Final TMDL
October 24, 2000

Fecal Coliform TMDL for The Big Black River Segment 2 Big Black Basin Warren County, Mississippi

Prepared By

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MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

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. 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.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	µ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45

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MONITORED SEGMENT IDENTIFICATION

Name:	Lower Big Black River, Segment 2
Waterbody ID:	MSLBGKRM2
Location:	Near Bovina: from the confluence with Porter Creek to the confluence with Fourteen Mile Creek
County:	Warren County, Mississippi
USGS HUC Code:	08060202
Length:	26 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	100
NPDES Permits:	There are 28 NPDES Permits issued for facilities that potentially 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% of the samples may exceed 400 per 100 ml. November through April - Geometric mean of 2000 per 100 ml, Less than 10% of the samples may exceed 4000 per 100 ml.
Waste Load Allocation:	38.1E+12 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	222E+12 counts per 30 day critical period
Additional Assimilative Capacity:	207E+12 counts per 30 day critical period
Margin of Safety:	Implicit modeling assumptions - The model was run for a time span of 11 years.
Total Maximum Daily Load (TMDL):	467E+12 counts per 30 day critical period 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.

EXECUTIVE SUMMARY

A segment of the Big Black River has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as impaired due to fecal coliform bacteria. The applicable state standard specifies that for the summer months, the maximum allowable level of fecal coliform shall not exceed a geometric mean of 200 colonies 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 indicates that, prior to 1996, there was a violation of the standard for the waterbody. Current monitoring data indicates there is no impairment due to fecal coliform bacteria.

The Big Black River flows in a southwesterly direction from its headwaters in Webster County to Claiborne County, where it flows into the Mississippi River. This TMDL has been developed for one impaired section of the Big Black River. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. The weather data used for this model were collected at Jackson and Lexington, MS. The representative hydrologic period used for this TMDL was January 1985, through December 1995.

Fecal coliform loadings from nonpoint sources in the watershed were calculated based upon wildlife populations; livestock populations; information on livestock and manure management practices for the Big Black River 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 that have direct access to tributaries of the Big Black River. There are 28 NPDES Permitted discharges included as point sources in the model. Under existing conditions, output from the model indicates no violation of the summer geometric mean fecal coliform standard. After applying a TMDL scenario, there were no violations of the standard according to the model.

The TMDL scenario for the fecal coliform load does not involve any reductions. No changes are required to existing NPDES permits. Prior to 1996, Ceres Industrial Interplex (MS0044202) was not disinfecting its discharge. However, in April of 1996, disinfection equipment was installed. Bacteria data MDEQ collected at ambient station 07290000, located downstream of the Ceres Industrial Interplex, indicate there is now no impairment of the designated use caused by fecal coliform bacteria in the waterbody. Monitoring of all permitted facilities in the Lower Big Black River Watershed should be continued to ensure that compliance with permit limits is consistently attained. The model assumed there is a 40% failure rate of septic tanks in the drainage area. Additionally, a fecal coliform load allowance has been made for assimilative capacity in the Lower Big Black Watershed.

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 restore and maintain the quality of water resources.

The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of the Big Black River as being impaired by fecal coliform bacteria for a length of 26 miles as reported in the Mississippi 1996 Section 303(d) List of Waterbodies. This segment is listed as impaired because historical monitoring data was available to show that there was an impairment in this segment. Current monitoring data indicates that there is no impairment in the segment. The listed segment is near Bovina, from the confluence with Porter Creek to the confluence with Fourteen Mile Creek. The monitored section is shown in Figure 1.1a.

The impaired segment of the Lower Big Black River is in the Big Black River Basin Hydrologic Unit Code (HUC) 08060202 in west central Mississippi. The drainage area of the monitored segment is approximately 955,000 acres; and lies within portions of Madison, Hinds, Warren, and Yazoo Counties. The watershed is rural but includes the urban areas of Canton and Clinton. Forest is the dominant landuse within the watershed. The land distribution is shown in Table 1.1.

Table 1.1 Land Distribution in Acres for the Lower Big Black River Watershed

	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
Area (Acres)	8,925	318,136	119,809	262,484	2,019	243,589	954,962
% Area	1%	33%	13%	27%	0%	26%	

Figure 1.1a Lower Big Black River Watershed Impaired Segment

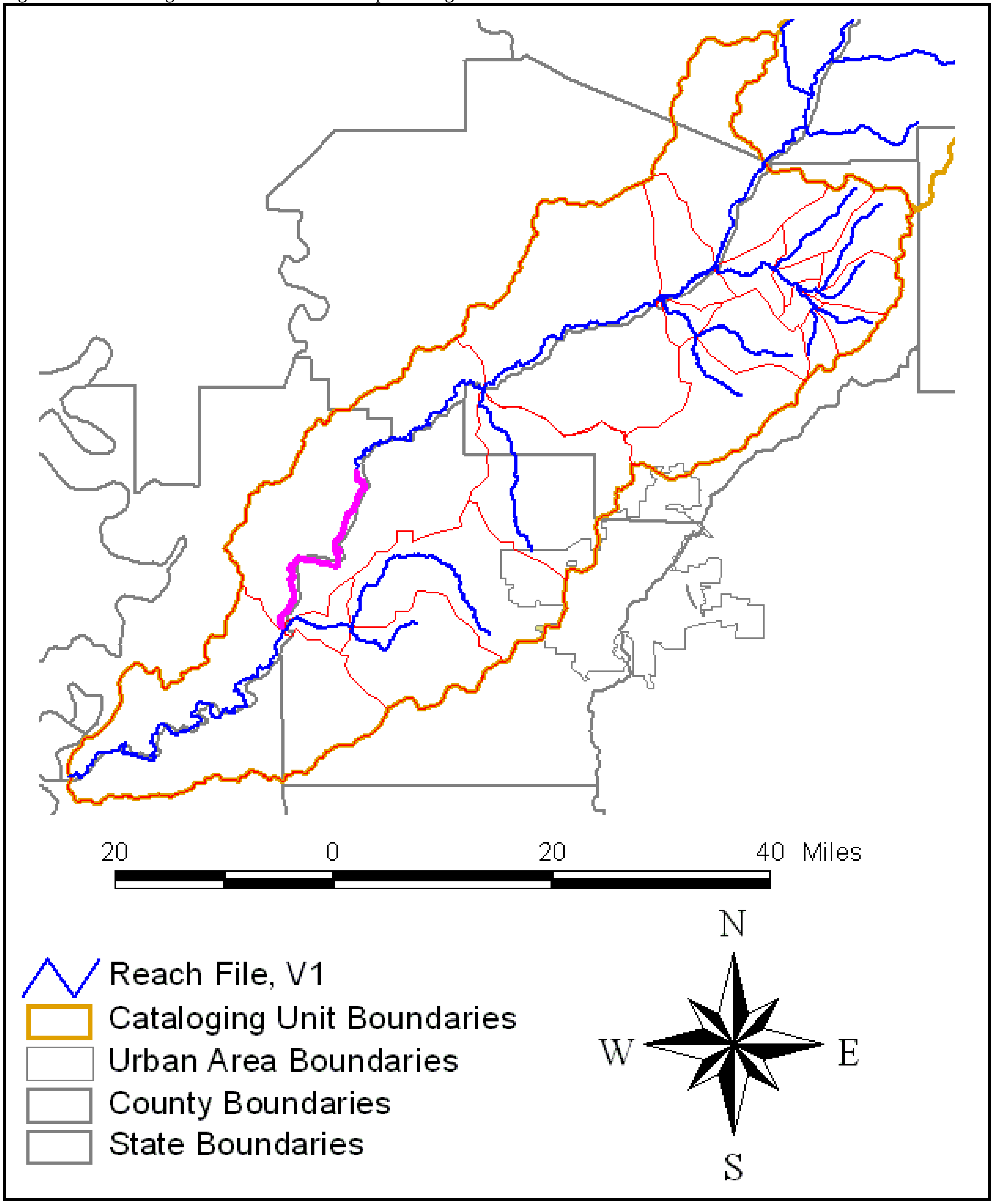
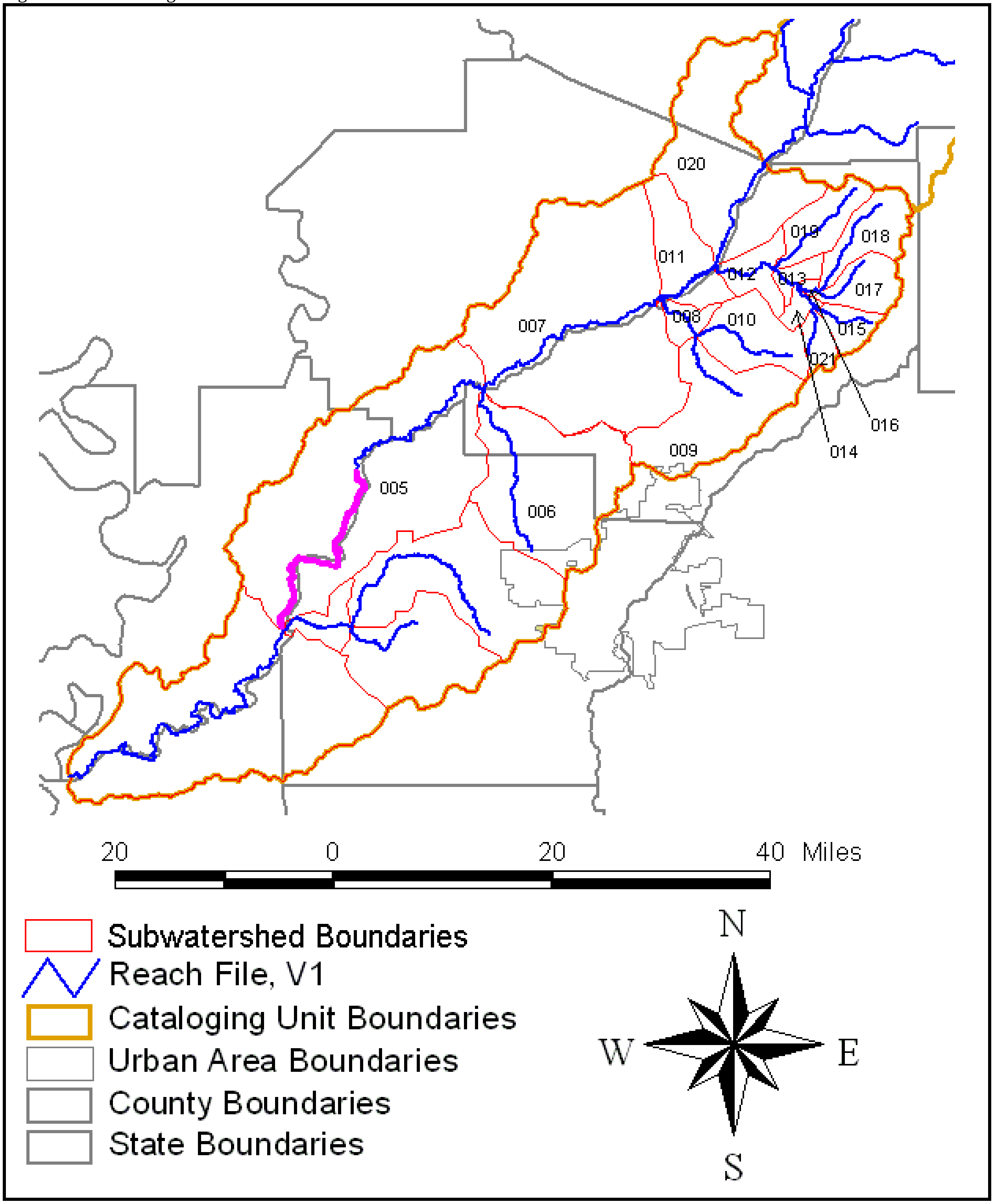


Figure 1.1b Lower Big Black River Subwatersheds



The drainage area, or watershed, has been divided into 17 subwatersheds based on the major tributaries and topography. Figure 1.1b shows the subwatersheds with a three-digit Reach File 1 segment identification number. Each subwatershed is assigned a corresponding identification number, which is a combination of the eight-digit HUC and the three-digit Reach File 1 segment identification number. The impaired portion of the waterbody is made up of (using HUC and Reach File 1 identification numbers) segment 08060202005.

1.2 Applicable Waterbody Segment Use

The water use classification for the Big Black River, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Fish and Wildlife Support. The designated beneficial uses for the Lower Big Black River are Secondary Contact Recreation and Aquatic Life Support.

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 for the months of May through October the 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 and that for the months of November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, not shall more than ten percent 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 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 allocations 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 derived within 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 used to find the critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 Discussion of Instream Water Quality

According to the State's 1998 Section 305(b) Water Quality Assessment Report, this segment of the Big Black River is partially supporting the use of Secondary Contact Recreation. This conclusion is based on instantaneous data collected at station 07290000 (Bovina).

2.2.1 Inventory of Available Water Quality Monitoring Data

Monitoring for flow and fecal coliform was performed on a bimonthly basis (six per year) at station 07290000 until August of 1994. Monthly monitoring began again in December of 1996. The conclusion that the stream segment is impaired is based on the data collected from January of 1992 through December of 1996. Data collected at the station during that time frame are given in Table 2.2a. In April of 1996, Ceres Industrial Complex, located upstream of station 07290000, began disinfecting its discharge. Data collected at the station from December of 1996 through December of 1998 is given in Table 2.2b. There have been no fecal coliform violations since Ceres Industrial Complex began disinfecting.

Table 2.2a Fecal Coliform Data reported in the Big Black River, Station 07290000

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
2/19/1992	8110	580
6/17/1992	2300	100
8/10/1992	327	42
10/7/1992	241	80
12/7/1992	1720	660
2/10/1993	1100	63
6/16/1993	438	40
8/10/1993	2200	200
10/4/1993	234	22
1/10/1994	3270	2900
2/11/1994	17400	**7400**
6/22/1994	720	190
8/19/1994	400	62
12/11/1996	781	20

Table 2.2b Fecal Coliform Data reported in the Big Black River, Station 07290000

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
12/11/1996	781	20
1/7/1997	3080	600
2/11/1997	11700	2200
3/11/1997	No Data	100
4/17/1997	1190	90
5/13/1997	8730	300
6/5/1997	7300	150
7/2/1997	1710	180
8/6/1997	685	10
9/3/1997	466	10
10/9/1997	No Data	20
11/4/1997	No Data	400
1/7/1998	No Data	2400
2/10/1998	No Data	120
3/5/1998	No Data	140
4/14/1998	No Data	20
6/10/1998	No Data	230
7/09/1998	No Data	10
8/11/1998	No Data	50
9/5/1998	No Data	20
10/12/1998	No Data	30
11/3/1998	No Data	60
12/3/1998	No Data	70

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data discussed above are presented in Tables 2.2c and 2.2d. Samples are compared to the instantaneous maximum standard of 400 counts per 100 ml for the summer standard and 4000 counts per 100 ml for the winter standard. 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 2.2c Statistical Summaries for Station 07290000 (Jan. 1992 – Dec. 1996)

Season	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
Winter	6	20	7400	1	17%
Summer	8	22	200	0	0%

Table 2.2d Statistical Summaries for Station 07290000 (Dec. 1996 – Dec. 1998)

Season	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
Winter	12	20	2400	0	**0%**
Summer	11	10	300	0	**0%**

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Big Black River Watershed. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. The sources were analyzed according to the 17 separate subwatersheds. The subwatershed delineations were based primarily on an analysis of the Reach File 3 (RF3) stream network and the digital elevation model of the watershed. 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, Modeling Procedure: Linking the Sources to the Endpoint.

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. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low flow, critical condition period. The 28 wastewater treatment plants in the Lower Big Black River Watershed serve a variety of activities including residential subdivisions, schools, recreational areas, and other businesses. The majority of the 28 wastewater treatment plants serve schools or municipalities.

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 (DMRs) were the best data source for characterizing effluent because they report measurements of flow and fecal coliform present in effluent samples. Of the facilities for which they were available, the DMRs for the past five years, 1993 through 1998, were analyzed. When data were available, the fecal coliform concentrations used in the model were calculated by taking an average of fecal coliform concentrations reported in the discharge monitoring reports. If evidence of insufficient treatment existed or when data were not available, professional judgement was used to estimate a fecal coliform loading rate in the model. Every facility included in the model is listed in Table 3.1.

Table 3.1 Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Receiving Waterbody
Bovina Elementary School	8060202005	MS0042811	Clear Creek
Brookwood Place Subdivision	8060202005	MS0044229	Wren Bayou
Ceres Plantation Subdivision	8060202005	MS0055204	Crouches Creek
Culkin Elementary School	8060202005	MS0030465	Shiloh Creek
Dogwood Lake Estates	8060202005	MS0037851	Clear Creek
Edwards POTW-West	8060202005	MS0036374	Lower Big Black River
Fairview Plantation Utility Co.	8060202005	MS0047333	Lower Big Black River
Fairways Subdivision	8060202005	MS0048593	Muddy Creek
South Park Elementary School	8060202005	MS0039144	Duren Creek
Villanova Sewage District	8060202005	MS0034215	Clear Creek
Baptist Children's Village	8060202006	MS0021849	Bogue Chitto Creek
Clinton Briars Biolac	8060202006	MS0047619	Tributary to Bogue Chitto Creek
Clinton POTW-Lovett	8060202006	MS0023230	Straight Fence Creek
Clinton POTW-Northeast	8060202006	MS0021164	Straight Fence Creek
Lake Lorman POTW	8060202006	MS0043401	Limekiln Creek
Southern Oak Subdivision	8060202006	MS0046647	Bogue Chitto Creek
West View Subdivision	8060202006	MS0031453	Little Bakers Creek
Bentonia POTW	8060202007	MS0020478	Lower Big Black River
Canton POTW-HCR Lake Caroline NE	8060202007	MS0046451	Panther Creek
Canton POTW-HCR Lake Caroline SW	8060202007	MS0046469	Persimmon Creek
Flora POTW	8060202007	MS0055719	Lower Big Black River
Flora POTW	8060202007	MS0025119	Town Creek
West Madison Utility District	8060202007	MS0033081	Lower Big Black River
Canton POTW-HCR	8060202008	MS0042455	Bear Creek
Central Ms. Industrial Center-HCR	8060202008	MS0036765	Bear Creek
Deerfield Subdivision	8060202008	MS0035467	Little Bear Creek
Luther Branson Elementary	8060202012	MS0029378	Doaks Creek
Velma Jackson School	8060202012	MS0034045	Doaks Creek

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for the Big Black River, including:

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

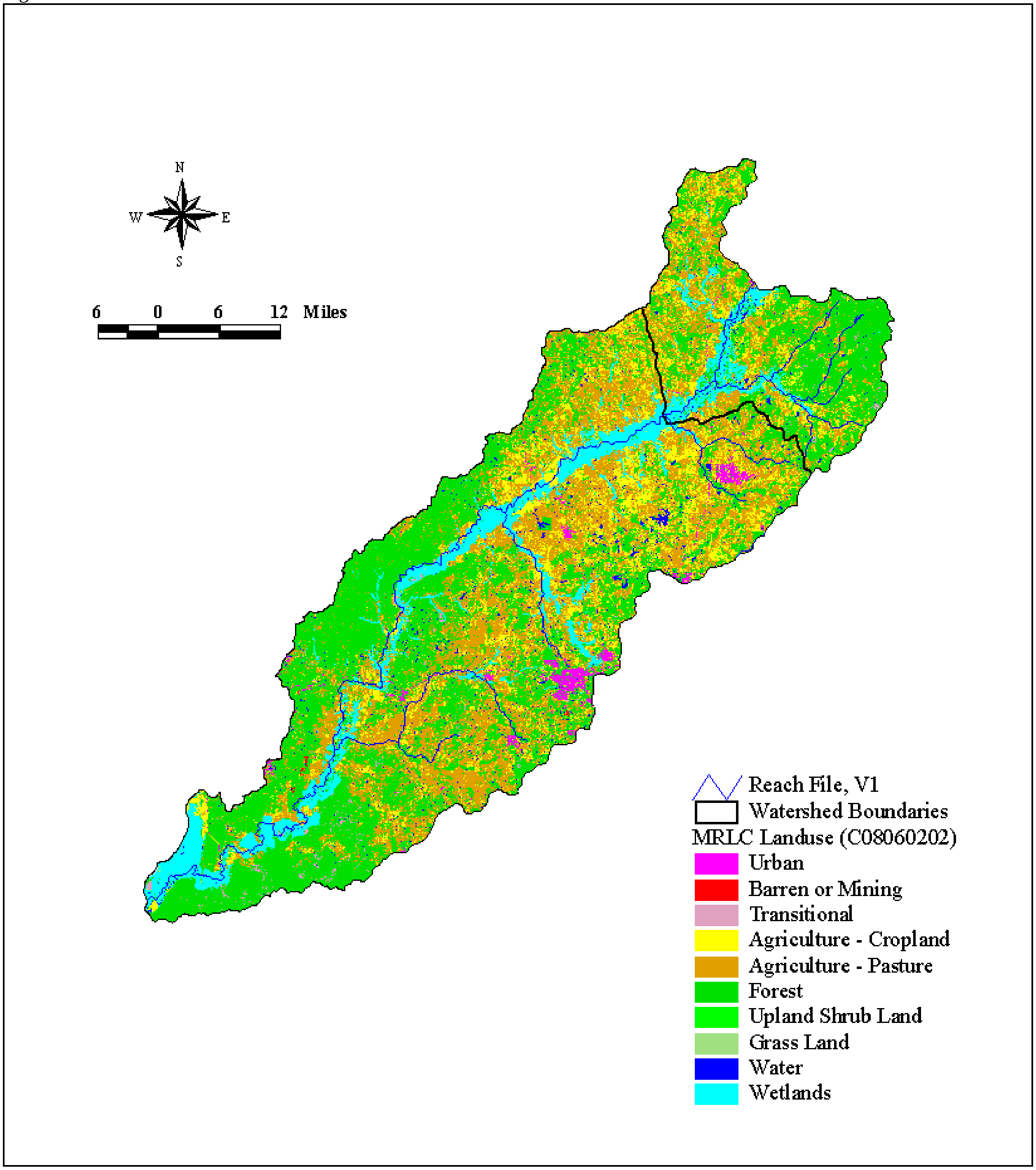
The 955,000 acre drainage area of the Lower Big Black River contains many different landuse types, including urban, forest, cropland, pasture, barren, and wetlands. The modeled landuse information for the entire watershed is based on data collected by the Mississippi Automated Resources Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. For modeling purposes the landuse categories were grouped into the landuses of urban, forest, cropland, pasture, barren, and wetlands. The contributions of each of these land types to the fecal coliform loading of the Lower Big Black River was considered on a subwatershed basis. Table 3.2 and Figure 3.2 show the landuse distribution for the watershed.

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, and agriculture census data. 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 Lower Big Black River 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.

Table 3.2 Landuse Distribution in Number of Acres

Subwatershed	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
8060202005	794	127,348	16,217	36,649	328	22,591	203,927
8060202006	2,669	29,285	14,172	33,907	559	22,988	103,580
8060202007	2,188	56,926	40,599	83,856	953	30,758	215,280
8060202008	145	1,988	3,701	2,955	0	11,368	20,157
8060202009	1,332	8,411	14,333	16,539	179	8,914	49,708
8060202010	739	5,025	6,706	11,037	0	9,873	33,380
8060202011	391	9,237	4,944	11,753	0	12,711	39,036
8060202012	9	6,006	2,287	4,579	0	10,067	22,948
8060202013	0	2,416	677	1,238	0	3,378	7,709
8060202014	0	1,282	226	1,685	0	10,054	13,247
8060202015	0	3,961	302	4,485	0	9,810	18,558
8060202016	0	937	16	415	0	6,172	7,540
8060202017	0	5,940	125	3,154	0	9,169	18,388
8060202018	0	17,269	123	2,336	0	12,729	32,457
8060202019	0	9,606	730	5,033	0	12,934	28,303
8060202020	658	29,043	14,440	40,778	0	42,532	127,451
8060202021	0	3,456	211	2,085	0	7,541	13,293
Total	**8,925**	**318,136**	**119,809**	**262,484**	**2,019**	**243,589**	**954,962**

Figure 3.2 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.

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 may not 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 Big Black River Watershed contributes to fecal coliform bacteria on the land surface. In the Big Black River 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 Big Black River Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Big Black River Basin operate by either keeping the animals confined or by 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 Lower Big Black River 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. 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. The dairy farms that are currently operating in the Lower Big Black River Watershed only confine the animals for a limited time during the day. The model assumed a confinement time of four hours per day. During all other times, dairy cattle are assumed to graze on pasturelands. Beef cattle have access to pastureland for grazing all of the time. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland.

3.2.5 Land Application of Poultry Litter

Like hog and cattle manure, poultry litter in this region of the state is applied only to pastureland and not to cropland. It is also a potential contributor of pathogens to streams in the watershed when a rain event washes a portion of it to a receiving waterbody. It is assumed that all of the poultry litter from chicken houses is applied evenly to the available pastureland. While there are some alternative uses of poultry litter, such as utilization as cattle feed, almost all of the litter in the state is used as fertilizer.

Predominantly two kinds of chickens are raised on farms in the Big Black Basin, broilers and layers. The growth time of the broiler chickens from when the chicken is born to when it is sold off the farm is approximately 48 days, which is about 1/7 of a year. Conversely, layer chickens remain on farms for ten months or longer. To determine the number of chickens in the watershed on any given day, the number of broiler chickens sold is divided by seven and added to the number of layers.

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 Lower Big Black River 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 the Lower Big Black River 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 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 allocations. 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 Lower Big Black River 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 Lower Big Black River TMDL model includes the impaired section of the river. The Upper Big Black River, located in HUC 08060201, was modeled separately and the results of the model were added to the Lower Big Black River model. This point source input allows the model to assess the Upper Big Black River's contribution to the hydrology and fecal coliform loading in the reaches of the Lower Big Black River. This point source input of the Upper Big Black River was added to the model with the modeled existing loading conditions. No reductions were required in the Upper Big Black River. Thus, all upstream contributors of bacteria are accounted for in the model. The remaining watershed was divided into 17 subwatersheds in an effort to isolate the major stream reaches in the Lower Big Black River Watershed. This subdivision 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 model. A fecal coliform spreadsheet was developed for quantifying point and nonpoint sources of bacteria for the Lower Big Black River 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 28 NPDES permitted facilities in the watershed which discharge fecal coliform bacteria. 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 the Lower Big Black River. Other sources are represented as an application rate to the land in the Lower Big Black River 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, the 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 county populations. The percentage of the population on septic systems was determined from 1990 United States Census Data. Based on a very conservative assumption, a failure rate of 40% was included. This information was used to calculate the estimated number of failing septic tanks per watershed. The number of failing septic tanks also incorporates an estimate for the failing individual onsite wastewater treatment systems in the area. In reality, septic tank failures are both point and nonpoint sources. Therefore, the load from failing septic tanks has been considered to contribute equally to the wasteload allocation component and load allocation component of the TMDL calculation

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 Lower Big Black River Watershed was estimated to be 30 to 45 animals per square mile. For the model, the upper limit of 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. The per acre loading rate applied to the landuses is 3.52E+07 counts/acre/day.

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 subwatershed scale. This is calculated by multiplying the county livestock figures with the area of the county within the subwatershed 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 (Metcalf and Eddy, 1991). The resulting fecal coliform loads are in the units of counts per acre per day.

4.3.5 Land Application of Poultry Litter

The concentration of bacteria, which accumulates in the dry litter where poultry waste is collected, is estimated with the fecal coliform spreadsheet. This is done by multiplying the daily number of chickens on farms by a fecal coliform production rate in counts per day per animal given in Metcalf & Eddy, 1991. 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, if applicable, 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 0.5 percent of the number of grazing cattle in each subwatershed 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 (Metcalf and Eddy, 1991).

4.3.7 Urban Development

The MARIS landuse data divide urban land into several categories. For the Lower Big Black River 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. A single, weighted urban loading value of 7.18E+6 counts/acre/day is quantified for each subwatershed based on individual built-up landuses present and their corresponding loading rates

4.4 Stream Characteristics

The stream characteristics given below describe the entire impaired section of the Lower Big Black River. This section begins at the confluence with Porter Creek and ends at the confluence of Fourteen Mile Creek. The channel geometry and lengths for the Lower Big Black River 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 the Lower Big Black River are as follows.

- ♦ Length 26 miles
- ♦ Average Depth 1.3 ft
- ♦ Average Width 152 ft
- ♦ Mean Flow4,261 cubic ft per second
- ♦ Mean Velocity 22 ft per second
- ♦ 7Q10 Flow 88 cubic ft per second
- ♦ Slope 0.00017 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. 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

Hydraulic calibration has been achieved by comparing predicted flow to historical flow data from USGS Station 02790000. Some of the factors included in this calibration are groundwater inflow, groundwater storage, evapotranspiration, infiltration capacity of the soil, and length of overland flow. The weather data used for the model were collected at Jackson and Lexington for the hydrologic period of January 1, 1985 through December 31, 1995. A sample of the results of the calibration is included in Appendix A. Modeled output and gage data are shown on the same graph for one of the model years.

Several assumptions were made to determine the fecal coliform loading rates from the nonpoint source contributors. Many of these assumptions were incorporated into the fecal coliform spreadsheet. An effort was made to contact researchers and agricultural experts to give as much validity as possible to the assumptions made within the BASINS model.

4.7 Existing Loading

Appendix A includes graphs of the model results showing the instream fecal coliform concentrations for reach 08060202005 of the Lower Big Black River. Graph A-4 shows the fecal coliform levels during the 11-year modeling period. The graph shows a 30-day geometric mean of the data. There have been no standards violations in 11 years according to the model. The straight line at 200 counts per 100 ml indicates the summer water quality standard for the stream.

Graph A-5 shows the 30-day geometric mean of the fecal coliform levels after the TMDL scenario has been modeled. The scale matches the previous graph for comparison purposes. The graph indicates that there are no summer violations of the water quality standard for the monitored segment after the TMDL scenario is applied.

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources, a load allocation for nonpoint sources, and an allocation for assimilative capacity. Point source contributions enter the stream directly in the appropriate reach. The nonpoint fecal coliform sources used in the model have two different transportation methods. Cows in the stream and failing septic tanks were modeled as direct inputs to the stream. 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 entering the stream.

5.1 Wasteload Allocations

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. Table 5.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. The TMDL scenario for subwatersheds 08060202011 through 08060202020 is included in the TMDL report for the Lower Big Black River Segment 1 (MSLBGBKRM1.) The final wasteload allocation on the summary page also accounts for the load from 50% of the failing septic tanks.

Table 5.1 Wasteload Allocations

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
08060202005	9.57E-01	1.95E+08	9.57E-01	1.95E+08	0%
08060202006	2.02E+00	4.12E+08	2.02E+00	4.12E+08	0%
08060202007	1.02E+00	1.92E+08	1.02E+00	1.92E+08	0%
08060202008-08060202010	1.11E+01	2.94E+10	1.11E+01	2.94E+10	0%

5.2 Load Allocations

The load allocation for this TMDL involves 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 5.2a 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 5.2b gives the same parameters for contributions due to septic tank failure. The TMDL scenario for subwatersheds 08060202011 through 08060202020 is included in the TMDL report for the Lower Big Black River Segment 1 (MSLBGBKRM1) and those subwatersheds are not included in the following tables. 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.

Nonpoint fecal coliform loading 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 the Lower Big Black River to achieve water quality standards.

Table 5.2a 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
08060202005	2.17E-03	5.72E+10	2.17E-03	5.72E+10	0%
08060202006	1.58E-03	4.15E+10	1.58E-03	4.15E+10	0%
08060202007	2.89E-03	7.61E+10	2.89E-03	7.61E+10	0%
08060202008-08060202010	1.49E-03	3.94E+10	1.49E-03	3.94E+10	0%
Total	**8.13E-03**	**2.14E+11**	**8.13E-03**	**2.14E+11**	**0%**

Table 5.2b Fecal Coliform Loading Rates for the Contribution of Failing Septic Tanks (50% WLA and 50% LA)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
08060202005	1.30E+00	1.32E+10	1.30E+00	1.32E+10	0%
08060202006	6.38E-01	6.49E+09	6.38E-01	6.49E+09	0%
08060202007	8.15E-01	8.29E+09	8.15E-01	8.29E+09	0%
08060202008-08060202010	5.92E-01	6.02E+09	5.92E-01	6.02E+09	0%
Total	**3.35E+00**	**3.40E+10**	**3.35E+00**	**3.40E+10**	**0%**

The model estimated the fecal coliform bacteria count per 30 days entering Lower Big Black River for each impaired segment and evaluated drainage area due to runoff during the 30-day critical period. These values are given in section 5.5 Calculation of the TMDL.

The scenario used in this analysis for the load allocation in the Lower Big Black River Watershed assumes no reduction in contributions from cows in the stream or from failing septic tanks is required to meet standards. Also, this scenario includes an allowance for assimilative capacity.

5.3 Additional Assimilative Capacity

Both the water quality data and the model results indicate that under existing conditions, the fecal coliform levels are well below the water quality standard for the listed segment of the Big Black River. Therefore, the waterbody has additional assimilative capacity for fecal coliform. This assimilative capacity is given in Table 5.3.

Table 5.3 Additional Assimilative Capacity

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)
08060202005	6.52E-01	7.25E+10
08060202006	3.20E-01	5.58E+10
08060202007	4.09E-01	1.06E+11
08060202008-08060202010	2.97E-01	5.30E+10
Total	**1.68E+00**	**2.87E+11**

5.4 Incorporation of a Margin of Safety (MOS)

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.

5.5 Calculation of the TMDL

This TMDL is calculated based on the following equation:

TMDL = WLA + LA + MOS + Additional Assimilative Capacity

The TMDL was calculated based on the 30-day critical period for the Lower Big Black River Watershed according to the model. Each of the loading rates has been converted to the 30-day equivalent. The wasteload allocation incorporates the fecal coliform contribution from identified NPDES Permitted facilities and 50% of the contribution from failing septic tanks. The load allocation includes the fecal coliform contributions from surface runoff, cows in the stream, and 50% of the contribution from failing septic tanks. The margin of safety for this TMDL is derived from the conservative loading assumptions used in setting up the model and are implicit. The additional assimilative capacity is an allowance for an additional load that, when applied, will not result in a violation of the water quality standard. Also, the TMDL reported in the Lower Big Black Segment 1 (MDLBGBKRM1) TMDL Report is included in the TMDL values reported here. Table 5.5 gives the TMDL for the monitored segment.

WLA = NPDES Permitted Facilites + ½ of the Septic Tank Failures

LA = Surface Runoff + Cows in Stream + ½ of the Septic Tank Failures

MOS = implicit

Additional Assimilative Capacity =load that will not cause a violation of the water quality standard

Table 5.5 TMDL Summary for Monitored Segment (counts/30 days)

	MSLBGBKRM2
NPDES Permits	2.17E+13
½ Failing Septic Tanks	1.63E+13
WLA	**3.81E+13**
Surface Runoff	7.39E+11
Cows in Stream	2.05E+14
½ Failing Septic Tanks	1.63E+13
LA	**2.22E+14**
Additional Assimilative Capacity	**2.07E+14**
TMDL = WLA + LA + Additional Assimilative Capacity	**4.67E+14**

5.6 Seasonality

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

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 CONCLUSION

The fecal coliform scenario used in this TMDL included requiring all NPDES Permitted dischargers to maintain current permit limits. The TMDL scenario also included an allowance for assimilative capacity in the Lower Big Black Watershed.

6.1 Future 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 North Independent Streams Basin, Lower Big Black River may receive additional monitoring to identify any change in water quality.

6.2 Public Participation

This TMDL was published for a 30-day public notice twice. The public was given an opportunity to review the TMDL and submit comments. No public comments were received during the public notice periods. MDEQ has therefore decided that a public hearing is not necessary for this TMDL project.

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 30^{th} 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.

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.

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.

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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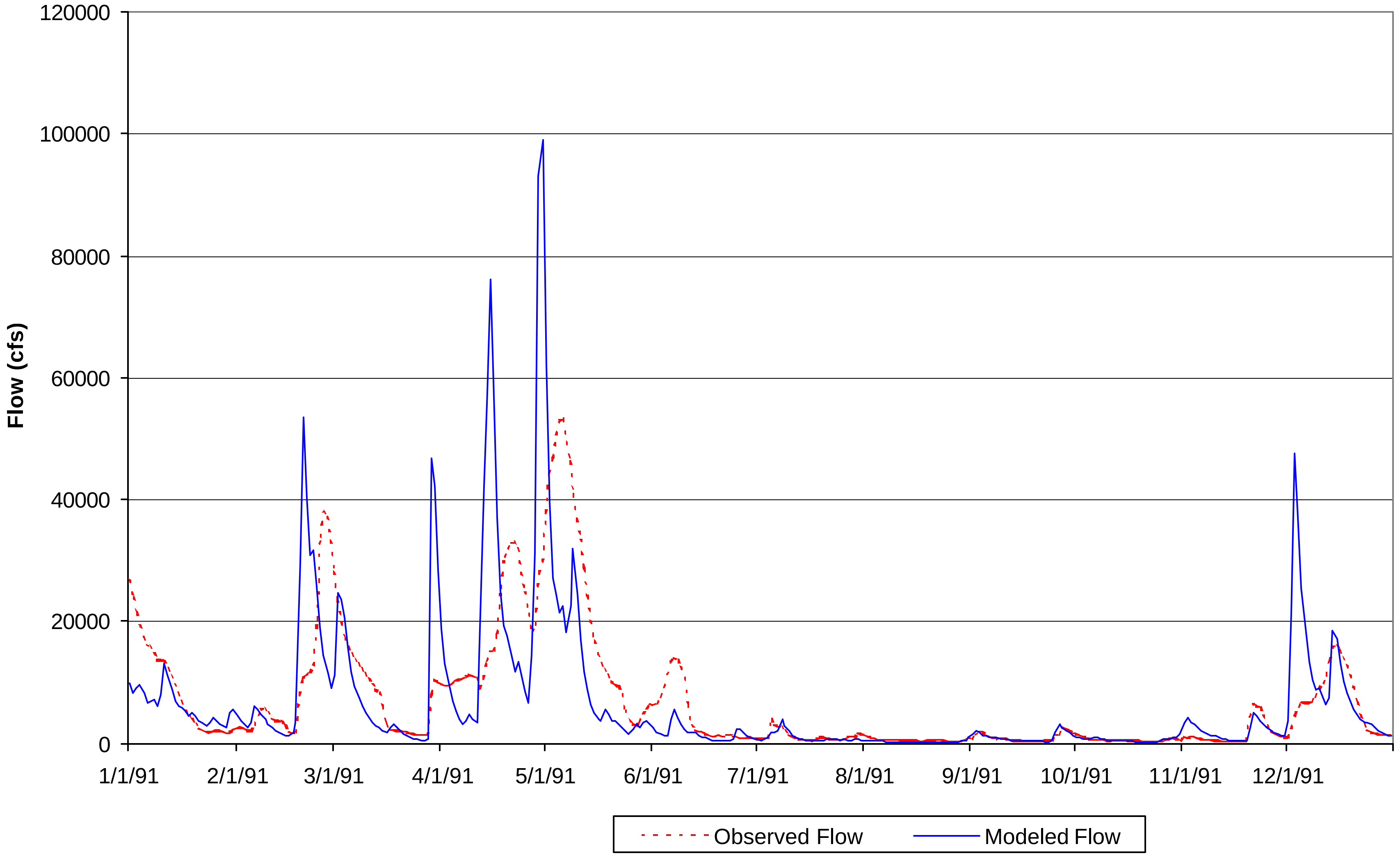
APPENDIX A

This appendix contains printouts of the various model run results. Graphs A-1 through A-3 show the modeled flow, in cubic feet per second, through reach 08060202005 compared to the USGS flow readings from the Lower Big Black River, station 02790000. The following graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the listed section of the Lower Big Black River River. The graphs contain a reference line at 200 counts per 100 ml. Graph A-4 shows the fecal coliform levels in reach 08060202005 during the 11-year modeling period. Graph A-5 shows the modeled fecal coliform levels in reach 0806020627005 after the TMDL scenario has been applied. Graphs A-4 and A-5 are shown with the same scale for comparison purposes.

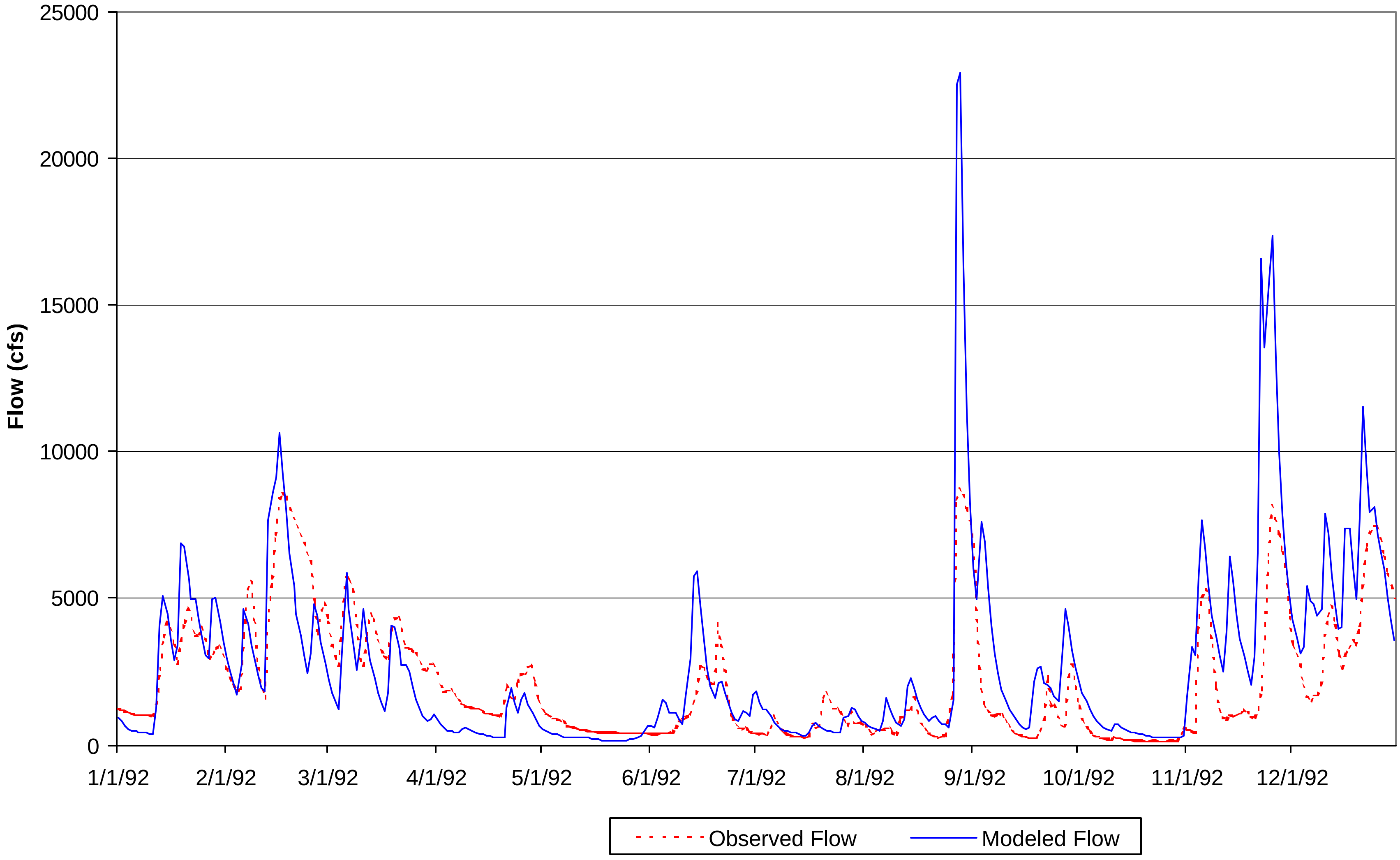
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during 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 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.

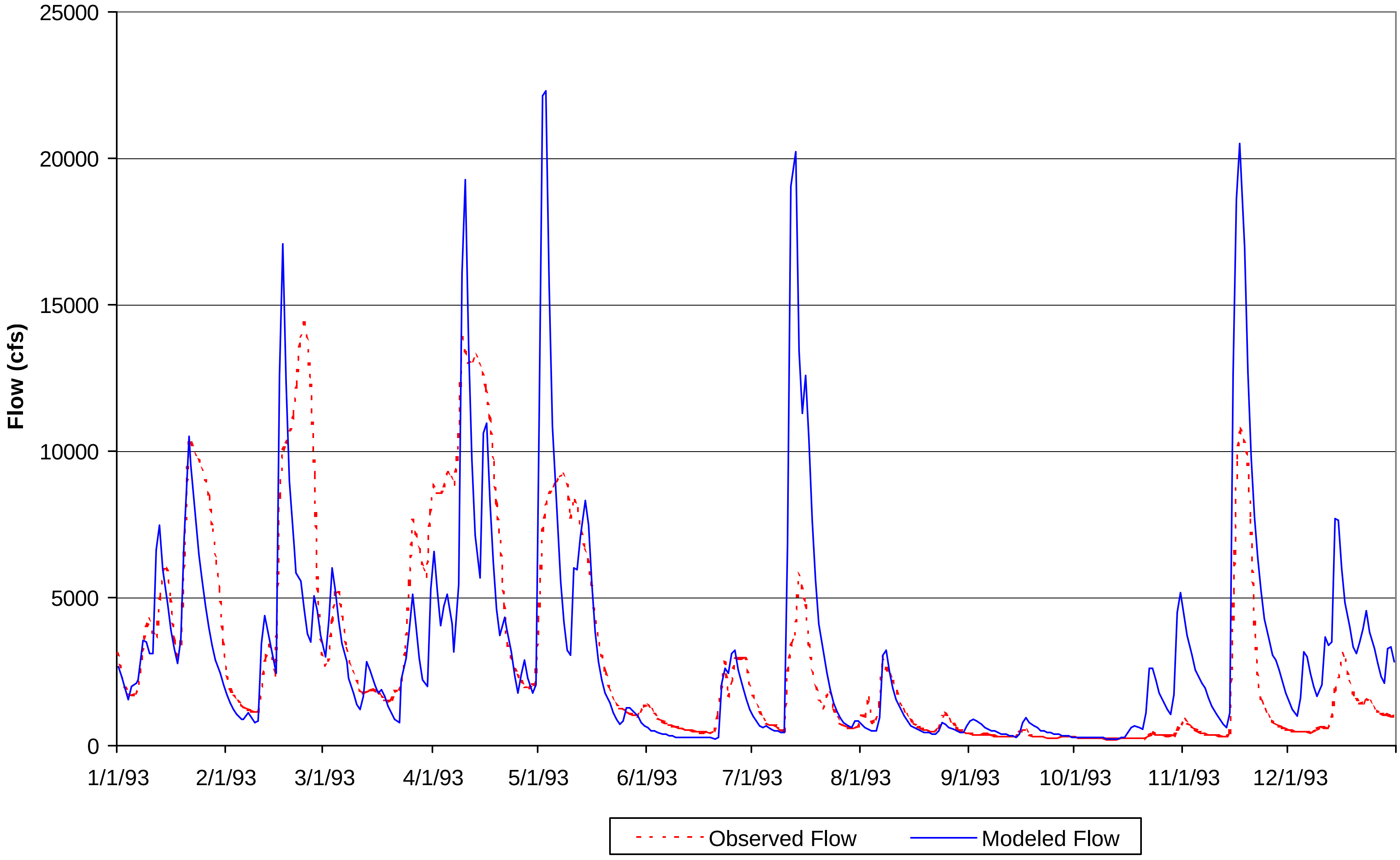
Graph A-1 Daily Flow Comparison between USGS Gage 02790000 and Reach 08060202005 for 1/1/1991 - 12/31/1991



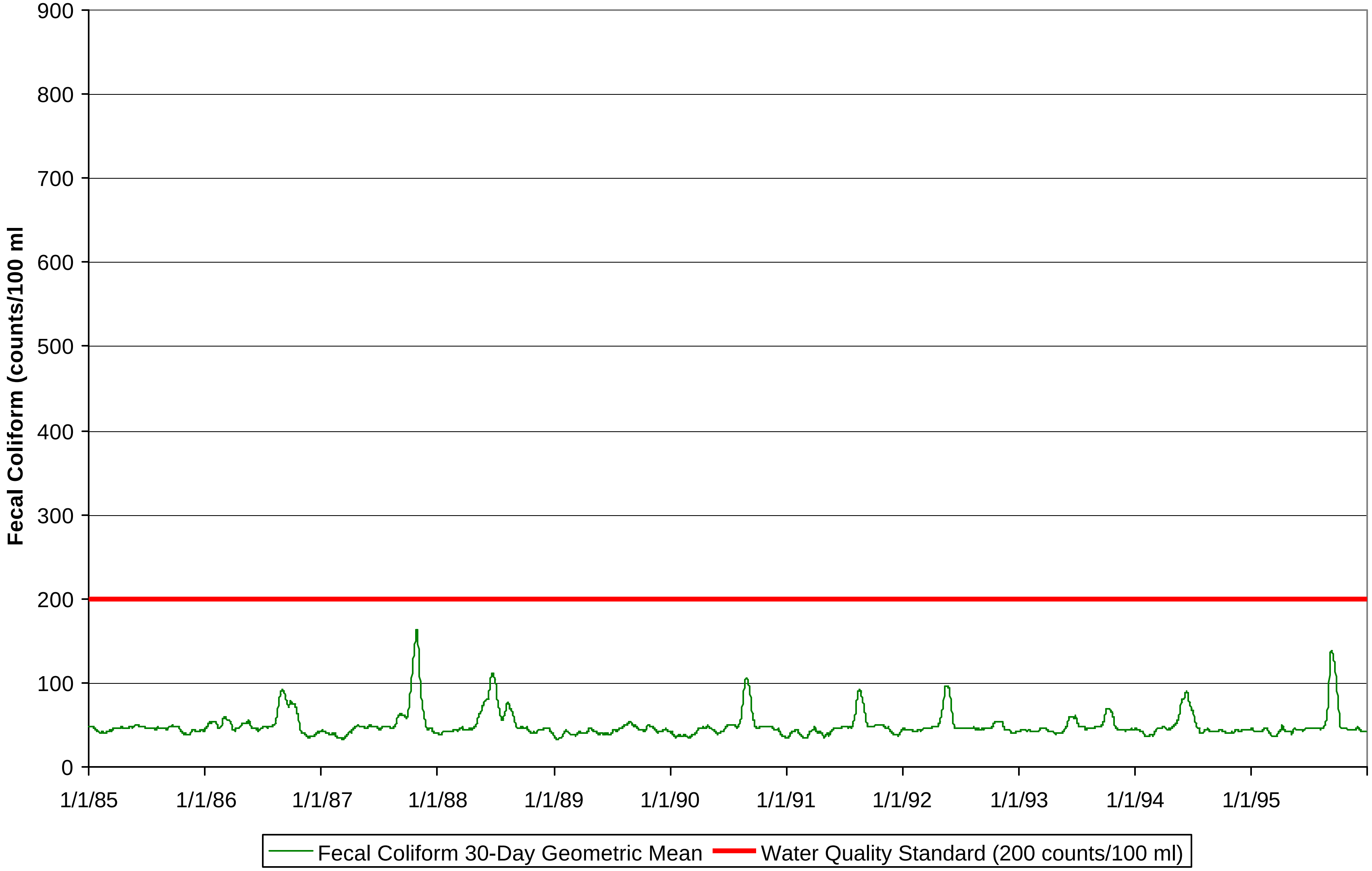
Graph A-2 Daily Flow Comparison between USGS Gage 02790000 and Reach 08060202005 for 1/1/1992 - 12/31/1992



Graph A-3 Daily Flow Comparison between USGS Gage 02790000 and Reach 08060202005 for 1/1/1993 - 12/31/1993



Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions



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