Watershed Management Plan - James Island Creek

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Terracon Project No. EN207473

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ABBREVIATIONS AND ACRONYMS

Below is a list of commonly used abbreviations and acronyms of water quality management throughout the narrative of the James Island Creek Watershed Management Plan.

BMP – Best Management Practice

CDBG – Community Development Block Grant

CWA – Clean Water Act

CWK - Charleston Waterkeeper

HSGs – Hydrological Soil Groups

HUC – Hydrologic Unit Code

JIC – James Island Creek

MPN – Most Probable Number

MS4 – Municipal Separate Storm Sewer System

NCLD – National Landcover Database

NPDES – National Discharge Elimination System

SCDHEC – South Carolina Department of Health and Environmental Control.

SCDNR – South Carolina Department of Natural Resources

SCDOT – South Carolina Department of Transportation

SS – Site Specific

SSO – Sanitary Sewer Overflows

SWPPP – Stormwater Pollution Prevention Plan

TMDL – Total Maximum Daily Load

USEPA – United States Environmental Protection Agency

WW – Watershed-Wide

1.0 EXECUTIVE SUMMARY

The project area of this watershed management plan is the James Island Creek watershed which is an approximately 6.8 square miles (mi^2) portion of the Cooper River (portion of Hydrologic Unit Code (HUC) 03050201) and Stono River watershed (portion of HUC 03050202) (. James Island Creek is a tidal creek that is located within an urban area surrounded by tidal marsh within portions of Charleston County, Town of James Island, and City of Charleston, South Carolina. James Island Creek is listed as a South Carolina 303(d) impaired stream for the saltwater fecal bacteria indicator, *Enterococci*. Based on the total maximum daily load (TMDL) calculations in this report, the bacteria load reduction needed at water quality station JIC1 and JIC2 is 80% and 95%, respectively to meet *Enterococci* water quality standards. The improvement of James Island Creek's water quality will improve the quality of life and local economic activity for the communities that live around the creek.

Numerous point and non-point sources have the potential to cause fecal bacteria loading into James Island Creek watershed. Point sources including municipal wastewater discharge and Municipal Separate Stormwater Sewer Systems (MS4s) must meet *Enterococci* limits to remain in compliance with their permits. Illicit discharges are illegal discharges not composed entirely of stormwater into MS4s or other areas (typically illegal dumping into storm drains) that can lead to water quality impairment of *Enterococci*. Improperly maintained, poorly designed, and failing septic tanks can be a major contributor of bacterial contamination into the watershed specifically in two areas where they are clustered together and in close proximity to water bodies. Urban runoff from impervious surfaces can discharge pet waste and land-applied waste into water bodies. Boating vessels can contribute waste into water bodies if the marine sanitation device is not functioning properly.

An action plan as part of this watershed management plan was developed to achieve the watershed goals associated with the watershed management plan to attain the *Enterococci* water quality standards. As part of the action plan, a watershed planning committee is recommended to oversee the implementation of this suggested plan. The action plan consists of best management practice (BMP) recommendations that will require multiple funding sources to implement. The suggested BMPs include septic removal/maintenance, connection to municipal wastewater for homes currently using septic systems, vegetative buffers, pet waste stations, private property rain collection systems, and others. A public outreach program should be developed to assist in public acceptance and education during the implementation of this watershed plan. The public outreach and education committee should be established to oversee the public outreach program. The ultimate goal is to attain water quality standards in James Island watershed and maintain it.

2.0 INTRODUCTION

2.1 What is a Watershed?

A watershed is an area where all the water on the surface and subsurface drains to the same water bodies (rivers, streams, lakes, etc.) in a general area, see Figure 1. A watershed's size is driven by topography and water control structures. Watersheds can be a large system encompassing a large network of streams through multiple states such as the Santee River Basin or could be a smaller system such as a tidal creek draining into James Island Creek.

Figure 1: Illustration of a watershed (via SCDHEC)

James Island Creek is a relatively small watershed that has a land area of approximately 6.8 mi^2 (4,352-acres). The watershed encompasses parts of Town of James Island and City of Charleston within Charleston County, South Carolina. James Island Creek (also known as Ellis Creek by the Folly Road Bridge and Newtown Cut by the James Island County Park) is a saltwater tidal creek that begins near the James Island County Park and flows into the Charleston Harbor estuary, which is the confluence of the Ashley River and Cooper River basins. The Charleston Harbor estuary discharges into the Atlantic Ocean. James Island Creek is popular for its recreational and cultural value including kayaking, fishing, boating, and swimming.

2.2 Water Quality Parameter of Concern: *Enterococci*

James Island Creek is currently listed on the South Carolina's 303(d) impaired waters list for *Enterococci* (fecal indicator bacteria) since 2016 (reviewed every two years). The United States Environmental Protection Agency (USEPA) defines impaired waterbodies as any waterbody that does not meet water quality criteria based on its designated usage. Based on the 2019 TMDL report (discussed further in Section 3.0), a *Enterococci* load pollution load reduction of 82% and 96%, respectively, at JIC1 and JIC2 (the two long-term monitoring stations in James Island Creek Watershed) is required to meet water quality standards as part of the TMDL requirements. The

improvement of James Island Creek's water quality will improve the quality of life and local economic activity in the surrounding area. A watershed management plan is developed as a planning tool for stakeholder's decision making to help improve water quality.

Enterococci originates from the intestines of warm-blooded animals. *Enterococcus* are not generally considered harmful to humans but is an indicator of other pathogenic bacteria, protozoans, and viruses that pose human health risks. Pathogens can cause water-borne illnesses with full body contact during reactional activities in water bodies but are difficult to detect. *Enterococcus* are tested for because it is an indicator organism, tends to persist for a longer length of time in the environment than pathogens, and reduces the costs of testing for numerous parameters. Since 1986, the USEPA has recommended using *Enterococci* as the indicator organism for fecal contamination and health risk in marine waters (USEPA 1986). *Enterococci* can enter from surface waters from a variety of point sources including MS4s and industrial/domestic wastewater and non-point sources including agricultural runoff, septic systems, urban runoff, and wildlife, the sources are discussed further in Section 5.0.

2.3 Purpose and Intended Plan Usage

High levels of bacteria in a water body are harmful to the water body health, potentially human health, and the local economy. Therefore, the purpose of this watershed management plan is to determine the sources of *Enterococci* into the James Island Creek watershed through available information regarding the watershed and develop specific strategies through short-term, medium-term, and long-term actions to achieve measurable water quality improvement. A watershed management plan in South Carolina must meet the EPA 9[1] elements to be a sufficient plan for approval. The watershed management plan must also meet the 9 elements to be eligible for the Section 319 non-point source pollution control implementation funding. The watershed management plan for James Island Creek Watershed is being developed with the intention of qualifying for funding to assist in successful implementation of the strategies discussed in this plan. The ultimate goal is for the actions suggested in this plan to be implemented to reduce bacteria levels and provide a benefit to the community at large to enjoy the many values of James Island Creek.

The plan was developed through a multi-disciplinary collaborative approach that included important stakeholders: Charleston Waterkeeper (CWK), Open Space Institute, Town of James Island, City of Charleston, Charleston Water Systems, Charleston County, and Terracon. The plan has also been developed for groups concerned with the water quality, land use decisions, and habitat management within the James Island Creek watershed. The plan should be read by municipalities and counties within the vicinity of the watershed to use as reference for local watershed management decisions.

[1] *https://scdhec.gov/sites/default/files/Library/CR-010496.pdf*

2.4 Watershed Plan Goals

The goals of this watershed plan were developed through input of watershed planning committee and input from the public. These goals are not absolute and are intended to provide guidance for stakeholders involved with decision making for improving the water quality of James Island Creek. The general outline of the goals of this watershed plan are shown below and are discussed throughout the plan, specifically in Sections 6.0.

- Develop a watershed management plan that is reflective of the community goals through a multi-disciplinary approach with numerous stakeholders
- Identify all the sources of *Enterococci* into James Island Creek watershed so applicable management measures can be developed to mitigate the bacteria levels
- Promote sustainable development practices with emphasis on protection of natural resources as the Charleston area continues to grow
- Ultimately, improve water quality of James Island Creek to meet South Carolina's water quality standards

3.0 WATERSHED CHARACTERISTICS

The following three sections have been developed using the November 2019 South Carolina Department of Health and Environmental Control (SCDHEC) "Total Maximum Daily Load (TMDL) James Island Creek Enterococcus Daily Loads for Stations RT-052098, JIC1, and JIC2 in Hydrologic Unit Codes 030502020202 and 030502010605"[2].

3.1 Site Description

The James Island Creek watershed has a total land area of ~6.8 mi^2 (4,352 acres) that encompasses portions of the City of Charleston, Town of James Island, and Charleston County (see Figure 2). The watershed was delineated in collaboration with City of Charleston, Town of James Island, Charleston County, SCDHEC, and Charleston Waterkeeper using topography, digital elevation models, flow patterns, and satellite imagery (SCDHEC 2019). James Island Creek is a Class SA urban tidal stream located southwest of Charleston Harbor. James Island Creek is less than 1-foot wide near James Island County Park and approximately 600 feet wide at its confluence with the Charleston Harbor estuary. James Island Creek has an average tidal range of five feet. Based on local knowledge, James Island Creek was historically a connector creek between the Stono River and Charleston Harbor to transport goods between Johns Island and James Island. The 2019 TMDL report investigated this connection by the James Island County Park near the Newtown Cut in January 2018 with a drone and it was concluded that, under the investigated conditions, James Island Creek does not connect the Stono River and Charleston Harbor. This may change due to factors such as sea level rise and may need to be investigated again in the future.

The James Island Creek watershed is located within two twelve-digit HUC codes: Lower Ashley River portion of the larger Santee River basin (030502010605) and the Stono River-Atlantic Intracoastal Waterway (030502020202). James Island Creek is in the Sea Island/Costal Marsh ecoregion. This ecoregion is within the lowest elevations in South Carolina. Environment is highly dynamic and is affected by wind, ocean wave, and river flows. In these types of ecoregions slash pine, cabbage palmetto, red cedar, and live oaks forests are common. In the marshes: salt grass, rushes, and various cordgrasses are the dominant flora. Marshes are nursery grounds for shrimp, fish, crabs, and other species (Griffith, et al. 2002).

[2] *https://scdhec.gov/sites/default/files/media/document/25_Mile_Creek_%20Bacteria%20WBP_Catawba_2013.pdf*

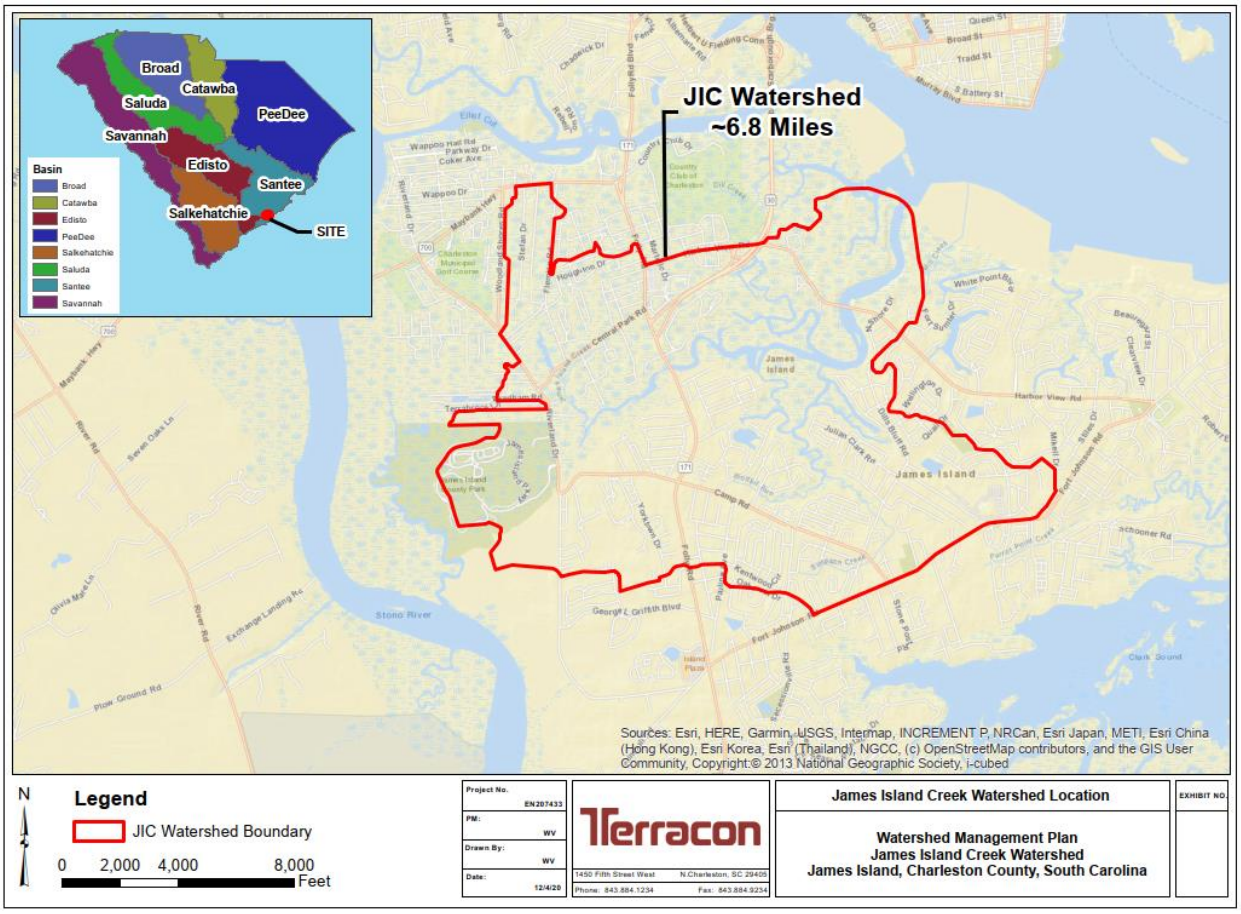

Figure 2: Location of James Island Creek Watershed and depiction within the major river basins within South Carolina.

3.2 Climate and Soil Characteristics

According to South Carolina Department of Natural Resources (SCDNR) resources from 1981-2010, Charleston County has had an average temperature of 66.7°F (19.28°C) and an annual precipitation of 44.42 inches per year. Charleston County is a region characterized as a containing temperate deciduous forest. The implementation plan will need to address and account for climate resiliency considerations and measures. The increase in atmospheric greenhouse gases will continue to accelerate climate change issues and will be essential to account for in a vulnerable coastal system.

There are approximately 15 soil series, includes tidal marsh, mine pits/dumps, and made lands, within the watershed according to the 1971 Charleston Soil survey (USDA). The four main soil textures within the watershed are loamy fine sand: 64.43%, tidal marsh: 20.11%, fine sandy loam: 8.13%, and silty clay loam: 1.84%, see Figure 3. The soil series and their respective textures can be important when discussing suitable soil for septic systems. Well-drained soils such as sandy and silty soils that are well-drained and have high permeability can cause water quality impairments downstream for fecal bacteria by not allowing the wastewater to be treated. Soils

that are too poorly drained such as clay-rich soils can cause backups in the septic systems. The soil textures will be discussed further in Section 5.0 when discussing septic systems as a probable source of fecal bacteria into James Island Creek watershed. It is noted that in urban areas, soils are continuously disturbed, covered with impervious surfaces, and replaced with non-native soil thus the designated soil texture may not be representative of every area.

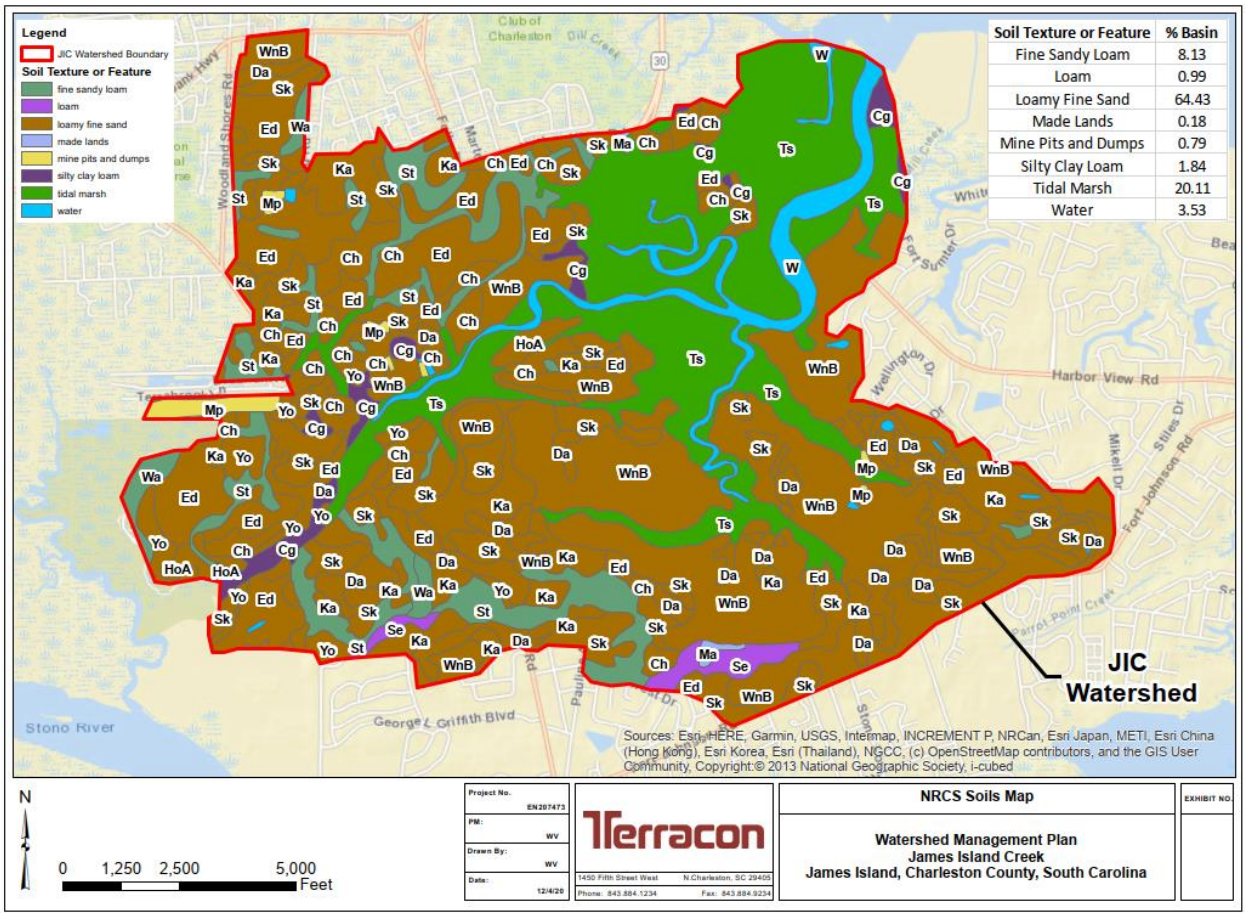

Figure 3: Soil series and textures within the James Island Creek watershed (Charleston Soil Survey 1971).

Another useful soil indicator is hydrologic soil groups (HSGs) to determine areas of high runoff potential. The HSGs are determined by the National Resource Conservation (NRCS) to describe the infiltration capacity of the soil and a group type is given per soil series. The soil associations are categorized in decreasing infiltration capacity from A to D and are described further below and shown in Figure 4. The HSG will be useful when determining areas that may have a higher potential area for bacteria runoff.

Group A soils are sand, loamy sand or sandy loam soils. The Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. The Group A soils consist of deep, well to excessively drained sand or gravel. Group B soils are silt loam or loam. The Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils moderately fine to moderately coarse textures.

The Group B soils have a moderate rate of water transmission (greater than 0.30 in/hour). Groups C soils are sandy clay loams. The soils have moderate infiltration rates when thoroughly wetted and consist chiefly soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. The soils have a low rate of water transmission (0.05-0.15 in/hour). Group D soils are clay loam, silty clay loam, sandy clay, silty clay, or clay. The Group D soils have the highest runoff potential. The soils have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. The soils have a very low rate of water transmission (0-0.05 in/hour).

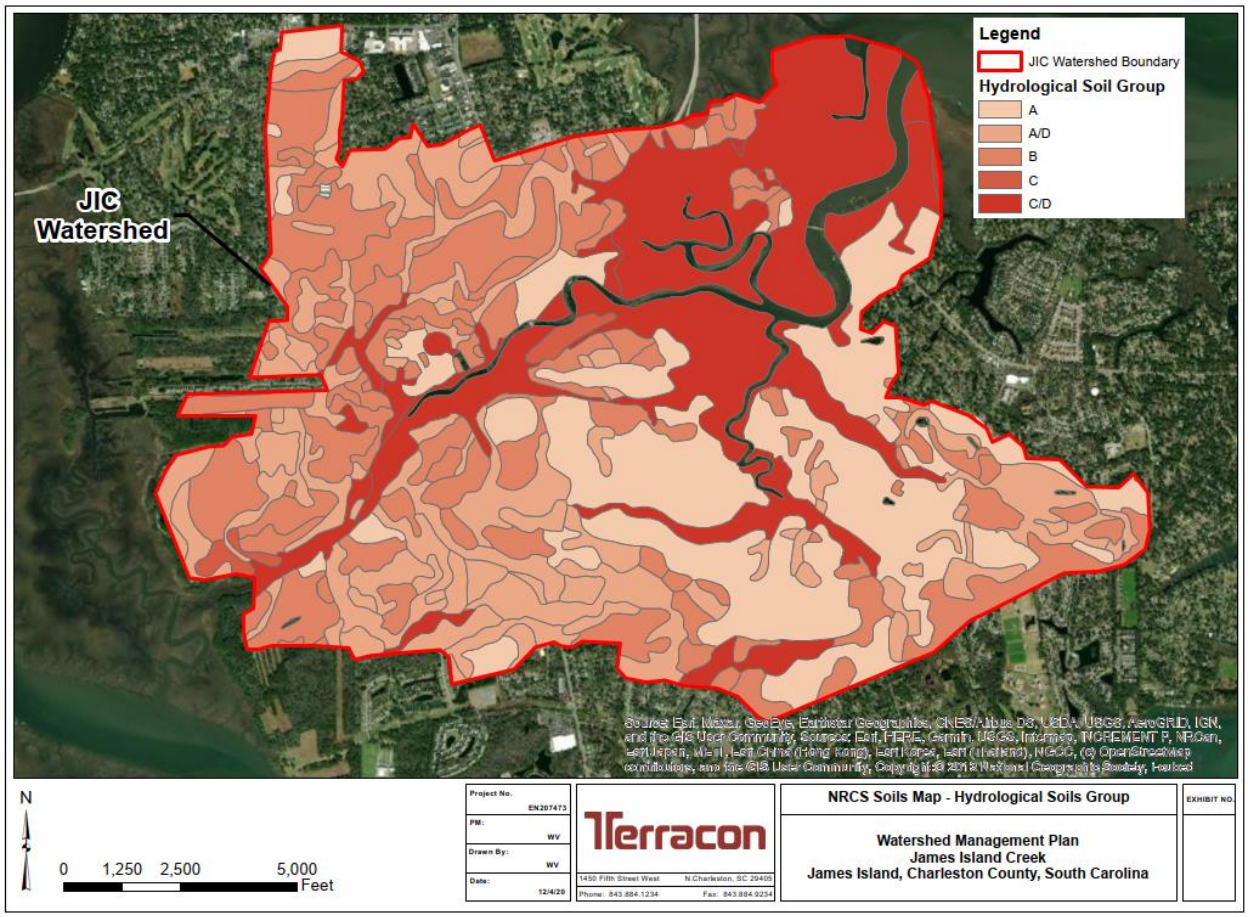

Figure 4: Depiction of hydrological soil groups of James Island Creek (NRCS Charleston Soil Survey 1980).

The large swath of areas adjacent to James Island Creek and its tributaries near the largest width of James Island Creek on the eastern to northeastern portion are characteristically poorly drained tidal marshes that are known for filtering runoff. Many of the developed areas in the central to western portion of the James Island Creek that are adjacent to or in close proximity are more well-drained Class A to B soils. The HSG also provides insight into the erodibility of soil. Soil erodibility is an estimate of soils' ability to resist erosion, based on the physical characteristics of each soil. Sandy loam and sandy soils are typically less erodible than silt, very fine sand, and some clay textures. The HSG is primarily for infiltration rates and basic soil texture, however, it can assist in

the decision process of narrowing down potential sources of pollution from increased sediment loads from storm events.

3.3 Population Trends and Land Cover

The coastal area in South Carolina has experienced rapid growth in the last thirty years which has led to urban sprawl in these areas. Table 1, shows the Charleston County population each decade since 1980 and includes 2019 to be representative for present-day at the time of this plan. It is noted that even though Charleston County is much larger than the James Island Creek watershed, the area has seen similar growth percentages.

Table 1: Population trends for Charleston County for 1980 to 2019.

Year	Population	Growth from Previous Decade
1980	276,974	11.8%
1990	295,039	6.5%
2000	309,969	5.1%
2010	350,209	13%
2019	411,405	17.5%

The population of Charleston County has grown steadily from 1980 ranging from 5.1% to 17.5% each decade (Table 1). The urban growth will present on-going water quality challenges, which presents an even greater need to improve the water quality of James Island Creek watershed. Fortunately; development of this watershed management plan, the advancement of stormwater technologies, and the advancement of the water resources field will provide numerous resources to tackle the anticipated challenges.

Land cover in the James Island Creek is developed in areas outside of wetland consistent with the growth in this area. The land cover in the James Island Creek watershed was calculated using the 2016 National Land Cover Database (NCLD). The 2001 NCLD was compared to 2016 NLCD to see the difference in land cover over a 15-year period. The land cover was roughly the same from 2001 to 2016 with most of the area that is developable is already developed due to the coastal setting (Figure 5).

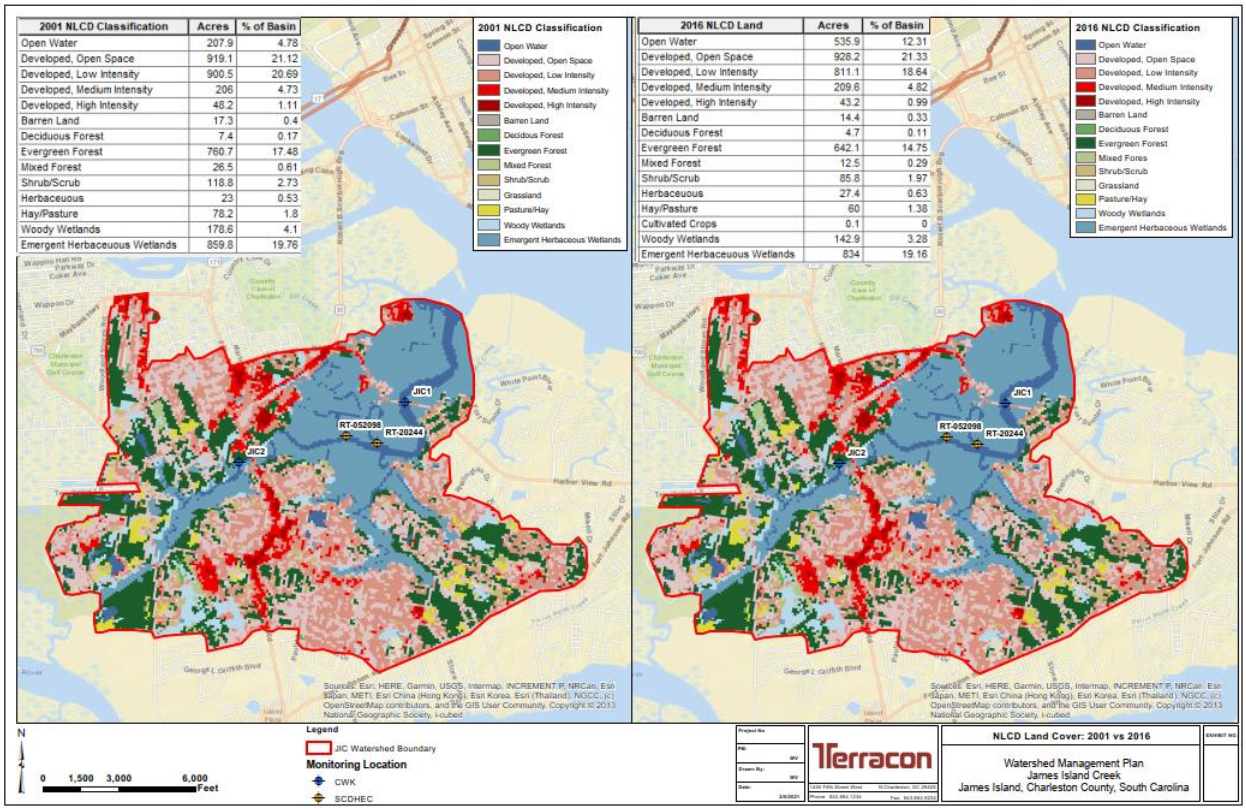

Figure 5: The comparison of the 2001 NLCD in the watershed to the 2016 NLCD.

The watershed is approximately 45.56% urban land, 1.23% of forested land, 25.7% forested and non-forested wetlands, 12.31% open water, 1.38% pasture, and 0.33% barren land, characterized in Table 2. In summary, James Island Creek watershed is approximately 45.46% developed based on the 2016 NCLD data.

Table 2: James Island Creek watershed landcover based on 2016 NCLD data.

NLCD Landcover Classification	Approximate Area (mi^2)	Percent of Area (%)
Barren	0.02	0.33
Forest	1.23	18.08
Forested and Non-Forested Wetland	1.53	22.44
Open Water	0.84	12.31
Pasture/Hay	0.09	1.38
Urban	3.1	45.46

3.4 Cultural and Economic Benefit

James Island Creek represents a tremendous cultural and economic benefit to the Charleston area. Overall, the coastal resources of the Charleston area provide recreational benefits for the citizens and bolsters the regional economy from the millions of visitors to the area (this plan

acknowledges that tourism was significantly reduced in 2020 due to the Covid-19 pandemic). In 2018, the Office of Tourism Analysis estimated that 7.3 million people visited the Charleston area generating an estimated $2.8 billion in labor earnings and total economic impact of an estimated $8.1 billion (Office of Tourism Analysis 2019). James Island Creek and its plentiful resources is a major part of the local culture. During the public comment period of the 2019 James Island Creek watershed TMDL, hundreds of concerned citizens commented on the importance of cleaning up James Island Creek. James Island Creek, specifically, provides numerous outdoor recreational activities such as boating, birding, kayaking, fishing, sunbathing, and swimming. The economic sectors that benefit from this resource include county parks, real estate, restaurants, arts and entertainment, and retail. The improvement of water quality in James Island Creek watershed is imperative to preserve this cultural and economic resource to the local community at large.

4.0 WATERSHED CONDITION

4.1 Stream Class & Criteria

South Carolina has established classification standards (SC Regulation 61-68) for all streams' water quality based on the stream's characteristics. The standards are designed so the water quality standards protect the unique qualities of the stream characteristics and provide a standard to restore the stream as needed. The impaired James Island Creek is listed as a Class SA water. Class SA waters are defined as "tidal saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption and uses listed in Class SB. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora" (SC Regulation 61-68).

James Island Creek has been listed as a South Carolina 303(d) impaired stream since 2016 (40 CFR part 130). As part of this designation, states are required to establish a TMDL to determine the allowable loadings of pollutants or other parameters in a water body. The TMDL is based on the relationship between the pollution sources and in stream water quality conditions so the TMDL can best be implemented to restore and maintain water quality resources.

4.2 Stream Assessments

Charleston Waterkeeper (CWK) collects weekly water samples for *Enterococci* from 15 monitoring stations from heavily used recreational marine waters throughout the Charleston area every year since 2013 from May to October. Two of the CWK's monitoring stations are within the watershed denoted as JIC1 and JIC2, see Figure 6. The CWK is a local non-profit part of the larger international Waterkeeper Alliance, that strives to "protect, promote, and restore the quality of Charleston's waterways…". The data collected by the CWK is available through their website[3].

[3] *http://charlestonwaterkeeper.org/what-we-do/watchdogs/water-quality-monitoring/*

Figure 6: Photos of the Charleston Waterkeeper monitoring locations on James Island Creek: JIC1 (A) sampled via boat and JIC2 (B) sampled via private dock.

4.2.1 Enterococci Assessments

James Island Creek is monitored weekly from May to October every year since 2013 by the CWK for *Enterococci* at JIC1 and JIC2 to analyze the recreational quality of the water, see Figure 8 below. The JIC1 station is sampled on the northern side of the Harbor View Road bridge crossing over James Island Creek assessed by boat. At JIC1, the creek is approximately 400 feet wide and approximately 0.9 miles southwest and upstream of Charleston Harbor. The area around JIC1 contains a large section of tidal marsh to the south, west, and north. The JIC2 station is sampled from a private dock upstream from Folly Road bridge assessed by land. The JIC2 station is a narrower section of the creek and is approximately 2.9 miles upstream of Charleston Harbor. The samples are collected by CWK personnel and volunteers using pre-sterilized 120 mL bottles, see Figure 7. The CWK has an approved quality assurance project plan (QAPP) with SCDHEC to sample and conduct the *Enterococci* analysis using IDEXX Enterolert® assay.

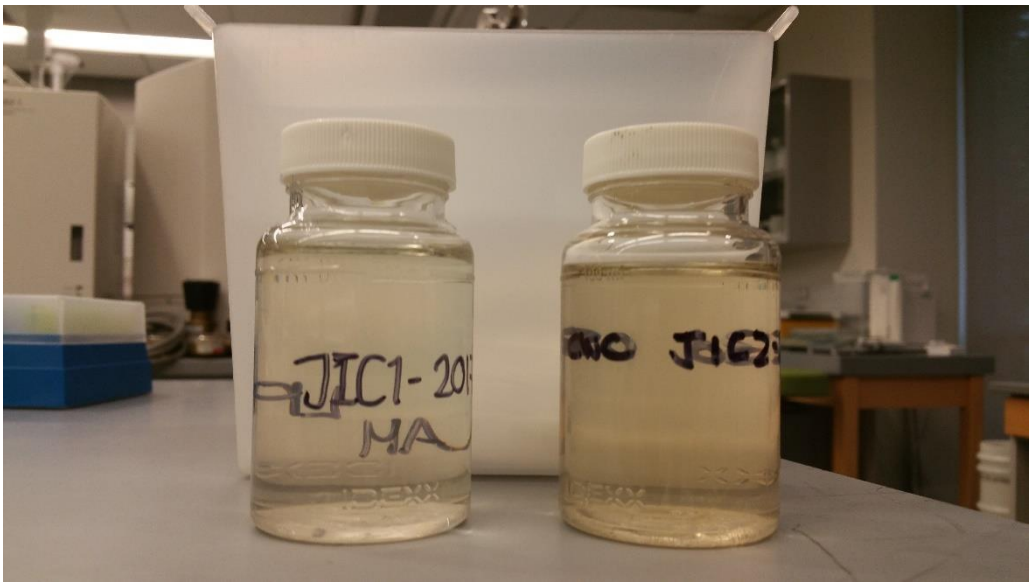

Figure 7: Samples bottles collected from the CWK monitoring stations: JIC1 and JIC2

The SCDHEC has two water quality monitoring stations (RT-052098 and RT-20244) sampled for *Enterococci* in James Island Creek, see Figure 8. The RT-052098 station sampled randomly once in 2005 is located roughly between Folly Road bridge and Harbor View Road Bridge. The RT-20244 sampled randomly once in 2020 is located at the mouth of tributary to James Island Creek opposite the mouth of Simpson Creek. The SCDHEC monitoring stations have been assessed as less representative of the current watershed conditions by SCDHEC and the assessment of *Enterococci* concentrations in the creek should be focused on the CWK monitoring stations.

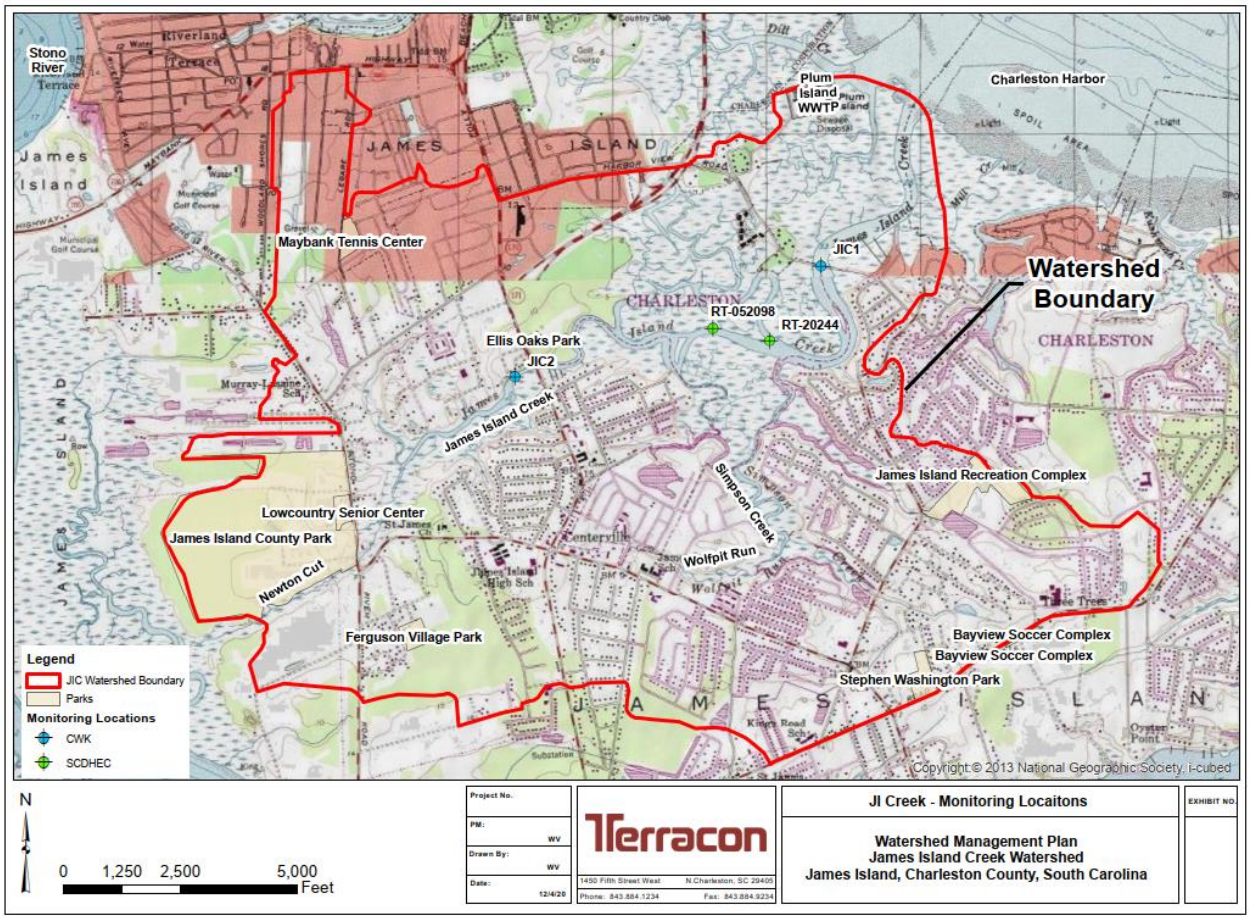

Figure 8: Map of the CWK and SCDHEC monitoring stations within the watershed.

4.2.2 Relevant Water Quality Standard

Based on SCDHEC regulation for Class SA waters, the enterococci in a water body "cannot exceed a geometric mean of 35 MPN/100 mL based on at least four samples collected from a given sampling site over a 30-day period; nor shall a single sample maximum exceed 104 MPN/100 ml. Additionally, for beach monitoring and notification activities for CWA Section 406 only, samples shall not exceed a single sample maximum of 104 MPN/100 mL" (SCDHEC 2014). Based on the sufficient frequency of sampling by CWK, the 35 MPN/100 mL standard described above will be the applicable standard for this assessment.

4.2.3 *Enterococci* Data Analysis

Charleston Waterkeeper has collected eight years-worth (2013-2020) of *Enterococci* data at JIC1 and JIC2, which collectively provides a thorough understanding of the water quality related to *Enterococci* levels in the watershed. The vast amount of data also accounts for potential seasonal variability issues. The CWK has taken approximately 207 water samples for *Enterococci* at each monitoring station. In the 2019 TMDL report for James Island Creek prepared by SCDHEC using

the 2013-2018 CWK data determined that an *Enterococci* reduction of 81% for JIC1 and 96% for JIC2 is needed to meet water quality standards based on the geometric mean determination (Varlick 2019). The TMDL is the total amount of a pollutant that can be assimilated by the receiving water body while still achieving compliance with water quality standards, see Equation 1.

.

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Equation 1: Equation of the TMDL method equation. The WLA is waste load allocation which represents point sources. The LA is load allocation which represents non-point sources. The MOS represents a margin of safety to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving body.

The calculated reductions needed at JIC1 and JIC2 are considered sufficient to meet the water quality standards at the two SCDHEC monitoring stations: RT-052098 and RT-20244 (Varlick 2019).

This plan wants to utilize all available data to give the most accurate picture of the current water quality conditions at James Island Creek. SCDHEC provided the spreadsheets and methodology to assist in developing an up to date analysis, including the 2019 and 2020 sampling year, for the required *Enterococci* reductions at JIC1 and JIC2 to meet TMDL requirements. Load reduction percentage are being used instead of a calculated loading at each station due to the lack of data regarding tidal exchange and flow patterns within James Island Creek. Further investigation is needed into the tidal exchange and flow patterns, that is outside the scope of this plan, to calculate an estimated *Enterococci* load at each monitoring station within the watershed.

The cumulative probability method was used, consistent with the methodology described in the 2019 TMDL report, to calculate the existing conditions and percent reductions based on the geometric mean necessary to meet the water quality standard of 35 MPN/100 mL in the James Island Creek Watershed utilizing the 2013 to 2020 *Enterococci* data for JIC1 and JIC2, see Equation 2.

$$p(\%) = \frac{100M}{N+1}$$

Equation 3: Equation of the cumulative probability method. The M = rank and N = number of samples (Novotny 2004).

Geometric mean was calculated for each 30-day period starting in May 2013 for the eight years of data. The log of the geometric means were used for a normalized distribution and were plotted utilizing Cumulative Probability Plot 3.0 program. Assuming the data follows a log-normal distribution, the straight line is compared to the water quality standard at the appropriate distribution percentile, see Figure 9 for example plot.

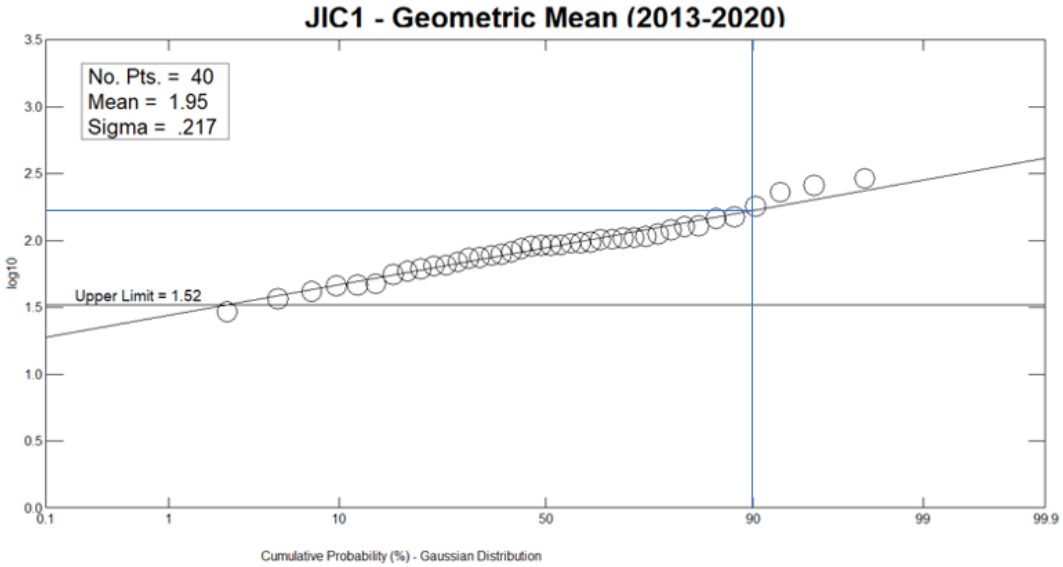

Figure 9: Example plot of geometric mean for JIC1 to determine percent reduction. The upper limit is representative of the standard minus the MOS in the watershed. The 90th percentile is above the upper limit showing the watershed is impaired.

For Class SA waters in South Carolina with sufficient data (4 samples over a 30-day period), the TMDL target is the 35 MPN/100 mL standard minus a 5% MOS at the 90th percentile resulting in a standard of 33.25 MPN/100 mL for the percent reduction calculation purposes. If the fit line crosses the 90th percentile reference line above the standard (upper limit in Figure 9), the site is considered to not meet the water quality standard. The necessary percent reduction is calculated as the difference between distribution at the 90th percentile point, see Equation 3.

$$\frac{Existing\ Load - (Standard - MOS)}{Existing\ Load} * 100$$

Equation 3: Equation of the percent reduction calculation of *Enterococci* concentrations for each CWK monitoring station.

As stated above, if sufficient approximations of tidal exchange and flow patterns were available, the method could be extended to calculate an approximate total *Enterococci* loading in MPN/day in the two CWK monitoring stations within the watershed. The determined average daily tidal exchange would be multiplied by the geometric mean at each monitoring station and a conversation factor to determine the *Enterococci* load at each monitoring station. The target *Enterococci* load in the stream could be calculated using a standard of 35 MPN/100 mL multiplied the average daily tidal exchange and a conversation factor. This would be useful if estimates of each source (even if roughly approximated) were available when prioritizing items in the action plan, that is outside the scope of this assessment.

A 2019 study by the College of Charleston investigated the stormwater and tidal hydraulics in a tributary of James Island Creek near the Harris Teeter at 675 Folly Road (approximately 1,100 feet west of JIC1), described as Teeter Creek by the locals interviewed in the study (Kuhl 2019).

The study took several transects of the tributary and conducted flow calculations using an acoustic doppler current profiler (ADCP) pulled by a kayak from an ebb tide to a flood tide to determine the differing discharge during the tidal change. The 2019 study's flow calculations are not considered representative (depth and width) of the creek at the CWK monitoring stations so should not be used for calculations of *Enterococci* load for this study. A study similar to the 2019 investigation should be undertaken in areas more representative of the creek at JIC1 and JIC2. Currently, there is not sufficient data to calculate the loadings for each CWK monitoring station which is a limitation of the method.

James Island Creek must meet the *Enterococci* percent reduction in order to attain the *Enterococci* water quality standard set forth by SCDHEC, see below in Table 3.

Table 3: Geometric mean percent reduction needed for each CWK monitoring station within the James Island Creek Watershed

Monitoring Station ID	Geomean % Reduction Needed	30-Day Geometric Mean Range (MPN/100 mL)	90th Percentile of Existing Load (MPN/100 mL)	30-Day Geometric WQ Standard (MPN/100 mL)*
JIC1	80%	29.6-291.5	178	35
JIC2	95%	84.8-1112.8	769	35

*33.25 MPN/100 mL was used as standard in the percent reduction calculations to account for the margin of safety of 5%

Studies have investigated relationships between *Enterococci* levels and other parameters such as turbidity, salinity, seasonal factors, and precipitation events before a sampling. The highest *Enterococci levels* at JIC1 and JIC2 were observed following days of one inch or plus of rainfall but further investigation would be needed to better understand the relationship of stormwater loading of *Enterococci* bacteria. In the 2019 TMDL report, SCDHEC used precipitation data from the PRISM Climate Group to investigate how wet conditions (cumulative rainfall for 24, 48, 72, and 96 hours before sampling) and dry conditions (no rainfall for 24, 48, 72, and 96 hours before sampling) before a sampling event relate to whether the CWK monitoring station meets the *Enterococci* water quality standard (Varlick 2019). One takeaway of note from this analysis was a majority of samples at JIC2 is not meeting the water quality standard after no precipitation for up to 72 hours. This is an indication of potential of continuous sources of fecal bacteria entering James Island Creek at JIC2 during dry conditions (note: there can be some survival of *Enterococci* beyond three days. Additional investigation of the relationships between *Enterococci* levels and other parameters would be useful in determining how specific events/factors and/or specific sources could be related to those relationships to better develop an action plan to attain the water quality standard.

The following sections will discuss the potential point and non-point sources of fecal bacteria into James Island Creek watershed, watershed goals/objectives, and the implementation action plan designed to help the watershed meet the *Enterococci* water quality standards.

5.0 POLLUTANTS, SOURCES, AND CAUSES

There are numerous sources of *Enterococci* into surface waters. The sources are classified as either point and non-point sources. Point sources are defined as pollution discharges that come from a defined location such as a pipe, outfall, ditches, and other channels and sources for *Enterococci* include industrial plants, municipal wastewater facilities, MS4s, etc. Nonpoint sources do not have a defined discharge location and are largely unregulated. Nonpoint sources can encompass relatively large areas. Nonpoint sources of *Enterococci* include failing or improperly maintained septic systems, agricultural runoff, urban runoff from impervious surfaces, improper animal keeping practices, wildlife, etc. The determination of an estimated value of *Enterococci* coming from each source is outside the scope of this plan, however, loads coming from an entity within a source (deer in the wildlife section, pets in the urban runoff section, etc.) such as MPN/day will be discussed where available in this section. A general estimate by source category would be extremely useful in the planning and implementation phases of this plan thus it should be considered for a future amendment. A field reconnaissance by boat and car was done to investigate the sources described below.

5.1 Point Sources

Point sources are required to have a National Pollution Discharge Elimination System (NPDES) permit in accordance with the Clean Water Act (CWA). The South Carolina NPDES permit requires discharges of sanitary wastewater to meet *Enterococci* standards and other pollutants of concern at the point of discharge or face fines and/or sanctions. Point sources are considered either continuous or non-continuous. Continuous point sources include municipal and private sanitary treatment facilities. Non-continuous point sources are all-NPDES stormwater discharges including MS4s, industrial discharges, and current/future construction covered under permits numbered SCS and SCR regulated under South Carolina Water Pollution Control Permits: R.61-9, 122.26(b)(4),(7),(14) – (21) (SCDHEC 2011). The percent reduction of *Enterococci* described in Table 3 applies to all point sources in accordance with each respective permit according to SCDHEC (Varlick 2019).

5.1.1 Continuous Point Sources

Municipal and private sanitary wastewater treatment facilities have the potential to be a source of *Enterococci* if the permit limits are not being met properly. These facilities that discharge wastewater must meet their permit limits thus they are not causing or contributing to impairment in addition to meeting the daily maximum limit specified in the 2019 TMDL report. The Charleston Water System, one of the municipal water supplier and wastewater management in the watershed, has a wastewater treatment plant located within the northeastern portion of the watershed called Plum Island Wastewater Treatment Plant (Figure 10).

Figure 10: Plum Island WWTP located on the northeastern portion of the watershed.

Plum Island discharges into the Charleston Harbor estuary outside of the James Island Creek Watershed and downstream. Plum Island discharge has been in compliance with their permit for *Enterococci* ranging from levels 1.6 to 7.6 MPN/100 mL in 2020 at the point of discharge into the Charleston Harbor estuary. Currently there are no continuous NPDES-permitted discharges within the James Island Creek watershed with an *Enterococci* effluent limit on their NPDES permit. Future NPDES dischargers of *Enterococci* into the watershed must comply with assumptions/requirements and load reductions set in the 2019 TMDL report.

5.1.2 Non-Continuous Point Sources

All regulated MS4s in the watershed have the potential to contribute to the *Enterococci* pollutant load. The three main permitted MS4s in the watershed are: Charleston County (SCR0319020), City of Charleston (SCR031901), and Town of James Island (SCR031910). The total area of each MS4 within the watershed equals to 5.9 mi^2 (3,795.2 acres). There are 0.9 mi^2 (576 acres) in the watershed that are not associated with a designated MS4 and the runoff from that area is primarily associated with non-point sources. Table 4 shows the total contributing area (mi^2) within each monitoring station for each MS4.

As part of the TMDL, there are additional assumptions and requirements in conjunction with the TMDL that the MS4s are required to meet. Due to the recent listing of the stream as impaired in 2016, SCDHEC acknowledges that progress towards meeting requirements/assumptions will take one or more permit iterations (Varlick 2019). The entities meeting their MS4 compliance, as long as their defined maximum extent practicable is met, are considered sufficient in meeting TMDL requirements. The regulated MS4 entities are required to have a stormwater management plan (SWMP) that must include the following: public education/involvement, illicit discharge

detection and elimination, construction site and post construction runoff control, and pollution prevention.

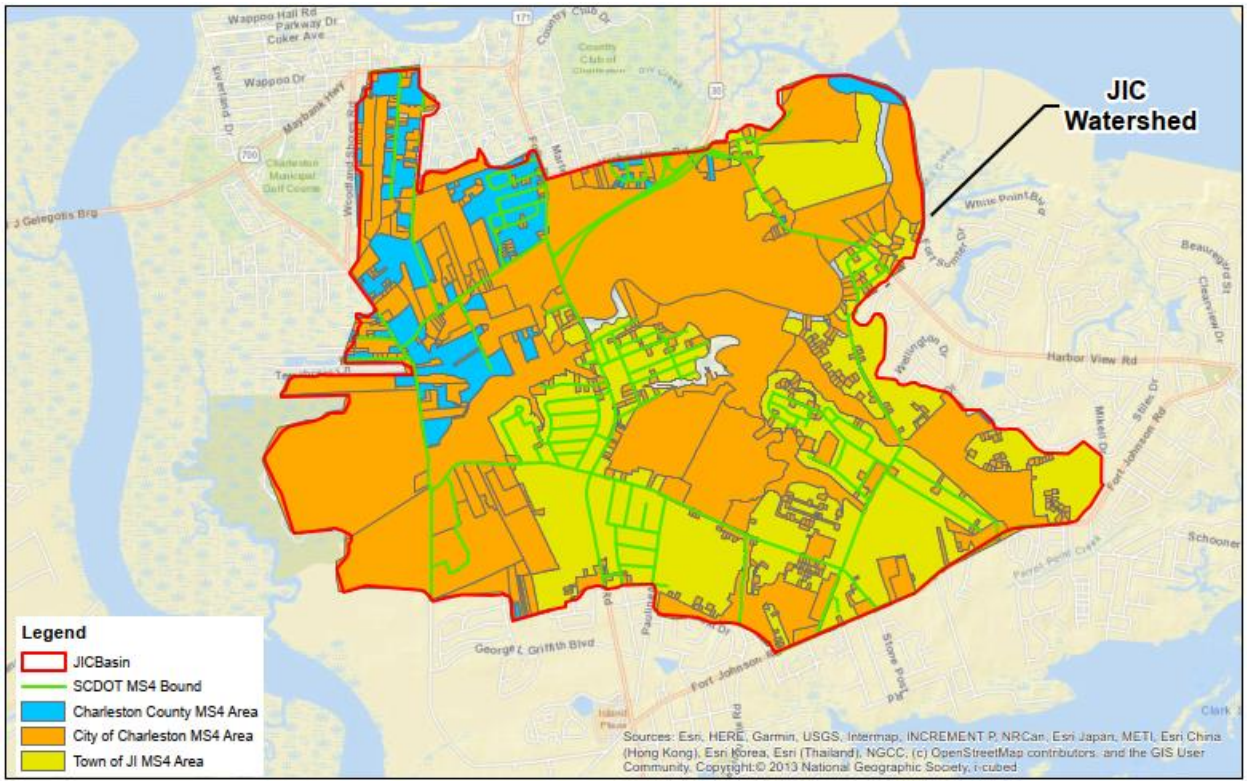

Figure 11: MS4 areas located within the watershed.

Sanitary sewer overflows (SSO) to surface water bodies can lead to water quality impairment and in some cases violation of water quality standards. The SSOs occur when wastewater overflows a manhole which can occur from a large precipitation event, sewer line blockage, or a wastewater pump station issue. The responsibility to prevent SSOs is the NPDES wastewater discharger or collection system operator for non-permitted 'collection only' systems. It is common for SSOs to be under reported or not preventable. Based on SCDHEC records, there has not been a documented SSO in James Island Creek watershed since 2019. The most recent SSO based on reasonably ascertainable information was roughly 6,000 gallons of wastewater entering James Island Creek by Central Park in 2019 caused by heavy rainfall. Illicit discharges are defined as any discharge into a storm drain system that is not composed entirely of stormwater which can include hazardous household products, pet waste, car soaps, automotive fluids, etc.. Illicit discharges oftentimes are not preventable and can lead to water quality impairment issues. Illicit discharges are illegal and the regulated MS4s within the watershed have illicit discharge detection and eliminations programs as part of their SWMPs.

South Carolina Department of Transportation (SCDOT) operates under NPDES MS4 Permit SCS040001 and owns/operates the roads within the watershed. The SCDOT is not a traditional

MS4 since SCDOT does not possess statutory taxing or enforcement powers. SCDOT does not regulate land use/zoning or issue building or development permits.

Table 4: The MS4s within the James Island Creek watershed and their acreage contributing to each CWK monitoring station.

Monitoring Station	Charleston County MS4 (mi^2)	City of Charleston MS4 (mi^2)	Town of James Island MS4 (mi^2)	SCDOT MS4 (mi^2)
JIC1	0.09	2.09	1.44	0.16
JIC2	0.38	1.18	0.45	0.16
Total (mi^2)	5.9 (3,795.2 acres)			

Industrial facilities have the potential to cause or contribute to violation of a water quality standard are covered by NPDES Stormwater Industrial General Permit (SCR000000). Construction activities that are within an impaired watershed must comply with the water quality standards associated with it and other industry requirements with a Stormwater Pollution Prevention Plan (SWPPP). Construction activities are covered by NPDES Stormwater Construction General Permit (SCR100000).

Water and sewer utilities are not included under the same organization in the Town of James Island, thus are billed separately. It is possible for the water services to continue as long as water bills are paid and the sewer services to be turned off due to lack of payment. In these cases, untreated sewage may be discharged directly onto the land surface. The untreated sewage becomes a major health concern and potential water quality issue if sewage runs off. There was has not been a documented case of untreated sewage being directly discharged onto land surface due to lack of payment of sewer services. Water and sewer utilities are under the same organization in the watershed areas within the City of Charleston.

5.2 Non-Point Sources

Non-point source pollution (also known as diffuse pollution) from stormwater is considered the number one pollutant impairment of water quality in the US by the USEPA. Potential non-point sources that could be contributing to the *Enterococci* levels in James Island Creek are related to land and water use activities including failing septic systems, agricultural sources, urban runoff, wildlife, boating activities, and other contributors located outside the boundary of James Island Creek watershed. Stormwater runoff is a major pathway of non-point source pollution into a watershed. A homeless camp, which can be a major source of *Enterococci* into a watershed, was mentioned in the 2019 TMDL report located at the intersection of Folly and Oak Point Road (Varlick 2019). This area was investigated during the field reconnaissance, and no signs of a homeless camp was identified. Based on the field investigation of the homeless camp, homeless camps are not anticipated to be source of *Enterococci* into the James Island Creek watershed.

5.2.1 Septic Systems

Improperly maintained, poorly designed, and failing septic tanks can be a major contributor of bacterial contamination of downstream water bodies. Septic tanks were historically installed in the watershed for homes that did not connect to the municipal wastewater system. The potential amount and location of septic tanks in the watershed was determined by Charleston Water Systems determining who does not have a water/sewage bill and historical information, see Figure 12. It should be noted that the SCDHEC also conducted an analysis of the potential number of septic tanks in the watershed in the 2019 TMDL report (Varlick 2019). In the stakeholder meeting for this plan, it was decided to use the Charleston Water Systems data due to it being the most up to date and accurate information on potential septic tanks in the watershed.

There are approximately 346 septic systems within the watershed with many being adjacent or in close proximity (within 500 feet) to a water body. The Charleston Water Systems list is not exhaustive, there could be additional septic systems within the watershed. Historically there were likely many more septic systems within the watershed that have been removed or abandoned. The potential of untreated sewage entering the waterbodies of this watershed from septic systems is high.

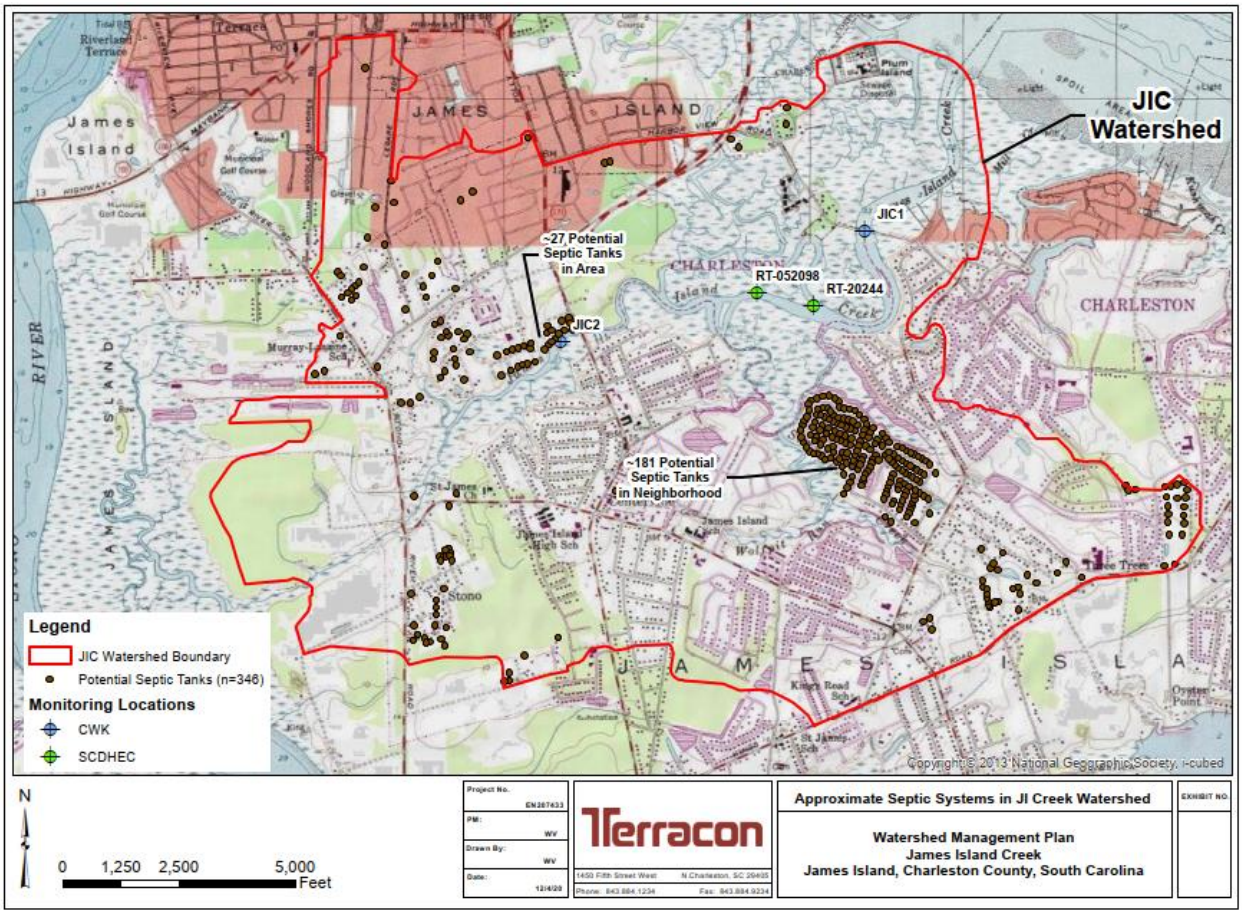

Figure 12: Approximate number of potential septic systems in the James Island Creek Watershed.

Septic tanks are a buried tank that collect wastewater from a household and holds the wastewater long enough for solids (oil & grease scum rise and sludge sinks) to settle out. The wastewater is digested and treated by collection of microbes in the septic system. Then the wastewater exits the septic tank and is discharged into a drainfield for further treatment by soil each time new wastewater is added, see Figure 13 below. The soil needs to have adequate permeability but not too much permeability to allow the wastewater time in the drainfield to purify before entering water resources. The loading of fecal bacteria from septic systems is a likely continual source into the watershed through groundwater discharge into surface water, precipitation events and/or tidal influences would likely increase the loading from the failing septic systems.

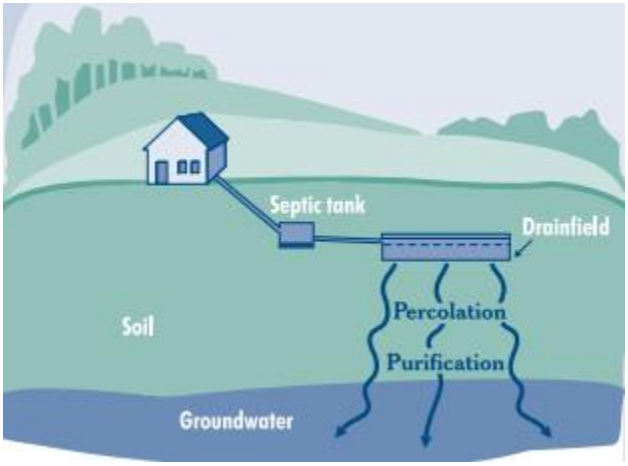

Figure 13: Illustration of how a septic tank works (USEPA 2005).

Septic systems are typically associated with rural areas that are not close enough to connect to municipal wastewater services. Issues can arise in the drainfield if it gets overloaded with liquid which will cause a flood, leading to sewage flowing to the ground surface or plumbing backups (USEPA 2006). The essential criteria needed for a properly functioning septic system to prevent groundwater contamination and ultimately surface water contamination downstream are: proper maintenance, suitable soil, effective design with local features and topography, backup septic system in some cases, and periodic pump-outs. The USEPA recommends having regular septic inspections and pumping the system every 3-5 years or as necessary for the best maintenance. A septic drainfield should never be placed up-gradient of a drinking water well due to the water quality concerns (most states do not allow this presently, may have occurred historically) unless designed to account for it.

Presently, if a septic tank will be installed at a home or property, SCDHEC must determine if a soil conditions are is suitable for a septic tank and drainfield. The soil must be sufficiently permeable to readily absorb the liquid effluent flowing through it and have enough depth from the water table. Historically, evaluations may not have been performed in some areas and it is possible septic systems were installed without much subsurface consideration in the watershed. In the 1971 Charleston County soil survey, each soil series was given a limitation characteristic

(none, slight, moderate, and severe) to having a septic drainfield based on its water table, percolation rate, and permeability among other factors, see Figure 14. Approximately 72.2 percent of the soil within the watershed is considered to have moderate to severe limitations of having a drainfield primarily due to a high-water table and percolation rates (USDA 1971). There are no soils within the watershed considered to have “no limitations” for a septic drainfield.

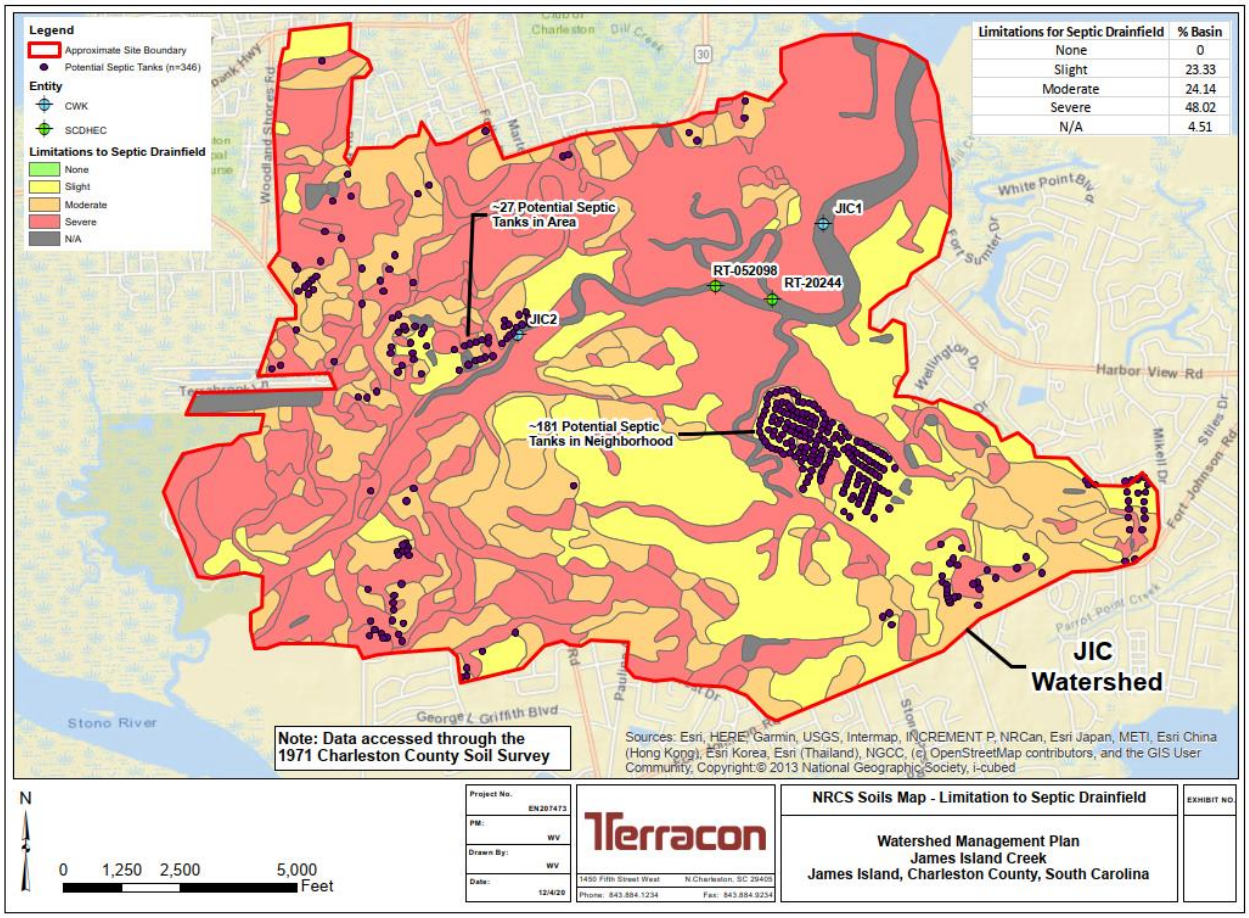

Figure 14: Depiction of septic systems, provided by Charleston Water Systems data, and limitations of a septic drainfield based on soil series, obtained from the 1971 Charleston Soil Survey, in the James Island Creek watershed.

The subsurface around James Island Creek are known for high water tables due to its coastal setting and moderately to well drained soils specifically in the central and western portion of James Island Creek as discussed in Section 3.2. There are two clusters of septic systems that are in proximity of a water body that have a higher likelihood of being a major source of *Enterococci* into the watershed which are: approximately 181 septic tanks in the densely populated neighborhood off the Simpson Creek tributary that is upstream of JIC1 but downstream of JIC2 and approximately 27 septic tanks in the lesser densely populated neighborhood north and upstream of JIC2. The 27 septic tanks by JIC2 are mostly directly adjacent to the creek and in soil depicted as having moderate to severe drainfield limitations mainly due to a high-water table and high infiltration rate of soil. It is likely these 27 septic tanks are contributing to the fecal

bacteria impairment in the creek especially the significant impairment at JIC2 due to its proximity and non-suitable soils. The 181 septic tanks in the densely populated neighborhood off Simpson Creek tributary are in primarily slight to moderate drainfield limitation soil mainly due to high water table. This neighborhood is likely a source of fecal bacteria into James Island Creek due to its proximity to a tributary and its partially non-suitable soils. The focus of the addressing septic system section (exact age range of septic systems is unknown) in the action plan needs to focus in on these two geographic areas first, specifically, the tanks adjacent to the water bodies then addressing septic tanks further inland from there.

The other septic systems not clustered around a waterbody are less likely to be a major source of *Enterococci* but may still discharge some *Enterococci* depending on the factors described previously. These septic systems not within proximity of a water body should be addressed outside of the initial implementation phases of the action plan. Soils evaluations can be performed at septic sites as needed (recommended for the inland septic) to determine if soil is suitable and is a cost-effective approach. If it is determined the septic systems need to be removed or repaired, funding will be essential to achieving that goal. There will be significant up-front costs in removing tanks or repairing them and connecting households to wastewater. However, the effort would be major milestone on the path to a clean watershed. The consideration of septic tanks as a major source of *Enterococci* needs to be a focus point of the action plan and should include educational resources for properties on septic.

5.2.2 Agricultural Sources

Agricultural activities from livestock and other animals are a potential source of *Enterococci* contamination in surface water. The *Enterococci* can enter water bodies from runoff or direct discharge into the water bodies. Commercial animal feeding operations (AFO) are required by South Carolina Standards for the Permitting of Agricultural Animal Facilities R 61-43 to obtain permits for handling, storage, treatment (if applicable), and disposal of all fecal matter, litter, and dead animals generated at the facility (SCDHEC 2002). The state regulation is in place to assume if an AFO is in compliance with their permit, their operation will not impair downstream water quality. If the AFO is considered a concentrated animal feeding operation (CAFO), the facility is required to have a NPDES permit to discharge into surface waters. Currently, there are no AFOs or other regulated agricultural operations within the watershed.

5.2.3 Land Application of Industrial, Domestic Biosolids or Treated Wastewater

The NPDES-permitted industrial and domestic wastewater treatment processes can generate solid waste biproducts, also known as sludge or biosolids (plan will refer to them as biosolids). In certain instances, facilities can be permitted to land apply sludge at designated locations and under specific conditions. Also, there are some NPDES-permitted facilities permitted to land apply treated effluent at designated locations during specific conditions. The land application permits for industrial and domestic wastewater facilities can be covered under SC Regulation 61-9

Sections 503, 504, or 505 (SCDHEC 2011). In some areas, citizens can pick up treated biosolids from their local wastewater treatment plant to use for agricultural purposes.

In the 2019 TMDL, SCDHEC recognized that there may be operating, regulated land application sites within the watershed. If properly managed, the applied biosolids are applied at a rate where the potential pollutants are absorbed into the plants and/or plants thus the incorporated pollutants will not enter water bodies. Stormwater runoff could discharge the land applied biosolids if they are not managed properly this can lead to *Enterococci* stream impairment. Consistent with waste application discussed with AFOs in Section 5.2.2, it is illegal for treated biosolids to be directly discharged into water bodies in South Carolina from land application site. Currently, there are no NPDES permitted facilities with a land application permit of wastewater within James Island Creek watershed.

5.2.4 Urban Runoff

Due to the urban nature and growing population around the James Island Creek watershed as discussed in Section 3.3, urban runoff is considered significant within the watershed due to impervious surfaces and could be potential source of *Enterococci*. Consistent with regulated MS4s, potentially designated MS4 entities or unregulated MS4 communities located within James Island Creek watershed have the potential to contribute bacterial loads into urban runoff. Areas with impervious surface that receive periodic flooding from high tides and/or small precipitation events are potential areas of concern for constant urban runoff. The identification of these flood-prone areas specifically as an *Enterococci* source are outside the scope of this watershed plan and should be investigated further, please also review flood maps for the Charleston area to identify flood-prone areas.

A potential source of fecal bacteria in urban runoff is from domesticated animals which include household dogs, cats, horses, chicken, pigs, etc. According to the 2014 US Pet Ownership Statistics shows 28% of households own dogs and 23% own cats (American Veterinary Medical Association). Based on the 2010 US Census, there are 7,961 households with a population of 15,962 within James Island Creek watershed. Furthermore, there are approximately 2,229 domesticated dogs and 1,831 domesticated cats living within James Island Creek watershed based on 2010 US Census (it is likely higher with the population growth described in Section 3.3 but the 2020 US Census data is not yet available). A 2005 veterinary study found that cat feces contain between $3.3x10^4$ to $4.1x10^7$ MPN/g (wet), and dog feces between $8.4x10^6$ to $1.2x10^8$ MPN/g (wet) of fecal indicator bacteria (Cox et al.). There are numerous housing developments and apartment complexes within the watershed that are likely densely populated with pets. It is essential that these communities have enough pet waste stations that are frequently maintained. The promotion of proper pet waste keeping practices are essential for controlling domesticated dog and cat waste in the communities living within the watershed.

As discussed above in Section 5.2.2 there are no commercial agricultural operations located within the watershed. In the Town of James Island (portion located within the watershed) as of

2016, residents are allowed to have up to 12 chickens confined in the backyard for personal poultry use depending on their community rules (apartment community rules, homeowners association (HOAs), etc.). Aerial photograph review of the watershed showed areas with horses including on the western portion of the watershed to the north of James Island County Park. It is essential these owners are practicing best management practices for their pet's waste management to prevent fecal bacteria from running off into the watershed. Residents are also allowed to keep pigs as pets but cannot use for livestock purposes. Public outreach in regard to the betterment of water quality in the watershed for owners of chickens, horses, pigs, and others is important since a majority of focus is typically put on domesticated dog waste management. As these domesticated livestock animals move on, it is important for proper disposal of the carcasses in regard to air and water quality[4].

As part of this plan, areas around/in proximity to the creek were investigated for potential fecal bacteria sources and areas that maybe susceptible to fecal bacterial runoff. The Wag Factory, a dog boarding and daycare facility, located at 719 Folly Road near the Folly Road bridge is approximately 200-250 feet south of James Island Creek and is a potential source of fecal bacteria based on their business type and proximity. However, there is no evidence of fecal bacteria coming from the Wag Factory at this time. James Island County Park operated by Charleston County Parks and Recreation Commission (CCPRC) is located on the western portion of the watershed along the Newtown Cut portion and the beginning of James Island Creek (Figure 2). The James Island County Park has an approximately 4-acre dog park located along the main pond of the county park, see Figure 15.

Figure 15: View of the James Island County Park dog park from a drone (Photo via CCPRC).

[4] *https://www.epa.gov/agriculture/agriculture-and-carcass-disposal*

The CCPRC stated there is a riparian buffer located around the pond. A potential connection of the pond by the dog park to James Island Creek was investigated to determine if the pond adjacent to the dog park is connected to James Island Creek by culvert or other means. It appears James Island County is connected to James Island Creek by culvert using remote sensing data and other GIS information. According to the James Island County Park website, the pond is tested for water quality to meet recreational uses for humans and dogs. The CCPRC provided the water quality testing done annually for the last three years (2018-2020) in the pond for *E. coli* (fecal indicator bacteria used in freshwater systems). The water quality results at the James Island County Park dog park in 2018-2020 for *E. coli* comply with the SCDHEC recreational use standard (349 MPN/100 mL of *E. coli* for daily maximum). There are several other parks located within the watershed, but none have a notable dog park.

5.2.5 Wildlife

The waste from resident, migrant, and seasonal wildlife can be carried into waterbodies by runoff from rainfall or direct deposition. Wildlife is a possible significant source of fecal bacteria into the watershed. Probable wildlife of significance (based on size) for fecal bacteria in the watershed are deer, raccoons, stray cats and dogs, and waterfowl. According to Charleston Waterkeeper, there is not a known issue with stray cats and dogs within the watershed. Other wildlife within the wildlife include other birds and smaller rodents. According to SCDNR's 2013 deer density study there are approximately 15 to 30 deer per square mile in the vicinity of the James Island Creek watershed. Based on deer density study, approximately 105 to 210 deer are within the vicinity of James Island Creek watershed based on its watershed size showing deer are a potential water quality concern in the watershed. Research by Yagow show that fecal indicator bacteria production for wildlife that is relevant to James Island Creek watershed is approximately 347 x 10^6 MPN/deer/day, 113 x 10^6 MPN/raccoon/day, and 4,853 x 10^6 MPN/duck/day (Yagow 2001). Ducks are less of a concern year-round due to their migratory nature.

5.2.6 Boating Activities

Presently, there are no marinas or public boat landings located within the watershed. However, there are hundreds of private docks throughout James Island Creek and it is assumed many of these private docks utilize boats. Boats can also enter from the eastern portion of the watershed from the Charleston Harbor estuary. Boats have the potential to discharge untreated sewage from their vessels. However, discharging untreated sewage is prohibited within navigable waters under federal law as stated in the Clean Vessel Act. Marine sanitation devices are used on boats to handle untreated sewage and there are currently three main types (Type 1, Type II, and Type II), standardized by US law with varying effluent treatment levels. Properly maintained marine sanitation devices should be not be impacting or causing the *Enterococci* exceedances within the watershed. The marine sanitation devices use a combination of maceration and disinfections to treat vessel sewage. Charleston Waterkeeper offers a free mobile pumpout service for marine

vessels in the lower Charleston Harbor to ensure proper sewage disposal. Further information regarding the mobile pumpout program[5].

[5] *http://charlestonwaterkeeper.org/what-we-do/watchdogs/mobile-pumpout/#:~:text=Charleston%20Waterkeeper%20is%20proud%20to,onboard%20sanitary%20waste%20holding%20tank*

6.0 WATERSHED GOALS AND OBJECTIVES

The goals and objectives of the James Island Creek watershed are focused on restoring the creek to attain water quality standards, protection of the watershed for the long-term amid the population growth, and the involvement of diverse community-driven stakeholders. The goals stated below are reflective of the ideas of the community driven stakeholders. The goals will include a brief list of how they can be accomplished. The more detailed steps to accomplish the goals are described further in the following sections.

Goal #1: Identify all the sources of *Enterococci* into James Island Creek watershed so applicable management measures can be developed to mitigate the bacteria levels.

- Sufficient research into other watershed plans and applicable investigations to understand sources investigated in other studies
- Thorough review of the watershed and its history to get an idea of potential sources
- Work with appropriate stakeholders to obtain applicable information and data regarding potential sources of *Enterococci* into the watershed
- Possibly, obtaining funding to do a flow pattern/tidal exchange study within an applicable section of James Island Creek so an estimated load could be determined for *Enterococci* at the monitoring stations

Goal #2: Ultimately, improve the water quality of the stream relating to *Enterococci* levels to meet South Carolina's water quality standards.

- Through the review of water quality data and potential sources, develop an action plan that describes implementation steps and measurable milestones to attain water quality standards
- Have a thorough and meaningful public outreach program that encourages citizens to be part of the solution to clean and restore the watershed. Include the specific watershed action as a focus of the public outreach program.
- Utilize the watershed management plan as a resource to help guide stakeholder decisions as the planning phase moves into the implementation phase
- Successfully win funding to assist in cleaning the creek through implementation of the action plan and the public outreach program
- Ultimately reduce the *Enterococci* levels at JIC1 by 80% and 95% at JIC2 to attain SCDHEC water quality standards

Goal #3: Promote and protect the water quality and the immense natural resources of the watershed as the areas continues to see growth.

- Continue to monitor bacteria levels in James Island Creek watershed as done presently by the Charleston Waterkeeper to ensure the 30-day geometric mean of monitoring stations are below the SCDHEC standard
- Promote sustainable development practices with emphasis on protection of natural resources as the Charleston area continues to grow

Continue public outreach program to ensure the importance of keeping James Island Creek clean is showcased and the important watershed management principles are reinforced.

7.0 ACTION PLAN

The next step in achieving the watershed goals listed in this plan is the preparation of an action plan describing the specific implementation steps needed. The recommended action plan items listed below are not exhaustive and are presented as a guide for achieving the goals set forth in this plan. The timeline of the action plan items will be described as the following: immediate actions (0-1 years), intermediate actions (1-3 years), and long-term actions (>3 years). The estimation of costs for the BMPs was outside the scope of this watershed plan and was not discussed in detail. However, cost estimation and budgeting will be a major aspect of successful implementation and will need to be a priority as the implementation phase begins.

The first step to assessing and implementing action plan is develop a watershed planning committee. There is James Island Task Force that initiated this plan and it is recommended to reorganize into a formal watershed planning committee. The watershed planning committee should represent a diverse group of entities within the watershed with unique respective particular to their role in the watershed. The watershed planning committee needs to include the municipalities within the watershed, wastewater providers within the area, local nonprofits, important members of the community and economic sector, among others. The watershed planning committee should provide a quarterly update in a newsletter to the community to discuss progress and their future work.

7.1 Best Management Practices

The implementation of best management practices (BMPs) are significant step in achieving water quality goals. The BMPs are typically categorized into structural and non-structural BMPS. Structural BMPs are typically physical structures or practices. Non-structural BMPs are typically policy changes to improve water quality practices such as a local ordinance and public outreach campaigns such as a stormwater hotline. Structural BMPs can be utilized with non-structural BMPs to encourage individual action such as installing pervious pavement for a driveway or collecting rainwater with a rain barrel and then local government reducing their stormwater fee for a certain amount of time or receiving a tax credit.

The BMPs can be implemented watershed-wide or within a specific area to address point and non-point source pollution. An example of a watershed-wide BMP is the reduction of pet waste entering a water body through a public ordinance and public education. A site-specific BMP would be removing a septic tank in a specific backyard. The next two sections will discuss specific BMPs that will be at the watershed-wide and site-specific scale. These BMPs will include structural and non-structual options with a brief description of timetable and possible obstacles that will be encountered. There will be a brief section following the BMPs to further discuss potential obstacles to implementation. There will be a separate section discussing the public outreach program that is recommended to achieve public acceptance and represent the community goals

to attain water quality standards within James Island Creek watershed. The public outreach program will be run by the Public Outreach and Education Committee for the watershed. It is likely one BMP or program will not solve the water quality issues in the watershed but will take a collection of actions to solve immediate issues and educate the community to promote watershed stewardship.

For any stormwater improvement projects, the installation costs can be a major limiting factor and will raise the principal of opportunity cost when selecting BMPs. The site-specific characteristics (soil type, drainage patterns, creek size, etc.) could be a limiting factor when determining how successful a structure BMP can be in certain areas. Another potential pitfall for maintaining BMPs is the required maintenance. Before installation of a BMP, it needs to be clear what local department is responsible for maintenance and the proper funding allocated to maintain it. If a BMP is installed for a local homeowner, proper training needs to be offered to them.

7.1.1 Watershed-Wide BMPs

Below are the recommendations for watershed-wide BMPs to improve the water quality of James Island Creek watershed and ultimately attain the SCDHEC water quality standard.

Recommendation Watershed-Wide 1 (WW-1): The "get to know your watershed" campaign will include content beyond stormwater impacts including the history, hydrology, tidal creek flora and fauna education, water quality education, watershed boundary education, and watershed stewardship. The goal of the "get to know your watershed" campaign is to provide background history and knowledge necessary to build a foundation for stewardship and community caring for James Island Creek. This is a public education campaign should include the installation of signs on the roads and waterways when entering the James Island Creek watershed that includes a protecting the watershed message, see Figure 16. This campaign could include a door to door outreach effort to engage homeowners directly, this has been done in several other impaired watersheds.

Figure 16: Example of an "entering a watershed" sign from an unrelated municipality. Signs promoting the protection of the watershed can be mounted along roadways and waterways where applicable on the James Island Creek watershed boundaries.

It should also include signs in targeted areas to discuss the importance of water quality. This also could include pamphlets at county parks in watershed and/or short 5-minute video discussing the watershed boundaries and its significance to the area. The video should be accessible on the county, Town of James Island, and City of Charleston website. The timeframe for this should be immediate. The potential obstacles are determining who oversees this task and funding.

Recommendation Watershed-Wide 2 (WW-2): Incentivizing the installation of vegetative buffers by property owners along the creek bank, ponds, and other water features. A majority of the properties along James Island Creek are private homes. There are several ponds within housing developments in the watershed that would benefit from a vegetated buffer along the banks. It became clear during the field visit on James Island Creek that vegetative buffers are not wide-spread along the private homes and the main protection is various riprap to prevent bank erosion, see Figure 17 for an example.

Figure 17: Example of a private home along James Island Creek that could use a vegetative buffer.

Vegetated buffers can help reduce surface runoff and increase stabilization of banks. If there is a high enough tide and/or flood stage, water can be directly discharged into water bypassing the banks. If the buffer has enough width it can potentially filter stormwater as well, this will be difficult due to the close proximity of the waterfront homes to James Island Creek and limited yard size for many. However, in some instances a 3-foot grass/shrub buffer has shown to be effective reducing stormwater runoff volume. The anticipated timeline would be intermediate to long-term to allow time to create an incentive program and establishment of the vegetative buffers. The main obstacle will be public acceptance due to property owners especially entities relying on the economic benefit (real estate, etc.) of having a waterfront view. However, well-maintained continue grass strips can be an effective buffer and would circumvent the “waterfront view” issue. Public outreach is crucial for this action discuss the proper design and plants associated with an effective buffer with the public, see Figure 18 for Clemson Extension’s depiction of a vegetated

buffer along a saltwater system. It will also be important to work through the likely public concerns of a buffer reducing the waterfront views or limiting creek access.

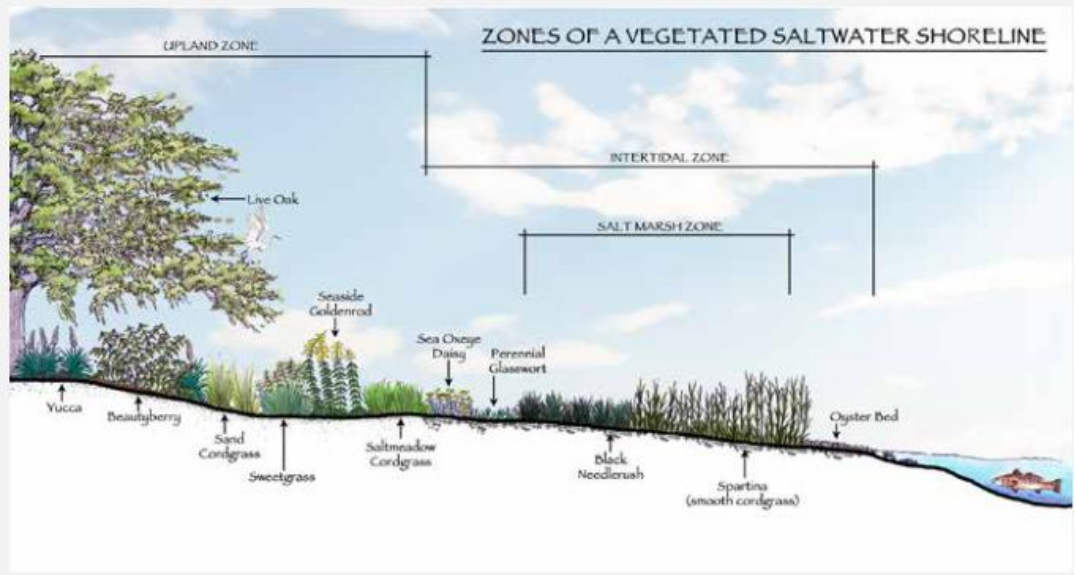

Figure 18: Depiction of a vegetated buffer and its various components (Clemson Extension 2013).

Recommendation WW-3: Working with appropriate animal control centers and animal rescue centers to assess the feral cat and stray dog population within watershed. Feral cat and stray dog populations can be a source of *Enterococci* into waterways. As stated above, there is not a known issue of feral cat and stray dog population within the watershed but is something that should be evaluated during the implementation process and periodically evaluated. If action is needed, a spay, neuter, and release program is a humane alternative. The timeframe for this is intermediate and as stated should be evaluated during the implementation phase. The potential barrier would be funding of spay, neuter, and release program if action is needed. See Section 8.1.1 for specific funding for a spay, neuter, and release program.

Recommendation WW-4: The reinforcement of the importance of pet waste cleanup specifically dogs and the continual maintenance of the pet waste stations. There are numerous locations throughout the watershed that have pet waste stations. Appropriate signage is also recommended to remind people to clean their pet's waste. It is important to ensure that pet waste is not entering the water bodies since it is highly preventable. It is recommended to assess the amount of pet waste stations at the parks in the watershed and other heavily used areas for pets to ensure there is an adequate amount of pet waste stations. The timeline would be an immediate action and one that is on-going. The main obstacle is the re-filling of the waste stations. It is important to also have messaging to tourists of the area the importance of keeping pet waste out of coastal watersheds.

Recommendation WW-5: The discouragement of people feeding wildlife, specifically birds. The feeding of wildlife can attract large wildlife populations to urbanized areas which can contribute

Enterococci into the stormwater runoff. The discouragement of feeding wildlife can be achieved by placing "Do Not Feed Wildlife" signs in the public parks and other highly congregated areas throughout the watershed. The timeframe for this implementation is immediate. Potential barriers to the implementation are public acceptance due to the lack of connection between feeding birds and water quality contamination. The messaging will need to be playful and targeted as part of public outreach due to the innocence of feeding wildlife. This is essential to prevent nuisance wildlife and large populations from getting established in the watershed in the future.

Recommendation WW-6: The encouragement and incentivizing of rainfall collection devices such as rain barrels, above-ground cisterns, and rain gardens for private property owners to help decrease the volume of stormwater entering the watershed through rainwater harvesting and reuse. A rain barrel works by catching water flowing from a downspout and then storing the rainwater for future use, see Figure 19. A rainwater garden utilizes gutter and down spouts to divert water into a garden preferably in a berm with deep-rooted plants to encourage infiltration and nutrient uptake. An above-ground cistern functions similarly to a rain barrel but is a larger system that typically has a standard pressurized plumbing system for use.

Figure 19: An example of a rain barrel system (photo via HGTV).

The more rainfall collection devices on private land in the watershed the better for reducing the cumulative amount of stormwater runoff and it can be hugely effective if widespread. The decrease of stormwater runoff volume into James Island Creek watershed will in turn reduce the load of fecal bacteria in the watershed. Partnership with native plant societies would be beneficial during implementation of rain gardens. The promotion of rainfall collection devices should be targeted at first such as Charleston Waterkeeper volunteers and other environmental organizations. The potential obstacle will be public buy-in and finding a vendor that will provide these at a reasonable price to incentivize use of them.

Recommendation WW-7: Provide septic educational workshops to educate individual with properties on septic. Charleston Water Systems has determined the likely septic tanks within the system so the workshops can specifically be targeted towards those individuals. The workshops will provide education on how septic works, when it needs to be inspected and repaired, and provide resources to who to contact if they have issues. The workshop will be a key strategy in preventing septic failures from becoming a water quality issue. A septic funding pool will be started in conjunction with septic educational workshop to provide septic tank inspections, maintenance, pump outs, and upgrades as requested by individuals on septic within the watershed. The septic funding pool will be a key strategy as the plan for septic tank removal are developed discussed further in SS-1. This plan acknowledges that these workshops will need to be remote during the Covid-19 pandemic. These workshops are a tool to the get word out about septic response plan recommended in WW-8. The timeline for this should be immediate to begin managing septic systems issues while the plan for some removals are determined. The potential obstacle to implementation, who will manage the workshops, and public willingness to participate.

Recommendation WW-8: Development of a uniform septic tank policy for the James Island Creek watershed. The uniform septic tank policy is essential for protecting water resources especially in vulnerable coastal. A uniform septic tank policy will provide much clearer guidance for the future use of septic tanks in this area. Local lawmakers will be essential in the development of an effective septic tank policy. The uniform septic policy should include a septic spill response plan to address future septic system failures. A septic spill response plan needs to be developed to people with a way to report septic failure within the watershed. The response plan needs to provide resources and vendors to help mitigate issues as they are reported. It will be crucial to incentivize septic failure for the benefit of water quality such as not fining for reporting. The timeline should be intermediated to long-term. The potential obstacle to this will be politics since it will be a policy reform, the funding of septic tank spill reporting system, who manages this program since septic systems are largely unregulated and getting the word out about the program.

Recommendation WW-9: Incentivizing the use of pervious surfaces for driveways and walkways by private homeowners. The pervious surfaces include but not limited to: permeable asphalt, permeable concrete, permeable pavers, and flexible paving systems. The pervious surfaces would most likely be retrofitted in areas with existing impervious surfaces and added where applicable. Retrofitting projects are usually eligible for Section 319 funding, eligibility would be screen by SCDHEC MS4 staff to confirm eligibility. Pervious surfaces allow for infiltration of stormwater into the subsurface to reduce the volume of stormwater runoff discharging into water bodies, see Figure 20. The reduction of stormwater volume which in turn reduces the load of *Enterococci* entering the water bodies.

Figure 20: Example of a permeable driveway (photo via Interlocking Concrete Pavement Institute).

Benefits for pervious driveway include the elimination of stagnant water puddles, decreased erosion around driveway, can reduce need for expensive drain systems, and reduces heat trapping. The timeframe for this is intermediate. Potential obstacles to implementation for homeowners will be costs of installation, costs of upkeep (needs at least cleaning a year with vacuum sweeper to prevent clogging) and providing resources for the public to understand the environmental benefit of it. The upkeep of the pervious pavement stems from periodic sweepings that are required to keep the pores from getting clogged with sediment.

Recommendation WW-10: Incentivizing the use of pervious surfaces (permeable asphalt, permeable concrete, permeable pavers, and flexible paving systems) for public and commercial infrastructure including parking lots, sidewalks, and other applicable areas throughout the watershed. Pervious surfaces in public and commercial infrastructure could have major impact on reducing stormwater runoff volume in areas with large impervious surfaces like shopping center parking lots, several are located within the watershed. An example of a pervious parking lot is shown below in Figure 21. The pervious surfaces would most likely be retrofitted in areas with existing impervious surfaces. Retrofitting projects are eligible for Section 319 funding.

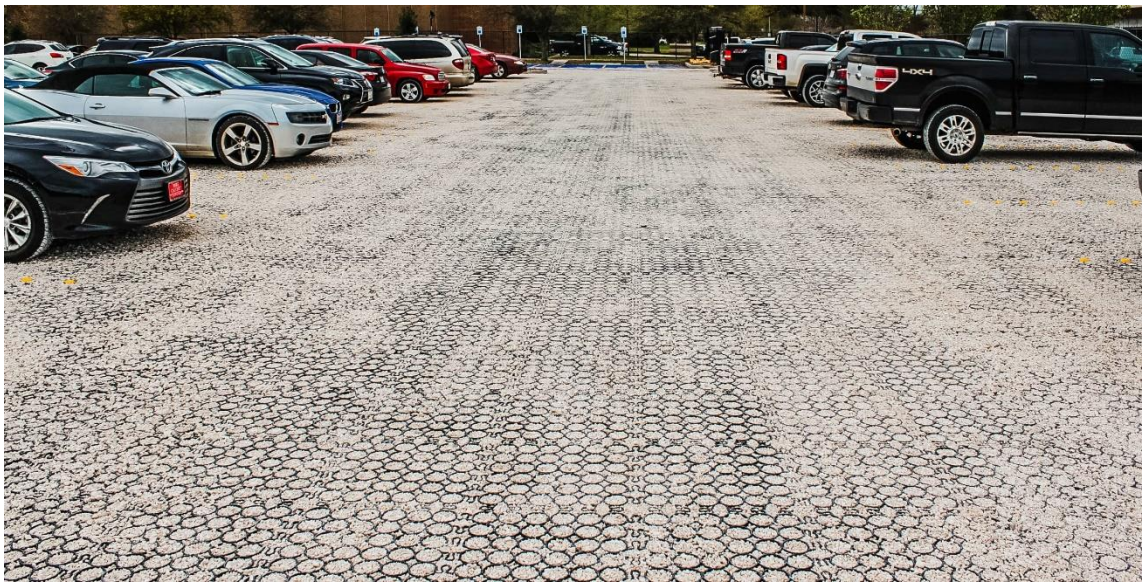

Figure 21: An example of pervious pavement in a parking lot (photo via TrueGrid pavers).

In this coastal system, it is important to investigate the groundwater level before installation of pervious surfaces, issues have been documented in areas with a groundwater table of 18 inches or higher. The timeframe for this implementation is likely intermediate to long-term. The potential obstacles to limitation are the installation and upkeep costs (needs at least cleaning a year with vacuum sweeper to prevent clogging), disruption of business in commercial areas during installation, and understanding the long-term benefit of the reduction of the stormwater runoff volume. For implementation of pervious pavement on Charleston County, Town of James Island, and City of Charleston property, it is recommended to start with a small area to see benefits as a case study and utilize as an education resource for implementing WW-9 for private property owners.

WW-11: Partnering with schools in the local area to provide education to youth regarding the importance of watershed water quality specifically for the fecal bacteria impairment in James Island Creek. An effective way to promote watershed stewardship is to provide resources to the youth so they will grow up knowing its importance for the community at large. It is also beneficial for the youth to bring the importance of watershed stewardship home with them and pass on to their friends and family. The timeframe is intermediate and on-going. Potential obstacles will be coordination with the schools and setting up a time efficient program that is understandable to youth. It is noted that these educational resources to school children will need to be virtual during the Covid-19 pandemic.

WW-12: Plant trees utilizing native trees and shrubs in areas that need additional land cover in the watershed. Increase tree coverage slows stormwater runoff and provides shade and green space benefit to the community. The tree plantings should be in conjunction with WW-2 that discusses a vegetative buffer model for this watershed as a green infrastructure mitigation. The tree plantings could be added to impervious curbs to create curb gardens throughout the

watershed to add more pervious areas. Areas that need additional land cover should be identified to maximize efforts. This allows opportunity for community members to have a direct opportunity to improve the watershed. The timeframe is long-term and is an on-going project throughout the Charleston area. Potential obstacles will be funding and coordination to conduct the tree plantings.

WW-13: Partner with the City of Charleston's and Keep Charleston Beautiful' s adopt-a-drain program to get all the stormwater drains adopted in the watershed. The adopt-a-drain program allows local citizens or community organizations to adopt a stormwater drain to help keep unwanted debris and pollutants from drain and prevent blockages. There has been 255 stormwater drain adoptions within the Charleston area. This partnership would be a major help to reduce preventable pollutants from entering the watershed and flooding from storm drain blockage that wash more pollutants into water bodies. The timeframe for this action is immediate and on-going. Potential barriers to implementation are coordination to setup the partnership.

WW-14: Recent research has shown that source tracking of fecal indicator bacteria in recreational waters is possible to determine the provenance of the bacteria (Sinigalliano et. Al 2021). Source tracking utilizes DNA extraction techniques to determine where the bacteria originates such as human, dog, cat, livestock, shorebirds, etc. Source tracking would be extremely helpful information to know the bacteria origin point and then that information can be compared to other environmental factors to determine likely source. Source tracking would be recommended near JIC1 and JIC2. Partnership with SC Adopt-A-Stream would likely be beneficial for the source tracking effort and increase community involvement. The timeframe for this action would be long-term. Potential barriers to implementation are coordination to find partner and funding. Research should be done if a company can perform this work and if not, partnering with a research institution.

WW-15: In similar thought to WW-2 in areas where runoff is directly discharged into James Island Creek, develop constructed wetlands and/or restore wetlands to treat stormwater. Constructed wetlands utilize natural ecology and hydric soil to treat stormwater in an engineered manner. The constructed wetlands can include extended detention shallow wetlands, pond/wetland system, and pocket wetlands. Constructed wetlands are more effective than typical stormwater detention ponds because of the higher biological and chemical treatment capacity of the vegetated zone of a constructed wetland. The development of constructed wetlands are ideal in low-lying areas with high-water table typically adjacent to surface water bodies. A potential partner for a constructed wetlands or wetland restoration is the SCDOT. The SCDOT is active with working South Carolina partners to mitigate new transportation development with wetlands. The timeframe for this action would be long-term. Potential barriers to implementation are having enough space/right location to build a wetland in this coastal urbanized watershed and costs of development.

WW-16: Stream restoration is a multidisciplinary practice that involves ecological and engineering design to re-establish structure, function, and habitat of a stream system before disturbance or is similar in nature to a reference reach in the general geographic area. Primarily, stream restoration

is used to reconnect a disturbed stream to its floodplain to better distribute a 2 year storm discharge (bankfull discharge) over a vegetated area as opposed to erodible and unprotected banks that can be common in urban systems that can have little habitat, stormwater runoff control, and aesthetic value. A variety of permitting will be needed to undertake and successfully complete the stream restoration process. Stream restoration would be extremely useful in areas within the watershed with highly erodible banks to decrease sediment loads which can be associated with higher fecal indicator bacteria levels. An additional study would be needed to identify specific stream reaches within the watershed that could be benefitted by stream restoration. The timeframe would be long-term to perform the stream restoration work and the 5-year post-restoration monitoring. Potential barriers to implementation would be funding, an applicable reach for stream restoration, and finding a partner to undertake the long-term effort to restore/monitor a stream reach.

WW-17: Identify stormwater ponds or other ponds for the installation of a floating wetland mechanism. Floating wetlands are essentially container gardens that float on the surface of water (Figure 22).

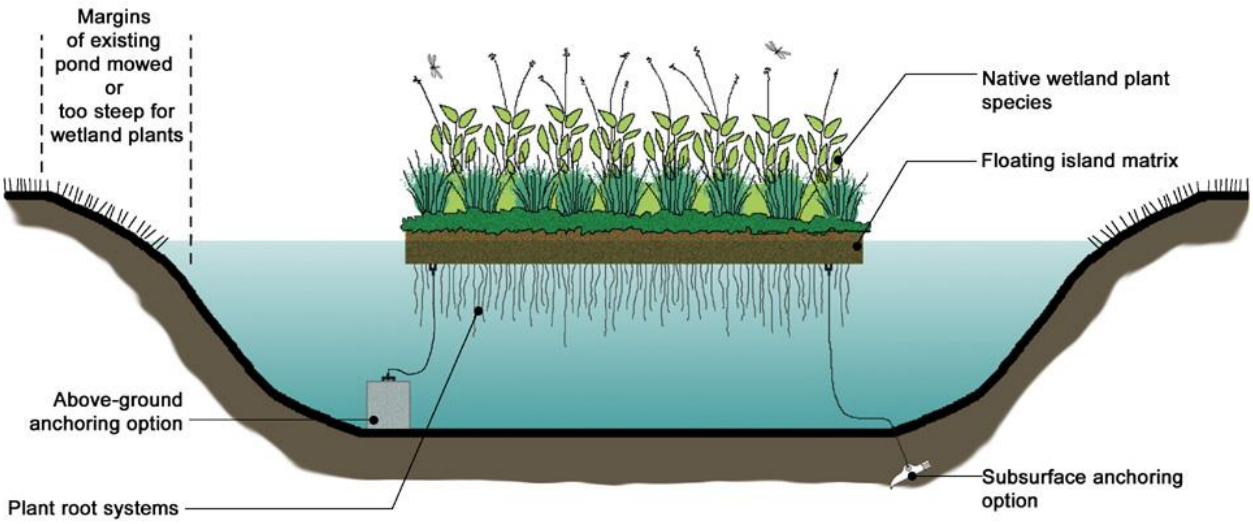

Figure 22: Depiction of a floating wetland mechanism (Image via the Texas Community Watershed Partners).

Floating wetlands are an emerging stormwater BMP that provides water quality benefits including reduction of sediment and fecal bacteria. Floating wetlands can also provide habitat for wildlife. It would be recommended to implement one floating wetland and showcase to engage/encourage watershed stewardship. The timeframe would be intermediate. Potential barriers of implementation would be public acceptance, finding an applicable pond, and having an adequate pond salinity for the plants.

WW-18: The development of a watershed planning committee specifically for the implementation phase of this plan. The committee would be a reorganization of the current watershed task force.

The primary partners need to be Charleston County, City of Charleston, Town of James Island, Charleston Water, Charleston Waterkeeper, and other community leaders. Stakeholders can be added as the implementation phase progresses. The main objectives of the committee are to help implement the plan and monitor progress then adjust as needed. Meetings should take place as required but should set a goal of 2-3 meetings annually. The timeframe for implementation is immediate. Potential barriers of implementation would be coordination between the stakeholders.

WW-19: Establish the Public Outreach and Education Committee and develop a public outreach plan. The Public Outreach and Education Committee is discussed further in Section 7.4. The timeline for implementation is immediate. Potential barriers of implementation include coordination between the stakeholders.

WW-20: The promotion and incentivizing roof gardens including green roofs (roofs covered with soil and plants) for applicable buildings to increase stormwater infiltration and reduce stormwater surface runoff. Green roofs are an emerging stormwater technology that utilizes planted vegetation, permeable membrane, and soil on rooftops to capture rainfall then slowly it through evapotranspiration (Figure 23: Depiction of the layers of a green roof (via Green Roof Service LLC).. Green roofs can be installed on new buildings or retrofitted on existing roofs.

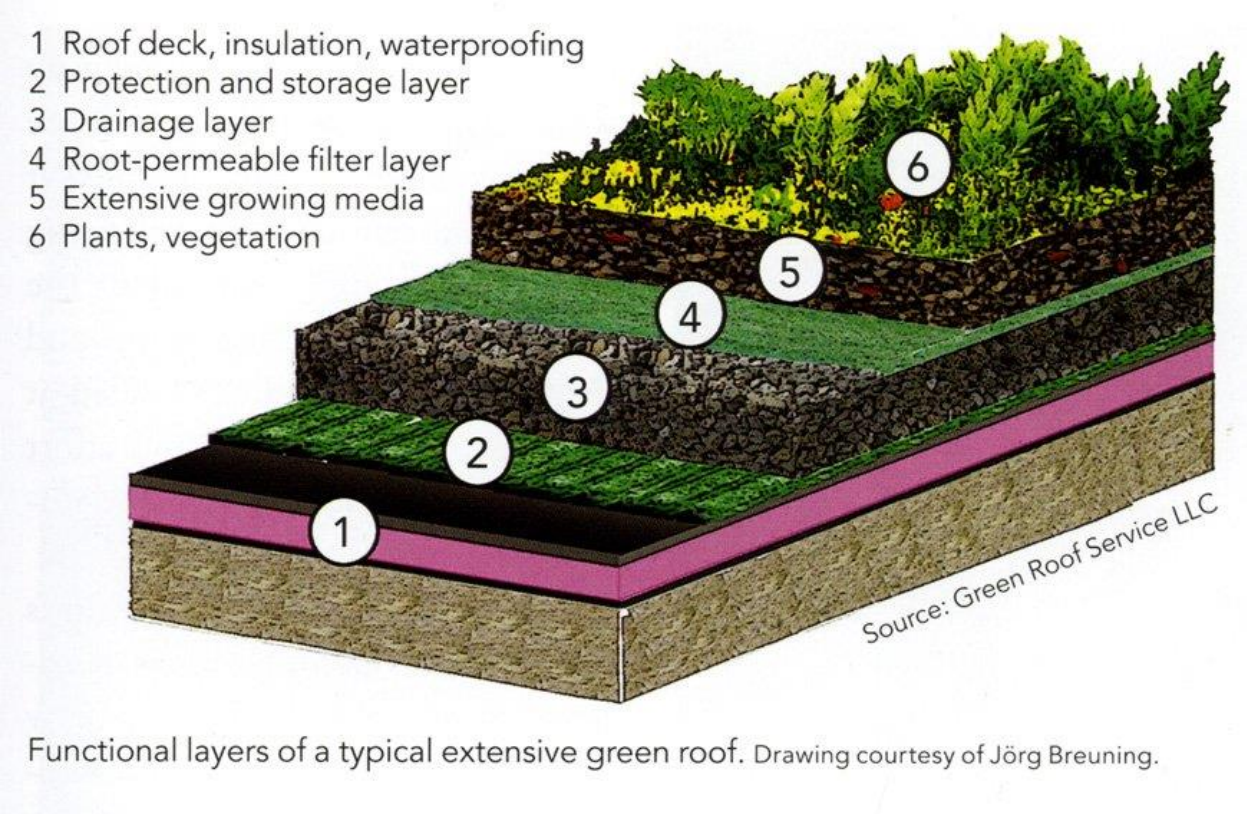

Figure 23: Depiction of the layers of a green roof (via Green Roof Service LLC).

Another benefit of a green roof is they have longer lifespan than a typical roof because they are protected from increased heat and UV-rays that degrades normal roof material. The timeline for implementation is intermediate to long-term. Potential barriers of implementation include the high installation costs and maintenance.

WW-21: The encouragement of owners within the watershed who own agricultural animals (chickens, pigs, horses, etc.) as pets to practice proper waste management. Runoff of these pets' waste can be a water quality concern and is very preventable with the right targeted outreach. Provide resources to these owners as applicable to prevent any runoff of the waste. The owners of these animals would need to be identified to maximize effectiveness. The timeline for implementation is intermediate. Potential barriers of implementation is proper targeted outreach.

WW-22: Begin a campaign to encourage property owners to secure trash bins and larger dumpsters. Unsecured trash bins and dumpsters are prevalent on impervious surfaces in many commercial areas meaning runoff will collect in the area of these trash bins and dumpsters. Unsecured trash bins and dumpsters can attract large groups of nuisance animals primarily racoons, turkey vultures, and possums. The areas around the trash bins and dumpsters can become a source of bacteria into water bodies if the nuisance animals frequent them enough. The timeline for implementation is immediate to intermediate. Potential barriers of implementation is coordination and messaging to the proper property owners.

WW-23: Install a greenway within the watershed to encourage stormwater infiltration and an additional outdoor space for people to enjoy the watershed. Greenways improve stormwater infiltration with pervious surface and can be a buffer during runoff events. Water quality education can be included as part of the greenway with signage as an interpretive trail. It would ideal for the greenway to be long enough to encourage use for exercise and education. The timeline for implementation is long-term. Potential barriers of implementation are public buy-in, ideal location for greenway, and costs of installation.

WW-24: Bio-retention ponds are designed depressions that are used to slow and treat stormwater runoff. Stormwater within the area is directed into the bio-retention pond and then it percolates through the basin where it is treated by numerous biological and chemical processes. The effluent that has percolated through the soil then is discharged.

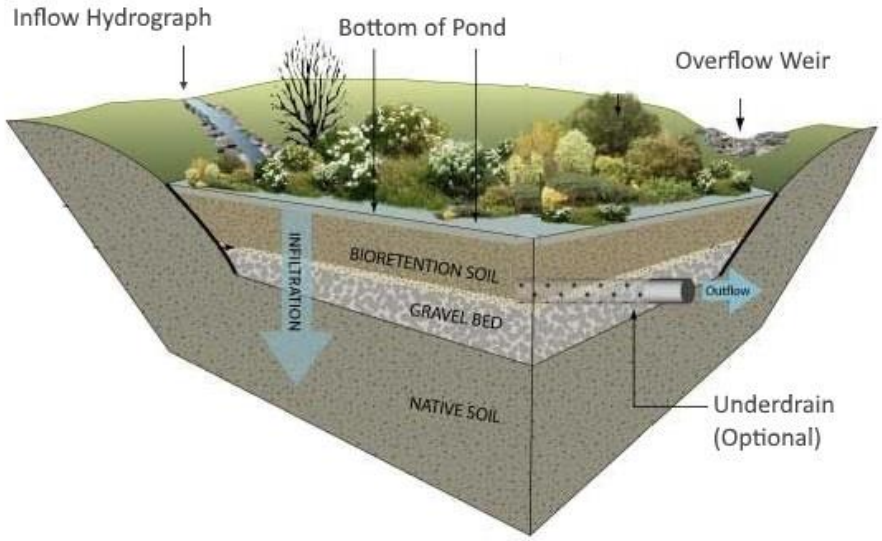

Figure 24: Diagram of the bioretention pond functions and mechanisms.

Bio-retention basins/ponds should be encouraged (i.e.: being part of permit requirements) for new construction within watershed since it can be a widely effective BMP in treating stormwater and reducing stormwater volume. The timeline for implementation is long-term. Potential barriers of implementation are finding an ideal location, costs of installation, and an entity to handle maintenance as required.

WW-25: In connection with WW-13, another idea for stormwater drain management is stenciling the stormwater drains with fish or other animals to have the drain stick out. The stormwater drain stenciling is a small way to remind people that trash that ends up in a stormwater drain does not just disappear but ultimately will affect the environment. The stormwater drain stenciling could be a great way to get community organizations and children involved in watershed stewardship activities. Even for individuals outside the watershed, it can give ideas to bring back to their local watershed. The timeframe of implementation is short to intermediate. Potential barriers of implementation is having an organization to lead the effort and coordination.

7.1.2 Site-Specific BMPs

Below are the site-specific BMPs recommendations to improve the water quality of the James Island Creek Watershed. and ultimately attain the SCDHEC water quality standards.

Recommendation Site Specific 1 (SS-1): The removal of septic tanks in the two identified clusters in Section 5.2.1 and connection of homes to municipal wastewater services is a major priority of this action plan. It is likely that untreated sewage is a major source of fecal bacteria into the watershed. In Section 5.2.1, two geographic areas of focus were identified for addressing septic systems within the proximity of water bodies. The two geographic areas are: approximately 181 septic tanks in the densely populated neighborhood off the Simpson Creek tributary that is

upstream of JIC1 but downstream of JIC2 and approximately 27 septic tanks in the lesser densely populated neighborhood north and upstream of JIC2, highlighted in Figure 12. The likely issue of the septic systems in this area are the proximity to water bodies and the non-suitable soils and high water table for a septic drainfield, see Table 5 below for number of septic tanks in watershed and their limitation to a septic drainfield based on soil classification. If a septic system is outside the two clusters but has a severe limitation to septic drainfield, it should still be prioritized for removal.

Table 5: The number of septic tanks within the watershed characterized by their suitability of having a drainfield based on Charleston County Soil Survey.

	N/A*	No Limitation	Slight Limitation	Moderate Limitation	Severe Limitation
Number of Septic Tanks (n=346)	6	0	176	119	45

*No drainfield limit given for some soil classification

The addressing of the septic system issue is ultimately a long-term action that will likely take over 5 years to accomplish. However, there are several short-term actions that must be taken to begin to address this issue. The initial focus needs to be on the septic systems adjacent to water bodies in these geographic areas and should be classified into priority phases of 30-40 septic systems to streamline the evaluation and removal process. Due to the non-suitable soils and other factors such as maintenance which could be causing additional issues, this plan is recommending for removal of septic systems ultimately in these two areas. Potential obstacles to implementation are costs and acceptance by the property owners. Funding will be crucial to cover the septic removal costs and connection to municipal wastewater. It is also needs to be determined that sewer services are available for a particular property before a septic system is removed. It is expected for some property owners to not be accepting of the septic removal from their properties and reiterates the importance of a public outreach program. Ideally over time, most of the septic tanks within the watershed are removed due to the general non-suitable soils for a drainfield in the watershed and their proximity to water bodies in this coastal setting. This however will take time and sufficient funding, it is not something that is reasonable to be accomplished in 5 years. It is noted that perc tests could be performed in some areas to determine suitability of soil for septic and septic could remain in some instances but will be dependent on how the watershed planning committee will want to proceed. For areas further away from water bodies, performing a perc test is a cost-effective alternative to determine if action is needed.

Recommendation SS-2: Continue the water quality monitoring at JIC1 and JIC2 by the Charleston Waterkeeper. The crucial element in knowing this implementation plan is having a positive effect on the water quality within the watershed is continuing to monitor *Enterococci* as has been done since 2013 by Charleston Waterkeeper, annually from May to October. The Charleston Waterkeeper data will be the key analytical information needed to ultimately have the James Island Creek removed from the impairment list. If funding allows, it is recommended to periodically monitor along Simpson Creek for *Enterococci* or consider having a full-time JIC3 near

the 181 septic tank cluster to weekly measure the progress of SS-1. The JIC2 will be a good measurement of the effectiveness of SS-1 near the 27 septic cluster. The JIC1 will be a good measurement of the cumulative impact of SS-1 for both clusters. The timeframe is immediate and on-going.

Recommendation SS-3: Performing a flow pattern/tidal exchange study within an applicable section of James Island Creek (JIC2 is recommended) so an estimated load (MPN/day) could be determined for *Enterococci* at the monitoring stations. This would allow for an *Enterococci* load to be calculated which makes it clearer to see what specific load reductions are needed to attain water quality standards. Partnership with a local research institution is recommended to perform the study to engage local research scientists in watershed stewardship. The timeframe for this is intermediate to long-term. Potential obstacles to implementations are funding and coordination with a research institution.

7.2 Addressing Point Sources

The primary point source control program within the Clean Water Act (CWA) is the NPDES. There are currently no NPDES direct discharges into the James Island Creek watershed. Any future NPDES discharger within the watershed is required to comply with the load reductions with *Enterococci* as well. The MS4s permits in conjunction with TMDL requirements are expected to provide significant implementation for point sources. Sewer systems maintenance is an essential part of achieving the watershed goals to ensure all sewer system components including pump stations and sewer lines are functioning properly. A specific action includes discovery and removal of any illicit storm drain cross connections which is on-going.

7.3 Potential Obstacles to Implementation

The potential factors that may hinder the implementation of the watershed management plan need to be discussed for this plan to be successful. The lack of funding is a major obstacle for many of the action plan steps described above. This reinforces the need for the stakeholders to pursue multiple sources of funding to achieve the watershed goals. It is likely that a recommended BMP, especially ones related to septic systems, are located on private property or easements, which makes communications with these landowners essential. It is likely not every property owner will buy-in but transparency and full explanation at the beginning will lead to the most successful implementation. Partnership with SCDOT will also be important for stormwater improvement projects located within SCDOT rights-of-way and obtaining the appropriate encroachment permits before beginning work. Another key aspect is to have a diverse representation of the various decision makers within the watershed. Successful partnership between the stakeholders is essential for this plan to be successful. The lack of public acceptance into the restoration of water quality in James Island Creek watershed could limit the effectiveness of watershed management tools like this plan and it is imperative to have a well-designed public outreach program to achieve community buy-in.

7.4 Public Outreach Program

One of the essential aspects to the successful implementation of this plan is a major emphasis on public outreach. The emphasis on public outreach should lead to a well-developed public outreach program to help implement this plan. The public outreach program will be run by the public outreach and education committee for the watershed. This committee will be integral to the public acceptance needed for many of the suggested implementation strategies. The WW-1 describes the "get to know your watershed" campaign which will be one of the earlier and most important actions to begin implement this plan. The committee will be needed to help coordinate public outreach efforts and partner with other community organizations. The committee should make developing a public outreach plan a priority in 2021 to accompany this watershed management plan. The public outreach and education committee should provide a yearly update to community to discuss progress and their future work.

Materials for outreach and education can include letters, brochures, watershed advertisements on pet waste stations, educational workshops/videos, fridge magnets, door hangers, etc. Messaging for the public outreach should be targeted to particular groups as deemed necessary including: pet owners, property with septic, full-time residents, tourists and seasonal residents, local businesses, and boaters. The main goal of a public outreach program is to raise awareness of the water quality issues in the James Island Creek Watershed and the importance of cleaning up the creek for the betterment of the community. Funding will be imperative in achieving this goal and potential funding opportunities are discussed further in Section 8.0, there are several specifically for public outreach. Suggested timeline for public outreach measures is described in Section 9.0.

7.4.1 Local Partnerships

Partnership with local and state-wide organizations that already provide resources to protect natural resources in the watershed is essential to develop an effective public outreach program since they know the area and the people in these communities. Partnership with local government officials for implementing any policy changes in connection with this watershed plan. Keep Charleston Beautiful in partnership with Keep America Beautiful and Palmetto Pride has operated in the Charleston area including the watershed since 1977 with a mission of maintaining the beauty of the area. Keep Charleston Beautiful accomplishes these goals through education, awareness, and community involvement (i.e. trash cleanups) in keeping the environment clean. Keep Charleston Beautiful has an adopt-a-drain program where citizens adopt a storm drain along a roadway and our responsible for keeping it clean. Keep Charleston Beautiful also provides a youth education program called "Talking Trash" where children learn about the harm of trash in water bodies. Partnership with Keep Charleston Beautiful would be beneficial with their local knowledge, adopt-a-drain program, and community involvement.

James Island Pride is a citizen's committee based in the Town of James Island, their goal is to keep James Island beautiful by keeping the roadways, marshes, and parks clean. James Island

Pride provides an Adopt-A-Highway program to encourage community groups to protect the roadways of litter. James Island Pride would be a great opportunity to partner with the community of James Island in implementing this watershed plan. Partnership with the homeowner associations (HOAs) throughout the watershed would be a great partner to help engage large amounts of people. The HOAs is also a great place to pursue successful implementation of action plan items: WW-2, WW-6, and WW-9. For the neighborhood by Simpson Creek with the 181 septic systems it is crucial to identify a community leader or representative to begin the process of evaluating that area for septic removal and informing them about the septic educational resources. Other relevant community organizations should be identified for partnership for the public outreach program.

7.4.2 Workshops and Other Resources

Workshops will be a major part of managing larger issues like septic system awareness/training and general watershed related education. Local organizations such as the Charleston Waterkeeper and others non-profit organizations will be essential in achieving the public acceptance needed for successful implementation. A great resource for educational materials for many of the suggested actions including WW-2 and WW-6 among others and general watershed stewardship actions is Ashley Cooper Stormwater Education Consortium, a service of Clemson Extension. More information about the Ashley Cooper Stormwater Education Consortium[6]. The workshops will likely need to be virtual during the Covid-19 pandemic.

An immediate priority needs to be made to educate the public on the watershed boundaries and appropriate signage as effective first step. The signage should include a message to protect the watershed. As part of the general watershed related education workshop, illicit discharges need to be focus point since many people do not realize the potential environmental harm of pouring non-stormwater related substances down stormwater drains. The SCDHEC is committed to working with agencies within the watershed such as SCDNR, Clemson Extension, SC Sea Grant Extension Program, Charleston Counties Soil and Water Conservation Districts, among others to assist in providing non-point source education to the community (Varlick 2019). The SCDNR could be a resource when determining where to put the “Do Not Feed Wildlife” signs suggested in WW-5.

7.5 Estimated BMP Load Reductions

The section below gives rough estimates of the fecal bacteria load reductions and stormwater volume reductions of the applicable BMPs discussed in Section 7.1 (Table 6). The estimation of the fecal bacteria load and stormwater volume reductions by a BMP is significant to understand how each BMP will factor in the watershed ultimately meeting water quality standards. The table includes applicable BMPs, estimated fecal bacteria load and stormwater volume reductions, and literary source of estimated reductions. The estimated load and stormwater volume reductions

[6] *https://www.clemson.edu/extension/carolinaclear/regional-consortiums/acsec/index.html*

are being used from research papers and their assumptions/limitations may not be completely representative of the stream characteristics, land cover, and climate of James Island Creek watershed. The plan used readily available data and not every BMP is included below. The percentage reduction discussed below are for the localized area of the BMP will interact with and one BMP would not provide the below reductions in the whole watershed.

Table 6: Estimated reductions of fecal bacteria loads and stormwater volume by recommended BMPs.

BMP	BMP #	Estimated Fecal Bacteria Load Reduction (%)	Estimated Stormwater Volume Reduction (%)	Reference
Vegetative Buffers	WW-2	1 to 25 meter wide vegetative buffer: ~99% reduction	95% stormwater volume reductions	Sullivan et al. 2007
Rainfall Collection Devices	WW-6	Does not directly treat fecal bacteria	~90% to 92%	Gee and Hunt 2016
Rain Gardens	WW-6	92% to 99% fecal bacteria reduction dependent on the type of rain garden	>90% of stormwater runoff	Wang et al. 2014 and Richards et al. 2015
Pervious Surfaces	WW-10	Does not directly treat fecal bacteria	~70% to 80% of stormwater runoff (assuming proper maintenance of the pervious surfaces)	Pennsylvania Metropolitan Area Planning Council (MAPC)
Wetland Restoration	WW-15	Can be highly effective depends on the wetland restoration design	Can be highly effective depends on the wetland restoration design	NRCS 2007
Stream Restoration	WW-16	Can be highly effective depends on the stream restoration design	Can be highly effective depends on the stream restoration design	NRCS 2007
Floating Wetland	WW-17	~99% removal rate	N/A	Palacios et al. 2012
Roof Gardens/Green Roofs	WW-20	N/A	34% to 57% (depends on antecedent precipitation)	Strovin et al. 2010
Bioretention Ponds (stormwater feature)	WW-24	79% to 87%	~70% (depends on antecedent precipitation)	Batalini de Macedo et al. 2019

BMP	BMP #	Estimated Fecal Bacteria Load Reduction (%)	Estimated Stormwater Volume Reduction (%)	Reference
Septic Removal	SS-1	~99% in localized area with 2.42e10 MPN/year reduction for removal per household	N/A	Horsley and Whitten 1999

The below table describes an example scenario of BMP implementation and estimated reduction in *Enterococci* load based on the researched parameters and bacterial load reduction numbers. The scenario below describes a year of implementation of this plan's recommendations and what the anticipated bacterial reduction and stormwater volume would be. Calculations were made utilizing the best readily available resources and used medians of a particular land use as the basis of the estimated reductions below (Table 7).

Table 7: An example year of BMP implementation.

Example Year of Implementation				
BMP	**BMP #**	**# of BMPs Implemented**	**Annual Estimated Fecal Bacteria Load Reduction**	**Reference**
Vegetative Buffers	WW-2	5 acres of vegetative buffer	6.06e9 MPN/ac-year	Shaver 2007
Rainfall Collection Devices	WW-6	3 acres of rainfall collection devices (assuming 91% stormwater reduction I urban area)	5.51e9 MPN/ac-year	Shaver 2007
Rain Gardens	WW-6	1 acre of rain garden (assuming 95% bacterial treatment)	5.76e9 MPN/ac-year	Shaver 2007
Pervious Surfaces	WW-10	10 acres of pervious surface (assuming 75% stormwater reduction in urban area)	4.55e9 MPN/ac-year	Shaver 2007
Floating Wetland	WW-17	0.25 acres of floating wetland	5.94e9 MPN/ac-year	Shaver 2007
Roof Gardens/Green Roofs	WW-20	1 acre of roof gardens/green roofs (assuming 45% stormwater reduction)	2.73e9 MPN/ac-year	Shaver 2007
Bioretention Ponds (stormwater feature)	WW-24	2 acres of bioretention pond (assuming 83% stormwater reduction in urban area)	5.03e9 MPN/ac-year	Shaver 2007
Septic Removal	SS-1	40 septic tanks removal	9.68e11 MPN/year	Horsley and Whitten 1999

Based on the above information, the removal of septic tanks would have the greatest impact in terms of estimated fecal bacteria load reduction. The institutional educational BMPs described in Section 7.1.1 will result in further BMP reductions that can't be estimated for annual reduction.

8.0 FUNDING OPPORTUNITIES

A major hurdle of implementing this plan to the fullest is lack of funding to properly implement the suggestive actions. Watershed protection of James Island Creek must be viewed as investment to the water resources that provides tremendous cultural and economic value to the local area. Opportunity cost is an essential concept when determining whether to implement a BMP or not. This section analyzes state, private, and federal funding opportunities to help improve the water quality of James Island Creek watershed. It is essential the stakeholders pursue more than one source of funding due to the risk of relying on one source of funding. To note, this list of funding opportunities is not exhaustive and regular review of funding opportunities is part of successful management of water resources. Following discussion of funding opportunities, other resources regarding technical assistance such as staff and resources for specific organizations will be discussed.

8.1 Private Funding Options

8.1.1 PetSmart Charities

PetSmart supports local initiatives in addressing the issue of reducing bacterial loads from feral cats and stray dog population. This funding would be useful if large growth of feral cat and stray dog populations are identified as part of WW-3 The main strategy to reduce bacterial loads from feral cats and stray dog populations is to gradually reduce the size and reproduction rate of known populations. PetSmart awards grants to assist governments or animal welfare organizations to institute trap, spay, neuter and release programs. The program is harmless to the animals and has been a proven response to reduce these populations from growing unsustainably. Information on PetSmart grant programs can be found at https://petsmartcharities.org/.

8.2 Local Government Funding Options

8.2.1 Stormwater Utility Fees

Charleston County, City of Charleston, and Town of James Island have a stormwater utility fee due to the construction, operation, and maintenance costs associate with managing a drainage system. The stormwater utility fee provides a revenue stream to cover the costs associated with stormwater projects and programs. The fee is determined by an assessment of each property based on the approximate area of impervious service.

8.2.2 Local Nonprofits

Nonprofits within community could provide funding resources for the watershed plan implementation. Local non-profit organization members typically live within their service community and thus their impact is of the up-most importance. Non-profit organization can provide

financial resources directly or through in-kind matching. Potential non-profit partners for the watershed plan are the Charleston Waterkeeper, Coastal Community Foundation, Open Space Institute, Coastal Conservation League, City Craft Foundation, and Charleston Surf Rider among others.

8.3 State of South Carolina Funding Options

8.3.1 SCDHEC – 319 Nonpoint Source Pollution Grant Program

The USEPA recognizes nonpoint source pollution from stormwater runoff as the number one contributor to water pollution in the US. The Section 319 program was established as part of the CWA 1987 amendment. The SCDHEC receives an annual grant allocation from EPA per CWA Section 319(h) to "help, prevent, control and/or abate nonpoint source pollution in support of the state's non-point source management plan". The guidelines for submission are typically released in March annually. The initial scope proposal for 2021 is due March 19th, 2021 and the final RFP package is due May 28th, 2021. The main requirement for eligibility set by SCDHEC and USEPA for this grant is an approved watershed management plan. Once this watershed management plan is approved, the nonpoint source elements of the James Island Creek watershed will be eligible for the funding. Further information regarding the Section 319 grant program can be found at https://scdhec.gov/environment/your-water-coast/watersheds-program/section-319-nonpoint-source-implementation-grants.

8.3.2 Community Development Block Grant

South Carolina Department of Commerce administers the community development block grant (CDBG) program allocation funded through the US Department of Housing and Urban Development. A main purpose of the CDBG program is to make improvements in communities where at least 50% of direct beneficiaries are low to moderate income households. For the James Island Creek watershed, this funding could be useful in funding repairs and maintenance of septic systems for low-income families. In the James Island Creek watershed, the sewer and drainage projects are eligible for funding. Further information can be found at https://www.cdbgsc.com/.

8.3.3 South Carolina Sea Grant Consortium

The SC Sea Grant Consortium is a nationally certified organization under the National Sea Grant College Program and receives its funding primarily from NOAA and US department of Commerce. According to the current 2018-2023 strategic plan, the SC Sea Grant Consortium is focused on five critical issues: the coastal and ocean landscape, sustainable coastal development and economy, hazard resilience in coastal communities, sustainable fisheries and aquaculture, and scientific literacy and workforce development. The SC Sea Grant Consortium administers a grant program to assist in achieving these goals by funding research, outreach, and education projects. The request for proposal guidelines are typically released at the beginning of February annually.

Further information regarding the grant guidelines can be found at https://www.scseagrant.org/requests-for-proposals/.

8.3.4 SCDHEC State Revolving Loan Fund Program

The SCDHEC state revolving loan program provides low-interest loans for a variety of water infrastructure projects that includes stormwater quality improvement projects. The stormwater quality projects are typically for upgrades or maintenance to address non-point source pollution issues. Further information can be found at https://scdhec.gov/environment/businesses-communities-go-green/environmental-loans-grants-businesses-communities/state.

8.4 Federal Funding Options

The most up to date federal funding announcements can be found at grants.gov.

8.4.1 USEPA Environmental Education Grants Program

The USEPA has put a focus on environmental education and environmental stewardship throughout the country. Since 1992, the USEPA has awarded between $2 and $3.5 million in grant funding per year, averaging roughly 3,800 grants per year. Grant information for fiscal year 2021 has not been announced yet, further information is available at https://www.epa.gov/education/grants.

8.4.2 USEPA Five Star and Urban Waters Restoration Grant Program

The Urban Waters Federal Partnership that is managed by the National Fish and Wildlife Foundation supports watershed restoration projects that incorporate on land management activities, public education/outreach, post-project monitoring, and strengthen community relations. Further information can be found at https://www.epa.gov/urbanwaterspartners.

8.5 Technical Assistance

A general plan is needed for the technical assistance required to pursue these funding opportunities. It is anticipated the watershed planning committee will coordinate the technical assistance needed to pursue funding opportunities. The main aspect of technical assistance needed will be the staff time to prepared funding applications. Partnership between community organizations and local governments will be essential to successful completion of funding applications and coordination. The local governments that can potentially provide technical assistance for funding pursuits include City of Charleston, Town of James Island, and Charleston County. The community organizations and other entities that can potentially provide technical assistance for the funding pursuits include Charleston Waterkeeper, Lowcountry Land Trust,

Coastal Conservation League, Open Institute, Coastal Community Foundation, and other organizations that are willing to provide technical assistance to pursuits.

9.0 TIMELINE OF ACTION PLAN

One of the main objectives of this watershed management plan is to be a guide to assist James Island Creek watershed stakeholders in future decision making to meet the SCDHEC *Enterococci* standard in the watershed. It's imperative as the planning phase is completed, there is a strategic timeline for the long-term implementation of the action plan and milestones to strive for each year. The tables below outline steps to implement the action plan proposed in Section 7.0 over the next three years for short and intermediate action and the long-term action beyond three years. The timeline includes measurable milestones for stakeholders to track implementation progress (Table 8).

Table 8: Timeline of action plan.

Implementation Activities and Strategies in 2021				
Activity/Strategy	Resources	Parties Involved	Milestones	Action Plan Item #
Development of a watershed planning committee	Reorganizing the watershed task force and adding member as needed	Municipalities within watershed, wastewater provider, local nonprofits, and other applicable individuals	The identification of the committee members, holding meetings at least 2-3 times annually, and development of how the committee operates	WW-18
Development of a watershed management plan	-Personnel Time -Information from Stakeholders within watershed -Boat for site reconnaissance	Charleston County, City of Charleston, Town of James Island, Terracon, and local non-profits	Approval of plan by SCDHEC and completion in time for eligibility of funding sources	N/A
Establish the Public Outreach and Education Committee and develop a public outreach plan	-Mobilizing the current members	Members of the Public Outreach and Education Committee	Development of a public outreach plan by the end of summer 2021 that discusses specifically how the program will run and create framework for committee. Meet twice by the end of 2021	WW-19
Pursue funding sources especially the Section 319 Grant which has initial proposal due 3/19/21	-Personnel Time -SCDHEC Approved Watershed Plan -Potential matching promises from organizations	Stakeholders involved likely the watershed planning committee and other applicable organizations	Submittal of the application packages (Section 319 proposal package on 5/28/21) and ultimately securing funding sources	All applicable WWs and SSs

Implementation Activities and Strategies in 2021				
Activity/Strategy	Resources	Parties Involved	Milestones	Action Plan Item #
Implement "Do Not Feed Wildlife" signs and other public education to prevent wildlife feeding	-Funding for Signs -Personnel Time	Charleston County, City of Charleston, Town of James Island, and other applicable organizations	Reduction of nuisance wildlife and education to reduce wildlife feeding. Implement signs by end of 2021	WW-5
Begin the "Get to Know Your Watershed" campaign	-Funding for Signs -Personnel Time	Charleston County, City of Charleston, Town of James Island, Public and Outreach Committee, and other applicable organizations	Placement of "Entering Watershed" sign along the roadway and waterway on the watershed boundary by the end of 2021. Have a community event to stencil each stormwater drain to remind people that what ends up in the stormwater drain will ultimately affect the environment	WW-1 / WW-25
Inventory the first phase priority of septic systems for removal/connection to wastewater	-Personnel -Appropriate GIS data -Property Owner Access Agreements	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed Planning Committee, and other applicable organizations	Identify 30-40 septic systems for removal and connection to municipal wastewater by the end of summer 2021 (focus on the two clusters identified in Section 5.2.1)	SS-1
Begin removal of first phase priority of septic systems and connection to wastewater as feasible	-Personnel -Appropriate GIS data -Property Owner Access Agreements -Applicable permits and coordination	Watershed Planning Committee, appropriate local agencies, and other applicable organizations	Removal of ~20 septic systems for removal and connection to municipal wastewater by end of 2021	SS-1
Continue the Charleston Waterkeeper water quality monitoring at JIC1 and JIC2	-Charleston Waterkeeper personnel and volunteers	Charleston Waterkeeper	Water quality monitoring sampling from May to October 2021	SS-2
Continual refilling and maintenance of pet waste stations	-Personnel Time	Applicable organizations	Keep the pet waste stations stocked with bags and emptied on a regular basis	WW-4

Implementation Activities and Strategies in 2021				
Activity/Strategy	Resources	Parties Involved	Milestones	Action Plan Item #
Develop a general watershed educational workshop (can be a 30-minute video)	-Personnel Time -Funding - Educational Materials and Presentation	Public Education and Outreach Committee and other applicable organizations	Develop a 30-minute workshop or video to go over general watershed education to engage residents and be transparent with the current water quality issues that will take the whole community to fix. Video can be put on county, city, and town websites	All Applicable WWs
Develop a septic educational workshop (can be a 30-minute video)	-Personnel Time -Funding - Educational Materials and Presentation	Public education and outreach committee and other applicable organizations	Develop a 30-minute workshop to discuss proper septic maintenance and potential issues. Provide resources if spill or other issues occur, promote the septic spill reporting program in development	WW-7
Partner with the City of Charleston's adopt-a-drain program	-Personnel Time -Coordination	City of Charleston, Keep Charleston Beautiful, and Public education and outreach committee	Partner with the City of Charleston's existing adopt-a-drain program in 2021 to get all stormwater drains adopted in the watershed by the end of 2023	WW-13
Begin a campaign to encourage property owners to secure trash bins and larger dumpsters,	-Personnel Time -Coordination	City of Charleston, Keep Charleston Beautiful, and Public education and outreach committee	Start campaign in heavily trafficked areas and other media to get message out	WW-22

Implementation Activities and Strategies in 2022				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
Identify funding sources and pursue funding sources as needed	-Personnel Time -SCDHEC Approved	Stakeholders involved likely the watershed planning committee and	Submittal of the application packages and ultimately securing funding sources	All applicable WWs and SSs

Implementation Activities and Strategies in 2022				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
	Watershed Plan -Potential matching promises from organizations	other applicable organizations		
Continue the Charleston Waterkeeper water quality monitoring at JIC1 and JIC2	-Charleston Waterkeeper personnel and volunteers	Charleston Waterkeeper	Water quality monitoring sampling from May to October 2022	SS-2
Working with appropriate animal control centers and animal rescue centers to assess the feral cat and stray dog population within watershed	-Personnel Time -Partnership with applicable animal control and animal rescue centers	Applicable animal control centers and animal rescue centers, watershed planning committee, and other applicable organizations	Get a rough numerical assessment of the feral cat and stray dog population within the watershed. Consider a spay, neuter, and release program based on assessment results	WW-3
Continual refilling and maintenance of pet waste stations	-Personnel Time	Applicable organizations	Keep the pet waste stations stocked with bags and emptied on a regular basis	WW-4
Assessment to determine if the watershed has enough pet waste stations	-Personnel Time -Partner with applicable organizations	Charleston County, City of Charleston, Town of James Island, CCPRC, and other applicable organizations	Add pet waste stations if assessment shows need	WW-4
Partnering with schools in the local area to provide education to youth regarding the importance of watershed water quality and its benefit to the community	-Personnel Time -Educational Materials and Presentation	Local Schools and Public Outreach and Education Committee for watershed	-Provide 2 educational workshops at 2 different schools by end of 2022 (pending feasibility). Try to make educational workshops for watershed quality an annual task	WW-11
Finish removal of the first phase priority of septic systems for removal/connection to wastewater	-Personnel Time -Appropriate GIS data	Watershed Planning Committee, appropriate local agencies, and	Removal of the remaining first phase priority of septic systems for removal and connection to municipal wastewater by end of 2022	SS-1

Implementation Activities and Strategies in 2022				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
	-Property Owner Access Agreements -Applicable permits and coordination -Funding	other applicable organizations		
Inventory the second phase priority of septic systems for removal/connection to wastewater	-Personnel Time -Appropriate GIS data -Property Owner Access Agreements -Funding	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed Planning Committee, and other applicable organizations	Identify 30-40 septic systems for removal and connection to municipal wastewater by the end of summer 2022 (focus on the two clusters identified in Section 5.2.1)	SS-1
Removal of the second phase priority of septic systems for removal/connection to wastewater	-Personnel Time -Appropriate GIS data -Property Owner Access Agreements -Funding	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Removal of the second phase priority of septic systems for removal and connection to municipal wastewater by end of 2022	SS-1
Development of a septic spill response program	-Personnel Time -Appropriate GIS data -Property Owner Access Agreements -Funding	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Create a citizen reporting system (online or by phone) for septic spills to prevent further water quality issues. Target it for septic owners include with workshop	WW-8
Present the septic education workshop annually for properties still on septic	-Personnel Time -Septic Education Workshop	Watershed planning committee, Public outreach and education committee, and other applicable organizations	Present the septic education workshop annually to provide resource as preventative management for the remaining tanks in the watershed	WW-7
Encourage the use of rain barrels and other rain collection	-Personnel Time -Funding	Public education and outreach committee and	Create educational materials to be displayed at county parks and other highly	WW-6

Implementation Activities and Strategies in 2022				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
devices for private property to help reduce the amount of stormwater runoff	- Educational Materials and Presentation	other applicable organizations	trafficked areas including county, city, and town websites. The local organizations can also promote this. Promotion material should be out by end of 2021 and could be in conjunction with watershed workshop	
Encourage owners of typically agricultural animals (chickens, pigs, horses, etc.) to practice proper waste management	-Personnel Time -Targeted Audience	City of Charleston, Town of James Island, Charleston County, and Public education and outreach	Increase knowledge of targeted audience to practice proper waste management	WW-21
Identify any areas for stream and wetland restoration, pursue as applicable	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Assess the suitability of stream and wetland restoration in applicable areas	WW 15/16
Installation of a bio-retention pond to encourage stormwater infiltration and land cover	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	The installation of one bio-retention pond within the watershed by 2026	WW-24

Implementation Activities and Strategies in 2023 and Beyond				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
Continue the Charleston Waterkeeper water quality monitoring at JIC1 and JIC2, consider adding a	-Charleston Waterkeeper personnel and volunteers	Charleston Waterkeeper	Water quality monitoring sampling from May to October 2023 and beyond	SS-2

Implementation Activities and Strategies in 2023 and Beyond				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
JIC3 in Simpson Creek to monitor septic removal progress				
Continual refilling and maintenance of pet waste stations	-Personnel Time	Applicable organizations	Keep the pet waste stations stocked with bags and emptied on a regular basis	WW-4
Partnering with schools in the local area to provide education to youth regarding the importance of watershed water quality and its benefit to the community	-Personnel Time -Educational materials and presentation for workshop prepared by Public Outreach and Education Committee	Local Schools and Public Outreach and Education Committee for watershed	Provide 2 educational workshops at 2 different schools by end of 2023 (pending feasibility). Try to make educational workshops for watershed quality an annual task	WW-11
Identify funding sources and pursue funding sources as needed	-Personnel Time -SCDHEC Approved Watershed Plan -Potential matching promises from organizations	Stakeholders involved likely the watershed planning committee and other applicable organizations	Submittal of the application packages and ultimately securing funding sources	All applicable WWs and SSs
Determine if a third priority of septic systems removal/connection to wastewater is necessary. Performing perc tests in areas still with septic is cost-effective approach to determine if soil is suitable for septic	-Personnel Time -Appropriate GIS data -Property Owner Access Agreements -Funding	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Perform perc tests at properties with septic where necessary to determine if further septic removal is necessary after removal of highest priority septic. Take action as deemed necessary	SS-1
Development of a vegetative buffer incentive program for private home's backyards to	-Personnel Time -State Agencies	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed	Development of vegetative buffer program through assistance with applicable state agencies and	WW-2

Implementation Activities and Strategies in 2023 and Beyond				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
reduce stormwater runoff volume	-Local Agencies -Public Interest -Funding for educational materials	planning committee, and other applicable organizations	resources by the end of 2024	
Continue on-going tree-planting activities	-Funding -Materials for Planting	Applicable Organizations	Continue the on-going tree-planting activities in the watershed that are prevalent throughout the Charleston area to improve land cover	WW-12
Encourage and incentivize the use of pervious surfaces for private properties and public infrastructure	-Funding -Public Interest -Funding for educational materials -Local/State Agency Interest	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Begin to add pervious surface in areas throughout the watershed to reduce stormwater runoff volume	WW-9 & WW-10
Present the septic education workshop annually for properties still on septic	-Personnel Time -Septic Education Workshop	Watershed planning committee, Public outreach and education committee, and other applicable organizations	Present the septic education workshop annually to provide resource as preventative management for the remaining tanks in the watershed	WW-7
Performing a flow pattern/tidal exchange study within an applicable section of James Island Creek (JIC2 is recommended)	-Research associates -Funding	Watershed planning committee, funding source, research institution, and other applicable organizations	Determine a flow number in an applicable part of the creek to determine *Enterococci* load for monitoring stations	SS-3
Determine whether a source tracking of the fecal bacteria is necessary and perform assessment as needed	-Funding -Personnel time	Watershed planning committee, Charleston Watershed, and other applicable organizations	Assess whether source tracking is necessary based on the CWK monitoring data. If need, perform a fecal bacteria source investigation at JIC1 and JIC2	WW-14

Implementation Activities and Strategies in 2023 and Beyond				
Activity/Strategy	**Resources**	**Parties Involved**	**Milestones**	**Action Plan Item #**
Installation of a bio-retention pond to encourage stormwater infiltration and land cover	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	The installation of one bio-retention pond within the watershed by 2026	WW-24
Identify any areas for stream and wetland restoration, pursue as applicable	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Assess the suitability of stream and wetland restoration in applicable areas	WW 15/16
Identify stormwater ponds or other ponds for the installation of a floating wetland mechanism	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Assess and identify areas for a stormwater pond or other applicable areas for floating wetland mechanism.	WW-17
The promotion of roof gardens including green roofs within watershed	-Funding -Personnel time -Vendor -Targeted Audience	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Increase of roof gardens/green roofs within watershed	WW-20
Install a greenway within the watershed	-Funding -Personnel time -Vendor -Appropriate Data needed to make location decision	Charleston County, City of Charleston, Town of James Island, Charleston Water, Watershed planning committee, and other applicable organizations	Develop a greenway trail to improve stormwater infiltration	WW-23

The ultimate objective of the above timeline is to achieve water quality standards at James Island Creek watershed as efficiently and effectively as a possible within a reasonable timeframe.

10.0 MEASURABLE MILESTONES

The table below describes each BMP and measurable milestone to monitor progress of the implementation plan. The measurable milestone table should be used as a guide to monitor progress and should not be relied upon solely as things may change during the implementation phase.

Time Period	BMP #	Measurable Milestones	Deliverable	Completed
2021	WW-18	Development of a Watershed Planning Committee (specifically for implementation phase of plan)	Formalized Watershed Planning Committee	
	WW-19	Establish the Public Outreach and Education Committee	Formalized Public Outreach and Education Committee	
	WW-1	Start the "get to know your watershed" campaign	Adding "Entering Watershed" signs throughout watershed and have workshop developed	
	N/A	Pursue Section 319 Grant in 2021	Submit Section 319 completed grant package by May deadline	
	WW-22	Begin a campaign to encourage property owners to secure trash bins and larger dumpsters	Start campaign in heavily trafficked areas and other media to get message out	
	WW-5	Discouragement of people feeding wildlife specifically birds within the watershed	Place "Do Not Feed Wildlife signs" in public parks and other highly congregated areas within watershed	
	WW-4	Continue refilling and maintenance of pet waste stations	Keep the pet waste stations stocked with bags and emptied on a regular basis	

Time Period	BMP #	Measurable Milestones	Deliverable	Completed
	WW-13	Partner with the City of Charleston's adopt-a-drain program	Get 75% of stormwater drains adopted within the watershed	
	SS-1	Inventory the first phase priority of septic systems for removal/connection to wastewater	Identify 30-40 septic systems for removal and connection to municipal wastewater	
	SS-1	Begin removal of first phase priority of septic systems and connection to wastewater as feasible	Removal of ~20 septic systems for removal and connection to municipal wastewater by end of 2021	
	WW-7	Develop a septic educational workshop	Develop a 30-minute workshop to discuss proper septic maintenance and potential issues	
	WW-25	Have an event where community members especially children help stencil each stormwater drain within the watershed remind people that what ends up in a stormwater drain will ultimately impact the environment	Implement an event where the stormwater stenciling for a majority of the stormwater drains within the watershed.	
2022	WW-6	Encouragement and incentivizing of rainfall collection devices for rainwater harvesting and reuse	Increase of rainfall collection devices within watershed	

Time Period	BMP #	Measurable Milestones	Deliverable	Completed
	WW-3	Working with appropriate animal control centers and animal rescue centers to assess feral cat and stay dog population	Get a rough numerical assessment of the feral cat and stray dog population. Consider a spay, neuter, and release program based on assessment results	
	WW-12	Conduct tree plantings utilizing native trees and shrubs to improve land cover	Conduct a tree planting with community organizations once a quarter	
	WW-11	Partnering with schools in the local area to provide education to youth regarding the importance of watershed water quality and its benefit to the community	Provide 2 educational workshops at 2 different schools by end of 2022 (pending feasibility)	
	SS-1	Finish removal of the first phase priority of septic systems for removal/connection to wastewater	Removal of the remaining first phase priority of septic systems for removal and connection to municipal wastewater by end of 2022	
	N/A	Pursue funding sources as needed	Submit at least 2 application for funding sources	
	SS-2	Continue the Charleston Waterkeeper water quality monitoring at JIC1 and JIC2	Weekly water quality data from May to October	
	WW-21	Encourage owners of typically agricultural animals (chickens, pigs, horses, etc.) to practice proper waste management	Increase knowledge to practice proper waste management	

Time Period	BMP #	Measurable Milestones	Deliverable	Completed
	SS-1	Inventory the second phase priority of septic systems for removal/connection to wastewater	Identify 30-40 septic systems for removal and connection to municipal wastewater by the end of summer 2022	
	SS-1	Removal of the second phase priority of septic systems for removal/connection to wastewater	Removal of the second phase priority of septic systems for removal and connection to municipal wastewater by end of 2022	
2023 and Beyond	WW-24	Installation of a bio-retention pond to encourage stormwater infiltration and land cover	The installation of one bio-retention pond within the watershed by 2026	
	SS-1	Determine if a third priority of septic systems removal/connection to wastewater is necessary	Perform perc tests at properties with septic where necessary to determine if further septic removal is necessary after removal of highest priority septic	
	SS-3	Performing a flow pattern/tidal exchange study within an applicable section of JI Creek (JIC2 recommended)	Estimate load of *Enterococci* at a monitoring station	
	WW-14	Source tracking study of the fecal indicator bacteria within watershed	Begin study and start to determine specific sources of bacteria within watershed	
	WW-2	Incentivizing the installation of vegetative buffers by property owners along water bodies	Increase the vegetative buffer cover along water body banks	

Time Period	BMP #	Measurable Milestones	Deliverable	Completed
	WW-9/WW-10	Incentivizing the use of pervious surfaces for private/commercial impervious surfaces	Increase the pervious surface cover within the watershed	
	WW-8	Development of an uniform septic policy for the watershed. A septic spill response plan needs to be developed to accompany the policy	Develop an uniform septic policy for watershed. Lay framework for a septic spill response plan.	
	N/A	Pursue funding sources as needed	Submit at least 2 application for funding sources per year	
	WW-23	Install a greenway within the watershed	Develop a greenway trail to improve stormwater infiltration	
	WW-17	Identify stormwater ponds or other ponds for the installation of a floating wetland mechanism	Priority areas for a floating wetland mechanism	
	WW-20	The promotion of roof gardens including green roofs within watershed	Increase of roof gardens/green roofs within watershed	
	WW-15/16	Identify any areas for stream and wetland restoration, pursue as applicable	Priority areas for stream and wetland restoration	

11.0 REFERENCES

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12.0 ACKNOWLEDGEMENTS

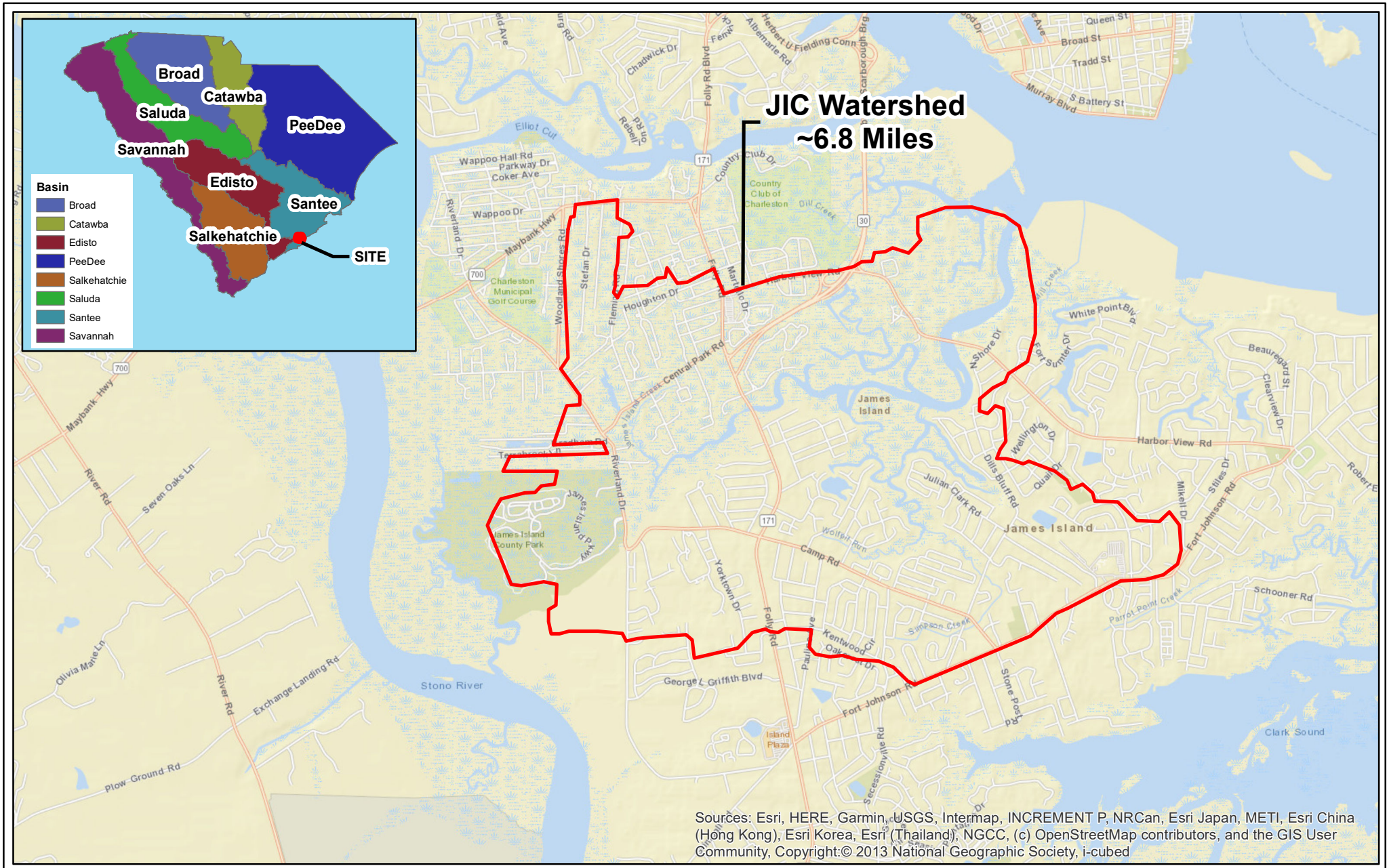
As the lead author, the James Island Creek watershed management plan has been a project of a lifetime and an opportunity that I will not soon forget. I would like to first thank Patrick Moore of Open Space Institute for allowing us the opportunity to assist with this watershed management plan. Terracon was excited for this opportunity to help clean this creek when you hear citizen's passion like Patrick's and others when discussing the present water quality issues at James Island Creek.

From the beginning of the project, the Charleston Waterkeeper specifically Andrew Wunderly has been an integral part in coordination of various aspects of this project. Specifically, Charleston Waterkeeper helped coordinate meetings, provided their essential annual water quality data, and provided their boat to assist during site reconnaissance of James Island Creek. It is organizations like Charleston Waterkeeper that advocate daily for clean water resources and do the essential little things that lead to large action like this watershed management plan. I would like to thank the other stakeholders which included Charleston Water Systems, Charleston County, City of Charleston, and Town of James Island for their assistance throughout the project and data support. I would also like to thank Andy Miller and Banu Varlick of SCDHEC for their guidance and resources throughout the project. Finally, I would like to thank my supervisor at Terracon Andy Ruocco for giving me opportunity to work on this project and reviewing the management plan.

The watershed management plan has been an incredible learning opportunity for all parties involved and has taught us many lessons throughout the process. I hope the watershed management plan has been made with a successful community-first approach and will be an indispensable tool as the planning process transitions into the implementation phases. In the future, I hope to continue to assist with James Island Creek as needed and help other impaired watersheds in the Lowcountry area.

Will Vesely, M.S.
Environmental Scientist, Terracon Consultants – Charleston, SC office

APPENDIX A
MAPS



N

Legend

JIC Watershed Boundary

0 2,000 4,000 8,000 Feet

Project No.	EN207433
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon
1450 Fifth Street West N.Charleston, SC 29405
Phone: 843.884.1234 Fax: 843.884.9234

James Island Creek Watershed Location

Watershed Management Plan
James Island Creek Watershed
James Island, Charleston County, South Carolina

EXHIBIT NO.

N

0 1,500 3,000 6,000 Feet

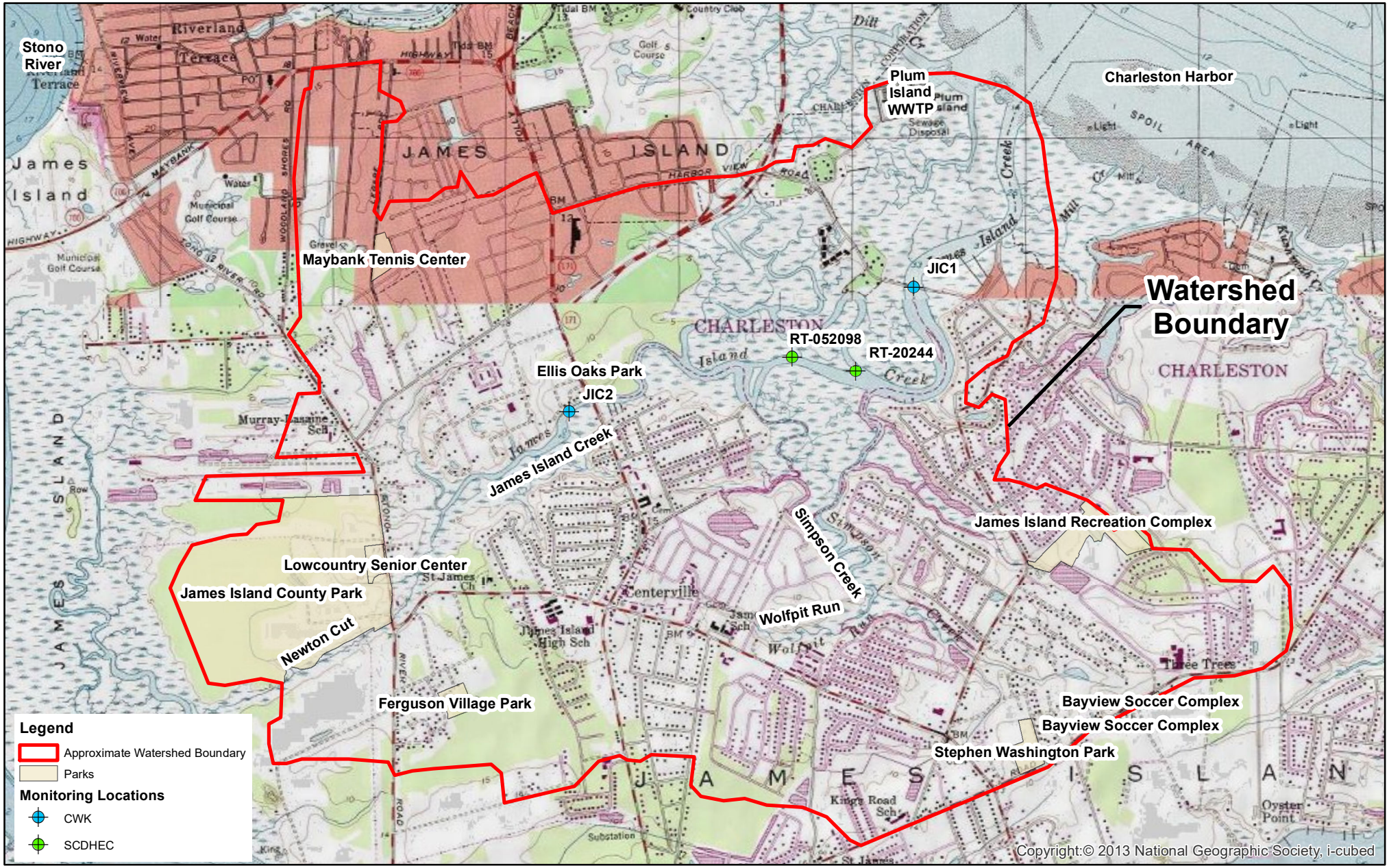
Project No.	EN207433
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon
1450 Fifth Street West N.Charleston, SC 29405
Phone: 843.884.1234 Fax: 843.884.9234

James Island Creek Watershed - Monitoring Locations

Watershed Management Plan
James Island Creek Watershed
James Island, Charleston County, South Carolina

EXHIBIT NO.



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Project No.	
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon

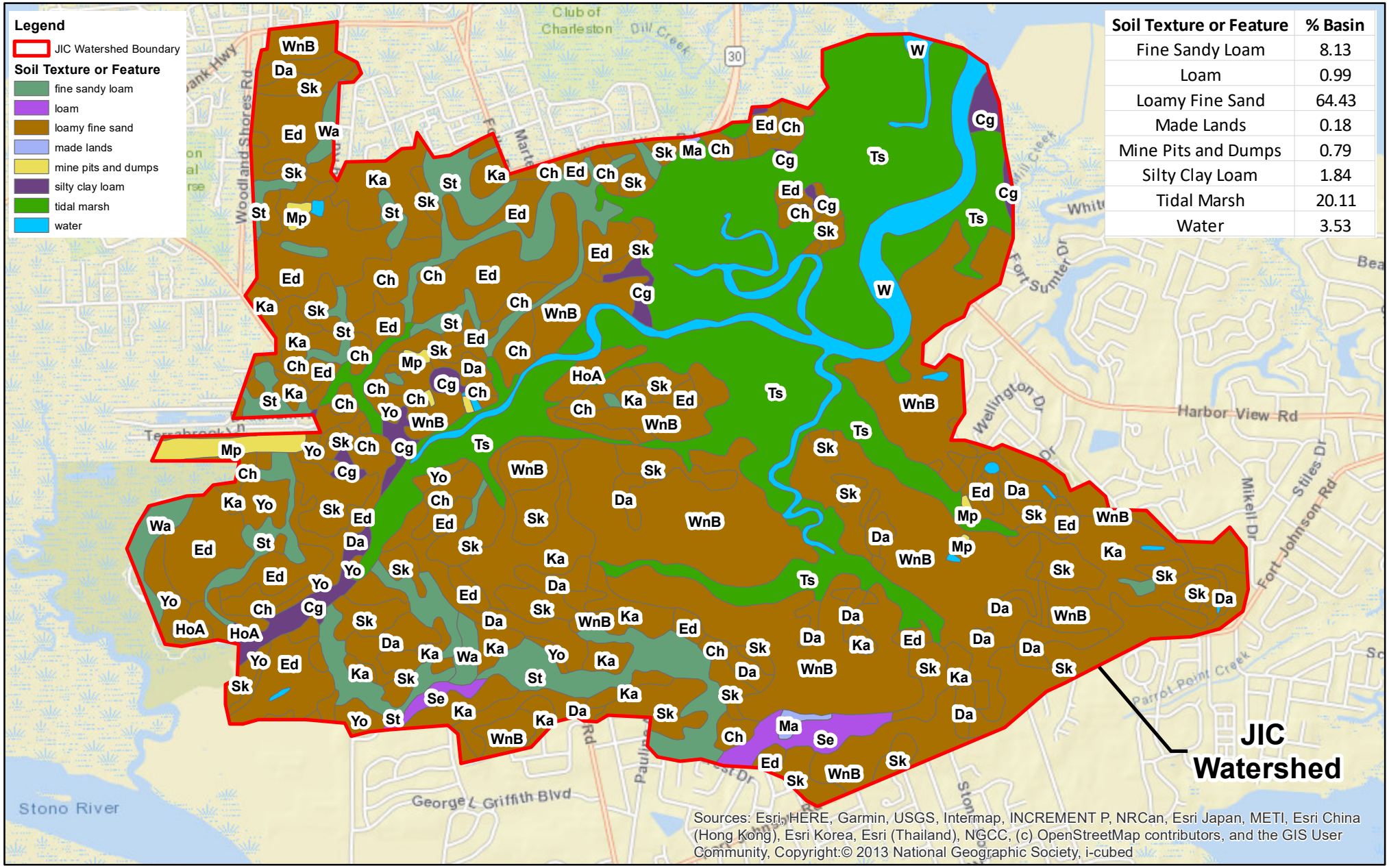
1450 Fifth Street West N.Charleston, SC 29405

Phone: 843.884.1234 Fax: 843.884.9234

JI Creek - Monitoring Locaitons

Watershed Management Plan
James Island Creek Watershed
James Island, Charleston County, South Carolina

EXHIBIT NO.



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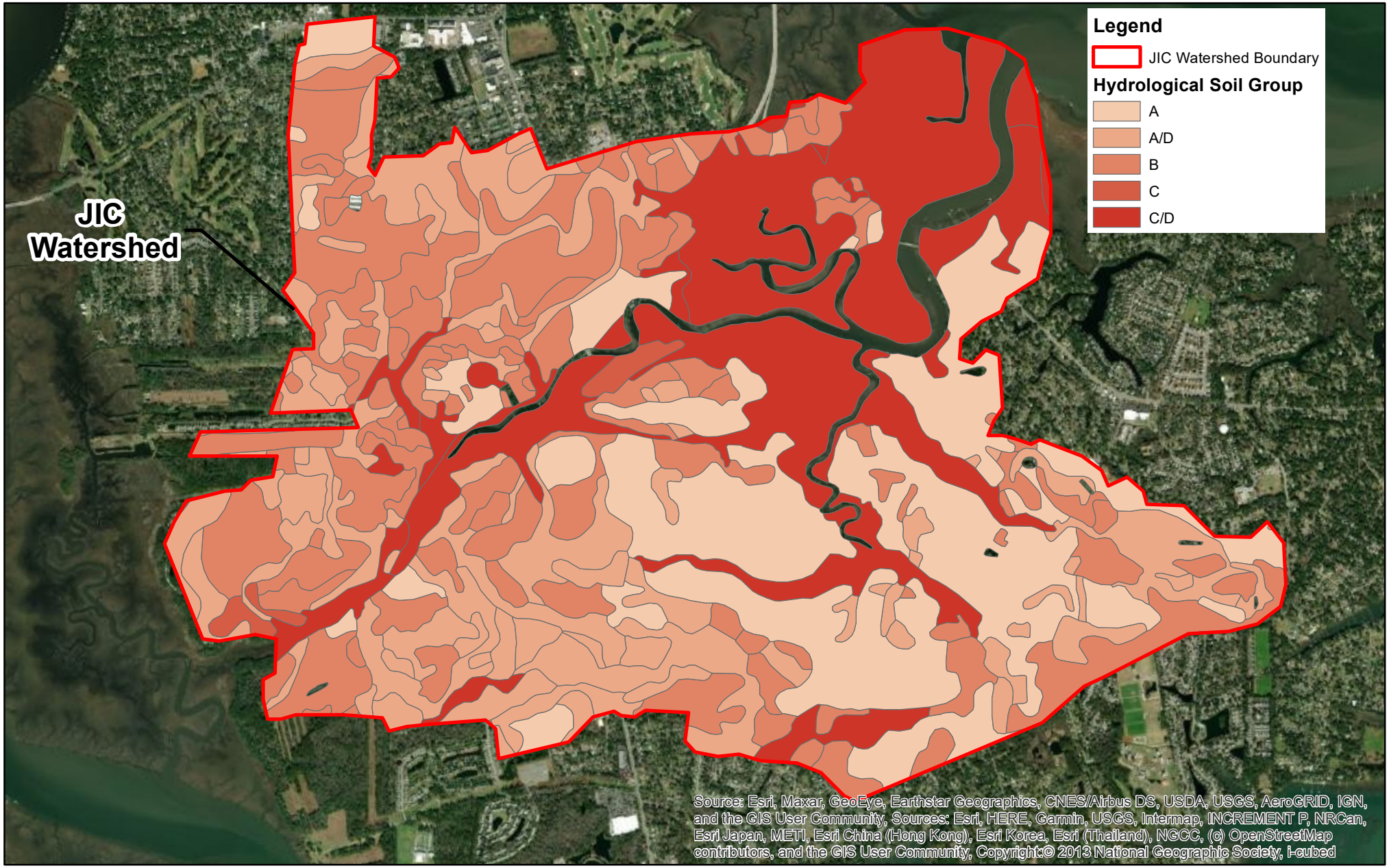
Project No.	EN207473
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon
1450 Fifth Street West N.Charleston, SC 29405
Phone: 843.884.1234 Fax: 843.884.9234

NRCS Soils Map

Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.



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Project No.	EN207473
PM:	WV
Drawn By:	WV
Date:	12/4/20

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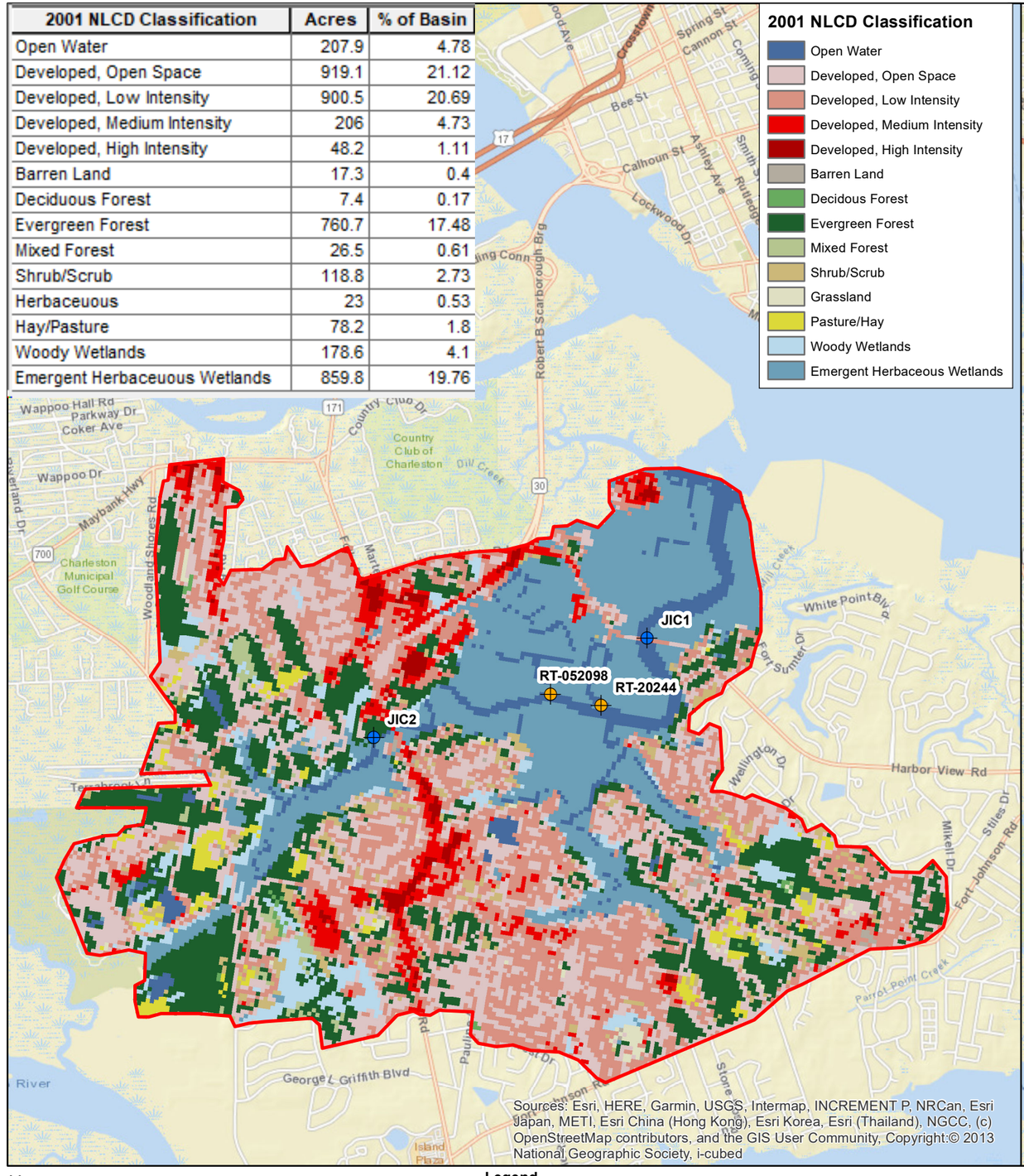
NRCS Soils Map - Hydrological Soils Group

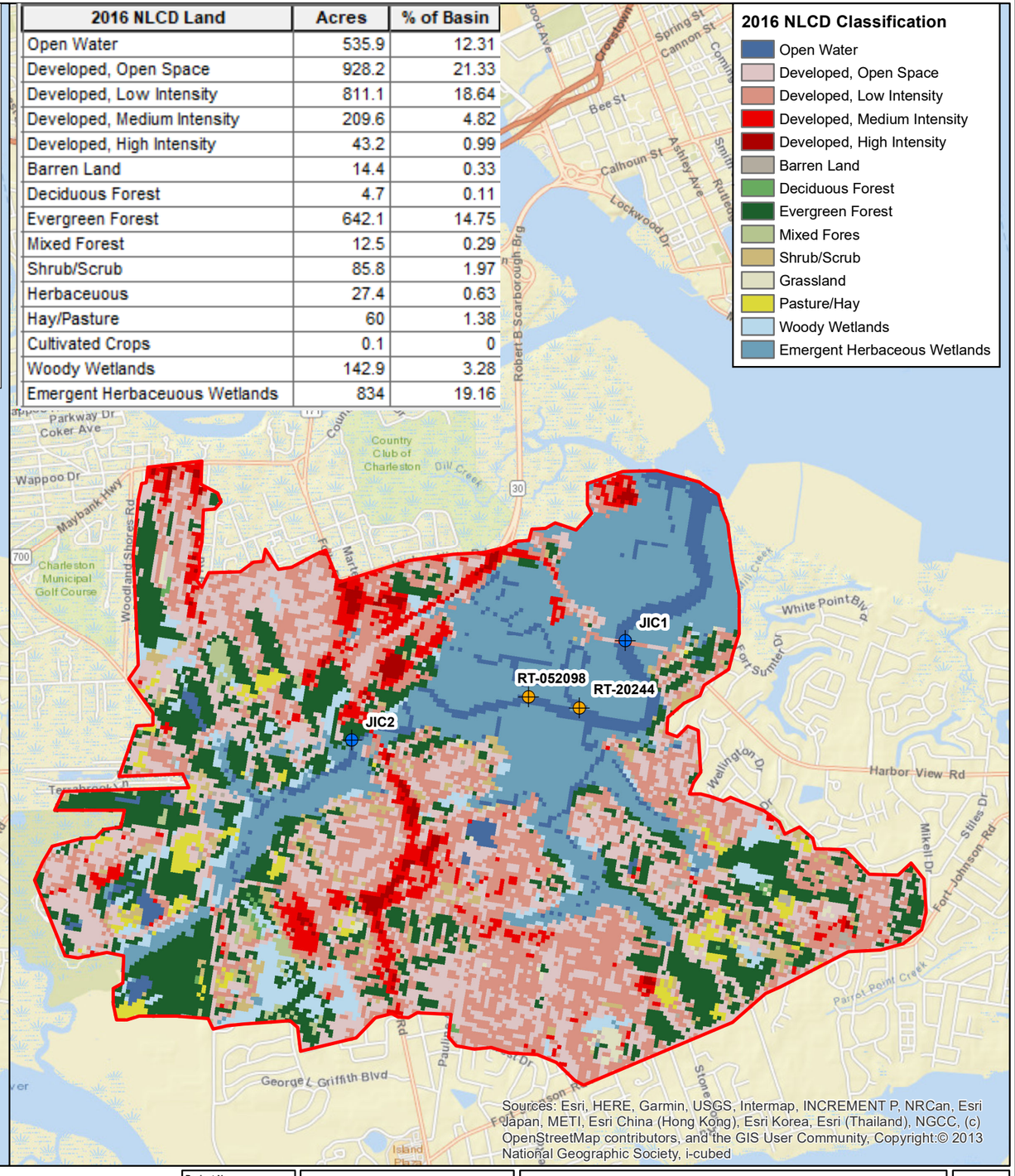
Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.

2001 NLCD Classification	Acres	% of Basin
Open Water	207.9	4.78
Developed, Open Space	919.1	21.12
Developed, Low Intensity	900.5	20.69
Developed, Medium Intensity	206	4.73
Developed, High Intensity	48.2	1.11
Barren Land	17.3	0.4
Deciduous Forest	7.4	0.17
Evergreen Forest	760.7	17.48
Mixed Forest	26.5	0.61
Shrub/Scrub	118.8	2.73
Herbaceuous	23	0.53
Hay/Pasture	78.2	1.8
Woody Wetlands	178.6	4.1
Emergent Herbaceuous Wetlands	859.8	19.76



2016 NLCD Land	Acres	% of Basin
Open Water	535.9	12.31
Developed, Open Space	928.2	21.33
Developed, Low Intensity	811.1	18.64
Developed, Medium Intensity	209.6	4.82
Developed, High Intensity	43.2	0.99
Barren Land	14.4	0.33
Deciduous Forest	4.7	0.11
Evergreen Forest	642.1	14.75
Mixed Forest	12.5	0.29
Shrub/Scrub	85.8	1.97
Herbaceuous	27.4	0.63
Hay/Pasture	60	1.38
Cultivated Crops	0.1	0
Woody Wetlands	142.9	3.28
Emergent Herbaceuous Wetlands	834	19.16



N

0 1,500 3,000 6,000 Feet

Legend

JIC Watershed Boundary

Monitoring Location

CWK

SCDHEC

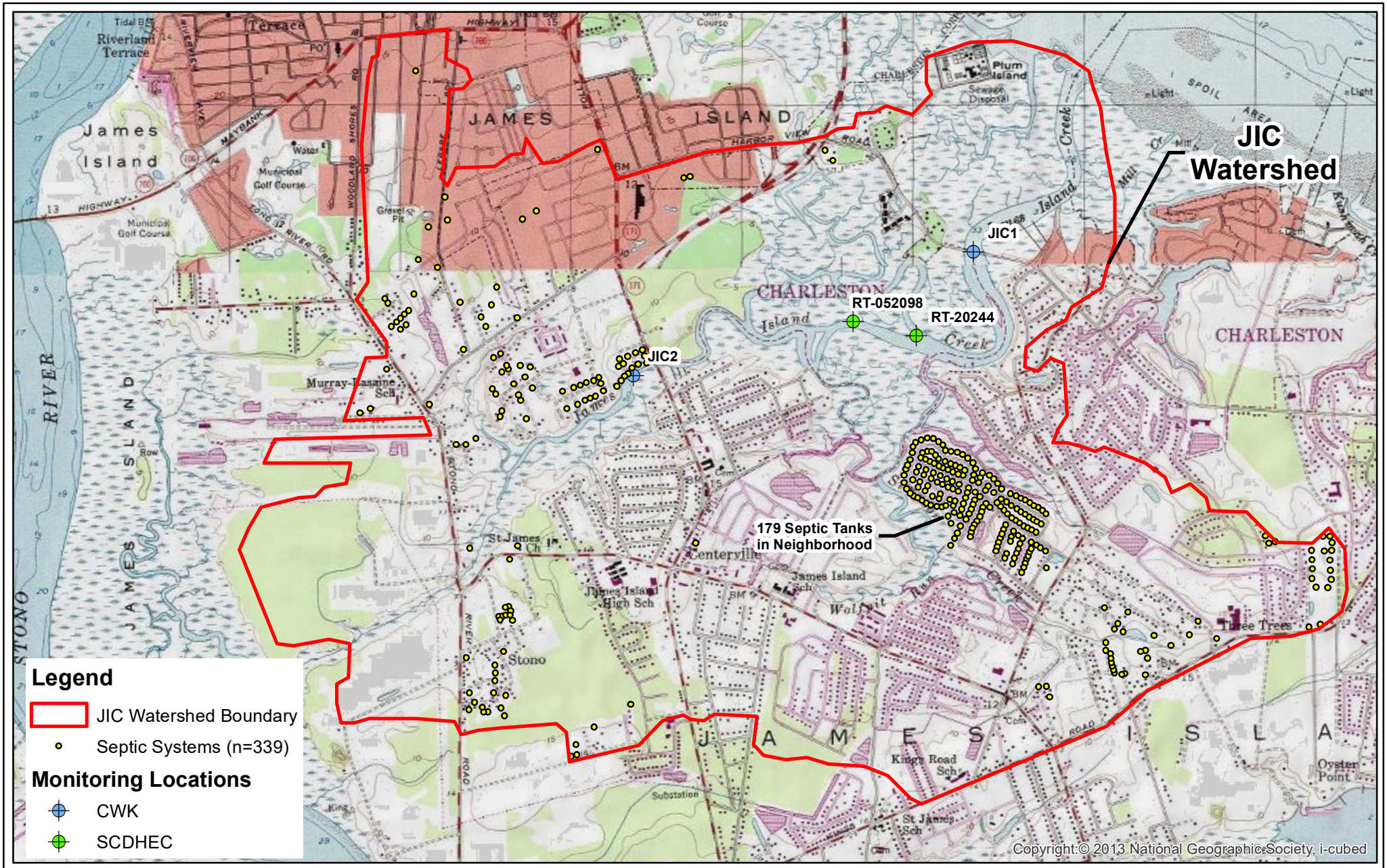
Project No.	
PM:	WV
Drawn By:	WV
Date:	2/5/2021

Terracon
1450 Fifth Street West N.Charleston, SC 29405
Phone: 843.884.1234 Fax: 843.884.9234

NLCD Land Cover: 2001 vs 2016

Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.



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Project No.	EN207433
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon
1450 Fifth Street West N.Charleston, SC 29405
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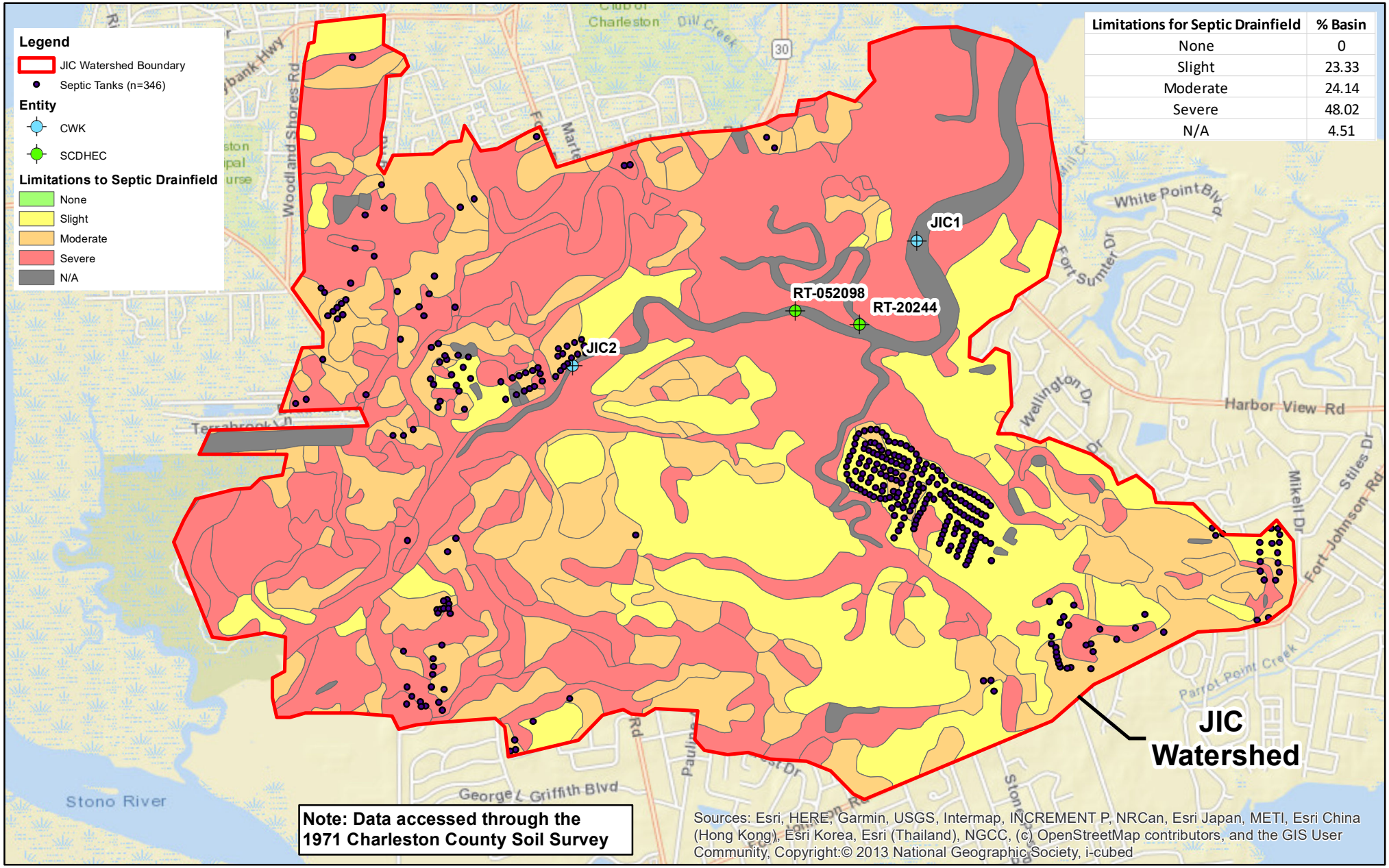
Approximate Septic Systems in JI Creek Watershed

Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.



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PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon

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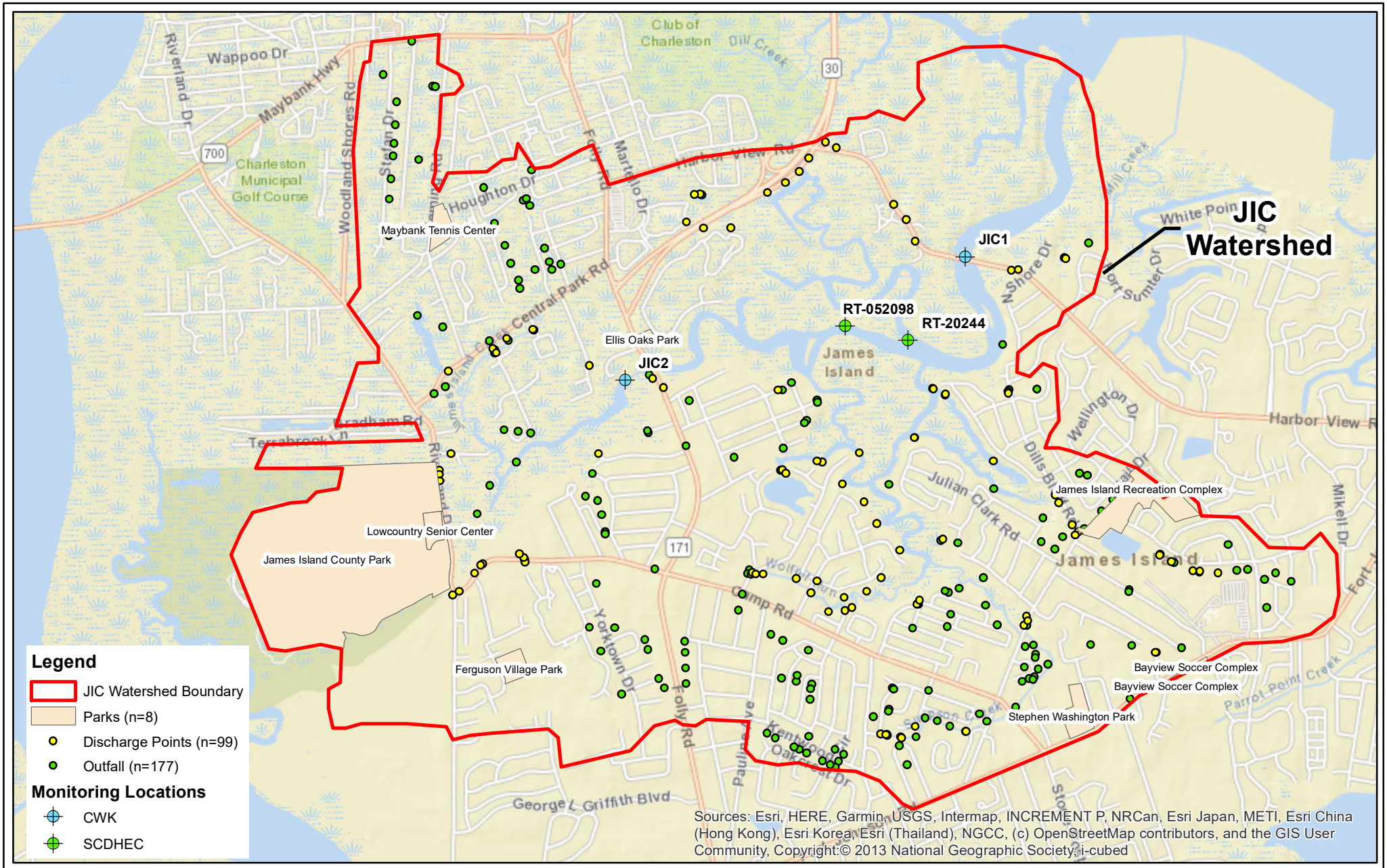
NRCS Soils Map - Limitation to Septic Drainfield

Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.



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Project No.	EN207473
PM:	WV
Drawn By:	WV
Date:	12/4/20

Terracon
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Stormwater Discharge Points

Watershed Management Plan
James Island Creek
James Island, Charleston County, South Carolina

EXHIBIT NO.

APPENDIX B
2013-2020
James Island Creek Watershed Data

JIC1

Sampling Date	Time	Enterococci (MPN/100 mL)	Rainfall in last 24 hours (in)	Tide Stage	Weather	Wind/Current
2013-07-10	8:48:00	52	0.00	3/4 flood	fair	SW
2013-07-17	8:33:00	121	0.00	ebb	fair	NW
2013-07-24	8:39:00	52	0.00	3/4 flood	fair	WSW
2013-07-31	8:57:00	166	0.11	3/4 ebb	fair	S
2013-08-07	8:45:00	10	0.00	flood	fair	SE
2013-08-14	8:34:00	140	0.00	1/4 flood	partly cloudy	W
2013-08-21	8:47:00	31	0.17	flood	clear	N
2013-08-28	8:38:00	120	0.00	ebb	fair	SW
2013-09-04	8:54:00	60	2.08	flood	fair	SW
2013-09-11	8:45:00	100	0.00	1/4 flood	fair	E
2013-09-18	8:57:00	30	0.23	flood	fair	NNE
2013-09-25	8:32:00	132	0.00	1/4 flood	fair	NE
2013-10-02	8:44:00	30	0.00	1/4 ebb	sunny	N
2013-10-09	8:28:00	262	0.00	1/4 flood	cloudy	NNE
2013-10-16	8:48:00	161	0.00	1/4 ebb	fair	N
2013-10-23	8:43:00	144	0.04	1/4 flood	fair	NW
2013-10-30	8:50:00	613	0.00	1/2 ebb	fair	NNE
2014-05-07	8:36:00	63	0.00	ebb	clear	calm
2014-05-14	8:45:00	20	0.00	flood	clear	calm
2014-05-21	8:30:00	256	0.00	ebb	clear	SW
2014-05-28	8:26:00	31	0.00	flood	clear	SW
2014-06-04	8:39:00	20	0.00	ebb	clear	W
2014-06-11	8:23:00	20	0.00	1/4 ebb	clear	calm
2014-06-18	8:25:00	52	0.00	1/4 flood	clear	calm
2014-06-25	8:28:00	52	0.00	1/4 ebb	cloud	W
2014-07-02	8:21:00	41	0.00	1/4 flood	clear	calm
2014-07-09	8:25:00	10	0.00	1/2 ebb	clear	SW
2014-07-16	8:24:00	134	0.07	1/4 flood	cloud	calm
2014-07-23	8:25:00	20	0.32	1/4 ebb	clear	calm
2014-07-30	8:25:00	31	0.11	1/4 flood	cloud	calm
2014-08-06	8:28:00	63	0.31	3/4 ebb	clear	W/calm
2014-08-13	8:28:00	41	0.02	1/2 flood	clear	W
2014-08-20	8:28:00	31	0.03	3/4 ebb	clear	SW
2014-08-27	9:43:00	20	0.00	3/4 flood	clear	N
2014-09-03	10:03:00	63	0.03	ebb	fair	SW
2014-09-10	8:36:00	41	0.00	3/4 flood	fair	calm/SE
2014-09-17	8:45:00	441	0.83	ebb	clear	NE
2014-09-24	9:47:00	1467	n/a	flood	cloud	N
2014-10-01	8:28:00	345	n/a	ebb	clear	calm
2014-10-08	8:33:00	52	0.00	flood	clear	calm/W
2014-10-15	9:38:00	833	0.95	1/4 flood	cloud	calm
2014-10-22	8:18:00	96	0.01	1/4 ebb	clear	N
2014-10-29	8:57:00	85	0.00	1/4 flood	cloud	SW
2015-05-06	9:48:00	10	0.00	3/4 flood	fair	NNE
2015-05-13	9:00:00	121	0.00	3/4 ebb	cloud	W
2015-05-20	8:40:00	51	0.00	1/2 flood	clear	calm
2015-05-27	8:18:00	41	0.00	3/4 ebb	clear	SE
2015-06-04	9:38:00	97	0.4	3/4 flood	rain	N
2015-06-10	8:36:00	480	1.41	low	cloud	calm
2015-06-17	8:50:00	158	0.00	3/4 flood	clear	SW
2015-06-24	8:30:00	30	0.00	3/4 ebb	clear	SW
2015-07-01	10:29:00	52	0.00	1/2 ebb	clear	SW
2015-07-08	8:30:00	75	0.01	low	fair	SSW

2015-07-15	8:35:00	10	0.00	high	fair	WSW
2015-07-22	8:30:00	51	0.05	1/4 flood	clear	W
2015-07-29	9:53:00	62	0.00	1/2 ebb	clear	N
2015-08-05	8:20:00	211	0.00	1/4 flood	fair	SSW
2015-08-12	8:35:00	10	0.00	1/4 ebb	clear	WNW
2015-08-19	8:50:00	2098	2.51	1/2 flood	clear	S
2015-08-26	8:49:00	134	0.00	1/2 ebb	cloud	SW
2015-09-02	8:36:00	63	0.00	1/2 flood	clear	NW
2015-09-09	8:41:00	331	0.60	1/2 ebb	fair	calm
2015-09-16	8:38:00	110	0.00	1/2 flood	fair	NE
2015-09-23	9:44:00	131	0.00	ebb	cloud	NNE
2015-09-30	9:40:00	41	0.00	flood	clear	calm
2015-10-07	9:58:00	355	0.00	slack ebb	clear	NE
2015-10-14	9:03:00	187	0.00	3/4 flood	clear	W
2015-10-21	9:30:00	211	0.00	1/4 flood	clear	NE
2015-10-28	10:14:00	1281	0.72	1/4 ebb	rain	SW
2016-05-04	1040	155	0.66	3/4 ebb	clear	E/SE
2016-05-11	0950	31	0.00	1/2 flood	clear	NE
2016-05-18	1021	160	0.82	1/2 ebb	cloud	SE
2016-05-25	1033	10	0.00	flood	fair	W
2016-06-01	0820	146	0.01	1/2 ebb	clear	SE
2016-06-08	1012	41	0.00	3/4 flood	fair	SW
2016-06-15	0900	135	0.00	1/2 ebb	clear	SW
2016-06-22	0827	20	0.00	1/2 flood	clear	calm
2016-06-29	0839	663	0.39	3/4 ebb	cloud	calm
2016-07-06	0827	52	0.00	1/2 flood	clear	E
2016-07-13	0837	72	0.00	3/4 ebb	clear	SW
2016-07-20	0831	109	0.01	flood	cloud	N
2016-07-27	1022	20	0.00	1/4 flood	fair	calm
2016-08-10	0815	146	0.05	ebb	cloud	SW
2016-08-17	1011	216	0.00	1/4 ebb	fair	SW
2016-08-24	0852	41	0.00	ebb	fair	NE
2016-08-31	0843	86	0.21	flood	cloud/rain	N
2016-09-07	0844	41	0.00	1/4 flood	clear	SW
2016-09-21	0855	63	0.00	1/4 flood	cloud	calm
2016-09-28	0838	85	0.00	1/4 ebb	fair	N
2016-10-12	0858	399	0.00	1/2 ebb	cloud	calm
2016-10-19	0835	98	0.00	1/2 flood	clear	NW
2016-10-26	0841	120	0.00	1/2 ebb	clear	N
2017-05-03	0905	41	0.00	ebb	clear	W
2017-05-10	0833	10	0.00	flood	clear	SE
2017-05-17	0836	161	0.00	1/4 flood	fair	E
2017-05-24	0831	884	3.10	flood	fair	W
2017-05-31	0829	135	0.00	ebb	clear	W
2017-06-07	0832	292	3.25	flood	rain	SSW
2017-06-14	0858	41	0.00	1/4 flood	fair	calm
2017-06-21	0845	305	0.65	1/4 ebb	cloud	WSW
2017-06-28	0840	97	0.00	1/4 flood	clear	calm
2017-07-05	0930	41	0.00	1/2 ebb	clear	SW
2017-07-12	0826	132	0.00	3/4 flood	clear	calm
2017-07-19	0854	107	0.00	3/4 ebb	clear	N
2017-07-26	1050	63	0.08	3/4 flood	cloud	SW
2017-08-02	0834	84	0.00	3/4 ebb	clear	SE
2017-08-09	0824	145	0.34	3/4 flood	cloud	calm
2017-08-16	0852	156	0.00	3/4 ebb	clear	calm

2017-08-23	0855	51	0.00	3/4 flood	cloud	N
2017-08-30	1024	2489	0.00	ebb	cloud	calm
2017-09-06	0845	218	0.98	1/4 ebb	rain	calm
2017-09-14	0938	272	0.00	ebb	fair	N
2017-09-20	0857	84	0.00	flood	fair	calm
2017-09-27	0840	226	0.00	1/4 flood	clear	NW
2017-10-04	0844	52	0.00	1/4 ebb	clear	N
2017-10-11	0901	171	0.00	ebb	clear	NE
2017-10-18	0900	41	0.00	flood	clear	NE
2017-10-25	0832	616	0.00	1/4 flood	clear	E
2018-05-02	0846	20	0.00	3/4 flood	clear	
2018-05-09	0820	52	0.00	1/2 ebb	fair	
2018-05-16	0851	30	0.01	full flood	cloud	
2018-05-23	0825	97	0.00	3/4 ebb	fair	
2018-06-06	0851	86	0.00	full ebb	fair	
2018-06-13	0838	63	0.11	full flood	cloud	
2018-06-20	0850	41	0.00	full ebb	clear	
2018-06-27	0845	41	0.00	full flood	fair	
2018-07-02	0832	96	0.00	1/2 flood	clear	
2018-07-11	0955	144	0.00	1/2 ebb	fair	
2018-07-18	0930	199	0.26	1/4 flood	cloud	
2018-07-25	0850	94	0.07	1/4 ebb	cloud	
2018-08-01	0845	733	0.42	1/2 flood	cloud	
2018-08-08	0840	97	0.00	1/2 ebb	clear	
2018-08-15	0845	183	0.22	1/2 flood	clear	
2018-08-22	0848	41	0.00	1/4 ebb	fair	
2018-08-29	0843	52	0.00	3/4 flood	clear	
2018-09-05	0838	185	0.00	3/4 ebb	fair	
2018-09-19	0843	109	0.00	1/2 ebb	clear	
2018-09-26	0835	20	0.00	3/4 flood	clear	
2018-10-03	0848	169	0.00	full ebb	clear	
2018-10-12	0835	805	0.00	1/2 flood	clear	
2018-10-17	0919	61	0.00	full ebb	cloud	
2018-10-24	0851	61	0.00	full flood	clear	
2018-10-31	0855	327	0.00	1/4 flood	clear	
2019-05-08	1022	31	0.00	3/4 flood	clear	
2019-05-15	0900	86	0.00	1/2 ebb	clear	
2019-05-22	0852	30	0.00	3/4 flood	cloud	
2019-05-29	0835	52	0.00	1/2 ebb	clear	
2019-06-05	0850	41	0.05	full flood	cloud	
2019-06-13	0838	1850	3.24	1/4 ebb	cloud	
2019-06-19	0851	31	0.00	3/4 flood	cloud	
2019-06-26	0831	96	0.00	full ebb	clear	
2019-07-01	0835	41	0.00	full flood	clear	
2019-07-10	0850	86	0.02	full ebb	cloud	
2019-07-17	0840	74	0.00	full flood	clear	
2019-07-24	1000	368	1.12	1/4 flood	cloud	
2019-08-07	0830	121	0.00	full ebb	clear	
2019-08-14	0841	41	0.00	full flood	cloud	
2019-08-28	0838	74	0.00	1/4 ebb	cloud	
2019-09-11	0856	158	0.02	1/4 ebb	fair	
2019-09-18	0852	52	0.00	1/2 flood	cloud	
2019-09-25	0846	183	0.00	3/4 ebb	fair	
2019-10-02	0845	52	0.00	1/2 flood	clear	
2019-10-09	0845	181	0.00	1/4 ebb	cloud	

2019-10-17	0849	72	0.07	3/4 flood	fair
2019-10-23	0835	193	0.00	3/4 ebb	fair
2019-10-30	0845	52	0.00	3/4 flood	cloud
2020-05-06	0945	51	0.00	1/4 ebb	cloud
2020-05-13	0900	51	0.00	1/4 flood	fair
2020-05-20	1000	75	0.00	1/2 ebb	cloud
2020-05-27	0228	107	1.49	1/4 ebb	fair
2020-06-03	0942	51	0.00	1/2 ebb	clear
2020-06-10	0854	160	0.00	1/4 flood	clear
2020-06-17	0845	189	0.00	1/4 ebb	cloud
2020-06-24	0859	134	0.18	3/4 flood	clear
2020-07-01	0846	336	0.95	3/4 ebb	clear
2020-07-08	0835	216	1.19	1/4 flood	cloud
2020-07-15	0851	63	0.00	3/4 ebb	fair
2020-07-22	0847	10	0.00	3/4 flood	clear
2020-07-29	0902	109	0.00	3/4 ebb	cloud
2020-08-05	0854	52	0.05	3/4 flood	fair
2020-08-12	0958	10	0.06	1/4 flood	fair
2020-08-19	0913	41	0.58	full flood	fair
2020-08-26	0900	473	0.01	slack ebb	clear
2020-09-02	0853	41	0.00	full flood	clear
2020-09-09	1010	275	0.97	1/4 flood	cloud
2020-09-16	1005	96	0.00	1/2 ebb	rain
2020-09-23	1031	160	0.00	1/2 flood	fair
2020-09-30	0838	368	0.43	1/4 ebb	clear
2020-10-07	0845	63	0.00	1/2 flood	clear
2020-10-14	0830	187	0.00	1/4 ebb	clear
2020-10-21	0855	142	0.00	1/4 flood	fair
2020-10-28	0844	84	0.00	1/4 ebb	clear

Total Avg.	177.6		**2013**	**2014**	**2015**
St. Dev.	318.1	Avg.	130.82	166.46	246.19
Max	2489	St. Dev.	136.25	314.34	446.30
Min	10	Max	613	1467	2098
Geo Avg.	90.34	Min	10	10	10
SSM					

JIC2

Sampling Date	Time	Enterococci (MPN/100 mL)	Rainfall in last 24 hours (in)	Tide Stage	Weather	Wind/Current
2013-07-10	8:30:00	1014	0.00	3/4 flood	fair	W
2013-07-17	8:20:00	538	0.00	ebb	clear	W
2013-07-24	8:30:00	171	0.00	3/4 flood	fair	SW
2013-07-31	8:43:00	616	0.11	3/4 ebb	fair	NE
2013-08-07	8:25:00	94	0.00	flood	fair	SW
2013-08-14	8:26:00	370	0.00	1/4 flood	fair	calm
2013-08-21	8:27:00	168	0.17	flood	clear	W
2013-08-28	8:40:00	440	0.00	ebb	clear	calm
2013-09-04	8:50:00	500	2.08	flood	clear	SE
2013-09-11	8:32:00	540	0.00	1/4 flood	fair	calm
2013-09-18	8:40:00	160	0.23	flood	clear	SE
2013-09-25	8:25:00	909	0.00	1/4 flood	cloudy	NW
2013-10-02	8:30:00	299	0.00	1/4 ebb	clear	calm
2013-10-09	8:53:00	633	0.00	1/4 flood	fair	SW
2013-10-16	8:30:00	317	0.00	1/4 ebb	clear	NE
2013-10-23	8:52:00	573	0.04	1/4 flood	fair	calm
2013-10-30	8:40:00	990	0.00	1/2 ebb	fair	calm
2014-05-07	8:38:00	275	0.00	ebb	clear	calm
2014-05-14	8:30:00	96	0.00	flood	clear	calm
2014-05-21	8:36:00	275	0.00	ebb	clear	W
2014-05-28	8:45:00	63	0.00	flood	clear	SW
2014-06-04	8:51:00	85	0.00	ebb	clear	W
2014-06-11	8:23:00	10	0.00	1/4 ebb	clear	calm
2014-06-18	8:38:00	269	0.00	1/4 flood	clear	calm
2014-06-25	8:45:00	41	0.00	1/4 ebb	cloud	calm
2014-07-02	8:15:00	171	0.00	1/4 flood	clear	W
2014-07-09	8:34:00	233	0.00	1/2 ebb	clear	SW
2014-07-16	8:28:00	464	0.07	1/4 flood	cloud	calm
2014-07-23	9:31:00	331	0.32	1/2 ebb	clear	calm
2014-07-30	8:30:00	98	0.11	1/2 flood	fair	calm
2014-08-06	8:30:00	862	0.31	3/4 ebb	clear	calm
2014-08-13	8:48:00	171	0.02	1/2 flood	clear	calm
2014-08-20	8:45:00	195	0.03	3/4 ebb	clear	SW
2014-08-27	8:38:00	52	0.00	3/4 flood	clear	calm
2014-09-03	8:45:00	1333	0.03	ebb	fair	calm
2014-09-10	8:38:00	122	0.00	3/4 flood	fair	calm
2014-09-17	8:30:00	6131	0.83	ebb	clear	calm
2014-09-24	8:45:00	305	n/a	flood	cloud	calm
2014-10-01	8:30:00	1076	n/a	ebb	clear	calm
2014-10-08	8:31:00	122	0.00	flood	clear	calm
2014-10-15	8:36:00	24196	0.95	ebb	rain	calm
2014-10-22	8:17:00	160	0.01	1/4 ebb	clear	calm
2014-10-29	8:31:00	414	0.00	1/4 flood	fair	calm
2015-05-06	8:33:00	145	0.00	3/4 flood	fair	calm
2015-05-13	8:25:00	181	0.00	3/4 ebb	fair	N
2015-05-20	8:30:00	135	0.00	1/2 flood	clear	calm
2015-05-27	8:27:00	246	0.00	3/4 ebb	fair	SW
2015-06-04	8:27:00	1259	0.4	3/4 flood	rain	calm
2015-06-10	8:30:00	11199	1.41	3/4 ebb	cloud	calm
2015-06-17	8:34:00	131	0.00	3/4 flood	clear	W
2015-06-24	8:41:00	96	0.00	low	clear	S
2015-07-01	10:19:00	223	0.00	1/2 ebb	clear	S

2015-07-08	8:39:00	520	0.01	low	clear	calm
2015-07-15	8:54:00	31	0.00	high	fair	calm
2015-07-22	8:44:00	350	0.05	1/4 flood	clear	calm
2015-07-29	8:34:00	63	0.00	1/4 ebb	clear	S
2015-08-05	8:36:00	282	0.00	1/4 flood	fair	SW
2015-08-12	8:25:00	52	0.00	1/4 ebb	clear	calm
2015-08-19	8:57:00	12033	2.51	1/2 flood	clear	calm
2015-08-26	8:40:00	171	0.00	1/2 ebb	fair	W
2015-09-02	8:31:00	213	0.00	1/2 flood	fair	calm
2015-09-09	8:43:00	5475	0.60	1/2 ebb	clear	calm
2015-09-16	7:42:00	279	0.00	1/4 flood	fair	calm
2015-09-23	8:30:00	682	0.00	3/4 ebb	cloud	NE
2015-09-30	8:40:00	148	0.00	3/4 flood	fair	calm
2015-10-07	8:46:00	305	0.00	3/4 ebb	clear	calm
2015-10-14	8:47:00	435	0.00	3/4 flood	clear	calm
2015-10-21	8:42:00	759	0.00	slack ebb	fair	calm
2015-10-28	8:52:00	556	0.72	flood	cloud	SW
2016-05-04	0853	221	0.66	1/2 ebb	fair	calm
2016-05-11	0835	269	0.00	1/4 flood	clear	N
2016-05-18	0845	1106	0.82	1/4 ebb	rain	E
2016-05-25	0831	52	0.00	1/2 flood	clear	calm
2016-06-01	0732	307	0.01	1/4 ebb	fair	S
2016-06-08	0948	262	0.00	3/4 flood	clear	calm
2016-06-15	0849	160	0.00	1/2 ebb	clear	calm
2016-06-22	0823	109	0.00	1/2 flood	clear	calm
2016-06-29	0842	9804	0.39	3/4 ebb	fair	W
2016-07-06	0825	909	0.00	1/2 flood	clear	calm
2016-07-13	0837	428	0.00	ebb	clear	SW
2016-07-20	0837	441	0.01	flood	fair	calm
2016-07-27	0837	256	0.00	ebb	clear	SW
2016-08-03	0852	285	0.67	flood	cloud	calm
2016-08-10	0834	1106	0.05	1/4 flood	cloud	calm
2016-08-17	0830	171	0.00	1/4 ebb	clear	calm
2016-08-24	0854	106	0.00	1/4 flood	clear	calm
2016-08-31	0853	512	0.21	1/4 ebb	rain	S
2016-09-07	0835	85	0.00	1/4 flood	clear	calm
2016-09-14	0856	1081	1.21	1/2 ebb	rain	NE
2016-09-21	0837	1281	0.00	1/4 flood	fair	N
2016-09-28	0828	269	0.00	1/4 ebb	clear	calm
2016-10-12	0839	355	0.00	1/2 ebb	cloud	calm
2016-10-19	0847	320	0.00	3/4 flood	clear	W
2016-10-26	0834	259	0.00	1/2 ebb	clear	calm
2017-05-03	0845	359	0.00	3/4 ebb	clear	E
2017-05-10	0819	52	0.00	flood	clear	W
2017-05-17	0854	109	0.00	1/4 flood	clear	calm
2017-05-24	0835	24196	3.10	1/4 ebb	fair	calm
2017-05-31	0858	328	0.00	ebb	fair	NW
2017-06-07	0836	7270	3.25	1/4 ebb	rain	calm
2017-06-14	0855	108	0.00	1/2 flood	fair	calm
2017-06-21	0833	3968	0.65	1/4 ebb	cloud	calm
2017-06-28	0840	359	0.00	1/4 flood	clear	calm
2017-07-05	0933	109	0.00	3/4 ebb	clear	S
2017-07-12	0822	181	0.00	3/4 flood	clear	W
2017-07-19	0842	345	0.00	3/4 ebb	clear	calm
2017-07-26	0836	4611	0.08	1/2 flood	cloud	calm

2017-08-02	0830	253	0.00	3/4 ebb	fair	calm
2017-08-09	0850	496	0.34	flood	cloud	calm
2017-08-16	0833	867	0.00	3/4 ebb	clear	calm
2017-08-23	0824	284	0.00	3/4 flood	fair	calm
2017-08-30	0858	7270	0.00	ebb	fair	calm
2017-09-06	1005	480	0.98	1/4 ebb	rain	calm
2017-09-14	0842	1334	0.00	ebb	cloud	NW
2017-09-20	0854	235	0.00	flood	fair	calm
2017-09-27	0856	426	0.00	1/4 flood	clear	calm
2017-10-04	0853	63	0.00	1/4 ebb	clear	calm
2017-10-11	0847	860	0.00	1/4 flood	clear	calm
2017-10-18	0838	142	0.00	flood	clear	
2017-10-25	0845	2064	0.00	1/4 flood	clear	
2018-05-02	0831	131	0.00	3/4 flood	clear	
2018-05-09	0834	131	0.00	3/4 ebb	fair	
2018-05-16	0842	118	0.01	3/4 flood	fair	
2018-05-23	0823	457	0.00	3/4 ebb	fair	
2018-05-30	0843	272	0.58	3/4 flood	rain	
2018-06-06	0852	341	0.00	slack ebb	fair	
2018-06-13	0840	301	0.11	full flood	cloud	
2018-06-20	0914	197	0.00	full ebb	clear	
2018-06-27	0836	135	0.00	1/4 ebb	fair	
2018-07-02	0832	459	0.00	1/2 flood	fair	
2018-08-08	0825	627	0.00	1/2 ebb	clear	
2018-08-15	0847	6867	0.22	1/2 flood	clear	
2018-08-22	0854	269	0.00	1/4 ebb	fair	
2018-08-29	0845	405	0.00	3/4 flood	clear	
2018-09-05	0844	145	0.00	3/4 ebb	fair	
2018-09-19	0838	1585	0.00	3/4 ebb	clear	
2018-09-26	0830	97	0.00	3/4 flood	clear	
2018-10-03	0900	373	0.00	slack ebb	clear	
2018-10-12	0843	934	0.00	1/2 flood	clear	
2018-10-17	0855	933	0.00	full ebb	fair	
2018-10-24	0859	175	0.00	full flood	clear	
2018-10-31	0852	1281	0.00	slack ebb	clear	
2019-05-08	0847	238	0.00	3/4 flood	clear	
2019-05-15	0845	148	0.00	1/2 ebb	clear	
2019-05-22	0839	63	0.00	1/2 flood	fair	
2019-05-29	0833	379	0.00	1/2 ebb	clear	
2019-06-05	0853	199	0.05	3/4 flood	cloud	
2019-06-13	0840	7701	3.24	1/2 ebb	cloud	
2019-06-19	0842	86	0.00	3/4 flood	cloud	
2019-06-26	0834	331	0.00	3/4 ebb	clear	
2019-07-01	0842	84	0.00	1/4 ebb	clear	
2019-07-10	0905	364	0.02	full ebb	fair	
2019-07-17	0847	75	0.00	full flood	clear	
2019-07-24	0838	3609	1.12	slack ebb	fair	
2019-08-07	0840	262	0.00	full ebb	clear	
2019-08-14	0837	63	0.00	1/4 ebb	cloud	
2019-08-28	0850	173	0.00	1/4 ebb	fair	
2019-09-11	0855	238	0.02	1/4 ebb	clear	
2019-09-18	0905	85	0.00	3/4 flood	cloud	
2019-09-25	0854	420	0.00	1/2 ebb	clear	
2019-10-02	0912	109	0.00	3/4 flood	clear	
2019-10-09	0847	932	0.00	1/2 ebb	cloud	

2019-10-17	0901	408	0.07	3/4 flood	fair
2019-10-23	0858	598	0.00	3/4 ebb	clear
2019-10-30	0911	197	0.00	3/4 flood	cloud
2020-05-06	0821	52	0.00	slack flood	fair
2020-05-13	0834	537	0.00	1/4 flood	fair
2020-05-20	0841	20	0.00	1/4 ebb	cloud
2020-05-27	0120	3873	1.49	1/4 ebb	fair
2020-06-03	0831	73	0.00	1/4 ebb	clear
2020-06-10	0842	272	0.00	1/4 flood	fair
2020-06-17	0846	762	0.00	1/4 ebb	cloud
2020-06-24	0840	1674	0.18	1/2 flood	clear
2020-07-01	0843	4106	0.95	1/2 ebb	fair
2020-07-08	0844	1198	1.19	1/2 flood	clear
2020-07-15	0852	272	0.00	3/4 ebb	fair
2020-07-22	0850	41	0.00	3/4 flood	clear
2020-07-29	0841	631	0.00	3/4 ebb	fair
2020-08-05	0833	153	0.05	3/4 flood	fair
2020-08-12	0835	432	0.06	full ebb	cloud
2020-08-19	0850	95	0.58	full flood	fair
2020-08-26	0905	6131	0.01	full ebb	clear
2020-09-02	0851	110	0.00	slack flood	clear
2020-09-09	0846	2603	0.97	1/4 flood	rain
2020-09-16	0845	223	0.00	full flood	rain
2020-09-23	0914	480	0.00	1/4 flood	fair
2020-09-30	0841	1674	0.43	1/4 ebb	fair
2020-10-07	0905	292	0.00	1/2 flood	clear
2020-10-14	0841	637	0.00	1/4 ebb	clear
2020-10-21	0857	479	0.00	1/2 flood	fair
2020-10-28	0842	195	0.00	1/4 ebb	fair