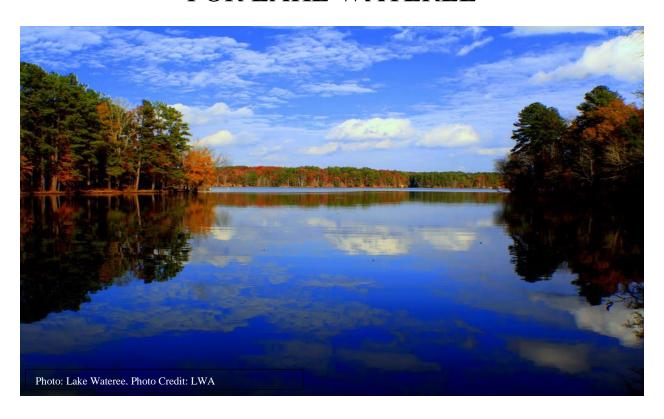
# WATERSHED-BASED PLAN FOR LAKE WATEREE



SOUTH CAROLINA RURAL WATER ASSOCIATION for SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL March 2023



#### **ACKNOWLEDGMENTS**

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#### 1) Executive Summary

The project area for the Lake Wateree Watershed Based Plan (WBP) includes the Lake Wateree-Catawba River (030501040111), Headwaters Lake Wateree-Catawba River (030501040106), Singleton Creek (030501040107), Beaver Creek-Catawba River (030501040109), and White Oak Creek (030501040110) watersheds. These watersheds total roughly 168 square miles and are in portions of Kershaw, Lancaster, and Fairfield counties in South Carolina.

Kershaw, Lancaster, and Fairfield counties are a part of the Piedmont physiographic region in South Carolina. The topography of this region consists of rolling hills, with steep slopes and numerous granite outcroppings. The region is characterized as having a humid subtropical climate, which consists of relatively high temperatures and evenly distributed precipitation throughout the year. The land use in this region included significant periods of cultivation, erosion, and sedimentation throughout the 19<sup>th</sup> and early 20<sup>th</sup> centuries. After decades of agricultural production and extensive soil loss, the land use transitioned from agricultural to forests. The project area now consists of roughly 74% forested land and only 2% agricultural land. The remaining land cover in the project area includes roughly 10% open water, 7% herbaceous, 3% developed, 2% shrub/scrub, 1% woody wetlands, less than 1% barren land, and less than 1% emergent herbaceous wetlands.

Lake Wateree is a part of a series of dammed reservoirs throughout the Catawba-Wateree River Basin. The headwaters of the Catawba-Wateree River begin in western North Carolina, flowing east, then south into South Carolina and eventually into Lake Wateree. When the Catawba River reaches the Lake Wateree Reservoir (approximately 30 miles northeast of Columbia, South Carolina) it becomes the Wateree River. In 1920, Duke Energy dammed the Wateree River and constructed what is now known as Lake Wateree. Lake Wateree originally was created as a reservoir for the Wateree Hydroelectric Station. There are two municipal drinking water intakes on the lake – City of Camden and the Lugoff-Elgin Water Authority. Both public drinking water utilities service approximately 2,800 residents in the project area and an additional 34,000 outside of the project area.

Lake Wateree is a freshwater waterbody with state defined designated uses including contact recreation, drinking water supply, aquatic life uses (including fishing and the survival and propagation of a balanced indigenous aquatic community of flora and fauna), and agricultural and industrial uses. Water quality at Lake Wateree is impaired due to numerous water quality standards not being met. There are 15 SCDHEC Water Quality Monitoring Stations (WQMSs) within the project area that are currently included on the 303(d) List of Impaired Waters. The listed impairments include biological, copper, dissolved oxygen (DO), *E. coli*, pH, Polychlorinated Biphenyls (PCBs), total nitrogen (TN), total phosphorus (TP), and turbidity. Stakeholder input and field surveys indicate that the primary sources of pollution in the project area are failing septic systems, agricultural runoff, stormwater runoff, flooding, and upstream urban influence.

The calculated estimated annual load from bacteria nonpoint pollution sources in the project area is 4.81E+16 Colony Forming Units (CFU)/year. This is a combined calculation from specific sources including septic systems, agricultural (livestock and cropland), and urban. The total estimated annual load from sediment pollution is 2,196 tons/year. The Environmental Protection Agency (EPA) Spreadsheet Tool for Estimating Pollutant Loads (STEPL) model was used to calculate the combined sediment pollutant load through the analysis of data relating to land cover, agriculture, soil, and precipitation. The total estimated annual load from nutrient pollution is 257,892 lbs/year. The STEPL model was used in the same manner to determine this combined load.

This WBP addresses the bacteria, sediment, and nutrient pollutants through mitigation strategies that will efficiently reduce and/or prevent nonpoint source pollutants from contaminating the lake and its tributaries. The recommended actions are intended to improve water quality and reduce the potential burden of increased water treatment costs to the local water utilities. The proposed mitigation strategies include installing 435 Best Management Practices (BMPs) over a 15-year timeline that consists of three five-year phases. For each phase there are 145 BMPs listed. Each phase includes the same number and kind of BMP. Over the proposed 15-year project timeline, the proposed BMPs could reduce bacteria, sediment, and nutrient loads by approximately 3.66E+15 CFU, 508 tons, and 7,214 lbs respectively. The calculated reductions from the proposed BMPs are more than double the current estimated pollutant load. This type of strategy not only addresses the current pollutant issues in the project area, but also has the potential to mitigate future impacts from continued upstream development.



SCRWA completed a Geographical Information Systems (GIS) land prioritization analysis for five BMP categories of restoration. The categories include land protection, forest management, riparian buffers, shoreline management, and agriculture. The analyses identify specific parcels that, if restored, would provide the most effective benefit or improvement to water quality. A weighted criteria was assigned to each category based on importance to water quality restoration and then applied to each parcel, resulting in detailed maps with priority categories for implementation (*i.e. high* and *low*). The maps are intended to facilitate targeted implementation projects in the project area by identifying areas that have the greatest potential impact to water quality restoration.

The land prioritization analyses were used to develop a targeted education and outreach strategy, project implementation timeline, and estimated costs for BMP installations. Installing the 435 BMPs over the recommended 15-year timeline will cost approximately \$1.5 million, which breaks down to approximately \$500,000 per each five-year phase. Recommended education, outreach, and prevention strategies will cost an additional \$201,900 over 15-years, or \$67,300 per five-year phase. Sections 9 and 17 provide more details regarding the recommended BMP installation timeline, their costs, and definitions and maintenance plans for each.

If implemented, these BMPs over time will greatly reduce the bacteria, sediment, and nutrient nonpoint source pollution causing the current water quality impairments in the project area. Though these BMPs are specifically prescriptive to the identified sources of pollution in the project area, supplemental BMPs should be considered as funding opportunities allow. Continued engagement with partners and stakeholders will increase the likelihood of the successful implementation of the recommendations proposed in this WBP.



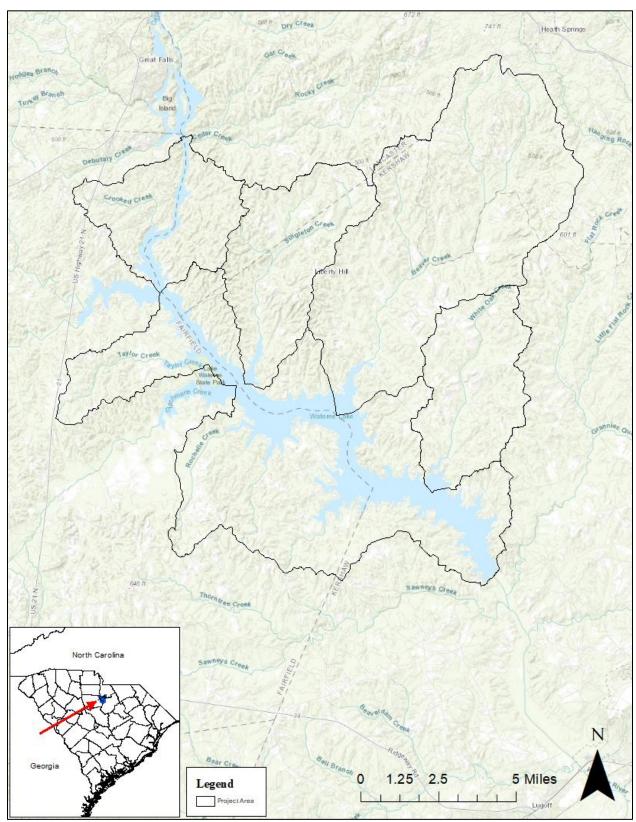
#### 2) Introduction

The purpose of a Watershed Based Plan (WBP) is to identify, assess, and develop strategies that address specific water quality impairments in a watershed(s). The WBP ultimately provides a clear roadmap that specifically addresses the identified impairments in the watershed(s). That is, the roadmap is used to manage and maintain or restore waterbodies to their designated use(s). Including local stakeholder input is a critical piece in completing this roadmap. The South Carolina Rural Water Association (SCRWA) and the Planning Team for this project requested, received, and have incorporated, where necessary, stakeholder feedback in this WBP.

Specifically, the roadmap for the Lake Wateree WBP is made up of proposed best management practices (BMPs) and/or other strategies that, if implemented, will help control or mitigate the effects to water quality impairments caused by nutrients, sediment, pathogens, pH, and dissolved oxygen (DO) in the watershed. The Planning Team will continue to incorporate stakeholder feedback for this plan, especially with regards to funding for implementing BMPs. The Planning Team anticipates applying for funding for BMP implementation from entities such as county governments, local businesses, state agencies, and federal agencies.

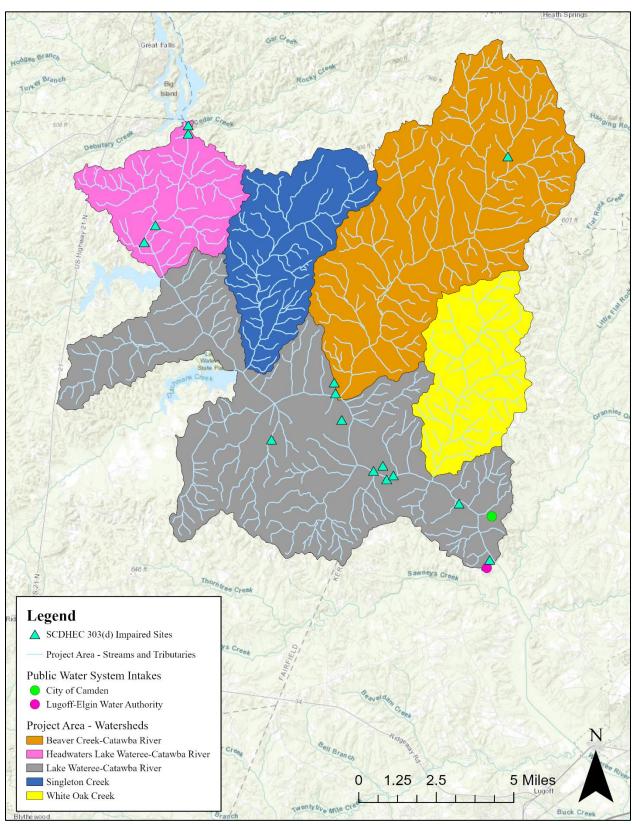
The WBP for the Lake Wateree project area is defined by five contiguous Hydrologic Unit Code (HUC) 12 watersheds including 030501040111 (Lake Wateree-Catawba River), 030501040106 (Headwaters Lake Wateree-Catawba River), 030501040107 (Singleton Creek), 030501040109 (Beaver Creek-Catawba River), and 030501040110 (White Oak Creek). These watersheds are located in portions of three counties of South Carolina: Kershaw, Lancaster, and Fairfield. Maps 1 and 2 show where the project area is located and the watersheds that are included. Lake Wateree is a manmade reservoir that is fed by the Catawba/Wateree River. The headwaters begin in North Carolina's McDowell County as the Catawba River, flowing east, then southward into South Carolina where it becomes the Wateree River.





Map 1: Project Area





Map 2: Project Area



#### 2.1) Purpose

Like many river systems in South Carolina, the Catawba-Wateree is an important water resource for many different stakeholders. The Catawba-Wateree River is a drinking water source for 18 public water utilities in North and South Carolina. These water utilities support close to two million residents throughout the basin [1]. It is also home to the Duke Energy Catawba-Wateree Hydroelectric Project, which provides renewable power to roughly 100,000 homes in both North Carolina and South Carolina [2]. Other notable water users also include farmers, nurseries, and golf courses.

Located about 30 miles northeast of Columbia, South Carolina, Lake Wateree is the primary drinking water source for the cities of Camden, Lugoff-Elgin, and other rural communities in Lancaster, Kershaw, and Fairfield Counties. The cities of Camden and Lugoff-Elgin have intakes located at the south end of Lake Wateree and together, they supply drinking water to approximately 40,000 residents [3]. Lake Wateree is also home to the Wateree Hydro Station. Built in 1919, the hydro station is located on the west side of the Catawba River in Kershaw County, roughly eight miles north of Camden.



Photo 1: Lake Wateree Hydro Station (Photo Credit: Duke Energy)

Lake Wateree also provides several recreational opportunities including fishing, boating, and swimming. It supports numerous wildlife species, including white tailed deer, turkey, quail, short-nose sturgeon, and bald eagles.

Upstream development, increased sedimentation, flood management, and harmful algal blooms (HABs) have become growing concerns for stakeholders living in and around Lake Wateree. This group of concerns has negatively impacted recreational opportunities, lakeside property value, and species habitats. There are numerous completed and active projects that focus on one or more of these concerns. For example, Duke Energy received a new Federal Energy Regulatory Commission (FERC) (2015) relicensing agreement for the Catawba-Wateree Hydro Project that will install new flood gates to improve the spillway flow release for better flood management capability at the lake. Currently, the lake does not have a way to release water in a controlled manner. The flood gates (Obermeyer gates) will provide an additional 10,000 cubic feet per second (approximately 75,000 gallons per second) of controlled flow release capacity from the lake. Per the FERC Relicense requirements, the lake will be drawn down to between six and seven feet below full pond for safe installation. The work will begin in the fall of 2022 [4].



The increase in upstream development, coupled with the absence of effective flood management, has in part contributed to substantial shoreline erosion and an overall increase in sediment deposition and water quality degradation in Lake Wateree (see Photos 2 and 3). Sediments are an effective vehicle for pollutants, including those related to bacteria and nutrients. Recommendations made in this plan will address sedimentation and other nonpoint source pollution contributions through various mitigation strategies.



Photo 2: Shoreline Erosion at Lake Wateree State Park (Photo Credit: Lake Wateree Association)





Photo 3: Flooding at Lake Wateree (2020) (Photo Credit: Lake Wateree Association)

Benthic cyanobacteria mats like the ones shown in Photos 4 and 5 appear throughout Lake Wateree, increasing year after year in shallow coves. During surveys for hydrilla in the early 1990s, Duke Energy discovered the presence of scattered populations of benthic cyanobacteria algae known as Microseira (Lyngbya) wollei. The distribution of the algae remained unchanged throughout the decade. Around 2004, the populations began to spread and become well-established on the lake, expanding even more rapidly during the late 2010s. The Microseira (Lyngbya) wollei species is thought to be native to the Southeast and has established nuisance populations in various reservoirs like Lake Wateree. The species is poorly understood in this ecological setting, which prompted the University of South Carolina to begin extensive research to better understand its characteristics and drivers for growth. Duke Energy provides to the University of South Carolina, and other interested parties, information on Microseira (Lyngbya) wollei distribution and spread for research purposes. Map 3 provides a snapshot of observed Microseira (Lyngbya) wollei populations as of 2021. Recommendations presented in this plan are made with consideration to conclusions derived by the University of South Carolina and Duke Energy.



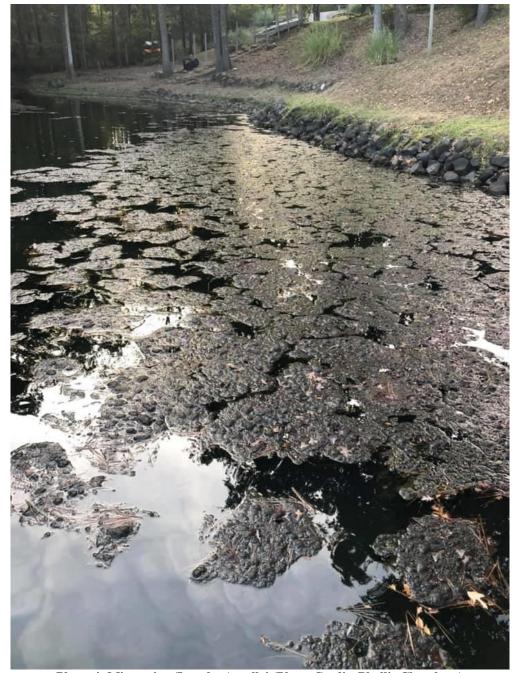


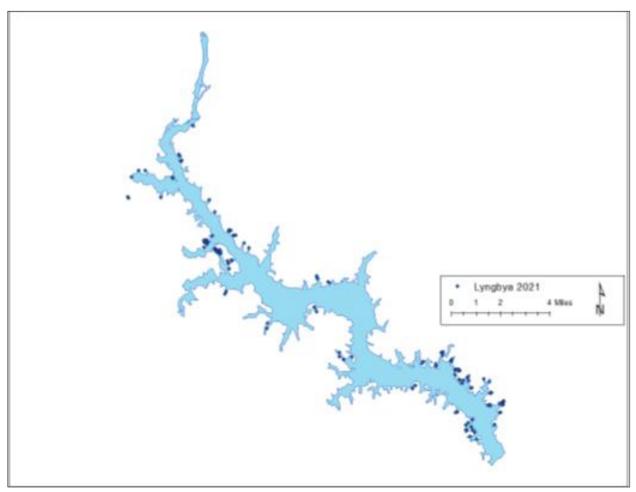
Photo 4: Microseira (Lyngbya) wollei (Photo Credit: Phyllis Chambers)





Photo 5: Microseira (Lyngbya) wollei – Lake Wateree (Photo Credit: Duke Energy)





Map 3: Microseira (Lyngbya) wollei Distribution at Lake Wateree (2021) [5]

Watershed protection is a multibarrier approach that establishes prescribed steps that eliminate or minimize the impacts from point and nonpoint source pollution. Careful consideration to long-term, cost-effective strategies is central to this approach. Strategies that create barriers to the causes of the impairments on Lake Wateree will ultimately improve the health of the lake and its designated uses.

#### 2.2) Watershed-Based Plan Development

The Lake Wateree WBP was created using input from stakeholders in the project area. The stakeholders represented various interests and points of view. This was a collaborative approach that utilized community meetings, online resources, virtual conferences, and other forms of communication to develop a plan that when implemented will successfully mitigate water quality problems in Lake Wateree. The SCRWA managed and administered the overall project with contributions coming from the following members of the Planning Team:

- City of Camden
- Lugoff-Elgin Water Authority
- Lake Wateree Association
- South Carolina Forestry Commission
- Kershaw County Soil and Water Conservation District
- Forestry Association of South Carolina
- South Carolina Department of Natural Resources
- Catawba Riverkeeper Foundation
- Catawba Wateree Water Management Group



- University of South Carolina
- Kershaw County
- Lake Wateree Coalition

Contributions from these members accounted for many professional and local perspectives including public water utilities, state forestry, county administration, academia, water basin planners, and local citizens. Our Team conducted the following activities to gather information needed for plan development:

Activity	Date
Introductory Meeting with Planning Team	7/2020
Stakeholder Survey #1	7/2020
GIS Online Mapping Tool	4/2021
Stakeholder Meeting – Pollutant Sources and Reduction Strategies	9/2021
Windshield Surveys	Six Surveys Conducted
GIS Data Collection	Data Collected Over Eight Months
Community Stakeholder Meetings	Five Meetings Conducted

Over the course of the planning process, the Planning Team met, conducted numerous windshield surveys on and around Lake Wateree, published a public facing stakeholder survey, published a pollutant locator mapping tool, and participated in several water quality sampling runs on the lake. Figure 1 below shows a pollutant locater mapping tool developed by SCRWA to help identify local nonpoint sources of pollution. The tool was built using ArcGIS Survey 123 and ArcGIS Experience Builder software. SCRWA also recorded a training video utilizing YouTube that provided step-by-step instructions for completing the dashboard. Digital links to the training video and dashboard were then distributed to the Planning Team. The dashboard allowed stakeholders to perform several functions including filling in written detail for identified pollution, pinpoint pollution locations on a map, and attaching pictures showing the pollution as observed by the stakeholder. SCRWA provided a list of pollutants on the dashboard from which stakeholders could choose from including Water Quality, Erosion/Sedimentation, Failing Septic System, Presence of Algae, Excess Fertilizers, Livestock in Streams/Rivers, Foam, Trash, Illicit Discharge/Effluent, Land Disturbance (Construction-Related), Land Disturbance (Forestry-Related), and Other. There was a total of 15 submissions to the dashboard with nine identifying Presence of Algae, two identifying Land Disturbance, one identifying Erosion/Sedimentation, one identifying Excess Fertilizers, one identifying Water Quality, and one identifying Other. The complete detail for each submission can be found in Appendix A. All contact information is redacted to protect the stakeholder's anonymity.



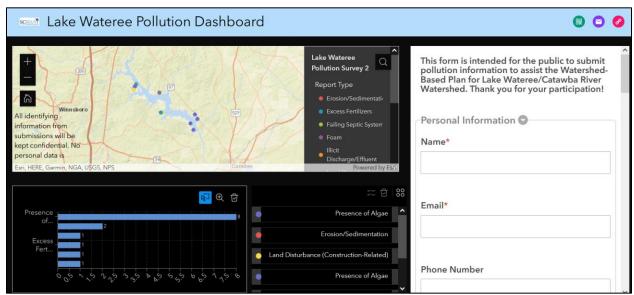


Figure 1: Lake Wateree Pollution Dashboard/Survey

The following data and information were used to assess watershed conditions, water quality, and potential management strategies.

- SCDHEC surface water monitoring data
- SCDHEC 303(d) List of Impaired Waters
- Lake Wateree Association/WaterWatch water quality monitoring data
- Land Cover data
- Windshield surveys
- Lake Wateree Association/WaterWatch monitoring runs
- Stakeholder knowledge of specific pollutants
- South Carolina Forestry Commission forestry data

This WBP incorporates the nine elements required for WBPs developed with the Clean Water Act (CWA) Section 319 funding. The nine elements include identify causes and sources of pollution, estimate pollutant loading and expected load reductions, describe management measures that will achieve load reductions and targeted critical areas, estimate amounts of technical and financial assistance, develop an education component, develop a project schedule, describe interim measurable milestones, identify indicators to measure progress, and develop a monitoring component. By completing the required nine elements for WBP development, project partners will be eligible to seek future CWA Section 319 funding for implementation strategies detailed in this WBP. Additional funding options for implementation strategies are detailed in Sections 11 through 15.

#### 2.3) How the Plan Will Be Used

This plan will be a great resource for local community groups, counties, public works departments, and local, state, and federal agencies. These stakeholders can utilize this plan in several ways including:

- Watershed conditions education
- Water quality education
- Water quality monitoring coordination
- Planning decision making
- Community engagement
- BMP implementation guidance



Plan implementation is voluntary and can be accomplished through financial incentives and community involvement.

The following sections provide a detailed assessment of the of the project area, water quality impairments, and a watershed implementation plan for protecting and restoring the waterbodies in the project area. Data and information on water quality, water quality impairments, land cover, pollutant sources, and pollutant load measurements are also provided. Goals, practices, and strategies for mitigating pollutant loading, monitoring framework, and financial opportunities are explained in following sections.

#### 3) Watershed Characteristics

#### 3.1) Watershed Assessment Area

The headwaters of the Catawba-Wateree River begin in the western portion of McDowell County, North Carolina and flow east before turning southeast, flowing to the North/South Carolina border. From the headwaters in McDowell County the river flows into Lake Norman, north of Charlotte, then into Lake Wylie, and eventually into Lake Wateree. When the Catawba River reaches the Lake Wateree Reservoir (approximately 30 miles northeast of Columbia, South Carolina) it becomes the Wateree River.

In 1920, Duke Power (now Duke Energy) dammed the Wateree River and constructed what is now known as Lake Wateree. Lake Wateree originally was created as a reservoir for the Wateree Hydroelectric Station. The lake has approximately 13,864 surface acres and 181 miles of shoreline. Lake Wateree also provides drinking water through two municipal drinking water sources – City of Camden, and the Lugoff-Elgin Water Authority [6]. The City of Camden began treating and distributing drinking water from Lake Wateree in 1999 and the Lugoff-Elgin Water Authority began treating and distributing in 1971. The current raw water intake on Lake Wateree for the Lugoff-Elgin Water Authority went online in 2005.

This WBP focuses on five contiguous HUC-12 watersheds: Headwaters Lake Wateree-Catawba River (030501040106), Lake Wateree-Catawba River (030501040111), Singleton Creek (030501040107), Beaver Creek-Catawba River (030501040109), White Oak Creek (030501040110). Together, these watersheds total 107,508 acres (168 square miles) in portions of Kershaw, Lancaster, and Fairfield Counties in South Carolina (see Map 2). The five watersheds forming the project area include:

- 1. Headwaters Lake Wateree-Catawba River (030501040106). This is the northernmost watershed in the project area, covering 10,025 acres (16 square miles) in Lancaster and Fairfield Counties. Lake Wateree is dammed north of this watershed boundary. Cedar Creek, McDowell Creek, and Crooked Creek are all tributaries that drain to the main stem of the lake. The watershed is 69% forested, 2% developed, and ~1% agriculture.<sup>1</sup>
- 2. Lake Wateree-Catawba River (030501040111). This is the largest watershed in the project area, covering 40,524 acres (63 square miles) in parts of Fairfield and Kershaw Counties. The watershed makes up the main body of Lake Wateree and is fed by numerous tributaries including Taylor Creek, Dutchman Creek, Singleton Creek, Rochelle Creek, Fox Creek, Colonel Creek, and Stillhouse Branch. Both municipal drinking water utility intakes are located in the southern portion of the watershed. The watershed is 66% forested, 4% developed, and 1% agriculture.<sup>1</sup>
- 3. Singleton Creek (030501040107). The watershed covers 12,500 acres (20 square miles) on the eastern side of Lake Wateree in portions of Kershaw and Lancaster Counties. McDow Creek and Rocky Branch join Singleton Creek and then feed to the main stem into the lake. The watershed is 82% forested, 2.4% developed, and 1% agriculture.<sup>1</sup>

<sup>&</sup>lt;sup>1</sup> Percent forested was determined using *Deciduous Forest, Evergreen Forest,* and *Mixed Forest* designations from the 2020 National Land Cover Database (NLCD). Percent developed was determined using *Developed-Open Space, Developed-Low Intensity,* and *Developed-Medium Intensity* designations from the 2020 NLCD. Percent agriculture was determined using the *cultivated crops* and *hay/pasture* designations from the 2020 NLCD.



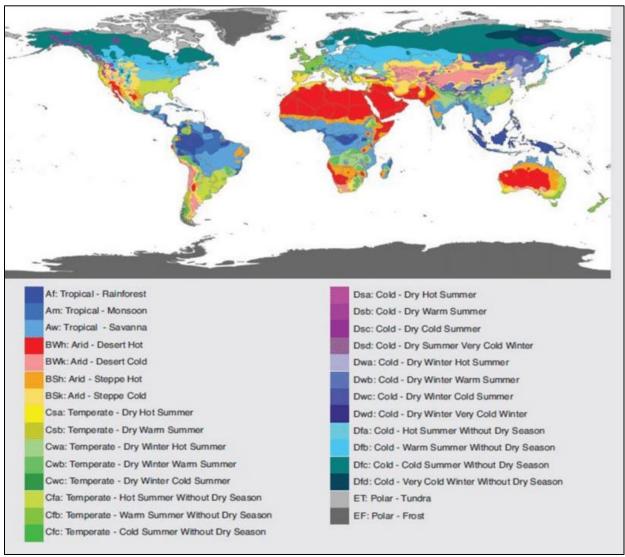
- **4. Beaver Creek-Catawba River (030501040109)**. The watershed covers 33,329 acres (52 square miles) on the eastern side of Lake Wateree, directly south of the Singleton Creek Watershed, in portions of Kershaw and Lancaster Counties. Tranham Creek, Showerbath Branch, and Little Beaver Creek form to create Beaver Creek, which feeds to the main stem and into the lake. The watershed is 80% forested, 2.6% developed, and 3% agriculture.<sup>1</sup>
- **5.** White Oak (030501040110). This watershed covers 11,132 acres (17 square miles) on the eastern side of Lake Wateree, directly south of Beaver Creek-Catawba River Watershed, in Kershaw County. White Oak Creek tributary originates in the watershed and eventually empties in the main stem into the lake. The watershed is 78% forested, 3% developed, and 1.6% agriculture.<sup>1</sup>

#### **3.2) Climate**

According to the Köppen climate classification, South Carolina is in the "humid subtropical climate." The humid subtropical climate is characterized as "relatively high temperatures and evenly distributed precipitation throughout the year. This climate type is found on the eastern sides of the continents between 20° and 35° N and S latitude" [7].

During summer months these regions are influenced by moist, maritime airflow over low-altitude ocean waters. Temperatures are high during the summer, with the warmest months averaging about 81 °F, with mean daily maximum temperatures between 86 ° to 100 °F. Convectional thunderstorms create more rainfall during the summers than the winters. The coldest month in this region falls between 41 ° to 54 °F [7].





Map 4: Köppen Climate Classifications Map [8]

South Carolina's climate is controlled by the state's location in the northern mid-latitudes, proximity to the Atlantic Ocean and Appalachian Mountains, and elevation. The state's position on the eastern coast of the continent is also important for climate characterization. The sea breeze cools during the summer and warms the immediate coast during winter. South Carolina's weather is dominated by maritime tropical air, which is referred to as a Bermuda high. The Appalachian Mountains affect South Carolina's climate in three primary ways. First, the mountains block many cold air masses, which makes the winters milder. Second, downsloping winds cause the areas leeward of the mountains to experience slightly higher temperatures than the surrounding areas. Third, the mountains cause an area of decreased precipitation across the Midlands, running parallel to the fall line (see Map 5) [8].





**Map 5: South Carolina Fall Line** 

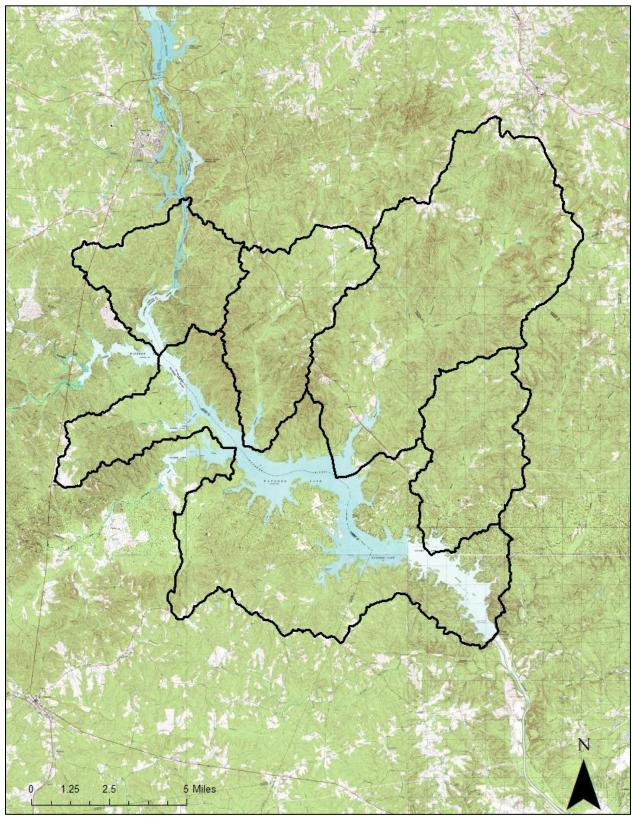


Because the project area is located within three counties, Kershaw, Lancaster, and Fairfield, an average of each county's climate normal was taken for the following parameters: minimum temperature, maximum temperature, mean temperature, and precipitation per year. From 1991 to 2020, temperatures in these counties ranged from an average minimum temperature of 53.1°F to an average maximum temperature of 75°F, with the mean temperature of 64.1° F. Precipitation totaled 42 inches per year, with the heavier precipitation events typically occurring in the winter months. From 1971 to 2020, all temperature statistics have continued to increase and precipitation totals have steadily decreased [7].

#### 3.3) Topography

The project area is located within the Southern Outer Piedmont region, a subregion of the larger Piedmont physiographic region of South Carolina. Elevation in the Piedmont increases dramatically throughout the region, from 300 feet in Richland, Lexington, and Kershaw Counties, to 1,200 feet in Oconee and Pickens Counties. The Piedmont, at one time, was considered the coast of the continent of North America. When the Atlantic Ocean receded, the Sandhills physiographic region was exposed. The Sandhills separates the Piedmont from the coastal plain. Due to tectonic collisions millions of years ago, most of the rock formations in the project area are metamorphic, which were originally sandstone and shale [9]. Field surveys of the project area indicate that the topography consists of rolling hills, rising from an elevation of 225 feet at the lakeshore to over 500 feet on the hilltops. Slopes are surprisingly steep with numerous granite outcroppings dotting the landscape. The area is often referred to by locals as the "Devil's Backbone." Map 6 shows the topographic features of the project area using digital elevation data.





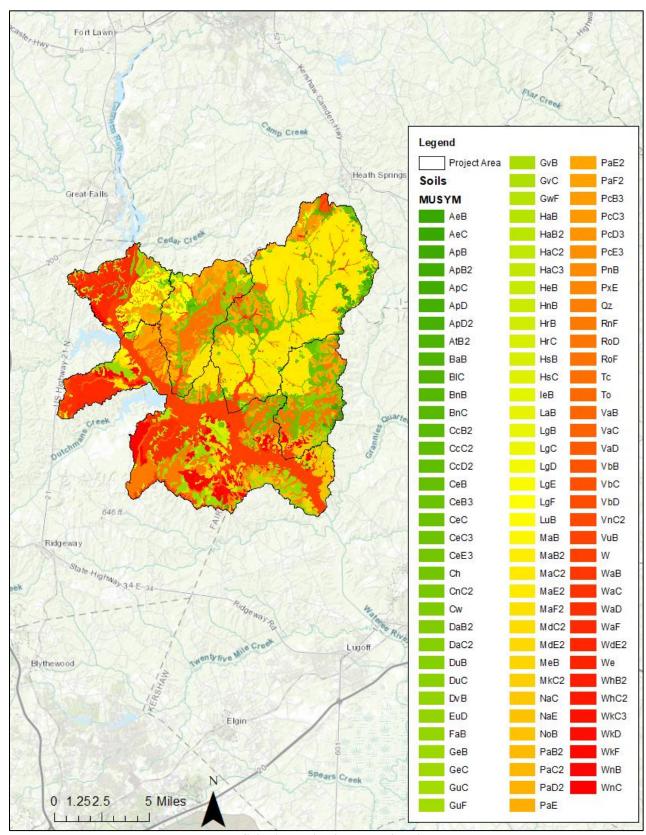
Map 6: Digital Elevation Model/Topographic Map of Project Area



#### **3.4) Soils**

Soils data produced by the National Cooperative Soil Survey show that the project area consists of 178 soil types ranging from clay to sandy clay loams. The general description of the soils in the project area includes clay soils at the surface with other surface soils that are mostly sandy loams, fine sandy loams, silt loams and clay loams. Subsoils are clay, sandy clays, silty clays, and heavy clay loams. The predominate soil type in the project area is Madison Sandy Clay Loam (MaC2), making up roughly 12% of all soils. This soil is considered well drained, moderately permeable and found on gentle slopes ranging from 6-10% [10]. Map 7 shows a spatial representation of the soils data.



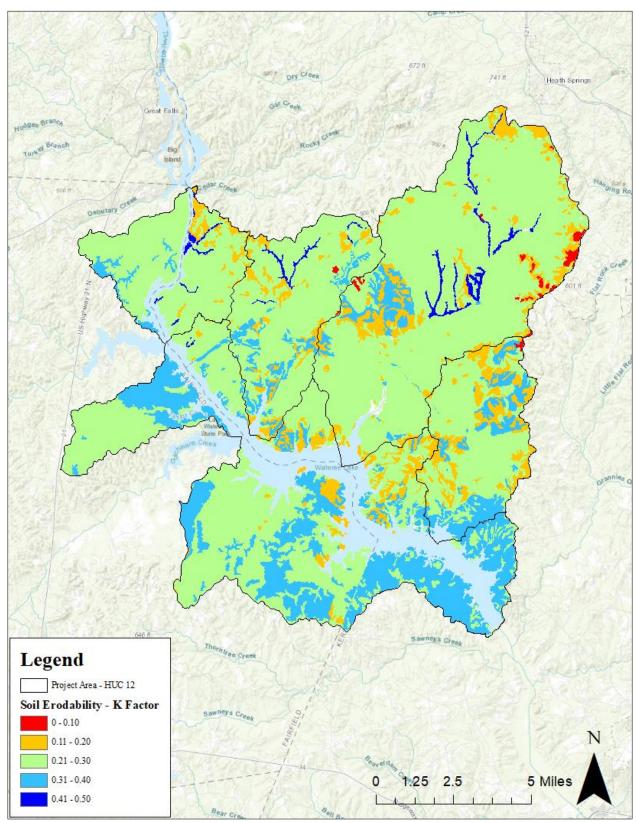


Map 7: Soils Allocation in the Project Area



Map 8 shows the soil erodibility factors (K-Factor) for soils in the project area. The K-Factor is an index that quantifies the relative susceptibility of the soil to sheet and rill erosion. The higher the K-Factor measurement, the more susceptible the soil is to sheet and rill erosion. As shown in Map 8, areas near or adjacent to waterbodies have higher measurements. There are particularly high measurements in segments of Beaver Creek, McDowell Creek, Singleton Creek, and McDow Creek.





Map 8: Soil K-Factor Measurements in Project Area



The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) developed designations for hydrologic soil groups to describe the conductivity of water through soil and are used in the determinations for runoff potential. The soil groups are categorized in decreasing water transmission capacity from A to D [11].

<u>Group A</u>: These soils have low runoff potential when thoroughly wet. Water is transmitted freely through the soil with less than 10% clay and more than 90% sand and gravel. Soils having loamy sand, sandy loam, loam or silt loam textures may be found in this group. The high rate of water transmission is calculated as greater than a K-Factor of 0.30 inches per hour.

<u>Group B</u>: These soils have moderately low runoff potential when thoroughly wet and water transmission is unimpeded. The soils typically have between 10% and 20% clay and 50% to 90% sand with sandy loam textures. Soils having loam, silt loam, silt, or sandy clay loam textures are put in this category if well aggregated, of low bulk density, or contain more than 35% rock fragments. The moderate rate of water transmission through these soils is calculated at a K-Factor between 0.15 to 0.30 inches per hour.

<u>Group C</u>: These soils have moderately high runoff potential when thoroughly wet and water transmission is somewhat restricted. The soils typically have between 20% and 40% clay and less than 50% sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures are placed in this category if well aggregated, of low bulk density, or contain more than 35% rock fragments. The low rate of water transmission through these soils is calculated at a K-Factor between 0.05 to 0.15 inches per hour.

<u>Group D</u>: These soils have high runoff potential when thoroughly wet and water movement is restricted or very restricted. The soils typically have more than 40% clay, less than 50% sand, and clay like textures. The very low rate of water transmission through these soils is calculated at a K-Factor between 0.00 to 0.05 inches per hour [11].

According to USDA NRCS hydrologic soil group classifications, "the slope of the soil surface is not considered when assigning hydrologic soil groups" [11]. Soil erodibility is the measure of how well soils and rocks resist erosion. Soils from Groups A and B are those with high water infiltration rates and therefore have a greater resistance to erosion. Conversely, soils from Groups C and D have low infiltration rates which indicates a lower resistance to erosion. Identifying what kind of hydrologic soil groups are in the project area will provide context to the potential sources of nonpoint source pollution in the area. It will also highlight areas, or hotspots, to be considered for implementation. The project area is predominately comprised of Groups A and B hydrologic soil groups as seen in Map 7.

#### 3.5) Land Use/Land Cover

#### 3.5.1) Historical Land Use

The project area falls within the southcentral Piedmont physiographic region in South Carolina. The historical land use practices in this region show significant periods of cultivation, erosion, and sedimentation. Stanley Trimble's *Man-Induced Soil Erosion on the Southern Piedmont* paints a clear and detailed picture of the historical land use in the project area. He states, "The Southern Piedmont is one of the most severely eroded agricultural areas in the United States. Much of the Piedmont has been stripped of the topsoil and many areas have been dissected and gullied so badly as to render the land unsuitable for agriculture. The debris from this erosion has filled stream channels and valleys to varying degrees, often swamping the adjacent bottomlands. The amount of material eroded from the Southern Piedmont has recently been quantified by analyzing the truncation of soil profiles. It was estimated that the study areas has [sic] lost about 6 cubic miles of soil material...9.5 inches from South Carolina. On a regional basis, maximum soil erosion occurred in the lower (southeastern) Piedmont of South Carolina" [12]. Figure 2 shows the average depth of total soil erosion throughout the Piedmont from 1700 to 1970. The project area has lost roughly 10 inches or more of soils during this time period, with the majority occurring in the 1800s, when cotton was the primary crop [12].



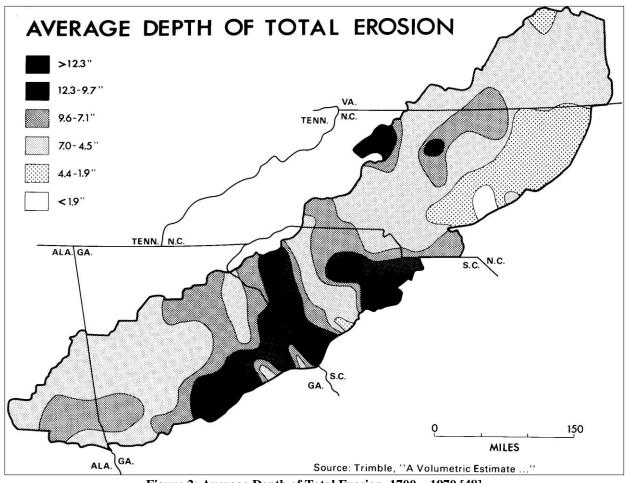


Figure 2: Average Depth of Total Erosion, 1700 – 1970 [48]

The cultivation of cotton became the primary crop in the area by 1810, which created a "rapidly increasing erosive land use (ELU)" [12]. According to Trimble, "ELU increased dramatically...With the availability of cotton gin circa 1795, the growing of cotton became widespread on the lower Piedmont of South Carolina...With the aid of slaves the clearing, exploitation and abandoning of land soon began to take place at a rate greater than that of the tobacco area to the north" [12]. In this area, an observer in 1818 noted, "Large quantities of land have been cleared within the last 20 years and a new tax was now imposed on the strength of the soil, compelled to bear alternate crops of corn and cotton, or successive crops of the latter. This system, if it may be so called, of perpetual exhaustion, has impoverished our lands to an alarming degree and, if pursued for a half century more, would make this interesting portion of the state a perfect desert – exhibiting a naked barren surface, spotted here and there by a few patches of broomstraw, or starved shrubbery, and ruined from future recovery by deep washed gullies, the permanent and accusing witnesses of our apathy and indolence" [13].



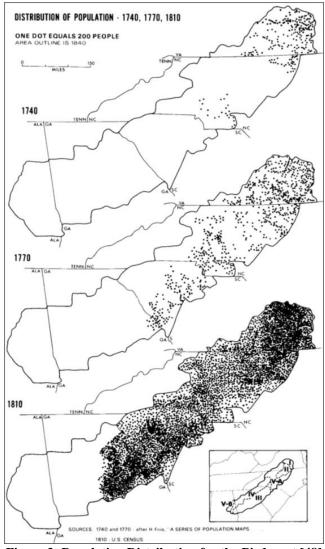
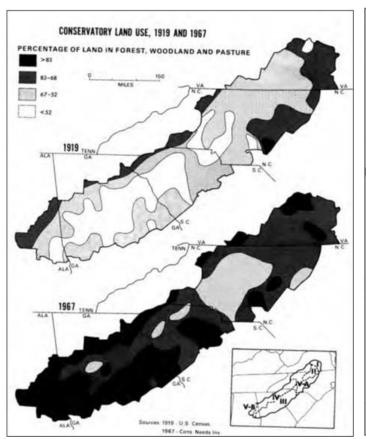


Figure 3: Population Distribution for the Piedmont [48]

European settlement in this region was considered completed by 1830 and by the early 1850s the region was flourishing with cotton plantations. The area was described as "Tens of thousands of acres of once productive lands are now reduced to the maximum of sterility...Water-worn gullied old fields everywhere meet the eye." And by the 1880s, after decades of cultivation, disastrous erosion resulted in the area. Streams in the area were "...in many places filling up with detritus...sand and mud...which is washed in from the hill-sides [sic] so that many shoals are being rapidly obliterated, and at many places where within the memory of middle aged men there were shoals or falls of 5 to 10 feet, at present scarcely any shoals can be noticed." According to Trimble, "Perhaps one of the most eroded parts of the lower region was Fairfield County, South Carolina, where 90,500 acres, or 20.8 per cent of the upland, was so devasted by 1909 that it was simply termed 'rough, gullied land' rather than being categorized by soil type" [12].

From 1900 to 1920, the area began the gradual decline of established agricultural production. The abandoned cropland slowly transitioned to forests or was intentionally made forests or pastureland (see Figure 3). From 1920 to 1960, farm tenancy in the area declined significantly, thereby marking an end to an almost century long cropping economy defined by destructive erosion and complete land use change (see Figure 4 and Figure 5) [12].





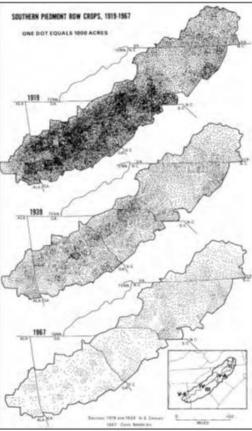


Figure 4: Conservatory Land Use, 1919 and 1967 [48]

Figure 5: Southern Piedmont Row Crops, 1919-1967 [48]

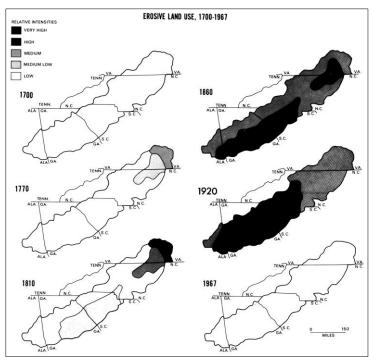


Figure 6: Erosive Land Use, 1700-1967 [48]



The following is a brief historical description of land use for each county within the project area. The counties include Fairfield, Kershaw, and Lancaster. The descriptions for each county are taken from USDA Soil Surveys conducted in the early 20<sup>th</sup> century.

### Fairfield County

According to the soil survey conducted in 1911 by the USDA Bureau of Soils for Fairfield County, "Many steep hillsides have been cleared and planted to cotton and corn, and these have become so badly gullied and washed as to prevent tillage. Such fields are to be found in all sections of the county and are now grown up to old-field pines. Not only these hillside fields, but many of more gentle slope, have been allowed to reach the same condition. Besides the loss in farm acreage due to the abandonment of these upland areas, much bottom land has been made worthless by a covering of sand washed down from the cleared uplands." The author later adds, "The soils of Fairfield County are in special need of organic matter. The system of cropping has deleted the soil of its former natural sore of such material, and the problem now is to aid nature in resorting it" [14]. Photo 6 and photo 7 included below, show signs of erosion in Fairfield County in the early  $20^{th}$  century. The evidence of erosion in these photos can be seen on the sloped areas of the field.



FIG. 1.-BADLY ERODED FIELD.

Cultivation will soon have to be abandoned along the lowerslope. Land of this kind is valuable only for forestry and pastures (Bermuda grass).]

Photo 6: Badly Eroded Field, Fairfield County [14]



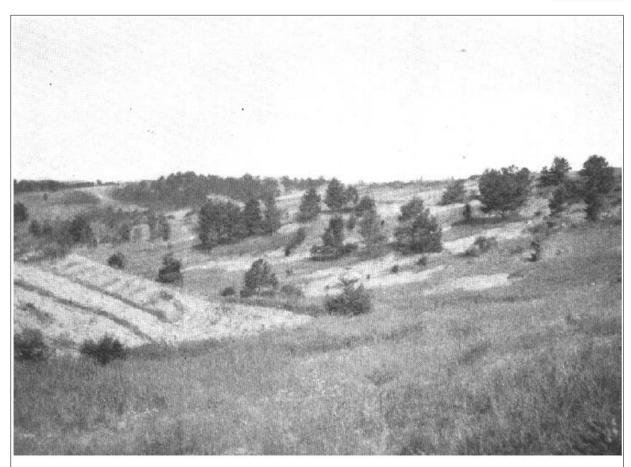


FIG. 2.-EROSION WELL STARTED ON GENTLE SLOPE.

[The volunteer trees on this abandoned slope indicate one means of utilizing such areas and of checking crosion, i. e., reforestation. Bermuda grass thrives on these washed areas, if not too severely guilied, and spreads rapidly when once started, checking erosion, and affording good pasturage.]

Photo 7: Erosion on Slope, Fairfield County [14]

The soil survey also details the areas in Fairfield County that are deemed "rough gullied land." "The rough gullied land comprises a variety of soils, which are so mixed, so badly washed and gullied, and so rough in topography that it was impracticable to make any satisfactory separation into distinct types...The slopes along the stream courses and narrow bottoms are badly washed and gullied. The surface features are generally so uneven and broken as to preclude the use of the land for farming" [15].

The survey states that in its natural state, Fairfield County is "covered with forests of hardwoods, largely oak and shortleaf pine. Most of this has been cut and the present growth is largely stunted shortleaf pine and scrubby oaks...Excessive erosion and poor management when under cultivation has caused the abandonment of much of this land. Erosion is advancing at a rapid pace on cleared areas, and will continue unless a different use is made of the land" [15]. The land use information provided in the USDA Soil Survey for Fairfield County (1911) is consistent with other documentation stated in this report. The land use in the project area consisted of heavy cotton cultivation for much of the 19th and early 20th centuries, which ultimately lead to significant erosion and other conditions unfavorable for further cultivation.



#### Kershaw County

The USDA Soils Survey, published in 1919, for Kershaw County describes land use dating back to the late 1700s. The author states, "The early settlers were attracted to this section by the rich bottom land along the Wateree River in the vicinity of the mouth of Big Pine Tree Creek, and settlements were made on both sides of the river for a distance of 6 miles above and below this point...The early settlers planted corn, wheat, oats, flax, and tobacco. An early chronicle describes a freshet in the Wateree River in 1795, which destroyed corn, oats, and hogsheads of tobacco. Cotton planting is mentioned in 1797, the report stating that it had just been introduced, but it did not become an important crop until about 1850. Rice planting began upon the low bottom land soon after its introduction to this State, but was not grown extensively until after the introduction of water culture in 1783...The Civil War brought a great change in the agriculture of this county. The increased costs of keeping ditches and dikes caused the abandonment of rice culture to a great extent, and subsistence crops ceased to be grown upon the scale that they grew before the war, while the high price of cotton soon led to its [sic] becoming the main money crop" [16]. The survey adds that "In, 1879, according to census reports, 28,978 acres were planted to cotton, 21,891 acres to corn, and 2,849 acres to oats. The succeeding census reports of 1890, 1900, and 1910 show a steady increase in these crops" [16]. The land use for Kershaw County from the late 18<sup>th</sup> century to the early 20<sup>th</sup> century consisted of various forms of crop cultivation including corn, oats, tobacco, and cotton.

### **Lancaster County**

The USDA Soil Survey, published in 1904, for Lancaster County describes land use dating back to the original settlers. The author writes, "The first permanent settlers, who emigrated from Pennsylvania, were of Scotch-Irish descent. A few French were also among the early settlers. They met with such poor success in the cultivation of the crops to which they had been accustomed that they resorted to collecting and exporting the products of the great forests which surrounded them" [14]. Regarding the agricultural conditions, the author states, "Although the soils and climatic conditions are identical with those found in other highly developed sections of the Piedmont Plateau, agriculture in Lancaster County is backward and is unquestionably retarded by the system of farming practiced...The Twelfth Census shows the total area in farms to be 271,316 acres, of which 119,117 acres are improved" [14]. The survey details cotton as the primary crop dating back to the early 1800s and that tenant farming practices resulted in poor care of soils and land use in this county. The popularity of cotton, coupled with tenant farming, over the course of almost a century left the area unfit for future agricultural success.

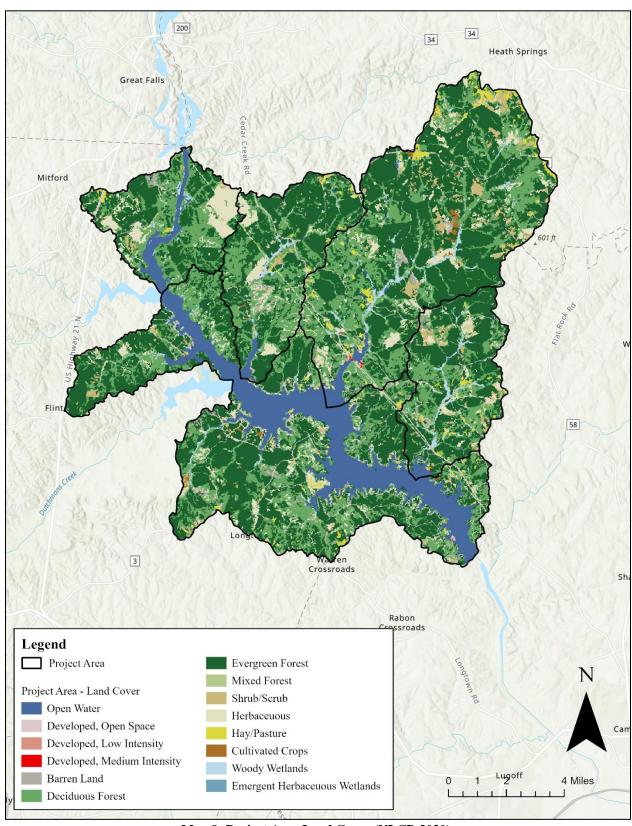
#### 3.5.2) Present Land Cover

Members of the SCRWA contributed to the watershed assessment for the project area utilizing desktop and field surveys. This section details current land cover conditions for the project area, land cover conditions for each of the five watersheds individually, and a snapshot of more recent land cover changes for the project area for the period of 2001 to 2019. The National Land Cover Dataset (NLCD) is organized by land cover characterizations based on existing land uses. The term "land cover" is used instead of "land use" in instances where NLCD data was utilized.

The 2020 National Land Cover Dataset (NLCD) was used as the most current data for determining current land cover in the project area. Each NLCD land cover designation was calculated as a single percent represented in the project area. Table 1 shows the breakdown of each designation and Map 9 shows the various land cover types in the project area. In Table 2 Forests represent the following as one combined calculated percentage: Evergreen Forest, Deciduous Forest, and Mixed Forests. Developed represents the following as one combined calculated percentage: Developed, Open Space; Developed, Medium Intensity; and Developed, Low Intensity. Agriculture represents the following as one combined calculated percentage: Hay/Pasture and Cultivated Crop.

The results of the desktop and field analyses indicated that roughly 74% of the project area is forested, 3% developed, 2% agriculture, 12% open water/wetlands, and the remaining 9% barren land, shrub/scrub, and herbaceous vegetation (see Table 2). The historical impacts from land use practices in this area, and the Piedmont physiographic region as a whole, is likely the primary reason forested land cover is significantly higher than traditional agricultural land cover. This section provides specific details, some firsthand, regarding the negative impacts to land cover from the traditional agricultural practices during the 19th and early 20th centuries.





Map 9: Project Area Land Cover (NLCD 2020)



Land Cover	Acres	Percent
Evergreen Forest	49,893	46.41
Deciduous Forest	28,898	26.88
Open Water	10,781	10.03
Herbaceous	7,247	6.74
Developed, Open Space	3,039	2.83
Shrub/Scrub	2,777	2.58
Woody Wetlands	1,624	1.51
Hay/Pasture	1,596	1.48
Barren Land	828	0.77
Mixed Forest	440	0.41
Cultivated Crops	222	0.21
Developed, Low Intensity	116	0.11
Emergent Herbaceous Wetlands	26	0.02
Developed, Medium Intensity	24	0.02
TOTAL	107,513	100.00

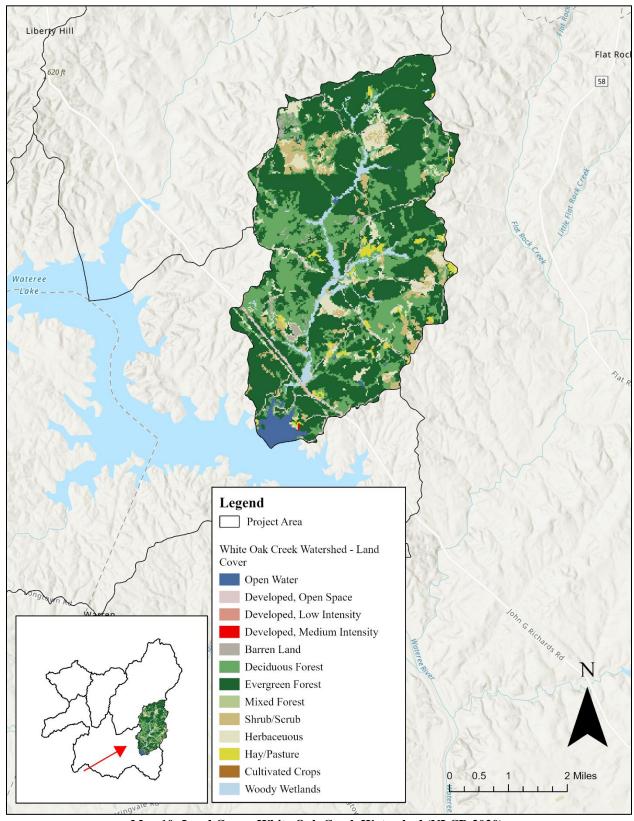
Table 1: NLCD Land Cover Designation by Acre and Percent in Project Area (NLCD 2020)

Land Cover			
Forests (Evergreen Forest, Deciduous Forest, Mixed Forest)	73.69		
Open Water	10.03		
Herbaceous	6.74		
Developed (Developed, Open Space, Developed, Medium Intensity, Developed, Low Intensity)	2.96		
Shrub/Scrub	2.58		
Agriculture (Hay/Pasture, Cultivated Crops)	1.70		
Woody Wetlands	1.51		
Barren Land	0.77		
Emergent Herbaceous Wetlands	0.02		
TOTAL	100.00		

Table 2: Combined Land Cover by Percent in Project Area (NLCD 2020)

The maps and tables presented below show the different types of land cover and the respective percentages of land cover for each of the five watersheds within the project area. Land cover types including forests, developed, and agriculture are fairly evenly distributed throughout each of the five watersheds. Forested land cover ranges from 81.92% to 66.24%, with the Singleton Creek watershed having the highest percentage for forested land cover. Developed land cover ranges from 3.74% to 1.57%, with the Lake Wateree-Catawba River watershed having the highest percentage for developed land cover. Agricultural land cover ranges from 2.96% to 0.88%, with the Beaver Creek watershed having the highest percentage for agricultural land cover.





Map 10: Land Cover, White Oak Creek Watershed (NLCD 2020)



Land Cover	Percent
Evergreen Forest	52.80
Deciduous Forest	25.22
Herbaceous	6.42
Shrub/Scrub	4.68
Woody Wetlands	3.05
Developed, Open Space	2.85
Open Water	1.97
Hay/Pasture	1.58
Barren Land	1.12
Mixed Forest	0.20
Developed, Low Intensity	0.07
Developed, Medium Intensity	0.03

Table 3: Land Cover Percentage, White Oak Creek Watershed (NLCD 2020)

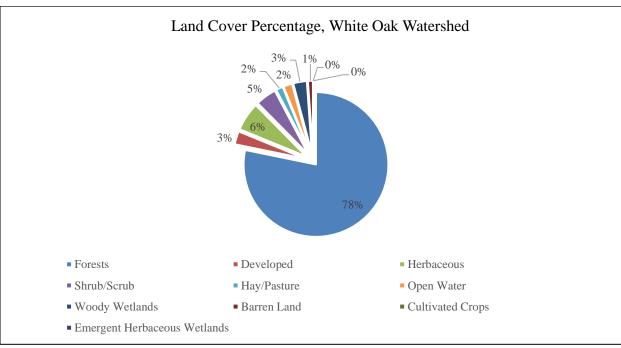
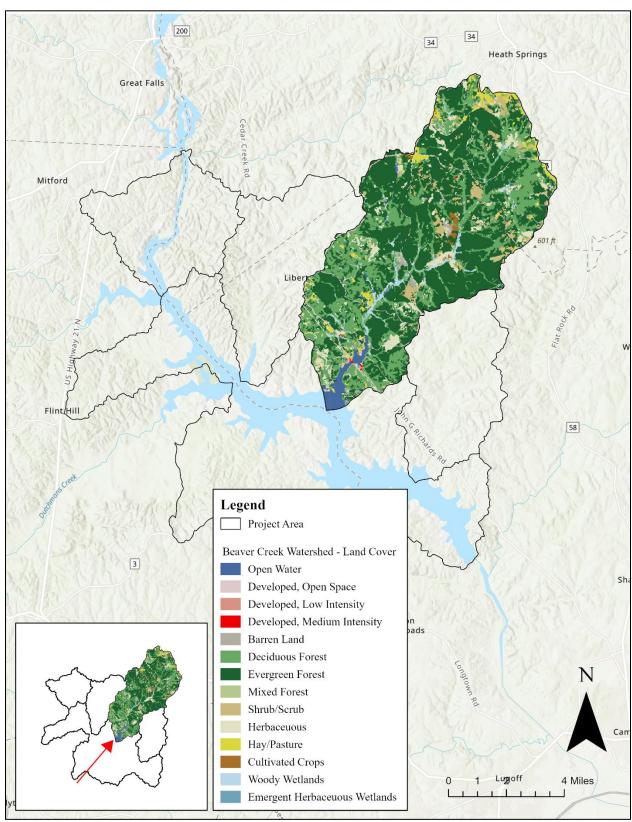


Figure 7: Land Cover Percentage, White Oak Creek Watershed (NLCD 2020)





Map 11: Land Cover, Beaver Creek Watershed (NLCD 2020)



Land Cover	Percent
Evergreen Forest	50.64
Deciduous Forest	28.25
Herbaceous	6.19
Shrub/Scrub	4.13
Hay/Pasture	2.51
Developed, Open Space	2.46
Open Water	2.01
Woody Wetlands	1.90
Mixed Forest	0.66
Barren Land	0.61
Cultivated Crops	0.45
Developed, Low Intensity	0.12
Developed, Medium Intensity	0.04
Emergent Herbaceous Wetlands	0.04

Table 4: Land Cover by Percentage, Beaver Creek Watershed (NLCD 2020)

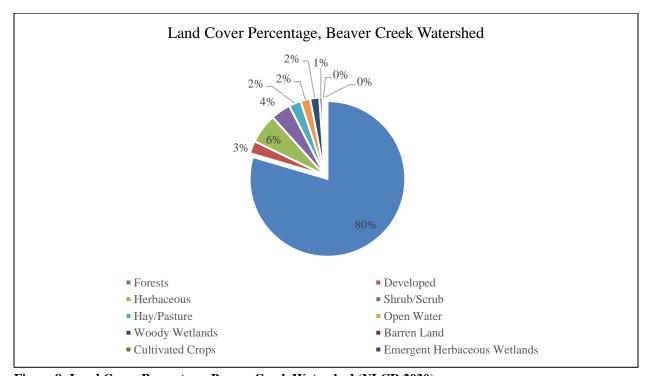
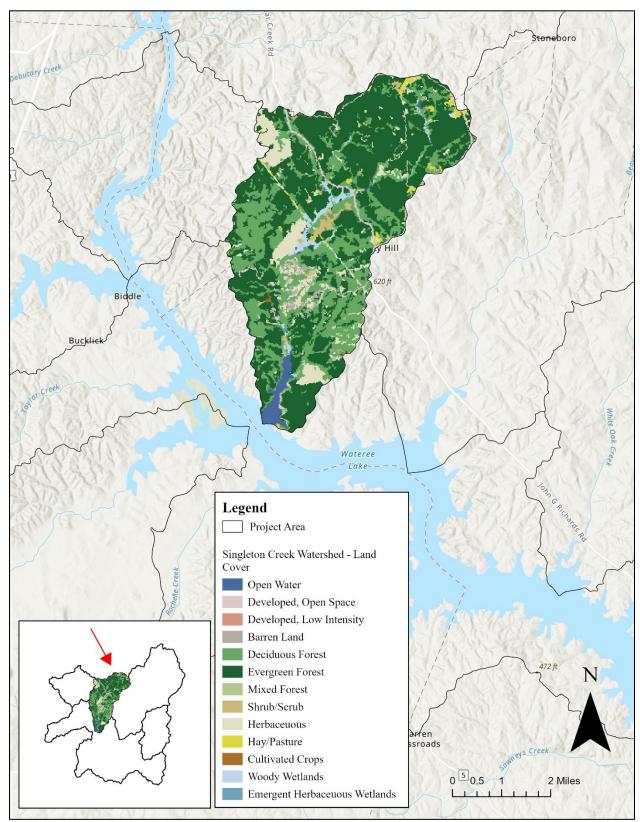


Figure 8: Land Cover Percentage, Beaver Creek Watershed (NLCD 2020)





Map 12: Land Cover, Singleton Creek Watershed (2020)



Land Cover	Percent
Evergreen Forest	52.41
Deciduous Forest	29.34
Herbaceous	8.26
Developed, Open Space	2.38
Open Water	1.99
Woody Wetlands	1.71
Shrub/Scrub	1.27
Barren Land	1.19
Hay/Pasture	1.13
Mixed Forest	0.17
Cultivated Crops	0.06
Emergent Herbaceous Wetlands	0.05
Developed, Low Intensity	0.03

**Table 5: Land Cover by Percentage, Singleton Creek Watershed (2020)** 

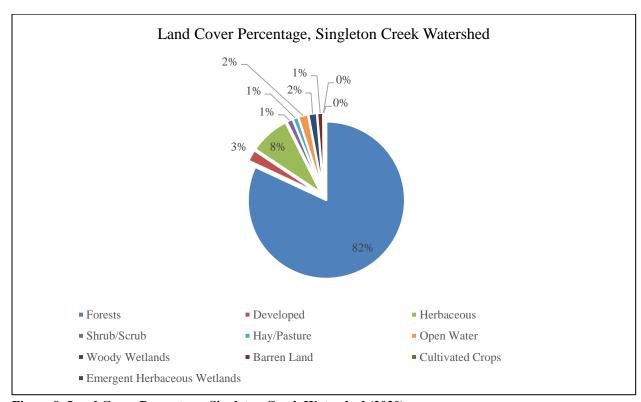
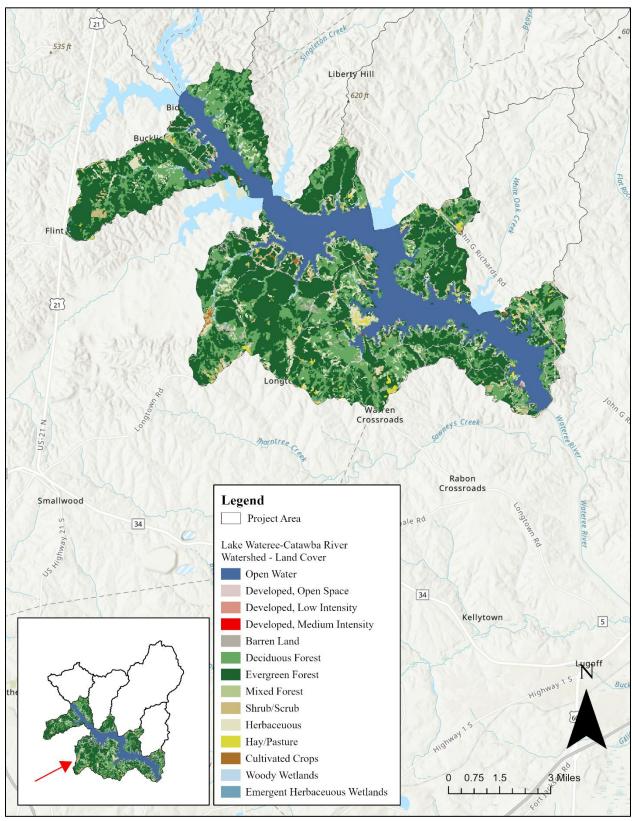


Figure 9: Land Cover Percentage, Singleton Creek Watershed (2020)





Map 13: Land Cover, Lake Wateree-Catawba River Watershed (NLCD 2020)



Land Cover	Percent
Evergreen Forest	41.50
Deciduous Forest	24.34
Open Water	21.38
Herbaceous	4.70
Developed, Open Space	3.58
Shrub/Scrub	1.41
Hay/Pasture	0.87
Woody Wetlands	0.83
Barren Land	0.65
Mixed Forest	0.40
Cultivated Crops	0.16
Developed, Low Intensity	0.14
Emergent Herbaceous Wetlands	0.02
Developed, Medium Intensity	0.02

Table 6: Land Cover by Percentage, Lake Wateree-Catawba River Watershed (NLCD 2020)

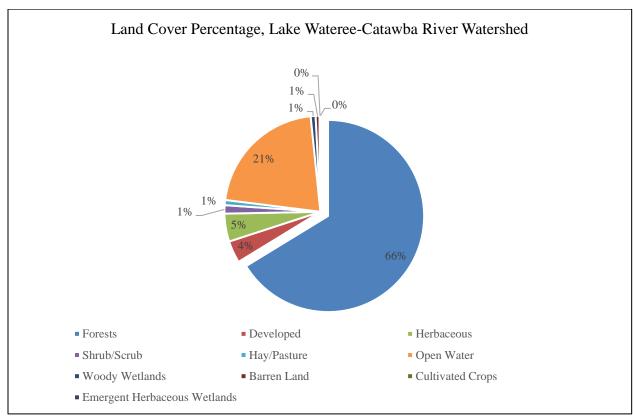
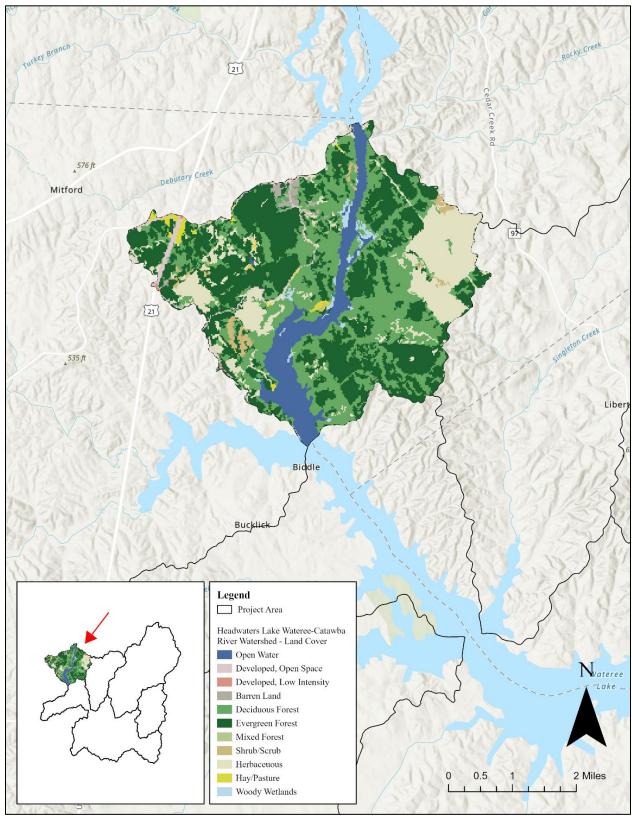


Figure 10: Land Cover Percentage, Lake Wateree-Catawba River Watershed (NLCD 2020)





Map 14: Land Cover, Headwaters Lake Wateree-Catawba River Watershed (2020)



Land Cover	Percent
Evergreen Forest	37.63
Deciduous Forest	31.32
Herbaceous	15.28
Open Water	9.75
Shrub/Scrub	1.52
Developed, Open Space	1.49
Woody Wetlands	1.03
Hay/Pasture	0.89
Barren Land	0.85
Mixed Forest	0.16
Developed, Low Intensity	0.08

Table 7: Land Cover by Percent, Headwaters Lake Wateree-Catawba River Watershed (NLCD 2020)

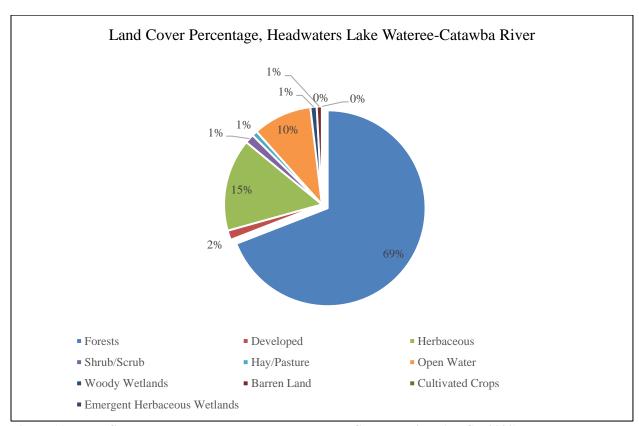


Figure 11: Land Cover Percent, Headwaters Lake Wateree-Catawba River (NLCD 2020)



	Whi	ite Oak	Beave	er Creek	Singlet	on Creek		Wateree- ba River	Watere	aters Lake e-Catawba iver
Land Cover Designation	Area (Acres)	Percent of Watershed	Area (Acres)	Percent of Watershed						
Forests	8,707	78.2	26,512	79.6	10,239	81.9	26,842	66.2	6,929	69.1
Developed	329	3.0	876	2.6	303	2.4	1,517	3.7	157	1.6
Herbaceous	715	6.4	2,062	6.2	1,032	8.3	1,904	4.7	1,532	15.3
Shrub/Scrub	521	4.7	1,375	4.1	159	1.3	570	1.4	152	1.5
Hay/Pasture	177	1.6	838	2.5	142	1.1	352	0.9	89	0.9
Open Water	219	2.0	669	2.0	249	2.0	8,666	21.4	977	9.7
Woody Wetlands	339	3.1	633	1.9	214	1.7	334	0.8	103	1.0
Barren Land	125	1.1	203	0.6	149	1.2	265	0.7	86	0.9
Cultivated Crops	0	0.0	149	0.4	7	0.1	66	0.2	0	0.0
Emergent Herbaceous Wetlands	0	0.0	12	0.0	6	0.1	8	0.0	0	0.0
Total	11,132	100	33,329	100	12,500	100	40,524	100	10,025	100

Table 8: Land Cover Distribution by Watershed (NLCD 2020)

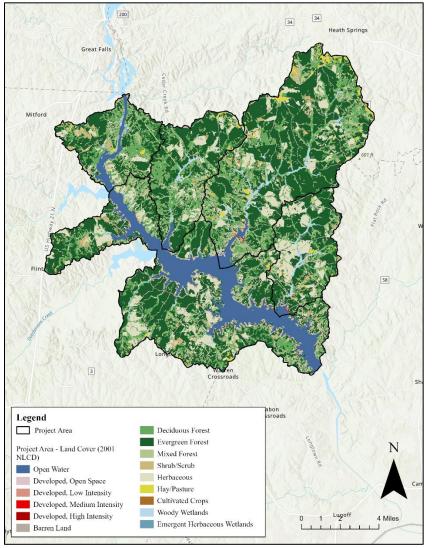


For additional context regarding land cover changes in the project area, calculations were made using the 2001 NLCD. The same combined land cover designation calculations (*i.e. forests* and *developed*) used for the 2020 data were applied to the 2001 data. Comparative analysis for the 2001 and 2020 project area land cover data reveals the changes to land cover designations. Table 9 shows the percent change in each land cover over this time period. The cells highlighted green indicate an increase in land cover and cells highlighted in red indicate a decrease in land cover. *Forests, Open Water, Shrub/Scrub, Hay/Pasture, Barren Land,* and *Cultivated Crops* all increased by land cover percentage from 2001 to 2020. *Herbaceous, Developed,* and *Emergent Herbaceous Wetlands* decreased by land cover percentage during this time. Maps 15 and 16 are provided to show a side-by-side visual comparison for land cover changes from 2001 to 2020.

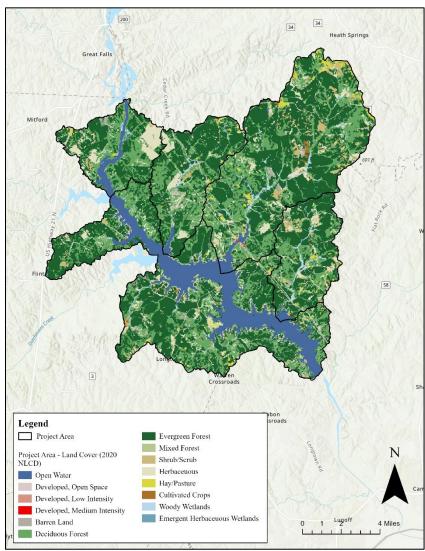
Land Cover	Percent Land Cover (2001)	Desktop/Field Analysis, Percent Land Cover (2020)	Percent Change (2001-2020)	
Forests	70.20	73.69	4.74	
Open Water	9.89	10.03	1.40	
Herbaceous	10.49	6.74	55.64	
Developed	4.21	2.96	42.23	
Shrub/Scrub	2.00 2.58		22.48	
Woody Wetlands	1.76	1.51	16.56	
Hay/Pasture	1.33	1.48	10.14	
Barren Land	0.10	0.77	87.01	
Cultivated Crops	0.01	0.21	95.24	
Emergent Herbaceous Wetlands	0.60	0.02	2,900.00	

**Table 9:Project Area, Percent Change in Land Cover (NLCD 2001-2020)** 





Map 15: Project Area Land Cover (2001 NLCD)



Map 16: Project Area Land Cover (2020 NLCD)

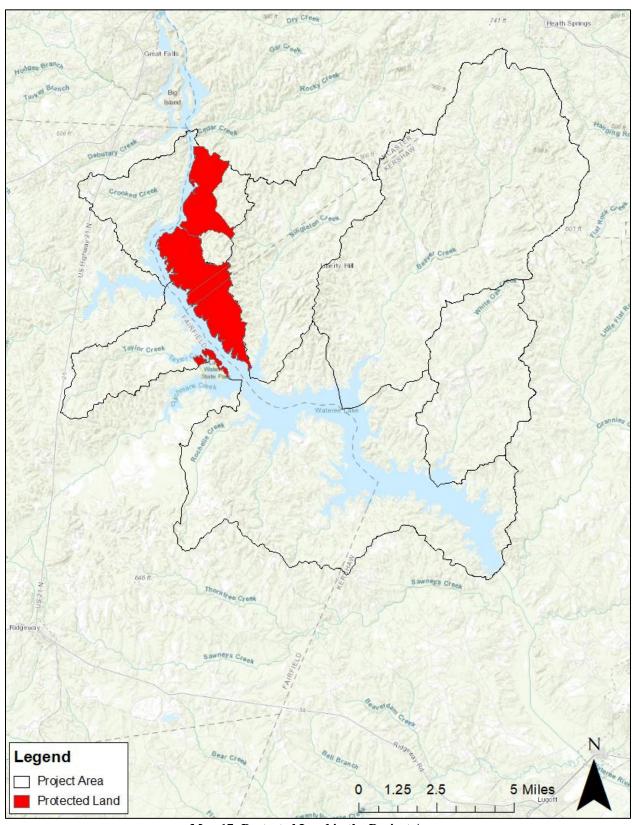


Map 17 shows the known protected land within the project area. Approximately 4.4% of all total land in the project area is protected. The Headwaters Lake Wateree-Catawba River watershed has roughly 28% of the watershed protected, which equates to about 2,838 acres. The Lake Wateree-Catawba River watershed has roughly 4.8% of the watershed protected, which equates to about 1,926 acres. The White Oak, Beaver Creek, and Singleton Creek watersheds do not have any known protected land. Table 10 show the breakdown of the protected land in the project area.

There are two locations within the Headwaters Lake Wateree-Catawba River watershed that are protected. The first is the Liberty Hill Wildlife Management Area (WMA), managed by the South Carolina Department of Natural Resources (SCDNR), located near Liberty Hill, South Carolina. This land is managed for biodiversity and measures close to 1,630 acres within the watershed. The second is the Catawba River WMA (McDowell Tract). The property is managed for biodiversity-disturbance events by SCDNR and is in the northern portion of the watershed, measuring close to 1,878 acres [17].

There are three tracts protected within the Lake Wateree-Catawba River watershed. The Liberty Hill Wildlife Management Area is split into three distinct tracts. The northern section of the tract spans both the Headwaters Lake Wateree-Catawba River watershed (identified above) and the Lake Wateree-Catawba River watershed. The middle section (second tract) is owned by The Conservation Fund. The lower section is owned by SCDNR. The portions of the Liberty Hill WMA within the Lake Wateree-Catawba River watershed total roughly 18,000 acres. The entirety of the Liberty Hill WMA is managed by SCDNR. SCDNR utilizes selective timber harvests and prescribed fire as the primary management tools to enhance habitat conditions on the tract. Other activities include managing openings and meadows to provide early successional habitat and supplemental forage for wildlife [18]. The third tract is the Lake Wateree State Park, which is managed by the South Carolina Department of Parks, Recreation and Tourism. The state park was established in 1981 and there is no known designation for biodiversity or other wildlife management. The park totals close to 296 acres [17].





**Map 17: Protected Land in the Project Area** 



Watershed	Acres	Protected (acres)	% of Watershed Protected	
Headwaters Lake Wateree-Catawba River	10,023	2,838	28.31	
Lake Wateree-Catawba River	40,524 18,764		46.30	
White Oak	11,132	0	0	
Beaver Creek	33,329	0	0	
Singleton Creek	12,500	0	0	
Total	107,508	21,602	20.10	

Table 10: Acres of Protected Land in Project Area

# 3.6) Population

Approximately 2,753 people reside in the project area, including portions of Kershaw, Lancaster, and Fairfield Counties (see Table 11). The population is generally evenly distributed throughout the project area, with a small population center at the town of Liberty Hill and newer construction in the northwest near Dutchman's Creek. Most of the housing units are located along the shoreline of the lake.

Population in Project Area	2000	2010	2000-2010 Annual Rate
Population	2,575	2,753	0.67%
Households	1,145	1,290	1.20%
Housing Units	2,330	2,751	1.67%
Population by Sex			2010 Percentage by Sex
Male		1,395	50.70%
Female		1,358	49.30%

**Table 11: Population in Project Area (ESRI 2010 Census Profile)** 

The Catawba-Wateree River Basin maintains a population of more than 1.5 million residents. It is important to note the growth projections (see Table 12), particularly at the upstream metropolitan locations (*i.e.* Mecklenburg County). The projected urbanization upstream will continue to have a direct effect on the water quality in the project area

Historical Population Data/Population Projections						
Category	2010	2065	$\mathbf{AGR}^2$			
Historical Data <sup>3</sup>						
NC Catawba-Wateree River Basin – 17 Counties (1970-2010)	1,273,918	2,499,941	1.70%			
SC Catawba-Wateree River Basin – 5 Counties (1970-2010)	213,081	421,518	1.72%			
Mecklenburg County Population Change (1970-2010)	354,656	919,628	2.41%			
Population Projections						
NC Population Projections (2010-2030) <sup>4</sup>	9,535,483	12,491,837	1.36%			
SC Population Projections (2010-2035) <sup>5</sup>	4,625,364	5,722,720	0.86%			
NC Catawba-Wateree River Basin – 17 Counties (2010-2030) <sup>4</sup>	2,499,941	3,187,969	1.22%			
SC Catawba-Wateree River Basin – 5 Counties (2010-2035) <sup>5</sup>	421,518	534,030	0.95%			
Mecklenburg County Population Projection (2010-2030) <sup>4</sup>	919,628	1,270,222	1.63%			

**Table 12: Population Data for Catawba-Wateree River Basin** 

**Sources:** <sup>2</sup> Annual Growth Rate – the change in the population measurement over a period of a year.

- <sup>3</sup> United States Census Bureau
- <sup>4</sup> North Carolina Office of State Budget and Management State Demographics
- <sup>5</sup> South Carolina Budget and Control Board, Office of Research and Statistics



# 4) Stream Classification, Use, and Impairment

### 4.1) Stream Classifications

In South Carolina, Regulation 61-68 (R.61-68) defines the classifications of the state's waterbodies and establishes water quality standards to protect and maintain the existing and classified uses of the waterbodies. Waterbodies in South Carolina are classified as one or more of the following, Outstanding National Resource Waters (ONRW), Outstanding Resource Waters (ORW), Trout Waters (TW), Freshwaters (FW), Shellfish Harvesting Waters (SFH), Class SA Waters, and Class SB Waters [19]. The FW classification are freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the SCDHEC. These waterbodies are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of flora and fauna. FW waterbodies are also suitable for industrial and agricultural uses [19]. According to R.61-69, all waterbodies found in the project area are classified as FW [20]. Table 13 lists these waterbodies.

Waterbody Name	County(ies)	Class	Waterbody Description and (Site-Specific Standard)
Beaver Creek	Kershaw	FW	The entire creek tributary to Wateree Lake
Big Dutchmans Creek	Fairfield	FW	The entire creek tributary to Wateree Lake
Big Pine Tree Creek	Kershaw	FW	The entire creek tributary to Wateree River
Catawba-Wateree River	Chester, Fairfield, Kershaw, Lancaster, Richland, Sumter, York	FW	The entire river tributary to Santee River
Granny's Quarter Creek	Kershaw	FW	The entire creek tributary to Wateree River
Sanders Creek	Kershaw	FW	The entire creek tributary to Wateree River
Sawneys Creek	Fairfield, Kershaw	FW	The entire creek tributary to Wateree River
Spears Creek	Kershaw, Richland	FW	The entire creek (and its tributaries) from its headwaters to its confluence with Wateree River
Town Creek	Kershaw	FW	The entire creek tributary to Wateree Creek
Wateree Lake	Fairfield, Kershaw, Lancaster	FW	The entire lake on Catawba-Wateree River
Wateree River	Chester, Fairfield, Kershaw, Lancaster, Richland, Sumter, York	FW	The entire river tributary to Santee River
White Oak Creek	Kershaw	FW	The entire creek tributary to Wateree Lake

**Table 13: Waterbody Classification (R.61-69)** 

#### 4.2) Designated Uses

The designated uses for all water classifications are detailed in SCDHEC's R.61-68. For FW waterbodies the designated uses include:

- 1. Contact recreation (swimming or primary boating/wading or secondary)
- 2. Drinking water supply
- 3. Aquatic life uses, which include fishing and the survival and propagation of a balanced indigenous aquatic community of flora and fauna
- 4. Agricultural and industrial uses

## 4.3) Water Quality Standards

SCDHEC seeks to "maintain and improve all surface waters to a level to provide for the survival and propagation of a balanced indigenous aquatic community of flora and fauna and to provide recreation in and on the water. It is also a goal to provide, where appropriate and desirable, for drinking water after conventional treatment, shellfish



harvesting, and industrial and agricultural uses" [19]. Narrative criteria for water quality standards are determined by SCDHEC based on the conditions of the Waters of the State through the measurement of physical, chemical, and biological characteristics of the waterbodies according to their classification. SCDHEC utilizes procedures for determining the Aquatic Life Use Support (ALUS) of a stream. These procedures are used to clarify criteria that determine if a stream is fully supporting, partially supporting, or not supporting its designated use(s) [20].

Water quality standards for FW pertaining to the pollutants of concern for this WBP include the following:

- pH between 6.0 and 8.5.
- *E. coli* Not to exceed a geometric mean of 126/100 milliliters (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.
- Fecal Coliform Maximum daily concentration of 400 Colony Forming Units (CFU) per 100 mL of water and a 30-day geometric mean of 200 CFU per 100 mL.
- Dissolved Oxygen Daily average not less than 5.0 milligrams per liter (mg/L) with a low of 4.0 mg/L.
- Total Nitrogen for the Piedmont and Southeastern Plains ecoregions of the State, Total Nitrogen shall not exceed 1.50 mg/L (lakes only). There is currently no state standard for non-lake waterbodies.
- Total Phosphorus for the Piedmont and Southeastern Plains ecoregions of the State, Total Phosphorus shall not exceed 0.06 mg/L (lakes only). There is currently no state standard for non-lake waterbodies.
- Turbidity (lakes only) Not to exceed 25 Nephelometric Turbidity Units (NTUs) provided existing uses are maintained.
- Turbidity (streams) Not to exceed 50 NTUs provided existing uses are maintained [19].

### 4.4) Water Quality Impairments

Water quality north of the project area is considered poor. Roughly ten miles north of the project area, along the Wateree River and main tributaries, SCDHEC has 41 Water Quality Monitoring Stations (WQMSs) on the 303(d) List of Impaired Waters (2018) (see Table 14) [21]. The 41 WQMSs are listed with a total of 67 impairments. The breakdown of these impairments include:

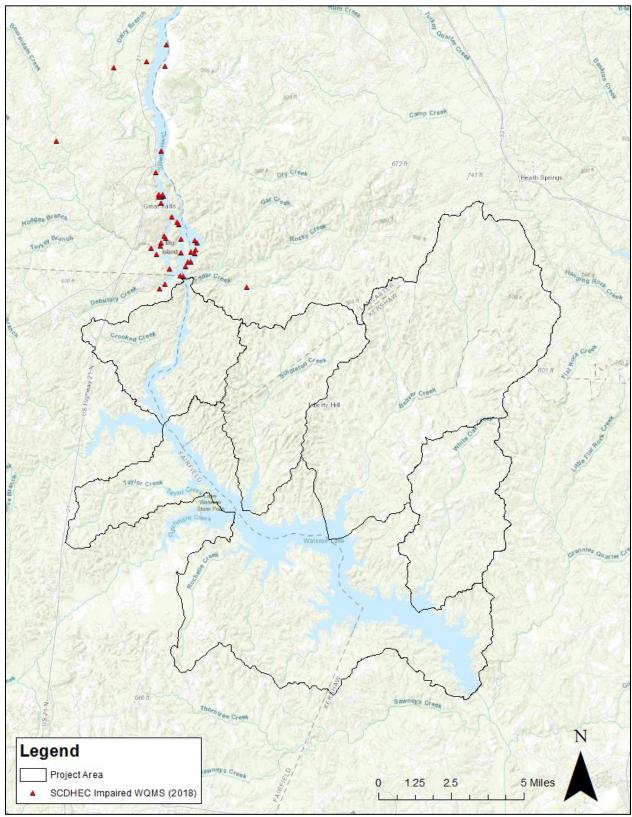
- 29 Phosphorus
- 13- Nitrogen
- 8 − pH
- 4 Turbidity
- 4 Dissolved Oxygen (DO)
- $2-E.\ coli$
- 4 Polychlorinated Biphenyl (PCB)
- 1 − Copper
- 2 Biological



Station	Impairment	Station	Impairment
CW-016	PCB	RL-05414	Phosphorus
CW-016F	Nitrogen, Phosphorus	RL-05416	Phosphorus
CW-017	DO	RL-06429	Phosphorus
CW-033	PCB, pH, Phosphorus	RL-06431	Phosphorus
CW-057	PCB, pH, Nitrogen, Phosphorus	RL-06443	рН
CW-133	PCB	RL-08046	Nitrogen, Phosphorus
CW-174	pH, Nitrogen, Phosphorus	RL-08062	Nitrogen, Phosphorus
CW-175	DO, Nitrogen, Phosphorus	RL-09094	Phosphorus
CW-210	pН	RL-10102	Phosphorus
CW-232	DO	RL-10106	Nitrogen, Phosphorus
CW-691	Biological	RL-11117	DO, Nitrogen, Phosphorus
RL-01007	Phosphorus	RL-11119	Nitrogen, Phosphorus
RL-02319	Phosphorus	RL-13072	Nitrogen, Phosphorus
RL-02452	Phosphorus	RL-13134	pH, Phosphorus
RL-03332	Nitrogen, Phosphorus, Turbidity	RL-15023	pH, Nitrogen, Phosphorus
RL-03351	Copper, Phosphorus, Turbidity	RL-15104	рН
RL-03353	Phosphorus, Turbidity	RL-16115	Nitrogen
RL-03458	Phosphorus, Turbidity	RS-06171	Biological
RL-04375	Phosphorus	RS-13144	E.coli
RL-04379	Phosphorus	RS-13152	E.coli
RL-05391	Phosphorus		

Table 14: SCDHEC Impaired WQMSs, North of Project Area (2018)





Map 18: SCDHEC Impaired WQMSs, North of Project Area



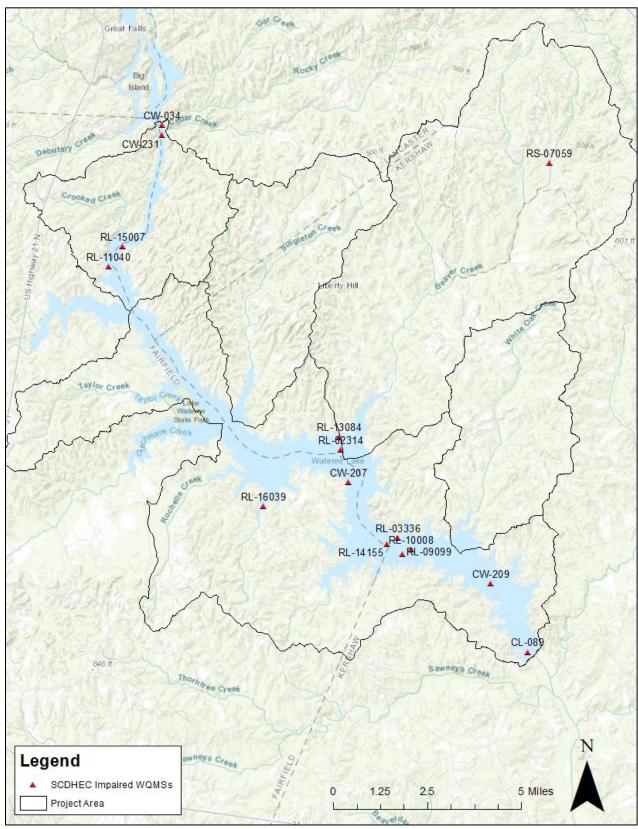
As detailed in Section 2.1, this WBP focuses on the water quality impairments listed below, as they relate to nonpoint source contributions north of and within the project area. Nonpoint source pollution, such as sediment loads, from upstream influences and local sources together have contributed in part to high measurements of turbidity, pathogens, and nutrients (*i.e.* nitrogen and phosphorus). As a result, measurements for *E. coli*, pH, TN, TP, and DO have not met their applicable standard for the lake and tributaries. Table 15 shows the SCDHEC WQMSs that are categorized as impaired.

BMPs suggested in this WBP can address these water quality impairments in these and other locations throughout the project area.

Station	Location	Impairment
CL-089	Lake Wateree in forebay equidistant from dam and shorelines	DO, pH
CW-034	Cedar Creek Reservoir Tailrace	PCB
CW-207	Lake Wateree at end S-20-291	pH, PCB
CW-209	Lake Wateree at small island 2.3 miles north of dam	pH, PCB
CW-231	Lake Wateree Headwaters approximately 50 yards south confluence of Cedar Creek	DO, TN, TP, E. coli
RL-02314	Lake Wateree 1.0 miles southwest from mouth of Beaver Creek	pH, TP
RL-03336	Lake Wateree near shore along S-28-802 opposite Colonel Creek confluence	pH, TP
RL-09099	Wateree Lake 1.9 miles west of the clearwater cove boat ramp	pH, TP
RL-10008	Lake Wateree 4.3 miles northwest of west end of Wateree dam	рН
RL-11040	Wateree Lake about 1 mile below the confluence with Crooked Creek and 1.3 miles above the Big Water confluence	pH, TN, TP
RL-13084	Lake Wateree approximately 0.15 miles southwest of end of Little Gull Road	рН
RL-14155	Lake Wateree approximately 1.7 miles northeast of off Colonel Creek boat ramp	pН
RL-15007	Lake Wateree 2.1 miles north northeast of Wateree Creek boat ramp	TN
RL-16039	Fox Creek cove of Lake Wateree approximately 300 yards northeast of June Creek boat ramp	рН
RS-07059	Tranham Creek at S-29-763 6.5 miles west southwest of Kershaw (the bridge has a sign labeling the creek as Beaver Creek)	E. coli

Table 15: Impaired SCDHEC WQMSs in Project Area





Map 19: SCDHEC Impaired WQMSs, within Project Area



### 5) Water Quality Monitoring and Assessment

The water quality assessment for the project area was completed using historical and current water quality data from sources including SCDHEC and the Lake Wateree Association's WaterWatch team. Regarding the SCDHEC data, a time frame from 2001 to 2021 was chosen as a sufficient representation for the most current water quality conditions and trends in the project area. A similar time frame (2008-2021) was chosen for the WaterWatch data. The WaterWatch data is not categorized as regulatory or actionable data in this WBP. It is presented as supporting data for the purpose of better understanding the impacts from nonpoint source pollutants and providing context for future BMP implementation options.

The remainder of this section presents the bacteria, nutrient, and sediment data from the water quality data sources stated above. The bacteria data analyzed includes *E. coli* and Fecal Coliform (FC). Prior to 2013, FC was used as the bacteria indicator to evaluate the safety of freshwaters for recreation. The standard for FC was a maximum daily concentration of 400 Colony Forming Units (CFU) per 100 milliliters (mL) of water, and a 30-day geometric mean of 200 CFU per 100 mL. Water samples that exceeded this standard more than 10% of the time were considered impaired and unsafe for recreational use. Sites considered impaired for FC were then placed on the SCDHEC 303(d) List of Impaired Waters. In 2013, SCDHEC switched to *Escherichia coli* (*E.coli*) as the bacteria indicator for freshwaters. The presence of *E. coli* in freshwater is indicative of fecal pollution and is considered a human health risk because it may contain pathogens causing disease. The current standard for *E.coli* is a daily concentration not to exceed 349 Most Probable Number (MPN) per 100 mL and a 30-day geometric mean of 126 MPN per 100 mL. The majority of the bacteria data in this section is presented as *E. coli*.

SCDHEC R.61-68 Water Classifications and Standards refers to nutrients such as nitrogen and phosphorus [19]. Section 4.3 details the standards for nitrogen and phosphorus for the project area. The standards apply to lakes greater or equal to 40 acres, such as Lake Wateree, however in-stream nutrient criteria do not yet exist for South Carolina. Therefore, streams are not eligible for nutrient impairment listing. The nutrient data presented includes all sampling locations within the project area between 2002 to 2021.

SCDHEC R.61-68 Water Classifications and Standards states that measurements for turbidity are not to exceed 25 NTUs in lakes [19]. The turbidity data below was retrieved from EPA's Water Quality Portal and from the WaterWatch citizen group. There are no SCDHEC WQMSs listed as impaired for turbidity within the project area.

SCDHEC R.61-68 Water Classifications and Standards states that measurements for DO are to be a daily average of not less than 5.0 mg/L with a low of 4.0 mg/L [19]. Measurements for pH are to be between 6.0 and 8.5. Data for both DO and pH were retrieved from EPA's Water Quality Portal and from the WaterWatch group.

### 5.1) SCDHEC Surface Water Quality Monitoring Stations and Data

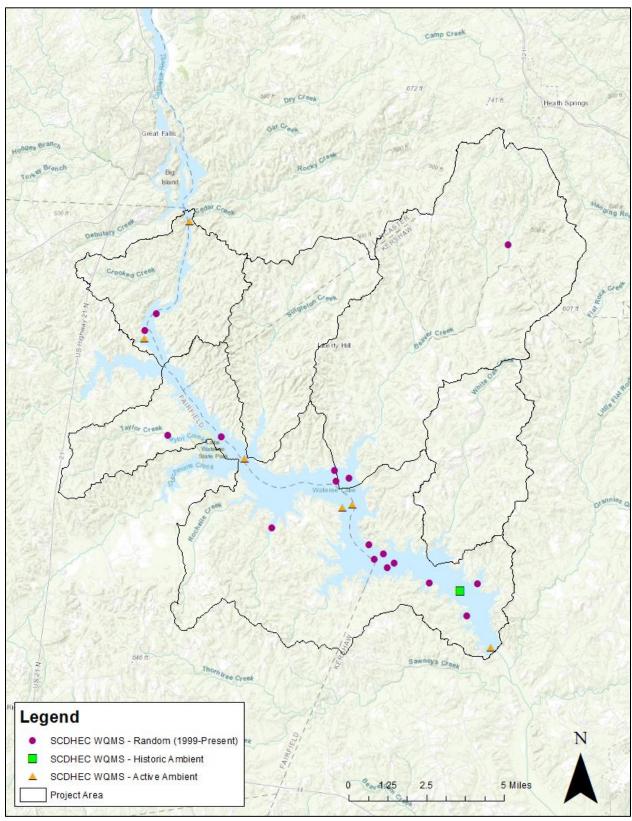
SCDHEC maintains data from various types of surface water WQMSs. These types include Ambient Surface (Fixed), Ambient Surface (Historic), and Ambient Surface (Random). There are a total of 25 WQMSs in the project area that are either active or inactive. The breakdown of these stations is listed in Table 16. Map 20 shows the locations of the WQMSs in the project area. Some spatial information for these WQMSs was obtained from the SCDHEC Watershed Atlas program.



SCDHEC WQMSs	Туре	Years Sampled	
CL-089	Ambient, Fixed	Active: 2001-present	
CW-034	Ambient, Fixed	Active in: 2006-2019	
CW-207	Ambient, Fixed	Active: 1999-present	
CW-207B	Ambient, Fixed	Active: 2019-present	
CW-209	Ambient, Historic	Active in: 1999-2014	
CW-231	Ambient, Fixed	Active: 2001-present	
LCR-02	Ambient, Fixed	Active: 2019-present	
LCR-03	Ambient, Fixed	Active: 2019-present	
RL-01003	Ambient, Random	Active in: 2001	
RL-01033	Ambient, Random	Active in: 2001	
RL-02314	Ambient, Random	Active in: 2002	
RL-03336	Ambient, Random	Active in: 2003	
RL-09099	Ambient, Random	Active in: 2009	
RL-10008	Ambient, Random	Active in: 2010	
RL-11040	Ambient, Random	Active in: 2011	
RL-13084	Ambient, Random	Active in: 2013	
RL-14155	Ambient, Random	Active in: 2014	
RL-15007	Ambient, Random	Active in: 2015	
RL-16039	Ambient, Random	Active in: 2016	
RL-17055	Ambient, Random	Active in: 2017	
RL-18083	Ambient, Random	Active in: 2018	
RL-19166	Ambient, Random	Active in: 2019	
RL-20198	Ambient, Random	Active in: 2020	
RL-21218	Ambient, Random	Active in: 2021	
RS-07059	Ambient, Random	Active in: 2007-2010	

Table 16: SCDHEC WQMSs within Project Area





**Map 20: SCDHEC WQMSs within Project Area** 



# 5.1.1) SCDHEC Surface Water Quality Monitoring Stations – Bacteria Data

Twelve SCDHEC WQMSs have FC data recorded from the years 2001 to 2012. Fifteen WQMSs have data recorded for E. coli from the years 2009 to 2021. Bacteria data for these stations was retrieved from the EPA Water Quality Portal (WOX) and is summarized in Table 17. In the column titled *Impairment Status*, all cells marked null indicate that the WQMS is not listed as impaired in the 2018 303(d) List of Impaired Waters. According to the 2018 303(d) List of Impaired Waters, there are two WQMSs in the project area that exceed that state standard for E. coli or FC. Figures 12-14 show the distribution of sampling at these two impaired WQMSs. The data shows that based on the spikes in bacteria data and impairments, bacteria reduction strategies should focus on the areas including the Beaver Creek headwaters, below the northern dam, and at the public surface water intakes at the south dam.

WQMS	Parameter	Sample Years	Total Samples	Sample Range	Impairment Status
CL-089	E. coli*	2009-2021	99	BQL***-2827.2	-
CL-089	FC**	2001-2012	119	BQL-190	-
CW 207	E. coli	2013-2021	87	BQL-933	-
CW-207	FC	2002-2012	42	BQL-77	-
CW-207B	E. coli	2020-2021	20	BQL-836	-
CW-209	FC	2002-2007	24	BQL-72	-
CW 221	E. coli	2013-2021	72	1-AQL****	I
CW-231	FC	2001-2012	114	BQL-AQL	Impaired
LCR-02	E. coli	2020-2021	19	2-122.2	-
LCR-03	E. coli	2020-2021	20	BQL-798	
RL-01003	FC	2001	11	BQL-120	-
RL-01033	FC	2001	11	BQL-130	-
RL-02314	FC	2002	12	BQL-54	-
RL-03336	FC	2003	12	BQL-110	-
RL-09099	FC	2009	10	BQL-50	-
RL-10008	FC	2010	12	BQL-160	-
RL-11040	FC	2011	12	BQL-AQL	-
RL-13084	E. coli	2013	12	BQL-22.8	-
RL-14155	E. coli	2014	13	BQL-93.2	=
RL-15007	E. coli	2015	10	1-2406.6	-
RL-16039	E. coli	2016	12	BQL-12.2	-
RL-17055	E. coli	2017	11	BQL-248.9	-
RL-18083	E. coli	2018	9	BQL-727	-
RL-19166	E. coli	2019	12	BQL-260.3	-
RL-20198	E. coli	2020	11	BQL-259	-
RL-21218	E. coli	2021	9	BQL-70.8	-
RS-07059	FC	2007	12	59-AQL	Impaired

**Table 17: SCDHEC Monitoring Results for Bacteria in Project Area (2001-2021)** 

<sup>\*</sup>E.coli data units: CFU/100 mL

<sup>\*\*</sup>FC data units: CFU/100 mL

<sup>\*\*\*</sup>BQL – Below Quantification Limit. These are samples taken that resulted in measurements below the detection quantification limit set for that sampling period.

<sup>\*\*\*\*</sup>AQL – Above Quantification Limit. These are samples taken that resulted in measurements above the detection quantification limit set for that sampling period.



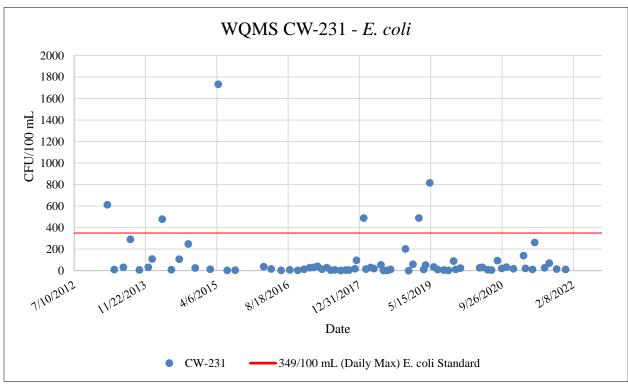


Figure 12: CW-231, E. coli (2013-2021) – Impaired WQMS

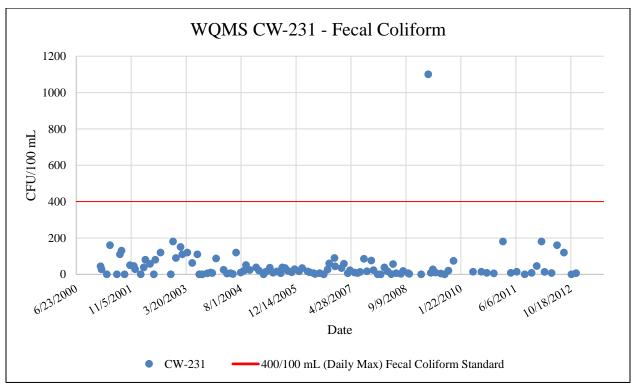


Figure 13: CW-231, Fecal Coliform (2001-2012) – Impaired WQMS



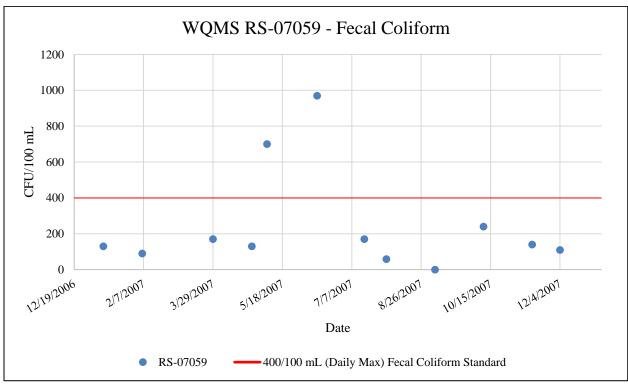


Figure 14: RS-07059, Fecal Coliform (2007) – Impaired WQMS

# 5.1.2) SCDHEC Surface Water Quality Monitoring Stations – Nutrient Data

Tables 18 and 19 depict data from impaired SCDHEC WQMSs. These tables summarize nutrient monitoring data (*i.e.* TP and TN) on Lake Wateree from 2002 to 2021. Figures 15 through 22 show the sampling results specifically for WQMSs with nutrient impairments. In the column titled *Impairment Status*, all cells marked null indicate that the WQMS is not listed as impaired in the 2018 303(d) List of Impaired Waters. Despite no current state standard for nutrient impairments for non-lake waterbodies, monitoring results for an in-stream station (RS-07059) are included in the tables in this section. The data provided for RS-07059 is not subject to regulatory standards for nutrients in lakes because it is an in-stream monitoring station..



WQMS	Parameter	Sample Years	<b>Total Samples</b>	Sample Range	Impairment Status
CL-089	Phosphorus*	2002-2021	229	BQL**-0.11	-
CW-207	Phosphorus	2002-2021	130	BQL-0.25	-
CW-207B	Phosphorus	2019-2021	62	BQL-0.06	-
CW-209	Phosphorus	2002, 2007	24	BQL-0.13	-
CW-231	Phosphorus	2002-2021	187	BQL-23	Impaired
LCR-02	Phosphorus	2019-2021	61	BQL-0.08	-
LCR-02F	Phosphorus	2019	32	BQL-0.05	
LCR-03	Phosphorus	2019-2021	54	BQL-0.08	
LCR-03F	Phosphorus	2019	24	BQL-0.06	
RL-02314	Phosphorus	2002	12	0.03-0.13	Impaired
RL-03336	Phosphorus	2003	12	BQL-0.10	Impaired
RL-09099	Phosphorus	2009	10	BQL-0.09	Impaired
RL-10008	Phosphorus	2010	12	0.02-0.06	-
RL-11040	Phosphorus	2011	12	0.03-0.09	Impaired
RL-13084	Phosphorus	2013	12	BQL-0.04	-
RL-14155	Phosphorus	2014	13	BQL-0.08	-
RL-15007	Phosphorus	2015	10	0.03-0.09	-
RL-16039	Phosphorus	2016	12	BQL-0.07	-
RL-17055	Phosphorus	2017	11	BQL-0.10	-
RL-18083	Phosphorus	2018	9	0.03-0.08	-
RL-19166	Phosphorus	2019	12	BQL-0.07	-
RL-20198	Phosphorus	2020	11	BQL-0.05	-
RL-21218	Phosphorus	2021	9	BQL-0.06	-
RS-07059	Phosphorus	2007-2010	15	BQL-0.27	N/A

**Table 18: SCDHEC Phosphorus Monitoring Results (2002-2021)** 

<sup>\*</sup>Phosphorus Data Units: mg/L
\*\*BQL – Below Quantification Limit. These are samples taken that resulted in measurements below the detection quantification limit set for that sampling period.



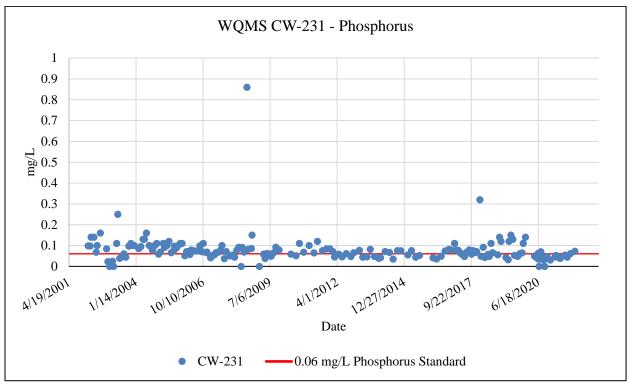


Figure 15: CW-231, Phosphorus (2001-2021) - Impaired WQMS

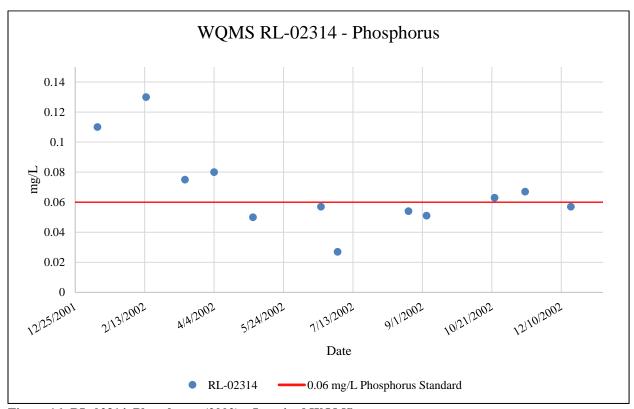


Figure 16: RL-02314, Phosphorus (2002) - Impaired WQMS



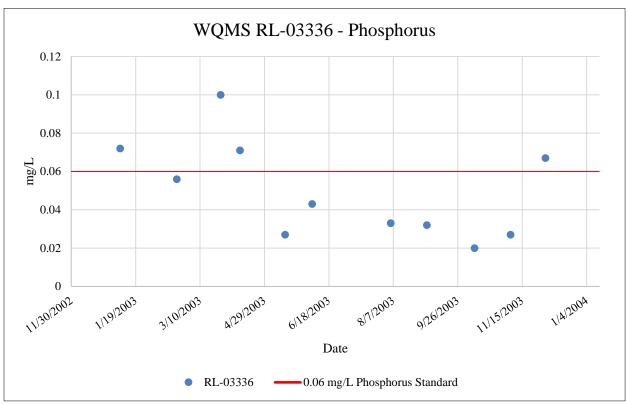


Figure 17: RL-03336, Phosphorus (2003) - Impaired WQMS

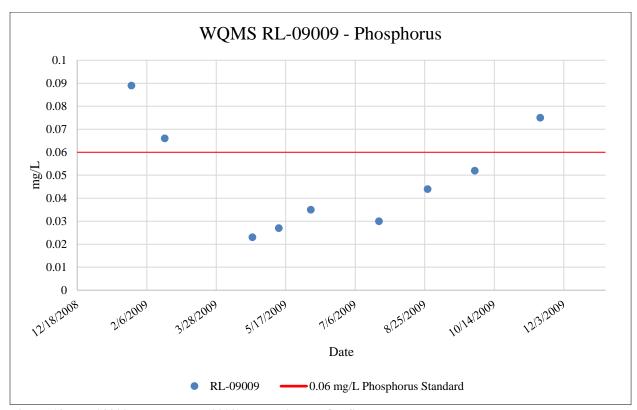


Figure 18: RL-09009, Phosphorus (2009) - Impaired WQMS



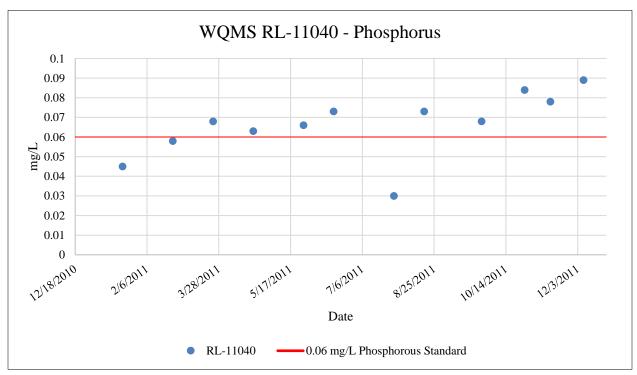


Figure 19: RL-11040, Phosphorus (2011) – Impaired WQMS



WQMS	Parameter	Sample Years	Total Samples	Sample Range	Impairment Status
CL-089	Nitrogen*	2001-2021	214	BQL**-7.75	-
CW-207	Nitrogen	2002-2021	118	BQL-2.51	-
CW-207B	Nitrogen	2019-2021	62	BQL-1.32	-
CW-209	Nitrogen	2002-2007	16	BQL-1.32	-
CW-231	Nitrogen	2001-2021	169	BQL-12.75	Impaired
LCR-02	Nitrogen	2019-2021	61	BQL-2.38	-
LCR-02F	Nitrogen	2019	32	BQL-1.55	
LCR-03	Nitrogen	2019-2021	54	BQL-1.23	
LCR-03F	Nitrogen	2019	24	BQL-1.04	
RL-01003	Nitrogen	2001	3	BQL-0.67	-
RL-01033	Nitrogen	2001	3	BQL-BQL	
RL-02314	Nitrogen	2002	6	BQL-2.48	-
RL-03336	Nitrogen	2003	6	BQL-1.45	-
RL-09099	Nitrogen	2009	10	BQL-1.02	-
RL-10008	Nitrogen	2010	12	BQL-1.37	-
RL-11040	Nitrogen	2011	8	BQL-21.90	Impaired
RL-13084	Nitrogen	2013	12	BQL-1.31	-
RL-14155	Nitrogen	2014	13	BQL-2.56	-
RL-15007	Nitrogen	2015	9	BQL-1.85	Impaired
RL-16039	Nitrogen	2016	12	0.33-1.55	-
RL-17055	Nitrogen	2017	11	BQL-1.18	-
RL-18083	Nitrogen	2018	9	0.44-1.07	-
RL-19166	Nitrogen	2019	12	BQL-0.84	-
RL-20198	Nitrogen	2020	11	BQL-1.44	-
RL-21218	Nitrogen	2021	9	BQL-1.04	-
RS-07059	Nitrogen	2007-2010	9	BQL-0.72	N/A

Table 19: SCDHEC Nitrogen Monitoring Results (2001-2021)

<sup>\*</sup>Nitrogen Data Units: mg/L

\*\*BQL – Below Quantification Limit. These are samples taken that resulted in measurements below the detection quantification limit set for that sampling period.



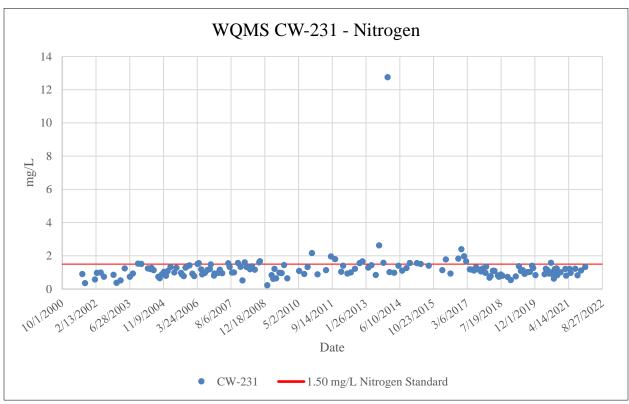


Figure 20: CW-231, Nitrogen (2001-2021) - Impaired WQMS

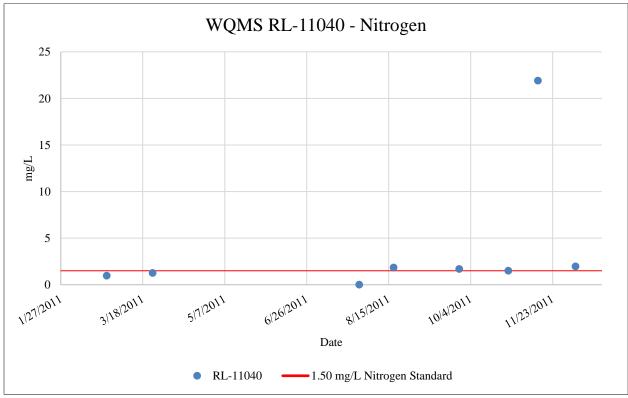


Figure 21: RL-11040, Nitrogen (2011) - Impaired WQMS



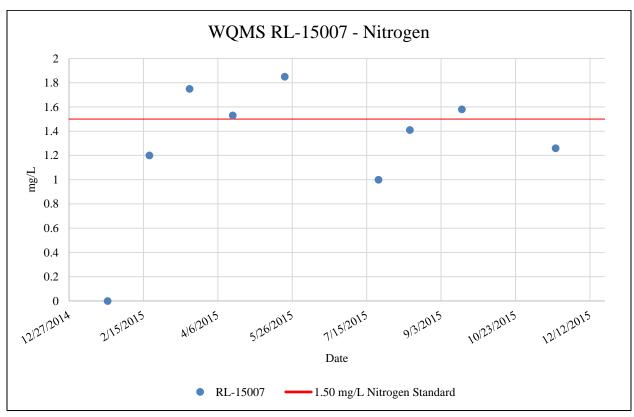


Figure 22: RL-15007, Nitrogen (2015) – Impaired WQMS

# 5.1.3) SCDHEC Surface Water Quality Monitoring Stations – Sediment Data

There are no current impairments for turbidity listed by SCDHEC in the project area. The column titled *Impairment Status* contains cells marked null to indicate no impairment designation. All WQMSs listed below in Table 20, except RS-07059, were analyzed to reflect the state turbidity standard for lakes only – not to exceed 25 NTUs. RS-07059 reflects the state standard for streams – not to exceed 50 NTUs.



WQMS	Parameter	Sample Years	<b>Total Samples</b>	Sample Range	Impairment Status
CL-089	Turbidity*	2001-2021	240	0.88-75	-
CW-207	Turbidity	2002-2021	130	2.7-46	-
CW-207B	Turbidity	2019-2021	62	2.2-50	-
CW-209	Turbidity	2002-2007	24	1.3-39	-
CW-231	Turbidity	2001-2021	197	1.5-220	-
LCR-02	Turbidity	2019-2021	60	7.4-37	-
LCR-03	Turbidity	2019-2021	53	3.5-55	
RL-01003	Turbidity	2001	11	2.6-14	-
RL-01033	Turbidity	2001	11	2-14	
RL-02314	Turbidity	2002	12	2.2-13	-
RL-03336	Turbidity	2003	12	5-49	-
RL-09099	Turbidity	2009	9	2.9-23	-
RL-10008	Turbidity	2010	12	2.8-80	-
RL-11040	Turbidity	2011	12	8.1-32	-
RL-13084	Turbidity	2013	12	2.7-16	-
RL-14155	Turbidity	2014	13	2-33	-
RL-15007	Turbidity	2015	10	4.7-130	-
RL-16039	Turbidity	2016	12	3.9-60	-
RL-17055	Turbidity	2017	11	2.5-27	-
RL-18083	Turbidity	2018	9	7.4-40	-
RL-19166	Turbidity	2019	12	6.5-31	-
RL-20198	Turbidity	2020	11	3.2-62	-
RL-21218	Turbidity	2021	9	3-25	-
RS-07059	Turbidity	2007-2010	15	3.8-40	-

Table 20: SCDHEC Turbidity Monitoring Results (2001-2021)

# 5.1.4) SCDHEC Surface Water Quality Monitoring Stations – Additional Data

This section includes SCDHEC data available for other impairments in the project area, including DO and pH. Tables 21 and 22 include data recorded in the selected time frame for only the impaired WQMSs. The state standard for DO (daily low) is 4.0 mg/L. Measurements below 4.0 mg/L are considered as not attaining the state standard for DO. The state standard for pH is between 6.0 and 8.5. Measurements either below 6.0 or above 8.5 are considered not attaining the state standard for pH.

This WBP does not explicitly address all water quality impairments listed on the 303(d) List of Impaired Waters in the project area. DO and pH data is included to provide additional context for future BMP implementation decisions.

WQMS	Parameter	Sample Years	<b>Total Samples</b>	Sample Range	Impairment Status
CL-089	Dissolved Oxygen*	2001-2021	216	1.60-13.8	Impaired
CW-231	Dissolved Oxygen	2001-2021	199	3.95-12.98	Impaired

**Table 21: SCDHEC Dissolved Oxygen Monitoring Results (2001-2021) – Impaired WQMSs** \*DO Data Units: mg/L

<sup>\*</sup>Turbidity Data Units: NTU



WQMS	Parameter	Sample Years	<b>Total Samples</b>	Sample Range	Impairment Status
CL-089	pН	2001-2021	216	5.92-9.48	Impaired
CW-207	pН	2002-2021	129	5.69-9.46	Impaired
CW-209	pН	2002-2007	24	6.52-9.09	Impaired
RL-02314	pН	2002	12	6.46-9.02	Impaired
RL-03336	pН	2003	12	6.57-9.11	Impaired
RL-09099	pН	2009	10	6.48-9.49	Impaired
RL-10008	pН	2010	12	6.76-8.91	Impaired
RL-11040	pН	2011	12	6.5-8.83	Impaired
RL-13084	pН	2013	12	6.82-9.03	Impaired
RL-14155	pН	2014	13	5.98-9.29	Impaired
RL-16039	pН	2016	12	6.84-8.95	Impaired

Table 22: SCDHEC pH Monitoring Results (2001-2021) – Impaired WQMSs

#### 5.2) Lake Wateree Association/WaterWatch Water Quality Sampling Data

Members of the Lake Wateree Association subgroup, WaterWatch, are volunteers that lead regular water quality monitoring runs at 20 locations including channels, embayments, and headwaters. Volunteers formed this group around 2008 in anticipation of needing robust monitoring data due to rapid development upstream. For the past four years, the University of South Carolina Arnold School of Public Health and the Marine Sciences department have established a formal partnership agreement with the WaterWatch program, providing graduate school and post-doctoral students with research opportunities.

WaterWatch volunteers, along with University of South Carolina researchers, conduct bi-monthly sampling trips to assess ambient water quality conditions on Lake Wateree. Sampling occurs in February, April, June, August, October, and December. Using multiparameter sondes, readings for several water quality parameters including water temperature, DO, pH, specific conductivity, and turbidity are taken at a depth of one, four, seven, and ten feet – then at ten foot intervals beyond that until maximum depth is reached.. In order to maximize sampling efficiency, WaterWatch utilizes two boats for the monitoring efforts. All ambient water quality variables are measured using several models of YSI multiparameter sondes including the ProDSS, Professional Plus, Quatro, and 6820 models.

WaterWatch owns and maintains a boat which, due to its ability to access shallow depths, is able to sample eight designated headwater locations. During sampling runs, one volunteer captains the boat and one researcher performs sampling. In the headwaters, ambient water quality parameters are measured at a depth of one foot. A Secchi Disc is used when turbidity is unable to be measured with a sonde. The sampling of the eight embayments and four channel sites is performed by a WaterWatch volunteer captaining their privately owned boat, a WaterWatch volunteer to assist, and a university researcher that performs the sampling.

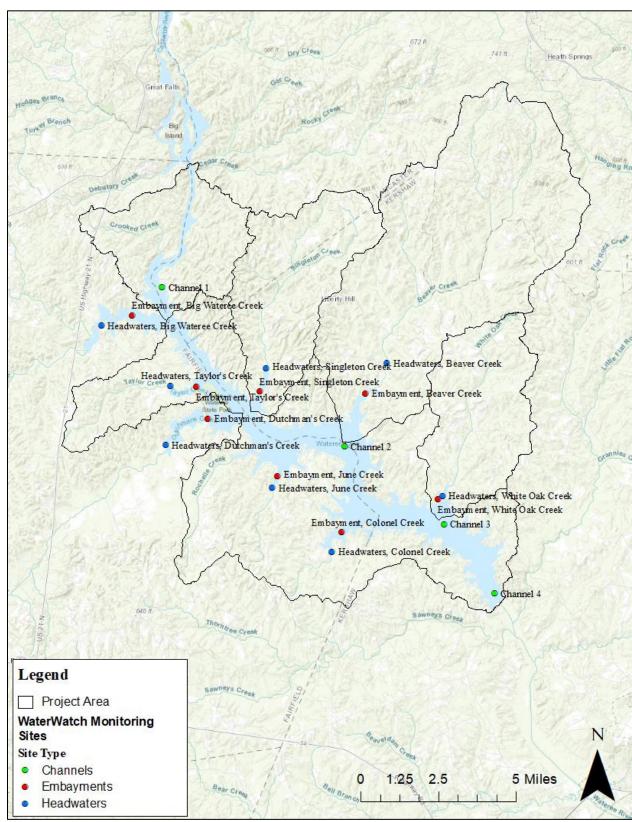
For nutrient data specifically, the WaterWatch team takes water samples at four locations during the months of April, June, August, and September. The designated sampling locations include the Dutchman's Creek Embayment, Singleton's Creek Embayment, Channel 2, and Channel 4. Samples are taken in triplicate at each sampling location using clean, acid-washed, 500 mL amber wide mouth Nalgene bottles. Without contaminating the clean bottle, the empty bottle is triple rinsed using lake water before being inserted upside-down into the water to a depth of approximately one foot, where it is then turned right side up to fill the bottle. This step is performed for each sample, A, B, and C, which are then capped and stored on ice in a cooler for transport. Each 500 mL sample is labeled as "whole," meaning that it is unfiltered. A 60 mL sample is removed from the whole sample using a Becton, Dickenson and Company (BD) 60 mL Luer-Lok Tip Syringe. A Pall Acrodisc 25 millimeter filter with a 0.45 micron membrane is then attached to the end of the syringe, where the water is then filtered directly in to clean, acid-washed, 60 mL Van Waters and Rogers (VWR) narrow mouth high density polyethylene (HPDE) bottle labeled with the appropriate site name, sample replicate, and filtered. All samples, 12 whole and 12 filtered, are



stored on ice and transported to the Marine Field Lab at the Belle W. Baruch Institute of Coastal Ecology for processing. The lab measures ammonia, nitrate, nitrite, TN, TP, orthophosphate, and chlorophyll A levels in the samples and tabulates the data in an Excel spreadsheet.

Map 21 shows the locations for each sampling site in the project area. The tables and graphs in this section provide a summary for all testing results for TN, TP, turbidity, DO, and pH for the sampling period 2008 to 2019.





Map 21: WaterWatch Water Quality Sampling Sites



# 5.2.1) WaterWatch Water Quality Sampling Sites – Nutrient Data

The WaterWatch nutrient data included in this section consists of four sampling sites – Dutchman's Creek Embayment, Singleton Creek Embayment, Channel 2, and Channel 4. The data was recorded from years 2012 to 2019. No nutrient data was collected during 2016. A summarization of the nutrient data can be found in Tables 23 and 24. Figures 23 and 24 show the distribution of the data over the sampling timeline.

Site	Parameter	Sample Years**	Total Samples	Average Sample	Highest Sample
Dutchman's Creek Embayment	TN*	2012-2019	73	0.74	1.24
Singleton Creek Embayment	TN	2012-2019	57	0.81	1.46
Channel 2	TN	2012-2019	57	0.79	1.41
Channel 4	TN	2012-2019	51	0.70	1.32

Table 23: WaterWatch Site Data, Nitrogen (2012-2019)

<sup>\*\*</sup>Does not include 2016 - no nutrient data recorded

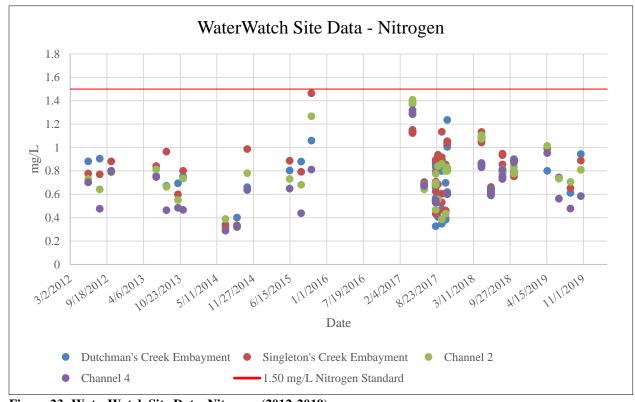


Figure 23: WaterWatch Site Data, Nitrogen (2012-2019)

<sup>\*</sup>TN Data Units: mg/L



Site	Parameter	Sample Years**	Total Samples	Average Sample	Highest Sample
Dutchman's Creek Embayment	TP*	2012-2019	73	0.058	0.11
Singleton's Creek Embayment	TP	2012-2019	57	0.058	0.12
Channel 2	TP	2012-2019	57	0.057	0.11
Channel 4	TP	2012-2019	51	0.045	0.087

Table 24: WaterWatch Site Data, Phosphorus (2012-2019)

<sup>\*\*</sup>Does not include 2016 - no nutrient data recorded

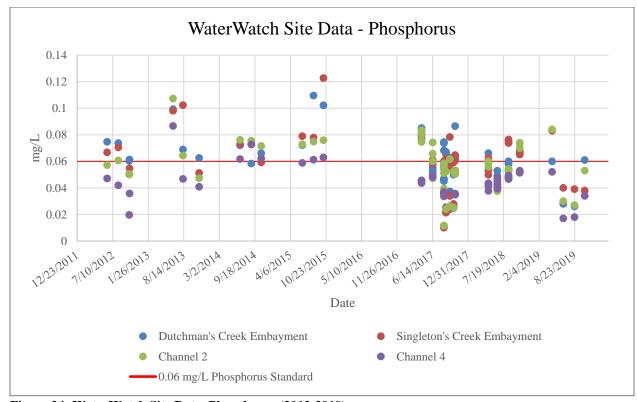


Figure 24: WaterWatch Site Data, Phosphorus (2012-2019)

# 5.2.2) WaterWatch Water Quality Sampling Sites – Sediment Data

The WaterWatch team collected and recorded sediment data at 20 locations within the project area from 2008 to 2019. Eight sites are located at the headwaters of Lake Wateree's major tributaries, eight more at their embayments, and four at primary channel locations. The figures below show that turbidity samples were consistently above the state standard throughout the sampling period. Table 25 below summarizes the turbidity measurements for all 20 locations. Figures 25 through 27 show the distribution of this data over the sampling timeline.

<sup>\*</sup>TP Data Units: mg/L



<b>Headwater Sites</b>	Turbidity				
	Samples Collected	Average Sample	High Sample		
Beaver Creek	50	14.46	94.20		
Colonel Creek	53	11.05	42.70		
Dutchman's Creek	54	21.35	111.70		
Singleton's Creek	53	14.16	120.70		
Taylor Creek	52	13.75	71.90		
Big Wateree Creek	54	44.07	256.20		
White Oak Creek	49	11.55	47.30		
June Creek	53	15.45	59		
<b>Embayment Sites</b>		Turbidity			
Beaver Creek	225	14.23	208.40		
Colonel Creek	234	22.78	2657		
Dutchman's Creek	226	17.19	104.50		
Singleton's Creek	238	17.71	116		
Taylor Creek	249	30.07	2823		
Big Wateree Creek	214	41.46	2533		
White Oak Creek	217	12.67	83.40		
June Creek	215	17.17	95.40		
<b>Channel Sites</b>		Turbidity			
Channel 1	282	21.75	136.80		
Channel 2	272	14.35	139.90		
Channel 3	313	10.94	75.40		
Channel 4	376	10.28	95.60		

Table 25: WaterWatch Sediment Data (2008-2019)



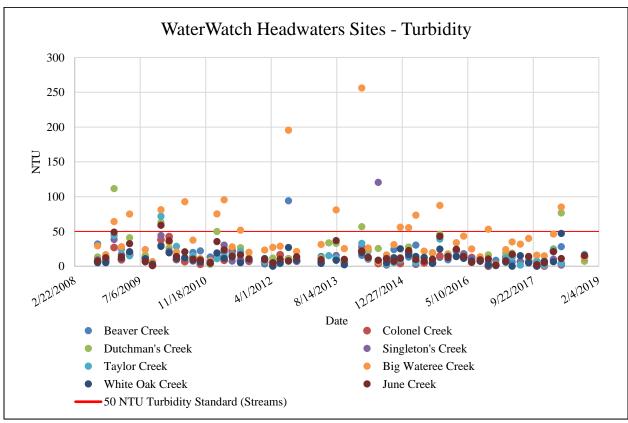


Figure 25: WaterWatch Headwaters Sites Only, Turbidity (2008-2019)

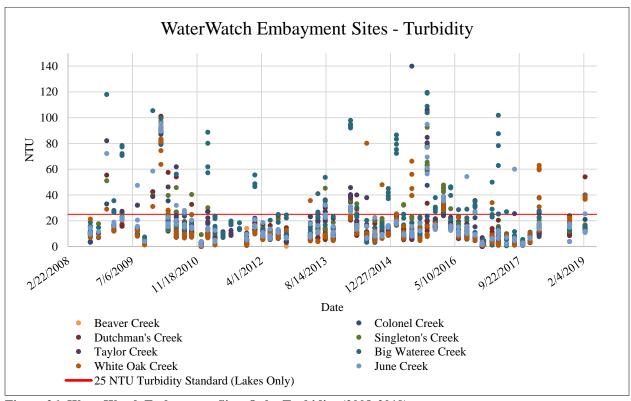


Figure 26: WaterWatch Embayment Sites Only, Turbidity (2008-2019)



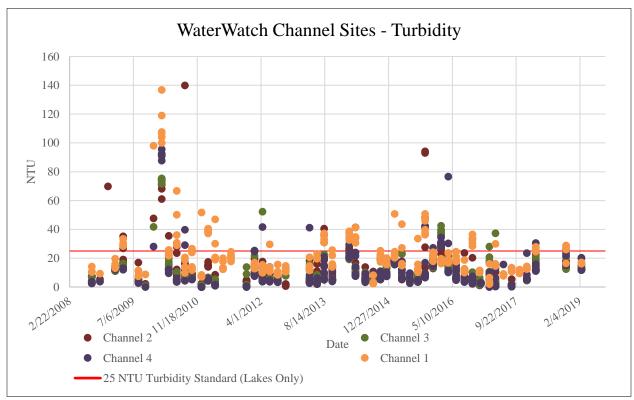


Figure 27: WaterWatch Channel Sites Only, Turbidity (2008-2019)

# 5.2.3) WaterWatch Water Quality Sampling Sites – Additional Data

The remaining data assessed from WaterWatch includes measurements for DO and pH at the 20 sampling sites from 2008 to 2019.

Roughly 7,700 samples were taken for DO and pH at the 20 sites over the sampling period. Table 26 summarizes the DO and pH samples at all locations and Figures 28 through 33 show the distribution of the data through the sampling timeline. The results for each parameter are presented in one corresponding figure for *headwater*, *embayment*, and *channel* sites. For DO data, the column labeled *Not Meeting Standard*, *Percent* reflects measurements that are below the state standard of 4.0 mg/L (daily low). For the pH data, the column labeled *Not Meeting Standard*, *Percent* reflects measurements that were either below 6.0 or above 8.5.



Headwater Sites		DO*			рН			
	Samples Collected	Lowest Sample	Average Sample	Samples Collected	Lowest Sample	Highest Sample	Average Sample	
Beaver Creek	55	4.90	9.19	55	6.71	8.04	7.10	
Colonel Creek	56	0.39	9.35	57	6.48	8.75	7.47	
Dutchman's Creek	54	4.80	9.07	58	6.32	8.47	7.34	
Singleton's Creek	55	3.98	10.23	57	6.27	8.94	7.58	
Taylor Creek	52	1.62	10.35	55	6.39	9.05	7.65	
Big Wateree Creek	55	3.66	8.81	57	6.38	9.26	7.26	
White Oak Creek	55	3.20	9.08	55	6.36	9.13	7.23	
June Creek	54	4.02	9.05	56	6.27	8.95	7.23	
Total	436	3.32	9.39	450	6.40	8.82	7.36	
<b>Embayment Sites</b>		DO*			pl	H		
	Samples Collected	Lowest Sample	Average Sample	Samples Collected	Lowest Sample	Highest Sample	Average Sample	
Beaver Creek	261	0.25	8.46	250	6.70	9.26	7.55	
Colonel Creek	271	0.04	8.58	262	6.54	9.21	7.69	
Dutchman's Creek	255	0.18	8.39	246	6.53	9.12	7.70	
Singleton's Creek	268	0.35	8.55	257	6.57	9.55	7.60	
Taylor Creek	259	0.80	8.60	254	6.57	9.10	7.35	
Big Wateree Creek	231	0.42	8.35	227	6.01	9.16	7.24	
White Oak Creek	250	0.27	8.73	241	6.63	9.45	7.68	
June Creek	234	0.97	8.61	225	6.56	9.08	7.58	
Total	2,029	0.41	8.53	1,962	6.51	9.24	7.55	
<b>Channel Sites</b>		DO*			pl	H		
	Samples Collected	Lowest Sample	Average Sample	Samples Collected	Lowest Sample	Highest Sample	Average Sample	
Channel 1	317	0.75	8.40	312	6.50	10.28	7.09	
Channel 2	318	0.24	8.43	305	6.66	9.37	7.62	
Channel 3	364	0.17	11.13	353	6.58	9.61	7.60	
Channel 4	441	0.07	7.20	423	6.47	9.45	7.40	
Total	1,440	0.31	8.79	1,393	6.55	9.68	7.42	

Table 1926: Sampling Results for DO and pH at All Sites, WaterWatch (2008-2019) \*DO Data Units: mg/L



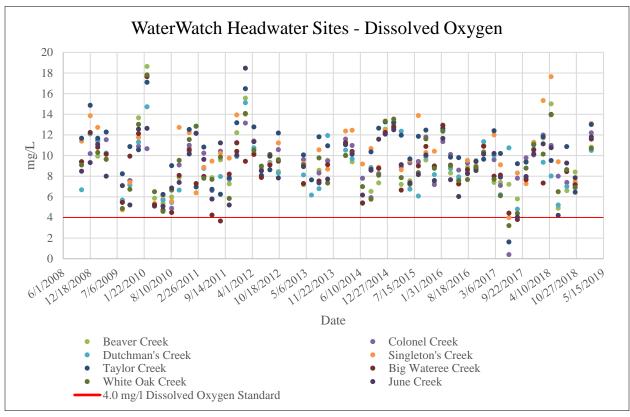


Figure 28: WaterWatch Headwater Sites Only, Dissolved Oxygen (2008-2019)

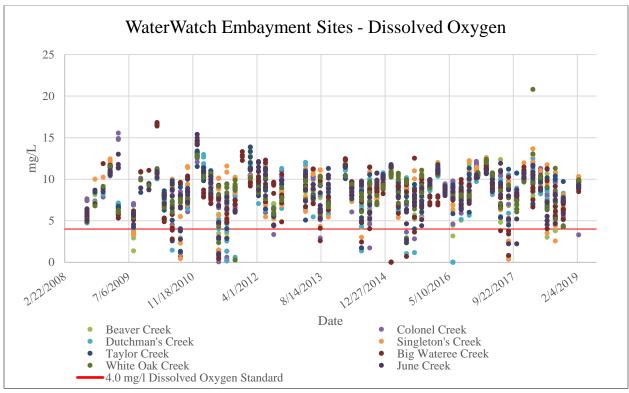


Figure 29: WaterWatch Embayment Sites Only, Dissolved Oxygen (2008-2019)



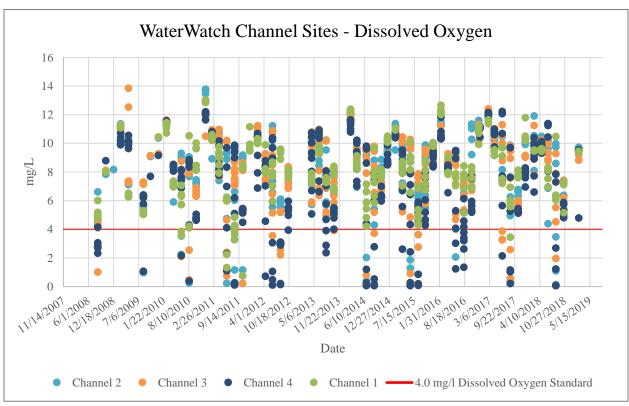


Figure 30: WaterWatch Channel Sites Only, Dissolved Oxygen (2008-2019)

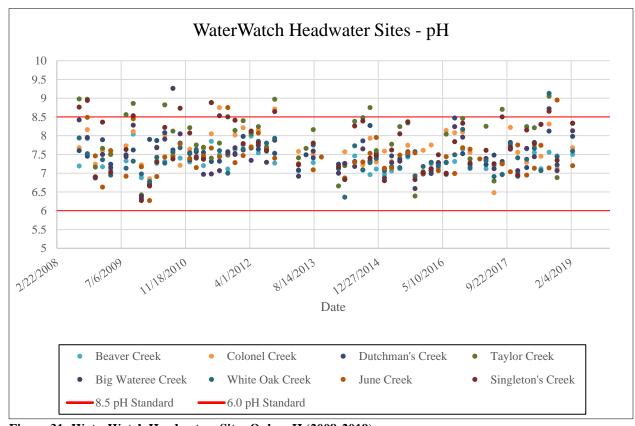


Figure 31: WaterWatch Headwaters Sites Only, pH (2008-2019)



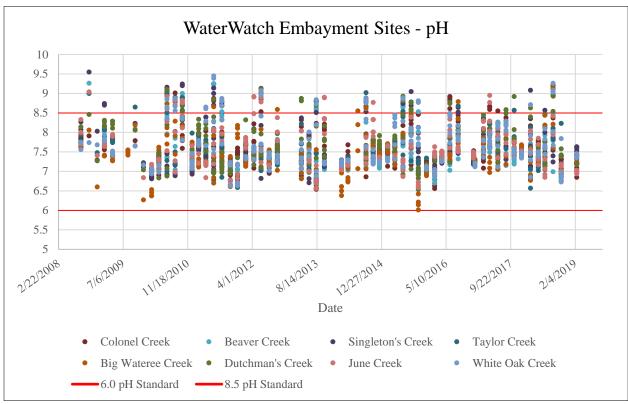


Figure 32: WaterWatch Embayment Sites Only, pH (2008-2019)

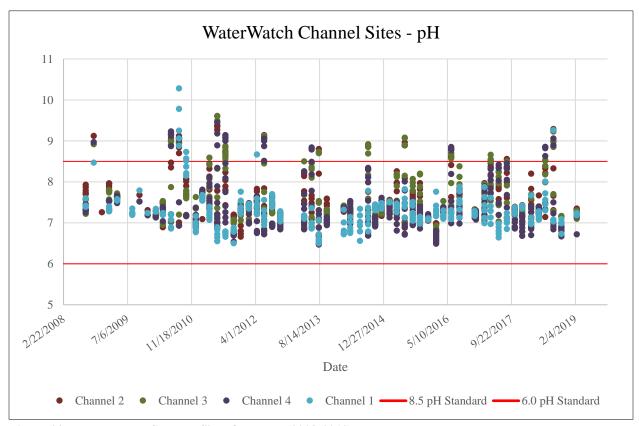


Figure 33: WaterWatch Channel Sites Only, pH (2008-2019)



## 5.3) Summary of Water Quality Monitoring Data

There are a total of 45 water quality monitoring sites within the project area used for this plan's water quality assessment. Twenty-five locations are regulatory sampling sites operated by SCDHEC and 20 are non-regulated sites operated by the WaterWatch team. The locations of the 45 sites include headwaters at all major lake tributaries, embayments for all major lake tributaries, lake channels, deep pool, and the north and south ends of the lake. Collectively, these locations provide a comprehensive assessment of the water quality within the project area.

Fifteen of the 25 SCDHEC WQMSs are listed as impaired by SCDHEC on the 2018 303(d) List of Impaired Waters. Eleven are listed for pH impairment, five for TP impairment, three for TN impairment, three for PCB impairment, two for DO impairment, and two for *E. coli* impairment. The available bacteria data shows impaired waters at the north end of the lake, just below the north dam, and at the headwaters on Beaver Creek. From north to south, the available nutrient data shows impaired waters at the north end of the lake, north of Big Wateree Creek, deep pool locations near the mid-point of the lake, and at the outflow of Beaver Creek. WaterWatch nutrient data, particularly TP, reveals nutrient measurements are consistently above the state standard at the Dutchman's Creek embayment, Singleton's Creek embayment, Channel 2, and Channel 4 locations. The Channel 4 site is located at the south end of the lake near the Duke Power Hydropower Dam and public drinking water intakes for the City of Camden and Lugoff-Elgin Water Authority. Of the approximate 3,500 samples for turbidity taken by WaterWatch from 2008 to 2019, measurements exceeded the state standard roughly 16% of the time. Therefore, sediments are not a localized issue, rather they are impacting the lake throughout.

# 5.4) Proposed Water Quality Monitoring

Water quality monitoring is distributed extremely well throughout the lake. SCDHEC maintains six active WQMSs, including one at the north end, one above the Big Wateree Creek outflow, one at the Dutchman's Creek outflow, two in deep pool locations near the center of the lake, and one at the south end near the Duke Power Hydropower Dam and public drinking water intakes. The WaterWatch team executes a thorough ambient water quality sampling strategy that includes samples taken at 20 locations. The sites include all major tributary headwater and embayment locations, and four deep channel locations. Samples are collected during February, April, June, October, and December to account for seasonal changes in water quality.

Based on the comprehensive ambient water quality monitoring strategy employed by the WaterWatch team, it is advised that SCDHEC and WaterWatch increase coordinated activities to better understand the bacteria and nutrient impairments, and to reconcile the disparity between their respective sediment data.

#### **5.4.1) Water Quality Monitoring Recommendations**

- 1. Recommend that the Lake Wateree Coalition be restored as a functional stakeholder group. This group was formed around 2019 and last held a meeting in 2020. Water quality was a focus of this group and would be an opportunity for stakeholders to coordinate water quality data sharing and analysis.
- 2. Recommend WaterWatch contact SCDHEC's Aquatic Science Program to determine more suitable sampling locations for measuring turbidity. This can include temporary Ambient, Random WQMSs or creating a new sampling site at the inflow of Big Wateree Creek where there is a known presence of livestock grazing in the area.
- 3. Recommend the WaterWatch team submit a Quality Assurance Project Plan (QAPP) to SCDHEC so that sampling data will be certified and documented by the state's primacy agency.
- 4. Utilize outreach methods to create long-term water quality research and analysis by nonregulatory organizations such as the University of South Carolina.
- 5. Utilize outreach methods to connect with volunteer organizations such as SC Adopt-a-Stream (SC AAS) to obtain additional data in support of the development of in-stream nutrient water quality standards. This would help provide baseline conditions for analyzing contributing streams with nutrient impairments and focus future implementation efforts within the project area.



#### 6) Bacteria Pollution Sources

Bacteria pollution can be attributed to both point and nonpoint sources within the project area. Table 27 provides some examples including wastewater effluent, agricultural land cover, and urban runoff.

Wastewater	Agriculture	Urban	
Private Septic Systems	Livestock	Ct D ff	
Private Wastewater Treatment Facilities	Cropland	Stormwater Runoff	

Table 27: Potential Point and Nonpoint Sources of Bacteria Pollution in Project Area

# **6.1) Bacteria Pollution - Point Sources**

The EPA defines point source pollutants as "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged" [22].

Regulating point sources falls under the jurisdiction of the National Pollution Discharge Elimination System (NPDES). The NPDES program was created by the federal government as a part of the CWA in 1972 to help address water pollution by regulating point sources discharging into public waters. The CWA authorizes the program to state, tribal, and territorial governments, which allows them to conduct permitting and enforcement steps [23]. Table 28 below details the NPDES sites within the project area.

NPDES Permit Number Facility		Facility Type	Bacteria Violations (2018-2020)
SCG570034	USAF Wateree Recreation Facility	Industrial	None
SCG730215	Georgia Stone/Kershaw Quarry	Industrial	None
SC0033651	NOSOCA Pines Ranch	Domestic	None

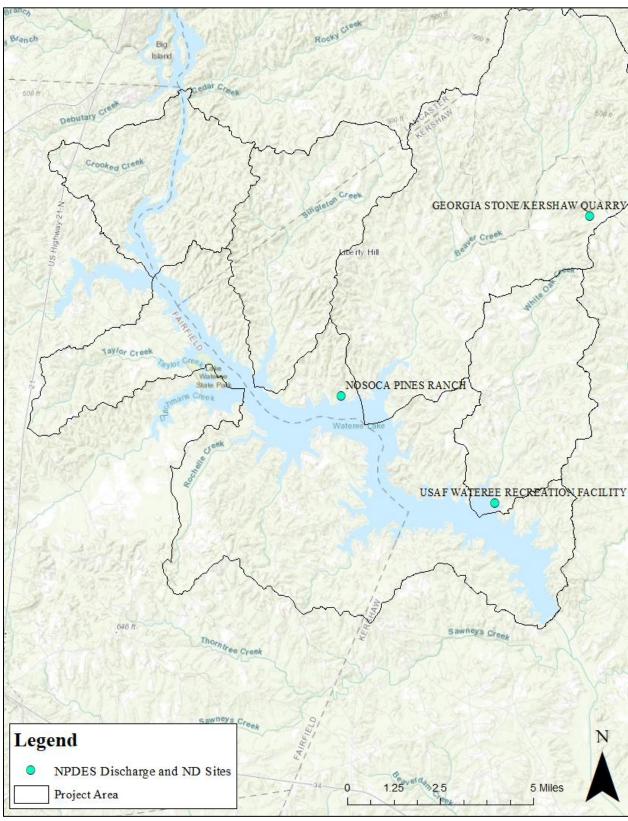
**Table 28: Active NPDES Permits in Project Area** 

NPDES permitting also includes No-Discharge (ND) Class B Sludge Application Sites. There are three ND sites in the project area where wastewater sludge is permitted to be land applied. These sites are included in this plan due to their potential for contributing bacteria pollution. Table 29 details ND Sites in the project area. Map 20 shows where the locations for the NPDES and ND Sites are located in the project area.

ND Sites (FRS ID)	ND Sites (FRS ID) Facility		Bacteria Violations (2015-2021)
110006693364	Georgia Stone Industrial - Coral Grey	Industrial	None
110006622217	NOSOCA Pines Ranch	Domestic Farm	None
110006796253	Shaw AFB Wateree Recreational Facility	Federal	Yes (2015)

Table 29: Active ND Permits in Project Area





Map 22: Active NPDES and ND Sites in Project Area



## 6.2) Bacteria Pollution - Nonpoint Sources and Estimated Pollutant Load

Nonpoint source pollution is a result of rainfall moving over and through the ground transporting pollutants, such as bacteria, to the nearest waterbody. Nonpoint sources of bacteria pollution that are being addressed in this WBP can be linked to failing septic systems, agricultural activity, and urban land cover.

The majority of residents at Lake Wateree are not connected to a municipal wastewater treatment system. It is reasonable to assume then that septic systems are the only means of processing wastewater. Nonpoint sources of bacteria pollution from agricultural activity and stormwater runoff originate from only 1.7% (*cultivated crop* and *hay/pastureland*) and 3% (*developed*) respectively. This does not imply that these land cover are insignificant sources of bacteria pollution. Activities such as cattle grazing can contribute concentrated levels of bacteria pollution to waterbodies. There is an *E. coli* impairment listed at SCDHEC WQMS RS-07059 in the Beaver Creek watershed. Site surveys confirmed grazing livestock (cattle) on pastureland in the Beaver Creek watershed. One other SCDHEC WQMS CW-231 is listed as impaired for *E. coli*, but the station is located at the north dam and is likely affected by upstream factors outside of the project area. Considering this information, this plan will focus on bacteria pollution originating from failing septic systems, agricultural sources (*i.e.* pastureland and cropland), and urban sources near the lake shoreline.

The EPA Spreadsheet for Estimating Pollutant Loads (STEPL) is a customizable Excel spreadsheet model used in watershed planning level decision making. The tool is designed to determine annual average pollutant loads from nonpoint pollution sources and estimate BMP pollutant load reduction rates. The STEPL Data Server was used to download watershed specific data for the project area. However, one limitation of STEPL is that it does not calculate bacteria nonpoint source pollutant loading. Literature and STEPL Data Server values were used to determine bacteria loads for the following sections including *Septic Systems*, *Agriculture – Livestock*, *Agriculture – Cropland*, and *Urban*.

# **6.2.1**) Bacteria Pollution – Septic Systems

Septic systems can have a significant impact on local drinking water wells and surface waterbodies. System maintenance is the key to a properly operating septic tank. The septic tank operates by storing generated wastewater, allowing the solids to settle at the bottom of the tank as sludge, with the fats, oils and greases floating to the top. Microorganisms then break down the sludge and eliminate most contaminants. The partially treated wastewater then flows out of the tank and through a drainfield. If the drainfield is overcome with too many liquids and solids, they will flood and cause sewage to back up into the home. The water table below the drainfield captures any remaining bacteria contamination released from the septic system. Shallow water tables and ground water are connected through subsurface passages to surface water riverine systems. Therefore, bacteria pollutants entering the groundwater can be transported into surface waters [24]. Based on the K-Factor measurements for soils in the project area, terrestrial water flows *moderately* well through the soils. Based on the interconnectedness between groundwater and surface water and the soils present in the project area, the aggregate effect of failing septic systems can directly impact water quality. Alternatively, moderately well drained soils over time can become saturated and restrict water percolation, thereby exposing stored wastewater overflow to potential runoff into nearby waterbodies.





Photo 8: Example of Failing Septic System (photo credit: Wexco Environmental)

SCRWA utilized STEPL to determine the number of septic systems, population per septic system, and septic system failure rate in the project area. Of the 348 total septic systems, 92 are considered to be failing. Table 30 details septic system data for the project area based on STEPL data.

Watershed	Number of Septic Systems	Number of Individuals Per Septic System	Septic Failure Rate, Percent	Estimated Number of Failing Septic Systems
White Oak Creek	23	2	27%	6
Headwaters Lake Wateree- Catawba River	23	3	27%	6
Singleton Creek	9	3	27%	2
Beaver Creek- Catawba River	99	3	27%	26
Lake Wateree- Catawba River	194	3	27%	52

Table 30: STEPL Data - Septic Systems within Project Area

The septic system count provided by STEPL seemed very low compared to the number of housing units found through the Environmental Systems Research Institute (ESRI) 2010 Census Profile (see Appendix B). The Profile revealed 2,751 housing units in the project area. The bacteria nonpoint source load reduction calculation for septic systems was made using a combination of the ESRI (2,751 housing units) and STEPL data (27% failure rate). It should be noted that assigning one septic system to every housing unit is likely not plausible and therefore the estimated bacteria pollutant load represents a maximum amount based on the available data used for the calculation.



According to SCDHEC, bacteria load from failing septic tanks per household amount to 2.76E+06 CFU/hour, which is 2.42E+10 CFU/year [24]. Many of the homes in the project area are second/vacation homes and are inhabited during certain months of the year. Therefore, the expected population of homes within the project area is closer to the standard assumption of 2.5 persons per household which aligns with the calculation for bacteria loading per year. Based on STEPL's 27% failure rate for ESRI's 2,751 housing units, a total of 743 septic systems are considered failing. It was estimated that the existing bacteria load from failing septic systems in the project area is 1.80E+13 CFU/year. This data is shown in Table 31 below.

Estimated Septic Systems	Estimated Failing Septic Systems	Bacteria Load per Household (CFU/year)	Total Estimated Bacteria Loading (CFU/year)
2,751	743	2.42E+10	1.80E+13

Table 31: Septic Systems and Bacteria Loading

# 6.2.2) Bacteria Pollution - Agricultural

Livestock, such as cattle, that have access to waterbodies can deposit bacteria loads directly into waterbodies through their fecal matter. Over time, this can lead to water quality impairments for bacteria such as *E. coli*. SCDHEC WQMS RS-07059 is listed as impaired for *E. coli* and is located at the headwaters of Beaver Creek in the Beaver Creek watershed. Grazing cattle in the Beaver Creek watershed was confirmed through site surveys.

Calculating the estimated total number of cattle in the Beaver Creek watershed includes taking the average of a calculated total number of cattle in Lancaster County from the 2017 USDA Census of Agriculture and the cattle estimation for the Beaver Creek watershed in STEPL. The calculation from the 2017 USDA Census of Agriculture utilizes the total number of cattle within the county divided by the total acreage of pastureland within the county multiplied by the acreage of pastureland within the Beaver Creek watershed. The data and calculated results can be found in Tables 32 and 33.

Total Cattle in Lancaster County	Acres of Pastureland within Lancaster County	Acres of Pastureland in Beaver Creek Watershed	Estimated Number of Cattle in Beaver Creek Watershed
7,185	11,363	837	529

Table 32: Estimated Cattle Population Using 2017 USDA Agricultural Census

Source Data for Estimating Cattle Population in Beaver Creek Watershed	Estimated Number of Cattle in Beaver Creek Watershed
2017 USDA Census of Agriculture	529
EPA STEPL	209
Average Estimated Number of Cattle in Beaver Creek Watershed	369

Table 33: Total Estimated Cattle Population in Beaver Creek Watershed

The same process for estimating the total number of cattle was applied to each of the other four watersheds in the project area. The remaining agricultural animal population figures found in Table 34 were taken from STEPL via the STEPL input data server estimates.



Watershed	Beef Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck
Lake Wateree-Catawba River Watershed	107	5	1	19	20,939	229	2
Headwaters Lake Wateree - Catawba River Watershed	143	1	6	47	15,519	7,044	4
Singleton Creek Watershed	74	5	3	31	19,044	3,255	3
Beaver Creek Watershed	369	9	10	87	44,234	10,499	8
White Oak Creek Watershed	29	5	1	13	15,976	0	2
Total	722	25	21	197	115,712	21,027	19

Table 34: Total Number of Agricultural Animals in Project Area

## 6.2.2.1) Bacteria Pollution – Agricultural Livestock

SCRWA was not able to get an accurate count of all livestock during site surveys. As previously stated, grazing cattle were identified in the Beaver Creek watershed. In lieu of site survey data, a combination of STEPL input data server estimates and/or USDA Census of Agriculture estimates were used (see Table 34 and Table 35). Data from SCDHEC's Load Estimation and Reduction Spreadsheet was used to convert animal bacteria load to a pasture beef cow equivalent (PBCE) (see Table 36). Total fecal coliform loading from livestock was determined using SCDHEC's Load Estimation and Reduction Spreadsheet and Larsen's *Manure Loading into Streams from Direct Fecal Deposits* [25][26]. Larsen states that one 1,000 pound beef cow can deposit into streams a 2.98E+09 load of fecal coliform per day. The total calculated bacteria load from livestock using this data can be found in Table 37 [26].

	Cow	Horse	Sheep	Total
Count	722	197	21	1,133
Livestock Equivalents	1	1.1	0.04	N/A
Pasture Beef Cow Equivalent (PCBE)	722	216.7	0.84	939.54

Table 35: STEPL-Based Agricultural Animal Population Count and PBCE Conversion

Livestock	PCBE Count	Equivalent (FC/day)	Fecal Coliform Load (CFU/yr)
Cow	722	3.84E+10	1.01E+16
Cow (in-stream)*	722**	2.98E+09	1.09E+12
Horse	216.7	3.84E+10	3.04E+15
Sheep	0.84	3.84E+10	1.18E+13
Total	939.54	1.18E+11	1.31E+16

Table 36: Total Estimated Bacteria Loading from Livestock in Project Area

<sup>\*\*</sup>Count included at 722 for consistency, though likely not plausible.

Total Estimated Bacteria Load from Livestock (CFU/yr)	Total Pastureland in Project Area (Acres)	Average Annual Livestock Bacteria Load from Pastureland (CFU/yr)
1.31E+16*	1,595	8.28E+12

Table 37: Average Annual Livestock Bacteria Load from Pastureland in Project Area

<sup>\*</sup>Included to account for bacteria loads from cows directly deposited into stream. Measurement to be used in conjunction with other measurements listed.

<sup>\*</sup>This number includes FC deposited in streams from cows.



## 6.2.2.2) Bacteria Pollution – Agricultural Cropland

Data presented in 3.5.2 shows that *cultivated crops* represents less than 1% of all total land cover. The total acreage calculated using the NLCD (2020) data resulted in 222 acres in the project area. STEPL does not estimate bacteria loads for agricultural croplands. Shaver, *et al.* (2007) published *Fundamentals of Urban Runoff Management - Technical and Institutional Issues* and provided an annual fecal coliform loading of 2.70E+10 CFU/ha-year from crop farms [27]. *Crop farms* applies to all *cultivated crops* for the purpose of this analysis. This rate was used to calculate bacteria loading for the 222 acres in the project area. The results are shown in Table 38.

Land Cover	Fecal Coliform Loading	Cropland	Cropland	Fecal Coliform
	(CFU/ha-yr)	(Acres)	(Hectares)	Loading (CFU/yr)
Cultivated Crops	2.70E+10	222	89.84	2.43E+12

Table 38: Total Estimated Bacteria Loading from Cropland in Project Area

#### 6.2.2.3) Bacteria Pollution – Urban

Stormwater runoff can originate from a number of different land covers, including urbanized areas. Urban areas typically have high percentages of impervious surfaces, which act as easy pathways to waterbodies for stormwater runoff. Prior to Low Impact Development (LID) strategies, most urban areas were built without a focus on stormwater management. Some results of urban stormwater runoff include channelized streams, increased erosion, and flooding, especially in low lying areas. Wildlife, pet waste, and urban infrastructure are the primary contributors to bacteria pollution in stormwater runoff.

Data presented in 3.5.2 shows that *developed* land cover represent almost 3% of all total land cover in the project area. The total acreage calculated using the NLCD (2020) data resulted in 9,210 urban acres in the project area. STEPL does not estimate bacteria loads for urban land cover. As an alternative, SCRWA utilized Shaver, *et al.* (2007) to determine bacteria loading [27]. The publication includes bacteria pollutant loads for developed land (ranges) including, *commercial, single family low density residential*, and *multifamily residential* (see Table 39). These values were then applied to the NLCD (2020) *developed* land cover data.

Land Cover Category	Fecal Coliform Loading (CFU/ha-yr)	
Commercial	Median	5.8E+09
Single Family Low Density Residential	Median	9.3E+09
Multifamily Residential	Median	2.1E+10

Table 39: Shaver, et al. Bacteria Pollutant Loading from Developed Land Cover [27]

Land Cover Category	NLCD Developed Land Cover*	Fecal Coliform Loading (CFU/ha-yr)	Acres	Hectares	Fecal Coliform Loading (CFU/yr)
Commercial	Developed, High Intensity	5.8E+09	0.0	0.0	0.0
Single Family Low Density Residential	Developed, Low Intensity	9.3E+09	116.27	47.07	4.38E+16
Multifamily Residential	Developed, Medium Intensity	2.1E+10	23.97	9.70	2.04E+11

Table 40: Estimated Bacteria Loading from Urban Land

<sup>\*</sup>Indicates Urban Land Cover



## 6.3) Bacteria Pollution - Nonpoint Source Load Reduction

There is not a targeted bacteria load reduction established through a Total Maximum Daily Load (TMDL) for the project area. As an alternative, this plan utilizes best professional judgement (BPJ) to determine bacteria load reductions based on a reasonable level of participation from landowners and the best options for BMP installations specific to the sources of bacteria pollution and their efficiency in mitigating the contributing land cover/activity.

In this WBP, SCRWA proposes a 15-year BMP implementation timeline. The timeline is broken down into three five-year phases (see Section 18). WBPs are intended to be a long-lived document that receives periodic updates as needed. SCRWA recommends reviewing the BMP implementation schedule and progress twice a year throughout the proposed timeline to assess overall effectiveness.

Bacteria load reductions will be achieved using the proposed BMP implementation timeline presented in Section 18. Among the various cost-share funding opportunities for BMP implementation, the CWA Section 319 Grant is the most commonly used. EPA guidance for this grant state that the funding is to be applied within a three year time frame. The proposed phased BMP implementation timeline allows for enough time to plan and secure funding from sources like the CWA Section 319 grant.

Table 41 shows the estimated loading from each source and Table 42 provides load reductions for the proposed BMPs targeting bacteria nonpoint source pollutants in the project area. The plan proposes to replace/repair 100 septic systems during each of the three five-year BMP implementation phases. During years two through five in each of the three BMP implementation phases, one agriculture-livestock (cattle) bundled project and one agriculture-cropland bundled project is recommended. An agriculture-livestock (cattle) BMP bundle includes alternative watering source, exclusionary fencing, stream crossing, manure composting (structure), and heavy use area stabilization. An agriculture-cropland bundle includes nutrient management, soil stabilization, and critical area planting. The frequency of these installations will depend on available funding from awarded grants. It should be noted that each grant has specific guidance and the guidance should be considered during the implementation phase. It is recommended that the findings found in the BMP strategy sections 11-15 be used during the BMP implementation planning stages.

For the agriculture-livestock projects proposed, SCRWA believes that the majority of livestock load reductions will come from alternative watering sources and exclusionary fencing BMPs. The load reductions for each agriculture-livestock BMP presented in Table 42 apply a 30% bacteria load reduction efficiency based on literature value for offstream watering and fencing [28]. The BMPs listed for livestock should be treated as a bundle (*i.e.* one project). SCRWA anticipates three cattle farms totaling roughly 600 cattle in the project area will participate during the proposed 15-year BMP implementation period. Livestock farms in the Beaver Creek watershed, where there is a listed *E. coli* impairment, should be prioritized in the implementation planning process.

For the agriculture-cropland projects proposed, SCRWA believes that the majority of the bacteria load reductions will come from farmers installing critical area planting BMPs. The load reductions for each agriculture-cropland BMP presented in Table 42 apply a 20% bacteria load reduction efficiency based on SCDHEC data for critical area planting (SCDHEC 2017). The BMPs listed for cropland should be treated as a bundle (*i.e.* one project). SCRWA anticipates three crop farms totaling roughly 150 acres will participate during the 15-year BMP implementation period.

Complete definitions and maintenance recommendations for each BMP listed in this section can be found in Section 9.



TOTAL ESTIMATED BACTERIA NONPOINT SOURCE POLLUTION LOADING					
Source Fecal Coliform (CFU/year)					
Septic	1.80E+13				
Agriculture – Livestock	1.13E+16				
Agriculture – Cropland	2.43E+12				
Urban	4.38E+16				
Total	5.51E+16				
Conversion to E. coli (MPN/100mL)*	4.81E+16				

Table 41: Total Estimated Bacteria Loading in Project Area

<sup>\*</sup>Utilized SCDHEC's change in standards from Fecal Coliform to E. coli. E. coli conversion factor is 0.8725.

	AVERAGE ANNUAL BACTERIA LOAD REDUCTION						
Category	ВМР	Bacteria Removal per Single BMP (CFU/year)	Estimated Number of Projects	Total Bacteria Reduction (CFU/ year)			
Septic	Septic Repair/Replacement [24]	2.42E+10	100	2.42E+12			
	Alternate Watering Source and Fencing [28]			1.40E+15			
Agriculture –	Stream Crossing	7.00E+12 (per one	1 (200 cattle)				
Livestock Bundle	Manure Composting (structure)	cow/year)					
	Heavy Use Area Stabilization						
	Nutrient Management		1 (20% cropland area)				
Agriculture –	Soil Stabilization	1.09E+10 (per one		4.84E+11			
Cropland Bundle	Critical Area Planting ( <i>e.g.</i> Cover Crop, No Till) [25]	acre)	1 (20% cropiano arou)	7.070/11			
Total				1.40E+15			
Conversion to E. coli (MPN/100mL)*				1.22E+15			

Table 42: Average Annual Bacteria Load Reduction After BMP Install

## 7) Sediment Pollution Sources

According to the EPA, sediments are becoming the most common source of pollution throughout the country [29]. Sediments are defined as loose sand, clay, silt, and other soil particles that settle at the bottom of a waterbody. They can originate from natural or anthropogenic sources including soil erosion or decomposing plants and animals. The project area is a perfect example for excess sediments impacting water quality. Poorly planned and managed flood control measures have created opportunities for sediments to deposit into the lake from streambanks and lakeside properties. Additionally, with population growth expected upstream (see Section 3.6), the effects from urbanization will compound the problems associated with sediment nonpoint source pollution.

<sup>\*</sup>Utilized SCDHEC's change in standards from Fecal Coliform to E. coli. E. coli conversion factor is 0.8725.



The impact from sediments is widespread at Lake Wateree. Sediments cause cloudy or turbid water – preventing animals from seeing food, preventing natural vegetation from growing, increasing drinking water treatment costs, clogging fish gills, and creating conditions that can promote cyanobacteria growth, also blue-green algae. The proliferation of Microseira (Lyngbya) wollei, a cyanobacteria species, has occurred over the last ten years at Lake Wateree. Microseira wollei can produce and release cyanotoxins that are a threat to human health. As a result, Duke Energy has taken a lead role in mitigation. The recently approved FERC Relicense for the Catawba-Wateree Hydroelectric Project includes sediment mitigation strategies such as the installation of a new gate system at the north dam to control peak storm flows [4].

SCRWA used downloaded watershed data from the STEPL input data server, NLCD (2020), and USDA Census of Agriculture (2017) to calculate sediment loads. The estimated sediment load contributing to the project area totals 1,343 tons of sediment per year. Figure 34 provides a breakdown of sediment contribution from each land cover in the project area. Urban and forested land contribute roughly 41% each.

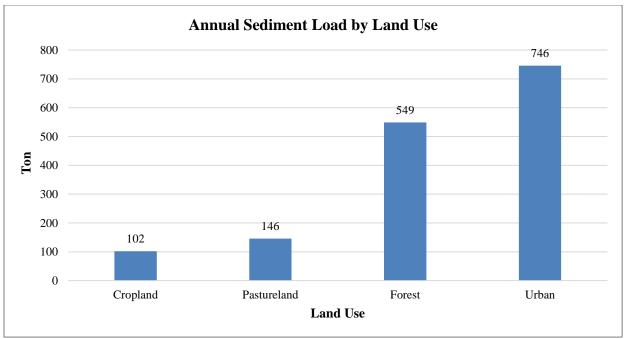


Figure 34: Sediment Load from Land Use per Year

#### 7.1) Sediment Pollution - Point Sources

The Municipal Separate Storm System (MS4) program is managed by SCDHEC to identify and regulate stormwater point sources. According to SCDHEC, a MS4 is a "system of conveyances that include, but are not limited to, catch basins, curbs, gutters, ditches, man-made channels, pipes, tunnels, and/or storm drains that discharge into Waters of the State" [30]. All point sources discharges in the project area are identified in Section 6.1.

# 7.2) Sediment Pollution - Nonpoint Sources and Estimated Pollutant Load

Based on the proliferation of Microseira (Lyngbya) wollei, contributions from nonpoint source sediment pollution are assumed to be prevalent throughout the project area. Activities in the project area contributing to nonpoint source sediment pollution include construction sites, agricultural operations, stormwater runoff, and forestry practices.

STEPL was utilized to determine the estimated nonpoint source pollutant loads from sediment in the project area. NLCD (2020) and USDA Census of Agriculture (2017) data replaced some of the automatically populated values downloaded through the STEPL input data server. This was done to create a more accurate representation of pollutant loads.



## 7.2.1) Sediment Pollution - Agricultural

Runoff from agricultural fields can be filled with fertilizers rich with nitrogen, phosphorus, and pesticides. The runoff is transported from agricultural fields into the nearby waterbodies after rain events. Other factors such as overgrazing, mismanaged Concentrated Animal Feeding Operations (CAFOs), and pivot irrigation systems also add to the nonpoint source sediment pollution problems. The estimated sediment pollutant load originating from agricultural land in the project area is provided in Table 43 below.

	Sediment (ton/year)			
Watershed	Cropland	Pastureland	Combined	
Lake Wateree-Catawba River	30	32	62	
Headwaters Lake Wateree-Catawba River	0	8	8	
Singleton Creek	3	13	16	
Beaver Creek	69	77	146	
White Oak Creek	0	16	16	
Total (ton/year)	102	146	248	

Table 43: Estimated Sediment Load from Agriculture Land in Project Area

#### 7.2.2) Sediment Pollution – Forest

The primary contributors for sediment pollution originating from forested land comes from logging road use, clearcutting, gullying, and mismanaged/poorly installed forestry BMPs. However, based on conversations with the South Carolina Forestry Commission (SCFC) Environmental Programs Manager (and past BMP forester), forestry BMP compliance by logging companies averages 99% compliance (Holly Welch - SCFC, personal communication, July 2021). Therefore, sediment loading from forestry practices are likely attributable to clear cutting and gullying. SCFC programs, such as Stewardship Management Plans, are proven tools that effectively manage forested land. The estimated sediment pollutant load originating from forested land in the project area is provided in Table 44 below.

	Sediment (ton/year)
Watershed	Forest
Lake Wateree-Catawba River	186
Headwaters Lake Wateree-Catawba River	48
Singleton Creek	71
Beaver Creek	184
White Oak Creek	60
Total (ton/year)	549

Table 44: Estimated Sediment Load from Forested Land in Project Area

### 7.2.3) Sediment Pollution - Urban

Land disturbance and impervious surfaces together represent the greatest contributions to urban nonpoint source pollution. Some urban characteristics that contribute to sediment loading include construction site activity, streets, yards, and streams. Impervious surfaces, like paved streets, prevent rainfall from being absorbed by natural landscapes. This can lead to a high volume of water flowing over areas with loose sediments (*e.g.* yards), which contribute to sediment deposition in nearby waterbodies. Streambanks with loose soils that accept a high volume of water during rain events can erode, causing sediments to deposit throughout the stream channel. Feedback from Lake Wateree residents indicate that there are new and existing home construction sites that have either no or ineffective silt fencing. Careful consideration should be given to proposing local ordinances for construction sites during the WBP's proposed BMP implementation period. The estimated sediment pollutant load originating from urban land in the project area is provided in Table 45.



	Sediment (ton/year)		
Watershed	Urban		
Lake Wateree-Catawba River	356		
Headwaters Lake Wateree-Catawba River	37		
Singleton Creek	71		
Beaver Creek	205		
White Oak Creek	77		
Total (ton/year)	746		

Table 45: Estimated Sediment Load from Urban Land in Project Area

## 7.3) Sediment Pollution – Nonpoint Source Load Reduction

There is no targeted sediment load reduction established through a TMDL for the project area. BPJ was used to determine sediment load reductions based on a reasonable level of participation from landowners and the best options for BMP installations specific to the sources of sediment pollution and their efficiency in mitigating the land cover/activity.

Like the load reductions for bacteria nonpoint source pollution, load reductions for sediment will be achieved using the proposed 15-year phased BMP implementation timeline detailed in Section 18. WBPs are intended to be a long-lived document that receives periodic updates as needed. It is recommended that the BMP implementation schedule be reviewed twice a year throughout the proposed BMP implementation period to assess overall effectiveness. Table 46 shows the total estimated annual nonpoint source sediment load for each source and Table 47 outlines the estimated BMP load reduction.

STEPL was used to calculate the estimated nonpoint source pollutant loads from sediment in the project area. The data sources for the calculations included NLCD (2020), USDA Census of Agriculture (Lancaster County only) (2017), Universal Soil Loss Equation (USLE), and County precipitation. After the data was populated in STEPL, the model was run for various BMPs for pastureland, cropland, forest, and urban land cover. The "parallel" BMP implementation configuration was used to determine load reduction efficiency for multiple BMPs for the same land cover within a given watershed.

This plan proposes 145 BMPs for each five-year implementation phase, which translates to 435 projects over the course of the 15-year BMP implementation timeline. SCRWA recognizes that this is a lofty goal but given the severity of all nonpoint source pollutant loading, especially sediment loading, this type of aggressive strategy will have a significant impact on improving water quality. The frequency of these installations will depend on available funding from awarded grants. It should be noted that each grant has specific guidance and the guidance should be considered during the implementation phases. It is recommended that BMP implementation planning utilize the analyses found in the BMP strategy sections 11 through 15.

For pastureland, STEPL was run for the following proposed BMPs: exclusionary/streambank fencing and stabilization, alternative watering source, and grass buffers (35 feet). These are proposed for all five watersheds. Three agricultural – livestock bundles are proposed for the Beaver Creek watershed, with one bundle assigned to each BMP implementation phase. Each bundle is treated as a single BMP project in this plan. Proposed BMP projects were assigned a 5% land allocation per BMP on pastureland in each watershed.

For cropland, the model was run for cover crop (high till for sediment and TP), grass buffer (35 feet), conservation tillage (30-59% residue), and forest buffer (100 feet) for the Lake Wateree-Catawba River and Beaver Creek watersheds only. Three agricultural – crop bundles are proposed for the Lake Wateree-Catawba River, Beaver Creek, and Singleton Creek watersheds. Each bundle is treated as a single BMP project in this plan. Proposed BMP projects were assigned a 10% land allocation per BMP on cropland in each selected watershed.

For forested land, the model was run for site prep/hydro mulching/seeding/fertilizer for all five watersheds in the project area. Proposed BMP projects were assigned a 10% land allocation per BMP on cropland in each selected watershed.



For urban land, the model was run for Low Impact Development (LID) filter/buffer strips at multi-family and single family sites and vegetated filter strips for transportation sites. Proposed BMP projects were assigned 5% land allocation per BMP on urban land in all five watersheds in the project area.

Table 47 includes all proposed BMPs listed above and their reduction measurements over the course of one year and should not be interpreted as sediment load reduction during one project phase (*i.e.* five years). Several BMPs are proposed to be implemented during different phases. Furthermore, many of these BMPs are intended to treat varying numbers of acres with different soil composition. For these reasons, the load reduction calculations were summarized on an annual basis in this section. Table 54 provides a correct representation of sediment load reduction for each watershed for the proposed BMP implementation schedule. Complete definitions and maintenance recommendations for each BMP listed in this section can be found in Section 9.

TOTAL ESTIMATED SEDIMENT NONPOINT SOURCE POLLUTION LOADING					
		Sediment (	ton/year)		
Watershed	Cropland	Pastureland	Forest	Urban	Total
Lake Wateree- Catawba River	30	32	186	356	604
Headwaters Lake Wateree- Catawba River	0	8	48	37	93
Singleton Creek	3	13	71	71	158
Beaver Creek	69	77	184	205	535
White Oak Creek	0	16	60	77	153
Total	102	146	549	746	1,543

Table 46: Total Estimated Sediment Pollutant Load in Project Area



AVERAGE ANNUAL SEDIMENT LOAD REDUCTION						
	Annual Sediment Load (ton/year)				Load Reduction (ton/year)	
Watershed	Cropland	Pastureland	Forest	Urban	Sediment Reduction (with BMP)	Percent Reduction
Lake Wateree-Catawba River	30	32	186	356	230.6	38.2
Headwaters Lake Wateree- Catawba River	0	8	48	37	52.4	56.3
Singleton Creek	3	13	71	71	80.8	51.1
Beaver Creek	69	77	184	205	327.3	61.2
White Oak Creek	0	16	60	77	71.8	46.9
Total (ton/year)	102	146	549	746	762.9	50.7

Table 47: Erosion and Sediment Delivery and Average Annual Load Reduction for Project Area



SCRWA completed an additional review for cropland BMP removal efficiencies. This data was not utilized in this plan but is available for future consideration. A summary of the BMP removal efficiencies and the complete literature review can be found in Appendix C.

#### 8) Nutrient Pollution Sources

The excessive acceleration rate of nitrogen and phosphorus concentrations entering aquatic environments is unprecedented when put in historical context. A result of this type of excessive nutrient loading can be seen in the Gulf of Mexico's Hypoxic Zone. The EPA has determined that excess agricultural nutrient pollution and urban runoff from the Mississippi River Valley are the primary causes for the hypoxia. The nutrient and sediment data provided in this plan indicate that excess nutrient and sediment loads are likely playing a role in the increasing magnitude and duration of cyanobacteria HABs (*i.e.* Microseira (Lyngbya) wollei). The possible sources for the elevated nutrient measurements at the lake come from upstream influence and local flooding. Duke Energy has an agreement in place through the most recent FERC Relicense to mitigate impacts from flooding by installing new flood gates to improve the spillway flow release. Currently, the lake does not have a way to release water in a controlled manner. The Obermeyer flood gates will provide an additional 10,000 cubic feet per second (approximately 75,000 gallons per second) of controlled flow release capacity from the lake. When high flow is anticipated through the Catawba-Wateree basin, Duke Energy will raise the four and a half foot gate system as a flood control measure [4]. This will help reduce excess nutrients and sediment captured from lakeside lawns entering into the lake.

#### **8.1) Nutrient Pollution – Point Sources**

Detailed in Section 6.1, there are four NPDES and ND Permitted sites located within the project area. Effluent from sewage treatment plants and industry can be causes of point source nutrient pollution. The Lake Wateree WWTP and Shaw Airforce Base Recreation Facility both have had violations for bacteria in 2021 and 2015 respectively, however no violations exist for nutrients for either of these facilities. Nevertheless, SCRWA recommends regularly monitoring these facilities for nutrient violations.

# 8.2) Nutrient Pollution - Nonpoint Sources and Estimated Pollutant Load

There are six SCDHEC WQMSs (CW-231, RL-02314, RL-03336, RL-09099, RL-11040, RL-15007) impaired for either TN or TP. Stations CW-231 and RL-11040 are impaired for both TN and TP. The aggregate effect from upstream influence, local flooding, and local urbanized impervious area has resulted in impaired water with elevated nutrient measurements and a persistent and toxic HAB (Microseira (Lyngbya) wollei). According to Duke Energy, populations of Microseira (Lyngbya) wollei began appearing throughout Lake Wateree in the early 1990's and started to increase around 2004. Over the last twenty years the algae expanded even more rapidly [5]. In 2019, SCRWA and WaterWatch personnel conducted an algae mapping run on the lake and documented that the overwhelming majority of the populations were located within shallow, low-flow coves.

The STEPL tool was utilized to determine the estimated nonpoint source pollutant loads from nutrients in the project area. NLCD (2020) and USDA Census of Agriculture data replaced some of the automatically populated values downloaded through the STEPL Input Data Server. This was done to create a more accurate representation of pollutant loads.

#### **8.2.1)** Nutrient Pollution – Agriculture

Much like sediment pollution, the runoff from agricultural fields can be filled with nitrogen and phosphorus rich soils. Without proper mitigation, over time the accumulated effect from the runoff often results in impaired water. Utilizing nutrient management planning and restricting livestock access to waterbodies are methods to reduce nutrient loading. The estimated pollutant load from agricultural land in the project area is provided in Table 48.



	Nutrient Load (lb/year)					
	Cropland		Pastureland		Combined	
Watershed	N	P	N	P	N	P
Lake Wateree-Catawba River	1,193	192	2,793	209	3,986	401
Headwaters Lake Wateree-Catawba River	0	0	453	34	453	34
Singleton Creek	58	6	731	54	789	60
Beaver Creek	1,894	305	4,312	323	6,206	628
White Oak Creek	0	0	906	68	906	68
Total (lb/year)	3,145	503	9,195	688	12,340	1,191

Table 48: Estimated Nutrient Load from Agriculture Land in Project Area

#### **8.2.2)** Nutrient Pollution – Forest

Similar to sediment loads from forested land, nutrient loads come from logging road use, clearcutting, gullying, and mismanaged/poorly installed forestry BMPs. Specific sources for nutrient loading form forested land can be difficult to identify. Gullying is often isolated from regular forestry practices. SCFC programs and private consulting foresters offer solutions to effectively managing forested land and reducing nutrient loads. The estimated sediment pollutant load originating from forested land in the project area is provided in Table 49.

	Nutrient (lb/year)			
	Forest			
Watershed	N	P		
Lake Wateree-Catawba River	8,152	4,076		
Headwaters Lake Wateree-Catawba River	1,260	630		
Singleton Creek	1,863	931		
Beaver Creek	4,824	2,412		
White Oak Creek	1,584	792		
Total (lb/year)	17,683	8,841		

Table 49: Estimated Nutrient Load from Forested Land in Project Area

#### 8.2.3) Nutrient Pollution – Urban

Land disturbance and impervious surfaces together represent the greatest contributions to urban nonpoint source pollution. With an increase in impervious surfaces in this region, landscapes will continue to lose the ability to naturally filter precipitation during rain events. The result of increased land disturbance and impervious surfaces will cause higher volume and overland flow of stormwater and discharge them into nearby waterways. Nitrogen and phosphorus can be associated with construction site land disturbance activity, runoff from impervious surfaces, and excess lawn fertilizer application. The estimated sediment pollutant load originating from urban land in the project area is provided in Table 50.



	Nutrient Urb	` •	
Watershed	N P		
Lake Wateree-Catawba River	12,461	1,923	
Headwaters Lake Wateree-Catawba River	1,069	164	
Singleton Creek	2,051	315	
Beaver Creek	5,962	917	
White Oak Creek	2,235	343	
Total (lb/year)	23,778	3,662	

Table 50: Estimated Nutrient Load from Urban Land in Project Area

# 8.2.4) Nutrient Pollution – Septic/Wastewater (WW)

Domestic wastewater contains nutrients from sources such as human waste and household cleaning supplies. Failing septic systems can leach these nutrients that may then enter nearby waterbodies through the various scenarios presented in Section 6.2.1. The STEPL calculation for nutrient nonpoint source loading from septic/wastewater was made using a combination of the ESRI (2,751 housing units) and STEPL data (27% failure rate). Without the benefit of having updated GIS (or other) data indicating an accurate septic system count within the project area the calculations for septic/wastewater nutrient pollutant represents a maximum amount. The total estimated nutrient load from septic/wastewater sources are included in Table 51.

	Nutrient	(lb/year)
	Se	ptic
Watershed	N	P
Lake Wateree-Catawba River	5,792	2,253
Headwaters Lake Wateree-Catawba River	5,710	2,236
Singleton Creek	5,710	2,236
Beaver Creek	5,765	2,247
White Oak Creek	3,861	1,502
Total (lb/year)	26,838	10,475

Table 51: Estimated Nutrient Load from Septic/Wastewater in Project Area

## 8.3) Nutrient Pollution – Nonpoint Source Load Reduction

There is no TMDL established for nutrients in the project area. As an alternative, this plan utilizes BPJ to determine nutrient load reductions based on a reasonable level of participation from landowners and the best options for BMP installations specific to the sources of nutrient pollution and their efficiency in mitigating the contributing land cover/activity.

Like the proposed load reduction schedule for bacteria and sediment nonpoint source pollution, nutrient load reduction will be achieved using the same phased BMP implementation schedule (see Section 18). It is recommended that the BMP implementation schedule be reviewed twice a year throughout the proposed BMP implementation period to assess overall effectiveness. Table 52 shows the estimated annual nonpoint source nutrient load for each source and Table 53 outlines the estimated annual BMP load reduction. The estimated annual load reduction provided in Table 53 is applicable after all proposed BMPs are installed. Among the various cost-share funding opportunities for BMP implementation, the CWA Section 319 Grant is the most commonly used. EPA guidelines for this grant state that the funding is to be applied within a three year time frame.

Nutrient data from the STEPL model show that the project area receives roughly 80,639 pounds of nitrogen and 24,168 pounds of phosphorus per year. Table 53 details the total estimated annual nutrient load reduction from the proposed BMPs. The nutrient removal rates for each BMP were multiplied by the proposed number of BMPs for the



project area. The same modeling characteristics applied to sediment load reduction were run for nutrient load reduction.

This plan proposes a number of BMP projects for nutrient load reduction for every five-year implementation phase (see Tables 67 through 69). See Appendix G for a list of these BMPs for each watershed over the course of the 15-year BMP implementation timeline. Because septic/wastewater can affect nutrient loading, the schedule for septic repair/replacement projects was added as a BMP option for reduction nutrient loads. The frequency of these installations will depend on available funding from awarded grants. It should be noted that each grant has specific guidance and the guidance should be considered during the implementation phases. It is recommended that BMP implementation planning utilize findings found in the BMP strategy sections 11 through 15.

The same explanation provided in Section 7.3 applies to nutrient load reduction calculations. Table 53 should not be interpreted as sediment load reduction during one project phase (*i.e.* five years). Table 53 includes all proposed BMPs listed above and their reduction measurements over the course of one year. Several BMPs are proposed to be implemented during different phases. Furthermore, many of these BMPs are intended to treat varying numbers of acres with different soil composition. For these reasons, the load reduction calculations were summarized on an annual basis in this section. Table 54 provides a correct representation of nutrient load reduction for each watershed for the proposed BMP implementation schedule. Complete definitions and maintenance recommendations for each BMP listed in this section can be found in Section 9.



	TOTAL ESTIMATED NUTRIENT NONPOINT SOURCE POLLUTION LOADING											
					Nutrient	(lb/year)						
	Crop	pland	Pastu	reland	For	rest	Url	oan	Seption	c/WW	То	tal
Watershed	N	P	N	P	N	P	N	P	N	P	N	P
Lake Wateree- Catawba River	1,193	192	2,793	209	8,152	4,076	12,461	1,923	5,792	2,253	30,391	8,653
Headwaters Lake Wateree-Catawba River	0	0	453	34	1,260	630	1,069	164	5,710	2,236	8,492	3,064
Singleton Creek	58	6	731	54	1,863	931	2,051	315	5,710	2,236	10,413	3,542
Beaver Creek	1,894	305	4,312	323	4,824	2,412	5,962	917	5,765	2,247	22,757	6,204
White Oak Creek	0	0	906	68	1,584	792	2,235	343	3,861	1,502	8,586	2,705
Total (lb/year)	3,145	503	9,195	688	17,683	8,841	23,778	3,662	26,838	10,475	80,639	24,168

Table 52: Total Estimated Nutrient Load in Project Area

	AVERAGE ANNUAL NUTRIENT LOAD REDUCTION								
Watershed	N Load (no BMP)	P Load (no BMP)	N Reduction	P Reduction	N Load (with BMP)	P Load (with BMP)	Percent N Reduction	Percent P Reduction	
	lb/year	lb/year	lb/year	lb/year	lb/year	lb/year	Percent	Percent	
Lake Wateree-Catawba River	30,391	8,653	1,077	262	29,314	8,391	3.5	3	
Headwaters Lake Wateree-Catawba River	8,492	3,064	162	48	8,330	3,016	1.9	1.6	
Singleton Creek	10,413	3,542	302	75	10,111	3,467	2.9	2.1	
Beaver Creek	22,757	6,204	1,253	283	21,504	5,921	5.5	4.6	
White Oak Creek	8,586	2,705	264	68	8,322	2,637	3.1	2.5	
Total	80,639	24,168	3,058	736	77,581	23,432	3.8	3	

Table 53: Average Annual Nutrient Load Reduction for Project Area



SCRWA completed an additional literature review for cropland BMP reduction efficiencies. These values are not represented in any of the reduction calculations. However, they can be reviewed for future management consideration. The summary table and literature review can be found in Appendix C.

# 9) Load Reduction Summary, BMP Cost Estimates and BMPs Defined

The load reductions summarized in Table 54 reflect measurements after all proposed BMPs are installed. The projects include installing BMPs for failing septic systems and on agriculture, forested, and urban land cover. The cost estimate for each BMP can be found in Table 55.



Watershed	Projects	Bacteria Load Reduction (MPN/100mL)	Sediment Load Reduction (ton/year)	Nutrient Load Reduction (lb/year)*			
		PHASE 1 (Years 1-5)					
Lake Wateree – Catawba River	31	4.22E+11	144	1,224			
Headwaters Lake Wateree- Catawba River	28	7.07E+11	52.4	210			
Singleton Creek	27	4.22E+11	53	361			
Beaver Creek	32	1.22E+15	327.3	1,536			
White Oak Creek	27	4.22E+11	71.8	332			
Total	145	1.22E+15	648.5	3,663			
		PHASE	2 (Years 6-10)				
Lake Wateree – Catawba River	32	7.07E+11	230.6	1,339			
Headwaters Lake Wateree- Catawba River	27	4.22E+11	52.4	210			
Singleton Creek	27	4.22E+11	53	361			
Beaver Creek	32	1.22E+15	155	1,460			
White Oak Creek	27	4.22E+11	71.8	332			
Total	145	1.22E+15	562.8	3,702			
		PHASE	3 (Years 11-15)	3 (Years 11-15)			
Lake Wateree – Catawba River	31	4.22E+11	144	1,224			
Headwaters Lake Wateree- Catawba River	27	4.22E+11	52.4	210			
Singleton Creek	28	7.07E+11	80.8	377			
Beaver Creek	32	1.22E+15	155	1,460			
White Oak Creek	27	4.22E+11	71.8	332			
Total	145	1.22E+15	504	3,603			
Total (Years 1-15)	435	3.66E+15	1,715.3	10,968			

**Table 54: Estimated Nonpoint Source Load Reduction After BMP Install for Each Watershed** \*Combined calculation for TN and TP

The total anticipated costs for implementing the recommended BMPs for the Lake Watersee Watershed-Based Plan is between \$1,455,354 and \$1,466,061 for the proposed 15-year project implementation timeline. The cost for each of the three five-year phases is between \$485,118 and \$488,687. The table in Appendix G shows the breakdown of each BMP per watershed and the treatment objective (*i.e.* bacteria, sediment, nutrients). The estimated costs for BMPs were taken from USDA NRCS Environmental Quality Incentives Program (EQIP) (South Carolina) and US Army Corps of Engineers published BMP costs. These are estimated costs and therefore are subject to change and variation. Cost-share rates for implementing these BMPs are dependent upon the funding source and will impact the implementation costs.



BMP	Average Cost	Units	Number of Projects	<b>Total Estimated Cost</b>
Septic System Repair/Replacement	\$4,000	None	300	\$1,200,000
Cover Crop (High Till for TP and Sediment)	\$52.47 - \$1,837.02	Acre	6	\$315 - \$11,022
Grass Buffer/Filter Strip (35 feet) (for Cropland)	\$188.37	Acre	6	\$1,130
Conservation Tillage (30-59% Residue)	\$2,365.39	None	6	\$14,192
Forest Buffer (100 Feet) (for Pasture and Crop)	\$1,747.48	Acre	6	\$10,485
Site Prep/Hydro Mulching/Seeding/Fertilizer	\$686.13	Acre	15	\$10,292
Streambank Fencing*	\$2.85	Feet	15	\$12,825
Alternative Water Source (less than 401-600 gallons)	\$450.58	None	15	\$6,759
Grass Buffer (35 feet) (for Pastureland)	\$188.37	Acre	15	\$2,826
LID Filter/Buffer (Multi-Family)**	\$0.50	Square Feet	15	\$150
LID Filter/Buffer (Single Family)**	\$0.50	Square Feet	15	\$150
Vegetated Filter Strip (Transportation)**	\$0.50	Square Feet	15	\$150
Agriculture-Cropland Bundle (Nutrient Management, Soil Stabilization, Critical Area Planting)	\$41,760	None	3	\$125,280
Agriculture-Livestock Bundle (Alternate Watering Source, Streambank Fencing, Stream Crossing, Manure Composting Structure, Heavy Use Stabilization Area)	\$23,600	None	3	\$70,800
Total (15-year Project Period)			435	\$1,455,354 - \$1,466,061
Total (Five-year Phase)			145	\$485,118 - \$488,687

**Table 55: Total Estimated Cost for BMP Installations in Project Area** 

<sup>\*</sup>Estimated fencing length per Project – 100 yards (300 ft.)
\*\* Estimated LID Filter/Buffer per Project – 20 feet



The following includes definitions and maintenance recommendations for the proposed BMPs listed in this plan. BMP maintenance is an important aspect of successful BMPs. The necessary maintenance and/or recommended maintenance plans are summarized with each BMP listed.

Septic System Repair/Replacement —This BMP includes identifying faulty septic systems to repair or replace, including rehabilitating drainfields as necessary. Septic system maintenance guidance published by the EPA suggests that an average household septic system should be inspected at least every three years by a service professional. Systems should be pumped every three to five years. The drainfield is a part of the system and should be free of parked cars and should not be exposed to root structures from trees [31].

Nutrient Management (Determined Rate) – A nutrient management plan manages the amount, source, placement, and timing of plant nutrients and soil amendments. The purpose is to reduce the amount of nutrients applied to agricultural fields without effecting production. The amount of nutrients entering waterbodies at the edge of field is reduced through this BMP. For BMP maintenance, the USDA NRCS suggests reviewing or revising plans periodically to determine if adjustments or modifications are needed. At a minimum, review and revise plans as needed with each soil test cycle, changes in manure management volume or analysis, plants and crops, or plant and crop management. Monitor fields receiving animal manures and biosolids for the accumulation of heavy metals and phosphorus. For animal feeding operation, significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content. Calibrate application equipment to ensure accurate distribution of material at planned rates. For products too dangerous to calibrate, follow equipment manufacturer guidance on proper equipment design, plumbing, and maintenance. Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation to explain the difference. Use material generated from cleaning nutrient application equipment in an environmentally safe manner. Collect, store, or field apply excess material in an appropriate manner. Recycle or dispose of nutrient containers in compliance with State and local guidelines or regulations [32].

<u>Cover Crop (High Till for TP and Sediment)</u> – Cover crops, such as grasses, legumes, forbs, and other herbaceous plants are established for seasonal cover on agricultural fields. Cover crops stabilize soils by increasing organic matter content and establishing root systems. For maintenance, USDA NRCS suggests evaluating the cover crop to determine if the cover crop is meeting the planned purpose(s). If the cover crop is not meeting the purpose(s) adjust the management, change the species of cover crop, or choose a different technology [33].

Grass Buffer (35 feet) – Linear strips of grass or other non-woody vegetation that is maintained to filter nutrients, sediment, and other pollutants from nonpoint source runoff. The USDA NRCS suggests the following for maintenance: conduct all farming operations parallel to the strip boundaries except on headlands or end rows with gradients less than the criteria set forth in this standard, time mowing or harvest of buffer strips to maintain appropriate vegetative density and height for optimum trapping of sediment from the upslope cropped strip during the critical erosion period(s), fertilize buffer strips as needed to maintain stand density, mow or harvest sod turn strips and waterways at least once a year, spot seed or totally renovate buffer strip systems damaged by herbicide application after residual action of the herbicide is complete, and redistribute sediment that accumulates along the upslope edge of the buffer strip/crop strip interface as needed. The sediment should be spread evenly upslope over the cultivated strip when needed to maintain uniform sheet flow along the buffer/cropped strip boundary [34].

Conservation Tillage – Manages the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting. The primary purpose is to reduce sheet, rill, and wind erosion and excessive sediments in surface waters and improve soil health by increasing organic matter content. USDA NCRS suggests for maintenance measures to evaluate/measure the crop residue cover and orientation for each crop to ensure the planned amounts and orientation are being achieved, adjust management as needed to either plan a new residue amount or orientation, and if there are areas of heavy residue accumulation (because of movement by water or wind) in the field, spread the residue prior to planting so it does not interfere with planter operation [35].

<u>Forest Buffer (100 feet)</u> – An area predominantly covered by trees and/or shrubs located adjacent to and up-gradient from a watercourse or waterbody. The primary purpose is to reduce the transport of sediments to surface water, and reduce transport of pathogens, chemicals, pesticides, and nutrients to surface and ground water. USDA NRCS



suggests preparing an operation and maintenance plan to include: limiting access or damage from vehicles, equipment, livestock, and wildlife, during tree planting and until riparian buffer establishment to protect new plants and minimize erosion, compaction, and other site impacts, inspecting the site at an appropriate time following planting to determine whether the survival rate for tree and shrubs meets practice and client objectives, replacing dead trees or shrubs and controlling undesirable vegetative competition until the buffer is or will progress to a fully functional condition, controlling undesirable plant species that may include but not be limited to those on the federal or state invasive species and noxious weed lists, inspecting the trees, shrubs, and site periodically, and protecting the plantings and site from adverse impacts of insects, diseases, competing vegetation, fire, livestock, excessive vehicular and pedestrian traffic, wildlife, concentrated flows, nonfunctioning tree shelters and/or weed barriers, etc., and applying fertilizers, pesticides, and other chemicals used to maintain buffer function in a way that will not impact water quality [36].

Site Prep/Hydro Mulching/Seeding/Fertilizer – Site Preparation consists of a treatment of sites to enhance the success of natural or artificial regeneration of desired trees and/or shrubs. The purpose is to manage soil conditions, naturally available water, and seasonally high water to favor tree and shrub establishment and survival. Hyrdo Mulching consists of applying plant residues or other suitable materials to the land surface. The purpose is to improve the efficiency of moisture management, reduce irrigation energy used in farming/ranching practices and field operations, improve the efficient use of irrigation water, prevent excessive bank erosion from water conveyance channels, reduce concentrated flow erosion, reduce sheet, rill, and wind erosion, improve plant productivity and health, and maintain or increase organic matter content. The maintenance of this BMP should comply with all local, state, and federal laws and ordinances, and with state's forestry best management practices for water quality [37] [38].

Streambank Fencing and Soil Stabilization – Streambank, or exclusionary, fencing is a common method for limiting livestock access to waterbodies. Limiting livestock access to waterbodies ensures that fecal waste is not directly deposited into the waterbody. Fencing also keeps livestock from disturbing loose soils near waterbodies thereby reducing the sediment load. USDA NRCS suggests that regular inspection of permanent, temporary, and portable fences be a part of an ongoing maintenance program that ensures proper function of the fence for the lifespan of the practice. As a minimum, the following should be included in the operation and maintenance plan: conduct inspections of fences after storms and other disturbance events, repair or replace loose or broken material, gates, and other forms of ingress and egress, remove trees and limbs, repair or replace water gaps as necessary, repair eroded areas as necessary, repair or replace markers or other safety and control features as required, and maintain fladry or signage as necessary [39].

Alternative Water Source – Alternative livestock watering systems are designed to provide an alternative to watering animals directly from streams, rivers, and lakes. The purpose is to decrease soil erosion and help maintain stable stream banks when a stream side filter is re-established, and provide a year-round supply of clean, freeze-proof water for livestock through a well-designed watering system. When used in conjunction with protected heavy-use areas, they provide a solid, mud-free watering area. It also provides more flexibility in managing forage grazing systems, manure distribution and pasture utilization and develops wildlife habitat along stream sides where the riparian zone has been re-established. For maintenance, USDA NRCS suggests to regularly check the flow of water to the trough, look for leaks and fix them right away, check the float valve regularly to make sure it is working, stop any leaks and cleanup eroded areas, and drain and cleanout troughs at least once a year [40].

<u>Vegetated Filter Strip</u> – Permanent strips of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas. The purpose is to reduce sheet and rill erosion, ephemeral gully erosion, and sediment transport to surface waters. Regarding maintenance, permanent filter strip vegetative plantings should be harvested and removed as appropriate to encourage dense growth, maintain an upright growth habit and remove nutrients and other contaminants that are contained in the plant tissue. Inspect the filter strip after storm events and repair any gullies that have formed, remove unevenly deposited sediment accumulation that will disrupt sheet flow, reseed disturbed areas and take other measures to prevent concentrated flow through the filter strip. Periodically regrade and reestablish the filter strip area when sediment deposition at the filter strip-field interface jeopardizes its function. Reestablish the filter strip vegetation in regraded areas, if needed [41].



<u>Critical Area Planting</u> – Establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal practices. The purpose is to stabilize stream/channel banks, shorelines, areas with existing or expected high rates of soil erosion by wind or water and rehabilitate/revegetate degraded sites that cannot be stabilized using normal establishment techniques. For maintenance, USDA NRCS suggests the use of the area should be managed as long as necessary to ensure the site remains stable. Plantings should be protected from pests (*e.g.* weeds, insects, diseases, livestock, or wildlife) as necessary to ensure long-term survival. Inspections, reseeding or replanting, and fertilization may be needed to ensure that this practice functions as intended throughout its expected life. Observation of establishment progress and success should be performed at regular intervals until the practice has met the criteria for successful establishment and implementation [42].

Stream Crossing – A stabilized area or structure constructed across a stream to provide controlled access for people, livestock, equipment, or vehicles. The purpose is to improve water quality by reducing sediment, nutrient, or organic loading to a stream and reduce streambank and streambed erosion. The USDA NRCS suggests maintenance measures include developing an operation and maintenance plan and implement it for the life of the practice. As a minimum, include the following items in the operation and maintenance plan: state the appropriate conditions when the crossing can be safely used and when it should not be used by a predetermined depth, inspect the stream crossing, appurtenances, approaches, and associated fence and exclusion gates at least annually and after each major storm event, remove accumulated organic material, woody material, or excess sediment, and replace surfacing stone for livestock crossing as needed [43].

Manure Composting Structure – A structure or device to contain and facilitate an aerobic microbial ecosystem for the decomposition of manure and/or other organic material into a final product sufficiently stable for storage, on farm use and application to land as a soil amendment. The purpose is to reduce water pollution potential and improve handling characteristics of organic waste solids, reuse organic waste as animal bedding, or use as a soil amendment that provides soil conditioning, slow-release plant-available nutrients and plant disease suppression. For maintenance, the USDA NRCS suggests developing an operation and maintenance plan that is consistent with the purposes of this practice and the design life of the composting facility. Outline periodic inspections and maintenance of equipment and facilities. Include structural elements of the facility to be inspected or maintained, an inspection interval time frame, and recommendations for preventive maintenance [44].

<u>Heavy Use Stabilization Area</u> – The purpose of this BMP is to stabilize or protection intensively used areas on agricultural land. The purpose is to reduce soil erosion and provide a stable, noneroding surface. For maintenance purpose, the USDA NRCS suggests preparing an operation and maintenance plan and review it with the operator prior to practice installation. The minimum requirements to be addressed in the plan include periodic inspections (annually and immediately following significant rainfall events), prompt repair or replacement of damaged components, especially surfaces that are subjected to wear or erosion, requirements for the regular removal and management of manure, as needed, for livestock heavy use areas, and restrict uses, as needed, to protect the stand and to allow vegetative recovery for vegetated heavy use areas [45].

### 10) Parcel Prioritization Methodology

The GIS-based parcel prioritization included in this section is adapted from scoring methodologies created by Upstate Forever and SCRWA [46]. Five categories are analyzed and prioritized including land protection, shoreline management, forest management, agriculture BMPs, and riparian buffers. The categories are assigned a total number of possible points based on their respective value to water quality protection and/or restoration. Each category is assigned specific weighted criteria with possible point values for each. The cumulative total points for each criterion per category create a matrix of high, mid, and low prioritized parcels.

The analysis utilizes parcel data for provided by Tax Assessor's Offices for Kershaw, Lancaster, and Fairfield Counties. The parcels were then clipped to the project area boundary and individually assigned scores per criteria for each category.



### **10.1) Parcel Scoring Methodology**

The parcels for each category were assigned scores based on the developed weighted criteria. The criteria for each category were assigned a specific point value based on the importance to water quality. The total points scored for each criterion per parcel were then added, creating a final score per parcel for each category. For each category, the parcel scores were organized by *high* or *low* priority. Instead of splitting these scores into three tiers (*high*, *medium*, and *low*), SCRWA determined that organizing the prioritization into two categories would produce a truer account of the most valuable parcels for future implementation projects. Organizing the prioritization in this way eliminates the possibility of parcels with specifically important value from being categorized as *low* priority. The higher point value indicates an increased importance to water quality within each category.

### 11) Land Protection

The purpose of the land protection analysis is to identify land that, if in good condition and protected, may provide benefits to water quality by mitigating future impairments or loss of benefits. Conversely, if developed, these lands would have the biggest negative impact on water quality. Parcels in current protection agreements are not to be considered as eligible parcels for future conservation planning. See Map 17 in Section 3.5.2 for the current parcels already protected in the project area.

### 11.1) Land Protection Criteria

Table 56 below includes the scoring criteria adapted from the scoring method created by Upstate Forever [46]. SCRWA utilized portions of the scoring methodology where appropriate for this plan. The scoring was organized into two priority categories -high (11-21 points) and low (1-10 points). Some parcels were not scored in the prioritization and appear blank in Map 23. These parcels were not assigned data by the county Tax Assessor's Office.



Crite	Points	Total Possible Points	
Stream Order	Headwaters Only Streams (1st and 2nd Order)	4	4
	FW Streams with No impairments	2	
Stream Classification	FW Streams with One or More Impairments	1	3
	40+ Acres of Riparian Buffer	4	
D D	20-39.9 Acres of Riparian Buffer	3	,
Riparian Buffer Areas (sensitive)	8-19.9 Acres of Riparian Buffer	2	4
	2-7.99 Acres of Riparian Buffer	1	
Riparian Buffer Area (with forests)	Falls within the Riparian Buffer Areas (Sensitive) and has Forested Land Cover.	1	1
	50+ Acres of Hydric Soils	3	
Hydric Soils	30-40.9 Acres of Hydric Soils	2	3
	5-29.9 Acres of Hydric Soils	1	
100 V-ss Flandalain	100 Year Floodplain with No Developed Land Cover	2	2
100-Year Floodplain	100 Year Floodplain with Developed Land Cover	1	2
Source Water Protection Area	Source Water Protection Area (yes)	2	2
Adjacency to Existing Protected Land	Adjacency to Existing Protected Land (yes)	1	1
Parcel Size	50 Acres or Larger	1	1
TOTAL POINTS POSSIBLE PER PARCEL			21

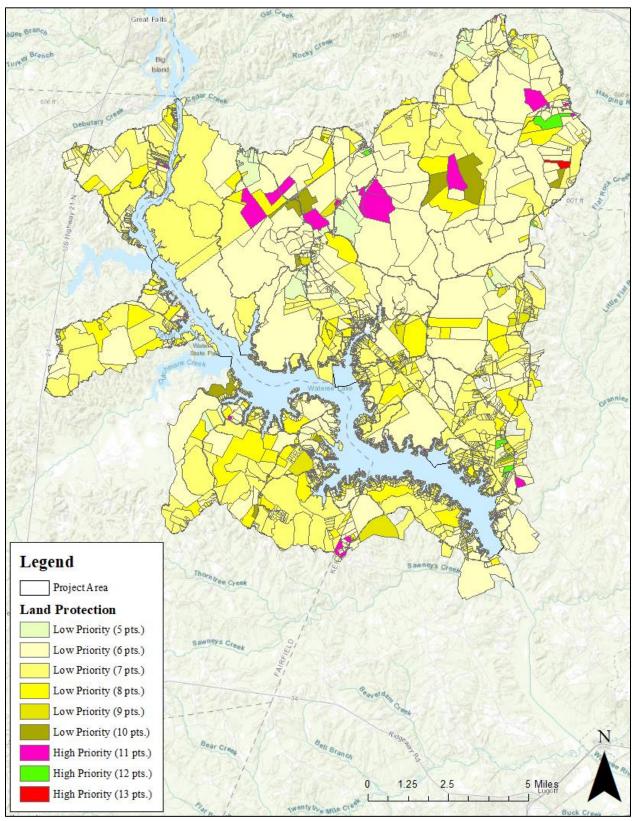
Table 56: Land Management Scoring Criteria for Project Area

## 11.2) Land Protection Scoring Results

Out of 21 possible points in this category, the highest score received was a 13. The analysis identified 65 parcels scored as high priority for land protection in the project area (see Map 23). The 65 high priority parcels were refined to include only parcels totaling 100 acres and greater, or 50 acres or greater with non-urban land cover. Of the 65 high priority parcels, 20 are 100 acres or more and 15 are parcels with 50 acres or greater and non-urban land cover (see Maps 24 and 25).

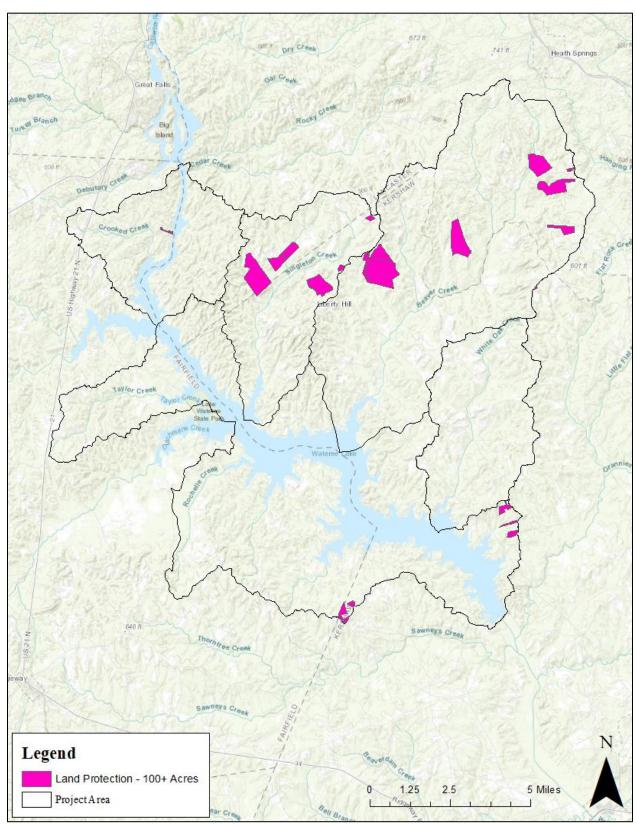
The highest concentrations of all high priority land protection opportunities are in the Beaver Creek and Singleton Creek watersheds, primarily along feeder streams. Therefore, it is recommended that land protection for the selected parcels focus on the headwaters of Beaver Creek and along Singleton Creek where there are highly ranked priority parcels. The majority of these parcels are considered forested and should be targeted as potential land protection projects.





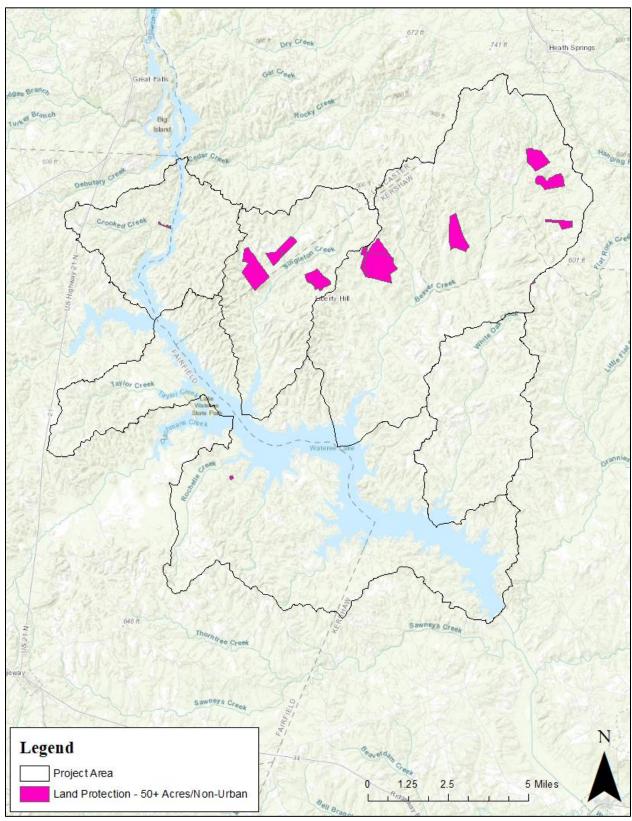
**Map 23: Land Protection Prioritization for Project Area** 





Map 24: Land Protection (Refined), High Priority – 100+ Acres





Map 25: Land Protection (Refined), High Priority - 50+ Acres/Non-Urban



### 11.3) Land Protection Strategies

Based on SCRWA's experience partnering with state and non-profit 501(c)(3) land conservation organizations in South Carolina, the primary opportunities for land protection are through conservation easements and fee-simple acquisitions.

#### Conservation Easement

The state of South Carolina defines a conservation easement as a "nonpossessory interest of a holder in real property imposing limitations or affirmative obligations, the purposes of which include on or more of the following:

- Retaining or protecting natural, scenic, or open-space aspects of real property
- Ensuring the availability of real property for agricultural, forest, recreational, educational, or open-space use
- Protecting natural resources
- Maintaining or enhancing air or water quality
- Preserving the historical, architectural, archaeological, or cultural aspects of real property" [47].

A conservation easement agreement between a landowner and the holder of the easement is one that is held in perpetuity by the easement holder, despite a land sale or the land willed to heirs. Governmental and land trust organizations are the most common managers of easements. The property owner however retains the rights of the existing land cover on the property. That is, if a landowner, who uses the property to harvest timber, establishes a conservation easement, the landowner retains the right to harvest timber. According to The Conservation Fund, easements include costs to the landowner in the form of attorney fees, appraisals, application fees, title insurance, and other due diligence items. Total costs of an easement can range from \$500 to \$2,000 per acre in the project area. This is highly depending on the location of the property. Property values adjacent to waterbodies are significantly higher than those even 100 yards away from waterbodies. For example, an easement for a 100 acre property abutting a waterbody in the project area will cost an average of \$200,000. This equates to roughly \$20,000 in fees responsible by the landowner (Conversation with The Conservation Fund's Jason Johnson, June 2, 2021).

### Fee-Simple Acquisition

A fee-simple acquisition purchase occurs when an entity purchases a parcel outright and controls the full ownership of the parcel. For example, a county can purchase a tract as a fee-simple acquisition and limit certain land covers that negatively affect water quality. Land can also be donated as a fee simple acquisition, through it is not common.

### 11.4) Land Protection Funding Sources

The following are options for funding land protection projects from federal, state, and local resources.

### CWA Section 319 Grant Funding

CWA Section 319 Grant funding is distributed each year by the EPA to states. The funding is used to develop locally led projects to reduce or prevent nonpoint sources of pollution. The grants distributed will pay up to 60% for eligible projects, with a 40% non-federal match that is typically provided by the landowner or county. For conservation easements, the portion covered by grant funding includes costs for due diligence only. EPA guidelines for this grant state that the funding is to be applied within a three year time frame.

## South Carolina Conservation Bank

One of the objectives of the South Carolina Conservation Bank is to fund the preservation of wildlife habitats, natural areas, sites of unique ecological significance, forested lands, farmlands, watersheds, and open spaces for the orderly development of land in the state. The Bank is able to protect open spaces through the acquisition of property from willing sellers. Application for funding occurs twice a year [48].

#### USDA Regional Conservation Partnership Program (RCPP)

RCPP is a \$300 million annual program funded by the USDA Farm Bill that promotes coordinated conservation projects between the USDA Natural Resources Conservation Service (NRCS) and local partners to address on-farm, watershed, and regional natural resource concerns. Eligible local partners include agriculture or silvicultural producer associations, farmer cooperatives or other groups of producers, state or local governments, municipal water treatment entities, water and irrigation districts, conservation-driven nongovernmental organizations, and institutions



of higher education. Agricultural landowners and owners of non-industrial private forested land are eligible to apply for RCPP Entity Held easements. Applications for RCPP grants occur each year through an announced Request for Proposal (RFP) made by the state USDA agency [49].

## Forest Legacy Program

The Forest Legacy Program (FLP) is a conservation partnership program between the US Forest Service and state agencies. The objective of the program is to promote land protection by encouraging conservation easements or land purchases on privately owned forested land. The FLP offers economic incentives for forest landowners to either sell their property or retain ownership through a conservation easement [50].

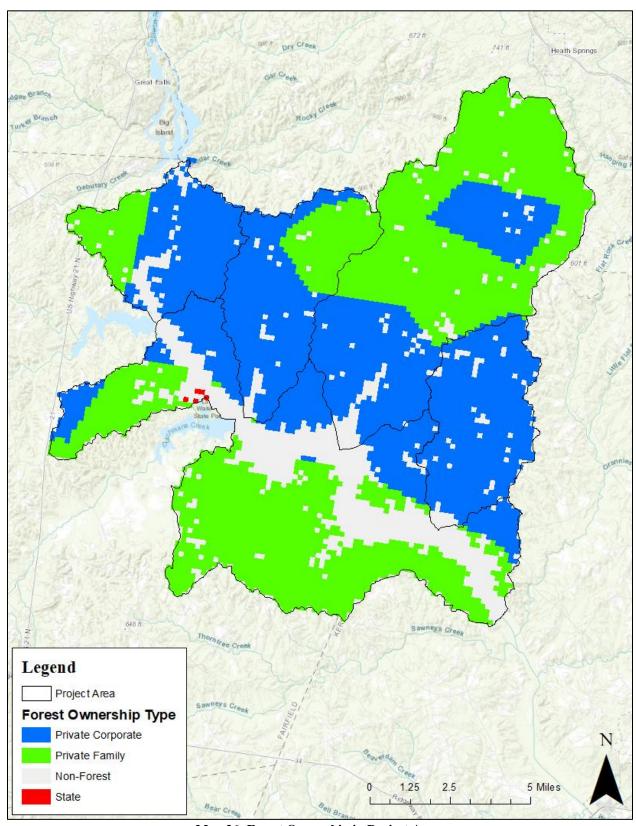
### 12) Forest Management

South Carolina forests contain a diverse population of softwood and hardwoods. According to the SCFC, the state is 66% forested, with 87% labeled as private family owned. As of 2019, forestland made up roughly 12.8 million acres and timberland roughly 12.6 million acres. Forestland is defined as land that is at least 10% forested and timberland is forestland that is available for harvest and capable of productivity over time. According to the SCFC, recent surveys show a slight loss of timberland, which they attribute to land conversion form forestry and agriculture to urban uses. Roughly 74% of the project area is classified as *Evergreen Forest, Deciduous Forest*, and *Mixed Forest*. Roughly 46,798 acres are considered Private, Family Owned Forests and 45,536 are considered Private, Corporate Owned Forests. The United States Department of Agriculture – Forest Service (USDA FS) private family owned forest data for the project area exceeds the total 2019 NLCD forest data for the project area detailed in Section 3.5.2. This is mostly likely due to the USDA FS considering other land covers, such as *Woody Wetlands*, to be forested. Despite the discrepancy, almost 100% of forests in the project area privately owned by families or corporations. See Map 26 for a breakdown of the various forest ownership in the project area.

The historical land use, detailed in Section 3.5.1, for the Southern Piedmont region consisted of cotton farming that lasted for most of the 19<sup>th</sup> and early part of the 20<sup>th</sup> centuries. The decades of cotton farming created "disastrous erosion" [12]. In parts of Fairfield County, "20.8 per cent of the upland was so devasted by 1909 that it was simply termed rough, gullied land rather than being categorized by soil type" [14]. By 1920, the abandoned cropland in the project area slowly transitioned to forests or was intentionally made forests or pastureland. These are important considerations to acknowledge because the historical land use has created highly erodible soils that can easily transport nonpoint sources of pollution throughout the project area.

Forest management focuses on objectives such as timber management, restoring ecosystems, soil and water quality protection, and maintaining forest health. Trained foresters provide general forestry advice to forested landowners to accomplish these objectives [51]. Forest management practices are a proven tool for mitigating nonpoint source pollution in rural watersheds. SCFC reports that 13% of forestland in South Carolina is managed [52]. The purpose of this analysis is to identify the forested parcels in the project area that are best suited for forest management practices.





Map 26: Forest Ownership in Project Area



## 12.1) Forest Management Criteria

Table 57 details each criterion for scoring parcels in the project area for potential forest management. Total scores were grouped into two priority categories – *high* (11-20 points) and *low* (1-10 points).

Cri	Points	Total Possible Points	
Land Cover	>50% Forested, Grassland, and/or Herbaceous Land Cover	2	3
	Known Logging Operations	1	
	Within 0.0 - 0.3 Miles of Stream/Waterbody	3	
Proximity to Streams and Waterbodies	Within 0.31 - 0.66 Miles of Stream/Waterbody	2	3
	Within 0.67 - 1 Mile of Stream/Waterbody	1	
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
	Predominately C/D Soil Classification	3	
Soil Hydrologic Group (SSURGO Data)	ydrologic Group (SSURGO Predominantly B Soil Classification		3
Data)	Predominately A Soil Classification	1	
	High Soil Erodibility (0.29 - 0.37)	3	
Soil Erodibility (K-Factor)	Moderate Soil Erodibility (0.20 - 0.28)	2	3
	Lowest Soil Erodibility (0.10 - 0.19)	1	
	>18% Slope	3	
Maximum Slope on Property	8 - 17% Slope	2	3
	<8% Slope	1	
100-Year Flood	Within/Adjacent to 100-Year Floodplain	2	2
TOTAL POSSIBLE POINT PER PARCEL			20

Table 57: Forest Management Scoring Criteria for Project Area

## 12.2) Forest Management Scoring Results

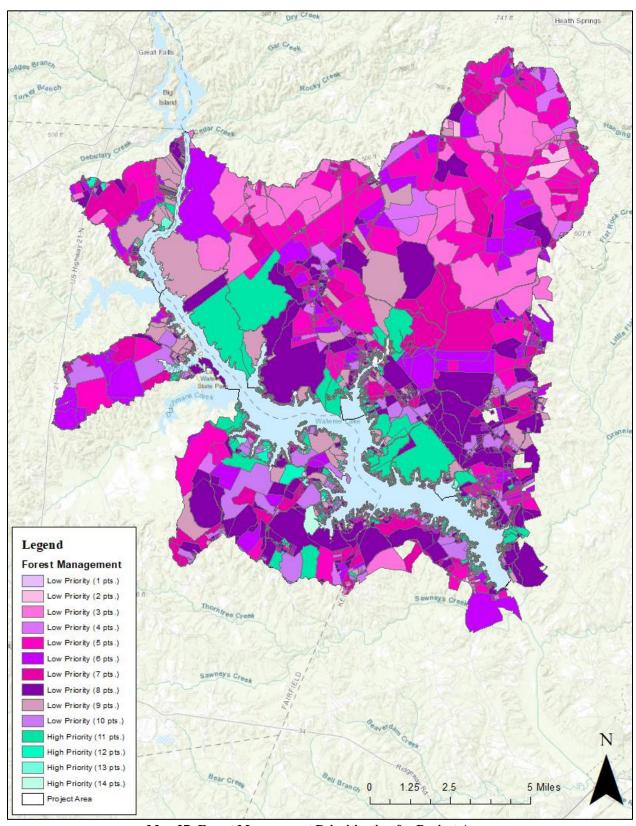
A total of 1,044 parcels scored as high priority for forest management in the project area. Thirty-one of the 1,044 parcels received the highest score of 14 points (see Map 27). Two SCDNR parcels were marked with a strikethrough icon in Map 28 to indicate that those parcels are already managed and should not be considered for future forest management planning. The concentration of high priority parcels is located on the western side of the lake between Rochelle and Fox Creek and on the eastern side along the lake side from Singleton Creek to the south dam at the bottom of the project area. Recommendations for forest management include:

- 1. Target private family owned forested landowners with property along the lakeshore in the White Oak Creek, Singleton Creek, and Catawba-Wateree River watersheds with education and outreach focused on the impacts from sediment loading. Sediment data indicates that all watersheds show elevated levels of nonpoint sediment pollution.
- 2. Coordinate efforts with SCFC for increasing total acres in SCFC Forest Management Plans and/or Stewardship Management Plans.
- 3. Coordinate communications with the SCFC for updated BMP compliance measurements/goals.



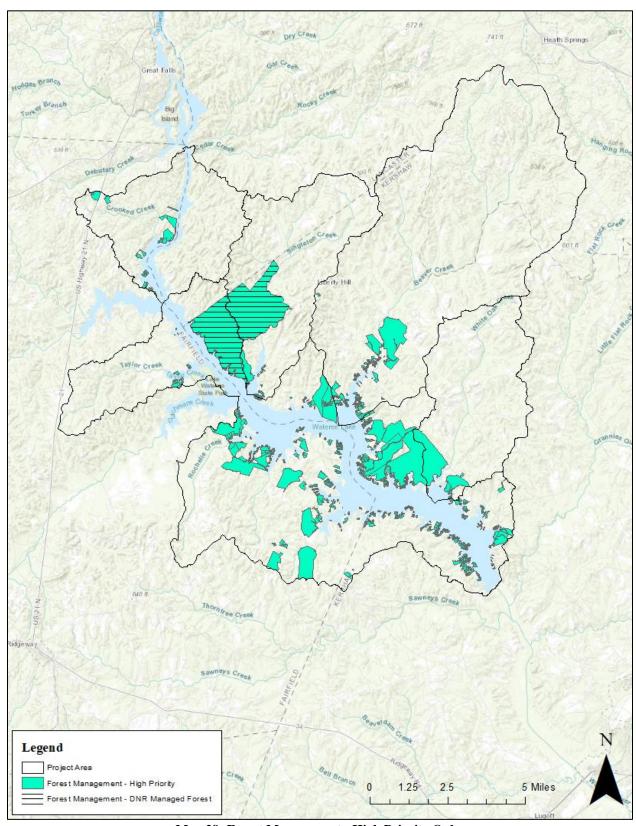
- 4. Encourage expanding riparian buffer widths on perennial streams with steep slopes. Work with SCFC to explore the feasibility of expanding buffers with private consulting foresters and logging companies in the project area.
- 5. Encourage extended buffers on intermittent streams with steep slopes in the project area. Work with SCFC to explore the feasibility of expanding buffers with private consulting foresters and logging companies in the project area.





Map 27: Forest Management Prioritization for Project Area





**Map 28: Forest Management - High Priority Only** 



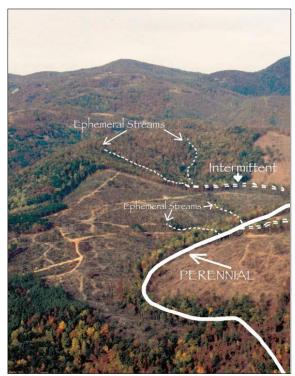
## 12.3) Forest Management BMP Strategies

SCRWA consulted with the SCFC and the South Carolina Best Management Practices for Forestry Manual to determine the best forest management BMP options for the project area. The SCFC recommended the following: streamside management zones, stream crossings, forest road construction, timber harvesting, and prescribed burning.

### Streamside Management Zones (SMZs)

Forestry operations by loggers can expose risk of nonpoint sources of pollution to perennial streams, intermittent streams, ephemeral streams, ponds, and lakes. Managing these SMZs is a critical part of mitigating the impacts from nonpoint sources of pollution. There are two types of SMZs. The primary SMZ is 40 feet wide on each side of the stream. The secondary SMZ depends on the average percent slope perpendicular to the stream.

The BMP strategies for SMZs can include selecting tree species for harvest with at least 50 square feet of overstory basil area per acre, removing vegetation and organic debris on intermittent streams, removing felled trees away from the stream, reducing land disturbance to the forest floor, and removing logging debris from stream channels [53].



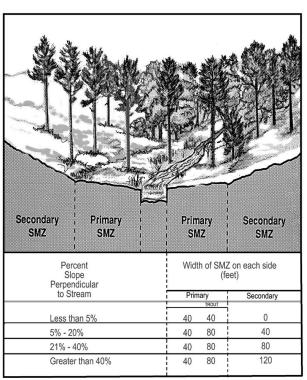


Photo 9: Perennial and Intermittent Streams / Primary and Secondary SMZs (Photo Credit: SCFC BMP Manual)

### **Stream Crossing**

Forestry operations by loggers are often met with the need to cross streams to reach additional forested lands. These crossings require careful planning to reduce environmental risks to water flow and aquatic organisms. When matched to the site and installed properly, stream crossings can mitigate these risks. There are three types of stream crossings – bridges, culverts, and fords.

The BMP strategies for stream crossings can include crossing at a right angle, keeping the slope as gentle as possible, utilizing drainage structures on both sides of the crossing, stabilizing the disturbed soil after construction of the crossing, and consulting a licensed forester prior to implementing a crossing to minimize impacts [54].

### Forest Road Construction

Loggers often require the use of forest roads to provide access for forest management and recreational activities. Careful planning and management for these roads is a critical part of lowering the risk of major sedimentation and



erosion. There are two types of forest roads, permanent main access (MA) roads and temporary limited use (LU) roads.

The BMP strategies for forest roads can include identifying and avoiding sites sensitive to erosion or sedimentation, designing the roads to meet long term objectives, ensuring proper drainage, following contour as best as possible, installing culverts at specified intervals, and utilizing broad based dips, water bars, filter strips, and other sediment control techniques [55].

#### **Timber Harvesting**

Timber harvesting by loggers, especially in sensitive sites, can pose a risk to the next generation of tree species as well as to aquatic habitat quality. Proper management and planning for the harvesting process is critical for maintaining the health and quality of forested land and the surrounding waterbodies. There are two major considerations when timber harvesting: on-site impacts and water quality impacts.

The BMP strategies for reducing the impact on water quality when timber harvesting can include minimizing the number of stream crossings required, identifying locations for these crossings that will minimize impacts, and identifying sensitive areas including SMZs, ephemeral streams, and soils prone to erosion. The BMP strategies for reducing the impact on site from timber harvesting can include careful planning that considers land cover, wildlife habitat, and aesthetics; planning skid trails to take as little space as possible, logging during dry conditions, and extensive follow up to ensure the health of the site [56].

### Prescribed Burning

Prescribed burning is a useful tool for preparing a site for forestry operations. Burns can be utilized for clearing a site of leaf litter and other logging debris to make the site suitable for planting and seedfall. If a prescribed burn is not properly managed, risks can include fire spreading farther than intended, becoming too hot, and/or entering sensitive areas.

The BMP strategies for prescribed burning can include ensuring that the burn site is enclosed to prevent escape, utilizing adequate fuel breaks, sufficient manpower, and staying with the fire until it is safe. Most importantly, consulting a SCFC employee to notify them of the burn and to ensure that the proper precautions are taken [57].

#### 12.4) Forest Management BMP Funding Sources

Funding for forest management BMPs is limited. Most BMPs installed on forested land in South Carolina are completed by logging companies or private consulting foresters. There are a few cost share programs and voluntary stewardship programs offered by the USDA and the SCFC.

#### SCFC Stewardship Program

Landowners can join the Forest Stewardship Program (FSP) with minimal costs. They are provided a professional forester that provides consultation for methods to best manage their forested land including rotational harvesting, seed planting, and prescribed burning. The FSP provides reimbursement for these plans. The eligibility requirement for this program is ownership of at least 50 forested acres. The parcel(s) must also be considered a Forest Stewardship Priority Parcel (*i.e.* parcels with greater than 50% FSP priority pixels). Reimbursements fall between \$600 and \$2,000 for each approved Stewardship Management Plan [58].





Photo 10: Stewardship Management Plan Recipient (Photo Credit: SCFC)

## USDA NRCS Healthy Forests Reserve Program

The Healthy Forests Reserve Program (HFRP) helps private forest landowners restore, enhance, and protect forestland resources on their land through easements and financial assistance. The HRFP also contributes to the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity, and enhances carbon sequestration.

Some benefits to the HFRP are that it provides landowners with a 10-year restoration agreement and 30-year or permanent easements for specific conservation actions. Eligibility requirements dictate that the land must be privately owned and have the ability to restore, enhance or increase the recovery of threatened or endangered species, improve biological diversity or increase carbon storage [59].

Other USDA NRCS programs include EQIP, CSP, and RCPP. All of these have components built in that help private landowners improve their forestland. A description for EQIP can be found in Sections 13.4 and 15.4. A description for CSP can be found in Section 15.4. A description for RCPP can be found in Section 11.4.



## 13) Riparian Buffer BMP

Riparian buffers are strips of vegetation adjacent to streams and wetlands that represent a method for controlling sediment and other nonpoint nutrient sources of pollution [60]. Buffers can include grasses, shrubs, and trees, which hold soils in place and act as living filters for pollution. Without buffers, various types of land disturbance can contribute pollutants such as sediments, fertilizers, pesticides, and many other pollutants to nearby waterbodies. Buffers also stabilize streambanks to prevent erosion. They also limit algae growth and slow runoff to help prevent flooding and flood damage.

## 13.1) Riparian Buffer BMP Criteria

Table 58 details each criterion for scoring parcels in the project area for potential riparian buffer BMPs. Total scores were grouped into two priority categories – *high* (9-17 points) and *low* (1-8 points).

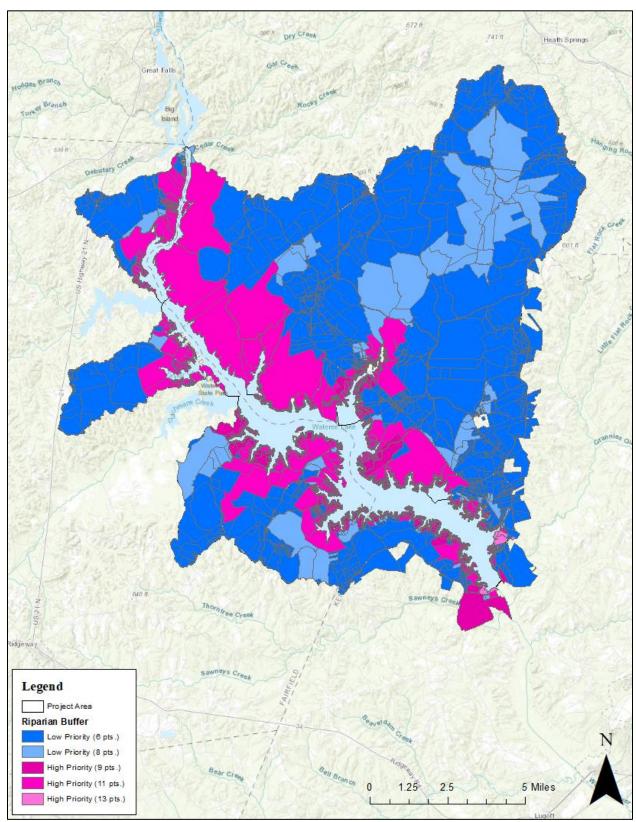
Cr	Points	<b>Total Possible Points</b>	
Highly Sensitive Riparian Buffer Areas	Within/Adjacent to The Highly Sensitive Riparian Buffer Areas Layer	4	4
Stream Order	First and Second Order Streams	4	4
Adjacency to Drinking Water Intakes/Impoundments/Reservoirs	Adjacent to Drinking Water Intakes/Impoundments/Reservoirs	rs 4	
mtakes/impoundments/keservoirs	Adjacent to Waterways	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream from Existing Impairments	3	3
100-Year Floodplain Within/Adjacent to 100-Year Floodplain		2	2
TOTAL POSSIBLE POINTS PER PARCEL			17

Table 58: Riparian Buffer BMP Scoring Criteria for Project Area

### 13.2) Riparian Buffer BMP Scoring Results

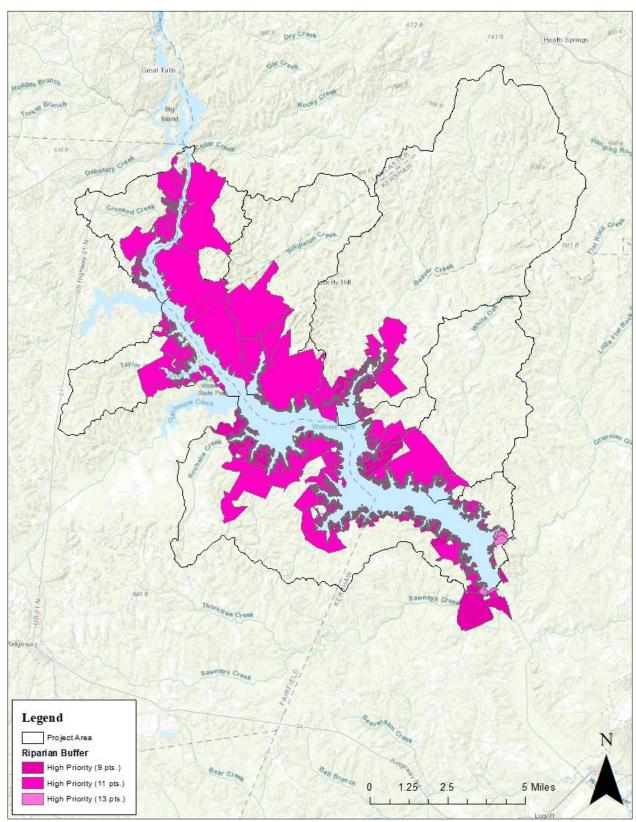
A total of 2,866 parcels in the project area were scored as high priority for riparian buffer BMP prioritization. Fourteen parcels scored 13 points, which was the highest score in this analysis. The parcels receiving high scores are concentrated along the lakeshore where there are first and second stream order waterbodies. The 14 parcels scoring the highest are located at the south end of the lake, near the public surface water intakes. Maps 29 and 30 show where the prioritized parcels are located within the project area.





Map 29: Riparian Buffer BMP Prioritization





Map 30: Riparian BMP Prioritization – High Priority Only



## 13.3) Riparian Buffer BMP Strategies and Recommendations

The following is a complete description of the compliance and ordinance requirements for riparian buffer BMPs in the project area. Pending installation location, all riparian buffer BMP implementations must meet either the Duke Energy or county guidelines.

#### Duke Energy Riparian/Vegetative Buffer Compliance

Duke Energy finalized their FERC Relicense for the Catawba-Wateree Hydroelectric Project in 2015 for a term of 40 years. The end date for the relicensing is October 2055.

The Catawba-Wateree Shoreline Management Plan created by Duke Energy was developed to assist in guiding responsible construction, shoreline stabilization, and excavation activities within all lake boundaries throughout the Catawba-Wateree Basin. The Plan shows various types and uses of the shoreline including areas protected for environmental or habitat values, areas of existing development, and areas of potential development and restrictions associated with each of these shoreline uses. Any activity within the FERC boundary deemed either a "Project Use" or "Non-Project Use" by Duke Energy is evaluated through permitting programs including Private Facilities Program, Shoreline Stabilization Program, Excavation Program, Marina Facilities Program, Conveyance Program, and Miscellaneous Reservoir Uses Program.

Duke Energy acknowledges that vegetation management and maintenance of vegetated terrestrial and riparian areas is an important factor in protecting and enhancing lake values. Based on information found in Duke Energy's FERC Project Number 2232, their vegetative management requirement consists of a 25-foot buffer within full pond elevations at activity locations within the FERC boundary. Their vegetative management requirement does not apply to county riparian/vegetative buffer ordinances [61].

#### Kershaw County Riparian/Vegetative Buffer Compliance

Kershaw County manages water quality buffer requirements through Section.5:3.6 of the *Unified Code of Zoning and Land Development Regulations*. There are buffer requirements for any development and/or subdivision on parcels in the county.

- 1. Perennial Streams a 100-foot natural buffer is required along the entire length of the steam's banks contained within or adjacent to the lot being developed. The perennial stream is verified through USGS topographic maps.
- Intermittent Streams a 50-foot natural buffer is required along the entire length of the steam's banks contained
  within or adjacent to the lot being developed. The intermittent stream is verified through USGS topographic
  maps.
- 3. Shoreline Buffers a 50-foot buffer perpendicular to the shoreline as defined by the 100-year high water elevation is required. The hydrologic connectivity between the perennial stream and waterbody is verified through USGS topographic maps.
- 4. Floodways and Wetlands Associated with Perennial and Intermittent Streams in areas where a floodway profile has been delineated along a perennial or intermittent stream on the FEMA Flood Map of Kershaw County, the stream buffer has to be the width of the floodway if the floodway is greater than the required buffer width [62].

#### Fairfield County Riparian/Vegetative Buffer Compliance

The riparian buffer setback requirement for Fairfield County of not less than 50 feet is required on all undeveloped lots fronting on the banks of Lake Wateree and the Reservoir. The setback and buffer area should be measured horizontally from the property line on The Reservoir and from the full pond elevation (225.5 feet MSL) on Lake Wateree. The buffer area should remain largely undisturbed [63].

#### Lancaster County Riparian/Vegetative Buffer Compliance

For developments 8,000 square feet or under of new impervious surface or land development with 10% or less impervious surface, native forested buffer must be maintained and no disturbance of natural vegetation within a distance of 200 feet from perennial streams, or within 100 feet of intermittent streams.

For developments 8,000 square feet or more of new impervious surface or land development with 10% or more impervious surface, native forested buffer must be maintained and no disturbance of natural vegetation within a



distance of 200 feet from perennial streams, or within 100 feet of intermittent streams. The 100-foot and 200-foot native forested buffer should be measured from the top of the bank on either side of the intermittent/perennial stream and wraps around the head of the stream at the intermittent/ephemeral breakpoint [64].

EPA has issued several technical guidance documents for aquatic buffers that focus on streams. The documents state that good aquatic buffer ordinances consist of the following elements [65]:

- Specified size and management of the stream buffer
- County planning maps that clearly mark buffer boundaries
- Language restricting vegetation and soil disturbance
- Consideration given to percent slope and stream type to determine buffer width adjustment
- Post construction public education

The US Forest Service suggests a number of additional land management actions to support riparian buffer functions including [66]:

- Manage land to reduce water runoff and increase infiltration
- Maintain, conserve vegetation cover as much as possible
- Avoid potentially polluting activities on steep slopes
- Minimize polluting activities during high rainfall seasons

SCRWA recommends that local communities at Lake Wateree attempt to meet or exceed the buffer ordinances defined by their respective county and consider the additional steps provided by the EPA and US Forest Service for riparian buffer enhancement.

# 13.4) Riparian Buffer BMP Cost Estimates and Funding Options

SCRWA considered several riparian buffer BMP cost estimates including those provided by USDA NRCS, State of Oregon Department of Environmental Quality, American Water Resource Association, and several published scholarly articles. SCRWA currently holds a USDA NRCS RCPP grant that includes a planning framework and budget utilizing various NRCS cost-share programs, including EQIP, to install BMPs on prioritized agricultural land in the Pee Dee River Basin in South Carolina. The USDA NRCS Payment Schedule for South Carolina was used for determining riparian buffer BMP cost estimates [67]. Table 59 details the vegetative riparian buffer cost for parcels within the project area. Table 60 includes costs for forested riparian buffers for parcels within the project area.

Code	Practice	Component Units		Unit Cost
490	Tree/Shrub Site Preparation	Chemical - Group Application	Acre	\$49.81
490	Tree/Shrub Site Preparation	Chemical Application	Acre	\$92.92
490	Tree/Shrub Site Preparation	Mechanical – Very Light	Acre	\$36.01
490	Tree/Shrub Site Preparation	Mechanical – Light	Acre	\$70.77
490	Tree/Shrub Site Preparation	Mechanical – Medium	Acre	\$163.88
490	Tree/Shrub Site Preparation	Mechanical – Very Heavy	Acre	\$272.74
<b>Total Cost</b>				\$686.13/acre

**Table 59: Vegetative Riparian Buffer BMP Cost** 



Code	Practice	Component	Units	Unit Cost
612	Tree/Shrub Establishment	Conifer Bare Root	Acre	\$101.18
612	Tree/Shrub Establishment	Conifer, high density, containerized	Acre	\$182.58
612	Tree/Shrub Establishment	Conifer, low density, containerized	Acre	\$151.69
612	Tree/Shrub Establishment	Hardwood Hand Planting – bare	Acre	\$306.26
612	Tree/Shrub Establishment	Hardwood Hand Planting – bare root – protected	Acre	\$325.76
612	Tree/Shrub Establishment	High Density mech planting	Acre	\$146.51
612	Tree/Shrub Establishment	High Density – hand plant BR	Acre	\$159.67
612	Tree/Shrub Establishment	High Density – hand plant Conifer	Acre	\$158.81
612	Tree/Shrub Establishment	Medium Density – Mech Plant Conifer	Acre	\$95.26
612	Tree/Shrub Establishment	Shrub Planting	Acre	\$119.76
Total Cost				\$1,747.48/acre

Table 60: Forested Riparian Buffer BMP Cost

There are several federal funding program opportunities for riparian buffer BMP implementation projects. Listed below are some options for consideration.

### **USDA EQIP**

EQIP provides cost sharing and technical assistance for the planning and installation of environmentally beneficial and cost-effective conservation practices that address natural resource concerns. Together, USDA NRCS personnel and producers invest in solutions that conserve natural resources for the future while also improving agricultural operations. EQIP contracts are set for five to 10-years. Agricultural or non-industrial forestry producers are eligible applicants for this funding [68].

## CWA Section 319

This program focuses on preventing or reducing nonpoint sources of pollutants from entering waterbodies. This allows the beneficial uses of the water resources to be maintained or restored. EPA provides annual funding allocations to SCDHEC to implement nonpoint source pollution mitigation strategies. The funding is open to a competitive grant process for applicants interested in implementing nonpoint source strategies outlined in an approved WBP. Applications for this funding are open to stakeholder groups, government entities, or other public agencies associated with the watershed planning process. The 319 grant pays up to 60% of eligible project costs, with the applicant providing a 40% non-federal match [69].

## 14) Shoreline Management

The parcel analysis for shoreline management BMPs focuses on areas near public surface water infrastructure and shoreline property with highly erodible soils that can negatively impact drinking water resources. The purpose of these BMPs is to reduce the impact from pollutants entering areas near the water intakes. Duke Energy developed, through the Catawba-Wateree Hydroelectric Project FERC License, a Shoreline Management Plan (SMP) to help ensure shorelines are managed properly and that water quality is not degraded through nonpoint source pollutants from stormwater runoff, streambank erosion, and flooding. According to the most recent FERC License agreement,



the SMP is to be updated every 10 years. Coordinating BMPs with the SMP can help reduce costs to water treatment and prevent pollutants from directly entering the lake in areas near the public drinking water intakes.

# 14.1) Shoreline Management BMP Criteria

Table 61 details each criterion for scoring parcels in the project area for potential shoreline management BMPs. Total scores were grouped into two priority categories -high (6-11) points and low (1-5 points).

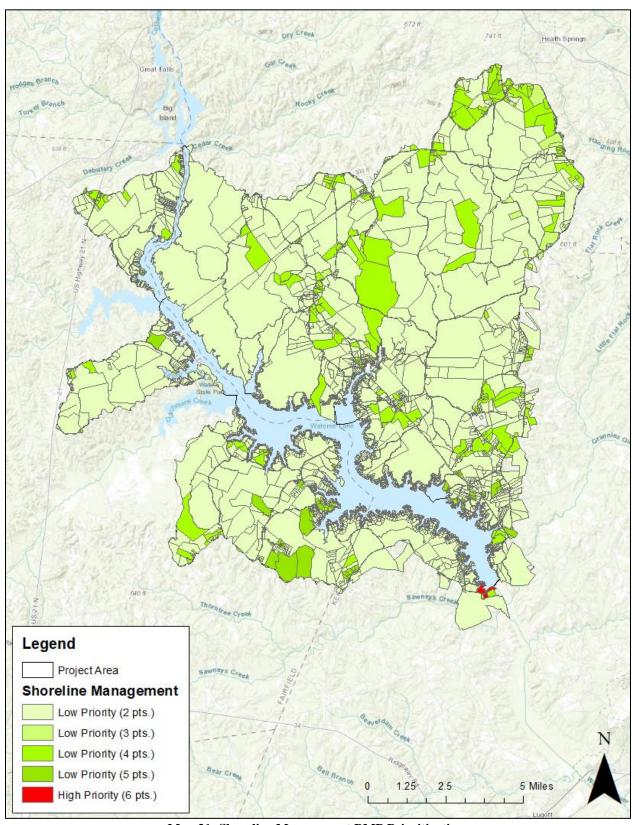
C	Points	Total Possible Points	
Adjacency to Drinking Water Intake or Reservoir/Impoundment	Adjacent to Drinking Water Intake	4	4
Highly Sensitive Riparian Buffer Area	Within/Adjacent to Highly Sensitive Riparian Buffer Area	4	4
	High Soil Erodibility (0.29 - 0.37)	3	
Soil Erodibility (K-Factor)	Moderate Soil Erodibility (0.20 - 0.28)	2	3
	Lowest Soil Erodibility (0.10 - 0.19)	1	
TOTAL POINTS POSSIBLE PER PARCEL			11

Table 61: Shoreline Management BMP Scoring Criteria

## 14.2) Shoreline Management BMP Scoring Results and Recommendations

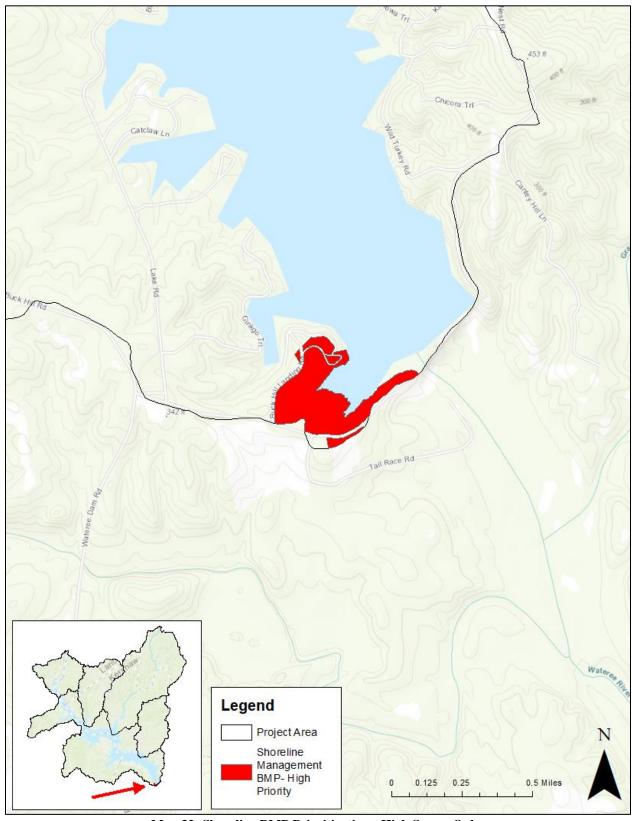
Five parcels in the project area were scored as high priority for the shoreline management BMP. All five parcels scored six points, which was the highest score for this analysis. These parcels are located at the southwestern side of the lake, near the public surface water intakes. Further refinement to the analysis could include private docks and rate of nutrient loading. There are 152 parcels that scored five points. By adding private docks data to this analysis, the number of high priority parcels would increase substantially. SCRWA unsuccessfully attempted to retrieve private dock data from Duke Energy and the counties. Maps 31 and 32 show the locations of prioritized shoreline management opportunities.





**Map 31: Shoreline Management BMP Prioritization** 





Map 32: Shoreline BMP Prioritization - High Scores Only



Duke Energy considers FERC project boundaries to include area within the full pool elevation of the lake reservoirs and lands immediately surrounding the dams and powerhouses. The FERC project boundary for Lake Wateree is 225.5 feet. The term "project boundary" can be used interchangeably with shoreline in this context. Duke Energy also maintains their own SMP through the FERC License. The SMP presents 11 classifications and lake use restrictions for shoreline management including environmental, bottomland hardwood area, natural area, Impact Minimization Zone (IMZ), commercial marina, residential marina, residential, business/industrial, project operations, public recreation, and public infrastructure (see Appendix D for more detail). Lake Wateree has 214 shoreline miles. The shoreline classifications, miles, and percent of miles for each classification are presented in the Table 62 [2].

Shoreline Classification – Lake Wateree								
Classification	Miles	Percent	Classification	Miles	Percent			
Bottomland Hardwood	1.3	0.7%	Impact Minimization Zone	7.7	4.1%			
Business Industrial	0.0	0.0%	IMZ Development	0.5	0.2%			
Commercial Marina	1.7	0.9%	Natural Areas	5.0	2.6%			
Environmental	42.4	22.4%	Project Operations	1.2	0.7%			
Future Commercial Marina	15.3	8.1%	Public Infrastructure	1.8	0.9%			
Future Public Recreation	8.7	4.6%	Public Recreation	0.5	0.3%			
Future Residential	11.8	6.2%	Residential	84.4	44.6%			
Future Residential Marina	4.9	2.6%	Residential Marina	0.7	0.4%			

Table 62: Duke Energy Shoreline Classifications at Lake Wateree

SCRWA recommends that residents with lakefront property reach 100% compliance with the SWP, repair and/or maintain boat docks, and establish riparian buffers at the prescribed FERC project boundary for Lake Wateree (225.5 feet).

### 14.3) Shoreline Management BMP Strategies

The following are options for shoreline management BMPs. These should be considered as compliance measures or supplemental improvement strategies.

#### Shoreline Buffer Restoration

Lakeside residential properties represent roughly 45% of all shoreline miles at Lake Wateree. These are not hardscape buffers, such as riprap, but natural buffers to reduce the impact of stormwater runoff. SCRWA recommends that residential owners with shoreline property maintain a natural buffer up to the FERC project boundary (225.5 feet), or above, to filter nonpoint source runoff from lawns and impervious surfaces. This could also help prevent the need for future erosion control measures, such as installing riprap. The SWP contains guidance on the natural buffers best suited for lakeside residential properties.

For forested shoreline properties on tributaries, SCRWA recommends buffers be installed in accordance with the SCFC minimum width for Streamside Management Zones (SMZs). The SCFC recommends a minimum buffer width of 40 feet for perennial streams. These areas would include forested shoreline properties on the primary tributaries in the project area. Shoreline properties with and without forest management plans should be considered for this BMP [70].

#### Private Dock Incentive Program

Duke Energy offers a Shoreline Preservation Incentive Program for new development projects on Lake Wateree. Owners of new development projects are incentivized to leave 20% of shoreline available during boat dock constructions. In exchange for doing this, the owner may be allowed multiple boat slips/moorings/docking locations for every 100 feet of shoreline preserved (see Table 63). Multiples may be increased if the preserved shoreline is accompanied with a buffer contiguous with and directly landward of the preserved shoreline. This would allow



many homes to have access to a multi-slip facility. These facilities are intended for new construction subdivisions. There are several other components to the Shoreline Preservation Incentive Program, which can be found in Appendix E [61].

Eligible Shoreline	Preserved (percent)	<b>Boatslip Multiple per 100 feet of Shoreline Preserved</b>				
At Least	But Less Than	With No Buffer	With 50 Foot Buffer	With 150 Foot Buffer		
20	25	1.5	2.5	3.5		
25	50	2.5	3.5	4.5		
50	-	4.5	5.0	6.0		

**Table 63: Duke Energy Private Dock Incentive Program** 

#### Shoreline Management Plan Compliance

Duke Energy completed a SMP in 2016 for the Catawba-Wateree Hydroelectric Project. The SMP details the shoreline management classifications, use restrictions (see Section 14.2 and Appendix D), and enforcement (see Appendix F).

Duke Energy regularly monitors project boundary shoreline to ensure activities are in compliance with the SMP. Inspections for permitted facility construction is conducted once construction in complete. Any change or alteration in the features or vegetations on shoreline land without the authorization from Duke Energy is prohibited and is considered encroachment. Legal action can be taken to correct the violation if the following conditions are not satisfied:

- 1. Use or occupancy violates the FERC license or conditions imposed by Duke Energy for the protection and enhancement of the lake's scenic, recreational, cultural, or other environmental values
- 2. Use violates local, state, or federal regulations
- 3. Covenant of a conveyance made under the authority of the standard land cover license article is violated.

Examples of violations include unauthorized construction, unauthorized removal of vegetation, and dumping of debris, including leaves and yard waste, within the project boundary. Legal actions include canceling permission to use and occupy the lake land and water and requiring that the non-complying structure or facility be removed [2].

### 15) Agriculture BMPs

Agricultural BMPs included in this plan will be used to manage agricultural land cover for livestock and cropland. The purpose of these BMPs is to limit the bacteria, sediment, and nutrient nonpoint source pollutants entering waterbodies from agricultural land. Livestock are considered the primary source for bacteria nonpoint source pollutants. Livestock also contribute to nutrient and sediment pollution through their feces and the disruption of loose soils.

#### 15.1) Agriculture BMP Scoring Criteria

Table 64 details each criterion for scoring parcels in the project area for potential agriculture BMPs. Total scores were grouped into two priority categories – high (6-11 points) and low (1-5 points). Only parcels classified as agriculture were scored for this analysis.



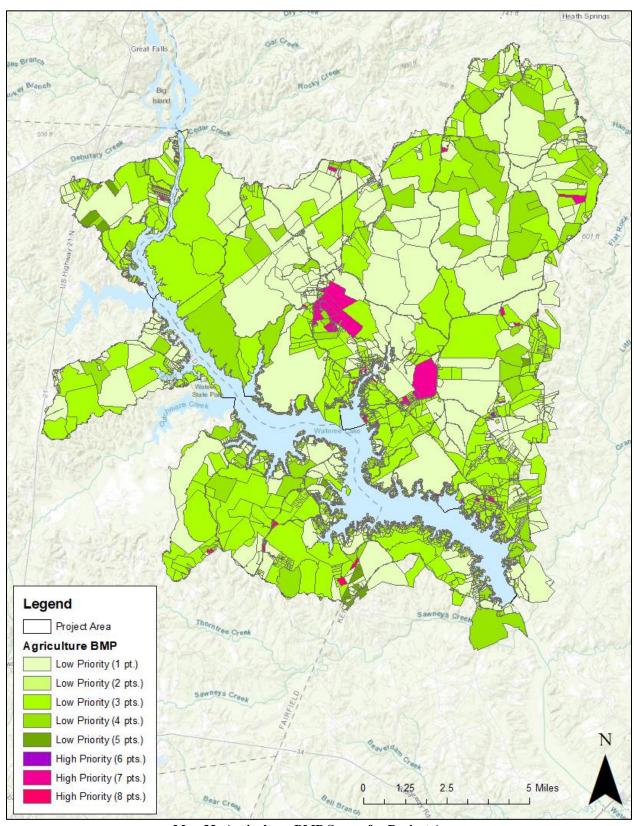
Criteria		Points	Total Possible Points
Land Cover	50% Or Greater Agriculture Land Cover	2	4
	Agricultural Land Cover Adjacent to Streams	2	
Current Water Quality Impairment	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Permitted and Unpermitted Point Source Pollutants - Agricultural Facilities in Project Area and NPDES Permits in Project Area	Unpermitted Point Sources (Farms)	1	1
	Permitted Point Sources (CAFO's, Biosolid Application Areas, Animal Management Areas)	1	
Soil Erodibility (K-Factor) on Parcels with Agricultural Land Cover	High Soil Erodibility (0.29 - 0.37)	3	3
	Moderate Soil Erodibility (0.20 - 0.28)	2	
	Lowest Soil Erodibility (0.10 - 0.19)	1	
TOTAL POINTS POSSIBLE PER PARCEL			11

Table 64: Agriculture BMP Scoring Criteria for Project Area

## 15.2) Agriculture BMP Scoring Results and Recommendations

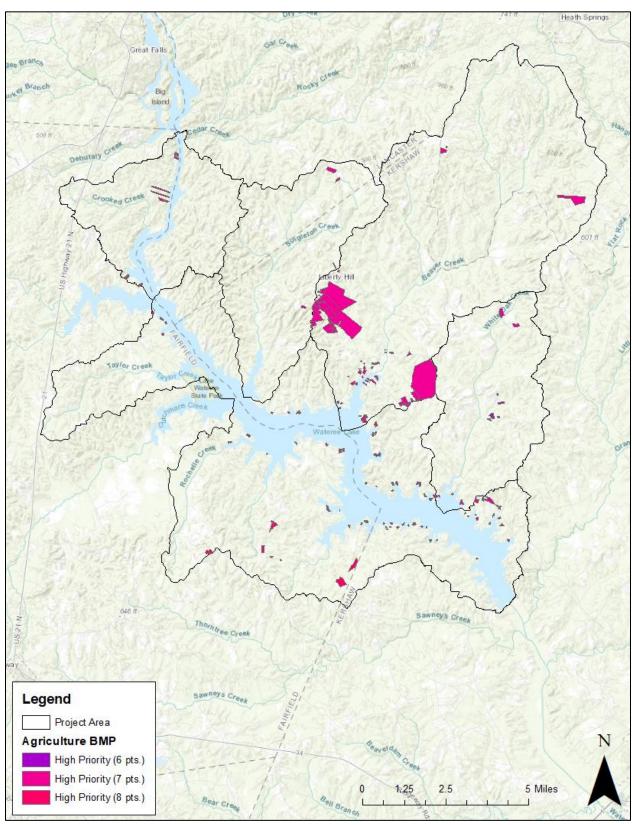
Two hundred and twenty-five parcels in the project area were scored as high priority for agriculture BMP prioritization). Eighty-four parcels scored 8 points, which was the highest score in this analysis. The parcels receiving high scores are located along the shoreline through the project area and within the Beaver Creek watershed. There are five parcels that each are over 500 acres. The project area consists of only approximately 1.7% agricultural land cover. Despite the small percentage of agricultural land cover, bacteria, sediment, and nutrient loads originating from these land covers directly impact water quality in the project area. Maps 33 and 34 show where prioritized parcels for agricultural BMP are located within the project area.





Map 33: Agriculture BMP Scores for Project Area





Map 34: Agriculture BMPs - High Priority Only



To combat the sediment and nutrient loading from agricultural land, SCRWA recommends focusing education and outreach strategies throughout the project area, especially within the Beaver Creek watershed. Due to the size of their properties, it is recommended that landowners for the five parcels over 500 acres are contacted individually to assess their existing agricultural BMPs implementations.

## 15.3) Agriculture BMP Strategies and Cost Estimates

The strategies listed below were chosen based on their ability to mitigate bacteria, sediment, and nutrient nonpoint source pollution originating from agricultural land. This plan identifies agricultural land cover as those areas with grazing livestock and row crop farming. For agricultural land with livestock the following goals for BMP strategies are suggested: limit fecal waste by reducing the number of livestock with access to streams, stabilize soils, and provide manure management education and assistance to famers. For agricultural land with row crops the following goals for BMP strategies are suggested: reduce field runoff and provide fertilizer management education and assistance to farmers.

#### Stream Bank Fencing

See Section 9.

#### Microirrigation

Also known as drip, or trickle, irrigation, this applies small quantities of water at or below the soil surface. These systems allow water to be more uniformly distributed directly to the plant root zone, which maintains soil moisture for optimum plant growth. Microirrigation also limits erosion where there are steep slopes and loose soils. The operation and maintenance of a microirrigation system involves periodic inspections and the prompt repair or replacement of clogged or damaged components. Additionally, the operator will need to determine and control the volume, frequency, and application rate of irrigation water in a planned, efficient manner [71].

### **Nutrient Management**

See Section 9.

Cover Crops

See Section 9.

Filter Strip

See Section 9.

The agricultural BMP cost estimates in Table 65 were taken from USDA NRCS 2022 EQIP state payment schedule for South Carolina.



	Code	Practice	Component	Units	Unit Cost
	382	Fencing	Woven Wire	Foot	\$2.85
	441	Microirrigation	Surface PE with Emitters	Acre	\$4,976.61
	590	Nutrient Management	Basic NM (Non-Organic/Organic)	Acre	\$6.27
	157	Nutrient Management Design and Implementation Activity	Design Nutrient Management for less than or equal to 100 Acres (No Manure)	None	\$2,337.56
le <sup>2</sup>	157	Nutrient Management Design and Implementation Activity	Design NM for less than or equal to 100 Acres (Fertilizer and Manure)	None	\$3,895.93
Bund	157	Nutrient Management Design and Implementation Activity	Design NM for 101 to less than 300 Acres (No Manure)	None	\$3,116.74
Nutrient Management Bundle <sup>2</sup>	157	Nutrient Management Design and Implementation Activity	Design NM for greater than 101 Acres and less than or equal to 300 Acres (Fertilizer and Manure)	None	\$5,454.30
Mana	157	Nutrient Management Design and Implementation Activity	Design Nutrient Management for greater than 300 Acres (No Manure)	None	\$3,895.93
utrient	157	Nutrient Management Design and Implementation Activity	Design Nutrient Management for greater than 300 Acres (Fertilizer and Manure)	None	\$6,623.08
<b>Z</b> ,	217	Soil and Source Testing for Nutrient Management	Manure and Compost Only	None	\$1,725.84
	217	Soil and Source Testing for Nutrient Management	Soil Test Only	None	\$1,617.89
	217	Soil and Source Testing for Nutrient Management	Zone or Grid Soil Test	None	\$2,297.53
	340	Cover Crop	Cover Crop - Basic (Organic and Non-Organic)	Acre	\$52.47
	340	Cover Crop	Cover Crop - Multi Species (Organic and Non-Organic)	Acre	\$64.11
	340	Cover Crop	Cover Crop - Adaptive Management	None	\$1,837.02
	393	Filter Strip	Native Species	Acre	\$188.37

**Table 65: Agriculture BMP Cost** 

## 15.4) Agriculture BMP Funding Options

The following funding options include federal program funding options from the EPA and USDA. The goal of these programs is to reduce agricultural nonpoint source pollution by helping to install the agricultural BMPs detailed in Section 15.3.

## CWA Section 319 Grant Program

This program focuses on preventing or reducing nonpoint sources of pollutants from entering waterbodies. This allows the beneficial uses of the water resources to be maintained or restored. EPA provides annual funding allocations to SCDHEC to implement nonpoint source pollution mitigation strategies. The funding is open to a competitive grant process for applicants interested in implementing nonpoint source strategies outlined in an approved WBP. Applications for this funding are open to stakeholder groups, government entities, or other public

<sup>&</sup>lt;sup>2</sup> A Nutrient Management BMP bundle can include multiple USDA NRCS conservation practices. The options for creating a Nutrient Management bundle are provided in the Table. The cost for each Nutrient Management BMP will vary based on the chosen components of the bundle.



agencies associated with the watershed planning process. The CWA Section 319 grant pays up to 60% of eligible project costs, with the applicant providing a 40% non-federal match.

### <u>USDA NRCS Environmental Quality Incentive Program (EQIP)</u>

EQIP is a frequently used program by agricultural producers throughout the US. The program is voluntary and provides financial and technical assistance to address specific natural resources concerns and deliver environmental benefits. Some of these benefits include the reduction of contamination from agricultural sources, more efficient use of nutrients, and increased soil health. A USDA NRCS conservationist from a local NRCS office will conduct a site evaluation and present a variety of practices or system alternatives to help address specific agricultural concerns [68].

## USDA Farm Service Agency (FSA) Conservation Reserve Program (CRP)

Established in 1985, CRP is one of the largest voluntary conservation programs provided to agricultural producers. In exchange for an annual rental payment, producers agree to remove environmentally sensitive land from agricultural production and plant species that will improve the environmental health and quality of their land. The long-term goal of the program is to reestablish valuable land to improve water quality, prevent erosion, and reduce loss of wildlife habitat. The contract agreement between the producer and USDA FSA last from 10 to 15 years. In South Carolina, applications are received between January and March of each year [72].

#### USDA NRCS Conservation Stewardship Program (CSP)

This program provides technical and financial assistance to producers so they can build on existing conservation efforts while strengthening operations, such as grazing conditions, crop resiliency, or wildlife habitat development. Eligible agricultural land cover include cropland, grassland, prairie land, pastureland, rangeland, non-industrial private forest land, tribal land, other forms of agricultural land. At its core, CSP is a problem solving mechanism for producers. For example, a CSP plan can solve problems related like soil loss, water loss, and promote energy efficiencies for on-farm activities. NRCS field offices receive applications at any time throughout the year [73].

### 16) Education and Outreach

Consistent and targeted outreach is central to the success of voluntary initiatives like watershed-based planning. SCRWA recommends that outreach initiatives remain active throughout the fifteen-year project implementation timeline. However, year one of each five year phase should be dedicated to building capacity for BMP implementation and developing relationships with potential BMP participants. The importance of building relationships cannot be overstated. Successful voluntary initiatives are often the result of strong relationship between the project organizer and project partner. Building capacity in year one will help create streamlined and organized outreach campaigns with defined roles for all project participants.

Detailed below are recommended education and outreach strategies for BMPs and land cover. Many of these recommendations were identified through conversations with project partners including Duke Energy, Lake Wateree Association, Catawba Riverkeeper, and the Catawba-Wateree Water Management Group.

### Septic System Repair/Replacement

Distribution Materials:

SCDHEC - Septic System Maintenance information and management flyers

### Riparian Buffer BMPs

Much like septic system outreach, riparian buffer outreach should target lakeside homeowners, homeowners' associations, city/county personnel, construction firms, and planned mitigation projects. Reaching these audiences with targeted outreach can be accomplished through local festivals/fairs, partnering with local groups to host native plant giveaways, working with city/council personnel to develop post construction riparian buffer ordinances, partnership with the SCFC and South Carolina Forestry Association (SCFA) to develop outreach to the local logging and timber companies for implementing additional forestry BMPs, and through social media accounts connected to potential project partners. The messaging content should include erosion prevention through planting native vegetation at streams, aesthetic, and functional value of buffers, and promoting forested riparian buffers. The



potential partners to assist with implementing this outreach campaign include Duke Energy, SCFC, SCFA, Kershaw County Soil and Water Conservation District, Kershaw County, Fairfield County, Lancaster County, Lake Wateree Association, Lugoff-Elgin Water Authority, Catawba Riverkeeper, Catawba-Wateree Water Management Group, USDA NRCS (county), and Clemson Extension (county).

#### Shoreline Management

The shoreline management outreach campaign should target lakeside homeowners, homeowners' associations, city/county personnel, and lake management. Reaching these audiences with targeted outreach can be accomplished through local festivals/fairs, partnering with lake management to host local meetings, and through social media accounts connected to potential project partners. The messaging content should align with the existing Duke Energy Shoreline Management Program guidelines, self-directed erosion prevention through planting native vegetation, and promoting no fertilizer or pesticide application areas along the lake shoreline, rivers, and streams. The potential partners to assist with implementing this campaign include Duke Energy, SCFC, Kershaw County Soil and Water Conservation District, Kershaw County, Fairfield County, Lancaster County, Lake Wateree Association, Lugoff-Elgin Water Authority, Catawba Riverkeeper, and the Catawba-Wateree Water Management Group.

#### Forest Management

The forest management outreach campaign should target forested landowners, private consulting foresters, logging companies, and timber buyers. Reaching these audiences with targeted outreach can be accomplished through partnerships with the SCFC and SCFA distributing forestry BMP material, attending county Forest Landowner meetings, local festivals/fairs, and through social media accounts connected to potential project partners. The messaging content for this campaign includes information about improper forestry practices degrading water quality, preserving SMZs, timber road construction design preventing erosion and sediment loading, and harvesting site restoration goals, and cost-share opportunities related to forest management. The potential partners to assist with implementing this campaign include the SCFC, SCFA, local private consulting forester firms, Kershaw County Soil and Water Conservation District, Kershaw County, Fairfield County, Lancaster County, Lake Wateree Association, Lugoff-Elgin Water Authority, and the Catawba-Wateree Water Management Group.

### Agriculture BMPs

The agriculture BMP outreach campaign should target landowners with agricultural land (pastureland and cropland), local Farm Bureau agencies, and local South Carolina Cattleman's Association chapters. Reaching these audiences with targeted outreach can be accomplished through mailers to landowners with agricultural operations, city/county council agenda time, partnership with Farm Bureau agencies and Cattleman's Association chapters to provide outreach materials to customers/members, local festivals/fairs, and through social media accounts connected to potential project partners. The messaging content for this campaign includes information about livestock exclusion from waterways, effectiveness of riparian buffers in reducing bacteria, sediment, and nutrient nonpoint source pollution loading, nutrient management for cropland, and cost-share opportunities available to both livestock and cropland farmers. The potential partners to assist with implementing this campaign include county Clemson Extension offices, county USDA NRCS offices, Kershaw County Soil and Water Conservation District, Kershaw County, Fairfield County, Lancaster County, Catawba-Wateree Water Management Group, and South Carolina Cattleman's Associations.

#### Urban/Stormwater BMPs

The urban/stormwater BMP outreach campaign should target homeowners, homeowners' associations, city/county governments, local community groups, local schools, and home builder contactors and associations. Reaching these audiences with targeted outreach can be accomplished through mailers to landowners about stormwater runoff and water quality, billboard marketing campaigns, presentations to public school Parent Teacher Association meetings, city/county council agenda time, local festivals/fairs, presentations to homeowners' associations, presentations to home builder contractors and associations, and through social media accounts connected to potential project partners. The messaging content for this campaign includes information about home builder contractor requirements for sediment control, soil testing to determine appropriate lawn fertilization, and LID materials to apartment



complex ownership and lakeside homeowners. The potential partners to assist with implementing this campaign include county Clemson Extension offices, county USDA NRCS offices, Kershaw County Soil and Water Conservation District, Kershaw County, Fairfield County, Lancaster County, and Catawba-Wateree Water Management Group.

## 17) Climate Change Adaptations

As the threat of climate change continues to increase, it is of utmost importance to address the potential and actual impacts that it may have on water resources. This WBP accounts for climate change adaptations in each of the planned BMPs. Specifically, these BMPs will address more frequent and intense rain events and flooding, tropical storm events, higher stream flows, increased rates of erosion, more frequent and larger wildfires, as well as the potential increase in pathogens, nutrients, and dissolved oxygen that come from a rise in temperature and inwatershed disturbances.

#### Riparian Buffers

Riparian buffers serve a variety of purposes in restoration and conservation, including many advantages that combat against the effects that climate change has on water quality. Forested/vegetated riparian buffers can help to prevent excess erosion, filter nutrients, and mitigate stormwater flow. The shoreline management analysis in this WBP outlines the importance of maintaining and creating riparian buffer areas throughout the project area. Riparian buffer restorations in the project area are estimated to eliminate 50 pounds of nutrients from entering the watershed each year, partially offsetting the increased nutrient load due to climate change.

## Land Protection/Land Management

Land protection is an effective natural solution that can be used to mitigate the impacts of climate change on local communities. Forests and undeveloped lands absorb greenhouse gasses, preventing them from releasing into the atmosphere. In fact, it is estimated that forests, prairies, farmlands, and other natural areas absorb roughly 15% of carbon dioxide emissions generated from the US [74]. Land protection also has the potential to prevent the release of greenhouse gasses by avoiding various land development activities such as deforestation and the conversion of natural and agricultural lands into sprawling residential/commercial areas. What is more, these protected lands can reduce the impacts of flooding in neighborhoods by serving as buffers in vulnerable areas (*e.g.* wetlands, floodplains, coastal areas). Per the criteria established in this WBP, a minimum of 55 acres of land is required to be considered eligible for a conservation easement. Land management strategies also play a key role in our efforts to mitigate climate change. For example, the preservation and proper management of forests in the watershed contributes to the capture and storage of carbon within the forest biomass. Forest management techniques, such as the ones outlined in this WBP, are crucial to climate change adaptation because they focus on the priority forested lands in the watershed and managing them according to SCFC BMPs.

#### Agricultural BMPs

Agricultural practices contribute to climate change through erosion and the release of excess nutrients. The release of excess nutrients from nitrogen rich fertilizers causes a chain reaction that ultimately affects climatic conditions. The agricultural BMP options outlined in this WBP will inadvertently address these issues using a variety of different techniques. Farmers can utilize no-till farming/conservation tillage, riparian buffers, livestock exclusion fencing, and armored streambank crossings to reduce the inflow of nutrients into the watershed and decrease the rate of erosion in agricultural areas. These steps help reduce the impact of more intense weather events and flooding on the watershed.

### 18) Project Implementation and Milestones

Many WQMSs within Lake Wateree do not currently meet state water quality standards due to the recreational use impairments detailed in this document. These impairments are a reflection of years of consistent bacteria, sediment, and nutrient nonpoint source pollution loading. The timeline reflects an incremental approach at mitigating the inputs causing the impairments. It is also important to acknowledge the external factors outside of the project area causing the water quality issues. With population growth and climate change as two primary external factors, the proposed BMP implementations are designed to address current and future nonpoint source pollution impacts. The goal of this plan is for all WQMSs within Lake Wateree to meet the state water quality standards by 2038 – 15-years



from 2023. This plan offers a suite of BMP options for implementation in five-year intervals. Included in Tables 66 through 68 are interim milestones that may be tracked through the 15-year implementation schedule.

Regarding future implementation efforts, some consideration should be given to the high nutrient water quality measurements at Dutchman's Creek embayment (see Section 5.2.1 and 5.3). The Dutchman's Creek watershed (HUC 030501040108) is not included as a part of this plan's project area. Any recommended BMP in this plan must be implemented within the stated five watershed project area. It is possible that the recommended BMPs, if implemented, may not have a significant effect on the elevated nutrient measurements at Dutchman's Creek embayment. Therefore, SCRWA recommends additional planning efforts that specifically address the water quality issues in the Dutchman's Creek watershed and the embayment be considered.



Years 1 to 5				
Action	Number of Projects	Percent Complete		
Applying for and securing adequate funding to complete restoration priorities identified in this Plan.		33.3		
Septic:				
Failing Septic System - Repair Replace	100	33.3		
Education and Outreach – See Section 16 for recommended actions.	1			
Agricultural BMPs:				
Pastureland				
Exclusionary/Streambank Fencing and Stabilization	5	33.3		
Alternative Watering Source (structure)	5	33.3		
Grass Buffer (35 feet)	5	33.3		
Agriculture Bundle – Livestock				
Alternative Watering Source, Stream Crossing, Manure Composting (structure), Heavy Use Area Stabilization	1	33.3		
Education and Outreach – See Section 16 for recommended actions.	1			
Cropland				
Cover Crop	2	33.3		
Grass Buffer (35 feet)	2	33.3		
Conservation Tillage	2	33.3		
Forest Buffer (100 feet)	2	33.3		
Agriculture Bundle – Crop				
Nutrient Management, Soil Stabilization, Critical Area Planting	1	33.3		
Education and Outreach – See Section 16 for recommended actions.	1			
Forest BMPs				
Site Prep, Hydro Mulching, Seeding, Fertilizer	5	33.3		
Education and Outreach – See Section 16 for recommended actions.	1			
Urban BMPs				
LID Filter/Buffer Strip (single family)	5	33.3		
LID Filter/Buffer Strip (multi-family)	5	33.3		
Vegetated Filter Strip (transportation)	5	33.3		
Education and Outreach – See Section 16 for recommended actions.	1			
Bi-Annual Meeting with Workgroup	1	33.3		
Update Contact Information for Partners Bi-Annually		33.3		

 Table 66: Lake Wateree WBP Measurable Milestones (Years 1-5)



Years 6 to 10				
Action	Number of Projects	Percent Complete		
Applying for and securing adequate funding to complete restoration priorities identified in this Plan.		66.6		
Septic:				
Failing Septic System – Repair Replace	100	66.6		
Education and Outreach – See Section 16 for recommended actions.	1			
Agricultural BMPs:				
Pastureland				
Exclusionary/Streambank Fencing and Stabilization	5	66.6		
Alternative Watering Source (structure)	5	66.6		
Grass Buffer (35 feet)	5	66.6		
Agriculture Bundle – Livestock				
Alternative Watering Source, Stream Crossing, Manure Composting (structure), Heavy Use Area Stabilization	1	66.6		
Education and Outreach – See Section 16 for recommended actions.	1			
Cropland				
Cover Crop	2	66.6		
Grass Buffer (35 feet)	2	66.6		
Conservation Tillage	2	66.6		
Forest Buffer (100 feet)	2	66.6		
Agriculture Bundle – Crop				
Nutrient Management, Soil Stabilization, Critical Area Planting	1	66.6		
Education and Outreach – See Section 16 for recommended actions.	1			
Forest BMPs:				
Site Prep, Hydro Mulching, Seeding, Fertilizer	5	66.6		
Education and Outreach – See Section 16 for recommended actions.	1			
Urban BMPs:				
LID Filter/Buffer Strip (single family)	5	66.6		
LID Filter/Buffer Strip (multi-family)	5	66.6		
Vegetated Filter Strip (transportation)	5	66.6		
Education and Outreach – See Section 16 for recommended actions.	1			
Bi-Annual Meeting with Workgroup	1	66.6		
Update Contact Information for Partners Bi-Annually		66.6		

Table 67: Lake Wateree WBP Measurable Milestones (Years 6-10)



Years 11 to 15				
Action	Number of Projects	Percent Complete		
Applying for and securing adequate funding to complete restoration priorities identified in this Plan.		100		
Septic:				
Failing Septic System - Repair Replace	100	100		
Education and Outreach – See Section 16 for recommended actions.	1			
Agricultural BMPs:				
Pastureland				
Exclusionary/Streambank Fencing and Stabilization	5	100		
Alternative Watering Source (structure)	5	100		
Grass Buffer (35 feet)	5	100		
Agriculture Bundle - Livestock				
Alternative Watering Source, Stream Crossing, Manure Composting (structure), Heavy Use Area Stabilization	1	100		
Education and Outreach – See Section 16 for recommended actions.	1			
Cropland				
Cover Crop	2	100		
Grass Buffer (35 feet)	2	100		
Conservation Tillage	2	100		
Forest Buffer (100 feet)	2	100		
Agriculture Bundle - Crop				
Nutrient Management, Soil Stabilization, Critical Area Planting	1	100		
Education and Outreach – See Section 16 for recommended actions.	1			
Forest BMPs:				
Site Prep, Hydro Mulching, Seeding, Fertilizer	5	100		
Education and Outreach – See Section 16 for recommended actions.	1			
Urban BMPs:				
LID Filter/Buffer Strip (single family)	5	100		
LID Filter/Buffer Strip (multi-family)	5	100		
Vegetated Filter Strip (transportation)	5	100		
Education and Outreach – See Section 16 for recommended actions.	1			
Bi-Annual Meeting with Workgroup	1	100		
Update Contact Information for Partners Bi-Annually		100		

Table 68: Lake Wateree WBP Measurable Milestones (11-15)



Land Cover/Sources	BMPs	N	lumber of Proj	ects	Action	Educatio	on and Outreac	h/Prevention
		Years 1-5	Years 6-10	Years 11-15		Years 1-5	Years 6-10	Years 11-15
Septic:								
Failing Septic Systems	Septic System Repair or Replacement	\$400,000	\$400,000	\$400,000	Workshop/Education/ Materials	\$6,500	\$6,500	\$6,500
					Acceptable Septic System Letter			
					FOG Can Lids (800 each)	\$800	\$800	\$800
Agriculture:								
Pastureland	Exclusionary Fencing and Stabilization	\$4,275	\$4,275	\$4,275	Workshops/Education/ Materials	\$25,000	\$25,000	\$25,000
	Alternative Water Source (structure)	\$2,253	\$2,253	\$2,253				
	Grass Buffer (35 feet)	\$942	\$942	\$942				
Agriculture Bundle - Livestock	Stream Crossing, Manure Composting (structure), Heavy Use Area Stabilization	\$23,600	\$23,600	\$23,600				
Cropland	Cover Crop	\$105	\$105	\$105	Workshops/Education/ Materials	\$25,000	\$25,000	\$25,000
	Grass Buffer/Filter Strip (35 feet)	\$566	\$566	\$566				
	Conservation Tillage	\$4,730	\$4,730	\$4,730				
	Forest Buffer (100 feet)	\$3,495	\$3,495	\$3,495				
Agriculture Bundle - Crop	Nutrient Management, Soil Stabilization, Critical Area Planting	\$41,760	\$41,760	\$41,760				
Forest:	Site Prep, Hydro Mulching, Seeding, Fertilizer	\$3,430	\$3,430	\$3,430	Workshops/Education/ Materials	\$10,000	\$10,000	\$10,000
Urban:	LID Filter/Buffer Strip (single family)	\$50	\$50	\$50	Commercial Contractor Good Housekeeping Education/Enforcement			
	LID Filter/Buffer Strip (multi-family)	\$50	\$50	\$50	Permanent Water Quality Buffers			
	Vegetated Filter Strip (transportation)	\$50	\$50	\$50				
Total		\$485,306	\$485,306	\$485,306		\$67,300	\$67,300	\$67,300

**Table 69: Project Implementation Matrix** 



### 19) Tracking Success

Once installed, BMPs often go unmanaged and eventually lose their efficiency at mitigating pollutants. Therefore, it is important to track their integrity and performance through specific evaluation methods. One proven method to ensure that BMPs remain efficient is through consistent education and proper maintenance. Agencies such as the EPA, USDA, and SCFC provide landowner education and BMP tracking materials (*e.g.* fact sheets and BMP maintenance checklists). SCRWA, and other Planning Team members, have access to these materials and are able to easily identify and distribute them to the appropriate landowners. There are other methods, such as online surveys through platforms like ArcPro that are public facing, easy to use, and accessible. The following are some options for evaluating the success of mitigation strategies proposed in this plan:

#### 1. Agriculture

- a. Number of farmers who attend education and outreach training (*e.g.* manure management training or nutrient management training).
- b. Number of acres addressed with manure or nutrient management plans.
- c. Number of cows prevented from access to streams and/or fenced out of riparian buffer areas.

### 2. Forestry

- a. Number of private forested landowners who attend education and outreach training (*e.g.* SCFC Forest or Stewardship Management Plan training).
- b. Number of acres addressed with SCFC Forest or Stewardship Management Plans.
- 3. Septic
  - a. Number of failing septic systems identified and mapped.
  - b. Number of septic systems inspected by a professional.
  - c. Number of septic systems upgraded to a more efficient system.
  - d. Number of attendees at education and outreach programs (e.g. FOG).

#### 4. Urban

- a. Number of stakeholders who attend urban education and outreach training.
- b. Area of impervious surfaces treated by LID BMPs.

Water quality monitoring data is a key element that can assist in determining current conditions, developing targeted management strategies, and tracking progress over time. It is recommended that current sampling at active monitoring stations be repeated regularly to track water quality trends and that additional monitoring be considered as a means to better identify specific sources of pollutants, to establish a more comprehensive baseline of conditions, to track water quality standard attainment, and track watershed conditions throughout BMP implementation phases. The following are some specific recommendations:

Stream monitoring – The water quality sampling information provided in Section 5 show that the majority
of sampling sites in the project area are located on the lake. These sites were established for regulatory
compliance and/or research purposes. It is recommended that additional sites be established in-stream to
better assess specific sources of pollutants and track the success of installed BMPs listed in this plan.
Additional monitoring sites can include tributaries not currently monitored, or those that drain to current
monitoring sites like the ones suggested in Table 70.

Additional monitoring could be achieved through the WaterWatch group or the SC AAS program. SC AAS is a public water quality network, administered by Clemson Public Service and Agriculture and SCDHEC, that trains citizen volunteers on water quality sampling. SC AAS is comprised of educators, volunteers, and local government officials who are tasked with providing baseline information about stream conditions and helping monitor and track water quality parameters within their local communities [75].

Success would be dependent on the watershed and BMPs implemented. For example, with the watersheds with the most septic systems, it is anticipated that after implementing inspection, repair, and education programs that bacteria concentrations during dry weather flows would decrease.



Stream	<b>Existing Station</b>	Existing Monitoring Group	Suggested Upstream Monitoring Group
Stillhouse Branch	None	None	SC AAS or WaterWatch
Singleton Creek (below confluence of Singleton Creek and McDow Creek)	None	None	SC AAS or WaterWatch
Beaver Creek (below confluence of Beaver Creek and Little Beaver Creek)	None	SCDHEC	SC AAS or WaterWatch
White Oak Creek	None	None	SC AAS or WaterWatch

Table 70: Suggested Supplemental Monitoring Water Quality Monitoring Stations

- 2. <u>Microbial Source Tracking (MST)</u> Sources of bacteria in specific locations in the project area are a cause for concern. Given the listed impaired WQMSs for bacteria (CW-231 and RS-07059) in the project area, it is likely that both upstream and local agricultural operations are the sources of the *E. coli* impairments. Implementing an MST program can identify the source of the bacteria (*e.g.* human or livestock), which could help stakeholders control the problem. For example, if a human marker is detected, the focus would be searching for failing septic systems. It is suggested that samples are taken on a quarterly basis, preferably during rain events. Laboratories able to process this information include:
  - Luminultra Microbial Monitoring [76]
  - University of South Carolina Arnold School of Public Health

## 20) Conclusion

The WBP for Lake Wateree recommends incremental water quality improvements over the proposed 15-year implementation timeline. The future success of this plan will depend on available funding and the continued engagement involving local stakeholders, including those not listed as Planning Team for this plan. The proposed BMPs listed in this plan were chosen for their specific ability to mitigate the causes of impairments for the project area. A key factor in the long-term success of this plan will be the maintenance of the recommended BMPs. Without following the maintenance plans for each BMP, their overall effectiveness will diminish with time.

SCRWA recognizes that the recommended BMPs and education and outreach strategies alone will not cure all of the water quality issues affecting Lake Wateree. Much of what affects the lake likely comes from upstream influences. SCRWA intends to purse future CWA Section 319 funding to address the issues upstream. This in essence is an intentional commitment to developing a long-term targeted strategy at improving water quality in both Lake Wateree and the Catawba-Wateree Basin.



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# **Appendices**



# Appendix A

## **Summary Report for ArcGIS Lake Wateree Mapping Tool**

# Summary Report for Lake Wateree Pollution Survey Selected record count: 15

Total record count: 15

Use !important to apply the filter to all responses, rather than just the responses selected for this report.

## Recent 3 records in a table:

You can reference any field from your survey in a table.

Anonymous user	June 3, 2022 8:28 AM
Anonymous user	December 30, 2021 6:07 PM
Anonymous user	December 30, 2021 2:13 PM
	Anonymous user

## Recent 3 records on a map:

You can print multiple geometries on a map.



A summary section can also be put at the end of the report.



Submitted By: Anonymous user

Submitted Time: June 3, 2022 8:28 AM

Personal Information Name

**Email** 

Phone Number

Report Information Incident Date

June 3, 2022

Report Type

Presence of Algae

Description

The algae seemed to begin about June 1st, 2022 and has steadily increased each day.







Submitted By: Anonymous user

Submitted Time: December 30, 2021 6:07 PM

Personal Information
Name

Email

**Phone Number** 

Report Information Incident Date

December 20, 2021

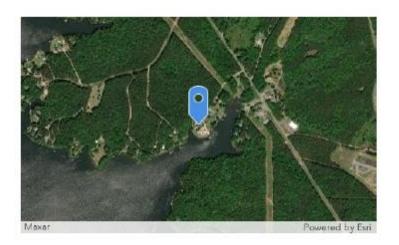
Report Type

Presence of Algae

Description

Large algae problem, my trolling motor had algae everywhere!







Submitted By: Anonymous user

Submitted Time: December 30, 2021 2:13 PM

Personal Information

Name

Email

**Phone Number** 

Report Information Incident Date

May 1, 2020

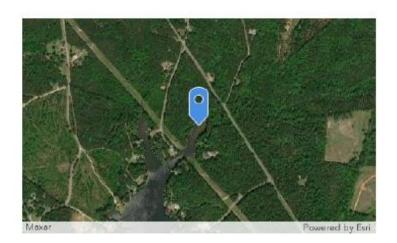
Report Type

Presence of Algae

Description

Algae is worse this year than last year in our cove. So bad this year that we can't leave our boat in water. It smells and looks terrible.











Submitted By: Anonymous user

Submitted Time: October 29, 2021 10:48 AM

Personal Information

Name

Email

**Phone Number** 

Report Information Incident Date

July 15, 2021

Report Type

**Excess Fertilizers** 

Description

contractor repaving windmill rd was washing out hydroseed truck from fire hydrant and water was running into molly creek





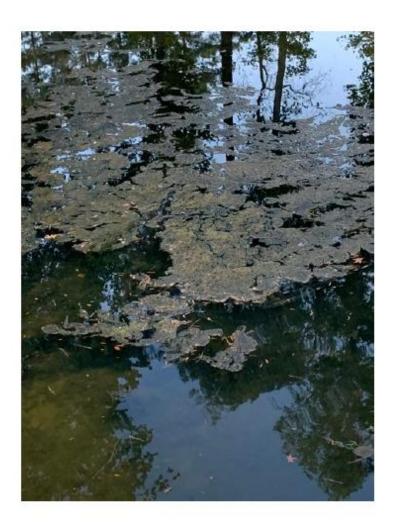


Survey Submitted By: Anonymous user Submitted Time: October 28, 2021 5:13 PM Personal Information Name Email **Phone Number Report Information Incident Date** October 27, 2021 Report Type Presence of Algae Description I may have selected the wrong location for algae. I'll do it again, at the dock











Submitted By: Anonymous user

Submitted Time: October 28, 2021 4:58 PM

Personal Information

Name

Email

Phone Number

Report Information Incident Date

October 27, 2021

Report Type

Presence of Algae

## Description

What I believe is algae all over the small cove next to my dock. It comes back every year. It surrounds the dock getting in the lower unit intake and around propeller.











Submitted By: Anonymous user

Submitted Time: October 28, 2021 3:28 PM

Personal Information Name

Email

Phone Number

Report Information Incident Date

October 28, 2021

Report Type

Water Quality

#### Description

The biggest risk to the water quality in Lake Wateree is the inflow of polluted water from Lake Wylie. There are currently two whole coves polluted by human waste. This is a regular occurrence in Lake Wylie. All water in Lake Wylie flows into Lake Watere







Submitted By: Anonymous user

Submitted Time: October 28, 2021 3:12 PM

Personal Information Name

Email

Phone Number

Report Information Incident Date

October 22, 2021

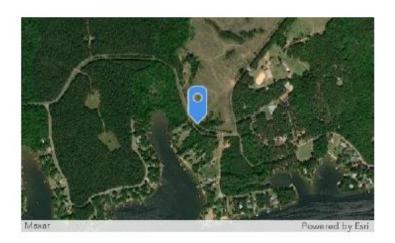
Report Type

Presence of Algae

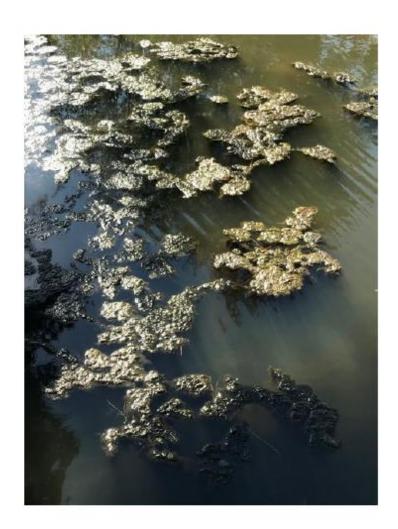
Description

Starting in the middle of May to the current date 10-28-2021, there is always the presence of algae











Submitted By: Anonymous user

Submitted Time: October 22, 2021 11:46 AM

Personal Information

Name

Email

Phone Number

**Report Information** 

**Incident Date** 

September 15, 2021

Report Type

Land Disturbance (Construction-Related)

#### Description

My neighbor is building a new house close to the water. The neighbor has been cutting down a lot of trees and cleared brush. I have been concerned about how this will affect water runoff and contribute to flooding.







Submitted By: Anonymous user

Submitted Time: October 22, 2021 11:44 AM

Personal Information

Email

Name

Phone Number

Report Information Incident Date

October 17, 2021

Report Type

Presence of Algae

Description

Approximately 30 foot long mat of algae located on Taylor Creek, north side of Lake Wateree State Park.







Submitted By: Anonymous user

Submitted Time: October 21, 2021 5:22 PM

Personal Information
Name

Email

**Phone Number** 

Report Information Incident Date

October 21, 2021

Report Type

Other

Description

jelly type substance growing on deck floats and pontoons







Submitted By: Anonymous user

Submitted Time: October 21, 2021 5:20 PM

Personal Information

Email

Name

**Phone Number** 

Report Information Incident Date

October 21, 2021

Report Type

Presence of Algae

Description

Algae bloom most of summer







Submitted By: Anonymous user

Submitted Time: October 20, 2021 8:36 AM

Personal Information

Name

Email

**Phone Number** 

Report Information Incident Date

October 20, 2021

Report Type

Land Disturbance (Construction-Related)

Description

Sediment runoff from lot clearing in Woods of Molly Creek subdivision







Submitted By: Anonymous user

Submitted Time: October 18, 2021 3:11 PM

Personal Information

Name

Email

**Phone Number** 

Report Information Incident Date

February 20, 2021

Report Type

Erosion/Sedimentation

Description

Mud/sediments/turbidity, leaves and branches in water at the Taylors Creek boat launch. I do not know if this is normal, as we were looking at homes/lots to relocate to the area. (We have since purchased a vacant lot on









Submitted By: Anonymous user

Submitted Time: October 18, 2021 3:05 PM

Personal Information
Name

Email

**Phone Number** 

Report Information Incident Date

October 18, 2021

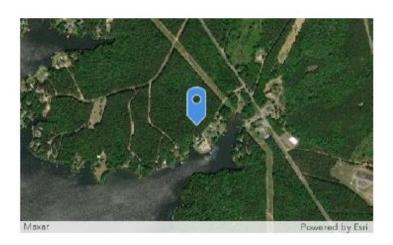
Report Type

Presence of Algae

Description

Excessive Algae



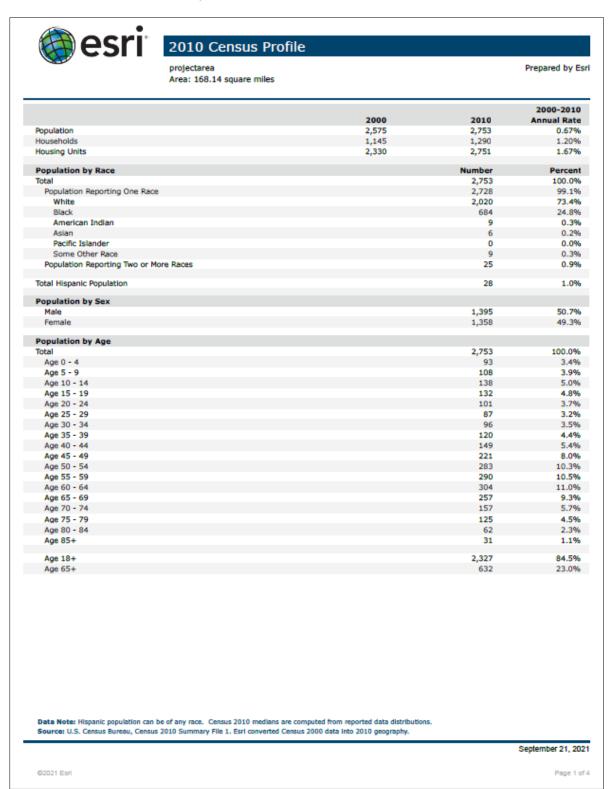






#### Appendix B

#### ESRI 2010 Census Profile for Project Area





#### Appendix C

#### **Literature Review - BMP Load Reduction**

SCRWA completed a comprehensive literature review for nutrient and sediment BMPs specific to cropland. A list of sources can be found after the last table in Appendix C.

The tables include TN, TP, and sediment reduction efficiency measurements for each BMP. Cells with an *orange* background indicates a calculation had to be made for the final measurement. Studies associated with these calculations included a measurement before BMP installation and then a measurement, or experimental result, after BMP installation. Cells with a *gray* background indicate a calculated median efficiency. Studies associated with these calculations contained a range of efficiencies. A negative number indicates an increase in the efficiency measurement. The measurements in these tables are presented as ratios.

EPA STEPL was used to calculate reduction efficiencies for BMPs presented in this plan. The data provided in the literature review should be used in coordination with the STEPL measurements for making decisions specific to nonpoint source pollution mitigation for cropland in the project area. Table 71 is a summary table for all cropland BMPs addressed in this literature review.

		Total Nitrogen	Т	otal Phosphorus		Sediment
BMPs	n	Median TN	n	Median TP	n	Median Sediment
Bioreactor	7	0.43				
Blind Inlet			1	0.79		
Buffer	1	0.21	1	0.08	3	0.77
Controlled Drainage	2	0.3575				
Conservation Tillage			4	0.565		
Cover Crops	5	0.3	4	0.295		
Filter Strip	6	0.64	8	0.6	10	0.805
Grassed Waterway	2	0.0005	11	0.17375	12	0.289855
Land Retirement	2	0.84	2	0.655		
Nitrification Inhibitor	3	0.1				
Nitrogen Management	5	0.175				
Terrace	5	0.213	11	0.28	12	0.263
Wetland	10	0.5	12	0.275	1	0.94

Table 71: Literature Review Summary Table - Cropland BMP Reduction Efficiencies



#### **BMP Efficiency Measurements for Total Nitrogen**

ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large- Sample 90% Confidence Interval (assume n=30)	Model	Source
Terrace and Diversion							
Terrace (Flow Diversion Terrace)						SWAT Model	[1]
Terrace (Flow Diversion Terrace)						SWAT Model	[1]
Terrace		0.213				SWAT Model	[2]
Terrace		0.185				SWAT Model	[2]
Terrace		0.670				SWAT Model	[2]
Terrace		0.330				APEX Model	[3]
Terrace						SWAT Model	[3]
Terrace						SWAT Model	[3]
Terrace		-0.006				SWAT Model	[3]
Terrace						SWAT Model	[5]
Terrace						SWAT Model	[5]
Terrace						SWAT Model	[5]
Terrace						SWAT Model	[5]
Terrace						SWAT Model	[5]
Terrace						SWAT Model	[5]
Terraces with Tile Outlets		0.1					[29]
Terraces with Grassed Waterways		0.3					[29]
Terraces and Diversions		0.44				PREDICT Model	[30]
Terrace		0.2	-				[25]
Diversion		0.1	0.15				[25]
Mean		0.253					
Median		0.207					•



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Grassed Waterway							
Grassed Waterway		0.000					[3]
Grassed Waterway							[3]
Grassed Waterway							[3]
Grassed Waterway		0.001					[3]
Grassed Waterway							[4]
Grassed Waterway							[4]
Grassed Waterway							[5]
Grassed Waterway							[5]
Grassed Waterway							[5]
Grassed Waterway							[5]
Grassed Waterway							[5]
Grassed Waterway							[5]
Grassed Waterway							[7]
Grassed Waterway							[7]
Grassed Waterway		0.565					[6]
Grassed Waterway							[8]
Grassed Waterway							[8]
Grassed Waterway							[8]
Mean		0.189					
Median		0.001					



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Filter Strips							
Filter Strip							[20]
Vegetative filter strip (general)							[10]
Vegetative filter strip							
(bromegass and crested							
wheatgrass)							[10]
Vegetative Filter Strip - Ky-31							
Fescue		0					[11]
Vegetative Filter Strips		0.77					[12]
Vegetative Filter Strips		0.57					[12]
Vegetative Filter Strips		0.61					[12]
Vegetative Filter Strips		0.67					[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[13]
Vegetative Filter Strips		0.84					[14]
Vegetative Filter Strips							[14]
Vegetative Filter Strips							[15]
Vegetative Filter Strips							[15]
Vegetative Filter Strips							[15]
Vegetative Filter Strips							[15]
Filter Strip		0.7					[25]
Mean		0.594					
Median		0.670					



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Buffer							
Riparian Forest Buffer							[20]
Contour Strip/Grass Buffer		0.21					[9]
Contour Strip/Grass Buffer							[9]
Contour Strip/Grass Buffer							[9]
Contour Strip/Grass Buffer							[9]
Buffer		0.91	0.2	0.85	0.97		[16]
Buffer		0.95					[17]
Buffer		0.9					[19]
Grass Buffers							[21]
Riparian Grass Buffer		0.61					[22]
Mixed Vegetation Buffers							[21]
Conservation buffers		0.8					[23]
Buffers		0.35					[29]
Grass Buffer		0.265				CBAY	[31]
Forested Buffer		0.38				CBAY	[31]
Riparian combined grass and							
woody buffer		0.92					[22]
Mean		0.630	0.505				
Median		0.705					

ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Controlled Drainage							
Controlled Drainage		0.33	0.32	0.23	0.43		[16]
Controlled Drainage		0.385					[16]
Controlled Drainage		0.45					[24]
Controlled Drainage		0.43				SWAT	[28]
Two stage ditch		0.12				SWAT	[28]
Mean		0.343	0.388				
Median		0.385					



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Conservation Tillage							
Conservation Tillage							[16]
Conservation Tillage							[17]
Conservation Tillage							[17]
Conservation Tillage							[19]
Conservation Tillage							[19]
Conservation tillage (30%							
residue)		0.15					[24]
No till		0.25					[29]
Reduced Tillage Systems		0.5					[30]
Reduced Tillage Systems		0.55			_		[25]
Mean		0.363	0.200		_		
Median		0.375					

ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Land Retirement							
Land conversion: Cropland to							
Forest		0.95				PREDICT	[30]
Land conversion: Cropland to Wetland		0.96				PREDICT	[30]
Land Retirement; cropland to grass or trees		0.85					[16]
Land Retirement; cropland to grass or trees		0.83					[17]
Mean		0.898					
Median		0.900					



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Cover Crops							
Cover Crops		0.31	0.29	0.22	0.40		[16]
Cover Crops (Rye)		0.28					[16]
Cover Crops (Oats)		0.31					[16]
Cover Crops		0.51					[17]
Cover Crops		0.1					[17]
crop rotation		0.25					[29]
cover crops		0.25					[29]
Cropland Protection (crop							
rotation, cover crops)		0.25					[30]
Cover Crops (early)		0.34					[31]
Cover Crops (standard)		0.18					[31]
Cover Crops		0.3					[11]
Cover Crops							[11]
Mean		0.280	0.295			_	
Median		0.280					

ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Land Retirement							
Land conversion: Cropland to							
Forest		0.95				PREDICT	[30]
Land conversion: Cropland to							
Wetland		0.96				PREDICT	[30]
Land Retirement; cropland to							
grass or trees		0.85					[16]
Land Retirement; cropland to							
grass or trees		0.83					[17]
Mean		0.898		_			
Median		0.900					



ВМР	Pre-BMP Efficiency Measurement	Total N Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Nutrient Management							
Nutrient Management		0.261					[26]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management		0.148					[19]
Nutrient Management		0.860					[19]
Nutrient Management							[20]
Apply P at agronomic rates							[16]
Limit P application (soil test P)							[16]
Placement: Banded		0.25					[29]
Nutrient Management		0.7				PREDICT	[30]
Nutrient Management		0.15					[25]
Mean		0.395					
Median		0.256					
Nitrogen Management							
Nitrogen Management > Timing							
and rate reduction		0.26					[17]
Nitrogen Management > Timing		0.06					[16]
Nitrogen Management > Timing		0.175					[19]
Nitrogen Management >							
Sidedress		0.05					[16]
Nitrogen Management > Split							
application		0.175					[19]
Mean		0.144					
Median		0.175					



### **BMP Efficiency Measurements for Total Phosphorus**

ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Terrace and Diversion							
Terrace (Flow Diversion							
Terrace)						SWAT Model	[1]
Terrace (Flow Diversion							
Terrace)						SWAT Model	[1]
Terrace		0.205				SWAT Model	[2]
Terrace		0.280				SWAT Model	[2]
Terrace		0.520				SWAT Model	[2]
Terrace		0.342				APEX Model	[3]
Terrace						SWAT Model	[3]
Terrace						SWAT Model	[3]
Terrace		0.438				SWAT Model	[3]
Terrace		0.143				SWAT Model	[5]
Terrace		0.321				SWAT Model	[5]
Terrace		0.378				SWAT Model	[5]
Terrace		0.060				SWAT Model	[5]
Terrace		0.088				SWAT Model	[5]
Terrace		0.130				SWAT Model	[5]
Terraces with Tile Outlets		0.3					[29]
Terraces with Grassed							
Waterways		0.3					[29]
•						PREDICT	
Terraces and Diversions		0.42				Model	[30]
Terrace		0.7					[25]
Diversion		0.3	0.5				[25]
Mean		0.308					
Median		0.300					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Grassed Waterway							
Grassed Waterway		-1.100					[3]
Grassed Waterway							[3]
Grassed Waterway							[3]
Grassed Waterway		0.242					[3]
Grassed Waterway		0.160					[4]
Grassed Waterway							[4]
Grassed Waterway		0.234					[5]
Grassed Waterway		0.521					[5]
Grassed Waterway		0.448					[5]
Grassed Waterway		0.060					[5]
Grassed Waterway		0.088					[5]
Grassed Waterway		0.130					[5]
Grassed Waterway							[7]
Grassed Waterway							[7]
Grassed Waterway		0.520					[6]
Grassed Waterway	0.080						[8]
Grassed Waterway	14.000						[8]
Grassed Waterway	224.000	0.188					[8]
Mean		0.136					
Median		0.188					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large- Sample 90% Confidence Interval (assume n=30)	Model	Source
Filter Strips							
Filter Strip		0.56					[20]
Vegetative filter strip (general)							[10]
Vegetative filter strip (bromegass							
and crested wheatgrass)							[10]
Vegetative Filter Strip - Ky-31							
Fescue		0.27					[11]
Vegetative Filter Strips		0.8					[12]
Vegetative Filter Strips		0.57					[12]
Vegetative Filter Strips		0.63					[12]
Vegetative Filter Strips		0.52					[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[13]
Vegetative Filter Strips		0.83					[14]
Vegetative Filter Strips							[14]
Vegetative Filter Strips							[15]
Vegetative Filter Strips		0.4					[15]
Vegetative Filter Strips		0.91					[15]
Vegetative Filter Strips							[15]
Filter Strip		0.75					[25]
Mean		0.624					
Median		0.600					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Buffer							
Riparian Forest Buffer		0.43	0.36	0.32	0.54		[20]
Contour Strip/Grass Buffer		0.08					[9]
Contour Strip/Grass Buffer							[9]
Contour Strip/Grass Buffer							[9]
Contour Strip/Grass Buffer							[9]
Buffer		0.58	0.32	0.48	0.68		[16]
Buffer		0.58					[17]
Buffer		0.5					[19]
Grass Buffers							[21]
Riparian Grass Buffer		0.72					[22]
Mixed Vegetation Buffers							[21]
Conservation buffers		0.78					[23]
Buffers		0.5					[29]
Grass Buffer		0.4				CBAY	[31]
Forested Buffer		0.4				CBAY	[31]
Riparian combined grass and							
woody buffer		0.93					[22]
Mean		0.536					
Median		0.500					

ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Controlled Drainage							
Controlled Drainage							[16]
Controlled Drainage							[16]
Controlled Drainage		0.35					[24]
Controlled Drainage		0.61				SWAT	[28]
Two stage ditch						SWAT	[28]
Mean		0.480					
Median		0.480					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Conservation Tillage							
Conservation Tillage		0.62					[16]
Conservation Tillage							
(Conservation Till)		0.33	0.49	0.18	0.48		[17]
Conservation Tillage		0.9	0.17	0.85	0.95		[17]
Conservation Tillage		0.63					[19]
Conservation Tillage		0.5					[19]
Conservation tillage (30%							
residue)		0.35					[24]
No till		0.4					[29]
Reduced Tillage Systems		0.38					[30]
Reduced Tillage Systems		0.45					[25]
Mean		0.507					
Median		0.450					

ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Land Retirement							
Land conversion: Cropland to Forest		0.94				PREDICT	[30]
Land conversion: Cropland to Wetland		0.98				PREDICT	[30]
Land Retirement; cropland to grass or trees		0.75					[16]
Land Retirement; cropland to grass or trees		0.56					[17]
Mean		0.808					
Median		0.845					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Cover Crops							
Cover Crops		0.29					[16]
Cover Crops (Rye)							[16]
Cover Crops (Oats)							[16]
Cover Crops		0.29					[17]
Cover Crops							[17]
Crop Rotation		0.25					[29]
Cover Crops		0.5					[29]
Cropland Protection (crop							
rotation, cover crops)		0.36					[30]
Cover Crops (early)		0.15					[31]
Cover Crops (standard)		0.07					[31]
Cover Crops		0.3					[11]
Cover Crops		0.5					[11]
Mean		0.301					-
Median		0.290					

ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Land Retirement							
Land conversion: Cropland to							
Forest		0.94				PREDICT	[30]
Land conversion: Cropland to Wetland		0.98				PREDICT	[30]
Land Retirement; cropland to grass or trees		0.75				TREBICT	[16]
Land Retirement; cropland to grass or trees		0.56					[17]
Mean		0.808					
Median		0.845					



ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Nutrient Management							
Nutrient Management		0.28					[26]
Nutrient Management		0.75					[27]
Nutrient Management		0.36					[27]
Nutrient Management		0.5					[27]
Nutrient Management		0.43					[27]
Nutrient Management							[19]
Nutrient Management							[19]
Nutrient Management		0.47					[20]
Apply P at agronomic rates		0.6	0.7	0.39	0.81		[16]
Limit P application (soil test P)		0.17	0.4	0.05	0.29		[16]
Placement: Banded		0.2					[29]
Nutrient Management		0.28				PREDICT	[30]
Nutrient Management		0.35					[25]
Mean		0.399					
Median		0.360					
ВМР	Pre-BMP Efficiency Measurement	Total P Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Nitrogen Management							
Nitrogen Management > Timing and rate reduction							[17]
Nitrogen Management > Timing							[16]
Nitrogen Management > Timing							[19]
Nitrogen Management > Sidedress							[16]
Nitrogen Management > Split application							[19]
Mean		None					
Median		None					



#### **BMP Efficiency Measurements for Sediment**

ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Terrace and Diversion							
Terrace (Flow Diversion Terrace)		0.670				SWAT Model	[1]
Terrace (Flow Diversion Terrace)						SWAT Model	[1]
Terrace		0.246				SWAT Model	[2]
Terrace		0.172				SWAT Model	[2]
Terrace		0.760				SWAT Model	[2]
Terrace		0.918				APEX Model	[3]
Terrace		0.639				SWAT Model	[3]
Terrace						SWAT Model	[3]
Terrace						SWAT Model	[3]
Terrace		-0.003				SWAT Model	[5]
Terrace		0.029				SWAT Model	[5]
Terrace		0.048				SWAT Model	[5]
Terrace		0.280				SWAT Model	[5]
Terrace		-0.037				SWAT Model	[5]
Terrace		0.560				SWAT Model	[5]
Terraces with Tile Outlets		0.3					[29]
Terraces with Grassed Waterways		0.3					[29]
Terraces and Diversions		0.71				PREDICT Model	[30]
Terrace		0.85					[25]
Diversion		0.35	0.6				[25]
Mean		0.400					
Median		0.300					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Grassed Waterway							
Grassed Waterway		0.598					[3]
Grassed Waterway		0.459					[3]
Grassed Waterway							[3]
Grassed Waterway							[3]
Grassed Waterway	0.690	0.290					[4]
Grassed Waterway							[4]
Grassed Waterway		-0.002					[5]
Grassed Waterway		0.173					[5]
Grassed Waterway		0.045					[5]
Grassed Waterway		0.280					[5]
Grassed Waterway		-0.037					[5]
Grassed Waterway		0.560					[5]
Grassed Waterway		0.970					[7]
Grassed Waterway		0.770					[7]
Grassed Waterway		0.930					[6]
Grassed Waterway							[8]
Grassed Waterway							[8]
Grassed Waterway							[8]
Mean		0.420					
Median		0.374					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Filter Strips							
Filter Strip							[20]
Vegetative filter strip (general)		0.68					[10]
Vegetative filter strip (bromegass and							
crested wheatgrass)		0.85					[10]
Vegetative Filter Strip - Ky-31 Fescue		0.66					[11]
Vegetative Filter Strips		0.95					[12]
Vegetative Filter Strips		0.88					[12]
Vegetative Filter Strips		0.87					[12]
Vegetative Filter Strips		0.76					[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[12]
Vegetative Filter Strips							[13]
Vegetative Filter Strips							[14]
Vegetative Filter Strips		0.5					[14]
Vegetative Filter Strips		0.98					[15]
Vegetative Filter Strips							[15]
Vegetative Filter Strips							[15]
Vegetative Filter Strips		0.35					[15]
Filter Strip		0.65					[25]
Mean		0.739					
Median		0.760					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Buffer							
Riparian Forest Buffer							[20]
Contour Strip/Grass Buffer		0.19					[9]
Contour Strip/Grass Buffer							[9]
Contour Strip/Grass Buffer		0.77					[9]
Contour Strip/Grass Buffer		0.83					[9]
Buffer							[16]
Buffer							[17]
Buffer							[19]
Grass Buffers		0.65					[21]
Riparian Grass Buffer							[22]
Mixed Vegetation Buffers		0.83					[21]
Conservation buffers		0.95					[23]
Buffers		0.5					[29]
Grass Buffer		0.53				CBAY	[31]
Forested Buffer		0.53				CBAY	[31]
Riparian combined grass and woody buffer							[22]
Mean		0.642					
Median		0.650					

ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Controlled Drainage							
Controlled Drainage							[16]
Controlled Drainage							[16]
Controlled Drainage							[24]
Controlled Drainage						SWAT	[28]
Two stage ditch						SWAT	[28]
Mean		None					
Median		None					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Conservation Tillage							
Conservation Tillage							[16]
Conservation Tillage (Conservation Till)							[17]
Conservation Tillage							[17]
Conservation Tillage							[19]
Conservation Tillage		0.5					[19]
Conservation tillage (30% residue)		0.3					[24]
No till		0.75					[29]
Reduced Tillage Systems		0.64					[30]
Reduced Tillage Systems		0.75					[25]
Mean		0.588					·
Median		0.640					·

ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large-Sample 90% Confidence Interval (assume n=30)	Upper Large-Sample 90% Confidence Interval (assume n=30)	Model	Source
Land Retirement							
Land conversion: Cropland to Forest		0.94				PREDICT	[30]
Land conversion: Cropland to Wetland		0.98				PREDICT	[30]
Land Retirement; cropland to grass or							
trees		0.75					[16]
Land Retirement; cropland to grass or							
trees		0.56					[17]
Mean		0.808					
Median		0.845					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large- Sample 90% Confidence Interval (assume n=30)	Model	Source
Cover Crops							
Cover Crops							[16]
Cover Crops (Rye)							[16]
Cover Crops (Oats)							[16]
Cover Crops							[17]
Cover Crops							[17]
crop rotation		0.25					[29]
cover crops		0.4					[29]
Cropland Protection (crop rotation, cover crops)		0.35					[30]
Cover Crops (early)		0.2					[31]
Cover Crops (standard)		0.1					[31]
Cover Crops							[11]
Cover Crops							[11]
Mean		0.950	0.260				
Median		0.950	0.250				

ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large- Sample 90% Confidence Interval (assume n=30)	Model	Source
Nutrient Management							
Nutrient Management							[26]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management							[27]
Nutrient Management							[19]
Nutrient Management							[19]
Nutrient Management							[20]
Apply P at agronomic rates							[16]
Limit P application (soil test P)							[16]
Placement: Banded		0					[29]
Nutrient Management		0				PREDICT	[30]
Nutrient Management		0					[25]
Mean		None					
Median		None					



ВМР	Pre-BMP Efficiency Measurement	Sediment Removal Efficiency	Standard Deviation	Lower Large- Sample 90% Confidence Interval (assume n=30)	Upper Large- Sample 90% Confidence Interval (assume n=30)	Model	Source
Nitrogen Management							
Nitrogen Management > Timing and rate							
reduction							[17]
Nitrogen Management > Timing							[16]
Nitrogen Management > Timing							[19]
Nitrogen Management > Sidedress							[16]
Nitrogen Management > Split application							[18]
Mean		None					
Median		None					



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#### Appendix D

This information was retrieved from Duke Energy's CW Shoreline Management Plan with Appendices (10-3-16).

#### **Shoreline Classifications and Lake Use Restrictions**

- 1. **Environmental** Vegetated areas or cove heads with stream confluence. These types of shorelines exist where either of the following two criteria are met:
  - Stable, wetland-type habitat and emergent vegetation (any portion of which is at least 5 horizontal ft wide) composes > 50% of the area between the minimum lakeward distance and the maximum lakeward distance of the vegetation for a linear distance of at least 100 ft (Figure 1). (Note: Common types of emergent vegetation in environmental areas may include, but are not limited to: black willow (Salix nigra), alder (Alnus serrulata), buttonbush (Cephalanthus occidentalis), cattail (Typha latifolia), and rushes (Juncus effusus)).
  - Intermittent or permanent streams enter the upper ends (i.e., heads) of shallow coves (with or lacking vegetation). For cove heads with a stream but lacking emergent vegetation, the environmental classification extends to the edge of the established sedimentation delta plus 50 ft or, in the absence of an established delta, 50 ft on each side of the intersection of the stream centerline and the full pond contour. While many wildlife species use environmental areas, the primary importance of these areas is to provide spawning, rearing, and nursery habitat for fish, and rearing, nursery and adult habitat for amphibians, reptiles and birds.

**LAKE USE RESTRICTIONS** – No removal of vegetation, construction, excavation or shoreline stabilization inside the Project Boundaries.

- 2. **Bottomland Hardwood Area** Bottomland hardwood areas typically have diverse, well-developed tree canopies consisting of some combination of hydrophytic tree species such as red maple, blackgum, sweetgum, willow oak, laurel oak, water oak, green ash, sycamore, river birch and black willow. The soils are typically sandy, organically rich, alluvial soils that exhibit hydric soil conditions. These areas have gentle slopes and often are associated with a drainage area or stream confluence. These areas must meet all three of the following criteria:
  - A gradual slope of 0-3% that equates to no more than a 1 foot rise in elevation within 35 feet measured horizontally and landward from the classified shoreline.
  - Extend along the classified shoreline a minimum distance of 250 feet either alone or in combination with the Environmental classification.
  - Contain a tree canopy of hydrophytic species such as red maple, blackgum, sweetgum, willow oak, laurel oak, water oak, green ash, sycamore, river birch and black willow.

**LAKE USE RESTRICTIONS – No removal of vegetation, construction, excavation or shoreline stabilization inside the Project Boundaries**. (Notes: The Bottomland Hardwood Area lake use restrictions are the same as those for the Environmental classification. Reclassification of these areas can only be accomplished with the written concurrence of the state and federal wildlife resource management agencies and Lake Services based exclusively upon errors in mapping. Based upon the Comprehensive Relicensing Agreement negotiated as part of the relicensing of the Catawba-Wateree Project (No. 2232), reclassification of Bottomland Hardwood Areas based on mapping errors does not require notification or approval by the Federal Energy Regulatory Commission.)

3. **Natural** – These areas have characteristics (i.e., shallow water, isolated berms, significant cultural resources or significant terrestrial habitat areas) that make most types of development inside the Project Boundaries undesirable from an overall lake management standpoint. Natural areas exist where any of the following four criteria are met:



- Large areas (e.g., > 500 ft of continuous shoreline length) where water depth would be < 3 ft at a distance of 150 ft or more from the natural eroded shoreline with the reservoir level 3 ft below full pond, since extensive dredging would be needed to support private boating access.
- Important terrestrial habitat areas that warrant protection from activities that could limit the area's ability to provide significant habitat important for wildlife.
- Significant cultural resource areas (i.e., areas within the Project Boundaries known to include culturally significant artifacts) that warrant protection from activities that could alter the archaeological integrity of the site.
- Narrow isolated berms within the Project Boundaries. These isolated berms characteristically are higher in
  elevation than the adjoining areas landward of the reservoir and lack the vegetation along the shoreline
  necessary to be classified as Environmental. Typically the landward areas adjoining the isolated berm
  include significant low-lying areas characteristic of floodplains, Environmental areas or wetlands.

**LAKE USE RESTRICTIONS – No removal of vegetation, construction or excavation inside the Project Boundaries.** (Notes: Shoreline stabilization is allowed within the Project Boundaries provided the stabilization adheres to the Shoreline Stabilization Technique Selection Process. Isolated berms typically have the same Lake Use Restrictions as other areas classified as Natural. In instances where these berms are not isolated by low-lying areas characteristic of floodplains, Environmental areas or wetlands within the Project Boundaries, the Lake Services Representative may allow Residential Facilities to extend into the reservoir provided there is no other practicable alternative.)

- 4. **Impact Minimization Zones** (IMZ) (*Note 2*) Project lands and waters that have specifically-identified importance on a given lake from a scenic, environmental, or cultural standpoint but protection of those important values does not necessarily preclude private, commercial, business or industrial access to the lake. Applicants must first try to avoid IMZs, but if complete avoidance is not a *practicable alternative*, then the following specific lake use restrictions will apply:
  - For areas identified in the 1998 Shallow Water Fish Habitat Survey (SWFHS) as having stable sand, gravel or cobble substrates on Lake James:

LAKE USE RESTRICTIONS – No boat ramps except those required for Public Recreation, no excavation and no Commercial Marina or Residential Marina Facilities. Construction within these areas may have specific mitigation requirements imposed by the federal, state or local resource agencies. Shoreline stabilization within the Project Boundaries must adhere to the Shoreline Stabilization Technique Selection Process.

 For areas identified in the SWFHS as having stable sand, gravel or cobble substrates on all other Catawba-Wateree lakes:

LAKE USE RESTRICTIONS – No boat ramps except those required for Public Recreation and no excavation. Construction within these areas may have specific mitigation requirements imposed by the federal, state or local resource agencies. Shoreline stabilization within the Project Boundaries must adhere to the Shoreline Stabilization Technique Selection Process.

5. **Commercial Marina** (*Note 3*) – Project lands and waters where boats can be launched, retrieved or moored, **and** where provisions for food services, convenience retailing such as petroleum sales, wet and dry storage of watercraft and other activities customarily associated with marinas, private recreation areas and yacht clubs take place.

LAKE USE RESTRICTIONS – Per the SMG- New Commercial Marina facilities will not be authorized in areas within a half-mile radius of an existing Commercial Marina facility nor areas where more than fifty



**percent of the shoreline within a half-mile radius is residentially developed.** (Note: This does not preclude expansion of existing facilities identified as True Public Marinas (TPM). TPMs provide public access similar to Public Recreation Facilities and therefore, expansion of existing TPMs may be exempted from adhering to certain requirements limiting expansion of existing commercial facilities.)

- 6. **Residential Marina** (*Note 3*) Project lands and waters where boats can be launched, retrieved or moored for the purpose of providing private access to the lake for specific residential properties including:
  - Multi-family dwellings (e.g., apartments, townhouses, condominiums).
  - Long-term campgrounds (typically those that lease campsites for more than 14 consecutive days).
  - Subdivision access lots that provide boating access for owners of any residential lots that don't have project frontage.

#### LAKE USE RESTRICTIONS - No Commercial Marina Facilities.

7. **Residential** (*Note 3*) – Project lands and waters occupied by private facilities for project-front landowners, none of which can have multi-family dwellings. This classification may include, among other things, piers, boathouses, boatshelters, boat docks, floats, and boat ramps.

#### LAKE USE RESTRICTIONS - No Commercial Marina or new Residential Marina Facilities.

8. **Business/Industrial** – Project lands and waters that are typically used by private businesses but which have little to no effect on boating. Examples include but are not limited to, business staging areas, shoreline associated with manufacturing operations, golf courses, law enforcement facilities, sand mining operations, etc.

## LAKE USE RESTRICTIONS – No facilities that have an appreciable effect on boating (e.g., No marina facilities).

9. **Project Operations** (*Note* 2) – Project lands and waters associated with hydro power production including but not limited to- dams, dikes, powerhouses and other hydro plant properties. **Downstream Clear Zones** (DCZ) are also part of this classification and they include project lands and waters immediately downstream of all operating hydro stations that are potentially subject to rapid and significant variations in flow rates based on plant operations. As a minimum, DCZs will extend 1000 ft downstream from the dam to the downstream edge of the hydro plant property or to a bridge crossing that is within 2500 ft of the dam, whichever provides for a greater distance. DCZs may extend beyond this minimum downstream length where deemed necessary by Duke Energy. DCZs are identified on the SMP maps by cross-hatches. (Note that DCZs are not established in downstream areas that are outside the Project Boundaries (e.g., regulated river reaches below the hydro plant property boundary at Lake James, Lake Hickory, Lake Wylie and Lake Wateree) or areas below retired hydro stations (i.e., Gunpowder II, Rink Dam, Icard Dam).

LAKE USE RESTRICTIONS – No new or expanded Residential Marina, Commercial Marina or Residential Facilities. (Note: Any existing facilities previously approved by DE-LS within a DCZ will be considered for potential rebuild applications, provided that no other practicable alternative exists.)

10. **Public Recreation** (*Note 3*) – Project lands and waters occupied by facilities supporting various public recreational amenities. Examples of the public recreation classification include Duke-owned Project Recreation Sites, and state, district, county and city parks that adjoin the Project Boundaries.

#### LAKE USE RESTRICTIONS - No non-project uses, except Public Infrastructure.

(Note: Any lake use that is necessary to maintain or enhance the public recreation facilities is considered a project use, including public recreation facilities that may be provided by commercial vendors at Duke-owned Project Recreation Sites or state, district, county or city parks.)

11. **Public Infrastructure** (*Note* 2) – Project lands and waters occupied by public, nonrecreational facilities supporting regional needs. This type of facility may include but is not limited to- overhead electric transmission line corridors; submarine utility line corridors (water, sewer, gasoline, natural gas, oil, phone, electric, etc.);



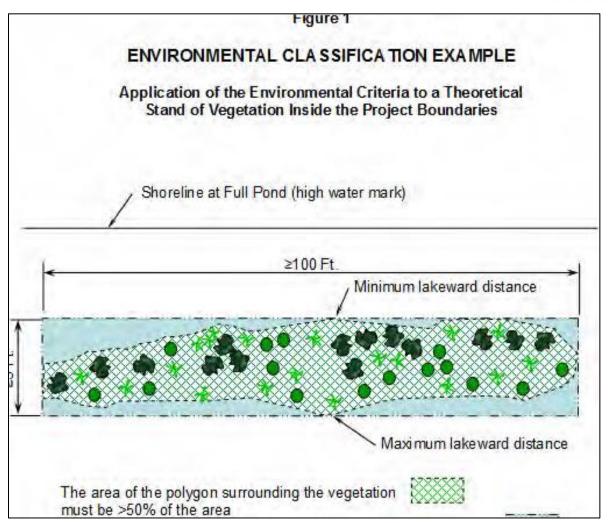
regional power generation facilities; rights-of-way for public bridges, causeways, roads, water intakes, effluent discharges, etc. Public infrastructure applicants/permittees normally have the power of eminent domain for their specific requested lake use.

LAKE USE RESTRICTIONS – No new or expanded Residential Marina, Commercial Marina or Residential Facilities. (Note: Any existing facilities previously approved by DE-LS within the Public Infrastructure right-of-way will be considered for potential rebuild applications, provided that no other practicable alternative exists.)

#### **Notes**

- 1. Public-need projects where the applicant has the power of eminent domain can be exempted from the listed lake use restrictions provided there is no other acceptable alternative (similar to practicable alternative, except it allows more consideration for economics of alternatives and desires of the applicant). Also note that the shoreline classifications and associated lake use restrictions are considered to generally apply to the Project Boundaries line and the area extending lakeward and perpendicular to the Project Boundaries line including the shoreline for a minimum distance of one-third the cove width. Where restrictive classifications (e.g., Environmental, Natural, Impact Minimization Zones, etc.) wrap around the heads of coves, the lake use restrictions will also apply to the entire cove width in the wrapped area.
- 2. At times, lake use permit applicants will be required to pursue practicable alternatives to their desired application to avoid impacting important hydro project values. An alternative is not considered practicable if choosing it over the desired option would result in any of the following:
  - a. Violation of any applicable permitting criteria or lake use restriction.
  - b. Requiring the applicant to dredge the lake bed in order to use the requested facility, whereas dredging would not be required if some allowance was made for crossing into the restricted area.
  - Modification of the desired facility to the point that the resulting structure would be of very limited usefulness.
  - d. Elimination of the desired type of lake access.
- 3. Final SMP maps include an Existing Use and Future Use classification for the Commercial Marina, Residential Marina, Residential and Public Recreation classifications. The appropriate Future Use classification is applied to all undeveloped shoreline not included in one of the Existing Use classifications.
- 4. Cultural resource data is included in a data layer that is not visible in the SMP maps provided to entities outside the parties to the Cultural Resources Programmatic Agreement (PA) developed as part of the 2001 SMP Update. This is necessary because of the sensitive nature of the data and the need to protect the integrity of these sites as required by the PA between the Federal Energy Regulatory Commission, the Advisory Council on Historic Preservation (ACHP) and the North Carolina and South Carolina State Historic Preservation Offices (SHPOs). Lake use permitting activities not specifically exempted in the PA that may potentially impact these sites require consultation with the appropriate SHPO. Lake use permitting activities may have additional mitigation requirements or the activity may not be allowed.







#### Appendix E

This information was retrieved from Duke Energy's CW Shoreline Management Plan with Appendices (10-3-16).

#### **Shoreline Preservation Incentive Program**

1. Description of Program – In the interest of preserving undisturbed shoreline to protect wildlife habitat, an incentive program is offered for development projects. The program allows more boat slips than would be allowed under criteria in previous versions of the SMG so long as the applicant preserves and leaves undisturbed at least 20 percent of the shoreline available for boat dock construction. In exchange for preserving this shoreline, the applicant may be allowed the multiple of boat slips/moorings/docking locations for every 100 ft of shoreline preserved as indicated in the table below. These multiples may be increased as also indicated in the table if the preserved shoreline is accompanied with a buffer contiguous with and directly landward of the preserved shoreline. These additional boat slips/moorings/docking locations would be constructed in a multislip facility that would serve lots or dwelling units in the subdivision whether or not they front on the water or the Project Boundaries. The total number of slips/moorings/docking locations within the incentive program cannot exceed the total number of off-water lots or dwelling units in the development and must be contiguous with the development that includes the preserved shoreline. The number of slips/moorings/docking locations will be rounded down as part of the incentive program.

Eligible Shoreline	Preserved (percent)	<b>Boatslip Multiple per 100 feet of Shoreline Preserved</b>					
At Least	But Less Than	With No Buffer	With 50 Foot Buffer	With 150 Foot Buffer			
20	25	1.5	2.5	3.5			
25	50	2.5	3.5	4.5			
50	-	4.5	5.0	6.0			

- 2. Eligible Shoreline Any shoreline not eligible for lake use permitting activities, such as those classified as Environmental, Natural, Natural Isolated Berm, Bottomland Hardwood Areas, Public Infrastructure, etc., would not be counted in the calculation of shoreline footage eligible for the incentive. The incentive preserved areas are in addition to the areas that will already be protected by one of these classifications.
- 3. Upland Buffer Incentive An additional incentive (see table above) may apply if the applicant also preserves in a buffer (between 50 ft and 200 ft) additional land upland and continuous to the preserved shoreline. No additional incentive will be provided for buffers less that (*sic*) 50 ft upland of the Project Boundaries. The incentive multiples for buffer widths between 50 ft and 200 ft will be interpolated or extrapolated, as appropriate, from the incentive numbers in the above table.
- 4. Upland Buffer Associated with Protected Shoreline Areas As an additional incentive to conserve upland habitat, an applicant may agree to preserve lands upland and contiguous with shoreline areas that are already protected through the SMP classifications of Environmental, Natural, Natural Isolated Berm, or Bottomland Hardwood Areas. For every two acres of the applicant's property outside the Project Boundaries preserved and left undisturbed, the applicant becomes eligible for one additional boat slip/docking/mooring location.
- 5. Alternative Upland Buffer Associated with Protected Shoreline Areas In lieu of Criteria 4, the applicant may request a maximum of one additional boat slip/docking/mooring location for preserving a buffer of 100 ft in width upland of the Project Boundaries that is contiguous with a protected habitat classification (i.e., Environmental, Natural, Natural Isolated Berm, or Bottomland Hardwood Areas). All preserved land above the Project Boundaries must encompass the entire length along the shoreline of the protected habitat shoreline. The minimum protected shoreline length to be eligible for this additional access is 100 ft. The SMP indicates the lateral extent of any single protected classification(s) along the shoreline that is/are eligible for an additional slip(s)/mooring(s)/docking location(s).



- 6. Identification of Upland Buffers in Application To be eligible for the incentive program, the preserved land buffers associated with preserved shoreline or acreage or buffers preserved upland of an Environmental, Natural, Natural Isolated Berm, or Bottomland Hardwood Areas classifications must be specifically identified in the application and must:
  - a. Include adequate protections in the form of a permanent conservation easement or conservation-type agreement, identified in the protective covenants of the development and managed by the homeowner's/boat slip owner's association or other conservation entity approved by DE-LS;
  - b. Be identified by survey stamped by a Registered Land Surveyor, provided by the applicant and included in the application that is also recorded in the county where the property is located;
  - c. Be specifically addressed in the application along with a verifiable calculation of the preserved shoreline and the associated slip(s)/mooring(s)/docking location(s);
  - d. Be provided under the incentive program along with a master plan of the development including all project-front lots and the location of the multi-slip marina facility;
  - e. Be in addition to any shoreline within a protected classification as identified in the SMP; and
  - f. Be in contiguous segments of not less than 800 ft for developments with more than 800 total ft of preserved shoreline.
- 7. Shoreline Stabilization There may be instances where the shoreline to be preserved is subject to significant erosion that could be detrimental to the purpose of preserving riparian habitat. In these cases, DE-LS, in consultation with the appropriate wildlife resource agency, will determine whether the habitat values of this shoreline would benefit from habitat friendly stabilization, such as bioengineering or enhanced rip-rap, which then may be permitted on a case by case basis.
- 8. Since the intent is to preserve important shoreline habitat areas, DE-LS will make the final eligibility determinations on a case-by-case basis. (Note: Shoreline areas that are not developable for multi-slip marina uses [e.g., their SMP classification, if applicable, does not allow Commercial Marina Facility or Residential Marina Facility use] are not eligible to accommodate the Residential Marina Facility although their shoreline will be used in the calculation for preservation and additional off-water access. Also note that the above limitations describe the maximum number of slips/moorings/docking locations that may be requested. Site-specific conditions may further restrict, or even eliminate the number of boat slips/docking/mooring locations that can be considered for approval.)



#### Appendix F

This information was retrieved from Duke Energy's CW Shoreline Management Plan with Appendices (10-3-16).

#### **SMP - Consequences for Violations**

- 1. **Penalties** DE-LS representatives will issue Stop-Work Directives for any violations that are detected within the Project Boundaries of a reservoir. Consequences for violations will include one or more of the following:
  - Unwanted delays;
  - Loss of security deposits;
  - Suspension or cancellation of approved applications;
  - Increases in fees:
  - Modification or removal of non-complying structures and restoration of disturbed
  - areas at the owner's expense; and
  - Loss of any consideration for future reservoir use applications.
- 2. **Violation Examples** Examples of specific violations and their applicable penalties include the following:
  - Unauthorized major cutting of the vegetated area (see Section 8) within the Project Boundaries (no existing pier/dock): Restoration with approved native vegetation. Loss of consideration for lake use permitting activities for up to five-years depending on severity and subject to successful plant restoration.
  - Unauthorized major cutting of the vegetated area (see Section 8) within the Project Boundaries (existing pier/dock): Removal of the pier/dock from Project property and restoration with approved native vegetation. Loss of consideration for lake use permitting activities for up to five-years depending on severity and subject to successful plant restoration.
  - Unauthorized minor cutting of trees within the vegetated area (see Section 8) within the Project Boundaries: Restoration as required in the Vegetation Management Requirements for approved tree removal. Refusal to remove an unapproved, dilapidated, or unsafe structure: Removal of the structure from the Project property by DE-LS. Loss of consideration for lake use permitting activities until cost of removal, which includes all removal costs including DE-LS or contractor expenses, landfill fees, and a set management fee of \$1,000, is paid.
  - Unauthorized structure built within the Project Boundaries: After-the-fact application may be accepted if structure conforms to the specific requirements. Fee will be twice the current permit fee to cover additional management costs. Non-complying structures will be subject to modification or removal and restoration of disturbed areas at the owner's expense.



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Watershed and Proposed BMPs	Number of Projects	Treatment for Bacteria	Treatment for Sediment	Treatment for Nutrients
Singleton Creek Watershed	110,000	200001100		1 (44421414)
Septic System				
Repair/Replacement	60	X		X
Grass Buffer (35 Feet) (for	2			
Cropland)	2		X	X
Site Prep/Hydro	3			
Mulching/Seeding/Fertilizer	3		X	
LID Filter/Buffer (Multi-	3	X	X	X
Family)	3	A	A	A
LID Filter/Buffer (Single	3	X	X	X
Family)				
Vegetated Filter Strip	3	X	X	X
(Transportation)				
Beaver Creek Watershed		Ī	T	T
Septic System	60	X		X
Repair/Replacement				
Cover Crop (High Till for TP	2			X
and Sediment)				
Grass Buffer (35 Feet) (for Cropland)	2		X	X
Forest Buffer (100 Feet) (for				
Pasture or Crop)	3		X	X
Site Prep/Hydro				
Mulching/Seeding/Fertilizer	3		X	
Streambank Fencing and	2			
Stabilization	3		X	X
Alternative Water Source	3		X	X
Grass Buffer (35 Feet) (for	2			
Pastureland)	3		X	X
LID Filter/Buffer (Multi-	3	v	X	X
Family)	3	X	Λ	Λ
LID Filter/Buffer (Single	3	X	X	X
Family)	3	A	A	A
Vegetated Filter Strip	3	X	X	X
(Transportation)				
Agriculture-Cropland Bundle	3	X	X	X
Agriculture-Livestock Bundle	3	X	X	X
Headwaters Lake Wateree -				
Catawba River Watershed				
Septic System Repair/Replacement	60	X		X
Site Prep/Hydro Mulching/Seeding/Fertilizer	3		X	
Streambank Fencing and Stabilization	3		X	X
Conservation Tillage (30-59% Residue)	3		X	X



Alternative Water Source	3		X	v
Grass Buffer (35 Feet) (for			Λ	X
Pastureland)	3		X	X
LID Filter/Buffer (Multi-				
Family)	3	X	X	X
LID Filter/Buffer (Single				
Family)	3	X	X	X
Vegetated Filter Strip	2			
(Transportation)	3	X	X	X
Lake Wateree-Catawba River				
Watershed				
Septic System	60			
Repair/Replacement	60	X		X
Cover Crop (High Till for TP	2		X	X
and Sediment)	2		Λ	Λ
Grass Buffer (35 Feet) (for	2		X	X
Cropland)	2		A	Α
Conservation Tillage (30-59%	3		X	X
Residue)	-			
Forest Buffer (100 Feet) (for	3		X	X
Pasture or Crop)				
Site Prep/Hydro Mulching/Seeding/Fertilizer	3		X	
Streambank Fencing and				
Stabilization	3		X	X
Alternative Water Source	3		X	X
Grass Buffer (35 Feet) (for			A	A
Pastureland)	3		X	X
LID Filter/Buffer (Multi-	2			
Family)	3	X	X	X
LID Filter/Buffer (Single	3			
Family)	3	X	X	X
Vegetated Filter Strip	3	X	X	X
(Transportation)	3	Λ	Λ	Λ
White Oak Creek Watershed				
Septic System	60	v		v
Repair/Replacement	UU	X		X
Site Prep/Hydro	3		X	
Mulching/Seeding/Fertilizer	,		^	
LID Filter/Buffer (Multi-	3	X	X	X
Family)		-*		
LID Filter/Buffer (Single	3	X	X	X
Family)				
Vegetated Filter Strip	3	X	X	X
(Transportation)	1			



### Appendix H

Individual BMP Reduction Efficiencies.

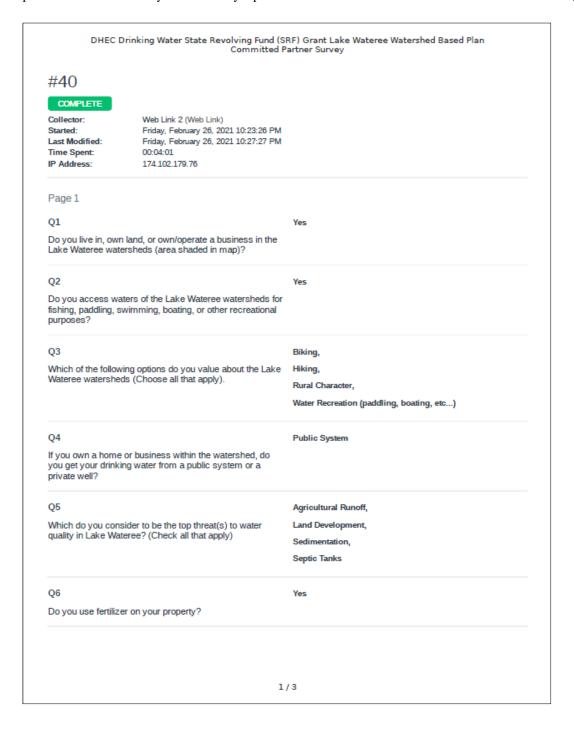
Land Cover	BMP & Efficiency	N	P	Sediment	E. coli
Cropland					
Cropland	Buffer - Forest (100ft wide)	0.478	0.465	0.586	ND
Cropland	Buffer - Grass (35ft wide)	0.338	0.435	0.533	ND
Cropland	Conservation Tillage (30-59% Residue)	0.15	0.356	0.403	ND
Cropland	Nutrient Management (Determined Rate)	0.154	0.45	ND	ND
Cropland	Cover Crop (High Till only for TP and Sediment)	0.196	0.07	0.1	ND
Pastureland					
Pastureland	Alternative Water Supply	0.133	0.115	0.187	ND
Pastureland	Grass Buffer (minimum 35 feet wide)	0.868	0.766	0.648	ND
Pastureland	Heavy Use Area Protection	0.183	0.193	0.333	ND
Pastureland	Livestock Exclusion Fencing	0.203	0.304	0.62	ND
Pastureland	Multiple Practices	0.246	0.205	0.221	ND
Pastureland	Streambank Stabilization and Fencing	0.75	0.75	0.75	ND
Pastureland	Use Exclusion (Fencing)	0.39	0.04	0.589	ND
Pastureland	Winter Feeding Facility	0.35	0.4	0.4	ND
Forest					
Forest	Site preparation/hydro mulch/seed/fertilizer	ND	ND	0.71	ND
Urban					
Urban	LID/Filter/Buffer Strip	0.3	0.3	0.6	ND
Urban	LID/Vegetated Swale	0.075	0.175	0.475	ND
Urban	Vegetated Filter Strips	0.4	0.4525	0.73	ND



#### Appendix I

#### **Supporting Materials**

The document below is a survey sent out to the Lake Wateree Watershed-Based Plan Planning Team and the general public within the project area. The results of this survey helped inform project development. The survey questions were adapted from a similar survey distributed by Upstate Forever and SCRWA for the Lake Greenwood WBP [46].





Q7	Yes
Is your home or business on a septic system?	
Q8	No
If you own more than 10 acres of forested land within the Lake Wateree watersheds (area shaded on map), do you actively manage your forested land? If yes, please briefly describe your methods and if government backed cost- share programs are utilized.	
Q9	Respondent skipped this question
If you own more than 10 acres of forested land within the Lake Wateree watersheds (area shaded on map), and you do not actively manage your forested land would you be willing to participate in government backed cost-share programs to help fund practices to better manage your forested land? Please explain.	
Q10	
Please rate.	
How important is water quality to you for local streams, rivers, and lakes?	Very Important
How important is recreational use of local streams, rivers, and lakes?	Very Important
How important to you are healthy fisheries and aquatic conditions for local waters?	Very Important
How important to you is land conservation for water quality and stream health?	Very Important
Q11	Yes
Do you think additional measures are needed to protect local streams, rivers, wetlands, and lakes as development in watersheds increases?	
Q12	Yes
Do you support riparian buffer (vegetated area) requirements at new development sites for protecting streams, rivers, lakes, and wetlands?	



# DHEC Drinking Water State Revolving Fund (SRF) Grant Lake Wateree Watershed Based Plan Committed Partner Survey Q13 Developers are required by SCDHEC under the Construction General Permit to buffer lakes and streams (30-45 ft) from development activities only during construction. Do you believe these buffers should remain permanent to protect water quality and habitat? Q14 Yes Do you support land conservation practices (conservation easements, parks, preserves) as a method to protect drinking water resources? Q15 Do you have any concerns with water quality in the Lake Wateree watersheds? Are there any problem areas we should be aware of? No Q16 No Would you like to receive information about future public meetings/workshops about watershed planning, protection, and restoration in the Lake Wateree watersheds? 3/3