South Carolina
Department of Health and Environmental Control

Total Maximum Daily Load Development for Brown Creek (HUC 03050101-180-030): Station CW-105 Fecal Coliform Bacteria

June 19, 2001
Bureau of Water

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DHEC
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South Carolina Department of Health and Environmental Control

Executive Summary

Brown Creek is a small creek in Clover, York County, SC, that is impaired by fecal coliform bacteria. This creek is a tributary of Beaverdam Creek (HUC 03050101-180-030) in the Catawba River Basin. The land use in the watershed is primarily residential, industrial, and open land. Much of the watershed, though it is inside the town limits of Clover, is not sewered. The sources of impairment are failing septic systems, possible direct discharges and runoff from the built-up areas. This TMDL proposes a 98.4% reduction in loading of fecal coliform to this watershed.

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(HUC 03050101-180-030)

1.0 INTRODUCTION:

1.1 Background

Levels of fecal coliform bacteria 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

Brown Creek (HUC 03050101-180-030) is a small creek located in Clover, York County, SC. It drains into a tributary of Beaverdam Creek which in turn drains into Crowders Creek and then Lake Wylie (Catawba River) (Figure 1). The drainage area of concern for this TMDL is a small part (1.2 km^2; 288 acres) of the Beaverdam Creek watershed (03050101-180-030) and consists of the area of land draining to station CW-105. Beaverdam Creek downstream at station CW-153 is being addressed in another TMDL.

Land use in the watershed is mostly built-up: mostly residential and industrial. However, over forty percent of the land is open and is probably visited by the local population and pets. The distribution of land use based on the MRLC database made about 1992 is provided in Table 1 and displayed in Figure 2. Though the MRLC data indicate forest and some agricultural land, my observation of this small watershed in 2000 found only scattered wooded and fallow areas, but no agricultural activities. The Brown Creek drainage begins in the center of Clover and runs northward through a less built-up area. Though more than half of the watershed is within the town limits of Clover; much of the watershed is not sewered.

1.3 Water Quality Standard

The impaired stream segment, Brown 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)

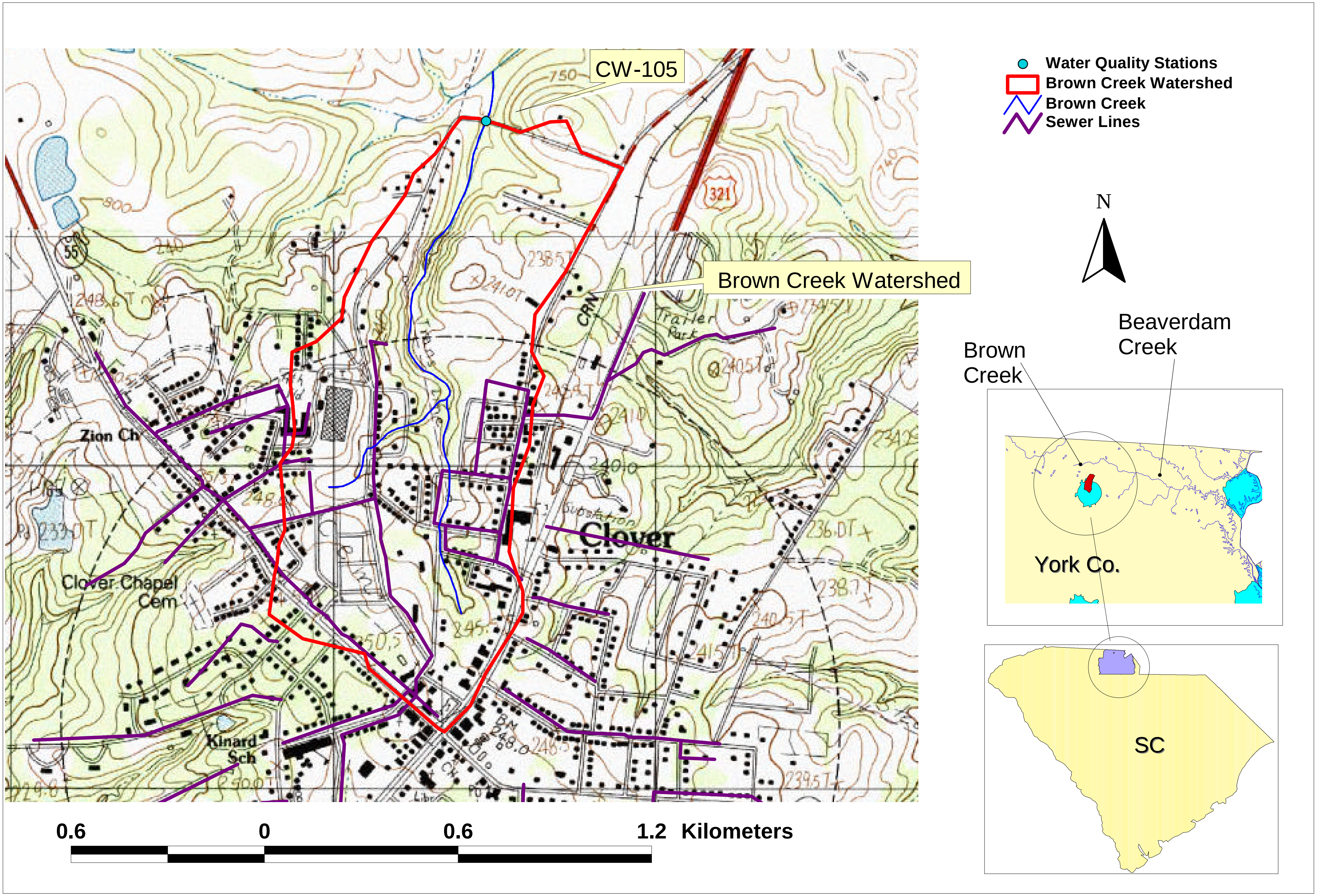

Figure 1. The Brown Creek watershed in Clover, York County, SC.

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. Land use distribution in the Brown Creek watershed.

Land Use Category		Area (acres)	Percentage
Residential, Low-Intensity		72.6	25.8%
Residential, High Intensity		32.9	11.7%
Industrial, Commercial, Transportation		55.5	19.7%
Bare Rock, Soil, Clay		1.9	0.7%
Forest, Deciduous		17.7	6.3%
Forest, Evergreen		24.7	8.8%
Forest, Mixed		15.8	5.6%
Grassland		22.8	8.1%
Cropland		19.8	7.0%
Other Grassland (Parks, lawns, etc)		17.7	6.3%
Wetlands, Woody		0.2	0.1%
Total		281.6	100.0%

2.0 WATER QUALITY ASSESSMENT

The Watershed Water Quality Management Strategy Catawba Basin (SCDHEC 1999) was used to identify this stream segment as impaired and for listing the water body on the 2000 South Carolina 303(d) list. Brown Creek was also included on the 1998 303(d) list. Waters in which no more than 10% of the samples collected over a five year period are greater than 400 fecal coliforms/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

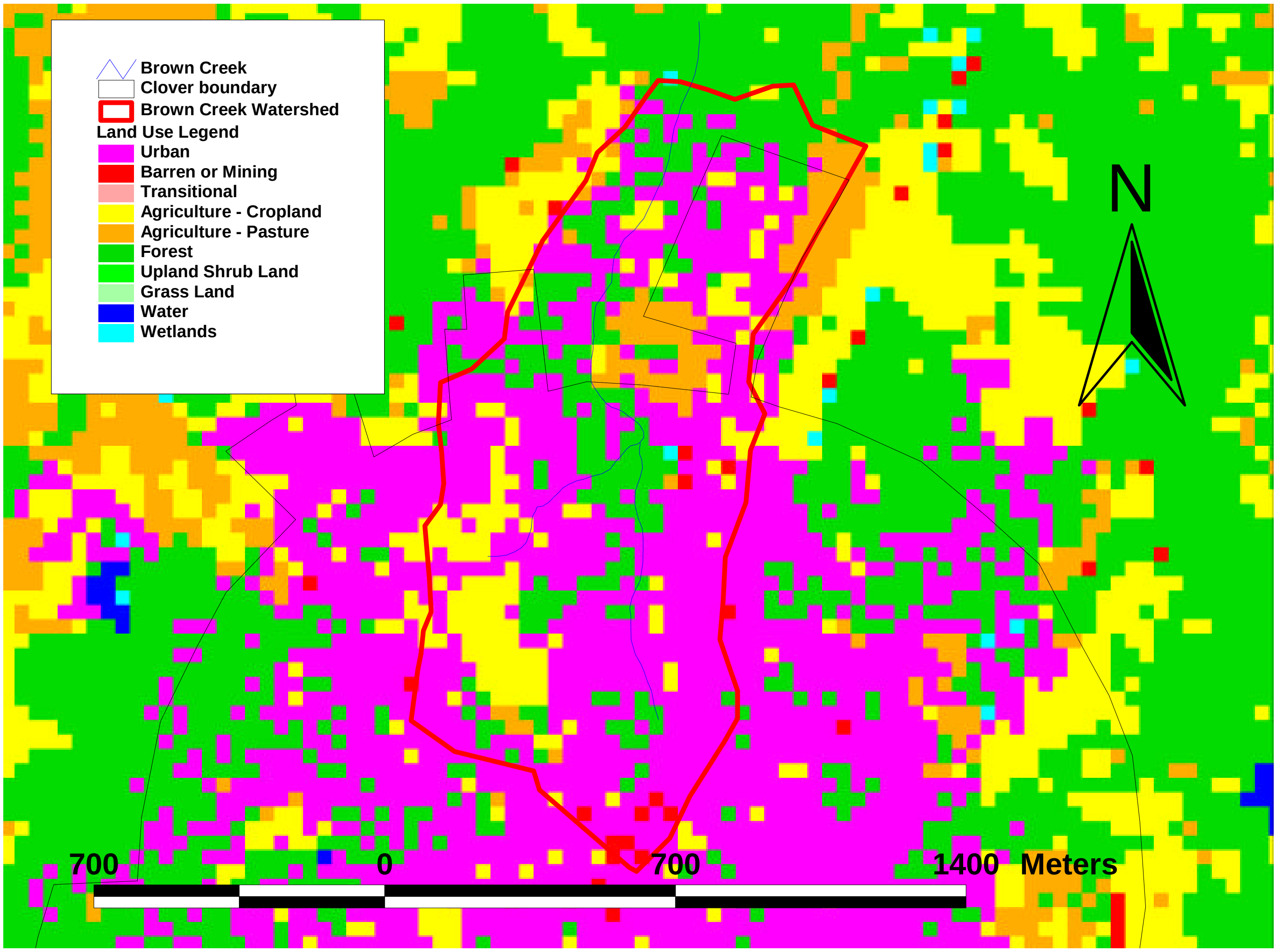

Figure 2. Land use in the Brown Creek watershed.

than 400 fecal coliforms/100 ml are considered impaired and listed for fecal coliform bacteria on South Carolina's 303(d) list.

The SCDHEC ambient monitoring station on Brown Creek is CW-105. Aquatic life uses are supported at the station, however CW-105 does not support recreational uses due to violations of the 400/100 ml fecal coliform criterion. During the assessment period (1994-1998), 67 % of samples did not meet the fecal coliform criterion. CW-105 on Brown Creek is a secondary station which means it is sampled only during the warm months. Fecal coliform data for CW-105 between 1993 and 1998 is in Appendix A.

3.0 SOURCE ASSESSMENT

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 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 at the discharge point.

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
- Leaking sewer collection systems

3.1 Point Sources in the Brown Creek Watershed

There are no active point sources in the Brown Creek watershed.

3.2 Nonpoint Sources in Brown Creek Watershed

3.2.1 Wildlife, Land Application of Manure, Grazing Animals

Wildlife (mammals and birds), manure application, and grazing animals are unlikely to be significant in this mostly built-up watershed. This small watershed is mostly urban with some undeveloped land. No agricultural activity has been observed by the author in the watershed. These natural sources are accounted for in the background load which is estimated to be 5.9×10^{7} counts/day.

3.2.2 Failing Septic Systems and Direct Discharges

Septic systems that are no longer functioning as designed may be failing and discharging untreated wastewater into nearby streams or lakes. The number of failing septic systems in the watershed was estimated by using a GIS to overlay the 1990 census blocks over a representation of the Clover sewer system. The unsewered population was estimated to be 187 people, with 2.7 people per septic system there are 69 septic systems in this watershed. Based on a 20 % failure rate, an intermediate rate from Schueler (1999), for septic systems in Brown Creek, there would be 16 failing septic systems. The estimated load from these failing septic systems is 9.9×10^{8} counts/day. The calculations for determining all loads are presented in Appendix B.

One direct discharge of untreated waste into this creek would provide a loading of 1.3×10^{10} counts/day. Together these two potential sources add 1.4×10^{10} counts/day of fecal coliform bacteria to Browns Creek. The high percentage of samples (67%) that exceeded the standard during the assessment period suggests that the source is a continual input.

3.2.3 Urban Storm Runoff

Urbanized or developed land typically generates an increased loading for pollutants relative to forest and other undeveloped land uses. Dogs, cats, and other pets are a primary source of fecal coliform deposited on the urban landscape. Storm runoff washes some of this fecal material into streams directly or through the storm sewers. For this TMDL the stormwater runoff was divided between built-up (residential, commercial, and industrial land uses) and not-built-up (other land uses). Loading from the built-up areas was estimated at 5.47×10^{10} counts/day. Loading from the not-built-up areas was estimated at 6.94×10^{8} counts/day. The total runoff load is 5.54×10^{10} counts/day. The concentrations of fecal coliform in runoff used for these calculations were 15,000 counts/ 100ml and 1500 counts/ 100ml, respectively. These numbers are in the range of literature values (Bales, 1999; US EPA, 1983).

Other possible sources of fecal coliform in urban areas are leaking sewerage collection systems and overflows of sanitary sewers. These potential urban sources are not specifically identified in this watershed. They are included in the urban runoff total in this TMDL.

4.0 TMDL DEVELOPMENT

This TMDL was developed using a simple mass balance approach as suggested in the USEPA (2001) Protocol for Developing Pathogen TMDLs. Because of the small size of this watershed and short travel times, fecal coliform decay was ignored. The estimated loads were added up to calculate the existing load. For the TMDL the average warm weather flow was multiplied by the target fecal coliform concentration (175 counts/ 100ml). These calculations are provided in Appendix C.

4.1 Critical Conditions

Novotny & Olem (1994) found statistically lower fecal coliform counts in cold weather urban runoff samples than in warmer weather urban runoff. To substantiate this, winter and summer fecal coliform values were compared at ambient water quality monitoring stations in the Piedmont Region in South Carolina impacted by nonpoint sources. This analysis reveals similar or higher values in the summer than the winter. Therefore, the warm season (May-October), which is also the most likely time for contact recreation, is considered critical conditions. This can be explained by the nature of storm events in the summer versus the winter. Thunderstorms are typical in the summer months. This pattern of rainfall allows for the accumulation and washing off of fecal coliforms into the streams resulting in spikes of fecal coliform concentrations. In the winter, long slow rain events are more typical. This pattern of rainfall does not allow for the high build-up of coliform that characterizes the summer. Rather, coliform are washed into the stream at a more even rate. This, coupled with the increased winter flows that provide more dilution, results in lower fecal coliform concentrations.

4.2 Margin of Safety

There are two basic methods for incorporating the MOS (USEPA 1991): 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the total TMDL as the MOS; use the remainder for allocations.

The MOS for this TMDL is explicit through the use of a critical period and by establishing a target concentration level of 175 counts/ 100 ml, that is a MOS of 25 counts/100 ml. By setting the target based on the geometric mean of 200 counts/ 100 ml we have some assurance that the stream can meet the criterion ‘not more than 10% of samples exceed 400/100 ml’. A review of water quality data in South Carolina by SCDHEC (unpublished data) showed that over 75% of waters having a fecal coliform concentration less than 175counts/ 100ml also meet the 10% less than 400 counts/ 100ml criterion.

4.3 Seasonal Variability

The discussion of critical conditions indicated that the warm weather months tend to have higher fecal coliform concentrations. Basing this TMDL on the warm weather months will also protect the stream during the cold weather months.

4.4 Existing Load

Loading from Failing Septic Systems and Possible Illicit Discharges	$= 1.4 \times 10^{10}$ counts/day
Loading from Runoff	$= 5.54 \times 10^{10}$ counts/day
Background	$= 5.89 \times 10^{7}$ counts/day
Total Existing Load	$= 6.95 \times 10^{10}$ counts/day

5.0 TOTAL MAXIMUM DAILY LOAD

A total maximum daily load (TMDL) for a given pollutant and waterbody 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 organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l).

5.1 Waste Load Allocations

Brown Creek has no NPDES permitted dischargers. The WLA for Brown Creek is 0 counts/day.

5.2 Load Allocations

The load allocation for Brown Creek is 1.13×10^{9} counts/day.

5.3 Margin of Safety

The margin of safety is 25 counts/ 100ml or 1.62×10^{8} counts/day.

5.3 TMDL

TMDL = 3WLA + LA + MOS

TMDL = 0 + 1.13×10^{9} counts/day + 1.62×10^{8} counts/day.

TMDL = 1.3×10^{9} counts/day

This target loading for Brown Creek requires a reduction of 98 % from the current load of 6.95×10^{10} counts/day.

6.0 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. 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. The York County Department of Health, a part of DHEC, has responsibility for permitting of and responding to complaints with private septic systems. The Bureau of Environmental Health within DHEC also has responsibilities regarding septic systems.

SCDHEC will work with existing agencies in this area to provide nonpoint source education in the Brown Creek watershed. Local sources of nonpoint source education include Clemson Extension Service, the York County Soil and Water Conservation District, and the South Carolina Department of Natural Resources. In addition, 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 Brown Creek Watershed in order to bring about a 98 % reduction in fecal coliform bacteria to Brown 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.

6.1 Potential funding options:

Local governments have a variety of funding options available for application towards water resource protection including: General revenue, issuance of bonds, special taxes, utility fees, and impact fees. Additionally, the State Clean Water Revolving Fund makes low interest loans available to local governments for water quality improvement projects.

Another available tool for addressing nonpoint sources in this watershed is implementation of NPS reduction projects through DHEC's Section 319 program. Funded by EPA through the Clean Water Act, this program provides resources for implementing projects that address NPS pollution problems. DHEC uses some of these funds internally for NPS projects and also provides funds for outside NPS projects through a competitive grants program.

SCDHEC and many of the natural resource protection partners in the area currently have funded staff available for education, planning and technical assistance. These personnel are expected to be available for efforts aimed at the reduction of bacterial inputs to Brown Creek.

7.0 REFERENCES

Bales, J. D., J. C. Weaver, and J. B. Robinson. 1999. Relation of Land Use to Streamflow and Water Quality at Selected Sites in the City of Charlotte and Mecklenburg County, North Carolina, 1993-98. US Geological Survey. Water-Resources Investigations Report 99-4180.

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Appendix A

Fecal Coliform Concentrations in Brown Creek at S-47-228, Clover, SC
Station CW-105

Date	Time	Fecal Coliform #/100ml
5/20/93	1115	570
6/15/93	1145	200
7/20/93	1130	960
8/4/93	1100	940
9/14/93	1100	1300
10/21/93	1130	3100
5/31/94	1045	6600
6/7/94	1109	1500
7/7/94	1247	420
8/18/94	1045	1600
9/21/94	1354	300
10/6/94	1055	280
5/24/95	1040	7700
6/20/95	1100	2200
7/12/95	1037	640
8/15/95	1041	1100
9/7/95	1149	60
10/10/95	1007	70
5/22/96	1025	720
6/18/96	1500	410
9/12/96	1025	780
5/22/97	1210	210
6/4/97	1120	310
7/7/97	1058	190
8/26/97	1206	530
9/3/97	1245	120
10/23/97	1010	2700
5/21/98	1145	1700
6/22/98	1140	1900
7/22/98	1140	1700
8/6/98	1030	400
9/10/98	1042	1600
10/29/98	1205	560

Appendix B

Stormwater Runoff Loading Calculations:
Method of Schueler (1987)

Loading ($\times 10^9$ counts/day) = Conversion Factor $\times$ runoff (in) $\times$ Concentration (Counts/100 ml) $\times$ Drainage Area (acres)

Loading Built-up $= 2.82 \times 10^{-6} \times 7.74^{1} \times 15{,}000 \times 167$

$= 5.47 \times 10^{10}$ counts/day

Loading Not-Built-up $= 2.82 \times 10^{-6} \times 1.35^{2} \times 1500 \times 121$

$= 6.9 \times 10^{8}$ counts/day

Loading Stormwater $= 5.47 \times 10^{10} + 6.9 \times 10^{8} = 5.54 \times 10^{10}$ counts/day

Runoff Calculations:

Runoff = Precip warm-season (in) $\times$ Fraction of events (unitless) $\times$ Runoff Coefficient (unitless)

1 Built-up Runoff $= 21.5 \times 0.9 \times 0.4 = 7.74$ in

2 Not-Built-up Runoff $= 21.5 \times 0.9 \times 0.07 = 1.35$ in

Background

Loading = baseflow $\times$ conc

$= 0.027$ cfs $\times$ 2446576 $\times$ 100 counts/100 ml
(conversion from cfs to l/day)
$= 6.6 \times 10^{7}$ counts/day

Baseflow is assumed to be 7Q10 flow which is 0.027 cfs for Brown Creek. USGS Water-Resources Investigations Report 90-4188 Generation Coefficient for Beaverdam Creek (USGS 02145650) of 0.06 cfs/mi ^{2}

Brown Creek 03050101 180 030 York County

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

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

Estimated # septics:	69	
Estimated # people served by septics:	187	
Avg # people served per septic:	2.7	people/septic
Assume a failure rate for septics in the watershed (as provided by) :	20	%
Percentage of non-sewered population assumed to be direct piped:	1	%
Therefore the number of failing septics in the watershed is:	14	
Assume the average FC concentration reaching the stream (from septic overcha	1.00E+04	#/100 ml
Assume a typical septic overcharge flow rate of: *	70	gal/day/person
Assume a typical direct discharge flow of:	150	gal/day/person
Assume the average FC concentration reaching the stream (from uncontrolled d	1.00E+06	

Septic as a Point Source

Sub water shed	Tot. # people on septics	Density of people/ septic	# failing septics	Tot. # people served	Septic flow (gal/day)	Septic flow (mL/hr)	FC rate (#/hr)	Septic flow (cfs)	FC rate (#/day)
P1	187	2.70	13.9	37.4	2618	412,880	4.13E+07	4.06E-03	**9.91E+08**

Direct Waste Discharge as a Point Source

Sub water shed	Tot. # people on septics	Density of people/ septic	# uncon- trolled discharge s	Tot. # people served	Discharg e flow (gal/day)	Discharg e flow (mL/hr)	FC rate (#/hr)	Discharg e flow (cfs)	FC rate (#/day)
P1	187	2.7	1.0	2.7	405	63,872	6.39E+08	6.28E-04	**1.53E+10**

*** (Horsely & Witten, 1996)** **Note: Number of direct discharges is assumed to be 1.**

Failing Septic Systems & Direct Discharges:
Current Load = 7.19 *x* 10 ^{10} counts/day

TMDL Allocation (Target = 175 counts/100 ml)

Load Allocation = 175 counts/ 100ml × 0.266 cfs × 2446576 (conv from cfs to l/day)
Load Allocation = 1.14 *x* 10 ^{9} counts/day
MOS = 25 counts/ 100ml × 0.266 cfs × 2446576 (conv from cfs to l/day)
MOS = 1.6 *x* 10 ^{8} counts/day

TMDL = 1.3 *x* 10 ^{9} counts/day

Reduction = (Existing Load - TMDL) / Existing Load × 100 %
= (7.19 *x* 10 ^{10} - 1.14 *x* 10 ^{9}) / 7.19 *x* 10 ^{10}
= **98.4 %**

Appendix C
Public Notifications

The following notice was placed in *The State* newspaper, on the DHEC website, and was mailed to interested parties.

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

Brown Creek in York County
Bush River in Newberry and Laurens Counties
Rocky Creek in Chester and Fairfield 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:

Brown Creek, York County, Fecal Coliform Bacteria, 03050101-180-030; Bush River, Newberry and Laurens Counties, Fecal Coliform Bacteria, 03050109-150; Rocky Creek, Chester and Fairfield Counties, Fecal Coliform Bacteria, 03050103-090.

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 June 14, 2001, to:

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

Mr. Bowles=s phone number is 803-898-4142. His E-mail address is bowlescb@columb32.dhec.state.sc.us.

Copies of individual TMDLs can be obtained by calling, writing, or e-mailing Mr. Bowles at the address above or from the Bureau of Water web site: http://www.scdhec.net/water/. 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.