Scape Ore Swamp Nonpoint Source Assessment Project:

Load Reduction Management Plan

September 2005

Santee-Wateree Resource Conservation and Development Council

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

This report represents a Load Reduction Management Plan supporting implementation of the fecal coliform bacteria total maximum daily load (TMDL) for the impaired sections of Scape Ore Swamp upstream of the Route 108 Bridge, approximately three miles south of the Town of Manville in Lee County (Ambient Water Quality Monitoring Station PD-355). The project watershed area is located entirely in Lee and Kershaw Counties, South Carolina (approximately 95 square miles). The Scape Ore Swamp mainstem flows in a southeasterly direction and eventually discharges into Rocky Bluff Swamp, a tributary of the Black River, outside of the project watershed area.

Fecal Coliform Bacteria Impairment. Water quality data collected at the PD-355 ambient water quality monitoring station, the downstream-most point of the project watershed area on the Scape Ore Swamp mainstem, shows that fecal coliform bacteria concentrations have routinely exceeded the water quality criterion of 400 colony forming units (cfu) per 100 ml in more than ten percent of the samples collected at this station. Due to these fecal coliform bacteria excursions, recreational uses are not supported. The State of South Carolina has, therefore, placed Scape Ore Swamp and its tributaries upstream of the Route 108 Bridge (Ambient Water Quality Monitoring Station PD-355) on the 303(d) list. Under the Clean Water Act, a TMDL is required to identify the load allocations, wasteload allocations, and a margin of safety that will bring Scape Ore Swamp into compliance with the fecal coliform standard.

Sources of Fecal Coliform Bacteria. Only one permitted minor discharge facility is located in the Scape Ore Swamp project watershed area upstream of the PD-355 ambient water quality monitoring station, in the headwaters of Scape Ore Swamp along the Black Creek tributary over fifteen miles upstream from the impaired PD-355 station. This Load Reduction Management Plan has, therefore, focused predominately on nonpoint sources of fecal coliform bacteria. The nonpoint sources that have been determined to be contributors to the Scape Ore Swamp impairment include wildlife, grazing livestock and livestock defecating directly into streams, land application of poultry litter, and failed or malfunctioning septic systems.

Agricultural Land Use Characterization. A Geographic Information System (GIS) Database was developed to characterize potential fecal coliform bacteria loading sources from agricultural land uses. A GIS datalayer of every United States Department of Agriculture Farm Service Agency (FSA) recognized farm field in the project watershed area was acquired from the United States Department of Agriculture (USDA). Additional attribute information was incorporated into the datalayer including the location of pastures, potential poultry litter application areas, hog farms, and other information pertinent to fecal coliform bacteria loading. Information was compiled for approximately 1,800 farm fields from interviews with local agricultural agency experts, field surveys, and reviews of aerial photographs. The database will be used during TMDL implementation planning to identify and prioritize viable pasture, poultry litter application and other types of farm field sites for agricultural BMP and conservation practice implementation.

Water Quality Assessment. The load-duration curve methodology was used to calculate the existing and TMDL loads for Scape Ore Swamp at water quality monitoring station PD-355. This method develops TMDLs based on a frequency analysis of the historic hydrologic record and pollutant concentration data. Water quality data were obtained from the DHEC monitoring stations PD-355 (located on Route 108). Scape Ore Swamp at water quality monitoring station PD-355 is not gauged; however, the USGS does maintain a stream (02135300) on Scape Ore Swamp approximately 3 miles upstream from the station PD-355. Data from this gage were used to estimate streamflow at station PD-355. Fecal coliform loads contributed by various non-point sources were estimated by using a mass balance approach, and load reduction estimates were determined using a combination of the results obtained from the mass balance approach and the calculated loads from the load duration curve method.

Load Reduction Allocation Scenario. The existing load for the Scape Ore Swamp at the impaired ambient water quality monitoring station (PD-355) was estimated to be 1.03×10^{12} counts/day. The appropriate TMDL at monitoring station PD-355 was determined to be 5.87×10^{11} counts/day, consisting of load allocation of 5.56×10^{11} counts/day and margin of safety of 3.13×10^{10} counts/day. To achieve compliance with water quality standards, it is necessary to reduce the existing fecal coliform bacteria load by 46% at PD-355. In order to achieve this overall reduction of fecal coliform bacteria load, it is recommended that the existing fecal coliform bacteria loads contributed by livestock sources and runoff from poultry litter application be reduced by approximately 58%, and existing fecal colifrom bacteria loads contributed by failing septic systems be reduced by 100%.

Stakeholder Participation. Stakeholder recruitment and participation from a number of working group partners was prioritized throughout the development of this Load Reduction Management Plan. The final working group of stakeholders and community participants included:

- The Santee-Wateree Resource Conservation and Development (RC&D) Council;
- The Lee Soil and Water Conservation District;
- The Kershaw Soil and Water Conservation District;
- The Lee Natural Resources Conservation Service (NRCS) field office;
- The Kershaw NRCS field Office;
- The South Carolina Department of Natural Resources;
- The Lee County Farm Service Agency (FSA) field office;
- The Kershaw County FSA field Office; and
- Consulting firms.

A stakeholder kick-off meeting was held on January 26, 2005 in the Lee County Agriculture Service Center in Bishopsville, South Carolina to detail the steps required to achieve a comprehensive Load Reduction Management Plan. Field surveys of the watershed and interviews with local agricultural BMP and conservation practice experts were conducted on May 18 and 19, 2005. A final presentation of the Load Reduction Management Plan and land use characterization approach and results was presented in July 2005 to the South Carolina Department of Health and Environmental Control

(SCDHEC), an assortment of local agricultural agency personnel, local growers from the project watershed area including Soil and Water Conservation District Commissioners and Farm Bureau representatives.

Recommendations for TMDL Implementation

This Load Reduction Management Plan supporting fecal coliform bacteria TMDL development for Scape Ore Swamp provides the framework and management tools for making informed decisions about the strategic selection, siting, and implementation of effective BMPs in the project watershed area. The long-term goal of the Load Reduction Management Plan is to develop a TMDL implementation plan that can be met through BMP implementation. To achieve this goal, three watershed planning components have been developed. Consultation with watershed stakeholders, including NRCS District Conservationists, has resulted in the development of a load reduction allocation scenario that can be both reasonably implemented and addresses the main sources of fecal coliform bacteria loading. In addition, a GIS database has been provided to watershed management decision makers that will assist to identify potential sources of fecal coliform bacteria loading, and target ideal farm field sites for BMP implementation. Finally, a group of agency and farming organizations in South Carolina have been recruited to provide advocacy assistance during the implementation planning phase of the project.

These three watershed planning components provide a starting point for developing effective implementation strategies. Results from load-duration curves and monitoring assessments show, for the most part, that periods of low flow (summer months) are the most critical for water quality. As a consequence, the result points out the primary need to reduce direct deposition of fecal coliform bacteria to the stream from livestock, and a secondary need to reduce runoff from pastures harboring grazing livestock and farm fields receiving poultry litter and to address faulty septic systems. To meet these needs, implementation funding must be acquired from a variety of sources. With the periodic and sporadic acquisition of these funds, a phased implementation planning approach is recommended where an iterative process for implementation is adhered to. Sets of farm fields would be targeted and prioritized for implementation as funds are obtained. A continued review of sampling results acquired at the ambient water quality monitoring stations PD-355 and PD-636 would occur following the implementation of prioritized farm field sets to measure (i.) the effectiveness of these implementation strategies, (ii.) the need for amending these strategies, and/or (iii.) progress toward the eventual removal of the impairment from the 303(d) list.

1.0 INTRODUCTION

1.1 Background

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) requires 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).

The South Carolina Department of Health and Environmental Control (DHEC) has identified the Scape Ore Swamp watershed (03040205-030) upstream of ambient water quality monitoring station PD-355 (located on the Route 108 Bridge three miles south of the Town of Manville) as being impacted by fecal coliform bacteria, as reported on the State of South Carolina 2004 303(d) list. An additional ambient water quality monitoring (PD-636), located on the Route 313 Bridge spanning the Beaverdam Creek tributary of Scape Ore Swamp, has not been reported as showing a fecal coliform bacteria impairment.

Fecal coliform bacteria can be elevated in surface water as the result of both point and nonpoint sources of pollution. It is assumed that water bodies possessing high concentrations of fecal coliform bacteria my also be contaminated by pathogens, or disease producing bacteria or viruses, which may exist in fecal material. Some waterborne diseases associated with fecal material include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. The presence of fecal contamination is, therefore, an indicator that a potential health risk exists for individuals exposed to this water. The objective of this study is to develop a Load Reduction Management Plan supporting future TMDL development efforts that will result in a reduction of fecal coliform bacteria concentrations to levels that do not present a health risk, and that are below the state standard.

1.2 Watershed Description

The Scape Ore Swamp project watershed area above station PD-355 is a large stream system extending from western Lee County into Kershaw County. Only the extreme headwater project areas are located in Kershaw County. The Scape Ore Swamp mainstem flows in a southeasterly direction and eventually discharges into Rocky Bluff Swamp, a tributary of the Black River, outside of the project watershed area. Major tributaries to the impaired Scape Ore Swamp in the project area include Timber Creek, Black Creek, Cedar Creek, and Beaverdam Creek. The watershed is approximately 100 square miles in size. The topography of the watershed is gently rolling with slopes ranging from one to six percent.

According to the ***Pee Dee Water Quality Assessment Report*** (2000), a permitted minor industrial effluent point source (South Carolina Pipeline Corporation - SCG6700010) is located in the headwaters of the Black Creek tributary to Scape Ore Swamp, over fifteen miles upstream from station PD-355. This discharge facility operates under a general permit indicating that the effluent should not contain a sanitary component. Consequently, effluent from this discharge facility is not expected to be a source of fecal coliform bacteria. Therefore, this point source is not considered to have an impact on the water quality at station PD-355 and is not included in the TMDL calculation. There are also several permitted Animal Feeding Operations that exist within the Scape Ore Swamp project watershed (Table 3-1).

It is estimated that approximately 2,100 septic systems are currently in use in the project area. Failing or malfunctioning septic systems are considered potential sources of fecal coliform bacteria loading to Scape Ore Swamp.

Agriculture is considered the largest contributor of fecal coliform bacteria to surface waters. Figure 1-1 delineates the location of approximately 1,800 farm fields in the 100 square mile Scape Ore Swamp project watershed area. The largest agricultural region in the project watershed area is located in the Beaverdam Swamp tributary and along the lower portion of the Scape Ore Swamp mainstem. According to the Natural Resource Conservation Service (NRCS) District Conservationist for Lee County (Lori Bataller, March 23, 2005), the types of agricultural practices that exist within the project watershed include row crop farms (including cotton, soybeans, peas, etc) and poultry farms. The major cropland product is cotton. It is estimated that over 14,000 tons of poultry waste is being spread annually on watershed cropland and pasture within the project area. The estimated numbers of animals that exist within the project watershed area are 118 cattle, 247,400 chickens and 20 horses. Many producers leave plowed fields barren after harvest, creating soil erosion and water quality problems. Excessive runoff from these unprotected fields can be contaminated with silt, chemicals, fecal coliform bacteria, and other harmful bacteria. Livestock watering in streams also remains a concern.

Two water quality monitoring stations are found in the Scape Ore Swamp project watershed area. The one showing fecal coliform bacteria impairment (PD-355) is located at the downstream-most point of the project watershed area on the Route 108 Bridge. A second ambient water quality monitoring station is located on the Route 313 Bridge over the Beaverdam Creek tributary (PD-636) to the Scape Ore Swamp. As depicted in Figure 1-1, the Scape Ore Swamp project area has been conceptually divided into the following five subbasins:

- Black Creek (16.9 square miles);
- Timber Creek (27.4 square miles);
- Beaverdam Creek (19.0 square miles);
- Upper Scape Ore Swamp (24.2 square miles); and

- Lower Scape Ore Swamp (14.2 square miles).

As described in the ***Pee Dee River Basinwide Plan*** (2000), the Scape Ore Swamp project watershed area is located in the Sandhills and Upper Coastal Plains regions of South Carolina. The predominant soil types consist of an association of the Pelion-Alpin-Norfolk series. The erodability of the soil (k) averages 0.14; and the slope of the terrain averages 7 % with a range of 2-15 %. The predominant land uses (NLCD, 1992) in the Scape Ore Swamp project watershed area are cropland/pasture (51%) and forest (48%). The remaining land use in the watershed is developed land (1.3%) (see Table 1-1 and Figure 1-2).

TABLE 1-1
Land Use Classification in the Scape Ore Swamp Watershed above Water Quality Monitoring Station PD-355

Land Use Class	Land Use	Area above PD-355 (acres)	Area above PD-355 (%)
Forest	Mixed Forest	22,820	33.9
	Evergreen Forest	4,304	6.4
	Forested Wetland	4,936	7.3
	Subtotal	***32,060***	***47.7***
Pasture/Hay		**15,095**	**22.4**
Cropland		**19,212**	**28.6**
Developed	Residential	182	0.3
	Other Urban or Built-up	713	1.1
	Subtotal	**896**	**1.3**
TOTAL		***67,264***	***100.0***

1.3 Water Quality Standard

The impaired stream, Scape Ore Swamp above PD-355, 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 convenient 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).

The South Carolina standard for fecal coliform bacteria 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 percent of the total samples during any 30-day period exceed 400/100 ml. (R.61-68).

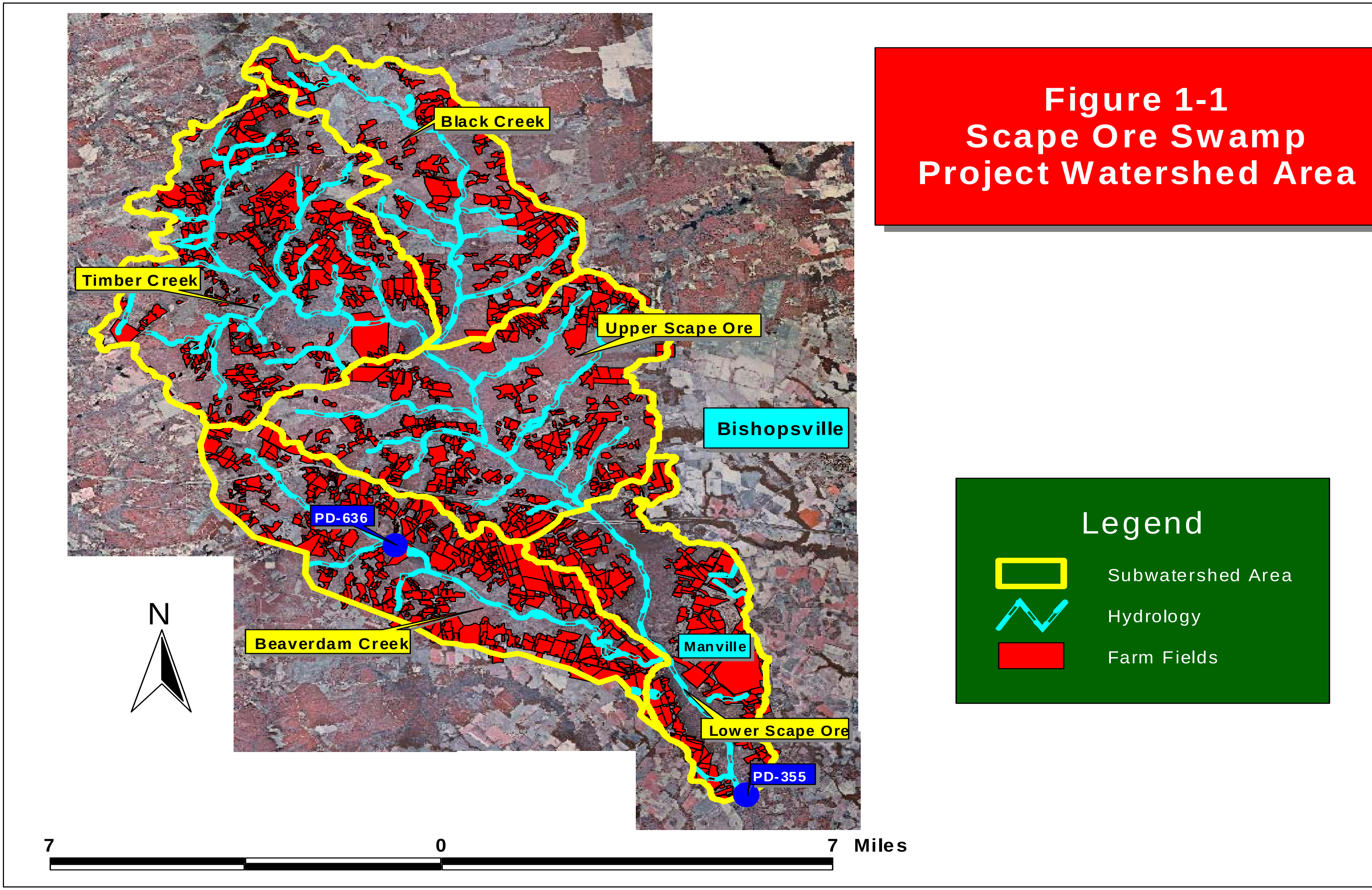
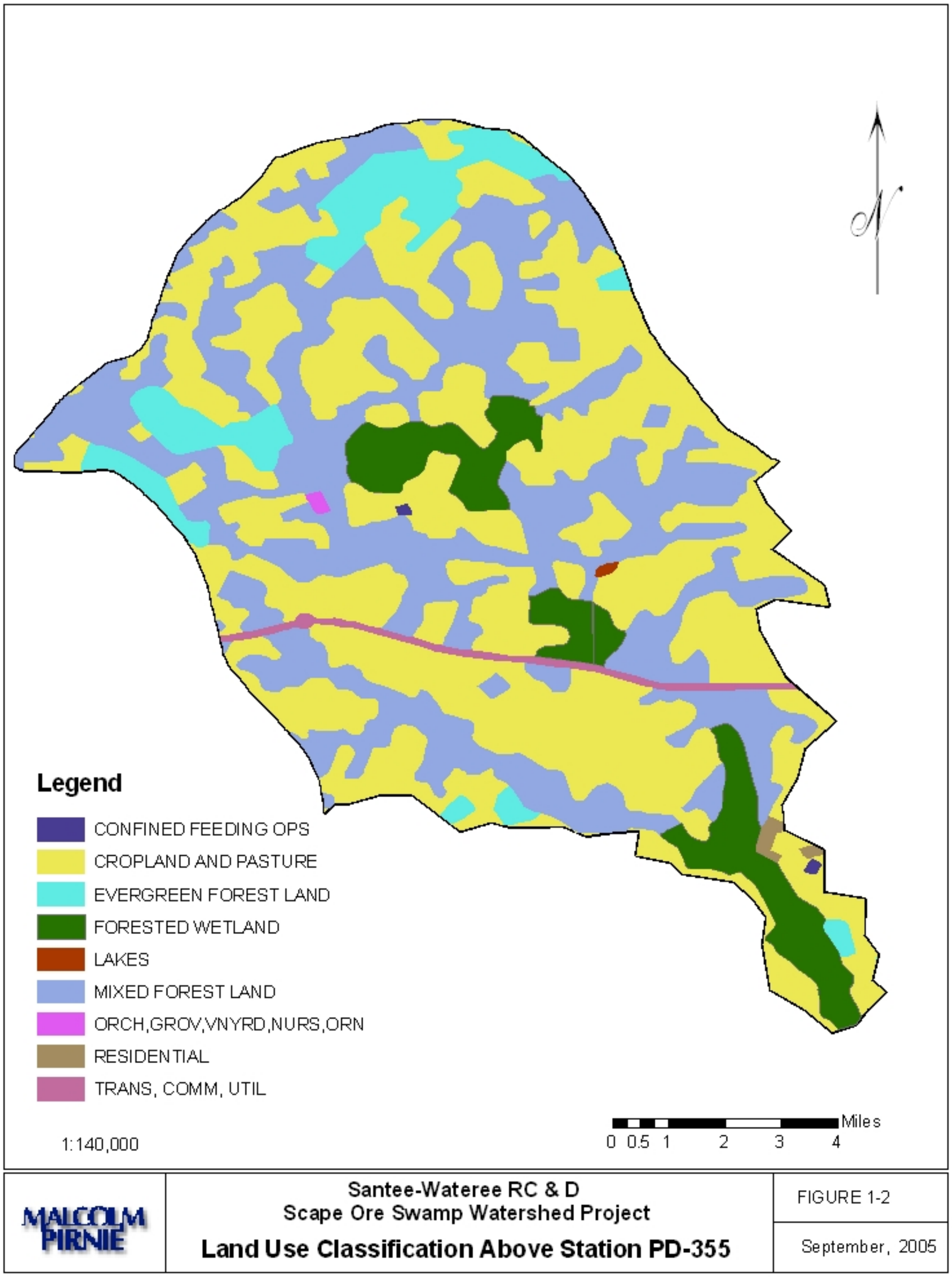


Figure 1-1
Scape Ore Swamp
Project Watershed Area
Black Creek
Timber Creek
Upper Scape Ore
Bishopsville
PD-636
Beaverdam Creek
Manville
Lower Scape Ore
PD-355
N
7
0
7 Miles
Legend
Subwatershed Area
Hydrology
Farm Fields



Legend
CONFINED FEEDING OPS
CROPLAND AND PASTURE
EVERGREEN FOREST LAND
FORESTED WETLAND
LAKES
MIXED FOREST LAND
ORCH,GROV,VNYRD,NURS,ORN
RESIDENTIAL
TRANS, COMM, UTIL
Miles
0 0.5 1 2 3 4
1:140,000
MALCOLM PIRNIE
Santee-Wateree RC & D
Scape Ore Swamp Watershed Project
Land Use Classification Above Station PD-355
FIGURE 1-2
September, 2005

2 WATER QUALITY ASSESSMENT

The seasonal and hydrologic variability of fecal coliform bacteria data collected from 1993-2003 at ambient water quality monitoring station PD-355 were examined, to provide insights into the contributing factors of high fecal coliform bacteria loading to the stream prior to conducting a detailed source assessment and TMDL analysis. For example, high concentrations during low flow conditions would be consistent with in-stream sources, whereas high concentrations only during storm events would indicate land-based sources.

Relatively equal numbers of data of fecal coliform bacteria collected during every month of the year (January-December) by DHEC at ambient monitoring station PD-355, and results from this station were the primary basis for the 303(d) listing of the stream for bacteria impairment. Scape Ore Swamp fecal coliform data from DHEC monitoring station PD-355 are provided in Appendix A. Figure 2-1 shows location of monitoring station PD-355.

MALCOLM PIRNIE	Santee-Wateree RC & D Scape Ore Swamp Watershed Project Water Quality and USGS Stream Gage Station Locations	FIGURE 2-1 September, 2005

2.2 Seasonal Variability

As shown in Figure 2-2, the mean fecal coliform bacteria concentrations were highest in August and November. However, the mean fecal coliform bacteria concentrations were higher than the water quality criteria for fecal coliform bacteria (400 count/100 mL) during three additional months of the year; March, June and October. The mean fecal coliform bacteria concentrations were lowest in January, February, April and December. Of all the months for which data were available, February (coldest month of the year) had the lowest mean concentrations. Generally, warmer months of the year (June-November) had higher mean fecal coliform bacteria concentrations than colder temperature months (January, February and December). However, the highest mean fecal coliform bacteria concentration was observed during November

The general seasonal pattern is due to several factors, including: (1) higher fecal coliform bacteria die-off rates occurring in colder temperatures and leading to lower concentrations in the water column during colder periods of the year; and (2) livestock spending more time in the stream during hot weather than during cold weather leading to higher direct fecal deposits from in-stream cattle during warmer periods of the year; (3) poultry litter application occurs in spring, summer, and early fall leading to increase in fecal load from poultry litter run off during these months; and (4) higher flows that are generally experienced during winter and spring months can dilute fecal coliform bacteria concentrations.

2.3 Hydrologic Variability

To assess the hydrologic variability of fecal coliform bacteria concentrations, stream flow data were estimated from measured flow data at the USGS gauging station 02135300 on Scape Ore Swamp, located approximately three miles upstream from the impaired DHEC water quality monitoring station PD-355. Streamflow at station PD-355 was estimated by simply multiplying flow data from the USGS gauge station (USGS 02135300) by the ratio of the drainage area above PD-355 to the drainage area above the USGS gauge station.

The plot of fecal coliform bacteria concentration vs. flow demonstrates that higher fecal coliform bacteria concentrations tend to occur during low flow conditions (Figure 2-3). In fact, most of the fecal coliform bacteria concentrations that violated the water quality standard were observed to occur during low flow conditions. However, the water quality criterion was also exceeded under moderate flow conditions. This indicates that although dry-weather sources of fecal coliform bacteria are predominant, wet-weather sources of fecal coliform bacteria also exist. Thus, under dry weather conditions, sources such as livestock in streams, failing septic systems and straight pipe discharge may provide fecal coliform bacteria loads to the stream. Under wet weather conditions, run-off related sources, such as livestock manure deposited on pastureland, wildlife, and poultry litter waste application may be more important.

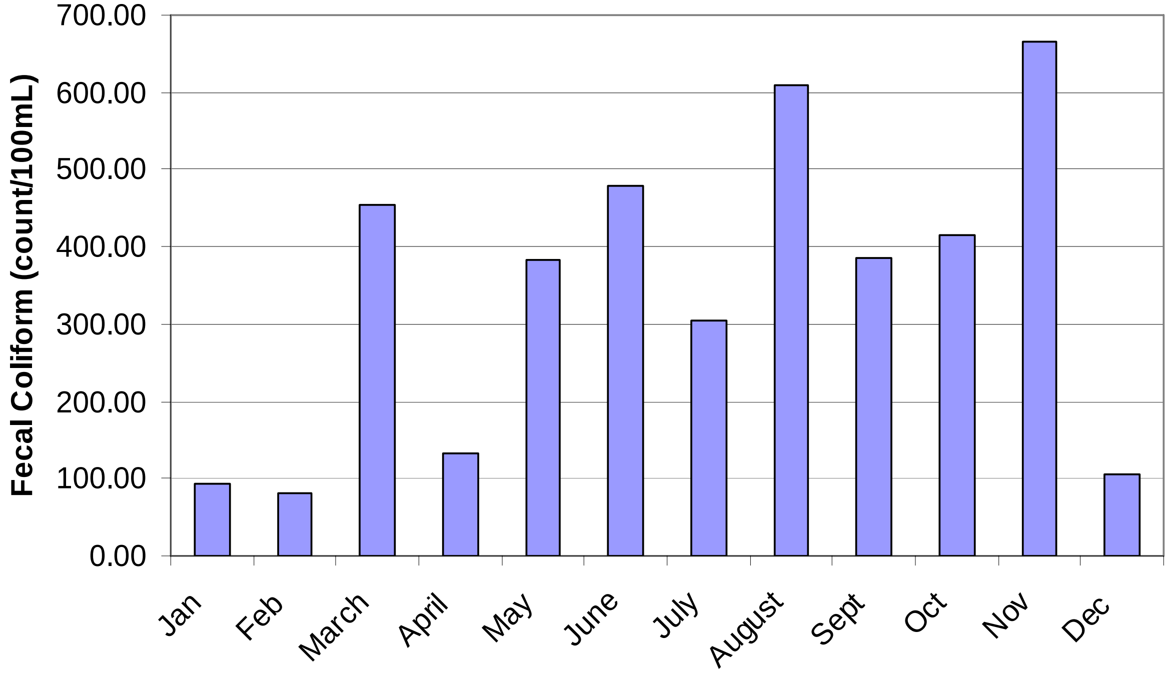


Figure 2-2: Mean fecal coliform concentration vs. month in Scape Ore Swamp at DHEC water quality monitoring station PD-355. Mean values were calculated using 1993-2003 data from DHEC water quality monitoring station PD-355.

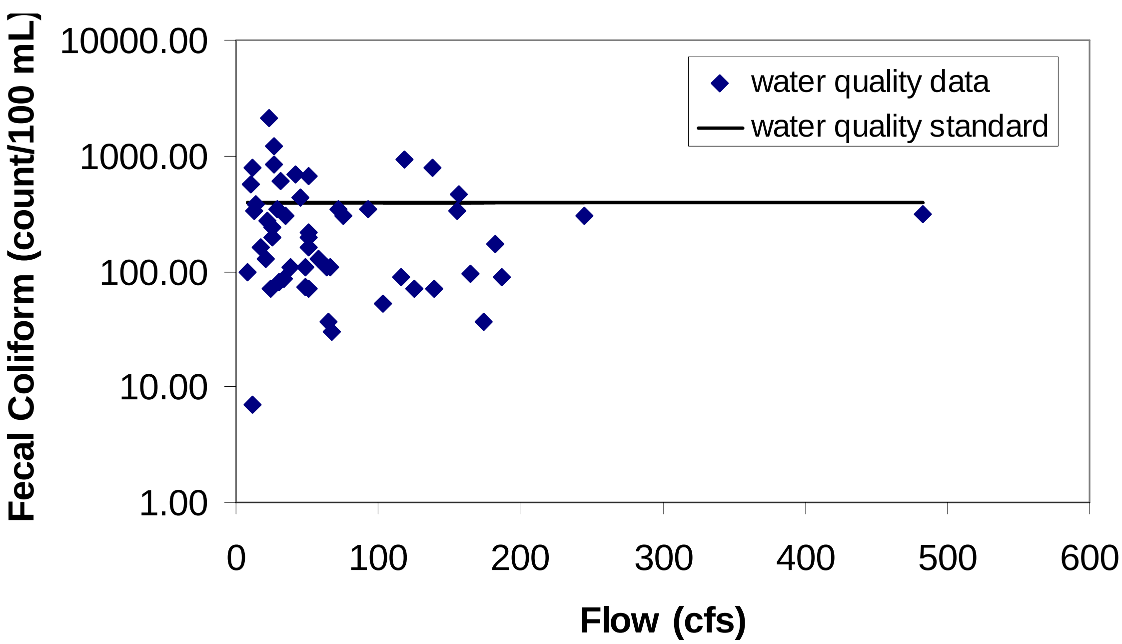


Figure 2-3: Fecal coliform concentration vs. estimated stream flow in Scape Ore Swamp at DHEC water quality monitoring station PD-355, 1993-20

3 SOURCE ASSESSMENT

Figure 1-2 and Table 1-1 show the distribution of land use categories in the Scape Ore Swamp project area, obtained from the Multi-Resolution Land Characteristics (MRLC) Consortium's National Land Cover Data (NLCD, 1992).

The source assessment phase of this study involved the identification and quantification of fecal coliform bacteria loads as applied to the land surface in the Scape Ore Swamp project area, or directly to the stream. The Bacterial Indicator Tool (BIT) developed by USEPA as part of its BASINS family of software was used to quantify the fecal coliform bacteria loading rates from various non-point sources (USEPA, 2000a). The BIT is a spreadsheet that calculates loading factors for various animal sources including wildlife, unconfined livestock, and manure application as fertilizer. The spreadsheet requires the user to define the number of animals present in the watershed, as well as area in acres for the forest, pastureland, cropland and built-up land components of the watershed. Estimated loading rates were used in a mass balance calculation (as described in section 4) to determine amounts of fecal coliform contributed to the stream by various sources.

The accuracy and precision of estimated loading rates are reduced by many sources of uncertainty and environmental variability. However, both local knowledge and a large body of previous studies and tools provide a basis for assessing the potential order-of-magnitude of various bacterial sources.

3.1 Point Sources

There is one permitted discharge facility in the project watershed (South Carolina Pipeline Corporation – SCG670001) that discharges a minor industrial effluent on to Black Creek. This NPDES discharge facility is situated at the opposite extreme of the watershed from the ambient water quality monitoring station. The average maximum discharge rate reported by SC Pipeline Corporation, from a water discharge hydrostatic test for monitoring period ranging from November 22, 1999 to August 2, 2001, was 481 gallons/minute (DHEC, April, 14 2005). The discharging facility has permit limits for total residual chlorine (TRC), pH and total suspended solids (TSS). As this facility operates under a general permit and should not discharge waste composed of a sanitary component, it is not expected to be a source of fecal coliform bacteria to Scape Ore Swamp above DHEC water quality monitoring station PD-355. Therefore, this point source was not included in the TMDL calculations as a wasteload source. Additionally, there are 29 permitted Animal Feeding Operations (AFOs), 20 that are currently active, found within the Scape Ore Swamp project watershed. Table 3-1 shows a list of the permitted AFOs and the types of field applications associated with the AFOs. All the active permitted AFOs within the project watershed are dry spreaders of poultry/turkey litter. Estimation of the magnitude of poultry litter application is discussed on section 3.2.3.

TABLE 3-1
Animal Feeding Operations (AFOs) within the Scape Ore Swamp Project Watershed

NPDES	FACILITY	STATUS	OPERATION	DESIGN COUNT	APPLICATOR
ND0075876	COUICK TURKEY FACILITY	ACTIVE	Turkey	45,000	Dry Spreader
ND0071251	JORDON POULTRY FACILITY	INACTIVE	Poultry (Broilers)	22,000	Dry Spreader
ND0077844	C&C FARMS	ACTIVE	Turkey	45,000	Dry Spreader
ND0075922	MCCASKILL FARM #114	ACTIVE	Turkey	22,500	Dry Spreader
ND0078140	BRAGG J/BROODER TURKEY FACILITY	ACTIVE	Turkey	25,000	Dry Spreader
ND0071251	JORDON POULTRY FACILITY	INACTIVE	Poultry (Broilers)	22,000	Dry Spreader
ND0011339	ATKINSON SWINE FACILITY	INACTIVE	Swine	20	Spray Irrigation
ND0066222	BAKER SWINE FACILTIY	INACTIVE	Swine	6	Spray Irrigation
ND0064327	DAVIS QUAIL FARMS	ACTIVE	Quail	60,000	Dry Spreader
ND0063584	ROBINSON W T TURKEY FACILITY	ACTIVE	Turkey	45,000	Dry Spreader
ND0071269	ELMORE POULTRY FACILITY	INACTIVE	Poultry (Broilers)	68,000	Dry Spreader
ND0074501	J L EPPS & SONS FARM	ACTIVE	Poultry (Broilers)	275,000	Dry Spreader
ND0065773	HICKSON POULTRY FARM #2	INACTIVE	Poultry (Broilers)	220,000	Dry Spreader
ND0071251	JORDON POULTRY FACILITY	INACTIVE	Poultry (Broilers)	22,000	Dry Spreader
ND0074241	W KING FACILITY	ACTIVE	Poultry (Broilers)	150,000	Dry Spreader
ND0071277	REEDY BRANCH FARMS INC	ACTIVE	Poultry (Broilers)	100,000	Dry Spreader
ND0074241	W KING FACILITY	ACTIVE	Poultry (Broilers)	150,000	Dry Spreader
ND0064327	DAVIS QUAIL FARMS	ACTIVE	Quail	60,000	Dry Spreader
ND0063584	ROBINSON W T TURKEY FACILITY	ACTIVE	Turkey	45,000	Dry Spreader
ND0066621	BOYKIN HARRY/BROILER FACILITY	ACTIVE	Poultry (Broilers)	120,000	Dry Spreader
ND0076741	J CAUGHMAN FARM	ACTIVE	Poultry (Broilers)	152,000	Dry Spreader
ND0071269	ELMORE POULTRY FACILITY	INACTIVE	Poultry (Broilers)	68,000	Dry Spreader
ND0074390	TRIPLE K FARMS	ACTIVE	Poultry (Broilers)	110,000	Dry Spreader
ND0074241	W KING FACILITY	ACTIVE	Poultry (Broilers)	150,000	Dry Spreader
ND0076252	D&S TURKEY FACILITY	ACTIVE	Turkey	52,000	Dry Spreader
ND0071277	REEDY BRANCH FARMS INC	ACTIVE	Poultry (Broilers)	100,000	Dry Spreader
ND0071463	B WHITE POULTRY FACILITY	INACTIVE	Poultry (Broilers)	17,500	Dry Spreader
ND0081078	ELMORE & SONS FARM	ACTIVE	Poultry (Roasters)	138,000	Dry Spreader
ND0081647	KEVIN KING POULTRY FARM	ACTIVE	Poultry (Broilers)	92,000	Dry Spreader

3.2 Non-Point Sources

Non-point sources of fecal coliform bacteria loading that were explicitly considered included wildlife, cattle, poultry litter application, and failing septic systems/straight pipe discharges. Estimates of the number of fecal coliform bacteria counts per animal per day were based on literature-derived values of the BIT and are summarized in Table 3-2. Other sources are expected to be relatively minor by comparison, and are implicitly included by inclusion in other sources. For example, the small number of horses, sheep and goats in the project watershed can be conceptually lumped into the cattle source.

TABLE 3-2
Fecal Coliform Unit Loading Rates

Source	Fecal Coliform Loading Rate	Units	BIT Reference
Deer	5.0×10^{8}	counts/animal/day	Best Professional Judgment
Raccoon	1.2×10^{8}	counts/animal/day	Best Professional Judgment
Cattle	1.0×10^{11}	counts/animal/day	ASAE, 1998
Poultry litter	1.3×10^{6}	counts/gram litter	LIRPB,1978
Septage	1.0×10^{4}	counts/100 mL	Horsley and Witten, 1996
Developed Land	1.1×10^{7}	counts/acre/day	Horner, 1992

3.2.1 Wildlife

A value of 30 deer per square mile was assumed for forest, pasture and cropland, based on estimates provided for West Lee County by the South Carolina Department of Natural Resources (personal comm., Charles Ruth, Deer Project Supervisor, SCDNR, May 23rd, 2005). A value of 128 raccoons per square mile was assumed for these same land uses, based on the upper end of the raccoon density range given in the South Carolina coastal plain according to the SCDNR Wildlife Management Guide for Raccoon (1997). Although the actual raccoon density might be as much as 10 times lower, the upper end of the range was used to implicitly account for other wildlife such as birds, rodents, etc. Due to the presence of riparian wetlands near Scape Ore Swamp and the tributaries of Scape Ore Swamp within the project watershed, in-stream contributions from wildlife sources can occur. In-stream contributions from wildlife sources were estimated by assuming that a fraction (the fraction of the forested land that is forested riparian wetland) of the accumulated load on forested land is deposited direct to surface water.

3.2.2 Cattle

Cattle density on pastureland within the Scape Ore Swamp project watershed was estimated by dividing the total number of cattle in Lee and Kershaw Counties (according to the USDA 1997 Census of Agriculture) by the area of pastureland within the watershed in those counties. This resulted in an estimate of about 118 cattle in the Scape

Ore Swamp project watershed. There are no dairy or feedlot operations in the project watershed (personal communication, Lori Bataller, District Conservationist for Lee County, March, 2005), and so cattle were assumed to be evenly distributed on pastureland. Cattle manure is not collected or applied as fertilizer to cropland in any parts of the watershed (personal conversation, Lori Bataller, March, 2005).

There are places where cattle can directly access Scape Ore Swamp or its tributaries; however, uncertainties exist about the percentage of time cattle spend in streams. As a result, direct deposit of fecal coliform from in-stream cattle was not explicitly differentiated from deposition on land. Instead, run-off resulting from manure deposits on pastures was used to estimate the load from all livestock sources (grazing and in-stream).

3.2.3 Poultry Litter Application

An estimation of the magnitude of poultry litter application was based largely on the local knowledge and professional judgment of the District Conservationist, Lori Bataller. Poultry litter was assumed to be applied to both cropland and pastureland at a rate of 2 tons/acre. In any given year, 70% of cropland and 40% of pastureland was assumed to receive an application. Higher percentage of the litter application occurs during growing seasons, which include spring, summer and fall seasons.

3.2.4 Failing Septic Systems

Large portion of the population residing in the Counties that are located within the project watershed of Scape Ore Swamp are served by septic systems. It is assumed that approximately 90% of the population in the project watershed is served by septic systems. The total number of septic systems within the project watershed of Scape Ore Swamp was estimated to be 2,089 based on the average number of people served per septic (approximately 2.55 people/septic) and the assumed number of people served by septic systems (approximately 5,327).

The failure rate of septic systems was assumed to be approximately 5% based on the average failure rate encountered in three Counties (Chesterfield, Dillon and Marlboro) within South Carolina that have similar septic system densities as the Scape Ore Swamp watershed project area. Implicitly included with failing septic systems are “straight pipe” discharges of wastewater directly to the stream. Default values of the BIT that were used for this project include 2.55 persons served per septic system, a volume of 70 gallons wastewater generated per person per day, and a fecal coliform count of 10,000 counts/100 mL in wastewater reaching the stream (Horsley and Witten, 1996).

3.2.5 Urban/Suburban Runoff

Runoff from developed land contributes fecal coliform loads mostly from domestic animals, and to a lesser extent, wildlife. Instead of explicitly calculating the number of domestic animals (e.g. cats, dogs, etc.) in the watershed, the BIT uses literature-based rates of fecal coliform accumulation on different types of built-up land. For the Scape Ore Swamp project area, an average value of 1.13×10^7 counts/acre/day was used based on the work of Horner (1992).

4 LOAD-DURATION CURVE METHOD

The load duration curve method was used to calculate the existing and the TMDL load for Scape Ore Swamp at DHEC water quality monitoring station PD-355 (located on Route 108). The load-duration method develops TMDLs based on a frequency analysis of the historic hydrologic record, resulting in a cumulative frequency of daily flows, and pollutant concentration data. A water quality standard load or "allowable load" is calculated by multiplying the numeric water quality criteria by the flows from the frequency analysis. Multiplication of the observed concentrations by the estimated streamflow results in an estimate of the actual pollutant loads. The critical flow and loads allocations are determined by a comparison of the pollutant loads with the allowable loads.

The load-duration method was selected for this project because it is a relatively simple method that provides adequate estimate of fecal coliform bacteria loading over a range of stream flow conditions. In addition, the load-duration method has a successful track record for DHEC and USEPA approval for similar fecal coliform bacteria TMDL applications in South Carolina. Primary disadvantages of the load-duration method are its limited predictive capability and its limited capability to link load reduction estimates, hydrologic conditions and contributing areas. In this project, the load duration curve analysis was supplemented by mass balance calculations to estimate the loads contributed by various non-point sources (as discussed on section 4.2). Estimates of the necessary load reduction were determined using a combination of results obtained from the mass balance approach and the calculated loads from the load-duration curve method. The load-duration curve method includes all flow conditions, ensuring that critical hydrologic conditions are addressed.

4.1 Development of the Load-Duration Curve

Because the load-duration curve methodology is based on frequency analysis of stream flow, the first step in the analysis involved collecting or estimating historical record of flow in Scape Ore Swamp at DHEC water quality monitoring station PD-355. Scape Ore Swamp at water quality monitoring station PD-355 is not gauged. Therefore, streamflow at this station was estimated from streamflow records USGS station 02135300. This stream gauge, located approximately 3.3 miles north of station PD-355 in Lee County, has similar watershed characteristics (size, land use and topography) as Scape Ore Swamp above the impaired station.

The flow for Scape Ore Swamp at PD-355 was estimated by multiplying the daily flow rates (for flow period ranging from July 26, 1968 to September 30, 2003) from Scape Ore Swamp at the USGS station, up stream from PD-355, by the ratio of Scape Ore Swamp drainage area above PD-355 to that of Scape Ore Swamp above the USGS station (1.04). These streamflow data was then used to generate the flow-duration curve at water quality monitoring station at PD-355.

To evaluate the cumulative distribution of the streamflow, daily streamflow for the time period of July 26, 1968 to September 30, 2003 were ranked from low to high and the values that exceeded certain selected percentiles determined. The fecal coliform bacteria loads at the water quality monitoring station were calculated by multiplying the fecal coliform bacteria concentration data by the flow rate that corresponded to the date of coliform sampling. Only fecal coliform bacterial concentration data collected since 1990 were used in the analysis. To generate the load-duration curves, the loads were plotted against the appropriate flow recurrence interval (Figure 4-1). The water quality standard load or "allowable load" (target line on Figure 4-1) was calculated by multiplying the appropriate fecal coliform bacteria standard concentration by the flows from the frequency analysis. At a given streamflow, fecal coliform bacteria loads above the target line are in violation of the standard, while loads below the line are in compliance.

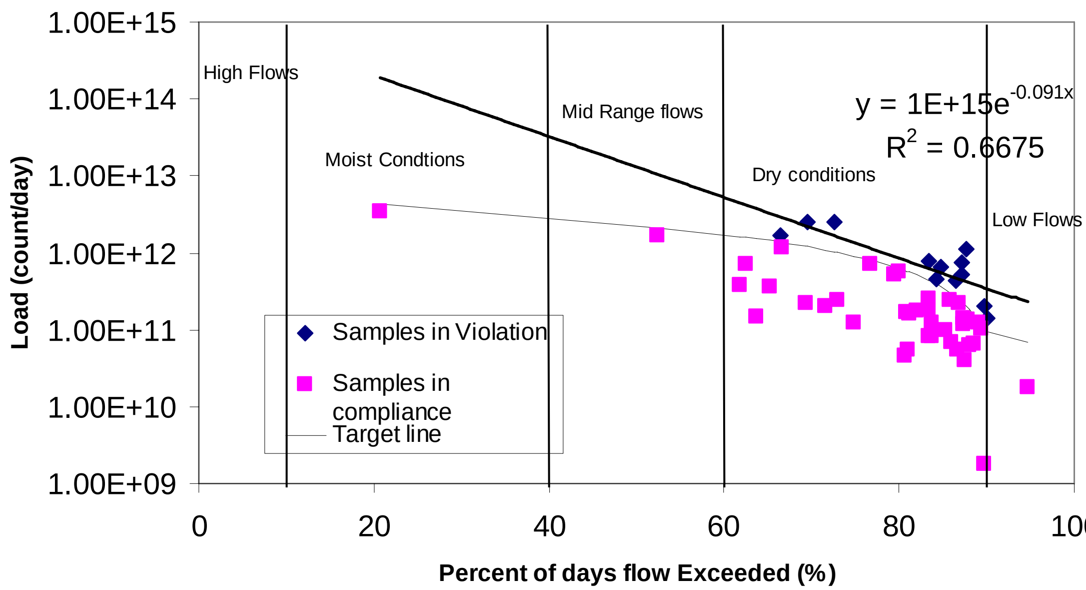


Figure 4-1: Load Duration curve for Scape Ore Swamp at Monitoring Station PD-355

The total existing load of fecal coliform bacteria at the water quality monitoring station in the Scape Ore Swamp project area was determined from the samples that violated the water quality standard. That is, a best fit trend line was determined for fecal coliform bacteria load data in violation of the standard, and the equation of the trend line used to estimate loads for the range of the flow recurrence intervals that had a majority of the loads in violation of the standard. The existing loads were then calculated by taking the average of the loads estimated within those flow duration intervals.

The best fit trend line at water quality monitoring station PD-355 was an exponential curve with a regression coefficient value of $R^2 = 0.67$. The majority of the violating loads were between 66% and 90% streamflow duration intervals. Therefore, the average loads were determined within these flow duration intervals at 2% intervals. Similarly, the allowable load at the monitoring station PD-355 on Scape Ore Swamp was calculated by determining trend line for the target load at the water quality monitoring station and calculating the average load estimated within the appropriate flow duration intervals (i.e, 66% - 90%). Calculations for both existing and allowable loads are provided in Appendix B.

4.2 Mass Balance Calculations

A mass balance approach was used to estimate amounts of loads contributed by various non-point sources including livestock, wildlife (from land deposits and directly deposited to streams), poultry litter application; urban runoff, and failing septic systems. In quantifying the fecal coliform bacteria load contributed by the various sources, the BIT described in section 3.0 was used to estimate fecal coliform bacteria loads to the land surface and stream (USEPA, 2000a).

The BIT spreadsheet was used to estimate loads to the land surface from wildlife, urban sources, livestock, poultry and treated swine litter applications, and failing septic systems. To determine the loads actually reaching the stream from these sources, land surface accumulated loads resulting from these sources were multiplied by an attenuation factor that was evaluated by a trial and error method as explained below. An attenuation factor is a fraction amount by which the total land surface accumulated load is reduced before it is directly deposited into the stream.

In determining the attenuation factor used, individual in-stream fecal coliform bacteria loads resulting from urban run-off, sanitary sewer overflow, failing septic systems, wildlife, livestock and poultry and treated swine litter applications were summed, and the resulting total load equated to the total existing load estimated from the load-duration curve method. The attenuation factor that allowed the summed total of the individual loads to equal the existing load estimated from the load-duration curve method was used in the mass balance calculation. Attenuation factor evaluated at the water quality monitoring station PD-355 was 0.281%. Percentages of the fecal coliform bacteria load contributed by each source were then evaluated, allowing for the determination of the dominant fecal coliform sources to the stream. It is important to note that the evaluated run-off fecal coliform bacteria load resulting from livestock is used to account for loads from all livestock sources, including grazing and in-stream livestock.

5 LOAD ASSESSMENT RESULTS

This section summarizes results of the total existing and recommended loads estimated by the load-duration curve analysis, and the breakdown by source of those determined from the mass balance calculations.

5.1 Existing Conditions

The total load under observed conditions at water quality monitoring station PD-355 was calculated from the trend line of the observed values that violated the water quality standard. Observed values exceeded the water quality standards within flow recurrence intervals of 66% to 90% at PD-355. Based on the load duration curve analysis, the total existing load at PD-355 is 1.03×10^{12} counts/day. This is the mean load for flow recurrence interval ranging from 66% - 90%, which corresponds to a flow range of 10.82 ft^3/sec – 160 ft^3/sec.

Results of the mass balance estimates of fecal coliform bacteria loads contributed by different sources to Scape Ore Swamp at water quality monitoring station PD-355 are listed in Table 5-1. At the impaired water quality monitoring station, livestock is estimated to be the largest contributing source on an annual animal basis, followed by poultry litter application, and then by wildlife. The relatively high proportion of the total load contributed by wildlife is due to the higher proportion of forest cover and extensive riparian wetlands of Scape Ore Swamp, which provide a large area for direct deposition by wildlife.

Urban runoff and failing septic systems were estimated to be the least contributing sources; all showing negligible components of the total load; which is not surprising given the small proportion of developed land and fairly low density of the population in the watershed. It is important to note that percentages of the total load contributed by each source are estimates, but these estimated percentages indicate the relative importance of each source.

TABLE 5-1
Fecal Coliform Bacteria Load to Scape Ore Swamp at Water quality Monitoring Station PD-355

Source	Land Accumulated Load (count/day)	Fecal Load (count/day)	Percent of Total Load (%)
Wildlife	1.83E+13	2.17E+11	21.2
Livestock	1.47E+14	4.13E+11	40.2
Poultry Litter application	1.39E+14	3.90E+11	37.9
Urban Runoff	7.72E+09	2.17E+07	<0.1
Failing Septic systems	0	7.06E+09	0.7
ALL		**1.03E+12**	**100.0**

5.2 Total Maximum Daily Load

The Total Maximum Daily Load (TMDL) is the maximum amount of a pollutant loading a water body can receive and still maintain water quality standards. In this case, the pollutant of concern is fecal coliform bacteria, and the load is expresses as counts/day (number of coliform bacteria counts/day). Conceptually, the TMDL load is calculated using the following equation:

TMDL = Sum of WLA + Sum of LA + MOS

Where:

WLA (Waste load allocation) is the pollutant load allocated to existing and future point sources.

LA (Load allocation) is the pollutant load allocated to non-point sources and natural occurrences.

MOS (margin of safety) is used to account for uncertainty in determining pollutant loads allowing for the unknown.

Table 5-2 shows TMDL components for Scape Ore Swamp at water quality monitoring stations PD-355.

The South Carolina DHEC has previously used a margin of safety at 5% of the fecal coliform bacteria standard or a fecal concentration of 20 counts/ 100 ml. For Scape Ore Swamp at water quality monitoring station PD-355, this equates to MOS fecal load of 3.13×10^{10} counts/day.

There is no waste load allocation for this TMDL because the Scape Ore project watershed has no NPDES facilities that discharge fecal coliform bacteria.

The LA was determined from the target line of the load-duration curve within the range of flow recurrence intervals for which the water quality standard was violated (66% to 90% or stream flow ranging from 10.82 ft^3/sec – 160 ft^3/sec), which was developed by setting the fecal coliform bacteria concentration of 380 counts/day that is equivalent to the standard concentration less the MOS. The LA for Scape Ore Swamp at PD-355 is 5.56×10^{11} counts/day.

TABLE 5-2
TMDL Components for Scape Ore Swamp at Monitoring Stations PD-355

Impaired Station	Sum of WLA (counts/day)	Sum of LA (counts/day)	MOS (counts/day)	TMDL (counts/day)
PD-355	0	5.56×10^{11}	3.13×10^{10}	5.87×10^{11}

5.3 Critical Conditions

Both monitoring and load-duration curve results demonstrate that the fecal coliform bacteria standard at monitoring station PD-355 on Scape Ore Swamp can be exceeded under dry conditions (at flow exceedence intervals ranging from 66 – 90 % as evaluated by the load-duration curve method). The Load-duration curve shows that all of the standard violations occurred during dry conditions. It shows that most of the violation occurred in the upper range of dry conditions, closer to the low flow ranges, while a few of the violations were in the lower range of dry conditions, closer to mid range flows (Figure 4-1). Monitoring results also indicate that the critical seasonal conditions for Scape Ore Swamp at PD-355 are during the summer (August), warm weather period, and fall (November). During the warm period season of the summer in-stream livestock contribute the most fecal coliform load while runoff from poultry litter application most likely contributes the highest fecal coliform load during the fall season. Because the load duration method makes use of data from the full range of flow and seasonal conditions, the resulting TMDL inherently addresses the critical hydrologic and seasonal conditions

6 POTENTIAL ALLOCATIONS

As there are no existing and future point sources discharging fecal coliform bacteria into Scape Ore Swamp within the project watershed, the TMDL at water quality monitoring station PD-355 is not comprised of a waste load allocation.

The required total load reduction is the difference between the existing load and the target load expressed as a percentage. The target load to the stream is the TMDL minus MOS. The target loading for Scape Ore Swamp at PD-355 requires a total reduction of 46% from the current load of 1.03×10^{12} counts/day (Table 6-1). Because both livestock and poultry litter sources are relatively equal contributors of fecal coliform bacteria to Scape Ore Swamp at monitoring station PD-355 (accounting for 40% and 38% of the total coliform load at the water quality monitoring station), it is recommended that allocations include equal percentage of reductions from livestock and poultry litter sources at the impaired water quality monitoring station. Recommended allocations at monitoring station PD-355 includes a 58% reduction in loads from livestock and poultry litter sources and a 100% reduction in loads from failing septic systems. The net result is a 46% reduction in the total existing load of fecal coliform bacteria to Scape Ore Swamp at the impaired station, which is the required reduction needed to achieve the target load.

The recommended load allocations are based on good engineering and agricultural practices. For example, although failing septic systems are not major causes of water quality violations, their elimination is important for public health reasons. Similarly, the reduction in loads from poultry litter application will help reduce exceedances of the criteria magnitude during spring storm events and/or at times when poultry production increases. The resultant reduction in litter application would prevent over fertilization of certain crops and help improve maintenance of soil nutrient levels.

TABLE 6-1
Recommended Load Reduction for Scape Ore Swamp at Monitoring Station PD-355

Source	Existing Load (counts/day)	Target Load (counts/day)	Reduction (%)
Livestock	4.13×10^{11}	1.79×10^{11}	58[r]
Poultry Litter Application	3.90×10^{11}	1.69×10^{11}	58[r]
Failing Septic Systems	7.06×10^{9}	0	100[r]
Total	*1.03×10^{12}*	*5.56×10^{11}*	*46[R]*

[r] – recommended reduction
[R] – required reduction

7.0 AGRICULTURAL LAND USE CHARACTERIZATION

A Geographic Information System (GIS) database will be used during TMDL implementation planning to identify viable pasture, poultry litter application and other types of farm field sites for agricultural BMP and conservation practice implementation.

7.1 GIS Datalayer Development of Agricultural Land Uses

Numerous South Carolina agricultural agencies are charged with the responsibility of satisfying the provisions described in this fecal coliform bacteria Load Reduction Management Plan, and any future requirements resulting from state TMDL development endeavors. GIS datalayers have been developed to assist these agencies meet the following future tasks associated with the implementation of agricultural BMP and conservation practices in the Scape Ore Swamp project watershed area:

- Assess potential sources of fecal coliform bacteria loading from specific pasture, hayfield and cropland land use areas;
- Effectively and efficiently consolidate and monitor corrective actions (i.e., Best Management Practices (BMPs) and conservation practices) associated with meeting the goals of the Load Reduction Management Plan;
- Facilitate consensus building among the various agencies and landowners during implementation decision making.

The datalayer development effort included the following steps:

1. The County-wide Common Land Use (CLU) datalayer of farm practices developed by the Farm Service Agency (FSA) possess farm field delineations as defined by the individual land owners. The datalayers were created by the FSA by referencing the hardcopy hand-marked FSA aerial photographs located in the respective County Agricuture Service Centers. These farm field boundaries were then digitized over 1999 color Digital Ortho Quarter Quadrangle (DOQQ) electronic aerial photographs. Those digitized farm fields within the Scape Ore Swamp project watershed area (approximately 1,750 farm fields) were extracted from the Lee and Kershaw County CLU databases. The FSA tract and farm field numbers were retained for project referencing purposes. Additional farm fields were also digitized using the FSA procedures when they were noted on DOQQ aerial photographs but lacked an FSA designated boundary because the grower has not enrolled in an FSA program.

2. Once this farm field datalayer was completed, it was combined with other datalayers including roads to form a GIS project database. A Geographic Positioning System (GPS) was linked to the GIS project database. The GPS was connected to a laptop computer and interfaced with the GIS ArcView 3.2 software. The GPS provides a real time display of the GPS location on the GIS project database. The exact location, movements, and direction of movement were displayed on the laptop screen in conjunction with the GIS program displaying the DOQQ base map and spatial data, roads, streams, field boundaries, and other features.

3. The GIS/GPS system was taken into the field where drive-byes were conducted on May 18 and 19, 2005 to acquire information on bacteria-related loading information from agricultural sources in the impaired watershed. The GPS unit showed the movement of the survey vehicle on the roads datalayer. In addition, a record of those roads that had been traveled during the drive-bye survey was maintained. To note farm fields with pertinent bacteria information, the GIS database of farm fields was referenced to determine and record the administrative number of respective farm fields in question, and any bacteria loading information specific to the individual farm fields.

4. This drive-bye information was compiled in the GIS database by incorporating the following farm field GIS attributes or tabular data: agricultural land uses (i.e., pasture, hayfield, or cropland farm field types), farm fields that have gone idle, the location of poultry houses, and animal sitings.

5. Additional information regarding fecal coliform bacteria loading from farm fields was acquired from USDA Natural Resource Conservation Service (NRCS) District Conservationists via interviews conducted on May 18, 2005 and was subsequently incorporated in the GIS database.

6. Other fecal coliform bacteria information was added to the farm field datalayer through a review of aerial photographs..

7.2 Agricultural Land Use Characterization Results

The results of the agricultural land use characterization are detailed below for each of the five subwatersheds of the Scape Ore Swamp project watershed area. Table 7-1 depicts an assortment of farm field information categorized by subwatershed that is pertinent to fecal coliform bacteria loading. The information was acquired during this agricultural land use characterization.

Table 7-1
Subwatershed Agricultural Information

Subwatershed	Total Farm Fields	Pastures	Cropland	Hayfields	Poultry Operations	Idle or Converted to Forestry
Black Creek	209	14	10	5	0	70
Timber Creek	470	30	48	5	2	155
Beaverdam Creek	483	34	133	4	5	87
Upper Scape Ore Swamp	397	31	38	4	2	95
Lower Scape Ore Swamp	232	7	80	7	5	40
Total	*1,791*	*116*	*309*	*25*	*14*	*447*

The Scape Ore Swamp project watershed area is divided into two differing land use areas based on the productivity of the farm land. The headwater areas of the project watershed area, including the Black Creek and Timber Creek subwatersheds, are located predominately in the Sandhills region of South Carolina. The soils and slopes in this region are not conducive to farming. As a consequence, a considerable number of farm fields have gone idle or were converted to forestry. Conversely, the Beaverdam Creek and Lower Scape Ore Swamp subwatersheds in mainly the Upper Coastal Plan region of South Carolina contain lands that are easier to farm. As a consequence, a fewer number of farm fields have gone idle or were converted to forestry. The Upper Scape Ore Swamp subwatershed represents a transition area from the Sandhills region to the Upper Coastal Plain. Table 7-2 shows this regional difference by comparing the potential active farms in a respective subwatershed (total farms minus those known to have gone idle or have been converted to forestry) per subwatershed area. Beaverdam Creek, the most intensely farmed subwatershed, possesses approximately 21 farms per square mile. In contrast, the Black Creek subwatershed contains a total of only 8.2 active farms per square mile. The Lower Scape Ore Swamp total of 13.5 active farms per square mile is lower than expected because, as portrayed in Figure 7-5, a large portion of this subwatershed contains the wetland areas associated with the Scape Ore Swamp mainstem. Those areas outside of these low-lying areas contain a large quantity of active farm fields.

Table 7-2
Active Farm Fields

Subwatershed	Total Farm Fields	Potential Active Farm Fields	Subwatershed Area (Square Miles)	Active Farms per Square Mile
Black Creek	209	139	16.9	8.2
Timber Creek	470	315	27.4	11.5
Beaverdam Creek	483	396	19.0	20.8
Upper Scape Ore Swamp	397	302	24.2	12.5
Lower Scape Ore Swamp	232	192	14.2	13.5
Total	*1,791*	*1,344*	*101.7*	*13.2*

It is, therefore, expected that:

- An overall reduction in fecal coliform bacteria will occur in the entire Scape Ore Swamp project watershed area; particularly in the headwater areas, due to an increase in the more economically viable forestry land uses;

- The lower subwatershed portion of the project watershed area will continue to be farmed intensely; and

- Agricultural agency field personnel will be able to conduct a more refined search of those farm fields that are potentially the greatest sources of fecal coliform bacteria loading; particularly pastures areas and litter application sites in the Beaverdam Creek and the Lower Scape Ore Swamp subwatersheds. These two subwatersheds are prioritized because they posses the largest number of farm fields per square mile and are located in a close proximity to the PD-355 ambient water quality monitoring station.

This land use information will be consolidated with the water quality modeling results and stakeholder recruitment efforts to initiate the development of an effective TMDL implementation effort. The following Scape Ore Swamp subwatershed descriptions and figures provide a detailed accounting of agricultural practices in the Scape Ore Swamp project watershed area. The figure scales are approximate.

Black Creek Subwatershed

The Black Creek Subwatershed represents the extreme eastern headwaters of the Scape Ore Swamp project watershed area; and is located in the agriculturally unproductive Sandhills Region of South Carolina. Black Creek and Timber Creek converge to form Scape Ore Swamp at the bottom of this Subwatershed area. As shown in Figure 7-1, the farm fields in this Subwatershed are more greatly scattered than in the other subwatersheds. Moreover, many of the FSA recognized farm fields have either been converted to forestry or gone idle. The greatest concern for bacteria loading in the Black Creek Subwatershed is associated with the quantity of pastures that appear to provide access to streams. One group of pastures is located adjacent to a headwater tributary; a second group of pastures lies next to the Black Creek mainstem; and one pasture may be providing farm animal access to the most southern and largest tributary to Black Creek.

Timber Creek Subwatershed

The Timber Creek Subwatershed is located in the western headwater section of the Scape Ore Swamp project watershed area. The Subwatershed is located in the Sandhills Region of South Carolina and, as a result, contains a number of FSA recognized farm fields that have gone idle or have been converted to forestry. Three very large farm fields are designated pastures on Figure 7-2. The pastures do not encompass the entirety of the delineated farm field areas. Aerial photographs show that these farm fields also contain substantial forested area, and farm animal access to the streams may be occurring on just one of these farm fields. A smaller pasture in the northern reaches of the watershed was also noted to provide definitive stream access during the drive-bye survey. Several cropland and hayfields are also located in the vicinity of a stream, and due to the presence of two poultry operations in the Subwatershed, the potential application of poultry litter should be investigated.

Upper Scape Ore Swamp Subwatershed

The Upper Scape Ore Swamp Subwatershed, depicted in Figure 7-3, possesses a greater concentration of farm fields in the more southern areas where the stream appears to be transitioning into the Upper Coastal Plain of South Carolina. Two sites possessing poultry houses are found in the Subwatershed; and it is, therefore, expected that poultry litter application is occurring on many of the Subwatershed’s farm fields. Numerous pastures were also identified in the Subwatershed. Two of these pasture areas were noted to provide direct access to streams. Moving upstream along the Scape Ore Swamp mainstem, one of these pasture sites is found at the headwaters of the second tributary branching towards the north. The second pasture providing noted stream access is located with the group of pastures both along the Scape Ore Swamp mainstem and the first tributary branching northward. The large number of pastures found adjacent to the first tributary branching towards the south should also be investigated for potential fecal coliform bacteria loading.

Beaverdam Creek Subwatershed

This Subwatershed, characterized in Figure 7-4, possesses an ambient water quality monitoring station at the Route 313 Bridge spanning Beaverdam Creek (PD-636). Fecal coliform bacteria exceedances to the state water quality standard have not occurred at the PD-636 ambient water quality monitoring station. This is consistent with the land use characterization findings. All pasture areas and poultry houses in this Subwatershed were found in the Beaverdam Creek drainage area below the PD-636 monitoring station. Five poultry house sites suggest that the application of poultry litter to this Subwatershed is extensive; particularly in the lower sections of the Subwatershed, potentially in the vicinity of the impaired PD-355 ambient water quality monitoring station. Two pastures were also identified to provide direct access to the Beaverdam Creek during the drive-bye field survey. One is located as part of a group of farm fields found just north of where the Beaverdam Creek mainstem divides in two, only to rejoin as one hydrologic system a short distance downstream. The Beaverdam Creek mainstem is also shown to flow through several pastures towards the bottom of Subwatershed area. One of these pastures was noted to provide access to Beaverdam Creek during the drive-bye field survey.

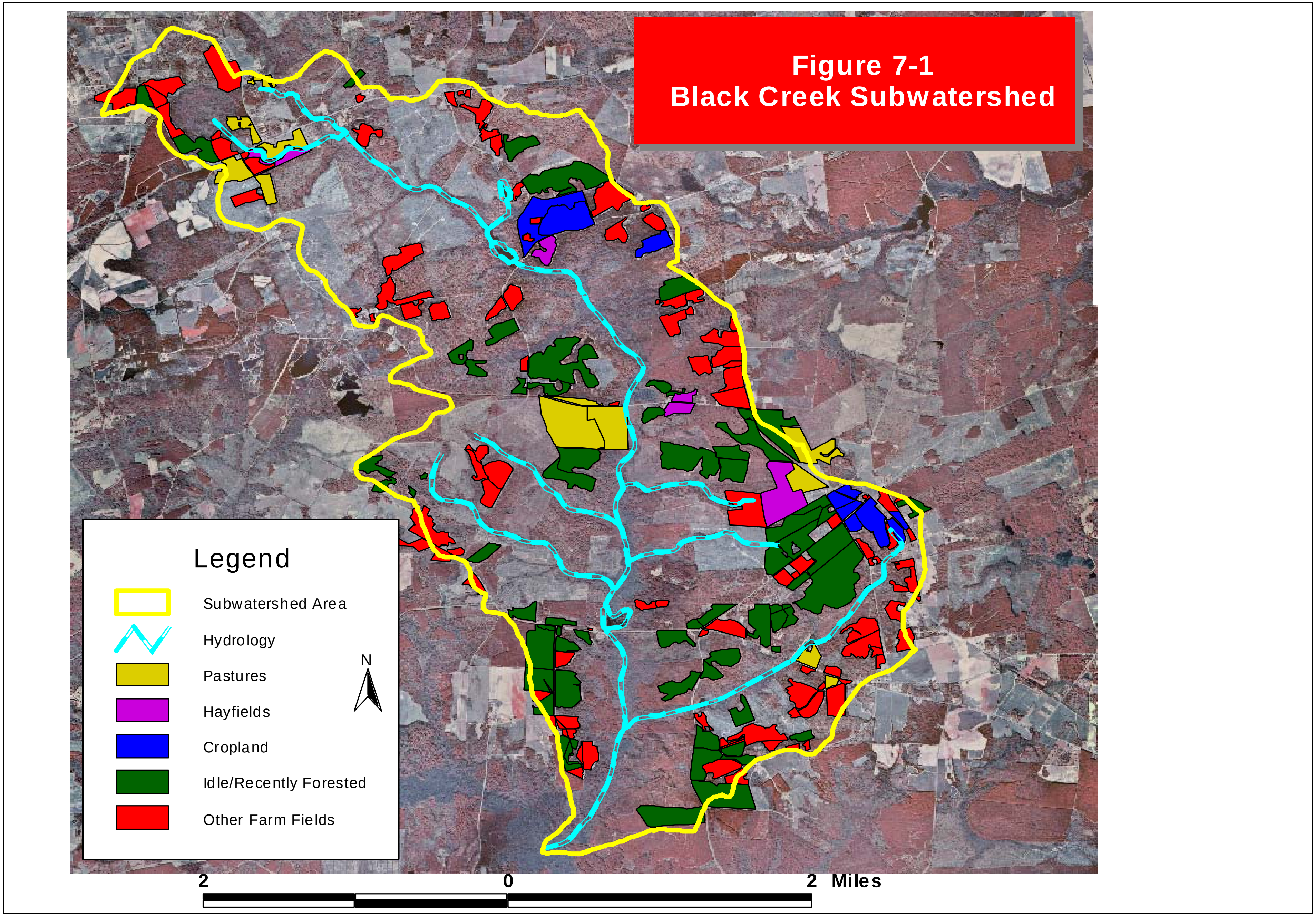


Figure 7-1
Black Creek Subwatershed
Legend
Subwatershed Area
Hydrology
Pastures
Hayfields
Cropland
Idle/Recently Forested
Other Farm Fields
N
2
0
2 Miles

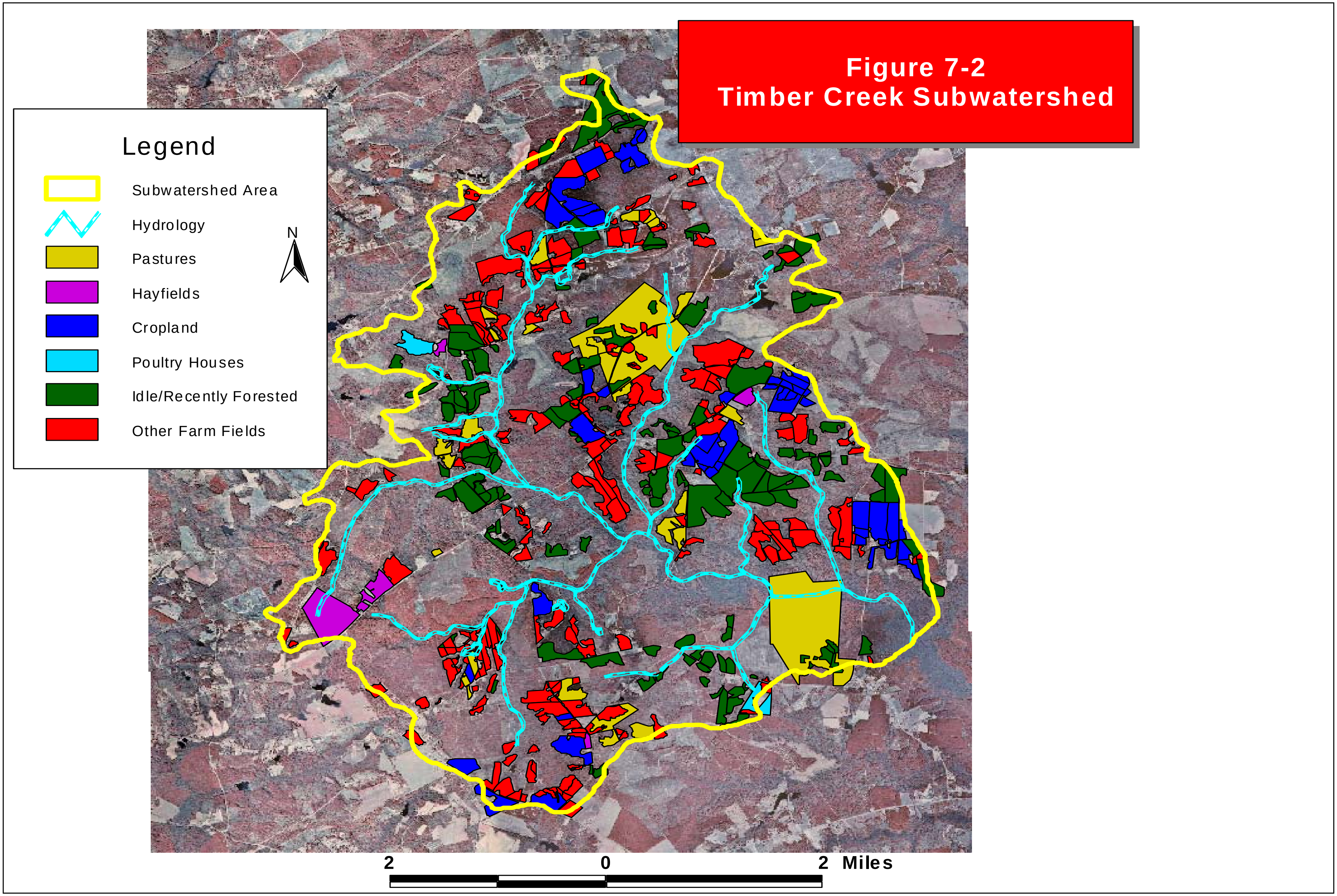


Figure 7-2
Timber Creek Subwatershed
Legend
Subwatershed Area
Hydrology
Pastures
Hayfields
Cropland
Poultry Houses
Idle/Recently Forested
Other Farm Fields
N
2
0
2 Miles

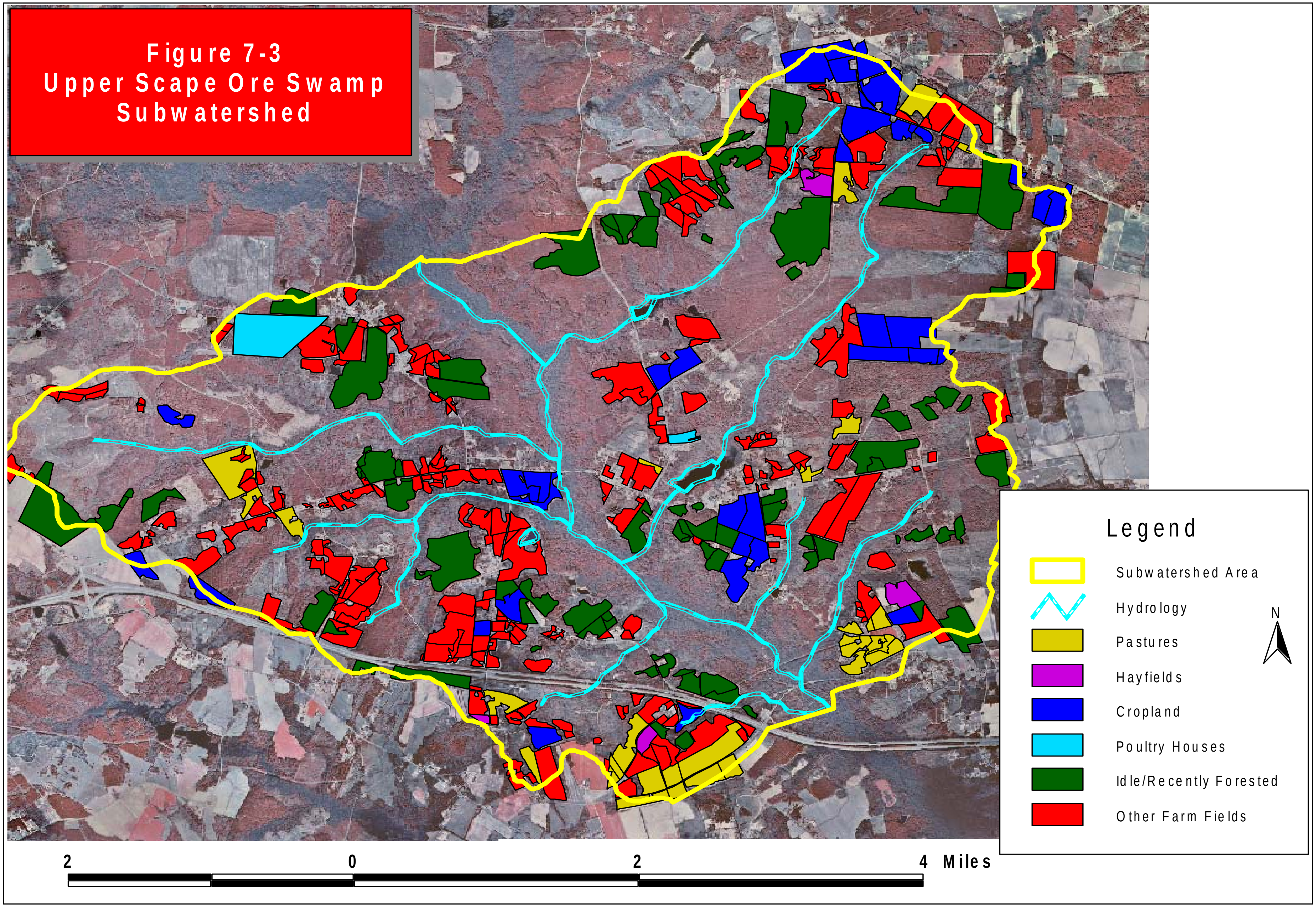


Figure 7-3
Upper Scape Ore Swamp
Subwatershed
Legend
Subwatershed Area
Hydrology
Pastures
Hayfields
Cropland
Poultry Houses
Idle/Recently Forested
Other Farm Fields
N
2
0
2
4 Miles

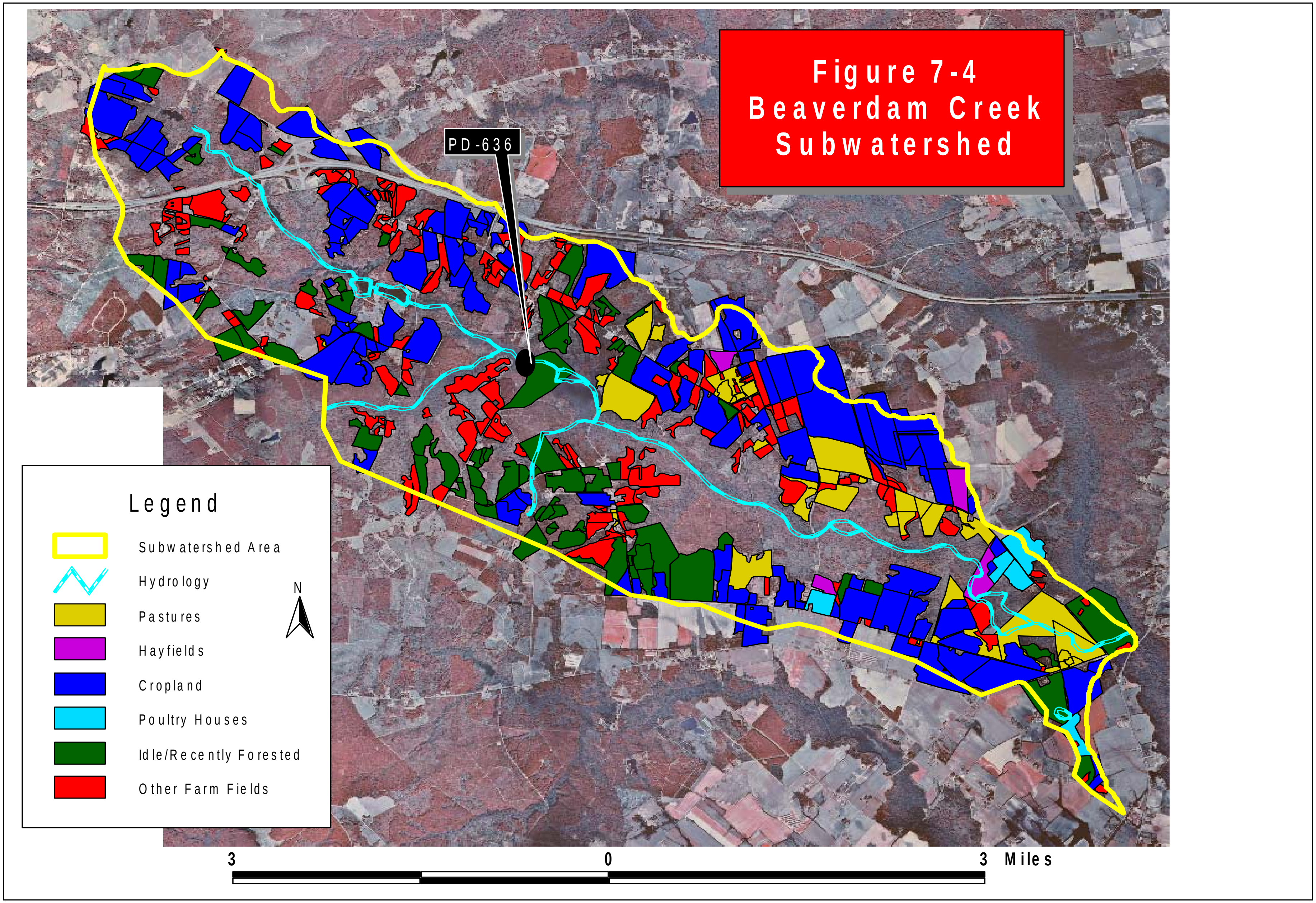


Figure 7-4
Beaverdam Creek
Subwatershed
PD-636
Legend
Subwatershed Area
Hydrology
Pastures
Hayfields
Cropland
Poultry Houses
Idle/Recently Forested
Other Farm Fields
N
3
0
3 Miles

Lower Scape Ore Swamp Subwatershed

The Lower Scape Ore Swamp Subwatershed, depicted in Figure 7-5, is the smallest Subwatershed in the Scape Ore Swamp project watershed area. It is a narrow Subwatershed that consists mainly of the Scape Ore Swamp mainstem and associated wetlands, and the immediate drainage to the Swamp. Several poultry house sites are grouped together towards the northern end of the Subwatershed on the western bank of Scape Ore Swamp. It is probable that a number of the farm fields in this northwestern corner of the Subwatershed are receiving poultry litter; including many adjacent to the mainstem. Although pastures are not as prevalent as in other Subwatershed, two small pastures should be investigated because they have potential access to the stream along the northwestern bank of the Scape Ore Swamp mainstem. This Subwatershed area also contains a hog operation and a landfill away from the Scape Ore Swamp mainstem.

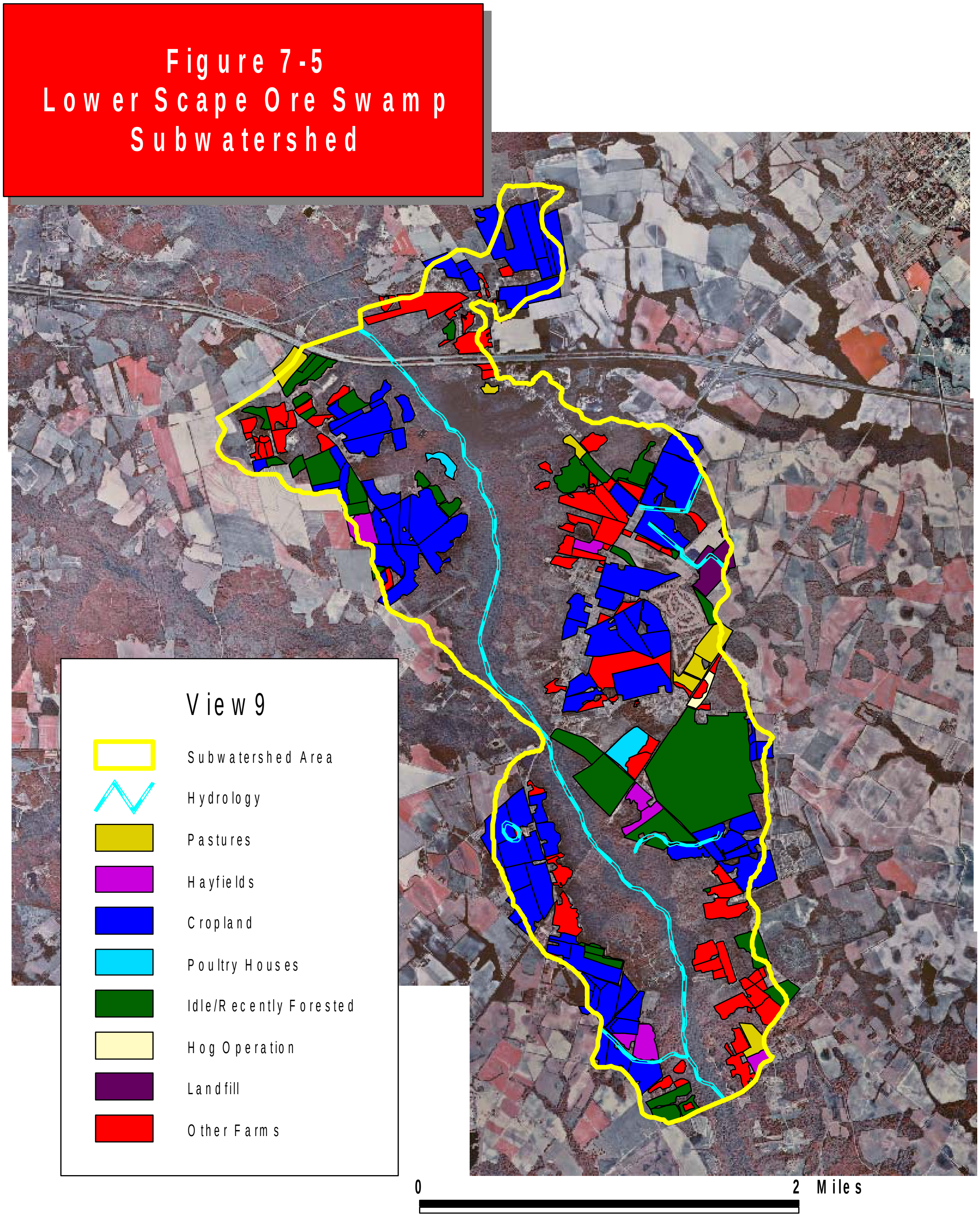


Figure 7-5
Lower Scape Ore Swamp
Subwatershed
View 9
Subwatershed Area
Hydrology
Pastures
Hayfields
Cropland
Poultry Houses
Idle/Recently Forested
Hog Operation
Landfill
Other Farms
0
2 Miles

8.0 IMPLEMENTATION PLANNING RECOMMENDATIONS

The Load Reduction Plan was developed using the best data available to identify a **load reduction allocation scenario** that, when implemented, will meet the state water quality goals for fecal coliform bacteria in the Scape Ore Swamp project watershed area. Additional watershed planning efforts included in this Load Reduction Plan consist of a **detailed characterization and accounting of agricultural land uses** and the formation of a **stakeholder group and an informed citizenry**. These three Load Reduction Plan components will facilitate and provide a structure for the development and application of an effective TMDL implementation plan. Four implementation planning strategies are recommended:

- Watershed Management and Planning Administration;
- Selection and Implementation of Corrective Actions;
- Citizen Awareness and Education, and;
- Continued Water Quality Sampling.

Watershed Management and Planning

To reduce the quantities of fecal coliform bacteria from the potential loading sources within the Scape Ore Swamp project watershed area, a decision-making framework and management process is required. This framework will be developed to:

- Foster cooperation between federal, state and local agencies and partners; and
- Advance a coordinated approach to acquiring landowner support for the implementation of corrective actions that meet the goals of the load reduction allocation scenario.

The recommended framework will contain provisions that address the monitoring of implementation tasks (and their measured success) in the Scape Ore Swamp project watershed area, the application of a citizen awareness and education program, and the administration of multiple and concurrent grant and other cost-share programs.

Selection and Implementation of Corrective Actions

The administration of the load reduction allocation scenario suggests the need for a multi-phased approach to TMDL implementation to meet the applicable water quality standards and support the recreation use classification. The load reduction allocation scenario identifies a primary need for corrective actions that address fecal coliform bacteria loading reductions from direct livestock deposition into the stream, runoff from pasture manure, over-application of poultry litter, and failing septic systems. A DHEC sampling program has shown that the concentrations of fecal coliform bacteria are frequently in violation of the state standard at the PD-355 ambient water quality monitoring stations in the Scape Ore Swamp project watershed area. The agricultural land use characterization has identified over one hundred farm fields with practices that are potential sources of fecal coliform bacteria loading.

Prioritization of Land Use Activity. As a result of these quantities and widespread locations of potential fecal coliform bacteria loading sources, the targeting and ranking of farm fields for implementation measures is a necessary component to implementation planning. It not only ensures the optimal utilization of implementation revenues, but also facilitates a multi-phased implementation approach where stakeholders can identify and prioritize sets of farm fields for corrective action based on their probability of success and the availability of implementation funds.

Due to the intensity of farming in the Beaverdam Creek and Lower Scape Ore Swamp Subwatershed areas, and their proximity to the PD-355 ambient water quality monitoring station, it is recommended that those practices identified during the agricultural land use characterization effort as potential sources of fecal coliform bacteria loading be prioritized for immediate implementation activities. Second stage BMP and conservation practices implementation is recommended to occur in the Upper Scape Ore Swamp Subwatershed area because parts of the Subwatershed are found in the Upper Coastal Plain of South Carolina where farming is more intensive. Should the PD-355 ambient water quality monitoring station maintain exceedances to the standard following implementation of practices during the first two stages, the application of funds for implementation endeavors in the headwater areas of Black Creek and Timber Creek is recommended as a final stage.

Corrective Action Implementation. Once farm fields have been prioritized based on their potential for causing unacceptable loads of fecal coliform bacteria, fundable and site-specific corrective actions will be selected. The South Carolina Department of Natural Resources and the NRCS have jointly developed a handbook of conservation practices applicable to South Carolina farming concerns entitled ***Farming for Clean Water in South Carolina*** (July, 1997). The Handbook provides descriptions of several corrective actions that address various sources of fecal coliform bacteria loading, and the relative costs for the implementation of these respective corrective actions. Corrective actions that are applicable to the direct deposition of farm animal waste into streams include:

- ‘Stream protection’ that promotes the fencing off buffer zones and managing livestock access to streams;

- ‘Stream crossings’ which allows livestock to drink and cross streams a designated points; and

- ‘Water tanks’ and ‘Farm Ponds’ that provide livestock with alternative sites for drinking water.

To limit fecal coliform bacteria loading from pasture runoff, ‘pasture management’ and ‘runoff management’ are recommended by the Handbook where rotational grazing, proper pasture stocking rates, paddock planning based on cutting intervals for forage, methods of keeping feedlots and loafing areas dry, and other grazing techniques that improve water quality are promoted.

To address the over-application and non-uniform application of poultry litter on farm fields in the project watershed area, the Lee and Kershaw County NRCS District Conservationists have suggested the adoption of an education program. This program could be designed to promote the following activities specified in the ‘Nutrient Management’ and ‘Manure Testing’ sections of the Manual:

- Testing litter at the poultry houses for fertilizer value;

- Testing farm field soils to determine if and how much litter should be applied to meet crop yield goals;

- Calibrating litter spreading by trucks to apply proper rates; and
- Applying litter at proper times and frequencies.

In addition, many of the farm fields accepting poultry litter are potentially lacking buffers. Numerous USDA conservation programs (i.e., Conservation Reserve Program, the Environmental Quality Incentives Program) provide funding for streamside buffers.

Although only one stockpile of litter was noted during the field survey, it is probable that this practice occurs, on occasion, in the Scape Ore Swamp project watershed area due to the presence of a large quantity of poultry houses. The leaching and runoff of litter from the open stockpiles could result in marked fecal coliform bacteria loading. Corrective actions could include the short-term application of plastic sheeting or long-term use of covered facilities with impervious ground liners.

Site-specific corrective actions for the sources of fecal coliform bacteria outlined in the load reduction allocation scenario will be made by technical experts following on-site farm field investigations.

Citizen Awareness and Education

The success of this multi-phased approach to implementation also requires support and acceptance from the landowners, growers, and operators farming in the project watershed area. A citizen awareness and education program is, therefore, suggested to make the local citizenry aware of:

- The human health risks of fecal coliform bacteria impaired water bodies;
- The different sources of fecal coliform bacteria;
- How these sources are contributing to the specific water quality impairment in the project watershed area; and
- The available, voluntary, and often cost-shared corrective actions utilized to minimize fecal coliform bacteria loading into Scape Ore Swamp project watershed area.

Outreach plan components may include field days where successful and demonstration corrective actions are endorsed; workshops presenting water quality issues and the benefits of corrective actions; use of agricultural operators willing to share management solutions; partner building with commodity groups to promote conservation; the use of local school districts to take part in water quality sampling or corrective action implementation and construction; and the development of brochures specific to fecal coliform bacteria impairment in the Scape Ore Swamp project watershed area. The brochures could be used to facilitate the advancement of project goals at large forums or at one-on-one meetings with landowners, growers, and operators.

A foundation of support for implementation endeavors has been established during the development of this Load Reduction Plan. Local, state, and federal agricultural and environmental agencies have dedicated an interest in the project; and landowners, growers, operators and farming organizations located in the Scape Ore Swamp project area will be introduced to the project when the findings are presented at a meeting scheduled for August 2005.

Continued Water Quality Sampling

It is recommended that DHEC continue their sampling at the PD-355 ambient water quality monitoring site in the Scape Ore Swamp project area throughout the implementation stage of the project to:

- Measure progress towards meeting the goals of the load reduction allocation scenario;
- Determine the effectiveness of the load reduction allocation scenario; and
- Allow for implementation flexibility by providing justification for making mid-course changes to the load reduction allocation scenario.

Potential action item tasks associated with the recommended implementation planning strategies are depicted in Table 8-1. Suggested lead organizations and funding sources for each action item task are also listed.

TABLE 8-1 RECOMMENDED IMPLEMENTATION ACTION ITEMS

Action Item	Lead Organization	Potential Funding Source
WATERSHED MANAGEMENT PLANNING AND ADMINISTRATION		
Development of Decision Making Stakeholder Group for Implementation Planning.	Santee-Wateree RC&D Council	EPA Section 319 Program.
Project Management and Coordination of Tasks and Agencies/Organizations in South Carolina.	Santee-Wateree RC&D Council	EPA Section 319 Program.
Identification of Funding Sources, Proposal Development, and Grant Administration.	Santee-Wateree RC&D Council	EPA Section 319 Program.
Continuous Measurement of Project Success and Administration of Mid-Course Changes to Meet Project Goals.	Santee-Wateree RC&D Council	EPA Section 319 Program.
SELECTION AND IMPLEMENTATION OF CORRECTIVE ACTIONS		
Targeting and Prioritizing Farm Fields for Implementation Using GIS Database of Farm Field Information (Criteria for Selection may Include Vicinity to Stream, Soil Types, Slopes, Land Use Practices, etc.).	Lee and Kershaw SWCDs with Support from NRCS District Conservationists.	EPA Section 319 Program.
Selection and Implementation of Farm Field Specific Corrective Actions.	Lee and Kershaw SWCDs with Support from NRCS District Conservationists and SC Department of Natural Resources (DNR).	EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program (EQIP), USDA Wildlife Habitat Incentives Program (WRP), USDA Wetland Reserve Program (WRP).
CITIZEN AWARENESS AND EDUCATION		
Public Awareness Effort Targeting Residential Landowners; Including Coordination with the local health department and Clemson Extension Personnel, Advocacy of Constructed Wetlands for Failing Septic Systems, News Articles and Brochures Promoting Septic Pump-out and Other Methods of Homeowner Cooperation.	Santee-Wateree RC&D Council/ SC Department of Natural Resources / SC DHEC	EPA Environmental Education and/or Environmental Justice Grant Programs.
Promotion of Various Voluntary BMP / Conservation Practices to Landowners of Prioritized Farm Fields at One-on-One Meetings.	Lee and Kershaw SWCDs with Support from NRCS District Conservationists and SC DNR.	EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program (EQIP), USDA Wildlife Habitat Incentives Program (WRP), USDA Wetland Reserve Program (WRP).
Poultry Litter Application Training.	Lee and Kershaw SWCDs with Support from NRCS District Conservationists and SC DNR.	EPA Section 319 Program. EPA Section 319 Program, USDA Conservation Reserve Program (CRP), USDA Environmental Quality Incentives Program (EQIP), USDA Wildlife Habitat Incentives Program (WRP), USDA Wetland Reserve Program (WRP).
CONTINUED WATER QUALITY SAMPLING		
Continued Review of Water Quality Information from DHEC Ambient Water Quality Monitoring Stations (PD-068 and PD-067) to Measure Progress.	Santee-Wateree RC&D Council	EPA Section 319 Program.

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APPENDIX A

FECAL COLIFORM CONCENTRATION DATA FROM DHEC MONITORING STATION PD-355

Date	Fecal Coliform Concentration (counts/100mL)
11/30/1993	470.00
12/14/1993	70.00
1/18/1994	95.00
2/3/1994	70.00
3/9/1994	37.00
4/20/1994	36.00
5/18/1994	200.00
6/9/1994	200.00
8/18/1994	170.00
9/27/1994	90.00
10/11/1994	780.00
3/10/1998	310.00
4/2/1998	89.00
5/27/1998	660.00
6/18/1998	600.00
7/30/1998	300.00
8/27/1998	340.00
9/24/1998	440.00
10/28/1998	270.00
1/9/2001	160
2/6/2001	110
3/5/2001	940
4/17/2001	110
5/8/2001	560
6/14/2001	1200
7/2/2001	780
8/9/2001	330
9/4/2001	840
10/15/2001	340
11/14/2001	110
12/3/2001	74
1/23/2002	30
2/19/2002	70
3/21/2002	680
4/25/2002	380
5/29/2002	160
6/17/2002	100

7/22/2002	7
8/13/2002	2100
9/3/2002	220
10/1/2002	240
11/26/2002	80
12/5/2002	130
1/8/2003	87
2/5/2003	71
3/20/2003	300
4/3/2003	52
5/27/2003	330
6/23/2003	300
7/31/2003	130
8/6/2003	110
9/11/2003	340
10/16/03	450
11/19/03	2000
12/10/03	150

APPENDIX B

CALCULATIONS OF EXISTING AND ALLOWABLE LOADS AT PD-355

Calculation of Existing Load from Trend Line

Equation of Trend line: $y = 1E{+}15\ e^{-0.091x}$

Percent Exceeded (%)	Existing Load (ct/day)
66	2.46E+12
68	2.05E+12
70	1.71E+12
72	1.43E+12
74	1.19E+12
76	9.92E+11
78	8.27E+11
80	6.89E+11
82	5.75E+11
84	4.79E+11
86	3.99E+11
88	3.33E+11
90	2.77E+11
Mean	**1.03E+12**

Existing Load = 1.03×10^{12} counts/day

Calculation of Allowable Load from Trend Line

Equation of Trend Line: $y = 8E{+}13\ e^{-0.0652x}$

Percent Exceeded (%)	Target Load (ct/day)
66	1.08E+12
68	9.50E+11
70	8.34E+11
72	7.32E+11
74	6.42E+11
76	5.64E+11
78	4.95E+11
80	4.34E+11
82	3.81E+11
84	3.35E+11
86	2.94E+11
88	2.58E+11
90	2.26E+11
Mean	**5.56E+11**

Allowable Load = $5.56{\times}10^{11}$ counts/day