Total Maximum Daily Load (TMDL)

For

pH exceedences in

Durbin Creek Basin (Hydrological Unit Code: 03050108010)

Water Quality Monitoring Station: B-097

April 20, 2006

SCDHEC Technical Report Number: 017-06

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South Carolina Department of Health and Environmental Control

Bureau of Water
2600 Bull Street
Columbia, SC 29201

Executive Summary

Water Quality Monitoring Station, B-097, located on Durbin Creek, has been placed on the SC's 2004 303 (d) list of impaired waters due to pH excursions. Durbin Creek is a part of the Enoree River Basin (8-digit HUC 03050108), which is located in portions of Union, Spartanburg, Newberry, Laurens, and Greenville counties. The Durbin Creek Watershed (14-digit HUC 03050108-010-090) consists of 32,883 acres (51.4 mi^2) (Figure 1). Based on 1996 USGS Multi-Resolution Land Characteristic (MRCL) land use data, 58% of the watershed is forested. The remaining 42% is composed of urban area (6%), cropland (19%), pastureland (16%), and a small mix of water (0.2%) and barren (0.3%) land uses. Currently, there are no permitted point sources discharging into Durbin Creek above WQMS B-097. Greenville County is the only Phase 1 Municipal Separate Storm Sewer Systems (MS4s) designated in the Durbin Creek Watershed. The towns of Simpsonville and Fountain Inn are considered regulated small MS4s.

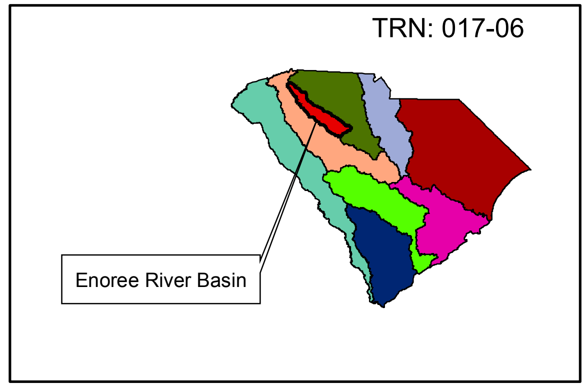
The applicable water quality criterion for pH is 6.0 to 8.5 standard units. It is concluded that point sources do not contribute to the pH excursions since none exist above the monitoring station; however, it cannot be deduced that the excursions are the result of non-point source activity and/or natural conditions since the data to justify these conclusions is lacking. Further evaluation is needed to determine the reason for the violations. The wasteload allocation for any new dischargers for this TMDL should continue to meet the pH criteria end-of-pipe administered through the NPDES permitting process. Additional surface and groundwater monitoring is recommended to identify any problem areas causing pH exceedences in Durbin Creek. If the causes were determined to be attributed to natural causes, then the pH goal in this TMDL would be deemed unattainable; however, if the causes were anthropogenic then a revision of this TMDL would be appropriate. The pH TMDL target for both point sources and nonpoint sources in the Durbin Creek watershed is 6.0 to 8.5 standard units.

Table of Contents

List of Figures and Tables

Durbin Creek pH TMDL

Figure 1
Enoree River Basin
03050108



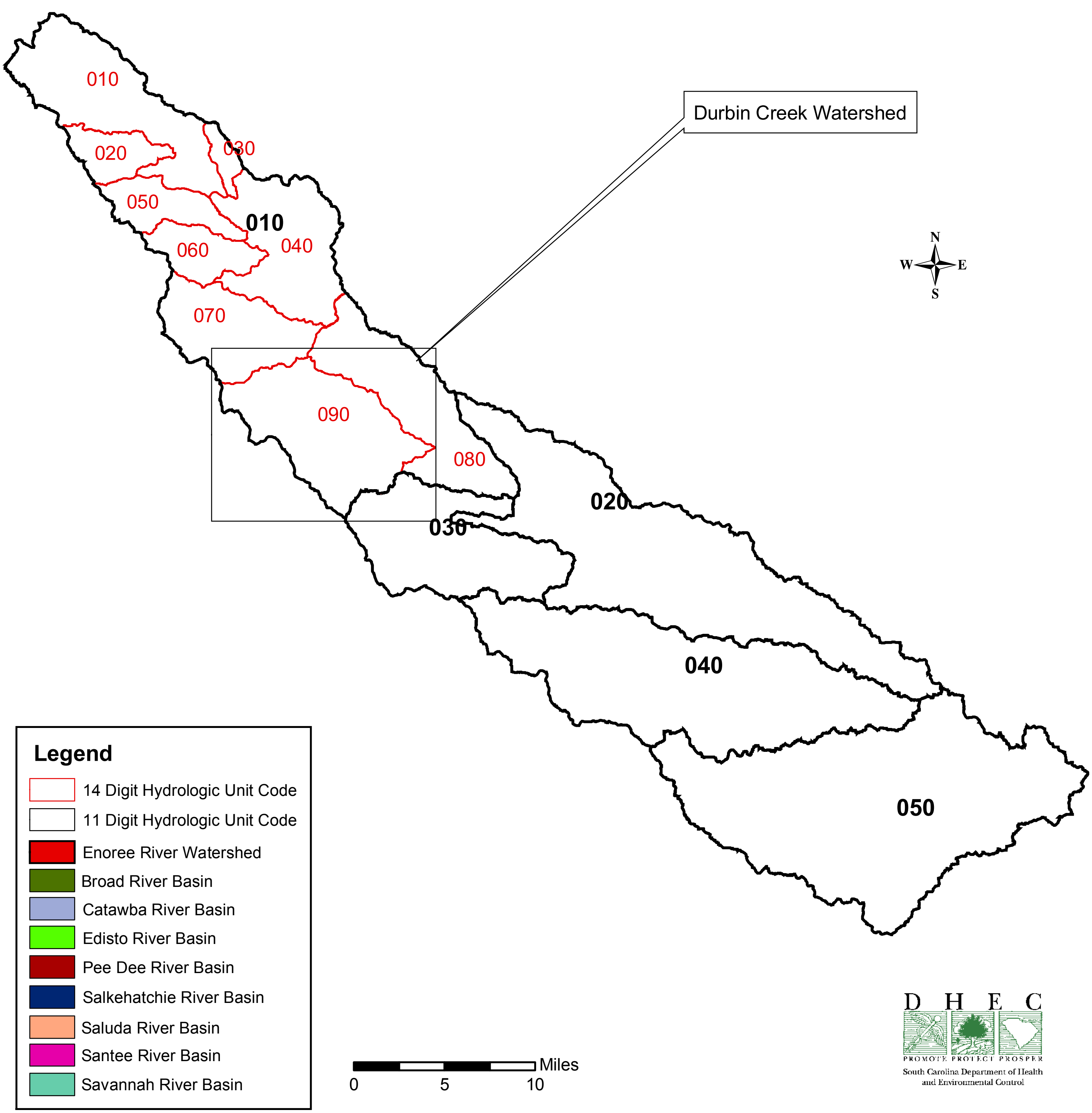
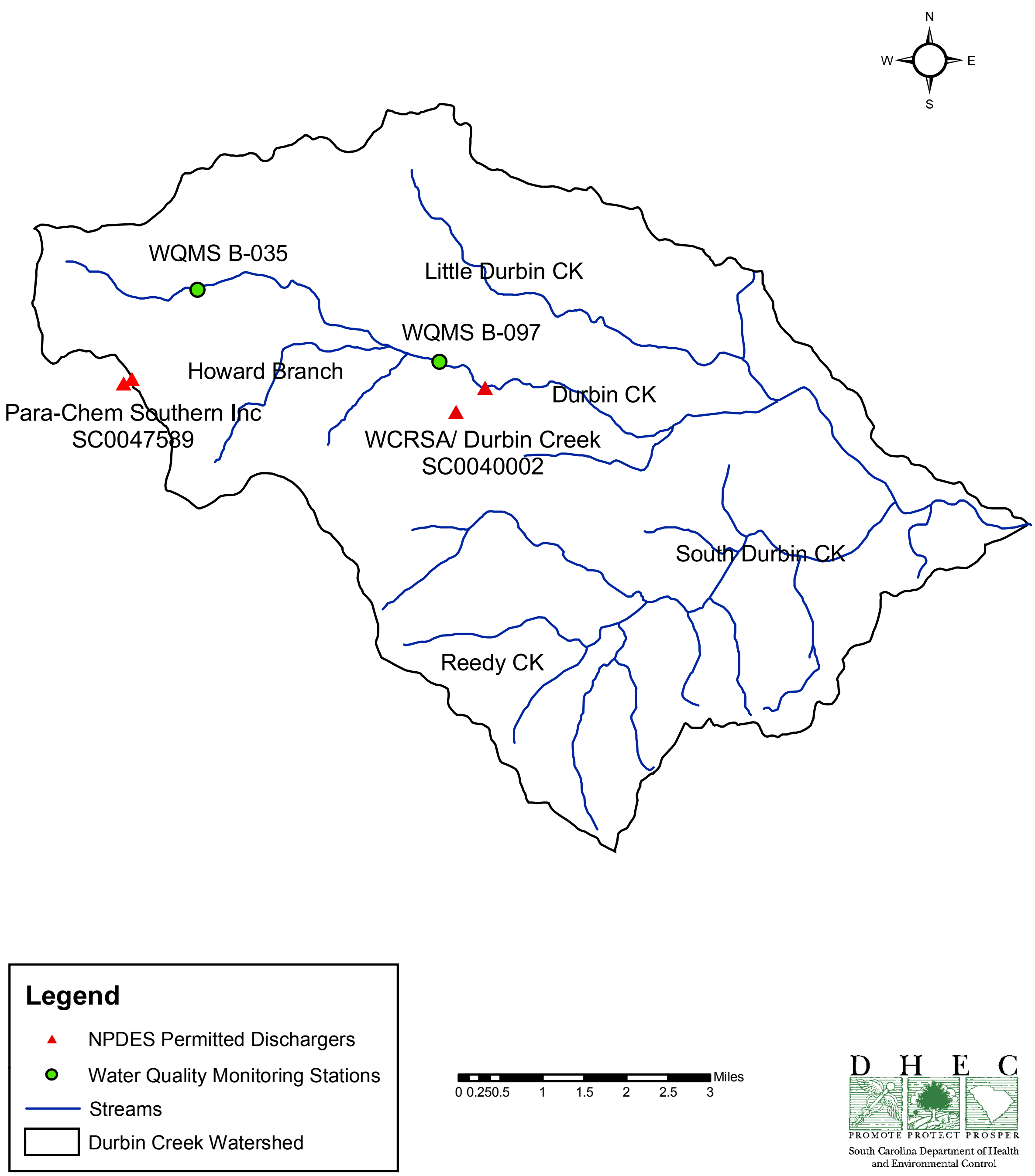


Figure 2
Durbin Creek Watershed



Introduction

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 waterbodies that do not meet designated uses under technology-based pollution controls. The development of a TMDL establishes an assimilative capacity loading for individual pollutants and other quantifiable constituents so that states may implement water quality based controls for all pollution sources to aid in the long-term restoration and maintenance of their waters.

Watershed Description

Landuse

The Enoree River Basin (8-digit HUC 03050108) is located in portions of Union, Spartanburg, Newberry, Laurens, and Greenville counties. It is located in the Broad River Basin. Enoree watershed consists of 167,337 acres (261.5 mi^2) of the Piedmont region of South Carolina (See Figure 1).

The Durbin Creek watershed is located in the 12-digit HUC 03050108010 of the Enoree River Basin. Durbin Creek starts near the city of Simpsonville and drains into the Enoree River after accepting drainage from Howard Branch, Wilson Branch, Little Durbin Creek, and South Durbin Creek (Reedy Creek). The Durbin Creek Watershed consists of 32,883 acres (51.4 mi^2) (Figure 1). Based on 1996 USGS Multi-Resolution Land Characteristic (MRCL) land use data, 58% of the watershed is forested. The remaining 42% is composed of urban area (6%), cropland (19%), pastureland (16%), and a small mix of water (0.2%) and barren (0.3%) land uses. Table 1 presents the percentage of total watershed area for each aggregated land use.

This TMDL addresses the portion of the watershed (14 mi^2) above the South Carolina Monitoring Station B-097. Table 2 presents the percentage of land use area in the monitoring station, B-097. Figure 3 illustrates land use for the Durbin Creek Basin.

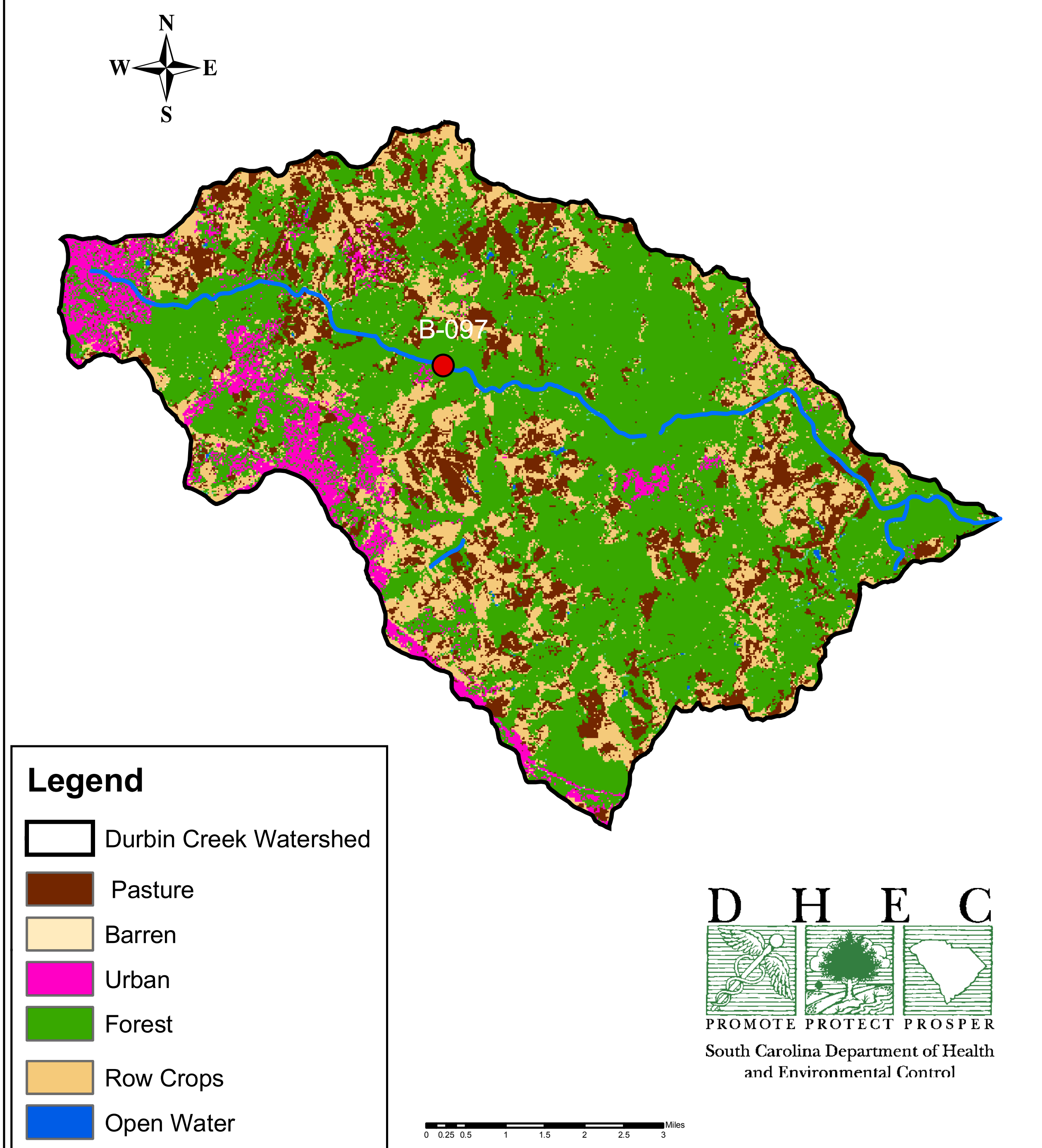
Table 1. MRLC Aggregated Land Use in the Durbin Ck Watershed (03050108)

Land use	Total Area (mi^2)	Percent of Total Area
Forested	29.9	58.2
Urban	3.2	6.1
Row Crops	9.8	19.1
Pasture	8.2	16.1
Barren	0.17	0.3
Water	0.08	0.2
Total	51.35	100.0

Table 2. MRLC Aggregated Land Use above WQMS B-097

Land use	Total Area (mi^2)	Percent of Total Area
Forested	7.2	51.4
Urban	2.2	15.5
Row Crops	2.3	16.5
Pasture	2.3	16.4
Barren	0.01	0.1
Water	0.01	0.1
Total	14	100.0

Figure 3
Durbin Creek Basin Land Use



Soils

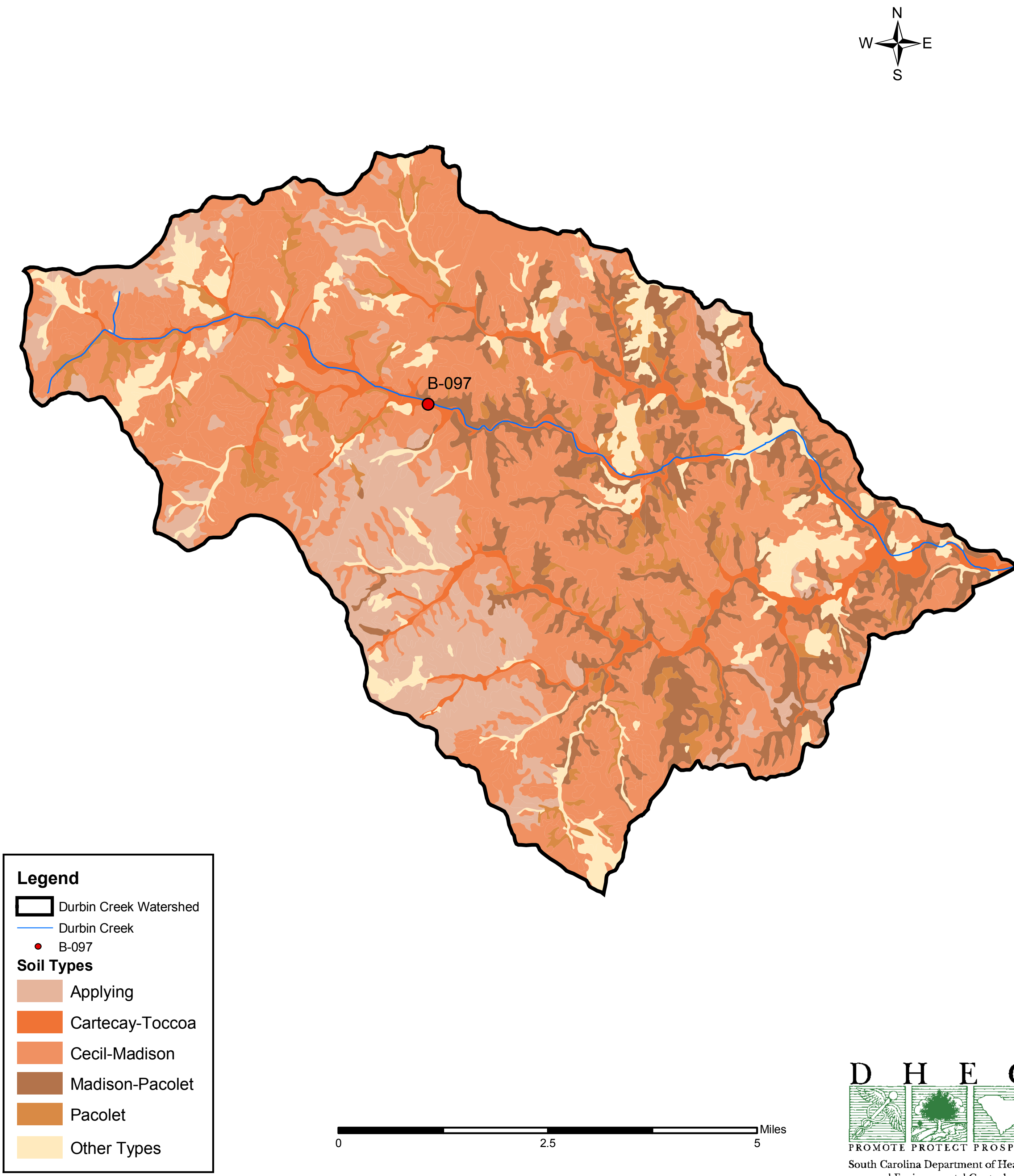
The soils in the Durbin Creek watershed are comprised mostly of Cecil-Madison series with averages of 0.27 for erodibility and 10% for slopes. Table 3 shows the breakdown of the soil types and their associated pH located in the Durbin Creek Watershed. Cecil-Madison series makes up about 52.8 % of the soil types and has an associated pH range of 4.5- 6.1. Figure 4 shows the distribution of the soil types in this watershed.

Table 3. Soils Breakdown and Associated pH in the Durbin Creek Watershed

Soil Type*	Square Miles	Percent	Associated pH*
Appling	7.14	14.0	4.8-6.4
Catecay-Toccoa	2.87	5.7	4.8-5.9
Cataula	0.64	1.2	5.1-6.1
Cecil-Madison	27.05	52.8	4.5-6.1
Chewacla	0.78	1.5	5.3-6.5
Colfax	0.06	0.1	5.1-5.6
Durham	0.24	0.4	5.0-7.4
Enon	0.09	0.2	5.6-6.5
Enoree	0.31	0.6	6.1-6.2
Helena	0.11	0.2	4.5-5.2
Hiwassee	1.02	2.0	5.0-6.5
Louisburg	0.7	1.4	5.3-5.9
Madison-Pacolet	6.27	12.3	4.5-5.9
Mecklenburg	0.02	0.04	5.6-6.2
Pacolet	3.1	6.1	4.5-5.5
Vance	0.53	1.1	5.3-5.6
Wehadkee-Chewacla	0.36	0.8	5.6-6.2
Wilkes	0.06	0.1	5.5-6.7
Total	51.35	100.0	

*Source: Soil Survey of Greenville and Laurens County, SC by USDA

Figure 4
Soil Types in the Durbin Creek Watershed



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Climate

Figures 5 and 6 show the climatic patterns for the Durbin Creek counties (Greenville-Spartanburg International Airport). Air temperatures in this basin are lower in the fall and winter and increase to peak in the months of July and August. Precipitation (mean daily and max daily) in the Durbin Creek watershed is generally highest in spring and lowest in the summer months. See Appendix A-1 for more climatic data.

Figure 5. Air Temperature (F) in the Durbin Creek Counties

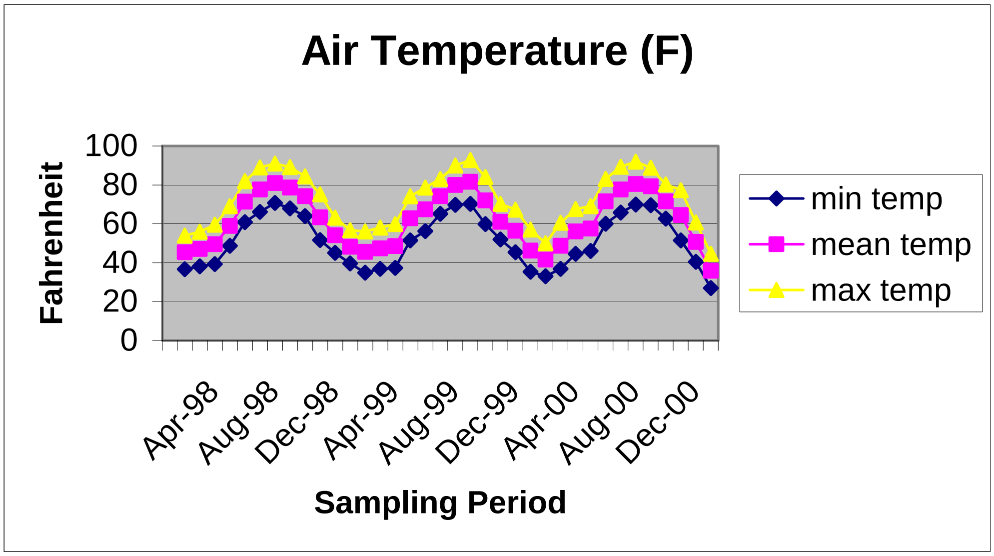
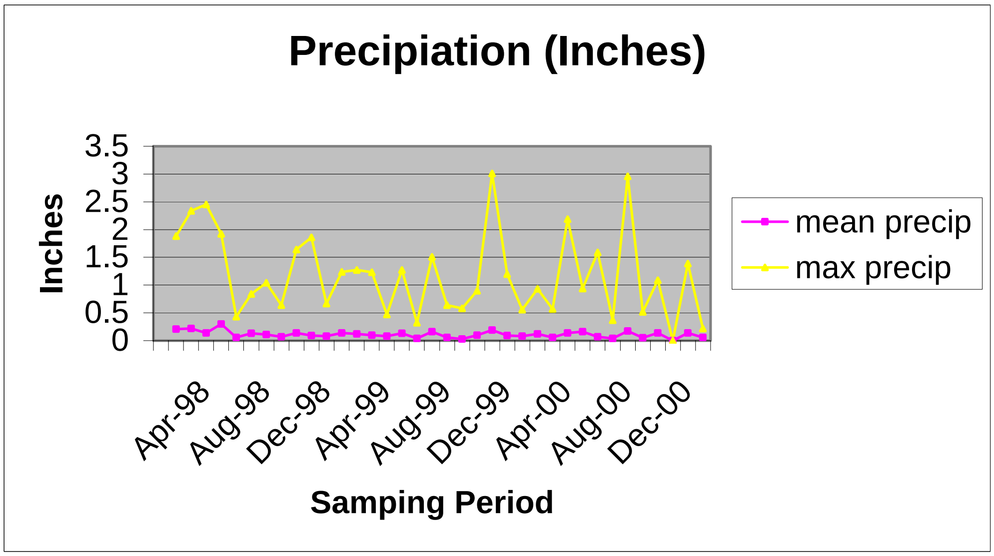


Figure 6. Precipitation (inches) in the Durbin Creek Counties



Hydrology/ Streamflow

The mean annual flow in Durbin Creek has decreased severely over the past few years due to a drought in the southeastern US (Figure 7). Figure 8 shows that during the Water Years 1999 to 2002, there was a decrease in the mean daily flow due to the drought. Peak flow in this stream generally occurred during the late winter/early spring and low flows during the summer months. Peak flows in this stream generally respond immediately to episodic storm events, which are common in this location.

Figure 7. Mean Annual Flow in Durbin Creek Above Fountain Inn @ USGS Station # 02160381

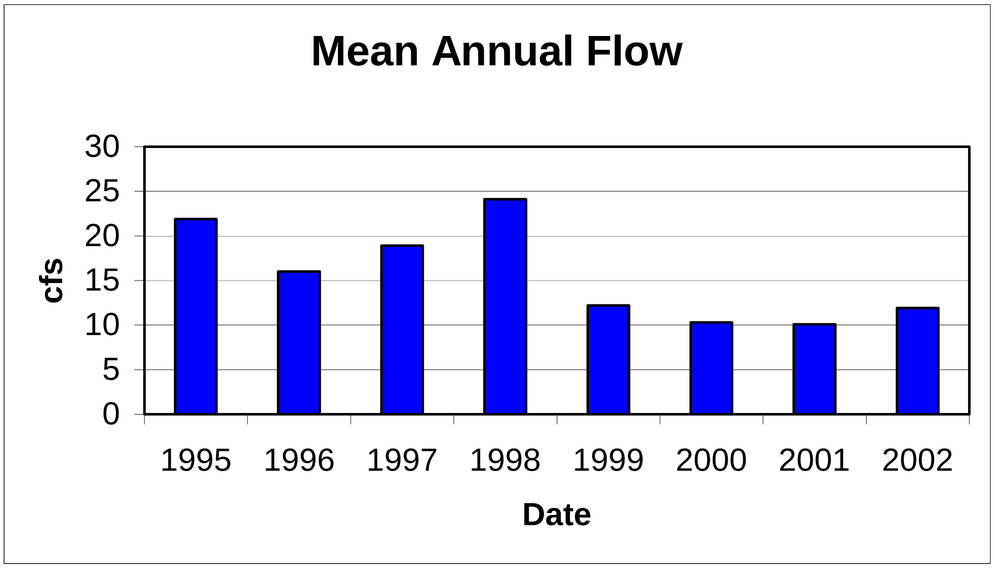
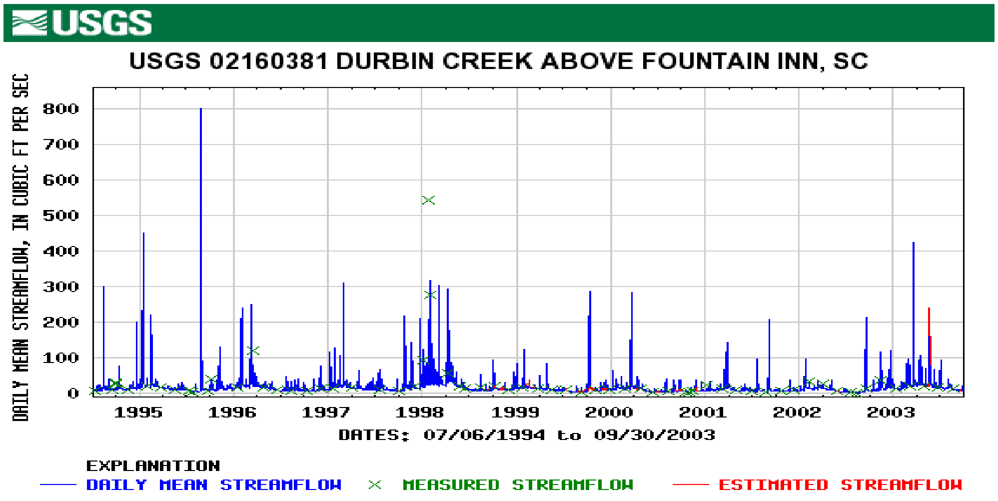


Figure 8. Durbin Creek Hydrograph



Water Quality Standard

South Carolina Water Quality Standard

The impaired stream segment of the Durbin Creek is designated as Class Freshwater. Waters of this class are described as:

> "Freshwaters suitable for primary and secondary contact and recreation and as a source of 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 pH in freshwater is:

> "Between 6.0 and 8.5 [standard units]." (R.61-68)

Problem Definition

South Carolina has listed this segment of Durbin Creek (WQMS B-097) on the 2004 and 2006 303d list(s) due to low pH levels that fail to meet the state's standard range for waters classified as Freshwaters. Since this criterion has not been met, it can be concluded that aquatic life use is not supported thus it is listed as impaired. One of the most significant environmental impacts of pH involves synergistic effects. Agricultural, domestic, and industrial runoff may contain metals, ammonia, or other elements. The pH of the receiving waters will determine the toxic effects, if any, of these substances. For example, metals are more soluble in acidic waters and thus more bioavailable to aquatic life.

Water Quality Assessment

Monitoring Data

pH measurements were taken in Durbin Creek monthly from 1998 through 2000. The data in Table 4 below show that 8% of the samples tested were not in compliance with the SC Water Quality Standard in 1999 and 25% of the samples did not meet the standard in 2000. During this review period, a total of 12% of the sample failed to meet the pH criterion thus the Durbin Creek was placed on the 2004 303 (d) list as impaired for pH. The pH violations occurred during late summer and early fall conditions. (See Appendix A-2 and A-3 for more detailed data.)

No biological impairments were documented in this portion of Durbin Creek watershed. The extent of the pH impairments on the macroinvertebrate community has not been evaluated.

Table 4. pH Exceedences in Durbin Creek @ WQMS B-097

Year	# Samples	# Exceedences	% Exceedence
1998	10	0	0 %
1999	12	1	8 %
2000	12	3	25%
Total	34	4	12 %

Pearson's Correlation

To look at the correlation between pH and the other water quality variables, Pearson's correlation was used, which is the most common measure of correlation. It reflects the degree of linear relationship between two variables. When computed for a sample, it is designated by the letter "r" and has a value ranging from –1 to +1. The larger the value, regardless of the sign, the stronger the association is between the two variables. A correlation of +1 means that there is a perfect positive linear relationship between variables. A correlation of -1 means that there is a perfect negative linear relationship between variables. A correlation of 0 means there is no linear relationship between the two variables.

Table 5 shows the correlation between pH and various water quality variables. Turbidity, DO, and Nitrate + Nitrite have a slightly stronger association than the other variables. There is almost no association between ammonia and BOD_5 and pH in Durbin Creek. Though there are stronger associations between pH and various water quality parameters, none of the relationships appear to be important, i.e. they do not possess a strong correlation to pH in this section of Durbin Creek.

Table 5. Pearson's Correlation Coefficients for Durbin Creek @ WQMS B-097

Correlations	Pearson's r
Air Temp and pH	-0.12
Flow and pH	0.18
Turbidity and pH	-0.33
Ammonia and pH	0.08
DO and pH	0.31
BOD_5 and pH	-0.08
Nitrate + Nitrite and pH	0.37
Water Temp and pH	0.23

Source Assessment

This TMDL evaluation focuses on identifying those controllable and uncontrollable pH-altering sources in the Durbin Creek Watershed. pH-altering sources can result from either point or nonpoint sources. All point sources must have a National Pollutant Discharge Elimination System (NPDES) permit. Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. Some nonpoint sources are related to land use activities.

Point Sources

An evaluation of the current permitted point sources discharging to Durbin Creek was assessed to see if they had violated their pH standard. As shown in Table 6, one discharger is located approximately 4.7 mi upstream of WQMS B-097 discharging into an unnamed tributary of Durbin Creek. Their current pH limits are 6.0 – 8.5 standard units. A compliance history of 9.5 years shows no NPDES permit violations of the pH criterion.

Table 6. Identified NPDES Permitted Discharges Upstream of WQMS B-097.

Point Source	NPDES Permit	pH limit	Receiving Waterbody
Para-Chem Southern Inc.	SC0047589	6.0 – 8.5	Tributary to Durbin Creek

Urban Development

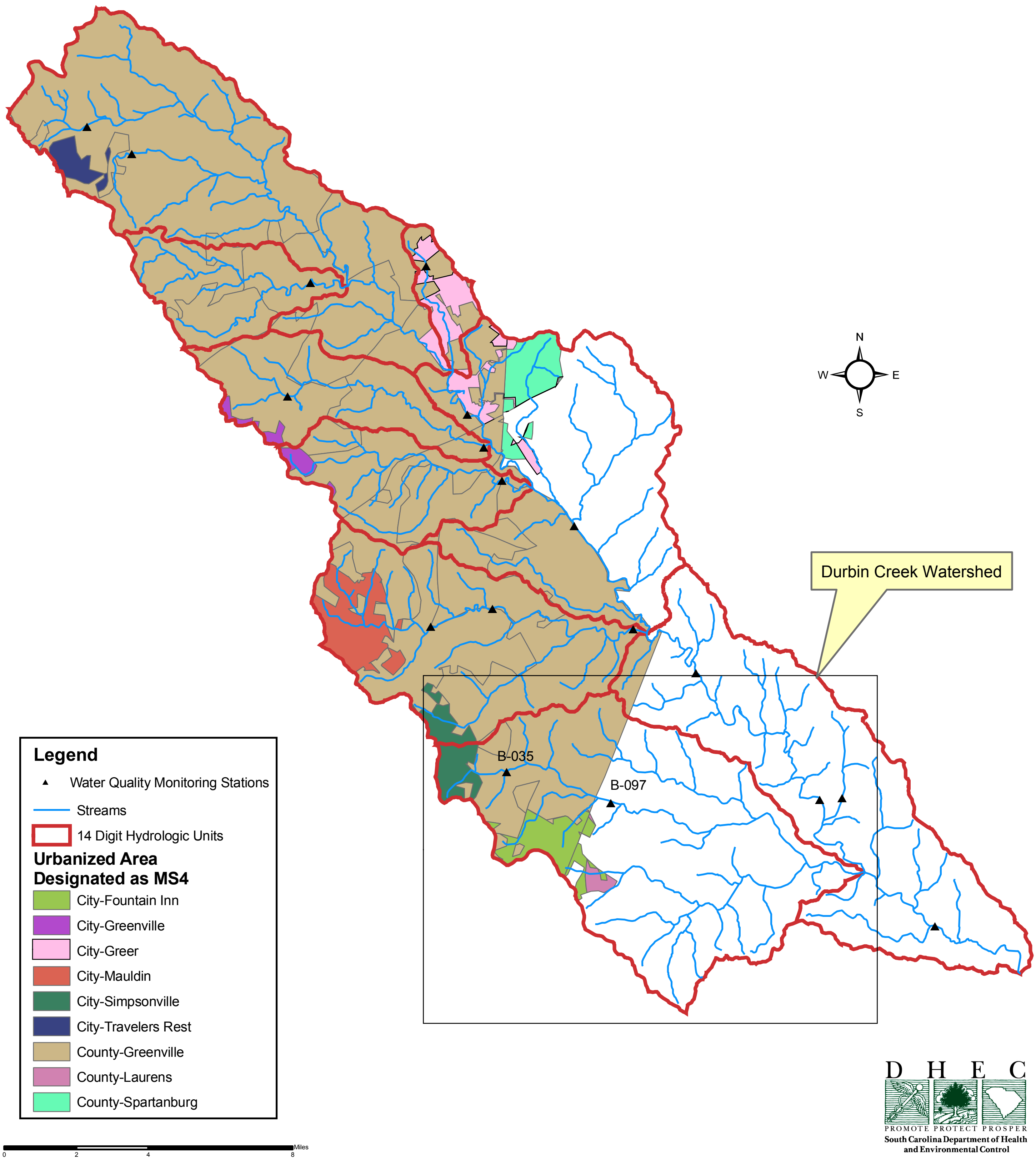
Urban areas may also contribute to pH alterations in Durbin Creek. Stormwater runoff contributions from these areas mainly come from construction sites and residential areas. However, due to such a low percentage of urban area in the Durbin Creek watershed, 15.5%, this source of pH-alteration is considered to be minor.

Municipal Separate Storm Systems (MS4s)

In 1990, EPA developed rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) storm water program, designed to prevent harmful pollutants from being washed by storm water runoff into Municipal Separate Storm Sewer Systems (MS4s) and then discharged from the MS4 into local waterbodies. Phase I of the program required operations of “medium” and “large” MS4s (those generally serving populations of 100,000 or greater) to implement a storm water management program as a means to control polled dischargers from MS4s. Approved storm water management programs for medium and larger MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc. Greenville County is the only Phase 1 MS4 designated in the Durbin Creek Watershed.

Phase II of the rule extends coverage of the NPDES storm water program to certain “small” MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Storm Water Program. Only a select subset of small MS4s, referred to as “regulated small MS4s”, require a NPDES storm water permit. Regulated small MS4s are defined as all small MS4s located in “urbanized areas” as defined by the Bureau of the Census, and those small MS4s located outside of a UA that are designated by NPDES permitting authorities. The towns of Simpsonville, located in the northwest part of the Durbin Creek Watershed, and Fountain Inn, located in the western portions of the watershed, are considered regulated small MS4s. A small part of Greenville County and the city of Laurens are considered to be “potential regulated small MS4s” and if designated as one, they may be required to obtain a MS4 permit. See Figure 8 for a depiction of the MS4’s coverage.

Figure 9
Designated MS4 Areas in Enoree River Watershed



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Nonpoint Sources

Acidic Soil

There are four main reasons for soils to become acidic: rainfall and leaching, parent material, organic matter decay, and agriculture practices. Also soils in hot and humid climates tend to be more acidic.

Rainfall and Leaching

Acid rain causes acidification of lakes and streams. It flows over and through the ground thus adding to both ground water and surface water acidity. Acid rain also may be gases and particles falling to the ground and covering objects, e.g. trees and homes. They are then washed from these objects via rainstorms. The runoff from these storms eventually flows into the surface water thus also adding more acidity to these waters. The 2000 South Carolina Air Quality Annual Report states that the weighted average of pH for the state from 1991 – 2000 is 4.452 s.u. Though acid rain may contribute to the pH violations in Durbin Creek, it is considered to be outside the scope of this TMDL.

Excessive rainfall leaches the soil's basic elements that prevent soil acidity. The major soil type found in Durbin Creek, Cecil-Madison, is considered to be well drained meaning that infiltration is high. As water moves through the soil, H+ combine with carbon dioxide (CO_2) and other compounds forming weak acids. Then these weak acids leach calcium and other bases away from the soil leaving soil more acidic than before.

Parent Material

The type of rock that is predominantly found in the Upstate watersheds of South Carolina is granite. Limestone is more commonly found in the piedmont regions. Soils that are derived from weathered granite have a tendency to be more acidic those soils developed from limestone or shale.

Organic Matter Decay

Since 58% of Durbin Creek watershed is forested, contribution of this land use to pH alteration was assessed. Forested land may contribute to altered pH by high amounts of decaying organic matter, e.g. pine needle decay (Duffy *et al.* 1991). Organic matter decay generates hydrogen ions (H^+), which are responsible for acidity. Acidic soil development from decaying organic matter and rainfall is insignificant in the short term when compared to high-yielding crops.

Agriculture Practices

Since 35% of the Durbin Creek Watershed is agriculture, its possible contribution to the pH violation was investigated. Agriculture practices play a significant role in increasing acidity mainly through the addition of acidifying fertilizers, increased nitrate leaching, and exportation. High-yielding crops are the leading cause of increased acidity in soil. During the growing season, the crops absorb basic soil elements (Ca, Mg, K) for their own nutrimental diets. These compounds are essential to prevent soil acidity. Thus, as the crop yield increases and their biomass removed, these lime-like substances are also eliminated leaving the soil vulnerable to acidity.

Total Maximum Daily Load Development

Definition

Traditional total maximum daily loads (TMDLs) comprise the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels for a given watershed. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relation between the pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$\textbf{TMDL = WLAs + LAs + MOS}$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while achieving water quality standards. TMDLs establish allowable waterbody loadings that are less than or equal to the TMDL and thereby provide the basis to establish water-quality-based controls.

TMDL, Las, and WLAs (including any future NPDES facilities and MS4s) are all expressed in standard units of pH in accordance with 40 CFR 130.2 (i) which states that TMDLs can be expressed in terms of “mass per time (e.g. pounds per day), toxicity, or other appropriate measure.” Thus, for this TMDL, pH standard units have been deemed as the appropriate measure.

Sources

Point Sources

Point source contribution was assessed for Durbin Creek. The one discharger located in this part of Durbin Creek Watershed is required to meet the pH standard Their discharge monitoring report from 1995- 2005 does not show any violation of the pH standard. Furthermore, WQMS B-035 located approximately 1.2 mi downstream of Para-Chem Southern Inc and 3.4 mi upstream from WQMS B-097, is not listed on the 2004 303d list for pH impairments. Thus, does not show to cause or contribute to the pH impairment of Durbin Creek. However, all new NPDES permits issued within the Durbin Creek watershed should have a WLA of 6.0 to 8.5 standard units. The NPDES permitting process should implement these allocations.

MS4's

Greenville County has been designated as a MS4 under NPDES Phase I Stormwater rules. Parts of this MS4 are in the Durbin Creek Watershed. Also the cities of Simpsonville and Fountain Inn are designated as a MS4 under NPDES Phase II Stormwater Rules. Parts of these MS4's are in this watershed (Figure 8). Approximately 15.5% of Durbin Creek Watershed is considered urbanized land. 62% of this urbanized land area under MS4 Phase I stormwater rules fall under jurisdiction of the Greenville County. 10% and 18% of this urbanized land under MS4 Phase II stormwater rules fall under jurisdiction of the Cities of Simpsonville and Fountain Inn respectively. The city of Laurens and a small portion of Greenville County that may be considered as "potential small MS4's" make up about 7% and 3% of the urbanized land. Runoff from developed land that is collected by storms sewers and discharged untreated into the streams is potentially a significant source of contamination to Durbin Creek and tributaries. The pH TMDL target for MS4s in the Durbin Creek watershed is 6.0 to 8.5 standard units.

Nonpoint Sources

There are possible nonpoint sources that could augment the exceedences of the pH standard in Durbin Creek at the SC Monitoring Station B-097; however, there is not enough information presently to differentiate nonpoint source loads and/or natural condition loads, which may influence pH. The pH TMDL target for nonpoint source in the Durbin Creek watershed is 6.0 to 8.5 standard units.

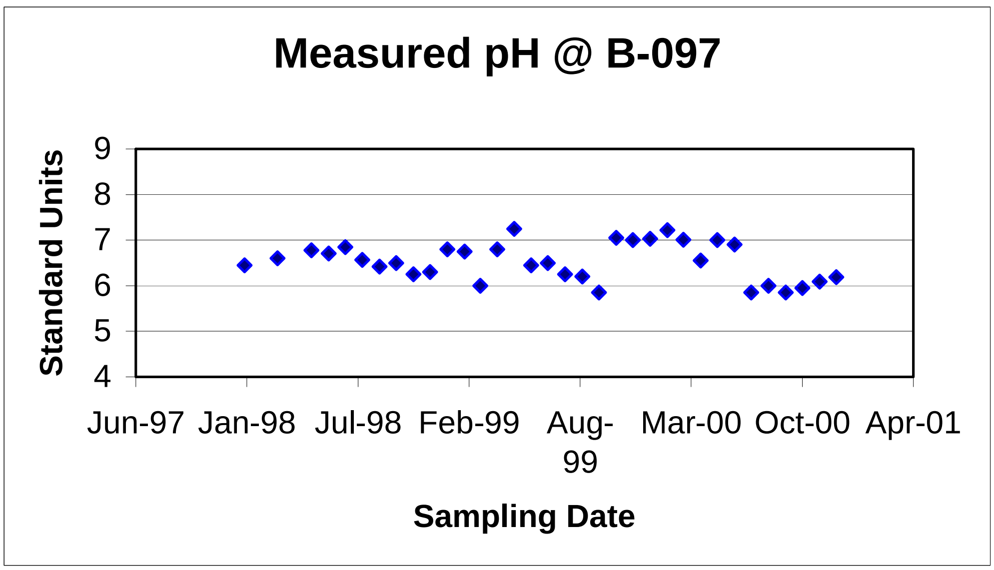
Margin of Safety

There are two methods for incorporating the MOS (USEPA, 1991). The first way is implicitly incorporate the MOS using conservative model assumptions to develop allocations. The second is explicitly specifying a portion of the total TMDL as the MOS and use the remainder for allocations. The allocations used in this TMDL warrant that the loads from any source must individually meet the pH goal of 6.0 to 8.5 standard units at the point of discharge. If both point and nonpoint sources are consistent with these allocations then any excursions would be considered natural. No additional margin of safety for Durbin Creek was deemed necessary.

Seasonal Variation

The pH levels were normally above 6 s.u. except in Oct 1999, July 2000, Sept 2000, and Oct 2000 when it fell below 6 s.u. A slight seasonal fluctuation was noticed (Figure 10). The pH in Durbin Creek at WQMS B-097 seemed to fall slightly during the fall and peak in the spring. The slightly higher precipitation in the fall yields slightly more acidic soil in the fall due to higher infiltration rate. This (pore) water will eventually make its way to either the groundwater via percolation or surface water via runoff consequently leading to somewhat more acidic surface water. However, this event is considered natural hence uncontrollable. See Appendix A-3 for the exact pH measurements.

Figure 10. pH Values @ WQMS B-097



Recommendations

The wasteload allocation for any new dischargers for this TMDL should continue to meet the pH criteria end-of-pipe administered through the NPDES permitting process. Additional surface and groundwater monitoring is recommended to identify any problem areas causing pH exceedences in Durbin Creek. If the causes were determined to be attributed to natural causes, then the pH goal in this TMDL would be deemed unattainable; however, if the causes were anthropogenic then a revision of this TMDL would be appropriate.

References

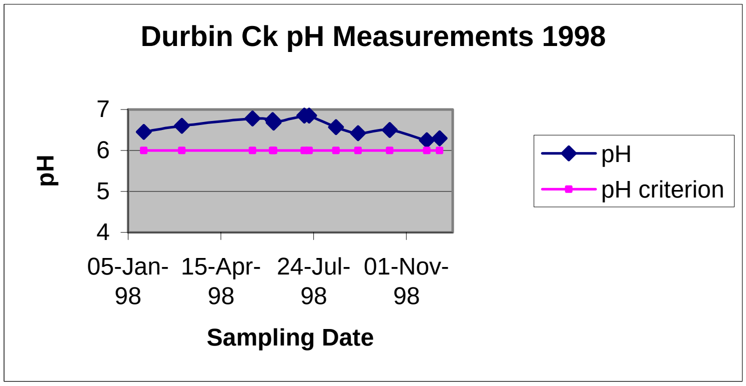
1. Duffy, P. D., J.D. Schreiber, and L.L. McDowell. 1989. Nutrient flux through a loblolly pine forest floor using simulated rainfall. *Soil Sce. Soc. Am. J.* 53(3): 951-957.
2. MDEQ. TMDL for Low pH in Turkey Creek Coastal Streams Basin, Harrison County, Mississippi.
3. SCDHEC. 2004 Section 303 (d) List
4. SCDHEC. Water Classifications and Standards (R.61- 68), Revised 2004
5. USEPA. Guidance for Water Quality-based Decisions: The TMDL Process. USEPA, Office of Water, Washington DC. EPA/440/4-91-001, April 1991.
6. USEPA. Proposed: TMDL for pH Exceedences in Ebenezer Creek, GA. April 30, 2004.
7. USDA. Soil Survey of Greenville County, SC.
8. USDA. Soil Survey of Laurens County, SC.
9. USGS Website (Flow data)

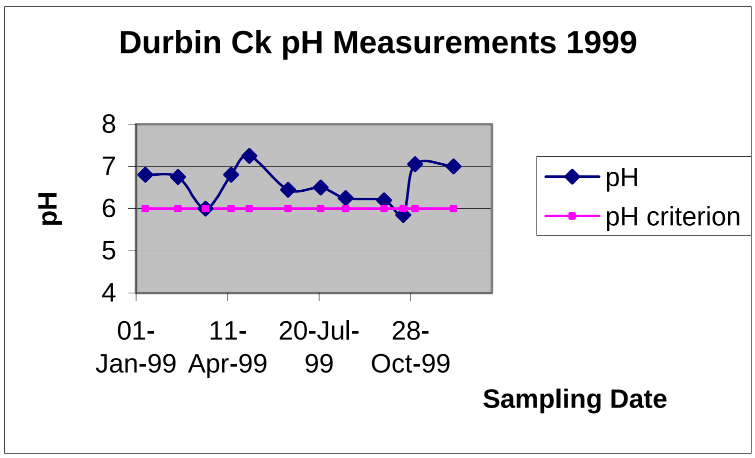
Appendix A-1. Climatic Data* for the Durbin Creek Watershed Counties.

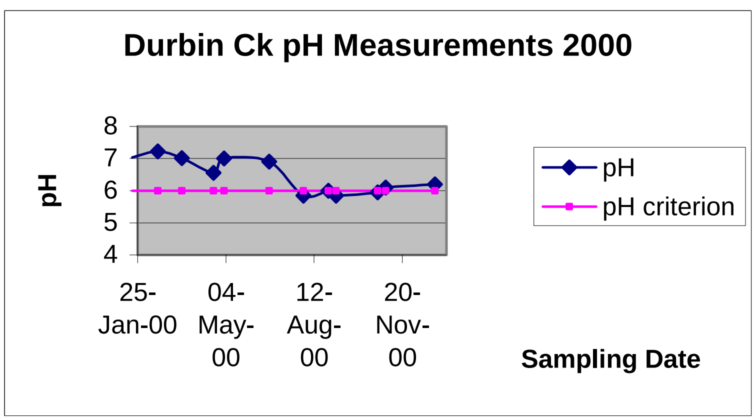
Date	MIN T (F)	MEAN T	MAX T	MEAN P (IN)	MAX P	TOTAL P
Jan-98	36.7	45.4	54	0.21	1.88	6.76
Feb-98	38.2	47.1	55.9	0.22	2.34	6.94
Mar-98	39.3	49.5	59.6	0.14	2.45	4.31
Apr-98	48.7	58.9	69.1	0.3	1.92	9.15
May-98	60.8	71.4	81.9	0.06	0.43	1.77
Jun-98	66.1	77.6	88.9	0.13	0.84	3.8
Jul-98	70.8	80.9	91	0.11	1.04	3.27
Aug-98	68	78.6	89.1	0.07	0.64	2.27
Sep-98	63.9	74.2	84.4	0.14	1.64	4.31
Oct-98	51.6	63.4	75.2	0.09	1.86	2.77
Nov-98	45	54.1	63.2	0.08	0.67	2.39
Dec-98	39.6	48.2	56.7	0.14	1.24	4.24
Jan-99	34.9	45.5	56.1	0.12	1.27	3.84
Feb-99	36.8	47.4	58	0.1	1.23	2.84
Mar-99	37.4	48.6	59.8	0.08	0.47	2.33
Apr-99	51.5	62.9	74.2	0.13	1.27	3.95
May-99	56.2	67.5	78.7	0.04	0.32	1.37
Jun-99	65.2	74.1	83	0.16	1.51	4.67
Jul-99	69.8	79.9	89.9	0.06	0.64	1.95
Aug-99	70.2	81.5	92.7	0.03	0.58	0.79
Sep-99	59.9	72	84	0.1	0.9	3.04
Oct-99	51.9	61.1	70.3	0.19	3.01	5.86
Nov-99	45.4	56.4	67.3	0.09	1.2	2.67
Dec-99	35.3	46.2	57	0.08	0.56	2.62
Jan-00	33.1	41.6	50	0.12	0.93	3.72
Feb-00	36.8	48.7	60.5	0.06	0.57	1.87
Mar-00	44.5	56.1	67.6	0.14	2.19	4.35
Apr-00	46.1	57.6	69	0.16	0.94	4.7
May-00	60	71.5	83	0.07	1.59	2.19
Jun-00	65.8	77.6	89.3	0.04	0.37	1.31
Jul-00	69.9	80.5	91.9	0.17	2.96	5.23
Aug-00	69.5	79.2	88.8	0.05	0.52	1.42
Sep-00	62.6	71.5	80.3	0.14	1.09	4.24
Oct-00	51.4	64.4	77.3	0	0	0
Nov-00	40.4	50.6	60.7	0.14	1.39	4.06
Dec-00	26.9	35.8	44.6	0.06	0.22	1.95

*Data collected at the Greenville-Spartanburg International Airport.
T = temperature & P = precipitation

Appendix A-2. Durbin Creek pH measurements.







Appendix A-3. pH Measurements at WQMS B-097.

Sampling Date	pH (s.u.)
Jan 98	6.45
Feb 98	*
Mar 98	6.6
Apr 98	*
May 98	6.78
Jun 98	6.71
Jul 98	6.85
Aug 98	6.57
Sept 98	6.42
Oct 98	6.5
Nov 98	6.25
Dec 98	6.3
Jan 99	6.8
Feb 99	6.75
Mar 99	6.0
Apr 99	6.8
May 99	7.25
Jun 99	6.45
Jul 99	6.5
Aug 99	6.25
Sept 99	6.2
Oct 99	5.85
Nov 99	7.05
Dec 99	7.0
Jan 00	7.03
Feb 00	7.22
Mar 00	7.01
Apr 00	6.55
May 00	7.0
Jun 00	6.9
Jul 00	5.85
Aug 00	6.0
Sept 00	5.85
Oct 00	5.95
Nov 00	6.09
Dec 00	6.19

*Two samples were taken in June and July 1998. No samples were taken in Feb and Mar 98. pH data in June 98 = 6.74 + 6.68 / 2 = 6.71 and July 98 = 6.85 + 6.85 / 2 = 6.85.

Appendix A-4. Stream Flow (cfs) at USGS Station 02160381.

Sampling Date	Flow (cfs)
Jan 98	39.1
Feb 98	51.4
Mar 98	39.3
Apr 98	57.2
May 98	23.9
Jun 98	16.0
Jul 98	7.9
Aug 98	9.73
Sep 98	9.31
Oct 98	14.5
Nov 98	10.7
Dec 98	13.1
Jan 99	17.5
Feb 99	22.9
Mar 99	14.1
Apr 99	16.0
May 99	10.9
Jun 99	7.53
Jul 99	6.06
Aug 99	3.06
Sep 99	3.63
Oct 99	24.8
Nov 99	8.3
Dec 99	11.9
Jan 00	15.7
Feb 00	14.2
Mar 00	26.5
Apr 00	14.9
May 00	7.54
Jun 00	3.48
Jul 00	5.08
Aug 00	6.2
Sep 00	10.5
Oct 00	4.07
Nov 00	7.14
Dec 00	7.86