	4.0	1.5	7.54	7.51	0.79	0.47	0.000E+00
eBr	----	3.8	1.4	7.96	--	--	0.46	0.000E+00

Current Variable Status -->

ON ON

TNH3 and Sub#2 are independent AND have no effect on DO.
 All Results (except DO Min) represent the 'Head-of-Reach'.
 DO Saturation is based on the STANDARD METHODS equation.
 Elevation Correction for DO Saturation has been turned ON.
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * PROCESSED REACH DATA * * *

06-22-1999

3:10 pm

RCH #	RIVER Mile	WIDTH ft	CUM Flow	VEL fps	TOT days	K2@T /day	TEMP degC	rDO mg/l
-(br 1) MAIN STEM: Bear Creek								
1	Dischg	-	0.42	--	--	--	--	--
2	8.44	0.0	2.46	0.10	0.124	3.956	24.6	6.49
3	8.23	0.0	2.74	0.10	0.314	3.913	24.6	6.49
4	7.72	0.0	2.82	0.10	0.211	0.580	24.6	6.49
5	7.38	0.0	3.19	0.10	0.061	8.030	24.6	6.49
6	7.28	0.0	3.21	0.10	0.237	2.585	24.6	6.49
7	6.88	0.0	3.29	0.29	0.070	8.754	24.6	6.49
8	-trib-	-	3.38	--	--	--	24.6	6.49
9	6.54	0.0	3.79	0.33	0.057	4.302	24.6	6.49
10	6.23	0.0	3.83	0.38	0.257	10.027	24.6	6.50
11	-trib-	-	4.04	--	--	--	24.6	6.50
12	4.63	0.0	4.55	0.40	0.012	21.310	24.6	6.50
13	-trib-	-	4.56	--	--	--	24.6	6.50
14	4.56	0.0	5.36	0.43	0.057	12.937	24.6	6.50
15	4.16	0.0	5.43	0.44	0.065	11.239	24.6	6.50
16	3.69	0.0	5.67	0.44	0.103	9.515	24.6	6.50
17	2.94	0.0	5.77	0.45	0.179	13.720	24.6	6.51
18	1.63	0.0	5.98	0.45	0.115	17.073	24.6	6.51
19	-trib-	-	6.04	--	--	--	24.6	6.51
20	0.79	0.0	8.66	0.52	0.092	20.096	24.6	6.51
eBr	0.00	-	8.90	--	1.954	--	--	--

SF = -- --- -- 1.00 --- 1.00 0.0 1.00
 (?) - means Width cannot be calculated (Depth turned OFF).
 Cumulative FLOW represents the inflow to 'Head-of-Reach'.
 rDO is the DO concentration of Reach Incremental Flows.
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * RATES: BOD, TNH3, Sub#2 (Base e @ T Deg.C) * * *
 06-22-1999 3:10 pm

```

=====
RCH  TEMP  Kr,CBOD  Kd,CBOD  INHIB  Kd,NBOD  K,TNH3  K,Sub#2
#    degC  /day      /day      Factor /day      /day      /day
=====
-(br 1) MAIN STEM:  Bear Creek
  1  Dischg  --        --        --        --        --        --
  2  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  3  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  4  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  5  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  6  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  7  24.6    0.432    0.432    1.000    0.285    0.000    0.000
  8  -trib-  --        --        --        --        --        --
  9  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 10  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 11  -trib-  --        --        --        --        --        --
 12  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 13  -trib-  --        --        --        --        --        --
 14  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 15  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 16  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 17  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 18  24.6    0.432    0.432    1.000    0.285    0.000    0.000
 19  -trib-  --        --        --        --        --        --
 20  24.6    0.432    0.432    1.000    0.285    0.000    0.000
=====

```

```

SF = 0.0  1.00  1.00  ---  1.00  1.00  1.00
Current Variable Status -->                ON  ON

```

TNH3 and Sub#2 are independent AND have no effect on DO.
 CAUTION: Kd for CBOD should NEVER exceed Kr for CBOD.
 NOTE: Nitrification Inhibition switch now turned OFF, thus
 Kd,NBOD rates are NOT inhibited in the Calculations.
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * RATES: REAER, SOD, P/R (Base e @ T Deg.C) * * *
 06-22-1999 3:10 pm

RCH #	TEMP degC	nP/R mgld	BOTTOM fract	SOD gsmd	DEPTH m	rSOD mg/l	K2, REAERATION Opt /day
- (br 1) MAIN STEM: Bear Creek							
1	Dischg	--	--	--	--	--	--
2	24.6	0.00	1.00	0.00	0.00	0.00	T 3.956
3	24.6	0.00	1.00	0.00	0.00	0.00	T 3.913
4	24.6	0.00	1.00	0.00	0.00	0.00	T 0.580
5	24.6	0.00	1.00	0.00	0.00	0.00	T 8.030
6	24.6	0.00	1.00	0.00	0.00	0.00	T 2.585
7	24.6	0.00	1.00	0.00	0.00	0.00	T 8.754
8	-trib-	--	--	--	--	--	--
9	24.6	0.00	1.00	0.00	0.00	0.00	T 4.302
10	24.6	0.00	1.00	0.00	0.00	0.00	T 10.027
11	-trib-	--	--	--	--	--	--
12	24.6	0.00	1.00	0.00	0.00	0.00	T 21.310
13	-trib-	--	--	--	--	--	--
14	24.6	0.00	1.00	0.00	0.00	0.00	T 12.937
15	24.6	0.00	1.00	0.00	0.00	0.00	T 11.239
16	24.6	0.00	1.00	0.00	0.00	0.00	T 9.515
17	24.6	0.00	1.00	0.00	0.00	0.00	T 13.720
18	24.6	0.00	1.00	0.00	0.00	0.00	T 17.073
19	-trib-	--	--	--	--	--	--
20	24.6	0.00	1.00	0.00	0.00	0.00	T 20.096

SF = 0.0 1.00 1.00 1.00 --- --- 1.00
 STATUS --> ON ON ON

If PhotoSynthesis > Respiration, then Net P/R is (+).
 rSOD = 'Reach SOD', the value actually used in DO sag calcs.
 NOTE: I - means Reaeration is INPUT (I), fixed-by-user.
 T or O - K2 is CALCULATED, Tsivoglou (T) or O'Connor (O).
 *T - O'Connor chosen, Depth disabled, Tsivoglou used.
 Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * AMMONIA TOXICITY RESULTS * * *

06-23-1999

8:55 am

Rch #.	pH	TEMP degC	TNH3-N mg/l	un-NH3 mg/l	**COLD-WATER** acute	**COLD-WATER** chronic	**WARM-WATER** acute	**WARM-WATER** chronic
- (br 1) MAIN STEM: Bear Creek								
1	Dischg	--	--	---	---	---	---	---
2	7.0	24.6	1.67	0.011	0.093	0.007	0.127	0.010
3	7.0	24.6	1.50	0.010	0.093	0.007	0.127	0.010
4	7.0	24.6	1.46	0.010	0.093	0.007	0.127	0.010
5	7.0	24.6	1.29	0.009	0.093	0.007	0.127	0.010
6	7.0	24.6	1.28	0.009	0.093	0.007	0.127	0.010
7	7.0	24.6	1.25	0.008	0.093	0.007	0.127	0.010
8	-trib-	--	--	---	---	---	---	---
9	7.0	24.6	1.08	0.007	0.093	0.007	0.127	0.010
10	7.0	24.6	1.07	0.007	0.093	0.007	0.127	0.010
11	-trib-	--	--	---	---	---	---	---
12	7.0	24.6	0.90	0.006	0.093	0.007	0.127	0.010
13	-trib-	--	--	---	---	---	---	---
14	7.0	24.6	0.77	0.005	0.093	0.007	0.127	0.010
15	7.0	24.6	0.76	0.005	0.093	0.007	0.127	0.010
16	7.0	24.6	0.72	0.005	0.093	0.007	0.127	0.010
17	7.0	24.6	0.71	0.005	0.093	0.007	0.127	0.010
18	7.0	24.6	0.69	0.005	0.093	0.007	0.127	0.010
19	-trib-	--	--	---	---	---	---	---
20	7.0	24.6	0.47	0.003	0.093	0.007	0.127	0.010
eBr	-	--	0.46	---	---	---	---	---

SF = 1.00 0.0

BASIS FOR LIMITS: USEPA Revision (30 July 1992) to 1985 Criteria.

NOTE: Valid pH should lie between 6.5 and 9; accordingly, (#) means that pH is out-of-bounds for that Reach.

Valid Temperature should lie between 0 and 30 degC; likewise, (*) means that Temp is out-of-bounds.

Model File Name: BCRCRIT

City of Lavonia WWTF, GA0047589
 Critical Conditions Model
 Bear Creek, WQMU 0103
 Paul Lamarre, 06/03/99

* * * DO RESULTS & CALIBRATION SUMMARY * * *

06-22-1999

3:10 pm

RCH #	RIVER Mile	DoSat River	%SAT River	DoSTD mg/l	<--- DO, mg/l Calc	Field	----> Diff	DoDEF mg/l
-(br 1) MAIN STEM: Bear Creek								
1	Dischg	8.11	84.0	5.00	6.81	--	--	1.30
2	8.4	8.11	75.7	5.00	6.14	--	--	1.97
3	8.2	8.11	75.1	5.00	6.09	--	--	2.02
4	7.7	8.11	76.0	5.00	6.16	--	--	1.95
5	7.4	8.11	63.9	5.00	5.18	--	--	2.93
6	7.3	8.11	74.5	5.00	6.04	--	--	2.07
7	6.9	8.11	74.4	5.00	6.04	--	--	2.07
8	-trib-	8.11	83.0	5.00	6.74	--	--	1.38
9	6.5	8.11	82.7	5.00	6.71	--	--	1.41
10	6.2	8.12	83.6	5.00	6.79	--	--	1.33
11	-trib-	8.12	94.2	5.00	7.65	--	--	0.47
12	4.6	8.12	92.6	5.00	7.52	--	--	0.60
13	-trib-	8.12	93.8	5.00	7.62	--	--	0.51
14	4.6	8.12	91.7	5.00	7.45	--	--	0.67
15	4.2	8.12	94.4	5.00	7.67	--	--	0.46
16	3.7	8.13	95.3	5.00	7.74	--	--	0.38
17	2.9	8.13	95.8	5.00	7.79	--	--	0.34
18	1.6	8.13	97.4	5.00	7.92	--	--	0.21
19	-trib-	8.14	98.1	5.00	7.98	--	--	0.16
20	0.8	8.14	92.6	5.00	7.54	--	--	0.60
eBr	0.0	8.14	97.7	--	7.96	--	--	0.19

NOTE: RiverMiles are 'Head-of-Reach' values, thus 'Field' data MUST correspond to Head-of-Reach RiverMiles.
 DO Saturation is based on the STANDARD METHODS equation.
 Elevation Correction for DO Saturation has been turned ON.
 The DO Standard is a FIXED Minimum value.
 Calibration File Name: NoCal
 Model File Name: BCRCRIT

APPENDIX C

**Total Maximum Daily Load
Summary Memorandum**

SUMMARY MEMORANDUM
Total Maximum Daily Load (TMDL)
Bear Creek

1. State Contact

Name: Paul Lamarre
Agency: Georgia Environmental Protection Division
Water Protection Branch
Watershed Planning and Monitoring Program
Address: 4220 International Parkway-Suite 101
Atlanta, Georgia 30354

Telephone: (404) 675-1672
Facsimile: (404) 675-6244
E-Mail: paul_lamarre@mail.dnr.state.ga.us

2. Waterbody Information

State: Georgia
County: Franklin
City/Town: Lavonia

Major River Basin: Savannah
8-Digit Hydrologic Unit Code: Broad River (03060104)
10-Digit Hydrologic Unit Code: Broad River-North and Middle Forks (0306010401)

Waterbody Name: Bear Creek
Stream Length: 2.1 miles
Watershed Area: 6.4 square miles
Tributary to: Unawatti Creek

Constituents of Concern: Dissolved Oxygen (DO)
Carbonaceous Biochemical Oxygen Demand (CBOD)
Ammonia (NBOD)

Designated Use: Fishing
Applicable Water
Quality Standard: Daily average dissolved oxygen concentration standard 5.0 milligrams per liter (mg/l) and no less than 4.0 mg/l at all times.

3. TMDL Development

Constituents: Carbonaceous Biochemical Oxygen Demand (CBOD)
Ammonia (NBOD)

Analysis/Modeling: Steady State Dynamic Watershed
 Other:

Describe: A steady state and conventional pollutant modeling approach was used.

Critical Conditions: Low Flow High Temperature Other:

Seasonal Variation: Considered
 Not Considered

Discuss: A seasonal 7Q10 analysis showed that seasonal variation in minimum flows and water temperatures was not critical to protecting the dissolved oxygen water quality standard in Bear Creek.

Allocation Watershed/Stream Reach:

The watershed/stream reach covered by this TMDL includes Bear Creek from its headwaters to Little Bear Creek.

Wasteload Allocations (WLA) (by constituent):

Ultimate CBOD

NPDES Number	Facility Name	Wasteload Allocation (pounds/day)
GA0047589	Lavonia WPCP	220
Total:		220

Ultimate NBOD

NPDES Number	Facility Name	Wasteload Allocation (pounds/day)
GA0047589	Lavonia WPCP	100
Total:		100

Load Allocations (LA) (by constituent):

Ultimate CBOD

Stream	Load Allocation (pounds/day)	
Bear Creek	22	
Total:		22

Ultimate NBOD

Stream	Load Allocation (pounds/day)
Bear Creek	2
Total:	2

Margin of Safety (MOS): Explicit Implicit

Explain: First, the MOS is implicitly incorporated into the modeling process by selecting critical conditions of combined high temperature and low streamflow with a low recurrence interval. Secondly, the minimum dissolved oxygen concentration was maintained at 5.2 mg/l which is above the 4.0 and 5.0 mg/l standard concentrations in order to provide another margin of safety in the analysis.