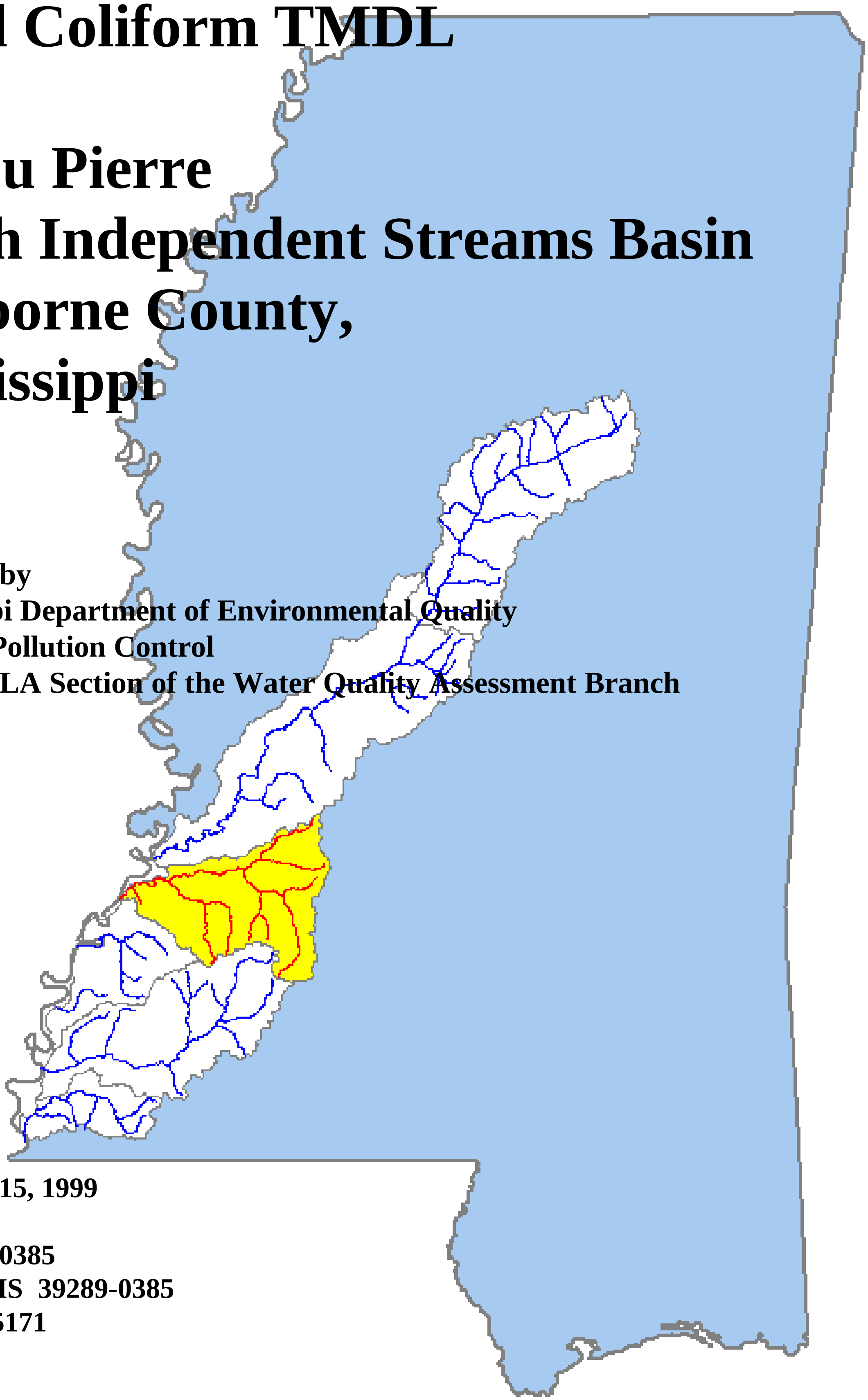
Fecal Coliform TMDL
For
Bayou Pierre
South Independent Streams Basin
Claiborne County,
Mississippi



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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:	Bayou Pierre
Waterbody ID:	MS449M
Location:	Near Willows: from Carlisle Bridge to Highway 61
County:	Claiborne County, Mississippi
USGS HUC Code:	08060203
NRCS Watershed:	040
Length:	15 miles
Use Impairment:	Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	23
NPDES Permits:	There are eight NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1).
Standards Variance:	None
Pollutant Standard:	Fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml.
Waste Load Allocation:	7.98E+11 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	1.67E+13 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	1.75E+13 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 SEGMENT IDENTIFICATION

Name:	Little Bayou Pierre –Drainage Area
Waterbody ID:	MS450E
Location:	Near Port Gibson
County:	Claiborne, Copiah, and Jefferson Counties, Mississippi
USGS HUC Code:	08060203
NRCS Watershed:	050
Area:	192,928 acres
Use Impairment:	Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are seven NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1).
Standards Variance:	None
Pollutant Standard:	Fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml.
Waste Load Allocation:	5.66E+11 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	6.11E+12 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of eleven years.
Total Maximum Daily Load (TMDL):	6.68E+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 SEGMENT IDENTIFICATION

Name:	Little Bayou Pierre – Drainage Area
Waterbody ID:	MS450E
Location:	Near Port Gibson
County:	Claiborne, Copiah, and Jefferson Counties, Mississippi
USGS HUC Code:	08060203
NRCS Watershed:	050
Area:	192,928 acres
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are seven NPDES Permits issued for facilities that discharge fecal coliform in the watershed (Table 3.1).
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:	5.66E+11 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	6.11E+12 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of eleven years.
Total Maximum Daily Load (TMDL):	6.68E+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 SEGMENT IDENTIFICATION

Name:	James Creek – Drainage Area
Waterbody ID:	MS451JE
Location:	Near Bruinsburg
County:	Claiborne County, Mississippi
USGS HUC Code:	08060203
NRCS Watershed:	060
Area:	16,897 acres
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	Low
NPDES Permits:	There are no NPDES Permits issued for facilities that discharge fecal coliform in the 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:	1.58E+10 counts/ 30 days (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	5.59E+11 counts/ 30 days
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of eleven years.
Total Maximum Daily Load (TMDL):	5.75E+11 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.

EXECUTIVE SUMMARY

A segment, MS449M, of Bayou Pierre has been placed on the Monitored Section of the Mississippi 1998 Section 303(d) List of Waterbodies as not supporting its designated use of contact recreation due to impairment caused by fecal coliform bacteria. For contact recreation the applicable state standard specifies that the fecal coliform colony counts shall not exceed a geometric mean of 200 colony counts per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. A review of the available monitoring data for the watershed indicate that there is a violation of the standard.

Within the Bayou Pierre Watershed there are also two drainage areas, MS450E and MS451JE, which account for three listings within the Evaluated Section of the Mississippi 1998 Section 303(d) List of Waterbodies. Drainage Area MS450E is listed for the uses of both contact recreation and secondary contact recreation due to fecal coliform bacteria. Drainage Area MS451JE is listed for the use of secondary contact recreation due to fecal coliform bacteria. For secondary contact recreation the applicable state standard specifies that for the months of May through October the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 colony counts per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml and that for the months of November through April the maximum allowable level of fecal coliform shall not exceed a geometric mean of 2000 colony counts per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 4000 per 100 ml.

Bayou Pierre is a major waterbody in the South Independent Streams Basin. It flows in a northeasterly direction from its headwaters in Lincoln County to its confluence with the Mississippi River in Claiborne County. This TMDL has been developed to bring the monitored segment of Bayou Pierre, which is 15 miles long, into compliance with the water quality standards. Even though the monitored segment is near Willows from Carlisle bridge to Highway 61 in Claiborne County, the entire Bayou Pierre Watershed was modeled. Therefore, the two evaluated drainage areas, which are downstream from the monitored segment of Bayou Pierre, are also covered by this TMDL and its recommendations. The entire drainage area modeled for this TMDL consists of approximately 680,000 acres.

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 Bayou Pierre near Willows were used to analyze the hydrologic flow for the watershed. The weather data used for this model was collected at Winnsboro, Louisiana. The representative hydrologic period used for this TMDL was January 1, 1985 through December 31, 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 South Independent Streams 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 Bayou Pierre or a tributary of Bayou Pierre.

There are permitted dischargers located in the watershed that 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 scenario used to reduce the fecal coliform load involves a cooperative effort between all fecal coliform contributors in the Bayou Pierre 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 Bayou Pierre Watershed should be continued to ensure that compliance with permit limits is consistently attained. Second, cattle access to streams should be reduced by 85%. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Finally, an 80% reduction in the fecal coliform contribution from failing septic tanks is required. The model assumed there is a 40% failure rate of septic tanks in the Bayou Pierre Watershed. 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 plant.

The model accounted for 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 and temperature 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.

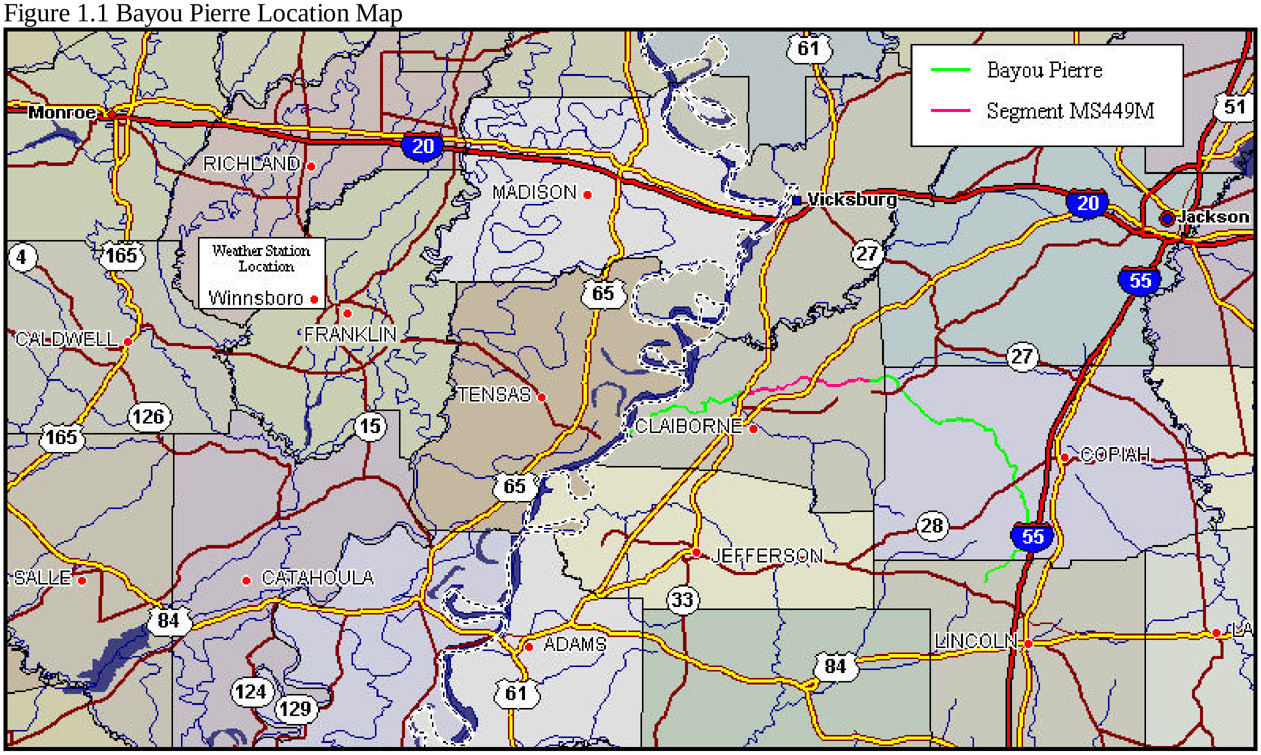
1.0 INTRODUCTION

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 bacteria are used as indicator organisms. They are readily identifiable and indicate 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 to restore and maintain the quality of water resources.

The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of Bayou Pierre as being impaired by fecal coliform bacteria for a length of 15 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. This segment is listed as impaired because sufficient monitoring data is available to show that there is an impairment in this segment. The impaired section of Bayou Pierre is in Claiborne County near Willows from Carlisle bridge to Highway 61. Bayou Pierre is highlighted in Figure 1.1.

Figure 1.1 Bayou Pierre Location Map



The monitored segment of Bayou Pierre, along with the evaluated drainage areas and the entire Bayou Pierre Watershed, lies within the South Independent Streams Basin Hydrologic Unit Code (HUC) 08060203 in southwestern Mississippi. The Bayou Pierre watershed has been divided into 17 subwatersheds based on the major tributaries and topography. Figure 1.2 shows the subwatersheds. Table 1.1 provides the corresponding identification number, which is a combination of the eight digit HUC and the three digit Reach File 1 segment identification number, and areas of the subwatersheds.

The monitored segment of Bayou Pierre lies within reach 08060203007, which is also shown in red on Figure 1.2. The evaluated drainage areas, MS450E and MS451JE, are approximately 193,000 acres and 17,000 acres respectively. These two drainage areas are downstream from the monitored segment of Bayou Pierre. Drainage area MS450E is comprised of subwatersheds 08060203004, 08060203005, and 08060203006, which are all highlighted in blue on Figure 1.2. Drainage area MS451JE is comprised of subwatershed 08060203002, which is highlighted in yellow in Figure 1.2. The entire Bayou Pierre Watershed lies within portions of Claiborne, Copiah, Hinds, Jefferson, and Lincoln Counties.

Figure 1.2 The Bayou Pierre Watershed

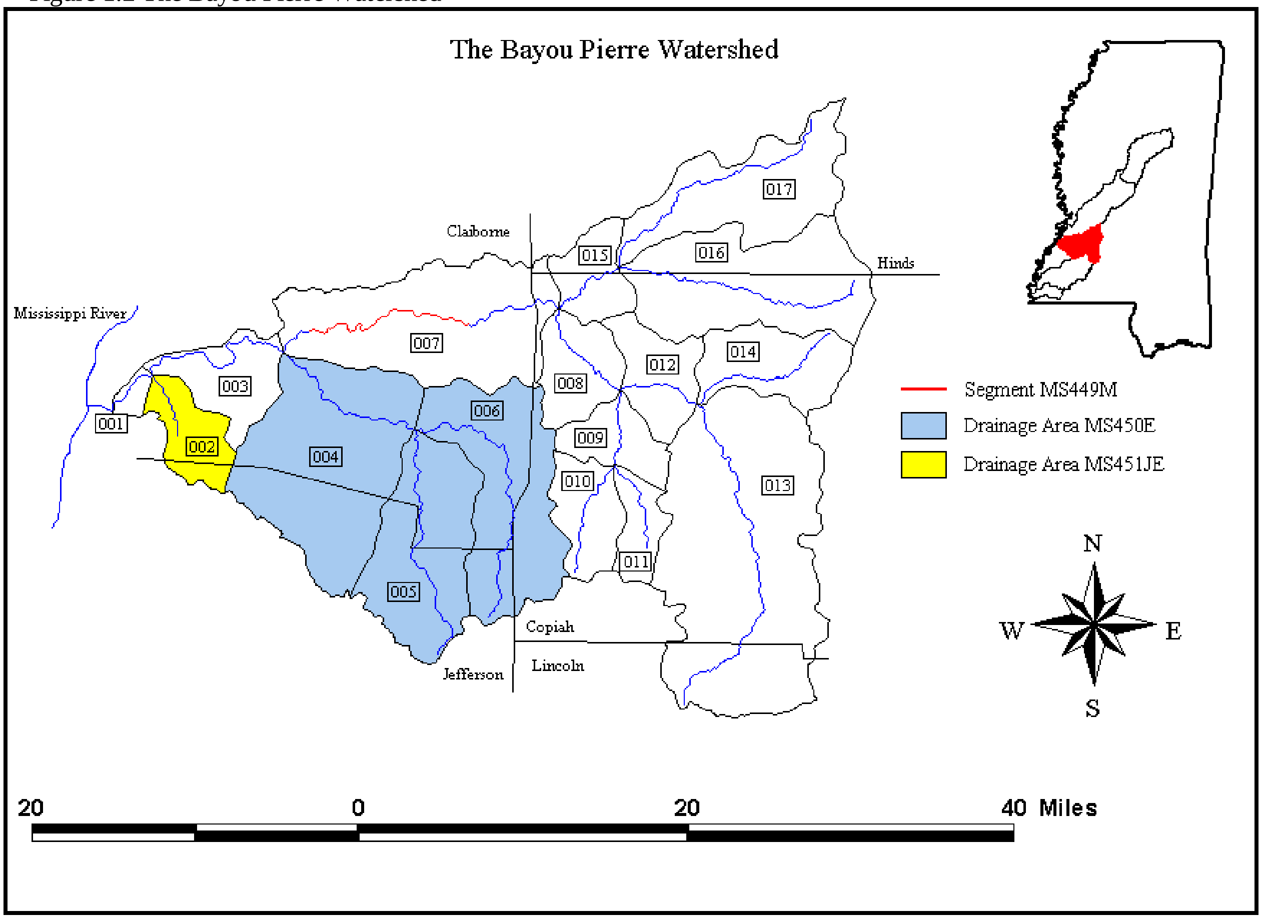


Table 1.1 Bayou Pierre Subwatersheds

Subwatershed	Stream Name	Area (acres)
08060203-001	Bayou Pierre	3,376
08060203-002	James Creek	16,897
08060203-003	Bayou Pierre	22,425
08060203-004	Little Bayou Pierre	80,638
08060203-005	Clarks Creek	52,002
08060203-006	Little Bayou Pierre	60,288
08060203-007	Bayou Pierre	74,118
08060203-008	Bayou Pierre	20,515
08060203-009	Foster Creek	15,829
08060203-010	Foster Creek	19,452
08060203-011	Jackson Creek	11,698
08060203-012	Bayou Pierre	20,297
08060203-013	Bayou Pierre	128,304
08060203-014	Turkey Creek	26,861
08060203-015	Tallahala Creek	16,361
08060203-016	White Oak Creek	62,593
08060203-017	Tallahala Creek	47,191
All		**678,845**

1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated use for Bayou Pierre as defined by the regulations is Contact Recreation. The monitored section of Bayou Pierre also has the designated use of Contact Recreation.

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*. The standard states that the fecal coliform colony counts shall not exceed a geometric mean of 200 colony counts per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 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 Endpoint 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 and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream fecal coliform target for this TMDL is a 30-day geometric mean of 200 colony counts per 100 ml.

Because fecal coliform 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, low-dilution conditions. The 1985-1995 period represents both low-flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the 11-year period was selected as representing critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 Discussion of Instream Water Quality

Water quality data available for the monitored segment of Bayou Pierre show that high levels of fecal coliform bacteria frequently impair the stream. There is one ambient station operated by MDEQ that collected fecal coliform monitoring data during the 11-year modeling period. Station 07290650 located on Bayou Pierre near Willows made measurements of flow and fecal coliform between January 1992 and September 1996. The data indicate that high instream fecal coliform concentrations occurred during both periods of high-flow and dry, low-flow conditions.

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, Bayou Pierre is not supporting the use of Contact Recreation. These conclusions were based on instantaneous data collected at station 07290650. Data collected at this station are listed below in Table 2.1.

Table 2.1 Fecal Coliform Data Reported in Bayou Pierre, Station #07290650

Date	Fecal Coliform (counts/100 ml)
01/06/1992	**1,100**
03/03/1992	80
05/04/1992	170
07/13/1992	140
09/14/1992	220
11/02/1992	50
01/12/1993	**5,400**
03/08/1993	2
05/03/1993	**460**
07/12/1993	**2,400**
09/13/1993	40
11/02/1993	**24,000**
01/10/1994	**790**
03/08/1994	**5,400**
05/02/1994	40
06/20/1994	350
08/23/1994	**700**
11/08/1994	**940**
01/09/1995	**920**
03/08/1995	**2,400**
04/19/1995	350
07/12/1995	240
09/12/1995	110
11/06/1995	130
01/09/1996	**540**
03/06/1996	**2,400**
05/07/1996	70
07/10/1996	70
09/10/1996	22

2.2.2 Analysis of Instream Water Quality Monitoring Data

A statistical summary of the water quality data discussed above is presented in Table 2.2. Samples are compared to the instantaneous maximum standard of 400 colony counts per 100 ml. The percent exceedance was calculated by dividing the number of exceedances by the total number of samples and does not represent the amount of time that the water quality is in violation.

Table 2.2 Statistical Summary

Station Number	Number of Samples	Minimum Value (counts/100 ml)	Maximum Value (counts/100 ml)	Number of Exceedances	Percent Instantaneous Exceedance
07290650	29	2	24,000	13	45%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Bayou Pierre Watershed. The source assessment was used as the basis of development for the model and the ultimate analysis of the TMDL allocation options. In evaluation of the sources, loads were 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.

Bayou Pierre was modeled as six reaches from its headwaters to the Mississippi River. The watershed delineations were 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.

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 dilution capacity of the stream is diminished during dry periods. Thus, an evaluation of all point sources was necessary in order to quantify the potential for impairment present during the low-flow, critical condition period. The 15 wastewater dischargers in the Bayou Pierre Watershed serve a variety of activities including municipalities, industries, residential subdivisions, schools, recreational areas, and other businesses.

A point source assessment was completed for each subwatershed in the Bayou Pierre Watershed. Reference maps were used to determine the appropriate subwatershed location of each discharger. Figure 1.2 shows a map of the drainage area of the monitored section of Bayou Pierre and its drainage area divided into subwatersheds. Figure 1.2 also shows the two evaluated drainage areas divided into subwatersheds. The map also shows the Reach File 1 identification number for each of the subwatersheds. Table 3.1 lists all of 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. Of the facilities for which they were available, the discharge monitoring reports for the years 1993 through 1998 were analyzed. If the discharge monitoring data were inadequate, permit limits were used to represent fecal coliform concentrations in the model, unless there was a history of an insufficient or malfunctioning disinfection system. If evidence of insufficient treatment existed, best professional judgement was used to estimate a fecal coliform loading rate in the model. The fecal coliform permit limits for each facility included in the model are also displayed in Table 3.1.

Table 3.1 Inventory of Identified NPDES Permitted Dischargers

Facility Name	Subwatershed	NPDES	Permit Limit (counts/100ml)	Receiving Waterbody
Claiborne County Vo-Tech	08060203004	MS0046981	200	Little Bayou Pierre
Grand Gulf Inn	08060203004	MS0028118	200	Little Bayou Pierre
Hermanville Facility	08060203004	MS0046850	200/2000*	Little Bayou Pierre
Hollyrood and Trace Hills S/D	08060203004	MS0031747	200	Little Bayou Pierre
Port Gibson POTW	08060203004	MS0024635	200	Little Bayou Pierre
Hazlehurst POTW – Sand Filter	08060203005	MS0023884	200	Johnson Creek
Fayette POTW – Southwest	08060203005	MS0026239	No permit limit	Hughes Creek
Ashland Trailer Park	08060203007	MS0029432	200	Bayou Pierre
MDOT I-55 Rest Area – Copiah	08060203013	MS0030112	200	Bayou Pierre
Wesson POTW	08060203013	MS0023779	200/2000*	Dye Branch
Wilson Slaughterhouse	08060203014	MS0037338	200	Turkey Creek
MS/Utica Junior College POTW	08060203016	MS0039306	200/2000*	White Oak Creek
Utica POTW – South	08060203016	MS0020613	200/2000*	White Oak Creek
Henry S. Jacobs Camp	08060203017	MS0031178	200	Tallahala Creek
Mountain Movers Retreat	08060203017	MS0031445	200	Elda Hill Creek

*Seasonal permit limits

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Bayou Pierre, including:

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

The 443,219-acre drainage area of the monitored segment of Bayou Pierre contains many different landuse types, including urban, forests, 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 contribution of each of these land types to the fecal coliform loading of Bayou Pierre was considered on a subwatershed basis. Table 3.2 and Figure 3.1 show the landuse distribution within the watershed in acres.

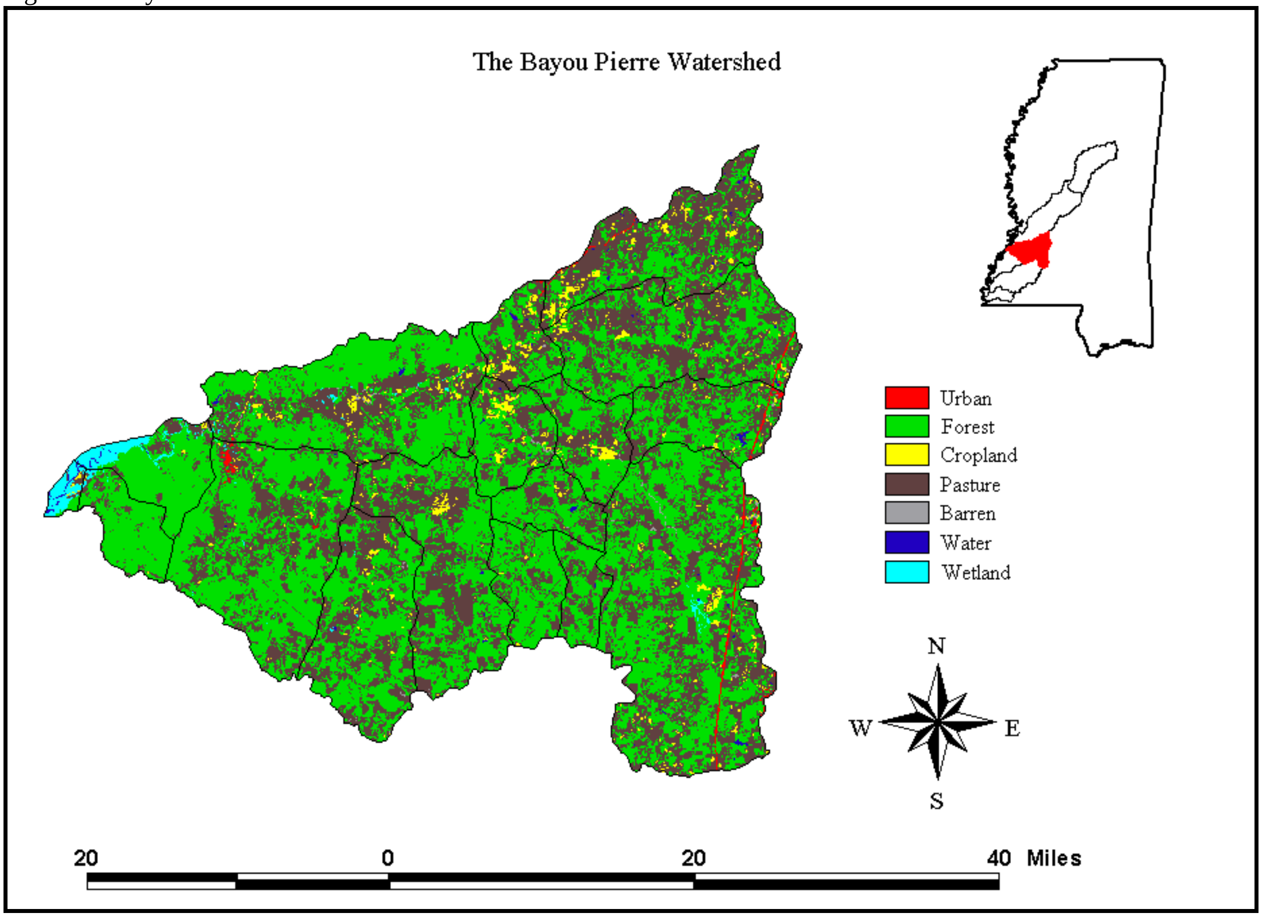
Figure 3.1 shows the general landuse distribution of the Bayou Pierre Watershed. While forest is the dominant landuse within this watershed, there are some urban areas in the Bayou Pierre Watershed such as the City of Port Gibson.

Table 3.2 Landuse Distribution in Number of Acres

Watershed	Forest	Croplands	Pasture	Urban	Barren	Wetland	Total
08060203001	2,284	137	358	0	0	597	**3,376**
08060203002	14,810	29	1,429	0	0	629	**16,897**
08060203003	19,254	77	2,056	57	0	981	**22,425**
08060203004	52,484	409	21,060	492	12	6,181	**80,638**
08060203005	29,299	583	14,677	0	118	7,325	**52,002**
08060203006	32,287	783	16,269	6	28	10,915	**60,288**
08060203007	46,733	1,851	19,892	135	102	5,405	**74,118**
08060203008	11,513	1,251	4,088	147	13	3,503	**20,515**
08060203009	10,344	159	1,843	0	15	3,468	**15,829**
08060203010	14,668	83	1,765	0	0	2,936	**19,452**
08060203011	7,469	0	1,473	0	0	2,756	**11,698**
08060203012	11,571	862	4,407	48	0	3,409	**20,297**
08060203013	72,043	2,305	27,472	1,831	314	24,339	**128,304**
08060203014	14,293	364	5,747	525	109	5,823	**26,861**
08060203015	7,456	1,068	4,629	89	41	3,078	**16,361**
08060203016	28,802	1,235	17,977	380	71	14,128	**62,593**
08060203017	15,628	2,329	18,428	310	24	10,472	**47,191**
Total	**390,938**	**13,525**	**163,570**	**4,020**	**847**	**105,945**	**678,845**

The nonpoint fecal coliform contribution from each landuse was estimated using the latest information available. The MARIS landuse data for Mississippi was utilized by the BASINS model to extract landuse sizes, populations, agriculture census data, and other information. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Bayou Pierre Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. Mississippi State University researchers provided information on manure application practices and loading rates for hog farms and cattle operations. The Natural Resources Conservation Service also gave MDEQ information on manure treatment practices and land application of manure.

Figure 3.1 Bayou Pierre Landuse Distribution



3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat 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 when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek, which can be represented as a point source.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems do not typically receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

3.2.2 Wildlife

Wildlife present in the Bayou Pierre Watershed contributes to fecal coliform bacteria on the land surface. In the Bayou Pierre 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 contributing to the area. An upper limit of 45 deer per square mile was used as the estimate. It was assumed that the wildlife population remained constant throughout the year, and that wildlife was 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 South Independent Streams Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during March through May and October through November. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the South Independent Streams 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 Bayou Pierre Watershed only 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 Beef and Dairy Cattle

Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving waterbodies. Beef cattle have access to pastureland for grazing all of the time. However, dairy cattle can spend four hours per day confined in milking barns, and the remainder of their time grazing on pastureland. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland.

3.2.5 Land Application of Poultry Litter

There is a considerable number of chickens produced in the Bayou Pierre 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 South Independent Streams 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. Layer chickens remain on farms for 10 months or longer. More than 93 percent 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 one-seventh 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 seven.

3.2.6 Cattle Contributions Directly Deposited Instream

Cattle often have direct access to flowing and intermittent streams that run through pastureland. These small streams are tributaries of larger streams. Fecal coliform bacteria deposited in these streams by grazing cattle are modeled as a direct input of bacteria to the stream. Due to the general topography in the Bayou Pierre 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 three percent of their time standing in the streams. Thus, the model assumes that three percent of the manure produced by grazing beef and dairy cows are deposited directly in the stream.

3.2.7 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to fecal coliform loading in Bayou Pierre was considered. Fecal coliform contributions from urban areas may come from storm water runoff, runoff from construction sites, and runoff contribution from improper disposal of materials such as household toxic materials and litter.

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loading 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 to fecal coliform levels in the Bayou Pierre 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 landuses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from selected watersheds, 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 sources in the simulation, as well as its ability to assess instream water quality response.

4.2 Model Setup

The Bayou Pierre TMDL model includes the monitored section of the creek as well as the two evaluated drainage areas and the rest of the Bayou Pierre Watershed. Thus, all upstream contributors of bacteria are accounted for in the model. To obtain a spatial variation of the concentration of bacteria along Bayou Pierre, the watershed was divided into 17 subwatersheds in an effort to isolate the major stream reaches in the Bayou Pierre Watershed. This allowed the relative contribution of point and nonpoint sources to be addressed within each subwatershed.

4.3 Source Representation

Both point and nonpoint sources were represented in the Bayou Pierre model. Due to die-off rates and overland transportation assumptions, the fecal coliform loadings from point and nonpoint sources must be addressed separately. A fecal coliform spreadsheet was developed for quantifying point and nonpoint sources of bacteria for the Bayou Pierre model. This spreadsheet calculates the model inputs for fecal coliform loading due to point and nonpoint sources using assumptions about land management, septic systems, farming practices, and permitted point source contributions. Each of the potential bacteria sources is covered in the fecal coliform spreadsheet.

The discharge from point sources was added as a direct input into the appropriate reach of the waterbody. There are 15 NPDES Permitted facilities in the watershed which discharge fecal coliform bacteria. Eight NPDES Permitted facilities lie within the drainage area of the monitored segment of Bayou Pierre, MS449M. The other seven NPDES Permitted facilities lie within the evaluated drainage area, MS450E. Fecal coliform loading rates for point sources are input to the model as flow in cubic feet per second and fecal coliform contribution in counts per hour.

The nonpoint sources are represented in the model with two different methods. The first of these methods is a direct fecal coliform loading to Bayou Pierre. Other sources are represented as an application rate to the land in the Bayou Pierre Watershed. For these sources, fecal coliform accumulation rates in counts per acre per day were calculated for each subwatershed on a monthly basis and input to the model for each landuse. Fecal coliform contributions from forests and wetlands were considered to be equal. Urban and barren areas were also considered to produce equal loads. The fecal coliform accumulation rate for pastureland is the sum of accumulation rates due to litter application, wildlife, processed manure, and grazing animals. For cropland in this area, the fecal coliform accumulation rate is only due to wildlife. Accumulation rates for pastureland are calculated on a monthly basis to account for seasonal variations in manure and litter application.

4.3.1 Failing Septic Systems

The number of failing septic systems used in the model was derived from the watershed area normalized population of Claiborne, Copiah, Hinds, Jefferson, and Lincoln Counties. The percentage of the population on septic systems, which was determined from 1990 United States Census Data, is given in Table 4.1. Based on the best available information, a failure rate of 40% was assumed. This information was used to calculate the estimated number of failing septic tanks per subwatershed. The number of failing septic tanks also incorporates an estimate for the failing onsite wastewater treatment systems in the area.

Table 4.1 Percent of Population on Septic Systems, by County

County	Percent on Septic Systems
Claiborne	57%
Copiah	53%
Hinds	10%
Jefferson	66%
Lincoln	59%

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 per person per day, and a septic system effluent fecal coliform concentration of 10^4 counts per 100 ml.

4.3.2 Wildlife

Based on information provided by the Mississippi Department of Wildlife, Fisheries, and Parks, the deer population throughout the Bayou Pierre Watershed was estimated to 45 animals per square mile. For the model, 45 deer per square mile was used to account for the deer and all other wildlife contributing to fecal coliform accumulation in the area. The wildlife contribution in counts per acre per day is calculated by multiplying a loading rate by the number of animals. The loading rate used in the model was estimated to be 5.00E+08 counts per day per animal.

4.3.3 Land Application of Hog and Cattle Manure

The fecal coliform spreadsheet was used to estimate the amount of waste and the concentration of fecal coliform bacteria contained in hog and dairy cattle manure produced by confined animal feeding operations. The livestock count per county is based upon the 1997 Census of Agriculture data. The county livestock count is used to estimate the number of livestock on a watershed scale. This is calculated by multiplying the county livestock figures with the area of the county within the watershed boundaries. This estimate is made with the assumption that the livestock are uniformly distributed throughout the county. A fecal coliform production rate in counts per day per animals was multiplied by the number of confined animals to quantify the amount of bacteria produced. The manure produced by these operations is collected in lagoons and applied evenly to all pastureland. Manure application rates to pastureland vary on a monthly basis. This monthly variation is incorporated into the model by using monthly loading rates.

4.3.4 Grazing Beef and Dairy Cattle

The model assumes that the manure produced by grazing beef and dairy cattle is evenly spread on pastureland throughout the year. The fecal coliform content of manure produced by grazing cattle is estimated by multiplying the number of grazing cattle by a fecal coliform production of 5.40E+09 counts per day per animal. The resulting fecal coliform loads are in the units of counts per acre per day.

4.3.5 Land Application of Poultry Litter

The fecal coliform spreadsheet estimates the concentration of bacteria which accumulates in the dry litter where poultry waste is collected. This is done by multiplying the daily number of chickens on farms by a fecal coliform production rate of 6.75E+07 counts/day/chicken (ASAE, 1998). The model assumed a watershed area normalized chicken population. The chicken population was determined from the 1997 Census of Agriculture Data for the number of chickens sold from each county per year. Litter application to pastureland varies monthly, and is modeled with a monthly loading rate.

4.3.6 Cattle Contributions Deposited Directly Instream

The contribution of fecal coliform from cattle to a stream is represented as a direct input into the stream by the model. In order to estimate the point source loading produced by grazing beef and dairy cattle with access to streams, it is assumed that three percent of the number of grazing cattle in each watershed are standing in a stream at any given time. When cattle are standing in a stream, their fecal coliform production is estimated as flow in cubic feet per second and a concentration in counts per hour. 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.

4.3.7 Urban Development

The MARIS landuse data divide urban land into several categories. For the Bayou Pierre 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. The literature values for each urban landuse category are given in Tables 4.2. Table 4.3 shows the urban landuse distribution within the watershed. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 4.2 Urban Loading Rates, by Landuse

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

Table 4.3 Urban Landuse Distribution

Subwatershed	High Density Area (acres)	Low Density Acres (acres)	Transportation Area (acres)	Total
08060203001	0	0	0	**0**
08060203002	0	0	0	**0**
08060203003	9	26	22	**57**
08060203004	81	227	197	**505**
08060203005	19	53	46	**118**
08060203006	5	15	13	**33**
08060203007	38	107	92	**237**
08060203008	26	72	62	**160**
08060203009	2	7	6	**15**
08060203010	0	0	0	**0**
08060203011	0	0	0	**0**
08060203012	8	21	19	**48**
08060203013	343	965	837	**2,145**

Table 4.3 Urban Landuse Distribution (Continued)

Subwatershed	High Density Area (acres)	Low Density Acres (acres)	Transportation Area (acres)	Total
08060203014	101	285	247	**633**
08060203015	21	59	51	**131**
08060203016	72	203	176	**451**
08060203017	54	151	130	**335**
Total	**779**	**2,191**	**1,898**	**4,868**

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of Bayou Pierre. This section begins at the headwaters and ends at the confluence with the Mississippi River. The channel geometry and lengths for Bayou Pierre are based on data available within the BASINS modeling system. The 7Q10 flow was determined from USGS data. The characteristics of the modeled section of Tuxachanie Creek are as follows.

- Length 82.50 miles
- Average Depth 1.35 ft
- Average Width 100.36 ft
- Mean Flow 1028.74 cubic ft per second
- Mean Velocity 1.65 ft per second
- 7Q10 Flow 25.0 cubic ft per second
- Slope 0.00082 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for 12 years, from January 1, 1984, through December 31, 1995. The first year of data were used to stabilize the model. Results from the model were evaluated for the time period from January 1, 1985, until December 31, 1995. Because this 11-year time span is used, 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 that is preceded 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 11-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

The model was calibrated for hydrology on various gages in southeast Mississippi. A set of input values was established through the hydrologic calibration. The hydrological model had a continuous USGS gage (07290650) available on Bayou Pierre near Willows for comparison with the modeled flow. Samples of these results are included in Appendix A, Graph A-1 through A-3. The modeled output and the actual gage data are shown on the same graph. Even though there is a good correlation between the simulated and observed data sets, the offset may be a result of the distance between the rain gage and the streamflow gage.

MDEQ contacted researchers and agricultural experts to quantify representative pathogen loads entering the stream and give as much validity as possible to the assumptions made within the BASINS model. The weather data used for this model were collected at Winnsboro, Louisiana. The representative hydrologic period used for the TMDL was January 1, 1985, through December 31, 1995.

4.7 Existing Loading

Appendix A includes two graphs of the model results showing the instream fecal coliform concentrations for Bayou Pierre. Graph A-4 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 are 20 violations in 11 years according to the model. The straight line at 200 counts per 100 ml indicates the water quality standard for the stream.

Graph A-5 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 no violations of the water quality standard for the monitored segment after the reduction scenario is applied.

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 MS449M. Point source contributions enter the stream directly in the appropriate reach. Cows in the stream and failing septic tanks were also 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 are subject to a die-off rate and an absorption rate before it enters the stream.

5.1 Wasteload Allocations

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 maximum permitted discharge, discharge monitoring data, and other records of past performance. In some cases, the fecal coliform contribution from a facility is much greater than the maximum permitted limit. As part of this TMDL, all permitted facilities which are not in compliance with their current NPDES Permits should take steps to comply with their NPDES permit. It is also recommended that all permit limits, which allow end of pipe concentrations greater than the water quality standards for the receiving stream, be lowered so that effluent concentrations are equal to water quality standards upon reissuance.

According to the available discharge monitoring data, the contribution from one point source in the Bayou Pierre Watershed is exceeding its maximum permitted discharge for fecal coliform. Wilson Slaughterhouse, NPDES Permit MS0037338, lies within subwatershed 08060203014. The discharge monitoring data indicates that this facility's fecal coliform contribution to the Bayou Pierre Watershed is much greater than its maximum permitted discharge. The 98% allocation for subwatershed 08060203014 was the amount necessary for this facility to meet its maximum permitted discharge.

Table 5.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. Subwatersheds not listed in Table 5.1 had no NPDES Permitted facilities. The final wasteload allocations on the summary pages also account for the portion of the failing septic tanks which have direct bypasses to the stream.

Table 5.1 Fecal Coliform Loading Rates for Point Source Contributions from NPDES Permitted Dischargers

Subwatershed	Existing Load (counts/hr)	Allocated Load (counts/hr)	Percent Load Reduction
08060203004	4.03E+08	4.03E+08	0%
08060203005	3.02E+08	3.02E+08	0%
08060203007	2.20E+06	2.20E+06	0%
08060203013	9.56E+08	9.56E+08	0%
08060203014	3.10E+07	4.72E+05	98%
08060203016	7.40E+08	7.40E+08	0%
08060203017	1.54E+07	1.54E+07	0%
Total	**2.45E+09**	**2.42E+09**	**1%**

5.2 Load Allocations

Nonpoint sources that contribute to fecal coliform accumulation within the Bayou Pierre Watershed are subject to reduction from their current level of contribution. Reductions in the load allocation for this TMDL involve two different types of nonpoint sources: cattle access to streams and 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 lists the nonpoint source contributions due to cattle access to streams in the watershed, along with their existing load, allocated load, and percent reduction. Table 5.3 gives the same parameters for contributions due to septic tank failure. Septic tank failures in reality are both point and nonpoint contributions and have been calculated as equal contributors to the wasteload allocation component and load allocation component of the TMDL calculation.

Table 5.2 Fecal Coliform Loading Rates for Nonpoint Source Contribution of Cattle Access to Streams

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
08060203001	1.11E-05	4.25E+08	1.67E-06	6.38E+07	85%
08060203002	4.08E-05	1.56E+09	6.11E-06	2.34E+08	85%
08060203003	6.33E-05	2.42E+09	9.50E-06	3.63E+08	85%
08060203004	5.61E-04	2.14E+10	8.42E-05	3.22E+09	85%
08060203005	3.52E-04	1.34E+10	5.27E-05	2.01E+09	85%
08060203006	4.89E-04	1.87E+10	7.33E-05	2.80E+09	85%
08060203007	6.17E-04	2.36E+10	9.26E-05	3.54E+09	85%
08060203008	1.51E-04	5.76E+09	2.26E-05	8.64E+08	85%
08060203009	6.79E-05	2.59E+09	1.02E-05	3.89E+08	85%
08060203010	6.50E-05	2.49E+09	9.76E-06	3.73E+08	85%
08060203011	5.42E-05	2.07E+09	8.13E-06	3.11E+08	85%
08060203012	1.62E-04	6.20E+09	2.44E-05	9.30E+08	85%

Table 5.2 Fecal Coliform Loading Rates for Nonpoint Source Contribution of Cattle Access to Streams (Continued)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
08060203013	1.05E-03	4.02E+10	1.58E-04	6.03E+09	85%
08060203014	2.12E-04	8.09E+09	3.18E-05	1.21E+09	85%
08060203015	1.64E-04	6.28E+09	2.46E-05	9.41E+08	85%
08060203016	6.37E-04	2.44E+10	9.56E-05	3.65E+09	85%
08060203017	6.31E-04	2.41E+10	9.46E-05	3.62E+09	85%
Total	5.33E-03	2.04E+11	8.00E-04	3.05E+10	85%

Table 5.3 Fecal Coliform Loading Rates for the Contribution from Failing Septic Tanks (50% WLA and 50% LA)

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
08060203001	4.95E-03	5.03E+07	9.90E-04	1.01E+07	80%
08060203002	2.15E-02	2.19E+08	4.31E-03	4.38E+07	80%
08060203003	3.01E-02	3.07E+08	6.03E-03	6.13E+07	80%
08060203004	9.82E-02	9.99E+08	1.96E-02	2.00E+08	80%
08060203005	5.98E-02	6.08E+08	1.20E-02	1.22E+08	80%
08060203006	8.83E-02	8.99E+08	1.77E-02	1.80E+08	80%
08060203007	1.02E-01	1.04E+09	2.05E-02	2.08E+08	80%
08060203008	3.85E-02	3.92E+08	7.71E-03	7.84E+07	80%
08060203009	2.98E-02	3.03E+08	5.96E-03	6.06E+07	80%
08060203010	3.64E-02	3.70E+08	7.28E-03	7.41E+07	80%
08060203011	2.19E-02	2.23E+08	4.38E-03	4.46E+07	80%
08060203012	3.80E-02	3.86E+08	7.60E-03	7.73E+07	80%
08060203013	2.75E-01	2.79E+09	5.49E-02	5.59E+08	80%
08060203014	5.06E-02	5.15E+08	1.01E-02	1.03E+08	80%
08060203015	3.70E-02	3.76E+08	7.40E-03	7.53E+07	80%
08060203016	1.38E-01	1.41E+09	2.76E-02	2.81E+08	80%
08060203017	1.28E-01	1.31E+09	2.57E-02	2.61E+08	80%
Total	**1.20E+00**	**1.22E+10**	**2.40E-01**	**2.44E+09**	**80%**

Nonpoint fecal coliform loadings due to cattle grazing; land application of manure produced by confined 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 Bayou Pierre to achieve water quality standards. The loading rates are constant throughout the year for forest, cropland, and urban land. However, the loading rates for pastureland vary monthly. In the Table 5.4 the rates given for pastureland are based on an average of the monthly accumulation rates. The estimated loads in Table 5.4 are that applied to the land, while the total load allocations shown on the summary pages are the loads which enter the stream due to runoff.

Table 5.4 Fecal Coliform Counts Per Day Applied to Land Available for Land Surface Runoff

Subwatershed	Urban & Barren	Forest & Wetland	Cropland	Pastureland	Total
08060203001	0.00E+00	1.01E+11	4.80E+09	3.68E+11	4.74E+11
08060203002	0.00E+00	5.43E+11	1.02E+09	1.36E+12	1.91E+12
08060203003	4.12E+08	7.12E+11	2.71E+09	2.09E+12	2.81E+12
08060203004	3.62E+09	2.07E+12	1.44E+10	1.90E+13	2.11E+13
08060203005	8.49E+08	1.29E+12	2.05E+10	1.69E+12	3.00E+12
08060203006	2.46E+08	1.52E+12	2.76E+10	1.73E+13	1.89E+13
08060203007	1.70E+09	1.84E+12	6.51E+10	2.07E+13	2.26E+13
08060203008	1.15E+09	5.29E+11	4.40E+10	6.30E+12	6.87E+12
08060203009	1.07E+08	4.86E+11	5.60E+09	2.84E+12	3.33E+12
08060203010	0.00E+00	6.20E+11	2.93E+09	2.72E+12	3.34E+12
08060203011	0.00E+00	3.60E+11	0.00E+00	2.27E+12	2.63E+12
08060203012	3.42E+08	5.27E+11	3.03E+10	6.79E+12	7.35E+12
08060203013	1.54E+10	3.39E+12	8.11E+10	4.35E+13	4.69E+13
08060203014	4.55E+09	7.08E+11	1.28E+10	8.86E+12	9.58E+12
08060203015	9.34E+08	3.71E+11	3.76E+10	6.16E+12	6.57E+12
08060203016	3.24E+09	1.51E+12	4.35E+10	2.39E+13	2.54E+13
08060203017	2.40E+09	9.19E+11	8.20E+10	1.99E+13	2.09E+13
Total	**3.50E+10**	**1.75E+13**	**4.76E+11**	**1.86E+14**	**2.04E+14**

The scenario chosen for the load allocation in the Bayou Pierre Watershed is an 85% reduction in contributions from cows in the stream and an 80% reduction from failing septic tanks. The scenario also requires all permitted dischargers to meet water quality standards for disinfection. This scenario 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. Running the model for 11 years with no violations of the water quality standard provides the primary component of the MOS. Ensuring compliance with the standard throughout all of the critical condition periods represented during the 11 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

For many streams in the state, fecal coliform limits vary according to the seasons. This stream, however, is designated for the use of contact recreation. For this use, the pollutant standard is constant throughout the year.

Because the model was established for an 11-year time span, it took into account all of the seasons within the calendar years from 1985 to 1995. 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, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the South Independent Streams Basin, Bayou Pierre may 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 85% of the cattle access to streams and 80% 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. MDEQ will reject any NPDES Permit application that does not plan to meet water quality standards for disinfection. Education projects that 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 will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in Port Gibson. The public will be given an opportunity to review the TMDL and submit comments. 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 to be held 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 IV for final approval.

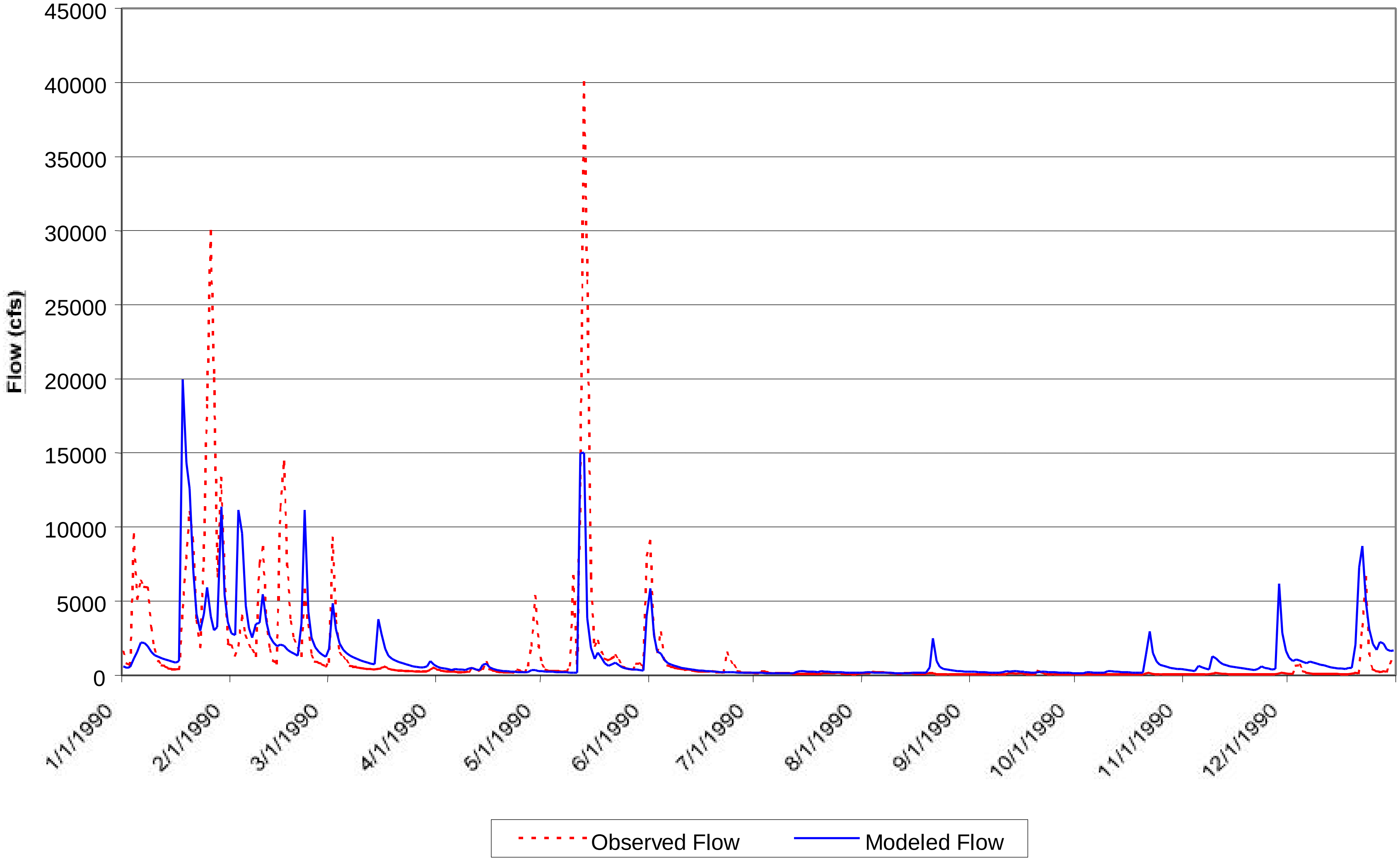
APPENDIX A

This appendix contains printouts of the various model run results. Graph A-1, A-2, and A-3 show the modeled flow, in cubic feet per second, through Bayou Pierre compared to the actual readings from USGS gage 07290650 on Bayou Pierre near Willows. The remaining graphs represent an 11-year time period, from January 1, 1985, to December 31, 1995. 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 Bayou Pierre. The graphs contain a reference line at 200 counts per 100 ml. Graph A-4 represents the existing conditions in Bayou Pierre. There are 20 violations of the fecal coliform standard on this graph. Graph A-5 represents the conditions in Bayou Pierre after the reduction scenario has been applied. Graph A-5 shows no violations of the standard. Graphs A-4 and A-5 are shown with the same scale for comparison purposes.

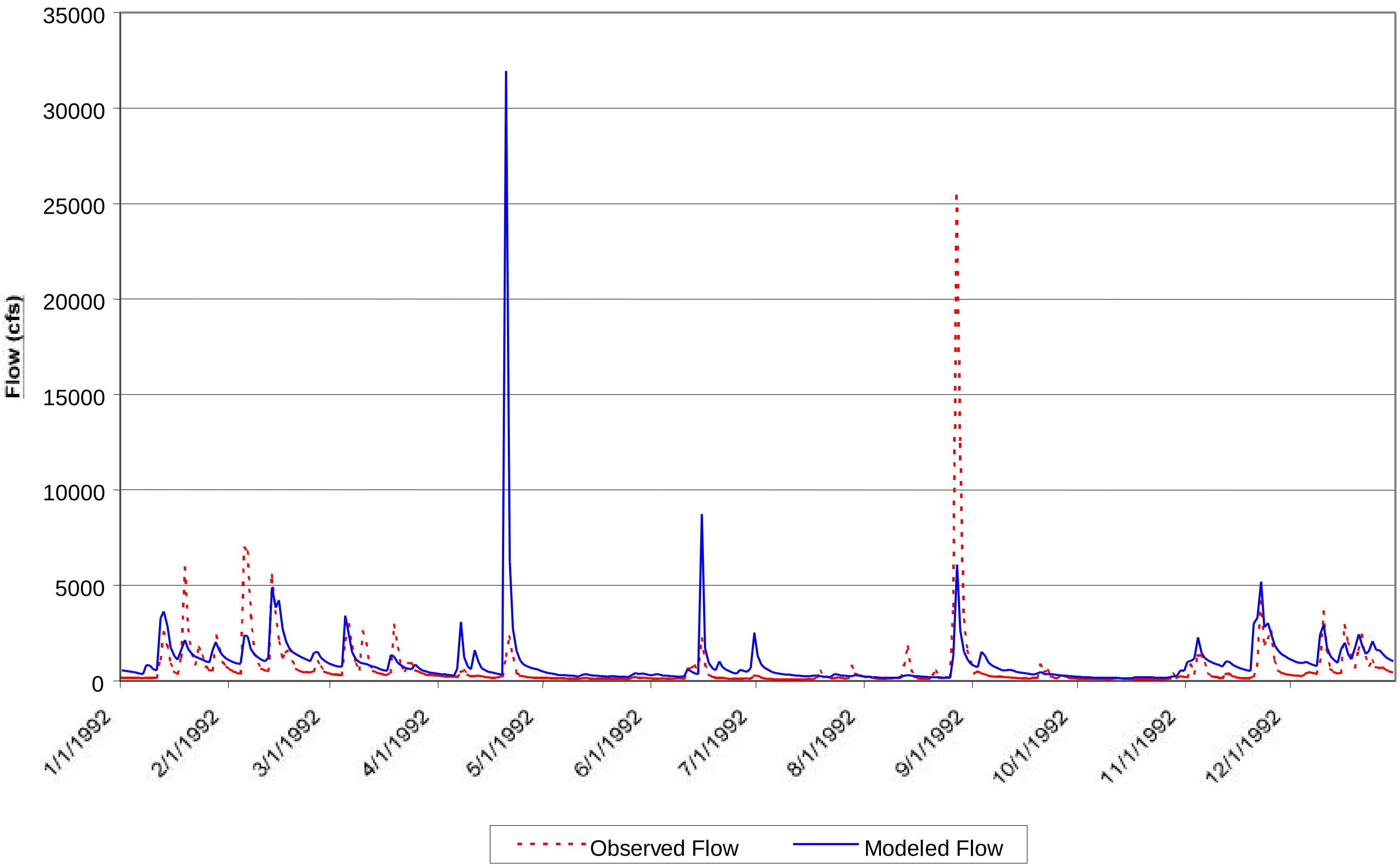
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario (Graph A-5) 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 and drainage area can be found on the waterbody segment identification pages at the beginning of this report

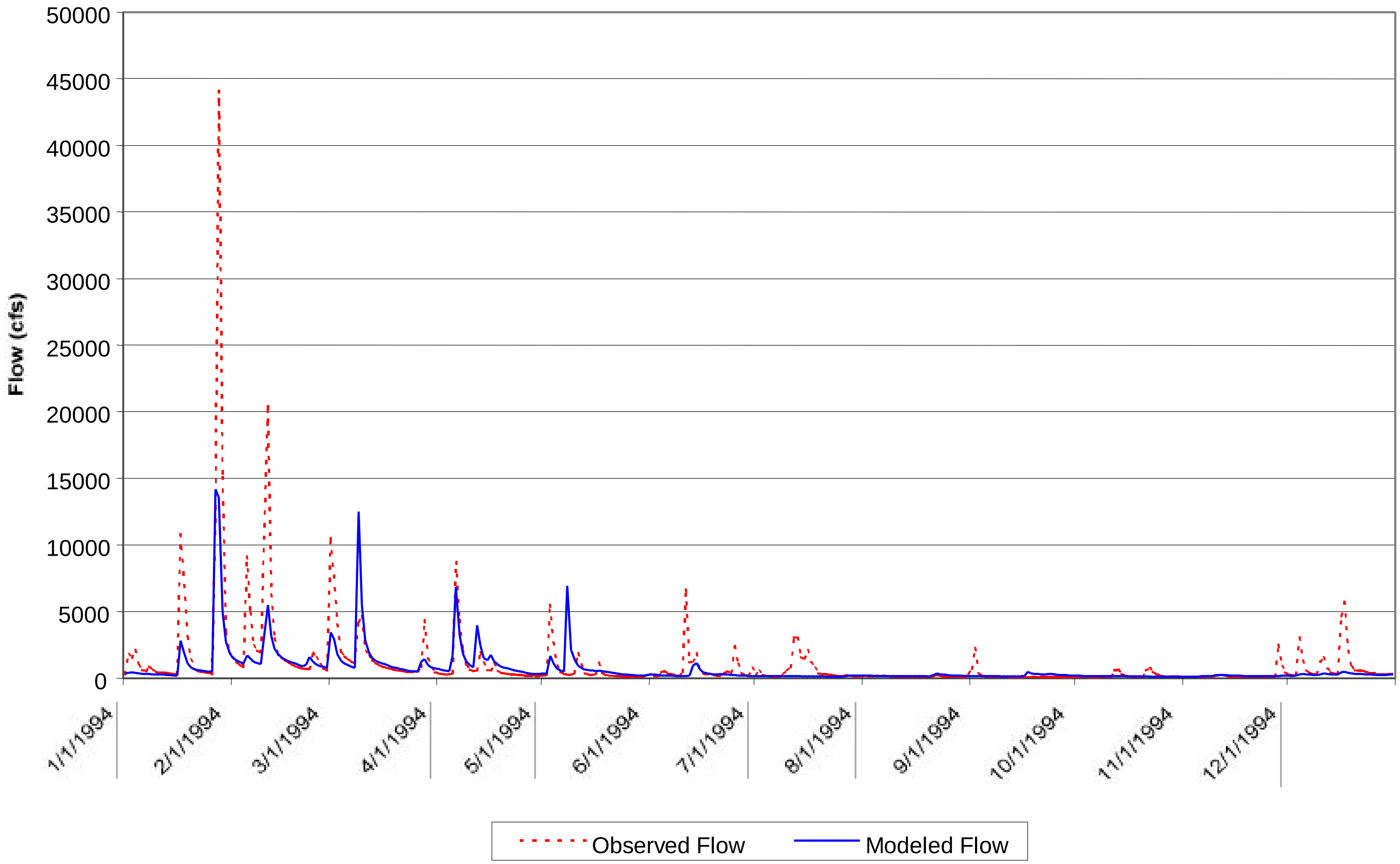
Graph A-1 Daily Flow Comparison between USGS Gage 07290650 and Reach 08060203007 for 01/01/1990 - 12/31/1990



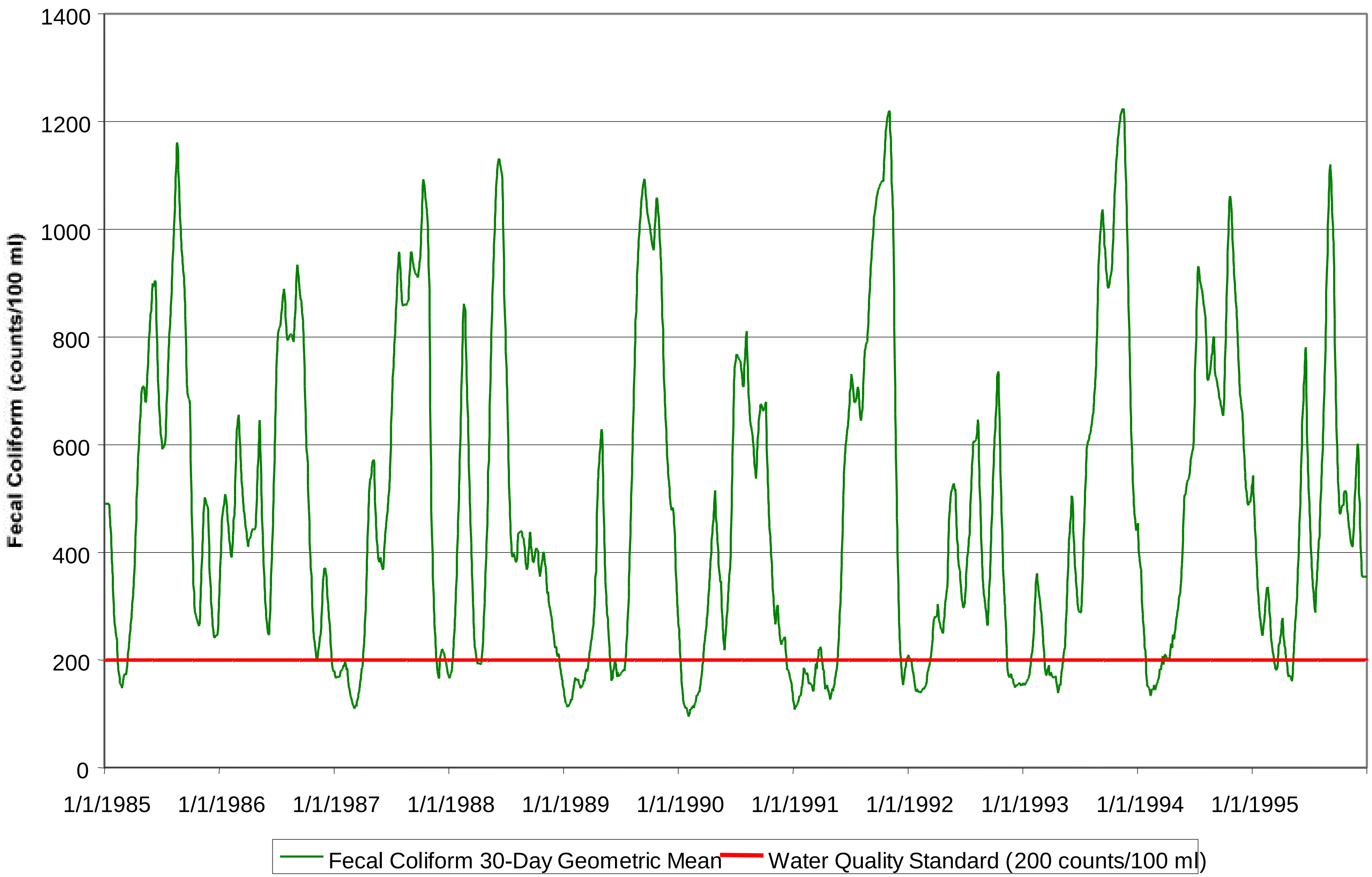
Graph A-2 Daily Flow Comparison between USGS Gage 07290650 and Reach 08060203007 for 01/01/1992 - 12/31/1992



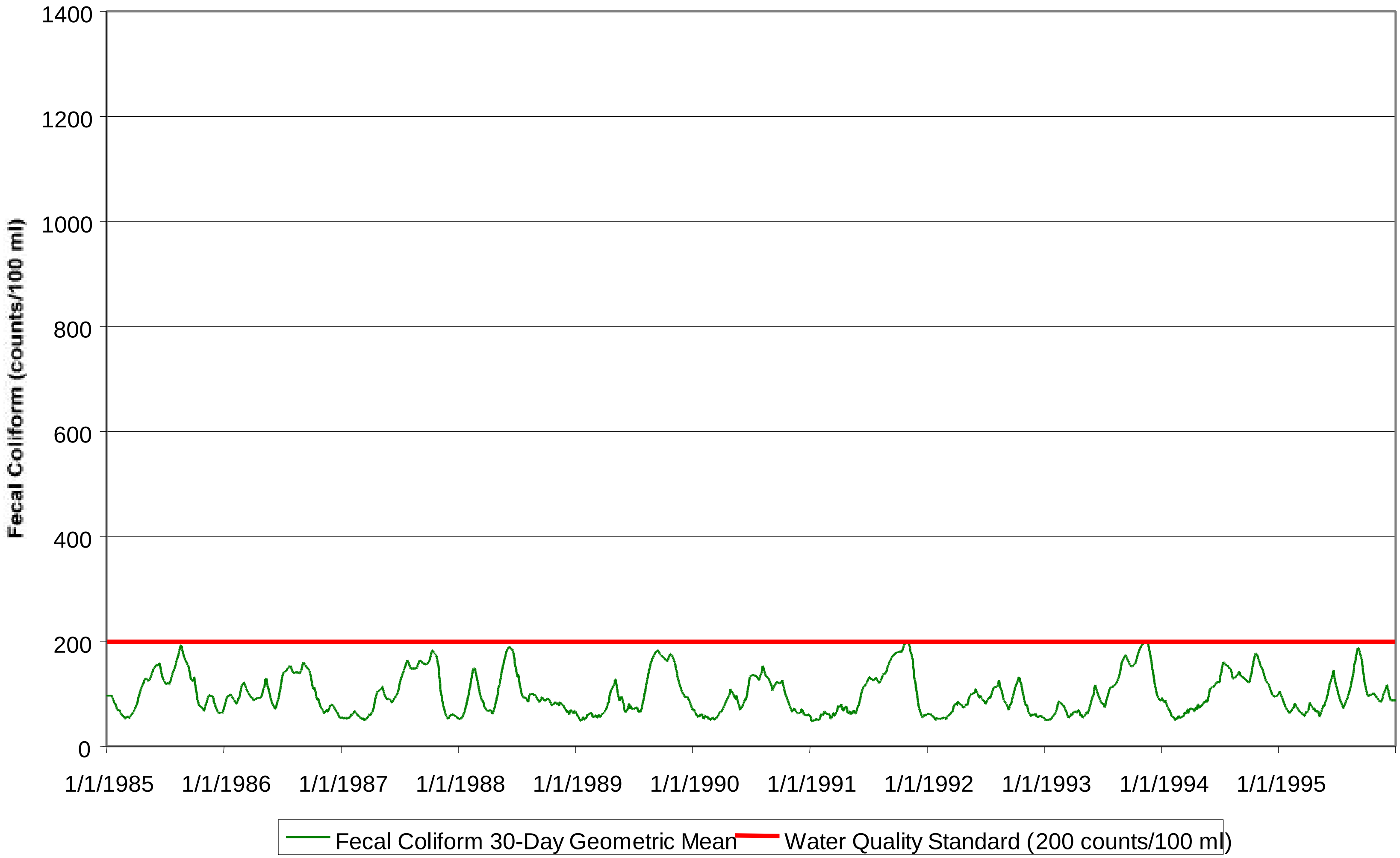
Graph A-3 Daily Flow Comparison between USGS Gage 07290650 and Reach 08060203007 for 01/01/1994 - 12/31/1994



Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions



Graph A-5 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario



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 an 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 become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. 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:

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

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. It also contains a portion of the contribution from septic tanks

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

DMR .... Discharge Monitoring Report

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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