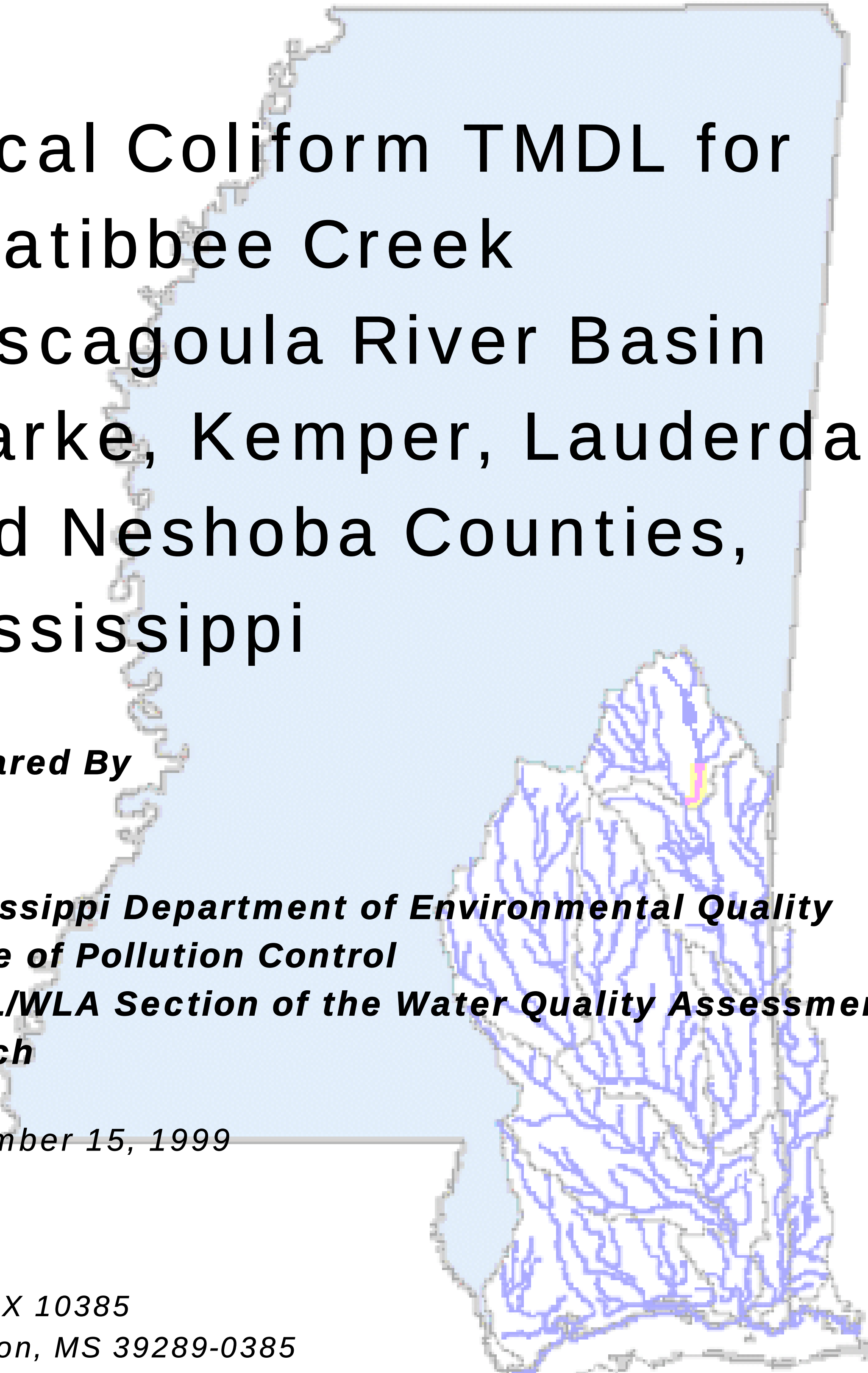
Fecal Coliform TMDL for Okatibbee Creek Pascagoula River Basin Clarke, Kemper, Lauderdale, and Neshoba Counties, Mississippi



Prepared By

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section of the Water Quality Assessment Branch

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MDEQ
PO BOX 10385
Jackson, MS 39289-0385
(601) 961-5171

FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one or more Total Maximum Daily Loads (TMDLs) for waterbody segments found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The segments addressed are comprised of monitored segments that have data indicating impairment. However, the report may also include evaluated segments with insufficient data to indicate impairment. The evaluated waterbody segments in this report were included because they are hydrologically linked to the monitored segment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

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MONITORED SEGMENT IDENTIFICATION

Name:	Okatibbee Creek
Waterbody ID#:	MS060M
Location:	At Arundel: From confluence with Sowashee Creek to confluence with Chunky River
Counties:	Lauderdale, Kemper, Clarke, and Neshoba
USGS HUC Code	03170001
NRCS Watershed:	040
Length:	17 miles impaired on 303(d) list, 26.3 miles modeled
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Pathogens (Fecal Coliform)
Priority Rank:	46
NPDES Permits:	There are 19 NPDES facilities contributing fecal coliform in this watershed.
Standards Variance:	None
Pollutant Standard:	May through October-Geometric Mean of 200 per 100 ml Less than 10 percent of the samples may exceed 400 per 100 ml November through April-Geometric Mean of 2000 per 100 ml Less than 10 percent of the samples may exceed 4000 per 100 ml
Waste Load Allocation:	5.38E+12 (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	28.6E+12 counts/30 days
Margin of Safety:	Implicit modeling assumptions - conservative modeling assumptions
Total Maximum Daily Load (TMDL):	34.0E+12 counts/30 days (The TMDL is a combination of the direct input of fecal coliform from NPDES permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates necessary to meet the fecal coliform standard.)

EVALUATED DRAINAGE AREA IDENTIFICATION

Name:	Okatibbee Creek-DA
Waterbody ID#:	MS059OE
Location:	Drainage Area near Shucktown
Counties:	Neshoba
USGS HUC Code	03170001
NRCS Watershed:	030
Area:	Approximately 39,898 Acres
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Pathogens (Fecal Coliform)
Priority Rank:	Low
NPDES Permits:	There are 19 NPDES facilities contributing fecal coliform in this watershed.
Standards Variance:	None
Pollutant Standard:	May through October-Geometric Mean of 200 per 100 ml Less than 10 percent of the samples may exceed 400 per 100 ml November through April-Geometric Mean of 2000 per 100 ml Less than 10 percent of the samples may exceed 4000 per 100 ml
Waste Load Allocation:	8.30E+11 counts/30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	63.5+11counts/30 days
Margin of Safety:	Implicit modeling assumptions - conservative modeling assumptions
Total Maximum Daily Load (TMDL):	71.8E+11counts/30 days (The TMDL is a combination of the direct input of fecal coliform from NPDES permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates necessary to meet the fecal coliform standard.)

EXECUTIVE SUMMARY

Elevated levels of fecal coliform bacteria can be observed in waterbodies as a result of both point and nonpoint sources of pollution. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in -stream water quality conditions. Through TMDL implementations, states can establish water-quality based controls to reduce pollution from point and nonpoint sources and restore and maintain the quality of their water resources.

A segment, MS060M, of Okatibbee Creek has been placed on the monitored portion of the Mississippi 1998 section 303(d) List of Waterbodies for fecal coliform violations. MDEQ has identified Okatibbee Creek as not supporting secondary contact recreation for 17 miles, and ranks it 46th on the 1998 303(d) List of Waterbodies. The determination for impairment was based on ambient monitoring data (station 02476600) that are used to assess the health or biological integrity of a waterbody. Additionally, drainage area, MS059OE, is on the evaluated portion of the1998 303(d) List of Waterbodies for secondary contact recreation. The applicable state standard specifies for the months of May through October, when water contact recreation activities may be expected to occur, fecal coliform shall not exceed a geometric mean of 200 per 100 ml nor shall more than 10% of the samples examined during any month exceed 400 per 100 ml. For the months of November through April, fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10% of the samples examined during these months exceed 4000 per 100 ml.

Okatibbee Creek is a major waterbody in the Pascagoula River Basin located in southeastern Mississippi. It is moderate in size and is approximately 53 miles in length. It lies primarily in Lauderdale County, Mississippi. The primary land uses in the watershed are forest and pasture, although, there are small areas of cropland and urban areas. Populated areas include portions of Collinsville, Enterprise, and Meridian.

The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. Daily flow values from the USGS gage on Okatibbee Creek at Arundel were used to calibrate the hydrologic flow for the watershed. The weather data used for this model were collected at Meridian, Mississippi. The representative hydrologic period used for this TMDL was 1985 through 1995.

Fecal coliform loadings from nonpoint sources in the watershed were calculated based upon wildlife populations; numbers of cattle, hogs, and chickens; information on livestock and manure management practices for the Pascagoula Basin; and urban development. The estimated fecal coliform production and accumulation rates due to nonpoint sources for the watershed were incorporated into the model. Also represented in the model were the nonpoint sources such as failing septic systems and cattle which have direct access to tributaries of Okatibbee Creek. There are 19 NPDES Permitted discharges located in the watershed which are included as point sources in the model. Under existing conditions, output from the model indicates violation of the fecal

coliform standard in the stream. After applying a load reduction scenario, there were no violations of the standard according to the model.

The model accounted for existing conditions in wildlife application rates, manure application rates, seasonal variations in hydrology, climatic conditions, and watershed activities. The use of the continuous simulation model allowed for consideration of the seasonal aspects of rainfall patterns within the watershed. Calculation of the fecal coliform accumulation parameters and source contributions on a monthly basis accounted for seasonal variations in watershed activities such as livestock grazing and land application of manure.

The scenario used to reduce the fecal coliform load involves a cooperative effort between all fecal coliform contributors in the Okatibbee Watershed. First, all NPDES facilities will be required to treat their discharge so that the fecal coliform concentrations do not exceed water quality standards. Monitoring of all permitted facilities in the Okatibbee Creek Watershed should be continued to ensure that compliance with permit limits is consistently attained. Second is the removal of 75% of the cattle's direct access to tributaries. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Finally, a 50% reduction in the fecal coliform contribution from failing septic tanks is required. The model assumed there is a 40% percent failure rate of septic tanks in the drainage area. A reduction could be accomplished by education on best management practices for septic tank owners. Additionally, users of individual onsite wastewater treatment plants could be educated on the importance of disinfection of the effluent from their treatment plants.

1.0 INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform is used as an indicator organism. It is readily identifiable and indicates the possible presence of other pathogenic organisms in the waterbody. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of water resources.

The objective of this report is to identify background information needed to develop a TMDL for Okatibbee Creek. This creek has been placed on Mississippi's 1998 303(d) List of Waterbodies due to fecal coliform violations. MDEQ has identified a segment of Okatibbee Creek as being impaired by fecal coliform standards starting at the confluence of Sowashee Creek to the confluence of Chunky River. Okatibbee Creek is located within the Pascagoula River Basin in southeastern Mississippi. It is medium in size and is approximately 53 miles in length. It lies primarily in Lauderdale County, Mississippi. MDEQ has also identified drainage area MS059OE as being evaluated for the presence of fecal coliform bacteria. This drainage area has an approximated area of 39,898 acres. It is listed as evaluated because the data available for this area are insufficient to show a definite impairment caused by fecal coliform. Figure 1.1a is a map of the waterbody, and Figure1.1b shows the location of the impaired reach as well as the evaluated drainage area.

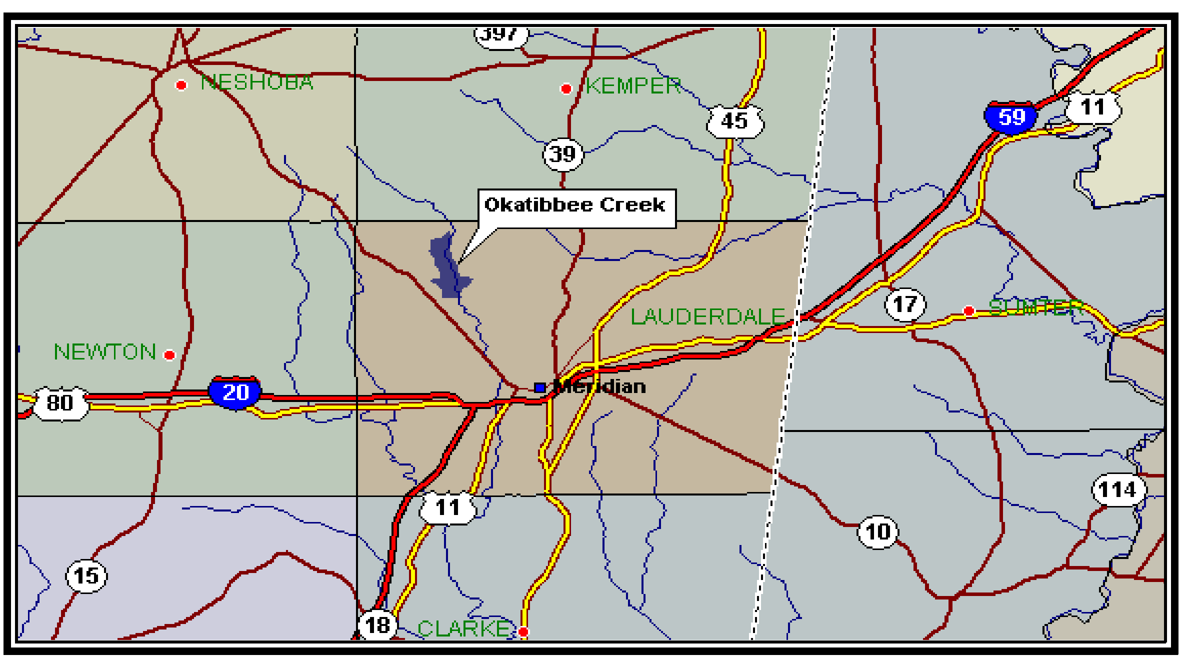

Figure 1.1a Area map of Okatibbee Creek

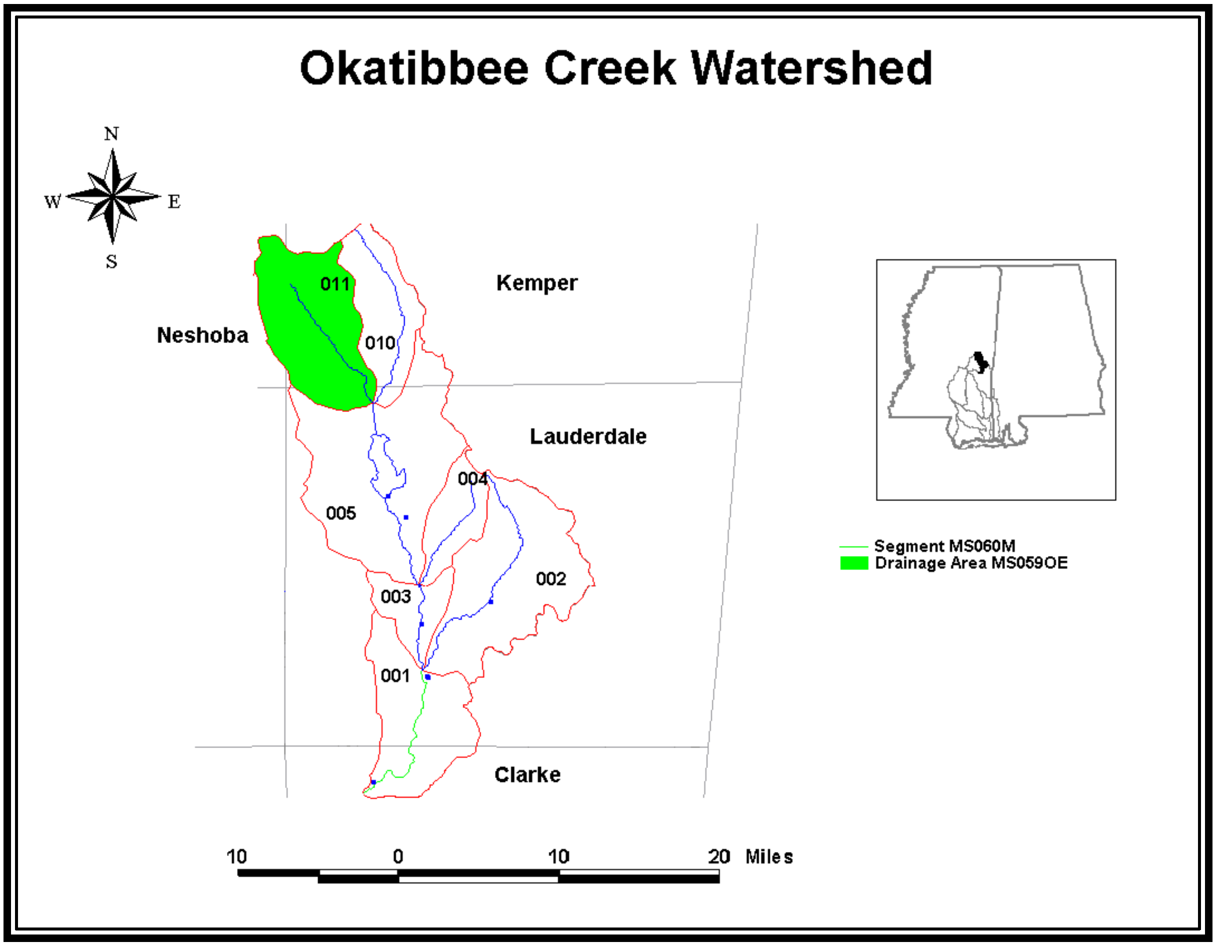

Figure 1.1b Okatibbee Creek Watershed Delineation

Okatibbee Creek Watershed has a land area that encompasses approximately 244,000 acres. The land distribution is shown below in Table 1.1b. The primary land uses in the watershed are forest and pastureland, although, there are small areas of urban, cropland, wetlands, and barren land. A map of all land uses can be seen in Figure 1.1c. Populated areas include portions of Collinsville, Enterprise, and Meridian (which is principally where the industry of this watershed is located). Okatibbee Creek joins with the Chunky River at Enterprise to form the Chickasawhay River.

Table 1.1b Land Distribution in acres for the Okatibbee Creek Watershed

Watershed	Urban	Forest	Wetlands	Pasture	Cropland	Barren	Total
Okatibbee Creek	14,672	172,988	209	53,715	2,230	205	244,019

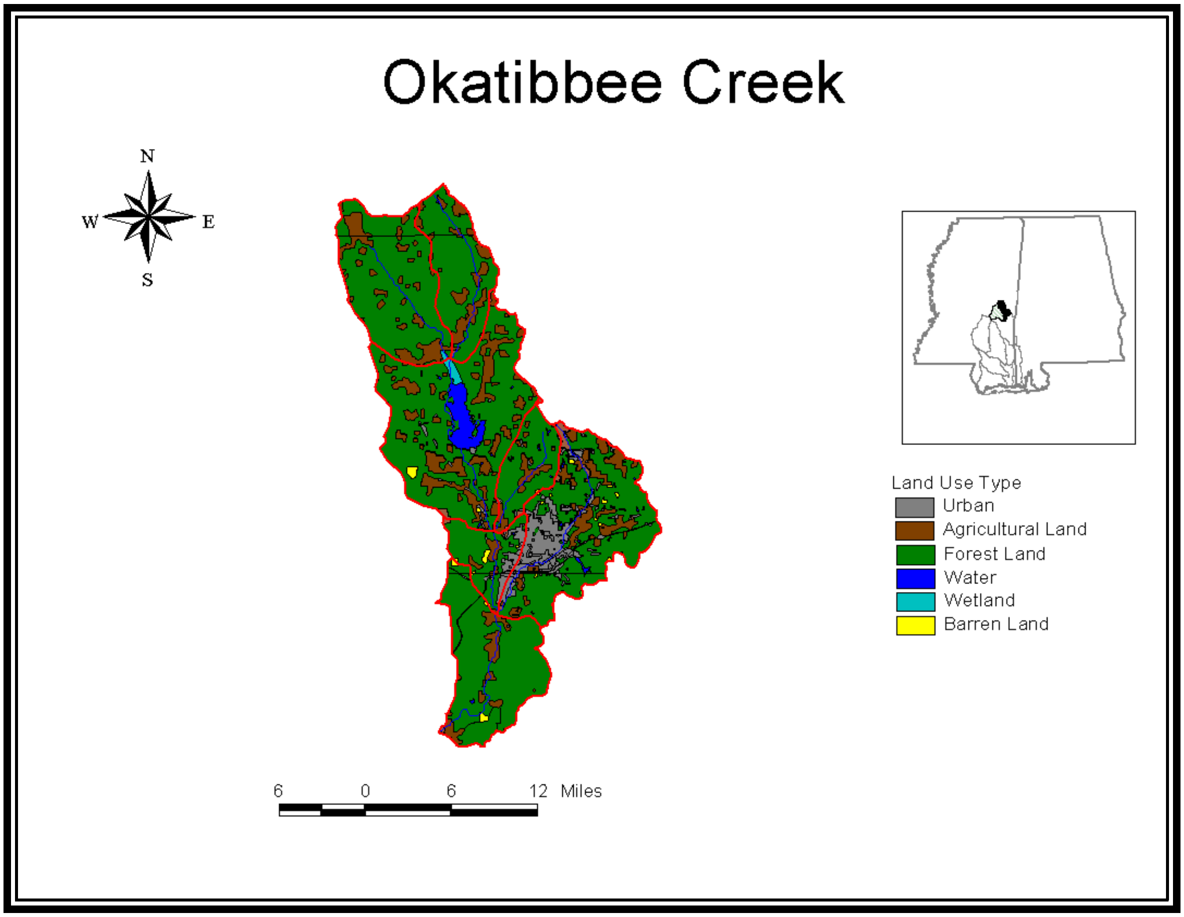

Figure 1.1c Landuse Map of Okatibbee Creek Watershed

1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi under the Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated uses for Okatibbee Creek as defined by the regulations are Secondary Contact Recreation and Fish and Wildlife.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the waterbody and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The standard states that for May through October the fecal coliform [colony counts] shall not exceed a geometric mean of 200 per 100ml, nor shall more than 10% of the samples examined during any month exceed [a colony count of] 400 per 100ml. For November through April, the fecal coliform [colony counts] shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10% of the samples examined during any month exceed [a colony count of] 4000 per 100 ml. This water quality standard will be used as targeted endpoints to evaluate impairments and establish this TMDL.

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Standpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load reductions specified in the TMDL. The instream fecal coliform bacteria target for this TMDL is a 30-day geometric mean of 200 counts per 100 ml.

Because fecal coliform bacteria may be attributed to both nonpoint and point sources, the critical condition used for the modeling and evaluation of stream response was represented by a multi-year period. Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet weather and high surface runoff. But, critical conditions for point source-dominated systems generally occur during low-flow and low dilution conditions. The 1985 -1995 time frame represents both low flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the period was selected as representing the hydrologic regime of the study area, accounting for critical conditions associated with all potential sources within the watershed.

2.2 Discussion of Instream Water Quality

Water quality data available for Okatibbee Creek show that the stream is impaired by high levels of fecal coliform bacteria. The data indicate that high instream fecal coliform concentrations occurred during both periods of high-flow and dry, low-flow conditions.

There are several known sources of fecal coliform for this stream, including 19 permitted dischargers in the watershed. A high percentage of the permitted dischargers are commercial facilities which discharge treated residential wastewater into Okatibbee Creek or a tributary of Okatibbee Creek. The total fecal coliform load, however, accounts for nonpoint source contributors as well. These sources include cows which have direct access to streams, failing septic tanks, urban development, grazing animals, and application of manure produced by confined animal feeding operations to pasture.

2.2.1 Inventory of Available Water Quality Monitoring Data

The State's 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. According to the report, Okatibbee Creek is not supporting the use of secondary contact recreation. This conclusion was based on data collected at station 02476600. Data collected at this station are listed below in Tables 2.2.1, and a graph showing the violations is shown in Figure 2.2.1.

Table 2.2.1 Fecal Coliform Levels reported in Okatibbee Creek, 02476600

Date	Flow (cfs)	Fecal Coliform (counts/100 ml)
03/02/92	714	110
05/04/92	123	9,200
07/13/92	46	350
09/14/92	68	350
11/02/92	235	20
01/11/93	1,608	1,400
03/08/93	824	110
05/03/93	612	490
07/12/93	183	2,400
09/13/93	50	110
11/01/93	129	16,000
01/10/94	142	2,400
07/03/94	1,440	16,000
02/05/94	155	330
06/20/94	75	330
08/23/94	68	1,300
11/07/94	116	9,200
01/09/95	21	110
03/09/95	1,290	920
04/19/95	94	136
07/11/95	79	54
09/11/95	540	1,240
11/07/95	70	377
01/08/96	26	610

03/04/96	79	240
05/08/96	49	139
07/08/96	2,400	68
09/09/96	21	600

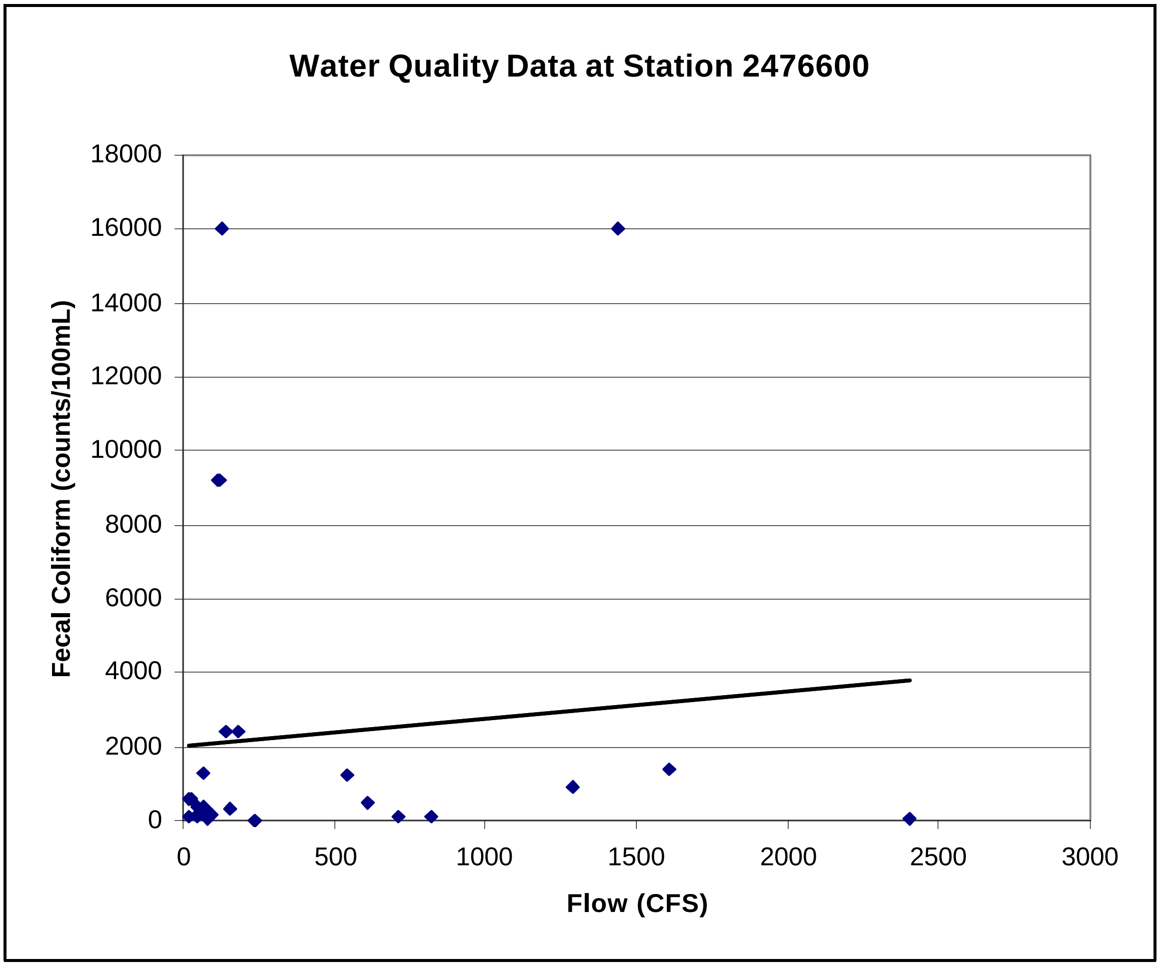

Figure 2.2.1. Graphical Illustration of Water Quality Data at 02476600

Peaks of fecal coliform above 400 counts/100mL seem to occur during periods of both high flow and low flow conditions. This illustrates the need for the model to consider fecal contributions from point sources as well as nonpoint sources.

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data retrieved from STORET are presented below in Table 2.2.2. The number of exceedances listed in the table is the number of times that the fecal coliform concentration exceeds the instantaneous limit of 400 counts/100 ml. The percent exceedances were calculated by dividing the number of exceedances by the total number of samples. There are insufficient data available to evaluate seasonal trends in the fecal coliform concentrations or correlation between flow and instream fecal coliform levels. However, the highest fecal coliform concentration recorded for Okatibbee Creek, 16,000 counts/100 ml, was recorded during an extremely high flow of 1440 cfs.

Table 2.2.2 Statistical Summaries at 02476600

Station	Samples	Minimum Violation (counts/100 ml)	Maximum Violation (counts/100 ml)	Average Value (counts/100 ml)	Exceedances	Percent Instantaneous Exceedance
02476600	28	490	16,000	5,440	11	39

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all potential sources of fecal coliform in the Okatibbee Creek watershed. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. In evaluation of the sources, loads are characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis. The representation of the following sources in the model is discussed in Section 4.0, Modeling Procedure: Linking the Sources to the endpoint.

In order to spatially analyze the sources of fecal coliform bacteria in the Okatibbee Creek watershed, the entire drainage area was divided into seven separate subwatersheds. The monitored section is contained entirely within subwatershed 031700010001. The evaluated drainage area, however, is located at the northern portion of the watershed. Due to the location of the monitored segment and the evaluated drainage area, the load and wasteload allocations required in this TMDL are based on water quality in the most downstream subwatershed. The subwatershed areas were based on reach divisions found in the Reach File 3 (RF3) and Digital Elevation Coverages. Okatibbee Creek was generally divided into a new reach at the confluence of each major tributary. Both point and nonpoint sources of fecal coliform bacteria were assessed at the subwatershed level.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow because the concentration of fecal coliform can be higher. Thus, a careful evaluation of all point sources was necessary in order to quantify the degree of impairment present during the low flow, critical condition period. The 19 point sources in the Okatibbee Creek watershed come from a variety of activities including residential subdivisions, schools, recreational areas, and other businesses. However, the majority of point sources are from residential subdivisions.

A point source assessment was completed for each subwatershed in the Okatibbee Creek watershed. Table 3.1.1 lists the dischargers according to subwatershed, along with the NPDES permit number, and receiving waterbody.

Once the permitted dischargers were located, the effluent from each source was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. Discharge monitoring reports were the best data source for characterizing effluent because they contain measurements of flow and fecal coliform present in effluent samples. If sufficient data were available, the fecal coliform concentrations in the effluent were determined by taking an average of fecal coliform concentrations reported in the discharge monitoring reports. If the discharge monitoring data were insufficient, permit limits were used to represent fecal coliform concentrations in the effluent, unless there were records of a malfunctioning treatment system. If evidence of a malfunctioning treatment system existed, best professional judgement was used to estimate a fecal coliform loading rate.

Table 3.1.1 Inventory of Identified NPDES Permitted Dischargers

Facility Name	NPDES	Subwatershed	Fecal Coliform (Counts/100mL)	Receiving Water
Briarwood Estates	MS0044491	3170001002	200	Sowashee Creek
Briarwood Hills Apt.	MS0023256	3170001002	200	Sowashee Creek
Briarwood Mobile Homes	MS0022641	3170001002	200	Tributary of Sowashee Creek
Plantation Village West	MS0043061	3170001002	200	Sowashee Creek
Chapelwood Subdivision	MS0053678	3170001002	200	Sowashee Creek
Meridian POTW	MS0020117	3170001002	200	Sowashee Creek
Tanglewood Subdivision	MS0035190	3170001002	200	Sowashee Creek
Valley Mobile Home	MS0030490	3170001002	200	Sowashee Creek
Van Zyverden	MS0046591	3170001002	200	Sowashee Creek
Super Stop #8	MS0053341	3170001005	200	Suqualena Creek
West Lauderdale Attendance Center	MS0030171	3170001005	200	Okatibbee Reservoir
Collinsville Shopping Center	MS0050555	3170001005	200	Suqualena Creek
Northeast Middle School	MS0048763	3170001002	200	Sowashee Creek
Price Trailer Park	MS0054887	3170001002	200	Nanabe Creek
C Matfey Trailer Park	MS0042803	3170001002	200	Tributary of Sowashee Creek
The Meadow Subdivision	MS0055514	3170001002	200	Tributary of Sowashee Creek
Kings Daughters and Sons Rest HM	MS0052787	3170001002	200	Gunn Creek
Vance Mobile Home	MS0042838	3170001001	200	Graham Mill Creek
Celotex Corporation	MS0003107	3170001002	200	Sowashee Creek

3.2 Assessment of Nonpoint Sources

The nonpoint sources of fecal coliform pollution consist of every fecal contributor that does not have a localized point of release into a stream. In the Okatibbee Creek watershed these sources are:

- Failing septic systems
- Wildlife
- Land application of hog and cattle manure
- Land application of poultry litter
- Grazing animals
- Cattle contributions directly deposited instream
- Urban runoff

The 244,000 acre drainage area of Okatibbee Creek contains many different landuse types, including urban, forest, cropland, pasture, barren, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. This classification is based on a modified Anderson level one and two system with additional level two wetland classifications. The contributions of each of these land types to the fecal coliform loading of Okatibbee Creek was considered on a subwatershed basis.

3.2.1. Failing Septic Systems

Septic systems provide the potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat the wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate thence into underground absorption. The systems can fail when the field lines are broken, or the underground substrate is clogged or flooded. The septic water reaches the surface and is then available for wash-off into the stream. Another related potential fecal source is the occurrence of direct bypasses to streams. In efforts to keep wastewater from seeping into a drain field, pipes are extended from the septic tanks or the field lines to the nearest creek, which can be represented as a point source.

Another consideration is the use of individual onsite wastewater treatment plants, which are widely used in Mississippi. They can adequately treat wastewater if properly maintained. However, the systems do not typically receive the attention needed for proper long-term operation. They require some sort of disinfection to properly operate. This expense is often ignored by the homeowner and the water does not receive adequate disinfection prior to release.

The estimate of failing septic systems is derived from the watershed area normalized population of Lauderdale, Clarke, Neshoba, and Kemper Counties currently utilizing septic systems (1997 estimates based on 1990 U.S. Census). Of these, it was estimated that 40% are currently failing. This number includes estimates for direct bypasses and estimates for failing onsite wastewater treatment systems in the watershed.

Discharges from failing septic systems were quantified based on several factors including the estimated population served by the septic systems, an average daily discharge of 100 gallons/person/day, and a septic system effluent fecal coliform concentration of 10^4 counts/100 ml.

3.2.2. Wildlife Contributions

Wildlife present in the Okatibbee Creek Watershed contribute to fecal coliform bacteria on the land surface. In the Okatibbee Creek model, all wildlife was accounted for by considering contributions from deer. Estimates of deer population were designed to account for the deer combined with all of the other wildlife present in the area. It was assumed that the wildlife population remained constant throughout the year, and that wildlife were present on all land classified as pastureland, cropland, and forest. It was also assumed that the wildlife and the manure produced by the wildlife were evenly distributed throughout these land types.

3.2.3. Land Application of Hog and Cattle Manure

In the Pascagoula Basin, processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during certain months of the year. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Pascagoula Basin operate by either keeping the animals confined by or allowing hogs to graze in a small pasture or pen. For this model, it was assumed that all of the hog manure produced by either farming method was applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations varied monthly according to management practices currently used in this area.

The dairy farms that are currently operating in the Okatibbee Creek watershed confine the animals for a limited time during the day. The model assumed a confinement time of four hours per day, during which time the cattle are milked and fed. During all other times, dairy cattle are allowed to graze on pasturelands. The manure collected during confinement is applied to the available pastureland in the watershed. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

3.2.4. Grazing Animals

Cattle, including beef and dairy, spend time grazing on pastureland, depositing manure containing fecal coliform bacteria on the land surface. In a rain event, a portion of this fecal coliform bacteria is available for wash-off and delivery to receiving waterbodies. In this region of the state there is no monthly variation in beef and dairy cattle access to the pastures. Therefore, it is assumed that their loading rates are equal throughout the year. Beef cattle spend all of their time in pasture, while dairy cattle are confined for a limited period each day, during which time they are being milked and fed. This is estimated to be four hours per day for each cow.

3.2.5. Land Application of Poultry Litter

There is a considerable number of chickens produced in the Okatibbee Creek Watershed as estimated by the 1997 Census of Agriculture. In this area, poultry farming operations use houses in which chickens are confined all of the time. The manure produced by the chickens is collected in litter on the floor of the chicken houses. This litter is routinely applied as a fertilizer to pastureland in the watershed. Application rates of the litter vary monthly.

Two kinds of chickens are raised on farms in the Pascagoula Basin, broilers and layers. For the broiler chickens, the amount of growth time from when the chicken is born to when it is sold off the farm is approximately 48 days or 1.6 months. Layer chickens remain on farms for 10 months or longer. More than 93% of the chickens raised in this area are broilers. For the model, a weighted average of growth time was determined to account for both types of chickens. An average growth time of 52 days, or 1/7 of a year, was used. To determine the number of chickens on farms on any given day, the yearly population of chickens sold was divided by 7.

3.2.6. Cattle Contributions to Stream

Cattle often have direct access to small, intermittent streams which run through fenced pastureland. These small streams are tributaries of larger streams. Fecal coliform bacteria deposited in these streams by grazing cattle are considered a direct input of bacteria to the stream. Due to the general topography in the Okatibbee Creek watershed, it was assumed that all land slopes in the watershed are such that cattle are able to access the intermittent streams in all pastures. In order to determine the amount of bacteria introduced into streams from cattle, it was assumed that all grazing cattle spent 2% of their time standing in the streams. Thus, the model assumes that 2% percent of the manure produced by grazing beef and dairy cows is deposited directly in the stream. The fecal coliform concentration is calculated using the number of cows in the stream and a bacteria production rate of 5.40E+09 counts per animal per day.

3.2.7. Urban Runoff

Municipalities in the watershed include the cites of Meridian, Collinsville, and Enterprise. Pathogen contributions from urban areas may come from storm water runoff through stormwater sewers (e.g. residential, commercial, industrial, road transportation), illicit discharges of sanitary wastes, and runoff contribution from improper disposal of waste materials. Urban land use is represented in Table 1.1 under the “Urban” and “Barren”categories.

The MARIS landuse data divide urban land into several categories. For the Okatibbee Creek watershed, the urban land is divided into three different categories, high density, low density, and transportation. For the model, fecal coliform buildup rates for each category were determined by using literature values from Horner, 1992. The literature value accounts for all of the potential fecal coliform sources in each urban category. They are given in Table 3.2.7a. Also shown in Table 3.2.7b are the urban landuse distributions within each subwatershed. They are assumed to be 50% impervious and 50% pervious. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 3.2.7a Urban Loading Rates, by Landuse

High Density Area	Low Density Area	Transportation Area
1.54E+07	1.03E+07	2.00E+05

Table 3.2.7b Urban Loading Rates, by Landuse for Okatibbee Subwatersheds

Subwatershed	High Density Area (AC)	Low Density Area (AC)	Transportation Area (AC)
03170001011	0	0	0
03170001010	0	0	0
03170001005	91	256	222
03170001004	80	224	194
03170001003	354	996	864
03170001002	1732	4871	4222
03170001001	90	254	220
Total	**2347**	**6601**	**5722**

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loadings is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established though a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

The BASINS model platform and the NPSM model were used to predict the significance of fecal coliform sources and fecal coliform levels in the Black Creek watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as land uses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from selected watershed, as well as the transport and flow of the pollutants through stream reaches. A key reason for using BASINS as the modeling framework is its ability to integrate both point and nonpoint source simulation, as will as its ability to assess instream water quality response.

4.2 Model Setup

The Okatibbee Creek TMDL model includes the impaired section of the creek as well as all the drainage areas which are upstream of the impaired segment. To obtain a spatial variation of the concentration of fecal coliform bacteria along Okatibbee Creek, the watershed was divided into seven subwatersheds in an effort to isolate the major stream reaches. This allowed the relative contribution of point and nonpoint sources to segments of Okatibbee Creek to be addressed within each subwatershed. The delineation of the watershed was based primarily on an analysis of the Reach File 3 (RF3) stream network in the basin as well as a topographic analysis of the watershed.

4.3 Source Representation

Both point and nonpoint sources were represented in this model. There were 19 NPDES facilities in the watershed which contribute fecal coliform. Their discharge was added as a direct input into the creek at the appropriate reach. Fecal coliform loading rates for point sources are input to the model as a flow in cfs and fecal coliform contribution in counts/hr contained in the flow. The nonpoint sources discussed in Section 3.2 are represented in the model with two different methods. The first of these methods is a direct fecal coliform loading to Okatibbee Creek. Other sources are represented as an application rate to the Okatibbee Creek watershed. For these sources, fecal coliform accumulation

rates in counts/acre/day were calculated for each subwatershed on a monthly basis and input to the model for each land use. Fecal coliform contributions from forest and wetlands were considered at the same time, and all forest and wetland contributions were combined for model input. Urban and barren areas were combined and input into the model in the same manner.

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of Okatibbee Creek. This section begins at the headwaters and ends at the end of the monitored reach, with the confluence of Chunky River. The channel geometry and lengths for Okatibbee Creek are based on data available within the BASINS modeling system. The 7Q10 flow of 12 cfs was determined from USGS data. The characteristics of the modeled section of Okatibbee Creek are as follows.

,	Length	53 miles
,	Average Depth	0.52 ft
,	Average Width	39.8 ft
,	Mean Flow	275.5 cfs
,	Mean Velocity	0.94 f/s
,	7Q10 Flow	12 cfs
,	Slope	0.00084 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for 11 years, from January 1, 1985 through December 31, 1995. The first year of data was used to stabilize the model. Results from the model were evaluated for the time period from January 1, 1986 until December 31, 1995. By using this ten-year time spread, a margin of safety is implicitly applied. Seasonality and critical conditions are accounted for during the extended time frame of the simulation.

The critical condition for fecal coliform impairment from nonpoint source contributors occurs after a heavy rainfall which is proceeded by several days of dry weather. The dry weather allows a build up of fecal coliform bacteria which is then washed off the ground by a heavy rainfall. By using the ten year time period, many such occurrences are captured in the model results. Critical conditions for point sources, which occur during low flow and low dilution conditions, are simulated as well.

4.6 Model Calibration Process

There are insufficient data available for calibration of the water quality model. Several assumptions were made to determine the fecal coliform loading rates from the nonpoint source contributors. A spreadsheet has been developed to incorporate those assumptions for the Pascagoula River Basin.

As described in section 2.2 the water quality data available are instantaneous samples collected approximately every two months. The data available are not sufficient for calibration purposes. Instead, MDEQ contacted researchers and agricultural experts to quantify representative pathogen loads entering the stream.

4.7 Existing Loadings

Appendix A also includes two graphs of the model results showing the instream fecal coliform concentrations for the impaired reach of Okatibbee Creek, 03170001001. Graph AB-1 shows the fecal coliform levels in the stream during the 11 year modeling period. The graph shows a 30-day geometric mean of the data. There have been 25 standards violations in 11 years according to the model. The straight line at 200 counts per 100 mL is an indication of the standards limits for the stream.

Graph AB-2 shows the 30-day geometric mean of the fecal coliform levels after the reduction scenario has been modeled. The scale matches the previous graph for comparison purposes. The graph indicates that there are two violations of the water quality standard.

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segment MS060M and drainage area, MS059OE. Point source contributions enter the stream directly in the appropriate reach. Cows in the stream and failing septic tanks were modeled as direct inputs to the stream. Cows in the stream are nonpoint sources while failing septic tanks are both point and nonpoint sources. The other nonpoint source contributions were applied to land area on a counts per day per acre basis. The fecal coliform bacteria applied to land is subject to a die-off rate and an absorption rate before it enters the stream. The TMDL was calculated based on modeling estimates which are referenced in Appendix A.

5.1 Wasteload Allocations

The TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For bacteria, however, TMDLs can be expressed in terms of organism counts (or resulting concentration). Total maximum daily loads (TMDLs) are composed of the sum of individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). This equation is expressed as follows:

$$\text{TMDL} = 3\,\text{WLA} + 3\,\text{LA} + \text{MOS}$$

Point sources within the watershed discharging at their current level are subject to some reduction from their current level of fecal coliform contribution. The contribution of point sources was considered on a subwatershed basis for the model. Within each subwatershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. In several cases, the fecal coliform contribution from a facility is much greater than the permitted limit of 200 counts per100 ml. Table 5.1.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. The final WLA on the summary page also accounts for the portion of the failing septic tanks which have direct bypasses to the stream.

Table 5.1.1 NPDES Fecal Coliform Load Contributions, by Subwatershed

Subwatershed	Existing Flow cfs	Existing Load counts/hr	Allocated Flow cfs	Allocated Load counts/hr	Reduction
03170001005	0.150	1.76e+06	0.150	1.38e+06	**22%**
03170001002	20.05	8.25e+08	20.05	4.15e+08	**50%**
03170001003	0.150	0	0.150	0	**0%**
03170001001	0.020	3.78e+05	0.020	2.58e+05	**32%**
Total	**20.37**	**8.27e+08**	**20.37**	**4.16e+08**	**50%**

5.2 Load Allocations

Nonpoint sources which contribute to fecal coliform accumulation within the Okatibbee Creek watershed are subject to reduction from their current level of contribution. Reductions in the load allocation for this TMDL involves two different types of nonpoint sources: cattle access to streams and failing septic tanks. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow and fecal coliform concentration in counts per hour. Table 5.2.a lists the nonpoint source contributions due to cattle access to streams, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. Table 5.2.b gives the same parameters for contributions due to septic tank failure. The septic tank failures in reality are both point and nonpoint source contributions and have been calculated as equal contributors to the WLA and the LA component of the TMDL calculation.

Table 5.2.a Fecal Coliform loading rates for nonpoint source contribution of cattle access

Subwatershed	Existing Flow cfs	Existing Load counts/hr	Allocated Flow cfs	Allocated Load counts/hr	Reduction
03170001011	1.96e-04	7.47e+09	4.89e-05	1.87e+09	**75%**
03170001010	9.24e-05	3.53e+09	2.31e-05	8.82e+08	**75%**
03170001005	2.01e-04	7.66e+09	5.01e-05	1.92e+09	**75%**
03170001004	4.28e-05	1.63e+09	1.07e-05	4.08e+08	**75%**
03170001003	3.86e-05	1.48e+09	9.66e-06	3.69e+08	**75%**
03170001002	1.60e-04	6.10e+09	3.99e-05	1.53e+09	**75%**
03170001001	1.08e-04	4.14e+09	2.71e-05	1.04e+09	**75%**
Total	**8.38e-04**	**3.20e+10**	**2.09e-04**	**8.04e+09**	**75%**

Table 5.2.b Fecal Coliform loading Rates for nonpoint and point source contribution of failing septic tanks

Subwatershed	Existing Flow cfs	Existing Load counts/hr	Allocated Flow cfs	Allocated Load counts/hr	Reduction
03170001011	0.2270	2.31e+09	0.113	1.15e+09	**50%**
03170001010	0.1140	1.43e+09	0.0701	7.13e+08	**50%**
03170001005	0.3520	3.58e+09	0.176	1.79e+09	**50%**
03170001004	0.0810	8.32e+08	0.040	4.16e+08	**50%**
03170001003	0.0740	7.53e+09	0.037	3.77e+09	**50%**
03170001002	0.3020	3.07e+09	0.151	1.53e+09	**50%**
03170001001	0.2100	2.14e+09	0.105	1.07e+09	**50%**
Total	**1.360**	**2.08e+10**	**0.6921**	**1.04e+10**	**50%**

Nonpoint fecal coliform loadings due to cattle and hog grazing, land application of manure produced by dairy cattle, hogs, and poultry, wildlife, and urban development are also included in the load allocation. Currently, no reduction is required for these contributors in order for Okatibbee Creek to achieve water quality standards. Daily fecal coliform loading rates for each landuse are given in Table 5.2.c. The total accumulation for each landuse type was determined by combining the contributions from each subwatershed. For example, the loading rate for forest was determined by combining all of the forest areas in each of the seven subwatersheds. The loading rates are constant throughout the year for forest, cropland, and urban land. The loading rates for pastures vary for each month. However, in the table, the given rate is based on an average of the monthly accumulation rates. The estimated loads shown in Table 5.2c are those applied to the land , while the total LA shown on the summary page is the load which enters the stream due to runoff.

Table 5.2c Daily Fecal Coliform Loads available for run-off, by Landuse Type

Landuse	Existing Load (counts/acre/day)	Total Acres (ac)	Existing Load (counts/day)	Allocated Load (counts/day)
Forest	3.52e+7	1.73e+05	6.17e+12	6.17e+12
Cropland	3.57e+7	2.20e+03	8.02e+10	8.02e+10
Urban	7.18e+6	1.47e+04	1.05e+11	1.05e+11
Pasture	8.93e+8	5.40e+04	4.79e+13	4.79e+13
Total	**9.70e+08**	**2.43e+05**	**5.42e+13**	**5.42e+13**

The scenario chosen for reducing the load allocation in the Okatibbee Creek watershed is a 75% reduction in contributions from cows in the stream, and a 50% reduction from failing septic tanks. This could be achieved by supporting BMP projects that promote fencing around streams in pastures,

and by supporting education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out, repairing broken field lines, and disinfecting the effluent from small individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit. The primary component of the MOS is provided by running the mode for eleven years with no violations of the water quality standard. Ensuring compliance with the standard throughout all of the critical condition periods represented during the eleven years is a conservative practice. Another component of the MOS is the conservative assumption that in the model all of the fecal coliform bacteria discharged from failing septic tanks reaches the stream, while it is likely that only a portion of the bacteria will reach the stream due to filtration and die-off during transport.

5.4 Seasonality

Because the model was established for an eleven year time span, it took into account all of the seasons within the calendar years from 1985 to 1995 for the monitored segment as well as the evaluated drainage area. The extended time period allowed the simulation of many different atmospheric conditions such as rainy and dry periods and high and low temperatures. It also allowed seasonal critical conditions to be simulated.

6.0 IMPLEMENTATION

6.1 Follow-Up Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management. The approach will provide for continued monitoring of the watershed in future cycles. During the next monitoring phase in the Pascagoula Basin, Okatibbee Creek will receive follow-up monitoring to identify the improvement in water quality from the implementation of the strategies in this TMDL.

6.2 Reasonable Assurance

The fecal coliform reduction scenario used by this TMDL includes requiring all NPDES permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing 75% of the cattle access to streams and 50% of the failing septic tanks in the watershed. Reasonable assurance for the implementation of the TMDL has been considered for both point and nonpoint source contributors. The TMDL will not impact existing or future NPDES permits as long as the effluent is disinfected to meet water quality standards for fecal coliform bacteria. However, should a permit applicant desire to install a wastewater treatment plant without the proper disinfection equipment, that NPDES permit application will be denied. Education projects which teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

6.3 Public Participation

This TMDL is scheduled for a 30-day public notice in September, 1999. During that notice, the public will be notified by publication in the statewide newspaper and a newspaper in Lauderdale County. The public will be given an opportunity to review the TMDL and submit comments on the TMDL. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing. If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality and would be transcribed. All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region 4 for final approval.

DEFINITIONS

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30th root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or a unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all cattle and land applied fecal coliform that enter a receiving waterbody. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate becomes surface runoff and either drains into surface waters or soaks into the soil and finds its way into ground water. This surface water may contain pollutants that come from land use activities such as: agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW) : a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (S): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_1$, $\mathbf{d}_2$, $\mathbf{d}_3$) respectively could be shown as:

$$\mathbf{S}_{\mathbf{i=1}}^{\mathbf{3}}\ d_i = d_1+d_2+d_3 = 24+123+16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant.

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10 . . . . Seven-Day Average Low Stream Flow With a Ten-Year Occurrence Period

BASINS . . . . Better Assessment Science Integrating Point and Nonpoint Sources

BMP . . . . Best Management Practice

CWA . . . . Clean Water Act

EPA . . . . Environmental Protection Agency

GIS . . . . Geographic Information System

HUC . . . . Hydrologic Unit Code

LA . . . . Load Allocation

MARIS . . . . State of Mississippi Automated Information System

MDEQ . . . . Mississippi Department of Environmental Quality

MOS . . . . Margin of Safety

NRCS . . . . National Resource Conservation Service

NPDES . . . . National Pollution Discharge Elimination System

NPSM . . . . Nonpoint Source Model

RF3 . . . . Reach File 3

USGS . . . . United States Geological Survey

WLA . . . . Waste Load Allocation

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APPENDIX A

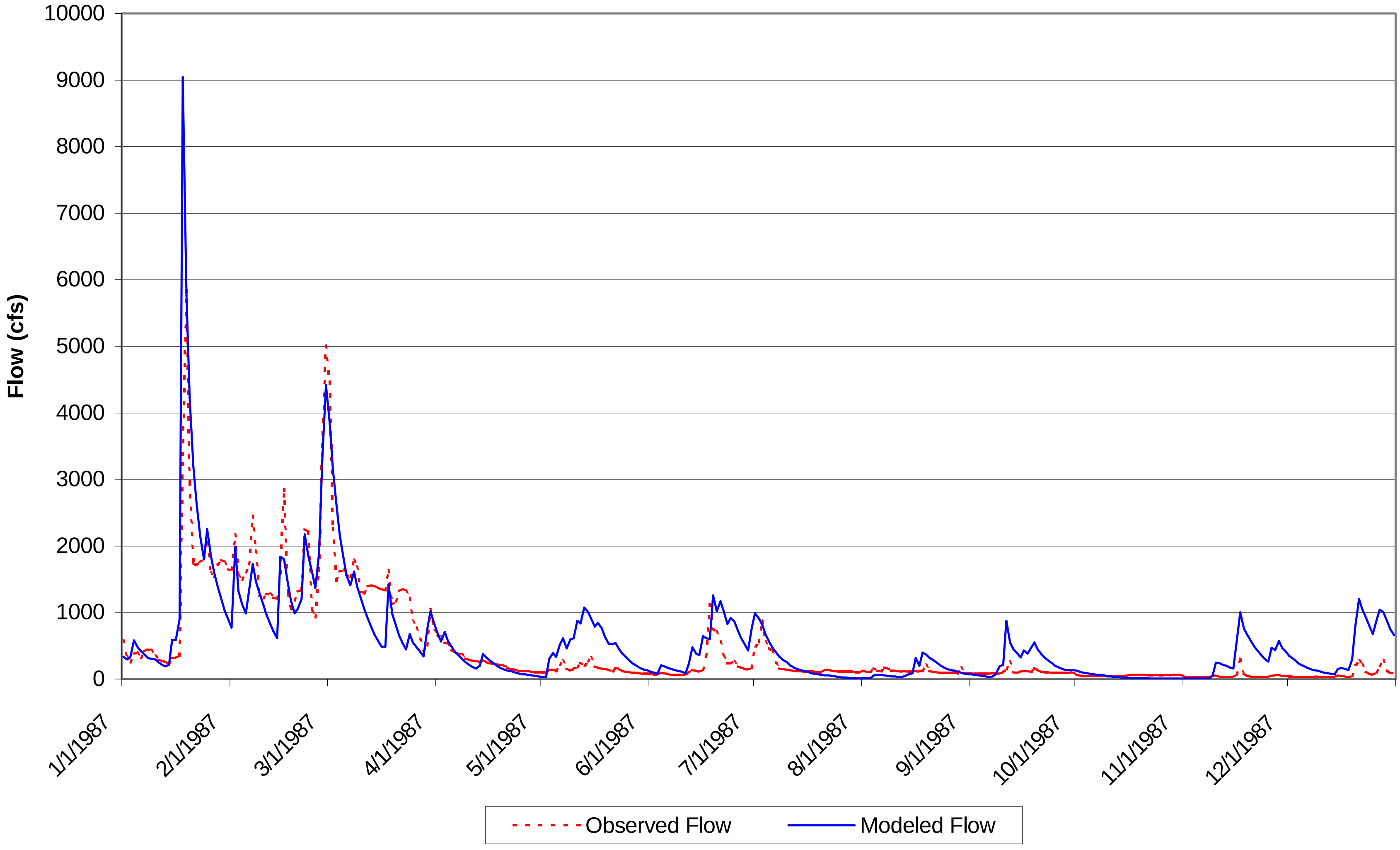
This appendix contains printouts of the various model run results. Graphs AA-1, AA-2, and AA-3 show the modeled flow, in cfs, through reach 031700070001 compared to the actual USGS gage readings from Okatibbee Creek near Arundel, station 02476600. The graphs show data from selected years of the modeled period, 1987, 1988, and 1989.

The second set of graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the impaired section of Okatibbee Creek. These graphs represent an 11-year time period, from 1985 to 1995. The graphs contain a reference line at 200 counts per 100 ml. Graph AB-1 represents the existing conditions in Okatibbee Creek. There are 25 violations of the fecal coliform standard on this graph. Graph AB-2 represents the conditions in Okatibbee Creek after the reduction scenario has been applied. Graphs AB-1 and AB-2 are shown with the same scale for comparison purposes.

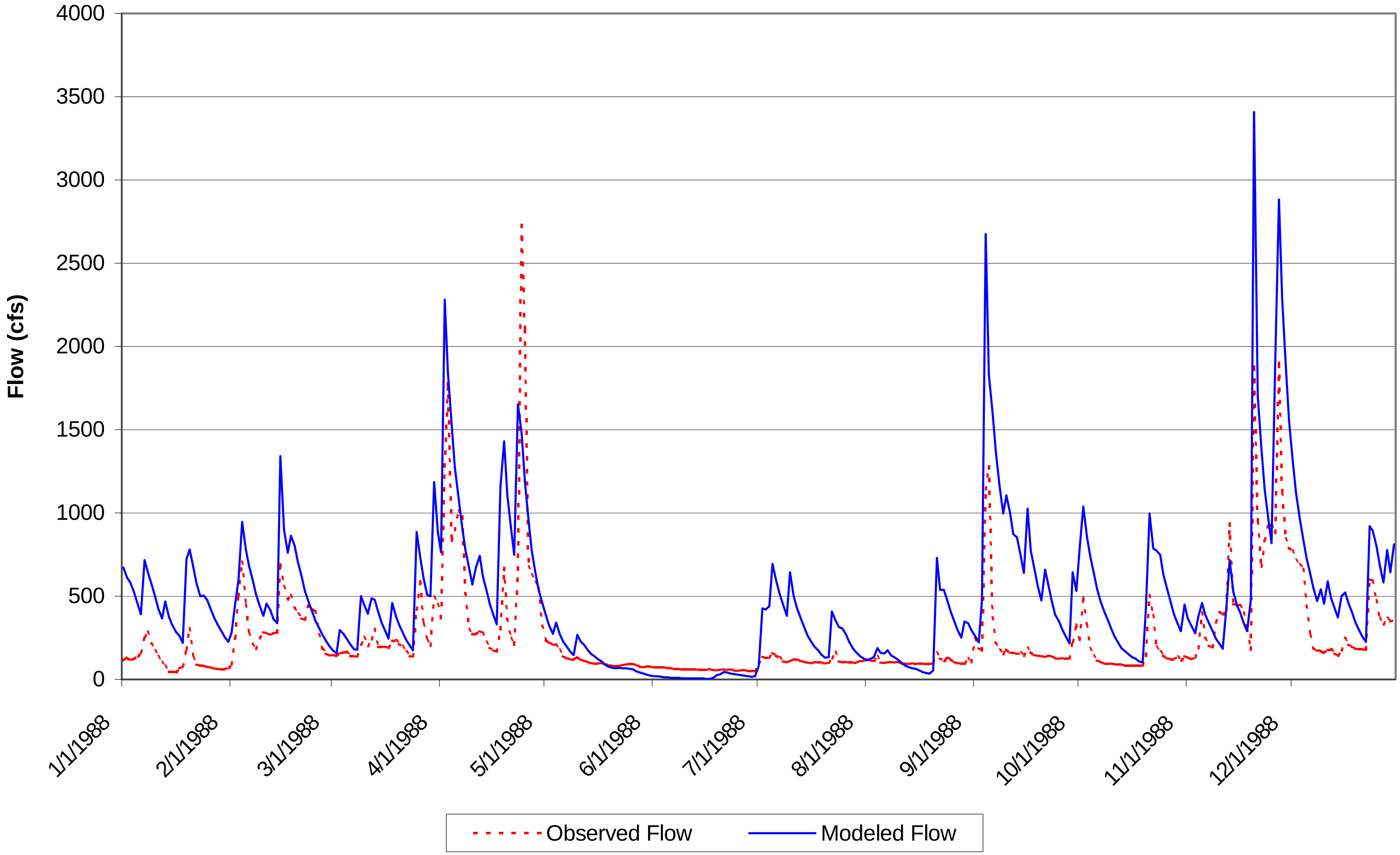
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario was used to identify the critical condition. The TMDL calculation includes the sum of the loads from all identified point and nonpoint sources applied or discharged within the modeled watershed.

An individual TMDL calculation was prepared for each waterbody segment and drainage area included in this report. The numerical values for the wasteload allocation (point sources) and load allocation (nonpoint sources) for each waterbody segment or drainage area can be found on the waterbody segment identification pages at the beginning of this report.

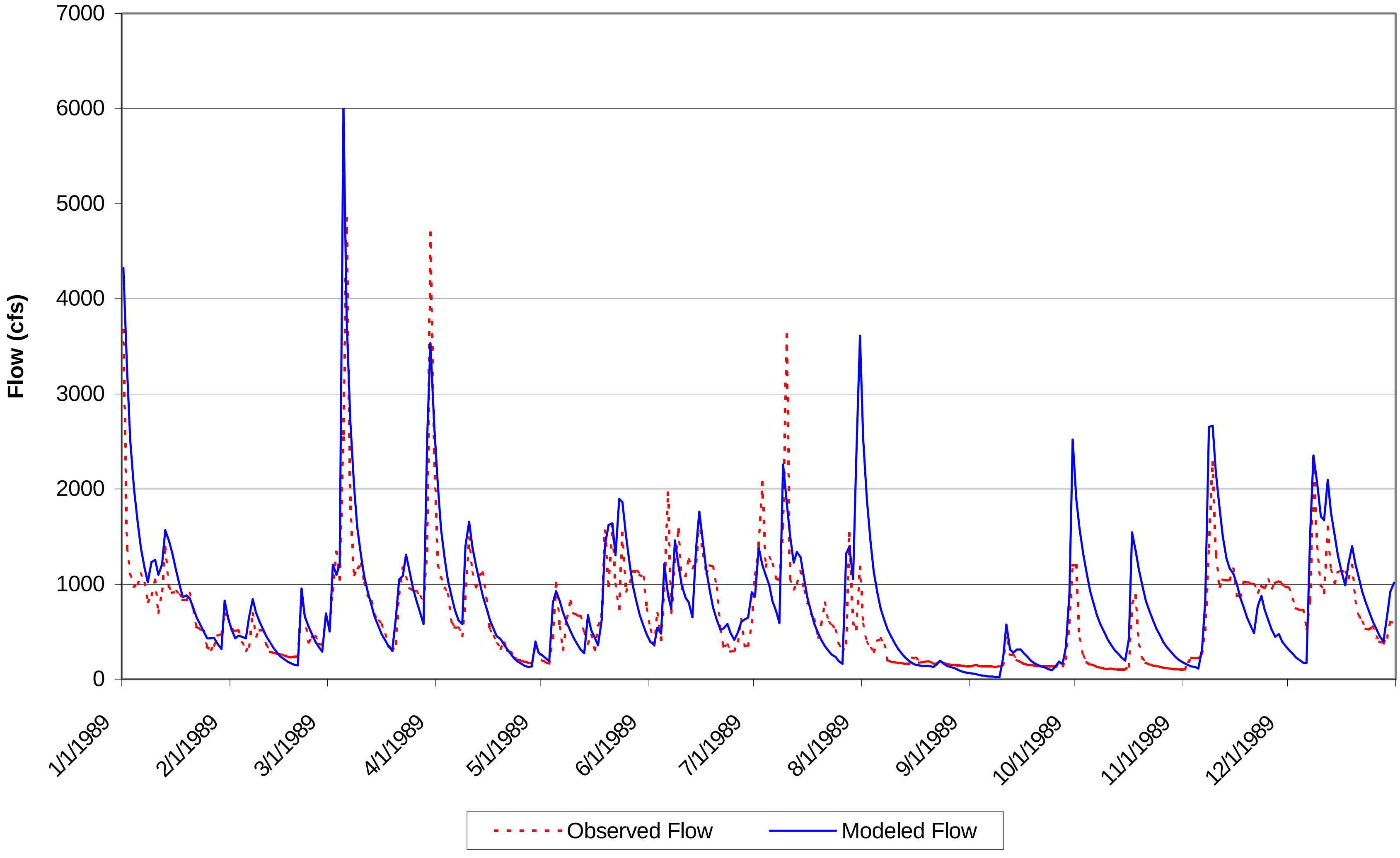
Graph AA-1 Daily Flow Comparison between USGS Gage 02476600 and Reach 03170001001 for 01/01/87 - 12/31/87



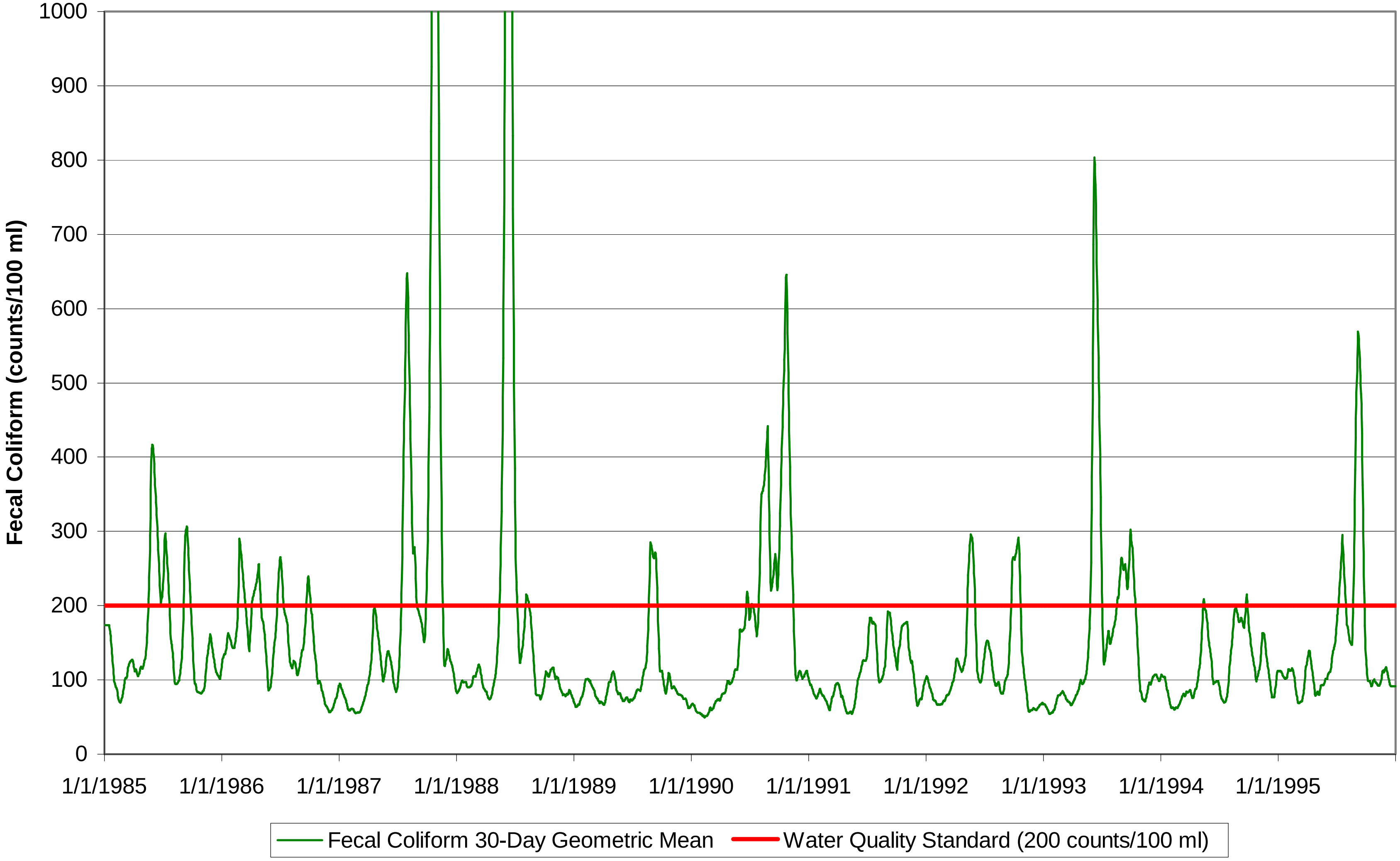
Graph AA-2 Daily Flow Comparison between USGS Gage 02476600 and Reach 03170001001 for 01/01/88 - 12/31/88



Graph AA-3 Daily Flow Comparison between USGS Gage 02476600 and Reach 03170001001 for 01/01/89 - 12/31/89



Graph AB-1 Modeled Fecal Coliform Concentrations in Okatibbee Creek Under Existing Conditions (Reach 03170001001)



Graph AB-2 Modeled Fecal Coliform Concentrations in Okatibbee Creek After Application of Reduction Scenario (Reach 03170001001)