Total Maximum Daily Load

Evaluation

Of Fecal Coliform

for

Little Brushy Creek

(Suwannee River Basin)

Submitted to:

The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified a segment of Little Brushy Creek in the Suwannee River basin as partially supporting the water quality standard criteria for fecal coliform bacteria. The entire extent of Little Brushy Creek has a designated water use classification of fishing with a fecal coliform bacteria water quality standard as follows:

> For the months of May through October, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample.

Fecal coliform data were collected from Little Brushy Creek at County Road 63 (Harrell Road) (GAEPD site 09010751), located approximately 6.5 miles southeast of the City of Ocilla. Sufficient samples were collected to calculate geometric means for four, distinct 30-day periods. One calculated geometric mean was in exceedance of the fecal coliform standard criteria of 200 per 100 ml (May - October). As a result, the segment of Little Brushy Creek from Stump Creek, located approximately 4.5 miles southeast of Ocilla, Georgia, down to Reedy Creek, located approximately 8.0 miles southeast of Ocilla, was included on the States 303(d) list and scheduled for TMDL evaluation. The approximate length of the segment is 4 miles.

The analysis performed to develop the fecal coliform TMDL for Little Brushy Creek utilized dynamic hydrologic and water quality modeling techniques that considered the characteristics of the watershed, meteorology, hydrology, and land use. Local meteorological data were used, and local watershed and stream characteristics were incorporated in the model simulations. Land use in the watershed was characterized from Landsat Thematic Mapper digital images developed in 1995. Model simulated land use activities contributing fecal coliform bacteria included septic tanks, cattle grazing, poultry operations, manure management, urban development, and wildlife. Model parameterization for urban, agricultural, and forest land uses were provided by the USEPA. National Pollutant Discharge Elimination System (NPDES) permitted discharges were also included in the modeling analysis.

A simulation period of 10 years (1989 – 1998) was used to develop the fecal coliform bacteria TMDL. Load reductions were applied until the simulated 30-day geometric mean of the fecal coliform bacteria counts did not exceed the water quality geometric mean standard. Modeling assumptions were considered conservative to constitute an implied margin of safety.

Approximately 92 percent of the Little Brushy Creek watershed is rural in nature. Consequently, model results indicate that nonpoint sources related to agricultural practices have the greatest impact on the fecal coliform bacteria loadings in the watershed. Significant fecal coliform bacteria loading to Little Brushy Creek may also be occurring as the result of leakage and overflows from old combined sewer lines which service the City of Ocilla. Leaking septic systems are secondary sources of fecal coliform, and are relatively insignificant in comparison to contributions from the agricultural land uses. Reducing the agricultural loading rates in the Little Brushy Creek watershed resulted in a significant decrease of the in-stream fecal coliform bacteria levels. Reduction in loading rates from leaking sewer systems and urban runoff had little impact on fecal coliform concentrations in Little Brushy Creek. However, Ocilla's sewer collection lines include some older, combined sewer lines which receive both domestic sewage and stormwater runoff. There is significant potential for leakage and sewer overflows into the watershed during storm events.

Modeling results indicate that an allocation scenario to meet in-stream water quality standards in both segments of Little Brushy Creek requires a 62% reduction in fecal loads from the Little Brushy Creek watershed. Management practices that could be used to implement this TMDL include adoption of NRCS resource management practices including covering manure and poultry litter stacks exposed to the environment; reducing animal access to streams; and applying manure to croplands at agronomical rates. Rehabilitation or replacement of old combined sewer lines by the City of Ocilla may further reduce fecal coliform loading to Little Brushy Creek. In addition, a slight improvement in water quality may be realized by controlling leaking underground septic systems, sewer line leaks and overflows, and urban runoff. Best management practices (BMPs) should be developed to address agricultural and urban runoff during extreme storm events.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories, supporting, partially supporting, or not supporting their designated uses depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* every two years.

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified a segment of Little Brushy Creek in the Suwannee River basin as exceeding the water quality standard criteria for fecal coliform bacteria. Fecal coliform bacteria data were collected from Little Brushy Creek in 1998 at County Road 63 (GAEPD site 09010751), located approximately 6.5 miles south of Ocilla, Georgia in Irwin County. From these data, four distinct 30-day geometric means were calculated. One geometric mean exceeded the state's water quality standard criteria for fecal coliform bacteria.

Based on these results, the segment of Little Brushy Creek from Stump Creek, located approximately 4.5 miles southeast of Ocilla Georgia, down to Reedy Creek, located approximately 8.0 miles southeast of Ocilla, was on the States 303(d) list and scheduled for TMDL evaluation. The approximate length of the impaired segment is 4 miles.

1.2 Watershed Description

The Little Brushy Creek watershed is located in the Suwannee River basin in southeastern Georgia, in Irwin County (See Figure 1). Little Brushy Creek is a tributary to the Suwannee River. The total watershed area of Little Brushy Creek is approximately 37 square miles, and is also the area upstream from the sampling point at GAEPD Site 10005501.

The land use characteristics of the Little Brushy Creek watershed were determined using data from Georgia's Multiple Resolution Land Coverage (MRLC). This coverage is based on Landsat Thematic Mapper digital images developed in 1995. The classification is based on a modified Anderson level one and two system. Table 1 lists the land use distribution in the watershed. The data show that the watershed is predominately agricultural land (row crops, pasture/hay and row crops) (65 percent), and forested land (28 percent). Only a small portion is urban area (7 percent). Landuse coverage for the watershed is shown in Figure 2.

Table 1. Landuse Distribution by Subwatershed

Landuse	Little Brushy Creek Drainage Basin At Reedy Creek	
	Area (ac)	Percent
Bare Rock/Sand/Clay	20	0.1
Deciduous Forest	1,268	5.4
Emergent Herbaceous Wetlands	134	5.4
Evergreen Forest	2,298	9.8
High Intensity Commercial/Industrial/ Transportation	276	1.2
High Intensity Residential	84	0.4
Low Intensity Residential	367	1.6
Mixed Forest	590	2.5
Open Water	273	1.2
Other Grasses (Urban/recreational; e.g. parks, lawns)	47	0.2
Pasture/Hay	3,603	15.4
Quarries/strip mines/gravel pits	233	1.0
Row Crops	11,289	48.1
Transitional	1,088	4.6
Woody Wetlands	1,833	8.0
Total	23,452	100.0

1.3 Water Quality Standard

The water use classification for Little Brushy Creek is fishing. The fishing classification water quality standard for fecal coliform bacteria as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(c) is:

(c) Fishing: Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality:

(iii) Bacteria: For the months of May through October, when water contact recreation activities are expected to occur, fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. Should water quality and sanitary studies show fecal coliform levels from non-human sources exceed 200/100 ml (geometric mean) occasionally, then the allowable geometric mean fecal coliform shall not exceed 300 per 100 ml in lakes and reservoirs and 500 per 100 ml in free flowing freshwater streams. The months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample. The State does not encourage swimming in surface waters since a number of factors, which are beyond the control of any State regulatory agency, contribute to elevated levels of fecal coliform. For waters designated as approved shellfish harvesting waters by the appropriate State agencies, the requirements will be consistent with those established by the State and Federal agencies responsible for the National Shellfish Sanitation Program. The requirements are found in the National Shellfish Sanitation Program Manual of Operation, Revised 1988, Interstate Shellfish Sanitation Conference, U.S. department of Health and

Human Services (PHS/FDA), and the Center for Food Safety and Applied Nutrition. Streams designated as generally supporting shellfish are listed in Paragraph 391-3-6-.03(14).

2.0 WATER QUALITY ASSESSMENT

Water quality monitoring data were collected at Little Brushy Creek at County Road 63, approximately 6.5 miles southeast of Ocilla,Georgia. Table 2 lists the fecal coliform bacteria data results at this station as well as computed geometric mean values. These data results were compared with the fecal coliform bacteria water quality standard to assess compliance.

Table 2: Water Quality Monitoring Data

Date	Little Brushy Cr at Reedy Cr Fecal Coliform Bacteria (MPN/100 ml)	Geometric Mean
02/25/98	230	
03/04/98	<20	
03/18/98	80	
03/24/98	130	83
04/08/98	330	
04/15/98	330	
04/22/98	220	
05/06/98	170	252.6
08/05/98	130	
08/11/98	50	
08/26/98	80	
09/03/98	2,400	188
10/01/98	130	
10/08/98	330	
10/22/98	330	
10/29/98	790	325

As shown in Table 2, the geometric mean of fecal coliform concentrations calculated for October 1998 exceeded the water quality standard criteria of 200 MPN per 100 ml (May - October). Therefore, the segment of Little Brushy Creek, starting at Stump Creek and running south to it's confluence with Reedy Creek, was included in the 303(d) list and scheduled for TMDL evaluation.

3.0 SOURCE ASSESSMENT

A source assessment is used to characterize the known and suspected sources of fecal coliform bacteria in the watershed for use in the water quality model, and the development of the TMDL. The general sources of fecal coliform bacteria are point and non-point sources. National Pollutant Discharge Elimination System (NPDES) permittees discharging treated domestic waste are the primary point sources of fecal coliform bacteria.

Nonpoint sources of fecal coliform bacteria are diffuse sources that cannot be identified as entering the water body at a single location. These sources generally involve land activities that contribute fecal coliform bacteria to streams during a rainfall runoff event. Nonpoint sources of fecal coliform bacteria considered in the analysis include:

- Wildlife,
- Land application of agricultural manure,
- Grazing animals,
- Leaking septic systems,
- Urban development, and
- Leaking sewer collection lines.

For nonpoint sources involving agricultural activities, the Natural Resources Conservation Service (NRCS) was consulted for information and parameters to be used to characterized agricultural activities represented in the water quality model

3.1 Point Source Assessment

There are no permitted NPDES discharges identified in the Little Brushy Creek watershed upstream from the listed segments. The City has a sewer collection system that delivers domestic wastewater to a land application system (LAS) for treatment. Part of the sewer system consists of old combined sewer lines which are reported to leak, and occasionally overflow during heavy storm events into Little Brushy Creek and it's tributaries (Georgia EPD files). The LAS is located south of the City, near Stump Creek (Figure 1). This is a no-discharge facility, and does not have an NPDES permit.

In accordance with GAEPD standards, all future NPDES dischargers in the watershed shall meet end-of-pipe water quality standards of 200 counts/100ml.

3.2 Nonpoint Source Assessment

3.2.1 Wildlife

Wildlife deposit fecal coliform bacteria with their feces onto the land where it can be transported during a rainfall runoff event to nearby streams. In the water quality model, the wildlife fecal coliform contribution is accounted for in the deer population. The deer population is estimated to be 30 to 45 animals per square mile in this area (Table A-1, Appendix A). The upper limit of 45 deer per square mile has been chosen to account for deer and all other wildlife present in the watershed. It is assumed that the wildlife population remains constant throughout the year, and that wildlife is uniformly distributed on all land classified in the MRLC database as forest, pasture, cropland, and wetlands.

3.2.2 Land Application of Agricultural Manure

Processed agricultural manure from confined hog, dairy cattle, and poultry operations is generally collected in lagoons and applied to land surfaces during the months April through October. Hog manure is applied only to cropland. An estimated 60 percent of poultry litter is applied to pastureland while 40 percent is applied to cropland. Approximately 75 percent of dairy cattle manure is applied to cropland and 25 percent to pastureland. All manure from beef cattle is assumed applied to pastureland. Imported manure is used both on cropland and pastureland at proportions of 75 percent and 25 percent, respectively. Manure application rates are included in Table A-2 (Appendix A).

Data sources for confined feeding operations include the 1997 Census of Agriculture. Table 3 shows animal distributions in the watershed. The livestock data are also based on the 1997 Census of Agriculture and is reported by county. The county data are assigned to the watersheds based on the percentage of agricultural area in each subwatershed classified as pasture/hay. Cattle numbers reported in the census data also represent other breeds of cattle and calves besides dairy and beef.

Table 3. Livestock Distribution

Livestock	Little Brushy Creek at Reedy Creek (individuals)
Beef Cow	550
Milk Cow	5
Cattle	1,012
Hogs	910

Chicken litter is normally piled for a period until it is used for manure application. Hog farms in the watershed operate by confining the animals or allowing them to graze in small pastures or pens. It is assumed that all of the hog manure produced by either farming method is applied evenly to available cropland. Application rates of hog manure to cropland vary monthly according to management practices.

There are few dairy cows in this watershed. In dairy farms, the cows are confined for a limited period each day, during which time they are fed and milked. This is estimated to be four hours per day for each dairy cow. The percentage of manure collected during confinement is applied to the available pasture and cropland in the watershed. Application rates of dairy cow manure to pasture and cropland vary monthly according to management practices.

3.2.3 Grazing Animals

Cattle, including beef and dairy, and hogs, spend time grazing on pasture land and depositing feces onto the land. During a rainfall runoff event, a portion of this manure containing fecal coliform bacteria is transported to streams.

In south Georgia, animal access to pasture land varies monthly, resulting in varying fecal coliform loading rates throughout the year. Beef cattle spend all their time in pasture, while dairy cattle and hogs are confined periodically. The percentage of feces deposited during grazing time is used to estimate the fecal coliform loading rates from pasture land.

In addition, cattle and other unconfined animals often have direct access to streams that pass through pastures. Feces deposited in these streams by grazing animals is included in the water quality model as a point source having constant flow and concentration. To calculate the amount of bacteria introduced into streams by cattle, it is assumed that only beef cow populations have access to the streams, and of those approximately 12 percent will defecate in the stream (personal communication, EPA, Georgia Agribusiness Council, NRCS, University of Georgia, et. al.).

3.2.4 Leaking Septic Systems

Table 4 shows estimates from county census data of people in the watershed on septic systems. In south Georgia, EPA (personal communication) estimates that there are approximately 2.37 people per household on septic systems. For modeling purposes, it is assumed that 20 percent of the septic systems in the watershed leak. Leaking septic systems are included in the water quality model as a point source having constant flow and concentration. Calculations for the model inputs of septic flow and fecal coliform bacteria contributions from the septic flow are presented in Table A-3 (Appendix A).

Table 4. Number of Septic Systems

Watershed	Number of Septic Systems
Little Brushy Creek at Reedy Creek	268

3.2.5 Urban Development

Fecal coliform bacteria from urban areas may originate from various sources including runoff through combined sewers and storm water sewers (e.g., residential, commercial, industrial, and road transportation), illicit discharges of sanitary waste, and runoff from improper disposal of waste materials. The Little Brushy Creek watershed consists of approximately 10 percent urban area. Overflowing sanitary sewers and leaking collection lines may be a significant source of fecal coliform bacteria in the Little Brushy Creek watershed. These potential sources were included in the watershed model. To estimate the load of fecal coliform bacteria from leaking sewer collection lines, it was assumed that 5 percent of the permitted design flow of the municipal water pollution control plant (WPCP) was lost through leaks. The average fecal coliform bacteria concentration in the wastewater is 10,000 counts/100 ml (Horsley & Whitten, 1996).]

4.0 MODELING APPROACH

Establishing the relationship between the in-stream water quality and the source loadings is an important component of TMDL development. It provides for both the identification of sources, and their relative contribution, as well as the examination of potential water quality changes resulting from varying management options to meet the water quality standard. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling techniques. In this section, the numerical modeling techniques developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed.

4.1 Model Selection

A dynamic water quality computer modeling approach was selected for the fecal coliform bacteria TMDL evaluation in order to satisfy a variety of objectives. The first objective was to simulate the time varying behavior of fecal coliform bacteria deposition on the land surface and transport to receiving water bodies. The second objective was to use a continuous simulation period to identify the critical condition and from which to develop the TMDL. Finally, the continuous simulation model provides the means to incorporate seasonal effects on the production and fate of fecal coliform bacteria. A series of computer-based tools were used to accomplish these objectives.

First, the Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display and analyze GIS information including land use, land type, point source discharges, soil types, population, and stream characteristics. The WCS was used to identify and summarize the sources of fecal coliform bacteria in the watershed, as well the other factors that affect its fate and transport.

Information collected using WCS was used in a series of spreadsheet applications designed to compute fecal coliform bacteria loading rates in the watershed from varying land uses including urban, agricultural, and forestry as described in Section 3.0. Computed loading rates were used in a hydrologic and water quality model, NPSM (Non-Point Source Model), to simulate the deposition and transport of fecal coliform bacteria, and the resulting water quality response. The NPSM program uses the Hydrologic Simulation Program Fortran (HSPF) to develop the TMDL. NPSM simulates nonpoint source runoff as well as the transport and flow of pollutants in stream reaches. A necessary feature of NPSM is its ability to integrate both point and nonpoint sources of fecal coliform bacteria and determine the in-stream water quality response.

4.2 Model Set Up

The Little Brushy Creek watershed was delineated in order to characterize the relative fecal coliform bacteria contributions from the various land uses (see Figure 1). Watershed delineation was based on the RF3 stream coverage and elevation data.

The initial model set up used default parameters for the hydrologic and water quality simulation models that were considered appropriate for the south Georgia region. The model simulation used an hourly time interval and results were reported on a daily basis. During the model calibration process described later, some parameters were adjusted to improve model calibration.

A continuous simulation period from January 1, 1988 to December 31, 1998, was used in the analysis. The period from January 1, 1988 to December 31, 1988, was used to allow the model results to stabilize. The period from January 1, 1989 to December 31, 1998, was used to identify the critical condition period from which to develop the TMDL. Since field data were collected during the period January 1, 1998 to December 31, 1998, this period was used for model calibration.

An important factor driving modeling results is the precipitation data obtained from meteorological stations located within the vicinity of the subject watershed. The pattern and intensity of rainfall affects the build-up and wash-off of fecal coliform bacteria from the land into the streams, as well as the dilution potential of the stream. Data from the Pearson, Georgia meteorological station, located approximately 31 miles southeast of the Little Brushy Creek watershed were used in the current simulation.

4.3 Fecal Coliform Bacteria Source Representation

Both point and nonpoint sources of fecal coliform bacteria are represented in the water quality model. Because of varying decay or die-off rates for fecal coliform bacteria, and varying transport assumptions, the fecal coliform bacteria loadings from these sources are computed separately. The following sections describe the assumptions used for the various sources described in Section 3.0. Appendix A contains the worksheets used to compute the loading rates used in the model.

4.3.1 NPDES Discharge

There are no NPDES discharges in the Little Brushy Creek watershed. The headwaters of Little Brushy Creek lie in the vicinity of the north side of the City of Ocilla, and a small tributary to Brushy Creek originates on the east side of the City. In addition, Stump Creek, a major tributary of Little Brushy Creek, runs through the west side of Ocilla. Ocilla's sanitary sewer lines carry the domestic wastewaters generated by the City to its sewage treatment plant located south of the City, near Stump Creek. The treatment plant employs land application for treatment.

To account for potential leakage from sewer lines into the watershed, a continuous, simulated leakage was added to the NPSM model. The leakage rate was equivalent to 5 percent of the permitted LAS treatment rate of 0.85 MGD.

4.3.2 Wildlife

Fecal coliform contributions from wildlife are represented in the model based on deer population. In the model, deer are uniformly distributed to forest, pasture, cropland and wetland areas at a density of 45 deer per square mile (Table A-1, Appendix A).

4.3.3 Land Application of Agricultural Manure

Fecal coliform accumulation and build-up rates resulting from the land application of hog and cattle manure and poultry litter are represented using monthly input values (Table A-2, Appendix A). For modeling purposes it is assumed that a typical poultry farmer produces 5.5 batches of chickens per year. Therefore, the number of chickens on a farm at any one time is about one-fifth the number shown in Table 3.

4.3.4 Grazing Animals

Beef and dairy cows in the watershed contribute feces containing fecal coliform bacteria directly to pastures during grazing. Because there is no monthly variation in animal access to pastures in south Georgia, the fecal loading rates to pasture land does not vary significantly throughout the year. Contributions of fecal coliform from wildlife are included in the pasture loading rate.

4.3.5 Urban Development

Urban land use represented in the MRLC database includes areas classified as: high intensity commercial, industrial, transportation, low intensity residential, high intensity residential, and transitional. A single, area-weighted loading rate from urban areas is used in the model and is based on the percentage of each urban land use type in the watershed and build-up and accumulation rates. These are presented in Table A-1 (Appendix A).

Both Little Brushy Creek and Stump Creek receive urban stormwater runoff from areas of Ocilla. Chronic leakage and occasional sewer overflows may occur from the combined sewers during heavy storm events, which could enter Brushy Creek or Stump Creek upstream from the impaired segment of Brushy Creek.

4.4 Model Calibration

The calibration of the watershed model involves both hydrologic and water quality components. The hydrologic calibration is performed first and involves comparing simulated streamflows to historic streamflow data from a U.S. Geological Survey (USGS) stream gaging station for the same period of time. Calibration of the hydrologic model involves adjusting model parameters (e.g., evapotranspiration, infiltration, upper and lower zone storage, groundwater storage and recession, and interflow discharge) used to represent the hydrologic cycle, until an acceptable agreement is achieved between simulated and observed streamflows. There is no streamflow gage in the Little Brushy Creek watershed. The USGS gage on the Okapilco Creek (USGS 02318700), located approximately 53 river miles south-southwest from the mouth of Little Brushy Creek, was used to calibrate the flow model. Estimated streamflow for Little Brushy Creek was developed by multiplying the gaged Okapilco Creek streamflow data by the Little Brushy Creek:Okapilco Creek watershed drainage area ratio. Results of the hydrology calibration are included in Appendix B.

The only fecal coliform bacteria data available for Little Brushy Creek were those data collected during 1998. These data were used to calibrate the water quality model. Model calibration results are shown in Figures B4 and B5 (Appendix B), along with observed sampling data. Results show that the model tends to generate peaks of fecal coliform loading during heavy rain events. This suggests that runoff from the largely rural watershed is a major contributor to fecal coliform loading in Little Brushy Creek. Considering the proximity of Little Brushy Creek and Stump Creek to the City of Ocilla, significant fecal coliform loading may also be the result of sewer collection line leakage and documented sewer overflows during heavy storm events.

4.5 Critical Conditions

Critical conditions for non-point fecal coliform sources are an extended dry period followed by a rainfall runoff event. The dry weather allows a build-up of fecal coliform bacteria, which is then washed off the ground by rainfall. Critical conditions for point sources occur during low flow and corresponding reduced dilution. Both conditions are simulated in the NPSM model.

The ten-year simulation period from January 1, 1989 to December 31, 1998, was used to identify the critical conditions from which to base the fecal coliform bacteria TMDL. This ten-year period contained a range of hydrological conditions including low and high streamflows. The range of hydrological conditions provided an opportunity to identify the conditions critical to fecal coliform bacteria, as well as the amount of in-stream fecal coliform bacteria in the stream that can be used to develop the TMDL.

4.6 Allocation Model

The calibrated model was used as the basis for developing the allocation scenario for the TMDL. In order to reduce the fecal coliform loading from non-point source, NRCS recommended parameters were used in the allocation model to represent the implementation of best management practices in the watershed. In addition, the loading rates from urban land, septic tanks, leaky collection systems, and animal access to stream were also reduced. The results of the allocation model were compared to the calibrated model to determine the resulting reduction in fecal coliform loading from the watershed.

5.0 MODEL RESULTS

5.1 Existing Conditions

Model results indicate that the primary sources of fecal coliform bacteria contamination in the Little Brushy Creek watershed is from agricultural runoff and direct input of fecal coliform bacteria into the stream from various sources (e.g., illicit dischargers, cattle and other animals having access to streams). During heavy storm events, documented overflows from the old combined sewer lines of the City of Ocilla are considered to be a significant contributor of fecal coliform bacteria loading. Chronic leakage from these lines may also be occurring. To a lesser extent, the application of agricultural manure, grazing animals, and wildlife may also contribute to fecal coliform bacteria contamination in the Little Brushy Creek watershed. Leaky septic systems are of minor significance with respect to fecal coliform bacteria contamination in the Little Brushy Creek watershed.

5.2 Critical Condition

Figure 3 shows the 30-day geometric mean model results over the ten-year model simulation period for the existing conditions. The 30-day critical period in the model is the time period preceding the largest simulated violation of the geometric mean standard (EPA, 1991). Achieving water quality standards during this time period ensures that water quality standards can be achieved for the ten-year period. Large spikes generated by the calibrated model occurred during an initial model stabilization period, and as a result of prolonged dry periods which caused the model to overestimate buildup of fecal coliform populations. These spikes were excluded from consideration as part of the selection of the 30-day critical period. For the listed segment in the Little Brushy Creek watershed, the highest violation of the 30-day geometric mean occurred on September 27 1995. The critical period is August 27, 1995 through September 27, 1995.

6.0 ALLOCATION

6.1 Overview

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while maintaining water quality standards. Therefore, the TMDL represents the maximum fecal coliform bacteria load that can be assimilated by the stream during the critical 30-day period while maintaining the fecal coliform bacteria water quality standard of 200 counts/100 ml. For some pollutants, TMDLs are expressed on a mass-loading basis (e.g., pounds per day). For fecal coliform bacteria the TMDLs are expressed as counts per 30 days.

A TMDL is the sum of the individual waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint sources and natural background (40 CFR 130.2). The sum of these components may not result in an exceedance of water quality standards for that water body. To protect against exceedances, the TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. Conceptually, a TMDL can be expressed as follows:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

TMDLs establish allowable pollutant loadings that are less than or equal to the TMDL, and thereby provide the basis to establish water quality based controls.

6.2 Waste Load Allocations (WLA)

There are no NPDES permitted discharges in the Little Brushy Creek watershed. The WLA for Little Brushy Creek is zero. All future NPDES facilities permits will require end-of-pipe criteria equivalent to the water quality standard of 200 counts/100 ml.

6.3 Load Allocations (LA)

The nonpoint fecal coliform bacteria sources in the model have two transportation modes. First, animals in the stream, leaking septic systems and leaky sewer collection lines are modeled as direct sources to the stream. The other nonpoint sources result from fecal coliform bacteria that are applied to land. Fecal coliform applied to land is subject to a die-off rate and an absorption rate before it is transported to the stream.

Model results indicate that nonpoint sources related to agricultural practices have a significant impact on fecal coliform bacteria loadings in the Little Brushy Creek watershed. Leaking sanitary sewer lines, and sewer overflows during storm events are also believed to have a pronounced impact on fecal coliform loading. Leaking septic systems provide a relatively small contribution to the fecal coliform loading.

6.4 Margin of Safety (MOS)

The MOS is a required component of TMDL development. There are two basic methods for incorporating the MOS: 1) Implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) Explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For this TMDL the MOS was implicitly incorporated into the modeling process by selecting a critical time period and critical default values for each of the summer and winter seasons based on the results of a 10-year simulation.

6.5 Seasonal Variation

Seasonal variability was incorporated in the continuous simulation water quality model by using varying monthly loading rates and daily meteorological data. The combination of a continuous simulation with varying loading rates and meteorological conditions creates a condition of seasonal variation.

6.6 Total Maximum Daily Load (TMDL)

A possible allocated loading scenario for Little Brushy Creek that would meet in-stream fecal coliform bacteria water quality standards is a 62 percent reduction in nonpoint sources. No contributing point sources exist in the watershed. Table 5 compares the existing allocated load to the allocated load that would result from the proposed nonpoint source reduction.

Table 5. Load Allocations in the Little Brushy Creek Watershed

Watershed ID	Existing Load (Counts / 30 days)	Allocated Load (Counts / 30 days)	Percent Reduction
Little Brushy Creek @ Reedy Cr	5.34×10^{12}	2.01×10^{12}	62

The total maximum daily load of fecal coliform bacteria was determined by adding the WLA and the LA. The MOS (as described in Section 6.5) was implicitly included in the TMDL analysis and does not factor directly in the TMDL equation as shown above. Table 6 shows the computation of the total maximum daily load using the WLAs and the LAs for the critical condition. The TMDLs are summarized in Appendix C. The TMDL for fecal coliform bacteria in the impaired segment of Little Brushy Creek is 2.01×10^{12} counts per 30 days.

Table 6. TMDL Components (counts/30 days)

Watershed ID	WLA	LA	MOS	TMDL
Little Brushy Cr @ Reedy Cr	0	2.01×10^{12}	Implicit	2.01×10^{12}

Management practices that could be used to implement this TMDL include adoption of NRCS resource management practices including covering manure and poultry litter stacks exposed to the environment and providing a generous buffer distance between these stacks and nearby drainage channels and streams; reducing animal access to streams; and applying manure to croplands at agronomical rates. Rehabilitation of sanitary sewer lines by the City of Ocilla would likely result in a significant reduction in fecal coliform bacteria loading. Replacement of leaking septic systems located within the watershed would provide limited improvement. Best management practices (BMPs) should be developed to address both agricultural runoff and urban runoff during extreme storm events. Additional monitoring and characterization of the watershed could be conducted to verify the various unknown sources of fecal coliform bacteria in the watershed.

7.0 Recommendations

7.1 Monitoring

GAEPD has adopted the Basin Approach to Water Quality Management, a plan that divides Georgia's major river basins in to five groups. During each year-long cycle, GAEPD's water quality monitoring resources are concentrated in one of the basin groups. In watersheds identified as having both urban and agricultural activities, microbial source tracking may be used in the future to clarify the specific sources of fecal coliform bacteria. During the next phase of monitoring in the South Georgia river basins, water quality monitoring in the watershed will identify current water quality conditions resulting from the implementation of management practices. Additional characterization is needed in the watershed to clarify the unknown sources of fecal coliform bacteria.

7.2 Point and Nonpoint Source Approaches

Permitted discharges will be regulated through the NPDES permitting process described in this report. Georgia is working with local governments, agricultural, and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission to foster the implementation of best management practices to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of best management practices to protect water quality.

7.3 Public Participation

A thirty-day public notice will be provided for this TMDL. During this time the availability of the TMDL will be public noticed, a copy of the TMDL will be provided as requested, and the public will be invited to provide comments on the TMDL.

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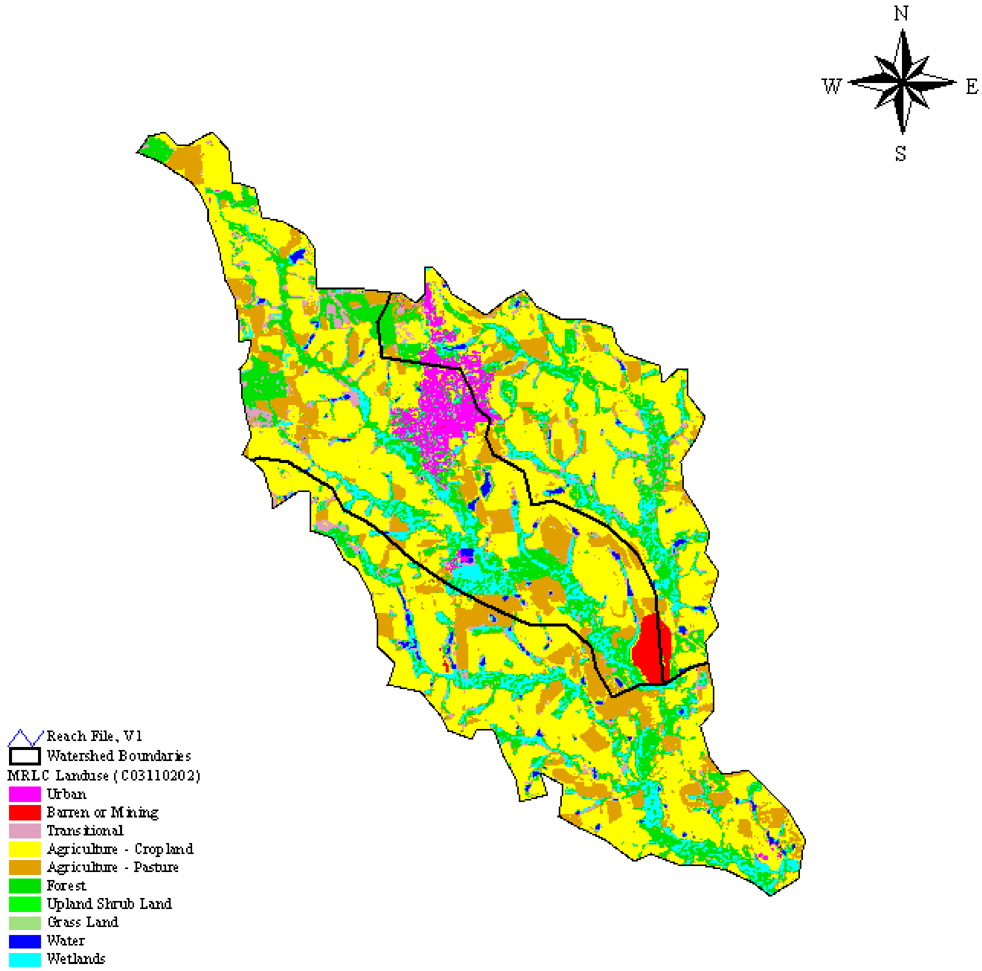
Total Maximum Daily Load (Fecal Coliform)
Little Brushy Creek Watershed
June 2000

Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

Figure 1
Little Brushy Creek Watershed



Total Maximum Daily Load (Fecal Coliform)
Little Brushy Creek Watershed
June 2000

Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

Figure 2
Little Brushy Creek Watershed
Land Use Distribution

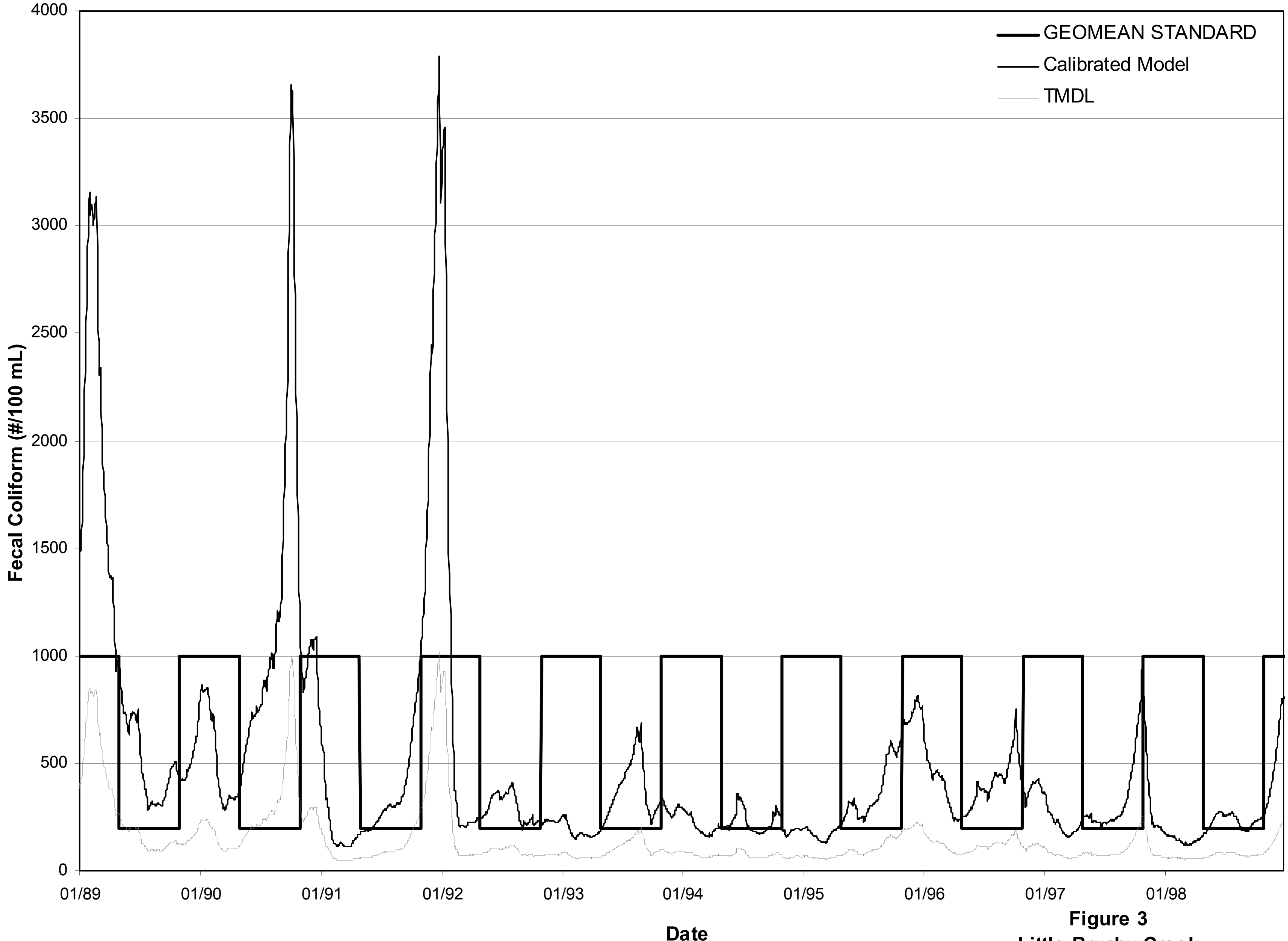


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Figure 3
Little Brushy Creek
30-Day Geometric Mean
Fecal Coliform Model Results

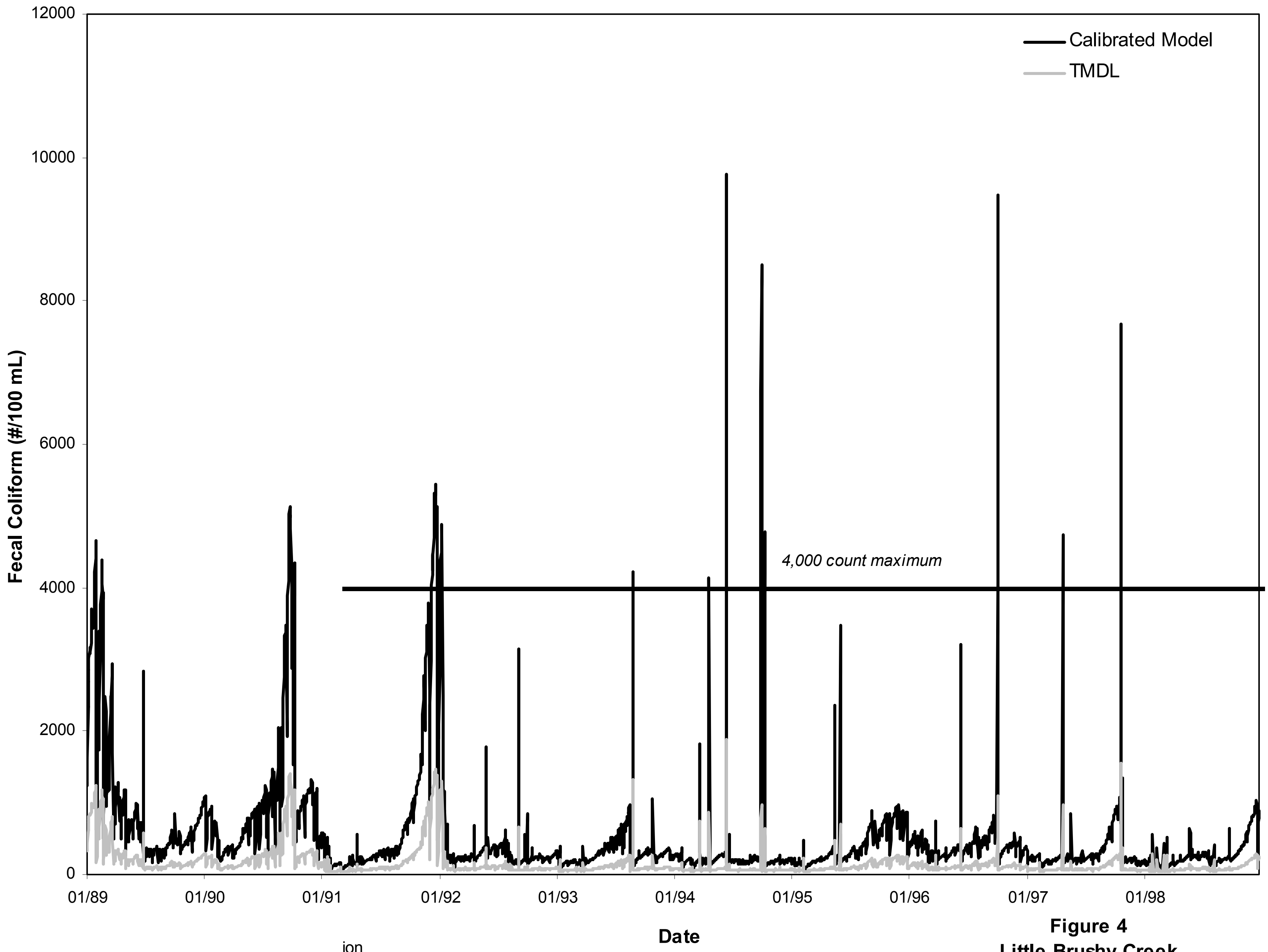

Figure 4
Little Brushy Creek
Daily Fecal Coliform Model Results

APPENDIX A

Water Quality Model Loading Parameters
For TMDL Scenario

APPENDIX A

Water Quality Model Assumptions

Total Maximum Daily Load Evaluation (Fecal Coliform)
Little Brushy Creek Watershed

Land Use Fecal Coliform Accumulation Rates and Storage Limits
ACQOP and SQOLIM by Landuse

This sheet contains values for ACQOP (or MON-ACCUM if monthly) and SQOLIM (or MON-SQOLIM if monthly). These parameters represent the rate of fecal coliform accumulation and the maximum storage of fecal coliform bacteria.

The value for SQOLIM is derived from Horsley & Whitten 1986, w here the follow ing equation w as used to represent surface die-off of fecal coliform bacteria:

$N_t = N_0(10^{-kt})$ w here: N_t = number of fecal coliforms at time t
N_0 = number of fecal coliforms at time 0
t = time in days
k = first order die-off rate constant. Typical values for w arm months = 0.51/day and for cold months = 0.36/day

Using the above equation and assuming the die-off rates presented, the maximum buildup during w arm months is approximately 1.5 x daily buildup rate and for colder months is 1.8 x daily buildup rate.
Assume that w armer months are April through September w hile colder months are October through March.

Assume a buildup limit of 1.8 x daily buildup rate for non-monthly varying SQOLIM.
SQOLIM ADJUSTED TO BE 4 * ACQOP IN WINTER AND 3.5* ACQOP IN SUMMER

CROPLAND

January

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	3.52E+07	1.41E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

February

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	5.90E+06	2.36E+07
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

March

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	5.90E+06	2.36E+07
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

April

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.99E+08	6.97E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

PASTURELAND

January

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.04E+09	8.16E+09
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

February

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.04E+09	8.16E+09
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

March

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.55E+08	1.02E+09
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

April

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	6.16E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

FOREST

All Months

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	3.52E+07	1.41E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

BUILT-UP

All Months

	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.79E+07	7.16E+07
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

May	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.99E+08	6.97E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

June	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.99E+08	6.97E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

July	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.99E+08	6.97E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

August	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	9.65E+07	3.38E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

September	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.27E+08	7.95E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

October	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.27E+08	9.08E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

November	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	7.05E+07	2.82E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

December	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	4.60E+07	1.84E+08
fips code	0.00E+00	0.00E+00
County3	0.00E+00	0.00E+00
County4	0.00E+00	0.00E+00
County5	0.00E+00	0.00E+00
County6	0.00E+00	0.00E+00
County7	0.00E+00	0.00E+00
County8	0.00E+00	0.00E+00
County9	0.00E+00	0.00E+00
County10	0.00E+00	0.00E+00

May	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	6.16E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

June	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	6.16E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

July	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	6.16E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

August	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	5.10E+08	1.79E+09
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

September	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	7.04E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

October	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.76E+10	7.04E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

November	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	1.63E+10	6.52E+10
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

December	ACQOP (#/acre/day)	SQOLIM (#/acre)
13155	2.04E+09	8.16E+09
fips code	#DIV/0!	#DIV/0!
County3	#DIV/0!	#DIV/0!
County4	#DIV/0!	#DIV/0!
County5	#DIV/0!	#DIV/0!
County6	#DIV/0!	#DIV/0!
County7	#DIV/0!	#DIV/0!
County8	#DIV/0!	#DIV/0!
County9	#DIV/0!	#DIV/0!
County10	#DIV/0!	#DIV/0!

Total Maxiumum Daily Loads Evaluation (Fecal Coliform)

Little Brushy Creek Watershed

Manure Application Loading

This sheet contains information relevant to land application of waste produced by agricultural animals in the study area.

Application of hog manure, beef cattle manure, dairy cattle manure, horse manure, poultry litter, and manure from import are considered.
Manure generated by in-county animals is assumed to be applied fresh (thus fecal content from fresh manure is used in calculations).
Manure values can be varied using a multiplication factor, in order to consider die-off due to known treatment/storage methods.
Manure imported into the county is assigned a fecal coliform content based on known storage/treatment methods.
The information is presented based on monthly variability of waste application.
It is assumed that cattle manure, poultry litter, and imported manure are applied to both Cropland and Pastureland. Hog manure is assumed to be applied only to cropland. Horse manure is assumed to be applied only to pasturel

note: the fecal die-off rates (fecal content multiplier) are assumed values, adjust accordingly

Hog Manure Available for Wash-off

Storage/treatment of manure prior to application may affect the fecal coliform content in the manure.
The multiplier below can be used to increase or decrease the fecal content in manure that is applied (to consider storage/treatment)

Manure fecal content multiplier 0.75

This is the fraction of the annual manure application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0	0	0.075	0.1575	0.1335	0.1335	0.1335	0.1335	0.1585	0.075	0	0

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

Fraction incorporated into soil (assumed)	0.80	FRACTION AVAIL FOR RUNOFF =	0.6 = (1 - [fraction incorporated]) + ([fraction incorporated] * 0.5)
Fraction available for runoff	0.6000	NRCS RATE: 0.3354	(INCLUDES DIE OFF)

The following is the resulting fraction of annual manure application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
fips code	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County3	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County4	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County5	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County6	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County7	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County8	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County9	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0
County10	0	0	0.045	0.0945	0.0801	0.0801	0.0801	0.0801	0.0951	0.045	0	0

Beef Cattle Manure Available for Wash-off

Storage/treatment of manure prior to application may affect the fecal coliform content in the manure.
The multiplier below can be used to increase or decrease the fecal content in manure that is applied (to consider storage/treatment)
Manure fecal content multiplier 1 (a value of 1 assumes fresh application)

This is the fraction of the annual manure application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0.0833	0.0833	0.0833	0.0833	0.0833	0.0834	0.0834	0.0834	0.0834	0.0833	0.0833	0.0833

The fraction of manure available for runoff is dependent on the method of manure application. The fraction available is computed below based on incorporation into soil. These are assumed values.
Fraction incorporated into soil (assumed) 0.80 FRACTION AVAIL FOR RUNOFF = 0.6 = (1 - [fraction incorporated]) + ([fraction incorporated] * 0.5)
Fraction available for runoff 0.6000 NRCS RATE= 0.0098 (INCLUDES DIE OFF)

% Applied to Cropland: 0.00 % Applied to Pastureland: 1.00 **1**

The follow ing is the resulting fraction of annual manure application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
fips code	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County3	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County4	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County5	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County6	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County7	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County8	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County9	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998
County10	0.04998	0.04998	0.04998	0.04998	0.04998	0.05004	0.05004	0.05004	0.05004	0.04998	0.04998	0.04998

Horse Manure Available for Wash-off

Storage/treatment of manure prior to application may affect the fecal coliform content in the manure.
The multiplier below can be used to increase or decrease the fecal content in manure that is applied (to consider storage/treatment)

Manure fecal content multiplier 1 (a value of 1 assumes fresh application)

This is the fraction of the annual manure application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0.0833	0.0833	0.0833	0.0833	0.0833	0.0834	0.0834	0.0834	0.0834	0.0833	0.0833	0.0833

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

Fraction incorporated into soil (assumed) 0.75 FRACTION AVAILABLE FOR RUNOFF = 0.625 = (1 - [fraction incorporated]) + ([fraction incorporated] * 0.5)

Fraction available for runoff 0.0122 NRCS VALUE = 0.0122 (INCLUDES DIE OFF)

The follow ing is the resulting fraction of annual manure application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
fips code	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County3	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County4	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County5	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County6	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County7	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County8	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County9	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163
County10	0.0010163	0.00101626	0.0010163	0.0010163	0.0010163	0.00101748	0.0010175	0.0010175	0.00101748	0.0010163	0.0010163	0.0010163

Poultry Litter Available for Wash-off

Storage/treatment of manure prior to application may affect the fecal coliform content in the manure.
The multiplier below can be used to increase or decrease the fecal content in manure that is applied (to consider storage/treatment)
Manure fecal content multiplier 0.5 (a value of 1 assumes fresh application)

This is the fraction of the annual litter application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of litter applied each month	0	0	0.075	0.1575	0.1335	0.1335	0.1335	0.1335	0.1585	0.075	0	0

The fraction of litter available for runoff is dependent on the method of litter application. The fraction available is computed below based on incorporation into soil. These are assumed values.
Fraction incorporated into soil (assumed) 0.96 FRACTION AVAILABLE FOR RUNOFF: 0.36 = (1 - [fraction incorporated]) + ([fraction incorporated] * 0.33)
Fraction available for runoff 0.36000 NRCS VALUES : 0.2029 FOR LAYERS; 0.00496 FOR BROILERS FOR TMDL USE 0.00496

% Applied to Cropland: 0.40 % Applied to Pastureland: 0.60 1

The following is the resulting fraction of annual litter application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
fips code	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County3	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County4	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County5	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County6	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County7	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County8	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County9	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0
County10	0	0	0.027	0.0567	0.04806	0.04806	0.04806	0.04806	0.05706	0.027	0	0

Dairy Cattle Manure Available for Wash-off

Storage/treatment of manure prior to application may affect the fecal coliform content in the manure.
The multiplier below can be used to increase or decrease the fecal content in manure that is applied (to consider storage/treatment)
Manure fecal content multiplier 1 (a value of 1 assumes fresh application)

This is the fraction of the annual manure application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0	0.0835	0.075	0.1585	0.05	0.1335	0.05	0.1335	0.075	0.1585	0	0.0825

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

Fraction incorporated into soil (assumed) 0.80 FRACTION AVAILABLE FOR RUNOFF: 0.6 = (1 - [fraction incorporated]) + ([fraction incorporated]
Fraction available for runoff 0.6000 NRCS VALUES: 0.0965 GRAZING; 0.2048 CONFINED (FOR TMDL, ASSUME CONFINED CONDITIONS)

% Applied to Cropland: 0.75 % Applied to Pastureland: 0.25 1

The follow ing is the resulting fraction of annual manure application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
fips code	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County3	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County4	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County5	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County6	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County7	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County8	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County9	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495
County10	0	0.0501	0.045	0.0951	0.03	0.0801	0.03	0.0801	0.045	0.0951	0	0.0495

Imported Manure Available for Wash-off (Optional)

Significant amounts of manure imported into the county for application to cropland or pastureland should be considered.
The amount of manure imported annually and the fecal coliform content in the manure must be designated.
See the References sheet for fecal coliform content in fresh manure from a variety of animals.

Estimated amount of imported manure annually (tons)	0
Amount of imported manure annually (lbs)	0.00E+00
Estimated fecal coliform content in imported manure (#/lb)	1.91E+09

This is the fraction of the annual manure application that is applied each month.

	January	February	March	April	May	June	July	August	September	October	November	December
Fraction of manure applied each month	0	0.0835	0.075	0.1585	0.05	0.1335	0.05	0.1335	0.075	0.1585	0	0.0825

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

Fraction incorporated into soil (assumed)	0.75	
Fraction available for runoff	0.63	= (1 - [fraction incorporated]) + ([fraction incorporated] * 0.5)

% Applied to Cropland: 0.75 % Applied to Pastureland: 0.25 **1**

The follow ing is the resulting fraction of annual manure application available for runoff each month based on the monthly fraction applied and incorporation into the soil.

COUNTY ID	January	February	March	April	May	June	July	August	September	October	November	December
13155	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
fips code	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County3	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County4	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County5	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County6	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County7	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County8	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County9	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625
County10	0	0.0521875	0.046875	0.0990625	0.03125	0.0834375	0.03125	0.0834375	0.046875	0.0990625	0	0.0515625

Total Maximum Daily Load Evaluation (Fecal Coliform)
Little Brushy Creek Watershed

Cattle Stream Access Loading

This sheet contains information related to the direct contribution of cattle fecal coliform bacteria to streams.

The direct contribution of fecal coliform from cattle to a stream can be represented as a direct source in the model. Required input for direct sources in NPS

It is assumed that only beef cattle are grazing and therefore have access to streams. They have access to streams based on information in the Cattle Farm

Assume the following:

Beef Cattle Wa 46 (lbs/animal/day)
The density of cattle manure (including urine) is approximately the density of water: 62.4

CATTLE AS A DIRECT SOURCE

January	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

February	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

March	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

April	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

May	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	4.54E+08	8.82E-07
002	100	0	0	0	2.21E+08	4.30E-07
003	245	1	0	0	5.43E+08	1.05E-06
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

June	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	4.54E+08	8.82E-07
002	100	0	0	0	2.21E+08	4.30E-07
003	245	1	0	0	5.43E+08	1.05E-06
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

July	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	4.54E+08	8.82E-07
002	100	0	0	0	2.21E+08	4.30E-07
003	245	1	0	0	5.43E+08	1.05E-06
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

August	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	4.54E+08	8.82E-07
002	100	0	0	0	2.21E+08	4.30E-07
003	245	1	0	0	5.43E+08	1.05E-06
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

September	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	4.54E+08	8.82E-07
002	100	0	0	0	2.21E+08	4.30E-07
003	245	1	0	0	5.43E+08	1.05E-06
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

October	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

November	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

December	# grazing beef cattle	# grazing dairy cattle	# beef cattle in streams	# dairy cattle in streams	FC Loading Rate (#/hr)	Waste Flow (cfs)
001	205	1	0	0	2.27E+08	4.41E-07
002	100	0	0	0	1.11E+08	2.15E-07
003	245	1	0	0	2.71E+08	5.27E-07
P4	0	0	0	0	0.00E+00	0.00E+00
P5	0	0	0	0	0.00E+00	0.00E+00
P6	0	0	0	0	0.00E+00	0.00E+00
P7	0	0	0	0	0.00E+00	0.00E+00
P8	0	0	0	0	0.00E+00	0.00E+00
P9	0	0	0	0	0.00E+00	0.00E+00
P10	0	0	0	0	0.00E+00	0.00E+00

Total Maximum Daily Load Evaluation (Fecal Coliform)
Little Brushy Creek Watershed

Septic System Loading

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 poir

The following assumptions are made for septic contributions.

Assume a failure rate for septics in the watershed: 40 %

Assume the average FC concentration reaching the stream (from septic overcharge) is: 1.00E+04 #/100 ml **(Horsely & WI**

Assume a typical septic overcharge flow rate of: 70 gal/day/person **(Horsely & WI**

SEPTICS AS A POINT SOURCE

Subwatershed	Tot. # people on septics	Density people/septic	# failing septics	Tot. # people served	Septic flow (gal/day)	Septic flow (mL/hr)	FC rate (#/hr)	Septic flow (cfs)
001	182	2.37	30.8	72.9	5105	805,077	8.05E+07	7.91E-03
002	166	2.37	28.0	66.4	4648	733,028	7.33E+07	7.20E-03
003	286	2.37	48.3	114.4	8008	1,262,928	1.26E+08	1.24E-02
P4	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P5	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P6	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P7	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P8	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P9	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00
P10	0	2.37	0.0	0.0	0	0	0.00E+00	0.00E+00

APPENDIX B

Hydrologic and Water Quality Model Calibration

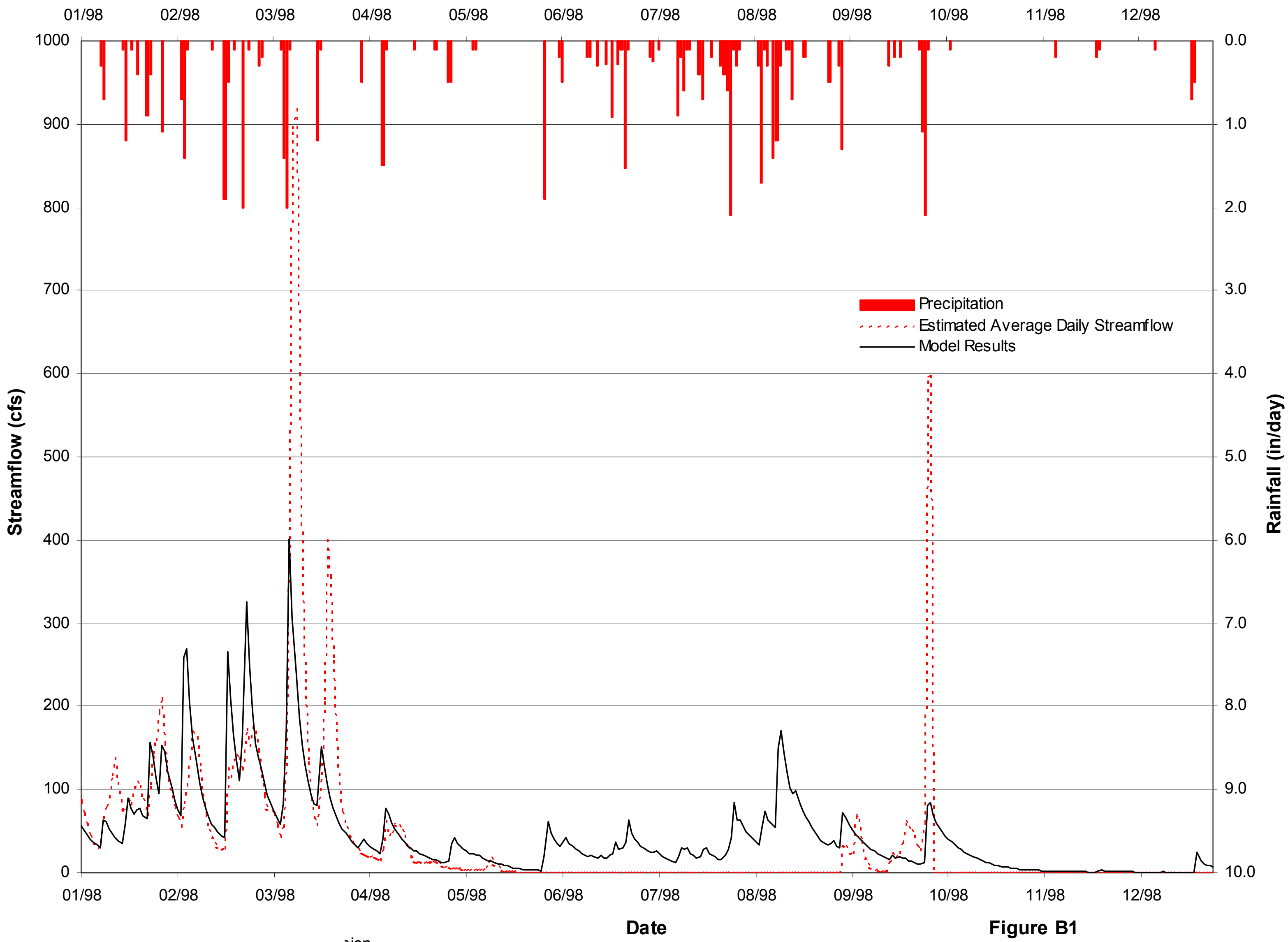

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Figure B1
Little Brushy Creek Hydrologic Model Calibration
1998 Calibration

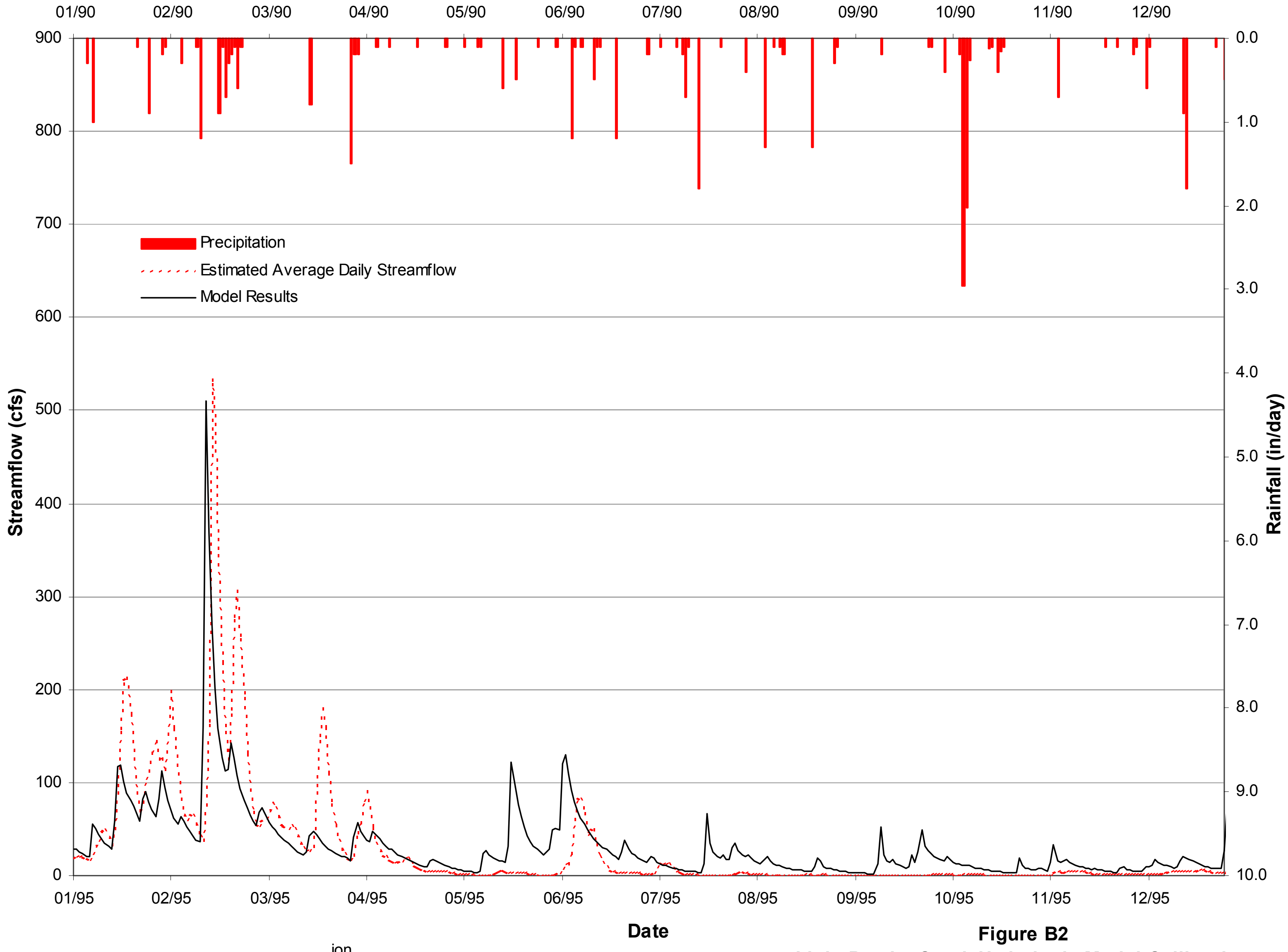

Figure B2
Little Brushy Creek Hydrologic Model Calibration
1995 Critical Conditions

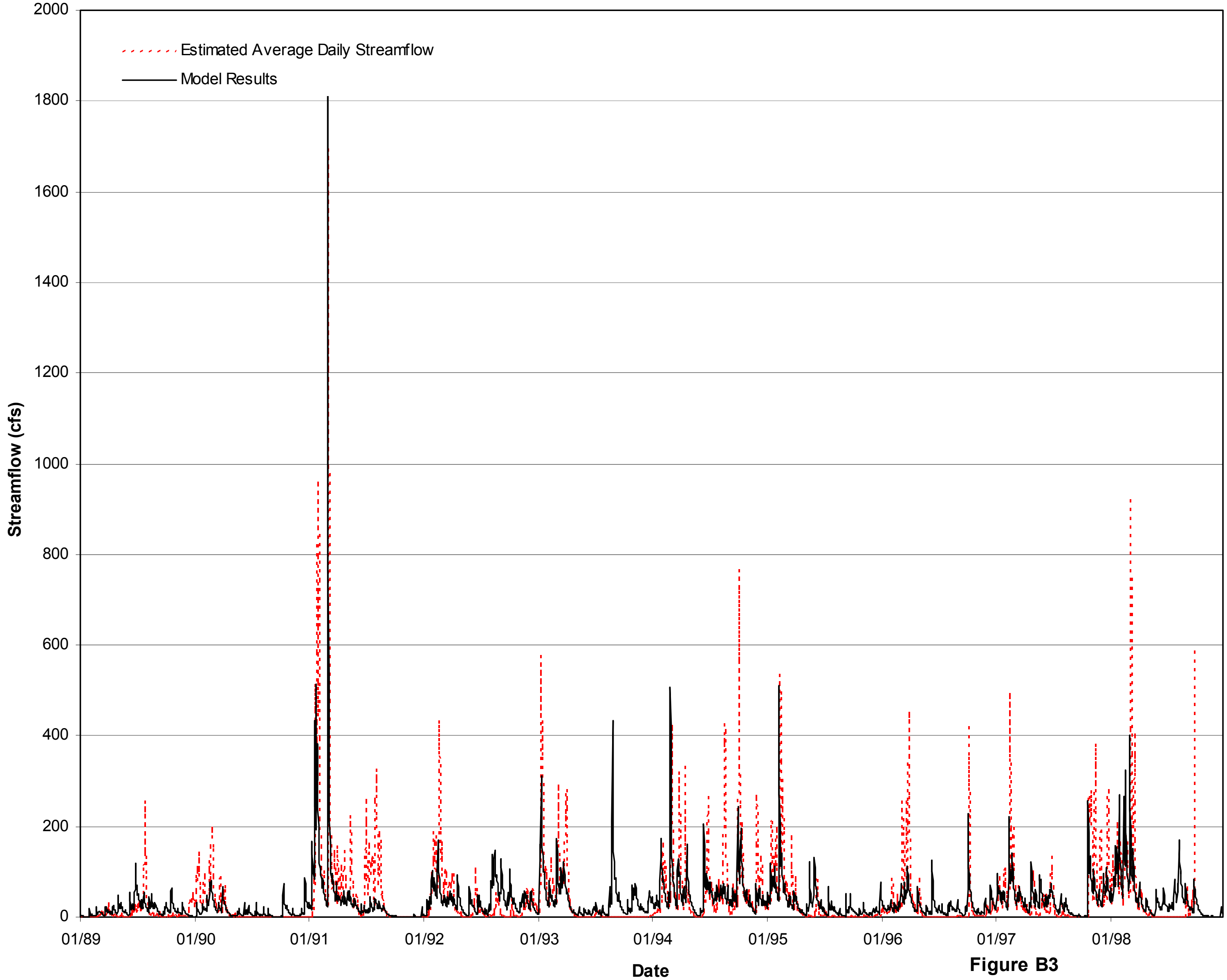

Figure B3
Little Brushy Creek
Simulation Period Streamflow Hydrograph

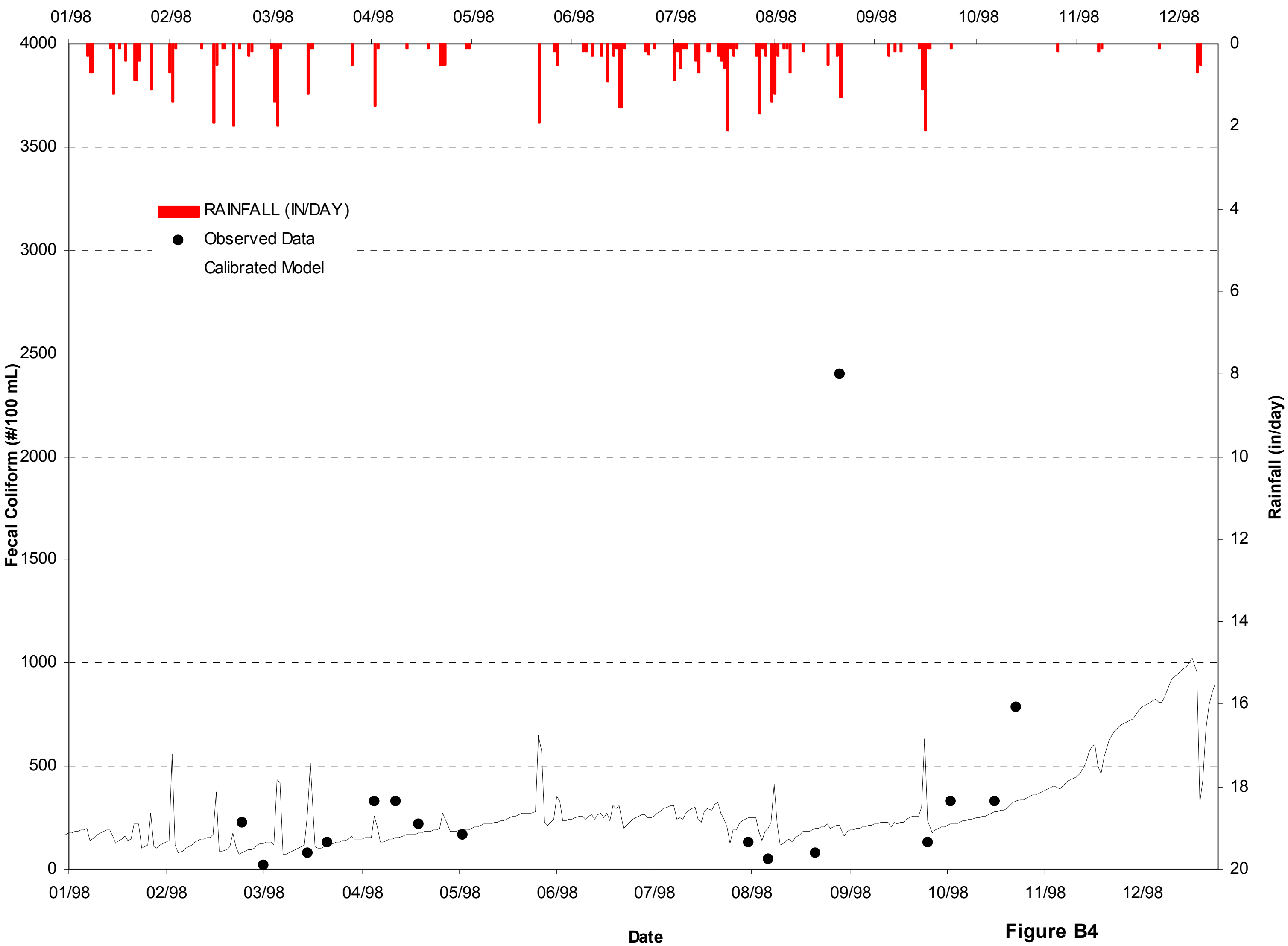

Figure B4
Little Brushy Creek
Fecal Coliform Water Quality Calibration

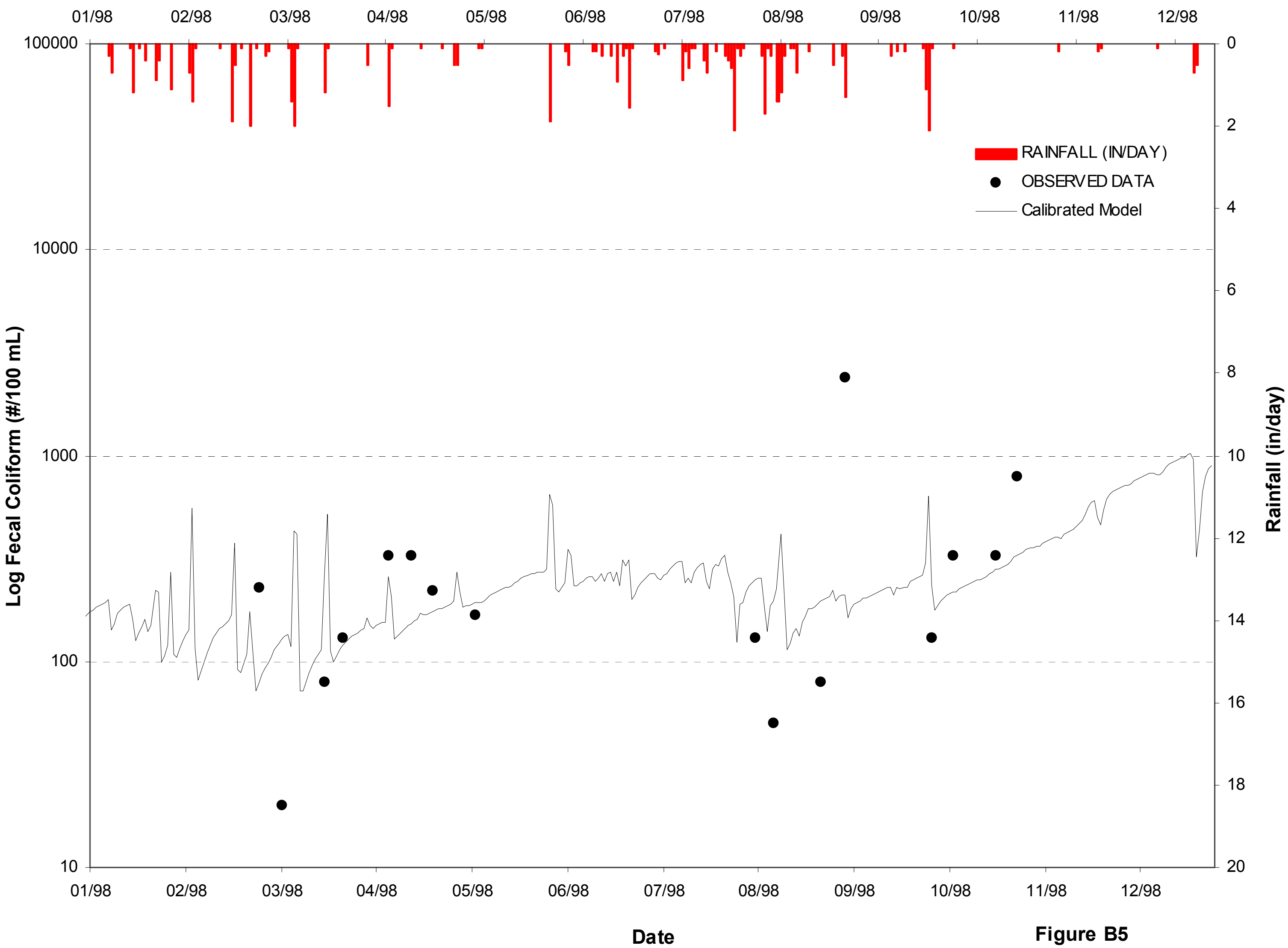

Figure B5
Little Brushy Creek
Fecal Coliform Water Quality Calibration

APPENDIX C

Total Maximum Daily Load
Summary Memorandum

SUMMARY MEMORANDUM
Total Maximum Daily Load (TMDL)
Little Brushy Creek

1. 303(d) Listed Waterbody Information

State:	Georgia
County:	Irwin
Major River Basin:	Suwannee
8-Digit Hydrologic Unit Code(s):	03110202
Waterbody Name:	Little Brushy Creek
Location:	South of Ocilla, Georgia, from Stump Creek downstream to Reedy Creek
Stream Length:	4 miles
Watershed Area:	37 square miles
Tributary to:	Suwannee River
Constituent(s) of Concern:	Fecal Coliform Bacteria
Designated Use:	Fishing (partially supporting designated use)

Applicable Water Quality Standard:
May through October fecal coliform not to exceed a geometric mean of 200 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. For the months of November through April, fecal coliform not to exceed a geometric mean of 1,000 per 100 ml based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours and not to exceed a maximum of 4,000 per 100 ml for any sample.

2. TMDL Development

Analysis/Modeling:
The Non-Point Source Model (NPSM)/Hydrologic Simulation Program Fortran (HSPF) was used to develop this TMDL. A daily time step was used to simulate hydrologic and water quality conditions. The model was developed for the entire watershed upstream from the 303(d) listed segment.

Critical Conditions:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period represents a range of hydrologic and meteorologic conditions.

Seasonal Variation:
A simulation period of 10 years was used to assess the water quality standards for this TMDL. This period represents a range of hydrologic and meteorologic conditions including seasonal variations.

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): 0 counts/30 days
Note: All future permitted discharges shall meet the water quality standard for fecal coliform bacteria of 200/100 ml as a geometric mean.

Load Allocation (LA): 2.01×10^{12} counts/30 days

Margin of Safety (MOS): Implicit (conservative modeling assumptions)

Total Maximum Daily Load (TMDL): 2.01×10^{12} counts/30 days