South Carolina Department of Health and Environmental Control
Total Maximum Daily Load Development for
Mill Creek: Station S-315
Fecal Coliform Bacteria

January 17, 2000
Bureau of Water

South Carolina Department of Health
and Environmental Control

INDEX

State of South Carolina Administrative Record
TMDL Submittal for Mill Creek
Stations (S-315)

Mill Creek
03050109-040
BASIS FOR 303(d) LISTING

INTRODUCTION:

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).

PROBLEM DEFINITION:

Impaired Waterbody: Mill Creek

Location: City of Greenville, Greenville County S.C., **Lat**: 34^{o} 50' 1" **Long**: 82^{o} 26' 57"

Water Classification: Freshwater

The impaired stream segment, Mill 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)

Water Quality Standard Being Violated: Fecal Coliform Bacteria

Pollutant of Concern: Fecal Coliform Bacteria

Fecal Coliform Criteria:

> "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)

The *South Carolina Watershed Water Quality Assessment: Saluda and Edisto River Basins* (SCDHEC 1995) was used to identify this stream segment as impaired and for listing the water body on the 1998 South Carolina 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 than 400 fecal coliforms/100 ml are considered impaired and listed for fecal coliform bacteria on South Carolina's 303(d) List. There is one SCDHEC ambient monitoring station, S-315, on Mill Creek at Bent Bridge Rd. in Greenville County. Data from this station show that recreational uses are not supported due to violations of the 400/100 ml fecal coliform criterion. During the assessment period (1988-1992), 50% of the samples did not meet the fecal coliform criterion. Station S-315 is also considered impaired for aquatic life use based on observed elevated levels of Zn and Cr. However, this TMDL will address only the recreational use impairment.

TMDL TECHNICAL BASIS

TARGET IDENTIFICATION:

Target levels for fecal coliform bacteria in water bodies are those levels established in South Carolina's Water Quality Standards, Regulation 61-68, as described earlier. The criterion used in this TMDL will be "not to exceed a geometric mean of 175/100 ml," allowing an explicit margin of safety of 25/100 ml to ensure that the 200/100 ml criterion will be met.

This target of a geometric mean of 175/100 ml is expected also to satisfy the criterion, "nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml." Based on a review of water quality assessments in South Carolina, over 75% of waters that have a fecal coliform geometric mean of 175/100ml also meet the criterion "not more that 10% of samples exceed 400/100ml" (SCDHEC unpublished data). Most of the data in those assessments, however, reflect fecal coliform concentrations in areas that do not have sufficient best management practices (BMPs) in place. Thus, implementation of BMPs as described in this TMDL will likely achieve an even greater rate of compliance with the latter criterion since the BMPs are generally focused on reducing fecal loadings during runoff events, the condition most likely to result in an exceedence of the 400/100ml criterion.

Source Assessment:

General Sources of Fecal Coliform:
Both point and nonpoint sources may contribute fecal coliform to a given water body. Potential sources of fecal coliform are numerous and often occur in combination. Nationwide, poorly treated municipal sewage is a major source of fecal coliform, but data presented below suggest this is not the case here. Urban storm water runoff, sanitary sewer overflows, and combined sewer overflows can be sources of fecal coliform. Rural storm water runoff can transport significant loads of fecal coliform from livestock pastures and animal feedlots. Failing septic systems and wildlife can also be sources of bacteria. Sources of fecal coliform loads to water bodies can be assigned to two broad classes: point source loads and nonpoint source loads.

Point Sources in the Mill Creek Watershed:
There are no point sources in the Mill Creek watershed.

Nonpoint Sources in Mill Creek Watershed:
As there are no point sources, fecal coliform loadings in this watershed can be attributed to nonpoint sources. The land use in the watershed is essentially 100% urban. The urban land use is comprised of unspecified percentages of commercial, light industrial, and medium to high density residential. Sanitary sewer service is provided to a majority of the residents however there are 10 buildings still using on site wastewater treatment systems.

Urban land use can result in significant loadings of fecal coliform bacteria. Mean concentrations in urban runoff are typically on the order of 15,000 and 20,000 fecal coliforms/100ml. Among the sources within in urbanized watersheds are pet waste in residential areas, sewer line leakage, sanitary sewer overflows, illicit sanitary connections, illegal dumping of sanitary waste, improper operation of septic systems and fecal matter from urban wildlife populations. (Schuler 1999).

Linkage Between Numeric Targets and Sources:

Land use analysis of this watershed indicates that the major sources of fecal coliform are necessarily derived from urban areas. Various effective Best Management Practices exist for urban lands that can successfully reduce fecal coliform levels in adjacent water bodies. Therefore, load reductions in this TMDL will be allocated to urban landuses.

The loading from typical un-urbanized forested lands will be considered background conditions. The geometric mean of fecal coliform concentration in water bodies flowing through forested areas in South Carolina during all flow conditions is estimated to be 30 fecal coliforms/100 ml (SCDHEC unpublished data). The 30 fecal coliforms/100 ml observed in South Carolina falls well within the range reported by Schueler (1999) of 10 to 100 fecal coliforms/100 ml from forested lands. Thus, 30 colonies/100 ml will be considered the background condition.

Data Availability and Analysis:

Watershed Characteristics:
Mill Creek, located in the Upper Saluda River basin, is a tributary to the Saluda River. The drainage area of concern for this TMDL is located in watershed 03050109-040 in Greenville County and consists of the area of land draining to station S-315. All references to the Mill Creek watershed in this TMDL refer specifically to the area draining to S-315. This area comprises 87.2 acres in the Piedmont region of South Carolina.

Mill Creek Watershed Land Use

Land Use	Acres	Percentage
Forest	0	0%
Agriculture/Grass	0	0%
Urban	87.2	100%

Fecal Coliform

SCDHEC monitors water quality on Mill Creek at ambient monitoring station S-315 once a month year round. Existing data from this monitoring station is available through STORET and is included in the data appendix. The geometric mean of fecal coliform using the most current five years of data (93-98) is 240 organisms/100ml.

Critical Conditions:

Novotny & Olem (1994) find 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 thought to be impacted by nonpoint sources in the Piedmont Region of South Carolina. This analysis showed summer fecal levels to be generally higher than or approximately the same as winter levels. Therefore, summer months (May-October) are generally considered critical conditions. This can be explained by the nature of summer and winter storm events. 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, longer and slower rain events are the norm. This pattern of rainfall does not allow for the high build-up of coliform that characterizes the summer. This, coupled with the increased winter flows that provide more dilution, usually results in lower winter fecal coliform concentrations.

In the Mill Creek watershed, the fecal coliform geometric means for warm weather months *are* substantially higher than that for a full year; 449/100ml vs 240/100ml. In fact cold weather samples (November-April) have a geometric mean below the 200/100ml standard (132/100ml). For this reason, warm weather conditions are a critical condition in this TMDL and the warm weather geometric mean of 449/100ml will be used as the load.

Flow

Critical period flow information for Mill Creek can be estimated using a warm weather generation coefficient derived from a nearby USGS flow station. For this TMDL station 02164000 on the upper Reedy River was used. This station is also located in metropolitan Greenville and has a predominantly urbanized watershed much like that of Mill Creek.

The warm weather generation coefficient (Gc) is established as follows:

$$Gc = \frac{\text{Mean flow from May-Oct in cfs}}{\text{Drainage are in square miles}}$$

For Metropolitan Greenville:

$$Gc = \frac{\text{63.9cfs(avg monthly flow may-october at USGS 02164000)}}{\text{48.6 square miles in upper Reedy River Watershed}}$$

Gc=1.315 cfs/square mile

For Mill Creek, the estimated average critical period flow is:

Q=0.136 square miles X 1.315 cfs/square mile
=0.179 cfs

Load Calculations:

With the observed warm weather geometric mean of 449 colonies/100 ml and the average critical period flow of 0.179 cfs, the current loading at S-315 is determined to be 1.967×10^9 organisms/day using the following equation:

Fecal Coliform * Qa * Factor = Loading

where: Fecal Coliform = # colonies/100ml
Qa = average critical period flow in cfs
Factor = conversion factor = 24468984
Loading = # fecal coliform colonies/day

Using the standard, a geometric mean of 200 colonies/100 ml, the allowable load during average critical period flow is 8.759×10^8.

TMDL Development:

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:

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

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 some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For bacteria, however, TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(l).

Since there are no contributing point sources, the TMDL for Mill Creek is equal to the load allocations from nonpoint sources and background conditions plus the MOS.

$$\text{Mill Creek TMDL} = \sum \text{LAs} + \text{MOS}$$

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.

This MOS is implicit through the use of a critical period and by establishing a target concentration level of 175 fecal coliforms/ 100 ml. This level is below the state standard of 200 fecal coliforms/ 100 ml.

TMDL

TMDL calculation:

The target level of fecal coliform bacteria is 175 fecal coliforms/100ml. For the Mill Creek watershed, this is equivalent to a loading of 7.665×10^8 fecal coliforms/day.

Allocation of Load:

Since the contributing watershed to this portion of Mill Creek is 100% Urban the entire existing load of 1.967×10^9 fecal coliforms/day must be reduced by 61.02% (1.200×10^9 #/day) to achieve the TMDL target of 7.665×10^8 fecal coliforms/day. So, an allocation strategy that will allow the target TMDL to be maintained is as follows:

Mill Creek Land Use	Current Loading	% Reduction	Final Loading
Urban	1.967×10^9	61% (1.2×10^9 #/day)	7.665×10^8

Implementation Strategy:

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 (NPS)TMDL. A variety of mechanisms both enforceable and voluntary can be applied in the Mill Creek Watershed.

In the year 2000 Greenville County will receive a Phase I Municipal Stormwater NPDES permit through SC DHEC's Industrial and Agricultural Permitting Division. This permit will mandate that the County and its co-permittees implement measures to control stormwater pollution inputs to all county waters receiving drainage through the major part of their stormwater transport infrastructure. Provisions of the permit that are expected to lessen NPS loads of fecal coliform are illicit discharge identification and elimination, home owner education, and adoption of BMP's by municipal service providers. Through the application of these measures in the Mill Creek Watershed, minimization of fecal coliform sources should be achieved through removal of any illicit sanitary sewer discharges, education of homeowners on proper pet waste management, and training of municipal workers on job related BMP's. At this time, it is not certain if the City of Greenville, the jurisdiction in which Mill Creek exists, will assent to becoming a co-permittee with Greenville County under a Phase I stormwater permit. In that case, the City will be required to apply for a Phase II permit sometime after October of 2001. The Phase II permit will require similar measures for reduction of NPS sources of fecal coliform bacteria.

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. DHEC's Appallachia II Environmental Quality Control District Office and and the Bureau of Water Enforcement Section will address sewage collection system problems, overflowing manholes, illicit sanitary sewer connections and other illegal discharges through existing authorities. The department has instituted a Sanitary Sewer Overflow Tracking System which will help track and bring into compliance problem collection systems.

In conjunction with county efforts related to the stormwater NPDES permit SCDHEC will work with existing agencies in this area to provide nonpoint source education in the Mill Creek watershed. Local sources of nonpoint source education include Clemson Extension Service, the Natural Resource Conservation Service (NRCS), the Greenville 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 Mill Creek Watershed in order to bring about a 61% reduction of fecal coliform bacteria to Mill Creek.

DHEC will continue to monitor water quality in Mill Creek according to the basin monitoring schedule in order to evaluate use support and the effectiveness of implementation measures.

Funding:

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 Mill Creek.

References

Bloxham, William M. 1979. Low-Flow Frequency and Flow Duration of South Carolina Streams. S.C. Water Resources Commission. Report Number 11.

Doran, J.W., J.S. Schepers, and N.P. Swanson. 1981. Chemical and Bacteriological Quality of Pasture Runoff. J. Soil Water Conserv. May-June:166-171.

Novotny, V. and H. Olem. 1994. Water Quality Prevention, Identification, and Management of Diffuse Pollution. Van Nostrand Reinhold, New York.

SCDHEC. 1997. Watershed Water Quality Assessment: Savannah and Salkehatchie River Basins. Technical Report No. 003-97.

SCDHEC. 1998. Implementation Plan for Achieving Total Maximum Daily Load Reductions From Nonpoint Sources for the State of South Carolina.

Scheuler, T. R. 1999. Microbes and Urban Watersheds: Concentrations, Sources, and Pathways. Watershed Protection Techniques 3(1): 554-565.

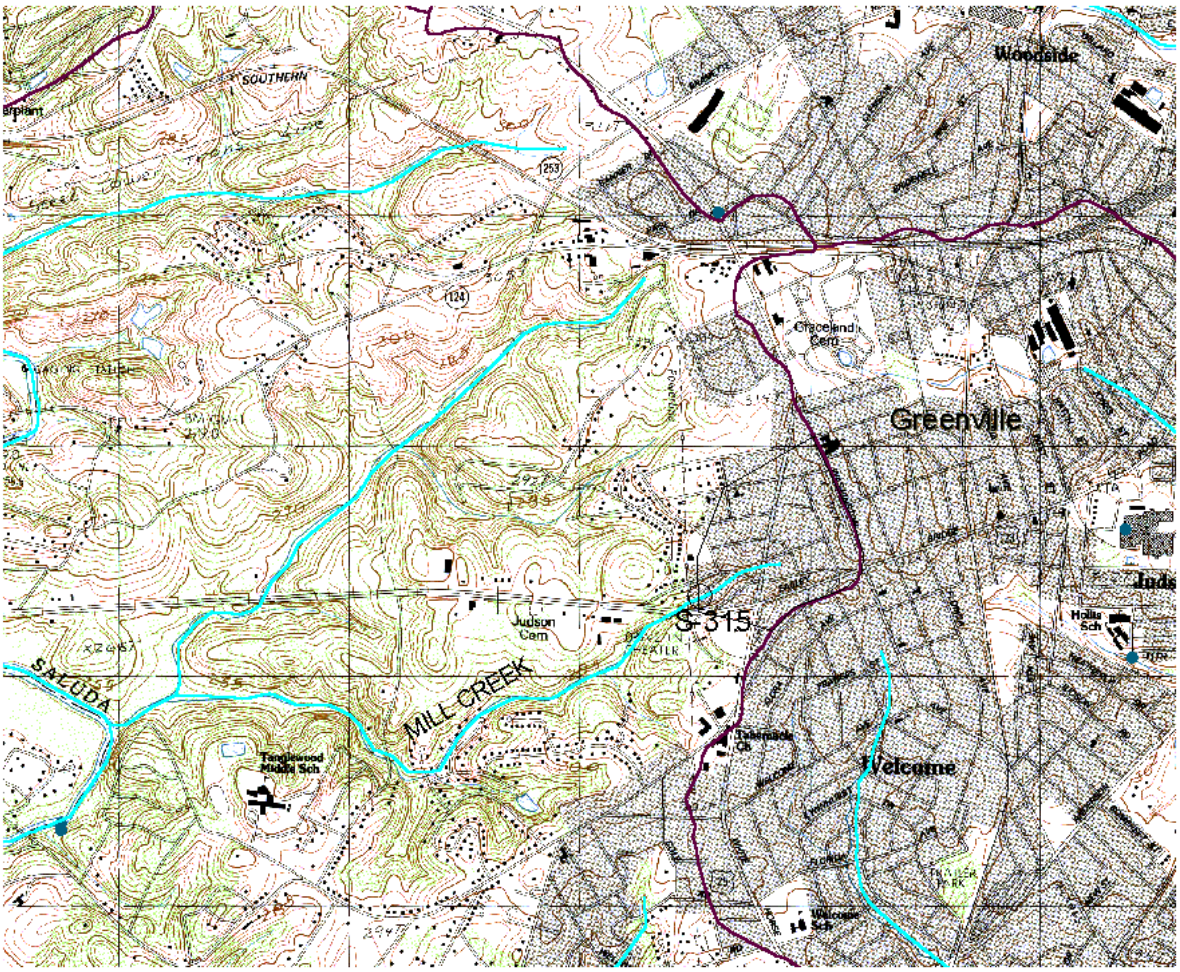
United States Environmental Protection Agency (USEPA). 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water, EPA 440/4-91-001.

Attachments

A. Map: Mill Creek Watershed

B. Calculations Sheet: S-315 Mill Creek TMDL

C. Data Sheet: S-315, Fecal Coliform


Woodside
SOUTHERN
Briant
Gracelend Cem
Greenville
Judson Cem
S-315
SALUDA
MILL CREEK
Tanglewood Middle Sch
Velcome
Hollis Sch

S-315 (Mill Creek)-Load Calculations

AREA

Acres	Square Miles
87.2335	0.136

FLOW

Equation:
1.315 cfs/square mile*.136squar miles=.179cfs

LOADING CALCULATIONS

	FC geo mean	Conversion Factor	Qa flow in cfs	FC #/day
Current level	449.00	24468984	0.179	1966596713
Standard	200	24468984	0.179	875989627.2
			difference	1090607086
			% difference	55.45657016
TMDL target	175	24468984	0.179	766490923.8
			difference	1200105789
			% difference	61.02%

Mill Creek FC data (1992-1998)

DATE	TIME OF DAY	DEPTH FEET	FEC COL MFM-FCB /100ML	WARM WEATHER DATA	COOL WEATHER DATA
1/5/92	1455		520		
5/11/92	1020		230		
6/18/92	920		55		
7/13/92	1005		95		
9/17/92	940		5		
10/28/92	1350		1400		
11/4/92	1050		20000		
12/10/92	1300		8000		
1/5/93	1455		520		520
2/19/93	1400		35		35
3/3/93	1340		440		440
4/15/93	940		520		520
5/12/93	1400		88	88	
6/3/93	1220		840	840	
7/27/93	1250		19	19	
8/18/93	1330		10	10	
9/22/93	1425		1100	1100	
10/13/93	1235		880	880	
11/5/93	1045		4500		4500
12/7/93	1315		940		940
1/12/94	1110		140		140
1/12/94	1450		490		490
2/1/94	1235		30		30
3/10/94	1230		140		140
4/13/94	1040		10000		10000
6/9/94	1250		1500	1500	
7/22/94	1300		370000	370000	
8/12/94	1400		820	820	
9/23/94	935		1600	1600	
10/31/94	1425		10	10	
11/4/94	1125		10		10
12/2/94	1140		10		10
2/3/95	1135		10		10

3/7/95	1045	150		150
4/26/95	1430	10		10
5/12/95	1140	460	460	
6/5/95	1520	33000	33000	
7/13/95	920	80	80	
8/25/95	1155	150	150	
9/14/95	1245	150	150	
10/23/95	1420	60	60	
11/16/95	1100	55		55
12/14/95	1100	50		50
1/3/96	1105	15		15
2/1/96	1250	25		25
3/14/96	1300	30		30
4/17/96	1240	71		71
6/14/96	1250	2000	2000	
7/26/96	1300	960	960	
8/16/96	1320	360	360	
9/20/96	1200	400	400	
10/25/96	1250	250	250	
11/20/96	1040	540		540
12/5/96	1100	160		160
1/24/97	1105	2200		2200
2/5/97	1115	480		480
3/4/97	1215	170		170
4/11/97	1230	390		390
5/1/97	930	230	230	
6/2/97	1120	6900	6900	
7/1/97	1345	4000	4000	
8/20/97	1300	700	700	
9/30/97	1100	290	290	
10/10/97	1325	100	100	
11/6/97	930	70		70
12/4/97	950	250		250
1/2/98	950	15		15
2/12/98	1050	45		45
3/4/98	1045	15		15
4/2/98	915	500		500
5/14/98	920	170	170	
6/12/98	1305	1100	1100	
7/1/98	950	460	460	
8/5/98	940	420	420	
9/1/98	1305	300	300	

10/27/98	925		100	100	
11/4/98	935		620		620
12/9/98	930		480		480
		GEO. MEAN	**240**	**450**	**133**

NOTICE OF AVAILABILITY OF PROPOSED TMDL
FOR WATERS AND POLLUTANTS OF CONCERN IN SC

The South Carolina Department of Health and Environmental Control (DHEC) has developed a proposed total maximum daily load (TMDL) for fecal coliform bacteria for Mill Creek located within Greenville County South Carolina.
The Department is proposing to establish this as a final TMDL. This TMDL has been developed in accordance with Section 303(d) of the Clean Water Act.

Persons wishing to offer comments or new data regarding the proposed TMDL may submit data and comments in writing no later than January 7, 2000 to: Andy Miller, DHEC, Bureau of Water, 2600 Bull Street, Columbia, SC 29201. For more information, please contact Mr. Miller at (803) 898-4031 or visit our website at www.state.sc.us/dhec/eqc/water/.

November 30, 1999

PUBLIC NOTICE

NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD
FOR WATERS AND POLLUTANTS OF CONCERN IN THE STATE OF SOUTH CAROLINA
Mill Creek in Greenville County

06/20/00

Section 303(d)(1) of the Clean Water Act (CWA), 33 U.S.C. §1313(d)(1)(C), and EPA's implementing regulation, 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 , accounting 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 (SC DHEC) has developed a proposed TMDL for the § 303(d)(1)(A) water, Mill Creek (Greenville County) and the pollutant of concern, fecal coliform bacteria, in watershed unit 03050109-040. The TMDL suggests a 61% reduction in fecal coliform loading from the urban areas necessary for Mill Creek to meet the fecal coliform standard. SC DHEC is proposing to establish this as a final TMDL.

Persons wishing to comment on the proposed TMDL or to offer new data regarding the proposed TMDL are invited to submit the same in writing no later than January 7, 2000, to:

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

Mr. Miller's phone number is 803-898-4031. His E-mail address is millerca@columb32.dhec.state.sc.us.

The proposed TMDL and the administrative record, including technical information, data, and analyses supporting the proposed TMDL, may be reviewed and copied at 2600 Bull Street, Columbia, South Carolina between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday, or are available by writing, calling, or e-mailing Mr. Miller at the address above. Copies will be provided at a minimal cost per page.

After review of comments, the proposed TMDL will be sent to EPA for approval shortly after January 7, 2000.