South Carolina
Department of Health and Environmental Control

Total Maximum Daily Load Development for Sawneys Creek: Stations CW-079 and CW-228 Fecal Coliform Bacteria

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Bureau of Water

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DHEC
PROMOTE PROTECT PROSPER
South Carolina Department of Health
and Environmental Control

Abstract

Sawneys Creek (03050104-050-010) in Fairfield and Kershaw Counties, South Carolina, is a small stream that is impaired for primary contact recreational uses by fecal coliform bacteria at two locations. Sawneys Creek is a tributary of the Wateree River. The Sawneys watershed (drainage area to CW-228: 60 km^2; to CW-079: 151 km^2) is mostly forested, with some cropland and pasture/hay. There are no permitted dischargers in the watershed and very little development. During the 1996-2000 assessment period, 26 % of samples at CW-228 and 25 % of samples at CW-079 exceeded the water quality standard of 400 cfu/100ml.

This TMDL was developed using a regional application of EPA's BASINS, a GIS-based water quality modeling software. The principal source of fecal coliform loading to the stream was determined to be failing septic systems and cattle or other livestock with direct access to the streams. The total maximum daily loads (TMDL) for these two locations for fecal coliform bacteria were determined to be 6.64×10^{11} and 4.49×10^{12} cfu /30-days, respectively. These TMDL values would require a reduction of 73 to 78 % in the current load to Sawneys Creek to meet standards. Several TMDL implementation strategies to bring about these reductions are suggested.

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Tables and Figures

Sawneys Creek
(HUC 03050104-050-010)

1.0 INTRODUCTION:

1.1 Background

Levels of fecal coliform bacteria, which are indicators of pathogens, can be elevated in water bodies as the result of both point and nonpoint sources of pollution. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are not meeting designated uses under technology-based pollution controls. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in stream water quality conditions so that states can establish water quality-based controls to reduce pollution and restore and maintain the quality of water resources (USEPA 1991).

1.2 Watershed Description

Sawneys Creek is in a rural watershed in Fairfield and Kershaw Counties, in the lower Piedmont region of South Carolina. The creek drains into the Wateree River just downstream of Lake Wateree (Figure 1). The watershed had a population in 2000 of approximately 2500. The town of Ridgeway is partly in the watershed, along its western edge.

The watershed has two named streams: Sawneys Creek and Thorntree Creek. Descriptions of the monitoring locations are given in Table 1. The drainage area for CW-228 is 60 km^2 (23 mi^2). For purposes of this TMDL the whole watershed is considered synonymous with the area draining to CW-079. The area of the whole Sawneys Creek watershed is 151 km^2 (58 mi^2).

The watershed is divided into four sub-watersheds in order to adequately model it. All four sub-watersheds are predominantly forest (Table 2; Figure 2). The part of the watershed draining to CW-228 (Sub-WS #2) is 80 % forest, 13 % row crops, and 3% pasture/hay, according to the MRLC database made in the early 1990s. There is a large inactive gold mine on the edge of this watershed. The area draining to CW-079 is also predominantly forest (84%), with cropland (8%) and transitional (6%) making up most of the balance. However, a windshield survey indicates that most of the land identified as transitional is pasture. The transitional land in sub-watersheds 1, 3, and 4 were apportioned to pasture (75 %) and developed land use (25 %) to estimate loading for the watershed model. Cattle in pastures were observed just upstream of both sampling stations. There is no significant urban land use in the watershed.

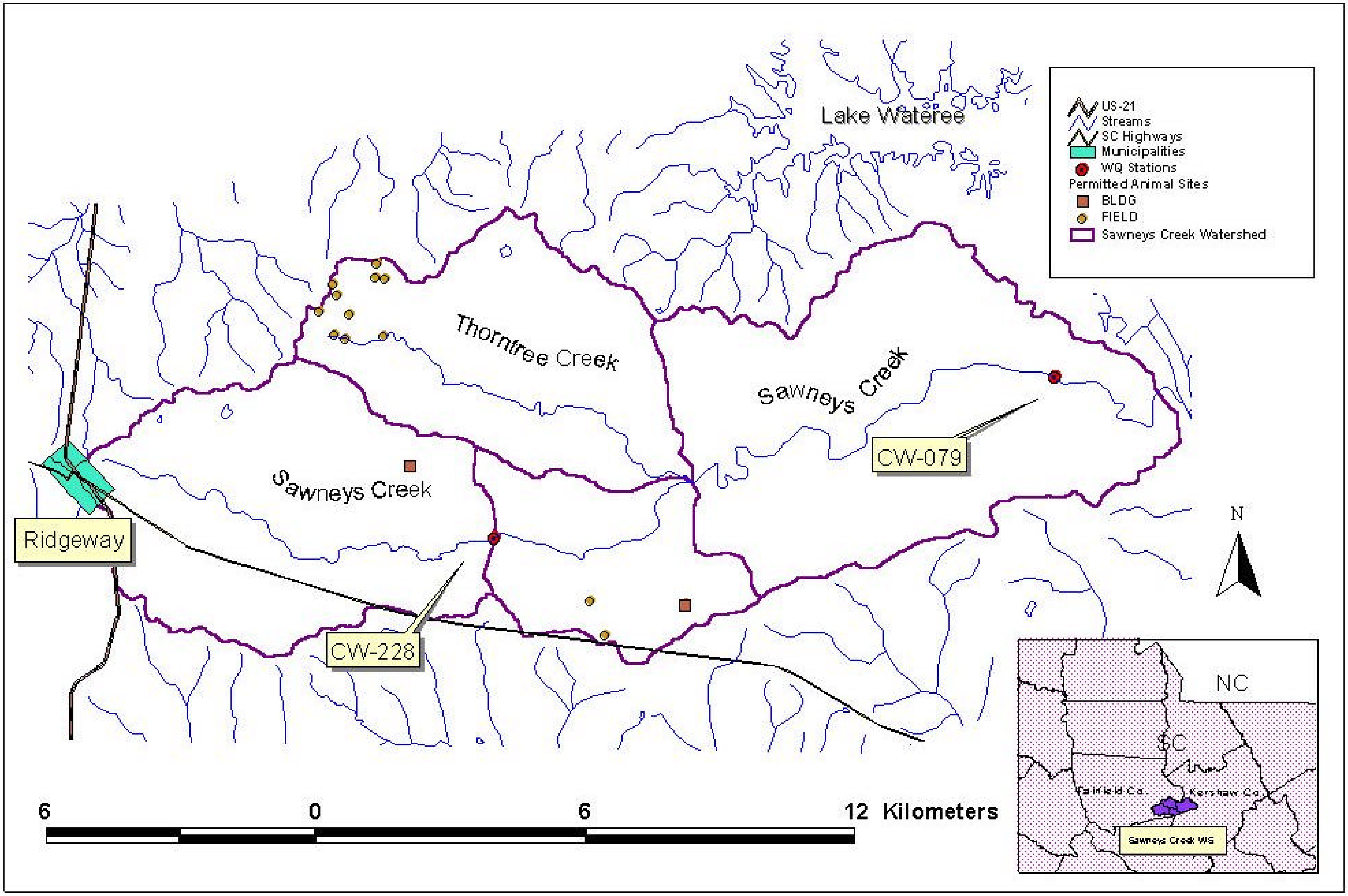


Figure 1. Map of the Sawneys Creek Watershed, Fairfield and Kershaw Counties.

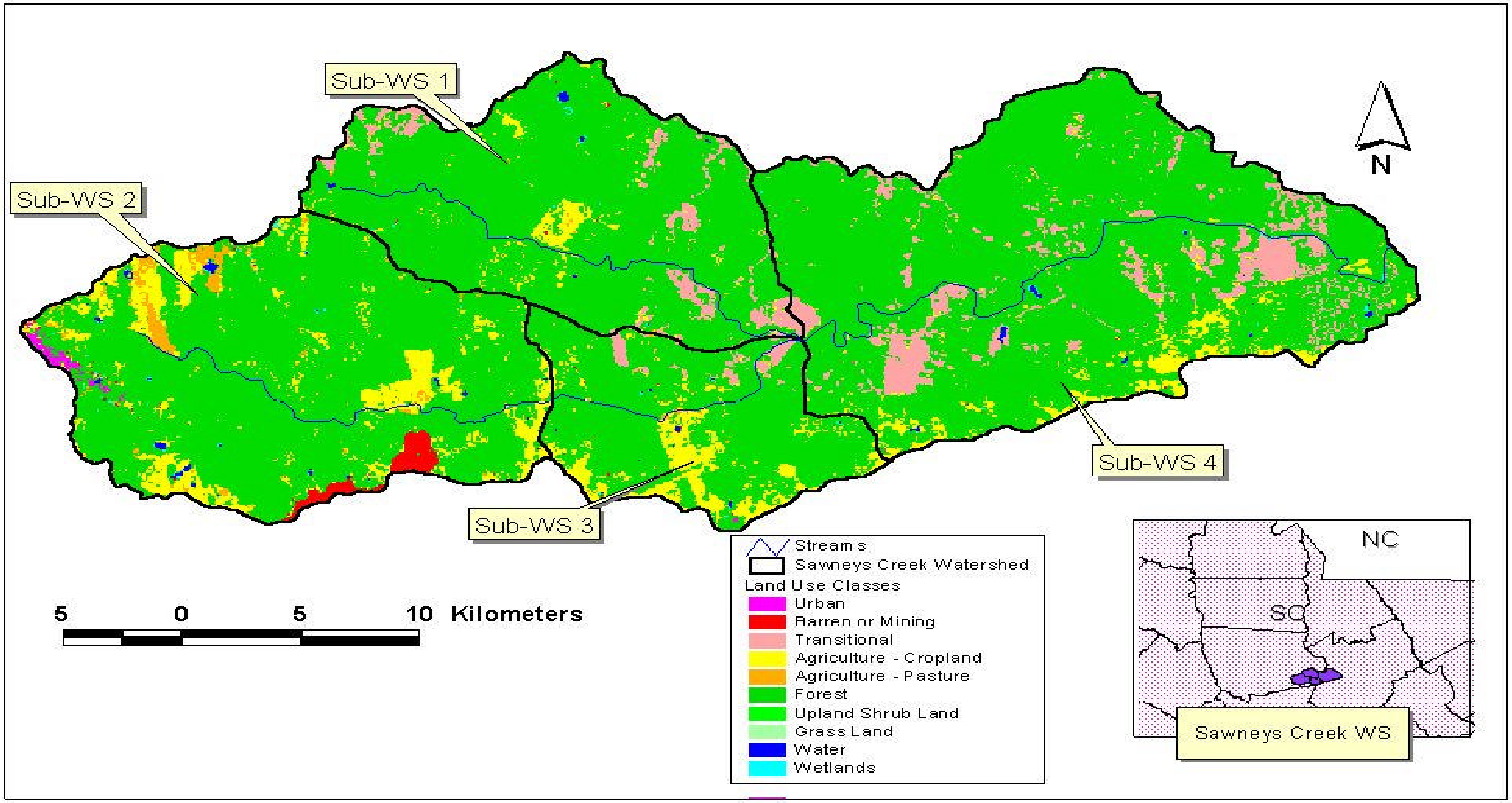


Figure 2. Land use in the Sawneys Creek Watershed, Fairfield and Kershaw Counties, SC.

1.3 Water Quality Standard

The impaired stream segment, Sawneys Creek, is designated as Class Freshwater. Waters of this class are described as follows:

> "Freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses." (R.61-68)

South Carolina's standard for fecal coliform in Freshwater is:

> "Not to exceed a geometric mean of 200/100 ml, based on five consecutive samples during any 30 day period; nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml."(R.61-68).

Table 1. Descriptions of water quality monitoring stations in the Sawneys Creek Watershed.

Station ID	Location Description	% Violations	Period of Data
CW-228	Sawneys Creek at S-20-151	26	1996-2000
CW-079	Sawneys Creek at S-28-37	25	1998

2.0 WATER QUALITY ASSESSMENT

An assessment of water quality data collected in 1996 through 2000 at water quality monitoring stations CW-079 and CW-228 indicated that Sawneys Creek at these two locations is impaired for recreational use. In addition to being listed on the 2002 303(d) list, Sawneys Creek was also on the 1998 and 2000 lists. Waters in which no more than 10% of the samples collected over a five year period are greater than 400 fecal coliform counts or cfu / 100 ml are considered to comply with the South Carolina water quality standard for fecal coliform bacteria. Waters with more than 10 percent of samples greater than 400 cfu/ 100 ml are considered impaired and listed for fecal coliform bacteria on South Carolina's 303(d) list. During the assessment period (1996-2000), 26% of the samples did not meet the fecal coliform criterion at CW-228 and 25% at CW-079. Fecal coliform data for both stations are provided in Appendix A.

3.0 SOURCE ASSESSMENT AND LOAD ALLOCATION

Fecal coliform bacteria enter surface waters from both point and nonpoint sources. Poorly treated municipal sewage has been a major source of fecal coliform, but with improved treatment and enforcement this is not usually the case now. All point sources must have a NPDES permit. In South Carolina NPDES permittees that discharge sanitary wastewater must meet the state standard for fecal coliform.

Table 2. Land Use in Sawneys Creek Watershed.

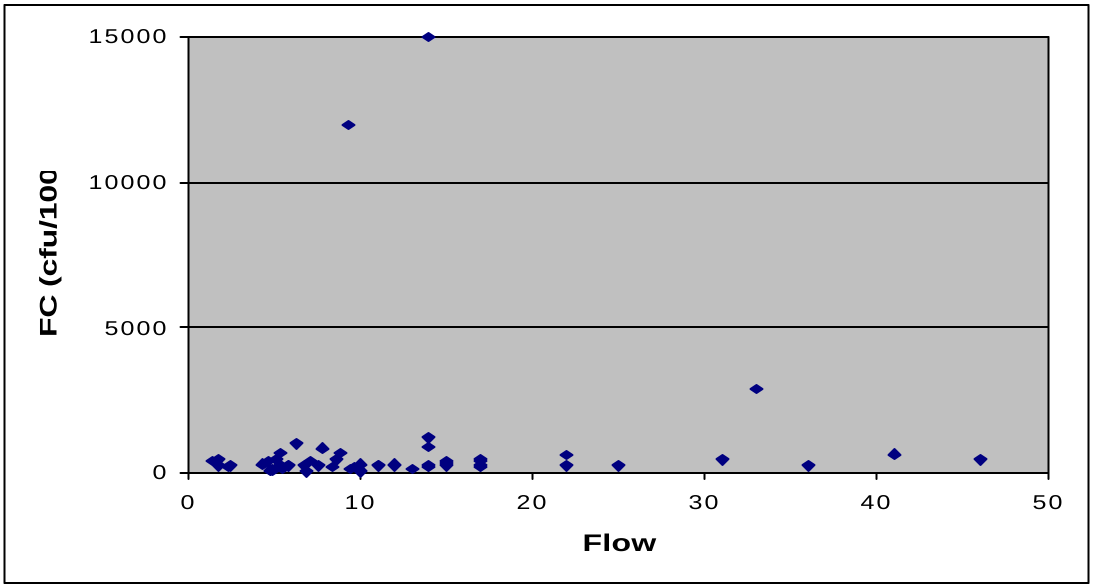
Sub-Watershed =>		Thorntree Creek Sub-WS #1		Sawneys Creek Above CW-228 Sub-WS #2		Sawneys Creek above Confluence Sub-WS #3		Lower Sawneys Creek Sub-WS #4		Total Watershed	
Category											
		Acres	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	%
Water		14.2	0.2%	41.0	0.4%	7.4	0.2%	24.4	0.2%	87.0	0.2%
Built-up		0.0	0.0%	72.8	0.7%	1.5	0.0%	2.8	0.0%	77.1	0.2%
Transitional, Barren		528.9	6.5%	237.6	2.3%	148.1	3.3%	1,487.0	10.5%	2,401.5	6.5%
Forest		7,215.4	89.3%	8,302.5	80.4%	3,575.0	80.1%	11,950.3	84.4%	31,043.2	83.8%
Cropland		299.9	3.7%	1,329.9	12.9%	702.0	15.7%	662.8	4.7%	2,994.6	8.1%
Pasture		11.1	0.1%	308.6	3.0%	21.6	0.5%	14.2	0.1%	355.5	1.0%
Wetlands		11.4	0.1%	33.3	0.3%	6.8	0.2%	21.3	0.2%	72.8	0.2%
Totals		8,080.9	100.0%	10,325.7	100.0%	4,462.4	100.0%	14,162.7	100.0%	37,031.7	100.0%

Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. Some sources are related to land use activities that accumulate fecal coliform on the land surface, which then runs off during storm events. Other sources are more or less continuous. Potential nonpoint sources of fecal coliform bacteria are: wildlife, land application of manure, grazing animals, failing septic systems, urban storm runoff, and leaking or overflowing sewer collection systems.

A comparison of observed fecal coliform bacteria concentrations with simulated flow for CW-228 and CW-079 shows a very weak correlation between flow and fecal coliform (Figure 3.). The highest observed fecal coliform concentrations occurred at relatively low flow rates. This suggests that there is a combination of continuous sources, such as failing septic systems and cattle-in-streams, and runoff induced sources. Flow rates were not collected with water samples.

3.1 Point Sources in the Sawneys Creek Watershed

There are no point sources in this rural watershed.



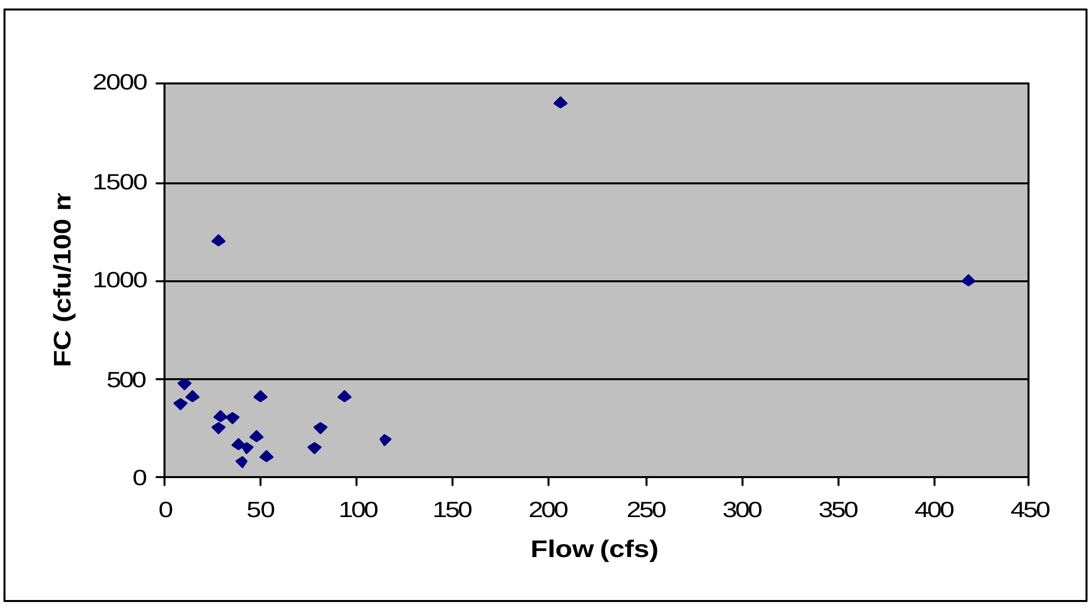


Figure 3. Comparison of simulated flow with observed fecal coliform concentrations in Sawneys Creek: CW-228 (top) and CW-079 (bottom).

3.2 Nonpoint Sources in Sawneys Creek Watershed

3.2.1 Wildlife

Wildlife (mammals and birds) contribute a low level of fecal coliform to surface waters. Wildlife wastes are carried into nearby streams by runoff during rainfall. Deer are used as a surrogate for all wildlife. The SC Department of Natural Resources (Charles Ruth, DNR Deer Project Supervisor, personal communication, 2000) has estimated a density of 45 deer/mi^2 for this area. Deer habitat includes forest, cropland, and pasture land. Deer are assumed to be distributed evenly throughout their habitat and the population uniform during the modeling period. Wildlife are the only contributors of fecal coliform bacteria to forest land which usually has the lowest loading rates per unit of area of any land uses.

3.2.2 Land Application of Manure

In this area manure from poultry houses is usually collected and distributed on pasture land. In the CW-228 drainage there is a brood turkey operation (ND0075370), which is permitted for 25,000 birds. A broiler chicken operation (ND0070611) in the CW-079 drainage is permitted for 224,000 birds. Application of the manure does not follow a strict schedule (David Findlay, NRCS Fairfield County conservationist, personal communication, 2002). Accumulation rates of fecal coliform from these sources were estimated using the spreadsheet tools in WCS.

3.2.3 Grazing Animals

Livestock such as cattle, goats, and horses spend most of their time grazing on pasture land. Runoff from rainfall washes some of the manure deposited in the pastures into nearby by streams. There are an estimated 200 cattle in the Fairfield portion of Sawneys Creek watershed and 400 cattle in the Kershaw County portion of the watershed, based on the Census of Agriculture, 1997 and NRCS (David Findlay, NRCS Fairfield County conservationist, personal communication, 2002; Mike Newman NRCS Kershaw County conservationist, personal communication, 2002).

Cattle and other livestock that are allowed access to streams deposit manure directly into the streams. Manure deposited in streams can be a significant source of fecal coliform bacteria. Loading from this source was estimated from the number of beef cattle and the percentage of time they spend in streams using the spreadsheet tool in WCS. Assumptions for these calculations are that beef cattle are not confined, have access to streams, and they spend 0.25 % of the time in the streams. Livestock directly depositing manure in streams was estimated to be the second largest source of fecal coliform in Sawneys Creek at both CW-228 and CW-079. Estimated loading values from cattle-in-streams is provided in Table 3.

3.2.4 Failing Septic Systems

The number of households that were not served by a sewer lines was estimated using a GIS. The 2000 census database layer was compared to a sewer line data layer theme and the boundaries of the Sawneys Creek Watershed. The population and number of houses using septic systems were entered into the WCS spreadsheet tool. Based on Horsley and Witten (1996), the average waste flow per person was assumed to be 70 gal/capita/day. The average household consisted of 2.5 persons. Septic systems were assumed to have a failure rate of 20 % (Schueler, 1999). Other assumptions were that all wastewater reached the stream and the concentration of fecal coliform in that wastewater was 10^4 cfu/100ml (Horsley and Witten, 1996). Failing septic systems were estimated to the most important source of fecal coliform loading to Sawneys Creek, slightly edging out livestock with stream access. The estimated loading values from failing septic systems are given in Table 3.

The 1990 census indicated the number of houses with 'other' waste treatment (not sewers or septic systems); but this data is not available from the 2000 census. These houses may have a higher potential for contributing fecal coliform to Sawneys Creek, because they may have wastewater piped directly into a creek or indirectly through ditches or overland.

Table 3. Load estimates to model for cattle-in-streams and failing septic systems.

Sub Watershed	**Existing Loads (cfu/30-days)**
Cattle-in-streams	
Sub-WS #1	1.17E+12
Sub-WS #2	7.78E+11
Sub-WS #3	2.73E+12
Sub-WS #4	7.78E+11
Totals	5.46E+12
Failing Septic Systems	
Sub-WS #1	3.65E+12
Sub-WS #2	1.78E+12
Sub-WS #3	9.22E+11
Sub-WS #4	2.64E+12
Totals	8.98E+12

4.0 MODELING

Watersheds with varied land uses and numerous potential sources of pollutants typically require a complex model to ascertain the affect of source loadings on in-stream water quality. This relationship must be understood to some degree in order to develop an effective TMDL. In this section, the numerical modeling techniques that have been developed to simulate fecal coliform bacteria fate and transport in the watershed are discussed as applied to the Sawneys Creek Watershed.

4.1 Model Selection

The US EPA has assembled a variety of tools to use in the development of TMDLs. The Sawneys Creek Watershed is a relatively large basin with primarily agricultural land uses that have the potential to cause impairment of water quality. The GIS-based dynamic modeling tool - Watershed Characterization System or WCS (USEPA - Region 4, 2001), was used for this watershed. WCS, which is a version of BASINS (US EPA, 1998), has additional source loading calculation tools, updated data, and is focused on a given state. The WCS 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 which is built around Hydrologic Simulation Program Fortran or HSPF), to simulate the deposition and transport of fecal coliform bacteria, and the resulting water quality response. 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 Sawneys Creek Watershed was delineated into four sub-watersheds in order to characterize the relative fecal coliform bacteria contributions from the significant contributing sub-watersheds (see Figure 1). In addition, sub-division of the watershed allows for management and load reduction alternatives to be varied by sub-watershed. Watershed delineation was based on the RF1 stream coverage and elevation data. 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.

An important factor driving model results is the precipitation data contained in the meteorological file used in the simulations. 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. Weather data from the Columbia meteorological station were used in all simulations. This station is outside of the watershed, which may contribute to difficulties in calibrating the model such as matching peak flows during the summer and using computed data to replace missing data.

4.3 Model Calibration

Sawneys Creek is an un-gauged stream. The calibrated model for a nearby gauged stream was used as the basis for the Sawneys Creek model. The hydrology parameter values (NPSM module Pwater) the Rocky Creek model were used in the Sawneys Creek model (SCDHEC, 2001). The Rocky Creek watershed does not border the Sawneys Creek watershed but is in the same basin (Catawba-Wateree) and ecoregion (Piedmont). Both watersheds have similar land uses.

Water quality was monitored at 2 stations in the Sawneys Creek watershed. Calibration of the model was based on both stations: CW-228 on the upper Sawneys Creek headwater reach an CW-079 on the lower Sawneys Creek reach. Model calibration results are shown in Appendix D. Results show that the model adequately simulates fecal coliform bacteria in response to rainfall events and suspected inputs. Often a high observed value is not simulated in the model due to lack of rainfall at the meteorological station as compared to the rainfall occurring in the watershed, or an unknown source that is not included in the model. A comparison of simulated water quality concentrations and observed concentrations for sampling stations in the watershed are shown in Appendix B.

4.4 Critical Conditions

EPA regulations at 40 CFR 130.7(c)(1) require that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that established uses of the stream (in this case primary contact recreation) are protected. The selection of a critical environmental condition sometimes corresponds to a specific stream flow condition. However, for this TMDL the 30-day period for which the model predicts the largest violation of the geometric mean standard (EPA 1991) and the flow during the period is closest to the stream average. Basing the TMDL on this period ensures that the standard can be met throughout the period of simulation.

5.0 MODELING RESULTS

5.1 Critical Conditions

The critical condition for Fishing Creek was determined from the plot of the 10-year simulation of fecal coliform and the comparison of average flow for the 30-day period to the average flow for Sawneys Creek (1989-98) (Appendix B). The critical period for this TMDL was the 30-day period prior to and including September 26, 1997 (August 27-September 26). This critical period was chosen because the geometric mean fecal coliform concentration for this date was the highest peak occurring while flow was between the 10^{th} and 90^{th} percentiles during the period of simulation, that is between 8.2 and 87.6 cfs. The mean flow for the 1989-98 period was 51.2 cfs. Extremes in flow, especially low flows, can affect the concentration of fecal coliform. The model seems to be especially sensitive to low flows. Basing this TMDL on these very low flow events would make the TMDL extremely conservative and protective of rare occurrences. The resulting TMDL could require reduction of the order of 99 % and greater. Recreational use of creeks is unlikely during high flow events and may be unsafe due to fast moving and deep water. In addition to basing decisions on the 30-day geometric means during the critical period; the percentage of predicted daily values exceeding the 400 cfu/100 ml standard was also calculated (Appendix C).

5.2 Model Uncertainty

There are several sources of uncertainty in the Sawneys Creek model. These include the rainfall data from outside the watershed, limited water quality data - especially during high flow conditions, inherent variability in fecal coliform sampling, and little or no information on sources like failing or leaking septic systems and sanitary sewer overflows. These uncertainties should be considered in evaluating the recommendations in this TMDL.

5.3 Existing Load

The existing load in Sawneys Creek is the sum of the nonpoint sources because there are no point sources in the Sawneys Creek Watershed. As indicated below the primary source of fecal coliform bacteria loading to Sawneys Creek is failing septic systems. Cattle or other livestock with access to the creeks is the second most important source. Almost all of the runoff loading is from pasture land.

Table 4. Components of existing load of fecal coliform for Sawneys Creek (cfu/30-days).

Impaired Station	Loading from Runoff	Cattle-in-streams	Failing Septic Systems	Total Existing Load
CW-228	5.32×10^{10}	7.78×10^{11}	1.78×10^{12}	2.61×10^{12}
CW-079	1.36×10^{11}	5.46×10^{12}	8.98×10^{12}	1.46×10^{13}

6.0 TOTAL MAXIMUM DAILY LOAD

A total maximum daily load (TMDL) for a given pollutant and water body is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is represented by the equation:

TMDL = 3 WLAs + 3 LAs + MOS

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis to establish water quality-based controls.

For most pollutants, TMDLs are expressed as a mass load (e.g., kilograms per day). For bacteria, however, TMDLs are expressed in terms of cfu or organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l).

6.1 Waste Load Allocations

There is no wasteload allocation for Sawneys Creek because there are no NPDES dischargers.

6.2 Load Allocations

Load allocations were determined by reducing loads into the model until the critical peak concentration was reduced to the target concentration (175 cfu/100 ml; standard of 200 minus MOS of 25). Loadings from failing septic systems, cattle-in-streams, and loading from runoff were summed for the 30-day critical period. The load allocations for Sawneys Creek are 5.75×10^{11} cfu/30-days for CW-228 and 3.31×10^{12} cfu/30-days.

6.3 Margin of Safety

The explicit margin of safety is 25 counts/ 100ml. For CW-228 this is equivalent to 8.95×10^{10} cfu/30-days and for CW-079 this is equal to 5.61×10^{11} cfu/30-days. Through the use of conservative assumptions in the model the margin of safety also has an implicit component.

6.4 TMDL

TMDL = 3 WLA + 3 LA + MOS

Table 5. TMDL components for Sawneys Creek.

Impaired Station	WLA cfu/30-days	LA cfu/30-days	MOS cfu/30-days	TMDL cfu/30-days	Target cfu/30-days
CW-228	0	5.75×10^{11}	8.95×10^{10}	6.64×10^{11}	5.75×10^{11}
CW-079	0	3.93×10^{12}	5.61×10^{11}	4.49×10^{12}	3.93×10^{12}

The target loading value is the load to the creek that it can receive and meet the water quality standard. It is simply the TMDL minus the MOS. The target loading for Sawneys Creek requires a reduction of 78 % from the current load of 2.61×10^{12} cfu/30-days for CW-228 and a reduction of 73 % from 1.46×10^{13} cfu/30-days for CW-079.

7.0 IMPLEMENTATION

As discussed in the *Implementation Plan for Achieving Total Maximum Daily Load Reductions From Nonpoint Sources for the State of South Carolina* (SCDHEC,1998), South Carolina has several tools available for implementing this nonpoint source TMDL. Specifically, SCDHEC's animal agriculture permitting program addresses animal operations and land application of animal wastes. In addition, SCDHEC will work with the existing agencies in the area to provide nonpoint source education in the Sawneys Creek Watershed. Local sources of nonpoint source education and assistance include Clemson Extension Service, the Natural Resource Conservation Service (NRCS), the Fairfield and Kershaw Counties Soil and Water Conservation Services, and the South Carolina Department of Natural Resources. Clemson Extension Service offers a 'Farm-A-Syst' package to farmers. Farm-A-Syst allows the farmer to evaluate practices on their property and determine the nonpoint source impact they may be having. It recommends best management practices (BMPs) to correct nonpoint source problems on the farm. NRCS can provide cost share money to land owners installing BMPs. The Kershaw County Soil and Water Conservation Service has expressed an interest in implementing TMDLs in their county.

SCDHEC is empowered under the State Pollution Control Act to perform investigations of and pursue enforcement for activities and conditions which threaten the quality of waters of the state.
In addition, other interested parties (universities, local watershed groups, etc.) may apply for section 319 grants to install BMPs that will reduce fecal coliform loading to Sawneys Creek. TMDL implementation projects are given highest priority for 319 funding.

In addition to the resources cited above for the implementation of this TMDL in the Sawneys Creek Watershed, Clemson Extension has developed a Home-A-Syst handbook that can help urban or rural homeowners reduce sources of NPS pollution on their property. This document guides homeowners through a self-assessment, including information on proper maintenance practices for septic tanks. SCDHEC also employs a nonpoint source educator who can assist with distribution of these tools as well as provide additional BMP information.

Using existing authorities and mechanisms, these measures will be implemented in the Sawneys Creek Watershed in order to bring about a 77 – 78 % reduction in fecal coliform bacteria loading to Sawneys Creek. DHEC will continue to monitor, according to the basin monitoring schedule, the effectiveness of implementation measures and evaluate stream water quality as the implementation strategy progresses.

8.0 REFERENCES

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APPENDIX A Fecal Coliform Data

Fecal Coliform Bacteria Concentrations (cfu/100ml) in Sawneys Creek at SR-20-150, CW-228

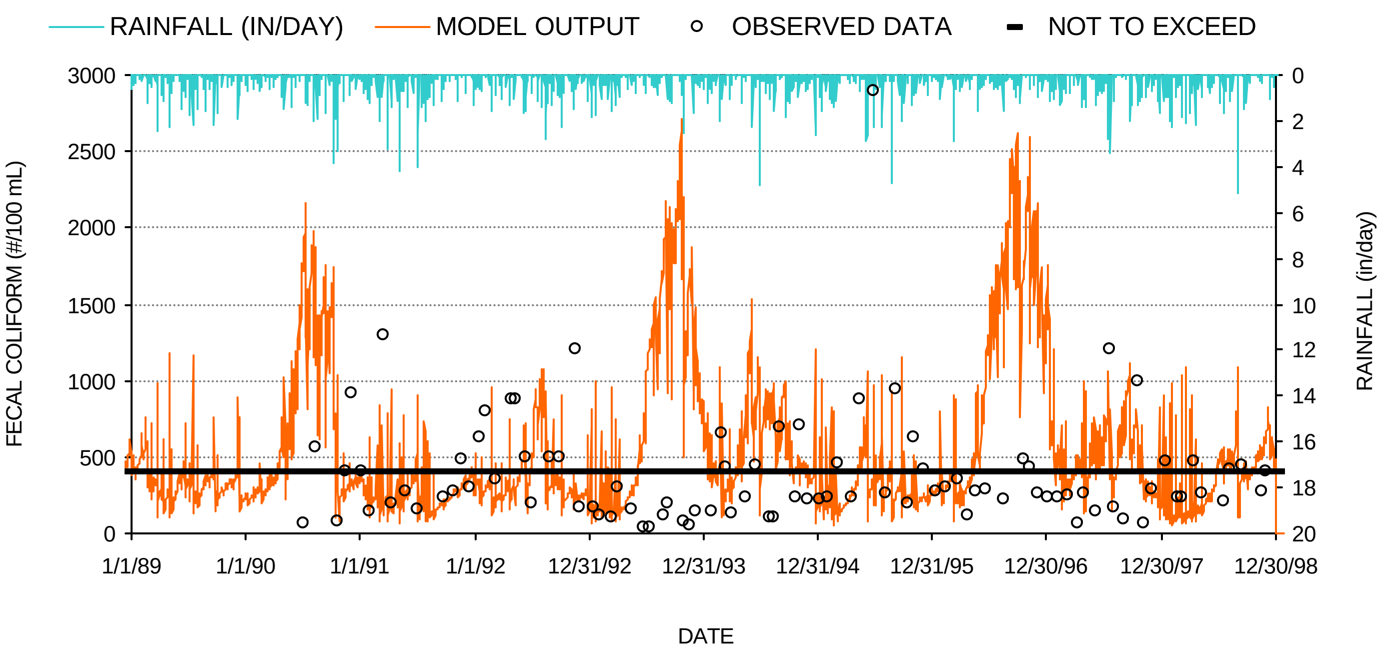
Date	FC (cfu/100ml)
6-Jul-90	66
10-Aug-90	560
14-Sep-90	4500
19-Oct-90	80
16-Nov-90	410
6-Dec-90	920
3-Jan-91	400
1-Feb-91	140
14-Mar-91	1300
12-Apr-91	190
23-May-91	280
20-Jun-91	4900
5-Jul-91	160
8-Aug-91	3200
27-Sep-91	230
25-Oct-91	280
20-Nov-91	490
13-Dec-91	300
17-Jan-92	630
7-Feb-92	800
6-Mar-92	350
30-Apr-92	880
14-May-92	880
12-Jun-92	500
2-Jul-92	200
28-Aug-92	500
4-Sep-92	130009
1-Oct-92	500
20-Nov-92	1200
4-Dec-92	170
15-Jan-93	170
5-Feb-93	120
11-Mar-93	100
Date	**FC (cfu/100ml)**
2-Apr-93	300
13-May-93	160
25-Jun-93	40
15-Jul-93	40
26-Aug-93	120
10-Sep-93	190
26-Oct-93	77
18-Nov-93	56
9-Dec-93	150
27-Jan-94	150
25-Feb-94	650
11-Mar-94	430
1-Apr-94	130
13-May-94	230
16-Jun-94	440
28-Jul-94	100
11-Aug-94	110
2-Sep-94	700
21-Oct-94	230
3-Nov-94	710
2-Dec-94	220
6-Jan-95	220
2-Feb-95	230
2-Mar-95	460
18-Apr-95	240
11-May-95	880
29-Jun-95	2900
3-Aug-95	260
5-Sep-95	940
12-Oct-95	190
2-Nov-95	630
7-Dec-95	420
11-Jan-96	280
15-Feb-96	300
21-Mar-96	350
25-Apr-96	120
16-May-96	280
20-Jun-96	290
Date	**FC (cfu/100ml)**
15-Aug-96	220
17-Oct-96	480
7-Nov-96	430
5-Dec-96	260
2-Jan-97	240
6-Feb-97	240
6-Mar-97	250
9-Apr-97	63
1-May-97	260
5-Jun-97	150
17-Jul-97	1200
5-Aug-97	170
2-Sep-97	89
16-Oct-97	1000
6-Nov-97	60
4-Dec-97	290
14-Jan-98	470
24-Feb-98	240
5-Mar-98	230
15-Apr-98	470
7-May-98	260
10-Jun-98	15000
16-Jul-98	210
6-Aug-98	420
14-Sep-98	450
8-Oct-98	12000
19-Nov-98	270
3-Dec-98	400
1/7/99	370
2/11/99	190
3/4/99	110
4/1/99	460
5/6/99	350
6/2/99	180
7/8/99	220
8/19/99	1400

9/2/99	90
10/21/99	270
Date	**FC (cfu/100ml)**
11/4/99	170
12/28/99	530
1/6/00	190
2/3/00	510
3/9/00	200
4/12/00	360
5/9/00	390
6/7/00	220
7/13/00	270
8/3/00	600
9/21/00	130
10/19/00	130
11/6/00	140
12/5/00	160

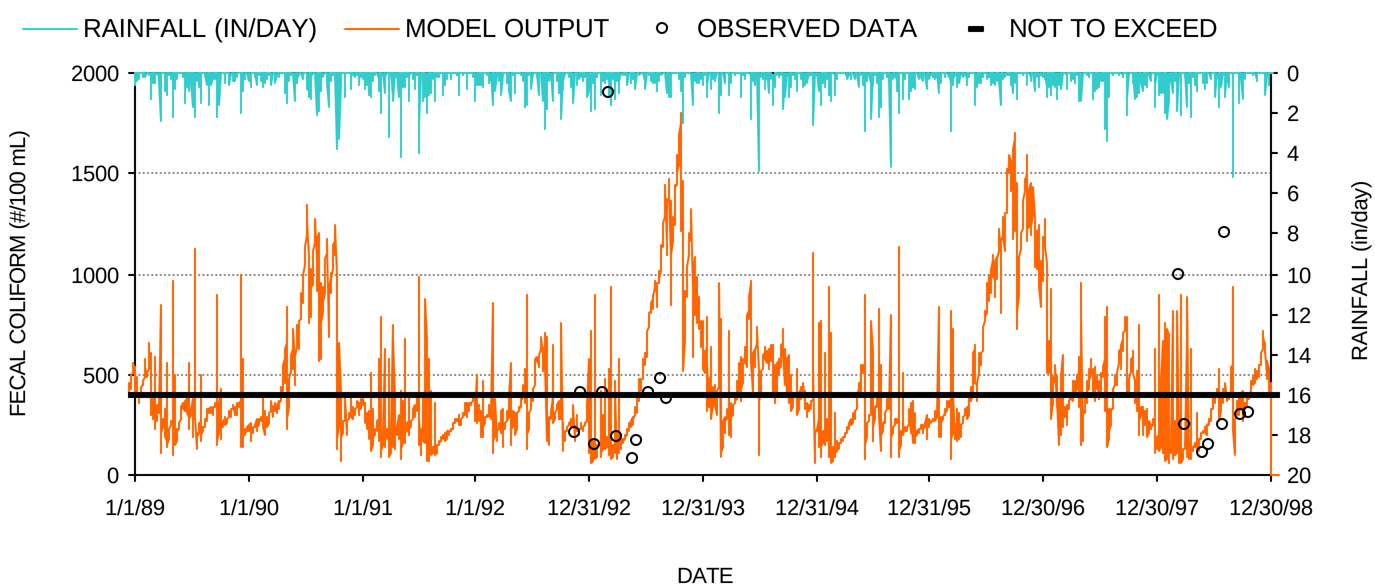
Fecal Coliform Bacteria Concentrations (cfu/100ml) in Sawneys Creek at SR-28-37, CW-079

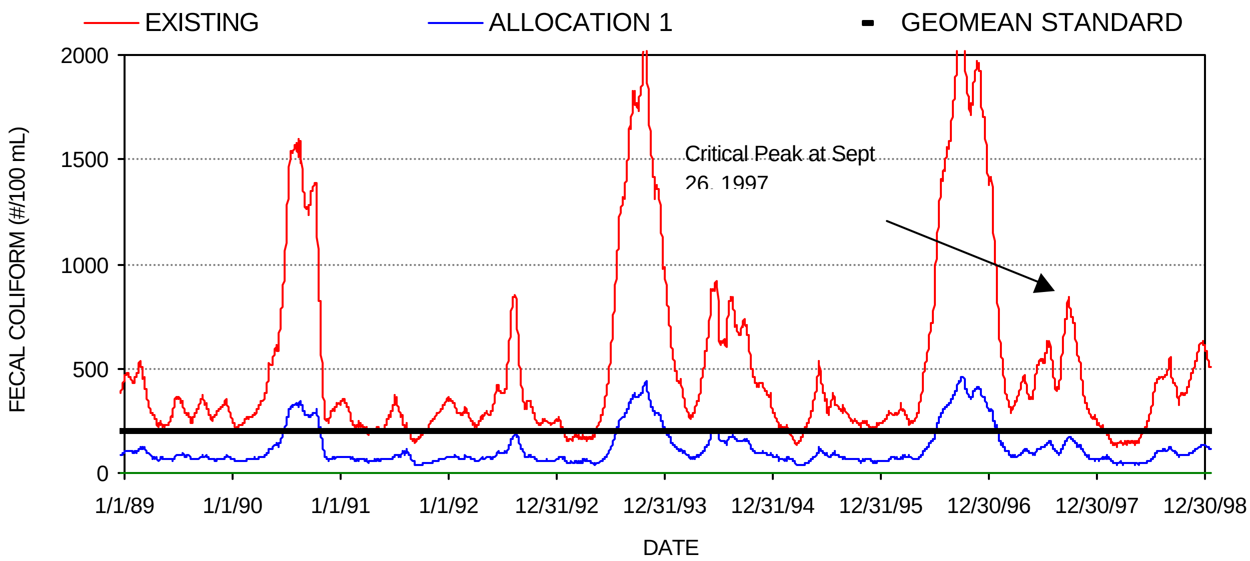
Date	FC (cfu/100ml)
18-Nov-92	210
8-Dec-92	410
19-Jan-93	150
11-Feb-93	410
4-Mar-93	1900
1-Apr-93	190
18-May-93	80
2-Jun-93	170
13-Jul-93	410
18-Aug-93	480
8-Sep-93	380
9-Mar-98	1000
2-Apr-98	250
27-May-98	110
18-Jun-98	150
30-Jul-98	250
5-Aug-98	1200
24-Sep-98	300
21-Oct-98	310

Appendix B   Calibration and Other Plots

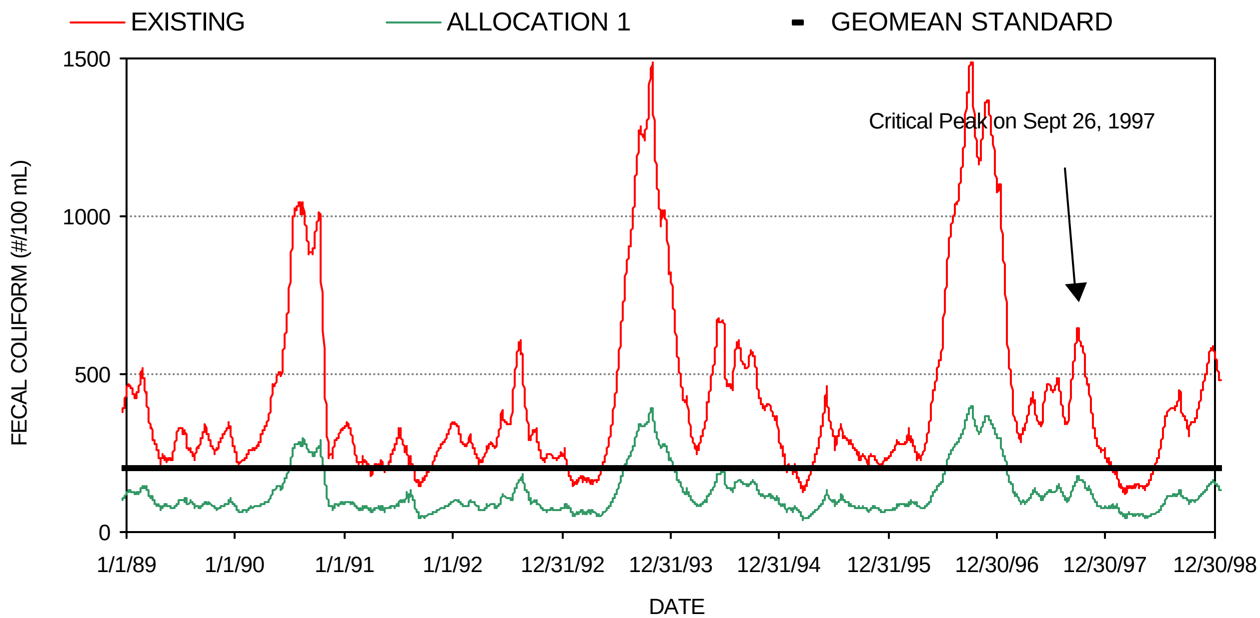


Calibration plot for CW-228.





Geomean plot of existing conditions for CW-228 showing critical peak.



Geomean plot of existing conditions for CW-079 showing critical peak.

Appendix C Miscellaneous Tables

Selected percentiles of simulated flow for Sawneys Creek (1988-98) at its mouth.

		Percentiles	Q (cfs)
Mean Q (cfs):	51.2	10 %	8.2
		50 %	35.0
		90 %	87.6

Simulated flow for Sawneys Creek at its mouth (CW-079) for the critical period.

Date	**Simulated Flow Daily Mean (cfs)**		**Daily total flow (l/day)**
8/27/97	22.2		5.44E+07
8/28/97	20.1		4.92E+07
8/29/97	19.1		4.67E+07
8/30/97	18.9		4.63E+07
8/31/97	18.8		4.59E+07
9/1/97	18.3		4.48E+07
9/2/97	18.0		4.40E+07
9/3/97	17.7		4.34E+07
9/4/97	20.1		4.92E+07
9/5/97	21.1		5.16E+07
9/6/97	20.0		4.89E+07
9/7/97	18.3		4.49E+07
9/8/97	16.8		4.11E+07
9/9/97	16.2		3.96E+07
9/10/97	16.8		4.12E+07
9/11/97	17.8		4.35E+07
9/12/97	16.7		4.08E+07
9/13/97	16.0		3.91E+07
9/14/97	15.7		3.83E+07
9/15/97	15.4		3.76E+07
9/16/97	15.1		3.70E+07
9/17/97	14.8		3.63E+07
9/18/97	14.6		3.58E+07
9/19/97	14.3		3.49E+07
9/20/97	13.6		3.34E+07
9/21/97	13.7		3.36E+07
9/22/97	14.1		3.45E+07
9/23/97	13.6		3.32E+07
9/24/97	15.3		3.75E+07
9/25/97	27.5		6.72E+07
9/26/97	22.6		5.52E+07
Flow for Critical Period (l)			**1.33E+09**

Simulated flow for Sawneys Creek at CW-228 during the critical period.

Date	Simulated Flow Daily Mean (cfs)		Daily total flow (l/day)
8/27/97	5.86		1.43E+07
8/28/97	5.22		1.28E+07
8/29/97	5.05		1.24E+07
8/30/97	5.02		1.23E+07
8/31/97	4.95		1.21E+07
9/1/97	4.83		1.18E+07
9/2/97	4.76		1.17E+07
9/3/97	4.69		1.15E+07
9/4/97	5.46		1.34E+07
9/5/97	5.60		1.37E+07
9/6/97	5.23		1.28E+07
9/7/97	4.78		1.17E+07
9/8/97	4.38		1.07E+07
9/9/97	4.34		1.06E+07
9/10/97	4.61		1.13E+07
9/11/97	4.82		1.18E+07
9/12/97	4.29		1.05E+07
9/13/97	4.14		1.01E+07
9/14/97	4.08		9.98E+06
9/15/97	4.00		9.79E+06
9/16/97	3.94		9.65E+06
9/17/97	3.87		9.47E+06
9/18/97	3.82		9.36E+06
9/19/97	3.72		9.11E+06
9/20/97	3.55		8.68E+06
9/21/97	3.62		8.85E+06
9/22/97	3.72		9.10E+06
9/23/97	3.52		8.61E+06
9/24/97	4.50		1.10E+07
9/25/97	10.59		2.59E+07
9/26/97	5.42		1.33E+07
Flow for critical Period (l)			**3.58E+08**

Predicted fecal coliform concentrations at CW-228 within 30-day critical period in relation to the 400 cfu/100ml standard.

Date	Predicted FC concentration (cfu /100ml)	% above standard
8/28/97	164	
8/29/97	171	
8/30/97	169	
8/31/97	170	
9/1/97	175	
9/2/97	175	
9/3/97	177	
9/4/97	126	
9/5/97	119	
9/6/97	131	
9/7/97	153	
9/8/97	183	
9/9/97	190	
9/10/97	169	
9/11/97	152	
9/12/97	183	
9/13/97	192	
9/14/97	193	
9/15/97	196	
9/16/97	200	
9/17/97	204	
9/18/97	204	
9/19/97	213	
9/20/97	229	
9/21/97	214	
9/22/97	194	
9/23/97	216	
9/24/97	145	
9/25/97	216	
9/26/97	132	
Percent of values that exceed 400 cfu/100ml standard:		**0%**

Predicted fecal coliform concentrations at CW-079 within 30-day critical period in relation to the 400 cfu/100ml standard.

Date	Predicted FC concentration (cfu /100ml)	% above standard
8/28/97	146.74	
8/29/97	155.72	
8/30/97	157.29	
8/31/97	158.34	
9/1/97	161.59	
9/2/97	164.12	
9/3/97	166.28	
9/4/97	150.93	
9/5/97	140.66	
9/6/97	146.15	
9/7/97	157.69	
9/8/97	172.11	
9/9/97	179.91	
9/10/97	173.93	
9/11/97	164.87	
9/12/97	172.7	
9/13/97	181.07	
9/14/97	184.53	
9/15/97	187.51	
9/16/97	190.32	
9/17/97	193.58	
9/18/97	195.84	
9/19/97	200.27	
9/20/97	208.64	
9/21/97	208.36	
9/22/97	201.94	
9/23/97	207.28	
9/24/97	191.17	
9/25/97	236.35	
9/26/97	147.91	
Percent of values that exceed 400 cfu/100ml standard:		0.0%

Appendix D Public Notification

The following notice was published in the *Camden Chronicle Independent* and sent to a list of interested parties:

AVAILABILTY OF PROPOSED TOTAL MAXIMUM DAILY LOADs FOR WATERS AND POLLUTANTS OF CONCERN IN THE STATE OF SOUTH CAROLINA

Sawneys Creek in Fairfield and Kershaw Counties

Section 303(d)(1) of the Clean Water Act (CWA), 33 U.S.C. ▪1313(d)(1)(C), and the implementing regulation of the US Environmental Protection Agency (EPA, 40 C.F.R. ▪ 130.7(c) (1), require the establishment of total maximum daily loads (TMDLs) for waters identified as impaired pursuant to ▪ 303(d)(1)(A) of the CWA. Each of these TMDLs is to be established at a level necessary to implement applicable water quality standards with seasonal variations and a margin of safety, to account for lack of knowledge concerning the relationship between effluent limitations and water quality. At this time, the South Carolina Department of Health and Environmental Control (DHEC) has developed proposed TMDLs for the ▪303(d)(1)(A) waters:

Sawneys Creek, Fairfield and Kershaw Counties, Fecal Coliform Bacteria, HUC 03050104-050-010.

Upon review of any public comment and revision, if necessary, the Department will submit these TMDLs to EPA for approval as final TMDLs.

Persons wishing to comment on the proposed TMDLs or to offer new data regarding the proposed TMDLs are invited to submit the same in writing no later than March 20, 2003, to:

South Carolina Department of Health and Environmental Control
Bureau of Water
2600 Bull St.
Columbia, S.C. 29201
Attn: Wayne Harden

Mr. Harden=s phone number is 803-898-7829. His E-mail address is hardencw@dhec.sc.gov. Persons may also contact Ms Kathy Stecker at 803-898-4011.

Copies of individual TMDLs can be obtained from the Bureau of Water web site: http://www.scdhec.net/water/ or by calling, writing, or e-mailing Mr. Harden at the address above. The administrative record, including technical information, data and analyses supporting the proposed TMDLs, are available for review. Requests to review this information must be submitted in writing to DHEC=s Freedom of Information Office at 2600 Bull Street, Columbia, SC 29201 or requests can be submitted via FAX to the Freedom of Information Office at 803-898-3816. Reproduction of documents is available at a cost of $0.25 per page.

Appendix E Responsiveness Summary

Commenters:
US Environmental Protection Agency Region 4

Comment: The commenter stated that Confined Animal Feeding Operations (CAFOs) should be included in Wasteload Allocation Section.

While there are two animal operations permitted by SCDHEC, these are not CAFOs as defined by EPA. They do not discharge wastewater into state waters.

Comment: The commenter wanted the reference to the estimation of the number of cattle made clearer.

The reference was changed as requested.

Comment: The commenter requested that the % of load coming off pastureland be included.

As stated in the final document essentially all of the runoff load is coming from pastureland.

Comment: The commenter asked for additional detail in the calculation of existing loads for Table 3.

Additional detail of the calculations was added to the section.

Comment: The commenter noted that the last sentence on page 8 stated that a USGS gauging station was used to calibrate the Rocky Creek model rather than the Sawneys Creek model.

In the interests of clarity this sentence was removed. The Rocky Creek mode,l which was calibrated to this gauging station was used as the basis for the Sawneys Creek model, because Sawneys Creek is ungauged.

Comment: The commenter requested the Appendix item that was cited as showing the % of predicted values that exceed the 400 cfu/100ml standard, be included.

This was included in Appendix C, however the table title will be made clearer.

Comment: The commenter asked for a more detailed explanation of the calculations used to develop the existing load for Section 5.3.

The explanation was rewritten to be more detailed.

Comment: The commenter asked for a more detailed explanation of the calculations fpor load allocations in Section 6.2.

The explanation for this section was made more detailed.

Comment: The commenter stated that Appendix B was blank.

The final version of the TMDL will include Appendix B.

Comment: The commenter asked if there was a way to associate flow with fecal coliform data. She stated this necessary to choose the critical period from within the 10^{th} and 90^{th} percentiles.

The relationship between flow and fecal coliform was not mentioned in the TMDL that was placed on public notice. However, it has been added to the final version.

Comment: The commenter asked for an explanation of the spreadsheet on the last page of the TMDL.

These spreadsheets show the predicted fecal coliform concentrations for the critical period in relation to the 400 cfu/100ml standard. This comment has the same answer as the comment above.