Total Maximum Daily Load

Evaluation

for

Seven Stream Segments

in the

Ocmulgee River Basin

for

Fecal Coliform

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

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

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of two categories with respect to designated uses: supporting or 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, 2008 – 2009). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

Some of the 305(b) 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 TMDLs in this document are based on the 2010 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

Every water in the State has one or more designated uses, and each designated use has water quality criteria established to protect them. The State of Georgia has placed seven stream segments in the Ocmulgee River Basin on the 303(d) list of impaired waters because they were assessed as "not supporting" their designated use of "Fishing" due to violation of the fecal coliform water quality criteria. The water quality criteria for fecal coliform bacteria for a water with a designated use of fishing are as follows: For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform counts are not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. For the months of November through April, fecal coliform counts are not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. A water is assessed as "not supporting" its use if more than 10% of the geometric means exceeded the water quality criteria cited above. If no geometric means are available, a water is assessed as "not supporting" its use if more than 10 percent of individual samples exceed the fecal coliform criteria.

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 accumulated fecal coliform bacteria that wash off land surfaces as a result of storm events.

The process of developing fecal coliform bacteria TMDLs for the Ocmulgee River Basin listed segments includes the determination of the following:

- The current critical fecal coliform load to the stream under existing conditions;
- The TMDL for similar conditions under which the current critical load was determined; and
- The percent reduction in the current critical fecal coliform load necessary to achieve the TMDL.

The calculation of the fecal coliform load at any point in a stream requires the fecal coliform concentration and stream flow. The availability of water quality and flow data varies considerably among the listed segments. The Loading Curve Approach was used to determine the current fecal coliform load and TMDL. The fecal coliform loads and required reductions for each of the listed segments are summarized in the table below.

Management practices that may be used to help reduce fecal coliform source loads include:

- Compliance with NPDES permit limits and requirements;
- Adoption of NRCS Conservation Practices; and
- Application of Best Management Practices (BMPs) appropriate to reduce nonpoint sources.

The amount of fecal coliform bacteria delivered to a stream is difficult to determine. However, the use of these management practices should improve stream water quality, and future monitoring will provide a measurement of TMDL implementation.

Fecal Coliform Loads and Required Fecal Coliform Load Reductions

Stream Segment	Current Load (counts/ 30 days)	TMDL Components					Percent Reduction
		WLA (counts/ 30 days)	WLAsw (counts/ 30 days)	LA (counts/ 30 days)	MOS (counts/ 30 days)	TMDL (counts/ 30 days)	
Big Cotton Indian Creek	5.05E+13	-	2.08E+12	2.45E+12	5.04E+11	5.04E+12	90
Cedar Creek	2.13E+12	-	3.38E+11	2.53E+11	6.56E+10	6.56E+11	69
Little Cotton Indian Creek	2.99E+13	-	4.88E+12	9.72E+12	1.62E+12	1.62E+13	46
Panther Creek	1.09E+13	1.30E+12	2.28E+11	2.12E+11	1.93E+11	1.93E+12	82
Reeves Creek	1.53E+13	-	1.46E+12	1.80E+12	3.62E+11	3.62E+12	76
Rum Creek	1.20E+13	-	2.01E+12	3.11E+12	5.70E+11	5.70E+12	52
Upton Creek	1.31E+12	-	1.01E+11	1.06E+11	2.30E+10	2.30E+11	82

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 categorized with respect to designated uses as supporting or not supporting. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that addresses the assessment process, and are published in *Water Quality in Georgia* (GA EPD, 2008 – 2009). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

Some of the 305(b) 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 TMDLs in this document are based on the 2010 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The list identifies the waterbodies that are not supporting their designated use classifications due to exceedances of water quality standards for fecal coliform bacteria. Fecal coliform bacteria are used as an indicator of the potential presence of pathogens in a stream. Table 1 presents the seven streams in the Ocmulgee River Basin included on the 2010 303(d) list for exceedances of the fecal coliform standard criteria.

Table 1. Water Bodies Listed on the 2010 303(d) List for Fecal Coliform Bacteria in the Ocmulgee River Basin

Stream Segment	Location	Reach ID	Segment Length (miles)	Designated Use
Big Cotton Indian Creek	Tar Creek to Panther Creek	GAR030701030213	1	Fishing
Cedar Creek	Hogan Lake to Alcovy River	GAR030701030715	7	Fishing
Little Cotton Indian Creek	Confluence of Reeves and Rum Creeks to Clayton County Hooper Reservoir	GAR030701030212	2	Fishing
Panther Creek	Headwaters to Big Cotton Indian Creek	GAR030701030207	6	Fishing
Reeves Creek	Minska Pinska Dam to Little Cotton Indian Creek	GAR030701030206	5	Fishing
Rum Creek	Lake Spivey to Little Cotton Indian Creek	GAR030701030205	4	Fishing
Upton Creek	Headwaters to Big Cotton Indian Creek	GAR030701030209	3	Fishing

1.2 Watershed Description

The Ocmulgee River Basin is located in central Georgia, occupying an area of 6,102 square miles, originating in the eastern edges of the City of Atlanta. The Ocmulgee River basin falls within the Level III Piedmont and Southeastern Plains Ecoregions. The Upper Ocmulgee River watershed is located in the Level IV Southern Outer Piedmont Subecoregion. The Lower and Little Ocmulgee River watersheds are multifaceted watersheds, with portions of the watersheds located in the Level IV Southern Outer Piedmont, the Sand Hills, the Coastal Plain Red Uplands and the Atlantic Southern Loam Plains. There is also a corridor, running the length of the river and extending (approximately) one half to two miles inland on each side of the River, which lies in the Southeastern Floodplains and Low Terraces Subecoregion. Typical characteristics for these subecoregions are as follows:

- Southern Outer Piedmont - this region contains mostly rolling to hilly terrain; mostly red clayey soils; southern most boundary occurs at the fall line; major forest type is loblolly short-leafed pine.
- Sand Hills – rolling to hilly, highly dissected coastal plain belt; generally low nutrient sand and clay soils.
- Coastal Plain Red Uplands - this region contains mostly well drained soils composed of red sand and clay; the majority of the land is utilized as cropland or pasture.
- Atlantic Southern Loam Plains - this region contains soils ranging from poorly drained to excessively drained; longleaf pine, oak and some distinctive evergreen shrubs are common vegetation.
- Southeastern Floodplains and Low Terraces - this region contains large sluggish rivers and backwaters with ponds, swamps and oxbow lakes; terraces are typically covered by oak forests, while forests of bald cypress and water tupelo grow in the swamps and river areas.

The Ocmulgee River Basin includes three United States Geologic Survey (USGS) eight-digit hydrologic units, HUC 03070103 (Upper Ocmulgee River watershed), HUC 03070104 (Lower Ocmulgee River watershed), and HUC 03070105 (Little Ocmulgee River watershed). 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 115 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. Figure 1 shows the locations of these sub-basins. Figure 2 shows the listed segments within HUC 03070103, and the associated counties within this sub-basin.

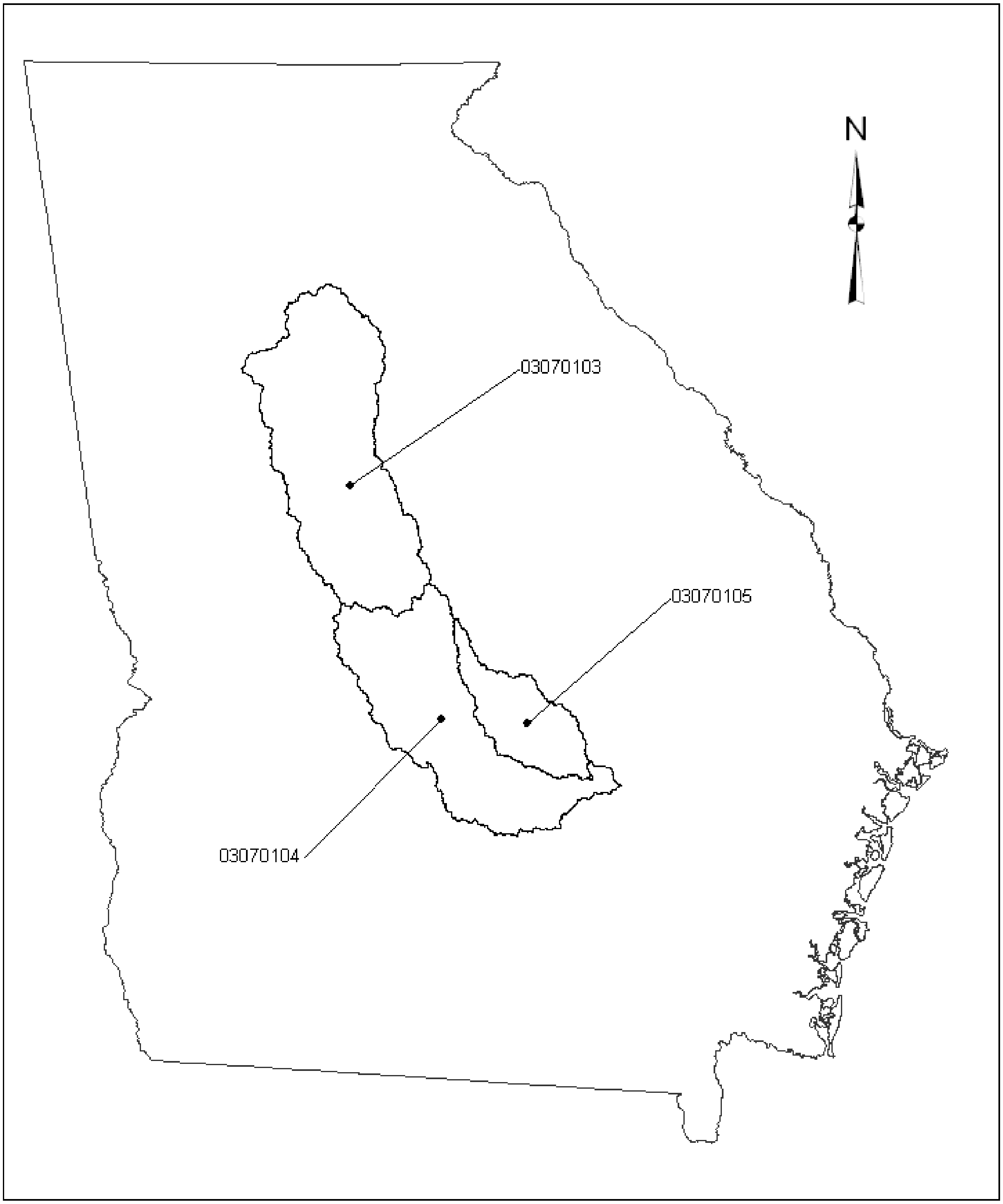
The land use characteristics of the Ocmulgee River Basin watersheds were determined using data from the Georgia Land Use Trends (GLUT) for Year 2008. This raster land use trend product was developed by the University of Georgia – Natural Resources Spatial Analysis Laboratory (NARSAL) and follows land use trends for years 1974, 1985, 1991, 1998, 2001, 2005 and 2008. The raster data sets were developed from Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+). Some of the NARSAL land use types were reclassified, aggregated into similar land use types, and were used in the final watershed characterization. Table 2 lists the watershed land use distribution for the drainage areas of the seven stream segments.

1.3 Water Quality Standard

The water use classification for the listed stream segments in the Ocmulgee River Basin is Fishing. The criterion violated is listed as fecal coliform. The potential causes listed include urban runoff, nonpoint sources, and municipal facilities. The use classification water quality standards for fecal coliform bacteria, as stated in the *State of Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(6)(c)(iii) (GA EPD, 2009), are:

(c) Fishing: Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality:

(iii) Bacteria: For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The State does not encourage swimming in surface waters since a number of factors which are beyond the control of any State regulatory agency contribute to elevated levels of fecal coliform. For waters designated as approved shellfish harvesting waters by the appropriate State agencies, the requirements will be consistent with those established by the State and Federal agencies responsible for the National Shellfish Sanitation Program. The requirements are found in the National Shellfish Sanitation Program Manual of Operation, Revised 1988, Interstate Shellfish Sanitation Conference, U. S. Department of Health and Human Services (PHS/FDA), and the Center for Food Safety and Applied Nutrition. Streams designated as generally supporting shellfish are listed in Paragraph 391-3-6-.03(14)



TMDL Evaluation - Fecal Coliform
Ocmulgee River Basin

Figure 1. USGS 8-Digit HUCs for Ocmulgee River Basin

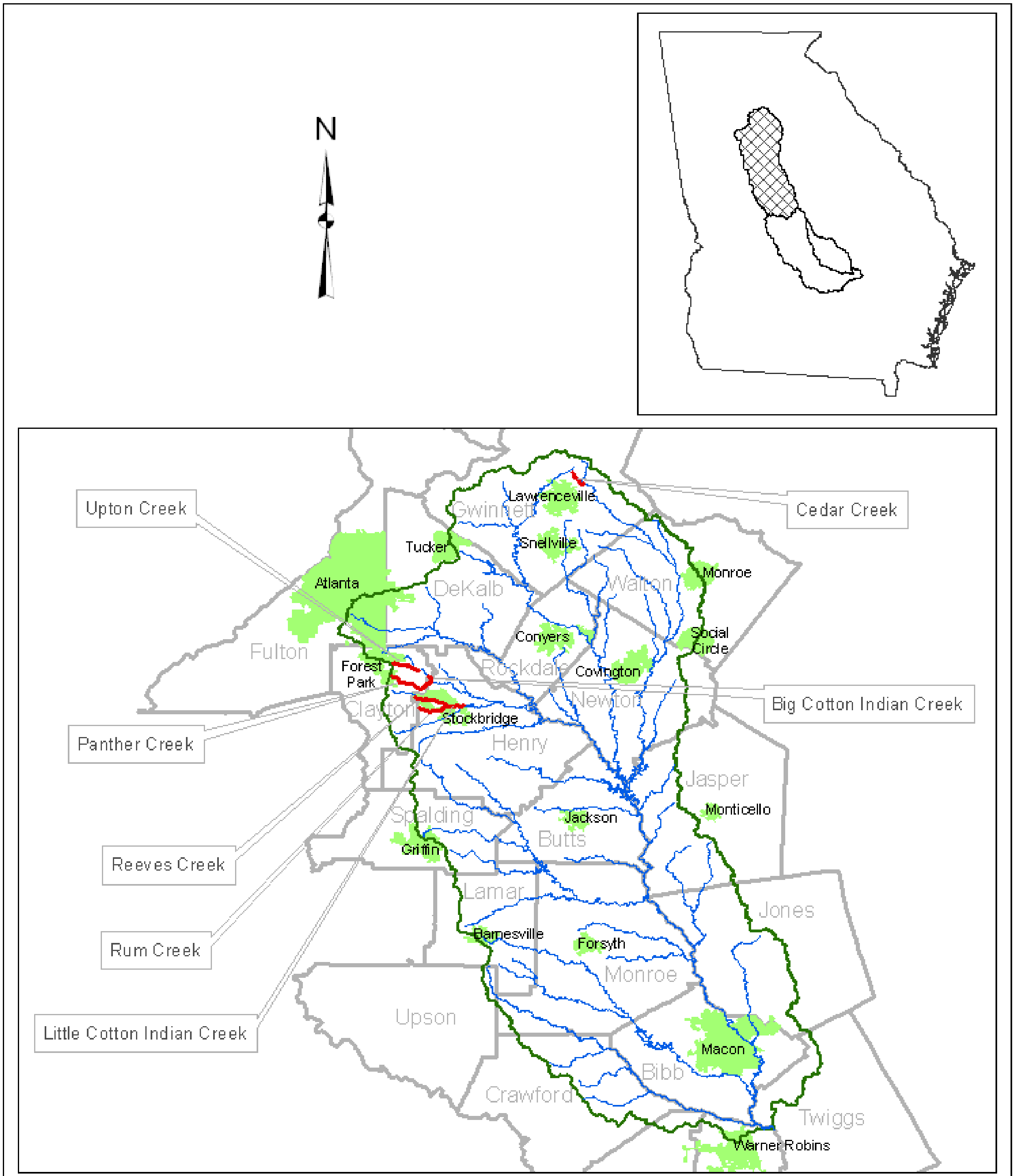


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Figure 2. Impaired Stream Segments in HUC 03070103

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	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
Big Cotton Indian Creek	39 (0.4)	2,983 (30.9)	1,067 (11.1)	794 (8.2)	4 (0.0)	0 (0.0)	220 (2.3)	1,879 (19.5)	0 (0.0)	692 (7.2)	1,513 (15.7)	452 (4.7)	2 (0.0)	9,647 (100.0)
Cedar Creek	12 (0.5)	773 (30.0)	532 (20.6)	448 (17.4)	7 (0.3)	0 (0.0)	93 (3.6)	251 (9.7)	0 (0.0)	101 (3.9)	355 (13.8)	8 (0.3)	0 (0.0)	2,581 (100.0)
Little Cotton Indian Creek	1,033 (3.3)	7,506 (24.2)	2,927 (9.4)	1,281 (4.1)	74 (0.2)	252 (0.8)	1,215 (3.9)	9,630 (31.0)	5 (0.0)	1,709 (5.5)	4,095 (13.2)	1,309 (4.2)	10 (0.0)	31,047 (100.0)
Panther Creek	33 (0.5)	2,329 (37.5)	916 (14.7)	654 (10.5)	9 (0.1)	0 (0.0)	96 (1.5)	879 (14.1)	1 (0.0)	117 (1.9)	886 (14.3)	289 (4.7)	5 (0.1)	6,213 (100.0)
Reeves Creek	22 (0.3)	2,059 (29.7)	1,019 (14.7)	483 (7.0)	8 (0.1)	0 (0.0)	193 (2.8)	1,532 (22.1)	0 (0.0)	317 (4.6)	993 (14.3)	306 (4.4)	1 (0.0)	6,933 (100.0)
Rum Creek	574 (5.3)	3,118 (28.6)	923 (8.5)	324 (3.0)	22 (0.2)	0 (0.0)	253 (2.3)	2,872 (26.4)	0 (0.0)	613 (5.6)	1,888 (17.3)	308 (2.8)	2 (0.0)	10,899 (100.0)
Upton Creek	23 (0.9)	676 (26.6)	379 (14.9)	315 (12.4)	3 (0.1)	0 (0.0)	70 (2.8)	482 (18.9)	0 (0.0)	68 (2.7)	411 (16.1)	121 (4.7)	0 (0.0)	2,548 (100.1)

2.0 WATER QUALITY ASSESSMENT

Stream segments are placed on the 303(d) list as not supporting their water use classification based on water quality sampling data. A stream is placed on the not support list if more than 10% of the samples exceed the fecal coliform criteria. Water quality samples collected within a 30-day period that have a geometric mean in excess of 200 counts per 100 milliliters during the period May through October, or in excess of 1000 counts per 100 milliliters during the period November through April, are in violation of the bacteria water quality standard. There is also a single sample maximum criterion (4000 counts per 100 milliliters) for the months of November through April.

Fecal coliform data used for TMDLs developed in this document were collected during calendar years 2003 through 2008 by GA EPD as part of the trend monitoring program. These data are presented in Appendix A.

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

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

The USEPA 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.

Discharges from municipal and industrial wastewater treatment facilities can contribute fecal coliform to receiving waters. The Clayton County Northeast wastewater treatment facility is the only NPDES permitted discharge with a flow greater than 0.1 MGD identified in the Ocmulgee River Basin that could potentially impact streams on the 2010 303(d) list for fecal coliform bacteria. Table 3 provides the monthly average discharge flow and fecal coliform concentrations for this facility. This data was obtained from calendar year 2009 Discharge Monitoring Reports (DMR). The permitted fecal coliform concentration is also included in this table.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are two permitted CSO outfalls in the Ocmulgee River Basin. Neither of these CSO outfalls is upstream of the listed segments.

Table 3. NPDES Facilities Discharging Fecal Coliform Bacteria into Ocmulgee River Basin 303(d) Listed Stream Segments

Facility Name	NPDES Permit No.	Receiving Stream	303(d) Listed Segment	Actual 2009 Discharge		NPDES Permit Limits		Number of Fecal Coliform/ Flow Violations 2007 –2009
				Average Monthly Flow (MGD)[a]	Average Monthly FC (No./100mL)	Average Monthly Flow (MGD)	Average Monthly FC (No./100mL)	
Clayton County Northeast WPCP	GA0020575	Panther Creek	Panther Creek	4.27	11	6.0	200	0

Source: GA EPD Regional Offices

Notes: [a] Values shown are the annual average of the monthly average flows.

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 fecal coliform bacteria consist of those associated with industrial activities including construction sites disturbing 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. The industrial general permit requires that storm water discharging into an impaired stream segment or within one linear mile upstream of and within the same watershed as any portion of an impaired stream segment identified as "not supporting" its designated use(s), must satisfy the requirements of Part III.C. if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to stormwater. Sampling must be conducted for the pollutant(s) from nonpoint sources identified in the TMDL as causing the impairment. This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping.

Storm water discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. 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 58 permittees in Georgia.

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 28 Phase I MS4s in the Ocmulgee River Basin (Table 4).

Table 4. Phase I Permitted MS4s in the Ocmulgee River Basin

Name	Watershed
Atlanta	Chattahoochee, Ocmulgee
Avondale Estates	Chattahoochee, Ocmulgee
Bibb County	Ocmulgee
Clarkston	Chattahoochee, Ocmulgee
Clayton County	Chattahoochee, Flint, Ocmulgee
Dacula	Oconee, Ocmulgee
Dekalb County	Chattahoochee, Ocmulgee
Decatur	Chattahoochee, Ocmulgee
Duluth	Chattahoochee, Ocmulgee
East Point	Chattahoochee, Flint, Ocmulgee
Forest Park	Flint, Ocmulgee
Fulton County	Chattahoochee, Coosa, Flint, Ocmulgee
Grayson	Ocmulgee
Gwinnett County	Chattahoochee, Oconee, Ocmulgee
Hapeville	Flint, Ocmulgee
Jonesboro	Flint, Ocmulgee
Lake City	Flint, Ocmulgee
Lawrenceville	Ocmulgee
Lilburn	Ocmulgee
Lithonia	Ocmulgee
Lovejoy	Flint, Ocmulgee
Macon	Ocmulgee
Morrow	Flint, Ocmulgee
Norcross	Chattahoochee, Ocmulgee
Pine Lake	Ocmulgee
Snellville	Ocmulgee
Stone Mountain	Ocmulgee
Suwannee	Chattahoochee, Ocmulgee

Source: Nonpoint Source Program, GA EPD, 2011

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 area with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Twenty-nine counties, 58 cities, and 7 Department of Defense facilities are permitted under the Phase II regulations in Georgia. There are 23 Phase II MS4s in the Ocmulgee River Basin (Table 5).

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

Name	Watershed
Byron	Ocmulgee
Centerville	Ocmulgee
Conyers	Ocmulgee
Covington	Ocmulgee
Fort Gilllem	Flint, Ocmulgee
Griffin	Flint, Ocmulgee
Hampton	Flint, Ocmulgee
Henry County	Flint, Ocmulgee
Houston County	Ocmulgee
Jones County	Ocmulgee
Loganville	Ocmulgee
McDonough	Ocmulgee
Newton County	Ocmulgee
Oxford	Ocmulgee
Payne City	Ocmulgee
Peach County	Ocmulgee
Porterdale	Ocmulgee
Robbins Air Force Base	Ocmulgee
Rockdale County	Ocmulgee
Spalding County	Flint, Ocmulgee
Stockbridge	Ocmulgee
Walton County	Ocmulgee
Warner Robbins	Ocmulgee

Source: Nonpoint Source Program, GA EPD, 2011

Table 6 lists the Phase I or Phase II MS4 city or county urbanized areas upstream of listed segments in the Ocmulgee River Basin. The table provides the total area of this watershed, and the percentage of the watershed that is MS4 city or county urbanized area.

Table 6. Percentage of MS4 City or County Urbanized Area Upstream of 303(d) Listed Segments in the Ocmulgee River Basin

Stream Segment	Location	Total Area (square miles)	% In MS4 Urbanized Area
Big Cotton Indian Creek	Tar Creek to Panther Creek	15.07	65.64
Cedar Creek	Headwaters to Brushy Creek	4.03	81.65
Little Cotton Indian Creek	Confluence of Reeves and Rum Creeks to Clayton County Hooper Reservoir	48.51	47.72
Panther Creek	Headwaters to Big Cotton Indian Creek	9.71	74.01
Reeves Creek	Minska Pinska Dam to Little Cotton Indian Creek	10.83	63.90
Rum Creek	Lake Spivey to Little Cotton Indian Creek	17.03	56.07
Upton Creek	Headwaters to Big Cotton Indian Creek	3.98	69.75

3.1.3 Concentrated Animal Feeding Operations

Under the Clean Water Act, Concentrated Animal Feeding Units (CAFOs) are defined as point sources of pollution and are therefore subject to NPDES permit regulations. From 1999 through 2001, Georgia adopted rules for permitting swine and non-swine liquid manure animal feeding operations (AFOs). Georgia rules require medium size AFOs with more than 300 animal units (AU) but less than 1000 AU to apply for a non-discharge State land application system (LAS) waste disposal permit. Large operations with more than 1000 AU must apply for an NPDES permit (also non-discharge) as a CAFO. There are no swine and non-swine liquid manure CAFOs located upstream of the listed segments in the Ocmulgee River Basin that are registered or have land application permits.

In 2002, the USEPA promulgated expanded NPDES permit regulations for CAFOs that added dry manure poultry operations larger than 125,000 broilers or 82,000 layers. Georgia is consistently among the top three states in the U.S. in terms of poultry operations. The majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. Freshly stored litter can be a nonpoint source for fecal coliform. However, land applied litter that was previously stored for an extended length of time typically exhibits very low fecal coliform levels. There are no dry manure poultry operations located upstream of the listed segments in the Ocmulgee River Basin that have submitted an application for the General NPDES Permit GAG930000.

The USEPA CAFO regulations were successfully appealed in 2005 and revised to comply with the court decision. That decision limits permitting to actual discharges rather than those with a potential to discharge. Georgia's rules are scheduled to be revised by the end of 2011 to incorporate the USEPA revisions. The effect of these revisions will be to reduce the permitted CAFO community to only those that actually discharge to surface waters.

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. Typical nonpoint sources of fecal coliform bacteria include:

- Wildlife
- Agricultural Livestock
  - Animal grazing
  - Animal access to streams
  - Application of manure to pastureland and cropland
- Urban Development
  - Leaking sanitary sewer lines
  - Leaking septic systems
  - Land Application Systems
  - Landfills

In urban areas, a large portion of storm water runoff may be collected in storm sewer systems and discharged through distinct outlet structures. For large urban areas, these storm sewer discharge points may be regulated as described in Section 3.1.2.

3.2.1 Wildlife

The importance of wildlife as a source of fecal coliform bacteria in streams varies considerably, depending on the animal species present in the watersheds. Based on information provided by the Wildlife Resources Division (WRD) of GA DNR, the animals that spend a large portion of their time in or around aquatic habitats are the most important wildlife sources of fecal coliform. Waterfowl, most notably ducks and geese, are considered to potentially be the greatest contributors of fecal coliform. This is because they are typically found on the water surface, often in large numbers, and deposit their feces directly into the water. Other potentially important animals regularly found around aquatic environments include racoons, beavers, muskrats, and to a lesser extent, river otters and minks. Recently, rapidly expanding feral swine populations have become a significant presence in the floodplain areas of all the major rivers in Georgia. Population estimates of these animal species in Georgia are currently not available.

White-tailed deer populations are abundant throughout the Ocmulgee River Basin. Fecal coliform bacteria contributions to water bodies from deer are generally considered to be less significant than that of waterfowl, racoons, and beavers. This is because a greater portion of their time is spent in terrestrial habitats. This also holds true for other terrestrial mammals such as squirrels and rabbits, and for terrestrial birds (GA WRD, 2007). However, feces deposited on the land surface can result in the introduction of fecal coliform to streams during runoff events. Between storm events, considerable decomposition of the fecal matter might occur, resulting in a decrease in the associated fecal coliform numbers.

3.2.2 Agricultural Livestock

Agricultural livestock are a potential source of fecal coliform to streams in the Ocmulgee River Basin. The animals grazing on pastureland deposit their feces onto land surfaces, where it can then be transported during storm events to nearby streams. Animal access to pastureland varies monthly, resulting in varying fecal coliform loading rates throughout the year. Beef cattle spend all of their time in pastures, while dairy cattle and hogs are periodically confined. In addition, agricultural livestock will often have direct access to streams that pass through their pastures, and can thus impact water quality in a more direct manner (USDA, 2002).

Table 7 provides the estimated number of beef cattle, dairy cattle, goats, horses, swine, sheep, and chickens reported by county. These data were provided by the Natural Resources Conservation Service (NRCS).

Table 7. 2009 Estimated Agricultural Livestock Populations in the Ocmulgee River Basin

County	Livestock								
	Beef Cattle	Dairy Cattle	Swine	Sheep	Horses	Goats	Chickens-Layers	Chickens-Broilers Sold	Chickens-Breeders
Ben Hill	2,900	-	100	-	750	1,600	-	1,656,000	-
Bibb	900	200	-	-			-	1,430,000	-
Bleckley	4,200	-	-	-	200	5,500	-	700,000	-
Butts	1,325	-	-	10	-	-	-	-	-
Clayton	-	-	-	-	-	2,000	-	-	-
Coffee	9,500	-	250	100	200	7,500	15,600	12,174,600	56,000
Crawford	1,500	-	-	-	200	200	-	12,525,500	-
De Kalb	-	-	-	-	-	-	-	-	-
Dodge	10,500	-	-	-	250	1,200	-	2,848,000	-
Dooly	2,000	275	350	-	50	200	-	8,784,000	-
Fulton	6,000	-	-	50	-	150	-	-	-
Gwinnett	3,500	-	-	-	-	550	-	2,496,000	-
Henry	7,345	-	-	45	750	275	-	-	-
Houston	800	350	-	20	275	275	-	3,795,000	-
Jasper	8,300	780	10	400	175	650	22,000	704,000	234,000
Jeff Davis	6,500	-	20	-	600	1,000	-	19,297,600	-
Jones	4,700	350	-	-	150	150	-	1,830,400	-
Lamar	2,700	200	25	25	350	1,500	-	8,112,500	-
Laurens	7,000	600	-	250	100	200	-	-	-
Macon	3,000	12,000	-	-	400	800	286,000	32,340,000	352,000
Monroe	3,850	200	-	40	300	1,200	-	10,898,349	-
Newton	7,000	75	-	55	150	1,000	-	312,000	-
Peach	800	-	-	-	225	100	-	-	-
Pulaski	700	-	50	20	200	150	-	11,000,000	-
Rockdale	-	-	-	-	250	200	-	-	-
Spaulding	1,700	350	-	-	200	100	-	1,020,000	-
Telfair	4,000	-	100	35	50	1,500	-	-	-
Twiggs	3,125	-	25	-	60	750	-	-	-
Upson	3,700	400	-	15	400	1,200	-	7,280,000	-
Walton	6,300	-	40	-	1,000	1,000	84,000	3,212,000	-
Wheeler	5,170	-	96	-	360	945	-	-	-
Wilcox	4,000	560	60	6	160	800	72,000	18,360,000	-

Source: NRCS, 2011

3.2.3 Urban Development

Fecal coliform from urban areas are attributable to multiple sources, including: domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges, leaking septic systems, runoff from improper disposal of waste materials, and leachate from both operational and closed landfills.

Urban runoff can contain high concentrations of fecal coliform from domestic animals and urban wildlife. Fecal coliform bacteria enter streams by direct washoff from the land surface, or the runoff may be diverted to a storm water collection system and discharged through a discrete outlet structure. For large, medium, and small urban areas (populations greater than 50,000), the storm water outlets are regulated under MS4 permits (see Section 3.1.2). For smaller urban areas, the storm water discharge outlets currently remain unregulated.

In addition to urban animal sources of fecal coliform, there may be illicit connections to the storm sewer system. As part of the MS4 permitting program, municipalities are required to conduct dry-weather monitoring to identify and then eliminate these illicit discharges. Fecal coliform bacteria may also enter streams from leaky sewer pipes, or during storm events when inflow and infiltration can cause sewer overflows.

3.2.3.1 Leaking Septic Systems

A portion of the fecal coliform contributions in the Ocmulgee River Basin may be attributed to failure of septic systems and illicit discharges of raw sewage. Table 8 presents the number of septic systems in each county of the Ocmulgee River Basin existing in 2004 and the number existing in 2009, based in part on U.S. Census data, and on the Georgia Department of Human Resources, Division of Public Health data. In addition, an estimate of the number of septic systems installed and repaired during the five-year period from 2005 through 2009 is given. These data show an increase in the number of septic systems in all of the counties. Often, this is a reflection of population increases outpacing the expansion of sewage collection systems.

Table 8. Estimated Number of Septic Systems in the Ocmulgee River Basin

County	Existing Septic Systems (2004)[1]	Existing Septic Systems (2009)	Number of Septic Systems Installed (2005 to 2009)	Number of Septic Systems Repaired (2005 to 2009)
Ben Hill	4,479	4,971	492	30
Bibb	10,820	11,258	438	417
Bleckley	3,325	3,569	244	69
Butts	7,243	8,017	774	171
Clayton	14,014	14,219	205	633
Coffee	11,681	12,926	1,245	89
Crawford	4,148	4,437	289	77
De Kalb	22,292	22,572	280	1,029
Dodge	6,526	7,124	598	8
Dooly	2,397	2,526	129	34
Fulton	26,994	27,881	887	530
Gwinnett	63,665	65,130	1,465	1,929
Henry	34,691	38,153	3,462	520
Houston	16,582	18,236	1,654	448
Jasper	5,102	5,081	572	93
Jeff Davis	3,982	4,318	336	7
Jones	9,035	9,755	720	264
Lamar	5,177	5,740	563	117
Laurens	13,630	14,920	1,290	255
Macon	2,409	2,535	126	13
Monroe	8,413	9,624	1,211	141
Newton	24,605	27,212	2,607	166
Peach	5,965	6,527	562	83
Pulaski	2,529	2,744	215	32
Rockdale	14,302	15,287	985	266
Spaulding	15,156	16,250	1,094	447
Telfair	2,961	3,209	248	11
Twiggs	3,752	3,956	204	37
Upson	7,960	8,312	352	382
Walton	20,248	23,472	3,224	367
Wheeler	2,134	2,306	172	13
Wilcox	2,275	2,371	96	0

Source: The Georgia Dept. of Human Resources, Division of Public Health, 2011
Notes: [1] Adjusted from State Water Plan values

3.2.3.2 Land Application Systems

Many smaller communities use land application systems (LAS) for treatment of their sanitary wastewaters. 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 fecal coliform bacteria to nearby surface waters. Some of these facilities may also exceed the ground percolation rate when applying the wastewater, resulting in surface runoff from the field. If not properly bermed, this runoff, which probably contains fecal coliform bacteria, may discharge to nearby surface waters. There is one permitted LAS system located upstream of the listed streams in the Ocmulgee River Basin (Table 9).

Table 9. Permitted Land Application Systems Upstream of 303(d) Listed Segments in the Ocmulgee River Basin

<table>
<tr><th>LAS Name</th><th>303(d) Listed Stream Segment</th><th>County</th><th>Permit No.</th><th>Type</th><th>Flow (MGD)</th></tr>
<tr><td rowspan="2">Clayton County LAS</td><td>Little Cotton Indian Creek</td><td rowspan="2">Clayton</td><td rowspan="2">GA02-008</td><td rowspan="2">Municipal</td><td rowspan="2">19.5</td></tr>
<tr><td>Rum Creek</td></tr>
</table>

Source: Permitting Compliance and Enforcement Program, GA EPD, Atlanta, Georgia, 2011

3.2.3.3 Landfills

Leachate from landfills may contain fecal coliform bacteria that may at some point discharge into surface waters. Sanitary (or municipal) landfills are the most likely to serve as a source of fecal coliform bacteria. These types of landfills receive household wastes, animal manure, offal, hatchery and poultry processing plant wastes, dead animals, and other types of wastes. Older sanitary landfills were not lined and most have been closed. Those that remain active and have not been lined operate as construction/demolition landfills. Currently active sanitary landfills are lined and have leachate collection systems. All landfills, excluding inert landfills, are now required to install environmental monitoring systems for groundwater and methane sampling. There are 159 known landfills in the Ocmulgee River Basin. Of these, 25 are active landfills and 134 are inactive or closed. Table 10 presents the one landfill that is upstream of a 303(d) listed stream segment.

Table 10. Landfills Upstream of 303(d) Listed Segments in the Ocmulgee River Basin

Name	303(d) Listed Stream Segment	County	Permit No.	Status
Lawrenceville (new)	Cedar Creek	Gwinnett	-	Inactive

Source: Land Protection Branch, GA DNR, 2011

4.0 ANALYTICAL APPROACH

The process of developing fecal coliform TMDLs for the Ocmulgee River Basin listed segments includes the determination of the following:

- The current critical fecal coliform load to the stream under existing conditions;
- The TMDL for similar conditions under which the current load was determined; and
- The percent reduction in the current critical fecal coliform load necessary to achieve the TMDL.

The calculation of the fecal coliform load at any point in a stream requires the fecal coliform concentration and stream flow. The Loading Curve Approach was used to determine the current fecal coliform load and the TMDL. For the listed segments, fecal coliform sampling data were sufficient to calculate at least one 30-day geometric mean to compare with the regulatory criteria (see Appendix A).

4.1 Loading Curve Approach

For those segments in which sufficient water quality data were collected to calculate at least one 30-day geometric mean that was above the regulatory standard, the loading curve approach was used. This method involves comparing the current critical load to summer and winter seasonal TMDL curves.

The available field measurements and water quality data used to develop the TMDLs for this document did not include stream flow data for any of the sites. Therefore, stream flows for the sites were estimated using data from a nearby USGS gaged stream. The nearby stream had relatively similar watershed characteristics, including landuse, slope, and drainage area. The stream flows were estimated by multiplying the gaged flow by the ratio of the listed stream drainage area to the gaged stream drainage area. Table 11 provides the USGS stream gages used to estimate the flows for each of the listed stream segments.

Table 11. Stream Segments with Estimated Flows and Corresponding USGS Flow Gages

Stream Segment	Location	USGS Station Name	Station No.
Cedar Creek	Hogan Lake to Alcovy River	Alcovy River near Lawrenceville, GA	02208050
Big Cotton Indian Creek	Tar Creek to Panther Creek	South River at Forrest Park Road, at Atlanta, GA	02203655
Little Cotton Indian Creek	Confluence of Reeves and Rum Creeks to Clayton County Hooper Reservoir		
Panther Creek	Headwaters to Big Cotton Indian Creek		
Reeves Creek	Minska Pinska Dam to Little Cotton Indian Creek		
Rum Creek	Lake Spivey to Little Cotton Indian Creek		
Upton Creek	Headwaters to Big Cotton Indian Creek		

The current critical loads were determined using fecal coliform data collected within a 30-day period to calculate the geometric means, and multiplying these values by the arithmetic means of the flows measured at the time the water quality samples were collected. Georgia's instream fecal coliform standards are based on a geometric mean of samples collected over a 30-day period, with samples collected at least 24 hours apart. To reflect this in the load calculation, the fecal coliform loads are expressed as 30-day accumulated loads with units of counts per 30 days. This is described by the equation below:

= x

Where:

= current critical fecal coliform load
= fecal coliform concentration as a 30-day geometric mean
= stream flow as an arithmetic mean

The current estimated critical load is dependent on the fecal coliform concentrations and stream flows measured during the sampling events. The number of events sampled is usually 16 per year. Thus, these loads do not represent the full range of flow conditions or loading rates that can occur. Therefore, it must be kept in mind that the current critical loads used only represent the worst-case scenario that occurred among the time periods sampled.

The maximum fecal coliform load at which the instream fecal coliform criteria will be met can be determined using a variation of the equation above. By setting C equal to the seasonal, instream fecal coliform standard, the load will equal the TMDL. However, the TMDL is dependent on stream flow. Figures in Appendix A graphically illustrate that the TMDL is a continuum for the range of flows (Q) that can occur in the stream over time. There are two TMDL curves shown in these figures. One represents the summer TMDL for the period May through October when the 30-day geometric mean standard is 200 counts/100 mL. The second curve represents the winter TMDL for the period November through April when the 30-day geometric mean standard is 1,000 counts/100 mL. The equations for these two TMDL curves are:

= 200 counts (as a 30-day geometric mean)/100 mL x Q

= 1,000 counts (as a 30-day geometric mean)/100 mL x Q

The graphs show the relationship between the current critical load ( ) and the TMDL. The TMDL for a given stream segment is the load for the mean flow corresponding to the current critical load. This is the point where the current load exceeds the TMDL curve by the greatest amount. This critical TMDL can be represented by the following equation:

= x

Where:

= critical fecal coliform TMDL load
= seasonal fecal coliform standard (as a 30-day geometric mean)
summer - 200 counts/100 mL
winter - 1,000 counts/ 100 mL
= stream flow as an arithmetic mean (same as used for)

A 30-day geometric mean load that plots above the respective seasonal TMDL curve represents an exceedance of the instream fecal coliform standard. The difference between the current critical load and the TMDL curve represents the load reduction required for the stream segment to meet the appropriate instream fecal coliform standard. There is also a single sample maximum criterion (4,000 counts per 100 milliliters) for the months of November through April. If a single sample exceeds the maximum criterion, and the seasonal geometric mean criteria is also exceeded, then the TMDL is based on the criteria exceedance requiring the largest load reduction. The percent load reduction can be expressed as follows:

$$\text{Percent Load Reduction} = \frac{-}{} \times 100$$

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, which is, in this case, the seasonal fecal coliform standard. A TMDL is the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For fecal coliform bacteria, the TMDLs are expressed as counts per 30 days as a geometric mean.

A TMDL is expressed as follows:

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

The TMDL calculates the WLAs and LAs with margins of safety to meet the stream's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate data are available to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits and controls or lead to new limits, and 2) LAs that confirm existing controls or include implementing new controls (USEPA, 1991). A phased TMDL requires additional data be collected to determine if load reductions required by the TMDL are leading to the attainment of water quality standards.

The TMDL Implementation Plan establishes a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segment water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

The fecal coliform loads calculated for each listed stream segment include the sum of the total loads from all point and nonpoint sources for the segment. The load contributions to the listed segment from unlisted upstream segments are represented in the background loads, unless the unlisted segment contains point sources that had permit violations for fecal coliform. In these cases, the upstream point sources are included in the wasteload allocations for the listed segment. In situations where two or more adjacent segments are listed, the fecal coliform loads to each segment are individually evaluated on a localized watershed basis. Point source loads originating in upstream segments are included in the background loads of the downstream segment. The following sections describe the various fecal coliform TMDL components.

5.1 Waste Load Allocations

The waste load allocation 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 with flows greater than 0.1 MGD from municipal and industrial wastewater treatment systems with NPDES effluent limits for fecal coliform bacteria. There is one of these facilities in the Ocmulgee River Basin watershed that discharges into or upstream of a listed segment. The maximum allocated fecal coliform load for this wastewater treatment facility is given in Table 12. This WLA load was calculated from the permitted and permitted fecal coliform concentration. This was expressed as an accumulated load over a 30-day period, and presented in units of counts per 30 days. If a facility expands its capacity and the permitted flow increases, the wasteload allocation for the facility would increase in proportion to the flow.

Table 12. WLAs for the Ocmulgee River Basin

Facility Name	Permit No.	Receiving Stream	Listed Stream Segment	WLA (counts/30 days)
Clayton County Northeast WPCP	GA0020575	Panther Creek	Panther Creek	1.37E+12

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 is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

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

The waste load allocations from storm water discharges associated with MS4s (WLAsw) are estimated based on the percentage of urban area in each watershed covered by the MS4 storm water permit. At this time, the portion of each watershed that goes directly to a permitted storm sewer and that which goes through non-permitted point sources, or is sheet flow or agricultural runoff, has not been clearly defined. Thus, it is assumed that approximately 70 percent of storm water runoff from the regulated urban area is collected by the municipal separate storm sewer systems.

Wet and dry manure CAFOs are located within the Ocmulgee River Basin (see Section 3.1.3). These facilities are either included under or have applied for an LAS General Permit or an NPDES General Permit. A small number have an individual NPDES permit. Presently no CAFOs discharge wastewater, and therefore, they were not provided a WLA.

5.2 Load Allocations

The load allocation is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste;
- Land disposal;
- Agricultural and silvicultural;
- Mines;
- Construction;
- Saltwater intrusion; and
- Urban storm water (non-permitted).

The LA is calculated as the remaining portion of the TMDL load available, after allocating the WLA, WLAsw, and the MOS, using the following equation:

$$\Sigma \text{ LA} = \text{TMDL} - (\Sigma \text{ WLA} + \Sigma \text{ WLAsw} + \Sigma \text{MOS})$$

As described above, there are two types of load allocations: loads to the stream independent of precipitation, including sources such as failing septic systems, leachate from landfills, animals in the stream, leaking sewer system collection lines, and background loads; and loads associated with fecal coliform accumulation on land surfaces that is washed off during storm events, including runoff from saturated LAS fields. At this time, it is not possible to partition the various sources of load allocations. Table 13 presents the total load allocation expressed as counts per 30 days for the 303(d) listed streams located in the Ocmulgee River Basin for the current critical condition. In the future, after additional data has been collected, it may be possible to partition the load allocation by source.

5.3 Seasonal Variation

The Georgia fecal coliform criteria are seasonal. One set of criteria applies to the summer season, while a different set applies to the winter season. To account for seasonal variations, the critical loads for each listed segment were determined from sampling data obtained during both summer and winter seasons, when possible. The TMDL and percent reduction given in Table 13 for each listed segment was based on the season in which the critical load occurred. The TMDLs for each season, for any given flow, are presented as equations in Section 5.5.

Analyses of the available fecal coliform data and corresponding flows were performed to determine if the fecal coliform violations occurred during wet weather (high flow) or dry weather (low flow) conditions. The flow data from each sampling site were normalized by dividing the measured flow by the product of the average annual runoff (cfs/sq mile), published in Open-File Report 82-577 (Carter, 1982), and the appropriate drainage area. Plots of the normalized flows (Q/) versus fecal coliform are shown in Appendix B. The plots do not show a consistent relationship between fecal coliform concentrations and flow. The summer and winter plots show that the fecal coliform violations occur during both high (wet weather) and low (dry weather) flow conditions.

5.4 Margin of Safety

The MOS is a required component of TMDL development. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative modeling 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, an explicit MOS of 10 percent of the TMDL was used. The MOS values are presented in Table 13.

5.5 Total Fecal Coliform Load

The fecal coliform TMDL for the listed stream segment is dependent on the time of year, the stream flow, and the applicable state water quality standard.

The total maximum daily seasonal fecal coliform loads for Georgia are given below:

= 200 counts (as a 30-day geometric mean)/100 mL x Q

= 1,000 counts (as a 30-day geometric mean)/100 mL x Q

= 4,000 counts (instantaneous) /100 mL x Q

For purposes of determining necessary load reductions required to meet the instream water quality criteria, the current critical TMDL was determined. This load is the product of the applicable seasonal fecal coliform standard and the mean flow used to calculate the current critical load. It represents the sum of the allocated loads from point (WLA and) and nonpoint (LA) sources located within the immediate drainage area of the listed segment, the NPDES-permitted point discharges with recorded fecal coliform violations from the nearest upstream subwatersheds, and a margin of safety (MOS). For these calculations, the fecal load contributed by the permitted facility to the WLA was not the maximum presented in Table 12, but rather was the product of the fecal coliform permitted limit and the average monthly discharge at the time of the critical load. The current critical loads and corresponding TMDLs, WLAs (WLA and), LAs, MOSs, and percent load reductions for the Ocmulgee River Basin listed stream segments are presented in Table 13.

The relationships of the current critical loads to the TMDLs are shown graphically in Appendix A. The vertical distance between the two values represents the load reductions necessary to achieve the TMDLs. As a consequence of the localized nature of the load evaluations, the calculated fecal coliform load reductions pertain to point and nonpoint sources occurring within the immediate drainage area of the listed segment. These current critical values represent a worst-case scenario for the limited set of data. Thus, the load reductions required are conservative estimates, and should be sufficient to prevent exceedances of the instream fecal coliform standard for a wide range of conditions.

Evaluation of the relationship between instream water quality and the potential sources of pollutant loading is an important component of TMDL development, and is the basis for later implementation of corrective measures and BMPs. For the current TMDLs, the association between fecal coliform loads and the potential sources occurring within the subwatersheds of each segment was examined on a qualitative basis.

Table 13. Fecal Coliform Loads and Required Fecal Coliform Load Reductions

Stream Segment	Current Load (counts/ 30 days)	TMDL Components					Percent Reduction
		WLA (counts/ 30 days)[1]	WLAsw (counts/ 30 days)	LA (counts/ 30 days)	MOS (counts/ 30 days)	TMDL (counts/ 30 days)	
Big Cotton Indian Creek	5.05E+13	-	2.08E+12	2.45E+12	5.04E+11	5.04E+12	90
Cedar Creek	2.13E+12	-	3.38E+11	2.53E+11	6.56E+10	6.56E+11	69
Little Cotton Indian Creek	2.99E+13	-	4.88E+12	9.72E+12	1.62E+12	1.62E+13	46
Panther Creek	1.09E+13	1.30E+12	2.28E+11	2.12E+11	1.93E+11	1.93E+12	82
Reeves Creek	1.53E+13	-	1.46E+12	1.80E+12	3.62E+11	3.62E+12	76
Rum Creek	1.20E+13	-	2.01E+12	3.11E+12	5.70E+11	5.70E+12	52
Upton Creek	1.31E+12	-	1.01E+11	1.06E+11	2.30E+10	2.30E+11	82

Notes: [1] The assigned fecal coliform load from each NPDES permitted facility for WLA was determined as the product of the fecal coliform permit limit and the facility average monthly discharge at the time of the critical load.

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the subwatersheds for each 303(d) listed stream segment to identify, as best as possible, the sources of the fecal coliform loads causing the stream to exceed instream standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet fecal coliform water quality criteria so as to support the use classification specified for each listed segment.

This TMDL represents part of a long-term process to reduce fecal coliform loading to meet water quality standards in the Ocmulgee River Basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary in the next phase (next five-year cycle). The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions.

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. The Oconee, Ogeechee and Altamaha River Basins will again receive focused monitoring in 2014.

The TMDL Implementation Plan will outline an appropriate water quality monitoring program for the listed streams in the Ocmulgee River Basin. The monitoring program will be developed to help identify the various fecal coliform sources. The monitoring program may be used to verify the 303(d) stream segment listings. This will be especially valuable for those segments where limited data resulted in the listing.

6.2 Fecal Coliform Management Practices

Based on the findings of the source assessment, NPDES point source fecal coliform loads from wastewater treatment facilities usually do not significantly contribute to the impairment of the listed stream segments. This is because most facilities are required to treat to levels corresponding to instream water quality criteria. Sources of fecal coliform in urban areas include wastes that are attributable to domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, leaking septic systems, runoff from improper disposal of waste materials, and leachate from both operational and closed landfills. In agricultural areas, potential sources of fecal coliform may include CAFOs, animals grazing in pastures, dry manure storage facilities and lagoons, chicken litter storage areas, and direct access of livestock to streams. Wildlife, especially waterfowl can be a significant source of fecal coliform bacteria.

Management practices are recommended to reduce fecal coliform source loads to the listed 303(d) stream segments, with the result of achieving the instream fecal coliform standard criteria. These recommended management practices include:

- Compliance with NPDES permit limits and requirements;
- Adoption of NRCS Conservation Practices; and
- Application of Best Management Practices (BMPs) appropriate to agricultural or urban land uses, where applicable.

6.2.1 Point Source Approaches

Point sources are defined as discharges of treated wastewater or storm water into rivers and streams at discrete locations. The NPDES permit program provides a basis for municipal, industrial, and storm water permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations.

In accordance with GA EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times. In the future, all municipal and industrial wastewater treatment facilities with the potential for the occurrence of fecal coliform in their discharge will be given end-of-pipe limits equivalent to the water quality standard of 200 counts/100 mL. An exception is constructed wetland systems, which have a natural level of fecal coliform input from animals attracted to the artificial wetlands. In addition, the permits will include routine monitoring and reporting requirements.

6.2.2 Nonpoint Source Approaches

The GA EPD is responsible for administering and enforcing laws to protect the waters of the State. 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 to 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. The following sections describe, in more detail, recommendations to reduce nonpoint source loads of fecal coliform bacteria in Georgia's surface waters.

6.2.2.1 Agricultural Sources

The GA EPD should coordinate with other agencies that are responsible for agricultural activities in the state to address issues concerning fecal coliform loading from agricultural lands. It is recommended that information (e.g., livestock populations by subwatershed, animal access to streams, manure storage and application practices, etc.) be periodically reviewed so that watershed evaluations can be updated to reflect current conditions. It is also recommended that BMPs be utilized to reduce the amount of fecal coliform bacteria transported to surface waters from agricultural sources to the maximum extent practicable.

The following three organizations have primary responsibility for working with farmers to promote soil and water conservation, and to protect water quality:

- University of Georgia (UGA) - Cooperative Extension Service;
- Georgia Soil and Water Conservation Commission (GSWCC); and
- Natural Resources Conservation Service (NRCS).

UGA has faculty, County Cooperative Extension Agents, and technical specialists who provide services in several key areas relating to agricultural impacts on water quality.

The GA EPD designated the GSWCC as the lead agency for agricultural Nonpoint Source Management in the State. The GSWCC develops nonpoint source management programs and conducts educational activities to promote conservation and protection of land and water devoted to agricultural uses.

The NRCS works with federal, state, and local governments to provide financial and technical assistance to farmers. The NRCS develops standards and specifications for BMPs that are to be used to improve, protect, and/or maintain our state's natural resources. In addition, every five years, the NRCS conducts the National Resources Inventory (NRI). The NRI is a statistically based sample of land use and natural resource conditions and trends that covers non-federal land in the United States.

The NRCS is also providing technical assistance to the GSWCC and the GA EPD with the Georgia River Basin Planning Program. Planning activities associated with this program will describe conditions of the agricultural natural resource base once every five years. It is recommended that the GSWCC and the NRCS continue to encourage BMP implementation, education efforts, and river basin surveys with regard to river basin planning.

6.2.2.2 Urban Sources

Both point and nonpoint sources of fecal coliform bacteria can be significant in the Ocmulgee River Basin urban areas. Urban sources of fecal coliform can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed. In addition to water quality monitoring programs, discussed in Section 6.1, the following activities and programs conducted by cities, counties, and state agencies are recommended:

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;
- Further develop and streamline mechanisms for reporting and correcting illicit connections, breaks, surcharges, and general sanitary sewer system problems;
- Sustain compliance with storm water NPDES permit requirements; and
- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods.

6.3 Reasonable Assurance

Permitted discharges will be regulated through the NPDES permitting process described in this report. An allocation to a point source discharger does not automatically result in a permit limit or a monitoring requirement. Through its NPDES permitting process, GA EPD will determine whether a new or existing discharger has a reasonable potential of discharging fecal coliform levels equal to or greater than the total allocated load. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, the GA EPD will use its USEPA approved 2003 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

Georgia is working with local governments, agricultural and forestry agencies, such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission, to foster the implementation of best management practices to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of best management practices to protect water quality.

6.4 Public Participation

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

7.0 INITIAL TMDL IMPLEMENTATION PLAN

7.1 Initial TMDL Implementation Plan

This plan identifies applicable State-wide programs and activities that may be employed to manage point and nonpoint sources of bacteria loads for seven segments in the Ocmulgee River Basin. Local watershed planning and management initiatives will be fostered, supported, or developed through a variety of mechanisms. Implementation may be addressed by Watershed Improvement Projects, assessments for Section 319 (h) grants, the local development of watershed protection plans, or "Targeted Outreach" initiated by EPD. These initiatives will supplement or possibly replace this initial implementation plan.

7.2 Impaired Segments

This initial plan is applicable to the following waterbodies that were added to Georgia's 303(d) list available on the EPD website (www.gaepd.org):

Water Bodies Listed on the 2010 303(d) List for Fecal Coliform Bacteria in the Ocmulgee River Basin

Stream Segment	Location	Reach ID	Segment Length (miles)	Designated Use
Big Cotton Indian Creek	Tar Creek to Panther Creek	GAR030701030213	1	Fishing
Cedar Creek	Hogan Lake to Alcovy River	GAR030701030715	7	Fishing
Little Cotton Indian Creek	Confluence of Reeves and Rum Creeks to Clayton County Hooper Reservoir	GAR030701030212	2	Fishing
Panther Creek	Headwaters to Big Cotton Indian Creek	GAR030701030207	6	Fishing
Reeves Creek	Minska Pinska Dam to Little Cotton Indian Creek	GAR030701030206	5	Fishing
Rum Creek	Lake Spivey to Little Cotton Indian Creek	GAR030701030205	4	Fishing
Upton Creek	Headwaters to Big Cotton Indian Creek	GAR030701030209	3	Fishing

Fecal coliform bacteria are used as an indicator of the potential presence of pathogens in a stream. The current water quality standard [*State of Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(6)(c)(iii) (GA EPD, 2009)] states that four or more water samples collected within a 30-day period that have a geometric mean for fecal coliform either in excess of 200 Colony Forming Units (CFU) per 100 milliliters from May through October, or in excess of 1000 (CFU) per 100 milliliters from November through April are in violation of the bacteria water quality standard. In addition, a single sample in excess of 4000 (CFU) per 100 milliliters from November through April can also provide a basis for adding a stream segment to the 303(d) listing.

7.3 Potential Sources

An important part of the TMDL analysis is the identification of potential source categories. A source assessment characterizes the known and suspected bacteria sources in the watershed.

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. Point sources of bacteria include NPDES permittees discharging treated wastewater and stormwater. Nonpoint sources of bacteria are diffuse sources that cannot be identified as entering the water body at a single location. These sources generally involve land use activities that contribute bacteria to streams during a rainfall runoff event.

NPDES point source fecal coliform loads from wastewater treatment facilities usually do not contribute to impairments. This is because these facilities are required to treat to levels corresponding to instream water quality criteria. However, point sources can and do fail, which may contribute to bacteria loads through leaks and overflows from sanitary sewer systems, CAFOs, or leachate from operational landfills.

Nonpoint sources of fecal coliform in urban areas include wastes that are attributable to domestic animals, illicit discharges of sanitary waste, leaking septic systems, runoff from improper disposal of waste materials, and leachate from closed landfills. In non-urban areas, potential sources of fecal coliform may include animals grazing in pastures, dry manure storage facilities and lagoons, chicken litter storage areas, and direct access of livestock to streams. Wildlife, especially waterfowl can be a significant source of fecal coliform bacteria.

7.4 Management Practices and Activities

GA EPD is responsible for administering and enforcing laws to protect the waters of the State and is the lead agency for implementing the State's Nonpoint Source Management Program. Georgia is working with local governments, agricultural and forestry agencies such as the Georgia Department of Agriculture, the Natural Resource Conservation Service (NRCS), the Georgia Soil and Water Conservation Commission (GSWCC), and the Georgia Forestry Commission (GFC) to foster implementation of BMPs that address nonpoint source pollution. The following management practices are recommended to reduce fecal coliform loads to stream segments:

- Sustained compliance with NPDES permit limits and requirements where applicable;
- Adoption of NRCS Conservation Practices for primarily agricultural lands;
- Application of BMPs appropriate to specific non-urban and urban land uses;
- Further development and streamlining of local jurisdictional mechanisms for identifying, reporting, and correcting illicit connections, breaks, and other sanitary sewer system problems;
- Adoption of local ordinances (i.e. septic tanks, stormwater, etc.) that address local water quality; and
- Ongoing public education efforts on the sources of fecal coliform and common sense approaches to lessen the impact of this contaminant on surface waters.

Public education efforts target individual stakeholders to provide information regarding the use of BMPs to protect water quality. GA EPD will continue efforts to increase awareness and educate the public about the impact of human activities on water quality.

7.5 Monitoring

GA EPD encourages local governments and municipalities to develop water quality monitoring programs. These programs can help pinpoint various fecal coliform sources, as well as verify the 303(d) stream segment listings. This will be particularly valuable for those segments where listing was based on limited data. In addition, regularly scheduled sampling will determine if there has been some improvement in the water quality of the listed stream segments. GA EPD is available to assist in completing a monitoring plan, preparing a Sampling Quality Assurance Plan (SQAP), and/or providing necessary training as needed.

7.6 Future Action

This Initial TMDL Implementation Plan includes a general approach to pollutant source identification as well as management practices to address pollutants. In the future, GA EPD will continue to determine and assess the appropriate point and non-point source management measures needed to achieve the TMDLs and also to protect and restore water quality in impaired waterbodies.

For point sources, any wasteload allocations for wastewater treatment plant facilities will be implemented in the form of water-quality based effluent limitations in NPDES permits. Any wasteload allocations for regulated storm water will be implemented in the form of best management practices in the NPDES permits. Contributions of bacteria from regulated communities may also be managed using permit requirements such as watershed assessments, watershed protection plans, and long term monitoring. These measures will be directed through current point source management programs.

GA EPD will work to develop Watershed Improvement Projects (WIPs) to address non-point source pollution. This is a process whereby GA EPD and/or Regional Commissions or other agencies or local governments, under a contract with GA EPD, will develop a Watershed Improvement Plan intended to address water quality at the small watershed level (HUC 12). These plans will be developed as resources and willing partners become available. The development of these plans may be funded via several grant sources, including but not limited to, Clean Water Act Section 319(h), Section 604(b), and/or Section 106 grant funds. These plans are intended for implementation upon completion.

Any Watershed Improvement Plan that specifically address waterbodies contained within this TMDL will supersede the Initial TMDL Implementation Plan once GA EPD accepts the plan. Future Watershed Improvement Plans intended to address this TMDL and other water quality concerns, written by GA EPD and for which GA EPD and/or the GA EPD Contractor are responsible, will contain at a minimum the US EPA's 9-Key Elements of Watershed Planning:

1) An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load allocations or achieve water quality standards. Sources should be identified at the subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of cattle feedlots needing upgrading, Y acres of row crops needing improved bacteria control, or Z linear miles of eroded streambank needing remediation);

2) An estimate of the load reductions expected for the management measures;

3) A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;

4) An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;

5) An information/education component that will be used to enhance public understanding of and participation in implementing the plan;

6) A schedule for implementing the management measures that is reasonably expeditious;

7) A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

8) A set of criteria that can be used to determined whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9) A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8).

The public will be provided an opportunity to participate in the development of Watershed Improvement Plans that address impaired waters and to comment on them before they are finalized.

GA EPD will continue to offer technical and financial assistance (when and where available) to complete Watershed Improvement Plans that address the impaired waterbodies listed in this and other TMDL documents. Assistance may include but will not be limited to:

- Assessments of pollutant sources within watersheds;
- Determinations of appropriate management practices to address impairments;
- Identification of potential stakeholders and other partners;
- Developing a plan for outreach to the general public and other groups;
- Assessing the resources needed to implement the plan upon completion; and
- Other needs determined by the lead organization responsible for plan development.

GA EPD will also make this same assistance available, if needed, to proactively address water quality concerns. This assistance may be in the way of financial, technical, or other aid and may be requested and provided outside of the TMDL process or schedule.

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Appendix A

30-day Geometric Mean Fecal Coliform Monitoring Data

2003 Through 2008 Water Quality Monitoring Stations

Stream Segment	Location	GAEPD Monitoring Station No.	Monitoring Station Description
Big Cotton Indian Creek	Tar Creek to Panther Creek		Big Cotton Indian Creek at Homestead Road
Cedar Creek	Hogan Lake to Alcovy River	0403070102	Cedar Creek at Cedars Road near Dacula, Ga.
Little Cotton Indian Creek	Confluence of Reeves and Rum Creeks to Clayton County Hooper Reservoir		Little Cotton Indian Creek
Panther Creek	Headwaters to Big Cotton Indian Creek		Panther Creek at Highway 42
Reeves Creek	Minska Pinska Dam to Little Cotton Indian Creek		Reeves Creek at Tye Road
Rum Creek	Lake Spivey to Little Cotton Indian Creek		Rum Creek at Rock Quarry Road
Upton Creek	Headwaters to Big Cotton Indian Creek		Upton Creek

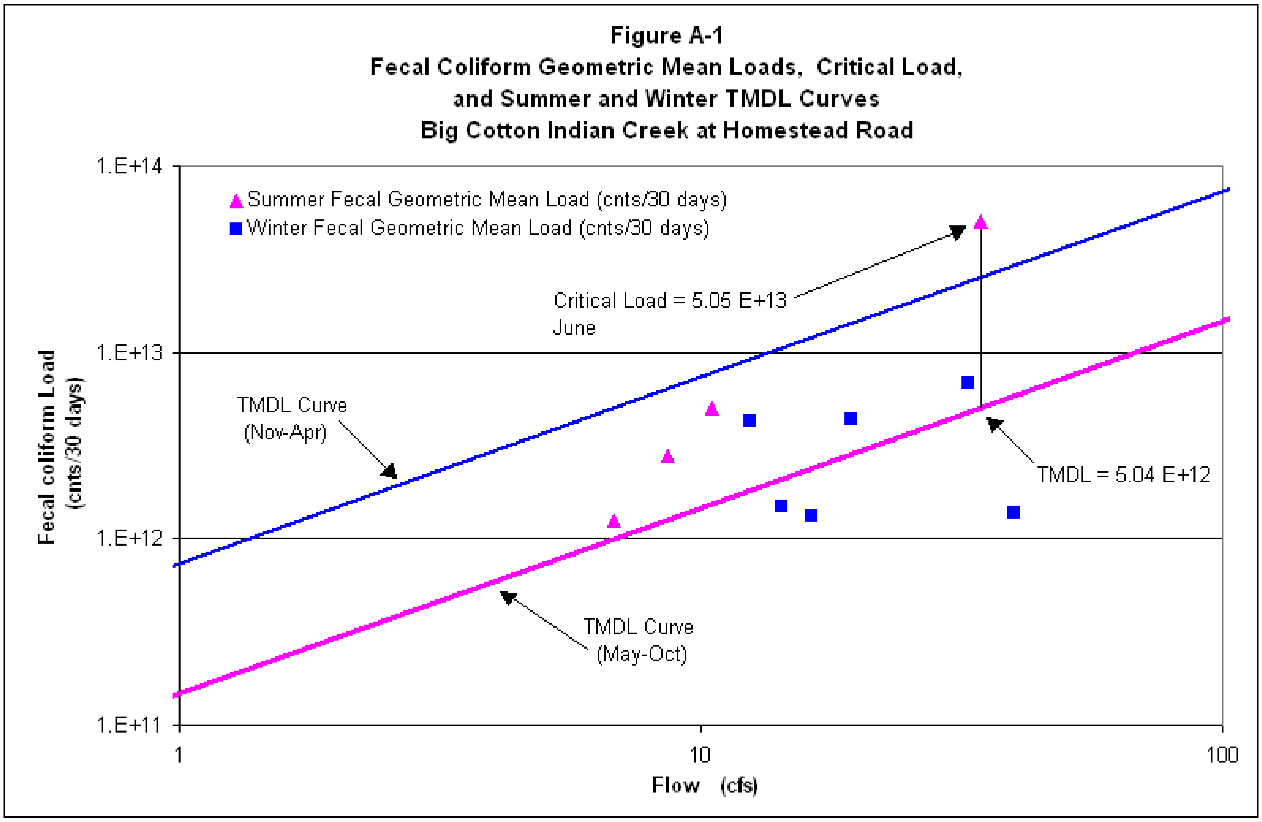


Figure A-1
Fecal Coliform Geometric Mean Loads, Critical Load,
and Summer and Winter TMDL Curves
Big Cotton Indian Creek at Homestead Road
Summer Fecal Geometric Mean Load (cnts/30 days)
Winter Fecal Geometric Mean Load (cnts/30 days)
Critical Load = 5.05 E+13
June
TMDL Curve
(Nov-Apr)
TMDL = 5.04 E+12
TMDL Curve
(May-Oct)
Fecal coliform Load
(cnts/30 days)
1.E+14
1.E+13
1.E+12
1.E+11
1
10
100
Flow (cfs)

Table A-1. Data for Figure A-1

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	45	12.1				
3/13/2003	20	10.1				
3/17/2003	15	68.4				
3/19/2003	373	68.4	47.4	39.7	1.38E+12	2.92E+13
3/21/2003	300	37.5				
3/25/2003	210	14.1				
3/27/2003	1050	13.4				
3/31/2003	130	12.7	304.5	19.4	4.35E+12	1.43E+13
4/3/2003	145	9.4				
4/7/2003	3500	90.5				
4/9/2003	210	21.5				
4/15/2003	64	8.7	287.4	32.5	6.86E+12	2.39E+13
4/5/2005	70	21.5				
4/14/2005	200	16.8				
4/19/2005	100	12.7				
4/25/2005	110	14.1	111.4	16.3	1.33E+12	1.19E+13
6/21/2005	130000	114.6				
6/23/2005	940	8.0				
6/27/2005	550	8.0				
6/29/2005	240	6.6	**2004.1**	**34.3**	**5.05E+13**	**5.04E+12**
9/22/2005	410	5.2				
9/27/2005	260	5.7				
9/29/2005	560	5.5				
10/6/2005	3100	25.5	655.9	10.5	5.04E+12	1.54E+12
12/16/2005	1100	23.5				
12/19/2005	566	8.7				
12/21/2005	100	8.7				
12/23/2005	790	8.7	470.9	12.4	4.29E+12	9.10E+12
3/1/2006	210	16.1				
3/9/2006	120	12.1				
3/16/2006	60	12.7				
3/23/2006	270	16.1	142.1	14.2	1.49E+12	1.05E+13
6/14/2006	82	7.4				
6/20/2006	545	5.2				
6/22/2006	260	5.3				
6/29/2006	330	9.4	248.8	6.8	1.25E+12	1.00E+12
9/12/2006	380	7.4				
9/18/2006	480	14.7				
9/21/2006	300	5.9				
9/26/2006	700	6.6	442.4	8.6	2.81E+12	1.27E+12

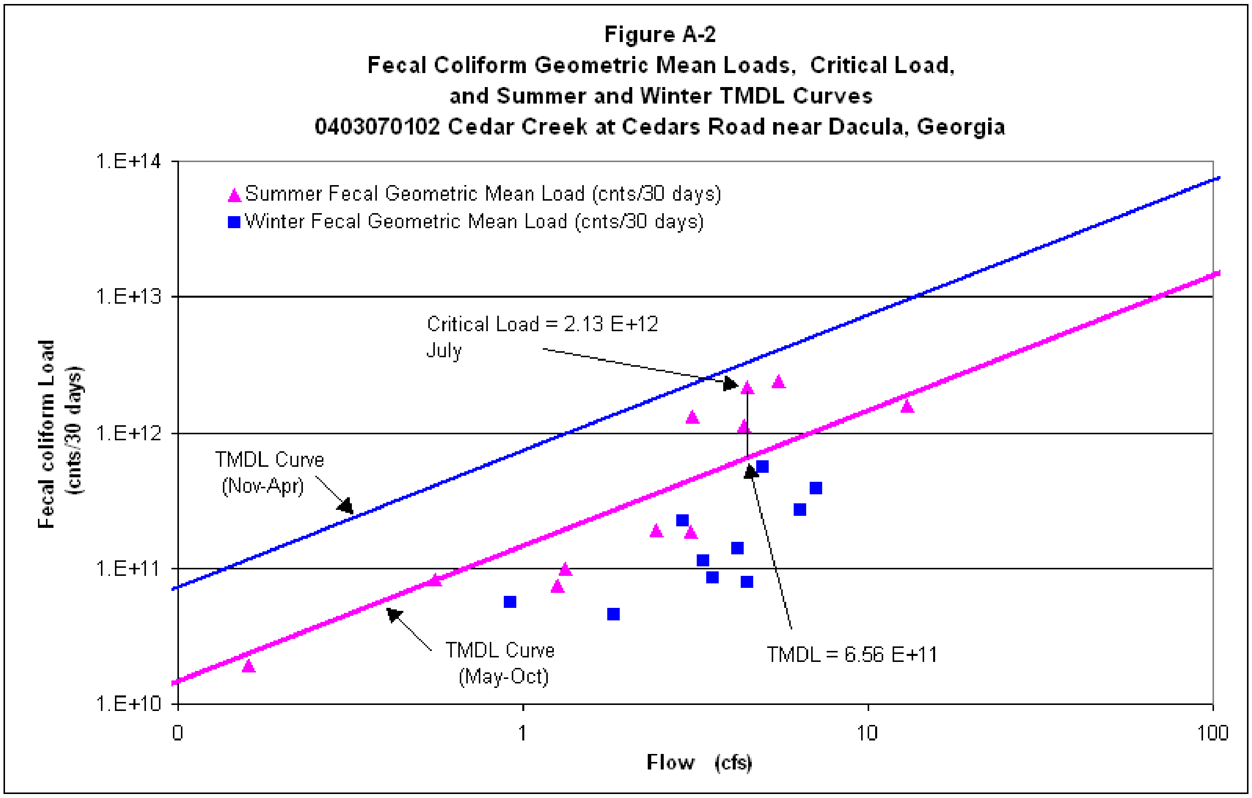


Table A-2. Data for Figure A-2

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
9/24/2003	1700	4.0				
9/25/2003	500	3.0				
9/26/2003	800	2.5				
9/29/2003	170	2.9	583.1	3.1	1.33E+12	4.56E+11
11/10/2003	40	3.4				
11/11/2003	70	3.4				
11/12/2003	80	3.4				
11/13/2003	20	3.2	46.0	3.3	1.13E+11	2.46E+12
3/2/2004	2382	5.7				
3/4/2004	88	5.3				
3/8/2004	130	4.5				
3/9/2004	20	4.5	152.9	5.0	5.56E+11	3.64E+12
5/12/2004	800	8.5				
7/6/2004	500	3.6				
7/7/2004	130	2.9				
7/8/2004	300	2.4	353.4	4.4	1.13E+12	6.40E+11
9/13/2004	80	3.9				
9/14/2004	130	3.8				
9/15/2004	300	3.7				
9/16/2004	230	40.5	163.7	13.0	1.56E+12	1.91E+12
1/10/2005	40	3.7				
1/11/2005	40	3.6				
1/12/2005	230	3.6				
1/13/2005	80	17.4	73.7	7.1	3.82E+11	5.19E+12

Table A-2. Data for Figure A-2 (Continued)

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
4/18/2005	20	4.9				
4/19/2005	20	4.5				
4/20/2005	40	4.5				
4/21/2005	20	4.0	23.8	4.5	7.77E+10	3.27E+12
5/12/2005	70	2.8				
5/17/2005	230	3.7				
5/19/2005	70	3.6				
5/25/2005	40	2.2	81.9	3.1	1.84E+11	4.50E+11
10/11/2005	130	3.6				
10/12/2005	80	3.0				
10/24/2005	300	1.6				
10/25/2005	40	1.5	105.7	2.4	1.88E+11	3.56E+11
12/13/2005	20	3.0				
12/14/2005	20	2.9				
12/19/2005	130	5.7				
12/20/2005	80	5.3	45.2	4.2	1.39E+11	3.08E+12
3/1/2006	20	7.3				
3/2/2006	20	6.9				
3/13/2006	20	5.3				
3/23/2006	1300	6.1	56.8	6.4	2.66E+11	4.68E+12
6/26/2006	5000	15.4				
6/27/2006	230	5.3				
7/11/2006	800	0.8				
7/12/2006	132	0.6	590.3	5.5	2.38E+12	8.08E+11
10/16/2006	80	0.8				
10/24/2006	300	1.0				
10/30/2006	230	1.9				
10/31/2006	20	1.6	102.5	1.3	9.97E+10	1.95E+11
11/6/2206	40	1.3				
11/13/2006	40	1.6				
11/20/2006	40	2.7				
11/28/2006	20	1.8	33.6	1.8	4.52E+10	1.34E+12
2/7/2007	20	3.4				
2/8/2007	70	3.2				
2/12/2007	20	2.7				
3/5/2007	40	4.9	32.5	3.5	8.43E+10	2.59E+12
5/1/2007	80	1.1				
5/2/2007	80	1.0				
5/8/2007	40	1.6				
5/9/2007	170	1.4	81.2	1.3	7.48E+10	1.84E+11
8/15/2007	500	0.1				
8/16/2007	230	0.2				
8/22/2007	80	0.1				
8/23/2007	80	0.1	164.7	0.2	1.93E+10	2.35E+10
12/11/2007	20	0.8				
12/12/2007	40	0.8				
12/13/2007	20	0.8				
12/17/2007	3000	1.3	83.2	0.9	5.62E+10	6.76E+11
3/18/2008	40	3.0				
3/24/2008	300	3.1				
3/26/2008	20	2.8				
4/1/2008	500	2.9	104.7	2.9	2.25E+11	2.15E+12
7/14/2008	300	3.1				
7/16/2008	220	1.4				
7/22/2008	300	8.9				
7/23/2008	9000	4.5	**649.7**	**4.5**	**2.13E+12**	**6.56E+11**
10/14/2008	500	0.5				
10/16/2008	300	0.4				
10/20/2008	40	0.6				
10/27/2008	300	0.7	206.0	0.6	8.38E+10	8.14E+10

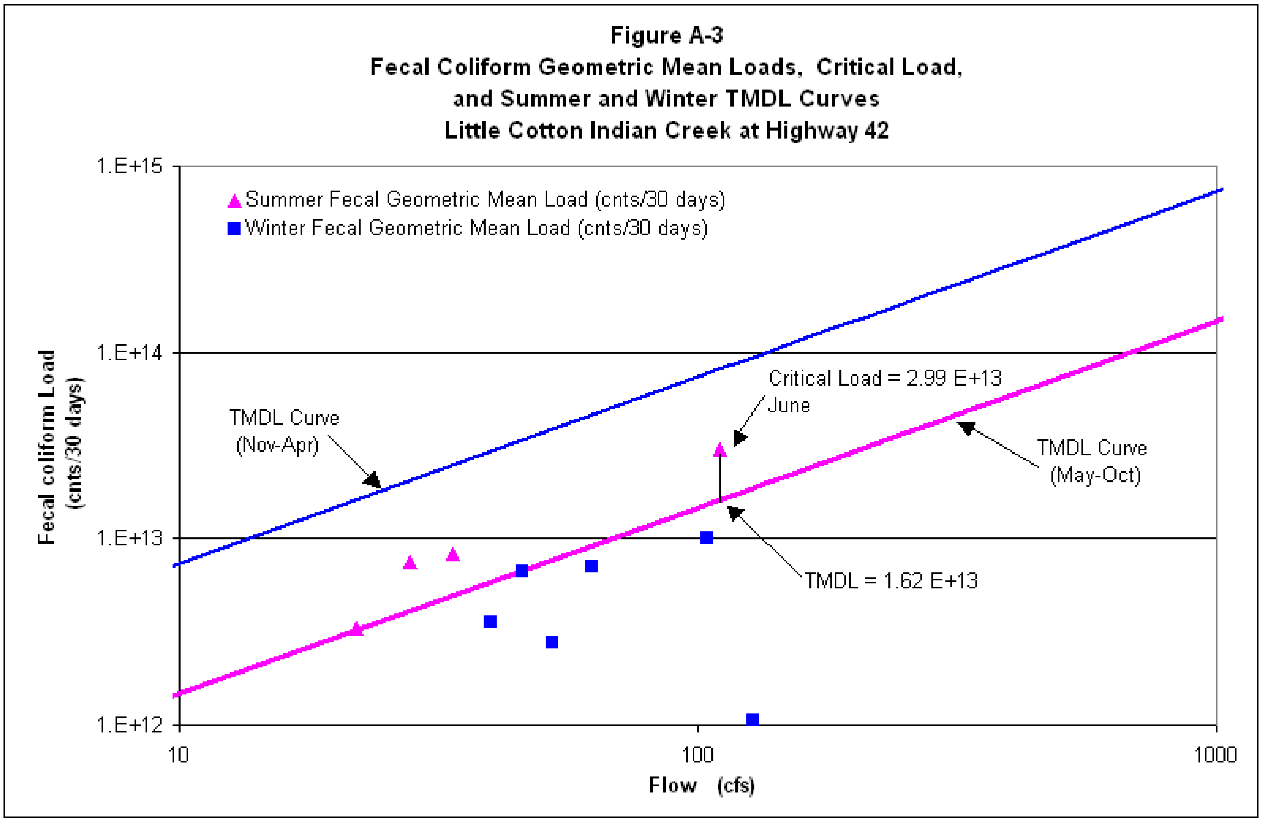


Figure A-3
Fecal Coliform Geometric Mean Loads, Critical Load, and Summer and Winter TMDL Curves
Little Cotton Indian Creek at Highway 42
Summer Fecal Geometric Mean Load (cnts/30 days)
Winter Fecal Geometric Mean Load (cnts/30 days)
Critical Load = 2.99 E+13
June
TMDL Curve
(Nov-Apr)
TMDL Curve
(May-Oct)
TMDL = 1.62 E+13
Fecal coliform Load
(cnts/30 days)
1.E+15
1.E+14
1.E+13
1.E+12
10
100
1000
Flow (cfs)

Table A-3. Data for Figure A-3

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	10	38.8				
3/13/2003	40	32.4				
3/17/2003	40	220.1				
3/19/2003	1	220.1	11.2	127.8	1.06E+12	9.38E+13
3/21/2003	800	120.8				
3/25/2003	20	45.3				
3/27/2003	450	43.2				
3/31/2003	80	41.0	154.9	62.6	7.11E+12	4.59E+13
4/3/2003	35	30.2				
4/7/2003	990	291.3				
4/9/2003	126	69.0				
4/15/2003	66	28.0	130.3	104.6	1.00E+13	7.68E+13
4/5/2005	50	69.0				
4/14/2005	180	53.9				
4/19/2005	50	41.0				
4/25/2005	60	45.3	72.1	52.3	2.77E+12	3.84E+13
6/21/2005	860	369.0				
6/23/2005	330	25.9				
6/27/2005	270	25.9				
6/29/2005	240	21.4	**368.3**	**110.5**	**2.99E+13**	**1.62E+13**
9/22/2005	270	16.8				
9/27/2005	45	18.3				
9/29/2005	320	17.7				
10/6/2005	3200	82.0	334.0	33.7	8.26E+12	4.95E+12
12/16/2005	660	75.5				
12/19/2005	40	28.0				
12/21/2005	60	28.0				
12/23/2005	140	28.0	122.0	39.9	3.58E+12	2.93E+13
3/1/2006	440	51.8				
3/9/2006	120	38.8				
3/16/2006	130	41.0				
3/23/2006	230	51.8	199.3	45.8	6.71E+12	3.37E+13
6/14/2006	360	23.7				
6/20/2006	170	16.8				
6/22/2006	90	17.0				
6/29/2006	330	30.2	206.5	22.0	3.33E+12	3.22E+12
9/12/2006	880	23.7				
9/18/2006	410	47.5				
9/21/2006	130	19.0				
9/26/2006	390	21.1	367.8	27.8	7.51E+12	4.09E+12

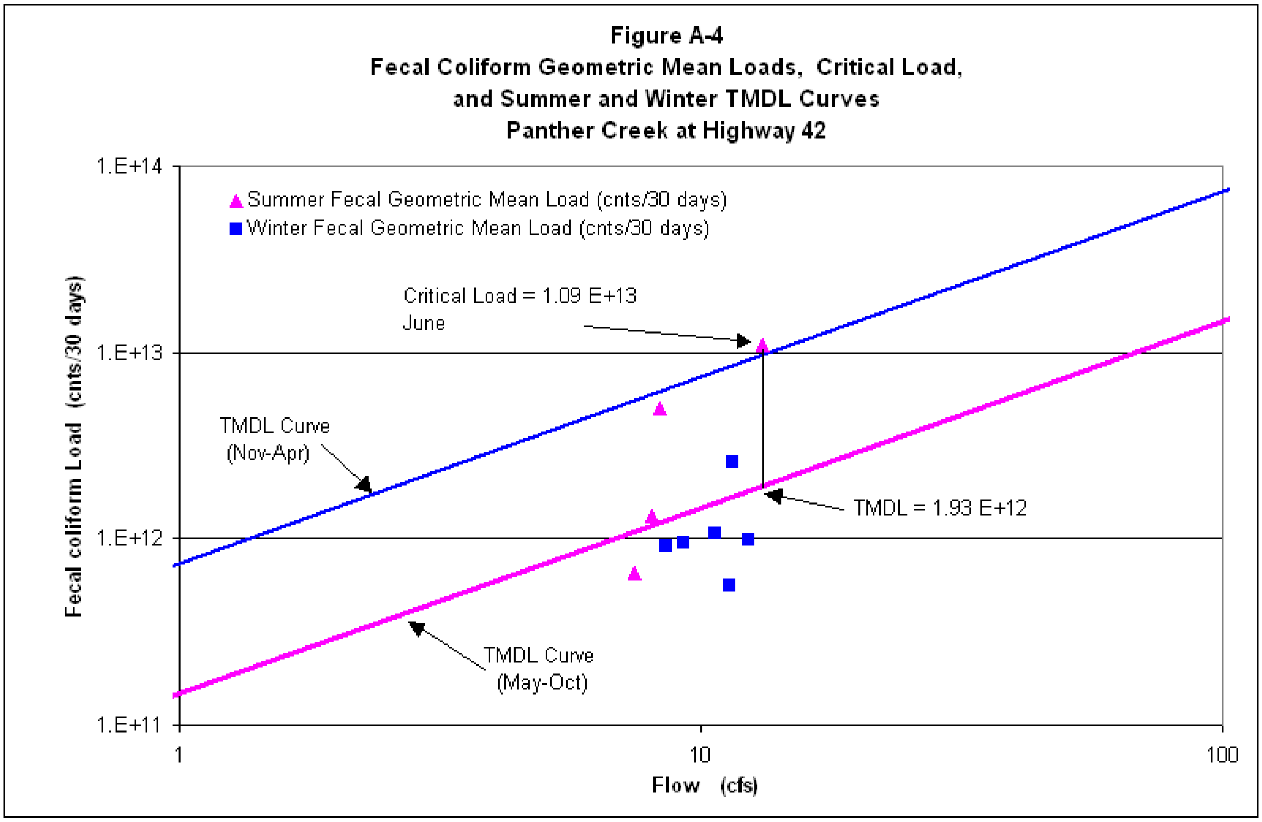


Figure A-4
Fecal Coliform Geometric Mean Loads, Critical Load, and Summer and Winter TMDL Curves
Panther Creek at Highway 42
Summer Fecal Geometric Mean Load (cnts/30 days)
Winter Fecal Geometric Mean Load (cnts/30 days)
Critical Load = 1.09 E+13
June
TMDL Curve
(Nov-Apr)
TMDL = 1.93 E+12
TMDL Curve
(May-Oct)
1.E+14
1.E+13
1.E+12
1.E+11
Fecal coliform Load (cnts/30 days)
1
10
100
Flow (cfs)

Table A-4. Data for Figure A-4

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	102	8.3				
3/13/2003	14	8.7				
3/17/2003	680	16.4				
3/19/2003	150	15.8	109.9	12.3	9.91E+11	9.02E+12
3/21/2003	790	13.9				
3/25/2003	150	11.4				
3/27/2003	1	11.0				
3/31/2003	170	9.1	67.0	11.3	5.57E+11	8.31E+12
4/3/2003	60	7.7				
4/7/2003	3840	19.8				
4/9/2003	210	10.3				
4/15/2003	175	8.3	303.3	11.5	2.56E+12	8.44E+12
4/5/2005	50	11.7				
4/14/2005	1010	10.9				
4/19/2005	120	10.0				
4/25/2005	60	9.9	138.1	10.6	1.08E+12	7.79E+12
6/21/2005	14850	21.4				
6/23/2005	1250	9.4				
6/27/2005	400	11.7				
6/29/2005	220	10.1	**1130.5**	**13.2**	**1.09E+13**	**1.93E+12**
9/22/2005	220	7.8				
9/27/2005	120	7.9				
9/29/2005	4140	7.6				
10/6/2005	3950	10.1	810.6	8.4	4.98E+12	1.23E+12
12/16/2005	1500	10.3				
12/19/2005	60	8.2				
12/21/2005	60	7.9				
12/23/2005	80	8.0	144.2	8.6	9.09E+11	6.31E+12
3/1/2006	180	9.8				
3/9/2006	100	8.7				
3/16/2006	140	8.8				
3/23/2006	150	9.8	139.4	9.3	9.50E+11	6.82E+12
6/14/2006	100	7.5				
6/20/2006	100	7.2				
6/22/2006	40	7.1				
6/29/2006	530	8.0	120.7	7.5	6.61E+11	1.10E+12
9/12/2006	230	8.6				
9/18/2006	140	8.2				
9/21/2006	180	8.2				
9/26/2006	440	7.2	224.7	8.1	1.33E+12	1.18E+12

Figure A-5
Fecal Coliform Geometric Mean Loads, Critical Load, and Summer and Winter TMDL Curves
Reeves Creek at Tye Road

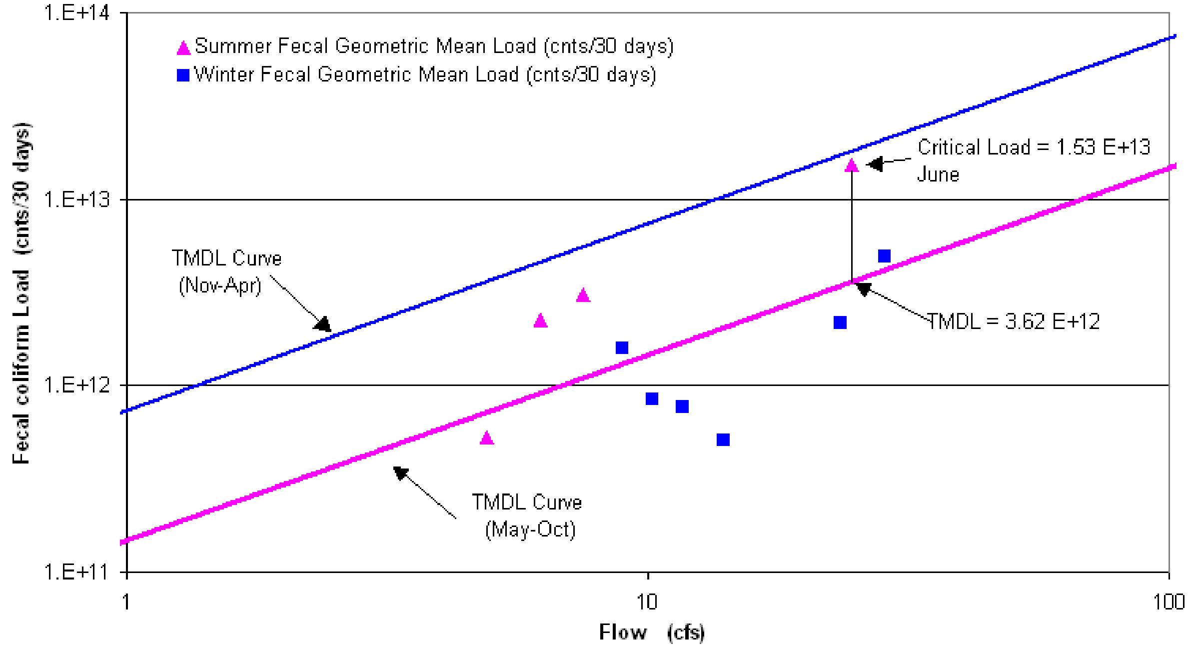


Table A-5. Data for Figure A-5

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	40	8.7				
3/13/2003	110	7.2				
3/17/2003	710	49.2				
3/19/2003	1000	49.2	236.4	28.6	4.95E+12	2.10E+13
3/21/2003	1	27.0				
3/25/2003	130	10.1				
3/27/2003	300	9.6				
3/31/2003	150	9.2	49.2	14.0	5.04E+11	1.03E+13
4/3/2003	110	6.7				
4/7/2003	2100	65.1				
4/9/2003	30	15.4				
4/15/2003	35	6.3	124.8	23.4	2.14E+12	1.72E+13
4/5/2005	45	15.4				
4/14/2005	235	12.0				
4/19/2005	80	9.2				
4/25/2005	75	10.1	89.2	11.7	7.66E+11	8.58E+12
6/21/2005	54400	82.4				
6/23/2005	315	5.8				
6/27/2005	100	5.8				
6/29/2005	300	4.8	**846.8**	**24.7**	**1.53E+13**	**3.62E+12**
9/22/2005	190	3.8				
9/27/2005	350	4.1				
9/29/2005	290	4.0				
10/6/2005	4900	18.3	554.4	7.5	3.06E+12	1.11E+12
12/16/2005	1550	16.9				
12/19/2005	75	6.3				
12/21/2005	25	6.3				
12/23/2005	1190	6.3	242.5	8.9	1.59E+12	6.54E+12
3/1/2006	45	11.6				
3/9/2006	115	8.7				
3/16/2006	130	9.2				
3/23/2006	230	11.6	111.5	10.2	8.38E+11	7.52E+12
6/14/2006	205	5.3				
6/20/2006	115	3.8				
6/22/2006	90	3.8				
6/29/2006	215	6.7	146.1	4.9	5.26E+11	7.20E+11
9/12/2006	420	5.3				
9/18/2006	330	10.6				
9/21/2006	330	4.2				
9/26/2006	1240	4.7	488.0	6.2	2.23E+12	9.13E+11

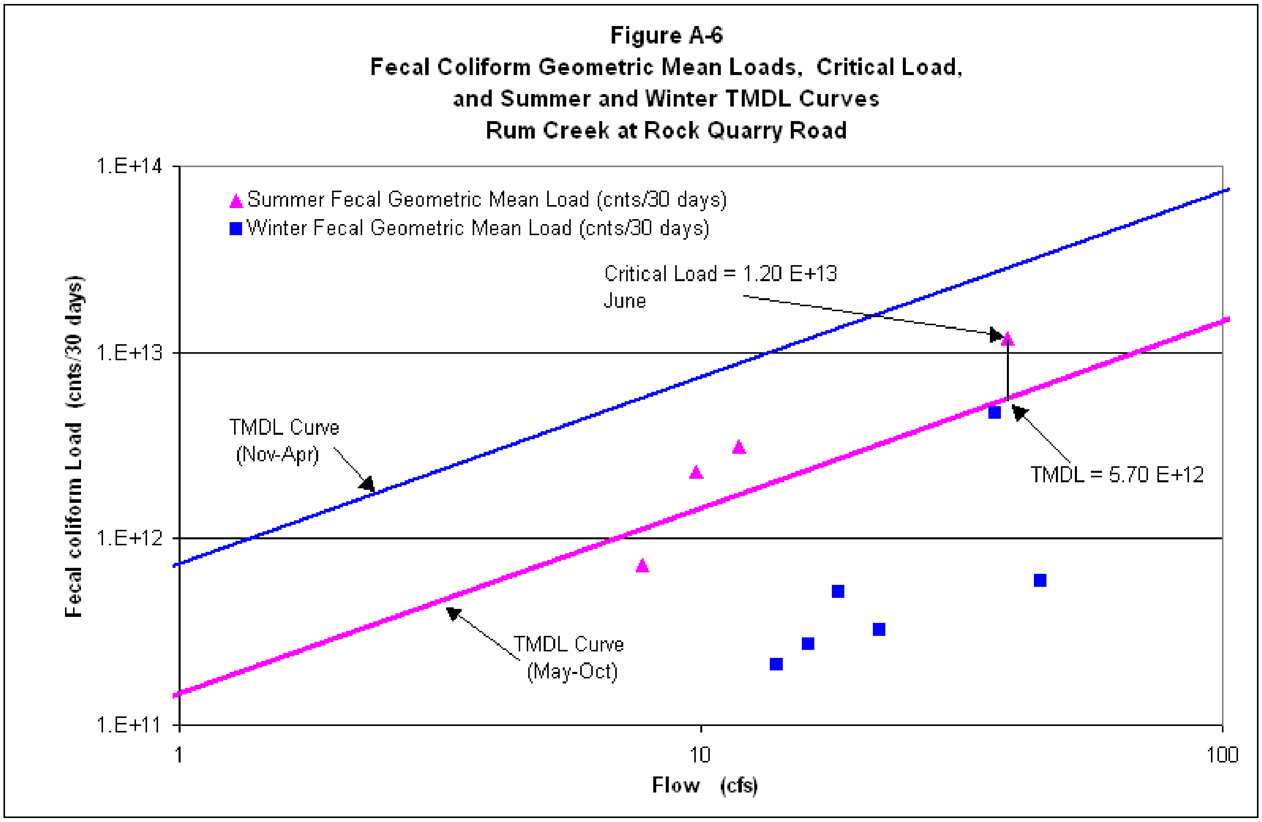


Figure A-6
Fecal Coliform Geometric Mean Loads, Critical Load,
and Summer and Winter TMDL Curves
Rum Creek at Rock Quarry Road
Summer Fecal Geometric Mean Load (cnts/30 days)
Winter Fecal Geometric Mean Load (cnts/30 days)
Critical Load = 1.20 E+13
June
TMDL Curve
(Nov-Apr)
TMDL = 5.70 E+12
TMDL Curve
(May-Oct)
Fecal coliform Load (cnts/30 days)
1.E+14
1.E+13
1.E+12
1.E+11
1
10
100
Flow (cfs)

Table A-6. Data for Figure A-6

Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	50	13.6				
3/13/2003	1	11.4				
3/17/2003	2100	77.3				
3/19/2003	1	77.3	18.0	44.9	5.93E+11	3.29E+13
3/21/2003	1	42.4				
3/25/2003	30	15.9				
3/27/2003	140	15.1				
3/31/2003	40	14.4	20.2	22.0	3.26E+11	1.61E+13
4/3/2003	78	10.6				
4/7/2003	1700	102.2				
4/9/2003	240	24.2				
4/15/2003	30	9.8	175.8	36.7	4.74E+12	2.70E+13
4/5/2005	20	24.2				
4/14/2005	100	18.9				
4/19/2005	10	14.4				
4/25/2005	110	15.9	38.5	18.4	5.19E+11	1.35E+13
6/21/2005	10000	129.5				
6/23/2005	370	9.1				
6/27/2005	70	9.1				
6/29/2005	120	7.5	**419.9**	**38.8**	**1.20E+13**	**5.70E+12**
9/22/2005	215	5.9				
9/27/2005	80	6.4				
9/29/2005	120	6.2				
10/6/2005	7970	28.8	358.1	11.8	3.11E+12	1.74E+12
12/16/2005	80	26.5				
12/19/2005	1	9.8				
12/21/2005	20	9.8				
12/23/2005	110	9.8	20.5	14.0	2.11E+11	1.03E+13
3/1/2006	1	18.2				
3/9/2006	50	13.6				
3/16/2006	60	14.4				
3/23/2006	90	18.2	22.8	16.1	2.69E+11	1.18E+13
6/14/2006	125	8.3				
6/20/2006	115	5.9				
6/22/2006	105	6.0				
6/29/2006	170	10.6	126.6	7.7	7.16E+11	1.13E+12
9/12/2006	400	8.3				
9/18/2006	220	16.7				
9/21/2006	180	6.7				
9/26/2006	650	7.4	318.5	9.8	2.28E+12	1.43E+12

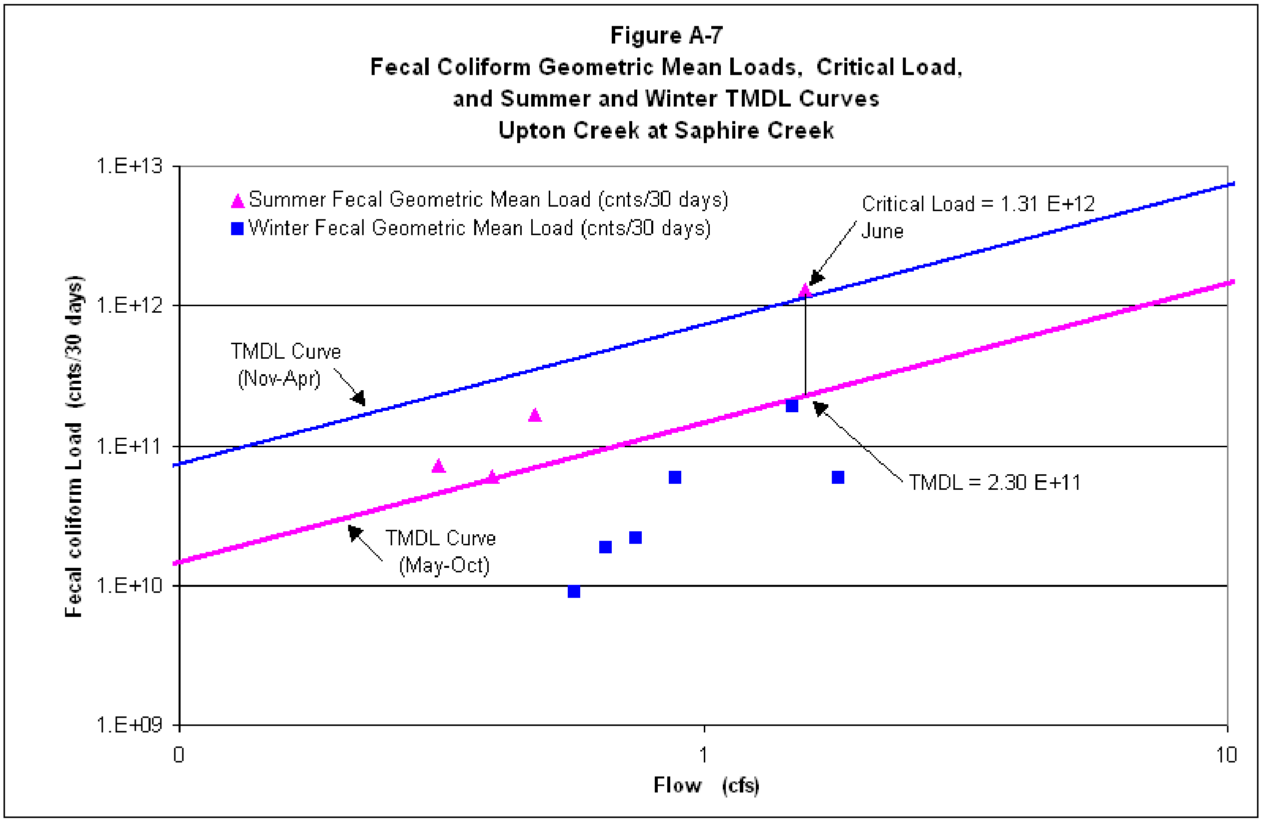


Figure A-7
Fecal Coliform Geometric Mean Loads, Critical Load, and Summer and Winter TMDL Curves
Upton Creek at Saphire Creek
Summer Fecal Geometric Mean Load (cnts/30 days)
Winter Fecal Geometric Mean Load (cnts/30 days)
Critical Load = 1.31 E+12
June
TMDL Curve
(Nov-Apr)
TMDL = 2.30 E+11
TMDL Curve
(May-Oct)
Fecal coliform Load (cnts/30 days)
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
0
1
10
Flow (cfs)

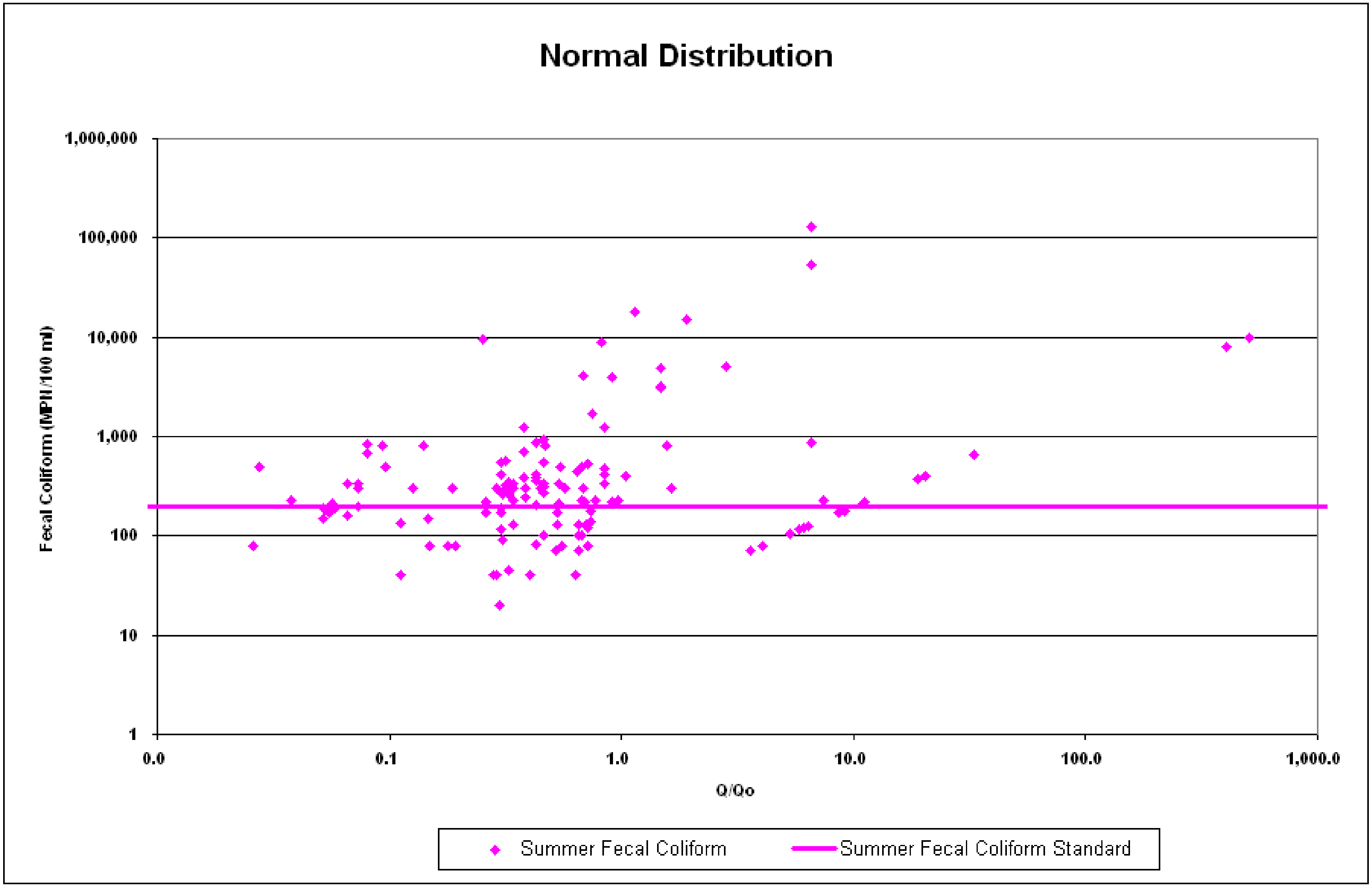
Table A-7. Data for Figure A-7

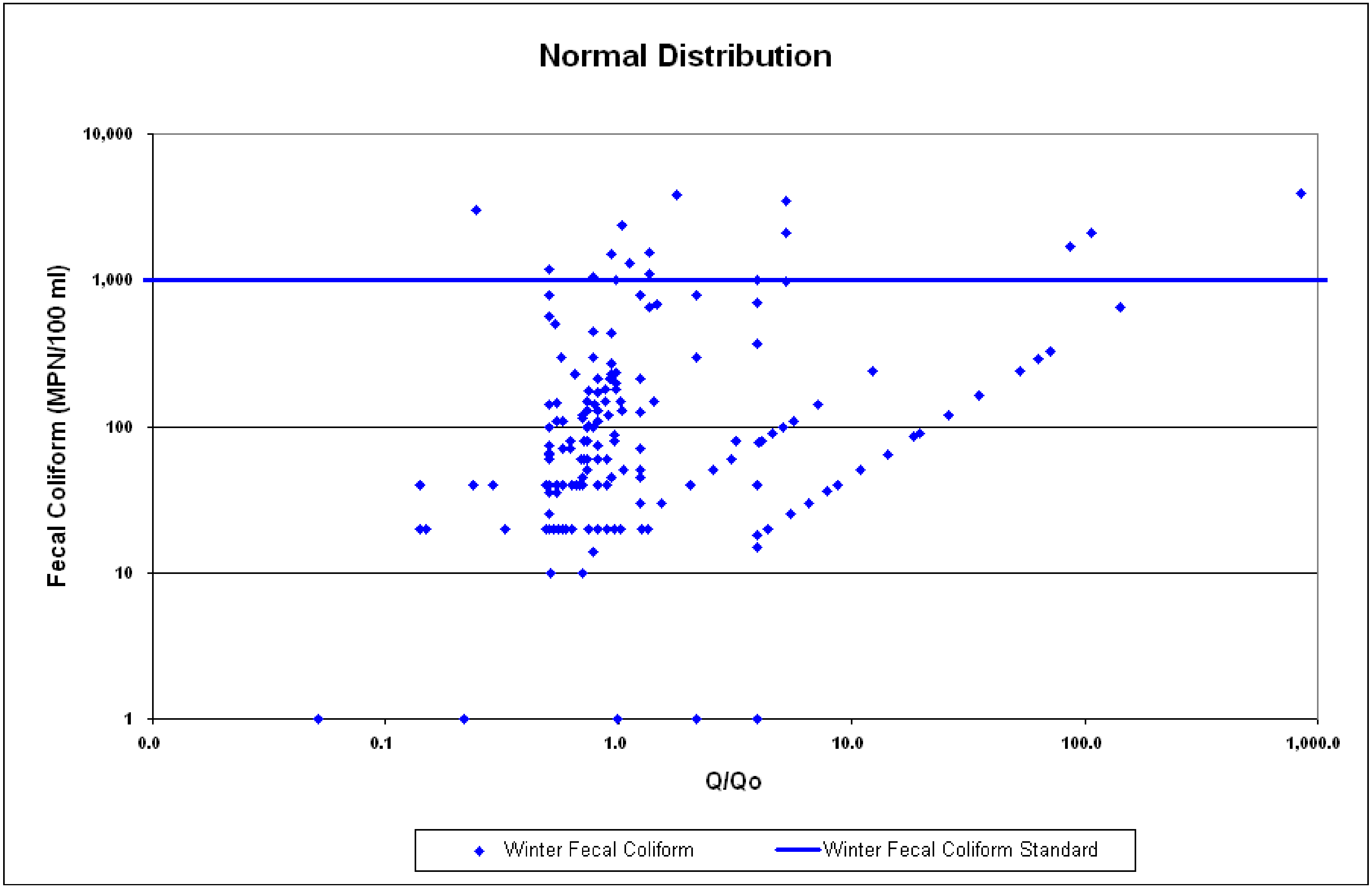
Date	Observed Fecal Coliform (counts/100 ml)	Estimated Instantaneous Flow On Sample Day (cfs)	Geometric Mean (counts/100 ml)	Mean Flow (cfs)	Geometric Mean Fecal Coliform Loading (counts/30 days)	Geometric Mean TMDL Fecal Coliform Loading (counts/30 days)
Date	Fecal	Q	Geomean	Mean Flow	Current TMDL	TMDL
3/11/2003	1	0.6				
3/13/2003	18	0.5				
3/17/2003	325	3.1				
3/19/2003	650	3.1	44.2	1.8	5.88E+10	1.33E+12
3/21/2003	290	1.7				
3/25/2003	30	0.6				
3/27/2003	120	0.6				
3/31/2003	65	0.6	90.8	0.9	5.92E+10	6.52E+11
4/3/2003	40	0.4				
4/7/2003	3900	4.1				
4/9/2003	162	1.0				
4/15/2003	36	0.4	173.7	1.5	1.89E+11	1.09E+12
4/5/2005	20	1.0				
4/14/2005	50	0.8				
4/19/2005	30	0.6				
4/25/2005	85	0.6	40.0	0.7	2.18E+10	5.45E+11
6/21/2005	18200	5.2				
6/23/2005	690	0.4				
6/27/2005	840	0.4				
6/29/2005	160	0.3	**1139.8**	**1.6**	**1.31E+12**	**2.30E+11**
9/22/2005	150	0.2				
9/27/2005	210	0.3				
9/29/2005	170	0.3				
10/6/2005	9500	1.2	474.9	0.5	1.67E+11	7.02E+10
12/16/2005	1	1.1				
12/19/2005	20	0.4				
12/21/2005	120	0.4				
12/23/2005	90	0.4	21.6	0.6	8.97E+09	4.16E+11
3/1/2006	20	0.7				
3/9/2006	25	0.6				
3/16/2006	20	0.6				
3/23/2006	240	0.7	39.4	0.7	1.88E+10	4.78E+11
6/14/2006	335	0.3				
6/20/2006	190	0.2				
6/22/2006	185	0.2				
6/29/2006	820	0.4	313.5	0.3	7.17E+10	4.57E+10
9/12/2006	200	0.3				
9/18/2006	150	0.7				
9/21/2006	190	0.3				
9/26/2006	330	0.3	208.3	0.4	6.04E+10	5.80E+10

.

Appendix B

Normalized Flows Versus Fecal Coliform Plots


Normal Distribution
Fecal Coliform (MPN/100 ml)
1,000,000
100,000
10,000
1,000
100
10
1
0.0
0.1
1.0
10.0
100.0
1,000.0
Q/Qo
Summer Fecal Coliform
Summer Fecal Coliform Standard


Normal Distribution
Fecal Coliform (MPN/100 ml)
10,000
1,000
100
10
1
0.0
0.1
1.0
10.0
100.0
1,000.0
Q/Qo
Winter Fecal Coliform
Winter Fecal Coliform Standard