

Total Maximum Daily Load
Evaluation
for
Seven Stream Segments
in the
Ocmulgee River Basin
for
Dissolved Oxygen

Submitted to:
The U.S. Environmental Protection Agency
Region 4
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* (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 seven (7) stream segments, located in the Ocmulgee River Basin, as water quality limited due to dissolved oxygen (DO). These waterbodies were included in the State's draft 2006 303(d) list. This report presents the dissolved oxygen TMDLs for these segments.

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 the Ocmulgee River Basin included developing computer models for the listed segments. Georgia DOSAG, a steady state water quality model developed by the Georgia Environmental Protection Division (GA EPD) was used for the freshwater segments. These models were calibrated to data collected in the Ocmulgee River Basin in the summer of 2004.

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; and
- 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, such efforts 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* (GA EPD, 2000-2001).

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The State of Georgia has identified seven (7) stream segments located in the Ocmulgee River Basin as water quality limited due to dissolved oxygen (DO). These waterbodies were included in the State's draft 2006 303(d) list. This report presents the dissolved oxygen TMDLs for the listed segments in the Ocmulgee River Basin identified in Table 1.

Table 1. Waterbodies Listed For Dissolved Oxygen in the Ocmulgee River Basin

| Stream Segment | Location | Segment Length (miles) | Designated Use | Listing |
|-------------------------|---|------------------------|----------------|---------|
| Bay Creek | Headwaters to Beaver Creek (Peach/Houston Co) | 9 | Fishing | NS |
| Gully Creek | Rocky Branch to Ocmulgee River (Jeff Davis Co) | 4 | Fishing | NS |
| Little Echeconnee Creek | Headwaters to Echeconnee Creek (Crawford Co) | 8 | Fishing | NS |
| Mosquito Creek | Headwaters to Ocmulgee River (Dodge/Pulaski Co) | 18 | Fishing | PS |
| Sandy Run Creek | Headwaters to Bay Gall Creek (Houston Co) | 5 | Fishing | NS |
| Sandy Run Creek | Bay Gall Creek to Ocmulgee River (Houston Co) | 7 | Fishing | NS |
| Tobesofkee Creek | Lake Tobesofkee to Rocky Creek (Bibb Co) | 10 | Fishing | NS |

Notes:

PS = Partially Supporting designated use

NS = Not Supporting designated use

1.2 Watershed Description

The Ocmulgee River Basin is located in Central Georgia, occupying an area of 6,102 square miles. The Oconee River Basin to the east and the Flint River Basin to the west border the Ocmulgee River Basin. The Ocmulgee River Basin originates in the eastern edges of the City of Atlanta. The Upper Ocmulgee Basin is made up of the South River, Yellow River and Alcovy River subwatersheds. These converge at Lake Jackson to form the Ocmulgee River. The Ocmulgee River flows south and southeast, runs through the northeast side of the City of Macon, and then travels approximately 120 miles until it finally joins the Oconee River near the City of Hazlehurst, to form the Altamaha River. The Altamaha River then continues in a southeastern direction to the Atlantic Ocean. The Ocmulgee River Basin contains parts of the Piedmont and Southeastern Plain physiographic provinces, which extend throughout the southeastern United States.

The USGS has divided the Ocmulgee River Basin into three sub-basins, or Hydrologic Unit Codes (HUCs). Figure 1 shows the location of these sub-basins. Figure 2 shows the locations of the seven listed dissolved oxygen segments in the Ocmulgee River Basin and the associated counties.

The land use characteristics of the Ocmulgee River Basin watersheds were determined using data from the National Land Cover Dataset (NLCD) for Georgia. This coverage is based on Landsat Thematic Mapper digital images developed in 2001. 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.

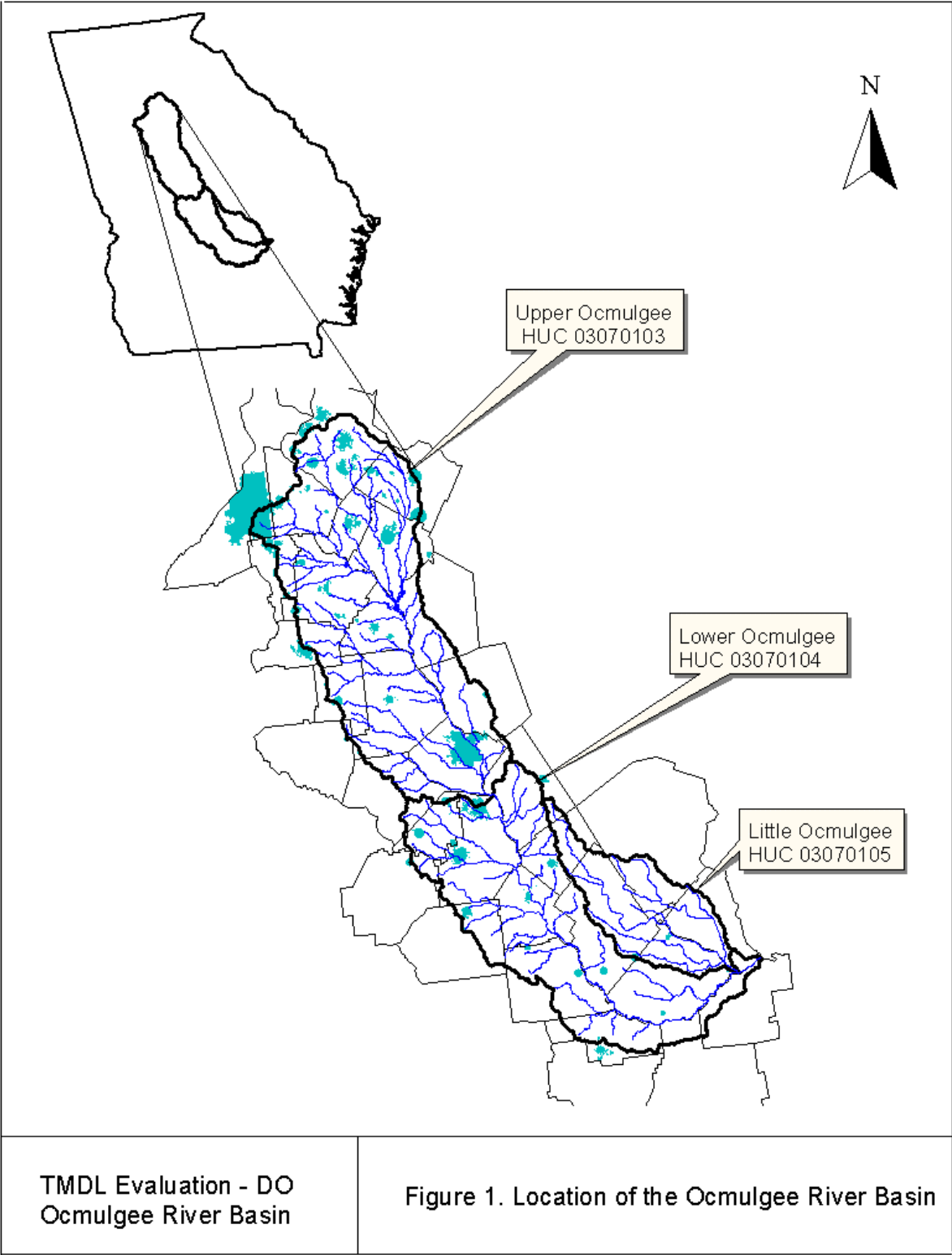
1.3 Water Quality Standard

The water use classification for the listed stream segments in the Ocmulgee River Basin is "Fishing." No segments in the Ocmulgee River Basin are classified as trout streams. The criterion violated is listed as dissolved oxygen. The potential cause listed includes municipal, urban, and nonpoint source runoff. The use classification water quality standards for dissolved oxygen, as stated in *Georgia's Rules and Regulations for Water Quality Control* (GA EPD, 2005), Chapter 391-3-6-.03(6)(c)(i) are:

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.

Certain waters of the State may have conditions where dissolved oxygen is naturally lower than the numeric criteria specified above and therefore cannot meet these standards unless naturally occurring loads are reduced or streams are artificially or mechanically aerated. This is addressed in *Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(7) (GA EPD, 2005):

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.



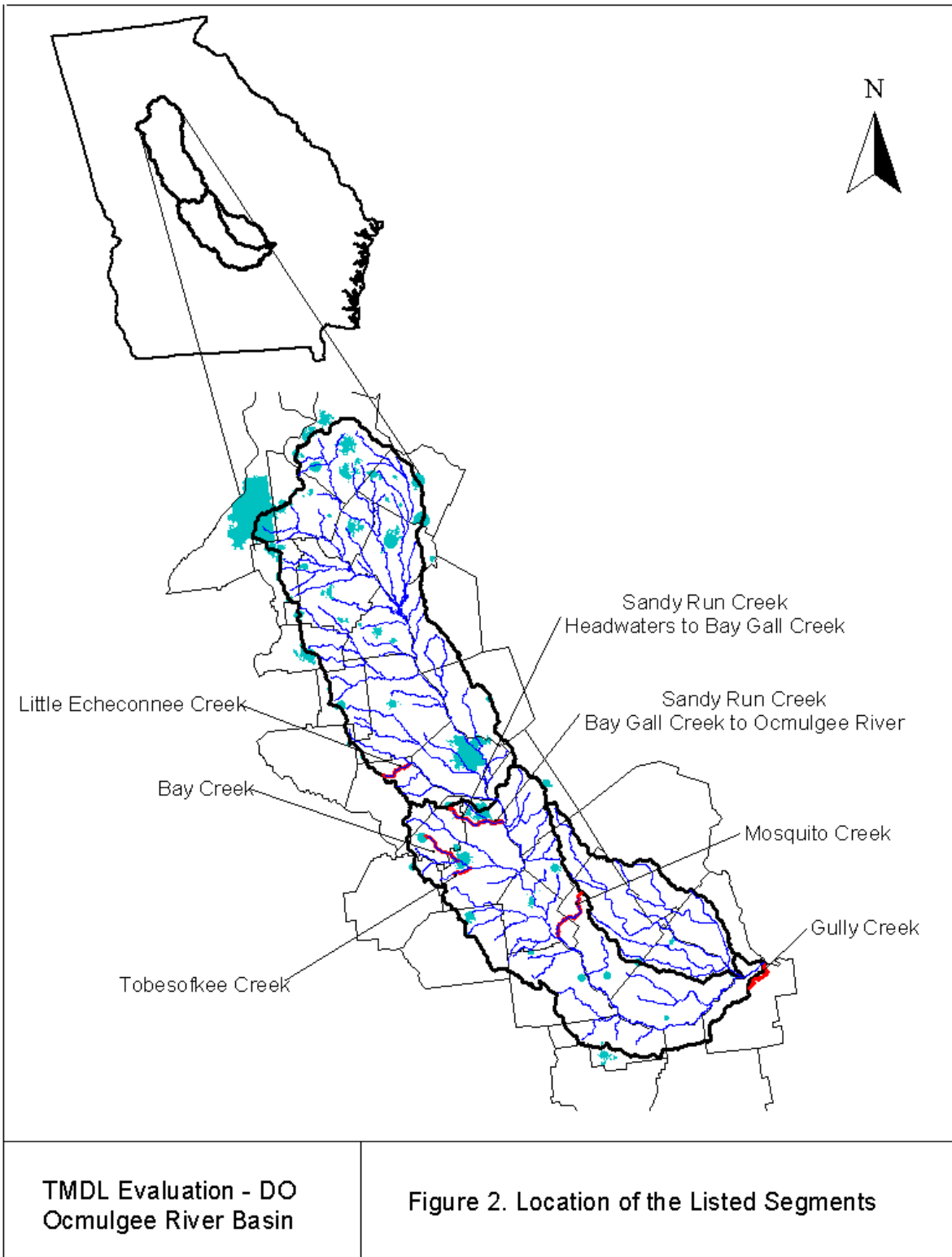


Table 2. Ocmulgee River Basin Land Coverage

| Stream/Segment | Land use Categories - Acres (Percent) | | | | | | | | | | | | |
|---|---------------------------------------|---------------------------|----------------------------|---|-----------------------|------------------------------------|------------------|-----------------|------------------|--|----------------|------------------------------|--------------------|
| | Open Water | Low Intensity Residential | High Intensity Residential | High Intensity Commercial, Industrial, Transportation | Bare Rock, Sand, Clay | Quarries, Strip Mines, Gravel Pits | Forest | Row Crops | Pasture, Hay | Other Grasses (Urban, recreational; e.g. parks, lawns) | Woody Wetlands | Emergent Herbaceous Wetlands | Total |
| Bay Creek | 17 (0.2) | 838 (7.9) | 260 (2.5) | 229 (2.2) | 0 (0.0) | 0 (0.0) | 4,130 (39.0) | 1,524 (14.4) | 1,626 (15.4) | 1,286 (12.2) | 651 (6.2) | 17 (0.2) | 10,578 (100.0) |
| Gully Creek | 62 (0.3) | 1,559 (8.6) | 987 (5.5) | 276 (1.5) | 0 (0.0) | 9 (0.0) | 7,770 (43.1) | 1,668 (9.2) | 1,182 (6.6) | 2,604 (14.4) | 1,748 (9.7) | 177 (1.0) | 18,042 (100.0) |
| Little Echeconnee Creek | 107 (0.8) | 349 (2.6) | 6 (0.0) | 0 (0.0) | 168 (1.3) | 0 (0.0) | 10,250 (77.8) | 0 (0.0) | 497 (3.8) | 954 (7.2) | 844 (6.4) | 0 (0.0) | 13,174 (100.0) |
| Mosquito Creek | 178 (0.6) | 1,200 (3.9) | 302 (1.0) | 10 (0.0) | 0 (0.0) | 27 (0.1) | 13,092 (42.5) | 7,182 (23.3) | 2,215 (7.2) | 3,385 (11.0) | 2,852 (9.3) | 382 (1.2) | 30,826 (100.0) |
| Sandy Run Creek- Headwaters to Bay Gall Creek | 45 (0.3) | 2,667 (17.7) | 1,989 (13.2) | 532 (3.5) | 0 (0.0) | 0 (0.0) | 4,508 (29.9) | 2,175 (14.4) | 1,455 (9.7) | 1,204 (8.0) | 435 (2.9) | 42 (0.3) | 15,054 (100.0) |
| Sandy Run Creek - Bay Gall Creek to Ocmulgee River | 40 (0.2) | 4,248 (21.9) | 2,736 (14.1) | 1,158 (6.0) | 9 (0.0) | 70 (0.4) | 5,112 (26.4) | 1,760 (9.1) | 1,900 (9.8) | 1,460 (7.5) | 798 (4.1) | 103 (0.5) | 19,393 (100.0) |
| Tobesofkee Creek | 2,758 (2.0) | 8,635 (6.4) | 2,822 (2.1) | 847 (0.6) | 820 (0.6) | 634 (0.5) | 78,905 (58.1) | 810 (0.6) | 22,463 (16.5) | 10,381 (7.6) | 6,504 (4.8) | 156 (0.1) | 135,734 (100.0) |

EPA dissolved oxygen criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions (USEPA, 1986).

Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration.

Accordingly, if the naturally occurring dissolved oxygen is greater than GA EPD numeric limits at critical conditions, then the GA EPD numeric limits apply. If naturally occurring dissolved oxygen is lower than the GA EPD numeric limits, then 90% of the natural dissolved oxygen will become the minimum allowable.

2.0 WATER QUALITY ASSESSMENT

During 2004, the United States Geological Survey (USGS) collected water quality data at thirty-three USGS Stations in the Ocmulgee River Basin. Figure 3 shows the GA EPD/USGS water quality and USGS flow stations that were sampled during 2004. Of these, a total of eight stations had dissolved oxygen standard violations in 2004. Appendix A provides the water quality data for these stations, and includes flow, DO, temperature, total organic carbon, 5-day biochemical oxygen demand, and NH₃ data.

In general, these data show that low dissolved oxygen values usually occurred during the summer months as shown in Figure 4. Furthermore, these values were usually limited to headwater streams where the drainage areas are relatively small and dry weather flows are low, intermittent, or zero. In larger watersheds where the flows are higher, the dissolved oxygen concentrations usually met the minimum standard of 4.0 mg/L and the daily average of 5.0 mg/L.

All field data relevant to the Ocmulgee River Basin were compiled by GA EPD and included in electronic database files. The data are managed using either the Water Resources Database (WRDB), a software database that was developed by GA EPD or the EXCEL database management software. Project data files contain the following information:

1. Historic trend monitoring data through 2004;
2. 2004 GA EPD/USGS water quality data; and
3. Historic USGS daily average flow data through December 31, 2004.

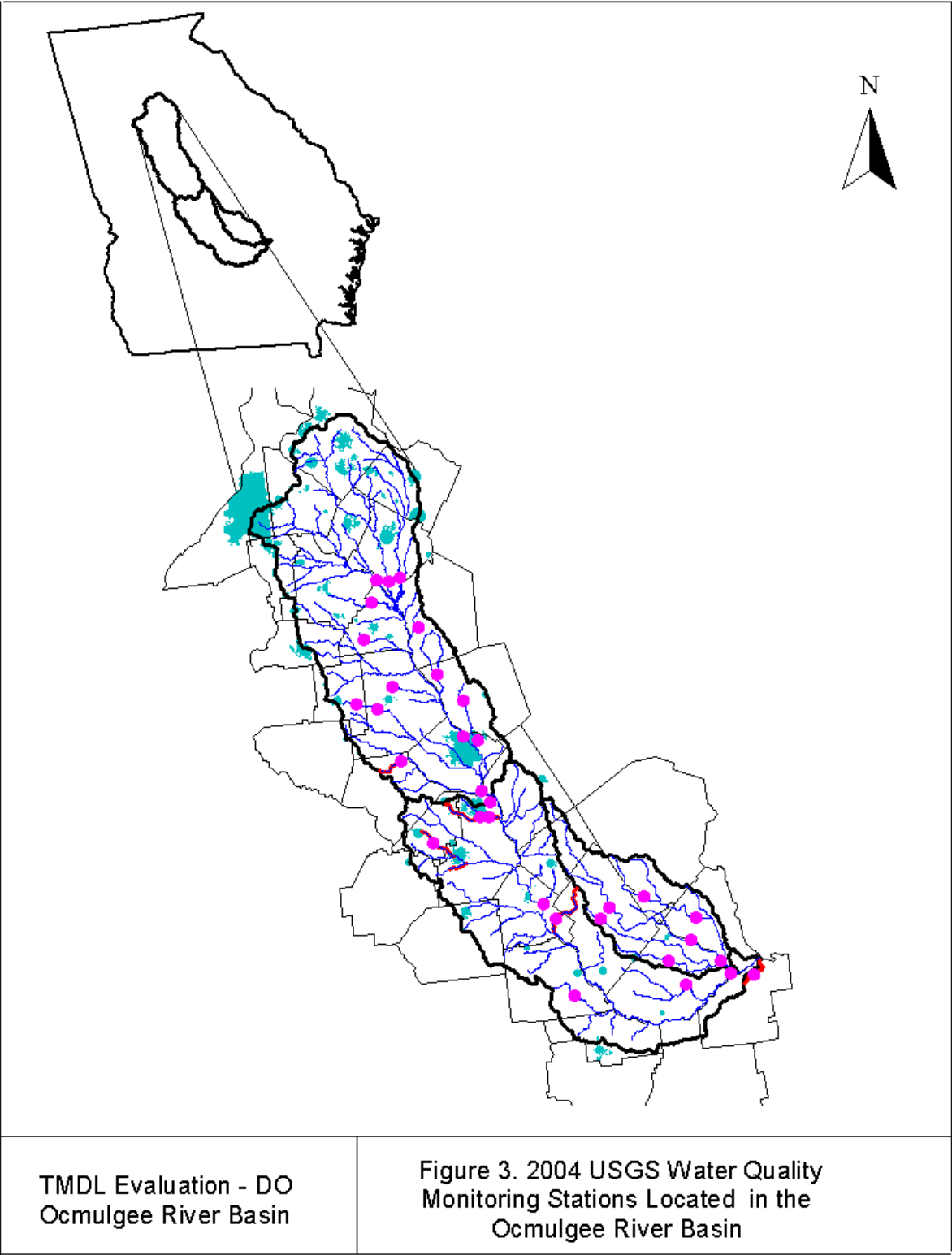
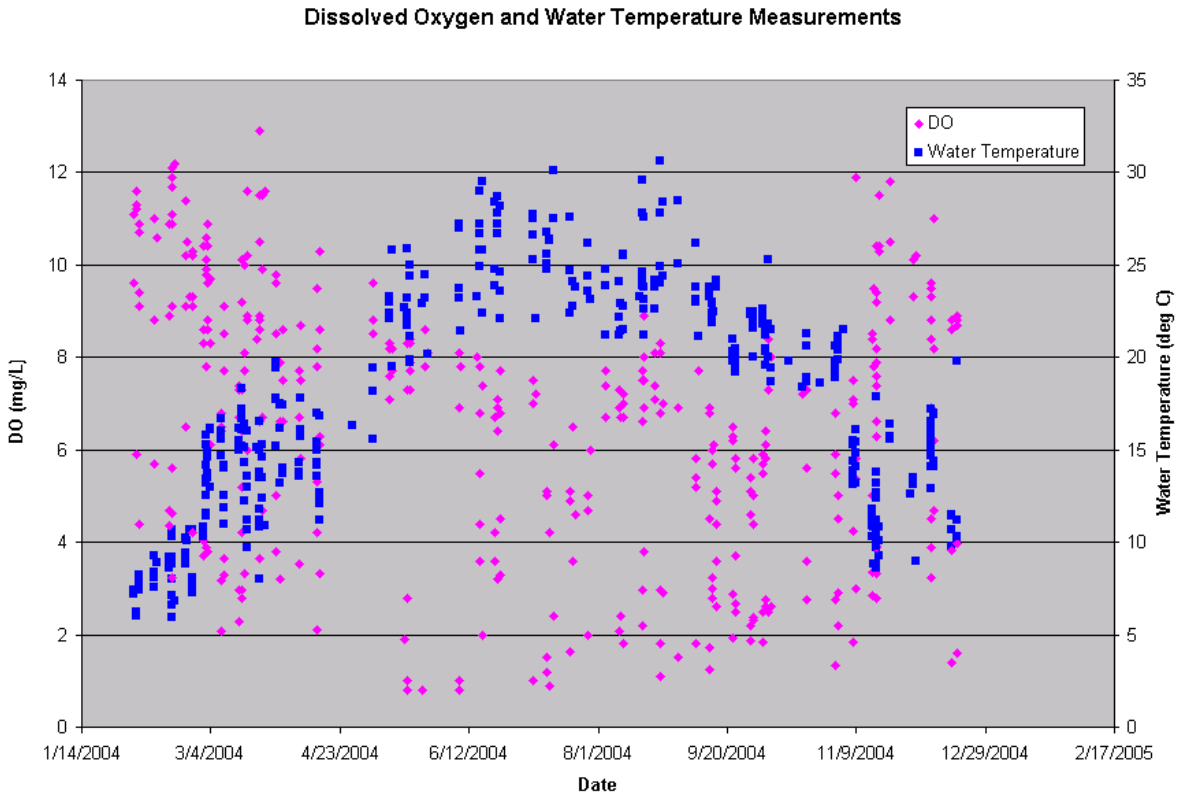


Figure 4. 2004 Dissolved Oxygen and Temperature Data for the Ocmulgee River Basin Monitoring Stations



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. Basically, 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 water quality standards (water quality-based limits).

EPA has developed technology-based limits, 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.

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 the receiving waters. There are twenty-six NPDES permitted discharges with effluent limits for oxygen consuming substances identified in the Ocmulgee River Basin watershed. Eight of these discharges are classified as major, with discharges of 1.0 million gallons per day (MGD) or more. Figure 5 provides the locations of NPDES discharges and Table 3 provides the permitted flows, as well as the 5-day Biochemical Oxygen Demand (BOD₅), ammonia (NH₃), and dissolved oxygen concentrations for the municipal and industrial treatment facilities.

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 and storm water exceed the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are three permitted CSO outfalls in the Ocmulgee River Basin, and these are given in Table 4.

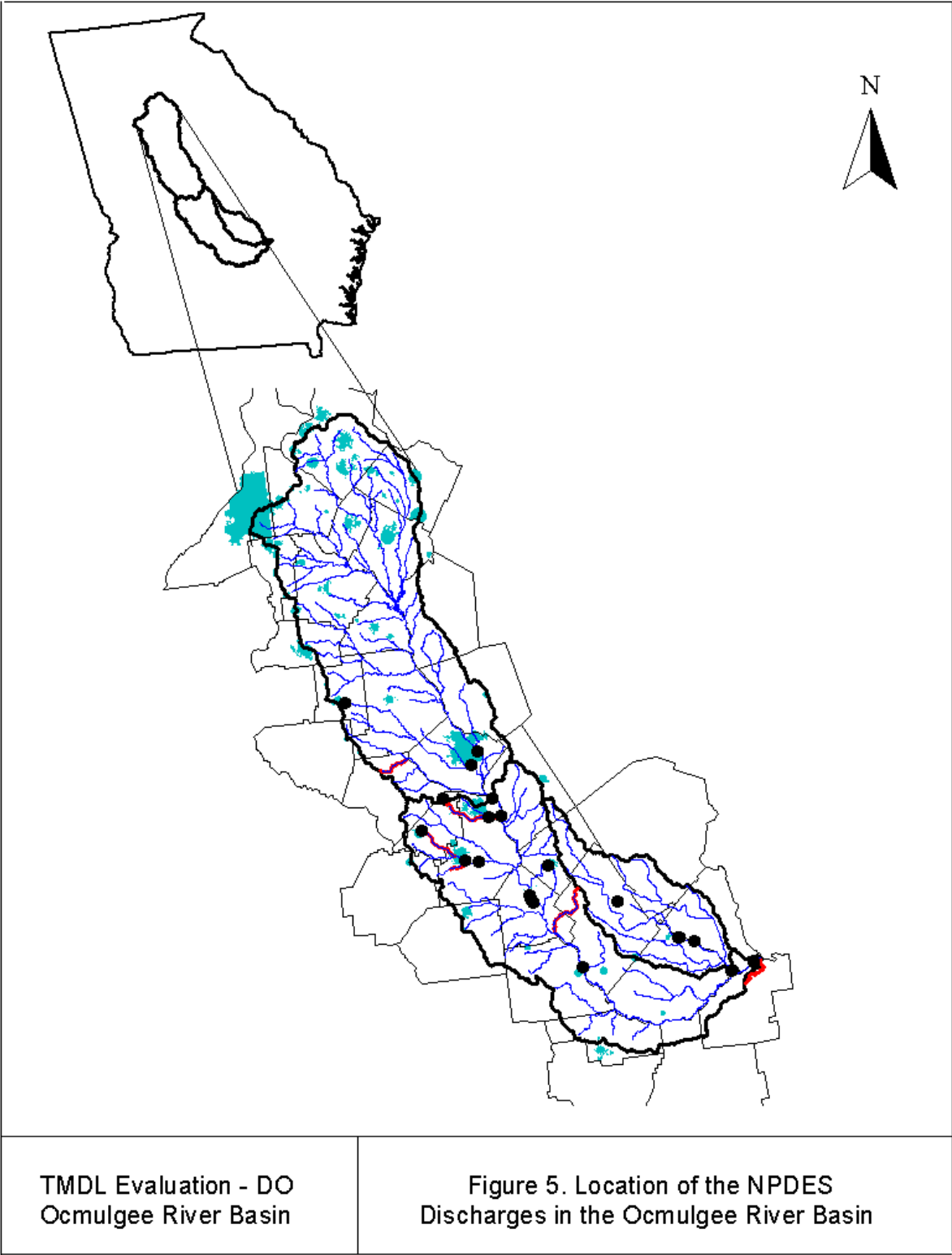


Table 3. NPDES Facilities in the Ocmulgee River Basin

| Facility Name | NPDES Permit No. | Receiving Stream | NPDES Permit Limits | | | | |
|-----------------------------|------------------|------------------------|----------------------------|---|--|-------------------|----|
| | | | Average Monthly Flow (MGD) | Average Monthly BOD ₅ (mg/L) | Average Monthly NH ₃ (mg/L) | Minimum DO (mg/L) | |
| Abbeville WPCP | GA0047643 | Ocmulgee River | 0.28 | 30 | 17.4 | 2 | |
| Alamo Pond | GA0021440 | Alligator Creek | Inactive | | | | |
| Alamo WPCP | GA0037753 | Alligator Creek | May - Oct | 0.375 | 20 | 5 | NL |
| | | | Apr - Nov | 0.375 | 30 | 10 | NL |
| Armstrong World Industrials | GA0003077 | Rocky Creek | NL | 79.5 lbs/day | NL | NL | |
| Byron Pond (use 2005) | GA0026794 | Juniper Creek | 0.44 | 25 | 10 | 5 | |
| Barnesville WPCP | GA0021041 | Tobesofkee Creek | Jan | 1.2 | 30 | 17.4 | 2 |
| | | | Feb | | 30 | 17.4 | 2 |
| | | | Mar | | 30 | 17.4 | 2 |
| | | | Apr | | 30 | 16 | 5 |
| | | | May | | 20 | 10 | 5 |
| | | | Jun | | 15 | 8 | 5 |
| | | | Jul | | 15 | 7 | 5 |
| | | | Aug | | 15 | 4 | 5 |
| | | | Sep | | 13 | 2 | 5 |
| | | | Oct | | 15 | 6 | 5 |
| | | | Nov | | 25 | 11 | 5 |
| | | | Dec | | 30 | 17.4 | 2 |
| Cadwell WPCP | GA0025887 | Unnamed Trib Bay Creek | 0.048 | 30 | NL | NL | |
| Cochran WPCP | GA0032107 | Jordan Creek | 1 | 5 | 2 | 6 | |
| Eastman (Roach Branch) WPCP | GA0026310 | Roach Branch | 0.9 | 10 | 2 | 6 | |
| Eastman South WPCP | GA0046485 | Sugar Creek | 0.9 | 10 | 2 | 6 | |
| Forsyth South WPCP | GA0024732 | Rock Branch | Jan-Mar | 0.6 | 30 | 17 | 5 |
| | | | Apr | | 24 | 12 | 5 |
| | | | May | | 20 | 12 | 6 |
| | | | Jun-Sep | | 20 | 4 | 6 |
| | | | Oct | | 20 | 8 | 6 |
| | | | Nov | | 20 | 13 | 6 |
| | | | Dec | | 20 | 13 | 6 |
| Fort Valley Bay Creek WPCP | GA0031046 | Bay Creek | 2.2 | 15 | 7.5 | 6 | |
| Hawkinsville N WPCP | GA0046027 | Ocmulgee River | 1 | 30 | 17.4 | 2 | |
| Hawkinsville WPCP | GA0020338 | Ocmulgee River | 1.3 | 30 | 17.4 | 2 | |

| Facility Name | NPDES Permit No. | Receiving Stream | NPDES Permit Limits | | | | |
|-----------------------------------|------------------|---------------------------|----------------------------|---|--|-------------------|---|
| | | | Average Monthly Flow (MGD) | Average Monthly BOD ₅ (mg/L) | Average Monthly NH ₃ (mg/L) | Minimum DO (mg/L) | |
| Hazlehurst WPCP | GA0036765 | Ocmulgee River | 1.5 | 30 | 17.4 | 2 | |
| Hollingsworth & Vose WPCP | GA0046426 | Ocmulgee River | NL | 250 (lbs/day) | NL | NL | |
| Lumber City WTF | GA0050199 | Ocmulgee River | 0.22 | 30 | NL | NL | |
| Macon Popular Street WPCP | GA0024538 | Ocmulgee River | Nov - May | 20 | 25 | 17.4 | 2 |
| | | | Jun | | 24 | 11 | 2 |
| | | | Jul | | 19 | 10 | 2 |
| | | | Aug | | 19 | 9 | 2 |
| | | | Sep | | 19 | 7 | 2 |
| | | | Oct | | 19 | 11 | 2 |
| Macon Rocky Creek Discharge | GA0024546 | Ocmulgee River | Dec - Apr | 24 | 25 | 17 | 5 |
| | | | May | | 25 | 13 | 5 |
| | | | Jun - Oct | | 25 | 2 | 5 |
| | | | Nov | | 25 | 9 | 5 |
| McRae Gum Swamp Creek | GA0026298 | Gum Swamp Creek | 0.2 | 30 | NL | NL | |
| Middle GA Nursing Home | GA0049280 | Gum Swamp Creek Tributary | Inactive | | | | |
| Perry WPCP | GA0021334 | Big Indian Creek | 3 | 30 | 17.4 | 2 | |
| Perdue Farm | GA0002844 | Big Indian Creek | 4 | 560 lbs/day | 110 lbs/day | 5 | |
| Scotland Pond | GA0032344 | Little Ocmulgee River | 0.18 | 30 | NL | NL | |
| USAF Robins AFB | GA0002852 | Ocmulgee River | 2.1 | 15 | 5 | NL | |
| Warner Robins Ocmulgee River WPCP | GA0037796 | Ocmulgee River | 3.0 | 30 | 17.4 | 6 | |
| Warner Robins Sandy Run WPCP | GA0030325 | Sandy Run Creek | Jan | 9 | 20 | 9.4 | 2 |
| | | | Feb | | 20 | 12.9 | 2 |
| | | | Mar | | 20 | 14.3 | 2 |
| | | | Apr | | 20 | 12 | 2 |
| | | | May | | 20 | 5.6 | 6 |
| | | | Jun | | 15 | 3 | 6 |
| | | | Jul | | 15 | 2.5 | 6 |
| | | | Aug | | 15 | 1.9 | 6 |
| | | | Sep | | 15 | 1.6 | 6 |
| | | | Oct | | 15 | 2.5 | 6 |
| | | | Nov | | 20 | 4.3 | 6 |
| | | | Dec | | 20 | 6.2 | 2 |

Table 4. Permitted Combined Sewer Overflows (CSOs) in the Ocmulgee River Basin

| Municipality/County | Permit No. | Facility Name | Receiving Stream |
|----------------------------|-------------------|-------------------------|-------------------------|
| City of Atlanta | GA0037168 | Custer Ave/Intrenchment | Intrenchment Creek |
| City of Atlanta | GA0037168 | McDaniel | South River tributary |

Source: Permitting and Compliance Program, Environmental Protection Division, GA EPD, 2006

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 one acre or greater, and large, medium, and small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more.

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

Storm water discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. At present, 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. This includes 60 permittees, with about 45 located in the greater Atlanta metro area.

Phase I MS4 permits require the prohibition of 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, as well as 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 twenty-eight Phase I MS4s in the Ocmulgee River Basin (see Table5).

As of March 10, 2003, small MS4s serving urbanized areas are 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. Thirty counties and 56 communities are permitted under the Phase II regulations in Georgia. There are seventeen counties or communities located in the Ocmulgee River Basin that are covered by the Phase II General Storm Water Permit (Table 6).

Table 5. Phase I Permitted MS4s in the Ocmulgee River Basin

| Name | Permit No. | Watershed |
|------------------|------------|--------------------------------------|
| Atlanta | GAS000100 | Ocmulgee, Fint, Chattahoochee |
| Avondale Estates | GAS000137 | Ocmulgee, Chattahoochee |
| Bibb County | GAS000204 | Ocmulgee |
| Clarkston | GAS000106 | Ocmulgee, Chattahoochee |
| Clayton County | GAS000107 | Ocmulgee, Fint |
| Dacula | GAS000139 | Ocmulgee, Oconee |
| Decatur | GAS000110 | Ocmulgee, Chattahoochee |
| DeKalb County | GAS000111 | Ocmulgee, Chattahoochee |
| Duluth | GAS000112 | Ocmulgee, Chattahoochee |
| East Point | GAS000114 | Ocmulgee, Fint, Chattahoochee |
| Forest Park | GAS000116 | Ocmulgee, Fint, Chattahoochee |
| Fulton County | GAS000117 | Ocmulgee, Fint, Chattahoochee, Coosa |
| Grayson | GAS000140 | Ocmulgee |
| Gwinnett County | GAS000118 | Ocmulgee, Oconee, Chattahoochee |
| Hapeville | GAS000119 | Ocmulgee, Fint |
| Jonesboro | GAS000120 | Ocmulgee, Fint |
| Lake City | GAS000141 | Ocmulgee, Fint |
| Lawrenceville | GAS000122 | Ocmulgee |
| Lilburn | GAS000123 | Ocmulgee |
| Lithonia | GAS000124 | Ocmulgee |
| Lovejoy | GAS000142 | Ocmulgee, Fint |
| Macon | GAS000203 | Ocmulgee |
| Morrow | GAS000126 | Ocmulgee, Fint |
| Norcross | GAS000127 | Ocmulgee, Chattahoochee |
| Pine Lake | GAS000143 | Ocmulgee |
| Snellville | GAS000133 | Ocmulgee |
| Stone Mountain | GAS000134 | Ocmulgee |
| Suwanee | GAS000144 | Ocmulgee, Chattahoochee |

Source: Nonpoint Source Permitting Program, GA DNR, 2006

Table 6. Phase II Permitted MS4s in the Ocmulgee River Basin

| Name | Watershed |
|-----------------|-----------------|
| Centerville | Ocmulgee |
| Conyers | Ocmulgee |
| Griffin | Ocmulgee, Flint |
| Hampton | Ocmulgee, Flint |
| Henry County | Ocmulgee, Flint |
| Houston County | Ocmulgee |
| Jones County | Ocmulgee |
| Liburn | Ocmulgee |
| Loganville | Ocmulgee |
| McDonough | Ocmulgee |
| Newton County | Ocmulgee |
| Peach County | Ocmulgee |
| Rockdale County | Ocmulgee |
| Spalding County | Ocmulgee, Flint |
| Stockbridge | Ocmulgee |
| Walton County | Ocmulgee |
| Warner Robins | Ocmulgee |

Source: Nonpoint Source Permitting Program, GA DNR, 2006

3.1.3 Confined Animal Feeding Operations

Confined livestock and confined animal feeding operations (CAFOs) are characterized by high animal densities. This results in large quantities of fecal material being contained in a limited area. Processed agricultural manure from confined hog, dairy cattle, and select poultry operations is generally collected in lagoons. It is then applied to pastureland and cropland as a fertilizer during the growing season, at rates that often vary monthly. Runoff during storm events may carry surface residual containing oxygen demanding substances to nearby surface waters.

In 1990, the State of Georgia began registering CAFOs. Many of the CAFOs were issued land application or NPDES permits for treatment of wastewaters generated from their operations. The type of permit issued depends on the operation size (i.e., number of animal units). Table 7 presents the swine and non-swine (primarily dairies) CAFOs located in the Ocmulgee River Basin that are registered or have land application permits.

Table 7. Registered CAFOs in the Ocmulgee River Basin

| Name | County | Animal Type | Total No. of Animals | Permit No. |
|-----------------------|---------|-------------|----------------------|------------|
| Adamson Dairy Farm | Lamar | Dairy | 430 | GAU700000 |
| B & S Dairy | Wilcox | Dairy | 420 | GAU700000 |
| Bush Dairy Farm | Monroe | Dairy | | |
| Haygood Farm | Upson | Dairy | 400 | GAU700000 |
| Ocmulgee Dairy, Inc. | Houston | Dairy | 360 | GAU700000 |
| Stoffell's Dairy Inc. | Peach | Dairy | 800 | GAG930000 |
| Walters Farm, LLP | Lamar | Swine | 7000 | GA0038181 |
| Wild Rose Dairy | Bibb | Dairy | 400 | GAU700000 |

Sources: Permitting Compliance and Enforcement Program, GA EPD, 2004
 GA Dept. of Agriculture, 2006

3.2 Nonpoint Source Assessments

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Typical nonpoint sources of oxygen demanding substances come from materials being washed into the rivers and streams during storm events. In 2004, many streams in the Ocmulgee River Basin were dry, or had ponded areas and stagnant pools. If these conditions existed during the monitoring period, the streams were not sampled. Due to the lack of rainfall typical during the summer of 2004, stormwater did not contribute to significant wash off of materials into the streams. Constituents that may have washed off of land surfaces in previous months or years had either flushed out of the system along with the water column flow; or settled out and became part of the stream channel bottom.

In this manner, historic wash off of settleable materials accumulates and exerts sediment oxygen demand (SOD). Constituents of concern from surface washoff include the fractions of NH₃ and BOD₅ that become an integral part of channel bottom sediments, thus becoming a potential source of SOD. Table 2 provides the land cover distributions for the listed Ocmulgee River watersheds. These data show that the watersheds are predominately forested, with approximately 44.1 percent (ranging from 26.4 to 77.8 percent) of forest land use. Residential is the next predominate land use with approximately 27.5 percent row crops (ranging from 9.9 to 49.5 percent). Agriculture follows, with approximately 9.4 percent row crops (ranging from 0.0 to 23.3 percent) and approximately 9.9 percent pasture (ranging from 3.8 to 15.4 percent). Approximately 7.4 percent (ranging from 2.9 to 15.9 percent) of the land use in these watersheds is woody wetlands.

In addition to nonpoint sources of SOD associated with land disturbing activities, most of the streams in the Ocmulgee River Basin receive significant natural contributions of oxygen demanding organic materials from local wetlands and forested stream corridors. The following sources of naturally occurring organic materials have been identified:

- Adjacent wetlands, swamps, and marshes with organically rich bottom sediments; and
- Direct leaf litterfall onto water surfaces and adjacent floodplains from overhanging trees and vegetation.

Leaf litterfall is a major contributor to the amount of dissolved organic matter in the stream water column and the amount of SOD being exerted. Many streams in southern Georgia are also referred to as “blackwater” streams because of highly colored humic substances leached from surrounding marshes and swamps. In addition, low dissolved oxygen in blackwater streams is very common in the summer months when the temperatures are high and the flows are low (Meyer, 1992). The oxygen demanding effects of leaf litterfall are reflected in two ways: 1) by lowering the dissolved oxygen saturation of water entering the channel from adjacent swampy areas caused by decaying vegetation; and 2) by increasing SOD associated with vegetation decaying on stream channel bottoms.

3.2.1 Land Application Systems

Many smaller communities use land application systems (LAS) for treatment of their sanitary wastewater. These facilities are required through LAS permits to treat all their wastewater by land application and are to be properly operated as non-discharging systems that contribute no runoff to nearby surface waters. However, runoff during storm events may carry surface residual containing oxygen demanding substances to nearby surface waters. Some of these facilities may also exceed the ground percolation rate when applying their wastewater, resulting in surface runoff. If not properly bermed, this runoff, which contains oxygen demanding substances, may discharge to nearby surface waters. There are twenty-six permitted LAS systems located in the Ocmulgee River Basin (Table 8).

Table 8. Permitted Land Application Systems in the Ocmulgee River Basin

| LAS Name | County | Permit No. | Type | Flow (MGD) |
|--|---------------|-------------------|-------------|-------------------|
| Atlanta South KOA | Peach | GA01-573 | Private | Inactive |
| Butts Co Water & Sewer Las | Butts | GA02-038 | Municipal | 0.3 |
| CA Simpson Commercial Property | Butts | GA02-225 | Private | 0.3 |
| Chester | Dodge | GA02-202 | Municipal | 0.175 |
| Christ Sanctified Holy Church | Newton | GA03-962 | Private | - |
| Clayton Co Huie Las | Clayton | GA02-008 | Municipal | 19.5 |
| Covington | Newton | GA02-055 | Municipal | 4.8 |
| Flying J. Travel Plaza | Dooly | GA03-799 | Private | - |
| GA Diagnostic Center | Butts | GA02-245 | Public | 0.225 |
| GA Public Safety Training Center | Monroe | GA02-201 | Public | 0.12 |
| Henry Co Indian Creek | Henry | GA02-250 | Municipal | 1.5 |
| Henry Co Simpson Mill LAS | Henry | GA02-203 | Municipal | Inactive |
| Henry Co Springdale LAS | Henry | GA02-239 | Municipal | 1.1 |
| Henry Co Walnut Creek Reclamation Facility | Henry | GA02-137 | Municipal | 4 |
| Locust Grove LAS | Henry | GA02-070 | Municipal | Inactive |
| Loganville LAS | Walton | GA02-174 | Municipal | 0.25 |
| McRae LAS | Telfair | GA02-248 | Municipal | 0.8 |
| Melrose Subdivision | Henry | GA03-832 | Private | - |
| Milan LAS | Dodge | GA02-086 | Municipal | 0.2 |
| Newton County High School | Newton | GA02-005 | Private | - |
| Newton County Water And Sewerage Authority | Newton | GA02-013 | Municipal | 1.8 |
| Publix Super Market | Gwinnett | GA02-220 | Private | - |
| Atlanta South RV Resort LLC | Henry | GA03-829 | Industrial | - |
| Unadilla | Dooly | GA02-151 | Municipal | 0.54 |
| Winding River Development | Houston | GA03-623 | Private | 2 |

Source: Permitting Compliance and Enforcement Program, GA EPD, Atlanta, Georgia, 2006

4.0 TECHNICAL APPROACH

The first step of the technical approach for these TMDLs was to select the models that can be effectively used to analyze the Ocmulgee River dissolved oxygen resources. After appropriate models are selected, data is gathered to develop and calibrate the models. The calibrated models are then used to establish the TMDL during critical conditions. The modeling approach is described in the following sections.

4.1 Model Selection and Structure

Various analyses were performed to correlate the measured low dissolved oxygen concentrations to basic causes such as point and nonpoint contributions, flow conditions, stream and watershed characteristics, seasonal temperature effects, and others. From these analyses, the low dissolved oxygen values were found to coincide with low or zero flows, slow stream velocities, shallow water depths, and high temperatures. Inflows of very low dissolved oxygen waters from adjacent marshes and forested swamps compounded the situation. Since the impairments noted in 2004 occurred during sustained periods of low flows, a steady-state modeling approach was selected.

Further analyses of the listed segments revealed that two different water quality models were required based on the geographic, hydrologic, and water quality characteristics. It was determined that Georgia DOSAG would be used.

USGS quadrangle maps and navigational maps along with Arcview and MapInfo spatial graphics files were used to develop drainage areas, stream lengths, bed slopes, segment geometry, and other physical input data for each model. Appendix B provides a summary of each model structure.

Georgia DOSAG is a one-dimensional steady state water quality model that was developed by the GA EPD. The model 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; and
- 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.

Georgia DOSAG consists of a mainstem and may include up to six branches. DOSAG can also include tributaries, water intakes, and dams, as well as point sources. One DOSAG model was developed to represent the seven listed segments in the Ocmulgee River Basin.

4.2 Model Calibration

The model calibration period was determined from an examination of the USGS 2004 water quality data for the listed segments. The data examined included streamflow, DO, water temperature, BOD₅, and NH₃. The combination of the lowest flow, lowest DO, and highest

water temperature defined the critical modeling period. For the listed segments, June through September was found to be the critical period. The calibration models were run to simulate an average dissolved oxygen from this period.

The average summer dissolved oxygen and average annual BOD₅ and NH₃ values were extracted from the 2004 dataset for each sampling station. Table 9 provides a summary of the 2004 monitoring data used to develop data for the model calibration.

Table 9. Summary of the 2004 Monitoring Data for the Ocmulgee River Basin

| Monitoring Station | Avg Annual BOD ₅ (mg/L) | Avg Annual NH ₃ (mg/L) | Avg Summer Flow (cfs) | Avg Summer DO (mg/L) | Max Summer Temp (deg C) |
|---|------------------------------------|-----------------------------------|-----------------------|----------------------|-------------------------|
| Ocmulgee River Basin Mainstem | | | | | |
| Ocmulgee River near Macon 02212940 | 1.28 | 0.05 | 3158.33 | 7.38 | 30.6 (Aug) |
| Ocmulgee River near Warner Robins 02213700 | 7.66 | 0.039 | 1457.135 | 6.70 | 28.7 (June) |
| Ocmulgee River at Lumber City 02215500 | 1.025 | 0.0525 | 3448.75 | 6.69 | 30.1 (July) |
| Ocmulgee River Basin Tributaries | | | | | |
| Walnut Creek at McKay Rd (CR 11), near Clinton 02213055 | -- | -- | 4.56 | 8.30 | 23.8 (Aug) |
| Walnut Creek at Jeffersonville Rd, at Macon 02213109 | -- | -- | 18.00 | 7.69 | 25.8 (May) |
| Tobesofkee Creek at Ramah Church Rd, near Barnesville 02213285 | 3.03 | 1.04 | 9.14 | 7.68 | 24.0 (Aug) |
| Tobesofkee Creek near Forsyth 02213300 | -- | -- | 9.56 | 7.94 | 24.8 (Aug) |
| Little Echeconee Creek at Smith Chapel Rd, near Musella 02213925 | 2.83 | 0.07 | | 2.80 | 27.8 (June) |
| Horse Creek at Warner Robins 02214190 | -- | -- | 11.58 | 5.67 | 23.8 (July) |
| Sandy Run Creek at South Houston Lake Rd, near Warner Robins 02214200 | 1.78 | 0.24 | 6.22 | 1.89 | 29.0 (June) |
| Sandy Run Creek at GA 247, at Warner Robins 02214210 | 6.42 | 1.44 | 6.23 | 4.55 | 32.5 (June) |
| Bay Creek at Hendricks Road, near Fort Valley 02214474 | -- | -- | 16.50 | 3.15 | 26.3 (July) |
| Limestone Creek at GA230, near Hawkinsville 02215041 | -- | -- | 21.08 | 5.04 | 26.4 (July) |
| Mosquito Creek at GA 230, near Hawkinsville 02215210 | 1.51 | 0.10 | 7.88 | 4.08 | 24.9 (June) |
| House Creek near Forest Glen 02215276 | -- | -- | 3.45 | 4.20 | 23.30 (Sept) |
| Alligator Creek at CR 59, near Jacksonville 02215365 | 2.06 | 0.06 | 5.67 | 2.70 | 24.1 (Sept) |
| Big Horse Creek near Lumber City 02215400 | -- | -- | 288.30 | 5.79 | 27.6 (July) |
| Gully Creek at Liberty Church Rd, near Hazelhurst 02216612 | 1.81 | 0.05 | 8.44 | 2.94 | 27.5 (July) |

Headwater and tributary water quality boundaries were developed from these instream field data, expected low dissolved oxygen saturation values (Meyer, 1992), and GA EPD standard modeling practices (GA EPD, 1978). BOD₅ was converted to Ultimate Carbonaceous Biochemical Oxygen Demand (CBOD_U) by multiplying by an f-ratio of 2.5 (GA EPD, 1978), and NH₃ was converted to Ultimate Nitrogenous Biochemical Oxygen Demand (NBOD_U) by multiplying by the stoichiometric conversion factor of 4.57. Water temperatures were varied across the basin in accordance with the summer sampling data.

Average monthly discharge flows, BOD₅, NH₃, and dissolved oxygen concentrations for the discharges were obtained from 2004 Discharge Monitoring Reports (DMRs). These data were input into the calibration model. BOD₅ was converted to CBOD_U by multiplying by an f-ratio of 2 if the BOD₅ is greater than 20 mg/L and an f-ratio of 3 if the BOD₅ is 20 mg/L or less (GA EPD, 1978). NH₃ was converted to NBOD_U by multiplying by 4.57. Table 10 is a summary of the actual discharges from these facilities for calendar year 2004.

Table 10. Summary of NPDES Discharges During 2004

| Facility Name | NPDES Permit No. | Actual Discharge for Calendar Year 2004 | | | |
|-----------------------------------|------------------|---|-------------------------|------------------------|-----------|
| | | Flow (MGD) | BOD ₅ (mg/L) | NH ₃ (mg/L) | DO (mg/L) |
| Abbeville WPCP | GA0047643 | 0.14 | 21.3 | 8.6 | 3.64 |
| Alamo Pond | GA0021440 | 0.17 | 14.5 | 13.1 | NL |
| Armstrong World Industrials | GA0003077 | 1.46 | 38.83 | NL | NL |
| Byron Pond (use 2005) | GA0026794 | 0.44 | 21.3 | 8.2 | 6.58 |
| Barnesville WPCP | GA0021041 | 0.86 | 12.3 | 0.5 | 8.28 |
| Cadwell WPCP | GA0025887 | 0.03 | 22.8 | NL | NL |
| Cochran WPCP | GA0032107 | 0.79 | 3.5 | 0.72 | 7.28 |
| Eastman (Roach Branch) WPC | GA0026310 | 0.6 | 4 | 0.5 | 8 |
| Eastman South WPC | GA0046485 | 0.5 | 3.75 | 0.5 | 8 |
| Forsyth South WPCP | GA0024732 | 0.36 | 2.65 | 1.84 | 6.34 |
| Fort Valley Bay Creek WPCP | GA0031046 | 1.1 | 2 | 1.37 | 7.21 |
| Hawkinsville N WPCP | GA0046027 | 0.43 | 13.17 | 1.43 | 3.83 |
| Hawkinsville WPCP | GA0020338 | 0.37 | 4.3 | 0.82 | 7.3 |
| Hazlehurst WPCP | GA0036765 | 0.82 | 2 | 0.14 | 4.94 |
| Hollingsworth & Vose WPCP | GA0046426 | 0.43 | 0.86 | NL | NL |
| Lumber City WTF | GA0050199 | 0.26 | 23.25 | NL | NL |
| Macon Popular Street WPCP | GA0024538 | 13.38 | 4.64 | 0.41 | 5.25 |
| Macon Rocky Creek Discharge | GA0024546 | 17.12 | 3.25 | 0.18 | 6.94 |
| McRae Gum Swamp Creek | GA0026298 | 0.19 | 4.6 | NL | 7 |
| Middle GA Nursing Home | GA0049280 | 0.008 | 17 | NL | NL |
| Perry WPCP | GA0021334 | 2.49 | 25.58 | 8.19 | 5.58 |
| Perdue Farm | GA0002844 | 1.49 | 199.73 lbs/day | 22.05 lbs/day | 9.1 |
| Scotland Pond | GA0032344 | 0.01 | 31.75 | NL | NL |
| USAF Robins AFB | GA0002852 | 1.91 | 6.19 | 0.55 | NL |
| Warner Robins Ocmulgee River WPCP | GA0037796 | 1.34 | 21.75 | 4.67 | 7 |
| Warner Robins Sandy Run WPCP | GA0030325 | 8.65 | 6 | 1.1 | 6.9 |

* NL - no permit limit or DMR data, assumed value

In shallow streams, SOD is an important part of the oxygen budget. However, there are no field SOD measurements in the Ocmulgee River Basin. In the South 4 Basins (Satilla, Ochlockonee, Suwannee, and St Mary's), there are several SOD measurements that ranged from 0.9 to 1.9 g/m²/day. An examination of South 4 SOD results was performed in order to develop realistic SOD values that could be applied to the Ocmulgee DOSAG models.

Results from the 1998 South 4 calibrated models of existing conditions were compiled and summarized. An average value of existing SOD was determined to be 1.35 g/m²/day. This represented 12 models that had mixed land uses and varying degrees of point source activity. When the same 12 models were analyzed under natural conditions (assuming zero point source discharges and completely forested watersheds), SOD averaged 1.25 g/m²/day. These two values were adopted for the Ocmulgee models to represent SOD for: 1) mixed land uses, including agriculture; and 2) natural or totally forested watersheds, respectively. From this, the anthropogenic nonpoint source contributions, those caused by land disturbing activities, are accounted for in the 0.1 g/m²/day difference between the two adopted SOD values.

Stream velocities were calculated using the soil equation based on either the Atlantic Coastal Flatwoods or Southern Coast Plain soil provinces coefficients. The kinetic rates and input parameters developed during model calibration are provided in Table 11. These parameters include the carbonaceous BOD (CBOD) decay rate, nitrogenous BOD (NBOD) decay rate, SOD rate, and the Tsivoglou reaeration coefficient used to determine stream reaeration.

Table 11. Modeling Parameters

| Parameter | DOSAG Values |
|-----------------------------|--------------|
| CBOD Decay Rate (1/day) | 0.1 |
| NBOD Decay Rate (1/day) | 0.25 |
| SOD (g/m ² /day) | 1.25-1.35 |
| Reaeration Coefficient | 0.054 |

The Ocmulgee River Basin DOSAG models were calibrated at locations where the USGS collected discrete water quality data during 2004. Appendix C provides the dissolved oxygen calibration curves plotted with the data from monitoring stations in the listed segments.

4.3 Critical Conditions Models

The critical conditions models were used to assess the dissolved oxygen standard and to determine if problems exist requiring regulatory intervention. Model critical conditions were developed in accordance with GA EPD standard practices (GA EPD, 1978).

None of the seven listed segments had both water quality and daily flow data. Since low flow data were limited, low flow analyses of the available Ocmulgee River Basin flow data were performed. Data from long-term USGS gages were analyzed to determine 7-day, 10-year minimum flows (7Q10s). Productivity factors, in cubic feet per second (cfs) per square mile, were computed by dividing the 7Q10s by the watershed areas at the gages. Table 12 summarizes the low-flow analyses and Figure 6 shows the proximity of these USGS long-term gages to the listed stream segments. The 7Q10 productivity factors developed from the USGS

data were used to develop model input for the Ocmulgee River Basin DOSAG models by multiplying them by the listed segment watershed drainage areas.

Table 12. Low-Flow Analysis Summary for the Ocmulgee River Basin

| DO TMDL Segment | 7Q10 (cfs) | Drainage Area (sq. miles) | Productivity Factor (cfs/sq. mile) |
|---|------------|---------------------------|------------------------------------|
| Upper Ocmulgee HUC03070103 | | | |
| Ocmulgee River at Macon 02213000 | 410 | 2,240 | 0.18 |
| Walnut Creek near Gray 02213050 | 0.71 | 29 | 0.02 |
| Walnut Creek (US Hwy 129, Old 80) at Macon 02213100 | 0.4 | 77 | 0.005 |
| Swift Creek near Macon 2213200 | 3.2 | 11 | 0.29 |
| Tobesofkee Creek near Forsyth 02213300 | 2.7 | 28 | 0.10 |
| Tobesofkee Creek near Macon 02213500 | 8.5 | 182 | 0.05 |
| Little Tobesofkee Creek near Forsyth 02213400 | 1 | 17 | 0.06 |
| Echeconnee Creek near Macon 02214000 | 3 | 147 | 0.02 |
| Lower Ocmulgee HUC 03070104 | | | |
| Big Indian Cree at Perry 02214500 | 21 | 108 | 0.19 |
| Ocmulgee River at Hawkinsville 02215000 | 590 | 1,400 | 0.42 |
| Tucsawhatchee Creek near Hawkinsville 02215100 | 5.5 | 163 | 0.03 |
| Ocmulgee River at Lumber City 02215500 | 1,252 | 5,80 | 0.19 |
| Little Ocmulgee HUC 03070105 | | | |
| Little Ocmulgee River at Towns 0221600 | 2.6 | 351 | 0.007 |

Source: USGS website <http://ga2.er.usgs.gov/lowflow/>

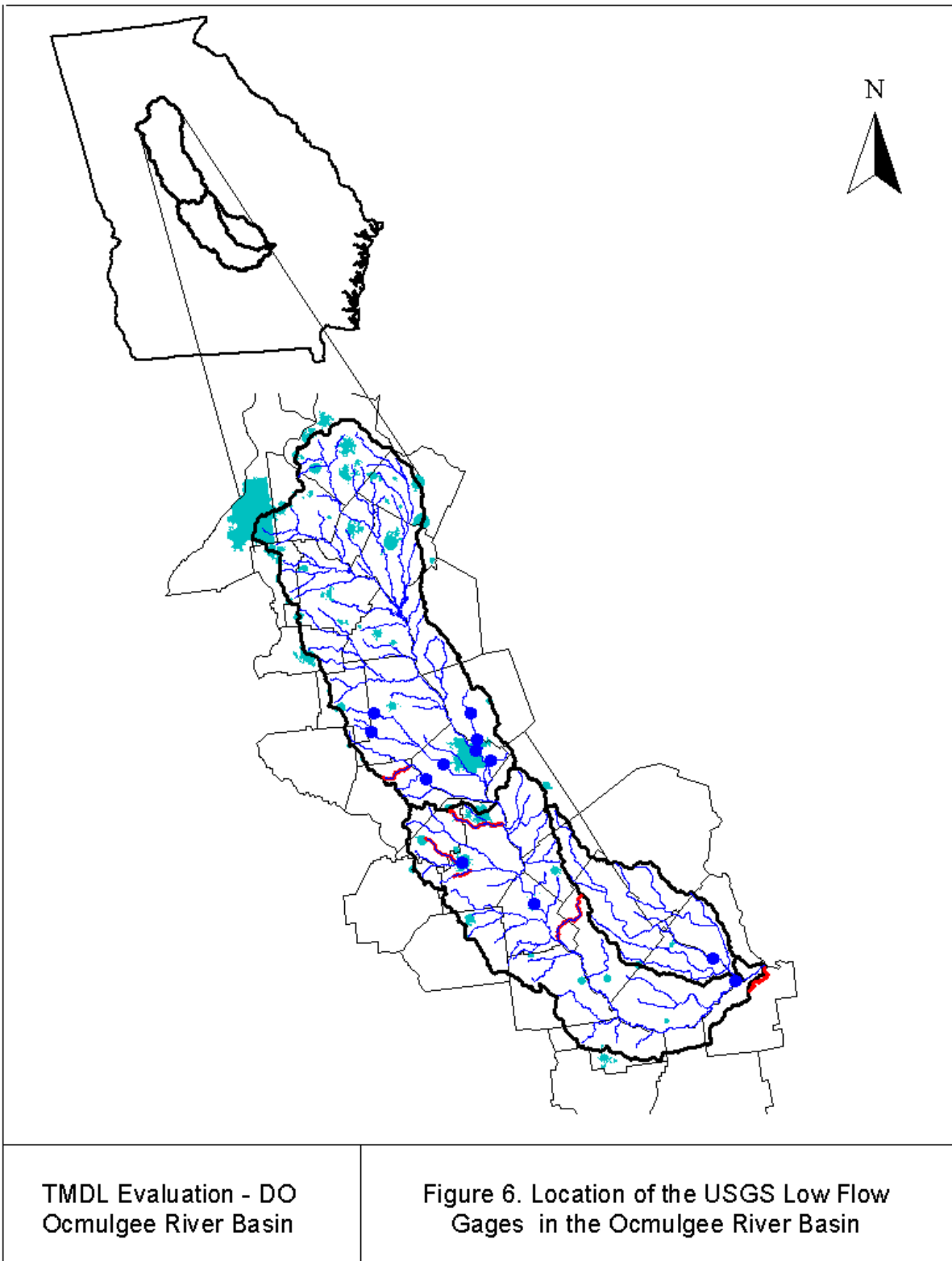
Critical water temperatures were determined by examining the 2004 water quality data and the long-term trend monitoring data. Harmonic sine functions were developed for the historical data from all of the long-term monitoring stations. The highest summer-time temperature from either the 2004 water quality data or the harmonic fit was used to represent each of the listed segments.

Point sources were incorporated into the critical conditions models at their current NPDES permit limits. For NPDES permits that do not have dissolved oxygen and/or NH₃ limits, values of 2 mg/L and 17.4 mg/L were assumed, respectively. Water quality boundaries, the SOD rate, and all other modeling rates and constants were the same as those in the calibrated models.

4.4 Natural Conditions Models

For the natural conditions models, two changes were made to the critical conditions models. First, the SOD was changed from 1.35 g/m²/day to 1.25 g/m²/day to reflect the change from mixed land uses to natural or completely forested land uses. Second, all point source discharges were completely removed from the model. All other model parameters remained the same. These models were used to determine the natural dissolved oxygen concentrations during critical conditions. These models predicted the natural dissolved oxygen concentrations, during the critical summer months, to be less than 5.0 mg/L. It is important to note: 1) even though dissolved oxygen was found to be low in the summer of 2004, the results

are even lower at standard critical conditions; and 2) the summer of 2004 conditions are very close to critical conditions and compare favorably with the target of 90 percent of the natural dissolved oxygen standard. Results of natural conditions runs are plotted in the graphs in Appendix C along with the calibration, critical conditions and TMDL results for comparison.



5.0 TOTAL MAXIMUM DAILY LOADS

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. A TMDL is the sum of the individual waste load allocations (WLAs) from point sources and load allocations (LAs) from nonpoint sources, as well as the 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 (USEPA, 1991). TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For oxygen demanding substances, this TMDL is expressed in lbs/day.

Conceptually, a TMDL can be expressed as follows:

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

This TMDL determines the allowable oxygen demanding loads to the listed segments in the Ocmulgee River Basin. The following sections describe the various oxygen demanding sources, which may contribute loads to the TMDL components.

5.1 Waste Load and Load Allocations

The waste load allocation (WLA) is the portion of the receiving water's loading capacity that is allocated to existing or future point sources. WLAs are provided to the point sources from municipal and industrial wastewater treatment systems, as well as permitted storm water discharges. There are eleven NPDES permitted facilities in the Ocmulgee River watershed that effect instream dissolved oxygen. The waste load allocations are provided in Table 13.

The Georgia DOSAG critical conditions model was used to determine the WLAs for the discharges upstream from or within the listed segments in order to meet the DO standards. Allocations are based on the EPA Dissolved Oxygen Criteria, which states that if the natural dissolved oxygen is less than the standard (5.0 mg/L) then a 10 percent reduction in the natural condition is allowed. The target limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions. Appendix C contains plots of the DO concentrations resulting from the TMDL loads versus the target DO Standard. Note that if the TMDL plot is higher than the target DO Standard plot, there is additional assimilative capacity in the stream available for future WLA.

When a wasteload allocation predicts the critical dissolved oxygen concentrations to be less 3.0 mg/L, the biological integrity of the stream will need to be evaluated. The biological evaluation should include a habitat assessment, aquatic macroinvertebrate community assessment, fish community assessment, and in-situ physical and chemical measurements. The most updated Standard Operating Procedures (SOP) should be used for the macroinvertebrate and fish assessments.

The TMDL will be used to assess permit renewals. If necessary, GA EPD may modify the WLAs during the NPDES permitting process. The assimilative capacity might not be fully allocated for all of the listed segments. Future wasteload allocations might be allowed if the discharge does not result in a concentration lower than 90 percent of the natural dissolved oxygen concentration during critical conditions. However, it should be noted that the SOD

Table 13. Ocmulgee River Basin WLAs

| Facility Name | NPDES Permit No. | Receiving Stream | WLA Limits | | | | |
|-----------------------------------|------------------|---------------------------|----------------------------|---|--|-------------------|-----|
| | | | Average Monthly Flow (MGD) | Average Monthly BOD ₅ (mg/L) | Average Monthly NH ₃ (mg/L) | Minimum DO (mg/L) | |
| Abbeville WPCP | GA0047643 | Ocmulgee River | 0.28 | 30 | 17.4 | 2 | |
| Alamo Pond | GA0021440 | Alligator Creek | Inactive | | | | |
| Alamo Pond | GA0021440 | Alligator Creek | May - Oct | 0.375 | 20 | 5 | NL* |
| | | | April - Nov | 0.375 | 30 | 10 | NL* |
| Armstrong World Industrials | GA0003077 | Rocky Creek | NL | 79.5 lbs/day | NL | NL | |
| Byron Pond (use 2005) | GA0026794 | Juniper Creek | 0.44 | 12.5 | 5.6 | 6 | |
| Barnesville WPCP | GA0021041 | Tobesofkee Creek | 1.2 | 13-30 | 2-17.4 | 2-5 | |
| Cadwell WPCP | GA0025887 | Unnamed Trib Bay Creek | 0.048 | 30 | 17.4 | 5 | |
| Cochran WPCP | GA0032107 | Jordan Creek | 1 | 5 | 2 | 6 | |
| Eastman (Roach Branch) WPCP | GA0026310 | Roach Branch | 0.9 | 10 | 2 | 8 | |
| Eastman South WPCP | GA0046485 | Sugar Creek | 0.9 | 10 | 2 | 8 | |
| Forsyth South WPCP | GA0024732 | Rock Branch | 0.6 | 10-15 | 2-8.7 | 5-6 | |
| Fort Valley Bay Creek WPCP | GA0031046 | Bay Creek | 2.2 | 5 | 1 | 6 | |
| Hawkinsville N WPCP | GA0046027 | Ocmulgee River | 1 | 30 | 17 | 2 | |
| Hawkinsville WPCP | GA0020338 | Ocmulgee River | 1.3 | 30 | 17 | 2 | |
| Hazlehurst WPCP | GA0036765 | Ocmulgee River | 1.5 | 30 | 17.4 | 2 | |
| Hollingsworth & Vose WPCP | GA0046426 | Ocmulgee River | NL | 250 (lbs/day) | 62 (lbs/day) | 5 | |
| Lumber City WTF | GA0050199 | Ocmulgee River | 0.22 | 30 | 17.4 | 5 | |
| Macon Popular Street WPCP | GA0024538 | Ocmulgee River | 20 | 19-25 | 7-17.4 | 2 | |
| Macon Rocky Creek Discharge | GA0024546 | Ocmulgee River | 24 | 25 | 2-17 | 5 | |
| McRae Gum Swamp Creek | GA0026298 | Gum Swamp Creek | 0.2 | 30 | 17.4 | 5 | |
| Middle GA Nursing Home | GA0049280 | Gum Swamp Creek Tributary | Inactive | | | | |
| Perry WPCP | GA0021334 | Big Indian Creek | 3 | 5 | 1 | 6 | |
| Perdue Farm | GA0002844 | Big Indian Creek | NL | 400 lbs/day | 55 lbs/day | 8 | |
| Scotland Pond | GA0032344 | Little Ocmulgee River | 0.18 | 30 | 17.4 | 5 | |
| USAF Robins AFB | GA0002852 | Ocmulgee River | 2.1 | 15 | 5 | 5 | |
| Warner Robins Ocmulgee River WPCP | GA0037796 | Ocmulgee River | 3 | 30 | 17.4 | 6 | |
| Warner Robins Sandy Run WPCP | GA0030325 | Sandy Run Creek | 9 | 5-20 | 1-6 | 2-6 | |

rates used in the TMDL allocation models were based on predictions and may need to be verified before WLAs are implemented.

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 the various allowable activities of others, and control of these activities are not solely within the discretion of the permittee; and 4) they do not incorporate wastewater treatment plants that control specific pollutants to meet numeric 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 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 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 (WLA_{sw}).

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 under critical conditions. The partitioning of allocations between point (WLA) and nonpoint (LA) sources shown in Table 14 is based on modeling results and professional judgment.

5.2 Seasonal Variation

The low flow, high temperature 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:

- Critical 7Q10 flows;
- Hot summer temperatures;
- Conservative reaction rates; and

- The assumption that all point sources continuously discharge at their NPDES permit limits for the same critical period.

Table 14. TMDL Loads for the Ocmulgee River Basin under Critical Conditions

| Stream Segment | WLA (lbs/day) | WLASw (lbs/day) | LA (lbs/day) | TMDL (lbs/day) |
|---|--------------------------|----------------------------|-------------------------|---------------------------|
| Bay Creek | 316 | NA | 113 | 429 |
| Gully Creek | - | NA | 15 | 15 |
| Little Echeconnee Creek | - | NA | 131 | 131 |
| Mosquito Creek | - | NA | 382 | 382 |
| Sandy Run Creek – Headwaters to Bay Gall Creek | - | NA | 27 | 27 |
| Sandy Run Creek –Bay Gall Creek to Ocmulgee Rvr | 1,293 | NA | 207 | 1,500 |
| Tobesofkee Creek | 424 | NA | 2,425 | 2,849 |

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

NA = no storm water discharges associated with MS4s contributing to the listed segment during critical conditions

6.0 RECOMMENDATIONS

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the State each year. The 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 (GA EPD, 1996). The Ocmulgee, Oconee, and Altamaha River Basins were the basins of focused monitoring in 2004 and will again receive focused monitoring in 2009.

The revised TMDL Implementation Plans for the listed streams in the Ocmulgee River Basin will include monitoring plans which describe pertinent current or impending water quality monitoring activities, recommended future monitoring activities, and suggest procedures for coordinating those activities.

6.2 Reasonable Assurance

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. The TMDL implementation will be conducted using a phased approach. Permitted discharges will be regulated through the NPDES permitting process described in this report. The permittee may be required to perform temperature and dissolved oxygen monitoring upstream and downstream of the point source. The target WLA reduction needed may not be implemented until sufficient data has been collected to verify the model assumptions. If it is determined that the model assumptions need to be modified, the target WLA reductions will be re-evaluated based on the new data collected during critical conditions, and the TMDL will be reallocated.

The GA 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 that 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 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 period was provided for this TMDL. During that time, the availability of the TMDL was publicly noticed, a copy of the TMDL was provided upon request, and the public was invited to provide comments on the TMDL. This TMDL was modified to address the comments received.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

The GA EPD has coordinated with EPA to prepare this Initial TMDL Implementation Plan for this TMDL. The GA EPD has also established a plan and schedule for development of a more comprehensive implementation plan after this TMDL is established. The 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. NPDES permit discharges are a primary source of excessive pollutant loading, where they are a factor. 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)]. Nonpoint sources are the secondary cause of excessive pollutant loading in most cases. EPA has identified a number of management strategies for the control of nonpoint sources of pollutants, representing some BMPs. The "Management Measure Selector Table" shown below identifies these management strategies by source category and pollutant.
2. The 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. The 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 September 2009.
 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 a 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 once GA EPD approves the Revised TMDL Implementation Plan.

Management Measure Selector Table

| Land Use | Management Measures | <i>Fecal Coliform</i> | <i>Dissolved Oxygen</i> | <i>pH</i> | <i>Oxygen demanding substances</i> | <i>Temperature</i> | <i>Toxicity</i> | <i>Mercury</i> | <i>Metals (copper, lead, zinc, cadmium)</i> | <i>PCBs, toxaphene</i> |
|--------------------|--|-----------------------|-------------------------|-----------|------------------------------------|--------------------|-----------------|----------------|---|------------------------|
| 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 | — | — | — | | — | | — | | |

| Land Use | Management Measures | <i>Fecal Coliform</i> | <i>Dissolved Oxygen</i> | <i>pH</i> | <i>Oxygen demanding substances</i> | <i>Temperature</i> | <i>Toxicity</i> | <i>Mercury</i> | <i>Metals (copper, lead, zinc, cadmium)</i> | <i>PCBs, toxaphene</i> |
|------------------------------------|---|-----------------------|-------------------------|-----------|------------------------------------|--------------------|-----------------|----------------|---|------------------------|
| Urban | 1. New Development | — | — | | — | — | | | — | |
| | 2. Watershed Protection & Site Development | — | — | | — | — | | — | — | |
| | 3. Construction Site Erosion and Oxygen demanding substances 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

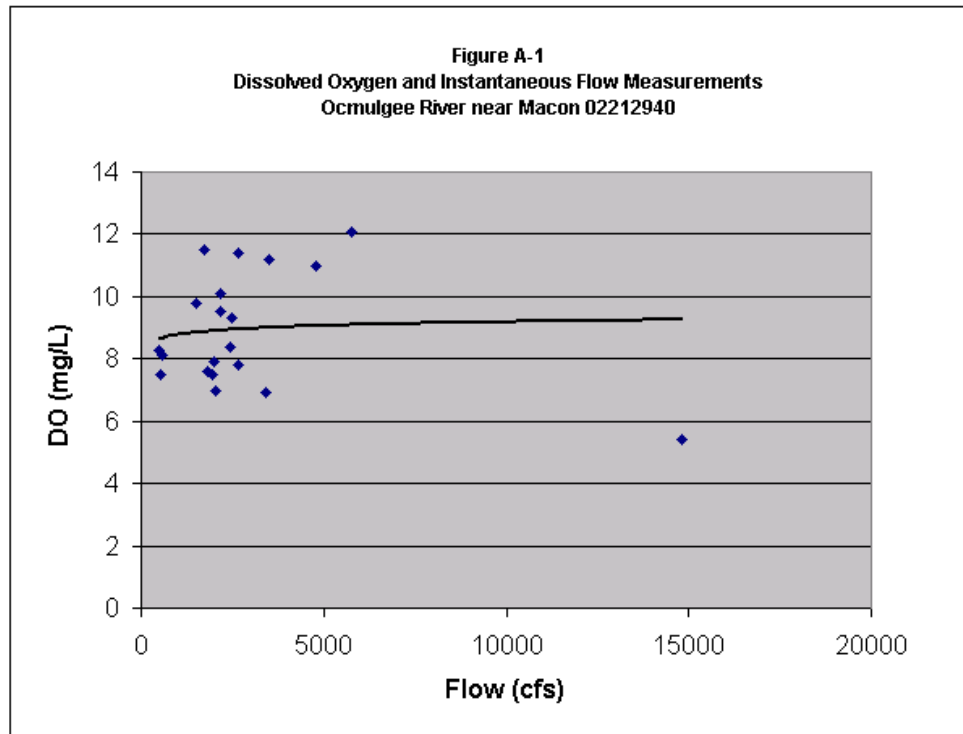


Table A-1. Data for Figure A-1

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/4/2004 | 3500 | 11.2 | 6 | | | |
| 2/11/2004 | 4800 | 11 | 8.1 | 2.5 | 0.9 | 0.06 |
| 2/18/2004 | 5770 | 12.1 | 8.8 | 2.6 | 1.2 | 0.04 |
| 2/23/2004 | 2680 | 11.4 | 9.4 | | | |
| 3/16/2004 | 2160 | 10.1 | 15.2 | 1.6 | 0.4 | 0.02 |
| 3/24/2004 | 1720 | 11.5 | 15.3 | | | |
| 3/29/2004 | 1490 | 9.8 | 19.4 | | | |
| 4/14/2004 | 2190 | 9.5 | 15 | 1.7 | 0.3 | 0.02 |
| 5/20/2004 | 1980 | 7.9 | 24.4 | 2.4 | 1 | 0.03 |
| 6/8/2004 | 571 | 8.1 | 27.2 | 2.7 | 0.1 | 0.03 |
| 6/16/2004 | 2640 | 7.8 | 25.8 | | | |
| 6/23/2004 | 3400 | 6.9 | 27.2 | | | |
| 7/7/2004 | 1970 | 7.5 | 27.7 | 2.7 | 2 | 0.1 |
| 8/11/2004 | 2040 | 7 | 25.6 | 2.9 | 2 | 0.1 |
| 8/18/2004 | 542 | 7.5 | 29.6 | | | |
| 8/25/2004 | 482 | 8.3 | 30.6 | | | |
| 9/8/2004 | 14800 | 5.4 | 26.2 | 2.8 | 2 | 0.052 |
| 10/6/2004 | 2440 | 8.4 | 25.3 | 4.1 | 2 | 0.03 |
| 11/17/2004 | 1830 | 7.6 | 17.9 | 3.6 | 2 | 0.03 |
| 12/8/2004 | 2470 | 9.3 | 17.2 | 2.9 | 1.5 | 0.084 |

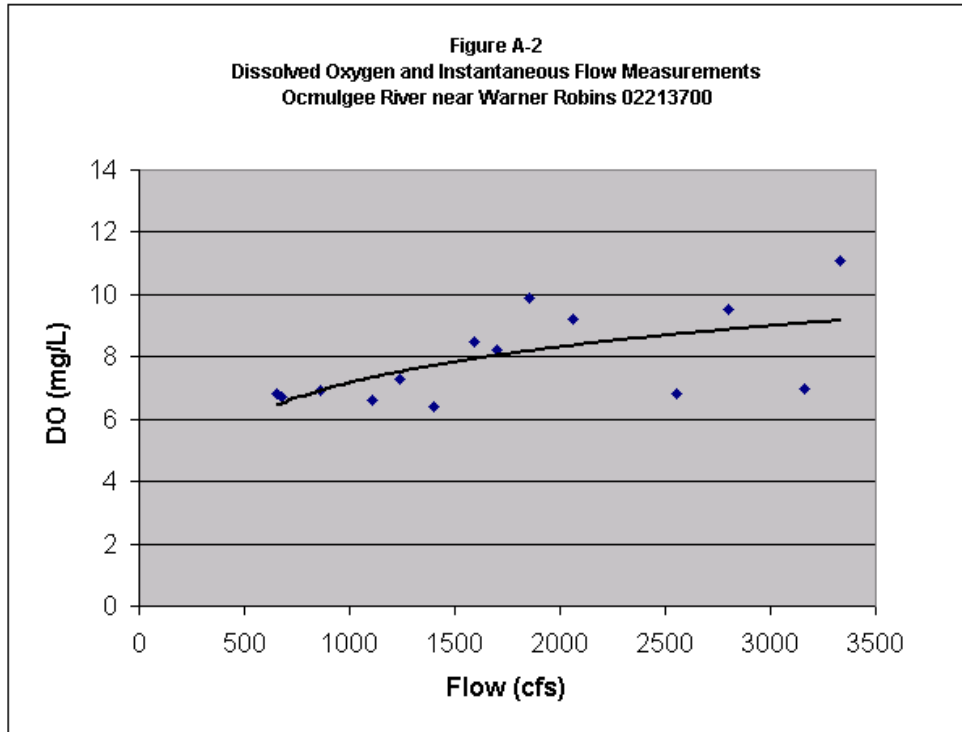


Table A-2. Data for Figure A-2

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/3/2004 | 3330 | 11.1 | 7.2 | | | |
| 2/11/2004 | | 11 | 7.6 | 3 | 0.8 | 0.05 |
| 2/18/2004 | | 11.7 | 8 | 2.7 | 1.1 | 0.04 |
| 2/23/2004 | | 10.2 | 10.2 | | | |
| 3/16/2004 | 2060 | 9.2 | 16.1 | 1.8 | 0.7 | 0.03 |
| 3/24/2004 | 1850 | 9.9 | 14.6 | | | |
| 3/29/2004 | 1590 | 8.5 | 19.7 | | | |
| 4/14/2004 | 1700 | 8.2 | 17 | 2 | 0.2 | 0.03 |
| 5/20/2004 | 1240 | 7.3 | 25 | 2.6 | 77 | 0.03 |
| 6/8/2004 | 861 | 6.9 | 27 | 3 | 0.1 | 0.03 |
| 6/16/2004 | 2550 | 6.8 | 27.2 | | | |
| 6/23/2004 | 1400 | 6.4 | 28.7 | | | |
| 7/7/2004 | 3160 | 7 | 27.5 | 3.3 | 2 | 0.1 |
| 8/11/2004 | 680 | 6.7 | 25.5 | 2.9 | 2 | 0.032 |
| 8/18/2004 | 1110 | 6.6 | 27.8 | | | |
| 8/25/2004 | 656 | 6.8 | 27.8 | | | |
| 9/8/2004 | | 5.8 | 23.8 | 5.6 | 2 | 0.034 |
| 10/6/2004 | | 7.3 | 21.8 | 4.5 | 2 | 0.03 |
| 11/17/2004 | | 9.4 | 13.2 | 3.7 | 2 | 0.03 |
| 12/8/2004 | 2800 | 9.5 | 14.1 | 3.4 | 2 | 0.03 |

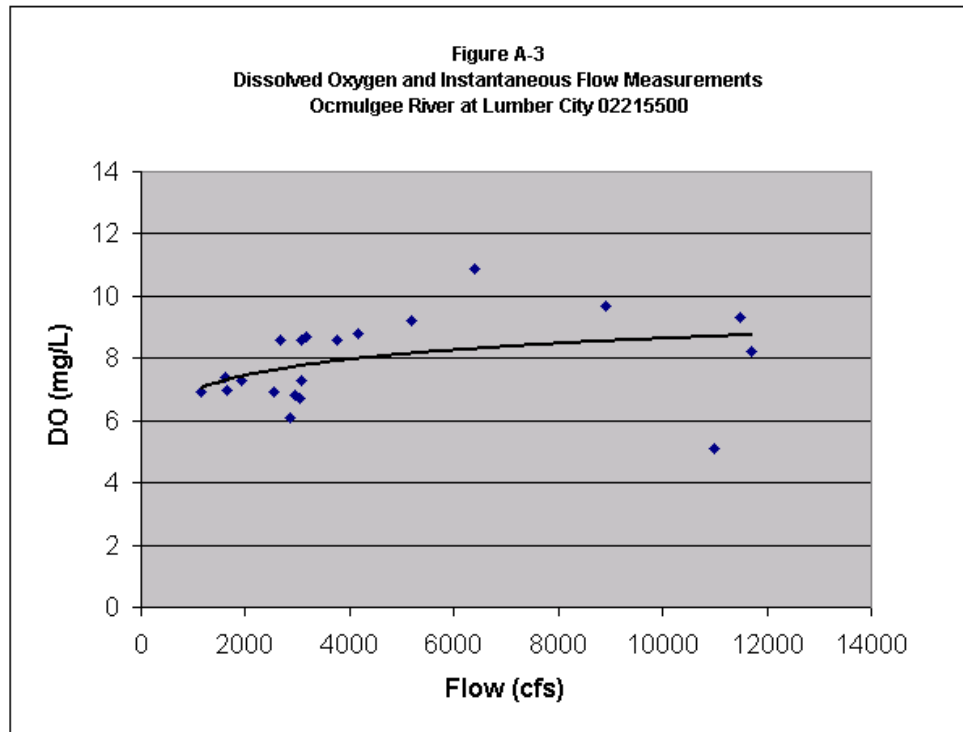


Table A.3. Data for Figure A-3

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/5/2004 | 6390 | 10.9 | 7.8 | 4.6 | 0.9 | 0.02 |
| 2/26/2004 | 11500 | 9.3 | 10.7 | 3.6 | 1.2 | 0.02 |
| 3/4/2004 | 8920 | 9.7 | 13 | | | |
| 3/18/2004 | 4170 | 8.8 | 16 | | | |
| 3/23/2004 | 3770 | 8.6 | 16.5 | 2.5 | 0.8 | 0.02 |
| 4/1/2004 | 3060 | 8.6 | 17.4 | | | |
| 4/8/2004 | 3170 | 8.7 | 17.8 | | | |
| 4/15/2004 | 2680 | 8.6 | 16.8 | 2.1 | 0.3 | 0.03 |
| 5/19/2004 | 1910 | 7.3 | 25.9 | 2 | 0.2 | 0.02 |
| 6/17/2004 | 1620 | 7.4 | 29.5 | 2.7 | 1.4 | 0.01 |
| 6/22/2004 | 3050 | 6.7 | 28.4 | | | |
| 6/24/2004 | 2960 | 6.8 | 28.2 | | | |
| 7/15/2004 | 2870 | 6.1 | 30.1 | 3.2 | 0.2 | 0.1 |
| 8/19/2004 | 2540 | 6.9 | 27.6 | 2.7 | 0.2 | 0.038 |
| 8/26/2004 | 1640 | 7 | 28.4 | | | |
| 9/1/2004 | 1140 | 6.9 | 28.5 | | | |
| 9/16/2004 | 11000 | 5.1 | 24.2 | 11 | 1.3 | 0.1 |
| 10/21/2004 | 3070 | 7.3 | 21.3 | 5.4 | 2 | 0.06 |
| 11/17/2004 | 5180 | 9.2 | 13.8 | 3.6 | 2 | 0.1 |
| 12/9/2004 | 11700 | 8.2 | 14.4 | 5.9 | 1.8 | 0.1 |

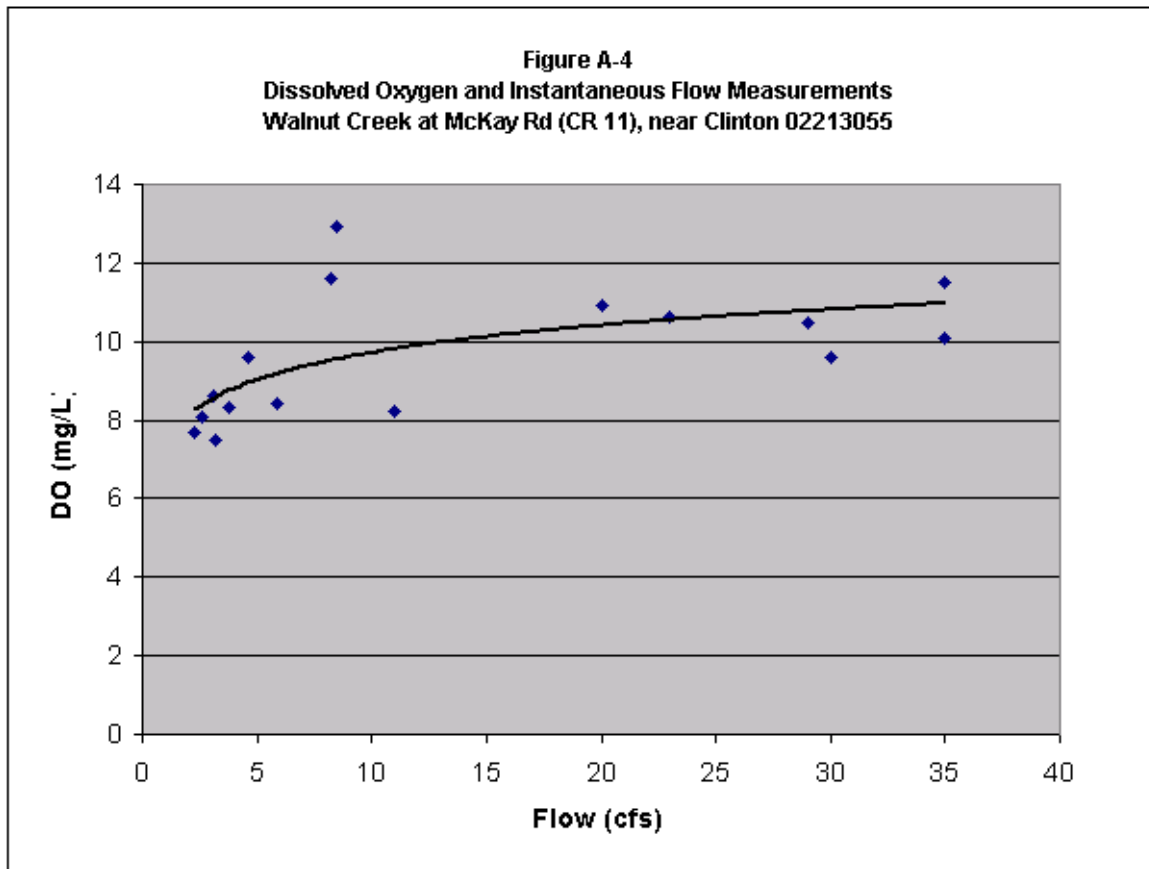


Table A.4. Data for Figure A-4

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 3/2/2004 | 23 | 10.6 | 15.3 |
| 3/3/2004 | 20 | 10.9 | 13.5 |
| 3/18/2004 | 8.2 | 11.6 | 9.7 |
| 3/23/2004 | 8.5 | 12.9 | 11.8 |
| 5/6/2004 | 4.6 | 9.6 | 18.2 |
| 5/12/2004 | 3.8 | 8.3 | 23 |
| 5/20/2004 | 5.9 | 8.4 | 19.9 |
| 5/26/2004 | 3.1 | 8.6 | 23.2 |
| 8/4/2004 | 2.3 | 7.7 | 21.2 |
| 5/12/2004 | 11 | 8.2 | 22.1 |
| 8/19/2004 | 3.2 | 7.5 | 22.6 |
| 8/23/2004 | 2.6 | 8.1 | 23.8 |
| 11/18/2004 | 35 | 11.5 | 9.3 |
| 11/22/2004 | 29 | 10.5 | 15.6 |
| 12/1/2004 | 35 | 10.1 | 13.5 |
| 12/8/2004 | 30 | 9.6 | 15.5 |

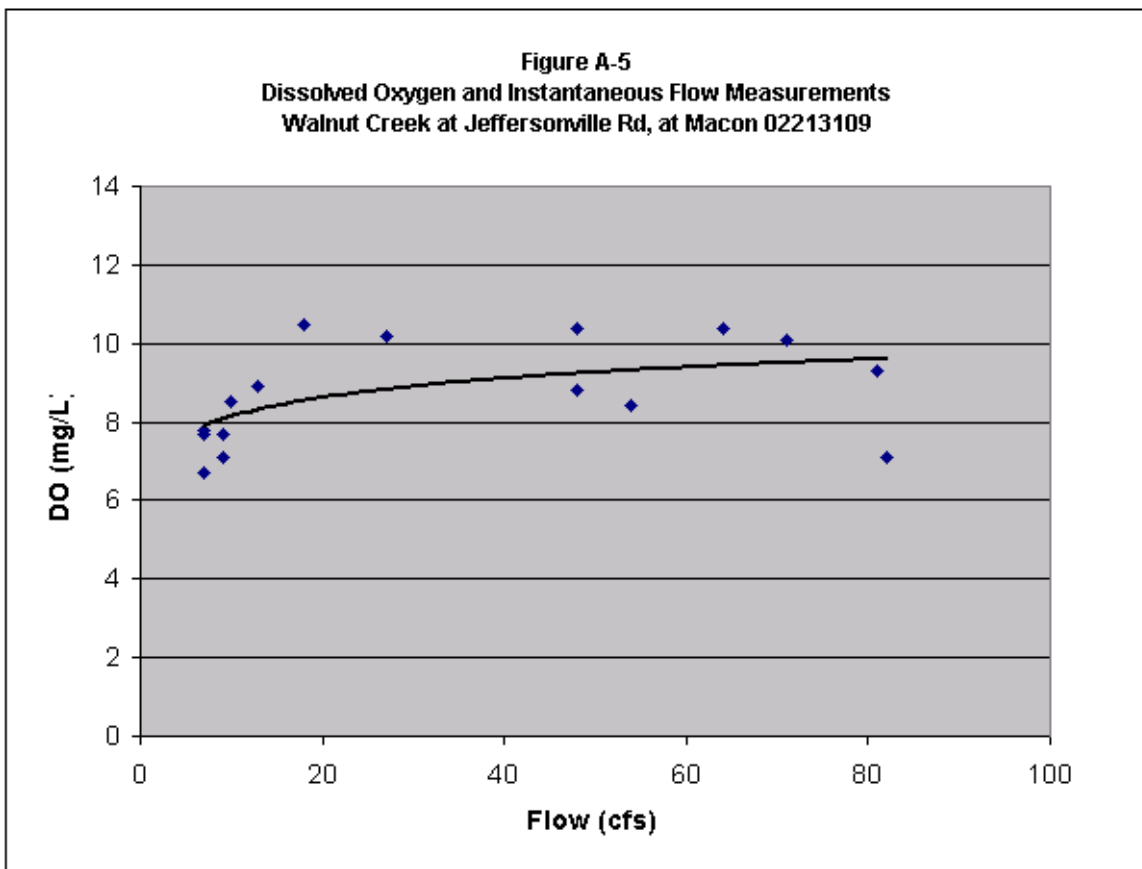


Table A-5. Data for Figure A-5

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 3/2/2004 | 71 | 10.1 | 15.8 |
| 3/3/2004 | 64 | 10.4 | 13.7 |
| 3/18/2004 | 27 | 10.2 | 11.2 |
| 3/23/2004 | 18 | 10.5 | 15 |
| 5/6/2004 | 10 | 8.5 | 19.4 |
| 5/13/2004 | 7 | 7.7 | 25.8 |
| 5/20/2004 | 9 | 7.7 | 21.1 |
| 5/26/2004 | 7 | 7.8 | 24.5 |
| 8/4/2004 | 7 | 6.7 | 24.8 |
| 5/12/2004 | 82 | 7.1 | 23.3 |
| 8/19/2004 | 13 | 8.9 | 23.1 |
| 8/23/2004 | 9 | 7.1 | 24.2 |
| 11/17/2004 | 48 | 10.4 | 12.4 |
| 11/22/2004 | 48 | 8.8 | 16.4 |
| 12/1/2004 | 81 | 9.3 | 13.1 |
| 12/8/2004 | 54 | 8.4 | 15.9 |

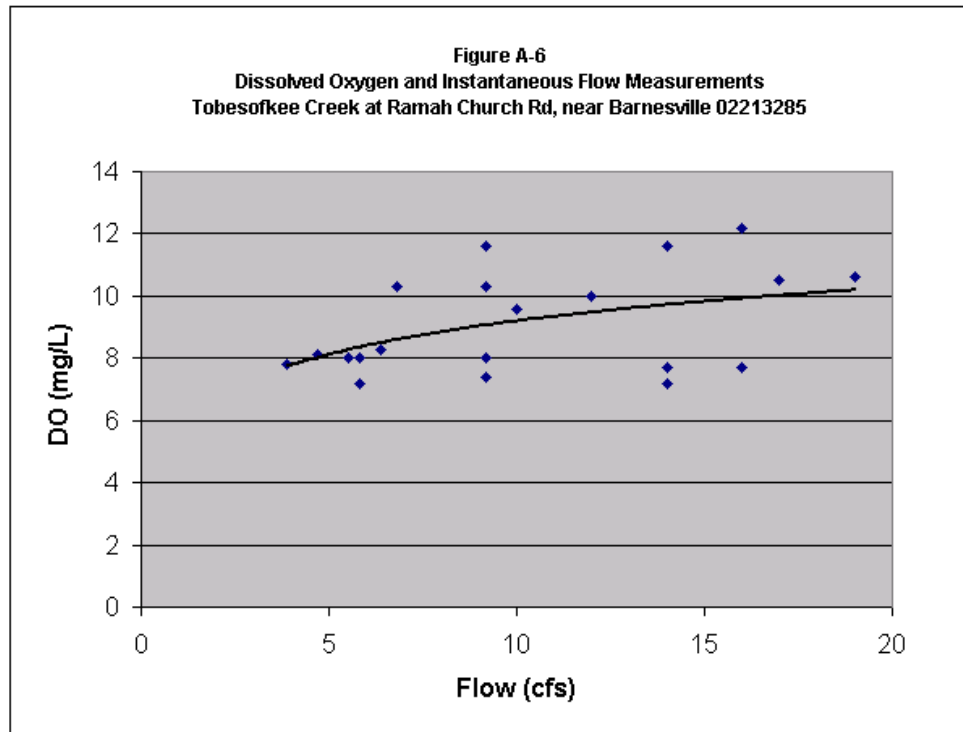


Table A-6. Data for Figure A-6

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/4/2004 | 14 | 11.6 | 6.2 | | | |
| 2/12/2004 | 19 | 10.6 | 8.9 | 6 | 8.2 | 1.8 |
| 2/19/2004 | 16 | 12.2 | 6.8 | 2.5 | 1.8 | 9 |
| 2/24/2004 | 17 | 10.5 | 10.1 | | | |
| 3/17/2004 | 12 | 10 | 12.2 | 1.9 | 1.1 | 0.08 |
| 3/25/2004 | 9.2 | 11.6 | 10.9 | | | |
| 3/29/2004 | 10 | 9.6 | 15.2 | | | |
| 4/15/2004 | 9.2 | 10.3 | 11.2 | 2.2 | 1.1 | 0.09 |
| 5/20/2004 | 6.4 | 8.3 | 19.7 | 2.8 | 1.5 | 0.06 |
| 6/9/2004 | 3.9 | 7.8 | 21.4 | 3.7 | 8.1 | 0.05 |
| 6/15/2004 | 9.2 | 8 | 23.3 | | | |
| 6/17/2004 | 9.2 | 7.4 | 22.4 | | | |
| 6/24/2004 | 16 | 7.7 | 22.1 | | | |
| 7/8/2004 | 14 | 7.2 | 22.1 | 5.7 | 3.3 | 0.52 |
| 8/11/2004 | 5.8 | 7.2 | 21.5 | 3.8 | 1.6 | 0.054 |
| 8/19/2004 | 5.5 | 8 | 21.2 | | | |
| 8/25/2004 | 4.7 | 8.1 | 24 | | | |
| 9/9/2004 | 14 | 7.7 | 21.1 | 4.5 | 2.7 | 0.28 |
| 10/7/2004 | 5.8 | 8 | 18.7 | 4.3 | 2 | 0.03 |
| 11/18/2004 | 6.8 | 10.3 | 10.8 | 3.4 | 2.0 | 0.2 |
| 12/9/2004 | 10.0 | 11.0 | 14.1 | 3.4 | 2.9 | 0.3 |

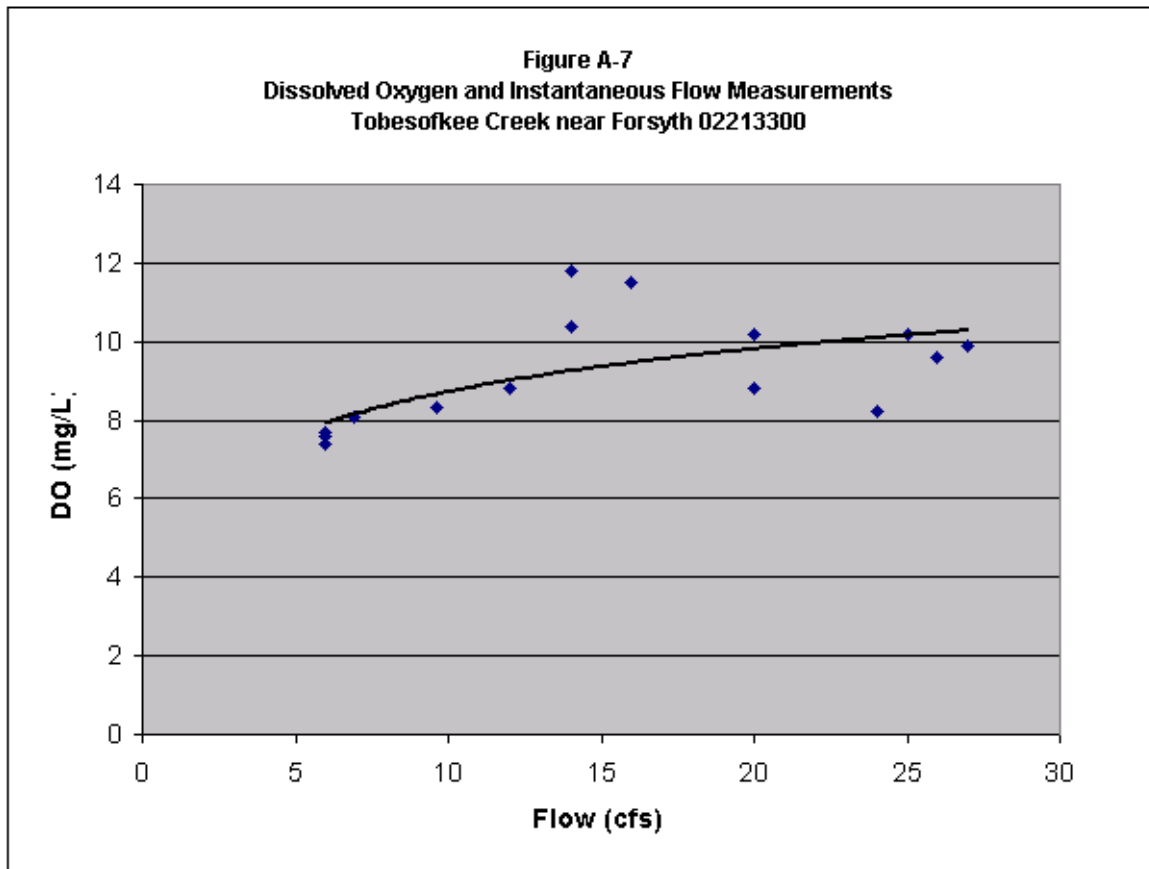


Table A-7. Data for Figure A-7

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 3/2/2004 | 27 | 9.9 | 14.2 |
| 3/3/2004 | 26 | 9.6 | 14.9 |
| 3/18/2004 | 20 | 10.2 | 10.7 |
| 3/23/2004 | 16 | 11.5 | 8 |
| 5/6/2004 | 12 | 8.8 | 15.6 |
| 5/13/2004 | 24 | 8.2 | 19.5 |
| 5/19/2004 | 9.6 | 8.3 | 22.2 |
| 5/27/2004 | 6.9 | 8.1 | 20.2 |
| 8/4/2004 | 6 | 7.4 | 23.9 |
| 5/12/2004 | 6 | 7.6 | 22.4 |
| 8/18/2004 | 6 | 7.7 | 24.6 |
| 8/23/2004 | 6 | 7.4 | 22.6 |
| 11/18/2004 | 14 | 10.4 | 10.1 |
| 11/22/2004 | 14 | 11.8 | 15.7 |
| 12/2/2004 | 25 | 10.2 | 9 |
| 12/8/2004 | 20 | 8.8 | 14.7 |

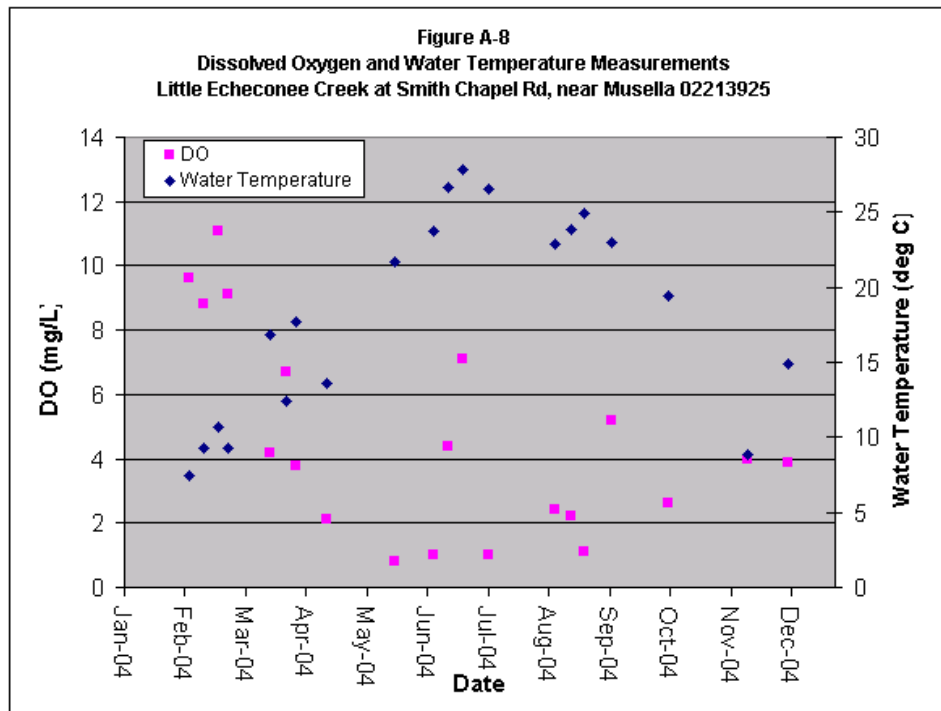


Table A-8. Data for Figure A-8

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/3/2004 | | 9.6 | 7.4 | | | |
| 2/11/2004 | | 8.8 | 9.3 | 4.4 | 0.9 | 0.05 |
| 2/18/2004 | | 11.1 | 10.7 | 4.4 | 1 | 0.02 |
| 2/23/2004 | | 9.1 | 9.3 | | | |
| 3/16/2004 | | 4.2 | 16.8 | 3.8 | 1.9 | 0.03 |
| 3/24/2004 | | 6.7 | 12.4 | | | |
| 3/29/2004 | | 3.8 | 17.7 | | | |
| 4/14/2004 | | 2.1 | 13.6 | 5.5 | 1.3 | 0.02 |
| 5/19/2004 | | 0.8 | 21.7 | 6.5 | 3.6 | 0.11 |
| 6/8/2004 | | 1 | 23.7 | 8.7 | 0.1 | 0.27 |
| 6/16/2004 | | 4.4 | 26.7 | | | |
| 6/23/2004 | | 7.1 | 27.8 | | | |
| 7/7/2004 | | 1 | 26.6 | 7.7 | 3.7 | 0.068 |
| 8/10/2004 | | 2.4 | 22.9 | 13 | 14 | 0.1 |
| 8/18/2004 | | 2.2 | 23.9 | | | |
| 8/25/2004 | | 1.1 | 24.9 | | | |
| 9/8/2004 | | 5.2 | 23 | 9.7 | 2 | 0.038 |
| 10/7/2004 | | 2.6 | 19.4 | 9.1 | 2 | 0.04 |
| 11/17/2004 | | 4 | 8.8 | 7.2 | 2 | 0.03 |
| 12/8/2004 | | 3.9 | 14.9 | 5.5 | 1.5 | 0.048 |

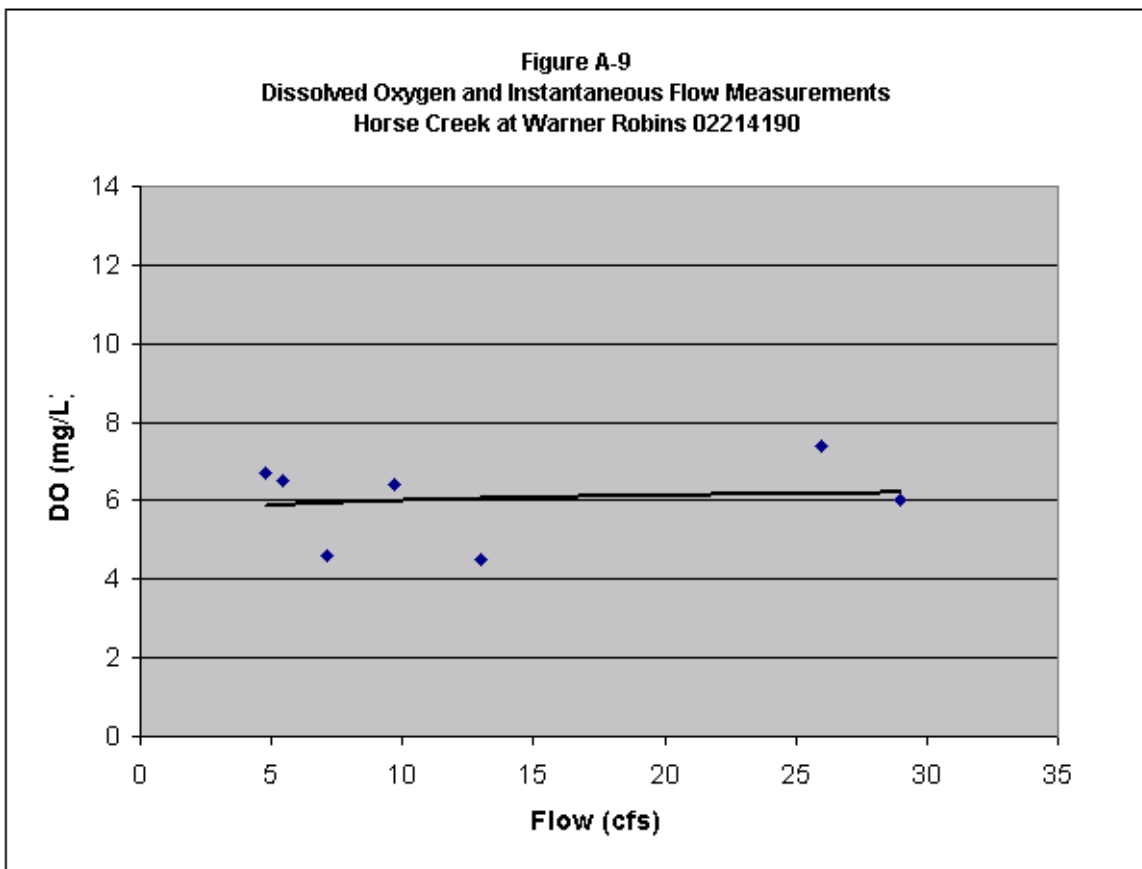


Table A.9. Data for Figure A-9

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/18/2004 | | 10.9 | 9.1 |
| 3/2/2004 | | 9.8 | 12.5 |
| 3/9/2004 | | 7.7 | 14.2 |
| 3/16/2004 | 9.7 | 6.4 | 18.3 |
| 7/23/2004 | 7.1 | 4.6 | 23.8 |
| 7/22/2004 | 5.4 | 6.5 | 22.8 |
| 7/29/2004 | 29 | 6 | 23.1 |
| 8/10/2004 | 4.8 | 6.7 | 21.4 |
| 9/14/2004 | | 5.7 | 22.9 |
| 9/23/2004 | | 5.8 | 20.5 |
| 9/30/2004 | | 4.4 | 21.6 |
| 10/5/2004 | | 6.4 | 21.2 |
| 11/2/2004 | 13 | 4.5 | 20.8 |
| 11/9/2004 | | 5.8 | 16.1 |
| 11/15/2004 | | 8.4 | 11.8 |
| 11/17/2004 | 26 | 7.4 | 12.7 |

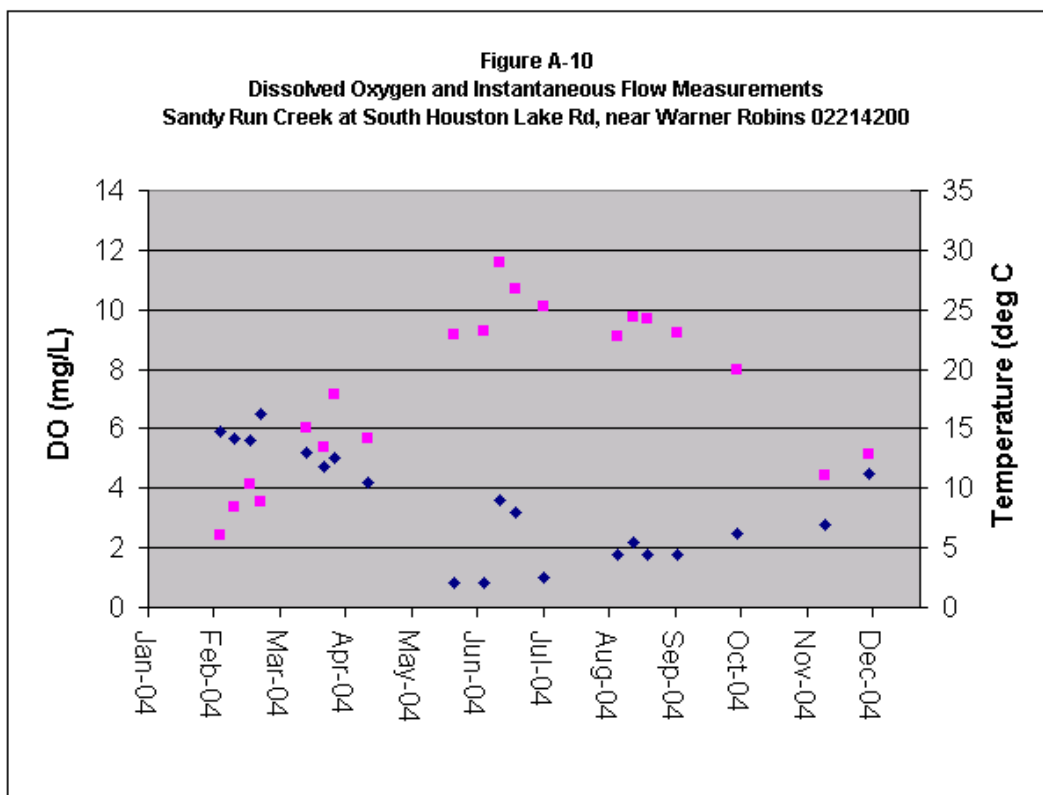


Table A-10. Data for Figure A-10

| Date | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/4/2004 | 5.9 | 6.1 | | | |
| 2/11/2004 | 5.7 | 8.4 | 4.7 | 0.6 | 0.05 |
| 2/18/2004 | 5.6 | 10.3 | 4.5 | 1.1 | 0.06 |
| 2/23/2004 | 6.5 | 8.8 | | | |
| 3/16/2004 | 5.2 | 15.1 | 3.9 | 1.2 | 0.04 |
| 3/24/2004 | 4.7 | 13.5 | | | |
| 3/29/2004 | 5 | 17.8 | | | |
| 4/14/2004 | 4.2 | 14.2 | 5.9 | 1.4 | 0.06 |
| 5/25/2004 | 0.8 | 22.9 | 10 | 2.2 | 0.97 |
| 6/8/2004 | 0.8 | 23.2 | 12 | 0.1 | 0.55 |
| 6/16/2004 | 3.6 | 29 | | | |
| 6/23/2004 | 3.2 | 26.7 | | | |
| 7/7/2004 | 1 | 25.3 | 9.5 | 4.3 | 0.42 |
| 8/11/2004 | 1.8 | 22.8 | 9 | 3.2 | 0.23 |
| 8/18/2004 | 2.2 | 24.4 | | | |
| 8/25/2004 | 1.8 | 24.2 | | | |
| 9/8/2004 | 1.8 | 23.1 | 8.5 | 2 | 0.046 |
| 10/6/2004 | 2.5 | 20 | 16 | 2 | 0.21 |
| 11/17/2004 | 2.8 | 11.1 | 6.5 | 2 | 0.17 |
| 12/8/2004 | 4.5 | 12.9 | 5.6 | 1.2 | 0.098 |

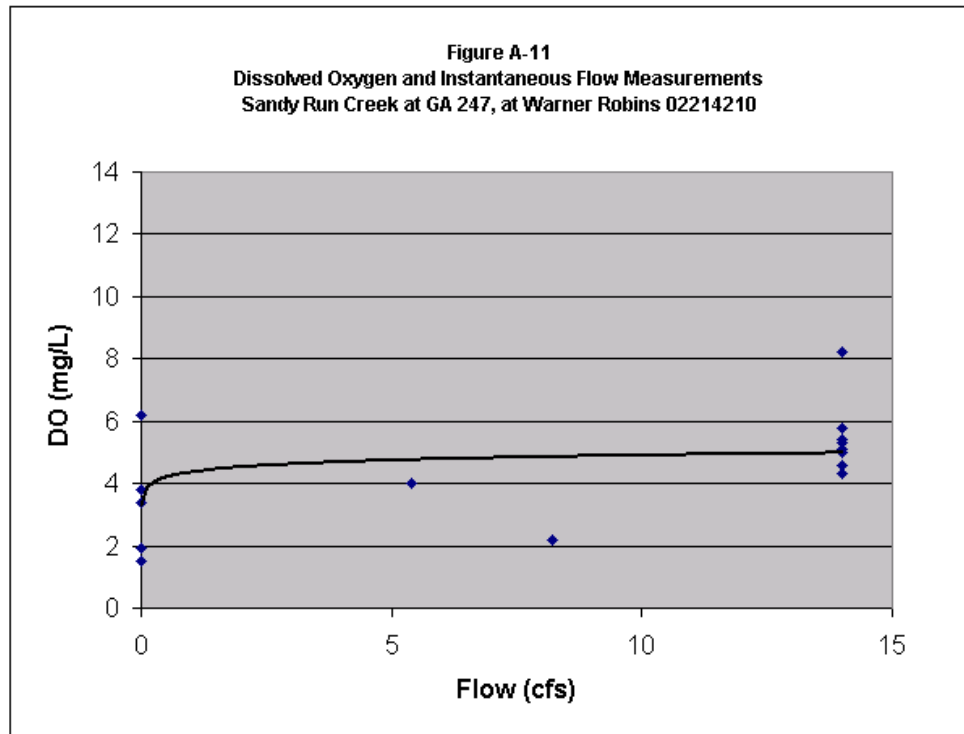


Table A-11. Data for Figure A-11

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/4/2004 | 14 | 5.8 | | | | |
| 2/11/2004 | 14 | 5 | 9.6 | 4.3 | 5.8 | 2.1 |
| 2/18/2004 | 14 | 8.2 | 20.4 | 3.8 | 3 | 0.32 |
| 2/23/2004 | 14 | 5.1 | 13.1 | | | |
| 3/16/2004 | 0.01 | 1.9 | 17.3 | 4.4 | 2.9 | 4.3 |
| 3/24/2004 | 0.01 | 6.2 | 21.7 | | | |
| 3/29/2004 | 14 | 4.6 | 24.6 | | | |
| 4/14/2004 | 8.2 | 2.2 | 7.6 | 5.3 | 3.7 | 3.4 |
| 5/20/2004 | 14 | 4.3 | 30.2 | 5.7 | 4.5 | 0.23 |
| 6/8/2004 | 0.01 | | 27 | | | |
| 6/16/2004 | 0.01 | | 32.5 | | | |
| 6/23/2004 | 0.01 | | | | | |
| 7/7/2004 | 0.01 | 1.5 | 31 | 5.9 | 20 | 3 |
| 8/11/2004 | 14 | 4.6 | 25.3 | 13 | 19 | 0.54 |
| 8/18/2004 | 14 | 5.3 | 32.5 | | | |
| 8/25/2004 | 0.01 | 3.8 | 27.1 | | | |
| 9/8/2004 | 14 | 5.4 | 24.6 | 6.4 | 2 | 0.12 |
| 10/6/2004 | 14 | 4.6 | 23.1 | 8.4 | 2 | 0.2 |
| 11/17/2004 | 0.01 | 3.4 | 18.4 | 7 | 4 | 1.5 |
| 12/8/2004 | 5.4 | 4 | 21.2 | 5.6 | 3.7 | 0.17 |

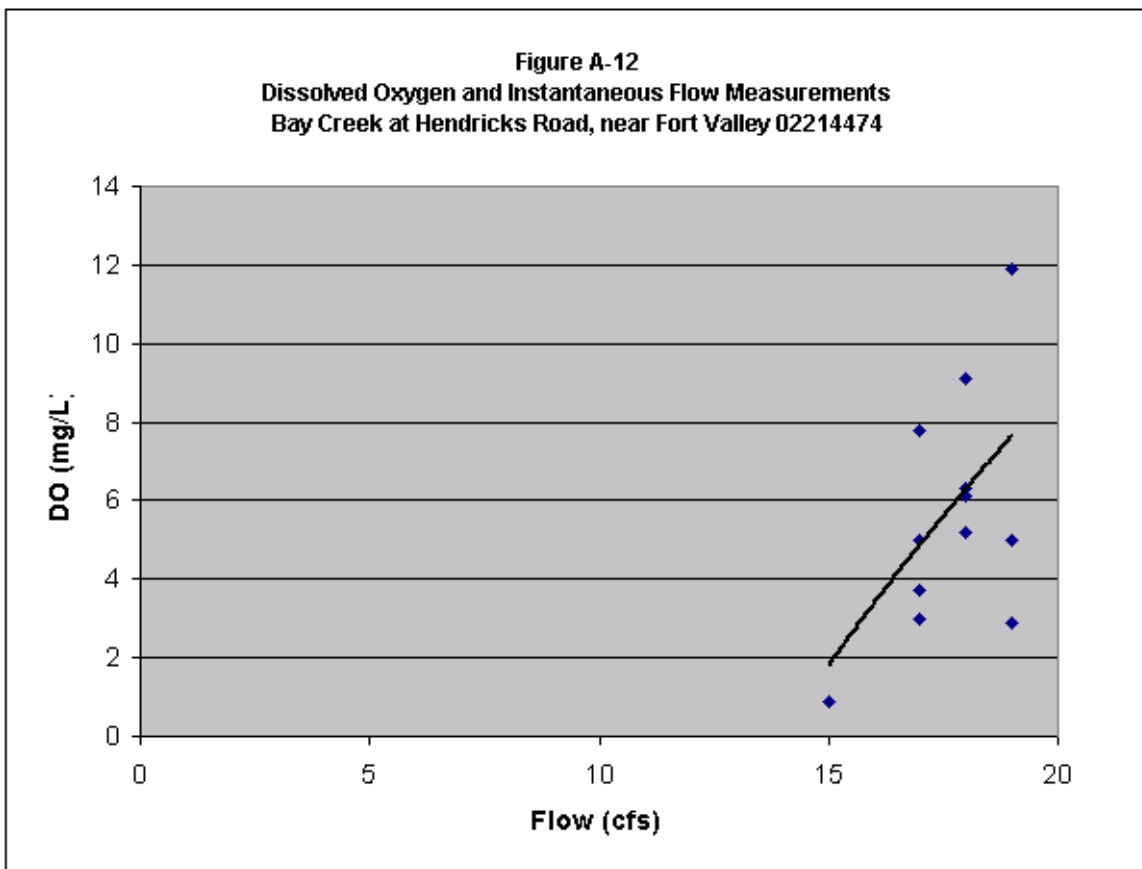


Table A-12. Data for Figure A-12

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/18/2004 | 18 | 9.1 | 9.2 |
| 3/2/2004 | 17 | 7.8 | 13.2 |
| 3/9/2004 | 18 | 9.1 | 11.9 |
| 3/16/2004 | 18 | 5.2 | 17.2 |
| 7/13/2004 | 15 | 0.9 | 26.3 |
| 7/22/2004 | | | |
| 7/29/2004 | | | |
| 8/10/2004 | | | |
| 9/14/2004 | 17 | 3 | 22.3 |
| 9/23/2004 | 17 | 3.7 | 19.4 |
| 9/30/2004 | 17 | 5 | 20 |
| 10/5/2004 | 18 | 6.1 | 20.5 |
| 11/2/2004 | 19 | 2.9 | 20.4 |
| 11/9/2004 | 19 | 11.9 | 14.8 |
| 11/15/2004 | 19 | 5 | 10.9 |
| 11/17/2004 | 18 | 6.3 | 10 |

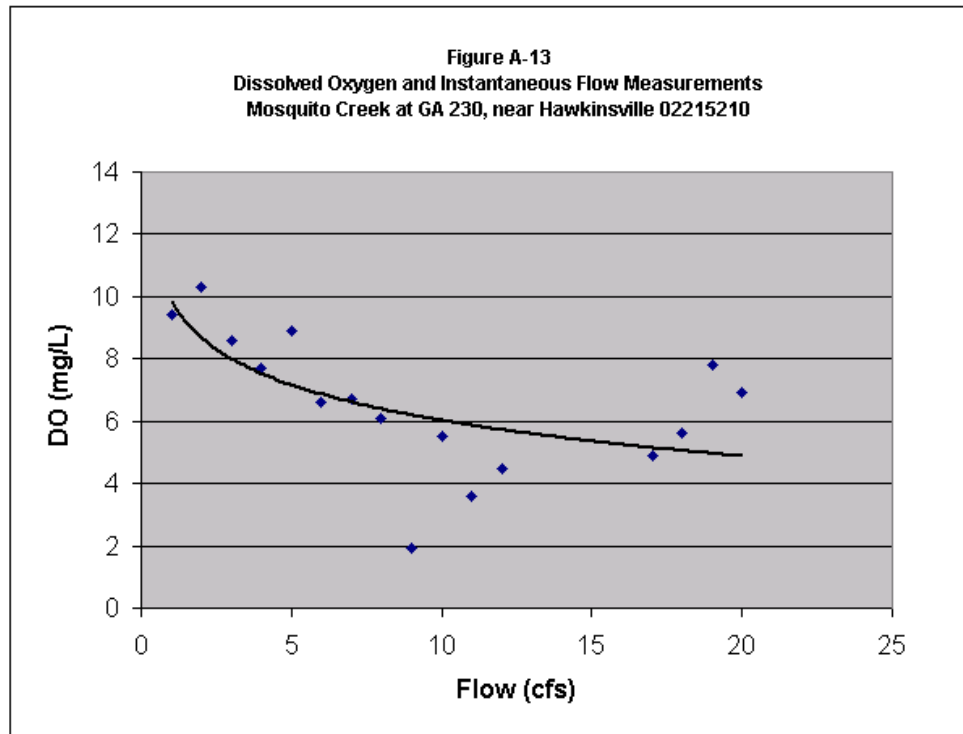


Table A-13. Data for Figure A-13

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/5/2004 | 12 | 9.4 | 8.2 | 3.9 | 0.7 | 0.03 |
| 2/26/2004 | 12 | 10.3 | 7.3 | 4.7 | 0.9 | 0.02 |
| 3/3/2004 | 12 | 8.6 | 14.9 | | | |
| 3/17/2004 | 7.7 | 7.7 | 15.1 | | | |
| 3/23/2004 | 5.7 | 8.9 | 13.5 | 4.6 | 1.4 | 0.04 |
| 3/31/2004 | 7 | 6.6 | 16.2 | | | |
| 4/7/2004 | 7.2 | 6.7 | 13.8 | | | |
| 4/15/2004 | 5.3 | 6.1 | 12.3 | 5.2 | 0.7 | 0.11 |
| 5/18/2004 | 1.1 | 1.9 | 22.7 | 6.8 | 2.1 | 0.5 |
| 6/16/2004 | 12 | 5.5 | 24.9 | 13 | 1.2 | 0.03 |
| 6/22/2004 | 9 | 3.6 | 23.9 | | | |
| 6/24/2004 | 9.4 | 4.5 | 23.6 | | | |
| 7/15/2004 | | | | | | |
| 8/18/2004 | | | | | | |
| 8/25/2004 | | | | | | |
| 8/31/2004 | | | | | | |
| 9/16/2004 | 12 | 4.9 | 24.2 | 12 | 2 | 0.1 |
| 10/21/2004 | 12 | 5.6 | 18.8 | 10 | 2 | 0.03 |
| 11/16/2004 | 3.6 | 7.8 | 10.8 | 6.3 | 2 | 0.068 |
| 12/8/2004 | 12 | 6.9 | 16.5 | 7 | 2.1 | 0.046 |

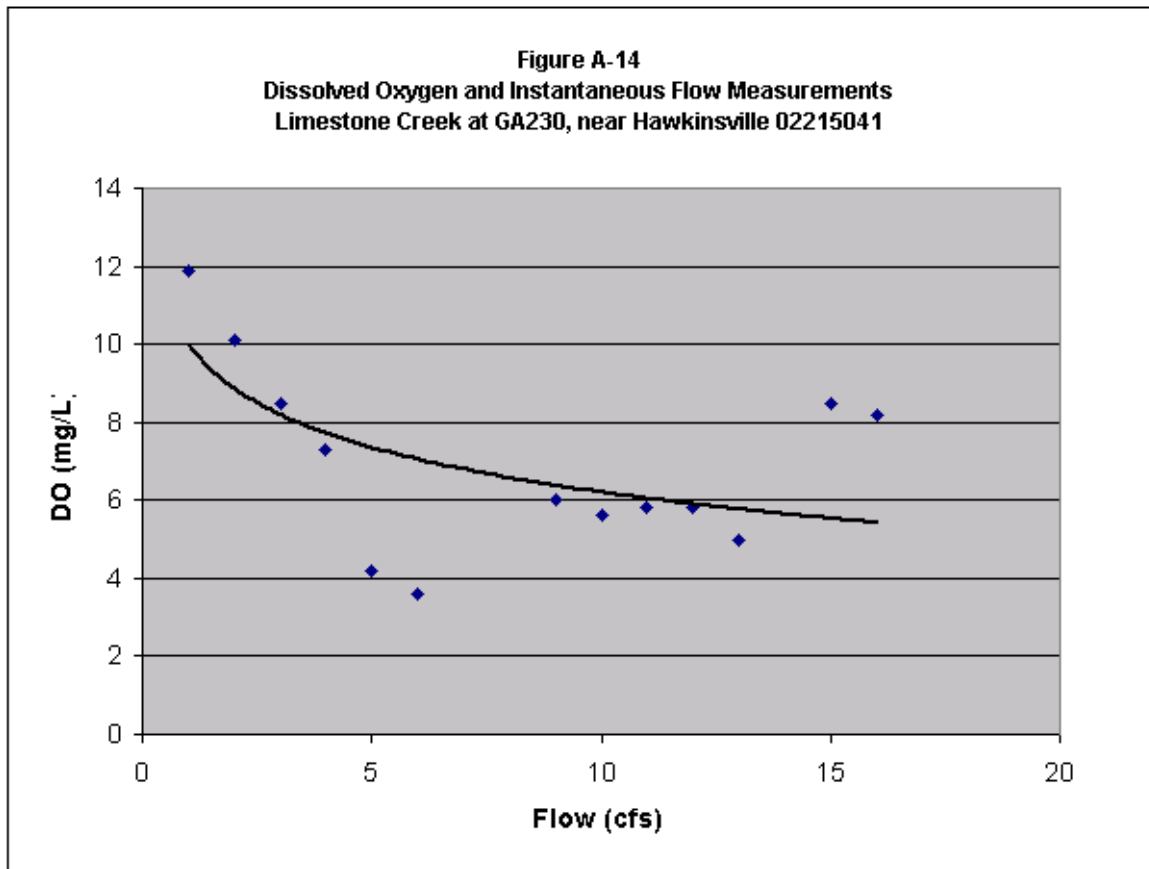


Table A-14. Data for Figure A-14

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/18/2004 | 35 | 11.9 | 6.6 |
| 3/2/2004 | 35 | 10.1 | 13.4 |
| 3/9/2004 | 35 | 8.5 | 14 |
| 3/16/2004 | 26 | 7.3 | 16.8 |
| 7/13/2004 | 0.2 | 4.2 | 26.4 |
| 7/22/2004 | 0.2 | 3.6 | 24.1 |
| 7/29/2004 | | | |
| 8/10/2004 | | | |
| 9/14/2004 | 35 | 6 | 23 |
| 9/23/2004 | 35 | 5.6 | 19.9 |
| 9/30/2004 | 35 | 5.8 | 22.5 |
| 10/5/2004 | 35 | 5.8 | 21.6 |
| 11/2/2004 | 13 | 5 | 21.1 |
| 11/9/2004 | 12 | | 15.4 |
| 11/15/2004 | 8.4 | 8.5 | 11.6 |
| 11/17/2004 | 6.2 | 8.2 | 11.2 |

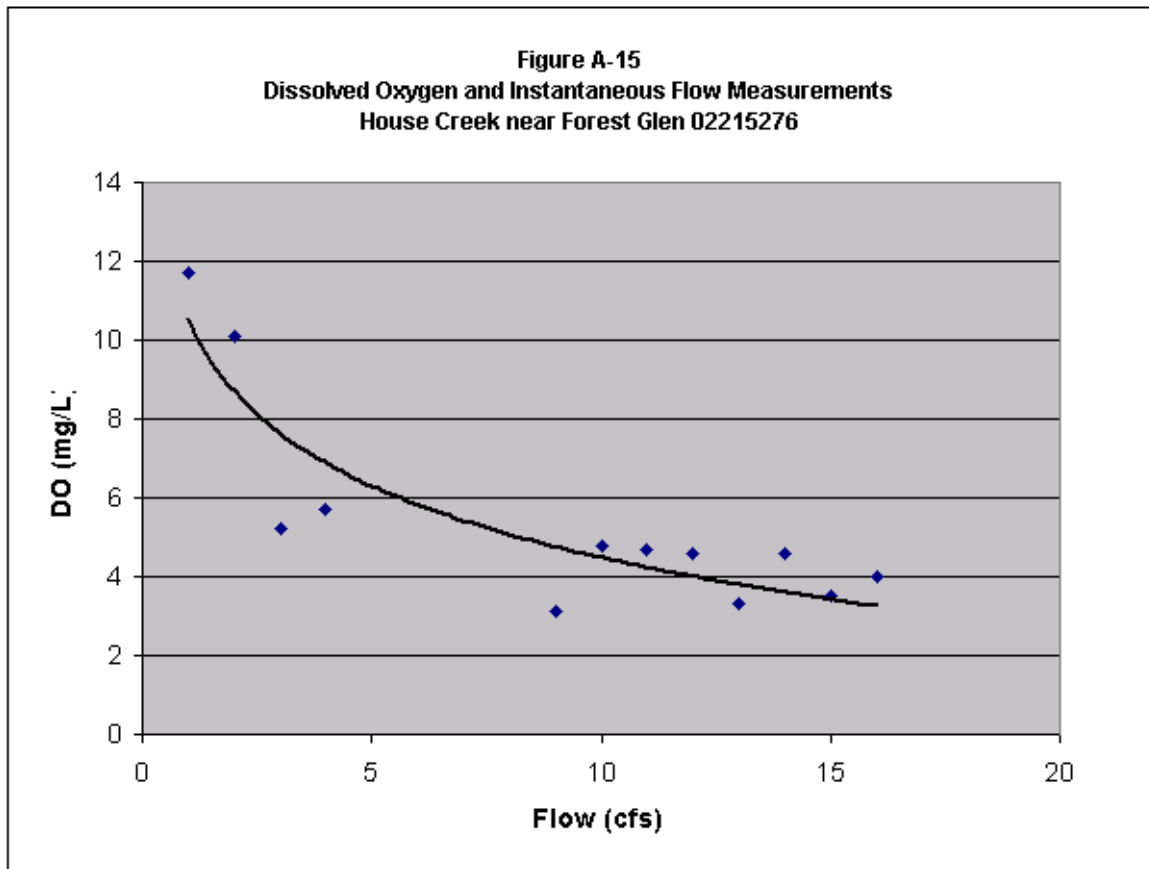


Table A-15. Data for Figure A-15

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/17/2004 | 127 | 11.7 | 8.6 |
| 3/1/2004 | 14 | 10.1 | 10.8 |
| 3/8/2004 | 2.8 | 5.2 | 14.7 |
| 3/15/2004 | 1.1 | 5.7 | 15.2 |
| 7/12/2004 | | | |
| 7/21/2004 | | | |
| 7/28/2004 | | | |
| 8/9/2004 | | | |
| 9/13/2004 | 3.8 | 3.1 | 23.3 |
| 9/22/2004 | 3.1 | 4.8 | 19.9 |
| 9/29/2004 | 127 | 4.7 | 22.5 |
| 10/4/2004 | 23 | 4.6 | 22.1 |
| 11/1/2004 | 0.3 | 3.3 | 18.9 |
| 11/8/2004 | 0.3 | 4.6 | 13.1 |
| 12/16/2004 | 0.2 | 3.5 | 9.8 |
| 12/18/2004 | 0.1 | 4 | 10 |

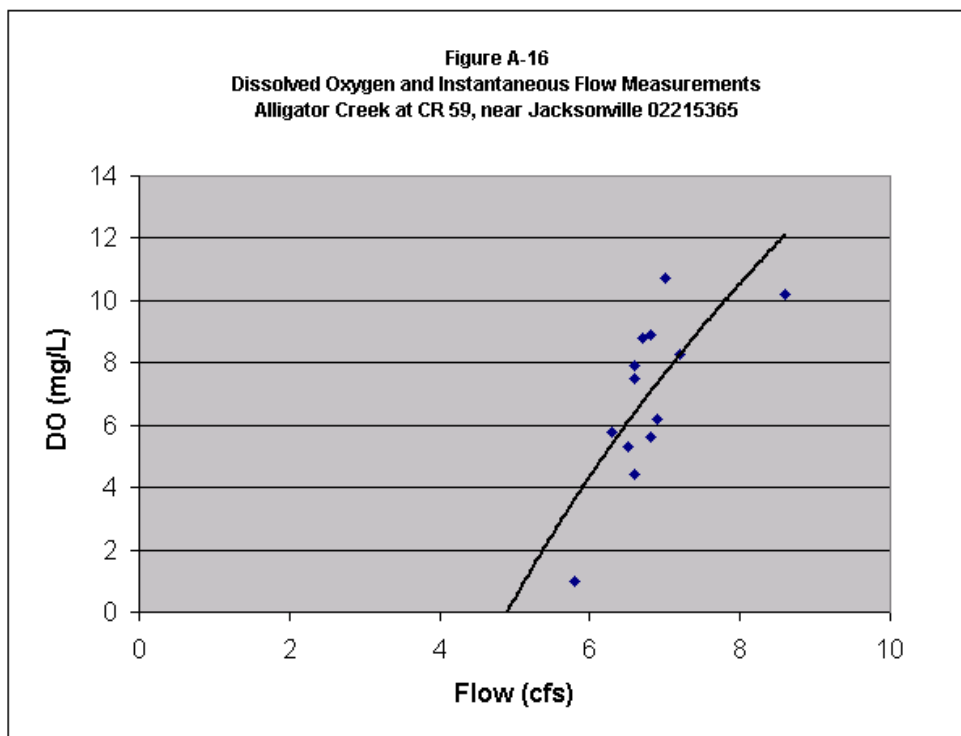


Table A-16. Data for Figure A-16

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/5/2004 | 7 | 10.7 | 7.4 | 9.3 | 0.8 | 0.02 |
| 2/26/2004 | 8.6 | 10.2 | 7.7 | 12 | 0.5 | 0.03 |
| 3/4/2004 | 7.2 | 8.3 | 16.2 | | | |
| 3/18/2004 | 6.8 | 8.9 | 13 | | | |
| 3/23/2004 | 6.7 | 8.8 | 10.8 | 13 | 1.8 | 0.03 |
| 4/1/2004 | 6.6 | 7.5 | 13.7 | | | |
| 4/8/2004 | 6.3 | 5.8 | 15.7 | | | |
| 4/14/2004 | 6.5 | 5.3 | 14.3 | 14 | 1.1 | 0.11 |
| 5/19/2004 | 5.8 | 1 | 23.2 | 16 | 4.5 | 0.2 |
| 6/17/2004 | | | | | | |
| 6/22/2004 | | | | | | |
| 6/24/2004 | | | | | | |
| 7/15/2004 | | | | | | |
| 8/19/2004 | | | | | | |
| 8/25/2004 | | | | | | |
| 8/31/2004 | 4.6 | | | | | |
| 9/16/2004 | 6.6 | 4.4 | 24.1 | 28 | 3 | 0.1 |
| 10/21/2004 | 6.8 | 5.6 | 18.9 | 24 | 2 | 0.04 |
| 11/17/2004 | 6.6 | 7.9 | 10 | 16 | 2.2 | 0.023 |
| 12/9/2004 | 6.9 | 6.2 | 17 | 19 | 2.6 | 0.024 |

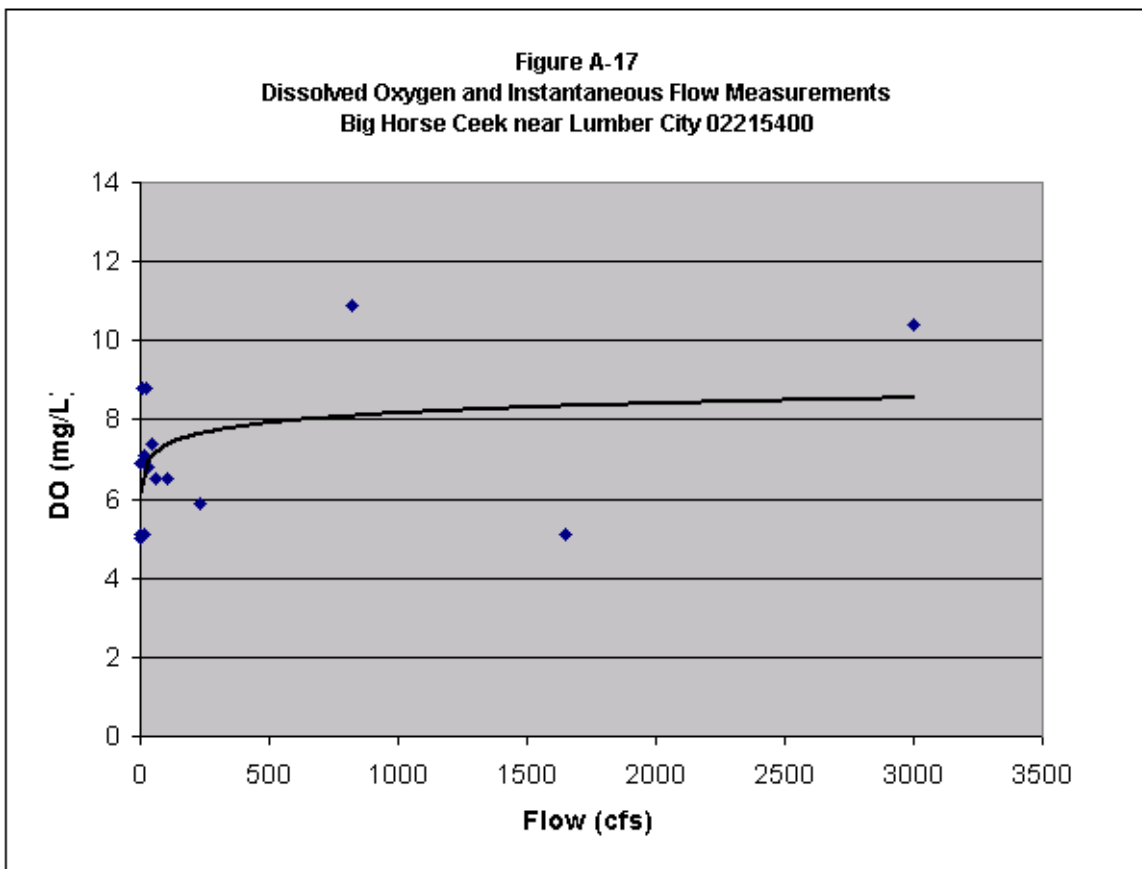


Table A-17. Data for Figure A-17

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/17/2004 | 820 | 10.9 | 9 |
| 3/1/2004 | 3000 | 10.4 | 10.3 |
| 3/8/2004 | 107 | 6.5 | 16 |
| 3/15/2004 | 48 | 7.4 | 15 |
| 7/12/2004 | 2.6 | 5.1 | 24.8 |
| 7/21/2004 | 15 | 5.1 | 27.6 |
| 7/28/2004 | 2.6 | 5 | 24.4 |
| 8/9/2004 | 2.6 | 6.9 | 22.2 |
| 9/13/2004 | | 6.8 | 23.8 |
| 9/22/2004 | 57 | 6.5 | 20.3 |
| 9/29/2004 | 1650 | 5.1 | 22.5 |
| 10/4/2004 | 231 | 5.9 | 22.6 |
| 11/1/2004 | 28 | 6.8 | 19.8 |
| 11/8/2004 | 16 | 7.1 | 14.4 |
| 12/16/2004 | 19 | 8.8 | 11.5 |
| 12/18/2004 | 8.3 | 8.8 | 11.2 |

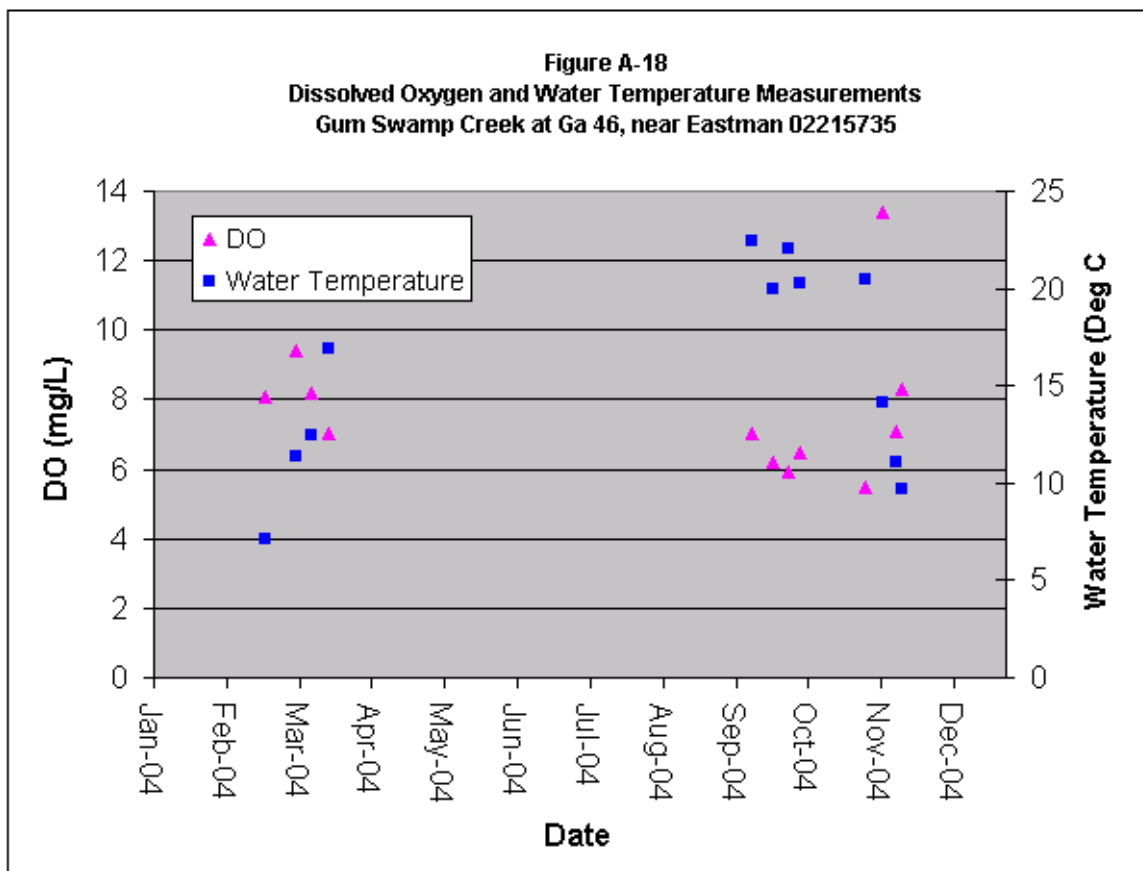


Table A-18. Data for Figure A-18

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/18/2004 | 130 | 8.1 | 7.1 |
| 3/2/2004 | 130 | 9.4 | 11.4 |
| 3/9/2004 | 130 | 8.2 | 12.5 |
| 3/16/2004 | 130 | 7 | 16.9 |
| 7/13/2004 | | | |
| 7/22/2004 | | | |
| 7/29/2004 | | | |
| 8/10/2004 | | | |
| 9/14/2004 | 130 | 7 | 22.4 |
| 9/23/2004 | 130 | 6.2 | 20 |
| 9/30/2004 | 130 | 5.9 | 22 |
| 10/5/2004 | 130 | 6.5 | 20.3 |
| 11/2/2004 | 130 | 5.5 | 20.5 |
| 11/9/2004 | 130 | 13.4 | 14.1 |
| 11/15/2004 | 130 | 7.1 | 11.1 |
| 11/17/2004 | 130 | 8.3 | 9.7 |

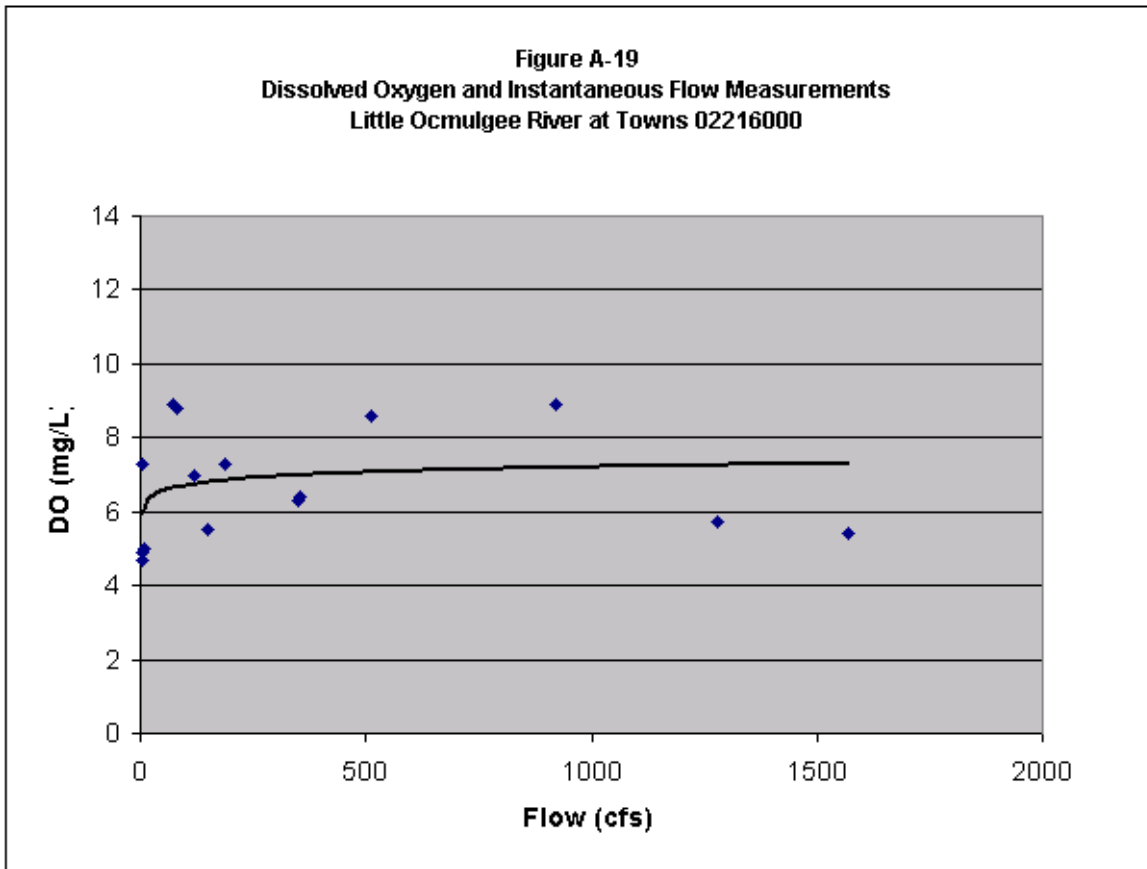


Table A-19. Data for Figure A-19

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/17/2004 | 919 | 8.9 | 9.2 |
| 3/1/2004 | 512 | 8.6 | 10.8 |
| 3/8/2004 | 356 | 6.4 | 16.7 |
| 3/15/2004 | 187 | 7.3 | 16.2 |
| 7/12/2004 | 8.5 | 5 | 26.8 |
| 7/21/2004 | 4.3 | 4.9 | 24.7 |
| 7/28/2004 | 3.6 | 4.7 | 26.2 |
| 8/9/2004 | 2.6 | 7.3 | 24.1 |
| 9/13/2004 | | 4.5 | 23.7 |
| 9/22/2004 | 351 | 6.3 | 21 |
| 9/29/2004 | 1570 | 5.4 | 22.5 |
| 10/4/2004 | 1280 | 5.7 | 22.6 |
| 11/1/2004 | 150 | 5.5 | 20.6 |
| 11/8/2004 | 119 | 7 | 15.5 |
| 12/16/2004 | 80 | 8.8 | 11.4 |
| 12/18/2004 | 71 | 8.9 | 11.2 |

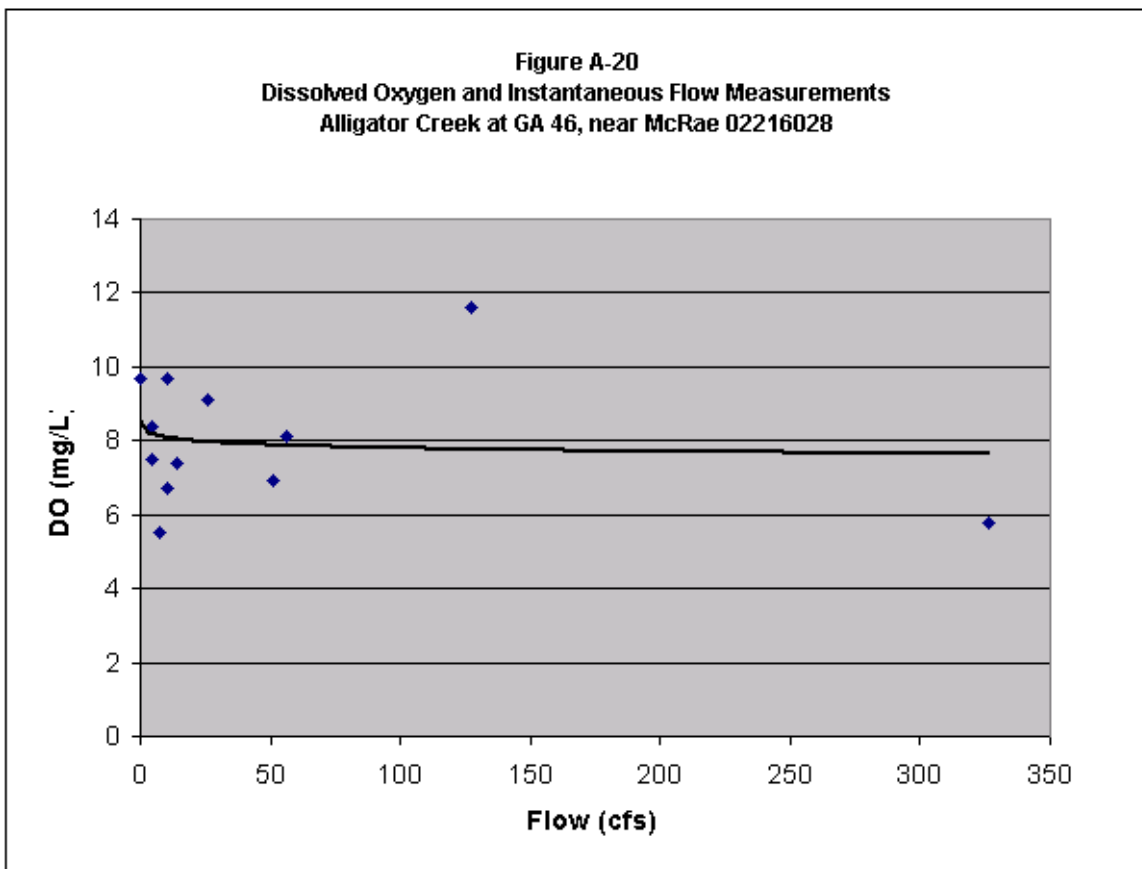


Table A-20. Data for Figure A-20

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/18/2004 | 127 | 11.6 | 5.9 |
| 3/2/2004 | 10 | 9.7 | 11.6 |
| 3/9/2004 | 26 | 9.1 | 11 |
| 3/16/2004 | 14 | 7.4 | 16.7 |
| 7/13/2004 | | | |
| 7/22/2004 | | | |
| 7/29/2004 | | | |
| 8/10/2004 | | | |
| 9/14/2004 | 56 | 8.1 | 21.9 |
| 9/23/2004 | 10 | 6.7 | 19.2 |
| 9/30/2004 | 326 | 5.8 | 21.8 |
| 10/5/2004 | 51 | 6.9 | 19.6 |
| 11/2/2004 | 7.7 | 5.5 | 19.9 |
| 11/9/2004 | 4.5 | 7.5 | 13.2 |
| 11/15/2004 | 4.2 | 8.4 | 10.3 |
| 11/17/2004 | 0.3 | 9.7 | 8.6 |

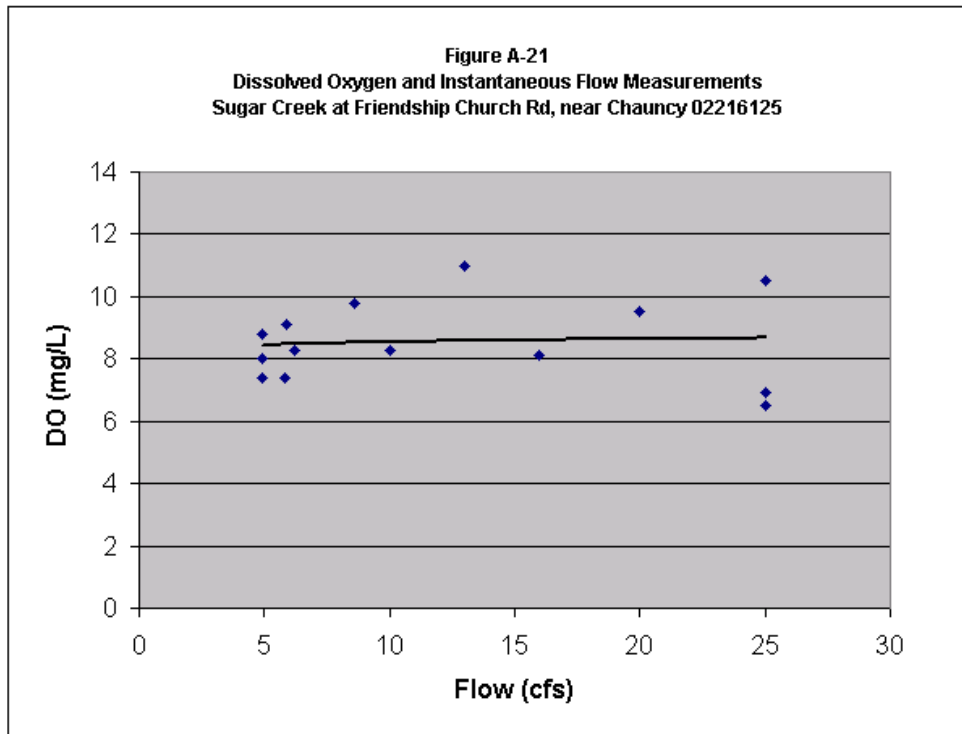


Table A-21. Data for Figure A-21

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/5/2004 | 13 | 11 | 7.5 | 5.5 | 0.5 | 0.02 |
| 2/26/2004 | 25 | 10.5 | 7.8 | 5.2 | 1.7 | 0.02 |
| 3/3/2004 | 20 | 9.5 | 14.6 | | | |
| 3/17/2004 | 10 | 8.3 | 16.4 | | | |
| 3/23/2004 | 5.9 | 9.1 | 13.8 | 6.5 | 1.2 | 0.05 |
| 3/31/2004 | 4.9 | 8 | 17.4 | | | |
| 4/7/2004 | 4.9 | 8.8 | 14.3 | | | |
| 4/15/2004 | 6.2 | 8.3 | 12.7 | 7.9 | 0.6 | 0.1 |
| 5/18/2004 | | | | | | |
| 6/16/2004 | | | | | | |
| 6/22/2004 | | | | | | |
| 6/24/2004 | | | | | | |
| 7/15/2004 | | | | | | |
| 8/18/2004 | 5.8 | 7.4 | 24 | 10 | 2.1 | 0.038 |
| 8/25/2004 | 4.9 | 7.4 | 24 | | | |
| 8/31/2004 | | | | | | |
| 9/16/2004 | 25 | 6.5 | 23.8 | 13 | 2 | 0.1 |
| 10/21/2004 | 25 | 6.9 | 18.7 | 13 | 2 | 0.03 |
| 11/17/2004 | 8.6 | 9.8 | 10.5 | 9.2 | 2 | 0.1 |
| 12/8/2004 | 16 | 8.1 | 16.2 | 9 | 2 | 0.024 |

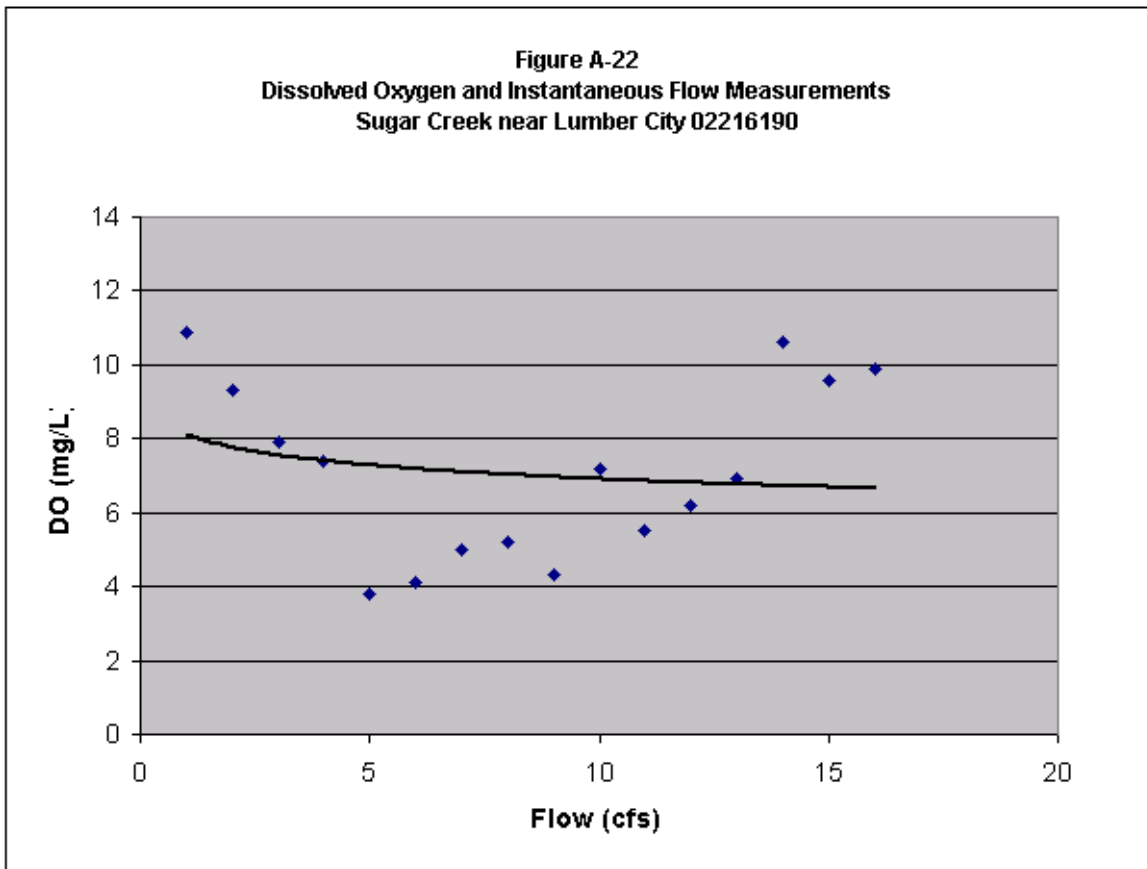


Table A-22. Data for Figure A-22

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/17/2004 | 1120 | 10.9 | 8.8 |
| 3/1/2004 | 338 | 9.3 | 10.4 |
| 3/8/2004 | 106 | 7.9 | 15.6 |
| 3/15/2004 | 55 | 7.4 | 15.4 |
| 7/12/2004 | 1.5 | 3.8 | 25.1 |
| 7/21/2004 | 1.4 | 4.1 | 22.4 |
| 7/28/2004 | 1.3 | 5 | 23.6 |
| 8/9/2004 | 1.3 | 5.2 | 21.2 |
| 9/13/2004 | | 4.3 | 23.4 |
| 9/22/2004 | 103 | 7.2 | 19.9 |
| 9/29/2004 | 1800 | 5.5 | 22.3 |
| 10/4/2004 | 536 | 6.2 | 22.3 |
| 11/1/2004 | 309 | 6.9 | 19.4 |
| 11/8/2004 | 420 | 10.6 | 13.9 |
| 12/16/2004 | 31 | 9.6 | 10.7 |
| 12/18/2004 | 25 | 9.9 | 10.3 |

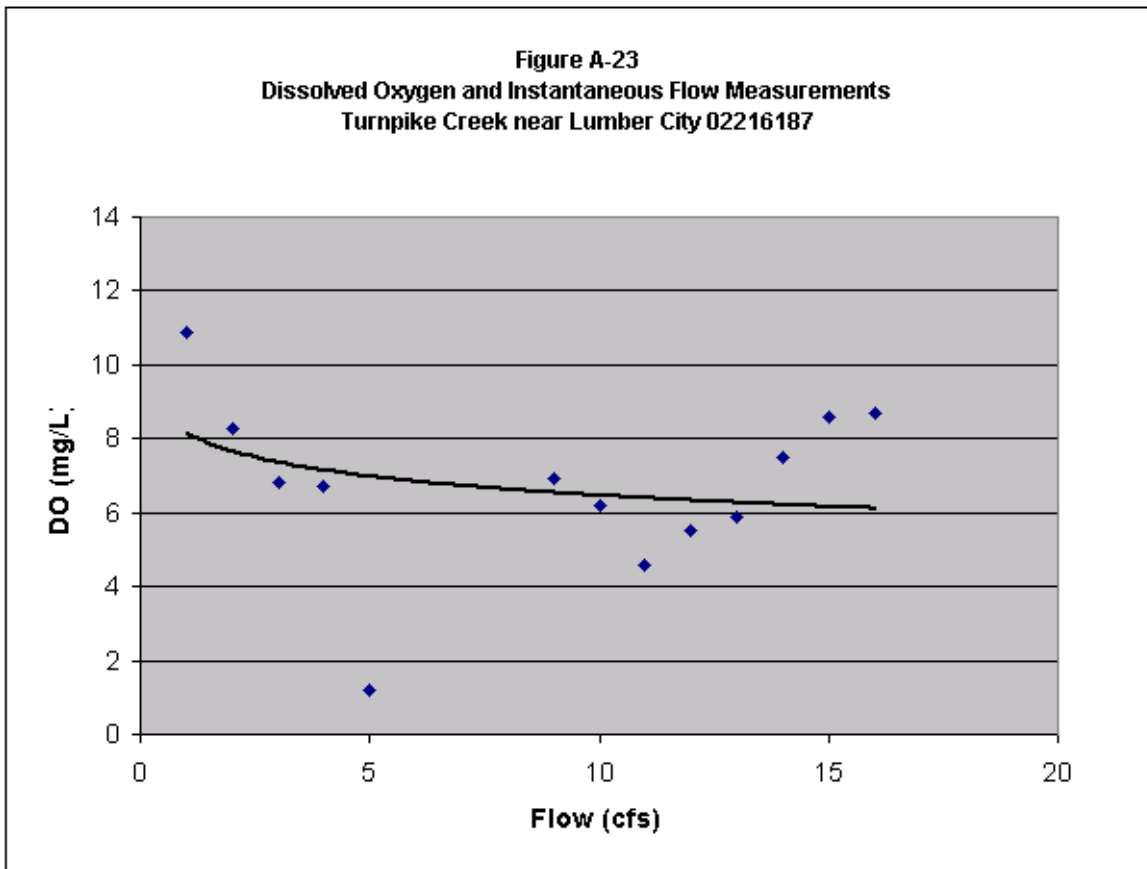


Table A-23. Data for Figure A-23

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) |
|------------|--|-------------------------|---------------------------|
| 2/17/2004 | 417 | 10.9 | 8.6 |
| 3/1/2004 | 158 | 8.3 | 10.7 |
| 3/8/2004 | 48 | 6.8 | 14.7 |
| 3/15/2004 | 25 | 6.7 | 15.5 |
| 7/12/2004 | 3.5 | 1.2 | 25.6 |
| 7/21/2004 | | | |
| 7/28/2004 | | | |
| 8/9/2004 | | | |
| 9/13/2004 | | 6.9 | 23.4 |
| 9/22/2004 | 43 | 6.2 | 19.8 |
| 9/29/2004 | 720 | 4.6 | 22.3 |
| 10/4/2004 | 134 | 5.5 | 21.8 |
| 11/1/2004 | 17 | 5.9 | 19.3 |
| 11/8/2004 | 21 | 7.5 | 13.6 |
| 12/16/2004 | 18 | 8.6 | 9.8 |
| 12/18/2004 | 13 | 8.7 | 19.8 |

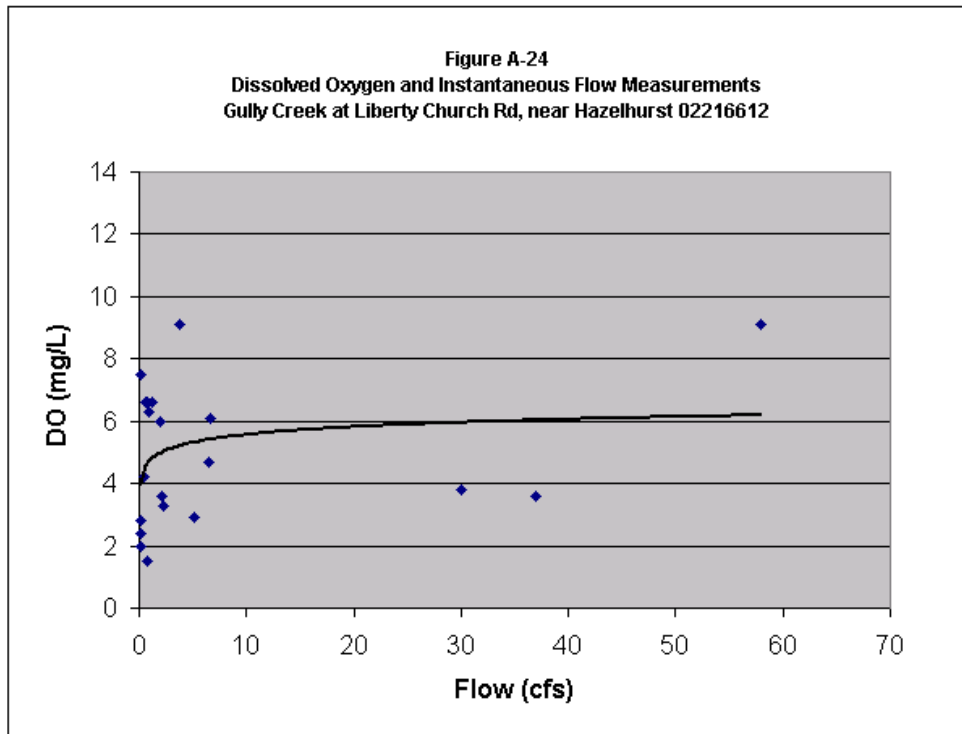


Table A-24. Data for Figure A-24

| Date | Instantaneous Flow on Sample Day (cfs) | Dissolved Oxygen (mg/L) | Water Temperature (deg C) | TOC (mg/L) | BOD ₅ (mg/L) | Ammonia (mg/L) |
|------------|--|-------------------------|---------------------------|------------|-------------------------|----------------|
| 2/5/2004 | 3.8 | 9.1 | 7.7 | 11 | 0.6 | 0.02 |
| 2/26/2004 | 58 | 9.1 | 8.1 | 11 | 1.6 | 0.03 |
| 3/4/2004 | 6.6 | 6.1 | 16.1 | | | |
| 3/18/2004 | 1.9 | 6 | 13.6 | | | |
| 3/23/2004 | 0.77 | 6.6 | 11.2 | 16 | 1.8 | 0.02 |
| 4/1/2004 | 0.58 | 6.6 | 14 | | | |
| 4/8/2004 | 0.2 | 7.5 | 16.1 | | | |
| 4/15/2004 | 0.88 | 6.3 | 12.1 | 17 | 0.8 | 0.04 |
| 5/19/2004 | 0.16 | 2.8 | 22.4 | 17 | 1.5 | 0.04 |
| 6/17/2004 | 0.1 | 2 | 25.8 | 13 | 2 | 0.2 |
| 6/22/2004 | 0.44 | 4.2 | 24.8 | | | |
| 6/24/2004 | 2.3 | 3.3 | 24.6 | | | |
| 7/15/2004 | 0.1 | 2.4 | 27.5 | 25 | 3.3 | 0.047 |
| 8/19/2004 | 30 | 3.8 | 23.8 | 20 | 2 | 0.039 |
| 8/26/2004 | 5.2 | 2.9 | 24.4 | | | |
| 9/1/2004 | 0.68 | 1.5 | 25.1 | | | |
| 9/16/2004 | 37 | 3.6 | 24.2 | 25 | 2 | 0.1 |
| 10/21/2004 | 2.1 | 3.6 | 20.6 | 28 | 2 | 0.03 |
| 11/17/2004 | 1.2 | 6.6 | 9.8 | 16 | 2.3 | 0.024 |
| 12/9/2004 | 6.5 | 4.7 | 16.9 | 17 | 1.8 | 0.024 |

APPENDIX B
Model Structure

B-1. Ohoopsee Creek Model Structure – Watershed Designation

| Reach Type | Reach Name | Reach Length (mile) | Drainage Area (mi ²) | Elevation Change(ft) |
|---|---|---------------------|----------------------------------|----------------------|
| Upper Ocmulgee River – Main Branch | | | | |
| | Headwaters | | 2215 | |
| 1 S | GA Power Plant Arkwright to USGS 02212940 | 3.05 | 23.9 | 16.5 |
| 2 S | UGS 02212940 to 5th Str Bridge Gage | 6 | 21 | 20 |
| 3 S | 5th Str Bridge Gage - Walnut Creek | 1.4 | 2 | 1.4 |
| 4 T | Walnut Creek tributary | 0 | 91 | 0 |
| 5 S | Walnut Creek - Macon Popular St WPCP | 1.5 | 15 | 1.5 |
| 6 D | Macon Popular Street WPCP | 0 | 0 | 0 |
| 7 S | WPCP - RM193.4 (include Swift Creek) | 2 | 40 | 2 |
| 8 S | RM 1934 - GA Kraft Intake | 4.7 | 15 | 4.7 |
| 9 I | GA Kraft Intake | 0 | 0 | 0 |
| 10 S | GA Kraft Intake - Ga Kraft Discharge | 0.1 | 0.001 | 0.15 |
| 11 D | Ga Kraft Discharge (no longer exists) | 0 | 0 | 0 |
| 12 S | GA Kraft Discharge - Rocky Creek WPCP | 0.1 | 0.001 | 0.1 |
| 13 D | Macon Rocky Creek Discharge | 0 | 0 | 0 |
| 14 S | Rock Creek WPCP - Tobesofkee Creek | 6.1 | 3 | 11.1 |
| 15 B | Junction of Tobesofkee River | 0 | 0 | 0 |
| 16 S | Tobesofkee Creek - Gage (USGS002213700) | 5.9 | 10 | 9.5 |
| 17 S | Gage (USGA02213700) to RM 174 | 1.1 | 4 | 1.5 |
| 18 D | Proposed S Macon WPCP | 0 | 0 | 0 |
| 19 S | RM 174 to Echeconnee Creek | 0.1 | 1 | 0.2 |
| 20 B | Junction of Echeconnee Creek | 0 | 0 | 0 |
| 21 S | Echeconnee Creek - Warner Robins Horse | 2.1 | 1 | 2.6 |
| 22 D | Warner Robins Ocmulgee River WPCP | 0 | 0 | 0 |
| 23 S | Warner Robins WPCP - Bullard Ramp | 5 | 62.5 | 6.2 |
| 24 S | Bullard Ramp - Horse Creek | 3.75 | 15 | 4.3 |
| 25 T | Horse Creek w/out Warner Robins Discharge tributary | 0 | 16 | 0 |
| 26 S | Horse Creek - USAF Robins AFB WPCP | 3.45 | 0.001 | 4.3 |
| 27 D | USAF Robins AFB WPCP | 0 | 0 | 0 |
| 28 S | USAF Robins AFB WPCP - Sandy Run Creek | 0.2 | 1.6 | 0.2 |
| 29 B | Junction of Sandy Run Creek | 0 | 0 | 0 |
| 30 S | Sandy Run Creek - Flat Creek | 3.1 | 41.3 | 3.3 |
| 31 S | Flat Creek - GA Hwy 96 | 0.1 | 0.1 | 0.1 |
| 32 S | GA Hwy 96 - Savage Creek | 1.6 | 4.6 | 1.4 |
| 33 T | Savage Creek tributary | 0 | 64.4 | 0 |
| 34 S | Savage Creek - Shellstone Creek | 12.4 | 39.8 | 13.3 |
| 35 T | Shellstone Creek tributary | 0 | 70.7 | 0 |
| 36 S | Shellstone Creek - Big Indian Creek | 5.5 | 8.4 | 5.8 |
| 37 B | Junction of Big Indian Creek | 0 | 0 | 0 |
| 38 S | Big Indian Creek - Jordan Creek | 8.1 | 24.6 | 8.6 |
| 39 B | Junction of Jordan Creek | 0 | 0 | 0 |
| 40 S | Jordan Creek - Hawkinsville N WPCP | 124.61 | 1 | 198.45 |
| 41 D | Hawkinsville N WPCP | 0 | 0 | 0 |
| 42 B | Junction of Lower Ocmulgee River | 0 | 0 | 0 |

| Lower Ocmulgee Branch | | | | | |
|-----------------------|---|---|------|--------|------|
| | | Headwaters | | 0 | |
| 43 | S | WPCP To Hollinsworth & Vose | 0.32 | 0.5 | 0.3 |
| 44 | D | Hollingsworth & Vose WPCP | 0 | 0 | 0 |
| 45 | S | Hollinsworth To Hawkinsville WPCP | 2.5 | 29 | 2 |
| 46 | D | Hawkinsville WPCP | 0 | 0 | 0 |
| 47 | S | WPCP To Limestone Creek | 4 | 18.75 | 3 |
| 48 | S | Limestone Creek To Big Creek | 2.2 | 63.8 | 1 |
| 49 | T | BIG CREEK Tributary | 0 | 223 | 0 |
| 50 | S | Big Creek To Boat Ramp | 2.69 | 9.12 | 1.99 |
| 51 | S | Boat Ramp To Bluff Creek | 2.4 | 7.34 | 1.5 |
| 52 | S | Bluff Creek To Mosquito Creek | 2.5 | 96.2 | 1 |
| 53 | B | Junction of Mosquito Creek | 0 | 0 | 0 |
| 54 | S | Mosquito Creek To RM107.5 | 0.8 | 81.2 | 0.76 |
| 55 | D | Possible Discharge From X | 0 | 0 | 0 |
| 56 | S | RM107.5 To Cedar Creek | 3.4 | 29.7 | 3.24 |
| 57 | S | Cedar Creek To Little Branch | 3.7 | 110.76 | 2.5 |
| 58 | S | Little Branch To RM 95.0 | 4.3 | 40.7 | 4 |
| 59 | S | RM 95 To Poor Robin Spring Ramp | 3.6 | 20.2 | 3.5 |
| 60 | S | Boat Ramp To Us 280 | 2.7 | 54.77 | 1.5 |
| 61 | S | Us 280 To Abbeville WPCP | 1 | 0.99 | 1.48 |
| 62 | D | Abbeville WPCP | 0 | 0 | 0 |
| 63 | S | Abbeville WPCP To Rhodes Lake Ramp | 4.46 | 13.02 | 6.59 |
| 64 | S | Boat Ramp To RM 79.2 | 4.04 | 24.8 | 5.97 |
| 65 | S | RM 79.2 To RM 75.5 | 3.7 | 10.4 | 5.47 |
| 66 | S | RM 75.5 To 72.5 | 3 | 4.87 | 1.95 |
| 67 | S | RM 72.5 To Mizell Creek | 2.4 | 2.98 | 1.56 |
| 68 | S | Mizell Creek To House Creek | 2.8 | 34.15 | 1.82 |
| 69 | S | House Creek To Otter Creek | 0.6 | 128.61 | 0.39 |
| 70 | S | Otter Creek To RM 64.7 | 2 | 36.8 | 1.3 |
| 71 | S | RM 64.7 To Boat Ramp At 31 48 40 | 3.7 | 7.26 | 2.4 |
| 72 | S | Boat Ramp To Yellow Bluff | 2.3 | 22.4 | 1.5 |
| 73 | S | Yellow Bluff To Lampkins Field Ferry | 2.3 | 9.36 | 1.5 |
| 74 | S | Lampkins Ferry To RM 54 | 2.4 | 6.28 | 1.56 |
| 75 | S | RM 54 To Sturgeon Creek | 2.3 | 5.96 | 1.5 |
| 76 | S | Sturgeon Creek To County Park Boat Ramp | 2.5 | 64.3 | 1.62 |
| 77 | S | Boat Ramp To Gregory Creek | 3.8 | 5.68 | 2.47 |
| 78 | S | Gregory Creek To RM 41.7 | 3.7 | 20.6 | 3.96 |
| 79 | S | RM 41.7 To Paul Creek | 1.9 | 22 | 2.01 |
| 80 | S | Paul Creek To RM 36.5 | 3.3 | 5.06 | 3.49 |
| 81 | S | RM 36.5 To Flat Tub Landing | 3.5 | 28.9 | 3.71 |
| 82 | S | Flat Tub To Rocky Hammock Landing | 4.2 | 30.66 | 4.45 |
| 83 | S | Rocky Hammock To Haddock Landing | 2.7 | 10.2 | 2.86 |
| 84 | S | Haddock Landing To Horse Creek | 2 | 2.36 | 2.12 |
| 85 | S | Horse Creek To RM21.6 | 2.5 | 158.7 | 2.64 |
| 86 | S | RM21.6 To Fishing Creek | 3.4 | 27.9 | 3.6 |
| 87 | S | Fishing Creek to Mcrae's Landing | 3.1 | 15.7 | 3.28 |
| 88 | S | Mcrae's Landing to US 341 (USGS 02215500) | 3.6 | 18.1 | 3.81 |
| 89 | S | US 341 (USGS 02215500) To Lumber City WTF | 0.2 | 0.59 | 0.16 |
| 90 | D | Lumber City WTF | 0 | 0 | 0 |
| 91 | S | Lumber City WTF To Little Ocmulgee | 2.19 | 4.61 | 1.81 |
| 92 | B | Junction Of Little Ocmulgee River | 0 | 0 | 0 |
| 93 | S | Little Ocmulgee R. To RM 5.4 | 3.7 | 17.8 | 3.06 |
| 94 | S | RM 5.4 To Hazlehurst WPCP | 2 | 5.09 | 1.6 |
| 95 | D | Hazlehurst WPCP | 0 | 0 | 0 |

| | | | | | |
|--------------------------------|---|--|------|-------|-------|
| 96 | S | Hazlehurst WPCP to Eachins Landing | 0.66 | 1.08 | 0.5 |
| 97 | S | Eachins Landing to Gully Creek | 2.4 | 2 | 2.11 |
| 98 | B | Junction Of Gully Creek | 0 | 0 | 0 |
| 99 | S | Gully Creek To Altamaha River | 0.4 | 0.7 | 0.2 |
| Tobesofkee River Branch | | | | | |
| | | Headwaters | | 0.08 | |
| 100 | D | William Carter Company Discharge | 0 | 0 | 0 |
| 101 | S | William Carter Co WPCP Discharge - Barnesville WPCP | 1.78 | 4 | 83 |
| 102 | D | Barnesville WPCP | 0 | 0 | 0 |
| 103 | S | Barnesville WPCP - Fredonia Road | 1.17 | 1.8 | 26 |
| 104 | S | Fredonia Road - Ramah Church Road (USGS 02213285) | 2.48 | 7 | 77 |
| 105 | S | Ramah Church Rd (02213285) - Lamar County Line | 2.9 | 4 | 58.9 |
| 106 | S | Lamar County Line - Cole Creek | 1.33 | 1.8 | 19.8 |
| 107 | T | Cole Creek tributary | 0 | 8.3 | 0 |
| 108 | S | Cole Creek - Parks Road (USGS 02213300) | 1.08 | 0.75 | 8.6 |
| 109 | S | Parks Road (02213300) - GA Route 83 | 2.47 | 8 | 25.2 |
| 110 | S | GA Route 83 - Forsyth Water Intake | 3.83 | 6.8 | 43 |
| 111 | I | Forsyth Water Intake | 0 | 0 | 0 |
| 112 | S | Forsyth Water Intake - Todd Creek | 0.39 | 0.1 | 13.9 |
| 113 | T | Todd Creek tributary | 0 | 10.6 | 0 |
| 114 | S | Todd Creek - Monpelier Springs Road | 2.6 | 2 | 38.5 |
| 115 | S | Monpelier Springs Road-Rock Branch | 1.61 | 0.1 | 1.7 |
| 116 | S | Rock Branch to Reedy Creek | 4.15 | 26 | 78.7 |
| 117 | S | Reedy Creek to Little Tobesofkee Creek | 4.5 | 8 | 19.7 |
| 118 | T | Little Tobesofkee Creek tributary | 0 | 61 | 0 |
| 119 | S | Little Tobesofkee to Lake Tobesofkee | 2.4 | 11.2 | 29.5 |
| 120 | S | Lake Tobefokee | 5.7 | 22.9 | 39.4 |
| 121 | S | Lake Tobesofkee to Wolf Creek (GA Sta.5013601)) | 10.5 | 31.2 | 52.5 |
| 122 | T | Wolf Creek (Rocky Creek) tributary | 0 | 48 | 0 |
| 123 | S | Wolf Creek to Ocmulgee River | 5.1 | 15.8 | 9.8 |
| Sandy Run Creek Branch | | | | | |
| | | Headwaters | | 8.5 | |
| 124 | S | State Route 11 to S. Houston Road | 4.5 | 9 | 55.8 |
| 125 | S | South Houston Road (USGS 02214200) to Bay Gall Creek | 3.3 | 5.7 | 45.9 |
| 126 | T | Bay Gall Creek tributary | 0 | 20 | 0 |
| 127 | S | Bay Gall Creek to Warner Robin WPCP | 1.65 | 1.65 | 9.8 |
| 128 | D | Warner Robins Sandy Run WPCP | 0 | 0 | 0 |
| 129 | S | Warner Robins WPCP - Hwy 247 Bridge (USGS 02214210) | 0.52 | 1.194 | 4.5 |
| 130 | S | Hwy Bridge 247/129 - Station 5 | 1.8 | 1.089 | 15.55 |
| 131 | S | Station 5 - Station 7 | 1 | 0.5 | 8.55 |
| 132 | S | Station 7 to Ocmulgee River | 0.78 | 0.102 | 2.36 |
| Big Indian Creek Branch | | | | | |
| | | Headwaters | | 2.9 | |
| 133 | D | Fort Valley WPCP @ Bay Creek | 0 | 0 | 0 |
| 134 | S | Fort Valley WPCP to SR96 | 0.8 | 0.63 | 34 |
| 135 | S | SR 96 to 400ft Contour | 0.44 | 1.54 | 11.6 |
| 136 | S | 400ft contour to 390ft contour | 1.02 | 1.29 | 10 |
| 137 | S | 390ft contour to proposed Fort Valley WPCP | 1.8 | 5.24 | 38.9 |
| 138 | D | Proposed Discharge | 0 | 0 | 0 |
| 139 | S | Proposed WPCP to Hedrick Road (USGS02214474) | 1.19 | 1.09 | 12.3 |
| 140 | S | Hedrick Road (USGS02214474) to Holland Road | 1.27 | 2.75 | 10.3 |
| 141 | S | Holland Road to 320ft contour | 0.6 | 0.75 | 10.1 |
| 142 | S | 320ft contour to 310ft contour | 0.78 | 0.87 | 10 |
| 143 | S | 310ft contour to Beaver Creek | 0.47 | 0.4 | 3.2 |
| 144 | T | Beaver Creek tributary | 0 | 6.06 | 0 |
| 145 | S | Beaver Creek to Unnamed Tributary | 0.18 | 0.04 | 1.2 |

| | | | | | |
|--------------------------------|---|--|------|-------|------|
| 146 | T | Unnamed Tributary | 0 | 3.78 | 0 |
| 147 | S | Unnamed Tributary to US 341 | 0.18 | 0.19 | 1.6 |
| 148 | S | US 341 to Valley Drive | 0.5 | 3.68 | 12.5 |
| 149 | S | Valley Drive to Baptist Creek | 0.5 | 0.31 | 4.1 |
| 150 | T | Baptist Creek tributary | 0 | 31.4 | 0 |
| 151 | S | Baptist Creek to Old USGS Gage | 1.2 | 3.9 | 5.8 |
| 152 | S | Old USGS Gage to Perry WPCP | 2.09 | 3 | 10 |
| 153 | D | Perry WPCP | 0 | 0 | 0 |
| 154 | S | Perry WPCP to 260ft Elevation | 2.55 | 20 | 10 |
| 155 | S | 260ft Elevation to 250ft Elevation | 2.06 | 20 | 10 |
| 156 | S | 250ft Elev to Hwy GA 11/ US 341 | 0.52 | 1 | 2 |
| 157 | S | Hwy 11/341 to Cagle's Discharge | 0.74 | 3 | 3 |
| 158 | D | Cagle's 001(formerly Stroh Brewery) | 0 | 0 | 0 |
| 159 | S | Cagle's to 240ft Elevation | 1.31 | 20 | 5 |
| 160 | S | 240ft Elev to Mossy Creek | 1.27 | 3 | 4 |
| 161 | B | Junction of Mossy Creek | 0 | 0 | 0 |
| 162 | S | Mossy Creek to 230ft Elev | 1.33 | 6 | 6 |
| 163 | S | 230ft Elev to Hwy GA 247 | 1 | 6 | 3 |
| 164 | S | Hwy GA 247 to 220ft Elev | 2.01 | 7 | 7 |
| 165 | S | 220ft Elev to 210ft Elevation | 2.73 | 10 | 10 |
| 166 | S | 210ft Elev to Ocmulgee River | 0.83 | 3 | 3 |
| Mossy Creek Branch | | | | | |
| | | Headwaters | | 141.6 | |
| 167 | S | Mossy Creek Hwy 247 to Cagle's 002 | 0.2 | 0.2 | 1 |
| 168 | D | Cagle's 002(formerly Stroh Brewery) | 0 | 0 | 0 |
| 169 | S | Cagle's 002 to 240ft Contour | 0.5 | 0.44 | 8 |
| 170 | S | 240ft to 238ft | 0.9 | 8.3 | 2 |
| 171 | S | 238ft to Big Indian Creek | 0.8 | 1.6 | 2 |
| Mosquito Creek Branch | | | | | |
| | | Headwaters | | 14.1 | |
| 172 | S | Headwater to Hogpen Branch | 4.9 | 13.1 | 19.7 |
| 173 | S | Hogpen Branch to Hwy 230 (USGS 02215210) | 3.5 | 15.2 | 6.6 |
| 174 | S | Hwy 230 to Ocmulgee River | 4.5 | 5.5 | 52.5 |
| Gully Creek Branch | | | | | |
| | | Headwaters | | 10.1 | |
| 175 | S | Headwater to 2nd Tributary from left | 3.8 | 6.8 | 23 |
| 176 | S | 2nd Tributary from left to Liberty Church Road (USGS 02216612) | 1.11 | 5.5 | 9.8 |
| 177 | S | Liberty Church Road to Ocmulgee River | 1.95 | 8.1 | 42.7 |
| Echeconnee Creek Branch | | | | | |
| | | Headwaters | | 6.3 | |
| 178 | S | Walnut Creek to Little Echeconnee Creek | 5.5 | 10.83 | 62.3 |
| 179 | B | Junction of Little Echeconnee Creek | 0 | 9 | 0 |
| 180 | S | Little Echeconnee Creek to Lamar Branch | 1.01 | 8.3 | 6.6 |
| 181 | S | Lamar Branch to Sweetwater Creek | 4 | 6 | 19.7 |
| 182 | T | Sweetwater Creek tributary | 0 | 19.86 | 0 |
| 183 | S | Sweetwater Creek to Deep Creek | 1.5 | 36.3 | 32.8 |
| 184 | S | Deep Creek to Gum Swamp Creek | 0.9 | 10.5 | 6.6 |
| 185 | S | Gum Swamp Creek to Whitewater Creek | 1.7 | 14.1 | 3.3 |
| 186 | S | Whitewater Creek to Juniper Creek | 2.15 | 4.7 | 13.1 |
| 187 | B | Junction of Juniper Creek | 0 | 0 | 0 |
| 188 | S | Juniper Creek to Unnamed Tributary from left | 6.3 | 28.6 | 29.5 |
| 189 | S | Unnamed Tributary to Ocmulgee River | 4.72 | 11.9 | 13.1 |

| Little Echeconnee Creek Branch | | | | | |
|--------------------------------|---|---|-------|--------|------|
| | | Headwaters | | 5 | |
| 190 | S | Headwaters to Cumby Spring Branch | 1.2 | 7 | 39.4 |
| 191 | S | Cumby Spring to Smith Chappel Road (USGS 02213925) | 2.7 | 7.6 | 32.8 |
| 192 | S | Smith Chappel Road (USGS 02213925) to Echeconnee Cr | 2.4 | 2.6 | 13.1 |
| Juniper Creek Branch | | | | | |
| | | Headwaters | | 1.37 | |
| 193 | D | Byron Pond Discharge | 0 | 0 | 0 |
| 194 | S | Byron Pond to 1st Tributary from right | 0.82 | 2.52 | 49.2 |
| 195 | S | 1st tributary from right to 1st Tributary from left | 0.52 | 2.15 | 6.6 |
| 196 | S | 1st Tributary from left to 2nd Tributary from right | 1.29 | 3.26 | 16.4 |
| 197 | S | 2nd Tributary from right to Echeconnee Creek | 1.18 | 0.8 | 23 |
| Jordan Creek Branch | | | | | |
| | | Headwaters | | 31 | |
| 198 | D | Discharge location 2 | 0 | 0 | 0 |
| 199 | S | Discharge location 2 to Paulk Lake Tributary | 0.2 | 0.55 | 5.7 |
| 200 | T | Paulk Lake Tributary | 0 | 1.9 | 0 |
| 201 | S | Paulk Lake Trib to Collins Branch | 0.71 | 0.47 | 8.1 |
| 202 | B | Junction of Collins Branch | 0 | 0 | 0 |
| 203 | D | Proposed Location 3 | 0 | 0 | 0 |
| 204 | S | Proposed Discharge to Road Crossing | 1.04 | 1.55 | 23.3 |
| 205 | S | Road Crossing to Henderson Branch | 2.67 | 5 | 32.7 |
| 206 | T | Henderson Branch tributary | 0 | 2.1 | 0 |
| 207 | S | Henderson Branch to 230ft contour | 0.72 | 0.85 | 6.9 |
| 208 | S | 230ft contour to Hwy 126 | 2.43 | 2.6 | 19.5 |
| 209 | S | Hwy 126 to Ocmulgee River | 0.54 | 0.45 | 10.5 |
| Collins Branch | | | | | |
| | | Headwaters | | 6.3 | |
| 210 | D | Cochran Current Discharge | 0 | 0 | 0 |
| 211 | S | Current discharge to small trib. Fr | 0.75 | 0.47 | 6.1 |
| 212 | S | small trib. to 300ft contour | 0.56 | 0.65 | 7.9 |
| 213 | S | 300ft contour to Jordan Creek | 1.27 | 2.03 | 9 |
| Little Ocmulgee River Branch | | | | | |
| | | Headwaters | | 1.68 | |
| 214 | S | Headwaters to Harvey Branch | 6.91 | 14.27 | 100 |
| 215 | S | Harvey Branch to SR 26 | 6.96 | 23.59 | 65 |
| 216 | S | SR 26 to SR 126 | 5.62 | 18.83 | 25 |
| 217 | S | SR 126 to Elev 70ft | 3.98 | 34.27 | 20 |
| 218 | S | Elev 270ft to Little Gum Swamp C | 4.69 | 9.55 | 16 |
| 219 | T | Trib Little Gum Swamp Creek | 0 | 10.88 | 0 |
| 220 | S | Little Gum Swamp to Walton Creek | 1.85 | 8.95 | 6 |
| 221 | S | Walton Creek to Crooked Branch | 5.1 | 39.4 | 17 |
| 222 | B | Junction of Crooked Branch | 0 | 0 | 0 |
| 223 | S | Crooked Branch to SR 46 (USGS 02215735) | 2.3 | 5.7 | 7 |
| 224 | S | SR 46 (USGS 02215735) to Roach Branch | 0.923 | 0.715 | 2 |
| 225 | B | Junction of Roach Branch | 0 | 0 | 0 |
| 226 | S | Roach Branch to Elev. 211ft | 2.7 | 16.89 | 11 |
| 227 | S | Elev. 211ft to Elev. 205ft | 2.3 | 6.23 | 6 |
| 228 | S | Elev. 205ft to Elev. 190ft at SR165 | 4.64 | 8.26 | 15 |
| 229 | S | SR 165 to Elev. 180ft Jay Bird Spring | 3.5 | 20.83 | 10 |
| 230 | S | Elev. 180ft Jay Bird Spring to Joiner Creek | 7.45 | 18.72 | 14 |
| 231 | T | Joiner Creek tributary | 0 | 29.997 | 0 |
| 232 | S | Joiner Creek to Dam | 3.5 | 6.38 | 7 |
| 233 | S | Dam to McRae discharge | 1.839 | 3.807 | 4 |
| 234 | D | GA0026298-McRae Gum Swamp Creek | 0 | 0 | 0 |

| | | | | | |
|-------------------------------|---|---|-------|--------|----|
| 235 | S | McRae discharge to Scotland Pond | 4.018 | 24.592 | 22 |
| 236 | D | GA0032344-Scotland Pond | 0 | 0 | 0 |
| 237 | S | Scotland Pond to SR134 (USGS02216000) | 5.031 | 25.102 | 14 |
| 238 | S | SR 134 (USGS02216000) to Alligator Creek | 4.572 | 11.398 | 18 |
| 239 | B | Junction of Alligator Creek | 0 | 0 | 0 |
| 240 | S | Alligator Creek to Sugar Creek | 0.6 | 0.62 | 1 |
| 241 | B | Junction of Sugar Creek | 0 | 0 | 0 |
| 242 | S | Sugar Creek to Ocmulgee River | 4.64 | 10.2 | 9 |
| Crooked Creek Branch | | | | | |
| | | Headwaters | | 0.5 | |
| 243 | D | GA0049280-Middle GA Nursing Home | 0 | 0 | 0 |
| 244 | S | Middle GA Nursing to Crooked Branch Tributary | 1.8 | 2.6 | 70 |
| 245 | T | Crooked Branch tributary | 0 | 13.4 | 0 |
| 246 | S | Crooked Branch tributary to Gum Swamp Creek | 2 | 1 | 9 |
| Roach Branch | | | | | |
| | | Headwaters | | 2.4 | |
| 247 | D | GA0026310-Eastman (Roach Branch WPCP) | 0 | 0 | 0 |
| 248 | S | Roach Branch to Gum Swamp Creek | 2.4 | 3.7 | 28 |
| Alligator Creek Branch | | | | | |
| | | Headwaters | | 15.361 | |
| 249 | D | GA0025887-Cadwell WPCP | 0 | 0 | 0 |
| 250 | S | Cadwell WPCP to Elev 270 | 2.4 | 7.948 | 25 |
| 251 | S | Elev 270ft to SR 338 | 3.68 | 12.684 | 25 |
| 252 | S | SR 338 to SR 46 (USGS02216028) | 6.437 | 23.439 | 32 |
| 253 | S | SR 46 (USGS02216028) to Lime Sink Creek | 4.402 | 8.998 | 19 |
| 254 | T | Lime Sink Creek tributary | 0 | 55.85 | 0 |
| 255 | S | Lime Sink Creek to Elev 168ft | 8.407 | 39.766 | 26 |
| 256 | S | Elev 168ft to Alamo WPCP | 6.668 | 17.534 | 18 |
| 257 | D | GA0037753-Alamo WPCP | 0 | 0 | 0 |
| 258 | S | Alamo WPCP to Little Creek | 2.665 | 4.81 | 7 |
| 259 | T | Little Creek tributary | 0 | 27.72 | 0 |
| 260 | S | Little Creek to SR 134 | 7.1 | 27.177 | 26 |
| 261 | S | SR 134 to Little Ocmulgee River | 5.789 | 7.899 | 16 |
| Sugar Creek Branch | | | | | |
| | | Headwaters | | 8.1 | |
| 262 | S | Elev 300ft to WPCP @ GA Hwy 117 | 1.16 | 2.7 | 9 |
| 263 | D | GA0046485-Eastman-Sugar Ck WPCP | 0 | 0 | 0 |
| 264 | D | Eastman Roach Branch WPCP relocation | 0 | 0 | 0 |
| 265 | S | Eastman-Sugar Creek WPCP to trib 1 | 0.46 | 2.3 | 4 |
| 266 | S | Tributary 1 to Tributary 2 | 1.16 | 2.4 | 8 |
| 267 | S | Tributary 2 to Hargrove Rd | 1.43 | 2 | 8 |
| 268 | S | Hargrove Rd to Friendship Baptist Rd | 3.5 | 10.9 | 21 |
| 269 | S | Friendship Baptist Road to SR 165 | 2.6 | 5.3 | 14 |
| 270 | S | SR 165 to Elev 220ft | 2.8 | 7.3 | 16 |
| 271 | S | Elev 220ft to Tributary | 5.8 | 13.65 | 28 |
| 272 | S | Tributary to GA Hwy 319/441 | 3.7 | 11.6 | 15 |
| 273 | S | GA Hwy 319/441 to SR 149 | 5.5 | 8.9 | 24 |
| 274 | S | SR 149 to Tributary | 5.7 | 14.3 | 24 |
| 275 | S | Tributary to Turnpike Creek | 2.9 | 3.7 | 14 |
| 276 | B | Junction of Turnpike Creek | 0 | 100 | 0 |
| 277 | S | Turnpike Creek to SR 27 (USGS02214474) | 2.3 | 4 | 4 |
| 278 | S | SR27 (USGS 02214474) to Little Ocmulgee River | 2.5 | 2.7 | 11 |

| Turnpike Creek Branch | | | | | |
|-----------------------|---|---------------------------------------|------|---------|-----|
| | | Headwaters to SR 280 | | 0.64117 | |
| 279 | S | Headwaters to SR 280 | 8.3 | 16.1 | 100 |
| 280 | S | SR 280 to SR 132 | 8.87 | 32.04 | 50 |
| 281 | S | SR 132 to CR 160 (USGS 02216187) | 9.73 | 25.45 | 40 |
| 282 | S | CR 160 (USGS 02216187) to Sugar Creek | 3.49 | 7.86 | 25 |

Note: S: Stream
 T: Tributary
 B: Branch
 D: Discharge
 I: Intake

APPENDIX C

Calibration, Natural Conditions, and TMDL Model Curves

Figure C-1
DOSAG Model Results
Ocmulgee Creek

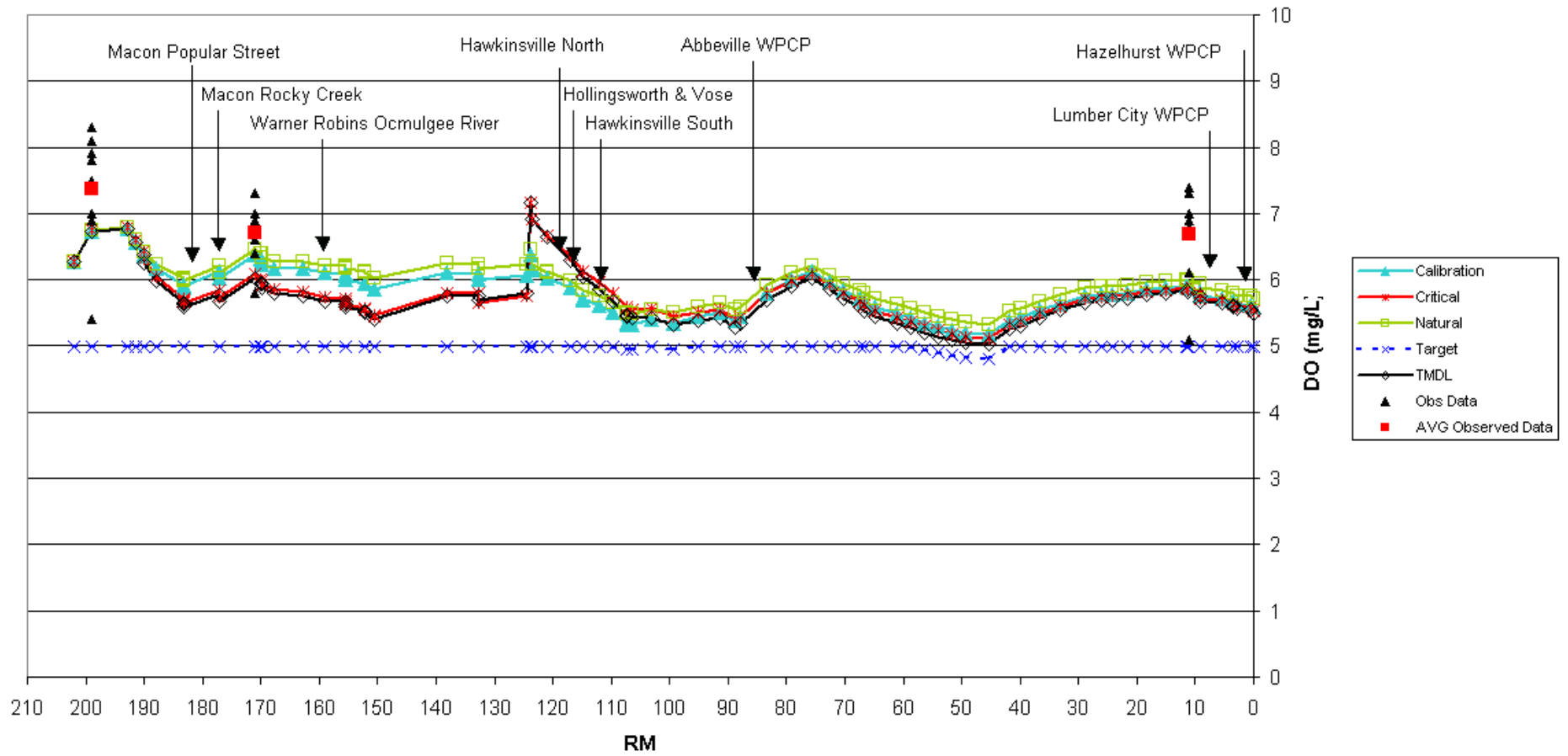


Figure C-2
DOSAG Model Results
Tobesofkee Creek

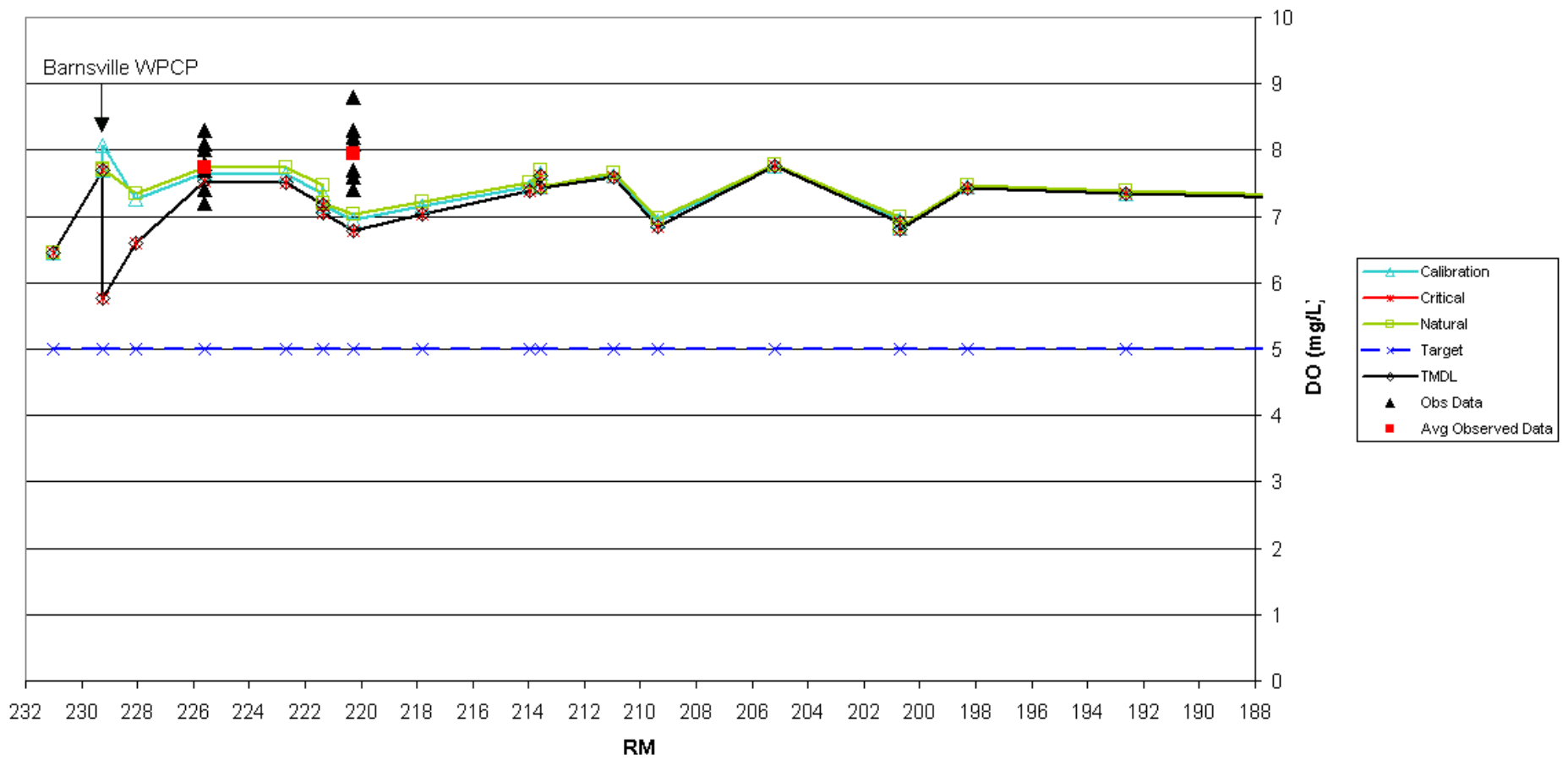


Figure C-3
DOSAG Model Results
Little Echeconnee Creek

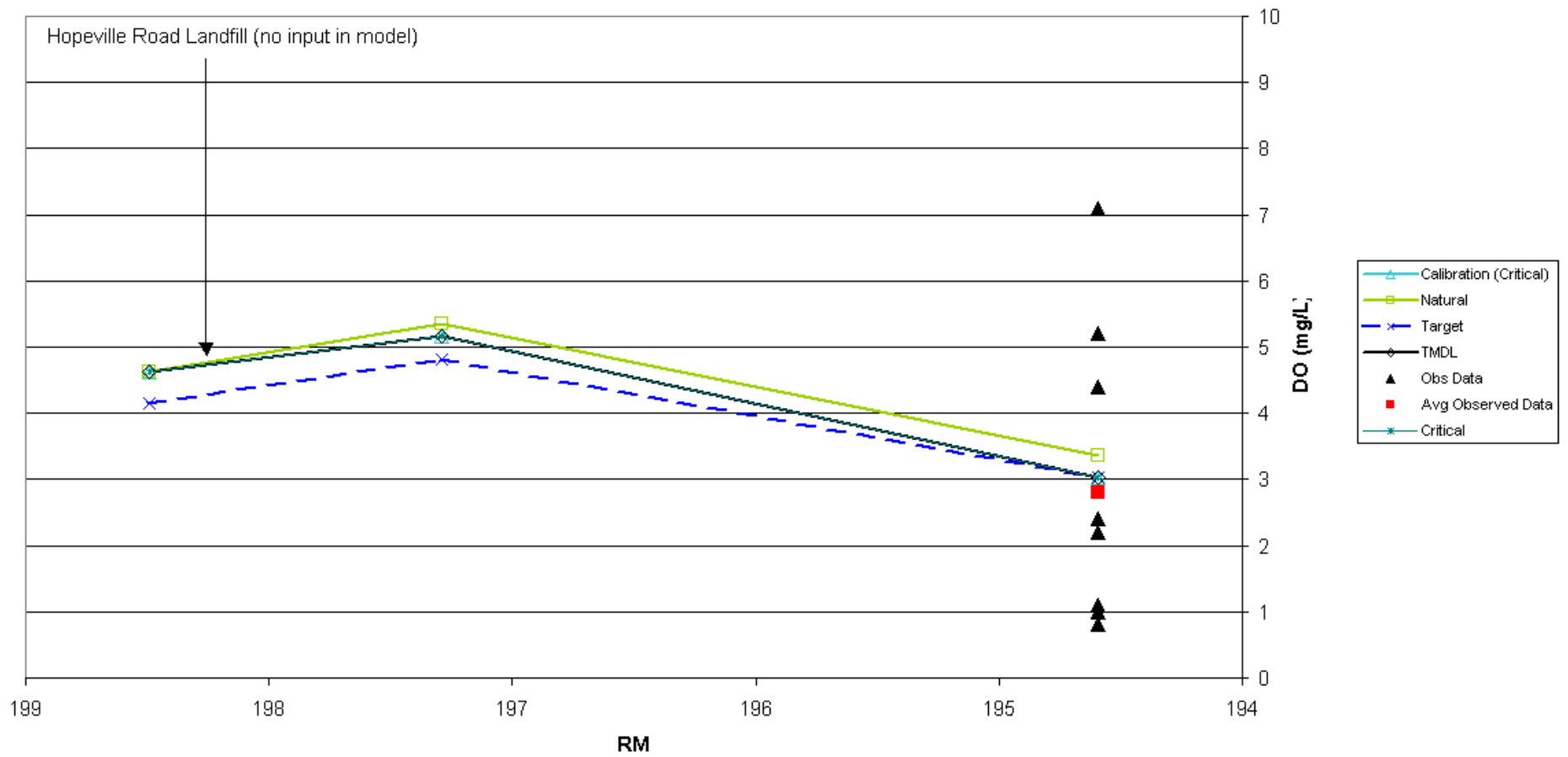


Figure C-4
DOSAG Model Results
Sandy Run Creek

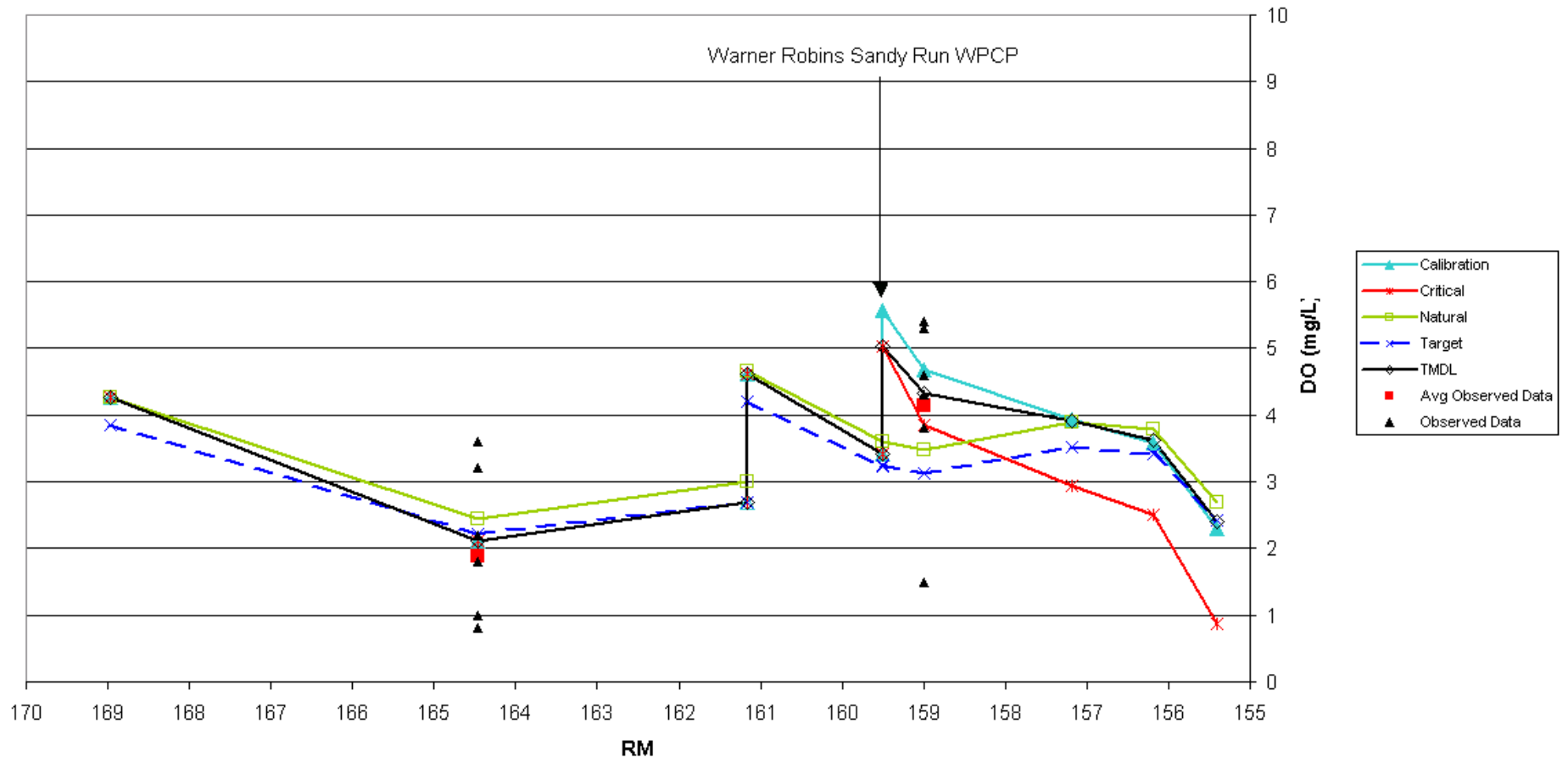


Figure C-5
DOSAG Model Results
Mosquito Creek

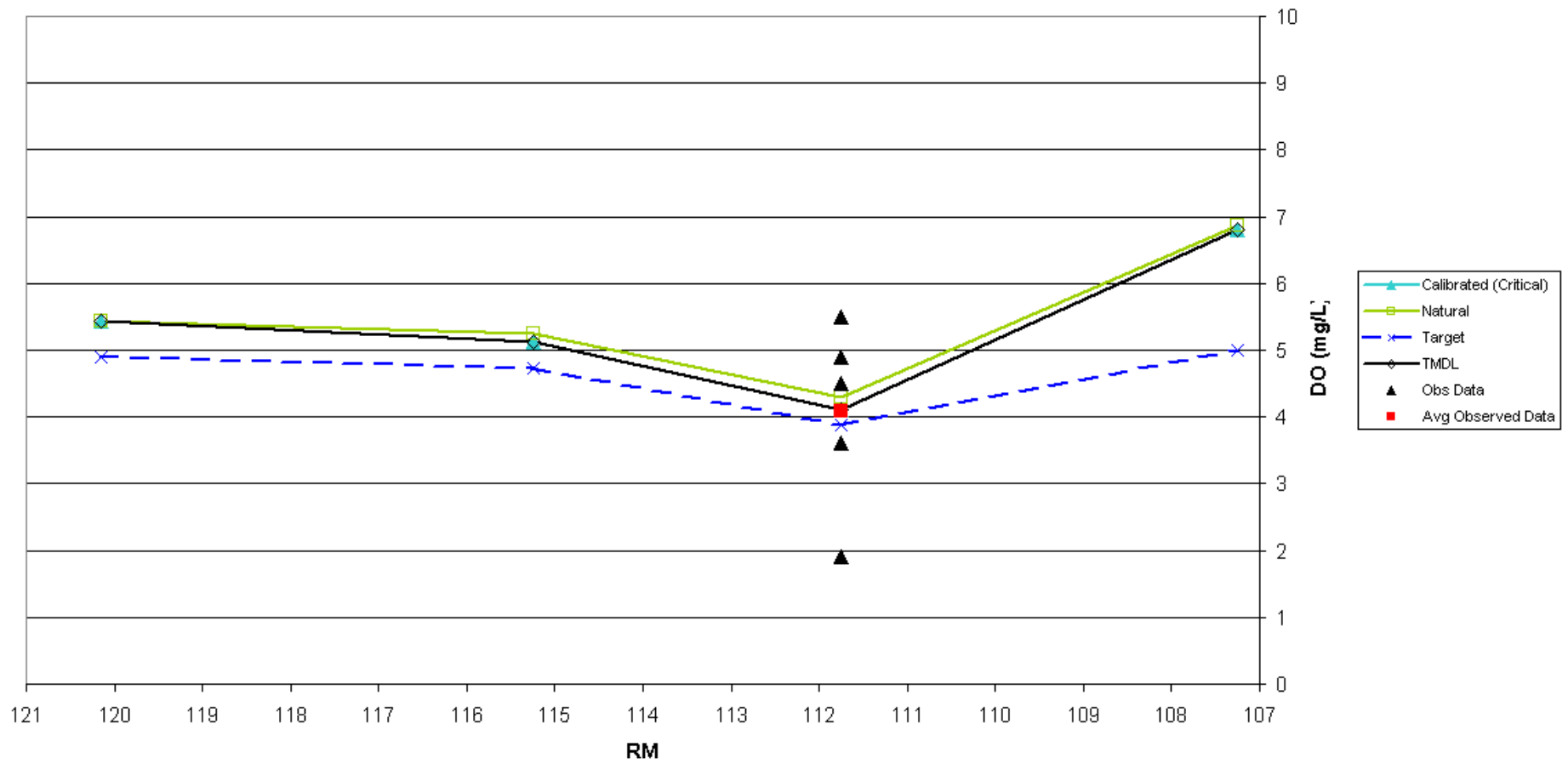


Figure C-6
DOSAG Model Results
Bay Creek and Big Indian Creek

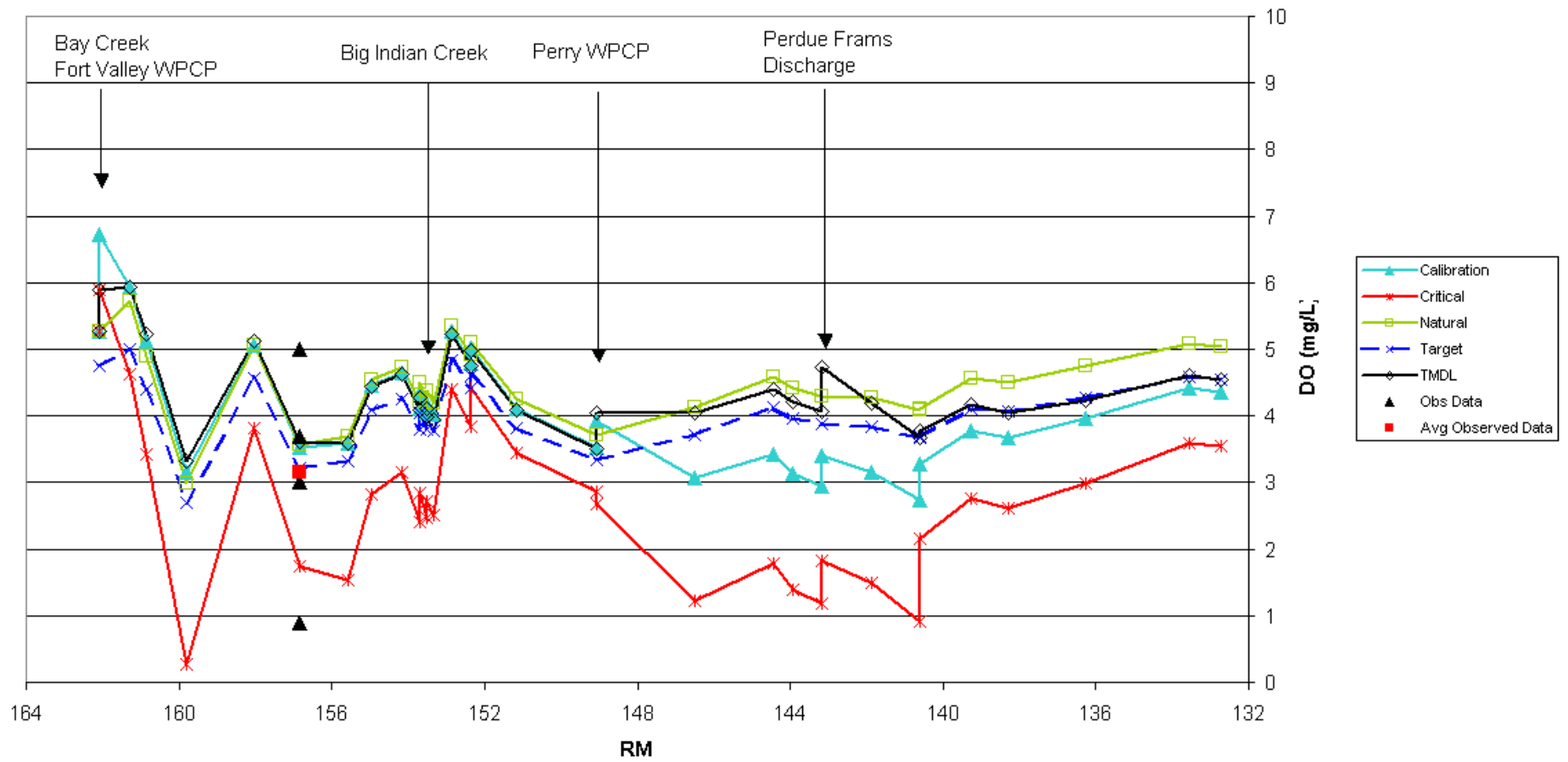


Figure C-7
DOSAG Model Results
Little Ocmulgee Creek

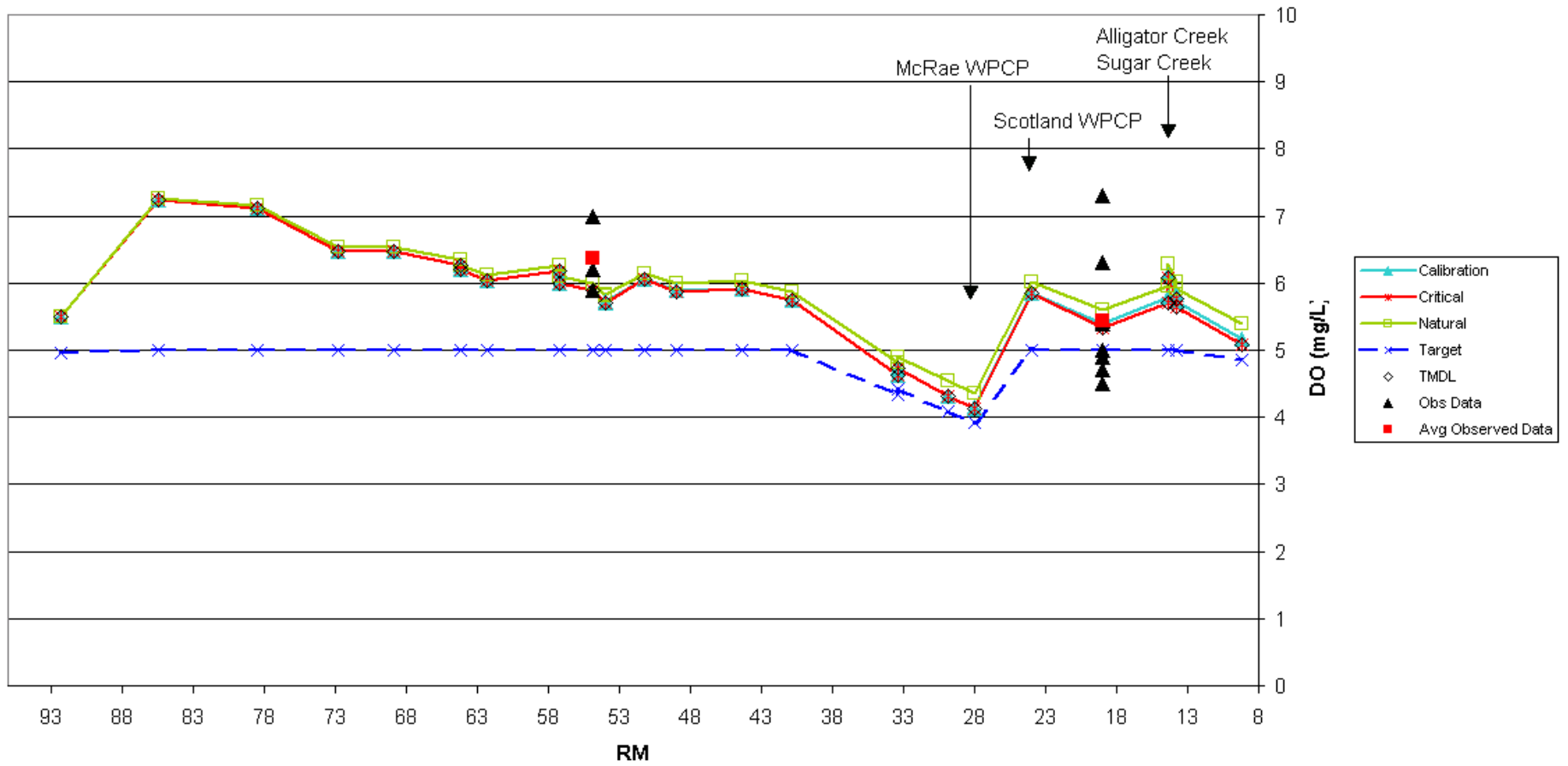


Figure C-8
DOSAG Model Results
Alligator Creek

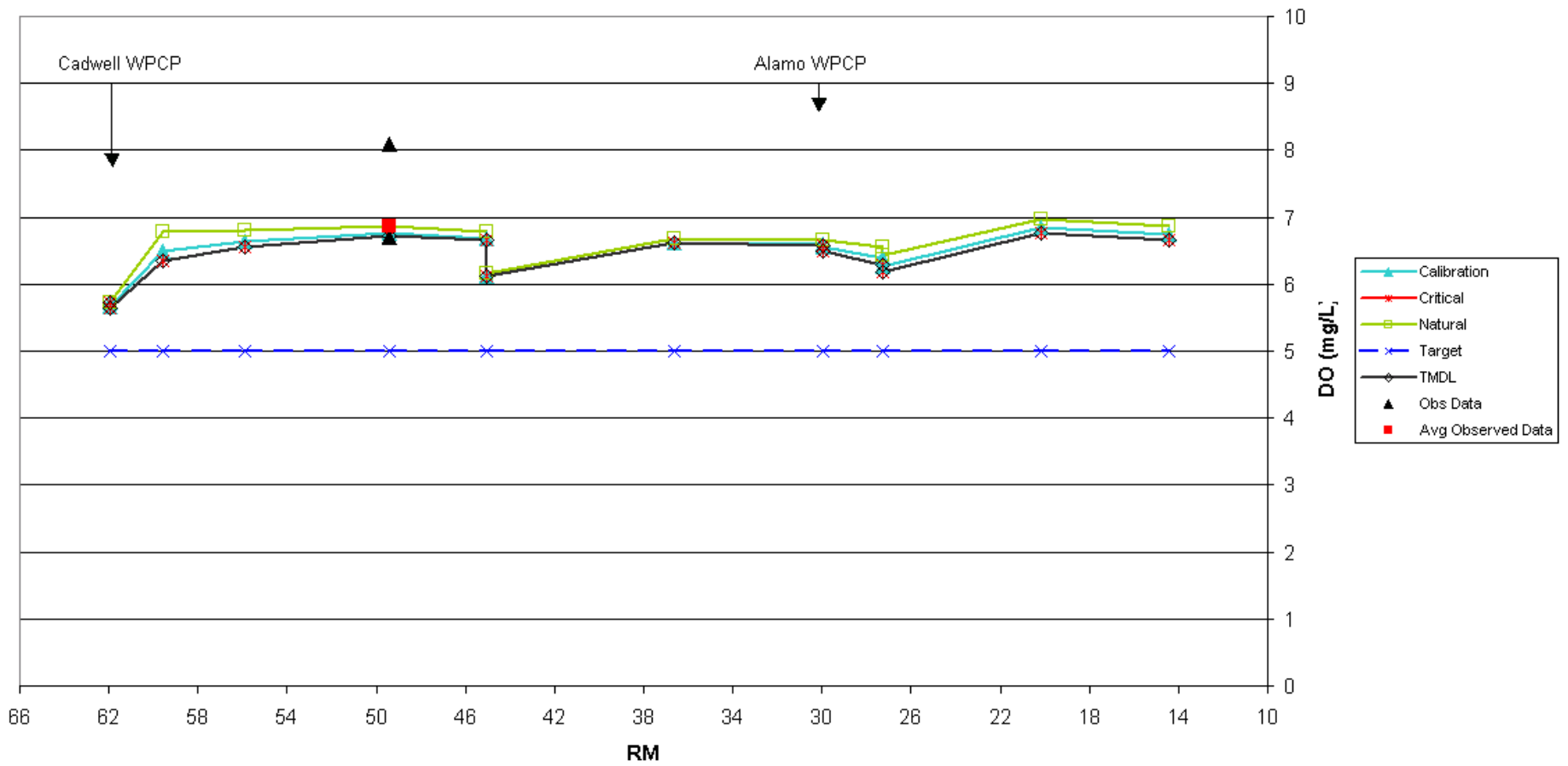


Figure C-9
DOSAG Model Results
Sugar Creek

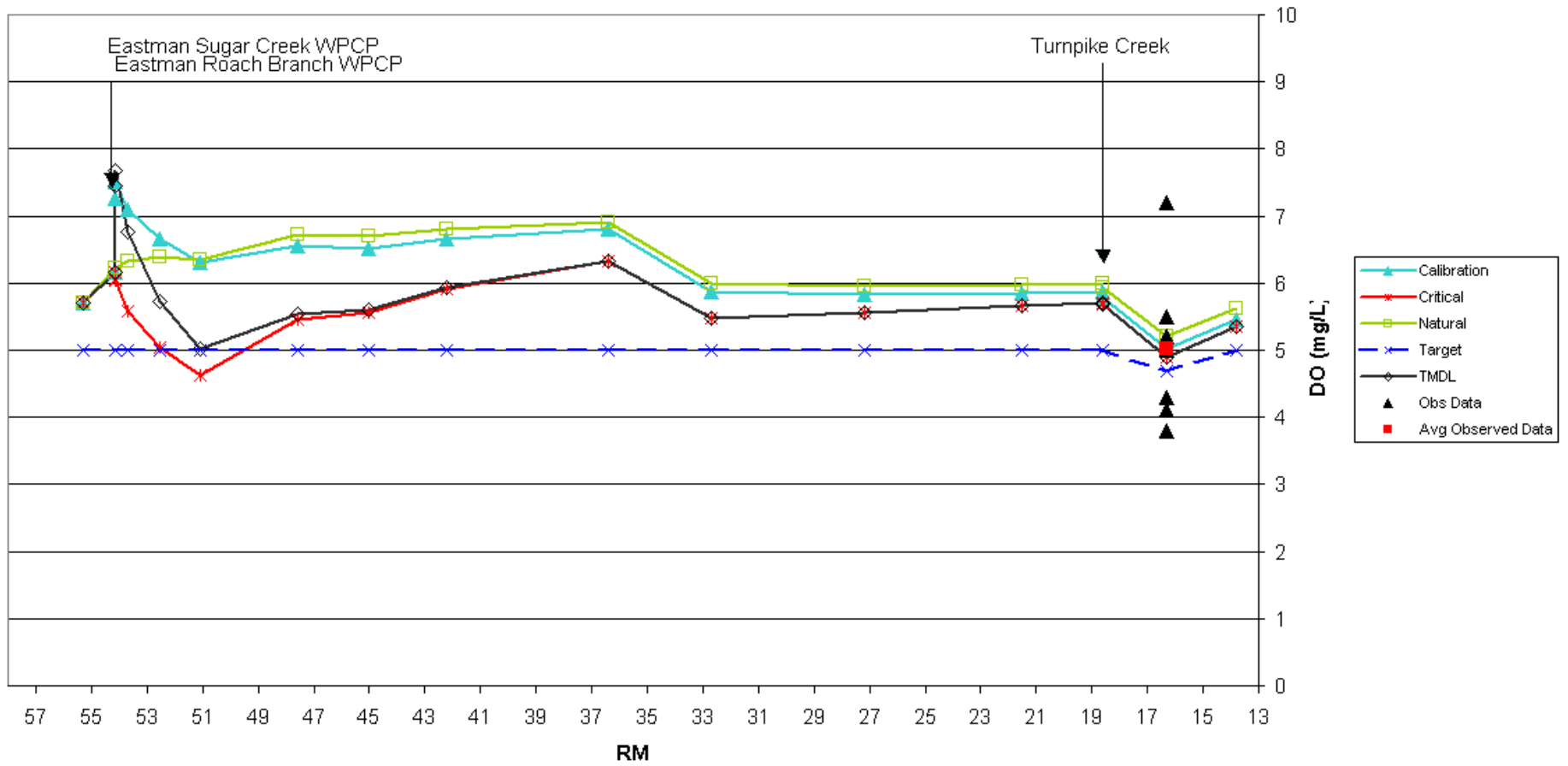


Figure C-10
DOSAG Model Results
Turnpike Creek

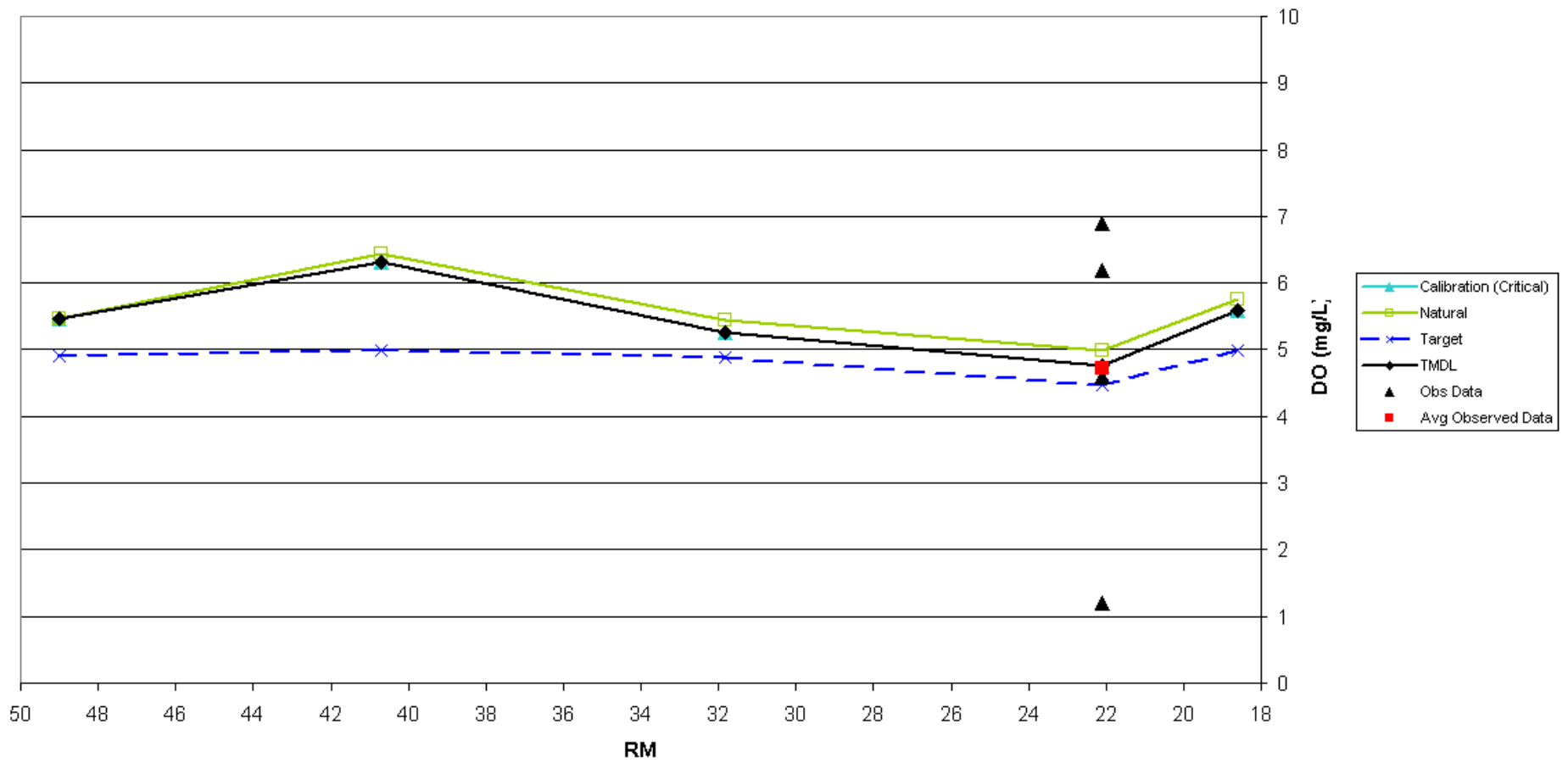
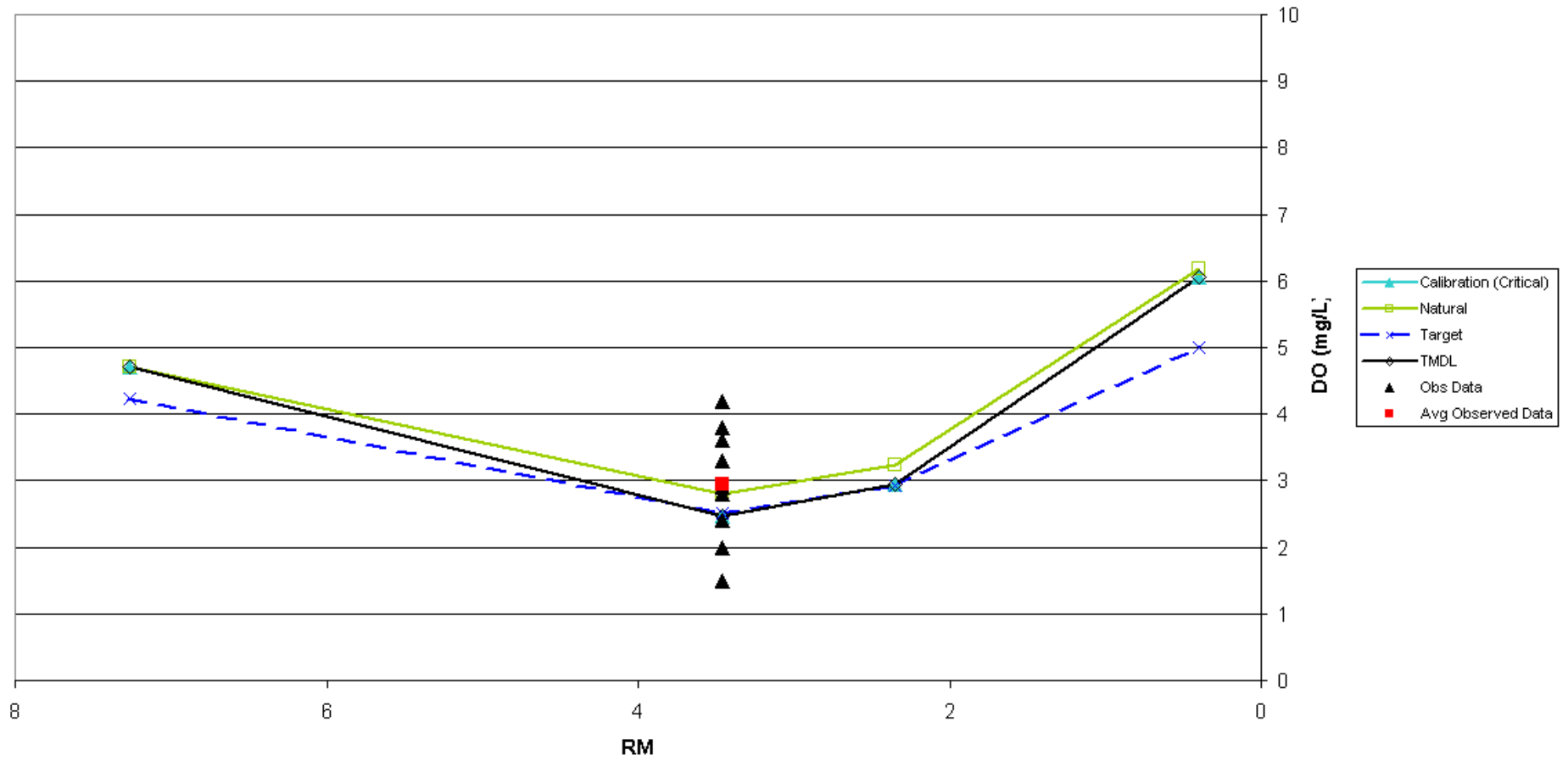


Figure C-11
DOSAG Model Results
Gully Creek



APPENDIX D

**Daily Oxygen Demanding Substances Load
Summary Memorandum**

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Bay Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Peach and Houston

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Bay Creek
Location: Headwaters to Beaver Creek
Stream Length: 9 miles
Watershed Area: 16.53 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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): 316 lbs/day - Fort Valley WPCP
Wasteload Allocations (WLA_{sw}): NA

Load Allocation (LA): 113 lbs/day

TMDL 429 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) Low flow 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 2004.**
- (4) Water depths are shallow, generally one foot, which increases the effect of SOD.**
- (5) Water velocities are sluggish, which intensifies the effect of BOD decay.**
- (6) All point sources discharge continuously at their NPDES permit limits for the same critical period.**

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Gully Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Jeff Davis

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Gully Creek
Location: Rocky Creek Branch to Ocmulgee River
Stream Length: 4 miles
Watershed Area: 28.19 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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 (WLA_{sw}): | NA |
| Load Allocation (LA): | 15 lbs/day |
| TMDL | 15 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) Low flow 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 2004.**
- (4) Water depths are shallow, generally one foot, which increases the effect of SOD.**
- (5) Water velocities are sluggish, which intensifies the effect of BOD decay.**
- (6) All point sources discharge continuously at their NPDES permit limits for the same critical period.**

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Little Echeconnee Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Crawford

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070103

Waterbody Name: Little Echeconnee Creek
Location: Headwaters to Echeconnee Creek
Stream Length: 8 miles
Watershed Area: 20.58
square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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 (WLA_{sw}): | NA |
| Load Allocation (LA): | 131 lbs/day |
| TMDL | 131 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) Low flow 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) Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period in the summer of 2004.**
- (4) Water depths are shallow, generally one foot, which increases the effect of SOD.**
- (5) Water velocities are sluggish, which intensifies the effect of BOD decay.**
- (6) All point sources discharge continuously at their NPDES permit limits for the same critical period.**

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Mosquito Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Dodge and Pulaski

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Mosquito Creek
Location: Headwaters to Ocmulgee River
Stream Length: 18 miles
Watershed Area: 48.17 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (partially supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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 (WLA_{sw}): | NA |
| Load Allocation (LA): | 382 lbs/day |
| TMDL | 382 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) Low flow 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) Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period in the summer of 2004. (4) Water depths are shallow, generally one foot, which increases the effect of SOD. (5) Water velocities are sluggish, which intensifies the effect of BOD decay. (6) All point sources discharge continuously at their NPDES permit limits for the same critical period. |
|--------------------------------|---|

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Sandy Run Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Washington and Johnson

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Sandy Run Creek
Location: Headwaters to Bay Gall Creek
Stream Length: 5 miles
Watershed Area: 23.54 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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 (WLA_{sw}): | NA |
| Load Allocation (LA): | 27 lbs/day |
| TMDL | 27 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) Low flow 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) Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period in the summer of 2004. (4) Water depths are shallow, generally one foot, which increases the effect of SOD. (5) Water velocities are sluggish, which intensifies the effect of BOD decay. (6) All point sources discharge continuously at their NPDES permit limits for the same critical period. |
|--------------------------------|---|

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Sandy Run Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Houston

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Sandy Run Creek
Location: Bay Gall Creek to Ocmulgee River
Stream Length: 7 miles
Watershed Area: 30.30 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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): 1293 lbs/day – Warner Robins WPCP
Wasteload Allocations (WLA_{sw}): NA

Load Allocation (LA): 207 lbs/day

TMDL 1,500 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) Low flow 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) Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period in the summer of 2004.**
- (4) Water depths are shallow, generally one foot, which increases the effect of SOD.**
- (5) Water velocities are sluggish, which intensifies the effect of BOD decay.**
- (6) All point sources discharge continuously at their NPDES permit limits for the same critical period.**

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Tobesofkee Creek

1. 303(d) Listed Waterbody Information

State: Georgia
County: Bibb

Major River Basin: Ocmulgee
8-Digit Hydrologic Unit Code(s): 03070104

Waterbody Name: Tobesofkee Creek
Location: Lake Tobesofkee to Rocky Creek
Stream Length: 10 miles
Watershed Area: 212.08 or 31.14 square miles
Tributary to: Ocmulgee River
Ecoregion: Southern Coastal Plain

Constituent(s) of Concern: Dissolved Oxygen

Designated Use: Fishing (not supporting designated use)

Applicable Water Quality Standards:

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.

Natural Water Quality. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

2. TMDL Development

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

Calibration Data: USGS field data from summer 2004.

Critical Conditions:

- (1) 7Q10 flows based on low-flow analysis of available data from the Ocmulgee River Basin.
- (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 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): 424 lbs/day Barnesville WPCP
Wasteload Allocations (WLA_{sw}): NA

Load Allocation (LA): 2,425 lbs/day

TMDL 2,849 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) Low flow 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) Dissolved oxygen saturation, for all flows entering the system, equal those measured during the low dissolved oxygen period in the summer of 2004.**
- (4) Water depths are shallow, generally one foot, which increases the effect of SOD.**
- (5) Water velocities are sluggish, which intensifies the effect of BOD decay.**
- (6) All point sources discharge continuously at their NPDES permit limits for the same critical period.**