Fecal Coliform TMDL

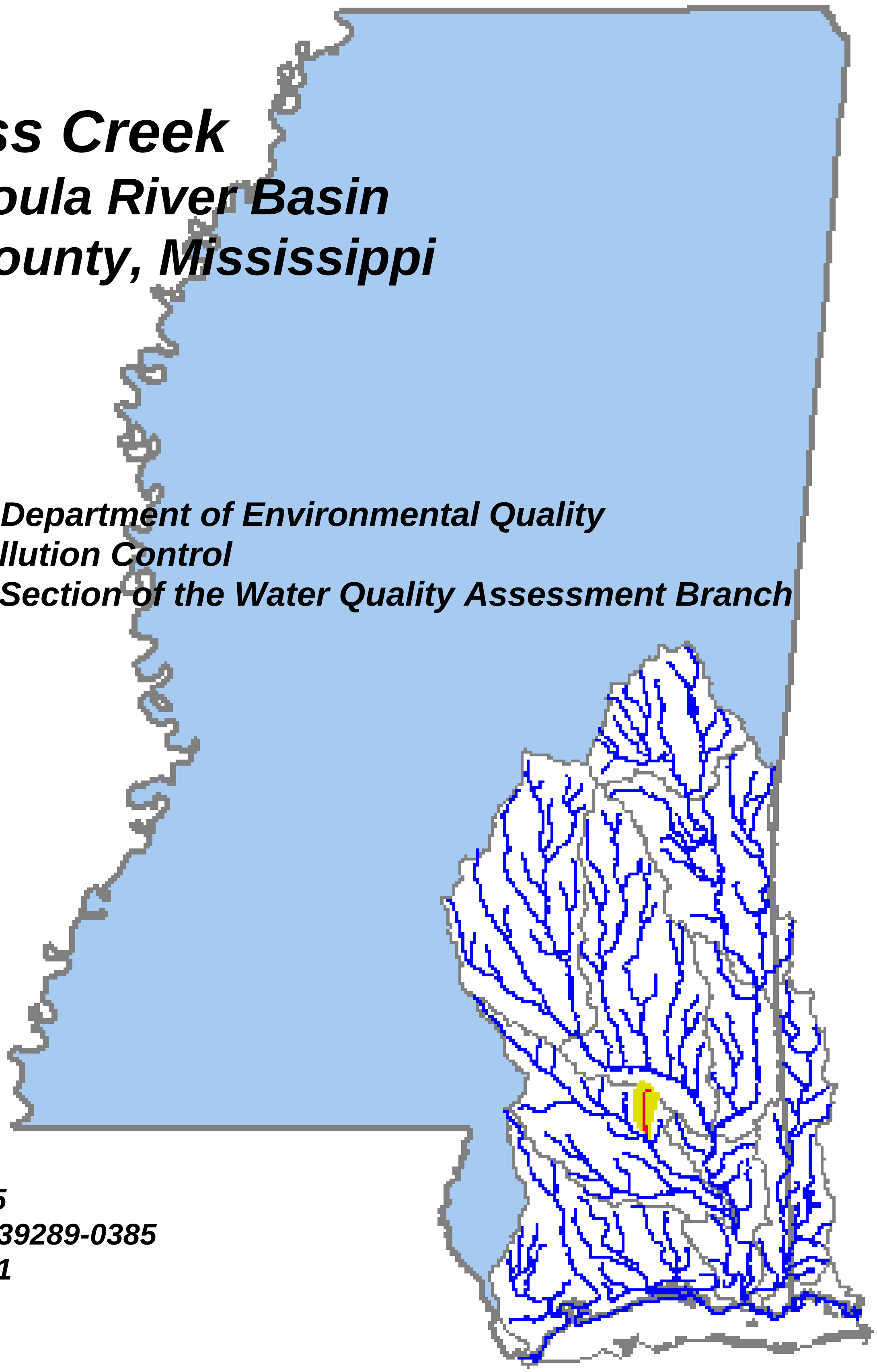
For

Cypress Creek
Pascagoula River Basin
Perry County, Mississippi

Prepared By

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

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



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MONITORED SEGMENT IDENTIFICATION

Name:	Cypress Creek
Waterbody ID:	MS101M1
Location:	Near Janice: From headwaters to confluence with Black Creek
County:	Perry
USGS HUC Code:	03170007
NRCS Watershed	030
Length:	12 miles impaired on 303(d) list, 15.2 miles modeled
Use Impairment:	Secondary Contact Recreation
Cause Noted:	Fecal Coliform, an indicator for the presence of pathogenic bacteria
Priority Rank:	110
NPDES Permits:	None
Pollutant Standard:	For summer months, fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml.
Waste Load Allocation:	The TMDL requires any dischargers to meet water quality standards for disinfection.
Load Allocation:	1.29E+10 counts per day directly into the stream 5.91E+12 counts per day available for land surface runoff
Margin of Safety:	Implicit in conservative modeling assumptions
Total Maximum Daily Load (TMDL):	The TMDL is a combination of the direct input of fecal coliform from NPDES permitted dischargers and nonpoint sources due to cows with access to streams, failing septic tanks, and land surface fecal coliform application rates necessary to meet the fecal coliform standard. Due to die-off rates and transport considerations, the load allocation is represented as two separate numbers, which vary by multiple orders of magnitude.

EXECUTIVE SUMMARY

Cypress Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as an impaired waterbody segment, 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 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml. A review of the available monitoring data for the watershed indicates that there is a violation of the standard for the impaired waterbody.

Cypress Creek is a small creek - 15.2 miles in length - completely located in Perry County, Mississippi. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. Daily flow values from the USGS gage on Cypress Creek at Janice were used to calibrate the hydrologic flow for the watershed. The weather data used for this model were collected at Leakesville. The representative hydrologic period used for this TMDL was January 1, 1985, through December 31, 1995.

Fecal coliform loading from nonpoint sources in the watershed were calculated based upon wildlife populations; numbers of cattle, hogs, and chickens; information on livestock and manure management practices for the Pascagoula Basin; and urban development. The estimated fecal coliform production and accumulation rates due to nonpoint sources for the watershed were incorporated into the model. Also represented in the model were the nonpoint sources such as failing septic systems and cattle that have direct access to tributaries of the Cypress Creek. There are no NPDES Permitted discharges located in the watershed. Under existing conditions, output from the model indicates violation of the fecal coliform standard in the stream. After applying a load reduction scenario, there were no violations of the standard according to the model.

The scenario used to reduce the fecal coliform load involves a cooperative effort between all fecal coliform contributors in the Cypress Creek Watershed. First is the removal of 88% of the cattle's direct access to tributaries. This could be accomplished by fencing streams in cattle pastures. Education on best management practices is a vital part of achieving this goal. Second, a 50% reduction in the fecal coliform contribution from failing septic tanks is required. The model assumed there is a 40% failure rate of septic tanks in the 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

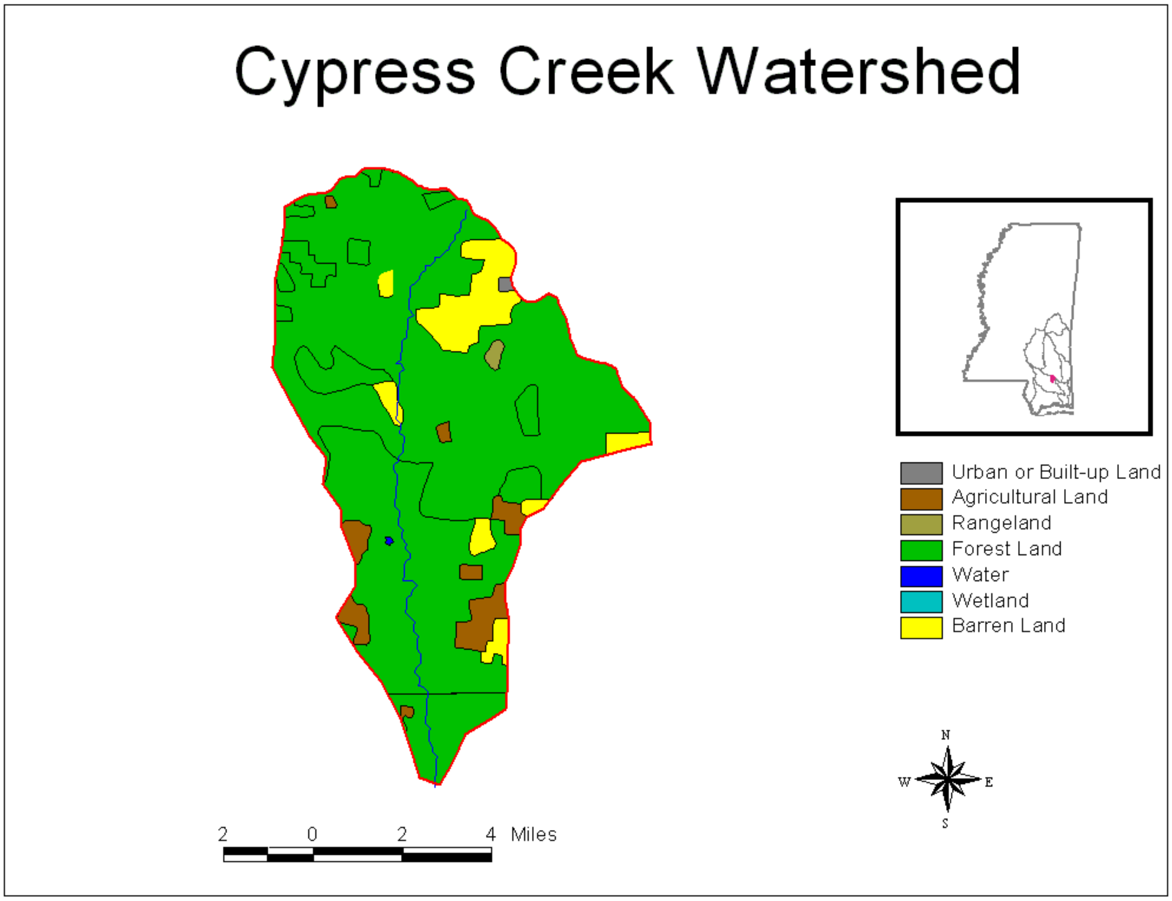
The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 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 Cypress Creek as being impaired by fecal coliform bacteria for a length of 12 miles as reported in the Mississippi 1998 Section 303(d) List of Waterbodies. This segment is listed as impaired because sufficient monitoring data is available to show that there is an impairment in this segment. The impaired segment begins at the headwaters and extends to the confluence with Black Creek in southern Perry County. Cypress Creek is ranked 110th on the 1998 303(d) list.

The Cypress Creek Watershed is in the Pascagoula River Basin Hydrologic Unit Code (HUC) 03170007 in southeastern Mississippi. The drainage area of the monitored segment from the headwaters to the confluence with Black Creek is approximately 39,000 acres; and lies within Perry County. The watershed is rural in nature and includes the small towns of Janice and Oak Grove. It is located approximately 10 miles south of New Augusta between Janice and Oak Grove. It is completely located within the DeSoto National Forest. Forest is the dominant landuse within this watershed. Cypress Creek flows into Black Creek, thence into the Pascagoula River, thence into the Mississippi Sound. The land distribution is shown in Table 1.1.

Table 1.1 Land Distribution in acres for the Cypress Creek Watershed

Watershed	Urban	Forest	Wetlands	Pasture	Cropland	Barren	Total
Cypress Creek	0	35980	179	2582	209	205	39155
% of total	0%	91.9%	.5%	6.6%	.5%	.5%	100%

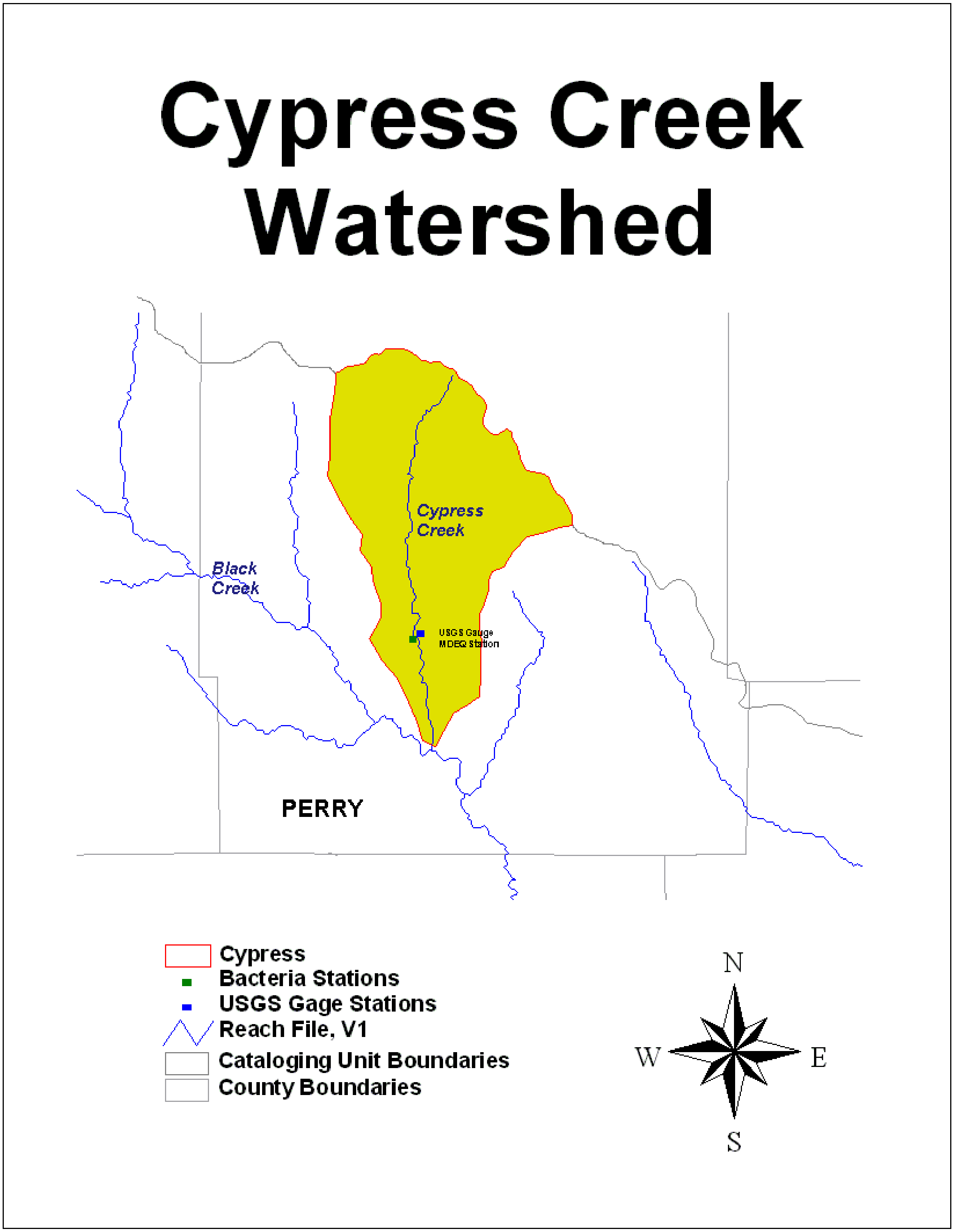


1.2 Applicable Waterbody Segment Use

Designated beneficial uses and water quality standards are established by the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* regulations. The designated uses for Cypress Creek as defined by the regulations are Secondary Contact Recreation and Fish and Wildlife Support. Secondary contact recreation is defined as incidental contact with the water, including wading and occasional swimming.

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 from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 400 per 100 ml. And that from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 % of the samples examined during any month exceed a colony count of 4000 per 100ml. This water quality standard will be used as targeted endpoints to evaluate impairments and establish this TMDL.


Cypress Creek Watershed
Cypress Creek
Black Creek
USGS Gauge
MDEQ Station
PERRY
Cypress
Bacteria Stations
USGS Gage Stations
Reach File, V1
Cataloging Unit Boundaries
County Boundaries
N
W
E
S

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

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

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

2.2 Discussion of Instream Water Quality

Cypress Creek is in very good condition. The ambient station operated by MDEQ at this site took quarterly samples for fecal coliform analysis from 1991 through 1996. There is no other known source of data on fecal coliform for this stream. There is no permitted discharge in the watershed. There is no known, commercial wastewater treatment facility with a direct discharge located within the watershed. The total fecal load must come from nonpoint source contributors, cows in the streams, and failing septic tanks.

The data supports the typical assumptions made for streams in the Pascagoula Basin which do not have a significant point source load. The critical condition appears to be the runoff from storms after a substantial dry period for buildup. The data indicating impairment are extremely marginal.

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, Cypress Creek is partially supporting the use of secondary contact recreation. These conclusions were based on instantaneous data collected at an MDEQ station located near Janice. Data collected are listed below in Table 2.1. There is a very limited amount of data available.

Table 2.1 Fecal Coliform Data reported in Cypress Creek

Date	Flow (cfs)	Fecal Coliform (counts/100 ml)
10/15/91	15	20
01/15/92	155	84
04/27/92	55	92
07/29/92	44	240
10/13/92	17	**860**
01/12/93	373	**1100**
04/20/93	45	150
07/14/93	332	**1100**
10/05/93	9	120
01/20/94	59	46
04/26/94	41	100
07/06/94	11	140
12/28/94	41	40
02/02/95	70	90
05/05/95	38	98
11/29/95	22	77
08/22/96	13	110

2.2.2 Analysis of Instream Water Quality Monitoring Data

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

Table 2.2 Statistical Summaries

Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
17	20	1100	3	18%

3.0 SOURCE ASSESSMENT

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

3.1 Assessment of Point Sources

There are no point sources discharging into Cypress Creek. There are no commercial wastewater treatment facilities located in the watershed. There are no NPDES Permits issued, nor are there any State Operating Permits (SOPs) issued in this watershed.

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Cypress Creek, including:

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

The 39,000-acre drainage area of Cypress Creek contains many different landuse types, including forests, cropland, pasture, barren, and wetlands. The landuse information is based on data collected by the State of Mississippi's Automated Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. This classification is based on a modified Anderson level one and two system with additional level two wetland classifications. The contribution of each of these land types to the fecal coliform loading of Cypress Creek was considered on a subwatershed basis. Table 3.1 shows the landuse distribution within the watershed in number of acres.

Table 3.1 Landuse Distribution in Number of Acres

Watershed	Forest	Croplands	Pasture	Urban	Barren	Wetland	Total
Cypress Creek	35980	209	2582	0	205	179	39155

The nonpoint fecal coliform contribution from each landuse was estimated using the latest information available. The MARIS landuse data for Mississippi was utilized by the BASINS model to extract landuse sizes, populations, agriculture census data, and other information. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Cypress Creek 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.

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 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 do not typically receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

3.2.2 Wildlife

Wildlife present in the Cypress Creek Watershed contributes to fecal coliform bacteria on the land surface. In the Cypress Creek model, all wildlife was accounted for by considering contributions from deer. Estimates of deer population were designed to account for the deer combined with all of the other wildlife 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 Pascagoula Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during March through May and October through November. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Pascagoula Basin operate by either keeping the animals confined by or allowing hogs to graze in a small pasture or pen. For this model, it was assumed that all of the hog manure produced by either farming method was applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations varied monthly according to management practices currently used in this area.

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

3.2.4 Grazing Beef and Dairy Cattle

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

3.2.5 Land Application of Poultry Litter

There are chickens produced in Perry County. Poultry farming operations use houses in which chickens are confined all of the time. The litter produced by the chickens is collected and is routinely applied as a fertilizer to pastureland in the watershed. Application rates of the litter vary monthly.

Predominantly, two kinds of chickens are raised on farms in the Pascagoula Basin, broilers and layers. For the broiler chickens, the amount of growth time from when the chicken is born to when it is sold off the farm is approximately forty-eight days or 1.6 months. Layer chickens remain on farms for ten months or longer. More than ninety-three percent of the chickens raised in this area are broilers. For the model, a weighted average of growth time was determined to account for both types of chickens. An average growth time of fifty-two days, or one-seventh of a year, was used. To determine the number of chickens on farms on any given day, the yearly population of chickens sold was divided by seven.

3.2.6 Cattle Contributions Directly Deposited Instream

Cattle often have direct access to flowing and intermittent streams that run through pastureland. These small streams are tributaries of larger streams. Fecal coliform bacteria deposited in these streams by grazing cattle are modeled as a direct input of bacteria to the stream. Due to the general topography in the Cypress Creek Watershed, it was assumed that all land slopes in the watershed are such that cattle are able to access the intermittent streams in all pastures. In order to determine the amount of bacteria introduced into streams from cattle, it was assumed that all grazing cattle spent two percent of their time standing in the streams. Thus, the model assumes that two percent of the manure produced by grazing beef and dairy cows are deposited directly in the stream.

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

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

4.1 Modeling Framework Selection

The BASINS model platform and the NPSM model were used to predict the significance of fecal coliform sources to fecal coliform levels in the Cypress Creek Watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as 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 Cypress Creek TMDL model includes the creek as well as the drainage areas that flow into the segment. To establish land use and watershed acreage along Cypress Creek, the watershed was delineated and Cypress Creek was isolated as the major stream reach in the watershed. The delineation of the watershed was based primarily on the reach file 3 (RF3) stream network, and secondarily on a topographic map of the watershed. Thus, all known upstream nonpoint source contributors of fecal coliform bacteria are accounted for in the model.

4.3 Source Representation

The nonpoint sources are represented in the model with two different methods. The first of these methods is a direct fecal coliform loading to Cypress Creek. Cows with access to the stream and failing septic tanks were considered with this method.

Other sources are represented as an application rate to the land in the Cypress Creek 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 at the same time, and all forest and wetland contributions were combined for model input. Urban and barren areas were combined and input into the model in the same manner.

Appendix A contains the Fecal Coliform Spreadsheet developed for quantifying point and nonpoint sources of bacteria for the Cypress Creek model. The model inputs for fecal coliform loading due to point and nonpoint sources are calculated 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 spreadsheet also contains a reference page that lists the literature references used to generate the fecal coliform loading rates.

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 Perry County. The percentage of the population on septic systems, which was determined from 1990 United States Census Data, is 80%. Based on the best available information, a failure rate of 40% was assumed. This information was used to calculate the estimated number of failing septic tanks per watershed. The number of failing septic tanks also incorporates an estimate for the failing onsite wastewater treatment systems in the area.

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. The model inputs for flow and fecal coliform concentration from failing septic tanks are shown in Appendix A.

4.3.2 Wildlife

Based on information provided by the Mississippi Department of Wildlife, Fisheries, and Parks, the deer population throughout the Cypress Creek 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 loading rates for each subwatershed are available in Appendix A.

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. The fecal coliform loading rates for land application of hog and liquid dairy manure are shown in Appendix A.

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. The fecal coliform loading rates due to grazing cattle are shown in the spreadsheet in Appendix A.

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 with a monthly loading rate. The fecal coliform loading rates from poultry litter application are shown in Appendix A.

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 two 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. As shown in Appendix A, 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).

4.4 Stream Characteristics

The stream characteristics given below describe the entire modeled section of Cypress Creek. This section begins at the headwaters and ends at the end of the monitored reach, with the confluence of Black Creek. The channel geometry and lengths for Cypress Creek 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 Cypress Creek are as follows.

- Length 15.2 miles
- Average Depth 0.52 ft
- Average Width 27.2 ft
- Mean Flow 131.34 cubic ft per second
- Mean Velocity 1.12 ft per second
- 7Q10 Flow 10.9 cubic ft per second
- Slope 0.00159

4.5 Selection of Representative Modeling Period

The model was run for twelve years, from January 1, 1984, through December 31, 1995. The first year of data were used to stabilize the model. Results from the model were evaluated for the time period from January 1, 1985, until December 31, 1995. Because this eleven-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 eleven-year time period, many such occurrences are captured in the model results.

4.6 Model Calibration Process

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 extensive effort was made to contact researchers and agricultural experts to give as much validity as possible to the assumptions made within the BASINS model.

The hydrological model had a continuous USGS gage available on Cypress Creek near Janice for comparison with the modeled flow in the creek. A sample of these results is included in Appendix B, Graph B-1. Modeled output and actual gage data are shown on the same graph for five years. The weather data was recorded approximately 27 miles east of the watershed in Leakesville, MS. This will account for much of the displacement in the hydrograph.

4.7 Existing Loading

Appendix B includes two graphs of the model results showing the instream fecal coliform concentrations for Cypress Creek. Graph B-2 shows the fecal coliform levels in the stream during the eleven-year modeling period. The graph shows a thirty-day geometric mean of the data. There have been seven standards violations in eleven years according to the model. The straight line at 200 counts per 100 ml indicates the water quality standard for the stream.

Graph B-3 shows the 30-day geometric mean of the fecal coliform levels after the reduction scenario has been modeled. The scale matches the previous graph for comparison purposes. The graph indicates that there are no violations of the water quality standard for the monitored segment after the reduction scenario is applied.

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources and a load allocation for nonpoint sources necessary for attainment of water quality standards in segment MS101M1. 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 it enters the stream. The difference in transportation methods prevents meaningful addition of the two sources into a total daily load. Thus, the two groups of nonpoint sources are presented separately.

5.1 Wasteload Allocations

As part of this TMDL, all future wastewater treatment facilities will be required to meet water quality standards at the end of their pipe. There are no known wastewater treatment facilities in the watershed. The entire area is within the DeSoto National Forest. There are no active or inactive NPDES permits in the subwatershed. Therefore, the model does not include any contributions or reductions from WLAs.

5.2 Load Allocations

Nonpoint sources that contribute to fecal coliform accumulation within the Cypress Creek Watershed are subject to reduction from their current level of contribution. Reductions in the load allocation for this TMDL involve two different types of nonpoint sources: cattle access to streams and septic tanks. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow and fecal coliform concentration in counts per hour. Table 5.2 lists the nonpoint source contributions due to cattle access to streams along with their existing load, allocated load, and percent reduction. Table 5.3 gives the same parameters for contributions due to septic tank failure.

Table 5.2 Fecal Coliform loading rates for nonpoint source contribution of cattle access to streams

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
Cypress Creek	3.33E-05	2.45E+09	7.69E-06	2.94E+08	88%

Table 5.3 Fecal Coliform loading Rates for nonpoint source contribution of failing septic tanks

Watershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
Cypress Creek	4.78E-02	4.87E+08	2.39E-02	2.43E+08	50%

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 Cypress Creek to achieve water quality standards. The total accumulation for each landuse type was determined by combining the contributions from each subwatershed. For example, the loading rate for forests was determined by combining all of the forest contributions from each of the five subwatersheds. The loading rates are constant throughout the year for forest, cropland, and urban land. The loading rates for pastureland vary for each month. However, in the table, the given rate is based on an average of the monthly accumulation rates. Monthly accumulation rates for pastureland are shown in the fecal coliform spreadsheet in Appendix A.

The scenario chosen for the load allocation in the Cypress Creek Watershed is an 88% reduction in contributions from cows in the stream, and a 50% reduction from failing septic tanks. The scenario also requires all permitted dischargers to meet water quality standards for disinfection. This scenario could be achieved by supporting BMP projects that promote fencing around streams in pastures, and by supporting education projects that encourage homeowners to properly maintain their septic tanks by routinely pumping them out, repairing broken field lines, and disinfecting the effluent from small individual onsite wastewater treatment plants.

5.3 Incorporation of a Margin of Safety

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. The MOS selected for this model is implicit. Running the model for eleven years with no violations of the water quality standard provides the primary component of the MOS. Ensuring compliance with the standard throughout all of the critical condition periods represented during the 11 years is a conservative practice. Another component of the MOS is the conservative assumption that in the model all of the fecal coliform bacteria discharged from failing septic tanks reaches the stream, while it is likely that only a portion of the bacteria will reach the stream due to filtration and die off during transport.

5.4 Seasonality

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

Because the model was established for an 11-year time span, it took into account all of the seasons within the calendar years from 1985 to 1995. The extended time period allowed the simulation of many different atmospheric conditions such as rainy and dry periods and high and low temperatures. It also allowed seasonal critical conditions to be simulated.

6.0 IMPLEMENTATION

6.1 Follow-Up Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Pascagoula Basin, Cypress Creek may receive follow-up monitoring to identify the improvement in water quality from the implementation of the strategies in this TMDL.

6.2 Reasonable Assurance

The fecal coliform reduction scenario recommended by this TMDL includes requiring all NPDES permitted dischargers of fecal coliform to meet water standards for disinfection, along with reducing 88% of the cattle access to streams and 50% of the failing septic tanks in the watershed. Reasonable assurance for the implementation of the TMDL has been considered for both point and nonpoint source contributors.

The TMDL will not impact existing or future NPDES permits as long as the effluent is disinfected to meet water quality standards for fecal coliform bacteria. 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 grants.

6.3 Public Participation

This TMDL will be published for a 30-day, public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in Perry County. The public will be given an opportunity to review the TMDL and submit comments. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing.

If a public hearing is deemed appropriate, the public will be given a 30-day notice of the hearing to be held at a location near the watershed. That public hearing would be an official hearing of the Mississippi Commission on Environmental Quality, and would be transcribed.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region IV for final approval.

APPENDIX A

The following spreadsheets comprise the information used to estimate all of the fecal coliform loading used in the model. The spreadsheet consists of several sheets, each dealing with a different aspect of the estimation. The final sheet brings all of the inputs into one format for model input.

THIS SPREADSHEET QUANTIFIES THE FECAL COLIFORM BACTERIA CONTRIBUTION FROM MULTIPLE SOURCES.
It is based on a modeling study of 9 subwatersheds, composed of four landuses (Cropland, Forest, Built-up, and Pastureland).

BLUE text found throughout the spreadsheet presents valuable information and assumptions.
GREEN text designates values specific to the Pascagoula Basin.
RED text designates values, which should be specified by the user.
BLACK text generally presents information which is calculated by the spreadsheet or that should not be changed.

There are 9 subwatersheds in this study.
The modeled landuses were derived from the original landuses.

Modeled landuses

Areas are listed in acres.

SUBSHED	CROPLAND	FOREST	URBAN	PASTURE LAND	TOTAL
Cypress Creek	209	35980	0	2582	38771
P2	0	0	0	0	0
P3	0	0	0	0	0
P4	0	0	0	0	0
P5	0	0	0	0	0
P6	0	0	0	0	0
P7	0	0	0	0	0
P8	0	0	0	0	0
P9	0	0	0	0	0
TOTAL	209	35980	0	2582	38771

The total number of animals in the 9 subwatersheds are as follows.

Fecal contributions from these animals are used to derive loading estimates for all landuses except for Built-up.
The number input for Poultry should be "Chickens Sold" from tbl_lstock2.dbf divided by 7.

Agricultural Animals

SUBSHED	BEEF COWS	SWINE (HOGS)	DAIRY COWS	POULTRY	CATTLE	BEEF FOR RATIO	MILK FOR RATIO
Cypress Creek	544	26	0	61765	544	1	0
P2	#DIV/0!	0	#DIV/0!	0	0	0	0
P3	#DIV/0!	0	#DIV/0!	0	0	0	0
P4	#DIV/0!	0	#DIV/0!	0	0	0	0
P5	#DIV/0!	0	#DIV/0!	0	0	0	0
P6	#DIV/0!	0	#DIV/0!	0	0	0	0
P7	#DIV/0!	0	#DIV/0!	0	0	0	0
P8	#DIV/0!	0	#DIV/0!	0	0	0	0
P9	#DIV/0!	0	#DIV/0!	0	0	0	0
TOTAL	#DIV/0!	26	0	61765	544	1	0

Wildlife

The deer population is the only major wildlife source considered. The same deer density is assumed for all subwatersheds.

Deer/sq. mile	45
Deer/acre	0.070312 5

This sheet contains information relevant to land application of waste produced

by agricultural animals in the study area.
Application of hog manure, cattle manure, and poultry litter is considered.
The information is presented based on monthly variability of waste application.
It is assumed that cattle manure is applied to both Cropland and Pastureland using the same method.

Hog Manure Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0.05	0.05	0.05	0.14	0.14	0.08	0.08	0.08	0.12	0.12	0.05	0.04	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.5)	0.6	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
Cypress Creek	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P2	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P3	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P4	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P5	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P6	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P7	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024

P8	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024
P9	0.03	0.03	0.03	0.084	0.084	0.048	0.048	0.048	0.072	0.072	0.03	0.024

Cattle Manure Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0	0	0	0.2	0.2	0.0666	0.0667	0.0667	0.2	0.2	0	0	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.5)	0.625	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
Cypress Creek	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P2	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P3	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P4	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P5	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P6	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P7	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P8	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0
P9	0	0	0	0.125	0.125	0.041625	0.04169	0.04169	0.125	0.125	0	0

Poultry Litter Available for Wash-off

This is the percentage of manure applied by month.

	January	February	March	April	May	June	July	August	September	October	November	December	
% of annual manure applied in month	0	0	0	0.143	0.143	0.143	0.143	0.143	0.143	0.142	0	0	1

The percent of manure available for runoff is dependent on the method of manure application. The percent available is computed below based on incorporation into soil. These are assumed values.

% available for runoff = (1 - % incorporated) + (% incorporated * 0.33)	0.36	% Applied to Cropland:	0.00	% Applied to Pastureland:	1.00

The following is the resulting manure application based on the monthly percentage applied and incorporation into the soil.

Subwatershed	January	February	March	April	May	June	July	August	September	October	November	December
Cypress Creek	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P2	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P3	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P4	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P5	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P6	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P7	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P8	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0
P9	0	0	0	0.05148	0.05148	0.05148	0.05148	0.05148	0.05148	0.05112	0	0

This sheet contains information relevant to cattle farming in the study area.

Dairy Cattle

Dairy cattle are assumed to be either kept in feedlots or allowed to graze (depending on the milking/feeding schedule, which is four hours per day). When grazing, a certain percentage is assumed to have direct access to streams.
Dairy cattle waste is therefore either applied as manure to Cropland and Pastureland, contributed directly to Pastureland, or contributed directly to streams (referred to as Cattle in Streams).

Beef Cattle

Beef cattle are assumed to be either kept in feedlots or allowed to graze (depending on the season). When grazing, a certain percentage is assumed to have direct access to streams.
Beef cattle waste is therefore either applied as manure to Cropland and Pastureland, contributed directly to Pastureland, or contributed directly to streams (referred to as Cattle in Streams).

	Beef Cattle Grazing	***Dairy Cattle Grazing***	***Assumed Cattle Access to Streams***
Month	**Percentage of Time not Confined (0.0 or 1.0)**	**Percentage of Time not Confined (0.0 or 1.0)**	**Percentage of Time (0.0 to 1.0)**
January	1.00	0.84	0.02
February	1.00	0.84	0.02
March	1.00	0.84	0.02
April	1.00	0.84	0.02
May	1.00	0.84	0.02
June	1.00	0.84	0.02
July	1.00	0.84	0.02
August	1.00	0.84	0.02
Septembe r	1.00	0.84	0.02
October	1.00	0.84	0.02

November	1.00	0.84	0.02
December	1.00	0.84	0.02

Month	**Total Beef Cattle Grazing Days**	**Total Dairy Cattle Grazing Days**
January	31	26.04
February	28	23.52
March	31	26.04
April	30	25.2
May	31	26.04
June	30	25.2
July	31	26.04
August	31	26.04
September	30	25.2
October	31	26.04
November	30	25.2
December	31	26.04
Total Grazing Days:	**365**	**306.6**

These data accessed from the following references are used in the remaining worksheets.

From ASAE

Animal	Total Manure prod (lb./day per 1,000 lb. animal)	Typical Animal Mass (lb.)	Manure prod per animal (lb./day)	Fecal Coliform (#/day E10 per 1,000 lb. animal)	Fecal Coliform (#/day)	Manure prod (lb./yr.)	Fecal Coliform (#/day)
Beef cow	40	794	32	13	1.03E+11	11587	5.71E+10
Dairy cow	86	1411	121	7.2	1.02E+11	44290	1.83E+11
Hog	84	134	11	8	1.08E+10	4123	1.08E+10
Sheep	40	60	2	20	1.19E+10	869	1.19E+10
Chicken	64	4	0	3.4	1.35E+08	93	1.35E+08
Broiler	85	2	0	3.4	6.75E+07	62	6.75E+07
Turkey	47	15	1	0.62	9.29E+07	257	9.29E+07
Duck	110	3	0	81	2.50E+09	124	2.50E+09

From Metcalf & Eddy

Estimated Fecal Coliform Production Rates by Animal

Animal	#/day	Reference	
Cow	5.40E+09	Metcalf & Eddy, 1991	pg. 101
Hog	8.90E+09	Metcalf & Eddy, 1991	
Sheep	1.80E+10	Metcalf & Eddy, 1991	
Chicken	2.40E+08	Metcalf & Eddy, 1991	
Turkey	1.30E+08	Metcalf & Eddy,	

		1991
Duck	1.10E+10	Metcalf & Eddy, 1991
Deer	5.00E+08	BPJ
Geese	4.90E+10	LIRPB, 1982

From: Horner, 1992

Fecal Coliform Loading Rates by Landuse

	Median #/ha-y	**#/acre/day**
Road	1.80E+08	2.00E+05
Commercial	5.60E+09	6.21E+06
Single family low density	9.30E+09	1.03E+07
Single family high density	1.50E+10	1.66E+07
Multifamily residential	2.10E+10	2.33E+07

This sheet contains information related to the contribution of failing septic systems to streams.

The direct contribution of fecal coliform from septics to a stream can be represented as a point source in the model.
Required input for point sources in NPSM are loading rate (#/hr) and flow (cfs).

The following assumptions are made for septic contributions.

People:	1102	
Estimated # septics:	394	
Avg. # people served per septic:	2.8	people/septic
Assume a failure rate for septics in the watershed:	40	%

Therefore the number of failing septics in the watershed is:	157.429		
Assume failing septics are distributed evenly across watershed based on land area. Therefore, density of failing septics is:	0.00406	septic/acre	
Assume the average FC concentration reaching the stream (from septic overcharge) is:	1.00E+04	#/100 ml	**(Horsely & Whitten, 1996)**
Assume a typical septic overcharge flow rate of:	70	gal/day/person	**(Horsely & Whitten, 1996)**

SEPTICS AS A POINT SOURCE

Subwatershed	Total area (acres)	# failing septics	Tot. # people served	Septic flow (gal/day)	Septic flow (mL/hr)	FC rate (#/hr)	Septic flow (cfs)

Cypress Creek	38771	157	440.8	30856	4866248.333	4.87E+08	4.78E-02
P2	0	0	0	0	0	0.00E+00	0.00E+00
P3	0	0	0	0	0	0.00E+00	0.00E+00
P4	0	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0	0.00E+00	0.00E+00
Total:	38771						

POINT SOURCES FOR EACH SUBWATERSHED (Point Sources\Loads)

Cattle in Streams, monthly averages

	Flow (cfs)	Fecal (#/hr)
Cypress Creek	7.69E-06	2.94E+08
P2	#DIV/0!	#DIV/0!
P3	#DIV/0!	#DIV/0!
P4	#DIV/0!	#DIV/0!
P5	#DIV/0!	#DIV/0!
P6	#DIV/0!	#DIV/0!
P7	#DIV/0!	#DIV/0!
P8	#DIV/0!	#DIV/0!
P9	#DIV/0!	#DIV/0!

Septic Tanks

	Flow (cfs)	Fecal (#/hr)
Cypress Creek	2.39E-02	2.43E+08
P2	0.00E+00	0.00E+00
P3	0.00E+00	0.00E+00
P4	0.00E+00	0.00E+00
P5	0.00E+00	0.00E+00
P6	0.00E+00	0.00E+00
P7	0.00E+00	0.00E+00
P8	0.00E+00	0.00E+00
P9	0.00E+00	0.00E+00

LANDUSE AREAS (Just to us as a check)

SUBSHED	CROPLAND	FOREST	URBAN	PASTURELAND	TOTAL
Cypress Creek	209	35980	0	2582	**38771**
P2	0	0	0	0	**0**
P3	0	0	0	0	**0**
P4	0	0	0	0	**0**
P5	0	0	0	0	**0**
P6	0	0	0	0	**0**
P7	0	0	0	0	**0**
P8	0	0	0	0	**0**
P9	0	0	0	0	**0**
TOTAL	**209**	**35980**	**0**	**2582**	**38771**

SCENARIOS

Source	% Reduced
Cattle Access	88
Septic Failure	50
Runoff	0

PASTURELAND AND CROPLAND – ACCUM (Data Editor\PERLND\PQAL\Monthly Input\MON-ACCUM)

Monthly Input - ACCUM

	Cypress Creek		**P2**		**P3**		**P4**		**P5**	
	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland
January	1.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	1.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	1.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	2.27E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	2.24E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	2.22E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	2.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	2.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	2.26E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	2.21E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	1.19E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	1.18E+09	3.52E+07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

	P6		P7		P8		P9	
	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland
January	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

PASTURELAND AND CROPLAND – SQOLIM (Data Editor\PERLND\PQAL\Monthly Input\MON-SQOLIM)

Monthly Input - SQOLIM

	Cypress Creek		**P2**		**P3**		**P4**		**P5**	
	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland
January	4.75E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	4.77E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	4.75E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	9.09E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	8.94E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	8.90E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	8.76E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	8.76E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	9.02E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	8.85E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	4.76E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	4.72E+09	1.41E+08	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

	P6		P7		P8		P9	
	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland	Pastureland	Cropland
January	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

URBAN AND FOREST - ACQOP & SQOLIM (Data Editor\PERLND\PQAL\QUAL-INPUT\ACQOP & SQOLIM)

ACQOP for all months

	Urban	Forest
Cypress Creek	0.00E+00	3.52E+07
P2	0.00E+00	0.00E+00
P3	0.00E+00	0.00E+00
P4	0.00E+00	0.00E+00
P5	0.00E+00	0.00E+00
P6	0.00E+00	0.00E+00
P7	0.00E+00	0.00E+00
P8	0.00E+00	0.00E+00
P9	0.00E+00	0.00E+00

SQOLIM for all months

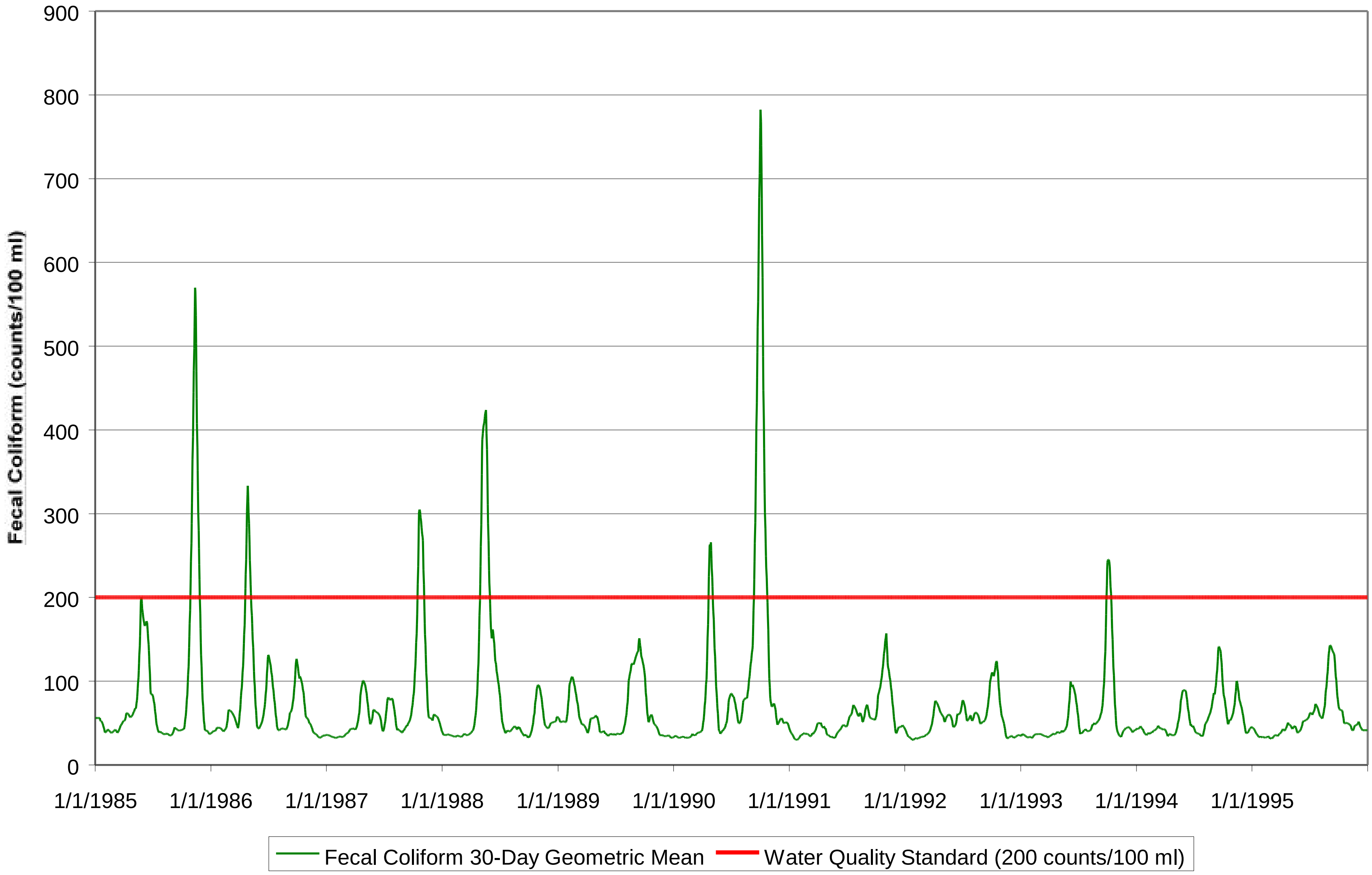
	Urban	Forest
Cypress Creek	0.00E+00	1.41E+08
P2	0.00E+00	0.00E+00
P3	0.00E+00	0.00E+00
P4	0.00E+00	0.00E+00
P5	0.00E+00	0.00E+00
P6	0.00E+00	0.00E+00
P7	0.00E+00	0.00E+00
P8	0.00E+00	0.00E+00
P9	0.00E+00	0.00E+00

APPENDIX B

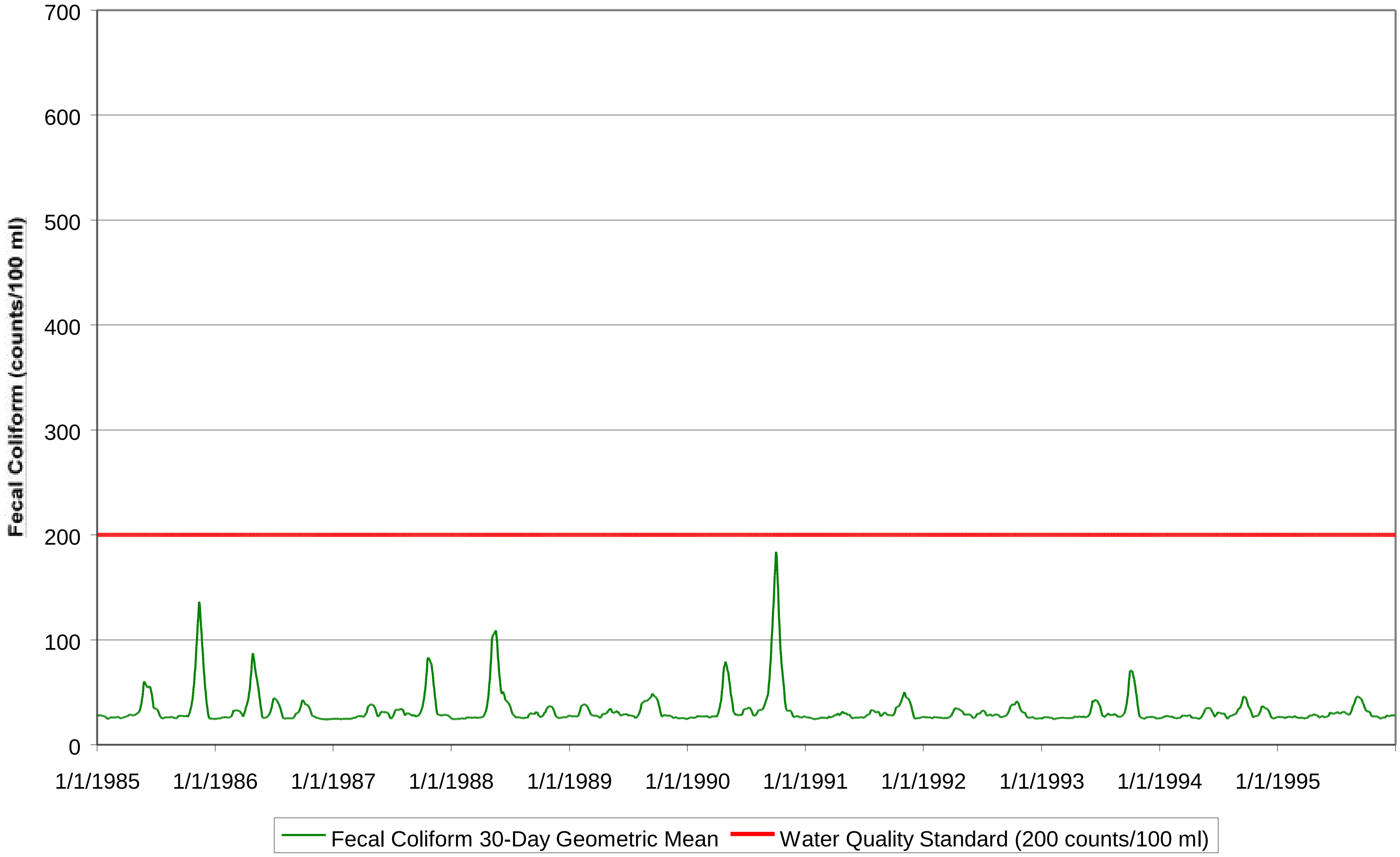
This appendix contains printouts of the various model run results. All graphs represent an 11-year time period, from January 1, 1985, to December 31, 1995. Graph B-1 shows the 30-day geometric mean for fecal coliform concentrations in counts per 100 ml in the impaired section of Cypress Creek. The graphs contain a reference line at 200 counts per 100 ml. Graph B-1 represents the existing conditions in Cypress Creek. Graph B-2 represents the conditions in Cypress Creek after the reduction scenario has been applied. Graphs B-1 and B-2 are shown with the same scale for comparison purposes.

Graph B-3 through B-5shows the modeled flow, in cubic feet per second compared to the actual USGS gage readings from Cypress Creek near Janice. The graphs each represent one year of flow model output and data.

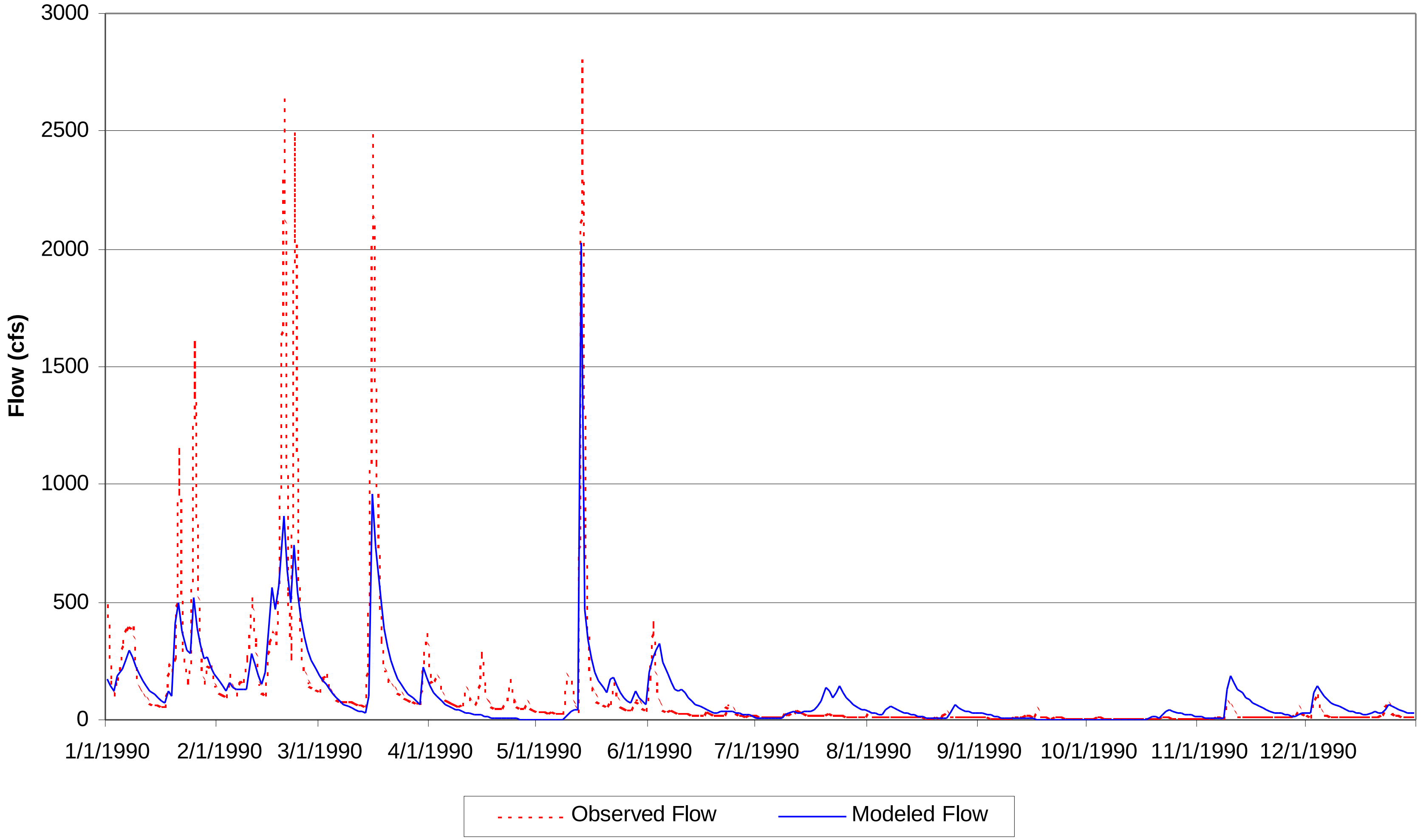
Graph B-1 Modeled Fecal Coliform Concentrations Under Existing Conditions



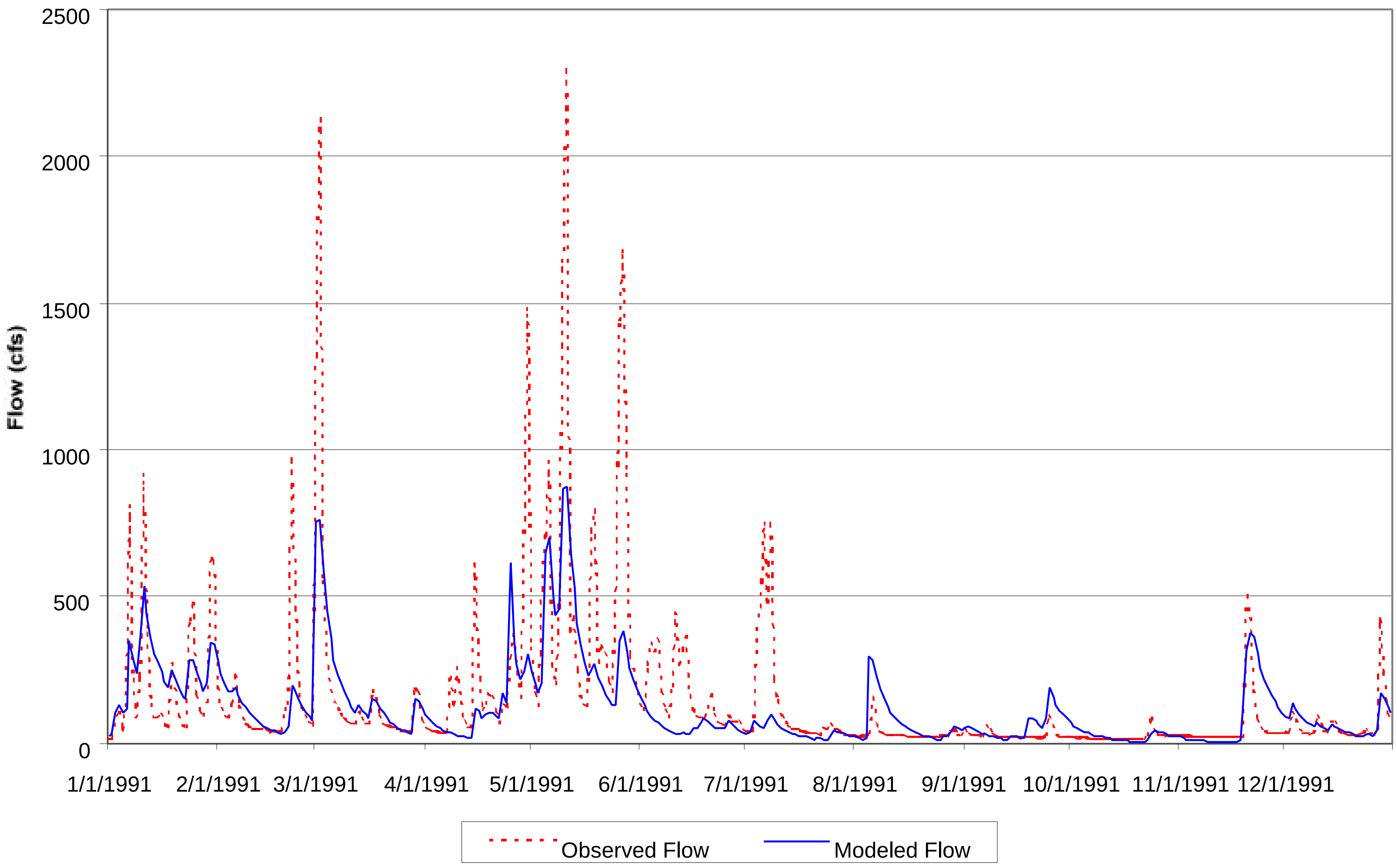
Graph B-2 Modeled Fecal Coliform Concentrations After Application of Reduction Scenario



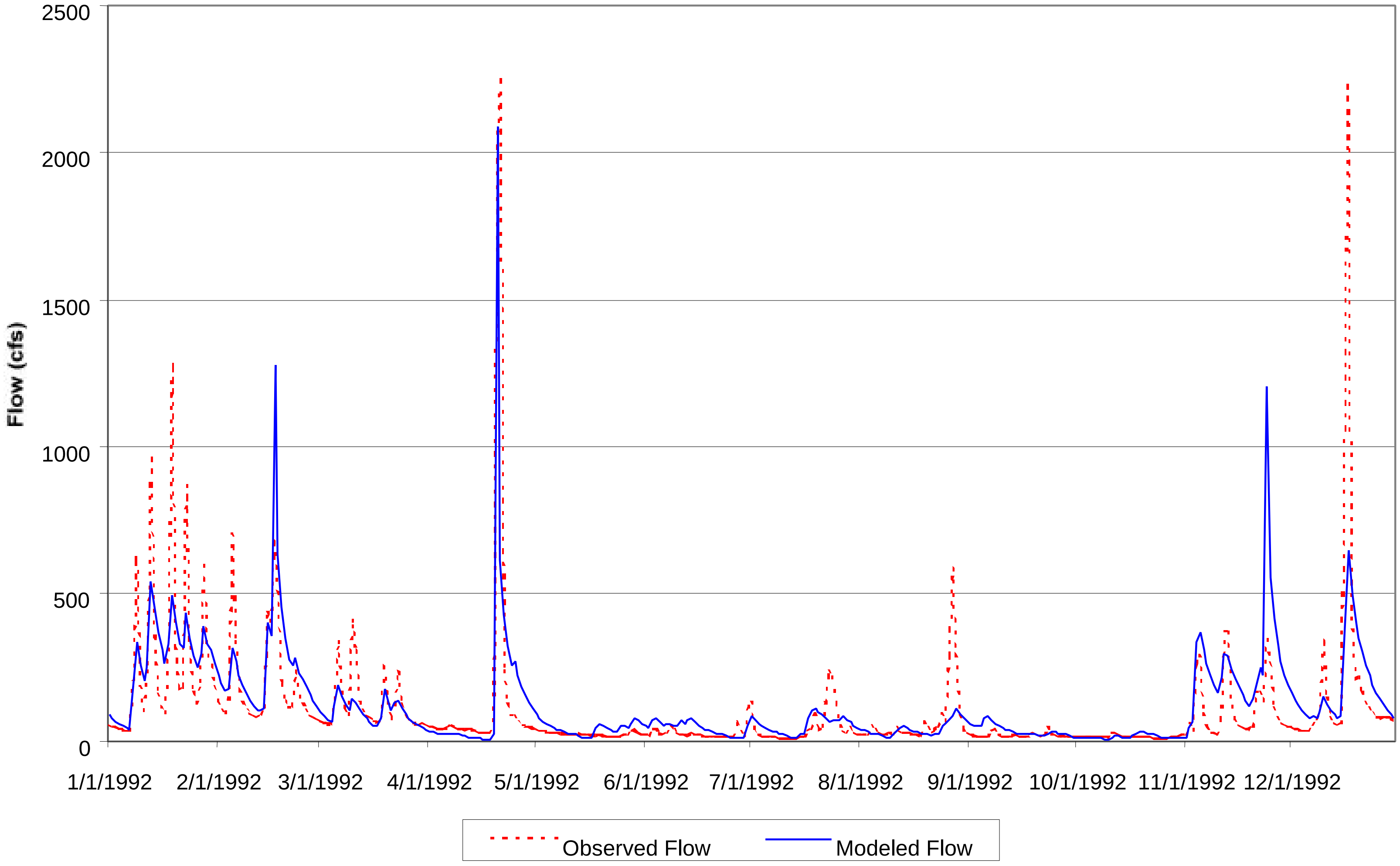
Graph B-3 Daily Flow Comparison between USGS Gage 02479155 and Reach 03170007005 for 01/01/90 - 12/31/90



Graph B-4 Daily Flow Comparison between USGS Gage 02479155 and Reach 03170007005 for 01/01/91 - 12/31/91



Graph B-5 Daily Flow Comparison between USGS Gage 02479155 and Reach 03170007005 for 01/01/92 - 12/31/92



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DEFINITIONS

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

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

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

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

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

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

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

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

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

Effluent: treated wastewater flowing out of the treatment facilities.

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

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

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

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.

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

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate becomes surface runoff and either drains into surface waters or soaks into the soil and finds its way into 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.

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

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

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

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

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

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

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

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

ABBREVIATIONS

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

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

BMP ....Best Management Practice

CWA ....Clean Water Act

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