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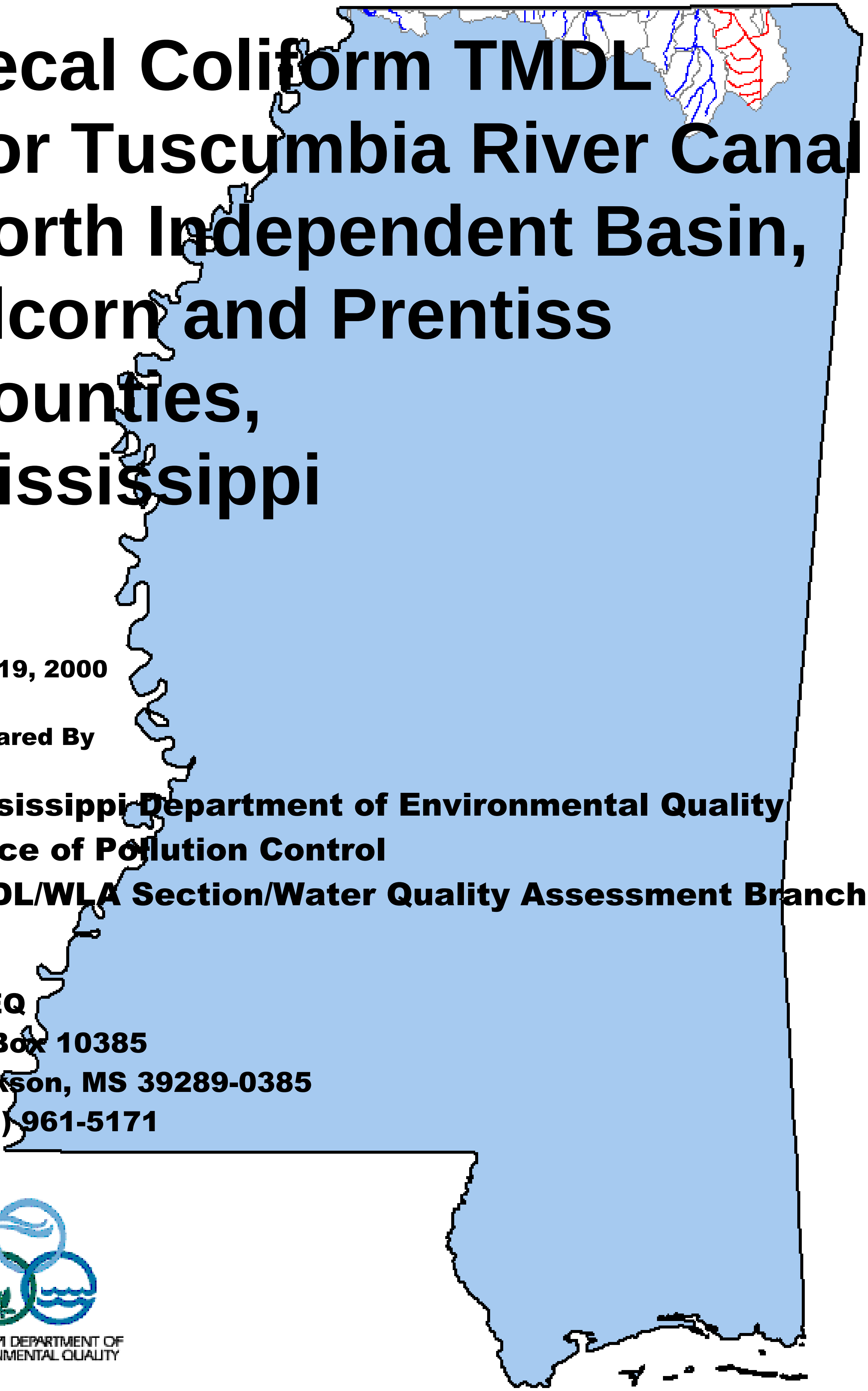

Fecal Coliform TMDL For Tuscumbia River Canal North Independent Basin, Alcorn and Prentiss Counties, Mississippi

May 19, 2000

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.

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MONITORED SEGMENT IDENTIFICATION

Name:	Tuscumbia River Canal
Waterbody ID:	MS203TM1
Location:	Near Corinth: from the confluence with Parmicha Creek to the confluence with Tarebreeches Creek
County:	Alcorn County, Mississippi
USGS HUC Code:	08010207
Length:	12 miles
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic organisms
Priority Rank:	44
NPDES Permits:	There are 9 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:	2.68E+12 counts per 30 day critical period (The TMDL requires all dischargers to meet water quality standards for disinfection.)
Load Allocation:	4.90E+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):	7.58E+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 Tuscumbia River Canal 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 there is a violation of the standard for the waterbody.

The Tuscumbia River Canal flows in a northerly direction from its headwaters in Prentiss County across the stateline into Tennessee, where it flows into the Hatchie River. This TMDL has been developed for one impaired section of the Tuscumbia 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 Booneville, 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 North Independent 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 Tuscumbia River Canal. There are nine NPDES Permitted discharges included as point sources in the model. Under existing conditions, output from the model indicates violation of the summer geometric mean fecal coliform standard. 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 Tuscumbia River Canal Watershed. First, all NPDES facilities would 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 Tuscumbia River Canal Watershed should be continued to ensure that compliance with permit limits is consistently attained. Second is the reduction of cattle=s direct access to tributaries. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Finally, a reduction in the fecal coliform contribution from failing septic tanks may be required. The model assumed there is a 25% failure rate of septic tanks in the drainage area. A reduction could be accomplished by education on best management practices for septic tank owners. Additionally, users of individual onsite wastewater treatment plants could be educated on the importance of disinfection of the effluent from their treatment 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 restore and maintain the quality of water resources.

The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of the Tuscumbia River Canal as being impaired by fecal coliform bacteria for a length of 12 miles as reported in the Mississippi 1996 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 segment is near Corinth, from the confluence with Parmicha Creek to the confluence with Tarebreeches Creek. The monitored section is shown in Figure 1.1a.

The impaired segment of the Tuscumbia River Canal is in the North Independent Basin Hydrologic Unit Code (HUC) 08010207 in north Mississippi. The drainage area of the monitored segment is approximately 185,000 acres; and lies within portions of Alcorn and Prentiss Counties. The watershed is rural but includes the urban area of Corinth. 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 Tuscumbia River Canal Watershed

	Urban	**Forest**	**Cropland**	**Pasture**	**Barren**	**Wetland**	**Total**
Area (Acres)	8,306	92,841	32,481	46,833	165	4,401	185,025
% Area	4%	50%	18%	25%	0%	2%	

Figure 1.1a Tuscumbia River Canal Watershed Impaired Segment

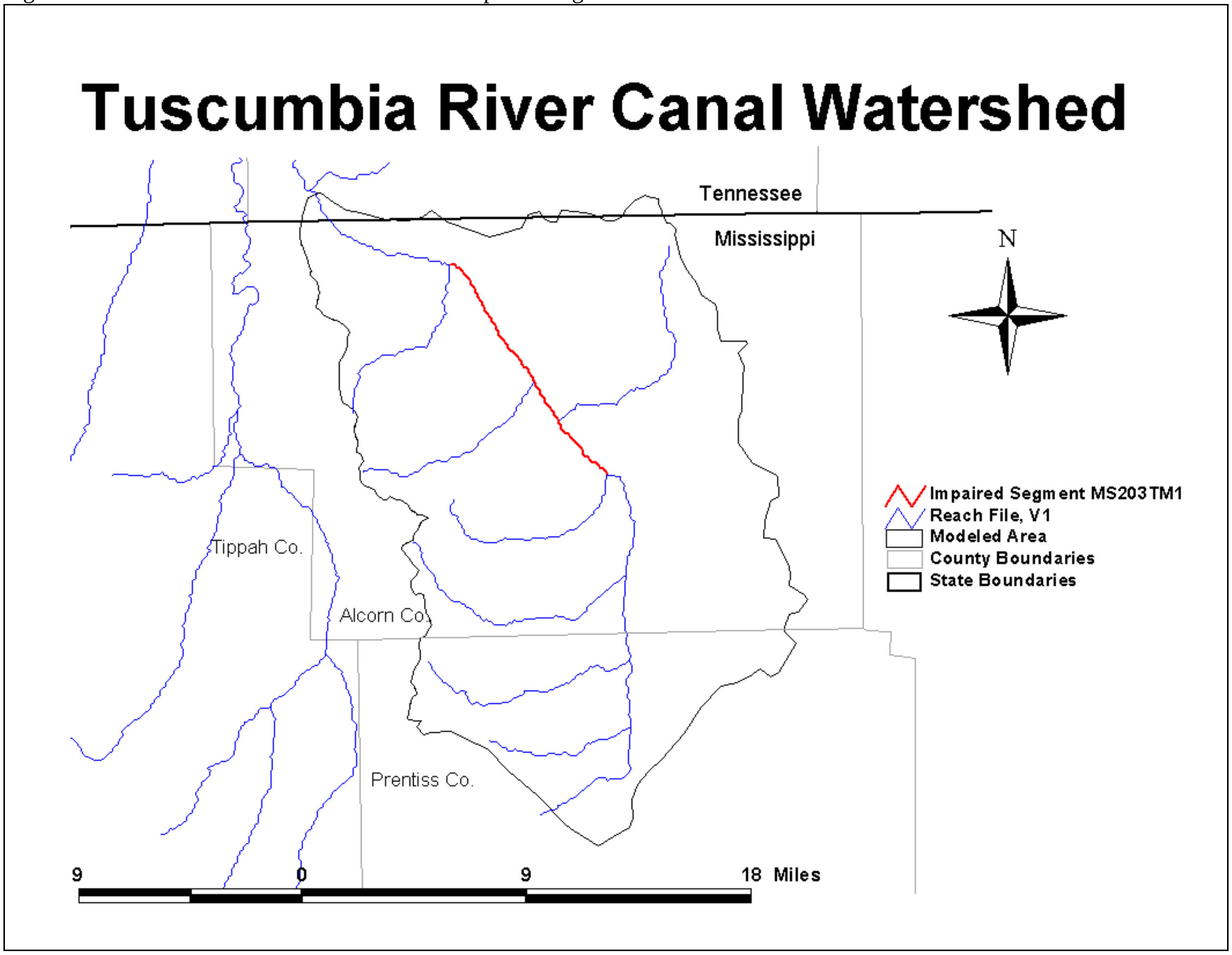
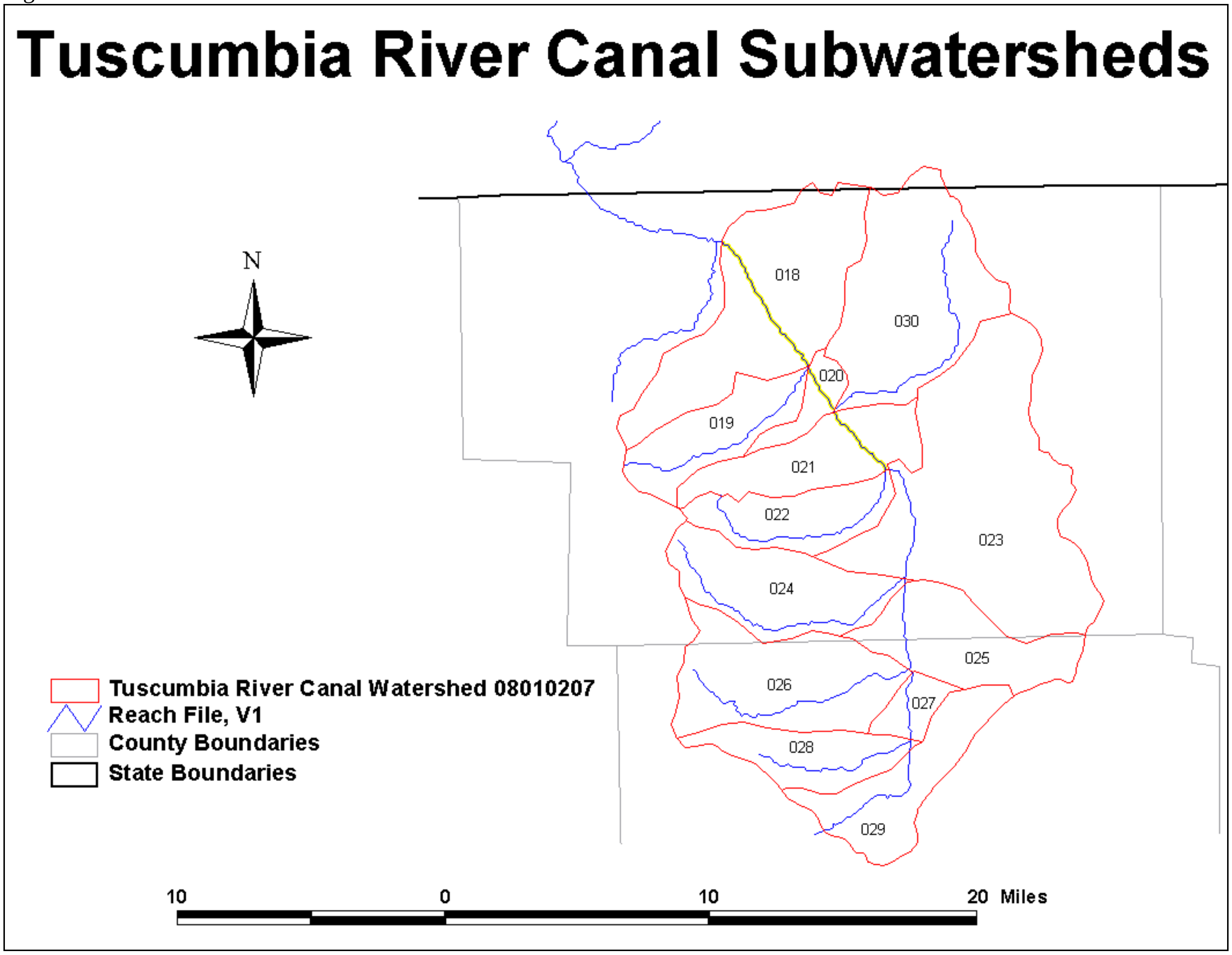


Figure 1.1b Tuscumbia River Canal Subwatersheds



The drainage area, or watershed, has been divided into 13 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) segments 08010207018, 08010207020, and 08010207021.

1.2 Applicable Waterbody Segment Use

The water use classification for the Tuscumbia River Canal, 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 Tuscumbia River Canal 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 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 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

Water quality data available for the monitored segment of the Tuscumbia River Canal show that high levels of fecal coliform bacteria impair the stream. There is one ambient station on the impaired segment operated by MDEQ that collected fecal coliform monitoring data during the 11-year modeling period. Data from this station was used to determine the impaired status of the segment. Monitoring for flow and fecal coliform was performed on a bimonthly (six per year) basis at station 07029310 at the Tuscumbia River Canal Smith Bridge (shown at right) near Corinth, from November 1991 to 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, the Tuscumbia River Canal is not supporting the use of secondary contact recreation and threatened for the use of aquatic life support. These conclusions were based on instantaneous data collected at stations 07029310. Data collected at the station are listed in Table 2.2a.

Table 2.2a Fecal Coliform Data reported in the Tuscumbia River Canal, Station 07029310

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
11/4/1991	18	230
1/6/1992	112	110
3/3/1992	218	130
5/4/1992	15	33
7/13/1992	35	79
9/14/1992	77	125
11/2/1992	370	230
1/12/1993	747	790
3/8/1993	214	350
5/3/1993	2663	**2400**
7/12/1993	31	**1600**
9/14/1993	30	350
11/1/1993	66	350
1/11/1994	325	170
3/7/1994	342	1500
5/2/1994	118	**2400**
6/20/1994	83	79
8/22/1994	150	**540**
11/7/1994	920	2400
1/11/1995	110	210
3/7/1995	2500	920
4/17/1995	No data	170
7/12/1995	60	94
9/11/1995	25	27
11/7/1995	60	2400
1/8/1996	380	240
3/4/1996	1000	110
5/6/1996	220	No data
7/9/1996	200	**2400**
9/9/1996	24	**1600**

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data discussed above are presented in Table 2.2b. 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 2.2b Statistical Summaries for Station 07029310

Season	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
Winter	16	110	2400	0	0%
Summer	12	27	2400	6	50%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Tuscumbia River Canal 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 13 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 nine wastewater treatment plants in the Tuscumbia River Canal Watershed serve a variety of activities including residential subdivisions, schools, recreational areas, and other businesses. The majority of the nine 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 3.1.1 Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Receiving Waterbody
Kossuth High School - Alcorn	08010207019	MS0029084	McElroy Creek
Monroe Meat Slaughterhouse	08010207020	MS0037231	Tuscumbia River
Biggersville School	08010207022	MS0030589	Parmicha Creek
Rienzi POTW	08010207025	MS0033961	Tuscumbia River
North Point Megamart & Fueling Center	08010207026	MS0055433	Polly's Creek
Thrasher High School	08010207027	MS0030082	Tuscumbia River
Booneville POTW	08010207029	MS0042030	Tuscumbia River
Farmington Apartments	08010207030	MS0036463	Bridge Creek
Corinth POTW	08010207030	MS0021652	Elam Creek

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for the Tuscumbia River Canal, 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

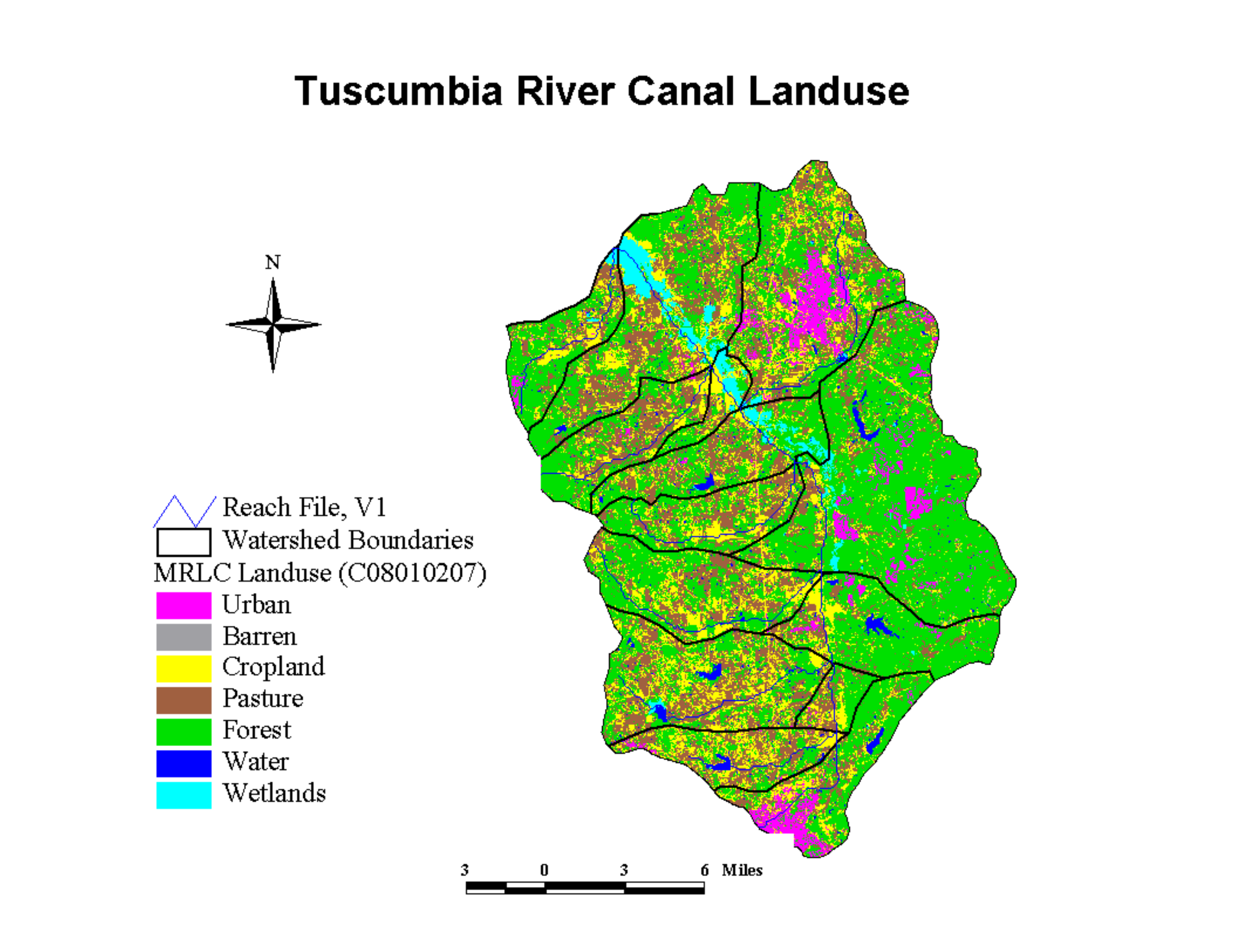
The 185,000 acre drainage area of the Tuscumbia River Canal contains many different landuse types, including urban, forest, cropland, pasture, barren, and wetlands. The modeled landuse information for the entire watershed is based on the Multi-Resolution Land Characteristic (MRLC) data, which is derived from Landsat Thematic Mapper digital images taken in the early 1990's. 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 Tuscumbia River Canal 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 MRLC 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 Tuscumbia River Canal 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
08010207018	140	10,299	4,359	7,587	0	2,250	24,634
08010207019	79	4,101	1,628	3,575	0	0	9,382
08010207020	0	954	852	504	0	582	2,893
08010207021	51	5,379	1,747	3,232	0	766	11,174
08010207022	17	4,097	2,073	2,834	0	0	9,021
08010207023	2,217	28,695	2,594	4,557	144	534	38,741
08010207024	16	6,922	3,185	3,878	0	0	14,002
08010207025	415	8,720	1,515	1,653	17	16	12,335
08010207026	27	6,119	4,888	6,526	0	106	17,666
08010207027	24	1,312	649	863	0	0	2,848
08010207028	119	2,216	2,544	3,123	0	4	8,007
08010207029	1,796	5,628	1,724	1,975	4	6	11,132
08010207030	3,405	8,399	4,723	6,526	0	137	23,190
Total	**8,306**	**92,841**	**32,481**	**46,833**	**165**	**4,401**	**185,025**

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 Tuscumbia River Canal Watershed contributes to fecal coliform bacteria on the land surface. In the Tuscumbia River Canal 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 North Independent 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 North Independent 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 Tuscumbia River Canal 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 Tuscumbia River Canal 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

There are no chickens sold in this area. There are very few layers and no broilers produced in the Tuscumbia River Canal Watershed. The loading contribution from these few layers was considered insignificant.

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 Tuscumbia River Canal 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 0.5 percent of their time standing in the streams. Thus, the model assumes that 0.5 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 Tuscumbia River Canal was considered. Municipalities within the Tuscumbia River Canal Watershed include Corinth and Booneville. 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 reductions. 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 Tuscumbia River Canal 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 Tuscumbia River Canal TMDL model includes the listed section of the creek and all upstream reaches. All upstream contributors of bacteria are accounted for in the model. This portion of the watershed was divided into 13 subwatersheds in an effort to isolate the major stream reaches in the Tuscumbia River Canal 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 Tuscumbia River Canal 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 nine 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 Tuscumbia River Canal. Other sources are represented as an application rate to the land in the Tuscummbia River Canal 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 population of Alcorn and Prentiss Counties. The percentage of the population on septic systems was determined from 1990 United States Census Data. Based on the best available information, a failure rate of 25% was assumed. 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 Tuscumbia River Canal 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 MRLC landuse data divide urban land into several categories. For the Tuscumbia River Canal 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. Table 4.3 shows the break up of urban land into high density, low density, and transportation on a subwatershed basis. The fecal coliform production rate for each of these subdivisions of urban land is 1.54E+07 for high density, 1.03E+07 for low density, and .02E+07 for transportation. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 4.3 Urban Landuse Distribution

Subwatershed	High Density Urban	Low Density Urban	Transportation	Total
08010207016	0	1	1	2
08010207017	35	98	85	218
08010207018	22	63	55	140
08010207019	13	36	31	79
08010207020	0	0	0	0
08010207021	8	23	20	51
08010207022	3	8	7	17
08010207023	378	1,063	921	2,361
08010207024	3	7	6	16
08010207025	69	194	168	432
08010207026	4	12	11	27
08010207027	4	11	10	24
08010207028	19	54	47	119
08010207029	288	810	702	1,800
08010207030	545	1,532	1,328	3,405
All Watersheds	**1,391**	**3,912**	**3,390**	**8,693**

4.4 Stream Characteristics

The stream characteristics given below describe the entire impaired section of the Tuscumbia River Canal. This section begins at the confluence with Parmicha Creek and ends at the confluence of Tarebreeches Creek. The channel geometry and lengths for the Tuscumbia River Canal 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 Tuscumbia River Canal are as follows.

- ♦ Length 12 miles
- ♦ Average Depth 0.44 ft
- ♦ Average Width 45.20 ft
- ♦ Mean Flow 397.03 cubic ft per second
- ♦ Mean Velocity 1.38 ft per second
- ♦ 7Q10 Flow 2.79 cubic ft per second
- ♦ Slope 0.00034 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

There is no USGS gage on Tuscumbia River Canal. Therefore, hydraulic calibration was not practical. However, modeled flow values were compared to flow data taken as part of MDEQ's ambient monitoring program. Flow values for reach 08010207018 were collected approximately bimonthly (six times a year) from November, 1991 through September, 1996. In Appendix A, Graph A-1 shows the modeled flow and the MDEQ data.

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 reaches 08010207018 and 08010207021 of the Tuscumbia River Canal. Graph A-2 shows the fecal coliform levels in the most upstream impaired reach (08010207021) during the 11-year modeling period. Graph A-4 shows the fecal coliform levels in the most downstream inpaired reach (08010207018) during the 11-year modeling period. The graphs show a 30-day geometric mean of the data. There have been 31 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.

Graphs A-3 and A-5 show the 30-day geometric mean of the fecal coliform levels after the reduction scenario has been modeled. The scale matches the previous graphs for comparison purposes. The graphs indicate that there are no summer 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. 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. As part of this TMDL, all wastewater treatment facilities will be required to meet water quality standards at the end of their pipe. Table 5.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. 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
08010207019	0.03	7.08E+06	0.03	7.08E+06	0%
08010207022	0.02	4.72E+06	0.02	4.72E+06	0%
08010207025	0.09	1.89E+07	0.09	1.89E+07	0%
08010207026	0.00	3.15E+05	0.00	3.15E+05	0%
08010207027	0.01	2.52E+06	0.01	2.52E+06	0%
08010207029	3.10	6.30E+08	3.10	6.30E+08	0%
08010207030	7.30	1.49E+09	7.30	1.49E+09	0%

5.2 Load Allocations

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 5.2a 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. 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 Tuscumbia River Canal 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
08010207018	4.77E-05	1.82E+09	2.43E-05	9.30E+08	49%
08010207019	2.25E-05	8.61E+08	1.15E-05	4.39E+08	49%
08010207020	3.17E-06	1.21E+08	1.62E-06	6.18E+07	49%
08010207021	2.04E-05	7.79E+08	1.04E-05	3.97E+08	49%
08010207022	1.79E-05	6.83E+08	9.11E-06	3.48E+08	49%
08010207023	2.87E-05	1.10E+09	1.46E-05	5.60E+08	49%
08010207024	2.45E-05	9.35E+08	1.25E-05	4.77E+08	49%
08010207025	8.84E-06	3.38E+08	4.51E-06	1.72E+08	49%
08010207026	2.95E-05	1.13E+09	1.50E-05	5.74E+08	49%
08010207027	3.73E-06	1.43E+08	1.90E-06	7.27E+07	49%
08010207028	1.35E-05	5.16E+08	6.89E-06	2.63E+08	49%
08010207029	8.53E-06	3.26E+08	4.35E-06	1.66E+08	49%
08010207030	3.92E-05	1.50E+09	2.00E-05	7.65E+08	49%
Total	**2.68E-04**	**1.03E+10**	**1.37E-04**	**5.23E+09**	**49%**

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
08010207018	5.77E-02	5.87E+08	4.39E-02	4.46E+08	24%
08010207019	2.21E-02	2.25E+08	1.68E-02	1.71E+08	24%
08010207020	6.83E-03	6.95E+07	5.19E-03	5.28E+07	24%
08010207021	2.67E-02	2.72E+08	2.03E-02	2.07E+08	24%
08010207022	2.13E-02	2.16E+08	1.62E-02	1.64E+08	24%
08010207023	9.15E-02	9.31E+08	6.95E-02	7.07E+08	24%
08010207024	3.31E-02	3.37E+08	2.52E-02	2.56E+08	24%
08010207025	2.48E-02	2.52E+08	1.88E-02	1.91E+08	24%
08010207026	3.21E-02	3.26E+08	2.44E-02	2.48E+08	24%
08010207027	4.82E-03	4.90E+07	3.66E-03	3.73E+07	24%
08010207028	1.40E-02	1.42E+08	1.06E-02	1.08E+08	24%
08010207029	1.92E-02	1.95E+08	1.46E-02	1.48E+08	24%
08010207030	5.35E-02	5.45E+08	4.07E-02	4.14E+08	24%
Total	**4.08E-01**	**4.15E+09**	**3.10E-01**	**3.15E+09**	**24%**

The model estimated the fecal coliform bacteria count per 30 days entering Tuscumbia River Canal for each impaired segment and evaluated drainage area due to runoff during the 30-day critical period. These values are given in section 5.4 Calculation of the TMDL.

The scenario used in this analysis for the load allocation in the Tuscumbia River Canal Watershed assumes an 49% reduction in contributions from cows in the stream and a 24% reduction from failing septic tanks. The scenario assumes all permitted dischargers meet water quality standards for disinfection. This scenario might 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 (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.

5.4 Calculation of the TMDL

The TMDL was calculated based on the following equation:

$$\textbf{TMDL} = \textbf{WLA} + \textbf{LA} + \textbf{MOS}$$

The TMDL was calculated based on the 30-day critical period for the Tuscumbia River Canal 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. Table 5.4 gives the TMDL for the monitored segments.

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

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

MOS = implicit

Table 5.4 TMDL Summary for Monitored Segment (counts/30 days)

	MS203TM1
NPDES Permits	1.55E+12
1/2 Failing Septic Tanks	1.13E+12
WLA	**2.68E+12**
Surface Runoff	1.30E+6
Cows in Stream	3.76E+12
1/2 Failing Septic Tanks	1.13E+12
LA	**1.29E+12**
TMDL = WLA + LA	**7.58E+12**

5.5 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 reduction scenario used in this TMDL included requiring all NPDES Permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing the assumed fecal load from 49% of the cattle access to streams and the assumed fecal load from 24% of the failing septic tanks in the watershed.

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 not approve 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.

6.1 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, Tuscumbia River Canal may receive additional monitoring to identify any change in water quality.

6.2 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 the area of the watershed. 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.

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 (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d}_l$, $\mathbf{d}_2$, $\mathbf{d}_3$) 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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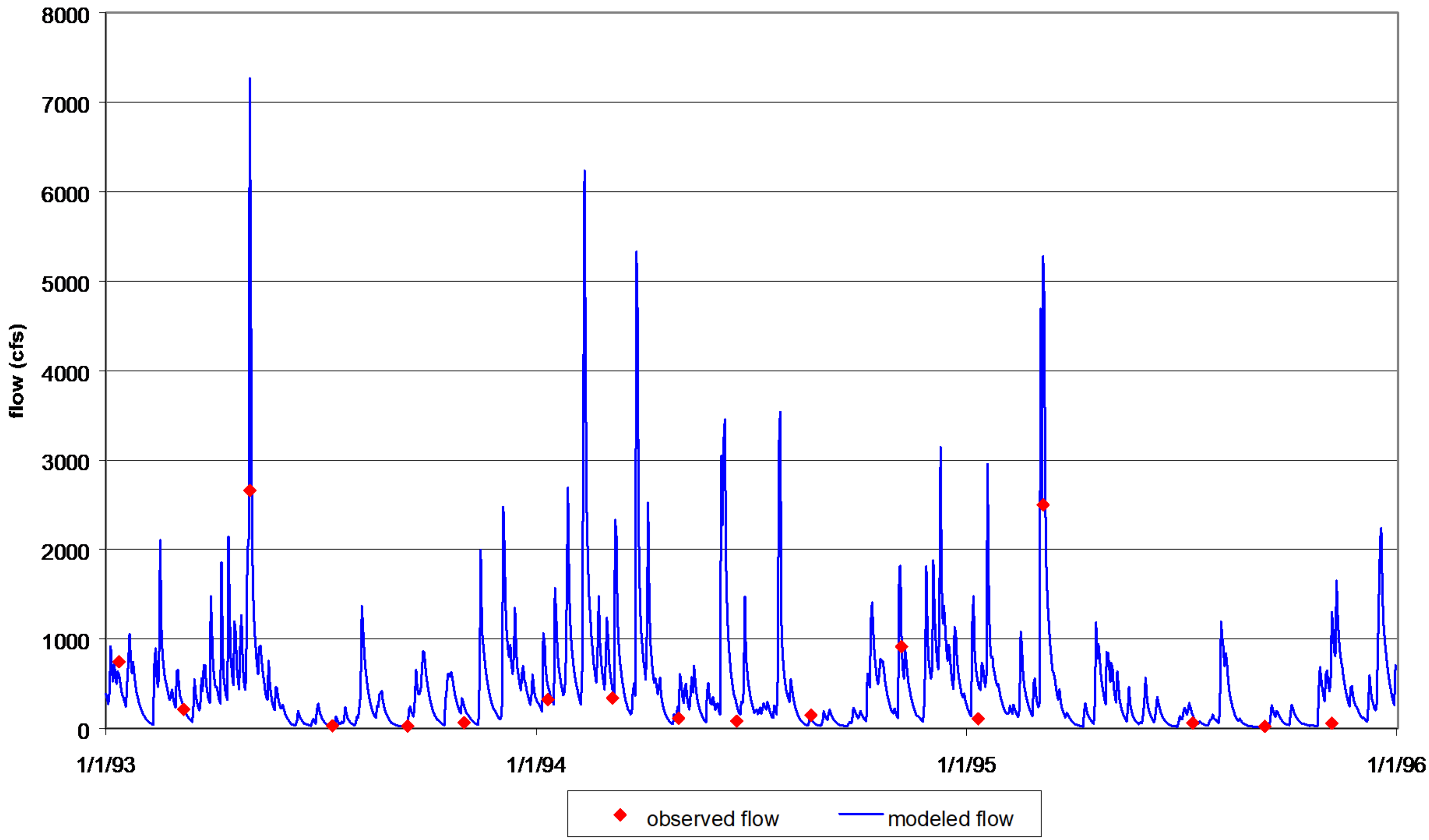
APPENDIX A

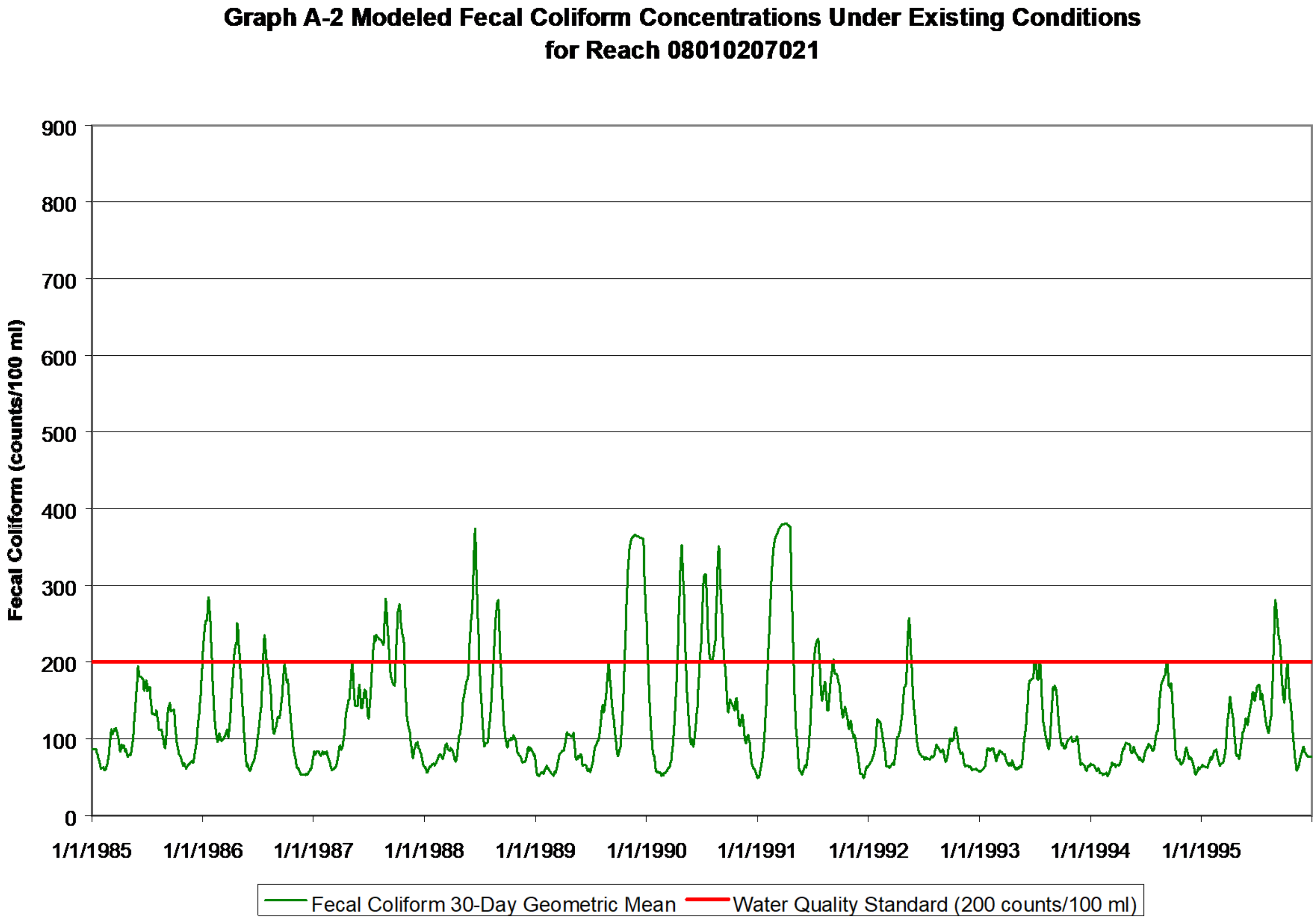
This appendix contains printouts of the various model run results. Graph A-1 shows the modeled flow, in cubic feet per second, through reach 08010207018 compared to the MDEQ flow readings from the Tuscumbia River Canal Smith Bridge near Corinth, station 07029310. The following graphs show the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the impaired section of the Tuscumbia River Canal River. The graphs contain a reference line at 200 counts per 100 ml. Graph A-2 shows the fecal coliform levels in the most upstream impaired reach (08010207021) during the 11-year modeling period. Graph A-3 shows the modeled fecal coliform levels in reach 08010207021 after the reduction scenario has been applied. Graph A-4 shows the fecal coliform levels in the most downstream impaired reach (08010207018) during the 11-year modeling period. Graph A-5 shows the modeled fecal coliform levels in reach 08010207018 after the reduction scenario has been applied. Graphs A-2 through A-5 are shown with the same scale for comparison purposes.

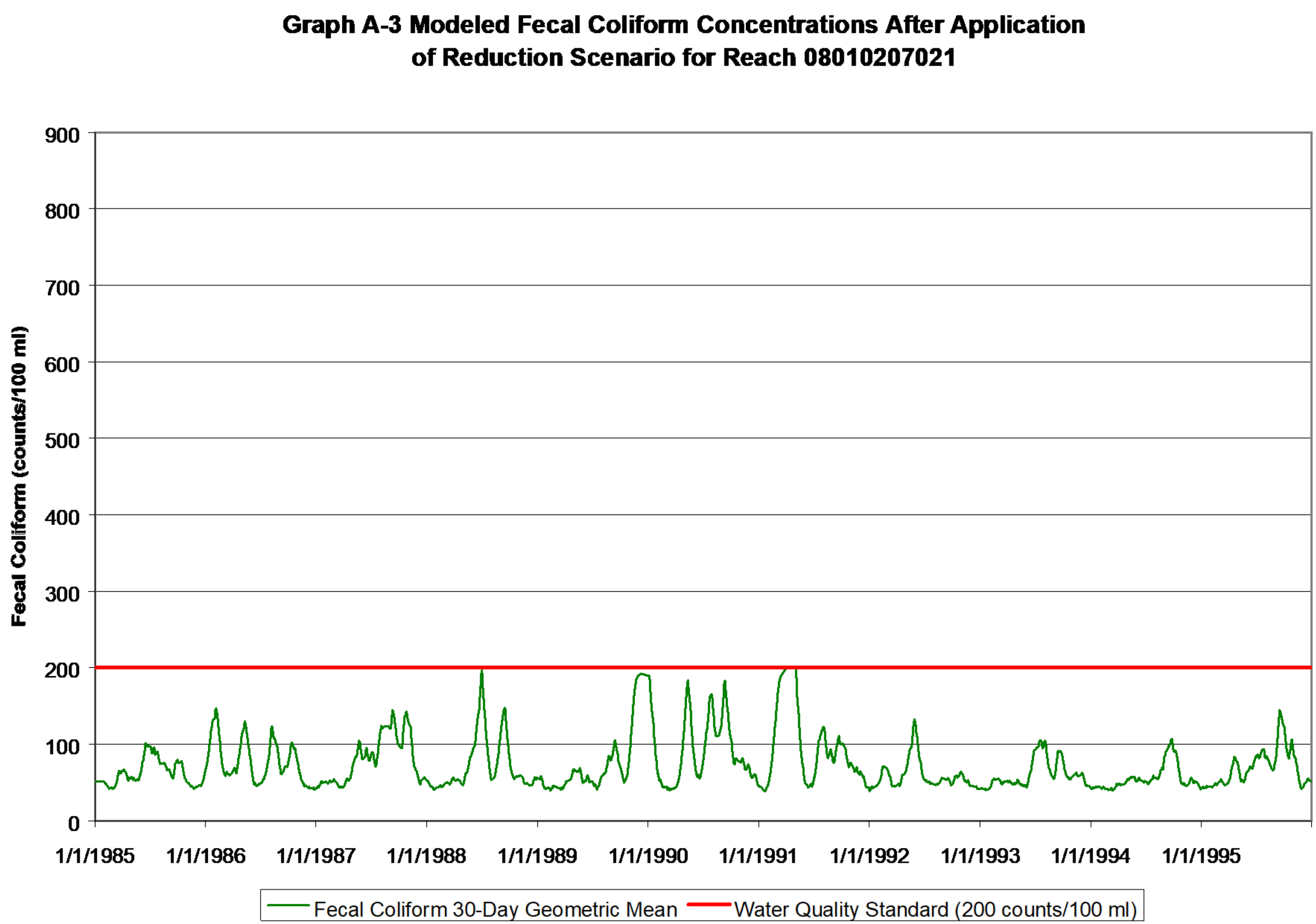
The TMDL calculated in this report represents the maximum fecal coliform load that can be assimilated by the waterbody segment during the critical 30-day period that will maintain water quality standards. The calculation of this TMDL is based on the critical hydrologic flow condition that occurred during the modeled time span. The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the allocated loading scenario for the most downstream reach (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.

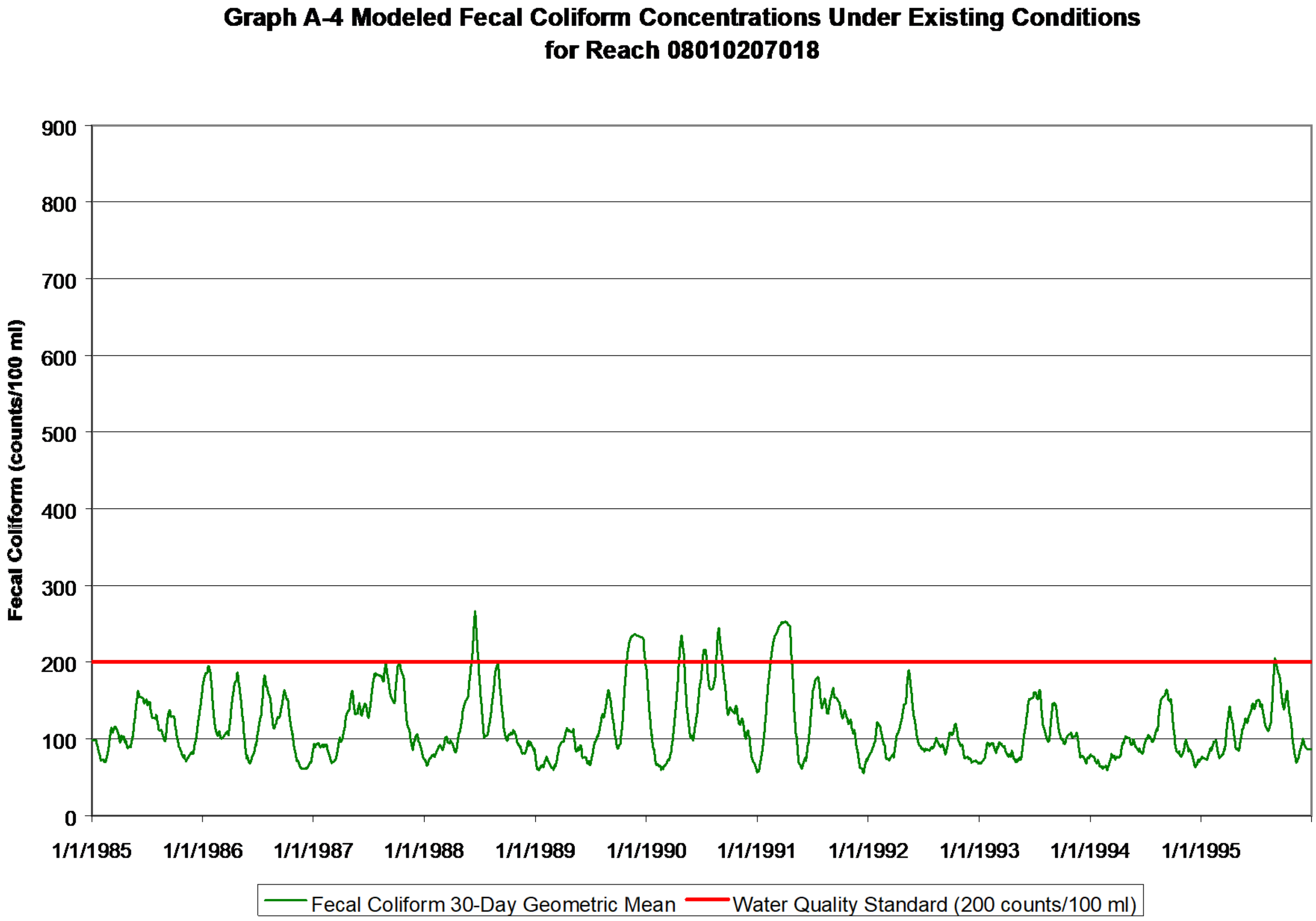
An individual TMDL calculation was prepared for each waterbody segment included in this report. The numerical values for the wasteload allocation (point sources) and load allocation (nonpoint sources) for each waterbody segment and drainage area can be found on the waterbody segment identification pages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

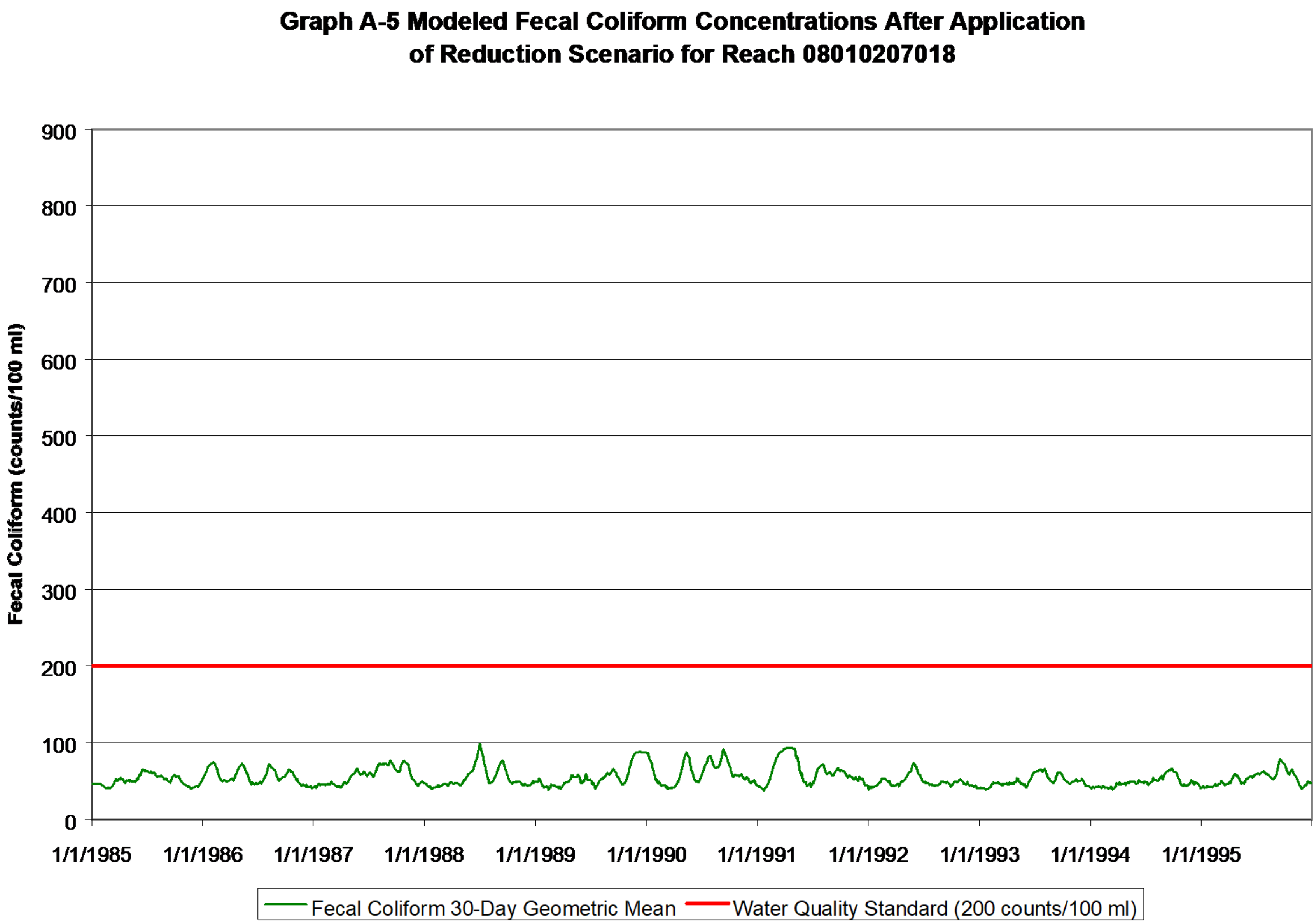
Graph A-1 Flow Comparison between DEQ Ambient Monitoring Station 07029310 and Reach 08010207018 for 1/1/1993-12/31/1995




Graph A-2 Modeled Fecal Coliform Concentrations Under Existing Conditions
for Reach 08010207021
Fecal Coliform (counts/100 ml)
900
800
700
600
500
400
300
200
100
0
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
1/1/1990
1/1/1991
1/1/1992
1/1/1993
1/1/1994
1/1/1995
Fecal Coliform 30-Day Geometric Mean
Water Quality Standard (200 counts/100 ml)


Graph A-3 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario for Reach 08010207021
Fecal Coliform (counts/100 ml)
900
800
700
600
500
400
300
200
100
0
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
1/1/1990
1/1/1991
1/1/1992
1/1/1993
1/1/1994
1/1/1995
Fecal Coliform 30-Day Geometric Mean
Water Quality Standard (200 counts/100 ml)


Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions
for Reach 08010207018
Fecal Coliform (counts/100 ml)
900
800
700
600
500
400
300
200
100
0
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
1/1/1990
1/1/1991
1/1/1992
1/1/1993
1/1/1994
1/1/1995
Fecal Coliform 30-Day Geometric Mean
Water Quality Standard (200 counts/100 ml)


Graph A-5 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario for Reach 08010207018
Fecal Coliform (counts/100 ml)
900
800
700
600
500
400
300
200
100
0
1/1/1985
1/1/1986
1/1/1987
1/1/1988
1/1/1989
1/1/1990
1/1/1991
1/1/1992
1/1/1993
1/1/1994
1/1/1995
Fecal Coliform 30-Day Geometric Mean
Water Quality Standard (200 counts/100 ml)