WATERSHED-BASED PLAN

Craven Creek, Grove Creek, Big Creek, and Hurricane Creek of the Saluda River, South Carolina

SUBMITTED TO:
The South Carolina Department of Health and Environmental Control

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SUBMITTED BY:

September 30, 2013
Revised July 16, 2014

Upstate Forever

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1. INTRODUCTION

Upstate Forever (UF), in collaboration with project partners developed this watershed based plan to reduce bacteria levels in select waterways to meet state water quality standards for Big Creek, Hurricane Creek, Craven Creek and the Grove Creek subwatersheds of the larger Upper Saluda River Basin (HUC 03050109-03). Project partners include: Anderson County, Appalachian Council of Governments (ACOG), Furman University, Hargett Resources, Inc., Metropolitan Sewer Sub-District, Natural Resource Conservation Service (NRCS), Pickens County Stormwater Partners (PCSP), Town of Pelzer, Town of West Pelzer, and the Town of Williamston. This watershed based plan provides a comprehensive overview of the sources of bacteria pollution in these watersheds and identifies critical areas for restoration and protection. In addition, this plan provides strategies to reduce or eliminate pollution loads within watersheds, suggests potential funding opportunities for pollution mitigation practices, and outlines a public outreach strategy to increase public awareness about water quality issues as it relates to bacteria.

A Fecal Coliform Bacteria TMDL for the Upper Saluda Basin was approved in 2004; however, water quality standards for many of the sites have not yet been achieved. According to the TMDL the watersheds included in this project call for overall reductions in bacteria ranging from 33% to 80%[1]. While some urban areas are present, these watersheds are predominately rural in nature. Most of the watersheds included in this project are impaired for recreation due to fecal coliform violations, and will require similar actions to achieve the necessary bacterial reductions.

2. GENERAL WATERSHED INFORMATION

The 200 mile-long Saluda River is encompassed by a 1,615,719-acre watershed (HUC 03050109-03), covering parts of eleven counties in the Upstate region of South Carolina[2]. This watershed based plan focuses on four HUC-12 subwatersheds within the Saluda River Watershed (Figure 1), covering 73,956 acres.

Name of Subwatershed	Hydrological Unit Code (HUC)	Acreage
Craven Creek	030501090307	29,443.19
Grove Creek	030501090305	22,290.14
Hurricane Creek	030501090304	9,685.18
Big Creek	030501090306	12,537.23
	TOTAL	***73,955.74***

Table 1: Subwatersheds HUC-Codes and Acreage

Location

Located near the top of the Saluda River Watershed, these four subwatersheds encompass 41 miles of the Saluda River. The majority of the subwatershed areas are within Anderson and Greenville Counties, with only the topmost portion of the Craven Creek subwatershed in Pickens

[1]SC DHEC, "EPA Finalized TMDL Upper Saluda River Basin."
[2]Ibid.

County. The Saluda River serves as the boundary line between Anderson County (to the west) and Greenville County (to the east).

Population, Communities, and Culture

The subwatersheds include the communities of Williamston, Pelzer, West Pelzer, Piedmont, Golden Grove, and Powdersville (Figure 1). Population estimates were calculated by identifying the U.S. Census Tracts within each subwatershed, and collecting the total number of occupied homes data within the Census Tracts as provided by the U.S. Census. The estimated population of the subwatershed area is 48,025, based on the number of occupied homes (19,210) and the average household size (2.5) from the 2010 U.S. Census[3].

Estimated Population in Subwatersheds	=	Number of Occupied Homes	X	Average Household Size

The northern portion of the planning area contains the majority of the population for the region just south of the City of Greenville (Figure 1). Although Pelzer, West Pelzer, Williamston, and Powdersville are the larger towns within the focus area, their populations are small, only making up about ten percent of the total population for the planning area. Rich in history and culture, the four subwatersheds were once home to many cotton mills and dominated by the textile industry. In the late 1800's, cotton and textile mills were placed near the Saluda River in Pelzer, West Pelzer, and Williamston, using the natural resource of water to sustain a textile-driven industry[4]. Many mills closed at the turn of the 20th century, however mill sites still exist in Pelzer, West Pelzer, and Williamston.

Geography and Climate

Nestled in the Piedmont Foothills region of South Carolina, the Upper Saluda River Basin is mainly composed of agricultural land and managed forestland (Figure 3). With a northern border of a mountainous ecoregion and a southern border of sand hill ecoregion, the Piedmont is characterized by rolling hills and level floodplains. The Saluda River is relatively slow moving in the focus area, sometimes even lake-like due to the existence of numerous dams. The average elevation of the focus area is 865 feet, with the elevation ranging from 640-1,040 feet above sea level. The northern region of the focus area is classified by higher elevations while the southern region of the focus area is less hilly with lower elevations. Soil types within the four subwatersheds area are primarily variations of sandy loams. Most soil associations in this region are mixes of soil series; for example, the Pacolet-Madison-Davidson-Cecil association (a mixture of Pacolet, Madison, Davidson, and Cecil series) is the primary soil surrounding the Saluda River, covering roughly forty percent of the focus area (Figure 2). The Cecil soils series are characterized by very deep, well-drained, moderately permeable soils found on upland ridges and side slopes with slopes ranging from 0-25%[5].

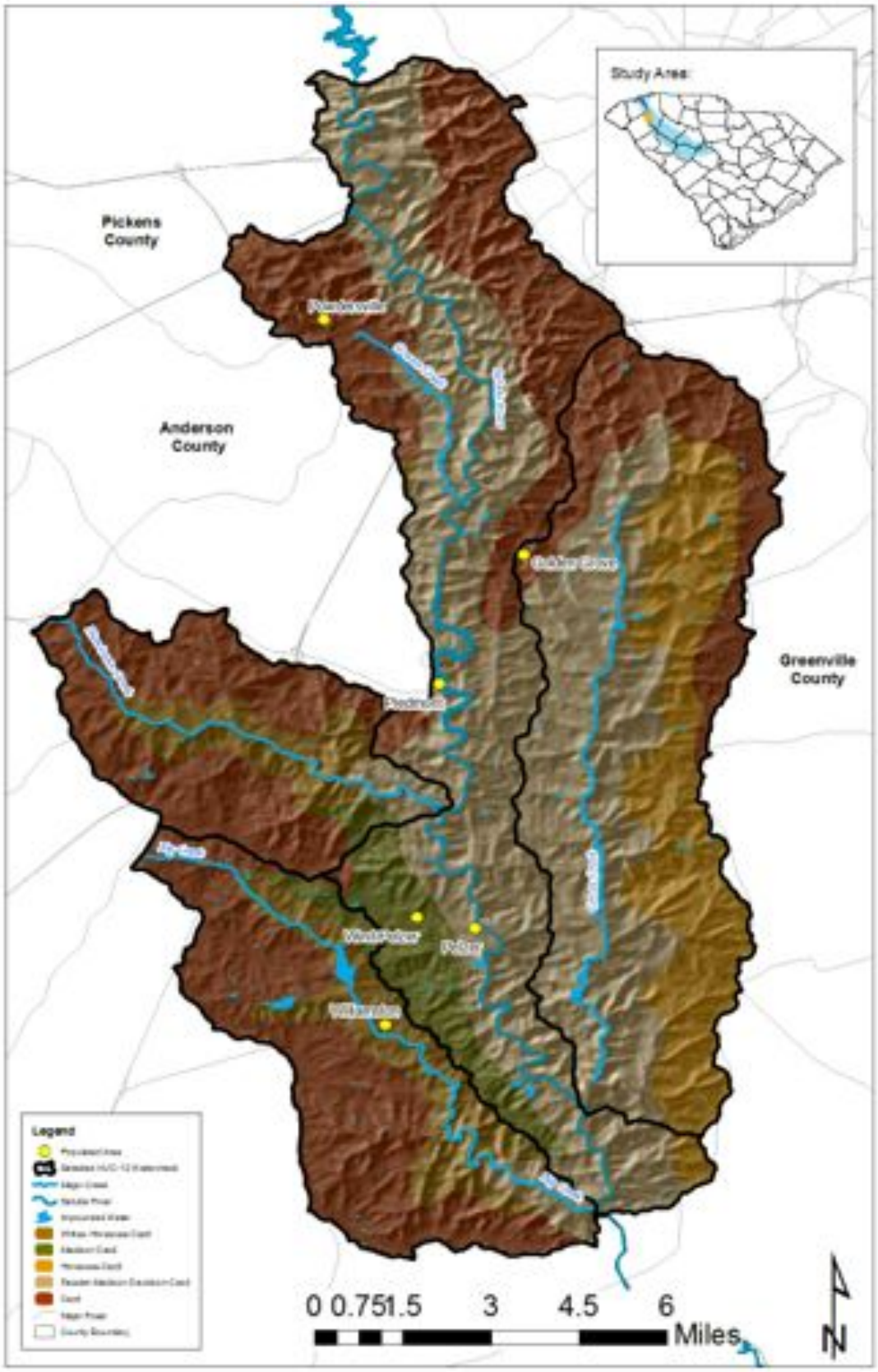
[3]The United States Census Bureau, "American Fact Finder."
[4]Anderson County Museum, "Town History."
[5]Natural Resources Conservation Service (USDA NRCS), "Cecil -- North Carolina State Soil."

The rolling hills and mild climate of the Piedmont region of South Carolina produce a temperate environment, with average temperatures of 40°F (winter), 80-90°F (summer), and 60-70°F in the spring and fall[6]. Average annual precipitation for the region is 46.66 inches for Anderson County and 50.77 inches for Greenville County[7].

[6]Department of Natural Resources (DNR), "South Carolina State Climatology Office."
[7]Ibid.

Figure 1. Saluda River Watershed Focus Area

Figure 2. Geographic Features and Soil Associations



Land Cover

Sourced from the 2006 National Land Cover Dataset (NLCD), land cover in the focus area (Figure 3) has been divided into eleven categories, as shown in Table 2. Together, the two dominant undeveloped land covers – forest and agricultural land – make up over fifty percent of the land cover in the subwatershed[8]. Developed land accounts for 24% of the subwatersheds' land cover, but is concentrated on the Greenville County, or eastern side, of the Saluda River. The Anderson County, western side of the Saluda River, is characterized primarily by concentrations of agriculture and forestlands. Forestland is the predominant land cover type, covering 41% of the subwatershed area.

Land Cover Type	Acres	Percent
Forest Lands	30,309	41%
Agricultural Land	14,323	19%
Developed, Open Space	9,652	13%
Grassland/Herbaceous	7,874	11%
Developed, Low Intensity	5,837	8%
Wetlands	1,706	2%
Developed, High Intensity	662	<1%
Developed, Medium Intensity	1,779	<1%
Open Water	856	<1%
Barren Land	605	<1%
Shrub/Scrub	352	<1%
Total	***73,955***	***100***

Table 2: Land Use Acreage and Percentages

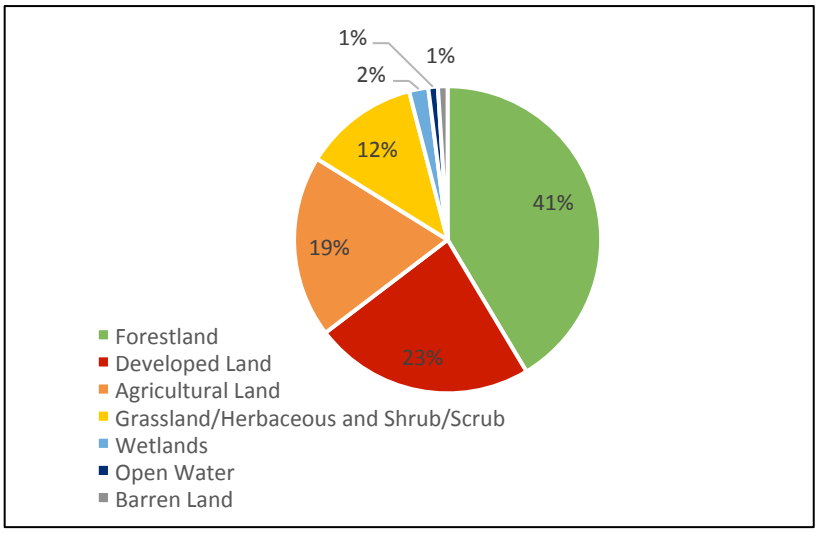
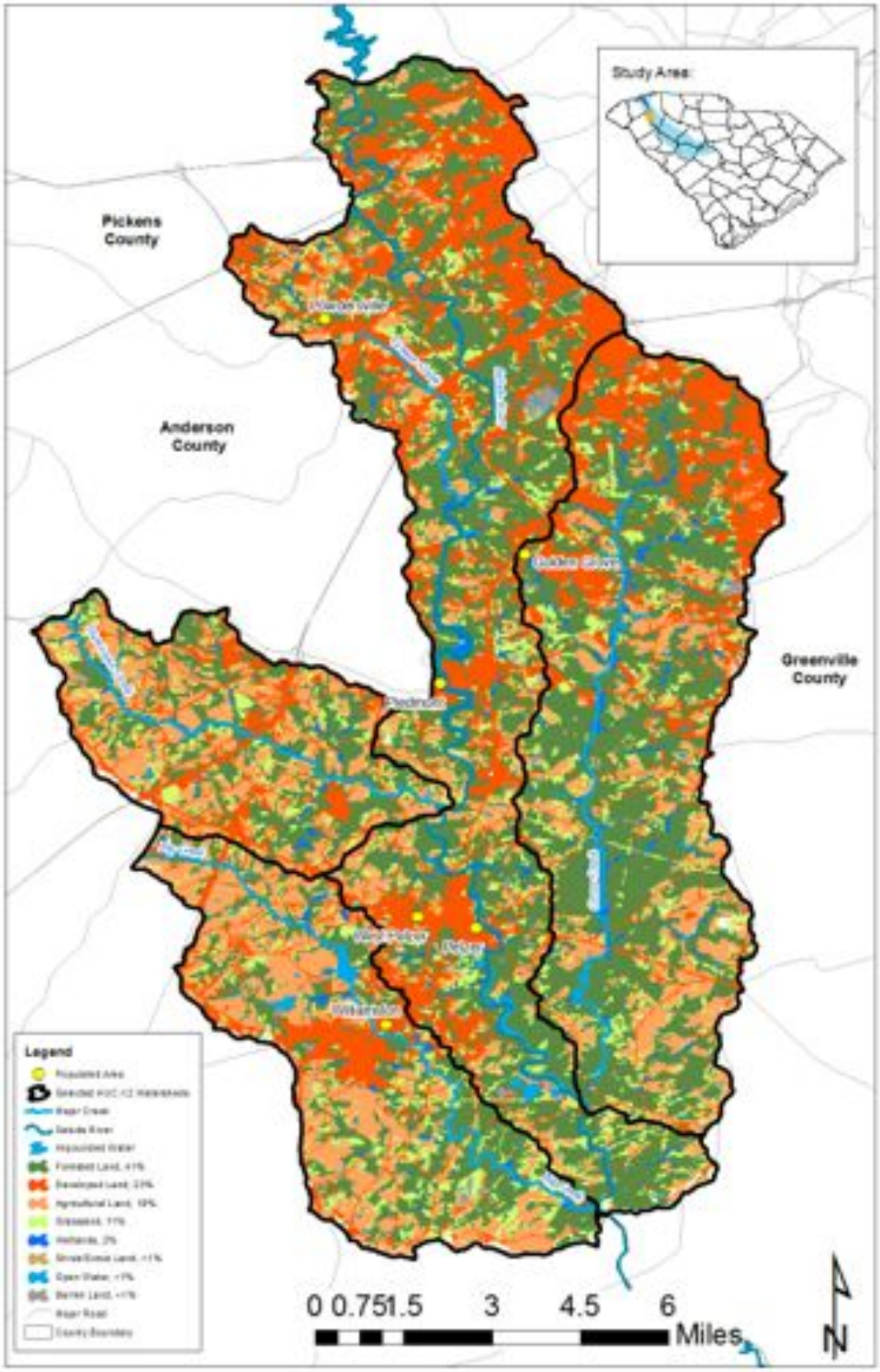


Figure 3: Overall Land Use Percentages

[8]Katie Premo, *ArcGIS 10.1 Analysis*.

Figure 4. Land Cover in the Saluda River Watershed Focus Area



3. WATER QUALITY IMPAIRMENTS AND SOURCES

Historically, the State of South Carolina (SC) used Fecal Coliform (FC) as the bacterial indicator to evaluate the safety of freshwaters for recreational purposes. The standard for FC was a daily concentration of 400 Colony Forming Units (CFU's) per 100 milliliters (mL) of water and a 30-day geometric mean of 200 counts per 100 mL. Water samples that exceeded this standard more than 10% of the time were considered unsafe for recreation and in violation of State standards; sites considered impaired for fecal coliform are placed on South Carolina Department of Health and Environmental Control's (SC DHEC) biennial 303(d) list. In 2012 SC DHEC switched to the *Escherichia coli* (*E. coli*) as the bacterial indicator for freshwaters[9]. Nationally, *E. coli* has long been considered the recommended indicator of fecal pollution in freshwaters. The current SC state standard for *E. coli* is a daily concentration not to exceed 349 CFU/100 mL and 30-day geometric mean of 126 CFU/100 mL. FC and *E. coli* are usually not a threat to human health however their presence in freshwater is indicative of fecal pollution[10]. Fecal contamination is a human health risk because it may contain disease-causing organisms such as pathogenic bacteria, viruses, protozoa, or parasites.

Because of the recent transition in bacterial indicators in SC from FC to *E. coli*, the majority of the available water quality data is for FC. As directed by SC DHEC the bacteria load reductions in this plan were calculated using FC data and are referred to generically as "bacteria". The monitoring plan however is designed specifically to test for *E. coli* bacteria.

Water Quality Monitoring Stations

According to SC DHEC, "the ambient surface water monitoring program is directed toward assessing attainment of water quality standards"[11]. Water quality monitoring stations are strategically placed to evaluate the water quality of streams and lakes. Within the subwatersheds, there are six water quality monitoring stations that have collected data, and monitoring done by SC DHEC has shown elevated levels of fecal coliform bacteria within the focus area.

History of Water Quality

As shown in Figure 5, several tributaries of the Saluda River were listed as impaired streams on the 2004 Section 303(d) of the Clean Water Act list of impaired or threatened waters, otherwise known as the 303(d) list, due to high levels of fecal coliform[12]. The 303(d) lists are compiled every two years by SC DHEC and provide information on waterbodies regarding their status of impairment. An impaired water body can be taken off of the 303(d) list by either attaining water quality standards or by the approval of a TMDL. Approval of a TMDL does not ensure that water quality standards will be achieved. SC DHEC provides a biennial report of the status of sites with an approved TMDL.

[9]SC DHEC, "R.61-68, Water Classifications & Standards."
[10]Centers for Disease Control and Prevention, "E. Coli (Escherichia Coli)."
[11]SC DHEC, "Surface Water Monitoring Program."
[12]SC DHEC, "The State of South Carolina's Integrated Report Part 1: Section 303(d) List of Impaired Waters."

The TMDL for fecal coliform bacteria in the Upper Saluda River Basin approved in September of 2004 includes four out of the six stations shown as impaired streams, totaling 34.59 miles in stream length[13]. Station S-007 has achieved water quality standards and is no longer considered impaired for fecal coliform. With portions of the Saluda River back in compliance, future load reductions will be focused on the main stream tributaries of the Saluda River. This includes stretches of Grove Creek and Big Creek, totaling 23.2 miles in length. The Hurricane Creek subwatershed is not currently monitored for water quality. Because the levels of fecal coliform bacteria are unknown in this subwatershed, it is included with the assumption that its similar land cover and uses to the Big Creek subwatershed would produce similarly impaired waters.

Station	Description of Station	Sub-Watershed	Length in Miles	Use Supported (2012)	TMDL Status
S-007	Saluda River at SC 81, SW of Greenville	Craven Creek	11.38	Yes	TMDL Supported
S-119	Saluda River at S-04-178, 3.2 miles SE Williamston	Craven Creek	2.14	Yes	N/A
S-171	Grove Creek below JP Stevens Estes Plant	Grove Creek	8.21	No	TMDL Developed
S-267	Saluda River Trib., 350 Ft below W. Pelzer WWTP	Craven Creek	1.65	No	TMDL Developed
S-302	Big Creek at S-04-116	Big Creek	11.42	No	TMDL Developed
S-315	Mill Creek at Bent Bridge Road	Craven Creek	1.92	No	TMDL Developed

Table 3: Monitoring Station Descriptions and Current Use Status

Table 3 provides a brief description of the monitoring stations in the focus area and their current status. Currently, all of the water quality monitoring stations within the subwatersheds are located in waters classified for recreational use. According to the most recent publication of SC DHEC's 303(d) list in 2012, only two of the stations are supported for recreational use. The 2004 Upper Saluda River Basin TMDL lists station S-171 as partially supported for recreational use due to fecal coliform bacteria excursions.A partially supported use indicates that the percentage of standard excursions is greater than 10% but equal to or less than 25%. Sites that are not supported have a percentage of excursions greater than 25%[14]. Recent 303(d) lists indicate that station S-171 is currently not supported for recreational use.

[13]SC DHEC, "EPA Finalized TMDL Upper Saluda River Basin."
[14]SC DHEC, "Terms Used in Tables."

The following table outlines the brief history of the six historically impaired sites in the focus area, as well as their current attainment status. Station S-007 is the only site with a developed TMDL that is fully supported for recreational use; the other four sites with developed TMDL's are not yet supported for use due to continued bacterial impairments.

	1998	2000	2002	2004	2006	2008	2010	2012
S-007		x	x	x	TMDL (9/30/04)	Not Supported	Supported	Supported
S-119	Supported	Supported	Supported	Supported	Supported	Not Supported	Supported	Supported
S-171	x	x	x	x	TMDL (9/30/04)	Not Supported	Not Supported	Not Supported
S-267	x	x	x	x	TMDL (9/30/04)	Not Supported	Not Supported	Not Supported
S-302		x	x	x	TMDL (9/30/04)	Not Supported	Not Supported	Not Supported
S-315	x	TMDL (2/23/00)	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported

Table 4: History of Impairments as Reported on the SC 303(d) Lists from 1998-2012

The table above indicates which sites were listed as impaired for fecal coliform bacteria on a 303(d) list from 1998-2012, where the "x" represents an impairment for bacteria. Once a TMDL is approved, each water body continues to be either supported or not supported, depending on whether or not water quality standards have been achieved. The 303(d) lists are determinedbased on the water quality sampling data collected from SC DHEC at each water quality monitoring station. The fecal coliform sampling data collected by SC DHEC provides information regarding specifics of the violations for the six stations of interest. Data is available for each station at varying frequencies. Water quality monitoring has been done in three of the four subwatersheds in the focus area; Hurricane Creek does not have a history of water quality data, therefore the levels of fecal coliform in that subwatershed is unknown.

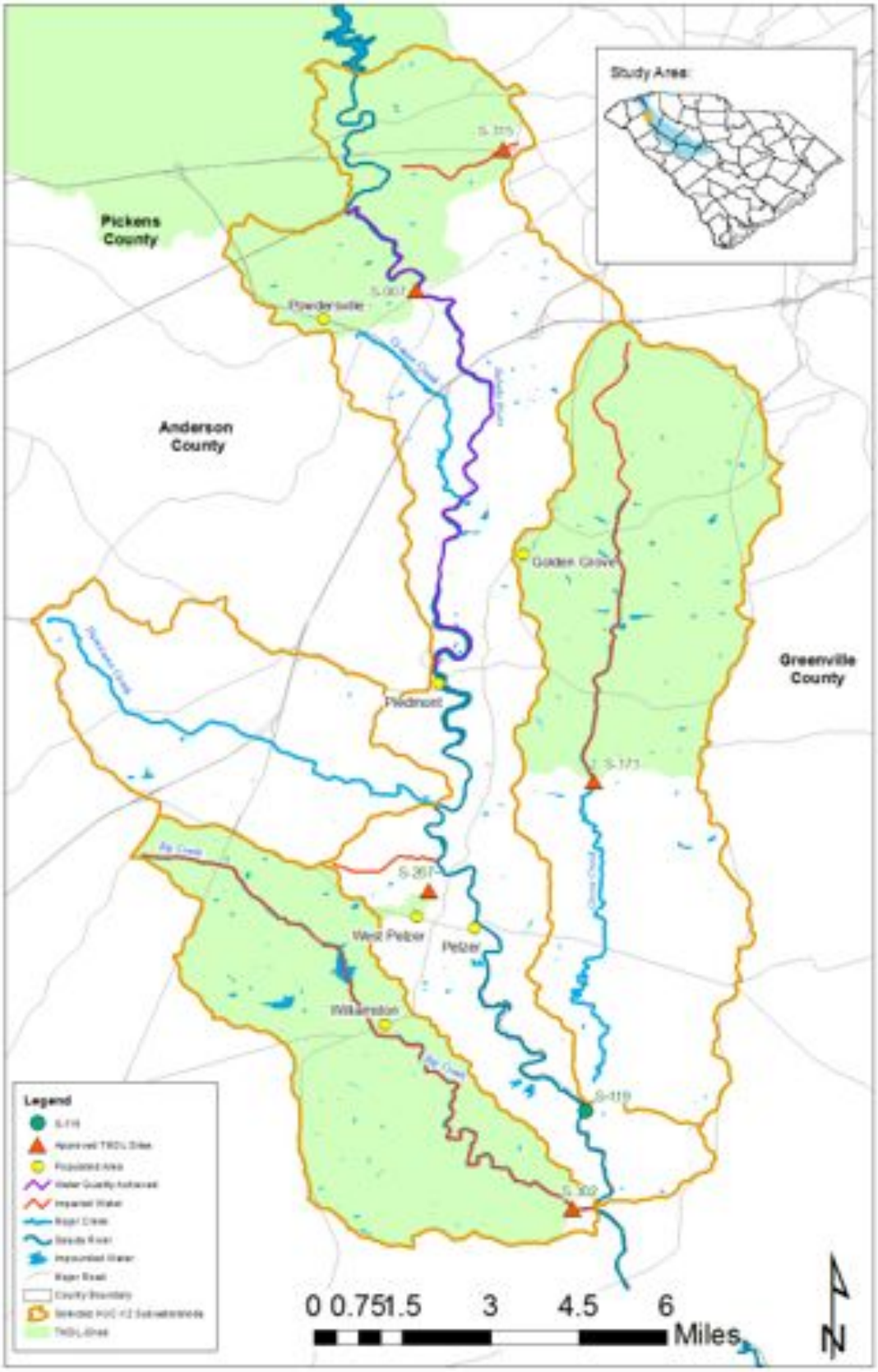
The following table summarizes the data available from SC DHEC from 1999-2012.

Station	Subwatershed	Average Sample (CFU/mL)	Percent Exceedences	Number of Violations (above 400 CFU/mL)	Highest Sample (CFU/mL)
S-007	Craven Creek	300.30	15.7%	11	6,000
S-119	Grove Creek	128.50	5.15%	7	920
S-171	Grove Creek	595.03	18.9%	7	5,500
S-267	Craven Creek	855.91	35.3%	12	13,000
S-302	Big Creek	425.83	22.5%	20	9,100
S-315	Craven Creek	1,375.91	61.3%	27	11,000

Table 5: Water Quality Sampling Data from 1999-2012 by Monitoring Station

As shown in the above table, the highest average sample, percent exceedence, number of violations, and highest sample are all located within the Craven Creek subwatershed. Station S-315 has the highest average sample; number of violations, and percent exceedences while station S-267 has the highest overall sample.

Figure 5. Impaired Waters in the Saluda River Watershed Focus Area



Description of TMDL's for Bacteria within Focus Area

The four selected subwatersheds include six stretches of water historically impaired for fecal coliform bacteria; two of these stretches have since attained water quality standards for fecal coliform bacteria and are no longer considered impaired. Four stretches of water remain impaired for bacteria, totaling 23.2 miles of impaired waters. As shown on Figure 4, the stretch along the Saluda River that has attained the water quality standard has been removed from the impaired waters listing. A TMDL was developed for Station S-007 in 2006, with water quality standards attained in 2010. According to Appendix B of the State of South Carolina's 2008 Impaired Waters Report, Station S-119 was not listed in the 2008 303(d) list because it falls within a previously developed TMDL.

The remaining four impairments are along major streams and tributaries of the Saluda River:

- **Station S-315**, located at the top of the Craven Creek subwatershed, this station monitors a small tributary to the Saluda River called Mill Creek, which is 1.92 miles in length. This waterbody was on the 1998 303(d) List as impaired for fecal coliform. A TMDL was approved in 2000, however the water quality standard has not yet been attained.

- **Station S-267** is located near the center of the Craven Creek subwatershed, monitoring a small 1.65-mile tributary of the Saluda River near the towns of Pelzer and West Pelzer. Station S-267 appeared on the 303(d) list in 1998, 2000, 2002, and 2004. A TMDL was approved in 2004, but the water quality standard has not yet been attained.

- **Station S-171** is located in the middle of the Grove Creek subwatershed and monitors the top half of Grove Creek, about 8.2 miles in length. Station S-171 appeared on the 303(d) list in 1998, 2000, 2002, and 2004. A TMDL was approved in 2004, but the water quality standard has not yet been attained. The site is partially supported for recreational use, but because the standard for bacteria has yet to be attained it is still considered "Not Supported" for recreational use.

- **Station S-302** is located at the base of the Big Creek subwatershed, monitoring the entirety of Big Creek. This stretch of water is the longest water body impaired for fecal coliform in the focus area, covering 11.4 miles. It is included on the 303(d) lists in 2000, 2002, and 2004. A TMDL was developed in 2004; however, the water quality standard has not yet been attained.

4. POLLUTION SOURCES

Bacterial pollution can be attributed to both point and nonpoint sources within the subwatersheds. Potential sources within the Upper Saluda River Basin include wastewater effluent, agriculture land uses, wildlife, and urban runoff, as shown in the table below.

Potential Sources of Bacteria Pollution in the Upper Saluda Watershed
Agriculture • Cattle • Horses • Sheep & Goats • Poultry • Cropland
Wastewater • Septic Tanks • Wastewater Treatment Plants
Urban • Stormwater Runoff • Domestic Pets
Wildlife • Deer • Feral Hogs • Water Fowl • Beavers

Table 6: Potential Sources of Bacteria Pollution in the Focus Area

A point source pollutant is one that can be identified as a single or definite source, while a nonpoint source pollutant generally results from many diffuse sources. Nonpoint sources can be caused by rainfall moving over and through the ground, picking up and carrying bacteria to waterways as it flows[15]. In the following sections, wastewater treatment plants are the only identified point sourcesthat are potentially contributing to bacterial pollution in the subwatersheds.

Point Sources of Bacteria in Freshwaters

Wastewater treatment plants are considered a point source of bacteria pollution. Wastewater treatment plants are required to obtain a National Pollution Discharge and Elimination System (NPDES) permit to discharge their treated effluent into surface waters. Unfortunately, wastewater treatment facilities occasionally experience sanitary sewer overflows (SSOs). During these events untreated sewage is discharged into local waterways. According to SC DHEC there have been an average of 600 SSOs annually throughout SC over the past 10 years[16]. SSOs can occur during both dry and wet weather conditions. Blockages in the pipes, construction

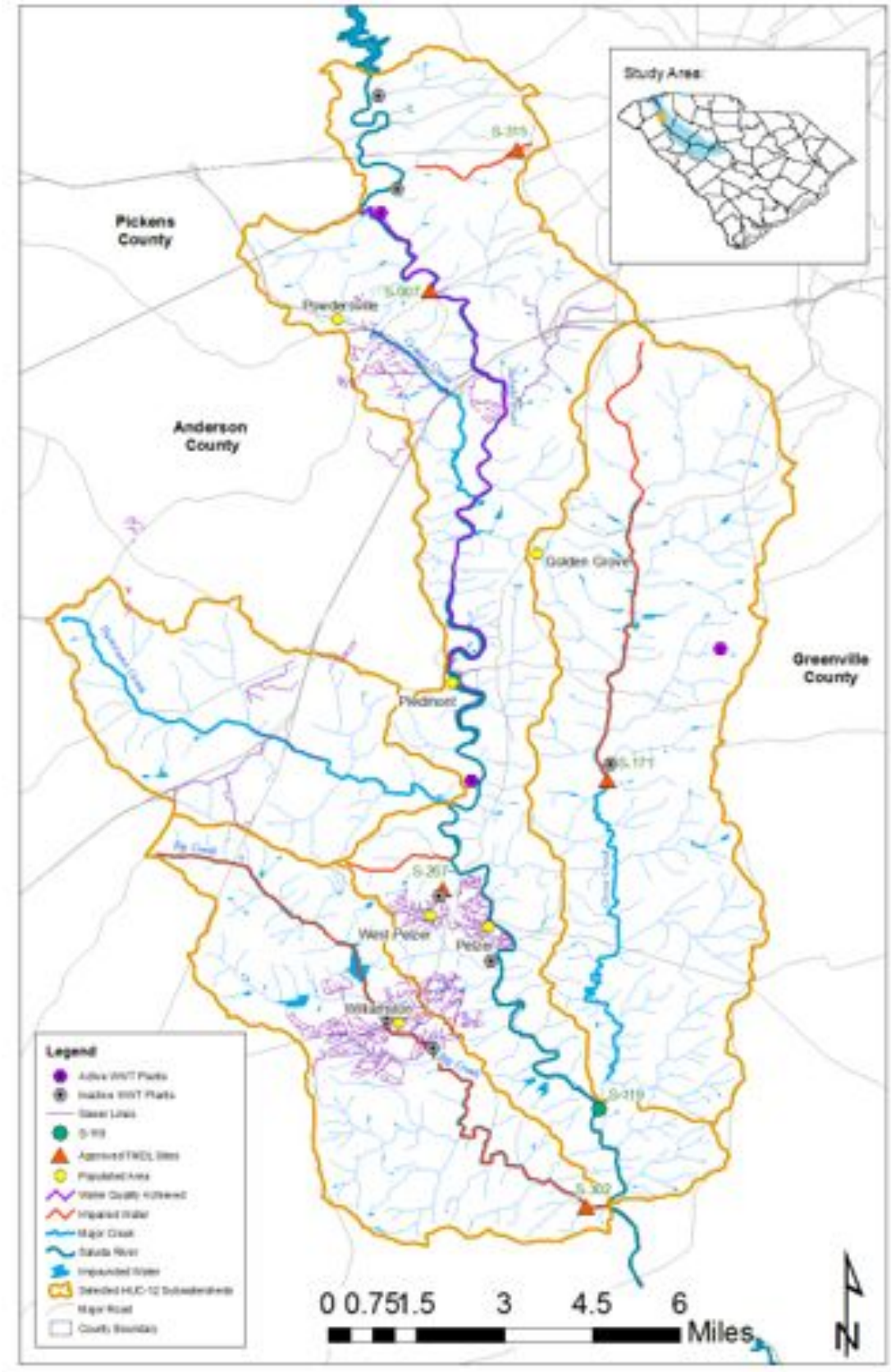
[15]United States Environmental Protection Agency (EPA), "What Is Nonpoint Source Pollution?".
[16]SC DHEC, "Sanitary Sewer Overflows."

activities, and equipment failures can result in improper wastewater discharges. In addition, wastewater treatment plants can also be overwhelmed during heavy rain events leading to SSOs into nearby surface waters. SC DHEC tracks SSOs and provides a list of the most recent within 90 days online. There are four active and seven inactive wastewater treatment plants in our focus area (Table 7). The Piedmont Regional Plant serves residents in both Anderson and Greenville Counties. It became operational in 2013 and replaced the Piedmont Plant, the Grove Creek Plant, the Town of Pelzer Plant and the West Pelzer Plant (Figure 6).

Wastewater Treatment Plant	Subwatershed	County	Receiving Waters	Status
United Utilities/ Valleybrook Plant	Grove Creek	Greenville	Tributary to Grove Creek	Active
George's Creek Plant	Craven Creek	Greenville	Saluda River	Active
Piedmont Regional Plant	Craven Creek	Greenville	Saluda River	Active
Big Creek East Plant	Big Creek	Anderson	Saluda River	Active
Saluda Plant	Craven Creek	Greenville	Saluda River	Inactive
Lakeside Plant	Craven Creek	Greenville	Saluda River	Inactive
Parker Plant	Craven Creek	Greenville	Saluda River	Inactive
Piedmont Plant	Craven Creek	Greenville	Saluda River	Inactive
Pelzer Plant	Craven Creek	Anderson	Saluda River	Inactive
West Pelzer Plant	Craven Creek	Anderson	Tributary to Saluda River	Inactive
Williamston Plant	Big Creek	Anderson	Big Creek	Inactive
Grove Creek Plant	Grove Creek	Greenville	Grove Creek	Inactive

Table 7: Wastewater Treatment Plants within the Focus Area

Figure 6. Wastewater Treatment Facilities in the Saluda River Watershed Focus Area



Nonpoint Sources of Bacteria in Freshwaters

Nonpoint source pollution comes from a variety of diffuse pollution sources and typically includes septic systems, agriculture (e.g., livestock operations, cropland, and sediment), stormwater runoff, domestic pets, and wildlife. Because the four subwatersheds in this plan are primarily rural in nature the emphasis is placed on addressing bacterial inputs from agriculture, failing septic tanks, and domestic pets. Addressing wildlife populations directly isdifficult so this plan focuses on public informational sessions to discourage the congregation of nuisance wildlife populations in an effort to reduce bacteria contributions from wildlife.

1) Agriculture

Livestock are the primary agricultural concern for increasing the concentration of bacteria in waterways. Livestock with access to streams can contribute bacteria directly into waterways through their fecal matter or indirectly by disturbing stream banks and causing erosion. Also, runoff from agricultural facilities (e.g., barnyards, feeding areas, manure storage areas) can lead to increases in bacteria levels as well as other contaminants (e.g., fertilizers, pesticides, and sediment). In addition, the improper application of fertilizers (e.g. manure, sludge) to cultivated crops can cause bacteria levels in waterways torise. Excess nutrients, or fertilizers applied before rain events, can wash off crops and drain directly into nearby waterways during rain events.

Agricultural land, comprised of pasture/hay and cultivated crops, is most heavily concentrated in the Hurricane Creek and Big Creek subwatersheds making up 35%, and 31% of the subwatersheds, respectively (Figure 8). The Grove Creek and Craven Creek subwatersheds have less agricultural land overall at 15% and 11%,respectively[17]. Land classified as either pasture/hay land or croplands are shown on Figure 7. Livestock activity, confirmed via aerial imagery or windshield surveys, is also identified.

The number of animals in each subwatershed was calculated by combining information from the USDA Census of Agriculture with a GIS analysis of the acreage of farmland in each subwatershed. The acreage of farmland within each subwatershed is based on an analysis of the 2006 National Land Cover Database Land Cover within ArcGIS. The USDA Census of Agriculture provides the total acreage of farmland and total animal counts for each county; based on this, a ratio of animals per acre in each county was calculated. This ratio was then applied to the acreage of farmland within each subwatershed to estimate the total number of farm animals living within the boundaries of each subwatershed area. An example formula is shown below.

$$\text{Number of (Cattle) in a Subwatershed Area} = \left(\frac{\text{Total Number of (Cattle) Within the County}}{\text{Total Acreage of Farmland Within the County}} \right) \text{X} \text{ Acreage of Farmland Within a Subwatershed Area}$$

[17]Katie Premo, *ArcGIS 10.1 Analysis*; USGS, "National Land Cover Database."

Based on these calculations, approximately 2,430 cattle live in the subwatersheds, with Big Creek having the largest population. Other farm animals having possible impacts on surface water bacteria levels in the focus area are horses, goats, and sheep.

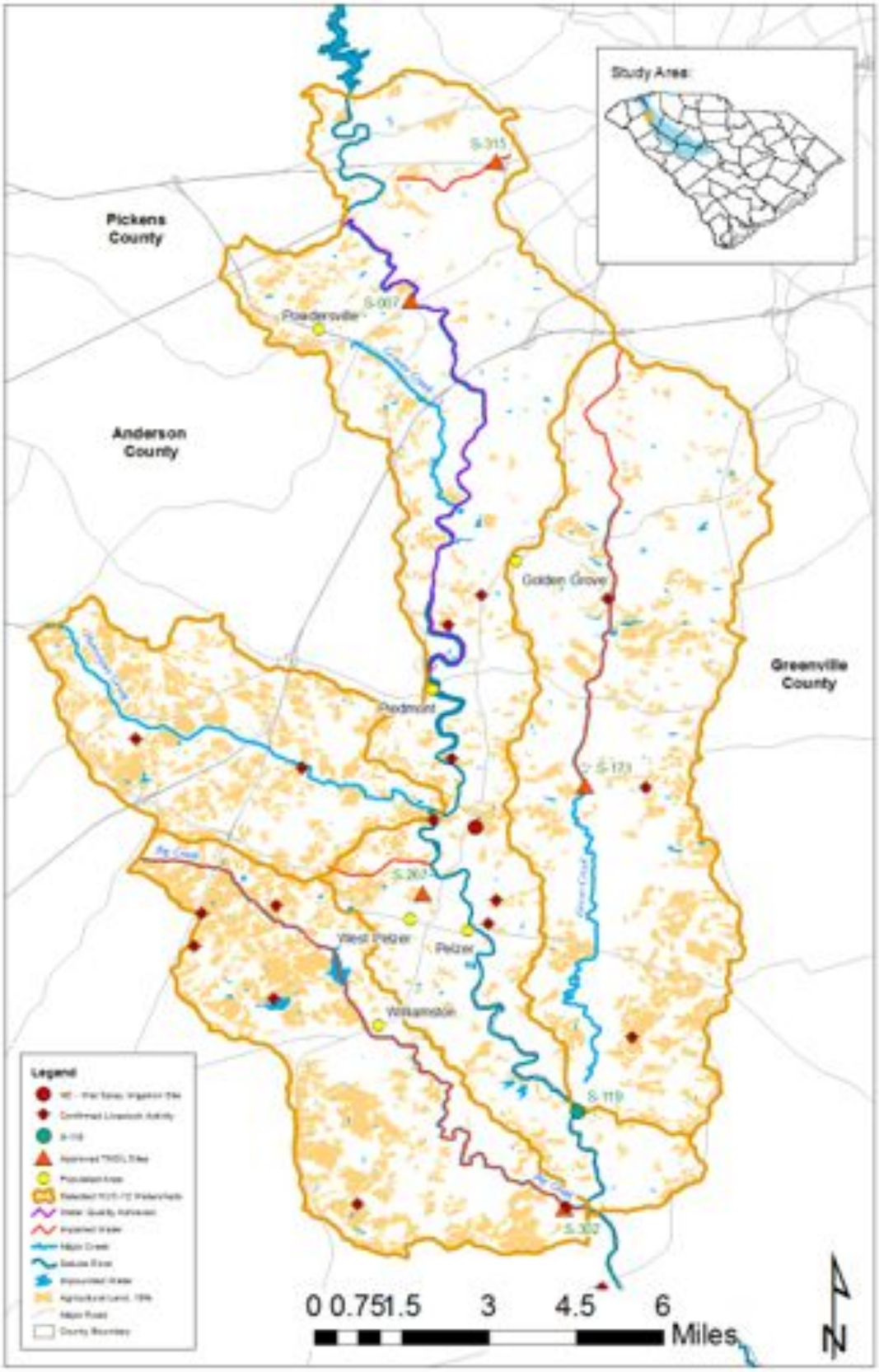
Subwatershed	Farm Animals			
	Cattle	**Horses**	**Goats**	**Sheep**
Craven Creek	521	72	73	16
Grove Creek	394	104	95	34
Big Creek	861	81	91	10
Hurricane Creek	654	61	69	8
TOTAL	***2,430***	***318***	***329***	***69***

Table 8: Number of Farm Animals per Subwatershed

Cropland can also cause bacteria levels to rise in waterways. Manure applications contain bacteria that may wash into nearby waterways during rain events. Severely eroded soils may also contribute fertilizers, pesticides, sediments and other toxins to the surface waters in the area. There are roughly 41.36 acres of cropland in the focus area[18]. From our analysis it does not appear that cropland is a major source of bacterial loading in the focus area, as noted in Figure 7. There is one site with a permit for wet spray irrigation, but most other sites located are pasturelands.

[18]Katie Premo, *ArcGIS 10.1 Analysis*; USGS, "National Land Cover Database."

Figure 7. Agricultural Land and Confirmed Livestock Activity in the Saluda River Watershed Focus Area



2) Septic Systems

Damaged or improperly maintained septic systems are a significant nonpoint source of bacteria to surface and groundwater resources. Septic systems typically have four main parts: an exit pipe that transports the wastewater out of the home to the septic tank, a septic tank where waste material naturally breaks down, a drain field where the effluent is discharged, and a soil layer that filters and breaks down wastewater contaminants[19]. Improper connections, clogs, heavy use, or unmaintained systems increase the chance that untreated wastewater will leak into surface and groundwater resources.

The total number of households on septic systems was calculated by using the total number of households within the subwatersheds (as described in Section 2 using U.S. Census data) and the number of households on sewer systems as provided by sewer providers.

Households on Septic Systems	=	Total Number of Households in Subwatershed	-	Total Number of Households on Sewer

There are approximately 10,821 septic systems within our focus area. The majority of septic systems are located in areas with restricted access to sewer such as Hurricane Creek, parts of Big Creek, and the lower section of Grove Creek. General numbers of households on sewer service were provided from sewer districtsfor the subwatershed areas. Where numbers could not be provided, a manual count of homes on sewer lines was executed through the use of GIS sewer line layers and aerial photos. Sewer districtsin the subwatershed area are:

- City of Williamston
- City of Pelzer
- City of West Pelzer
- Gantt Sewer District
- Metropolitan Sewer Sub-district
- Parker Sewer & Fire Sub-district
- Powdersville Water District / Easley Combined Utilities

An estimated breakdown of the number of septic tanks per subwatershed is as follows:

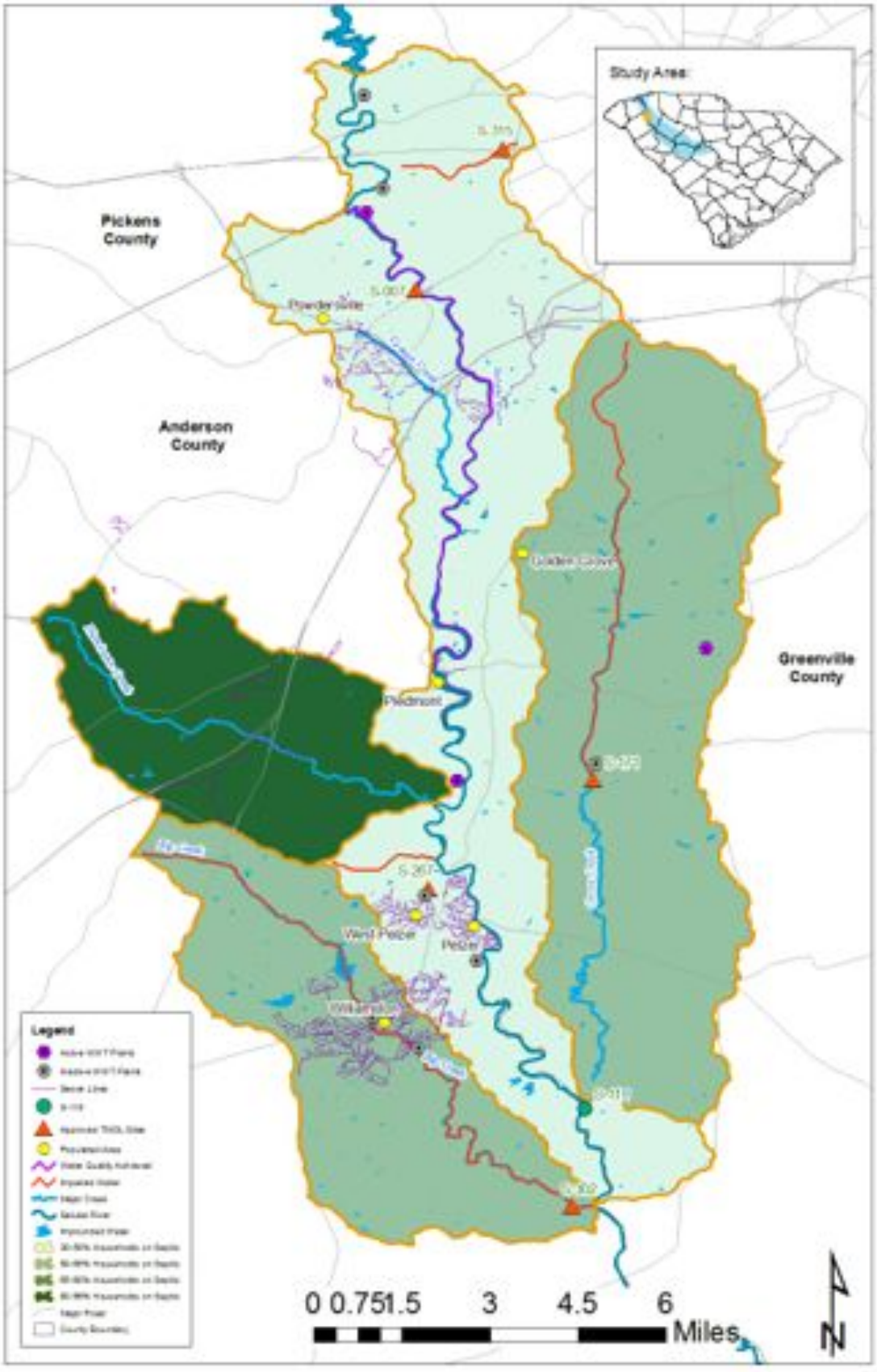
Subwatershed	Estimated # of Households	Estimated # of Households on Sewer	Estimated # of Septic Systems
Grove Creek	5,790	2,003	3,787
Craven Creek	7,648	5,157	2,491
Hurricane Creek	2,516	30	2,486
Big Creek	3,257	1,200	2,057
TOTAL	***19,211***	***8,390***	***10,821***

Table 9: Estimated Number of Septic Systems per Subwatershed

[19]SC DHEC, "How a Septic Tank System Works."

Figure 8 shows the sewer lines within the subwatersheds, as well as the percentage of households on septic systems, giving an idea of which areas are more septic or sewer dependent. This also shows where efforts for septic system repairs will be most beneficial. In Hurricane Creek, 98.81% of households are estimated to be on septic systems, whereas in Craven Creek, only 32.57% are on septic systems.

Figure 8. Households on Sewer and Septic Systems in the Saluda River Watershed Focus Area



3) Domestic Pets

Domestic pet waste is a threat to human health and water quality when not disposed of properly. Pet waste left on the ground can be carried by stormwater into nearby waterways and is especially a problem in developed areas containing a higher density of impervious surfaces. Developed land accounts for 24% of total land cover in the focus area, but is concentrated on the eastern boundary of the Grove Creek subwatershed (Figure 10). Overall, there is not much high intensity development in the focus area; most of the development in the developed land category is considered low to medium intensity[20].

According to the Environmental Protection Agency (EPA) a single dog can produce approximately 274 pounds of waste each year[21]. Pet waste can contain harmful organisms such as bacteria, viruses and parasites. Using the total number of households within a subwatershed area (as calculated in Section 2 using data from the U.S. Census) and a formula prepared by the American Veterinary Medical Foundation shown below, it was determined that roughly 11,219 dogs live within the planning area.

Number of Dog-Owning Households	=	National Percentage of Dog Owning Homes	X	Total Number of Households
7,012 Homes with Dogs	=	0.365	X	19,210 Homes

Number of Dogs	=	National Average of Dogs in Homes	X	Total Number of Dog-Owning Households
11,219	=	1.6	X	7,012 Dog-Owning Households

Based on the calculated number of dogs within the subwatersheds and the EPA statistic that a dog can produce 274 pounds of waste each year, dogs living within the subwatersheds produce 3.00 million pounds of waste annually[22].

Public outreach campaigns on proper pet waste disposal will be necessary to reduce bacterial loading in the subwatersheds. For this reason the location and number of pet stores, feed and seed stores, animal shelters, and pet groomers have been identified in the subwatersheds. Such

[20]Katie Premo, *ArcGIS 10.1 Analysis*; USGS, "National Land Cover Database."
[21]United States Environmental Protection Agency (EPA), "Pet Waste Management."
[22]American Veterinary Medical Association, "Pet Ownership Calculator."

businesses and organizations may prove helpful in sharing information on the environmental and human health risks of pet waste in waterways. In addition, community parks have been identified as places where pet waste stations would be effective. As shown in Figure 10, both pet stores and community parks will be effective in the distribution of pet waste information as well as pet waste station installations. For a full list of pet stores and community parks, please see Appendix A.

4) Wildlife

While wildlife have the possibility of impacting the bacteria levels in water, they do not seem to be a significant contributor to bacterial impairment in the four subwatersheds. The bacterial impacts from wildlife on forested lands tend to be reduced due to the undisturbed state of the soils and vegetation. Because forested land accounts for over 40% of land cover in the focus area, it is assumed that wildlife in these areas do not have a major effect on bacteria levels in the subwatersheds. Forested land density is relatively consistent across the focus area (Figure 8). The predominant forest type is deciduous, accounting for 80% of the forest cover. Evergreen forests make up 15% of the forest cover, and mixed forest account for less than 5%[23].

[23]Katie Premo, *ArcGIS 10.1 Analysis*; USGS, "National Land Cover Database."

Figure 9. Forested Land and Wildlife Populations in the Saluda River Watershed Focus Area

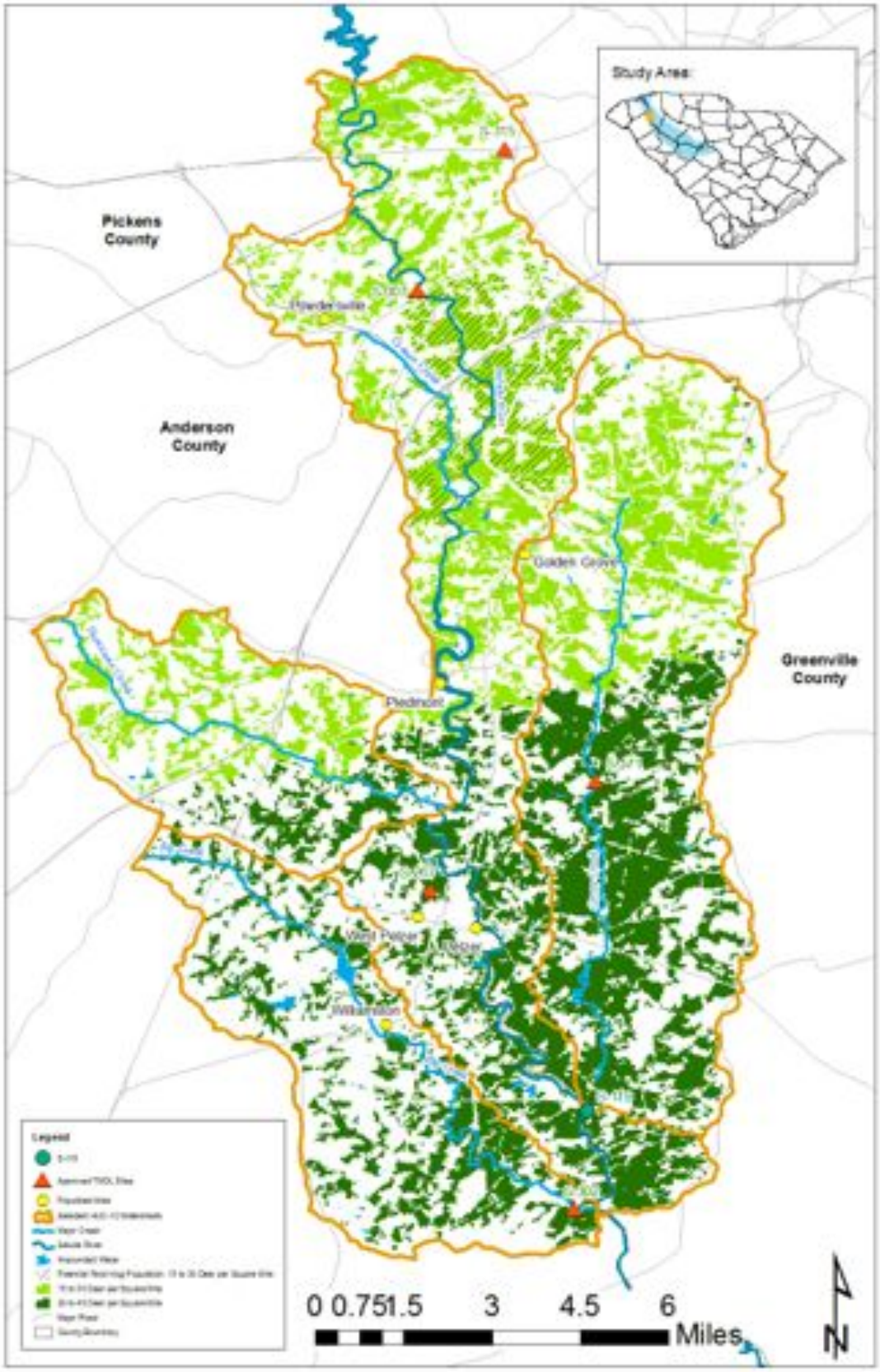
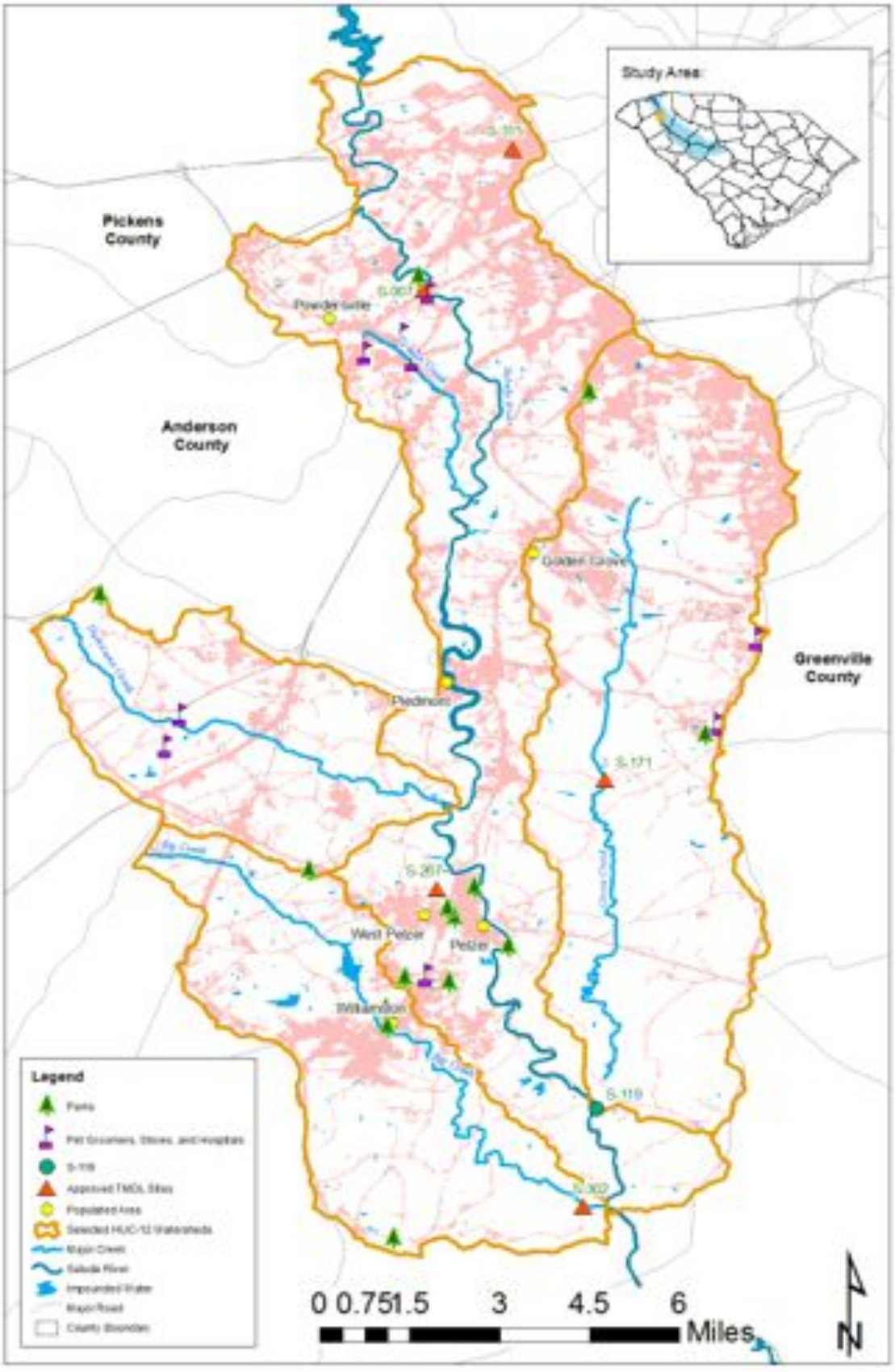


Figure 10. Developed Land and Potential Pet Waste Station Locations in the Saluda River Watershed Focus Area

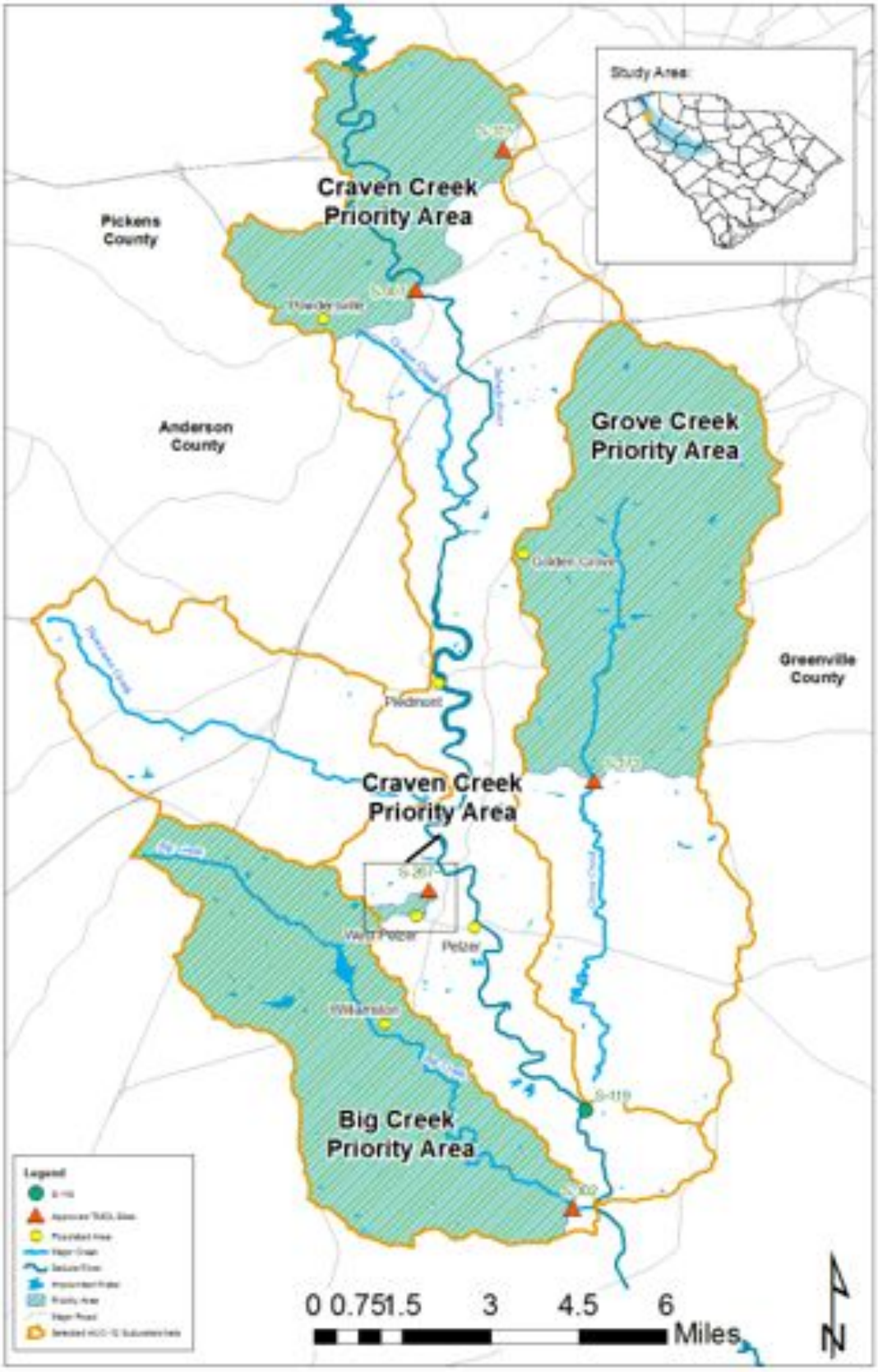


5. BACTERIA LOAD REDUCTIONS

The bacteria load reductions included in this plan were based on the Upper Saluda River Basin TMDL and the Mill Creek TMDL (Station S-315) for fecal coliform bacteria (SC DHEC 2004; SCHDEC 2000). The TMDLs include both point and nonpoint sources in the bacteria load calculations. This information was used to calculate specific nonpoint source bacteria load reductions for each of the subwatersheds. Four wastewater treatment plants (WWTPs) are currently operating in the focus area. WWTPs discharge in Craven Creek, Grove Creek, and Big Creek subwatersheds (see Section 2 for list of wastewater treatment plants and locations). The most recent WWTP to come online, the Piedmont Regional Plant, replaced four WWTPs, including two with a history of NPDES violations for bacteria. Consequently, water quality in this area is expected to improve significantly. Point sources with current NPDES permits were not included in the load reduction calculations in this watershed-based plan.

During the watershed planning process SC DHEC monitoring stations S-007 and S-119, both located in the Craven Creek subwatershed, achieved attainment for bacterial water quality standards. For this reason priority areas were identified for the focus area (Figure 11). Priority areas are regions in which bacterial water quality standards have not been met. Craven Creek has two priority areas; one is located in the northwest corner of the Craven Creek subwatershed and includes the TMDL-shed for S-315, the second is the TMDL-shed for S-267, which is a 0.7-acre drainage area and includes the community of West Pelzer. The Grove Creek priority area is in the northern portion of Grove Creek and includes the TMDL-shed for S-171. The Big Creek priority area includes the TMDL-sheds for S-302, which encompasses the majority of the subwatershed. While Hurricane Creek does not currently have a developed TMDL in the area it is considered a priority area because its water quality history is unknown.

Figure 11. Priority Areas in the Saluda River Watershed Focus Area



Bacteria Load Reduction Calculations

Table 10 shows reductions needed in the focus area, based on the 2000 and 2004 TMDLs (Refer to the 2000 TMDL, page 10 and the 2004 TMDL Table 1, page 3). The Nonpoint Load Reduction Needed was calculated using information from the 2004 Upper Saluda River Basin TMDL for Fecal Coliform Bacteria and represents the bacteria reduction needed from nonpoint sources per day and year in each subwatershed in order to meet water quality standards.

Station ID	TMDL Existing Load (counts/day)	TMDL Existing Waste Load Continuous (counts/day)	Existing Nonpoint Load (counts/day)	TMDL Nonpoint Percent Reduction Needed	Nonpoint Load Reduction Needed (counts/day)	Nonpoint Load Reduction Needed (counts/year)
S-315	1.97E+09	N/A	1.97E+09	61%	1.20E+09	4.38E+11
S-171	6.12E+11	3.17E+10	5.80E+11	72%	4.18E+11	1.53E+14
S-302	3.04E+11	NA	3.04E+11	46%	1.40E+11	5.10E+13
S-267	7.94E+10	NA	7.94E+10	80%	6.35+10	2.32E+13

Table 10: Focus Area Bacteria Load Reductions

TMDL Existing Load: This represents the total bacteria load from both point and nonpoint sources and comes directly from the 2004 Upper Saluda River Basin TMDL for Fecal Coliform Bacteria. See "Existing Load" column in Table 1 on page 3. Results are shown in counts/day, as per the TMDL. Numbers for S-315 are sourced from the 2000 Mill Creek Station S-315 TMDL for Fecal Coliform Bacteria.

TMDL Existing Waste Load Continuous: This represents the bacteria load from point sources and comes directly from the 2004 Upper Saluda River Basin TMDL for Fecal Coliform Bacteria. See "Existing Waste Load Continuous" column in Table 1 on page 3. Results are shown in counts/day, as per the TMDL. Numbers for S-315 are sourced from the 2000 Mill Creek Station S-315 TMDL for Fecal Coliform Bacteria.

Existing Nonpoint Load: This represents the bacteria load from nonpoint sources and is calculated, as shown below. Results are shown in counts/day, following the TMDL example.

$$\text{Existing Nonpoint Load} = \text{TMDL Existing Load} - \text{TMDL Existing Waste Load Continuous}$$

TMDL Nonpoint Percent Reduction Needed: This represents the percent reduction needed from nonpoint sources to achieve water quality standards. The information comes directly from the 2004 Upper Saluda River Basin TMDL for Fecal Coliform Bacteria. See "Percent Reduction[4]" column in Table 1 on page 3. Numbers for S-315 are sourced from the 2000 Mill Creek Station S-315 TMDL for Fecal Coliform Bacteria.

Nonpoint Load Reduction Needed (counts/day): This represents the bacteria load reduction needed from nonpoint sources and is calculated, as shown below. Results are shown in counts/day, following the TMDL example.

Nonpoint Load Reduction Needed (counts/day) = Existing Nonpoint Load × TMDL Nonpoint Percent Reduction Needed

Nonpoint Load Reduction Needed (counts/year): This represents the bacteria load reduction needed from nonpoint sources and is calculated, as shown below. Results are shown in counts/year, to facilitate calculations for recommended BMP installations per year.

Nonpoint Load Reduction Needed (counts/year) = Nonpoint Load Reduction Needed (counts/day) × 365 days/year

Table 11outlines bacteria reductions from various BMPs based on the actual number of septic systems, livestock within a ¼ mile of streams, and domestic pets in each water quality monitoring station area.See Appendix C for the standard bacteria equivalents used to estimate bacteria loads for all sources.

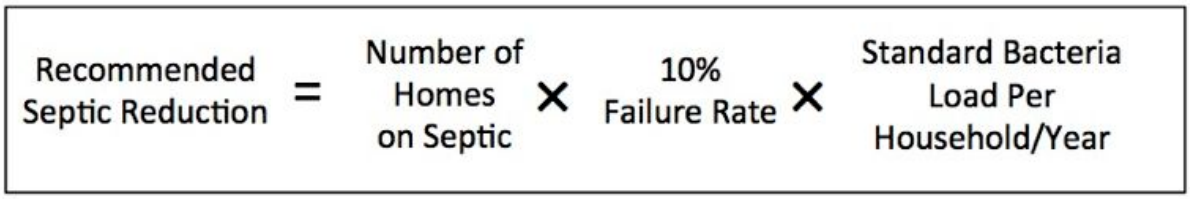
Station ID	Septic Reductions (Counts/Year)	Agricultural Reductions (Counts/Year)	Pet Waste Reductions (Counts/Year)	Total Bacterial Reduction (Counts/Year)
S-315	N/A	N/A	8.66E+13	8.66E+13
S-171	3.29E+12	1.36E+13	9.15E+14	9.32E+14
S-302	4.99E+12	1.05E+14	8.87E+14	9.97E+14
S-267**	N/A	N/A	2.19E+12*	2.19E+12
Hurricane Creek	6.03E+12	5.93E+13	6.85E+14	7.15E+14

Table 11: Annual Bacteria Load Reductions Needed

** Because S-315 is entirely within the Parker Sewer District and completely urban it is assumed no septic systems or agricultural properties are present in this area.*

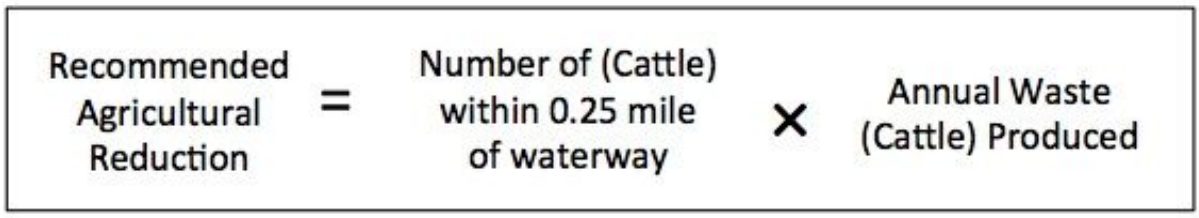
***Because S-267 is such a small area, and is later considered as a portion of Craven Creek, it was calculated that one pet waste station would sufficiently address any bacteria impairment; therefore, the bacteria removal from one pet waste station is listed as the pet waste reductions needed annually in S-267.*

The septic reductionslisted above refer to what is ideally needed annually to repair all malfunctioning septic systems in households that fall under the 10% failure rate.

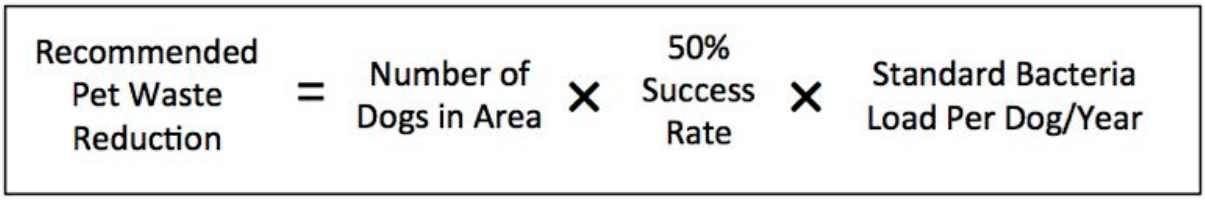


Standard Bacteria Load Per Household Per Year = 2.42E+10 colonies.

Agriculture reductions respresent the amount of bacteria removed annually byfencing livestorck out of 0.25 mile riparian buffer. See Section 4 for the number of livestock per subwatershed.



Pet waste reductionsrepresent the annual bacteria reductions expected from the installation of pet waste stations, with an assumed 50% success rate. The standard annual bacteria load per dog = 1.49E+12 colonies.



6. OVERVIEW OF AGRICULTURAL BMPS

Implementing agricultural BMPs reduces bacteria pollution in nearby streams while still maintaining, and often improving, conditions for livestock. The table below summarizes the bacteria load reductions from agricultural BMPssuggested for each subwatershed.

Subwatershed	Annual Agricultural Bacteria Reductions (Counts/Year)	Total Agricultural Bacteria Reductions (Counts/Phase*)	Total # of Agricultural Projects Needed
Craven Creek	7.92E+12	2.38E+13	1-2
Grove Creek	1.36E+13	4.08E+13	3
Big Creek	1.05E+14	3.15E+14	17
Hurricane Creek	5.93E+13	1.78E+14	10

Table 12: Total Annual Agricultural Bacteria Reductions Needed by Subwatershed
**A Phase is equivalent to three years*.
For the purposes of this plan agricultural land includes pasture (livestock), hay, and cultivated crops. Livestock are the primary agricultural source of bacterial pollution throughout the planning area. Therefore, agricultural BMPs will focus on restricting animal access to streams across the entire planning area with the exception of portions of Craven Creek that have little agricultural land. When fencing livestock out of streams it is often necessary to provide an alternative water source the animals, so this agricultural BMP requires several components.

Five completed 319 projects were analyzed to determine the costs and bacterial load reductions of the typical agricultural package[24]. The average components and bacterial reductions shown below are based on all of the agricultural BMPs that were implemented within these five 319 projects.See Appendix B for more information on these calculations.

Average Agriculture BMP Bundle:

- **1 well with pump**
- **1,868 feet of fencing**
- **2,138 square feet of Heavy Use Area protection**
- **599 linear feet of waterline**
- **1 watering facilities**
- **0.23 acres of riparian buffer area**
- **1.86E+13 annual bacteria reduction**

The following is a list of BMPs considered the most relevant and effective for agricultural areas in the subwatersheds for bacteria pollution. While they are defined separately, they are most often installed in combinations.

- **Streambank Fencing** – Installing fences limits livestock access to stream banks. This ensures that manure is not deposited directly into streams, protects riparian vegetation, and reduces erosion along streambanks.
- **Armored Streambank Crossings** – When stream crossings are necessary to move livestock from one area to another, armored streambank crossings provide protection to reduce erosion within the crossing area.
- **Alternative Watering Sources/Wells** – Streams in pastures are often used as the primary watering source for livestock. If fences restrict livestock's access to water, an alternative watering source will be needed. Alternative watering sources support removal of livestock from streams, therefore reduce manure deposited directly into streams, protect riparian vegetation, and reduce erosion along streambanks.
- **Linear Pipeline** – Additional pipelines may be necessary to transport water from the well to the alternative watering source. Again, keeping livestock out of streams reduces manure deposited directly into streams, protects riparian vegetation, and reduces erosion along streambanks.

[24]SC DHEC, "South Carolina Nonpoint Source Management Program 2012 Annual Report."

- **Animal Heavy Use Areas** – Heavy use areas, such as alternative water sources, experience high concentration of animals making it difficult to maintain vegetation. Installing a durable material (e.g., crush and run gravel) reduces erosion and pollutant loading of stormwater runoff.
- **Riparian Buffers** – Riparian buffers are vegetated areas along waterways that stabilize soil, filter runoff, and provide wildlife habitat. Restoring riparian buffers will reduce manure, sediment, fertilizers, pesticides, and other pollutants from washing into streams.

Within the focus area,the Hurricane and Big Creek subwatersheds have the highest concentration of agricultural land (Table 13). See Section 3 for calculations.

Subwatershed	Percentage of Agricultural Land
Big Creek	34.63%
Hurricane Creek	30.71%
Grove Creek	15.37%
Craven Creek	10.78%

Table 13: Percentage of Agricultural Land in Subwatersheds

The rural land cover and concentration of agricultural land in Big Creek indicates that livestock is the likely cause for the bacteria impairment throughout this subwatershed, making this area a high priority agricultural BMPs.

Agricultural BMP Unit Costs Estimates and Funding Options

Agricultural BMP unit cost estimates are based on information provided by the USDA. The following table summarizes the cost estimates and funding options for agricultural BMPs.

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
• Cattle • Horses • Sheep & Goats • Cropland	Linear Streambank Fencing	$3.50/foot	• WHIP • EQIP • AWEP • County Governments • US Fish and Wildlife • SCDHEC 319 Funds
	Well (500’ deep)	$9,000 each	
	Linear Pipeline	$1.40/foot	
	Alternative Watering Source	$760 each	
	Heavy Use Area	$1.00/square foot	
	Riparian Buffer	$250/acre	
	Average Total Agricultural BMP Bundle	$19,332	

Table 14: Agricultural BMP Unit Costs and Potential Funding Sources

There are numerous cost share programs at the federal, state, and local level available to landowners interested in installing these types of projects. Potential funding sources for agricultural BMPs include:

South Carolina Department of Health and Environmental Control (SC DHEC)

The EPA provides annual funding to SC DHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved TMDL. SC DHEC distributes these Section 319 funds through grants that will pay up to 60 percent of eligible project costs, with a 40 percent non-federal match generally provided by the landowner.

US Department of Agriculture Natural Resources Conservation Service (NRCS)

There are several voluntary NRCS programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources.

The Wildlife Habitat Incentives Program (WHIP) provides funding to landowners to devote some of their land to the development of wildlife habitat. Wildlife habitat may include upland, wetland, agricultural land, or aquatic habitat. The projects must target specific species for habitat improvement, and generally require an agreement of 5-10 years. Cost-share assistance is offered up to 75%, usually paid through reimbursements.

The Environmental Quality Incentives Program (EQIP)[25] promotes agricultural production while maintaining or improving environmental quality. Typically, up to a 75% cost-share assistance is offered for project costs and forgone income. Historically underserved farmers can receive a 90% cost share. Specific priorities to be addressed are:

- Improvement of water quality in impaired waterways;
- Conservation of ground and surface water resources;
- Improvement of air quality;
- Reduction of soil erosion and sedimentation; and
- Improvement or creation of wildlife habitat for at-risk species.

Within EQIP, the Agricultural Water Enhancement Program (AWEP) provides additional funding to NRCS offices to provide technical and financial assistance to agricultural producers to implement water enhancement activities on agricultural land to conserve surface and ground water and improve water quality[26]. Examples of previously funded projects include high efficiency irrigation systems, nutrient and pest management plans, and agricultural BMPs[27].

Local Governments

Both Greenville and Anderson County could be partners by assisting with in-kind support for local agricultural water quality projects in the subwatersheds as funding becomes available.

US Fish and Wildlife Service

The US Fish and Wildlife Service sponsor the Partners for Fish and Wildlife Program, which provides technical and financial assistance to conserve or restore native ecosystems. This voluntary program primarily involves streambank fencing, tree-planting, and invasive species

[25]Natural Resources Conservation Service (USDA NRCS), "Environmental Quality Incentives Program (EQIP)."
[26]Natural Resources Conservation Service (USDA NRCS), "Agricultural Water Enhancement Program (AWEP)."
[27]Natural Resources Conservation Service (USDA NRCS), "AWEP Projects Approved for Fiscal Year 2009."

control. Projects on private lands must improve the habitat of Federal trust species for the principal benefit of the Federal Government. Program projects must be biologically sound, cost-effective, and must include the most effective techniques based on state-of-the-art methodologies and adaptive management. Agreements are usually 10 years or more.

Community Participation

Community participation involves voluntary contributions, both monetary and in-kind, from watershed residents that can be used to meet match requirements for other grant funding sources.

7. OVERVIEW OF SEPTIC SYSTEM BMPS

Septic system repairs and replacements can reduce bacteria pollution in nearby streams by preventing bacteria leakage from faulty systems. The table below summarizes the septic bacteria load reductions needed in each subwatershed using septic BMPs.

Subwatershed	Annual Septic Bacteria Reductions (Counts/Year)	Total Septic Bacteria Reductions (Counts/Phase*)	Total Septic Projects (#)
Craven Creek	1.33E+12	3.99E+12	165
Grove Creek	3.29E+12	9.87E+12	408
Big Creek	4.99E+12	1.50E+13	619
Hurricane Creek	6.03E+12	1.80E+13	748

Table 15: Total Annual Septic Bacteria Reductions Needed by Subwatershed
**A Phase is equivalent to three years*.

According to the U.S. Environmental Protection Agency (US EPA) STEPL Model, a typical septic system generates 2.42E+10 bacteria a year. The following BMPs are considered the most relevant and effective for residential areas in the subwatersheds for bacteria pollution relating to wastewater.

- **Septic System Repairs and Replacements** – The estimated failure rate for septic systems is 10%[28]. Septic systems that are not functioning properly need to be repaired or replaced to prevent bacteria from leaking into nearby rivers and streams. Septic tanks should be pumped every 5 years to maintain efficiency.

- **Extending Sewer Lines** - In regions with a high concentration of failing septic systems extending municipal sewer lines to areas of concern may be the most cost effective long-term solution. Careful consideration and analysis should be given to this before it is viewed as a viable option.

[28]SC DHEC, "Septic Tanks in South Carolina."

Due to the relatively rural nature and the restricted access to sewer, septic repairs and replacements are recommended throughout the entire focus area. High priority septic repair and replacement areas include all of the priority areas; Big Creek and Hurricane Creek subwatersheds have limited access to sewer thus septic BMPs may prove to be very effective in these areas (See Figure 8). According to the Appalachian Regional Water Quality Plan, the northern portion of the focus area along Highway 123 and the 1-85 corridor are cited as infrastructure expansion area and will include water and sewer upgrades to accommodate development[29].

Septic System BMP Unit Cost Estimates and Funding Options

Many homes are not within access points of municipal sanitary sewer lines and therefore onsite septic systems are the most appropriate wastewater treatment. Traditional septic systems and drain fields can work well if properly installed and maintained, but replacements and repairs are sometimes necessary. The following table outlines the cost estimates and funding options for septic BMPs.

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
• Septic Tanks • Wastewater Treatment Plants	Replace/repair onsite failing septic systems and leach fields	$4,000 per system	• SC DHEC 319 Funds • USDA Rural Development • Duke Energy Foundation • State Revolving Funds
	Extend sewer lines to areas of concern	8" - $64/foot 10" - $75/foot 12" - $85/foot 15" - $105/foot 18" - $115/foot	

Table 16: Septic System BMP Costs and Potential Funding Sources

Potential cost share programs for septic system repair and replacement are listed below.

South Carolina Department of Health and Environmental Control (SC DHEC)
The US EPA provides annual funding to SC DHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved TMDL. SC DHEC distributes these Section 319 funds through grants that will pay up to 60 percent of eligible project costs, with a 40 percent non-federal match, typically provided by the homeowner.

Duke Energy Foundation
The Duke Energy Foundation provides limited funds to qualifying organizations to assist with the repair and replacement of septic systems, typically for low-income families.

[29]South Carolina Appalachian Council of Governments (ACOG), "Appalachian Regional Water Quality Plan Draft 208 Plan Updates."

Local Governments
Both Greenville and Anderson County could assist with providing in-kind support for septic system improvements. Additionally, local sewer authorities may be able to provide assistance for onsite septic system repairs and replacements.

USDA Rural Utilities Service – Water & Environmental Programs
The Rural Utilities Service provides financial assistance to eligible organizations for projects involving water, wastewater, and solid waste disposal systems in rural areas. Technical assistance by state is given to non-profit organizations to provide water and waste disposal-related technical assistance and/or training to rural water systems and rural areas, towns and cities with a population of 10,000 or less. The revolving fund program is also given to non-profits to assist rural communities with water and wastewater systems by establishing a lending program.

USDA Rural Development Office
The Section 504 Very Low-Income Housing Repair Program offers low-interest loans to rural residents who earn less than 50% of the area median income. These low-interest loans are to be used specifically to render the home more safe or sanitary. Homeowners over 62 years in age may be eligible for grant funds.

8. OVERVIEW OF URBAN BMPS

The table below summarizes the urban bacteria load reductions needed in each subwatershed to be addressed solely by the implementation of urban BMPs.

Subwatershed	Annual Pet Waste Bacteria Reductions (Counts/Year)	Total Pet Waste Bacteria Removed (Counts/Phase*)	Ideal# of Pet Waste Stations
Craven Creek	4.58E+14	1.38E+15	631
Grove Creek	9.15E+14	2.76E+15	1,261
Big Creek	8.87E+14	2.66E+15	1,215
Hurricane Creek	6.85E+14	2.06E+15	941

Table 17: Total Ideal Bacteria Reductions from Pet Waste by Subwatershed
**A Phase is equivalent to three years*.

Residential stormwater management is an effective method for preventing bacteria runoff into nearby streams. BMPs reduce pollutants in stormwater runoff from residential areas, including domestic pet waste. Stormwater education and outreach efforts should be a continuous effort throughout all subwatersheds since stormwater runoff is a widespread concern. The following is a list of BMPs considered the most relevant and effective for urban areas in the subwatersheds for bacteria pollution.

- **Pet Waste Stations** – While not the primary concern, encouraging proper disposal of pet waste is a cost effective way of reducing bacteria pollution in populated areas. Pet waste left on the ground will be carried into nearby streams during storm events, and therefore should be collected and disposed of in the garbage or an in-ground composting pit designed for this purpose. Strategically placed pet waste stations with dog waste bags increase the likelihood that residents will properly dispose of pet waste. Greenville County data from 2011-2012 is used below to estimate the average annual bacteria reductions per pet waste station.

$$\text{536 Average \# of Bags Used per Pet Waste Station} = \frac{\text{28,950 Total Bags Used Per Year}}{\text{54 Total Pet Waste Stations}}$$

$$\text{402.4 lbs Estimated Pet Waste Removed Annually} = \text{0.75 lbs Daily Waste Produced by a Dog} \times \text{536 Average \# of Bags Used per Pet Waste Station}$$

In Greenville County a typical pet waste station uses 536 bags annually and removes approximately 2.19E+12 bacteria per year.A general pet waste disposal public outreach campaign is an important component of a nonpoint source bacteria reduction campaign and should be implemented throughout the entire focus area.

$$\text{Amount of Pet Waste Bacteria Removed Annually} = \text{Average Amount of Bacteria Generated by A Dog Annually} \times \text{Number of Pet Waste Bags Used Annually}$$

- **Pet Waste Bag Holders** – while pet waste stations are an immobile solution, pet waste bag holders allow for convenient portable pet waste disposal. Clipping on leashes or belt loops, these bag holders can be taken with pet owners on walks, encouraging the proper disposal of pet waste. Along with education, dog waste bag holders can be an effective method of reducing the amount of bacteria from domestic pets within an area.

- **Storm Drain Stencils** - Marking storm drains with pollution prevention messages is an excellent public education tool. It is difficult to equate the amount of bacteria removed as it relates to storm drain stenciling. Regardless, storm drain stencils are effective because they help people understand that is important not to dispose of waste in storm drains because they are direct connections to waterways.

Urban BMP Unit Cost Estimates and Funding Options

Cost estimates for urban BMPs are based on information provided by Greenville County as well as the Pickens County Stormwater Partners; these numbers are based on previously installed projects. The following table outlines the funding options and cost estimates for urban BMPs.

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
• Stormwater Runoff • Domestic Pets	Storm Drain Stencils	$700/250	• Greenville County Soil & Water Conservation District • Anderson County Public Works • Pickens County Stormwater Partners • Clemson Extension Office • Carolina Clear
	Pet Waste Station	$225 each ($300 for installation with bags)	
	Pet Bags	$68/2,000	
	Pet Waste Bag Holders	$700/250	

Table 18: Urban BMP Unit Costs and Potential Funding Sources

With the previous calculation that a pet waste station uses roughly 536 bags annually, the initial installation of one pet waste station is estimated to cost around $300. This would give one pet waste station enough bags to use for an average of 3.7 years.

General stormwater education and outreach efforts could have significant benefits to local communities. Stormwater education and outreach is required as part of the Municipal Separate Storm Sewer System (MS4) Permit. A partnership with the Greenville County Soil and Water Conservation District, which is responsible for carrying out stormwater education in Greenville County, would help effectively complete stormwater outreach in portions of Craven and Grove Creek. Anderson County conducts stormwater education within their jurisdiction, which include parts of Big Creek, Hurricane Creek, and portions of the Craven Creek watersheds. Finally, Pickens County Stormwater Partners (PCSP) conducts stormwater outreach and education for Pickens County. Although only a small portion of Craven Creek lies within Pickens County, PCSP is an excellent resource for stormwater related educational materials.

9. OVERVIEW OF WILDLIFE BMPS

Wildlife contributes to elevated bacteria levels in the focus area; however,limited data availability prevented extensive knowledge of the wildlife population. According to South Carolina Department of Natural Resources (DNR) wildlife density maps (See Figure 9)approximately 30-40 deer per square[30]mile live within the focus area andone small area of low-density wild hog population[31]exists inthe northern region of the Craven and Grove Creek subwatersheds. It will be most cost effective to further identify nuisance wildlife populations and specific priority BMPs as part of the outreach and education campaign.

Outreach and Education –Educating landowners on the signs of nuisance wildlife activity, such as rooting damage by feral hogs,and asking them to help inventory locations of these wildlife populations can be completed simultaneously to improve efficiency. Once nuisance wildlife are identified, the types and locations of BMPs can be prioritized.

- **Streambank Fencing** – Streambank fencing can limit wildlife populations' access to streams, therefore protecting streams from both bacteria generated from waste as well as the damaging effects wildlife can have on landscape, such as erosion.

- **Riparian Buffers** – Vegetated riparian barriers remove bacteria from runoff. Wild hogs tend to be attracted to heavily vegetated areas near streams, so effective management of a riparian buffer area would be necessary to ensure wildlife is not destructive to the buffers.

- **Filter Strips** – Filter strips can be used in combination with riparian areas to help maintain buffers, as well as to slow runoff, remove sediment and bacteria, increase soil aeration, and recycle plant nutrients.

- **Trapping** – Particularly effective with feral hog populations, trapping can assist with the management of populations through harvest, relocation, or consumption. Box, swing, and corral traps are all effective in the trapping of feral hogs. This method can also be effective with beaver populations.Wildlife Control Operators (WCO's) perform wildlife control services on a contract-fee basis, and can be hired by landowners who do not wish to directly deal with beavers themselves

- **Hunting** – Hunting is a common method used to control wildlife populations. Educating landowners and community members about the safety and training needed for this BMP method is an important aspect of hunting.

- **Dam Removal** – Effective only with beavers, beaver dams and other woody debris can be removed from any waterway at any time in SC. Working from the downstream side with a sturdy potato rake will aid in dam breeching and debris removal[32].

[30]Department of Natural Resources (DNR), "Wildlife Information."
[31]Department of Natural Resources (DNR), "SC Wild Hog Distribution 2010."
[32]Department of Natural Resources (DNR), "Beaver Control - What a Landowner CAN Do in South Carolina."

Wildlife BMP Unit Cost Estimates and Funding Options

Some wildlife BMPs are also mentioned as possible agricultural solutions, and can be used to control both wildlife and farm animal populations. Because of this, some of the funding sources for wildlife BMPs are also mentioned in the agricultural BMP section. The following table provides an overview of wildlife BMP unit costs and possible sources of funding.

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
• Feral Hogs • Beavers • Deer • Water Fowl	Linear Streambank Fencing	$3.50/foot	• WHIP • EQIP • AWEP • County Governments • US Fish and Wildlife • DHEC 319 Funds
	Filter Strips	$275/acre	
	Riparian Buffers	$250/acre	
	Box, Swing, and Corral Traps	$320-460 each	Funding Sources Unknown

Table 19: Wildlife BMP Unit Costs and Potential Funding Sources

BMP unit cost estimates come from both the previously mentioned prices in the agricultural BMP section as well as estimates from NRCS. For a descriptive list of potential funding sources, please see Section 6.

10. RECOMMENDED BMPS AND TOTAL COST ESTIMATES

The calculations in Table 11provide the BMP reductions needed annually to address the total number of failing septic systems, total number of animals, and the total number of dogs in each subwatershed. Because these numbers are based on the calculations from Section 4, the total bacteria reductions for all three categories at a specific site will exceed the TMDL reductions needed as stated in Table 10. The recommendations in this section are based upon the TMDL reductions needed annually as well as the feasibility of implementation.

Standard bacterial reductions were used to determine the number and type of specific BMP installations recommended. (See Section 5 for additional information on the standard bacteria reductions.)

BMP Type	Standard Bacteria Reduction	Source of Standard	Average Cost
Agricultural BMP Bundle	1.86E+13 per bundle annually	Ag BMP Bundle Calculations (Section 5)	$19,332
Septic Repair	2.42E+10 per household	STEPL Model	$4,000
Pet Waste Station	2.19E+12 per station annually	SC DHEC Standard Numbers and Greenville County Pet Waste Station Data	$300

Table 20: Standard Bacteria Reductions, Sources, and Costs

Within the discussion of each subwatershed, the comparison of the ideal versus recommended BMP installations will be made, followed by a discussion of total cost estimates. Because the recommendations are made based upon the TMDL reductions needed, BMP installations should be focused in the priority areas of each subwatershed in order to attain water quality standards for bacteria.

BIG CREEK SUBWATERSHED

Ideal BMP Installations in the Big Creek Subwatershed

Within the Big Creek subwatershed, a total of 17 agricultural, 619 septic systems, and 1,215 pet waste BMPs would be needed to address the reductions calculated in Table 11. These idealistic numbers represent the paramount BMP installations and far exceed the TMDL reductions needed to meet water quality standards.

Ideal Total Agricultural BMPs	Ideal Total Septic System BMPs	IdealTotal Pet Waste BMPs	Ideal Total Bacteria Removed	Total Cost for Ideal BMP Installations
17	619	1,215	2.99E+15	$3,169,144

Table 21: Total Ideal BMP Installations in the Big Creek Subwatershed

Recommended BMP Packages in the Big Creek Subwatershed

The vastmajority of the Big Creek subwatershed is impaired for bacteria and included in the Big Creek priority area. The high percentage of agricultural land, 34.63%, indicates that nonpoint source pollution is a concern throughout the subwatershed. Septic systems are also prevalent throughout this area. As shown in Table 10, a total of 5.10E+13 bacteria reduction is needed annually in order to meet the 46% reduction needed as described in the TMDL for S-302. Suggested strategies for achieving this goal for a three-year phase are shown below

Package	Total Recommended Ag. BMPs	Total Recommended Septic System BMPs	Total Recommended Pet Waste BMPs	Total Bacteria Removed	Total Cost of Package
Package 1	9			1.67E+14	$173,988
Package 2	3	7	3	6.25E+13	$86,896

Table 22: Recommended BMP Packages in the Big Creek Subwatershed

Both strategies achieve the bacterial reduction goals; however, Package 1 uses only agricultural BMPs, while Package 2 uses a combination of agricultural, septic, and urban BMPs. Having a variety of BMP choices may ease implementation by appealing to a broader group of individuals, making Package 2 the recommended option. Package 2 would cost roughly $86,896 to implement. With this combination of BMPs, the bacteria standards would be met and exceeded annually in a cost efficient manner, as opposed to the $3.5 million that would be needed to install the ideal amount of BMPs.

GROVE CREEK SUBWATERSHED

Ideal BMP Installations in the Grove Creek Subwatershed

Within the Grove Creek subwatershed, a total of three agricultural, 408 septic systems, and 1,261 pet waste BMPs would be needed to address the reductions calculated in Table 11. These idealistic numbers represent the paramount BMP installations and far exceed the TMDL reductions needed to meet water quality standards.

Ideal Total Agricultural BMPs	Ideal Total Septic System BMPs	IdealTotal Pet Waste BMPs	Ideal Total Bacteria Removed	Total Cost for Ideal BMP Installations
3	408	1,261	2.83E+15	$2,068,296

Table 23: Total Ideal BMP Installations in the Grove Creek Subwatershed

Recommended BMP Packages in the Grove Creek Subwatershed

Grove Creek has a smaller concentration of available agricultural land, high percentage of houses on septic systems, and relatively more urban land cover. Recommendations for this area include septic system repairs, urban BMPs, and limited focus on agricultural BMPs. As shown in Table 10, a total of 1.53E+14 bacteria reduction is needed annually in order to meet the 72% reduction needed as described in the TMDL for S-171. Suggested strategies for achieving this goal are shown below.

Package	Total Recommended Ag. BMPs	Total Recommended Septic System BMPs	Total Recommended Pet Waste BMPs	Total Bacteria Removed	Total Cost of Package
Package 1	8	10	3	1.56E+14	$195,556

Table 24: Recommended BMP Packages in the Grove Creek Subwatershed

Because Grove Creek has limited agricultural land, the recommended BMPs for this area focus on urban and septic system BMPs. Package 1 would cost roughly $195,556 to complete in this subbasin. With this combination of BMPs, the bacteria standards would be met and exceeded annually in a cost efficient manner, as opposed to the $2 million that would be needed to install the ideal amount of BMPs.

HURRICANE CREEK SUBWATERSHED

Ideal BMP Installations in the Hurricane Creek Subwatershed

Within the Hurricane Creek subwatershed, a total of 10 agricultural, 748 septic system, and 941 pet waste BMPs would be needed to address the reductions calculated in Table 11. These idealistic numbers represent the paramount BMP installations based upon the number of animals, failing septic systems, and domestic pets in this subwatershed. Hurricane Creek's ideal BMP installations would require the most funding.

Ideal Total Agricultural BMPs	Ideal Total Septic System BMPs	IdealTotal Pet Waste BMPs	Ideal Total Bacteria Removed	Total Cost for Ideal BMP Installations
10	748	941	2.26E+15	$3,467,620

Table 25: Total Ideal BMP Installations in the Hurricane Creek Subwatershed

Recommended BMP Packages in the Hurricane Creek Subwatershed

Hurricane Creek has a high concentration of agricultural land (30.71%) and a very high percentage of households on septic systems, with sewer service available to less than 2% of households. The recommended BMPs for Hurricane Creek could include only agricultural BMPs, or could include a combination of agricultural, septic, and urban BMPs. Because there are no known parks or pet stores within the Hurricane Creek area, the recommended pet waste station mentioned in Package 2 would need to be placed in an area of high public use. Due to the lack of historical water quality monitoring in this subwatershed, the recommended BMP Packages are based upon land cover, neighboring water quality impairments, and the assumption that this subwatershed is impaired for bacteria.

Package	Total Recommended Ag. BMPs	Total Recommended Septic System BMPs	Total Recommended Pet Waste BMPs	Total Bacteria Removed	Total Cost of Package
Package 1	9			1.67E+14	$173,988
Package 2	3	7	3	6.25E+13	$86,896

Table 26: Recommended BMP Packages in the Hurricane Creek Subwatershed

With such a high percentage of households on septic systems, Package 2 would be the more effective option; with a septic failure rate of 10%, Hurricane Creek has the highest potential for benefiting from septic repair projects. Package 2 would cost roughly $86,896 to complete. With this combination of BMPs, the bacteria standards would be met and exceeded annually in a cost efficient manner, as opposed to the $3.5 million that would be needed to install the ideal amount of BMPs.

CRAVEN CREEK SUBWATERSHED

Ideal BMP Installations in the Craven Creek Subwatershed

Within the Craven Creek subwatershed, a total of two agricultural, 165 septic systems, and 631 pet waste BMPs would be needed to address the reductions calculated in Table 11. These idealistic numbers represent the paramount BMP installations and far exceed the TMDL reductions needed to meet water quality standards. Because Craven Creek has two priority areas, the ideal numbers are based upon both.

Ideal Total Agricultural BMPs	Ideal Total Septic System BMPs	Ideal Total Pet Waste BMPs	Ideal Total Bacteria Removed	Total Cost for Ideal BMP Installations
2	165	631	1.42E+15	$887,964

Table 27: Total Ideal BMP Installations in the Craven Creek Subwatershed

Recommended BMP Packages in the Craven Creek Subwatershed

Craven Creek is primarilyurban, with an agricultural land cover percentage of only 10.78%. Because of this, septic system repairs/replacements and urban BMPs will be more effective in this area. With the TMDL reductions needed for both priority areas in Craven Creek, a total bacteria reduction of 2.36E+13 is needed annually to meet standards for stations S-315 (northern priority area) and S-267 (southern priority area). Agricultural and septic reductions would need to be focused in the northern priority area while urban/pet waste BMPs should be focused in both the northern and southern priority areas.

Package	Total Recommended Ag. BMPs	Total Recommended Septic System BMPs	Total Recommended Pet Waste BMPs	Total Bacteria Removed	Total Cost of Package
Package 1	3		3	6.24E+13	$58,896
Package 2	1	2	3	2.52E+13	$28,232

Table 28: Recommended BMP Packages in the Craven Creek Subwatershed

Because Craven Creek is a more urban area, septic system repairs and pet waste station BMPs will be more effective in addressing the bacteria reductions needed; therefore, Package 2 will be the most effective strategy. Package 2 would cost roughly $28,232 to implement. With this combination of BMPs, the bacteria standards would be met and exceeded annually in a cost efficient manner, as opposed to the $880,000 that would be needed to install the ideal amount of BMPs.

RECOMMENDATIONS SUMMARY

Table 29shows the recommended BMP package types that will best suit each subwatershed - selected to address land cover, households on septic systems/sewer service, and how much of a bacterial reduction is needed to either meet or maintain bacterial standards. Total cost estimates are summarized by subwatershed.

Subwatershed	Number of Ag. BMP Bundles	Number of Septic System Repairs	Number of Pet Waste Stations	Total Bacteria Removed	Total Cost for Subwatershed
Big Creek	3	7	3	6.25E+13	$86,896
Grove Creek	8	10	3	1.56E+14	$195,556
Hurricane Creek	3	7	3	6.25E+13	$$86,896
Craven Creek	1	2	3	2.52E+13	$28,232
Total	15	26	12	3.06E+14	$397,580

Table 29: Summary of BMP Recommendations and Cost Estimates by Subwatershed

Big Creek has the highest concentration of agricultural land and over half of the households on septic systems. Effective BMPs include a focus on both agricultural BMPs and septic repairs, with limited focus on pet waste.

Grove Creek is diverse in its land cover as well as septic and sewer service distribution. Recommended BMPs include a combination of agricultural BMPs, septic repairs, and urban BMPs.

Hurricane Creek has a high concentration of agricultural land and septic systems. Recommended BMPs emphasize agricultural BMPs, but septic would also be effective.

Craven Creek has relatively less agricultural land in comparison to the other subwatersheds. BMP recommendations focus on septic repairs and urban BMPs, with light focus on agricultural reductions.

11. PUBLIC OUTREACH AND EDUCATION

A detailed public outreach strategy has been developed for the entire focus area that covers all nonpoint sources of bacteria impairments (i.e., wastewater, agricultural, urban stormwater, and wildlife). This table can be found in Appendix D. Detailed information includes the target audience to be addressed, messages to convey, outreach methods used, and recommended project partners are listed for each pollution source.

Mailings and Displays
Mailing lists will be compiled to facilitate communication with subwatershed residents regarding events and opportunities for potential projects. This list will be used to send mailings that could include postcard invitations to meetings, workshops, information on agricultural and septic system BMP projects, and other nonpoint source pollution outreach events.

Including inserts with local utility providers' bills will also be utilized when possible. Because some utility providers mail water bills in postcard format, bill stuffers will not be feasible for all locations. However placement of outreach material (e.g., septic system maintenance, agricultural BMP programs, and pet waste stations) at community gathering spots, such as city halls or community centers, will be an alternative way to provide information to homeowners.

Community Meetings, Workshops, and Festivals
Community outreach meetings should be conducted as needed to discuss the implementation plan, identify specific locations for BMP projects, make revisions to the plan based on community feedback, and generate landowner participation. Topics to be addressed may include:

- Overview of watershed plan
- Subwatershed water quality issues & goals
- Priority agricultural BMP and septic system projects per basin
- Priority Urban Stormwater and Wildlife BMP projects per basin
- Possible funding sources

- Community stormwater education opportunities

Schools, community groups, and public library patrons would benefit from a variety of water quality educational publications and community workshops. Presentations to local landowners and community groups are an effective way to introduce groups to nonpoint source pollution issues. Workshop topics could include agricultural BMPs, septic system maintenance and repair, pet waste, and nuisance wildlife. Storm drain stenciling and stream cleanups are excellent opportunities to engage the public, including youth organizations, while educating them about water quality issues. There are 19 schools in the focus area as well as several community centers and libraries (See Table 30). Finally, festivals are an excellent venue for reaching out to local residents. Two of the larger festivals in the focus area are Anderson County Parks Saluda River Rally and Spring Water Festival in Williamston, SC. The Saluda River Rally draws in hundreds of people and provides ample opportunities to interact with public who are there to participate in recreational activities on the Saluda River. Williamston's Spring Water Festival began over 30 years ago to celebrate of the medicinal spring waters of the region and also draws a significant crowd to the region.

List of Community Groups within the Subwatersheds	
Schools within the Subwatersheds:	
• Carolina High School and Academy • Cedar Grove Elementary • Cleveland School • Concrete Primary • Crosspointe Christian Academy • Ellen Woodside Elementary • Palmetto Elementary, Middle, High • Powdersville Elementary, Middle, High • Rehoboth School • Southside High • Spearman Elementary	• Sue Cleveland Elementary • Tabernacle Elementary • Tanglewood Elementary and Middle • Townville Elementary • Trinity Christian Academy • Welcome Elementary • West Dunklin School • West Pelzer Elementary • Woodmont Middle, High • Wren Elementary, Middle, High
Cities and Towns: • Town of Golden Grove • Town of Piedmont • Town of Pelzer • Town of Powdersville • Town of West Pelzer	
Libraries: • Anderson Road Library • Lander Memorial Regional Library • Piedmont Branch Library • Powdersville Branch Library	
Community Centers: • Mount Pleasant Community Center • Piedmont Community Center	
Boy Scout Packs and Troops: • Pack 3707/Troop 0711 Augusta Road United Methodist Church • Pack 3708 Fork Shoals School PTA • Pack 3103 Mountain Springs Baptist Church • Troop 0781 Mountain Pleasant Community Center • Troop 0238 Augusta Road Church of Christ	

Table 30: Community Groups, Municipalities, Schools, and Organizations for Public Outreach

Additional Public Outreach and Education Efforts

Watershed residents who wish to learn more about the watershed based plan will be able to find project updates as well as general water quality information online through partner websites.

12. IMPLEMENTATION SCHEDULE, MILESTONES, AND MEASURABLE GOALS

Subwatershed Prioritization

Due to the size of the focus area this plan is broken up into phases by subwatershed. Phase 1 begins with agricultural and septic BMP work in Big Creek subwatershed. To streamline efforts, work on urban and wildlife BMPs throughout the focus area is also included in Phase I. Big Creek contains the greatest number of impaired stream miles at 11.42 miles, has the highest potential for agricultural BMP projects, and ample opportunity for septic system replacement projects. Water quality improvements in the Big Creek subwatershed have the highest potential to yield considerable benefits to water quality – making it the highest priority within the focus area.

Phase 2 of the project is Grove Creek. Grove Creek requires the second largest reduction of the four subwatersheds, contains 8.21 miles of impaired streams and has the largest number of septic systems within the focus area. Based on this information it is anticipated that primary focus will be to address malfunctioning septic systems in Grove Creek with limited work on agricultural BMP projects.

Phase 3 is Hurricane Creek. In the absence of water quality data Hurricane Creek was selected as third priority because of its similarities to Big Creek. Water quality samples will be collected monthly in Hurricane Creek to determine water quality by a student volunteer for the 2013-14 academic year. Having time to establish the baseline data is essential to confirm or revise recommendations. Hurricane Creek is the smallest of the four watersheds and includes the second highest percentage of agricultural lands at 31%. This large concentration of agricultural properties increases the opportunities for the successful implementation of agricultural BMP projects. Also, because there is extremely limited sewer service in the region the majority of residents rely on septic systems for wastewater treatment.

Phase 4 of the project is Craven Creek. Craven Creek is the largest of the four subwatersheds in the focus area at roughly 29,443 acres. Craven Creek also contains the lowest percentage of agricultural land at 11%. Water quality monitoring stations S-315 and S-267 fall inside this basin and require a 61% and 80% bacterial load reductions, respectively. We anticipate that recent upgrades in wastewater treatment facilities will provide significant water quality improvement in in this region, including S-267. In the absence of any recent water quality data for S-267, agricultural and septic work in Craven Creek is considered a long-range priority in comparison to the other subwatersheds. Delaying implementation of work in this subwatershed will allow time for the watershed to respond to any improvements, and data to reflect sustained improvements before resources are expended.

An Implementation Schedule for all four basins is listed below (Table 31). Emphasis will be placed on developing projects first in the upper portions of each subwatershed then moving downstream so as to increase the overall water quality improvements to each subwatershed. Each phase will include a project identification, project implementation, and evaluation and refinement period.

PHASE	BMPs	TIME FRAME - YEARS											
		1	2	3	4	5	6	7	8	9	10	11	12
Phase 1 Big Creek	Agricultural BMPs												
	Septic BMPs												
	Urban BMPs												
	Wildlife BMPs												
Phase 2 Grove Creek	Agricultural BMPs												
	Septic BMPs												
	Urban BMPs												
	Wildlife BMPs												
Phase 3 Hurricane Creek	Agricultural BMPs												
	Septic BMPs												
	Urban BMPs												
	Wildlife BMPs												
Phase 4 Craven Creek	Agricultural BMPs												
	Septic BMPs												
	Urban BMPs												
	Wildlife BMPs												

Table 31: Phased Implementation Timeline for All Four Subwatersheds

General Implementation Strategies for All Subwatersheds

Project Identification Period:
Initial efforts will focus on building relationships with local landowners to identify specific potential projects and secure funding for such projects. Partnerships with NRCS and local Soil and Water Conservation Districts (SWCD) would facilitate project identification, design, and funding procurement. Because these agencies already have experience working with local landowners and farmers and designing agricultural related water quality BMPs such as streambank fencing, and alternative watering projects their knowledge and involvement is essential to the process.

In regards to septic systems a public outreach campaign should be conducted in each region with the help of the local stormwater outreach agencies, Clemson Extension - Carolina Clear (CU-CC), Pickens County Stormwater Partners (PCSP), Greenville County Soil and Water Conservation District (GC-SWCD), and Anderson County Public Works (ACPW) to enroll homeowners in the septic system replacement program. Outreach methods should consist of general media advertisements, community meetings, bill stuffers, and displays at local government offices and public facilities.

Preferred pet waste stations locations have already been identified as part of the planning process and these sites can be found in Figure 10 (Pet Groomers, Stores, and Hospitals). However it is important to gather additional input from residents to confirm these locations prior to installing the stations. It will be important to engage local Parks Departments to finalize site locations and

pet waste station maintenance schedules. More pet waste station sites may be added as appropriate locations are identified.

Finally, working with local residents, Clemson Extension (CU-Ext.), SC Department of Natural Resources (SC DNR), and Anderson County Parks Department (ACPD) would help to identify those regions of the entire focus area with nuisance wildlife populations. Deterrence or removal strategies of wildlife will vary depending upon the species of interest (e.g., feral hog, beaver, coyote, or deer).

Project Implementation Period:
Prior to project implementation it is extremely important that baseline water quality data be collected before and after projects are installed so that it is possible to measure changes in bacteria levels in relation to watershed improvements. Water quality monitoring should continue throughout the implementation period and is recommended to continue for up to a year after projects are installed. Subwatersheds will be prioritized based on the types of projects that will most benefit as well as their potential to provide needed bacteria reductions. The final number of BMP projects installed will depend upon landowner participation and available funding sources.

Evaluation and Refinement Period:
Since it is difficult to predict landowner preferences and participation rates it will be necessary to periodically reassess the project goals. Adjustments to the Public Outreach and Education Strategy may be needed if participation is lower than desired. It will also be important to evaluate the individual BMP projects themselves, making note of any problems that occurred before, during, and after construction to streamline the process for future participants. Consideration should also be given to new or revised stormwater management techniques as they become available.

PHASE 1: BIG CREEK, URBAN AND WILDLIFE BMPS

Big Creek Agricultural BMP Implementation Plan

According to the EPA Approved 2004 TMDL Big Creek (S-302) will require an overall 46% reduction in bacteria loading to meet state bacteria standards. Agriculture is a significant source of non-point source bacterial pollution to waterways in the Big Creek subwatershed so efforts will focus on installing agricultural BMPs to reduce 5.10E+13 of bacteria annually. Installing three agricultural BMPs that restrict livestock access to rivers, lakes, and streams in combination with septic and urban BMPs should achieve the bacterial reduction goal.

It is recommended that in cooperation with NRCS and Anderson County Soil and Water District (ACSWCD) the 319 three small landowner meetings are held over the course of three years to recruit interested landowners to participate. These meeting will allow the 319 Grantees and other potential partners to form relationships with landowners and gain support for implementing projects in the watershed. Minimal resources required include meeting space, speakers, staff time, and refreshments. With landowners'approval, NRCS will draft conservation plans for the properties. Again, the goal is to install three agricultural BMP bundles annually to fence livestock out of streams. Landowners will be responsible for BMP installation on their

properties. Once projects are complete it is important to obtain feedback on the overall process from the landowners. Clemson Extension's Carolina Clear (CU-CC) program specializes in public outreach focused on water quality and thus would be an excellent partner in combination with NRCS staff and the 319 Grantees. Any recommendations for improvement from landowners or project partners will be incorporated into the watershed plan to improve the overall success of the plan. See Table 32 for a summary of the agricultural BMP plan.

Objective: Work with farmers in Big Creek to fence 550 livestock out of waterways													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Hold meetings with 5 -10 landowners	319 Grantees, NRCS, ACSWCD												
Build relationships and recruit landowner participation	319 Grantees, NRCS, ACSWCD												
Write 2conservation plans per year	NRCS												
Install 2agricultural BMP bundles per year	Landowners												
Survey participating landowners	CU-CC, 319 Grantees, NRCS												
Revise plan as needed	319 Grantees												

Table 32: Big Creek Subwatershed Agricultural BMP Implementation Plan

Big Creek Septic System BMP Implementation Plan

Failing or malfunctioning septic systems are a source of non-point bacteria pollution to waterways and it is estimated that on average roughly 10% of septic systems do not function properly. There are approximately 2,057 septic systems in the Big Creek subwatershed. A 10% failure rate would mean roughly 206 septic systems in the Big Creek watershed are not operating correctly. Given previous low implementation rates of septic system replacements in other 319 Watershed Protection Implementation Projects plus the fact that it would cost approximately $800,000 to replace 200 septic systems in this region the number of recommended septic system replacements was reduced for Big Creek to what was necessary to attain water quality standards. The proposed number of septic system replacements was established using the assumption that average septic removal project is expected to yield a reduction of 2.42E+10 bacteria per household annually. This watershed plan calls for the replacement of 7 septic systems in combination with agricultural and/or urban stormwater BMPs. The total reduction for 7 systems equals a reduction of approximately 1.69E+11bacteria.

The first step is to find homeowners interested in participating in the septic system replacement program. Residents will be contacted through a variety of approaches. A general letter will be sent out to residents living along Big Creek informing them about the program and how to identify septic system issues. In addition, bill stuffers will be created providing information on the septic system program and distributed through the local water utility providers; the Greater Williamston Water and Sewer District (WWSD) and the Big Creek Water District (BCWD). Finally, a general informational display will be created and installed at the Town of Williamston

City Hall and the Lander Memorial Library. Although the Lander Memorial Library does not fall within the Big Creek Watershed it should be used as a point of contact for public outreach for water quality improvement projects in Big Creek because it is the main library for the area. Once sites are identified it will be necessary to verify that the system needs to be repaired or replaced. This will be done by a certified SC DHEC septic system professional. The homeowner will be responsible for arranging the septic system replacement. Finally, a general survey will be conducted to identify any weaknesses in the program. Changes to the plan will be made as necessary in order to increase homeowner participation rates and satisfaction.

Objective: Work with residents to replace malfunctioning septic systems in Big Creek													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Send out septic system replacement solicitation letter to 2,000 residents	319 Grantees, CU-CC, Williamston, Anderson County												
Build relationships and recruit landowner participation	319 Grantees,CU-CC, septic professionals, municipal staff												
Create septic system bill stuffer for utility providers	WWSD, CU-CC, 319 Grantees												
Install septic system displays at utility providers, libraries, town halls	319 Grantees, BCWD, CU-CC, WWSD, Williamston												
Conduct site visits to verify projects	SC DHEC certified septic professional, homeowners												
Repair/replace 10 septic systems per year	SC DHEC certified septic professional, homeowners												
Survey participating landowners	Staff time, mileage												
Revise plan as needed	Staff time												

Table 33: Big Creek Watershed Septic System BMP Implementation Plan

Urban Stormwater BMP Implementation Plan for All Subwatersheds

General stormwater education and outreach campaigns should be conducted throughout all subwatersheds in the focus area. Information on pet waste and bacterial pollution should be displayed at all Town Halls and public libraries (See Table 30 for list of Town Halls and libraries). It is recommended that three public meetings be held to educate citizens about general stormwater issues and solicit input from local residents about preferred locations for pet waste stations. The meeting locations should rotate to vary across the focus area. A total of 12 pet waste stations are recommended throughout the focus area to attain water quality standards with more added, as funds become available. Pet waste stations should be installed at municipal and county parks, various pet related businesses including, veterinary hospitals, groomers, and kennels. Doggie waste bags will also be made available to pet related businesses. Anderson County Parks Department (ACPD) manages 14 parks in the region while Greenville County Recreation District (GCRD) operates three parks in the region (See Table 34).

Recreational Facilities in Anderson and Greenville County	
Anderson County:	
• Brookdale Community Park • Cheddar Youth Center • Dolly Cooper Sports Complex • Hopkins Field at Pelzer Town Park • Hurricane Springs Park • Mineral Springs Park	• New Hope Community Sports Complex • Palmetto Elementary Walking Track • Pelzer Lower Boat Ramp • Pelzer Park (Monkey Park) • Timmerman JR Boat Ramp • Williamston Park
Greenville County	
• Lakeside Park • Piedmont Athletic Complex • Lorretta C. Wood Park	

Table 34: Anderson and Greenville County Parks within Focus Area

Storm drain stenciling projects are an excellent way to engage local citizens and school groups in pollution prevention strategies. All public schools within the Anderson County School District (ACSD) and Greenville County School District (GCSD) (Table 30) should be invited to participate in storm drain stenciling activities. Storm drain stencils will also be made available to all of the municipalities listed in Table 30 to be installed in town centers and public parks.

Municipalities within the focus area (i.e., Towns of Golden Gate, Piedmont, Pelzer, West Pelzer, Powdersville, and Williamston) could consider implementing a pet waste ordinance. The official adoption of these ordinances will be dependent upon majority votes from local town council members.

Objective: Reduce bacteria loading from urban stormwater in all four subwatersheds													
Milestones	**Potential Partners***	**Time Frame – Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Meet with community leaders to discuss urban stormwater BMPs	319 Grantees, ACPD, Municipalities												
Host public meetings on urban stormwater and pet waste	ACPW, 319 Grantees, CU-CC, PCSP Municipalities**												
Install pet waste stations at municipal and county parks	ACPD, ACPW, 319 Grantees CU-CC, PSCP, Municipalities, CU												
Mark storm drains at local schools and parks	ACPD, ACPW, ACSD, GCSC, CU-CC, PCSP												
Develop Pet Waste Ordinance	ACPW, 319 Grantees, PCSP, CU-CC, Municipalities**												
Approval of Pet Waste Ordinance	ACPW, GCSWD, 319 Grantees, Municipalities**												
Revise plan as needed	319 Grantees												

Table 35: Urban BMP Implementation Plan for Entire Focus Area

* *For full list of project partners please see Appendix D– Public Outreach Strategy*.

** *Municipalities include the Towns of Golden Gate, Piedmont, Pelzer, West Pelzer, Powdersville, and Williamston.*

Wildlife BMP Implementation Plan

Three workshops should be held to educate citizens about the impacts of wildlife on water quality and to encouragemethods to reduce or eliminate problem species in the region. General information on bacteria and wildlife will also be made available to citizens through the Anderson and Greenville County library system. Species of interest include feral hogs, beaver, deer, and Canadian Geese. The goals of this program will be to discourage nuisance wildlife species from congregating on properties, especially those properties bordering impaired waterbodies, and to reduce bacterial loading from wildlife.

Objective: Reduce bacterial pollution from nuisance wildlife in all four subwatersheds													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Host 3 public nuisance wildlife workshops	CU-CC,CU-Ext., SC DNR, PCSP, ACPD, GCRD, NRCS, GCSWCD												
Provide fliers to libraries, city halls, and community centers	CU-CC, CU- Ext., SC DNR, PCSP												
Collect workshop evaluations	319 Grantees, CU-CC												
Revise program as needed	319 Grantees, CU-CC												

Table 36: Wildlife BMP Implementation Plan for Entire Focus Area

PHASE 2: GROVE CREEK AGRICULTURAL AND SEPTIC BMPS

Grove Creek Agricultural BMP Implementation Plan

The Grove Creek subwatershed is made up of approximately 15% agricultural land and will require the installation of eight agricultural BMP bundle packages to reduce bacterial loading to within state water quality standards (See Section 6 for average agricultural BMP bundle). The first step will be to recruit willing landowners into the program. This will be accomplished through a series of three smaller landowner meetingsover a three-year period.Potential hosts for such meetings include319 Grantees, NRCS, and the Greenville County Soil and Water District (GCSWCD).The purpose of the meetings is to identify landowners who are interested in installing agricultural BMPs on their properties. Again, minimal resources will be required other than meeting space, speakers, staff time, and refreshments. NRCS will be asked to draft conservation plans for the properties while the landowners themselves will be responsible for the actual BMP installation on their properties. The 319 Grantees should maintain an open dialogue with landowners throughout the process. Suggestions from landowners that would improve the functionality and effectiveness of program (e.g., BMP installation, reimbursement process) will be incorporated into the watershed plan for the area. See Table 37 for a summary for Grove Creek's agricultural BMP plan.

Objective: Work with farmers in Grove Creek to fence 150livestock out ofstreams													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Hold meetings with 5 -10 landowners	319 Grantees, NRCS, GCSWCD												
Build relationships and recruit landowner participation	319 Grantees, NRCS GCSWCD												
Write 1 conservation plans per year	NRCS												
Install 1 agricultural BMP bundles per year	Landowners												
Survey participating landowners	CU-CC, 319 Grantees, NRCS, GCSWCD												
Revise plan as needed	319 Grantees												

Table 37: Grove Creek Watershed Agricultural BMP Implementation Plan

Grove Creek Septic System BMP Implementation Plan

Grove Creek has the greatest number of septic systems in comparison to other subwatersheds at an estimated 3,787 systems. The standard 10% septic failure rate would equate to approximately 379 malfunctioning septic systems in the Grove Creek subwatershed. Low resident participation rates for septic rehabs in other 319 Implementation Projects in the region in combination with the $1,500,000 estimated costs to repair all septic systems would make it difficult to repair all faulty septic systems in Grove Creek. In fact, in all of the subwatersheds in the focus area repairing septic systems alone will not achieve bacterial water quality standards. The most effective solution is to combine septic system repairs with agricultural and urban BMPs. Thus, the Grove Creek plan calls for the replacement of 10septic systems in combination with agricultural and urban stormwater BMPs. The strategy for implementing the Grove Creek Septic System BMP plan is to send solicitation letters to 3,000 residents. Bill stuffers will be included with Greenville Water System (GWS) bills when possible and informational displays placed at water district offices and town halls. Also, the Town of Golden Grove is the sole municipal area in this basin. See Table 38 for the Grove Creek Septic System BMP Plan.

Objective: Work with residents to replace malfunctioning septic systems in Grove Creek													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Send out septic system replacement solicitation letter to 3,000 residents	319 Grantees, CU-CC, GCSWCD												
Create septic system bill stuffer for utility providers	319 Grantees, CU-CC, GWS												
Install septic system displays at utility providers, city halls	319 Grantees, GCSWCD, CU-CC, GWS												
Conduct site visits to verify projects	SC DHEC certified septic professional, homeowners												
Repair/replace 5 septic systems per year	SC DHEC certified septic professional, homeowners												
Survey participating landowners	319 Grantees												
Revise plan as needed	319 Grantees												

Table 38: Grove Creek Subwatershed Septic System BMP Implementation Plan

PHASE 3: HURRICANE CREEK AGRICULTURAL AND SEPTIC BMPS

Hurricane Creek Agricultural BMP Implementation Plan

Hurricane Creek has the second highest proportion of agricultural land in comparison to the other subwatersheds at 31%. Hurricane Creek will need three agricultural BMP bundles installed to maintain water quality standards (See Section 6 for Average Agricultural BMP Bundle). NRCS, 319 Grantees, and the Anderson County Soil and Water Conservation District (ACSWCD) could collectively recruit landowners into the program through small landowner meetings. NRCS will be recruited for drafting conservation plans while the landowners themselves will be responsible for the actual BMP installation on their properties. The 319 Grantees will continue to maintain an open dialogue with landowners throughout the process. Suggestions from landowners that would improve the functionality and effectiveness of BMPs will be incorporated into the watershed plan for the area. See Table 39 for a summary for Hurricane Creek Agricultural BMP Implementation Plan.

Objective: Work with farmers in Hurricane Creek to fence out 300 livestock from streams													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Hold meetings with 5 -10 landowners	319 Grantees, NRCS, AC-SWCD												
Build relationships and recruit landowner participation	319 Grantees, NRCS ACSWCD												
Write 3 conservation plans per year	NRCS												
Install 3 agricultural. BMP bundles per year	Landowners												
Survey participating landowners	CU-CC, 319 Grantees, NRCS												
Revise plan as needed	319 Grantees												

Table 39: Hurricane Creek Watershed Agricultural BMP Implementation Plan

Hurricane Creek Septic System BMP Implementation Plan

Hurricane Creek has approximately 2,400 septic systems, assuming a standard 10% septic failure rate then 250 septic systems are in need of repair. It is estimated that is could $1,000,000 to repair/replace all 250 malfunctioning systems. Even if affordable, repairing septic systems alone will not achieve bacterial water quality standards for Hurricane Creek. The most effective solution is to combine septic system repairs with agricultural and urban BMPs. The Hurricane Creek plan calls for the replacement of seven septic systems in combination with three agricultural and three urban stormwater BMPs. The strategy for repairing septic systems will be to send solicitation letters to 2,000 residents. Bill stuffers will be included with water bills when possible and informational displays placed at water district offices and town halls. Water service providers in the area include Big Creek Water District (BCWD) and Powdersville Water District (PWD). See Table 40 below for Hurricane Creek Septic System BMP Plan.

Objective: Work with residents to replace malfunctioning septic systems in Hurricane Creek													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Send out septic system replacement solicitation letter to 2,000 residents	319 Grantees, CU-CC, Anderson County												
Create septic system bill stuffer for utility providers	BCWD, PWD, CU-CC, 319 Grantees												
Install septic system displays at utility providers	319 Grantees, BCWD, CU-CC, PWD												
Conduct site visits to verify projects	SC DHEC certified septic professional, homeowners												
Repair/replace 5 septic systems per year	SC DHEC certified septic professional, homeowners												
Survey participating landowners	319 Grantees												
Revise plan as needed	319 Grantees												

Table 40: Hurricane Creek Subwatershed Septic System BMP Implementation Plan

PHASE 4: CRAVEN CREEK AGRICULTURAL AND SEPTIC BMPS

Craven Creek Agricultural BMP Implementation Plan

The Craven Creek subwatershed contains relatively little agricultural land, at roughly 10%. This watershed will only require the installation of one agricultural BMP bundle a year to reduce bacterial loading from agricultural sources. A series of small landowner meetings will be held to recruit participants. It is recommended that the 319 Grantees, NRCS, the Anderson County Soil and Water Conservation District (ACSWCD) and Greenville County Soil and Water District (GCSWCD) host these meetings annually for three years. Resources needed for these meetings include a meeting space, speakers, staff time, and refreshments. NRCS will be recruited for drafting conservation plans while the landowners themselves will be responsible for the actual BMP installation on their properties. The 319 Grantees should maintain communication with landowners throughout the process. Suggestions from landowners that would improve the functionality and effectiveness of program (e.g., BMP installation, reimbursement process) will be incorporated into the watershed plan for the area. See Table 41 for a summary for Craven Creek's agricultural BMP implementation plan.

Objective: Work with farmers in Craven Creek to fence out 150 livestock from streams													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Hold meetings with 5 -10 landowners	319 Grantees, NRCS, ACSWCD, GCSWCD												
Write 1 conservation plan per year	NRCS												
Install 1 agriculturalBMP bundle per year	Landowners												
Survey participating landowners	CU-CC, 319 Grantees, NRCS												
Revise plan as needed	319 Grantees												

Table 41: Craven Creek Subwatershed Agricultural BMP Implementation Plan

Craven Creek Septic System BMP Implementation Plan

Craven Creek has approximately 2,400 septic systems, assuming a standard 10% septic failure rate; nearly 250 septic systems are in need of repair. The estimated cost to repair all of the malfunctioning systems is around $1,000,000. However, based on bacterial loading calculations the installation of two septic systemsin combination with urban and agricultural BMPs is sufficient to attain bacterial water standards. The strategy for implementing septic system replacement will be to send solicitation letters to roughly 2,000 residents. Bill stuffers will be included with water bills when possible and informational displays placed at water district offices and town halls. The service providers in the area include Big Creek Water District (BCWD) and Powdersville Water District (PWD), Greenville Water System (GWS), and Williamston Water and Sewer District (WWSC). There are two branches of the Anderson County Library System (ACLS) in Craven Creek, the Powdersville Branch and Lander Memorial Regional Library. Finally, the Towns of Powdersville, Piedmont, Pelzer and West Pelzer fall in the Craven Creek subwatershed. See Table 42 for Craven Creek Septic System BMP Plan.

Objective: Work with residents to replace malfunctioning septic systems in Craven Creek													
Milestones	**Potential Partners**	**Time Frame - Quarters**											
		Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Send out septic system replacement solicitation letter to 2,000 residents	319 Grantees, CU-CC, Anderson County, Greenville County												
Create septic system bill stuffer for utility providers	GWS, PWD, BCWD CU-CC, 319 Grantees												
Install septic system displays at utility providers, city halls, libraries	319 Grantees, CU-CC, AC, GWS, PWD, BCWD, WWSD, ACLS, Municipalities*												
Conduct site visits to verify projects	SC DHEC certified septic professional, homeowners												
Repair/replace 1 septic system per year	SC DHEC certified septic professional, homeowners												
Survey participating landowners	319 Grantees												
Revise plan as needed	319 Grantees												

Table 42: Craven Creek Subwatershed Septic System BMP Implementation Plan
** Municipalities include: Towns of Powdersville, Piedmont, Pelzer and West Pelzer*

13. WATER QUALITY MONITORING

Instream monitoring is used to assess baseline conditions of streams as well as changes or improvements in stream conditions after BMP projects have been installed. The water quality monitoring plan proposed below includes suggested sampling locations, parameters to be monitored, sample collection protocol, recommended microbial detection techniques, and potential individuals and/or organizations to conduct water sampling.

Proposed Monitoring Locations

Instream water quality monitoring for bacteria pollution is important for measuring current conditions as well as gauging the recovery of the streams after BMP projects have been installed. In the focus area priority sample sites arethe existing SC DHEC water quality monitoring locations (S-315, S-007, S-171, S-267, S-119, and S-302). Currently no water quality monitoring is being conducted in Hurricane Creek. At least two sampling locations are recommendedalong the main tributary to Hurricane Creek downstream of agricultural land to establish baseline conditions in this watershed (see Figure 12). If the sample sites indicate bacteria pollution then additional water samples should be taken further upstream to help pinpoint sources. For safety purposes these sample locations should be relatively easy to access from public roads.

In the case of impaired streams, additional water samples shouldbe taken upstream of current TMDL sites in areas where land use activities have the potential to contribute bacteria to waterways (e.g., agricultural land near streams, urban areas, and residential properties). If the

samples collected indicate high bacteria levels, additional samples shouldbe collected further upstream until the source area is identified. To reduce financial expenditures no more than five water samples shouldbe collectedin any particular watershed. Furthermore, prior to the installation of any BMP projects is it suggested that sampling take place at the nearest feasible downstream location so that changes in water quality can be documented.

Monitoring Frequency

Instream monitoring should occur at each of the proposed sites in the four subwatersheds. Ideally monitoring should occur on a monthly basis during a variety of hydrological conditions;water samples should be taken before and after a project is installed. It is highly recommended that water samples continue to be collected on a monthly basis downstream of project sites for at least a year after installation. Monitoring data shouldbe analyzed on a quarterly basis to identify trends, sources of pollution, and any changes in quality as a result of completed projects. Evaluating monitoring results to bacteria standards can determine percent attainment relating to water quality goals.

Microbial Source Detection Techniques

Most Probable Number (MPN) Method
Water samples will be processed for *E. coli* using the Most Probable Number (MPN) method of detection. This type of analysis is based on the presence or absence of bacteria. Water samples will be processed using the USEnvironmental Protection Agency (US EPA) approved standard for detection of total coliforms and *E. coli*, the IDEXX Colilert method for Coliform/*E. coli*[33].

Microbial Source Tracking
Microbial Source Tracking (MST),alsoknown as Bacterial Source Tracking, is a method used to discern sources of fecal contamination in surface waters. These methods are capable of determining if the source of fecal contamination is human, wildlife, domestic livestock and pets. MST could prove to be a useful tool for bacterial source detection in the focus area if funding and resources allow.

Voluntary Monitoring

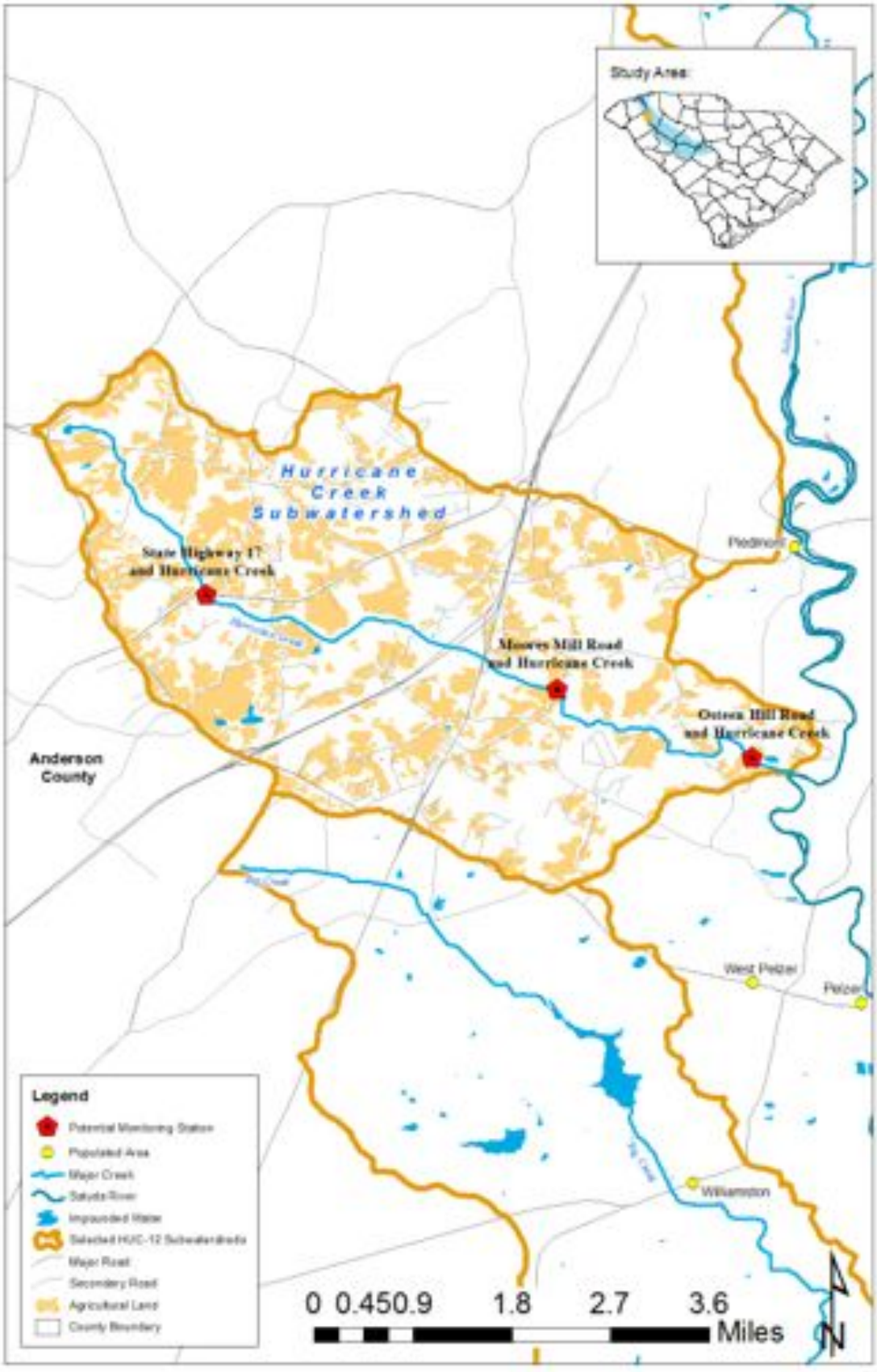
Voluntary monitoring programs are an excellent means to engage citizens while assessing water quality in a region. Schools, community groups, and interested citizens, such as the five volunteer Watershed Directors in the Big Creek Watershed, are great candidates for carrying out voluntary monitoring programs in the region. Voluntary stream monitoring is also an ideal project for Boy or Girl Scout troops in the region.

A student volunteer recently offered to conduct monthly monitoring of Hurricane Creek for the 2013-2014 academic school year. Water samples will be collected monthly and analyzed for *E. coli*according to SC DHEC and US EPA approved protocol.The results will be provided on a quarterly basis. Finally, Furman University (FU) has offered to incorporate bacterial monitoring of selected watersheds into their summer research projects if funding becomes available. During

[33]IDEXX Laboratories, "Water Testing Solutions: Colilert: Coliform/E.coli Results in 24 Hours."

a six week period in the months of June and July students could collect weekly water quality samples from selected sites in the focus area. These samples would then be processed for *E. coli* at FU using the MPN method. Also, depending upon student interest additional water samples could continue to be collected on a quarterly basis and processed for *E. coli*.

Figure 12. Potential Water Quality Monitoring Locations in the Hurricane Creek Subwatershed



14. CONCLUSION

The Upper Saluda River Basin is a SC DHEC and EPA Priority Watershed and has been the focus of substantial investments in research and water quality improvements for years. The watershed provides drinking water, assimilative capacity for numerous dischargers, and recreation opportunities for the region. A Fecal Coliform Bacteria TMDL for the Upper Saluda Basin was approved in 2004; unfortunately, water quality standards have still not been achieved in some of these areas. While some of the area is urban, the focus area is predominately rural in nature. Agricultural pollution and on-site waste water systems are the primary nonpoint sources of bacteria throughout the focus area. The subwatersheds included in this project are impaired for recreation due to fecal coliform violations, and require similar actions to achieve thewater quality standards.

Since the implementation of the 2004 Upper Saluda Basin TMDL, sites within Craven Creek have improved - with sites S-007 and S-119 no longer considered impaired for bacteria. These sites, which are along stretches of the Saluda River, have been in compliance since 2010, according to the SC DHEC 303(d) list. Considering these improvements, Craven Creek is given lowerpriority than Big, Hurricane, and Grove Creek.

General public education campaigns on urban stormwater, proper pet waste disposal, and nuisance wildlife should be targeted across the entire focus area; this is the most efficient and effective use of resources. Pet waste stations can remove large amounts of bacteria from watersheds if installed in high traffic areas and properly maintained. General public education should be done for proper pet waste disposal, storm drains, and wildlife workshops.

Using the following implementation plan, bacteria pollution will be reduced within the four subwatersheds, improving the water quality throughout the Upper Saluda River Basin.

Phase I (Years 1-3):

- All Areas: Public education on urban stormwater and wildlife
- All Areas: Installation of pet waste stations
- Big Creek – agricultural BMPs and septic repairs
  Big Creek: high concentration of agricultural land, so a large number of agricultural BMPs are expected. Access to sewer is limited.

Phase II: (Years 4-6)

- Grove Creek – agricultural BMPs and septic repairs

Phase III (Years 7-9):

- Hurricane Creek – agricultural BMPs and septic repairs.
  Hurricane Creek has a high concentration of agricultural land, so a large number of agricultural BMPs are expected.Access to sewer is limited. This area has the highest density of households with septic systems.

Phase IV (Years 10-12):

- Craven Creek – agricultural BMPs and septic repairs
  Craven Creek has the lowest density of households on septic systems.

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Appendix A:
List of Pet Stores and County Parks

List of Pet Stores, Hospitals, Groomers, and Kennels

Name	Address	Subwatershed
Animal Supply House	3312 S Carolina 153 Piedmont, SC 29673	Craven Creek
Furry Friends Pet Salon	3398 Anderson Road Greenville, SC 29611	Craven Creek
Palmetto Animal Hospital	10 Roberts Boulevard Williamston, SC 29697	Craven Creek
Powdersville Animal Hospital	10920 Anderson Road Powdersville, SC 29673	Craven Creek
Teresa's Mobile Grooming Salon	114 Ragsdale Drive Piedmont, SC 29673	Craven Creek
Foothills Veterinary Hospital	7740 Augusta Road Piedmont, SC 29673	Grove Creek
Man's Best Friend Dog Resort	8100 Augusta Road Piedmont, SC 29673	Grove Creek
Greystar Kennels	1402 Durham Road Piedmont, SC 29673	Hurricane Creek
Stone Retrievers	622 Hwy. 17 Piedmont, SC 29673	Hurricane Creek

List of County Parks

Name	Address	Subwatershed
Cheddar Youth Center	317 Azalea Court Williamston, SC 29697	Big Creek
Mineral Spring Park	Main Street (at Center St.) Williamston, SC 29697	Big Creek
New Hope Community Sports Complex	213 Easley Hwy Pelzer, SC 29669	Big Creek
Palmetto Elementary Walking Track	1 Roberts Blvd Williamston, SC 29697	Big Creek
Williamston Park	Center St. Williamston, SC 29697	Big Creek
Brookdale Community Park	Bigby and Crescent Dr. Williamston, SC 29697	Craven Creek
Dolly Cooper Sports Complex	170 Spearman Circle Powdersville, SC 29611	Craven Creek
Hopkins Field/ Pelzer Town Park	Hwy 20 and Woodcock Rd. Pelzer, SC 29669	Craven Creek
Pelzer Lower Boat Ramp	Lyman St. Pelzer, SC 29669	Craven Creek
Pelzer Park (Monkey Park)	Park Street Pelzer, SC 29669	Craven Creek
Timmerman JR Boat Ramp	Capers Street Pelzer, SC 29669	Craven Creek
Lakeside Park	1500 Piedmont Hwy Piedmont, SC 29673	Grove Creek
Piedmont Athletic Complex	150 Woodmont School Rd. Piedmont, SC 29673	Grove Creek
Hurricane Springs Park	West Pelzer, SC 29669	Hurricane Creek
Cheddar Youth Center	317 Azalea Court Williamston, SC 29697	Big Creek

Appendix B:
Typical Agricultural BMP Bundle and Bacteria Removal Calculations

Appendix B: TypicalAgricultural BMP Bundle and Bacteria Removal Calculations

Typical Agricultural BMP Bundle:Agricultural BMPs are most often installed in packages, or combinations of multiple BMPs.The SC DHEC Nonpoint Source Management Program 2012 Annual Report outlines several current and past 319 projects for both agriculture and septic BMPs.

Within the Upstate region of South Carolina, there have been five completed 319 projects that have focused predominantly on either septic or agricultural BMPs. The five projects completed various combinations of agricultural and/or septic BMPs, shown in the table below.

TMDL/319 Project	total fecal coliform removal (cfu)	alternative water sources (units)	controlled stream access for livestock watering(ft)	fence (ft)	water well (units)	heavy use area protection (sqft)	pipeline (ft)	watering facilities (units)	riparian buffers - vegetated (ac)	onsite wastewater treatment system projects (units)	streambank and shoreline protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	
Cane/Little Cane Creek	6.22E+11									17	2,644
Long Cane Creek	2.87E+12	5		3,735		23,491				9	41,916
Twelve Mile Creek	1.34E+14	4		57,122	14	55,391	14,135	44	10		29,267
Tyger River	3.14E+12	19		27,385	5	14,994	15,193			57	27,385
Total	***1.79E+14***	***30***	***152***	***91,385***	***19***	***104,794***	***29,328***	***45***	***12***	***126***	***101,212***

Looking only at the agricultural BMPs, which would include all but the onsite wastewater treatment system projects, there are only a few BMPs that are measured in units: watering facilities, water wells and alternative watering sources. Out of these three BMPs, water wells have the lowest total number of installations. Using this, we can assume that for every one water well that is installed, there is an average of 1868 feet of fencing, 2138 square feet of heavy use area protection, 599 feet of pipeline, 2 watering facilities, and 0.23 acres of riparian buffer installed. An average agricultural BMP bundle therefore looks like this:

Average Agriculture BMP Bundle:

- **1 well with pump**
- **1,868 feet of fencing**
- **2,138 square feet of Heavy Use Area protection**
- **599 linear feet of waterline**
- **1 watering facility**
- **0.23 acres of riparian buffer area**

Average Bacteria Removal:The SC DHEC Nonpoint Source Management Program 2012 Annual Report contains total fecal coliform removed from all septic and agricultural BMP project

combined. To determine the average fecal coliform bacteria one BMP bundle removes it is necessary to separate fecal reductions from septic and agricultural BMPs.

Since the Cane/Little Cane Creek project dealt exclusively with septic projects, we can determine the average bacteria reductions from a septic project.

$$\text{Average Septic Project Fecal Coliform Reductions} = \frac{\text{Total \# Septic Projects Completed}}{\text{Total Fecal Coliform Reduction}}$$

MDL/319 Project	total fecal coliform removal (cfu)	onsite wastewater treatment system projects (units)	average fecal coliform removed by one septic project
Cane/Little Cane Creek	6.22E+11	17	3.66E+10

The average septic project fecal coliform reduction can then be used to calculate the average reduction ofan agriculture BMP bundle. Since theRabon Creek 319 project had both septic and agricultural BMPs, we can determine the agricultural reduction by removing the total bacteria removed from septic.

TMDL/319 Project	total fecal coliform removal (cfu)	alternative water sources (units)	controlled stream access for livestock watering(ft)	fence (ft)	water well (units)	heavy use area protection (sqft)	pipeline (ft)	watering facilities (units)	riparian buffers - vegetated (ac)	onsite wastewater treatment system projects (units)	streambank and shoreline protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	

The table above shows all of the projects installed during the Rabon Creek 319 project. Using the calculated average septic reduction, the 43 septic projects removed 1.57E+12 cfu of fecal coliform. Subtracting this number from the total fecal coliform removal gives us the remaining reductions, 3.71E+13 cfu, that resulted from agricultural BMPs.

Using the average agriculture BMP bundle calculations from earlier, we can assume that the Rabon Creek 319 funds installed about 2 average agricultural BMP bundles.

TMDL/319 Project	fecal coliform removal from septic projects	remaining fecal coliform removal (total-septic removal)	number of agricultural BMP bundles installed	average fecal coliform removal from agricultural BMP bundles
RabonCreek	(43*3.66E+10)= 1.57E+12	(3.87E+13 – 1.57E+12) = 3.71E+13	2	(3.71E+13/2)= 1.86E+13

Dividing the total agricultural BMP removal by the 2 installed agricultural BMPs results in an average fecal coliform reduction of 1.86E+13 cfuper agricultural BMP bundle.

Appendix C:
Bacteria Standard Equivalents