Lower Savannah River Watershed Protection Plan

July 2019

GEOSCIENCE CONSULTANTS

Lowcountry Council of Governments

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Acronyms and Definitions

BOD	Biological Oxygen Demand
BJWSA	Beaufort-Jasper Water and Sewer Authority
BMP	Best Management Practice
DEM	Digital Elevation Model
DO	Dissolved Oxygen
E. coli	Escherichia coli
EMC	Event Mean Concentration
EPA	Environmental Protection Agency
FIB	Fecal Indicator Bacteria
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
Lbs./acre	Pounds per Acre
LID	Low Impact Development
LCOG	Lowcountry Council of Governments
mg/L	Milligrams per Liter
MS4	Municipal Separate Storm Sewer System
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NSPECT	Nonpoint Source Pollution and Erosion Comparison Tool
PLOAD	Pollutant Loading Estimator
SoLoCo	Southern Lowcountry Regional Board
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SFI	Sustainable Forestry Initiative
SLR	Sea Level Rise
SMZ	Streamside Management Zone
SRCWF	Savannah River Clean Water Fund
STEPL	Spreadsheet Tool for Estimating Pollutant Load

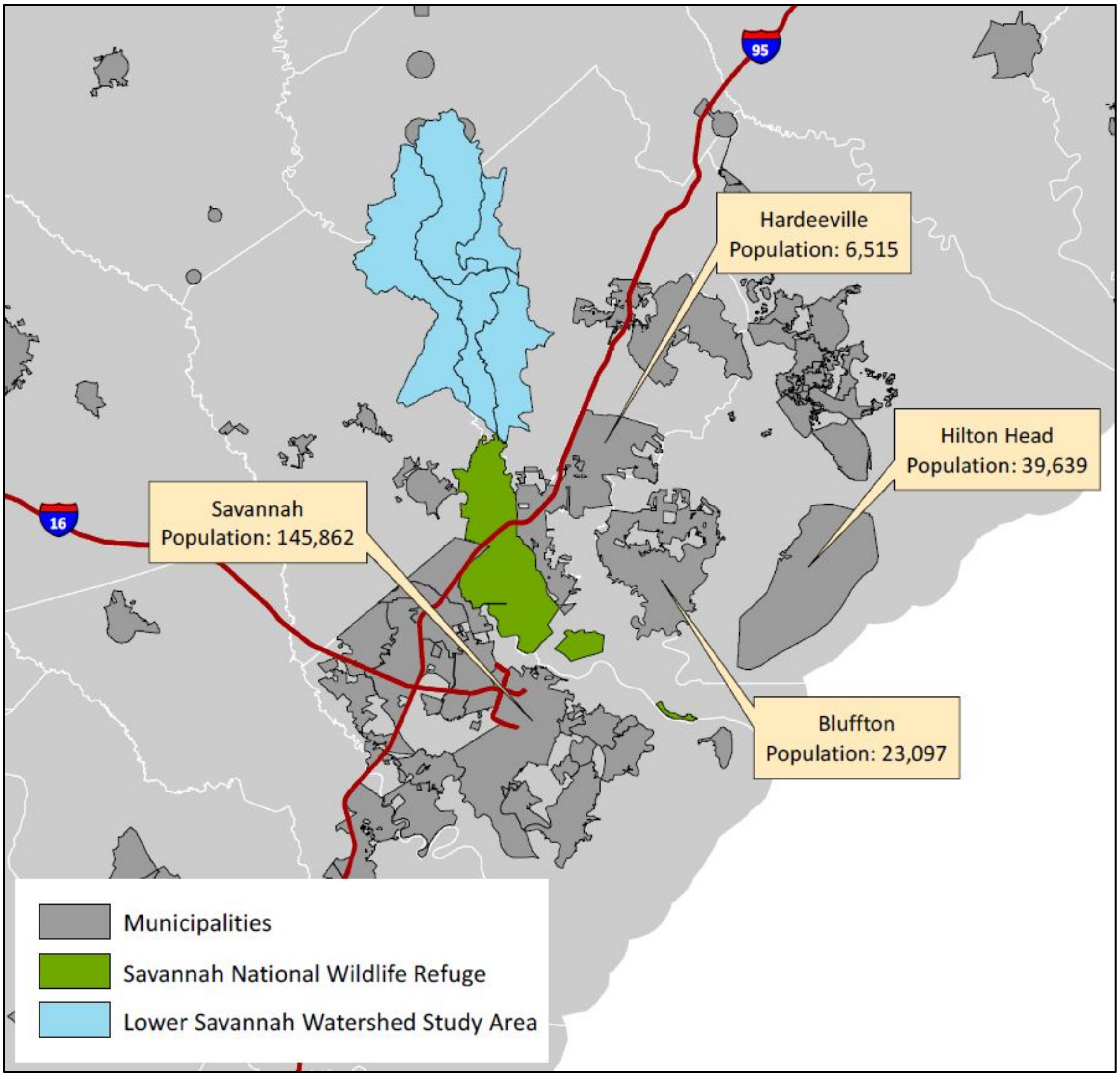
SWCD	Soil and Water Conservation District
TDR	Transfer of Development Rights
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WQM	Water Quality Monitoring

Executive Summary

Setting and Purpose

The study area, shown on the following page, includes portions of Jasper and Hampton counties in South Carolina and Effingham County in Georgia that drain into the Savannah River. The study area's mostly undeveloped stretches of wetlands, forests and farms play a critical role in maintaining the region's drinking water supply. Through surface water intakes along the Savannah River directly south of the study area, Beaufort-Jasper Water and Sewer Authority (BJWSA) serves more than 150,000 residents and the City of Savannah distributes potable water to various industrial, commercial and residential customers. The purpose of this plan is to evaluate current water quality conditions within the study area and develop strategies for managing identified pollutants. These tasks were completed with the primary goal of protecting a major source of drinking water for thousands of residents in South Carolina and Georgia.

The need to protect water quality in the Savannah River has become even more urgent in recent years. While the study area itself is rural, it is situated near rapidly growing urban centers in a region experiencing intense development pressure. The City of Hardeeville, located slightly south of the study area's boundary, has grown about 121% from 2,952 residents in 2010 to 6,515 residents in 2018 (U.S. Census Bureau, 2018). Further downstream, the Town of Bluffton's population grew 84% to 23,097 residents, the Town of Hilton Head Island grew 7% to 39,639 residents and the City of Savannah grew 7% to 145,862. The influx of residents and accompanying development downstream make interventions to improve water quality in the study area increasingly important.



Report Intent and Stakeholders

In late 2017, South Carolina Department of Health and Environmental Control (SCDHEC) awarded the Lowcountry Council of Governments (LCOG) a grant to develop a watershed-based plan. The overall goal of the Lower Savannah River Watershed Protection Plan is to evaluate current water quality conditions within the study area and develop a plan to manage identified pollutants. The water quality parameters for the plan are Phosphorus, Nitrogen, Dissolved Oxygen, Fecal Coliform and Turbidity. SCDHEC considers the watershed impaired but a Total Maximum Daily Load (TMDL) for pollutants has not been developed.

The success of a watershed-based plan largely depends on the participation and commitment from community members, businesses, agencies and nonprofit organizations operating within the watershed. Stakeholders from the region helped define this plan's goals, provided feedback on watershed assessment results and assisted in developing recommended strategies. The stakeholder group, which grew over time, based on recommendations from other members, included representatives from the organizations shown below.

Local Government & Utilities

- Beaufort Jasper Water and Sewer Authority (BJWSA)
- Jasper County Planning and Building Department
- Jasper County Soil and Water Conservation District (SWCD)

State/Federal Government

- South Carolina Department of Health and Environmental Control (SCDHEC)
- South Carolina Forestry Commission (SCFC)
- USDA Natural Resources Conservation Services (NRCS)
- Clemson Extension

Non-Governmental Organizations/Non-Profits

- Savannah River Clean Water Fund (SRCWF)
- Land trusts
- Watershed keepers and conservation groups
- Heirs properties groups

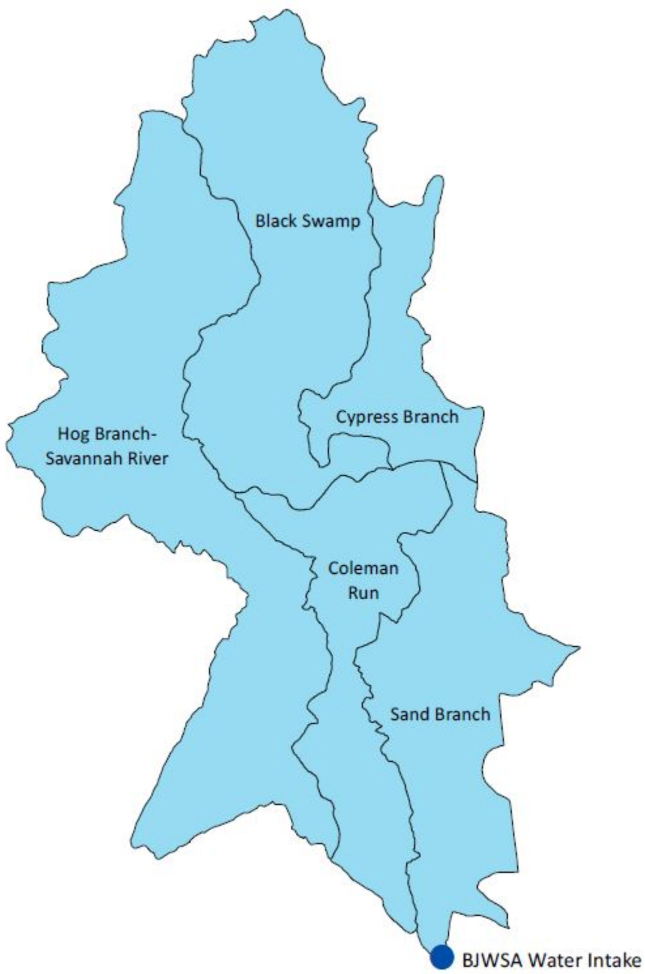
Community:Business & Residents

- Farmers
- Foresters
- Hunting clubs
- Residents

Assessments Results

Water quality in the study area was mostly assessed using spatial models because of the lack of water quality monitoring station data. These models, which rely heavily on remotely sensed and GIS data, found water quality in the study area is good overall. However, the results suggest certain watersheds in the study area have a higher propensity for nonpoint source (NPS) pollution contributions than others.

Models were also run to assess how water quality in the study area could be affected by increased precipitation and rainfall voracity associated with climate change. While the exact conditions used in these modeling scenarios may or may not occur, they are important considerations for evaluating BMPs and other interventions.



Pollutant	Most Affected Watershed	Potential Causes	Future Changes
Total Nitrogen	Black Swamp	Higher Ag, Urban Land Covers	Higher Concentrations
Total Phosphorus	Black Swamp	Higher Ag, Urban Land Covers	Higher Concentrations
Suspended Solids	None, Localized	Soil Types, Slopes, Ag Land Cover	Higher Loads
Fecal Coliform	Cyprus Branch	Soil Types, Development	Increased Soil Saturation
Sediment	Black Swamp, Coleman Run	Topography, Land Cover, Soil	Increased Erosion

Nutrients

Monitoring and baseline modeling information suggest nitrogen and phosphorus loads in the study area are not currently a major water quality issue. However, certain watersheds, such as Black Swamp, have physical attributes that theoretically could lead to degraded water quality in the Savannah River and at the surface water intakes.

The results of the climate change scenario do not suggest a drastic increase in nutrients loads overall, but show loads could increase about 50% in certain areas.

Total Suspend Solids and Sediment

The amount of areas showing high TSS levels relative to the BJWSA intake is less pronounced than the nutrient results. However, climate change may have a larger effect on TSS than nutrients. Sediment from erosion appeared to be mainly from the South Carolina side of the Savannah River with higher values from the Black Swamp watershed, which also had a higher increase in the climate scenario.

Urban Inputs

Wastewater discharge from non-functioning septic systems was the primary NPS input assessed from developed areas. Based on an accounting and spatial analysis there is the potential for E. coli bacteria counts (MPN) of around 70 trillion per year entering the waters in the study area. The area of highest concern is with Cyprus Creek.

Highlighted BMPs

A stormwater Best Management Practice (BMP) is a technique, measure or control used to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner. This plan identifies several structural and nonstructural BMPs that could be effective at addressing the issues identified during the assessment of the study area.

Forestry

The South Carolina Forestry Commission (SCFC) Forestry offers detailed BMPs guidance for forestry activities, including streamside management zones (SMZs), stream crossings and forest road construction. This plan recommends implementing SCFC BMPs and maintaining existing forestry lands through land protection. Conservation easements requiring low impact development (LID) and uses, and those that tie together protected parcels are recommended for the study area.

Agriculture

Black Swamp watershed is primarily agricultural and has the highest levels of modeled nutrient loads in the study area. Cover crops and other conservation activities identified by the Natural Resources Conservation Service (NRCS) are recommended as BMPs. This plan also recommends critical area plantings in pastures and barren areas.

Development

There is little development in the study area, which largely benefits water quality. However, a disadvantage to the rural character is the lack of sanitary sewer services available for the homes and businesses located there. All waste water is treated 'on-site' by various techniques with little oversight, which presents avenues for degraded surface water quality. Stakeholders recommended increased education and funding for on-site septic system repair and maintenance. Several areas with poorer soil conditions could be targeted, however, Cyprus Creek, which is fed by the Cyprus Branch and Coleman Run watersheds, has the potential to have the biggest influx of septic related NPS pollution.

Land Conservation and Protection

The quality of surface water in the study area is directly related to the land surface conditions and NPS discharges to surface water. Acquisition and protection of high-priority lands for conservation and management has been shown to be an effective BMP to protect surface water quality, and many stakeholder groups have been working for years to protect land in the study area. This plan recommended building upon their efforts to protect critical lands.

Targeted BMP Approach

Analysis of the Lower Savannah River Watershed study area, and its subwatersheds, suggests a targeted list of land use-focused BMPs, coupled with land conservation, could have a more pronounced water quality management effect than "random acts of conservation kindness." Four primary techniques were assessed as mechanisms to realistically maintain and improve water quality in the study area: septic repairs and pumping in developed areas; cover crops in agricultural lands; critical area planting in pastures and barren areas, and conservation easements in forested lands. Cost estimates and load reductions associated with these four techniques are included in Section 4.

Structure of the Watershed-Based Plan

This plan has been developed in accordance with the guidelines developed by SCDHEC and addresses the nine watershed-based planning elements required by SCDHEC and the EPA. The table below describes the nine elements and identifies where in this watershed-based plan each element is addressed.

Watershed-Based Plan Elements Crosswalk with LSR-WBP		
EPA-WBP Element	**SC-WBP Abbreviated Element**	**Document Location**
1. An identification of all of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X acres of row crops needing improved nutrient management or sediment control; or X linear miles of eroded streambank needing remediation).	**Element A-Identification of pollutant sources and their causes.**	**Yes (Section 2)**
2. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for row crops or eroded streambanks).	**Element B-Estimated load reductions from management measures identified in (c). (May also include overall pollutant reduction needed as found in a TMDL document.)**	**Yes (Section 2) 4**
3. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.	**Element C-Management measures (Best Management Practices, or BMPs) needed in order to eliminate or control pollutant(s)**	**Yes (Sections 4 & 5)**
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.	**Element D-Identification of funding and technical assistance needs as well as potential sources. Example: Watersheds with agricultural sources would most likely require the expertise of USDA Natural Resources Conservation Service staff and could potentially utilize Environmental Quality Incentive Program funds for implementation.**	**Yes (Section 5)**

Watershed-Based Plan Elements Crosswalk with LSR-WBP		
EPA-WBP Element	**SC-WBP Abbreviated Element**	**Document Location**
5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.	**Element E-Outreach strategy that is targeted towards members of the public that are impacted by the project and the management measures from (c).**	**Yes (Section 5)**
6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.	**Element F-Timeline of implementation events that proceeds in a logical and efficient manner.**	**Yes (Section 5)**
7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.	**Element G-List of milestones for keeping plan implementation progress on track.**	
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.	**Element H-A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.**	**Yes (Section 5)**
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.	**Element I-Monitoring strategy to determine effectiveness of plan implementation.**	**Yes (Section 5)**

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Section 1: Introduction

Introduction

A watershed is an area of land draining to a common point, such as a creek or river. Watersheds are characterized not only by their physical features, including hydrography and topography, but also by the people and land use activities occurring within the watershed's boundaries. The social, economic and political forces associated with human settlements combine with the area's physical characteristics to create a specific set of issues, challenges and opportunities for each watershed.

In the United States, the Clean Water Act regulates water quality and the United States Environmental Protection Agency (EPA) delegates to states the authority to set quality standards and manage water resources. The Section 319 grant program offers local and state stakeholders the opportunity to assess conditions in a watershed and develop an implementation plan for site-specific tasks designed to improve water quality. A watershed assessment is a background investigation that may include reviewing water quality monitoring station data, conducting field surveys and employing various models to estimate how certain locations and activities affect water quality. The results of the watershed assessment are shared with stakeholders who use the information to recommend strategies for improving water quality and develop an implementation plan. After a watershed-based plan is approved by the South Carolina Department of Health and Environmental Control (SCDHEC) and the EPA, public bodies and organizations are eligible to apply for additional grant money to implement specific projects and outreach activities recommended in the plan.

The watershed-based plan is a living document. The findings and recommendations in this document can and should evolve as conditions change, new information becomes available and stakeholder groups transform over time.

Lower Savannah River Watershed Study Area

The Lower Savannah River Basin covers 16 watersheds stretching from Edgefield County eastward to the Atlantic Ocean (SCDHEC). The project study area covers portions of two of these watersheds, the 10-digit hydrologic unit code (HUC) 0306010901 and 0306010903 watersheds.

The study area is mostly rural, covering parts of Jasper and Hampton counties in South Carolina and Effingham County in Georgia. The study area includes portions of the Town of Scotia (population 201) and the Town of Furman (population 217) (U.S. Census Bureau, 2018). While the study area itself is rural, it is situated near rapidly growing urban centers in a region experiencing intense development pressure. The City of Hardeeville, located slightly south of the study area's boundary, has grown about 121% from 2,952 residents in 2010 to 6,515 residents in 2018. Further downstream, the Town of Bluffton's population grew 84% to 23,097 residents, the Town of Hilton Head Island grew 7% to 39,639 residents and the City of Savannah grew 7% to 145,862. Although the influx of residents and accompanying development does not immediately threaten the study area, it makes maintaining water quality in the Savannah River an urgent need.

The study area covers about 188 square miles and has five 12-digit HUC watersheds. Hog Branch-Savannah River, the largest watershed, crosses the Georgia-South Carolina border to cover the western portion of the study area. Black Swamp and Cypress Branch watersheds cover the northern and northeastern portions of the study area, while Coleman Run and Sand Branch watersheds span the southern and southeastern areas of the study area.

The study area mostly consists of wetlands, forests and small agricultural farms. There are pockets of development in the towns of Scotia and Furman, as well as the unincorporated communities of Tillman, Tarboro, Robertville, Pineland and Garnett. However, the overall study area is sparsely populated and falls far outside Municipal Separate Storm Sewer System (MS4) stormwater regulations. Parcels in the study area range in size but are generally large, with an average area of 50 acres in Hampton County and 55 acres in Jasper County. Many of these parcels are protected by conservation easements, which limit the possibility of future development and conserve the area's ecological value.

The Savannah River is valued for its wildlife habitat, the economic opportunities it offers industries and small businesses, and recreational activities that enhance the region's quality of life. The river is also the primary source of drinking water for more than 150,000 residents in Beaufort and Jasper counties (BJWSA). BJWSA operates a surface water intake at the southern tip of the study area, and the City of Savannah operates similar infrastructure downstream along Abercorn Creek that distributes potable water to various industrial, commercial, wholesale and residential customers (City of Savannah, 2017). The primary goal of this plan is to protect the major source of drinking water for thousands of residents in both states.

In late 2017, SCDHEC awarded the Lowcountry Council of Governments (LCOG) a grant to develop a watershed-based plan for the Lower Savannah River Watershed study area. The purpose of the plan is to evaluate current water quality conditions within the study area and develop strategies for managing identified pollutants. This plan addresses the EPA's nine elements of watershed-based plans (Appendix 1). The water quality parameters for this plan, which were determined by SCDHEC, are phosphorus, nitrogen, dissolved oxygen, fecal coliform and turbidity. SCDHEC considers the study area impaired but a Total Maximum Daily Load (TMDL) for pollutants has not yet been developed.

Previous Work in Study Area

The Lower Savannah River Watershed Protection Plan is the latest in a long line of efforts to document and address water quality issues in the area. This plan recognizes previous projects, policies and planning initiatives in an attempt to build off of their successes, identify unmet needs and leverage existing resources.

One major effort underway to improve water quality in the Savannah River comes from the Savannah River Clean Water Fund (SRCWF). The fund, which hired its first executive director in 2016, pools resources from five South Carolina and Georgia water utilities, including BJWSA and the City of Savannah (Espinola, 2018). The goal of the fund is to protect water quality through research and improved land management. Leaders of the fund have recognized conservation easements as an effective tool in achieving this goal and have ranked parcels along the Savannah River where conservation easements would have the strongest effect on water quality.

Other groups have recently targeted stormwater issues in and around the study area as a means to improve water quality. In 2011, Jasper County developed a Stormwater Management Design Manual outlining minimum design, construction and maintenance requirements for effective stormwater best management practices (BMPs) as part of a 319 implementation grant for the Okatie River Watershed (HUC 03052080606) (Jasper County, 2011). The Southern Lowcountry Regional Board (SoLoCo) is currently developing a regional stormwater design manual and model ordinance for Beaufort and Jasper counties, the City of Hardeeville and towns of Bluffton and Hilton Head.

As part of the watershed assessment, the project team reviewed existing plans and recommendations relating to water quality in the study area. This review helped the project team understand various stakeholders' priorities and plans for the study area, and identify the successes and failures of past project ideas.

The plans included in this review are:

- Beaufort-Jasper Water and Sewer Authority Source Water Assessment
- Hampton County Comprehensive Plan
- Jasper County Comprehensive Plan
- Jasper County Natural Resources Conservation Plan
- Lowcountry Regional Natural Hazard Mitigation Plan
- Lowcountry Regional Water Quality Management Plan

Stakeholders

The success of a watershed-based plan largely depends on the participation and commitment from community members, businesses, agencies and nonprofit organizations operating within the watershed. Stakeholders from the study area helped define this plan's goals, provided feedback on watershed assessment results and assisted in developing recommended strategies. The stakeholder group, which grew over time, based on recommendations from other members, included representatives from the organizations shown in Figure 1- 1.

From September 2018 through February 2019 members of the project team spoke with individual stakeholders about their current initiatives in the study area and priorities for the plan. Stakeholders consulted during this time period include Tricia Kilgore from BJWSA, Brandon King and Benjamin Padget from the Jasper and Beaufort county offices of the Natural Resources Conservation Service (NRCS), representatives from state and regional offices of SCDHEC, Michael Broom from the South Carolina Forestry Commission (SCFC), Lyn Boyles and Tomas Stanley from the Jasper County Soil and Water Conservation District (SWCD), Lisa Wagner from Jasper County Planning and Building Department, Lisa Lord of The Longleaf Alliance and SRCWF, Eric Krueger from The Nature Conservancy and Josh Bell from the Lowcountry Land Trust.

Figure 1- 1. Stakeholders in the Lower Savannah River Watershed Study Area

The project team brought stakeholders together on two occasions to present results from the watershed assessment and brainstorm strategies to improve water quality. The first focus group on March 27, 2019 concentrated on water quality issues related to current and future development in the study area. An Esri story map with an online map were distributed before the event to orient participants to the study area and outline the goals of the focus group. At the focus group participants discussed the threat septic systems pose to water quality in the watershed, which is not served by a sanitary sewer system. To mitigate the effects of septic systems, participants identified the need for more financial resources to support septic tank maintenance and repairs, as well as opportunities to educate homeowners, real estate agents and developers about septic system care. The second focus group on April 30, 2019 concentrated on forestry, agriculture and land protection. A second Esri story map was developed for the event. This session included a discussion on targeting specific areas with land protection and agriculture/forestry BMPs to maximize the effect of each technique. Participants also discussed the potential to financially assist landowners who are interested in installing BMPs but have been denied or underfunded through existing avenues. Attendance sheets from both focus groups can be found in Appendix 1.

The third phase of stakeholder involvement included formal and informal reviews of the draft plan, and discussions about maintaining and expanding the involvement of current and future stakeholders.

The stakeholder group will likely grow and evolve as the Lower Savannah River Watershed Protection Plan is implemented and updated.

Project Staff Expertise

LCOG is the lead organization on this project. LCOG's mission to serve the 25 local governments in Beaufort, Colleton, Hampton and Jasper counties makes it well suited to manage a watershed-based plan crossing jurisdictional lines. LCOG has experience developing the Lowcountry Water Quality Management (208) Plan and managing a previous 319 implementation grant associated with the Okatie River Watershed Management Plan. LCOG hired Geoscience Consultants, LLC, and BMI Environmental Services, LLC, to provide technical assistance and support for this plan. The consultant team has experience working with water, modeling and climate change in the Lowcountry. The plan also relied heavily on expertise from stakeholders, particularly NRCS and SCFC, to identify BMPs for agriculture and forestry that could be most effective in the study area.

Section 2: Study Area Characterization

This section provides an overview of the study area. The first portion of this section discusses the environmental setting and describes the study area's physical and natural features, including the geography, topography, hydrology and climate. The second part focuses on population demographics and land uses. The third portion describes water quality standards and monitoring in the study area. The fourth portion overviews pollutant sources and their potential effect on the study area.

Environmental Setting

The study area is relatively rural, covering parts of Jasper and Hampton counties in South Carolina and Effingham County in Georgia. The Savannah River and surrounding study area are valued for their wildlife habitat and recreational values that enhance the Lowcountry's quality of life. The river is also the primary source of drinking water for more than 150,000 residents in Beaufort and Jasper counties (BJWSA). Figure 2- 2 shows the study area's geographic context, provides a closer look at the study area's five watersheds, and identifies the BJWSA surface water intake.

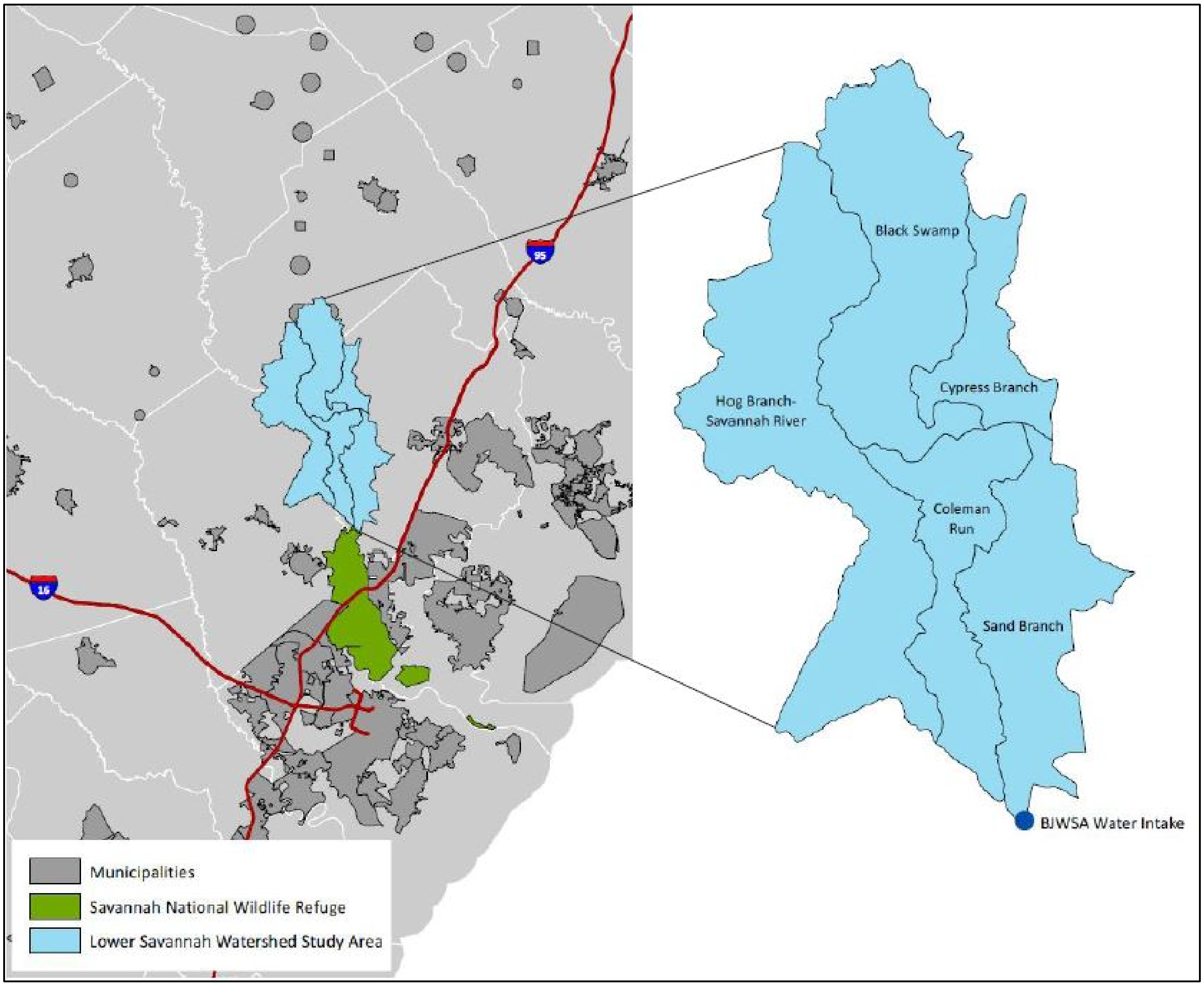

Figure 2- 1. Overview of the Lower Savannah River Watershed study area

Land cover in the study area consists primarily of wetlands, forests and small agricultural farms. There are small areas of development in the towns of Scotia (population 201) and Furman (population 217), as well as the unincorporated communities of Tillman, Tarboro, Robertville, Pineland and Garnett (U.S. Census Bureau, 2018).

While the quality of the watershed is generally high, changing land use and increased human activities threatens to degrade this vulnerable area.

Geography

The Lower Savannah River Watershed is one of four distinct watersheds (Savannah, Salkehatchie, Edisto, and Santee) located in the geographic area known as the Lowcountry. The Savannah River, which originates in the mountains of North and South Carolina, flows through the western portion of the study area on its way to the Atlantic Ocean and is a major feature of the watershed that shares its name. The study area crosses the border of South Carolina and Georgia, covering parts of Jasper, Hampton and Effingham counties. It is a rural area containing unincorporated communities, and portions of the towns of Scotia and Furman.

The study area is accessed by U.S. Highway 321, SC Highway 336, SC Highway 462 and GA Highway 119. South of the study area is the City of Hardeeville, City of Savannah and the Savannah National Wildlife Refuge, a 31,551-acre landscape of freshwater marshes, tidal creeks and bottomland hardwoods (U.S. Fish and Wildlife Service, 2018).

Ecoregion

While the framework for this planning effort is at the 12-digit HUC watershed level, it is important to also consider the ecological characteristics of the region. Consideration of both watershed and ecoregion assessment frameworks allows for a more holistic approach that considers spatial patterns of the aggregate of natural and anthropogenic relationships within and among watersheds (Omernik et al., 1997). The watersheds of the study area are five of several watersheds along the Savannah River intertwined not only by water, but geological, ecological and biological characteristics of the Middle Atlantic Coastal Plain Ecoregion.

This ecoregion (Figure 2-) is characterized by low elevation and flat plains, with many swamps and marshes. Forest cover in the region was once dominated by longleaf pine but is now mostly loblolly and some shortleaf pine, with patches of oak, gum and cypress near major streams. Its low terraces are underlain by unconsolidated sediments. Poorly drained soils are common, and the region has a mix of coarse and finer textured soils. Most of the land is in large holdings and is used for the production of lumber and pulpwood. The acreage of cropland is limited primarily because of a highwater table and the frequency of flooding.

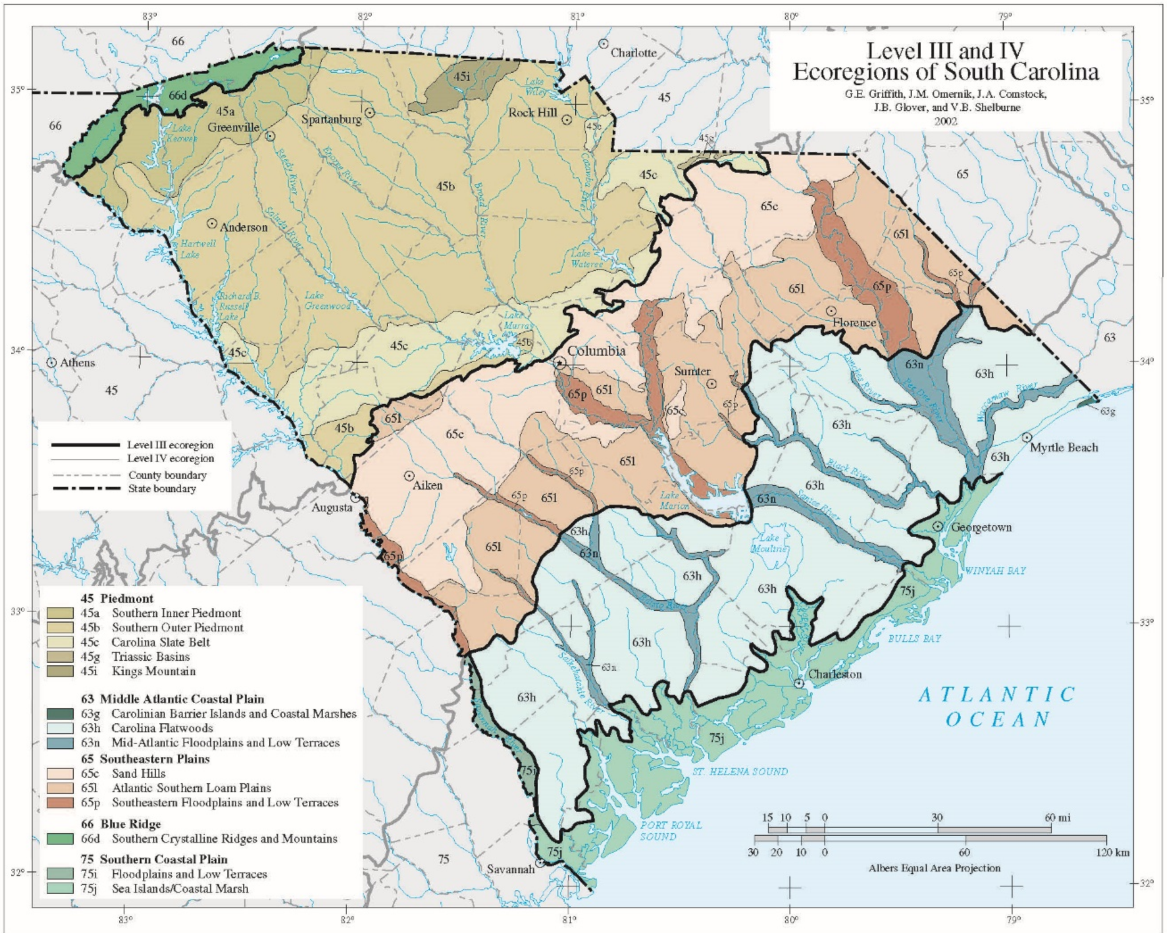

Figure 2- 2. Ecoregions of South Carolina

Lower Savannah River Watershed Study Area

The study area covers about 188 square miles and has five 12-digit HUC watersheds. Hog Branch-Savannah River, the largest watershed, crosses the Georgia-South Carolina border to cover the western portion of the study area. Black Swamp and Cypress Branch watersheds cover the northern and northeastern portions of the study area, while Coleman Run and Sand Branch watersheds span the southern and southeastern areas of the study area.

The HUC assigned by the United States Geological Survey (USGS) for the Lower Savannah River is HUC 03060109. The area of the five watersheds is shown in Table 2- 1.

Table 2- 1. Lower Savannah River Watersheds

Lower Savannah River Watersheds, HUC and Area		
Watershed	Hydrologic Unit Code (HUC)	Area in Acres
Coleman Run	030601090303	16,857
Hog Branch-Savannah River	030601090107	42,381
Cypress Branch	030601090301	9,930
Sand Branch	030601090304	21,462
Black Swamp	030601090302	29,710
	Total	**120,341**

Physical Features

Topography

The study area is located in a region of coastal lowlands, coastal plains, river systems, drowned estuaries, tidal marshes, islands and beaches along the Atlantic coast. The region is mostly level to gently sloping and has low relief (source).

Error! Reference source not found. shows elevation in the study area ranges from 132 feet above sea level in the northern and western edges, to lower than 10 feet (NAVD 88) at the southern tip. The lowest gradients are on the South Carolina side of the Savannah River. The only bluffs are on the Georgia side, which generally has higher elevations.

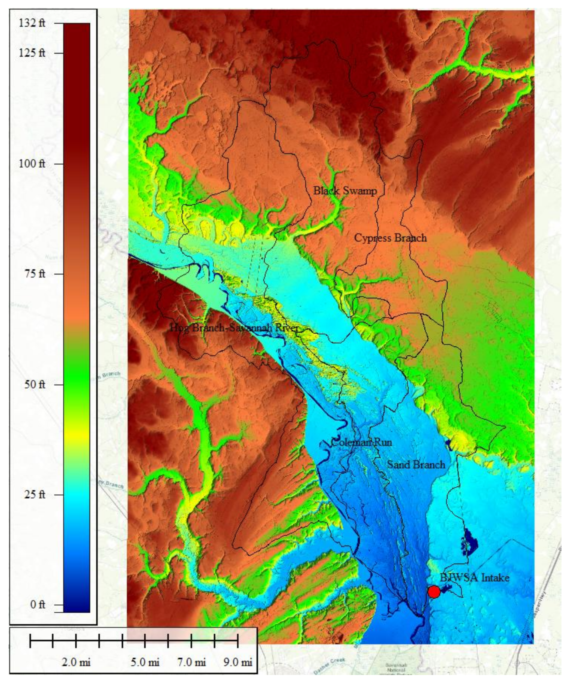

Figure 2- 3. A digital elevation model (DEM) depicting the elevations in study area (NAVD 88).

Soils

Soils in the study area typically formed in alluvium on floodplains, in depressions and on terraces. The dominant soil orders are Spodosols and Ultisols and they consist of very deep, well drained to very poorly drained, and loamy or clayey. The soil type and soil drainage class are important factors affecting the surface and substrate conditions and greatly influence surface water response both to precipitation and contaminants (Figure 2- 4). More specifically, the hydrogeologic conditions influence surface water runoff conditions and aid in identifying the BMPs that are best suited for a given area and possible contaminants.

Soils in the United States are classified by the NRCS into four Hydrologic Soil Groups (HSG) based on the soil's runoff potential (USDA). The four HSGs are A, B, C and D. Group A soils have the highest rate of infiltration and group D has the slowest infiltration rate.

Group A is comprised of sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B soils consists of silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

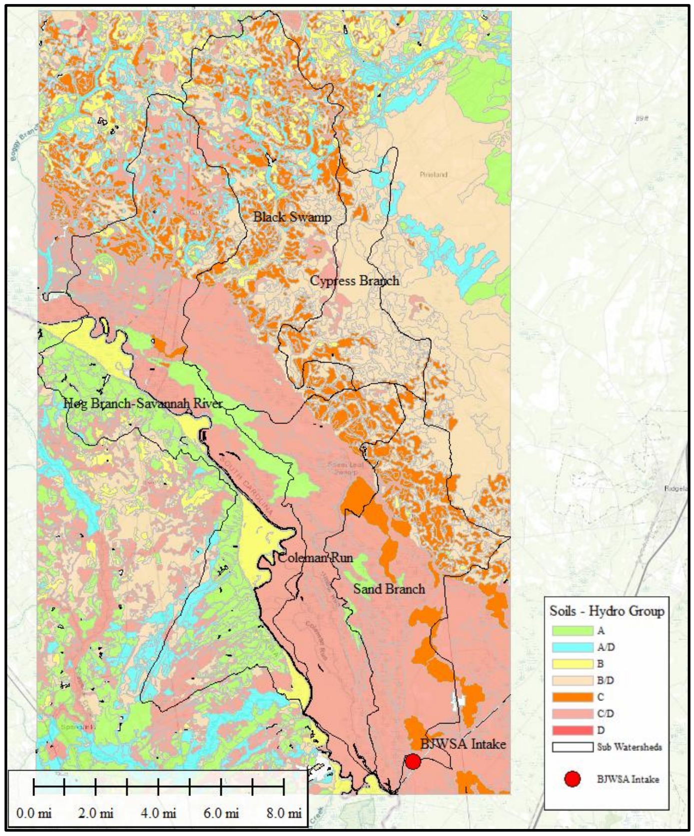

Figure 2- 4. Soils data was sourced from NRCS and populated with specific fields for use in the NSPECT model.

The soils in much of the northeastern portion of the study area north of the Savannah River are moderately to poorly draining (C & D) soils. Soils in the southern portion of the study area are, as a reflection of the geology, well drained to excessively well drained soils (A & B).

Geology

The geology varies slightly on the either side of the Savannah River (Figure 2- 5). In the study area watersheds on the northern (South Carolina) side, the underlying geology is dominated by riverine processes suggesting that the Savannah River is migrating south – i.e., the prominent cut bank is on the southern side of the river. The southern side is dominated by antecedent formations including beach ridges and more resistant formations, such as sandstone. These resistant formations are significantly older than the surrounding surficial geology and are responsible for the higher elevations on the southern side of the river.

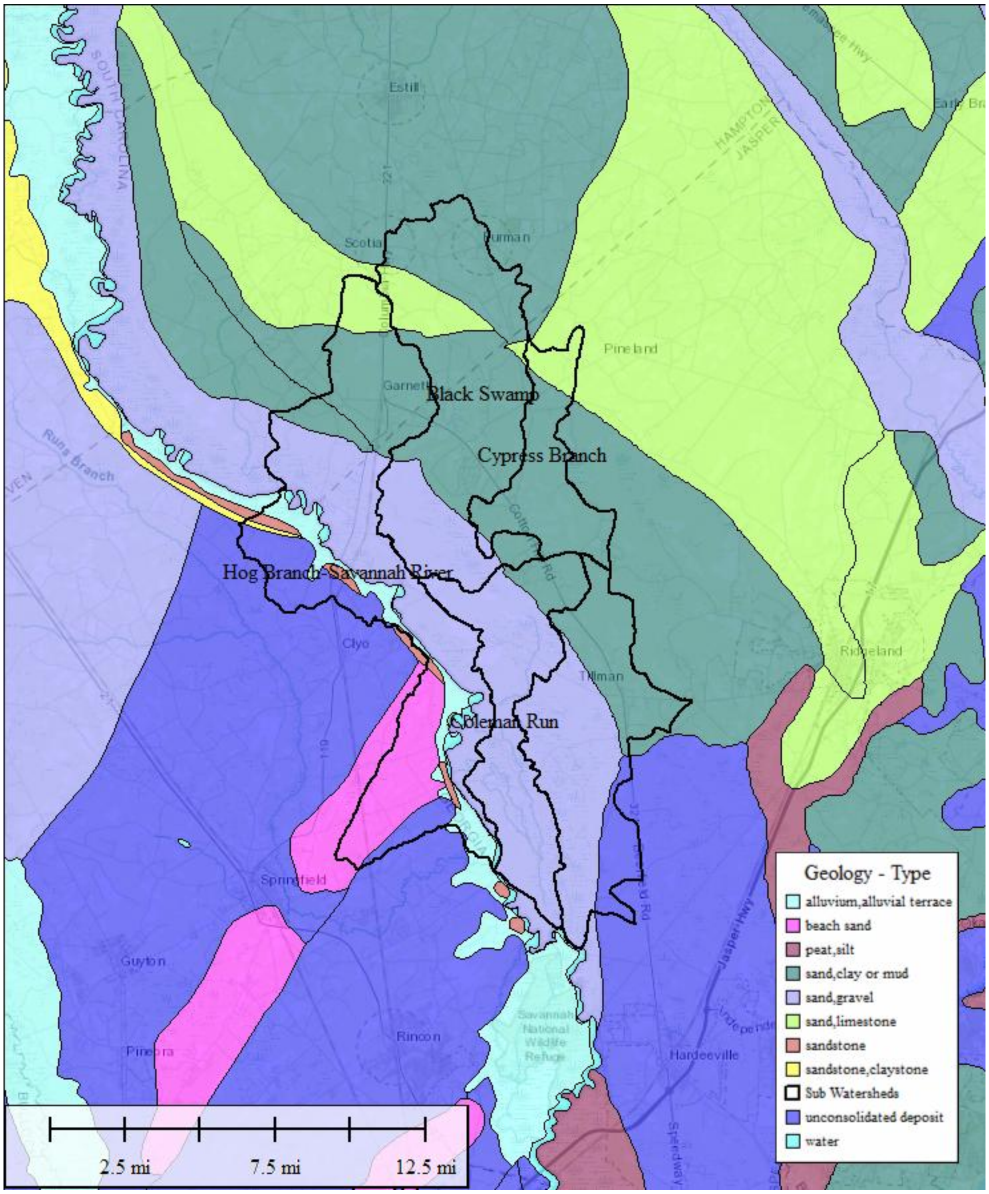

Figure 2- 5. Surficial geology types

Mostly unconsolidated Coastal Plain sediments occur at the surface throughout this area. These sediments are primarily Tertiary to Quaternary in age. They are a mixture of river-laid sediments in old riverbeds and on terraces, flood plains and deltas. These young sediments are made up of combinations of clay, silt, sand and gravel. From central North Carolina to Florida, Cretaceous marine, near-shore shale, sandstone and limestone deposits occur beneath the surface. Swamps were common in this area prior to agricultural development. The present-day river valleys are extensive and are flat near the coast. The water table typically is close to the surface in these river valleys. Soils having restricted drainage are common throughout the area.

Climate and Precipitation

Climate and precipitation in the Lower Savannah River Watershed study area are influenced by its proximity to the Atlantic Ocean to the east and the Appalachian Mountains to the west. The study area is located in a humid subtropical climate region characterized by long, hot summers and temperate winters. Rainfall is fairly evenly distributed through the year, but the region is also subject to periods of drought and floods. The present yearly precipitation in the study area watersheds ranges from 48 to 51 inches with the highest values in the southern part of the study area, as shown in Figure 2- 6. Prevailing southerly winds provide moisture and high humidity from May through September. Locally violent and destructive thunderstorms occur on average about 60 days each year.

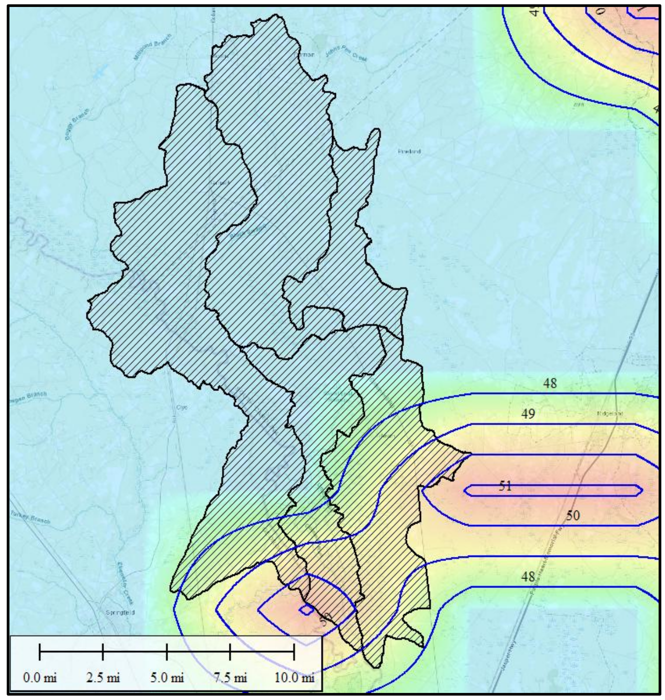

Figure 2- 6. Average yearly precipitation in the study area

The impacts from a changing climate, including extreme heat and more intense storms, present challenges to water, wastewater and stormwater utilities and the communities they serve. Understanding how climate change may affect a utility's ability to reliably maintain and deliver adequate clean water services is an important aspect of this watershed-based plan. The natural features of the study area provide beneficial filtering and storage of the rainwater entering the watersheds directly adjacent to the BJWSA intake. Climate change has the potential to increase stormwater and change the habitats' efficacy in providing the beneficial services they do at present.

All climate models project warming, although the extent of warming and the direction of changes in precipitation vary. Local examples of the potential changes in extreme rainfall and annual precipitation are included below (Figure 2- 7 and Figure 2- 8). The values for warm/wet and stormy were used to look at changes in potential runoff of nutrients in Section 3. One aspect of climate change – sea level rise (SLR) – is not expected with present projections to cause inundation in the area. It may, however, change the salinity and flow gradients of the Savannah River at or near the BJWSA and City of Savannah intakes.

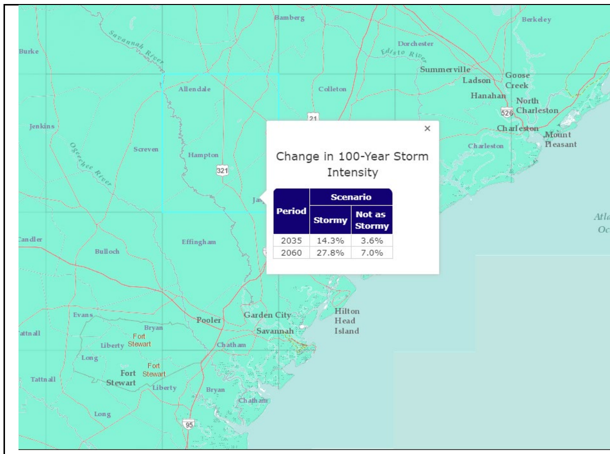

Figure 2- 7. Potential increases in future extreme rain events.

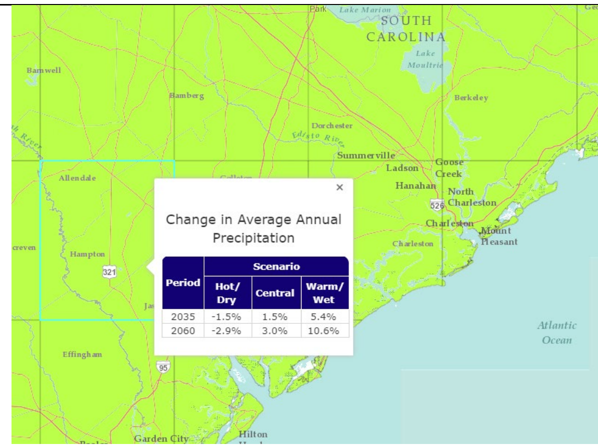

Figure 2- 8. Potential increase in future overall precipitation.

Habitats

At least three of the eight major habitat types of South Carolina occur in the study area (SCDNR, 2005). Grasslands, which include open areas such as meadows and pastures, are found in the southern and eastern portion of the study area. Pine woodlands with pine-dominated forests occur throughout the study area on a variety of soil moisture conditions, except floodplains. The study area also supports extensive bottomland hardwoods including oaks, bald cypress and water tupelo that are common in floodplains and low, wet areas. Within these major habitat types are habitats often described as longleaf pine forests, bottomland hardwoods forests, wet and mesic savannahs, and various ecotypes of coastal wetland depressions.

Land Use and Population Characteristics

Land Use and Land Cover Data

The predominant land covers in the study area are wetlands, forests and agriculture, as shown in

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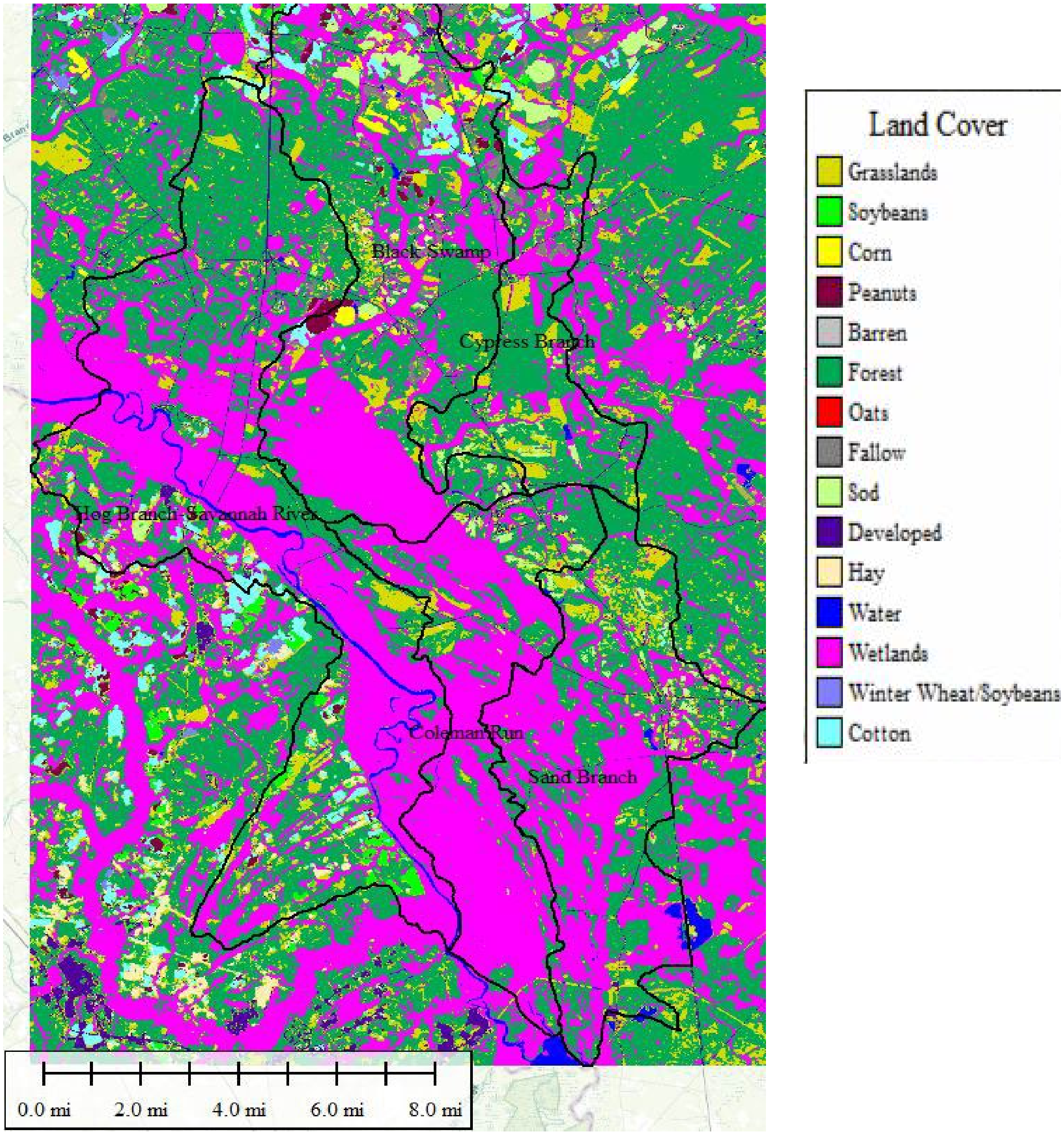

Figure 2- 9. Hybrid Land Cover product developed for study area

Land Cover		
Land Cover	Area (sq. mi)	Percent of Area (%)
Barren	0.33	0.1
Corn	2.3	0.6
Cotton	8.4	2.2
Developed	8.0	2.1
Fallow	4.5	1.2
Forest	165.9	43.8
Grasslands	31.5	8.3
Hay	3.7	1.0
Oats	0.04	0.01
Peanuts	2.7	0.7
Sod	5.9	1.6
Soybeans	3.5	0.9
Water	3.4	0.9
Wetlands	137.7	36.4
Winter Wheat/Soybeans	0.7	0.2

Table 2- 2. Land cover statistics for the study area

Land Use Changes and Future Growth

Past changes in land cover can highlight future potential changes (**Error! Reference source not found.** and Figure 2- 11). Two indicator land covers, Urban and Forest, represent the major changes occurring within the study area. Of these, urban change is the most permanent while forest change is primarily to scrub (immature forest), which will grow back. Urban change does not normally revert to natural habitats.

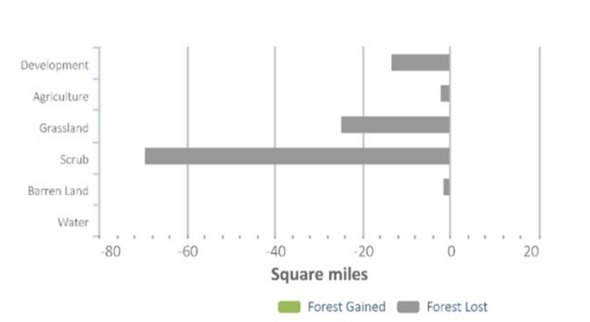

Figure 2- 10. Categories of forest land cover change (loss to)

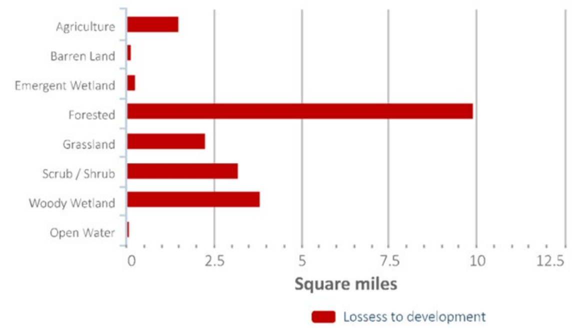

Figure 2- 11. Categories of urban land cover change (gained from)

Spatially, the primary lasting change is outside of the City of Savannah where development is concentrated (Figure 2- 12). This not only potentially affects water quality in the study area, it highlights the growing population receiving water from the study area. Forest change is scattered throughout the study area (Figure 2- 13), but again, it does not always represent a substantial loss.

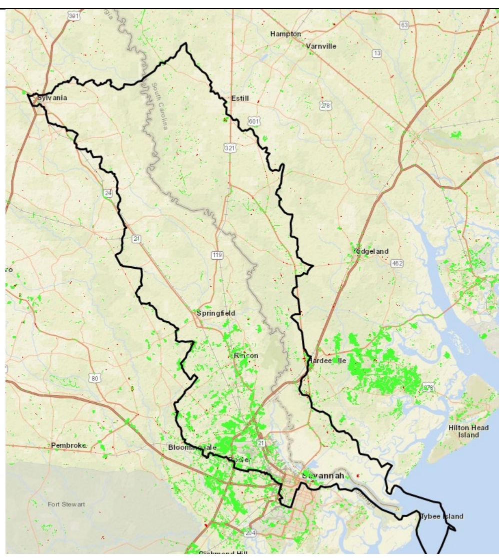

Figure 2- 12. Areas of conversion to development (green) between 1996 and 2010

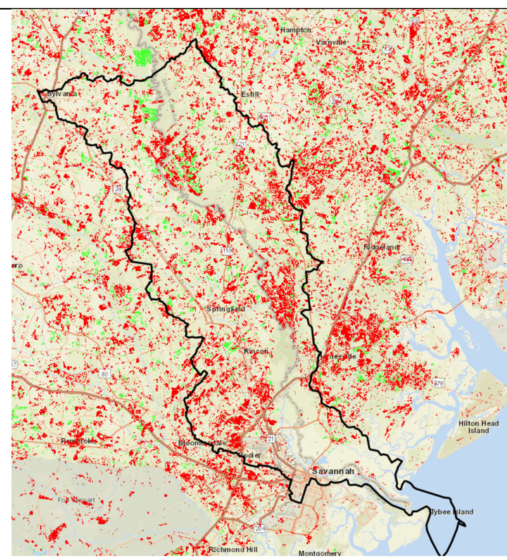

Figure 2- 13. Areas of loss of forest in red and gain in green (1996-2010)

Land use decisions, including where and how to develop, are almost always made at the local level. Jasper County's future land use map, approved in 2018, designates most land in the study area as “Resource Conservation” and “Rural Conservation” areas emphasizing natural habitat protection (Jasper County, 2018). Small amounts of development are proposed for the unincorporated hamlets of Tillman, Tarboro, Robertville and Pineland. Similarly, Hampton County broadly characterizes land within the study area as “Rural Development-Resource Conservation” in its 2009 zoning map (Hampton County, 2009).

Current land use plans and zoning ordinances suggest Jasper and Hampton county leaders recognize the study area’s ecological value, but they may not be strict enough to protect the land from the effects of future development. Land use planning for water quality protection often relies on additional regulatory tools, such as overlay zones and design requirements, or incentive-based approaches, such as a Transfer of Development Rights (TDR) program. A thorough evaluation of county land use planning techniques could lead to stronger protections for water quality. However, the current lack of development pressure in the study area may not inspire the political will needed to enact policy changes. Instead of relying solely on policy changes, land trusts, state and federal agencies, and other stakeholders have supported measures to protect land within the study area through acquisitions and conservation easements.

Demographics

The study area is sparsely populated. In 2017, about 1,081 people and 507 housing units were located in the U.S. Census Block Groups in and around the study area’s boundaries (U.S. Census Bureau, 2017). The average median income of study area block groups is $41,332, which is lower than the median incomes of both South Carolina and Georgia. Table 2- 3 shows how these figures have changed since 2013.

Table 2- 3. Watershed population and housing statistics

Census Data Population and housing units in the watershed U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates			
	2013	**2017**	**Percent Change 2013-2017**
Population	1,135	1,081	-4.8%
Housing Units	483	507	5.0%
Average Median Age	39	41	3.7%
Average Median Income	$43,937	$41,332	-5.9%

Figure 2- 14 shows Jasper and Hampton block groups are more racially diverse and have larger Latino populations than Effingham County block groups. Race and income can play a role in eligibility for BMP financial assistance through the NRCS and other organizations. A map of the block groups in the watershed is located in Appendix 2.

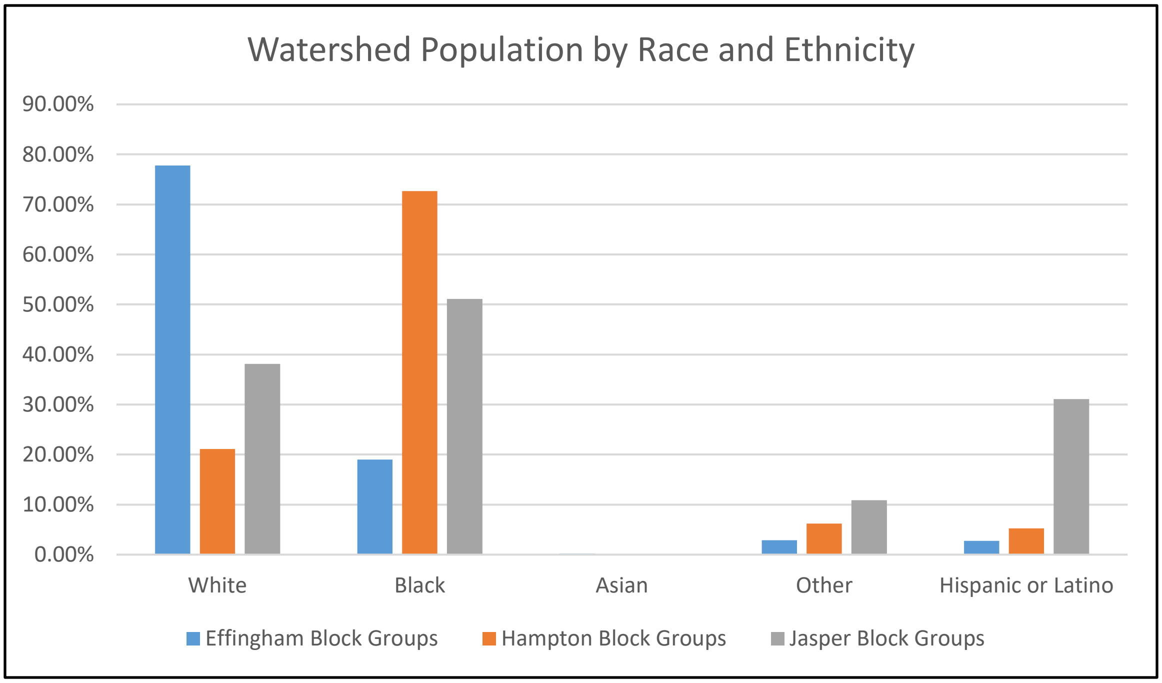

Figure 2- 14. Percent of the study area population by race and ethnicity

Water Quality

Water quality is generally good in the study area, but quality is locally impaired for some uses (Table 2- 4). The presence of mercury in fish is the most common impairment. Fish-consumption advisories were issued in 2005 for Jasper County in the following reaches: (a) south to SC Highway 119 for bowfin (mudfish), largemouth bass, and spotted sucker; (b) between SC Highway 119 and U.S. Highway 17 for bowfin, largemouth bass, black crappie, bluegill, channel catfish, redbreast sunfish and white catfish; and (c) downstream of U.S. Highway 17 for channel catfish, largemouth bass and white catfish (Table 2, SCDHEC Technical Report 003-97, 1997).

Water Quality Standards

The federal Clean Water Act requires states and federally-recognized Indian tribes adopt water quality standards to protect waters from pollution. These standards set the water quality goals for a lake, river, stream or wetland by stating the maximum amount of a pollutant that can be found in the water while still allowing it to be used for fishing, swimming, and allowing aquatic organisms and wildlife to thrive.

In general, water quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. Water quality standards consists of three basic elements:

- Designated uses of the water (e.g., fish and aquatic life, recreation, fish consumption, wildlife, etc.),
- Water quality criteria to protect designated uses (numeric pollutant concentrations and narrative requirements), and
- An antidegradation policy to maintain and protect existing uses and high-quality waters.

SCDHEC has classified all surface waters in the state based on the characteristics and use of the waters and water quality standards. Each of the classifications must be protected from degradation resulting from development or other activity. Waters of the study area are classified as Freshwaters. Freshwaters are defined as those waters suitable for primary and secondary contact recreation and as a source of drinking water supply after conventional treatment. They are also suitable for fishing and the survival and propagation of a balanced indigenous aquatic life.

Water Quality Monitoring Stations

The study area has been monitored by SCDHEC at six Water Quality Monitoring (WQM) stations. The station numbers, their respective watersheds and location description are given in Table 2-4 and Figure 2-15.

Table 2- 4. Impaired waters in the study area

Study Area WQM Stations on South Carolina's 303(d) List of Impaired Waters 1998-2016 and Cause for Inclusion							
Year	**SV-687**	**SV-369**	**SV-804**	**SV-356**	**RS-04372**	**SV-370**	**SV-209**
2016	Mercury	Zinc, Turbidity	Mercury	Dissolved Oxygen, E coli	Zinc	-	Mercury
2014	Mercury	Zinc, Turbidity	Mercury	Dissolved Oxygen, E coli	Zinc	-	Mercury
2012	Mercury	Zinc, Turbidity	Mercury	Dissolved Oxygen, Fecal Coliform	Zinc	-	Mercury
2010	Mercury	Zinc, Turbidity	Mercury	Dissolved Oxygen, Fecal Coliform	Zinc	-	Mercury
2008	Mercury	Zinc	Mercury	Dissolved Oxygen, Fecal Coliform	Zinc	-	Mercury
2006	Mercury	Zinc	Mercury	Dissolved Oxygen	Zinc	-	Mercury
2004	Mercury	-	-	Dissolved Oxygen	-	-	Mercury
2002	-	-	-	Dissolved Oxygen	-	-	-

2000	-	-	-	Dissolved Oxygen	-	-	-
1998	-	-	-	Dissolved Oxygen	-	-	-

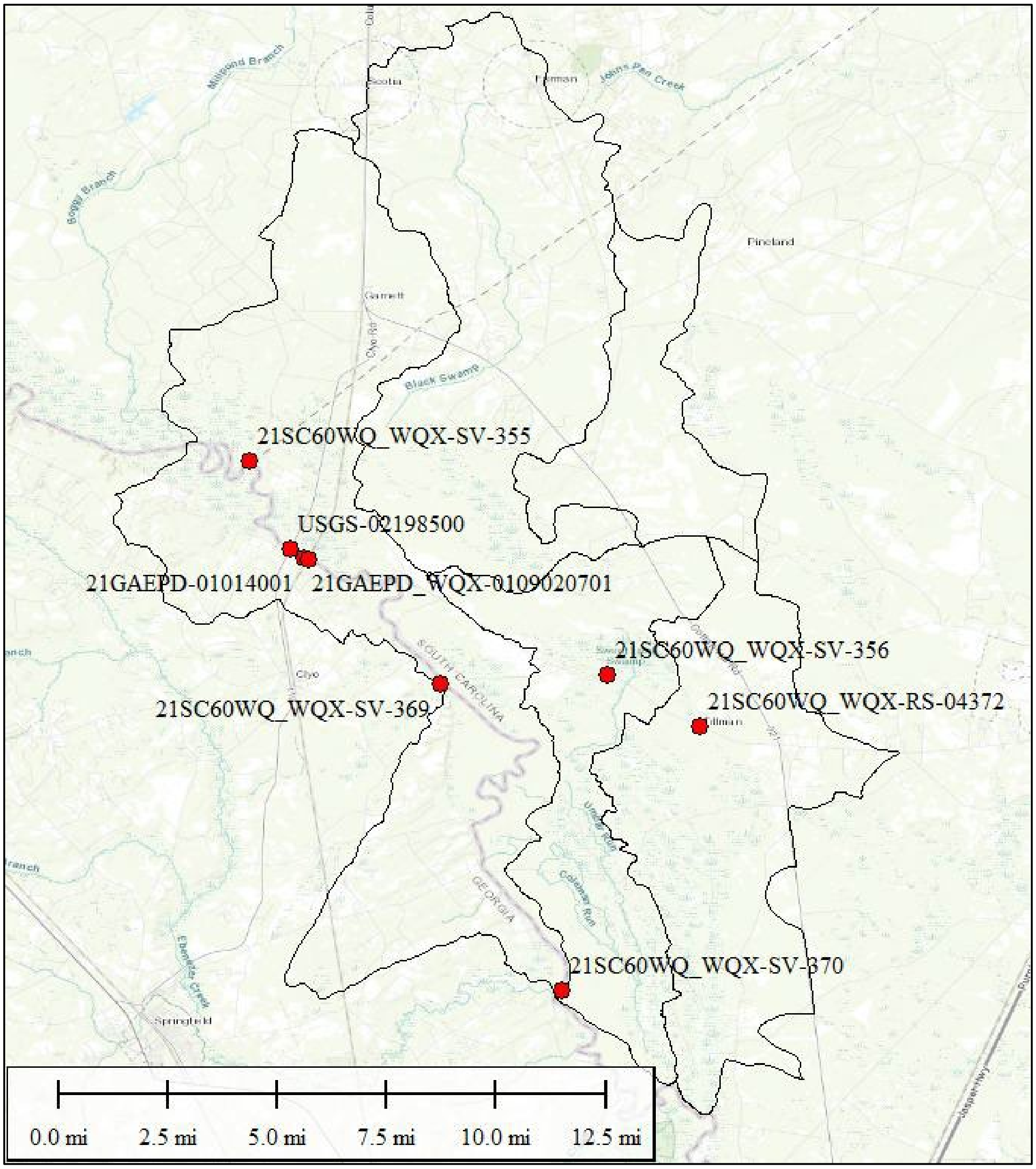

Figure 2- 15. Primary water quality monitoring locations in watershed

Data from SCDHEC indicate portions of the study area have failed to meet water quality standards within the past two decades. This data indicate problem areas and potential water quality concerns related to phosphorus, dissolved oxygen, fecal coliform bacteria, nitrogen and turbidity.

Pollutant Sources and Watershed Existing Conditions

NPS pollution is generally defined by the EPA as water pollution that is introduced into a system through a non-direct or unidentified route (EPA, 1996). The term *nonpoint* is used to distinguish it from point source pollution, which comes from a specific source such as sewage treatment plants or industrial facilities. It is a major factor affecting the quality of water supply, and it is greatly influenced by both anthropogenic activities and natural processes.

Stormwater is part of a natural hydrologic process. However, human activities, especially urban development, forestry and agriculture, cause significant changes in patterns of stormwater flow from land into receiving waters. Water quality can also be affected when runoff carries sediment and other pollutants into streams, wetlands, lakes and rivers, or groundwater.

The main hydrologic component transporting these pollutants to surface water bodies is runoff, which results from precipitation. Uncontrolled runoff can be a significant source of water pollution, causing decline in fisheries, swimming and other beneficial attributes of water resources. A list of some of the major categories of stormwater pollutants, their sources and related impacts are presented in Table 2- 5.

Table 2- 5. Pollutants and sources

Stormwater Pollutants, Sources and Impacts (Muthukrishnan et al., 2004)		
Pollutant	**Major Sources**	**Related Impacts**
Nutrients: Nitrogen, Phosphorus	Urban runoff; failing septic systems; croplands; nurseries; orchards; livestock operations; gardens; lawns; forests; fertilizers; construction soil losses	Algal growth; reduced clarity; lower dissolved oxygen; release of other pollutants; visual impairment; recreational impacts; water supply impairment
Solids: Sediment (clean and contaminated)	Construction sites; other disturbed and/or non-vegetated lands; road sanding; urban runoff; mining operations; logging operations; streambank and shoreline erosion	Increased turbidity; reduced clarity; lower dissolved oxygen; deposition of sediments; smothering of aquatic habitat including spawning sites; sediment and benthic toxicity
Pathogens: Bacteria, Viruses, Protozoans	Domestic and natural animal wastes; urban runoff; failing septic systems; landfills; illegal cross-connections to sanitary sewers; natural generation	Human health risks via drinking water supplies; contaminated shellfish growing areas and swimming beaches; incidental ingestion or contact
Metals: Lead, Copper, Cadmium, Zinc, Mercury, Chromium, Aluminum, others	Industrial processes; mining operations; normal wear of automobile brake pads and tires; automobile emissions; automobile fluid leaks; metal roofs; gutters; landfills; corrosion; urban runoff; soil erosion; atmospheric deposition; contaminated soils	Toxicity of water column and sediment; bioaccumulation in aquatic species and through food chain

Nitrogen

Nitrogen is an essential nutrient for plants and animals used in the structure of proteins and other molecules. Three simple inorganic forms of nitrogen are found in water and can be taken up directly by plants and bacteria or are easily changed to a usable form (Mesner et al., 2010).

> **Nitrate (NO3)** - the most common form of inorganic nitrogen in unpolluted waters. Nitrate moves readily through soils and into ground water, where concentrations can be much higher than in surface waters.
>
> **Ammonia (NH3)** - formed when organic nitrogen is broken down by bacteria. Plants prefer to use ammonia over nitrate, but ammonia is typically less abundant in natural waters.
>
> **Nitrite (NO2)** - converted from ammonia by bacteria, but the nitrite is usually converted again to nitrate (NO3) very rapidly. Because of this, nitrite is not usually found at measurable levels. Concentrations above 0.02 mg/L (ppm) usually indicate polluted waters.

Inorganic nitrogen is extremely soluble, and it is easily transported by surface water and it also travels easily through soils and groundwater. Thus, human introduction of nitrogen to a watershed has wide-ranging effects. Common human-influenced sources of inorganic nitrogen include:

- Fertilizers and animal manure;
- Malfunctioning septic systems;
- Discharge from sewage facilities;
- Acid precipitation from pollution

Phosphorus

Phosphorus is an important plant nutrient occurring in different forms throughout the environment. Excess phosphorus in aquatic systems can lead to over-fertilization in a lake or stream (Mesner et al., 2010). This over fertilization can result in an overabundance of aquatic plants, which in turn can deplete oxygen from the water through the decay process. Although phosphorus at concentrations found in natural waters is not toxic to humans or other animals, it may still have a significant impact on the living organisms in a lake or stream. This is because phosphorus is often the nutrient that limits how much plant growth occurs in a waterbody. Therefore, even a small amount of additional phosphorus, especially in its inorganic dissolved form, may lead to excess plant growth. Common human-influenced sources of phosphorus include:

- Fertilizers that runoff lawns, golf courses, and agricultural fields rain events or heavy irrigating;
- Runoff from poorly operated animal feeding operations or improper application of manure on fields;
- Poorly functioning septic tanks that release phosphorus into groundwater.

Total Suspended Solids

Suspended solids in lakes, streams and rivers is a major source of water pollution. Suspended solids consist of an inorganic fraction (silts, clays, etc.) and an organic fraction (algae, zooplankton, bacteria, and detritus) carried along by water as it runs off the land. The terms "sediment" and "silt" are often used to refer to suspended solids. The inorganic portion is usually considerably higher than the organic. Both contribute to turbidity, or cloudiness of the water. Suspended solids can clog fish gills, either killing them or reducing their growth rate. They also reduce light penetration, which reduces the ability of algae to produce food and oxygen. Indirectly, the suspended solids affect other parameters such as temperature and dissolved oxygen. They also interfere with effective drinking water treatment (Kentucky Water Watch).

- Runoff lawns, construction sites, and highly erodible soils,
- Runoff from agricultural fields;
- Erosion from unvegetated streams and drainage channels.

Fecal Coliform Bacteria

Water quality impairment related to “pathogens” is one of the most frequent causes of water quality problems in the United States, with over 14,168 waterbodies listed as impaired on state 303(d) lists (EPA, 1995). Pathogen impairments usually are identified based on elevated counts of fecal indicator bacteria (FIB) such as Escherichia coli (E. coli), Enterococci or Fecal Coliform. Pathogens are disease-causing organisms found in fecal waste, whereas FIB indicate the potential presence of such pathogens.

FIB indicate the presence of fecal wastes from warm-blooded animals. Livestock, failing septic systems, domestic pets, and wildlife are all potential contributors (Meals et al., 2014). Where bacteria levels exceed state standards, an unacceptable health risk exists for fishermen, bathers and children who engage in recreational activities involving contact with those polluted waters. Determinations regarding impairment are based on comparisons of FIB concentrations to applicable waterbody standards and classifications. The current water quality standard for bacteria for Freshwaters requires culturable E. coli bacteria to not exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30- day period, nor shall a single sample maximum exceed 349/100 ml (source).

In the majority of cases, this contamination cannot be traced to a single point discharge such as a wastewater treatment plant. There are many natural and human-induced sources of FIB in receiving waters and stormwater systems and identifying these sources and controlling them pose significant challenges. Unlike chemical pollutants, FIB and pathogens are living organisms that die-off, grow or persist depending on environmental conditions, which are mostly uncontrollable. Additionally, even when human and non-human anthropogenic sources of FIB and pathogens (e.g., leaking sanitary sewers, pet wastes, etc.) are controlled, urban wildlife and other ubiquitous non-fecal sources may persist as ongoing causes of elevated FIB.

Failing septic tank systems are one of the major contributors of fecal coliform bacteria in the Lower Savannah River Watershed study area. Septic systems that are improperly installed or poorly maintained are one of the major causes of failure. These factors coupled with failure due to high groundwater table, poorly drained soils, and structural failure, allow high concentrations of fecal bacteria, pathogens, and nutrients to be discharged to the watershed. Other contributors include wildlife and waterfowl throughout the watershed and pet waste in the more urbanized areas. Common sources of fecal bacterial include:

1. Runoff failing septic tanks;
2. Wildlife and waterfowl in the undeveloped areas of the watershed; and
3. Pet wastes from pets in urban areas.

Section 3: Watershed Data and Analysis

This section describes the process and results of the watershed analysis. The project team tailored the analysis to four focus areas, which were identified after assessing existing conditions in the study area and discussing issues with stakeholders. The analysis provides insight into the connection between each focus area and water quality in the study area.

Focus areas:

1. Agricultural runoff
2. Forestry land
3. Septic systems
4. Climate change and increased precipitation

The first two focus areas were explored through modeling work that established a baseline of NPS loadings of Total Nitrogen (TN), Total Phosphorus (TP), Total Suspended Solids (TSS) and sediments in the study area. The third focus area was addressed through an accounting and spatial analysis of the septic systems in the area and potential streams most affected by them. To address the fourth focus area, future conditions were incorporated into the model work and results were compared to present (baseline) loadings. The results of this analysis were used only to help identify watersheds and subwatersheds where BMPs could be most effective in the future.

Dissolved oxygen (DO) was not specifically modelled. DO is influenced by temperature and nutrient loads that can cause eutrophication from algal blooms. This report will concentrate on the nutrient aspect to address the problem of increased oxygen demand from algae resulting in lowered dissolved oxygen in the waters.

Summary of Available Data

SCDHEC operates few water quality monitoring stations within study area and only one, SV-370, has data from the past five years (SC DHEC, 2018). Given the lack of data from WQM stations, much of the data used in this analysis were model based, sourced "as is" from other agencies and/or developed from existing literature but customized for the study area. The following layers drove most of the analysis:

1. Digital Elevation Models (DEMs)
   a) Stream layer
   b) Subwatershed layer
2. Land cover data sets
3. Soils data
4. Precipitation data
5. Event mean concentrations (EMC)
6. Structure (building) locations

Water quality information includes both actual measured data (in-situ measurements) and layers of natural features that shape pollutant loads and inform water quality modeling. Information about each data layer can be found in Appendix 3.

BJWSA Intake

A primary goal of this work is to suggest methods to maintain water quality at the water intakes on the Savannah River that support a growing population. The TP and TN data collected at the BJWSA intake over the past 10 years, although some periods have missing information, highlight a general range of TN around 1.0 mg/L and TP at about 0.2-0.6 mg/L (Table 3- 1). The nitrogen levels have remained stable during the past several years (Figure 3- 1); however, the phosphate has shown signs of increases during the same period (Figure 3- 2). Given this trend and the desired outcome to maintain the existing water supply quality, phosphorus is a primary target for BMPs.

Table 3- 1. Mean and median calculation of nutrients at BJWSA intake over approximately 10-year period

Nutrient	Mean	Mode
TP	0.42	0.46
TN	1.21	0.90

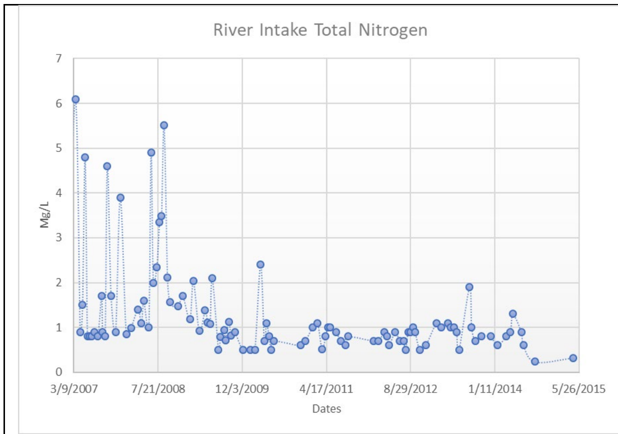

Figure 3- 1. BJWSA Nitrogen samples

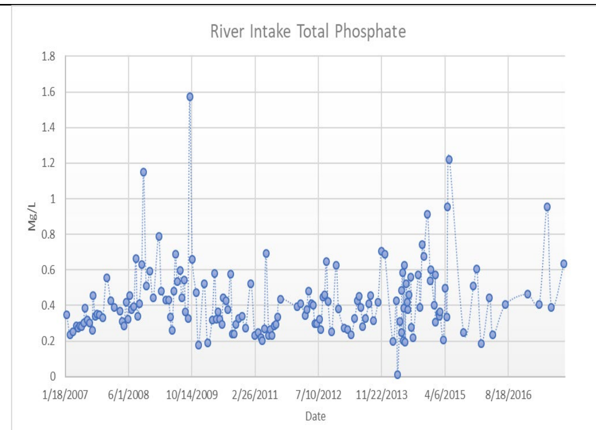

Figure 3- 2. BJWSA Phosphorus samples

Water Quality Analysis

Models

Three models were used in the water quality analysis. EPA's BASIN Pollutant Loading Estimator (PLOAD; US EPA, 2019) and the National Oceanic and Atmospheric Administration's (NOAA) Nonpoint Source Pollution and Erosion Comparison Tool (NSPECT; Eslinger et al., 2012) were used to analyze TN, TP, TSS and sediments. EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL; US EPA, 2018) was used to analyze, along with other data, the potential contribution of nutrients (TN, TP) and bacteria (E. coli) from different land covers and failing septic systems.

PLOAD and NSPECT

The models chosen for the initial stage of baseline results include PLOAD and NSPECT. A full discussion of each model is beyond the scope of this report. However, there are important differences and similarities to note. The models are similar in that they are largely driven by land cover and event mean concentrations (EMCs) of specific pollutants associated with the different land covers. Each type of land cover has its own coefficient for various pollutants, and this coefficient is not necessarily consistent across different areas, nor does it capture all local variability. Coefficients for use in the study area were chosen based on studies within the southeastern United States, mainly in North Carolina, Georgia and Florida (Lin, 2004).

The spatial models were not used as primary tools for BMP load reduction estimates. Given the present stage in planning and study area size, it was not efficient to run multiple scenarios and locations of each suggested BMP in spatial models. A more complete discussion of the uses, data and processes, along with examples of the NSPECT and PLOAD outputs, can be found in Appendix 3.

STEPL

STEPL is a non-spatial model that was used to provide summary information on nutrient loadings from the major land use categories (croplands, forests, pastures, and urban) and for the potential failing septic input analysis. It provides an accounting analysis of fecal coliform as well as nutrients in a watershed from human and animal sources and was combined with watershed network analysis (spatial) to provide results at a stream level. Since livestock farming is not presently common in the watershed, only human sources were considered.

An important aspect in the STEPL analysis is an accounting of failing septic systems. While the exact number of failing septic systems is unknown, the national average is between 10-30%. During the first stakeholder meeting, it was suggested by a septic system professional that 10-15% is an appropriate value in the area and 15% was used in this analysis.

STEPL was also used as the primary tool for assessing the magnitude of different BMP's on overall load reductions. STEPL provided a level of detail suitable for this planning effort. A more complete discussion of the uses, data, and processes, along with examples of the STEPL outputs, can be found in Appendix 3.

Presentation of Results

The nutrient results are presented in two separate sections to highlight baseline conditions for BMP development and potential future conditions of increased precipitation from a changing climate to highlight areas for BMP placement. A separate analysis of timber harvesting effects was performed to assess the general magnitude of the nutrient inputs on the system during this disturbance; the information is available in Appendix 3.

The baseline nutrient results include the two spatial models PLOAD and NSPECT as well as the non-spatial model STEPL, while the future conditions are modeled using NSPECT only. Like the baseline nutrient results, the TSS and erosion (sediment) analysis includes all models. The fecal coliform section concentrates on the septic contribution of E. coli from human development using STEPL, soil layers, watershed flow analysis and structure locations. The analyses do not include livestock or other animal sources, which was based on input from stakeholders.

Overview of Results

The Black Swamp watershed has the highest potential for adversely affecting water quality at the BJWSA intake from nutrient loads. There is significantly higher agriculture activities and development in this watershed. Increased rainfall, which is predicted under future climate scenarios, will only increase the effect. The other major aspect analyzed is the contribution of failing septic systems (private water treatment) since the study area is not served by a sanitary sewer system. The results of this analysis suggest the highest potential for increased contamination at the BJWSA intake is from the Cyprus Creek stream draining from the Cyprus Branch and Coleman Run watersheds. The changes in nutrient and TSS loads from periodic timber harvesting appear to be minor and confined to adjacent streams.

Nutrients

Non-spatial STEPL outputs are provided in pounds for the entire study area for a one year period and broken down by major land use. Four major land uses were chosen, unlike the spatial analyses which used 15, to highlight land uses where BMPs are most likely to be implemented; they include pasture, croplands, urban, and forests. Wetland land cover was not included. As a result the overall loads are different between the model types. The STEPL inputs are provided in Appendix 3.

The primary outputs from PLOAD for pollutant analysis are pounds per acre (lbs./acre) values. To highlight areas potentially contributing to higher levels of nitrogen and phosphorus, the subwatersheds with the highest (top 25%) lbs./acre values were selected.

Like the PLOAD analysis, a specific pollutant analysis was chosen in NSPECT to highlight areas that could be more susceptible to nutrification. In this case, it was the concentration (mg/L) of nutrients and TSS in the streams and waterbodies. Although no specific nutrient standard has been adopted in South Carolina, we are using the standards Florida has developed for the north-central counties to assess the levels. Florida's standard for TN is 1.87 mg/L and 0.3 for TP in rivers/streams (EPA, 2019). To highlight those waterbodies with higher levels and ones that could lower the quality of the drinking water, the concentrations were divided by the modeled concentration at the BJWSA intake. Those with a 10% higher concentration (i.e., 110% of concentration at intake) of nitrogen, phosphorous and TSS were selected.

Baseline Run – STEPL

STEPL results are shown in Table 3- 2. BMPs are primarily intended to address TN, TP, sediment and E. coli loads. From a phosphorus point of view the most important land cover category for BMPs to limit loads is the pastureland category with a phosphorus ratio of 0.2 vs 0.17 for croplands. The spatial results (PLOAD and NSPECT) are intended to provide more detail on BMP locations.

Table 3- 2. STEPL results in study area

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	32,381	3,598	135,472	450	0
Cropland	103,748	17,679	224,428	1,607	0
Pastureland	77,897	15,780	673,042	372	0
Forest	277,643	37,125	93,251	132	0
Septic	16,120	6,314	65,823	0	121,864
Total	**507,789**	**80,496**	**1,192,016**	**2,561**	**121,864**

Baseline Runs — PLOAD and NSPECT

NSPECT and PLOAD were run for TN, TP and TSS. NSPECT was also run for sediment from erosion. The run parameters were set to the baseline level of precipitation – around 48-50 inches – for the area. These results serve both as a "present" case as well as a means of comparison for increased future precipitation.

Nitrogen

The PLOAD results were consistent between the nitrogen and phosphorus outputs in that the subwatersheds with more than 125% of the average nutrient loading are the same (Figure 3- 3). The values are driven largely by land cover and highlight the higher level of development and agriculture in the Black Swamp subwatershed. Similarly, the NSPECT model also highlights potential nitrogen concentration in streams within the Black Swamp subwatershed are higher than the Florida standard (1.87; Figure 3- 4) and at the modeled value at the BJWSA intake (Figure 3- 5).

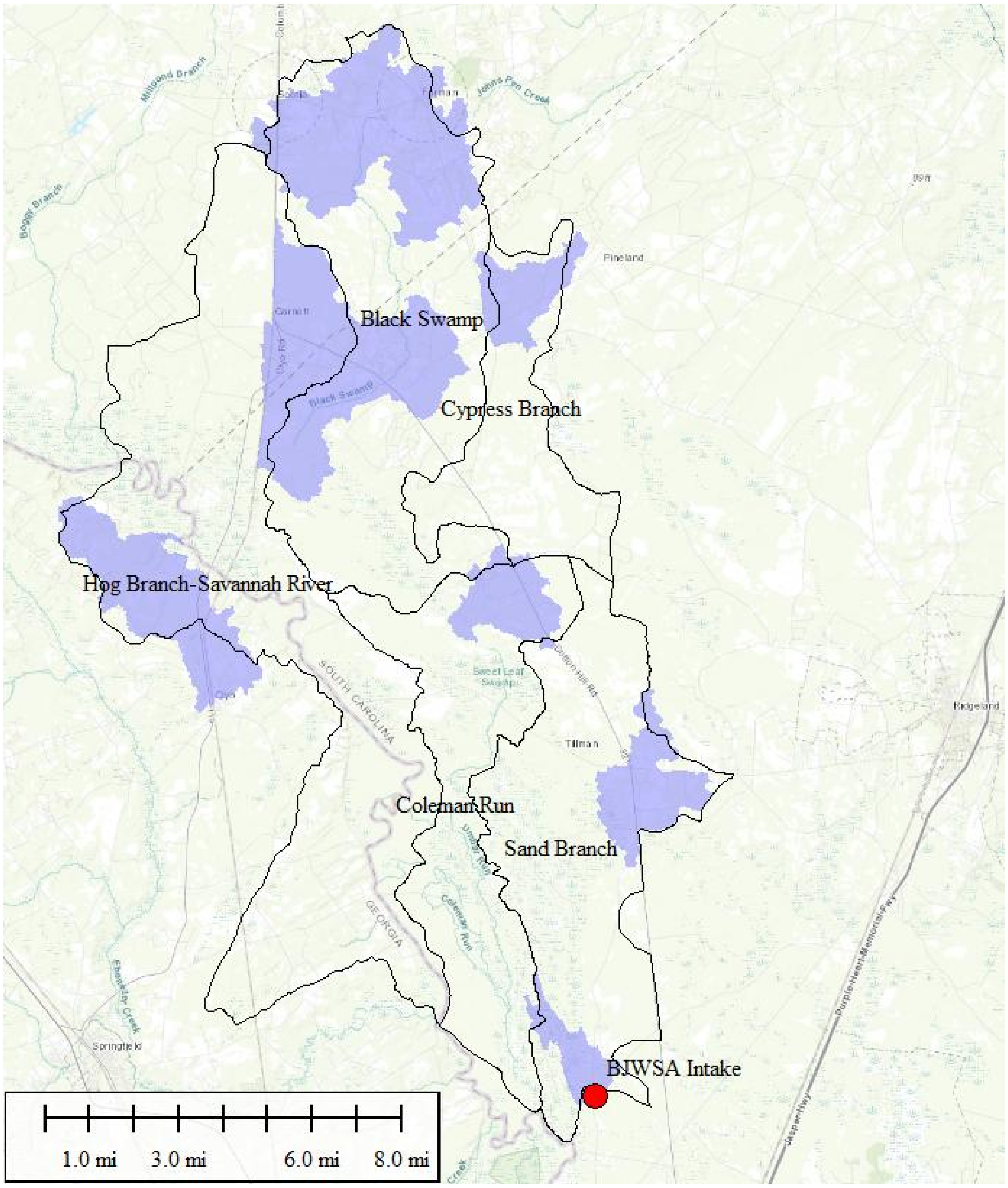

Figure 3- 3. Subwatersheds with 125% of Nitrogen and Phosphorus average for entire study area from PLOAD.

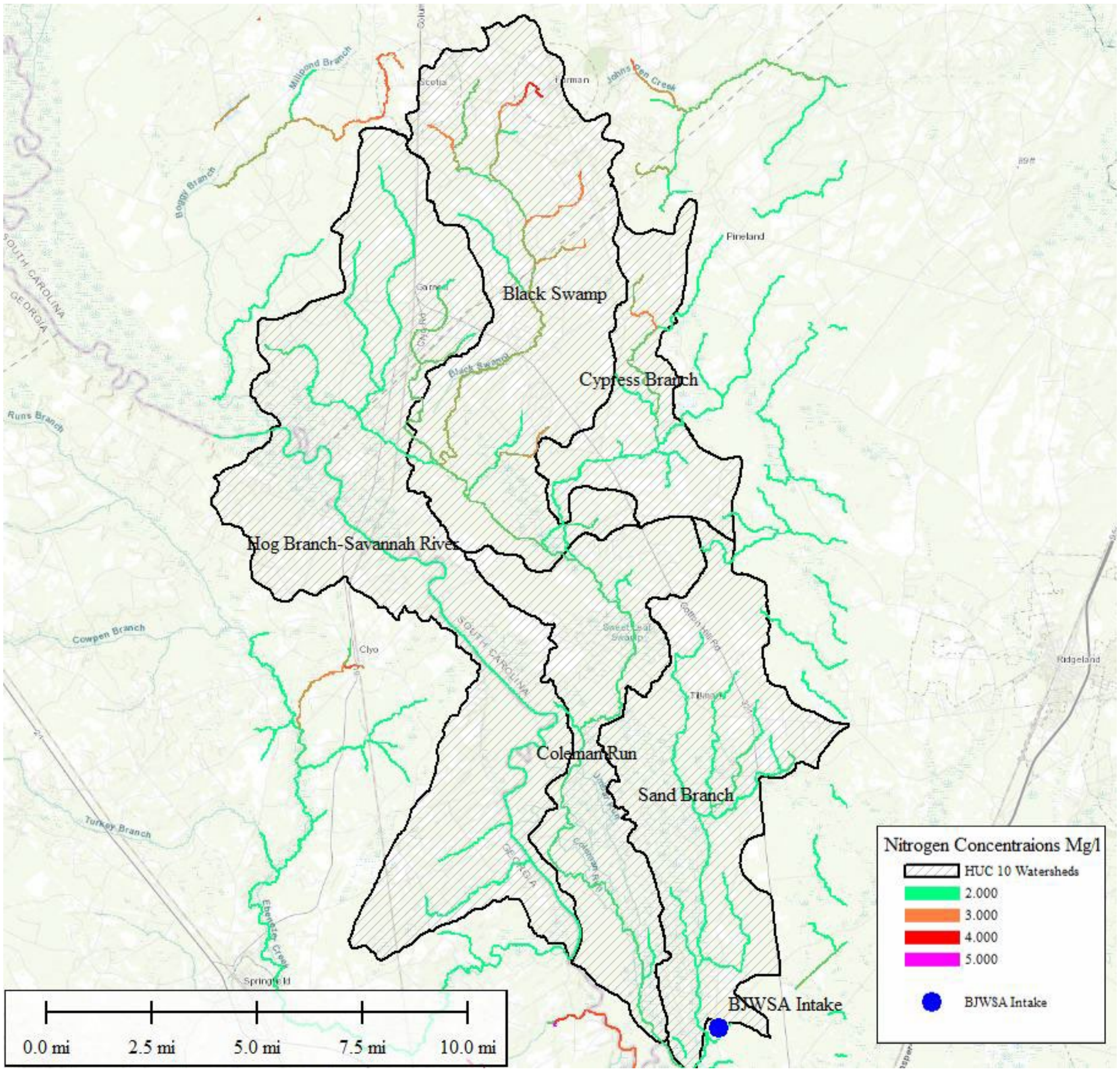

Figure 3- 4. Modeled nitrogen concentration in rivers.

Figure 3- 5. Nitrogen in streams with greater than 110% concentration compared to BJWSA intake location from NSPECT

Phosphorus

The modeled levels of phosphorus in the study area are generally lower than the FL standards (0.3 mg/L). Like nitrogen, the Black Swamp watershed has a higher level of concentration in the streams (Figure 3- 6) and with regards to the modeled BJWSA intake value (Figure 3- 7) than the other watersheds. The modeled level of phosphorus at the BJWSA intake is significantly lower (0.2 mg/L) than the average measured value (0.42) suggesting that at present the watersheds in the study area are not driving the relatively high phosphorus level at the intake.

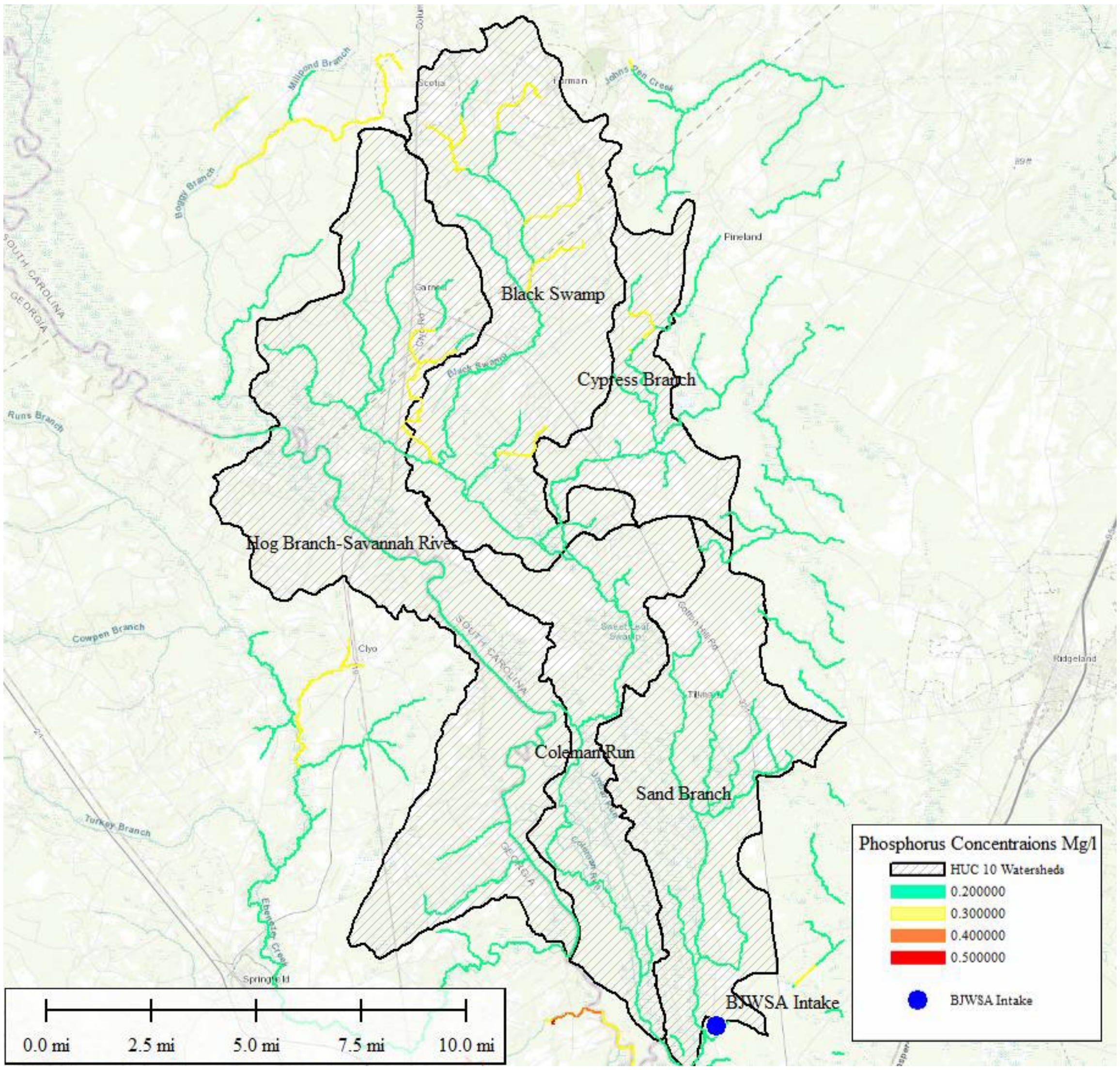

Figure 3- 6. Modeled phosphorus concentrations.

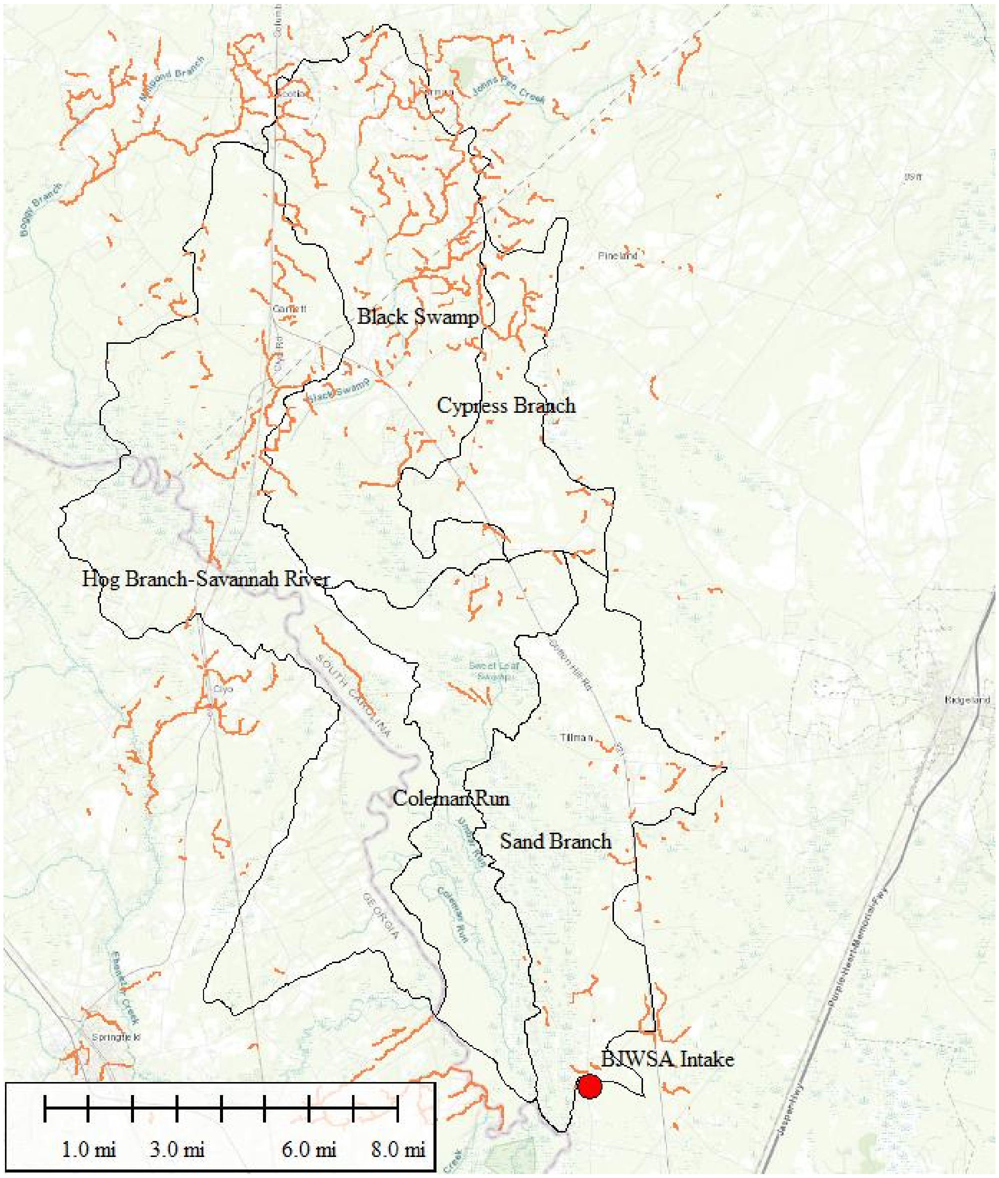

Figure 3- 7. Streams with greater than 110% phosphorus concentration compared to BJWSA intake location from NSPECT

Baseline Results

The nutrient results from both NSPECT and PLOAD suggest the Black Swamp watershed has the highest potential to contribute nutrients to the downstream water supply location. This is not surprising since this watershed has the highest density of agriculture. The actual levels of nutrient loading will vary from the results since individual farms have different processes and controls.

Assessing Future and Human Impacts

Climate Change - High Precipitation Scenario

The high precipitation projections come from EPA. Both annual and intensity of rainfall is likely to increase in the coming decades (**Error! Reference source not found.** and **Error! Reference source not found.**). To capture both aspects the yearly rainfall was increased from about 50 inches to 60 inches while keeping the number of rainy days the same, thus increasing overall rainfall and intensity in the model (NSPECT).

Since this is a theoretical result, phosphorus load reduction is a primary goal at the BJWSA intake based on monitoring information and the Florida standards, and the patterns are similar; only phosphorus is used to highlight the trends and processes (Figure 3- 8). Nitrogen and TSS have their own specific differences and are included, along with phosphorus, in Appendix 3.

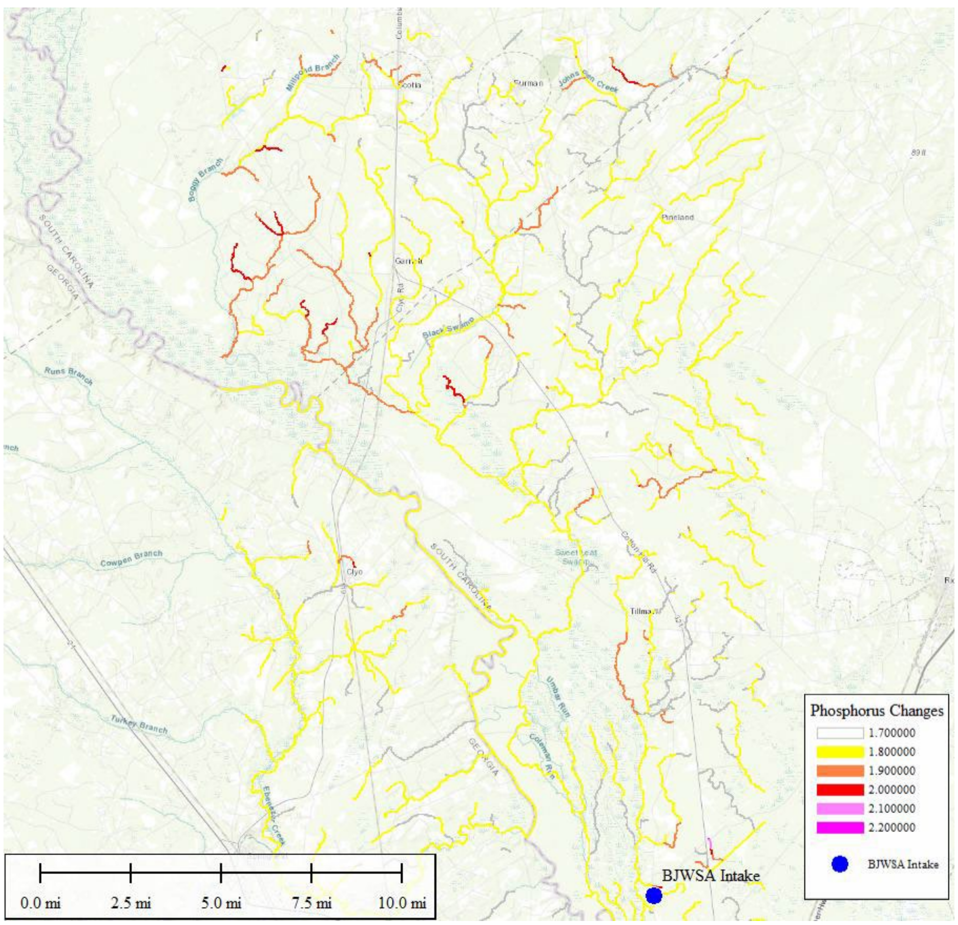

Figure 3- 8. Streams with at least 170% of baseline phosphorus load. Grey streams have 170% and red streams are up to 200% of baseline loads (kg).

There are a couple of key takeaways from the climate change results. The first is increasing rain quantity and voracity by 20% in the model creates upwards of a 50 to 100% increase in total loads of phosphorus. Although it is expected that an increase in runoff will lead to higher loads (kg), this is a non-linear result suggesting climate adaptation could play an important role in maintaining water quality in the study area. To highlight this, concentration ratios (high-precipitation/baseline) were calculated (Figure 3- 9). There are significant areas with higher concentrations (mg/L) of phosphorus in the runoff and, like total loads, suggests this is a non-linear process likely driven by soil and elevation factors in combination with land cover differences. Much of the increased phosphate concentration – along with nitrogen – is associated with development and agriculture-dense parts of southeastern Hampton County (Black Swamp watershed), which is highlighted as prime locations for BMPs.

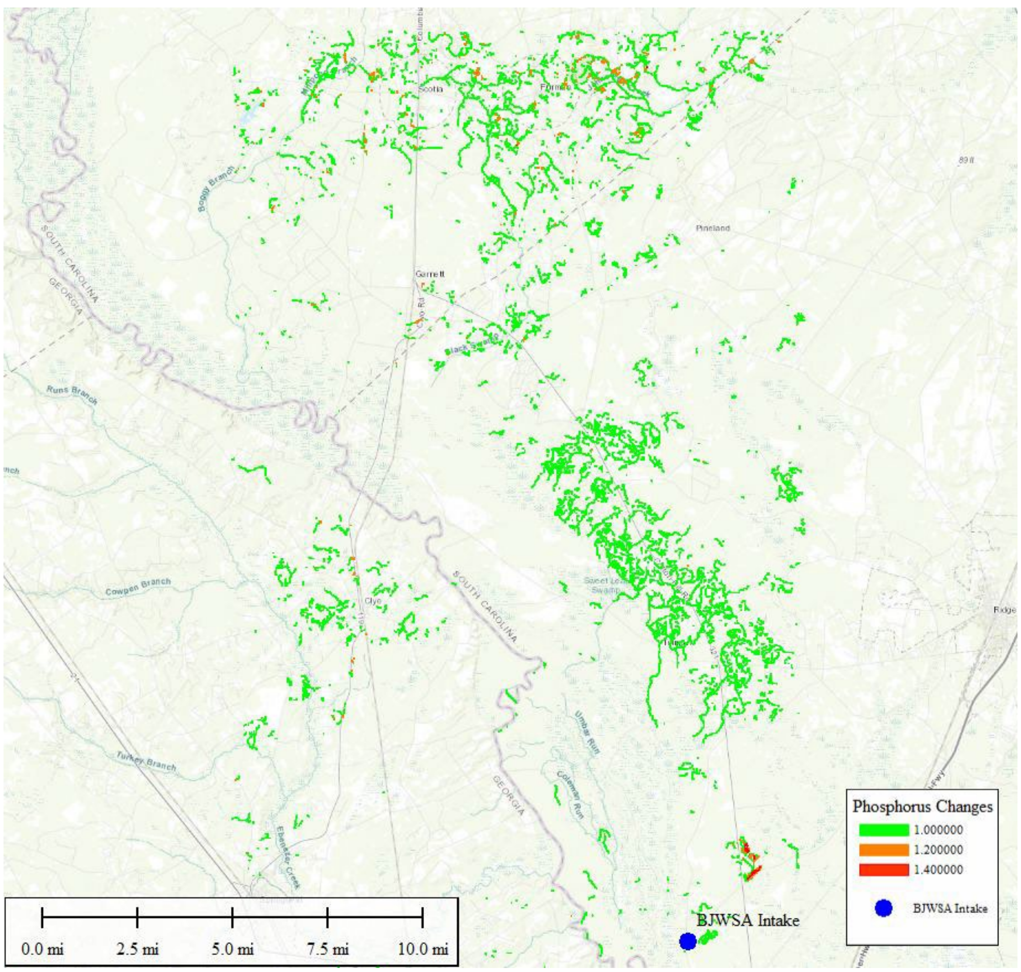

Figure 3- 9. Locations with concentrations (ratio) of phosphorus over baseline model runs of more than 1.0.

Septic Systems: E. coli Bacteria and Nutrients

It is unknown how many septic systems are failing in the Lower Savannah Watershed, but national estimates place 10-30% of systems failing at a given time. During the first stakeholder focus group, stakeholders involved in the septic industry estimated about 15% of septic tanks are failing in the study's watershed. There are approximately 2,100 buildings in the study area, so about 315 septic systems could be failing within the study area (Table 3- 3). Given an MPN estimate of 10^5/100 ml at the outlets of the septic systems there is potential for 1.22x10^14 E. coli per year entering the watershed from septic systems alone (Table 3- 4).

The type of soil also plays a role in the extent to which a failing septic system can affect water quality. Failing septic systems in permeable soils may have significantly less effect on local streams because the soil can filter some of the pollutants before the effluent reaches a waterbody. To get a better estimate of where BMPs would be most cost effective, only those structures in poorly draining soils where flow may be at the land surface and where there is relatively high building density were selected for the spatial analysis (Figure 3- 10).

There are about 1,200 buildings in poor soils/high density areas resulting in about 180 failing septic systems (Table 3- 3) based on a 15% failing estimate. These failing systems would be expected to have a higher degree of influence on the fecal coliform levels in the watersheds.

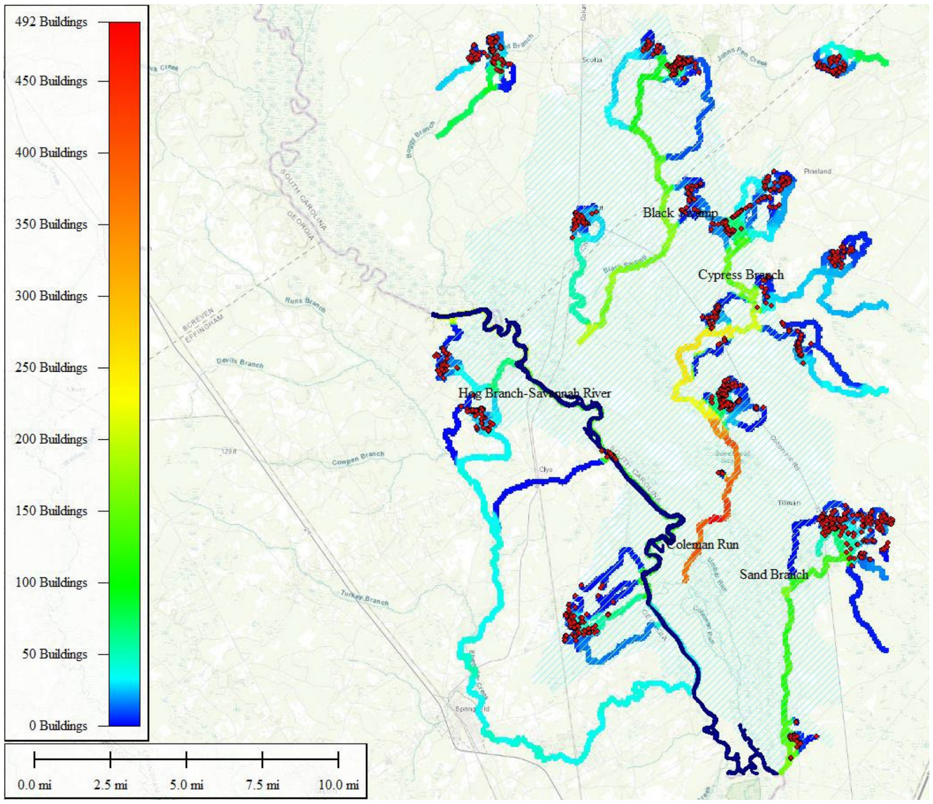

Figure 3- 10. Buildings in poor draining soils and number of buildings draining to each stream.

In areas within the study area with poor soils and high density, there is a potential worst-case scenario for E. coli counts (MPN) of 70 trillion per year entering the streams from failing septic systems alone. These results are shown in Table 3- 4. More importantly, the most affected tributary in the study area is in the Cyprus Branch/Coleman Run watersheds. There are about 500 buildings in poorly drained soils draining to the Cyprus Creek stream, which could result in counts (MPN) of 28 trillion per year. In addition to the E. coli counts there is the potential for additional nutrient loads and biological oxygen demand (BOD) that are not included in the previous discussions of baseline nutrient results.

Implementing BMPs to reduce the number of failing septic systems anywhere in the study area will have a positive effect on water quality at the BJWSA intake as well as human health in general in the watershed. Targeting areas with poor soils should have a multiplicative effect on those factors; and concentrating on the Cyprus Branch/Coleman Run watershed may also improve habitat and stream health.

Table 3- 3. Buildings and population in poor soils

Scenario	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Failing Septic Systems	Population on Failing Septic	Direct Discharge Population	Failing Septic Flow, gal/day
Poor Soils	1200	4	15	180	720	0	50400
All Areas	2100	4	15	315	1260	0	88200

Table 3- 4. Potential nutrient loads and most probably number (MPN) of E. coli from failing septic systems

Scenario	N Load, lb/yr	P Load, lb/yr	BOD, lb/yr	E. coli, MPN/yr
Poor Soils	9211	3607	37612	6.96 E+13
All Areas	16119	6313	65822	1.22E+14

To put this in context the MPN of E. coli was calculated for the other human-influenced land categories and compared to the potential septic input (Table 3- 5). The MPN values (per acre) were sourced from a report from Land Air Water AOTEAROA (LAWA) (https://www.lawa.org.nz/explore-data/river-quality/national-picture/faecal-indicators/). Based on these figures, and even given the limited number of septic systems, the majority of the E. coli indicator bacteria in the watershed, which does not have a significant number of feedlots, is likely a result of failing septic systems.

Table 3- 5. E. coli loads from human use

Sources	E. coli Load (Billion MPN/yr)	Percentage of Total
Urban	24475.70	13%
Cropland	36424.90	20%
Septic	121863.77	67%
Total	**182764.36**	**100.00%**

Other Water Quality Parameters

Total Dissolved Solids

TSS loads and concentrations are less consistent in the two models than the nutrients. The PLOAD model is, again, driven by land cover and EMC values, whereas NSPECT includes elevation, soil types and erosivity factors. As a result, it is suggested that the NSPECT results are used to highlight areas where conditions are conducive to transporting suspended solids. Similar to the nutrient analysis, the highest 25% subwatersheds modeled with PLOAD and 110%

of BJWSA intake concentration modeled with NSPECT are highlighted in Figure 3- 11 and Figure 3- 12.

In this case there are no specific areas with consistently high TSS concentrations highlighted in each model, and it appears to be more specific to individual site conditions (soil, elevation, land cover) and the streams that drain them. TSS results from NSPECT do not seem to be well correlated with nutrient results. Modeled future conditions with increased rainfall show TSS loads beyond 150% of baseline are widespread in the study area. These results, shown in Figure 3- 13, suggest stormwater management, even in this low density area, may be an important consideration for maintaining water quality at the BJWSA intake.

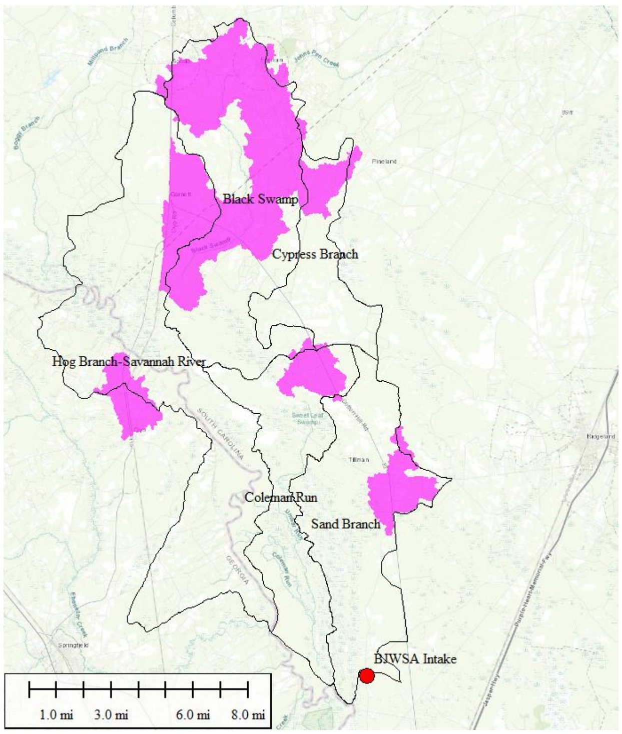

Figure 3- 11. Watersheds with 25% more TSS than the average

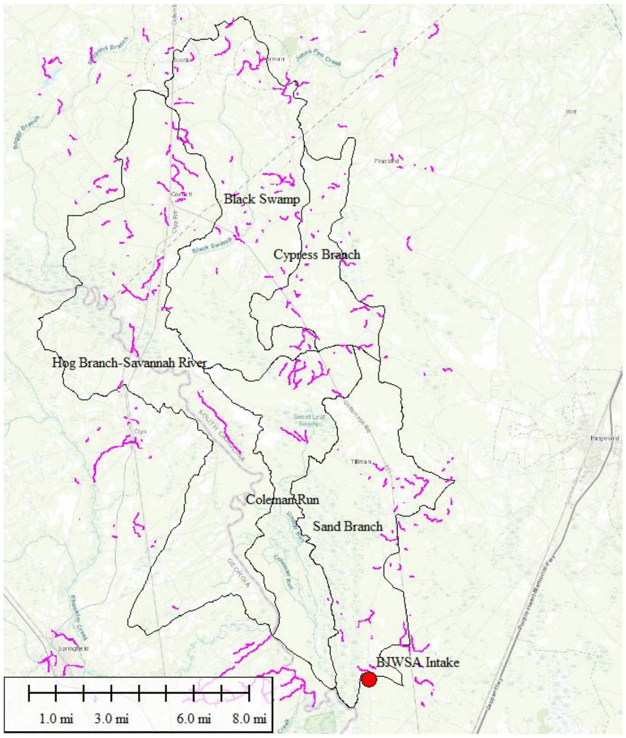

Figure 3- 12. Streams with concentrations greater than 110% of those at BJWSA intake location

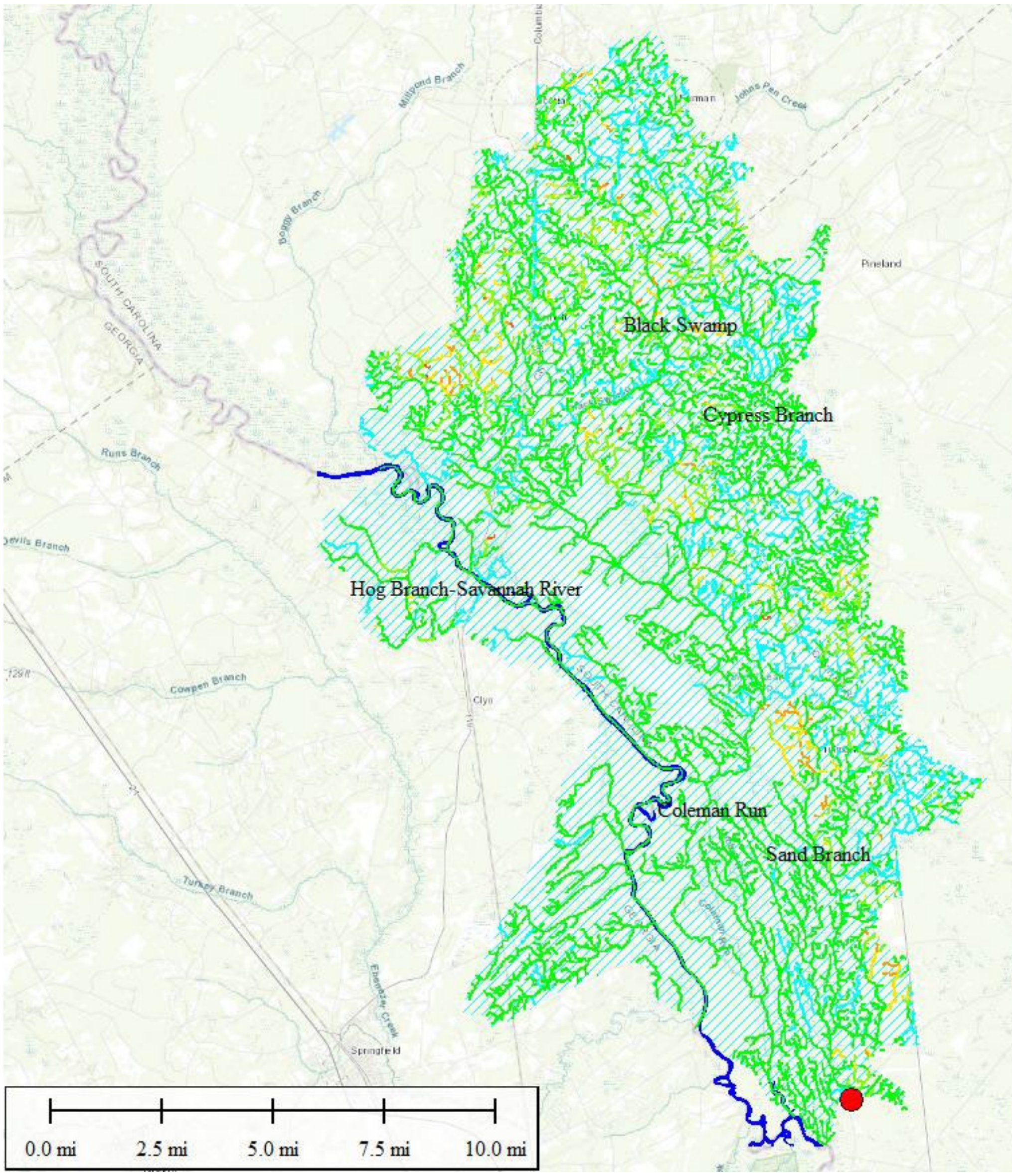

Figure 3- 13. Streams with greater than 150% (green) of baseline TSS loads. Red colors are over 200%.

Sediments

The sediment loads (kg) were calculated in NSPECT with the erosion process turned on (Figure 3- 14). The highest loads from streams carrying at least 1% of maximum load are coming from watersheds on the South Carolina side of the Savannah River. This is consistent with the differences in surficial geology on either side of the river. Similarly, the increases above 120% of sediment in the tributaries from increased precipitation is on the South Carolina side and concentrated in the Black Swamp watershed (Figure 3- 15).

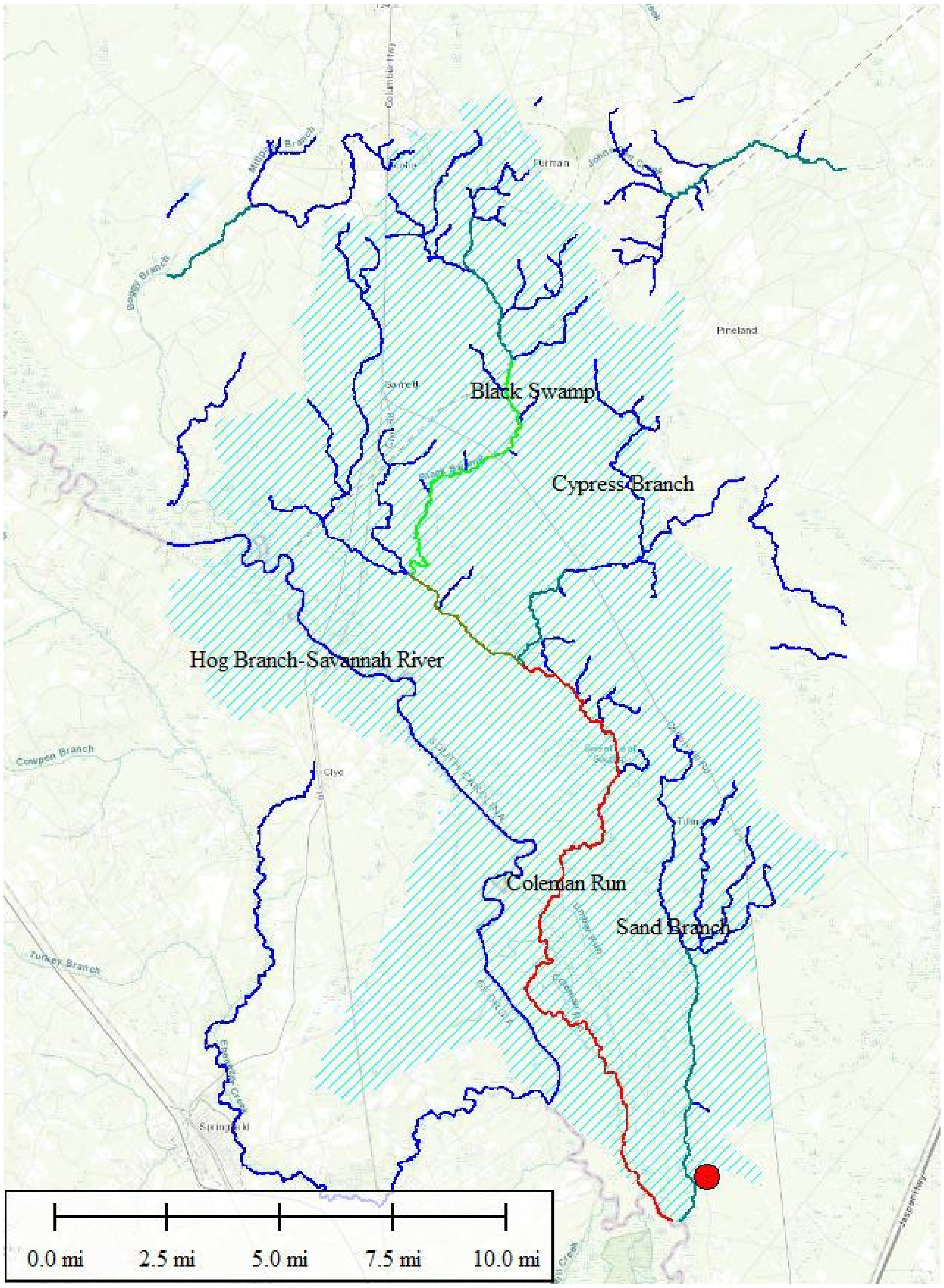

Figure 3- 14. Sediment loads from low (blue) to high (red) in watersheds

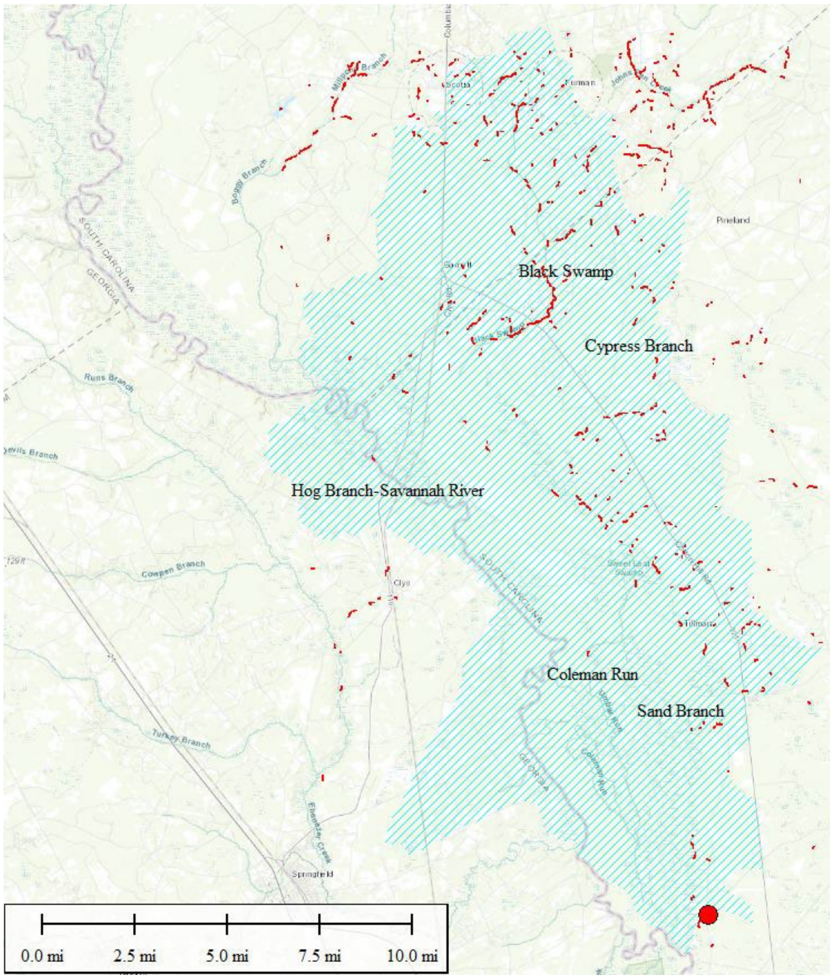

Figure 3- 15. Areas of increased (greater than 120%) erosion and sediment in streams from increased rainfall.

Monitoring Recommendations

Given the lack of monitoring information in much of the study area, especially in South Carolina, the results are driven by modeling. As previously mentioned, the ability to define specifics of the NPS pollution is extremely difficult in models; a generic handling of a limited number of stock land covers was used as a proxy for NPS pollution levels. This is not an advantageous situation with the present drinking water withdrawal located directly downstream of the study area watersheds.

While it will always be difficult to define accurate EMCs for each acre of land, one or two monitoring locations (Figure 3- 16) in each 12-digit HUC watershed would help highlight specifics that are not captured in a generic treatment. This targeted approach using existing monitoring locations will create both better coverage and a way to target areas that experience site-specific conditions or failing septic systems, which may create problems at the water intake.

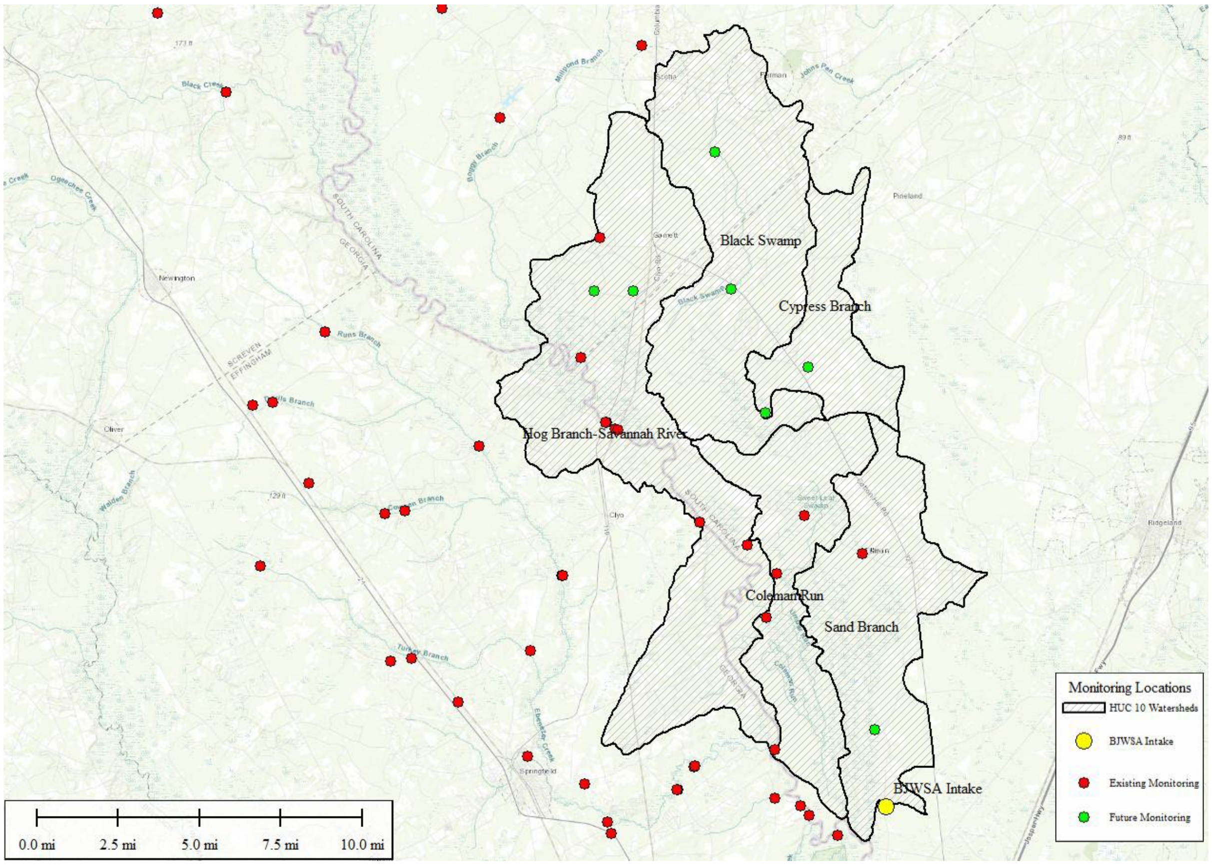

Figure 3- 16. Proposed (green) monitoring locations to improve coverage and watershed modeling capabilities.

The most straightforward way to achieve increased coverage is to work with SC DHEC and/or help fund additional Ambient Surface Water Physical & Chemical Discrete Monitoring. This program has a robust process and statistical background and includes nutrient monitoring data (SC DHEC, 2018).

One other avenue to achieve additional monitoring sites is through the SC Adopt-a-Stream Program. Currently there are no SC Adopt-a-Stream activities in the southeastern portion of the state (Figure 3- 17). The monitoring information is less robust, focusing mainly on physical measurements and E. coli, than the SC DHEC ambient surface water monitoring but would have the added benefit of public outreach (see Section 5).

In either case, there is a significant need for monitoring locations in the study area watersheds. Locating and assessing the outcomes of BMPs requires real measurements. Modeling can highlight potential areas but cannot measure the reality of the watersheds. Any chronic or acute NPS pollution issues can, because of the proximity to the BJWSA intake, have deleterious effects to drinking water supplies.

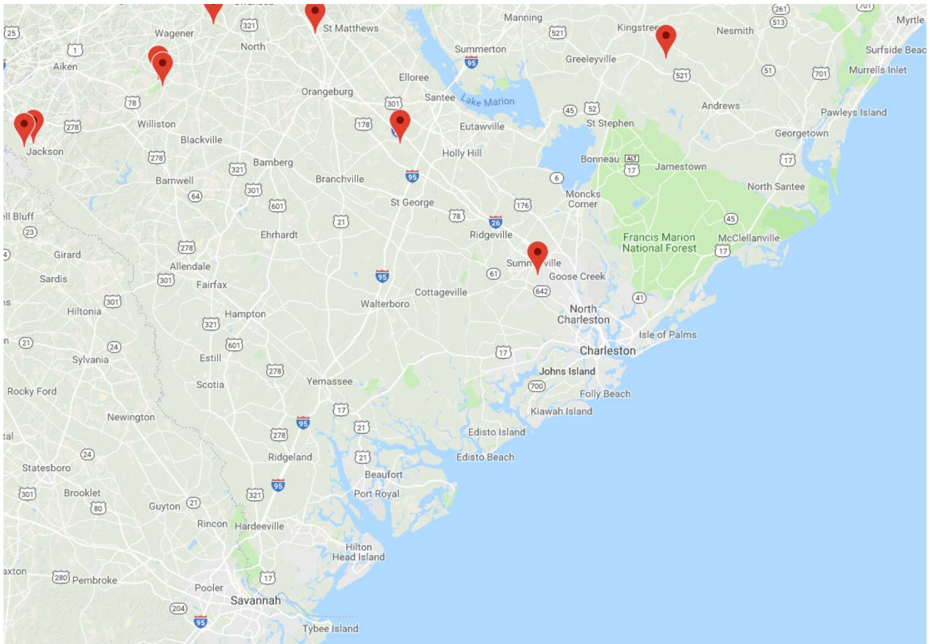

Figure 3- 17. Existing SC Adopt-a-Stream locations in the southeastern portion of the state

Summary of Results

Overview

An overarching result from the modeling is that present conditions in the target watersheds are generally good. This is an important aspect for the more than 150,000 BJWSA customers currently receiving water from the Savannah River. While the overall condition is good, there are a few watersheds that are at the higher relative end of NPS contributions from the study area as a whole (Table 3- 6). Moreover, there is a potential for future increases in NPS pollution from higher annual rainfall and voracity of rainfall. Given the growing population receiving water from the source area an important focus of BMPs should be maintaining and monitoring the present water quality originating in the study area.

Table 3- 6. Overview of Modeling Results

Pollutant	Most Affected Watershed	Potential Causes	Future Changes
Total Nitrogen	Black Swamp	Higher Ag, Urban Land Covers	Higher Concentrations
Total Phosphorus	Black Swamp	Higher Ag, Urban Land Covers	Higher Concentrations
Suspended Solids	None, Localized	Soil Types, Slopes, Ag Land Cover	Higher Loads
Fecal Coliform	Cyprus Branch	Soil Types, Development	Reduced Septic Efficiency
Sediment	Black Swamp, Coleman Run	Topography, Land Cover, Soil	Increased Sediment Runoff

Nutrients

Based on the existing monitoring and baseline modeling information the nutrient loads and concentrations in the study area are not a major water quality issue. Although no specific nutrient standard has been adopted in South Carolina, we are using the standards Florida has developed for the north-central counties to assess the levels. Florida's standard for TN is 1.87 mg/L and 0.3 for TP in rivers/streams. For the most of the study area the runoff values are at or below those levels for TN and TP (NSPECT results; Appendix 3). There are higher concentration areas associated with roads/development and some agricultural fields, but on the whole they are within the Florida standard.

There are a few watersheds – Black Swamp, for example – with physical attributes and land cover that could lead to degraded water quality in the Savannah River and at the BJWSA intake, but they are not presently at levels of high concern (NSPECT results; Appendix 3). Barring any unforeseen changes in development and agriculture in the study area, the existing water quality conditions should, overall, continue to meet standards.

Climate change, an increase in precipitation and rainfall voracity, is one study-wide scenario that was explored and may adversely affect the future quality of water flowing from the study area to the BJWSA intake. The results, however, do not suggest a drastic increase in nutrient concentration everywhere. Some land covers, however, may have concentration increases and are worthy of future study. The magnitude of nutrient loads is on the order of a 50% increase in some areas, such that average nutrient values may begin to put the water in a lower quality category. The exact conditions used in modeling may or may not occur, however, they indicate nutrient loading will increase exponentially with increased rainfall and may warrant some consideration in the near future.

Another "what-if" scenario was modelled for logging sites (Appendix 3). The results indicate high initial nutrient levels and TSS loads adjacent to the sources, but the effects are not felt too far downstream from harvesting locations. If multiple timber harvests occur on the same tributary at the same time, the effects could reach further downstream.

Total Suspend Solids and Sediment

The amount of areas showing high TSS levels relative to the BJWSA intake is less pronounced than the nutrient results. That said, the level of TSS is even higher when modeling potential changes in climate. Sediment from erosion appeared to be mainly from the SC side of the Savannah River with higher values from the Black Swamp watershed, which also had a higher increase in a wetter climate scenario.

Urban Inputs

Wastewater discharge from non-functioning septic systems was the primary NPS input assessed from urban areas. There is a total of 2100 structures in the study area; given this and an estimated 15% failing septic systems a total E. coli MPN of 1.22 x 10^14 per year may be entering the watersheds. More important for stream health are failing septic systems in poor draining soils where less soil interaction is present. Based on an accounting and spatial analysis there is the potential for E. coli bacteria counts (MPN) of around 70 Trillion (6.96 x 10^13) per year entering the waters in the study area. The area of highest concern is with Cyprus Creek.

Section 4: Best Management Practices

This section provides an overview of BMPs and discussion of potential BMPs that may be implemented in the study area to control and treat stormwater runoff. This discussion in not intended to be a comprehensive review of all possible BMPs, but a presentation of potentially effective BMPs given the study area's character, conditions and land uses; and given the effectiveness experienced in adjoining watersheds.

Other BMPs may be considered for implementation as sources and opportunities are discovered going forward in the general implementation of this plan. These BMPs may include but are not limited to, livestock mitigation BMPs such as exclusion, grazing management, and manure management as well as low impact development, such as biofiltration and impervious surface minimization. All BMPs that will help achieve the objectives of this plan will be considered."

A stormwater BMP is a technique, measure or structural control used to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner (Strassler, et al., 1999). The EPA defines BMPs as "schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States." There are two general types of BMPs used to reduce the threat of stormwater runoff pollution from construction, development, and various land uses: (i) nonstructural or source control BMPs and (ii) structural or treatment BMPs.

Structural BMPs

Structural BMPs are engineered systems and methods designed to provide temporary storage and treatment of stormwater runoff for the removal of pollutants. These practices are aimed at controlling the volume and discharge rate of stormwater runoff, as well as reducing the magnitude of pollutants in the discharge water with containment or flow restrictions, filtration, percolation and/or biological uptake (Livingston, et al., 1988). Examples include retention ponds, drainage infrastructure or wastewater systems.

Nonstructural BMPs

Nonstructural BMPs refer to stormwater runoff management techniques that use natural measures to reduce pollution levels, do not require extensive construction efforts, and either limit the generation of stormwater runoff or reduce the amounts of pollutants contained in the runoff. Nonstructural techniques include planting and harvesting best practices, bio-swales and riparian spaces, as well as funding easements, offering grants for septic tank maintenance, updating zoning ordinances and educating the public about watershed health.

Land Use and BMPs

Past and present land uses and land management activities are factors that must be considered when developing a watershed-based plan. Accurate information about land use, land management, and water quality conditions aid in developing a holistic approach to watershed management and form the basis of identifying the tools and techniques to address water quality threats.

In a typical NPS watershed project, BMPs are implemented or adopted at various locations and scales in the watershed to reduce the sources and discharge of NPS pollutants. While water quality monitoring is generally conducted to document the effectiveness of implemented BMPs linking water quality response to land treatment requires monitoring of both water quality and land management.

Forestry Land Use and BMPs

Sources of NPS pollution associated with forestry activities include removal of streamside vegetation, road construction and use, timber harvesting and mechanical preparation for the planting of trees. Road construction and road use are the primary sources of NPS pollution on forested lands, contributing up to 90% percent of the total sediment from forestry operations. In addition to other water quality impacts, an excessive quantity of sediment in a water body can reduce the ability of aquatic organisms to successfully live, forage and spawn. Harvesting trees in the area beside a stream can affect water quality by reducing the streambank shading that regulates water temperature and by removing vegetation that stabilizes the streambanks.

Forestry management practices are also important activities that contribute to the health of a watershed. Forest management practices such as the use of low impact equipment, pre-harvest planning, revegetation, and site preparation techniques aid in controlling impacts and maintaining a healthy more resilient landscape. Forest land conservation and stewardship programs are also effective management tools that allow land owners to manage their land for its economic and ecological value. SCFC plays an active role in advising forest landowners and the professional forestry community about BMPs and land management practices that lead to good stewardship activities that help protect water quality and more sustainable and resilient forests.

The SCFC has developed a comprehensive forestry BMP manual and the staff works closely with the forestry community to educate and assist as needed with BMPs implementation. Typical forestry BMPs shown in Table 4- 1 are commonly used in the study area and are generally successful in reducing NPS pollution.

Table 4- 1. Forestry related BMPs

Forestry BMPs (SCFC, 1994)		
BMP	**Area/Applicability**	**Approach**
Streamside Management Zones (SMZs)	- Perennial and Intermittent Streams - Primary and Secondary Zones	-BMP Rotational grazing - Management plans - Educational materials
Stream Crossings	- Perennial and Intermittent Streams - Primary and Secondary Zones	- Cross streams at right angles - Keep approaches to a gentle slope - Use drainage structures and turnouts to limit discharges and sedimentation
Forest Road Construction	- Steep slopes - Wetlands -Sensitive habitats	- Follow contours - Limit width to that necessary to handle equipment
Timber Harvesting	- Streamside zones - In or adjacent to wetlands - Near sensitive habitat	- Plan ingress and egress routes - Locate log decks away from sensitive areas - Use low-impact techniques
Site Preparation	- Streamside zones - In or adjacent to wetlands - Near sensitive habitat	- Avoid steep sloped area - Prepare planting beds only as high as needed - Leave vegetation and limit soil disturbance in gullies
Prescribed Burning	-Overgrown areas	-Help reduce detritus in streams during harvesting
Increase SFI knowledge base and Involvement	- Harvesting Activities	-Develop Benefits for Compliance -Encourage farmers to work with SC Forestry Commission on BMPs
Forestry Easements	-Existing forestry and undeveloped areas	- Funding for unmet needs for land conservation groups -Planning and targeting high impact locations

Agriculture Land Use and BMPS

Primary agricultural NPS pollutants are nutrients, sediment, animal wastes and pesticides. Agricultural activities also have the potential to directly affect the habitat of aquatic species through physical disturbances caused by livestock or equipment. Although agricultural NPS pollution is a serious problem nationally, a great deal has been accomplished over the past several decades in terms of sediment and nutrient reduction from privately-owned agricultural lands.

NRCS has played an active role in developing agriculture BMPs and working with the agriculture community to help educate and implement BMP measures to reduce soil erosion, protect productive farmland, reduce nutrient loading and protect natural habitats. In most cases, the NRCS works closely with local soil and water conservation districts to educate farmers and assist in identifying, implementing, and, in some cases, funding BMPs. Examples of the more common and successful techniques are shown in Table 4- 2.

Table 4- 2. Agricultural BMPs

Agriculture BMPs		
BMP	**Area/Applicability**	**Approach**
Conservation Tillage	- Previously harvested areas - Sloped areas near wetlands and waterways	- Rotational grazing - Management plans - Educational materials
Contour Buffer Strips	- Planted in-field and on contours - Planted between wider crop strips	- Place buffer where plant roots reach subsurface flow - Consider fewer production sections of land - Place at the foot of the slope
Cover Crops	-Seasonal use agricultural fields	-Nutrient cycling with cover crop
Access Control Fencing	- Near grazing areas - Adjacent to sensitive areas (wetlands)	- Select materials the will provide desired control (i.e. height, size, spacing)

Nutrient Management Techniques	- All crops, all fields	- Practice 4Rs (right rate, right source, right placement, right timing) - Maintain soil cover
Funding NRCS Management	-All crops, all fields	- Provide funds for NRCS management involvement

Development and Urbanization Land Use and BMPs

Land development and urbanization can have adverse stormwater impacts, particularly if the land is converted from woods, grasslands, or other natural conditions to developed areas with large areas of impervious and non-native vegetated covers (NJDEP, 2004). While large scale conversion of natural areas to developed areas is not currently a threat in this watershed, some conversion is likely and that conversion to developed space could impact stormwater conditions that must be addressed.

Effects from stormwater runoff from developed areas generally include an increase in stormwater runoff volume, rate, velocity and increases in pollutants from poorly designed septic systems, pet wastes, nutrients, and sediment BMPs for these runoff impacts has focused on collecting and conveying the runoff from the entire site through a structural conveyance system to a centralized facility (e.g., detention basin, wet pond) where it is stored and treated prior to discharge downstream. More recent approaches have focused attention on reducing not only the quantity of runoff but the quality or pollutant load carried by the runoff. This approach limits potential adverse runoff impacts to occur throughout the site and then provide BMP measures immediately prior to releasing the runoff downstream. One such BMP is low impact development (LID), which incorporates both nonstructural and structural stormwater management measures that are a subset of a larger group of practices.

Table 4- 3. Development BMPs

Development Land Use BMPs		
BMP	**Area/Applicability**	**Approach**
Septic System Retrofits	- Rural areas - Areas outside public utilities	- Repair and/or replace failing septic systems - Provide incentives and funding for repairs - Connect septic system to utility line
Litter and Pet Waste Prevention	-All areas	-Funds for trash removal -Organization of community groups to remove trash
Low Impact Development (LID)	- Planned subdivisions - Proposed commercial development	- Implement LID methods - Provide economic incentives

BMPs for Lower Savannah River Study Area

During the study's outreach activities participants identified several BMPs with universal appeal based on the existing physical conditions and population growth dynamics. Many of the BMPs listed below have been and continue to be used in neighboring watersheds to reduce effects related to specific land uses (i.e. forestry, agriculture, land development). These BMPs have been developed for specific land uses by resource managers and users alike, and are commonly used to reduce impacts and protect the integrity of the watersheds. Recognizing the overall goal of this plan, the following BMPs were identified as important management measures that could assist in maintaining a healthy watershed for future decades.

Forestry

Forestry BMPs play a critical role in keeping the surface and groundwater in good condition for the people and agriculture activities that rely on it. SCFC BMPs are voluntary but compliance is high, due in part to an emphasis on programs like the Sustainable Forestry Initiative (SFI) certification. Maintaining the high BMP compliance rate in the face of changing economic conditions, changing ownership and parcellation, and new BMP requirements may create the need for future outreach and education as well as financial incentives to continue high BMP compliance. Nutrient credits or a sustainable forestry credit system based on the ecosystem traits that are present and preserved would also help maintain high BMP compliance ratings.

As mentioned in the preceding section, maintaining existing forestry lands themselves is an important BMP for this study area. Easements requiring LID and uses, and those that tie together protected parcels are common in the area and should be part of the overall BMP goals.

Agriculture

The primary agricultural area in the study area is in the Black Swamp watershed. This area has the highest levels of modeled nutrient loads. Many of the crops are seasonal and have the potential to generate higher nutrient and sediment runoff when vegetation is not present. One effective way to reduce nutrient loading is to maintain cover crops, which trap nutrients during off season. The costs are on the order of $60 an acre to implement (NRCS) and cost sharing funding opportunities are available.

Development

Development activities are limited in the study area. However, an unfortunate consequence of this "rural character" is the lack of sanitary sewer services available to the homes and businesses that are located in the study area. At the present time all domestic wastewater is treated 'on-site' by septic systems. Systems may be old and inefficient, there are limited funds for inspection and repair, and water quality degradation from untreated domestic sewage is a concern. Notwithstanding the impacts from nutrient enrichment, untreated domestic sewage can introduce pathogens that create public health issues where septic systems are failing. One of the BMPs most commonly discussed by stakeholders was a funding program for on-site septic system repair and maintenance. While several areas with poorer soil conditions could be targeted, Cyprus Creek — which is fed by the Cyprus Branch and Coleman Run watersheds — has the potential to have the biggest influx of septic related NPS.

Land Conservation and Protection

The quality of surface water in the study area is directly related to the land surface conditions and NPS discharges to surface water. Acquisition and protection of high-priority lands for conservation and management has been shown to be an effective BMP to protect surface water quality. The benefits go well beyond water quality and include benefits related to clean air, recreation and natural beauty.

Targeted/Holistic BMP Approach

Watershed management is a multifaceted discipline involving conservation and restoration, land use monitoring, education and planning (Ernst, 2004). An effective watershed management approach depends on natural and man-made conditions, land use, and the influence these factors have on the quality of water in the watershed. Analysis of the Lower Savannah River Watershed study area its subwatersheds (see Section 3) suggests a targeted list of land use-focused BMPs coupled with land conservation could have a more pronounced water quality management effect than "random acts of conservation kindness."

The following BMPs were selected as activities that could be implemented for each major land cover type (i.e. Agricultural, Forestry, Pasture and Barren, and Developed) in the study area in an effort to maintain and/or reduce the existing pollutant loads. The exact locations and the specifics of each effort will have a large effect on the success of the BMP in load reductions.

Four primary techniques were assessed as mechanisms to realistically maintain and improve water quality in the study area: septic repairs and pumping in developed areas; cover crops in agricultural lands; critical area planting in pastures and barren areas, and conservation easements in forested lands. Due to unknowns in the application of BMPs, a generic handling of the load reductions is included for each action.

Conservation Easements/Load Reduction

Conservation easements are the most long-lasting of the BMPs, and can essentially maintain land in its present condition in perpetuity. For this reason, it is important to have a protection strategy that accomplishes as many goals (i.e. water quality protection, habitat conservation) as possible. Identifying specific locations is part of the work and cost associated with conservation easements.

For the purpose of this evaluation a budget of $100,000 was used to leverage the work of other non-profit stakeholders to secure conservation easements on lands within the study area. Using an estimated land value for quality forested land at $3,200/acre and a 35% decrease in land value from an easement for the owners, $100,000 could be used to secure conservation easements on about 100 acres of land.

Load reductions for the water quality goals of conservation easements, as well as this project, were calculated based on the likeness of the forested areas being converted to other land covers. A model generated by the Michigan Department of Environment, Great Lakes, and Energy (EGLE, 2019) and STEPL with and without calculations were used to define load reductions from 100 acres that could be converted to 10 acres of development with 10 septic systems (1 failing) and 90 acres of agriculture (Appendix 4). These assumptions are based on the local land cover changes through time in the study area, and may or may not represent the actual changes that could occur in the future.

Table 4- 4. Loading Estimates from 100 acres of mixed agriculture and development land use and the load reductions from conserving those areas in the forested land cover class.

	Loading Estimates for Development and Agriculture: (lbs/yr)	Load Reduction with Easement: Maintain Forest (lbs/yr)
TSS	15,310	7,610
TN	298	118
TP	40	30
Sediment	234,000	230,000
E. coli	3.8 x 10^11	3.8 x 10^11

Cover Crops

Cover crops were mentioned several times during stakeholder meetings. Cover crops would be planted in fields during periods when the primary cash crop is not being grown. They have the potential to increase soil organic matter, reduce erosion, improve water infiltration, increase soil fertility, and break pest and disease cycles (UC Davis, 2019). All of these are helpful for growing cash crops and improving water quality. During stakeholder meetings a price of $60 per acre was provided as a workable cost for cover crops in the area, which is a bit higher than some areas where an estimate of $37.00 per acre was provided (Plastina et al., 2018). Regardless, this plan uses the $60 per acre value for budget and load reduction calculations.

For the purpose of this evaluation, a hypothetical budget of $60,000 to implement cover crops was used. Given the local cost, this translates to a total of 1,000 acres of cover crops in the study area, which is about 6% of the agricultural area. This is a one-time subsidy of monies for water quality improvements is also meant to provide the benefits of improved cash crop performance, as noted above, to establish use of the technique beyond the subsidy period.

Load reduction of nitrogen, phosphorus, and sediment runoff depend on the type of cover crop, location in study area (type of sediments and slopes), and the application and maintenance processes. Given these unknowns, the magnitude of load reduction was calculated in a generic way using a traditional cover crop with a normal planting cycle (STEPL cover crop 2; Appendix 4).

Table 4- 5. Load reductions calculated for Cover Crops on 1000 acres

Cropland		
N (lbs/yr)	P (lbs/yr)	Sediment (ton/yr)
1245.0	144.5	275

Critical Area Planting

The generic term of "critical area planting" is being used to describe improvements to both barren erosional areas and areas next to streams (riparian) where vegetative planting and grading activities would help reduce runoff entering streams. These changes are long term and may require additional maintenance, making landowner buy-in especially important. Defining locations for critical area planting activities is an important part of the costs.

For the purpose of this evaluation, a budget of $105,000 for critical area plantings was used. The cost for this work is $300 per acre based on estimates from California of about $375 – $1,400 for high slopes (https://ucanr.edu/sites/farmwaterquality/files/156383.pdf). The lowest end of costs was chosen in the study area as less earthwork will be necessary to grade the slopes for vegetation. Planting, the primary activity, should be done with native species to provide benefit to local wildlife in addition to water quality.

Given the proposed budget and working costs, a total of about 350 acres is suggested as a reasonable goal for critical area planting in the study area. This is about 2% of total pasture and barren lands. Using STEPL (Appendix 4) the decrease in loads of TN, TP, and sediment are modest for the entire study area, however, the local improvement on water quality can be significant. This is a site-specific technique and should be directed at areas that can benefit from targeted (acute) restoration goals.

Table 4- 6. Load reductions calculated for Critical Area Planting on 350 acres of pasture and barren lands

Pasture/Barren		
N (lbs/yr)	P (lbs/yr)	Sediment (ton/yr)
271.0	61.0	44

Septic

The other BMPs recommended are aimed at NPS nutrients and sediment reductions from land cover management. Septic improvements are both NPS and point source activities as each septic system is a permitted source. That said, this plan looks at the NPS aspect much like the critical area planting where targeted measures provide the best returns on investment. In essence, every drain is, and will likely be in the future, directed to a septic system as municipal sanitary sewer systems are both presently limited and unlikely to be cost effective in the future. This is a long-term issue for the study area.

For the purpose of this evaluation a minimum budget of $150,000 could be put toward the rehabilitation and restoration of potentially failing septic systems in the watersheds. This would translate to about 50 systems using an average value of $3,000 to repair/clean each system based on previous studies in South Carolina (Refs – SC watershed studies). As with other BMPs, location is important in determining the realized load reduction. In this case we have information on where those more important areas are likely to be: in areas where the soils do not allow water to percolate well. Those areas are highlighted in Section 3.

This plan uses STEPL and the assumption that fixing systems will result in an 80% reduction in nutrients and E. coli reaching the rivers and streams for each location; i.e., the fixes will not be 100% effective. Using this assumption and the cost of $3,000 per fix, 50 faulty septic systems could be addressed and would result in the reduction of E. coli MPN counts of 1.5 x 10^13 per year. These septic system improvements calculated with STEPL at an 80% success rate would also result in significant nutrient load reductions.

Table 4- 7. Calculated load reductions reaching rivers and streams from fixing 50 septic systems based on an 80% success rate

N Load, lb/yr	P Load, lb/yr	E. coli, MPN/yr
2050	801	1.5 E+13

Total Load Reductions

The goal of the project is first to maintain the existing conditions, which are in line with a healthy rural watershed. The suggested BMPs do this and may also improve conditions in specific areas where acute issues are present. The following table summarizes the proposed actions, costs, and the resulting load reductions.

Table 4- 8. Summary of BMP costs and load reductions

BMP	Cost ($)	TN Reduction (lbs/yrs)	TP Reduction (lbs/yr)	Sediment Reduction (lbs/yrs)	E. Coli Reduction (MPN/yr)
Conservation Easements	$100,000	118	30	230,000	3.8 x 10^11
Cover Crops	$60,000	1245	144	550,000	
Critical Area Planting	$105,000	271	64	88,000	
Septic Repair/Cleaning	$150,000	2050	801	0	1.5 x 10^13
TOTAL	**$415,000**	**3,684**	**1039**	**868,000**	**1.54 10^13**

Additional BMPs

Other BMPs may be considered for implementation as sources and opportunities are discovered going forward in the general implementation of this plan. These BMPs may include but are not limited to, livestock mitigation BMPs such as exclusion, grazing management, and manure management as well as low impact development, such as biofiltration and impervious surface minimization. All BMPs that will help achieve the objectives of this plan will be considered.

Section 5: Management, Implementation and Funding Strategies

This section outlines initial management strategies for the study area and discusses the approach to implement BMPs discussed in Section 4. The management strategies are designed to focus attention on watershed needs identified in this plan and to address issues that will allow LCOG to reach planning goals. Implementation of this plan will take place over a five-year period of time and will depend largely on commitments from stakeholders. The actual timeframe for implementation may change based on progress, achievements and measured improvements within the study area.

Potential funding sources are also discussed in this section, and additional information relative to funding is provided in Appendix 5.

Management Strategies

One of the most meaningful steps in developing a watershed management plan is preparing a framework for developing a list of projects and actions necessary to address the watershed management goals. Developing a team of like-minded stakeholders who understand the environment and people of the study area, and can interpret and translate information that allows for informed decision making is also important. The individual interviews with stakeholders and the two focus groups in which stakeholders participated enthusiastically has laid the groundwork for the ongoing implementation process. Recognizing that the study area management planning process can be overwhelming, and the development of a comprehensive plan based on current data for watershed analysis, BMP identification, and implementation, multi-faceted and complex, a multi-year action plan is recommended.

Short-Term Management Strategies (1-2 Years)

- Identify and organize stakeholder groups that will work with LCOG, local governments, DHEC, user groups, and the public to continue the planning process and integrate new information and data to improve the management plan.
- Develop and implement a comprehensive monitoring plan in the study area. The sampling points should be located in the subunit areas and focused on specific points within the study area that would provide water quality data for determining sources contributing FIB and pathogens within the identified reaches.
- Review water quality data to determine current water quality conditions and identify any development or land use factors that may be contributing to water quality degradation.
- Coordinate with local, state, and federal representatives to identify and implement appropriate structural and nonstructural BMPs to reduce and control NPS discharges from anthropogenic related sources.
- Continue watershed planning efforts and build on accomplishments of previous watershed planning activities. This effort should include steps to document success of previous BMP projects and the identification of new and/or modified BMPs.
- Identify and seek additional funding for watershed planning, BMP identification and implementation.

Long-Term (2-5) Years

- Build on the conservation land acquisition and management activities in the Lower Savannah River Watershed study area. Seek cooperative agreements with federal, state and non-governmental organizations to maximize benefits of the respective organization's programs and projects.
- Continue to analyze land use changes within the study area and surrounding areas that impact the watersheds, including increased highway runoff as traffic in the surrounding areas increases, and identifying new and/or modified structural and non-structural BMPs to address land use impacts to water quality.
- Continue watershed planning efforts, assess progress and continue to build on accomplishments of previous watershed management actions.

- Continue water quality monitoring and BMP effectiveness using evaluation criteria.

Education and Outreach

Education and outreach are crucial for successful implementation of the Lower Savannah River Watershed Protection Plan. The education and outreach measures are organized across six target audiences in the study area. Proposed methods are designed to support implementation and maintenance of BMPs included in Section 4, and promote general watershed health.

Table 5- 1. Education and outreach strategy

Target Audience	Behaviors to Encourage	Water Quality Parameters Addressed	Methods
General public	-Understanding of water quality issues in the study area and steps to improve watershed health	Dissolved Oxygen, Fecal Coliform, Phosphorus, Nitrogen, Turbidity	-Maintain a public website with watershed-based plan, GIS mapping results, summary of issues in the study area, and educational materials. -Implement SC Adopt-a-Stream. Work with nearby schools (Estill High School, Ridgeland High School), outdoor education groups to build regional interest in the program. Encourage a public entity such as the Lowcountry Council of Governments to obtain a monitoring kit that can be loaned to community members. Work with SCDHEC and Clemson University Center for Watershed Excellence to offer a training in the Lowcountry for interested parties. Advertise the training and program through local media, schools and community centers. -Support Clemson Extension education programs by facilitating partnerships with the Blue Heron Nature Center in Jasper County.
Boaters/general public using boat launches	-Proper trash and pet waste disposal -Reporting of pollution and fish kills	Fecal Coliform	-Install signs with the contact information for reporting pollution and fish kills to SCDHEC and SCDNR. -Install signs to discourage littering and pet waste dumping in waterways. Work

			with Keep Jasper Beautiful and Clemson Extension for specific messaging. -Install trashcans and pet waste stations as needed at boat launches. Work with Jasper, Hampton and Effingham county staff to ensure regular maintenance. -Work with Keep Jasper Beautiful to implement an "Adopt-a-Landing" program. Berkeley County's Keep America Beautiful affiliate operates a similar program where volunteer teams commit to cleaning a landing at least four times a year for two years.
Homeowners in the study area	-Annual septic tank inspections -Septic tank pumping, repairs, and replacements as needed -Proper septic tank care during floods -Appropriate levels of lawn fertilization	Fecal Coliform, Phosphorus, Nitrogen	- Implement septic tank education and repair program. Identify churches and neighborhood champions in the study area to distribute information about septic tank maintenance and resources for repairs and/or replacements. Develop a flier or brochure advertising the septic tank repair program recommended in this plan. Print materials can be distributed through the network described above, posted in county buildings and adapted for social media. Offer neighborhood champions additional educational materials to distribute. Potential materials include the "Septic System Homeowner's Guide & Record Keeping Folder" available at the SCDHEC Lowcountry Environmental Affairs office and a list of steps to take when a septic tank floods. - Encourage residents to test soil to determine the appropriate amount and method of lawn fertilization. Soil can be tested at Clemson Extension offices for approximately $6 per sample.
Realtors who work within the study area	-Educate potential buyers about how septic systems work, required maintenance, and symptoms of a malfunctioning system	Fecal Coliform	-Organize a workshop with representatives from SCDHEC and licensed septic tank installers to educate realtors on septic system uses and care. -Work with the local chapters of the South Carolina Association of Realtors to

			identify participants and advertise the event.
Farmers	-Install cover crops, buffers, and/or other BMPs that work for their property -For interested parties, protect land through conservation easements	Phosphorus, Nitrogen, Turbidity	-Contact farmers in the study area directly and ensure they are aware of NRCS resources and funding opportunities. Work with NRCS to develop a message that conveys measures to improve water quality can also help the farmer's bottom line. Messages can be tailored by land use. -Organize a water quality workshop for area farmers in the study area. Work with Jasper and Hampton NRCS district conservationists, Soil and Water Conservation Districts, and Clemson Extension agents to develop presentations on cover crops and buffers. Invite Ducks Unlimited, Lowcountry Land Trust, The Nature Conservancy to present and/or distribute materials at the event. Offering pest management credits and soil tests may boost attendance.
Foresters	-Adhere to current and future updates to SC Forestry Commission BMPs -For interested parties, protect land through conservation easements	Phosphorus, Nitrogen, Turbidity	-Support Clemson Extension education programs by facilitating partnerships with the Lowcountry Landowner Association. -Once SC Forestry Commission BMPs are updated, partner with the SC Forestry Commission to organize a workshop to ensure local foresters understand the changes. Additional partner agencies may include Clemson Extension, NRCS, Ducks Unlimited, Lowcountry Land Trust, The Nature Conservancy, and the Center for Heirs Property Preservation.

Implementation Timeline and Milestones

The implementation timeline for the plan will begin in mid-2020 however, the actual start date will depend on funding available through Section 319 Grants and other sources. The early efforts will focus on a continued effort to organize stakeholders and begin coordinating with organizations who will be involved in BMP development and implementation.

While planning level activities will consume the majority of the effort during the short-term phase of the plan, analyzing the results of the monitoring efforts, evaluation of the BMPs, and incorporating new BMPs into the management strategy will be the major focus of the long-term phase of the 5-year plan.

Table 5- 2. Implementation Timeline and Milestones

Implementation Timeline and Milestones	
Year	Milestone
2020	Organize stakeholder groups/assign responsibilities
	Coordinate with SCDHEC and develop long range monitoring plan
	Seek funding for planning/monitoring effort
	Begin water quality monitoring project in conjunction SCDHEC
2021	Work with NRCS and Ag. Industry to identify, fund, and construct Ag BMPs
	Work with SCFC and Forestry Industry to identify, fund, and construct forestry BMPs
2022	Begin Education and Outreach Program
	Continue with BMP implementation/ evaluate success
2023	Begin Education and Outreach Program
	Continue with BMP implementation/ evaluate success
2024	Evaluate overall project implementation
	Determine BMPs effectiveness for pollutants of concern

Funding

The Federal Clean Water Act Section 319(h) provides funding for various types of practices to reduce NPS pollution. In addition to Section 319 program, there are a number of federal, state and private funding mechanism that can be used in tandem with other programs or by themselves to implement watershed plans. A list of possible federal, state and private funding sources and their potential contributions isprovided in Appendix 5. At this stage it is not possible to state how much each source will provide toward implementation because those amounts will be dependent upon the application process, which includes competition for funds.

Section 6: References

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