Fecal Coliform and *Enterococci* Bacteria Total Maximum Daily Loads for Shellfish and Recreational Monitoring Stations in the Tributaries of Morgan River HUC 030502071103

SCDHEC Bureau of Water

Banu Varlik

May 2024

Abstract

§303(d) of the Clean Water Act (CWA) and EPA's *Water Quality Planning and Management Regulations* (40 CFR - Protection of Environment 2017) require states to develop total maximum daily loads (TMDLs) for water bodies that are included on the §303(d) list of impaired waters. A TMDL is the maximum amount of pollutant a waterbody can assimilate while meeting water quality standards (WQS) for the pollutant of concern. All TMDLs include a waste load allocation (WLA) for any National Pollutant Discharge Elimination System (NPDES)-permitted dischargers, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS). This technical report describes the development of fecal coliform (FC) TMDLs for impaired shellfish monitoring stations and an *enterococci* TMDL for recreational use in tributaries of Morgan River: 16A-09, 16A-18, and 16A-23 in Eddings Creek, 16A-08 and 16A-38 in Village Creek, 16A-27 and 16A-28 in Coffin Creek, 16A-19 in Rock Spring Creek, and RT-16131 in Coffin Creek watersheds located in Beaufort County, South Carolina. All nine stations have been included in South Carolina's final 2020 and 2022 303(d) list of impaired waters for exceeding either the FC WQS for shellfish harvesting or the *enterococci* WQS for recreational use.

South Carolina Department of Transportation (SCDOT) is the only NPDES-permitted MS4 in these TMDL watersheds and has been allocated a WLA.

Table Ab1. TMDLs for tributaries of Morgan River. TMDLs are expressed as the mpn/100 ml and mpn per day, and allocations are expressed as % reductions.

Station	Existing Conc. (mpn/ 100ml)	TMDL Conc.[1] (mpn/ 100ml)	TMDL Load[2] (WLA+LA+ MOS) (mpn/ day)	WLA + LA (mpn/ day)	MOS (mpn/ day)	Implementation Targets[7]			
						Continuous Sources[3] (mpn/100ml)	Intermittent MS4[5] (%)	Intermittent MS4 SCDOT (%)	Non-Point Source LA (%)
16A-08	64.7	43	5.56E+12	5.28E+12	2.78E+11	See Note Below	36.8%	36.8%[4]	36.8%
16A-09	58.6	43	1.17E+13	1.11E+13	5.85E+11	See Note Below	30.3%	30.3%[4]	30.3%
16A-18	57.4	43	6.43E+12	6.11E+12	3.21E+11	See Note Below	28.9%	28.9%[6]	28.9%
16A-19	89.3	43	2.33E+12	2.21E+12	1.16E+11	See Note Below	54.3%	54.3%[6]	54.3%
16A-23	87.8	43	5.84E+12	5.56E+12	2.78E+11	See Note Below	53.5%	53.5%[6]	53.5%
16A-27	61.1	43	4.20E+12	3.99E+12	2.09E+11	See Note Below	33.1%	33.1%[6]	33.1%
16A-28	120.2	43	1.33E+12	1.26E+12	6.61E+10	See Note Below	66.0%	66.0%[6]	66.0%
16A-38	112.7	43	5.67E+12	5.39E+12	2.84E+11	See Note Below	63.8%	63.8%[6]	63.8%
RT-16131	412.2	104	1.53E+12	1.45E+12	7.64E+10	See Note Below	74.8%	74.8%[6]	74.8%

Table Notes:

1. TMDL = SFH water WQS for single sample maximum not to exceed 43 mpn/100 ml (FC), and for primary and secondary recreation in SFH waters 104 mpn/100 ml (*enterococci*).

2. WLA+LA at average flow conditions calculated using estimated average tidal flow at the WQ station; see Appendix D for calculation.
3. WLA is expressed as a daily maximum of 43 mpn/100 ml (FC) or 104 mpn/100 ml (*enterococci*). There are no continuous dischargers at this time. Future continuous discharges are required to meet the WQS for the pollutant of concern. Loadings to meet the WQS are developed based upon the permitted flow and an allowable permitted maximum concentration of 43 mpn/100ml (FC) or 104 mpn/100 ml (*enterococci*).
4. The total developed area in this TMDL watershed is currently less than 5% and the Department deems the contributions from SCDOT negligible, and no reduction of bacteria is necessary at this time. If the total developed area in this TMDL watershed increases to 5% and above, SCDOT will comply with applicable WLA to the MEP as required by its NPDES MS4 permit.
5. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4s, construction, and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for the pollutant of concern in accordance with their NPDES Permit.
6. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address bacteria, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.
7. Refer to section 6.0 for the derivation of implementation targets.

Contents

Figures

Tables

1.0 Introduction

1.1 Background

The federal *Clean Water Act (CWA)* requires each state to assess its waters, develop monitoring strategies, and establish water quality standards (WQS) for various types and uses of water bodies. Furthermore, the CWA mandates states to review the monitoring results every two years to ensure compliance with the established WQS. If monitoring indicates that the WQS are not being met or under threat, the states are required to list the impaired bodies under §303(d) of the CWA. These listed sites are then assigned a priority ranking for restoration efforts, and the impairments are addressed through the implementation of Total Maximum Daily Loads (TMDLs), as outlined in *40 Code of Federal Regulations* (CFR) Part 130, based on their respective ranks (40 CFR - Protection of Environment 2017).

A Total Maximum Daily Load (TMDL) is one part of a regulatory framework used to manage and control pollutant levels in water bodies that are impaired by pollutants. It establishes the maximum amount of a specific pollutant that a water body can receive from all sources, continuous point sources, intermittent point sources, nonpoint sources, and natural background levels, while still meeting WQS. The TMDL process includes estimating pollutant contributions from all sources, linking pollutant sources to their impacts on water quality, allocation of pollutant contributions to each source, and establishment of control mechanisms to achieve water quality standards.

A TMDL is comprised of the sum of individual waste load allocations (ΣWLAs) for continuous and intermittent point sources, and load allocations (ΣLAs) for nonpoint sources. In addition, the TMDLs include a margin of safety (MOS), either implicit or explicit, which is a buffer or safety factor included in the TMDL to account for uncertainties in the relationship between pollutant loads and water quality. Conceptually, this definition is represented by the equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

This TMDL document is a detailed analysis describing the development of fecal coliform (FC) and *enterococci* bacteria TMDLs for nine water quality monitoring stations that have exceeded the shellfish harvesting and recreational WQS. These stations, located in Beaufort County are tributary to Morgan River, were identified in South Carolina's 2020 and 2022 303(d) list of impaired waters (SCDHEC 2023c).

In South Carolina, oysters and clams are the two species of bivalve molluscan shellfish that are harvested commercially, recreationally, and utilized for aquaculture. These two species are the Eastern or American oyster, *Crassostrea virginica*, and the hard clam or Northern quahog, *Mercenaria mercenaria*. Both species are native to the North American Atlantic and Gulf coasts and have economic importance. Oysters in South Carolina cluster together to form oyster beds and oyster reefs. These formations stabilize shorelines from erosion, provide nursery grounds as well as protection for other marine species. In South Carolina, 95% of oyster reefs are intertidal, meaning they are exposed during low tide and submerged during high tide.

Both oysters and clams are filter feeders, meaning they filter water for algae as a nutrient source. In brackish and saltwaters, there are naturally occurring bacteria and viruses. Also, there are other sources for bacteria and viruses to enter these waters as a result of human activities, some examples are agricultural runoff, malfunctioning septic systems, pet waste, sanitary sewer overflows, and stormwater runoff. An adult oyster can filter approximately 50 gallons of water a day, while an adult clam can filter approximately 24 gallons a day. These filter feeders can concentrate naturally occurring bacteria, such as pathogenic bacteria *Vibrio vulnificus* and *Vibrio parahaemolyticus*, and viruses that are in the water as well as those resulting from human-related activities.

The National Shellfish Sanitation Program (NSSP) is the federal and state cooperative program recognized by both the United States Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC). States have agreed, through participation in NSSP and membership in the ISSC, to enforce the Model Ordinance (USFDA 2019). The Model Ordinance supplies states with standards as well as administrative practices required for the sanitary control of shellfish produced and sold for human consumption.

The FC group of bacteria is usually not pathogenic, and they are used as indicator organisms. As an indicator, they may indicate the presence of other pathogenic bacteria. In the NSSP Model Ordinance (USFDA 2019) and in South Carolina Regulation 61-47 Shellfish (SCDHEC 2017), the water quality standard for shellfish harvesting waters with an "approved" classification is "...the geometric mean FC MPN shall not exceed fourteen per one hundred milliliters, nor shall the estimated ninetieth percentile exceed an MPN of forty three per one hundred milliliters (per five tube decimal dilution)". Regulation 61-47 Shellfish was promulgated by the statutory

authority under S.C. Code Section 44-1-140. This regulation adopted the shellfish FC water quality standard as set forth in the NSSP Model Ordinance.

Genus *Enterococci* are Gram-positive cocci common in the feces of warm-blooded animals which includes humans. Starting in 1986, US Environmental Protection Agency (EPA) has recommended using *Enterococci* as the indicator organism for fecal contamination and health risk in marine waters (US EPA 1986).

Shellfish monitoring stations 16A-08, 16A-09, 16A-18, 16A-19,16A-23, 16A-27, 16A-28, 16A-38, and recreational use station RT-16131 have been included on the final 2020 and 2022 303(d) list of impaired waters (SCDHEC 2023c). These impaired stations have been prioritized and accepted by United States Environmental Protection Agency (EPA) as metrics in the CWA §303(d) program performance measures.

1.2 Watershed Description

Coffin, Eddings, Rock Spring, and Village creeks are tributary to Morgan River and are located north of St. Helena Island, east of the city of Beaufort in Beaufort County, South Carolina. The creeks are encompassed within Shellfish Management Area (SFMA) 16A and 12-digit hydrologic unit code (HUC) 030502071103. These TMDL watersheds are approximately 19.1 mi^2 in drainage area (Figure 1).

The TMDL watersheds are located in South Carolina's Sea Islands/Coastal Marsh ecoregion, characterized by the state's lowest elevations. This dynamic environment is shaped by elements such as wind, ocean waves, and river flows. Dominant forest types in this ecoregion include slash pine, cabbage palmetto, red cedar, and live oaks. Marshes play a significant role and are primarily populated by plant species like saltgrass, rushes, and various cordgrasses. Notably, these marshes serve as essential nursery grounds for a wide range of aquatic species, including shrimp, fish, crabs, and various other organisms (Griffith, Omernik and Comstock 2002).

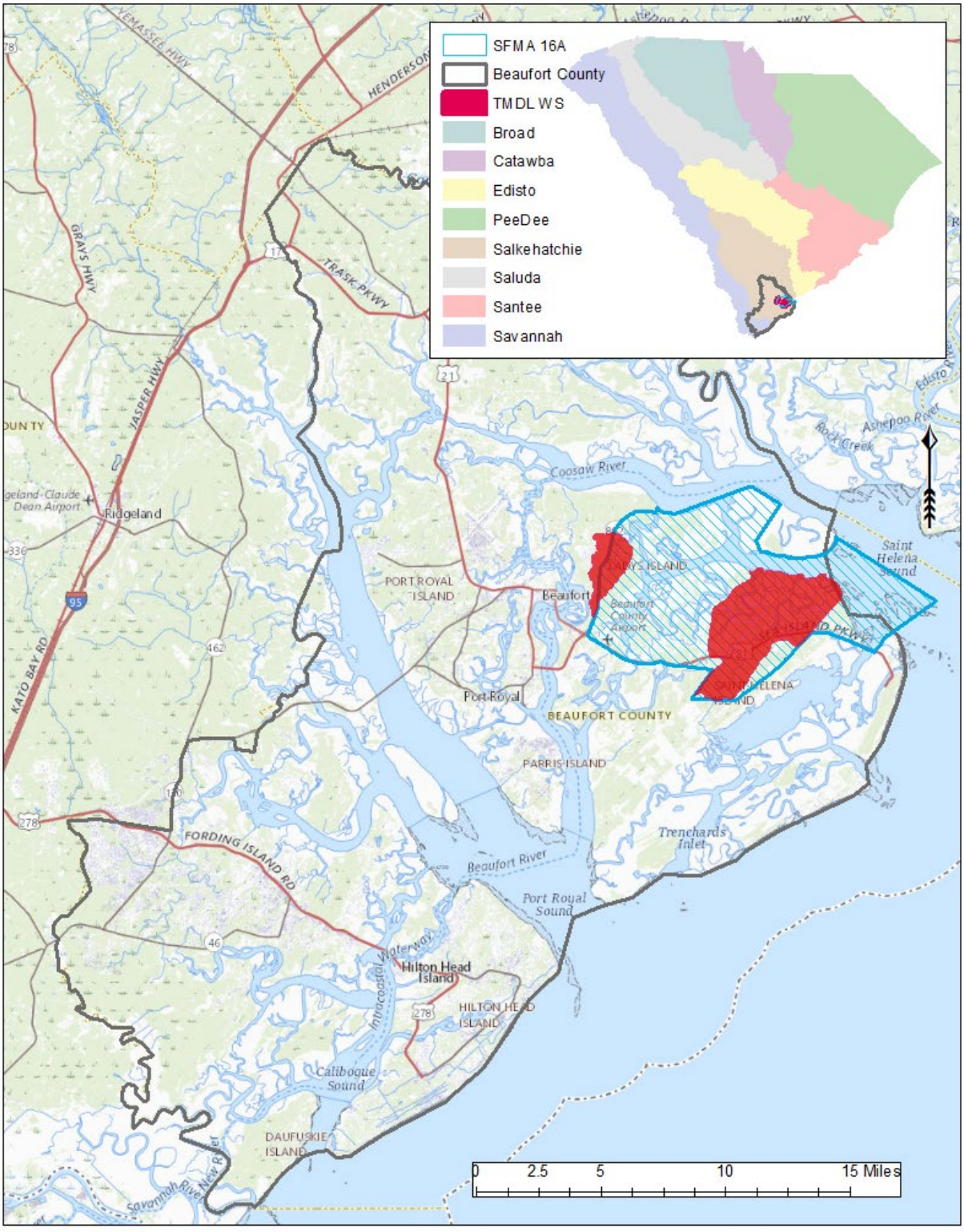


Figure 1. Locations of shellfish management area 16A, Coffin, Eddings, Rock Spring, and Village creeks TMDL watersheds in Beaufort County, SC.

SCDHEC currently has six active shellfish monitoring stations within SFMA 16A (Table 1). All currently active stations are impaired and classified as restricted for shellfish harvesting. Stations 16A-18 and 16A-28 were deactivated and are no longer sampled as of December 2010 by the SCDHEC's Shellfish Program. Station RT-16131 was a random statistical station and was monitored for one year during 2016. RT-16131 was located in the upstream area of Coffin Creek above station 16A-27. These stations were impaired when they were deactivated and remain on DHEC's 303(d) list of impaired waters (SCDHEC 2023c) (Figure 2).

Table 1. Coffin, Eddings, Rock Spring, and Village creeks monitoring stations and their location descriptions.

Station	Description
16A-08	Morgan River at Village Creek
16A-09	Eddings Creek at Morgan River
16A-18*	Eddings Creek at Shrimp Dock
16A-19	Upper Reaches Rock Springs Creek
16A-23	Eddings Creek at small tributary between stations 16A-09 and 16A-18
16A-27	Mouth of Coffin Creek at Morgan River
16A-28*	Headwaters of Coffin Creek at Shrimp Docks
16A-38	Village Creek at confluence with small unnamed tributary on western bank
RT-16131*	Coffin Creek Approx 330 M E of the end of N Front Drive

** Deactivated stations*

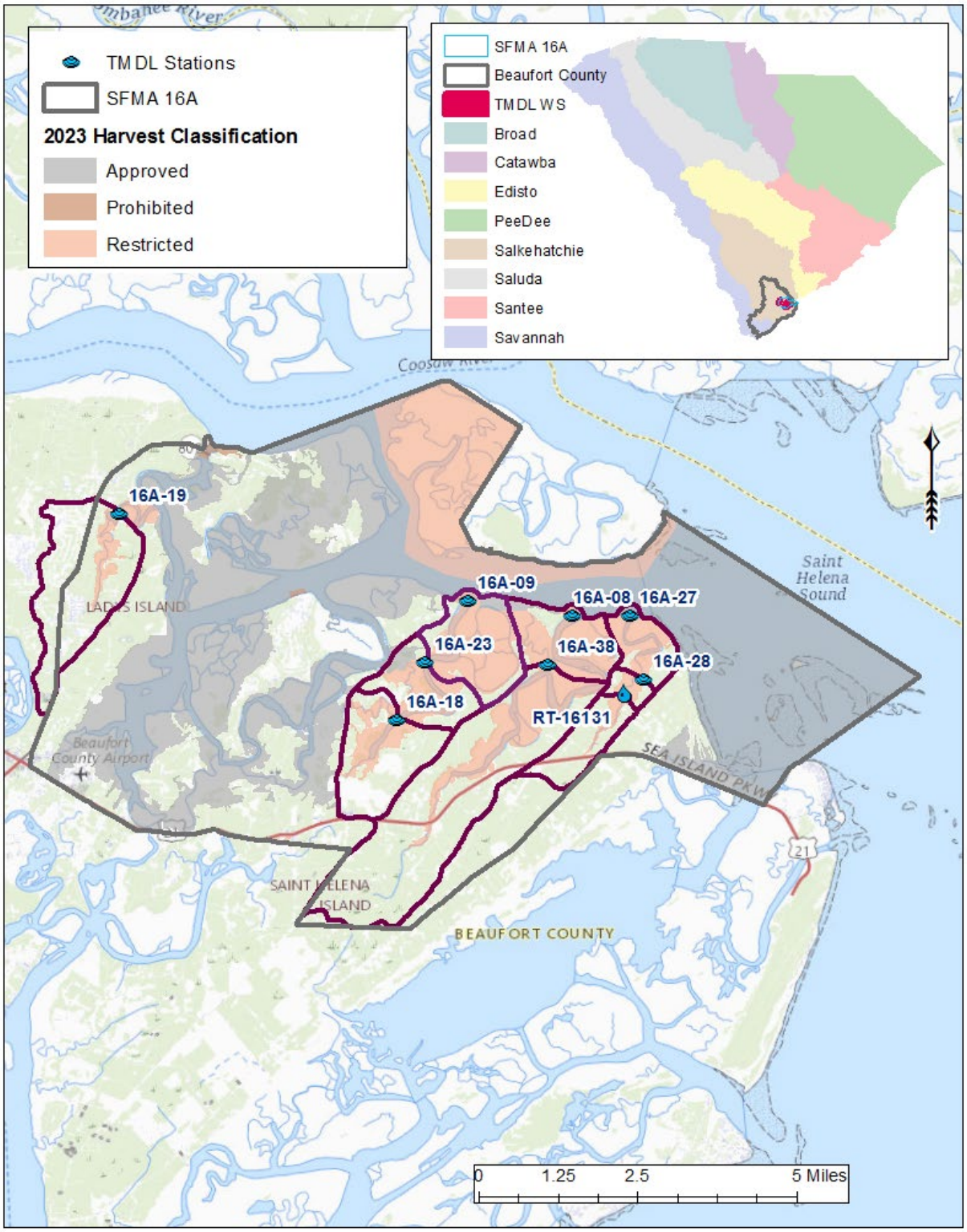


Figure 2. Coffin, Eddings, Rock Springs, and Village creeks in SFMA 16A, impaired shellfish monitoring stations and random statistical sampling station, and their drainage areas, and shellfish harvesting classifications for the 2021-2022 season.

1.3 Land Use

Land uses of the TMDL stations were determined using the National Land Cover Database (NLCD) 2019 edition, as depicted in Figure 3. Land use characteristics for station 16A-08 have been outlined. The primary and secondary dominant uses within the station's drainage area have been **bolded** (Table 2). Land uses of the remaining stations can be found in Appendix B – Land Use Tables.

Table 2. Station 16A-08's land uses determined using NLCD 2019 edition.

16A-08	Area (ac)	% of Area
Open Water	**166.1**	**16.7**
Developed	28.0	2.8
Forest	66.5	6.7
Forested Wetlands	44.3	4.4
Non-forested Wetlands	**692.8**	**69.4**
Total	997.7	100.0

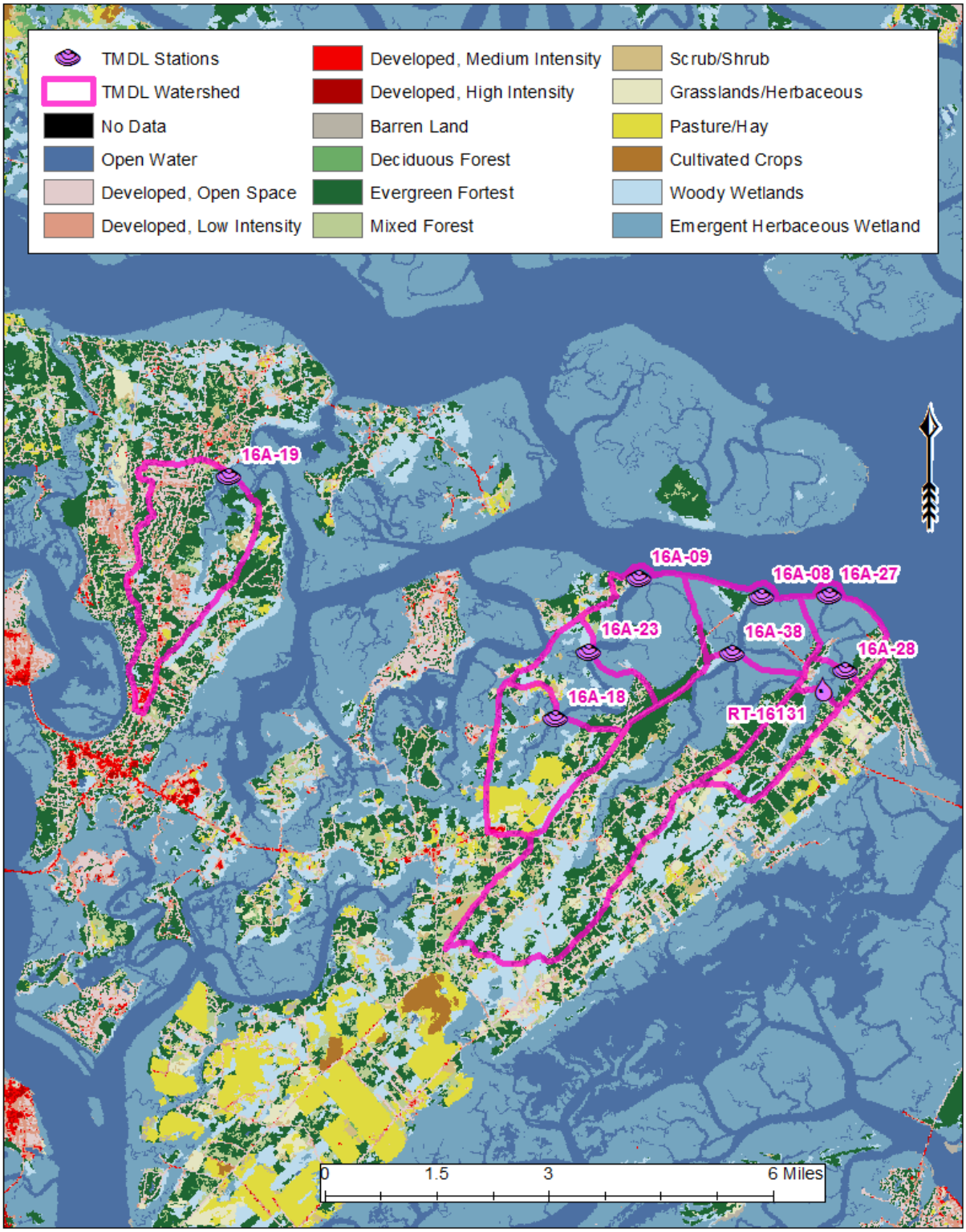


Figure 3. Land uses of the TMDL watersheds based on NLCD 2019.

1.4 Water Quality Standard

Coffin, Eddings, Rock Springs, and Village creeks are classified as shellfish harvesting waters (SFH) in SC Regulation 61-69 (SCDHEC 2023a).

SFH waters are defined in SC Regulation 61-68 (SCDHEC 2023b) as:

> "Shellfish harvesting waters (SFH) are tidal saltwaters protected for shellfish harvesting and uses listed in Class SA and Class SB. Suitable for primary and secondary contact recreation, crabbing, and fishing. Also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora."

FC WQS for SFH waters as defined in SC Regulation 61-68 Section G. 11. f (SCDHEC 2023b):

> "Not to exceed an MPN fecal coliform geometric mean of 14/100 ml; nor shall more than ten percent (10%) of the samples exceed an MPN of 43/100 ml."

Enterococci WQS for primary and secondary contact recreation in SFH waters as defined in SC Regulation 61-68 Section G. 11. g (SCDHEC 2023b):

> "Not to exceed a geometric mean of 35/100 ml based on at least four (4) samples collected from a given sampling site over a 30-day period; nor shall more than ten percent (10%) of the samples exceed a single sample maximum exceed 104/100 ml during any 30-day period."

2.0 Water Quality Assessment

The National Shellfish Sanitation Program (NSSP) allows shellfish growing areas to be classified using either total or FC, and application of either standard to different water bodies within the state. There are also two sampling strategies for the application of the standards:

a) Adverse pollution control
b) Systematic random sampling (SRS) (USFDA 2019).

The SCDHEC Shellfish Program currently utilizes the SRS strategy within the state instead of sampling under adverse pollution control conditions. To ensure random sampling, sampling dates are computer-generated before the beginning of each quarterly period. Due to shipping requirements and manpower constraints, samples are collected on Mondays, Tuesdays, or Wednesdays (SCDHEC 2023e).

To comply with NSSP guidelines, a minimum of 30 samples are required to be collected and analyzed from each station during the three-year review period. For harvest classifications, samples are collected according to the SRS strategy outlined in NSSP Guidance document for 12 months between January 1st and December 31st, for three years. This allows for a maximum of 36 samples per station for three years yet provides a six-sample "cushion" (above the NSSP required 30 minimum) for broken samples, lab error, breakdowns, etc. This also allows each annual report to meet the NSSP Triennial Review sampling criteria (SCDHEC 2023e).

The determination for 303(d) listing purposes is based on assessing three consecutive years of data from a shellfish station. For instance, for 2022 303(d) list, shellfish data collected from 2018 through 2020 were used. Station RS-16131 was a statistical random station and only sampled during 2016. For recreational uses, if more than 10% of the monthly geometric mean of available data collected during an assessment period exceeds the criterion, the station is listed on South Carolina's §303(d) list. If sufficient data are not available to calculate a monthly geometric mean, the available sample results are compared to the single sample maximum (SSM) criterion. If more than 10% of these samples exceed the criterion, the station is included on South Carolina's §303(d) list of impaired waters as not supporting recreational use. TMDL data period, samples exceeding WQS, percent exceedances, and number of samples used for calculation percent reductions are shown on Table 3.

In addition to bacteriological samples, surface water temperatures are measured using a hand-held, laboratory-quality calibrated thermometer. Salinities are measured in the laboratory using an automatic temperature compensated refractometer. Additional field data collected during samplings are ambient air temperature, wind direction, tidal stage, date, and time of sampling (SCDHEC 2023e).

Table 3. Data summaries of TMDL stations.

Station	Number of samples (n)	Samples Exceeding WQS	Percent Exceeding WQS	TMDL Data Period
16A-08	69	13	18.8	2017-2022
16A-09	69	11	15.9	2017-2022
16A-18	33	10	30.3	2008-2010
16A-19	70	21	30.0	2017-2022
16A-23	69	21	30.4	2017-2022
16A-27	69	12	17.4	2017-2022
16A-28	44	20	45.5	2007-2010
16A-38	69	24	34.8	2017-2022
RS-16131	10	3	30.0	2016

3.0 Source Assessment

Surface waters can be contaminated by various sources of pathogens, which can be categorized as point sources, and nonpoint sources. Efforts to control pollution from continuous point sources, such as WWTPs, have significantly reduced their impact through the implementation of technology-based controls. These point sources are regulated under the CWA and are required to obtain an NPDES permit. In South Carolina, NPDES permits mandate that dischargers with an FC or *enterococcus* limit meet the WQS at the discharge point (end of pipe). While dischargers, mostly domestic and municipal, can occasionally be sources of pathogens, if they are operating within their permit limits, they cannot be considered the cause of impairments. There are enforcement actions and mechanisms in place if these facilities fail to meet their permit requirements.

Regulated MS4, industrial, and construction site stormwater discharges are intermittent point sources. These intermittent sources are required to obtain discharge permits under the NPDES stormwater regulations. Each may be a source of pathogens. These sources are expected to meet the percentage reductions as prescribed in this TMDL document or the existing instream standard for the pollutant(s) of concern, to the maximum extent practicable (MEP), through compliance with the terms and conditions of their NPDES permit.

Nonpoint sources of bacteria in tidal stream include various land-use practices such as agricultural activities, silviculture, urban and rural runoff, malfunctioning septic

systems, sanitary sewer overflows, pet waste, wildlife, and poorly managed livestock operations. These activities can contribute to the presence of bacteria in surface water through runoff, leaching, and direct discharge.

3.1 Point Sources

Point sources refer to specific locations where NPDES-permitted effluent is discharged into the environment from identifiable sources such as pipes, outfalls, or conveyance channels. These sources can be traced to a single location such as industrial, municipal, domestic WWTPs, and NPDES-regulated stormwater discharges. Point sources are further divided into "continuous" and "intermittent".

3.1.1 Continuous Point Sources

Industrial, municipal, and domestic WWTPs have the potential to harbor pathogenic bacteria if their effluent fails to meet the WQS at the discharge point, as defined by their NPDES permit. If these facilities are discharging wastewater that meets their permit limits, they are not contributing to a bacteria impairment. If any of these facilities fail to comply with their permit limits, enforcement actions and mechanisms are in place to address the situation.

Currently, there are no continuous point sources within the TMDL watersheds. Future NPDES dischargers to these creeks are required to comply with their permit limit for FC and *enterococcus* which will limit them to the WQS at the point of discharge.

3.1.2 Intermittent Point Sources - MS4s

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial discharges covered under permits numbered SCS and SCR and regulated under *SC Water Pollution Control Permits*: R.61-9, §122.26(b)(4),(7),(14) - (21) (SCDHEC 2023d). All regulated MS4 entities have the potential to contribute FC, *enterococcus*, and other pathogen loadings to the TMDL watersheds and are subject to the WLA for intermittent point sources.

The presence of developed land in a watershed leads to increased runoff from these areas following precipitation, which can contribute to pollution along with other sources. The "developed" land class, which encompasses open spaces, low, medium, and high-intensity areas, was determined for each TMDL station's drainage area using ArcGIS and the NLCD 2019 dataset, and the results are shown in Table 4.

The NPDES stormwater industrial general permit (SCR000000) regulates industrial facilities that could potentially cause or contribute to violations of WQS through stormwater discharges. Similarly, the NPDES stormwater construction general permit (SCR100000) applies to construction activities. If construction activities have the potential to impact a water body with a TMDL, the stormwater pollution prevention plan (SWPPP) must address pollutants of concern and comply with the WLAs specified in this TMDL document. It's important to note that some stormwater discharges in the watershed may not fall under the SCS and SCR permits, and therefore they are not subject to the WLA portion of the TMDL.

Table 4. Aggregate developed land uses within the TMDL watersheds.

Station	Total Area (ac)	Developed Area (ac)	% Developed Area
16A-08	997.7	28.0	2.8
16A-09	1263.0	39.4	3.1
16A-18	1420.2	133.4	9.4
16A-19	2095.0	735.7	35.1
16A-23	889.1	82.5	9.3
16A-27	595.1	49.8	8.4
16A-28	184.8	31.1	16.8
16A-38	4072.3	460.4	11.3
RS-16131	701.4	126.1	18.0

Stormwater discharges from all regulated MS4 entities operating within the TMDL watersheds have the potential to contribute to FC, *enterococcus*, and other pathogens and are subject to the WLA portion of the TMDL. The South Carolina Department of Transportation (SCDOT) is a designated MS4 within these TMDL watersheds, operating under NPDES MS4 Permit SCS040001 (Figure 4). However, SCDOT is not a traditional MS4 as it lacks statutory taxing or enforcement powers, and does not regulate land use or zoning, or issue building or development permits.

The NPDES stormwater industrial general permit (SCR000000) regulates industrial facilities that could potentially cause or contribute to violations of WQS through stormwater discharges. Similarly, the NPDES stormwater construction general permit (SCR100000) applies to construction activities. If construction activities have the potential to impact a water body with a TMDL, the stormwater pollution prevention plan (SWPPP) must address pollutants of concern and comply with the WLAs specified in this TMDL document. It's important to note that some stormwater discharges in the

watershed may not fall under the SCS and SCR permits, and therefore they are not subject to the WLA portion of the TMDL.

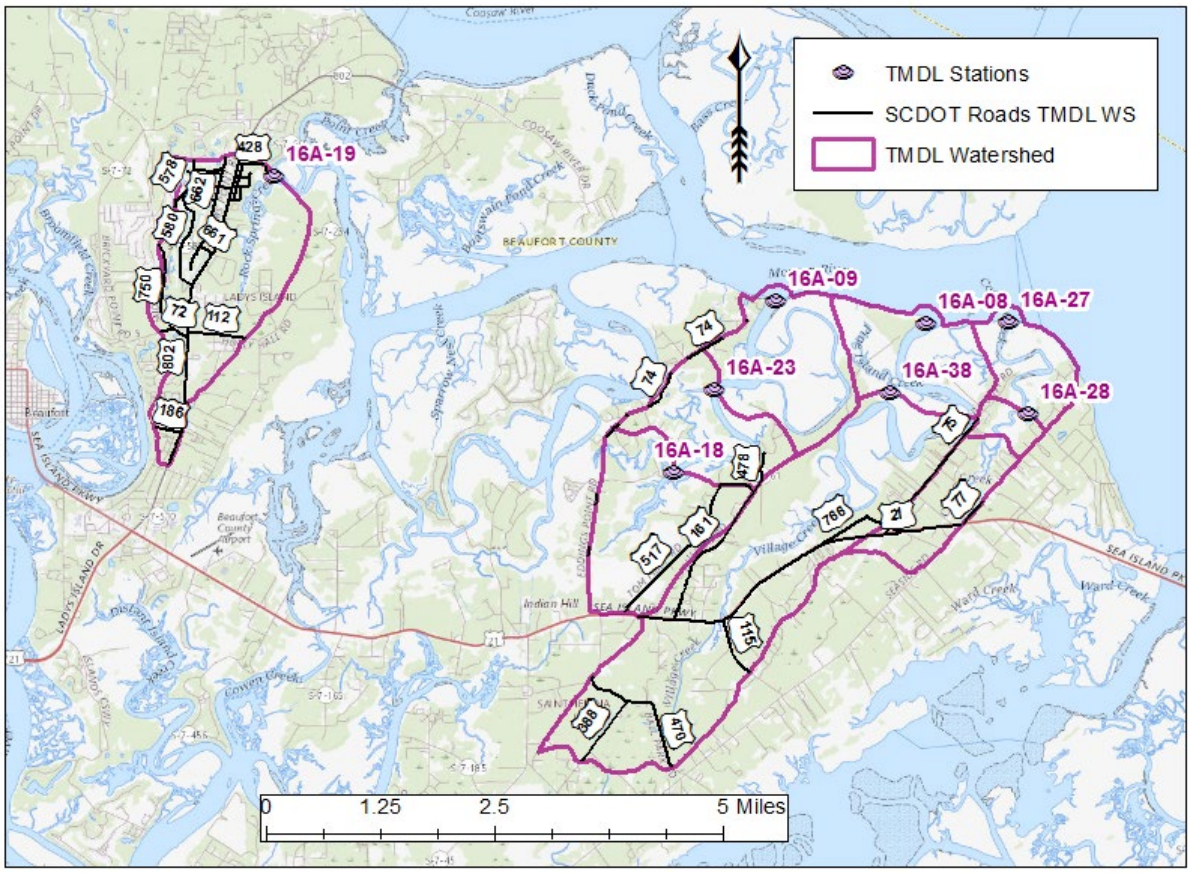


Figure 4. SCDOT owned and operated roads within Coffin, Eddings, Rock Spring, and Village creeks TMDL watersheds.

Sanitary sewer overflows (SSOs) are intermittent point sources that can have a significant impact on water quality when they release into surface waters. The responsibility for preventing SSOs lies with the NPDES wastewater discharger or the operator of the collection system for non-permitted systems that handle wastewater. However, it is important to note that SSOs are not always preventable or reported. In these TMDL watersheds, certain areas are serviced by municipal WWTPs and have sewer lines, which can increase the likelihood of SSO occurrences (Figure 5).

The Department acknowledges that MS4s may require multiple permit iterations to fully meet the assumptions and requirements of the TMDL. In order to comply with the MS4 permit, making progress towards achieving the WLA reduction for the TMDL through compliance with the stormwater management plan (SWMP) may be

considered sufficient, as long as the criteria of Maximum Extent Practicable (MEP) are met. This allows for flexibility in the implementation process.

For SCDOT, existing and future NPDES MS4 permittees, compliance with the terms and conditions of their NPDES permit is an effective implementation of the WLA to the MEP and demonstrates consistency with the assumptions and requirements of the TMDL. For existing and future NPDES construction and industrial stormwater permittees, compliance with the terms and conditions of their permit is an effective implementation of the WLA. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and are eligible for the *Clean Water Act* (CWA) §319 grants.

The Department recognizes that adaptive management/implementation of these TMDLs might be needed to achieve the water quality standards.

3.2 Nonpoint Sources

Nonpoint source pollution refers to pollution that originates from various sources across a large area, rather than being released through specific pipes. Nonpoint source pollution arises from a variety of land or water use activities, encompassing practices such as:

- Improper animal-keeping: Inadequate management of animal waste, runoff from livestock operations, and allowing livestock access to surface waters.
- Failing septic tanks: Malfunctioning or poorly maintained septic systems that release contaminants into groundwater or nearby water bodies.
- Agriculture: Runoff of fertilizers, pesticides, and sediment from agricultural lands.
- Forestry practices: Erosion and sedimentation resulting from logging activities and improper forest management.
- Wildlife: Animal waste and other natural sources contribute to water pollution.
- Urban and rural runoff: Surface runoff from developed areas (urban) and open spaces (rural), carrying pollutants like chemicals, oils, and litter into waterways.

These activities can lead to nonpoint source pollution, where pollutants are dispersed and do not have a single identifiable point of origin. These and other nonpoint source contributors located in unregulated areas can contribute to the presence of *Enterococci* and FC in these TMDL watersheds. Nonpoint sources in unregulated areas are addressed through the LA portion of the TMDL, rather than the WLA portion. During

precipitation events, nonpoint source contributions of pathogens to tidal streams are likely to increase as runoff carries pollutants from the land into waterways.

3.2.1 Wildlife

Wildlife, including deer, feral pigs, squirrels, raccoons, opossums, waterfowl, and other birds, can contribute to the presence of bacteria and pathogens in waterways. Their feces may directly enter surface waters or be transported into streams through runoff after rainfall events. According to a study conducted in 2013, the South Carolina Department of Natural Resources (SCDNR) estimated deer density based on suitable habitats such as forests, croplands, and pastures. Based on this study, there is an estimated deer population of 30 to 45 per square mile in these TMDL watersheds (SCDNR 2013). Based on a study by Yagow (2001), the bacteria production rate for deer was found to be 347 x 10^6 cfu/head-day, although only a portion of this bacteria will enter the water. As such, wildlife can be considered a potential source of FC, *enterococcus*, and other pathogens in these watersheds.

Wildlife in these TMDL watersheds include songbirds, shorebirds, migratory waterfowl, opossum, alligators, rodents, racoon, and white-tailed deer. Morgan Island (a.k.a. Monkey Island) is located between Morgan and Coosaw rivers, is a commercial free-range rhesus monkey farm owned by SCDNR. There are approximately 3500 monkeys on the island that are owned by the National Institute of Allergy and Infectious Diseases (NIAID) and could potentially impact SFMA 16A.

3.2.2 Agriculture

Agricultural activities involving livestock or animal waste can contribute to pathogen contamination of surface waters. Animal feces can enter waterways through runoff or direct deposition. The large quantity of bacteria associated with animal waste makes agricultural activities a significant source of bacteria which can affect water quality. Effective management of manure and animal waste is essential to prevent pathogen contamination in the TMDL watersheds.

3.2.2.1 Agricultural Animal Facilities

Under SC Regulation 61-43, owners/operators of most commercial animal growing operations are required to obtain permits for the proper handling, storage, treatment, and disposal of manure, litter, and deceased animals (SCDHEC 2021). These regulations aim to safeguard water quality, ensuring that compliant facilities do not

contribute to water quality impairments. South Carolina currently does not have confined animal feeding operations (CAFOs) under NPDES coverage. Currently, there are no regulated agricultural operations within Coffin, Eddings, Rock Springs, and Village creeks watersheds.

3.2.2.2 Grazing Livestock

Livestock, particularly cattle, are recognized contributors of bacteria and other fecal-borne pathogens in waters. On average, cattle typically produce approximately 1.0E+11 cfu/day per animal of FC bacteria. The presence of grazing cattle and other livestock can introduce bacteria into streams via runoff from pastures or through direct defecation into waters. The grazing of livestock in pastures is not regulated by SCDHEC.

The United States Department of Agriculture's National Agricultural Statistics Service reported 561 cattle in Beaufort County in 2017 (USDA 2019). Based on the assumption of an even distribution of cattle across pasture/hay areas in Beaufort County, approximate estimates of the cattle population were calculated. It is estimated that these cattle could contribute up to 3.1E+12 bacteria per day to TMDL watersheds, with the possibility of some fraction entering the waterways (Table 5). The NLCD classification system, derived from the Anderson Land Cover Classification System, includes the "Pasture/Hay" category, which represents areas where grasses, legumes, or grass-legume mixtures are grown for livestock grazing or hay production on a perennial cycle. However, it should be noted that not all cattle included in the USDA census are grazed, as dairy cattle and feedlot cattle are often confined and not evenly distributed across Pasture/Hay areas. Therefore, the calculations provide an approximate estimation of the cattle population. Nonetheless, the direct discharge of fecal indicator bacteria and other pathogens into surface waters by cattle and other livestock remains a potential contributing source within the TMDL watersheds. As highlighted in the Shellfish Management Area 16A 2023 Annual Update, there are small herds of cattle near the headwaters of Coffin and Eddings creeks. Additionally, there are several horse stables within approximately two miles of receiving waters (SCDHEC 2023e).

Table 5. Estimated number of bacteria produced by grazing cattle in the TMDL stations' drainage area.

WQM Station	Pasture/Hay Acres	Cattle/Acre of Pasture/Hay	Number of Cattle Grazing in Station DA	Bacteria Produced in Station DA
16A-08	0	0.044	0	0
16A-09	5.1	0.044	0.22	5.1E+11
16A-18	342	0.044	15.2	1.5E+12
16A-19	44.7	0.044	1.98	1.9E+11
16A-23	21.3	0.044	0.95	9.5E+10
16A-27	6.0	0.044	0.27	2.7E+10
16A-28	1.1	0.044	0.05	5.0E+9
16A-30	148.8	0.044	6.61	6.6E+11
RS-16131	30.0	0.044	1.33	1.3E+11

3.2.3 Land Application of Industrial, Domestic Sludge, or Treated Wastewater

Industrial and domestic wastewater treatment processes that are permitted under the NPDES may produce solid waste byproducts, known as sludge. Some facilities are authorized to apply this sludge to designated land areas under specific conditions. Similarly, there are NPDES-permitted facilities that can apply treated wastewater effluent to land at designated locations and under specific conditions. The regulations governing land application permits for these facilities can be found in SC Regulation 61-9, Sections 503, 504, or 505 (SCDHEC 2023d).

Proper management of the waste application is crucial to ensure that pollutants are effectively incorporated into the soil or taken up by plants, preventing their entry into streams or groundwater. If not managed correctly, land application sites can become a source of fecal pathogens and contribute to stream impairments. It's important to note that land application sites are not permitted to discharge directly into waterways. Any direct discharges from these sites to surface waters are illegal and can result in enforcement actions by SCDHEC.

It is recognized that there may be operating, regulated land application sites located in this watershed. If properly managed, waste is applied at a rate that ensures pollutants will be incorporated into the soil or plants and pollutants will not enter streams. Land application sites can be a source of bacteria and other pathogens and

contribute to stream impairment if not properly managed. The NPDES permitted land application sites are not allowed to directly discharge to surface waters in Coffin, Eddings, Rock Springs, and Village creeks watersheds. Direct discharges from land application sites to surface waters of the State are illegal and are subject to enforcement actions by the Department. Currently, there are no NPDES permitted facilities with a land application permit for applying treated wastewater within these TMDL watersheds.

3.2.4 Leaking Sanitary Sewer and Illicit Discharges

Leaking sewer pipes and unauthorized sewer connections pose substantial risks to public health by releasing partially treated or untreated human waste into the environment. However, quantifying the full extent of these sources without direct monitoring is challenging, as their impact is contingent on variables like volume and proximity to surface water. Untreated domestic wastewater typically contains bacteria levels within the range of 10^4 to 10^6 MPN per 100mL. GIS data indicates that some areas within the TMDL drainage area are serviced by a sanitary sewer system, suggesting the potential for sewer leaks (Figure 5).

Illicit sewer connections reroute sewage into storm drains, causing direct sewage discharge through the storm drainage system's outfalls. To assess this issue, monitoring the storm drain outfalls during dry weather periods is crucial to determine the presence or absence of sewage within the drainage systems. This monitoring process is essential for identifying and documenting the extent of unauthorized sewer connections and their environmental impact. Leaking sewer lines, illicit sewer connections, and SSOs are recognized as potential sources contributing to exceedances of fecal indicator bacteria and other pathogens in these TMDL watersheds.

3.2.5 Failing Septic Systems

As per the 2010 U.S. Census, there are approximately 3,525 housing units accommodating a population of 7,838 individuals. The Beaufort Jasper Water and Sewer Authority (BJW&SA) has provided the Department with their sewer and water-related GIS files. This information revealed that the majority of homes in the Coffin, Eddings, and Village creeks TMDL watersheds are not linked to a sewer system. Confirmation of this information was obtained from DHEC's regional shellfish officers, and it is also documented in the Shellfish Management Area 16A 2023 Annual Update

(SCDHEC 2023e). Additionally, based on BJW&SA's information, there are limited sewer lines within the Rock Springs TMDL watersheds (Figure 5).

When installed and maintained properly, septic systems are safe, long-term options for treating wastewater and preserving valuable water resources. Regulations stipulate that permits for new septic tanks will not be issued when a wastewater treatment facility/public sewer line is accessible for connection.

DHEC has an enforcement program that investigates complaints regarding the functioning of an onsite wastewater system and if an unpermitted discharge of sewage or other domestic wastewater is identified, prompt timelines for compliance are issued to the responsible party in order to minimize the risk of any discharge presenting significant harm to the environment and public health. At present, the state lacks sufficient regulatory authority for maintenance and upkeep of onsite wastewater systems.

Failing septic systems are identified as one of the potential sources contributing to FC and *enterococci* exceedances in these TMDL watersheds.

3.2.6 Stormwater Runoff

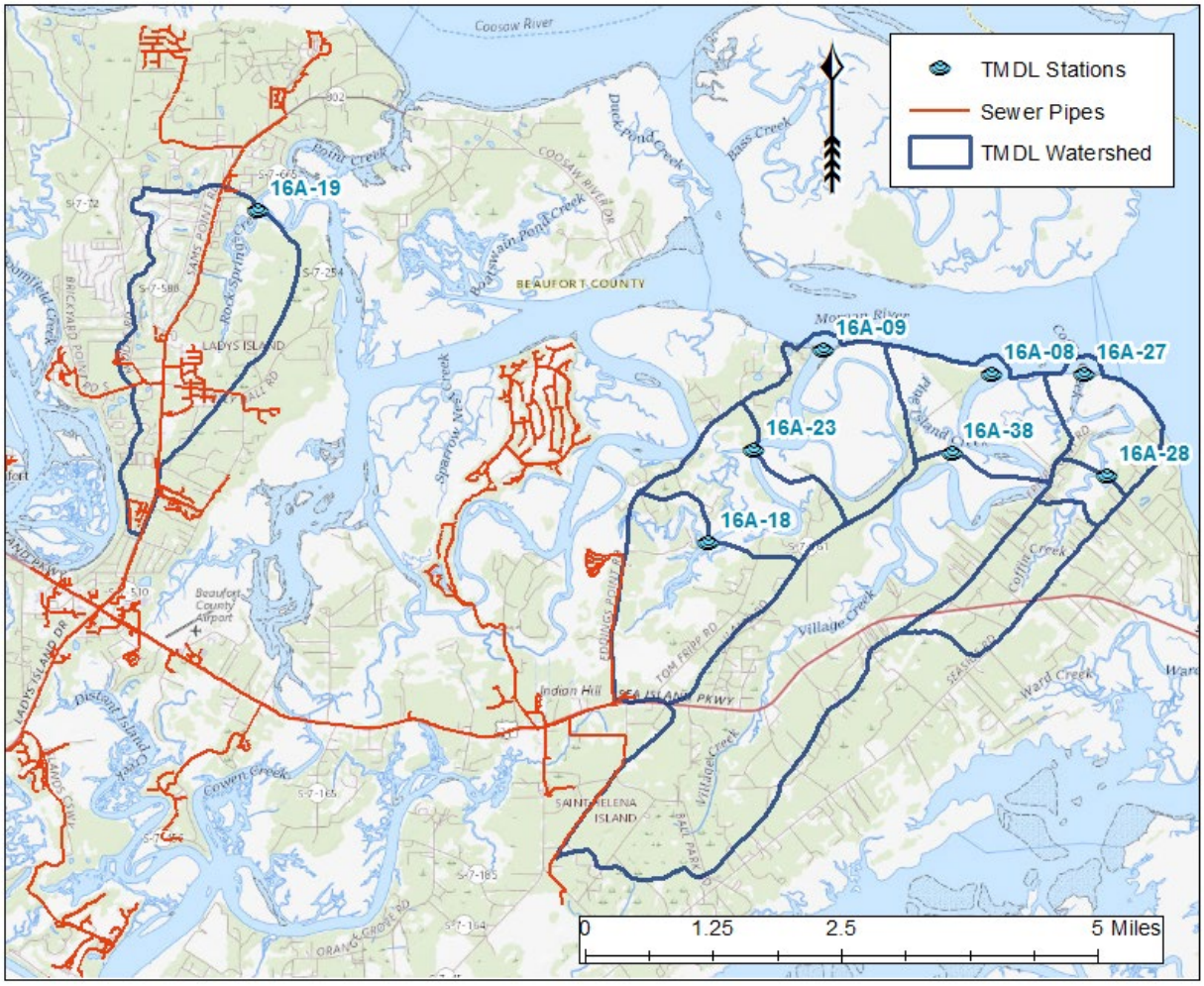
Domesticated pets, such as dogs and cats, are contributors of fecal indicator bacteria and other pathogens in urban and suburban areas. Wildlife species like deer, squirrels, raccoons, opossums, and birds also contribute to the overall bacteria load in these areas. Calculations based on the national pet statistics data from the American Veterinary Medical Association (AVMA) suggest an estimated count of 4,813 dogs and 3,582 cats within the TMDL watersheds. These pets can contribute to the overall bacterial load in these specific areas (AVMA 2022).

Unregulated MS4 communities have the potential to contribute to fecal indicator bacteria and other pathogens through stormwater runoff. These unregulated entities are subject to the LA portion of the TMDL document.

3.2.7 Marinas, Boating Activities, and Structures

Currently, there are no marinas, pump out stations, or public boat ramps within these TMDL watersheds, however, there are numerous private docks. There is one shrimp boat dock in Coffin Creek, upstream of station 16A-27.

There are 3 main types of marine sanitation devices (MSD) that are suitable for different kinds of marine vessels and have varying effluent treatment levels. Every vessel with an MSD installed as of January 30, 1980, must be equipped with one of the three types of MSDs (The United States Code 2012). Properly maintained MSDs should not be causing or contributing to bacteria exceedances in impaired waters. It is prohibited under Federal law to discharge untreated sewage from vessels within navigable waters as stated in the Clean Vessel Act.



Source: Data courtesy of BJW&SA.

Figure 5. BJW&SA sewer lines, sewer laterals, and water lines within Coffin, Eddings, and Village creek watersheds.

4.0 Cumulative Probability Method

Cumulative probability distributions were used to calculate existing conditions and percent reductions necessary to meet SFH WQS for FC in Coffin, Eddings, Rock Spring,

and Village creeks, and Class SA waters for primary and secondary contact recreation for *enterococci* in Coffin Creek.

For the calculation of the cumulative probability distributions, data collected by DHEC from 2017 through 2022 were used for shellfish monitoring stations 16A-08, 16A-09, 16A-19, 16A-23, 16A-27, 16A-38. Stations 16A-18 and 16A-28 were deactivated at the end of 2010. Therefore, for these stations, data collected by DHEC from 2007 through 2010 were used for calculating cumulative probability distributions**.** Data from statistical random station RT-16131 was collected only during 2016, and this data was used for calculating the cumulative probability distribution. (Appendix A – Shellfish Data Used for Calculation of the TMDL). Cumulative probability graphs were created using Cumulative Probability Plot 3.0 (Boeing 2003) and log base 10 of bacteria data. If the data follow a log-normal distribution, the data points on the plot will approximate a straight line (the normal distribution). This straight line is then compared to the water quality standard at the appropriate percentile. For SFH waters in South Carolina, the TMDL target equates to 43 mpn/100ml FC bacteria minus a 5% MOS (40.85 mpn/100ml) as referenced in R. 61-68 Section E.(15)d.(4) (SCDHEC 2023b) and R. 61-47 (SCDHEC 2017). For primary and secondary contact recreational uses in SFH waters, the TMDL target is 104 mpn/100ml *enterococci* minus 5% MOS (98.8 mpn/100ml). Evaluating the data at the 90th percentile allows for the 10% exceedance as referenced in R. 61-68 Section E.(15)d.(6) (SCDHEC 2023b) and R. 61-47 (SCDHEC 2017).

This evaluation is consistent with the NSSP approach under the SRS scheme. According to the NSSP approach under an SRS scheme, if the data do not meet the SSM WQS, a line is drawn parallel to the original normal distribution line that intersects the standard at the 90th percentile. Drawing the line parallel to the original distribution assumes that the coefficient of variation remains the same for the original data and the desired water quality data (Novotny, 2004). The necessary percent reduction is calculated as the difference between the distributions at the 90th percentile:

$$\frac{\text{Existing 90th \%tile concentration} - (\text{WQS} - \text{MOS})}{\text{Existing 90th \%tile concentration}} \times 100$$

Based on an evaluation of 2017 - 2022 FC data, stations 16A-08, 16A-09, 16A-19, 16A-23, 16A-27, and 16A-38 exceed the SSM criterion WQS. Additionally, evaluation of FC data collected from 2007-2010 from stations 16A-18 and 16A-28 exceed the SSM criterion WQS for SFH waters. Also, data from station RT-16131 exceeds the SSM criterion for SFH waters for primary and secondary contact uses. The SSM criterion will be targeted for the calculation of TMDLs for these stations.

Total maximum daily loadings of bacteria for the impaired stations listed in this document were calculated by estimating the cross-sectional area of the channel at the impaired station and estimating average tidal flow. TMDL loads were based on the SSM WQS. Detailed description of the methodology along with an example calculation can be found in Appendix D – The method used to calculate target.

This method provides an estimate of the target daily load based on average tidal flow. Actual tidal flows and loads are highly variable at these locations. The estimated daily loading calculations are based on multiple assumptions such as dated NOAA station data, channel geometry, cross sectional area of the channel, flow velocities, channel depth, and the dynamic nature of the environment. Therefore, the resulting loadings are only provided as an example.

Figure 6 shows the cumulative probability of station 16A-08. The remaining probability plots can be found in Appendix C – Cumulative Probability Graphs.

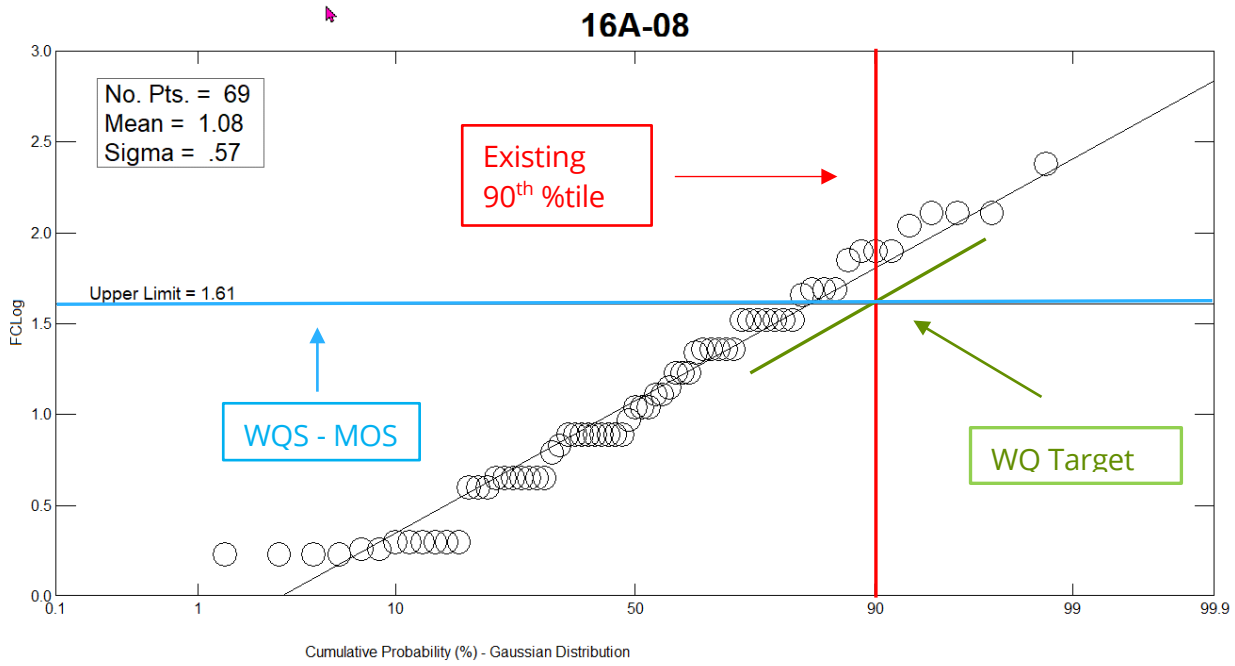


Figure 6. Cumulative probability plot for station 16A-08.

5.0 Development of the TMDL

5.1 Critical Conditions

Critical conditions are factors that either in combination or individually cause violations of WQS. In these TMDL watersheds, characterized by their tidal and complex hydrologic nature, determining a singular critical flow remains ambiguous. The implicit inclusion of critical conditions is achieved by considering data collected across all seasons over multiple years, diverse tidal states, and varying weather conditions during which the water samples were collected. This approach inherently addresses the range of potential critical conditions within the system.

5.2 Wasteload Allocation

The WLA is the portion of the TMDL allocated to NPDES-permitted point sources. These point sources typically include industrial facilities, wastewater treatment plants, and other regulated dischargers.

It is important to note that the WLA does not cover illicit dischargers, including SSOs or other illegal sources. Illicit discharges are considered unauthorized and are not granted any allocation under the TMDL. These sources are illegal because they introduce pollutants into the water without proper permits or compliance with regulatory requirements.

The WLA is specifically designed to address the allowable pollutant loadings from permitted point sources, while other mechanisms and enforcement actions are typically employed to address and reduce the impacts of illicit discharges and SSOs to protect water quality and public health.

5.2.1 Continuous Point Sources

Coffin, Eddings, Rock Spring, and Village creeks are classified as SFH waters and dischargers to these waters are allowable if the Department deems appropriate. Currently, there are no continuous NPDES-permitted discharges to the TMDL watersheds with an FC or *enterococcus* effluent limit on their NPDES permit. Future continuous discharges are required to meet the prescribed loading for the pollutant of concern based on permitted flow and assuming an allowable permitted single sample maximum of 43/100 ml FC or 104/100 ml *enterococci*. Continuous point source permit limits for bacteria are equivalent to the WQS.

5.2.2 Intermittent Point Sources

Intermittent point sources include all NPDES-permitted stormwater discharges, including current and future MS4s, construction and industrial stormwater discharges covered under permits numbered SCS000000 & SCR100000 regulated under SC *Water Pollution Control Permits* Regulation R61-9, §122.26(b)(4),(7),(14)-(21) (SCDHEC 2023a). Illicit discharges, including SSOs, are not covered under any NPDES permit and are subject to enforcement mechanisms. Other non-urbanized areas may be required under the NPDES Phase II Stormwater Regulations to obtain a permit for the discharge of stormwater.

SCDOT is the only regulated MS4 located in the TMDL watersheds. SCDOT operates under NPDES MS4 Permit SCS040001 and owns and operates roads within the watershed. However, the Department recognizes that SCDOT is not a traditional MS4 in that it does not possess statutory taxing or enforcement powers. SCDOT does not regulate land use or zoning, or issue building or development permits.

Waste load allocations for stormwater discharges are expressed as a percent reduction instead of a numeric concentration due to the uncertain nature of stormwater discharge volumes and recurrence intervals. All current and future regulated stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern. Table 6 presents the reductions needed for the impaired segment. The percent reductions identified for the impaired stations in this document also apply to the FC waste load attributable to those areas of the watershed which are covered or will be covered under NPDES MS4 permits.

5.3 Load Allocation

The LA applies to the nonpoint sources of FC and *enterococcus* bacteria which include unregulated processes/entities and is expressed as a percent reduction. The LA for TMDL stations is expressed in Table 6 as percent reductions. At such time that the referenced entities or other future unregulated entities become regulated NPDES MS4 entities and are subject to applicable provisions of SC Regulation 61-68D, they will be required to meet load reductions prescribed in the WLA component of the TMDL. This also applies to future discharges associated with industrial and construction activities that will be subject to SC R. 61-9 122.26(b)(14) & (15) (SCDHEC 2019).

5.4 Existing Load

Due to the tidal nature of the system, it is difficult to calculate an existing load for this system. For this reason, existing conditions are given as a concentration. The existing concentration is calculated as the concentration of FC and *enterococcus* bacteria at the 90th percentile based on the normal line fit to the monitoring data. The 90th percentile of the existing data is used to allow for the 10% exceedance outlined in the R. 61-68 and R. 61-47. The existing concentrations for impaired stations are shown in Table 6.

5.5 Margin of Safety

A MOS allows for an accounting of the uncertainty in the relationship between pollutant loads and receiving waters. MOS can be incorporated either explicitly or implicitly by using conservative assumptions. These TMDLs have an explicit 5% MOS. Water quality data collected from shellfish monitoring stations and random statistical station was compared to 40.85/100m and 98.8/100 mL which are the SSM WQS minus 5% for FC, and *enterococcus*, respectively.

5.6 Calculation of the TMDL

Shellfish monitoring data summarized in Table 3 and shown in Appendix A, from 2007 to 2010 for the deactivated stations and 2017 to 2022 for the active stations were used to calculate TMDLs. Station 16A-18, deactivated, is located upstream of 16A-23. The percent reduction calculated for 16A-18, using data from 2007 to 2010, is 28.9%. The downstream station 16A-23 has recent data, and the calculated reduction is 53.5 %. Since the downstream station has a higher percentage reduction of 53.5%, this higher percent reduction was also applied to station 16A-18. RT-16131 data collected through 2016 was used to calculate percent reductions. Calculated TMDL reductions applicable to the impaired stations are in Table 6.

5.7 Reasonable Assurance

When a TMDL is developed for a pollutant that originates from both point and nonpoint sources, or from nonpoint sources only, EPA guidance emphasizes the need to provide reasonable assurances that nonpoint source controls will effectively achieve their expected load reductions. For point sources, such as NPDES-permitted dischargers, the WLA provided in their permits already ensures this assurance.

However, for unregulated nonpoint sources of pollutants, achieving the necessary load reductions can be more challenging. To address this, various measures can be employed, including the implementation of Best Management Practices (BMPs), local ordinances, and outreach and educational efforts. CWA §319 grant funding may be available to interested parties for the purposes of implementing these measures.

Based on the information available at this time, the portions of the watersheds that drain directly to a regulated MS4 and that which drain through the non-regulated MS4 have not been clearly defined. Loading from both types of sources (regulated and non-regulated) typically occurs in response to rainfall events, discharge volumes and recurrence intervals are largely unknown. Therefore, where applicable, the regulated MS4 is assigned the same percent reduction as the non-regulated sources in the watershed. Compliance with the MS4 permit regarding this TMDL document is determined at the point of discharge to the waters of the state. The regulated MS4 entity is only responsible for implementing the TMDL WLA by following their MS4 permit requirements and is not responsible for reducing loads prescribed as LA in this TMDL document.

Table 6. TMDLs for tributaries of Morgan River. TMDLs are expressed as the most probable number (mpn) per 100 ml and mpn/day, and allocations are expressed as % reductions.

Station	Existing Conc. (mpn/ 100ml)	TMDL Conc.[1] (mpn/ 100ml)	TMDL Load[2] (WLA+LA+ MOS) (mpn/ day)	WLA + LA (mpn/ day)	MOS (mpn/ day)	Implementation Targets[7]			
						Continuous Sources[3] (mpn/100ml)	Intermittent MS4[5] (%)	Intermittent MS4 SCDOT (%)	Non-Point Source LA (%)
16A-08	64.7	43	5.56E+12	5.28E+12	2.78E+11	See Note Below	36.8%	36.8%[4]	36.8%
16A-09	58.6	43	1.17E+13	1.11E+13	5.85E+11	See Note Below	30.3%	30.3%[4]	30.3%
16A-18	57.4	43	6.43E+12	6.11E+12	3.21E+11	See Note Below	28.9%	28.9%[6]	28.9%
16A-19	89.3	43	2.33E+12	2.21E+12	1.16E+11	See Note Below	54.3%	54.3%[6]	54.3%
16A-23	87.8	43	5.84E+12	5.56E+12	2.78E+11	See Note Below	53.5%	53.5%[6]	53.5%
16A-27	61.1	43	4.20E+12	3.99E+12	2.09E+11	See Note Below	33.1%	33.1%[6]	33.1%
16A-28	120.2	43	1.33E+12	1.26E+12	6.61E+10	See Note Below	66.0%	66.0%[6]	66.0%
16A-38	112.7	43	5.67E+12	5.39E+12	2.84E+11	See Note Below	63.8%	63.8%[6]	63.8%
RT-16131	412.2	104	1.53E+12	1.45E+12	7.64E+10	See Note Below	74.8%	74.8%[6]	74.8%

Table Notes:

1. TMDL = SFH water WQS for single sample maximum not to exceed 43 mpn/100 ml (FC), and for primary and secondary recreation in SFH waters 104 mpn/100 ml (*enterococci*).

2. WLA+LA at average flow conditions calculated using estimated average tidal flow at the WQ station; see Appendix D for calculation.
3. WLA is expressed as a daily maximum of 43 mpn/100 ml (FC) or 104 mpn/100 ml (*enterococci*). There are no continuous dischargers at this time. Future continuous discharges are required to meet the WQS for the pollutant of concern. Loadings to meet the WQS are developed based upon the permitted flow and an allowable permitted maximum concentration of 43 mpn/100ml (FC) or 104 mpn/100 ml (*enterococci*).
4. The total developed area in this TMDL watershed is currently less than 5% and the Department deems the contributions from SCDOT negligible, and no reduction of bacteria is necessary at this time. If the total developed area in this TMDL watershed increases to 5% and above, SCDOT will comply with applicable WLA to the MEP as required by its NPDES MS4 permit.
5. Percent reduction applies to all NPDES-permitted stormwater discharges, including current and future MS4s, construction, and industrial discharges covered under permits numbered SCS & SCR. Stormwater discharges are expressed as a percentage reduction due to the uncertain nature of stormwater discharge volumes and recurrence intervals. Stormwater discharges are required to meet percentage reduction or the existing instream standard for the pollutant of concern in accordance with their NPDES Permit.
6. By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address bacteria, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit.
7. Refer to section 6.0 for the derivation of implementation targets.

6.0 Implementation

As implementation strategies progress, SCDHEC will continue to monitor the effectiveness of these measures and evaluate water quality where deemed appropriate. The Department recognizes that adaptive management might be necessary to achieve the water quality standard and we are committed to targeting the load reductions needed to improve water quality in these TMDL watersheds. As additional data and/or information become available, it may become necessary to revise and/or modify the TMDL target accordingly. The implementation strategies presented below are not inclusive and are only provided as guidance.

6.1 Continuous Sources

NPDES permitted continuous point sources are required to meet the instream WQS for bacteria at the discharge point (end of pipe). Currently, there are no direct discharges to TMDL watersheds described in this document.

6.1 Intermittent Point Sources – MS4s

NPDES MS4 entities are required to target and show progress towards implementing the calculated percent reductions to the MEP with each permit cycle by following their permit requirements. These entities are responsible for documenting and reporting their progress toward achieving the percent reductions allocated to the MS4s in these TMDL watersheds.

An iterative approach of water quality monitoring, illicit source detection, and elimination, deploying best management practices (BMPs) and evaluation of their effectiveness, outreach and education, optimization of other tools such as local ordinances, and revision of their stormwater management plan (SWMP) as needed in reducing bacteria loading to these TMDL watersheds is expected to show improvements in water quality.

For SCDOT, existing and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP). For existing and future NPDES construction and industrial stormwater permittees, compliance with the terms and conditions of its permit is an effective implementation of the WLA. Required load reductions in the LA portion of this TMDL can be implemented through voluntary measures and are eligible for CWA §319 grants.

6.2 Nonpoint Sources

South Carolina has several tools available for implementing the nonpoint source component of this TMDL. The Nonpoint Source Management Plan (SC DHEC, 2019) document is one example.

Interested parties (local stakeholder groups, universities, local governments, etc.) may be eligible to apply for CWA §319 grants to install BMPs that will implement the LA portion of these TMDLs and reduce nonpoint source bacteria and other pathogen loadings to impaired waters. Congress amended the CWA in 1987 to establish the §319 Nonpoint Source Management Program. Under §319, States receive grant money to support a wide variety of activities including the restoration of impaired waters. TMDL implementation projects are given the highest priority for §319 funding. CWA §319 grants are not available for implementation of the WLA component of these TMDLs but may be available for the LA component within permitted MS4 jurisdictional boundaries.

7.0 Bibliography

2017. "40 CFR - Protection of Environment." *Subchapter D Water Programs Part 130 Water Quality Planning and Management.* July 1.

AVMA. 2022. "U.S. Pet Statistics." https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics#formulas.

Boeing. 2003. "Cumulative Probability Plot 3.0."

Griffith, G. E., J. M. Omernik, and J. A. Comstock. 2002. "Ecoregions of South Carolina, Regional Descriptions." Virginia. https://www.nrc.gov/docs/ML1127/ML112710639.pdf.

Mallin, A. A., J. M. Burkholder, and L. B. Cahoon. 2000. "North and South Carolina Coasts." *Marine Pollution Bulletin* (Pergamon) 41 (1-6): 56-75. http://uncw.edu/cms/aelab/Reports%20and%20Publications/2000/2000,Mar%20Poll%20Bull,North%20and%20South%20Carolina%20Coasts.pdf.

Montague, Clay L, and Janet A Ley. 1993. "A Possible Effect of Salinity Fluctuation on Abandance of Benthic Vegetation and Associated Fauna in Northeastern Florida." *Estuaries*, December: 703-717.

Novotny, V. 2003. *Water Quality: Diffuse Pollution and Watershed Management.* John Wiles and Sons.

SCDHEC. 2023a. "Classified Waters (R. 61-69)." Columbia, SC: Bureau of Water, Includes all amendments through June 22, 2012.

SCDHEC. 2021. *R. 61-43 Standards for the Permitting of Agricultural Animal Facilities.* Effective June 28, 2002. Columbia, SC. Accessed March 19, 2018. http://www.scdhec.gov/Agency/docs/water-regs/r61-43.pdf.

SCDHEC. 2017. "Regulation 61-47 Shellfish." https://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-shellfish.
SCDHEC. 2023b. *Regulation 61-68 Water Classifications and Standards.* https://scdhec.gov/sites/default/files/Library/Regulations/R.61-68.pdf.
SCDHEC. 2023e. "Shellfish Management Area 16A 2023 Annual Update." https://scdhec.gov/monitoring-station-reports.
SCDHEC. 2023c. "The State of South Carolina's 2020 and 2022 Integrated Report (IR) Part I: Section 303(d) Listing of Impaired Waters." https://scdhec.gov/sites/default/files/media/document/IR_Part_I_Final_Submittal_2018.pdf.
SCDHEC. 2023d. *Water Pollution Control Permits: R61-9.* May. https://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-water-pollution-control.
SCDHEC. 2019. *Water Pollution Control Permits: R61-9.* May. https://scdhec.gov/BOW/water-regulations-standards/water-regulations-standards-water-pollution-control.
SCDHEC. 2011. *Water Pollution Control Permits: R61-9.* February. http://www.scdhec.gov/Agency/docs/water-regs/r61-9.pdf.
SCDNR. 2013. http://www.dnr.sc.gov/wildlife/deer/pdf/2013deerdensitymap.pdf.
—. 2013. *South Carolina Deer Density Map.* https://www.dnr.sc.gov/wildlife/deer/deermap.html.
The United States Code. 2012. "33 U.S.C. 1322 - Marine Sanitation Devices." *United States Code, 2006 Edition, Supplement 5, Title 33 -Navigation and Navigable Waters.* January 3.
USDA. 2019. *Census of Agriculture 2017 Census.* United States Department of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/South_Carolina/.
USEPA. 1999. "Draft Guidance for Water Quality-based Decisions: The TMDL Process." Vols. EPA 841-D-99-001. Washington DC: Office of Water, August.
USEPA. 1991. *Guidance for Water Quality Based Decisions: The TMDL Process.* Prod. US EPA Office of Water. Washington, DC.
USFDA. 2019. "National Shellfish Sanitation Program (NSSP). Guide for the Control of Molluscan Shellfish." https://www.fda.gov/food/federalstate-food-programs/national-shellfish-sanitation-program-nssp.
Yagow, G. 2001. "Fecal Coliform TMDL Mountain Run Watershed Culpeper County, Virginia." April. http://www.deq.state.va.us.

Appendix A – Data Used for Calculation of the TMDLs

16A-08	FC MPN	16A-08	FC MPN	16A-09	FC MPN	16A-09	FC MPN
1/31/2017	1.7	6/2/2020	33	1/31/2017	2	6/2/2020	46
2/23/2017	130	7/21/2020	4.5	2/23/2017	350	7/21/2020	2
3/22/2017	46	8/19/2020	2	3/22/2017	17	8/19/2020	2
4/18/2017	7.8	9/23/2020	13	4/18/2017	2	9/23/2020	11
5/24/2017	79	10/14/2020	23	5/24/2017	33	10/14/2020	79
6/21/2017	110	11/30/2020	240	6/21/2017	110	11/30/2020	95
7/27/2017	11	12/9/2020	4.5	7/27/2017	13	12/9/2020	2
8/22/2017	4	2/23/2021	23	8/22/2017	2	2/23/2021	8
9/27/2017	9.3	3/10/2021	79	9/27/2017	2	3/10/2021	23
10/25/2017	7.8	4/7/2021	13	10/25/2017	13	4/7/2021	2
11/7/2017	11	5/11/2021	22	11/7/2017	7	5/11/2021	8
12/4/2017	49	6/8/2021	17	12/4/2017	79	6/8/2021	5
1/30/2018	79	7/28/2021	1.8	1/30/2018	170	7/28/2021	6
2/26/2018	130	8/17/2021	6.8	2/26/2018	350	8/17/2021	11
3/27/2018	33	9/7/2021	2	3/27/2018	33	9/7/2021	2
4/17/2018	7.8	10/13/2021	4.5	4/17/2018	5	10/13/2021	8
5/22/2018	7.8	11/3/2021	70	5/22/2018	9	11/3/2021	33
6/26/2018	7.8	12/15/2021	130	6/26/2018	5	12/15/2021	33
7/25/2018	23	1/18/2022	14	7/25/2018	9	1/18/2022	33
8/22/2018	49	2/23/2022	2	8/22/2018	33	2/23/2022	2
9/24/2018	7.8	3/15/2022	33	9/24/2018	2	3/15/2022	17
10/22/2018	33	4/6/2022	2	10/22/2018	49	4/6/2022	11
11/6/2018	33	5/11/2022	7.8	11/6/2018	49	5/11/2022	8
12/13/2018	2	6/7/2022	4	12/13/2018	2	6/7/2022	2
1/30/2019	17	7/26/2022	4.5	1/30/2019	11	7/26/2022	2
3/13/2019	4	8/16/2022	1.8	3/13/2019	13	8/16/2022	2
4/10/2019	49	10/12/2022	1.7	4/10/2019	13	10/12/2022	2
5/20/2019	1.7	11/8/2022	4.5	5/20/2019	5	11/8/2022	2
6/5/2019	11	12/13/2022	1.7	6/5/2019	5	12/13/2022	2
7/8/2019	4.5			7/8/2019	13		
8/21/2019	7.8			8/21/2019	2		
9/25/2019	23			9/25/2019	22		
10/28/2019	17			10/28/2019	17		
11/6/2019	2			11/6/2019	5		
12/10/2019	33			12/10/2019	49		
1/29/2020	4.5			1/29/2020	8		
2/25/2020	6.1			2/25/2020	5		
3/11/2020	7.8			3/11/2020	11		
4/14/2020	33			4/14/2020	5		
5/19/2020	23			5/19/2020	33		

16A-18	FC MPN
1/15/2008	33
2/27/2008	120
3/11/2008	9
4/2/2008	64
5/6/2008	7
7/23/2008	5
8/7/2008	8
9/9/2008	80
10/14/2008	49
11/24/2008	21
12/16/2008	33
1/13/2009	13
2/23/2009	8
3/16/2009	130
4/13/2009	33
5/6/2009	33
6/16/2009	23
7/15/2009	17
8/4/2009	49
9/30/2009	15
10/14/2009	220
11/17/2009	17
12/7/2009	22
2/16/2010	11
3/16/2010	7.8
4/13/2010	95
5/11/2010	33
6/30/2010	49
7/22/2010	64
8/26/2010	4.5
9/22/2010	13
10/13/2010	14
11/2/2010	7.8

16A-19	FC MPN
1/31/2017	5
2/23/2017	220
3/22/2017	49
4/18/2017	49
5/24/2017	70
6/21/2017	17
7/27/2017	49
8/22/2017	17
9/27/2017	33
10/17/2017	5
10/25/2017	13
11/7/2017	13
12/9/2017	23
1/30/2018	130
2/26/2018	79
3/27/2018	17
4/17/2018	8
5/22/2018	33
6/26/2018	49
7/25/2018	33
8/22/2018	17
9/24/2018	5
10/22/2018	8
11/6/2018	26
12/13/2018	8
1/30/2019	33
3/13/2019	13
4/10/2019	23
5/20/2019	46
6/5/2019	17
7/8/2019	33
8/21/2019	11
9/25/2019	43
10/28/2019	2
11/6/2019	70
12/10/2019	11
1/29/2020	2
2/25/2020	13
3/11/2020	33

16A-19	FC MPN
4/14/2020	350
5/19/2020	8
6/2/2020	27
7/21/2020	8
8/19/2020	8
9/23/2020	130
10/14/2020	17
11/30/2020	79
12/9/2020	33
2/23/2021	240
3/10/2021	49
4/7/2021	49
5/11/2021	33
6/8/2021	13
7/28/2021	49
8/17/2021	33
9/7/2021	79
10/13/2021	33
11/3/2021	17
12/15/2021	79
1/18/2022	8
2/23/2022	17
3/15/2022	23
4/6/2022	13
5/11/2022	49
6/7/2022	23
7/26/2022	13
8/16/2022	5
10/12/2022	5
11/8/2022	13
12/13/2022	13

16A-23	FC MPN
1/31/2017	2
2/23/2017	170
3/22/2017	23
4/18/2017	95
5/24/2017	79
6/21/2017	79
7/27/2017	13
8/22/2017	17
9/27/2017	23
10/25/2017	46
11/7/2017	5
12/4/2017	70
1/30/2018	79
2/26/2018	240
3/27/2018	49
4/17/2018	2
5/22/2018	13
6/26/2018	11
7/25/2018	17
8/22/2018	33
9/24/2018	11
10/22/2018	49
11/6/2018	33
12/13/2018	2
1/30/2019	13
3/13/2019	13
4/10/2019	13
5/20/2019	2
6/5/2019	8
7/8/2019	49
8/21/2019	5
9/25/2019	17
10/28/2019	49
11/6/2019	8
12/10/2019	23
1/29/2020	2
2/25/2020	23
3/11/2020	11
4/14/2020	79

16A-23	FC MPN
5/19/2020	49
6/2/2020	49
7/21/2020	8
8/19/2020	8
9/23/2020	33
10/14/2020	79
11/30/2020	140
12/9/2020	23
2/23/2021	46
3/10/2021	49
4/7/2021	22
5/11/2021	23
6/8/2021	33
7/28/2021	5
8/17/2021	49
9/7/2021	13
10/13/2021	13
11/3/2021	79
12/15/2021	22
1/18/2022	8
2/23/2022	2
3/15/2022	33
4/6/2022	2
5/11/2022	17
6/7/2022	8
7/26/2022	33
8/16/2022	5
10/12/2022	2
11/8/2022	5
12/13/2022	4

16A-27	FC MPN
1/31/2017	2
2/23/2017	70
3/22/2017	13
4/18/2017	7
5/24/2017	13
6/21/2017	170
7/27/2017	8
8/22/2017	4
9/27/2017	2
10/25/2017	5
11/7/2017	22
12/4/2017	540
1/30/2018	350
2/26/2018	46
3/27/2018	23
4/17/2018	2
5/22/2018	2
6/26/2018	2
7/25/2018	33
8/22/2018	49
9/24/2018	8
10/22/2018	17
11/6/2018	79
12/13/2018	2
1/30/2019	33
3/13/2019	4
4/10/2019	13
5/20/2019	8
6/5/2019	5
7/8/2019	17
8/21/2019	2
9/25/2019	33
10/28/2019	46
11/6/2019	5
12/10/2019	79
1/29/2020	2
2/25/2020	4
3/11/2020	23
4/14/2020	8
5/19/2020	33

16A-27	FC MPN
6/2/2020	22
7/21/2020	2
8/19/2020	5
9/23/2020	7
10/14/2020	22
11/30/2020	110
12/9/2020	7
2/23/2021	23
3/10/2021	33
4/7/2021	13
5/11/2021	17
6/8/2021	5
7/28/2021	2
8/17/2021	5
9/7/2021	2
10/13/2021	7
11/3/2021	48
12/15/2021	49
1/18/2022	5
2/23/2022	2
3/15/2022	14
4/6/2022	2
5/11/2022	11
6/7/2022	2
7/26/2022	2
8/16/2022	5
10/12/2022	2
11/8/2022	2
12/13/2022	2

16A-28	FC MPN
1/31/2007	17
2/13/2007	13
3/19/2007	9
4/24/2007	49
5/30/2007	5
6/18/2007	22
7/2/2007	2
8/14/2007	6
9/11/2007	8
10/8/2007	2
11/7/2007	9
12/18/2007	64
1/15/2008	2
2/27/2008	49
3/11/2008	5
4/2/2008	110
5/6/2008	17
7/23/2008	33
8/7/2008	49
9/9/2008	50
10/14/2008	11
11/24/2008	23
12/16/2008	17
1/13/2009	11
2/23/2009	17
3/16/2009	49
4/13/2009	11
5/6/2009	130
6/16/2009	49
7/15/2009	79
8/4/2009	79
9/30/2009	79
10/14/2009	130
11/17/2009	23
12/7/2009	49
2/16/2010	33
3/16/2010	13
4/13/2010	64
5/11/2010	140
6/30/2010	79

16A-28	FC MPN
7/22/2010	280
8/26/2010	2
9/22/2010	64
10/13/2010	46

16A-38	FC MPN
1/31/2017	2
2/23/2017	170
3/22/2017	240
4/18/2017	5
5/24/2017	33
6/21/2017	110
7/27/2017	13
8/22/2017	7
9/27/2017	8
10/25/2017	13
11/7/2017	2
12/4/2017	33
1/30/2018	170
2/26/2018	110
3/27/2018	79
4/17/2018	49
5/22/2018	130
6/26/2018	11
7/25/2018	17
8/22/2018	79
9/24/2018	2
10/22/2018	79
11/6/2018	33
12/13/2018	9
1/30/2019	23
3/13/2019	2
4/10/2019	13
5/20/2019	2
6/5/2019	11
7/8/2019	33
8/21/2019	2
9/25/2019	49
10/28/2019	110
11/6/2019	46

16A-38	FC MPN
12/10/2019	49
1/29/2020	2
2/25/2020	11
3/11/2020	33
4/14/2020	140
5/19/2020	79
6/2/2020	49
7/21/2020	5
8/19/2020	33
9/23/2020	13
10/14/2020	23
11/30/2020	49
12/9/2020	33
2/23/2021	49
3/10/2021	110
4/7/2021	13
5/11/2021	49
6/8/2021	23
7/28/2021	14
8/17/2021	46
9/7/2021	2
10/13/2021	8
11/3/2021	33
12/15/2021	79
1/18/2022	33
2/23/2022	8
3/15/2022	22
4/6/2022	13
5/11/2022	17
6/7/2022	2
7/26/2022	2
8/16/2022	5
10/12/2022	2
11/8/2022	49
12/13/2022	2

RT-16131	Entero
1/26/2016	20
2/17/2016	10
3/31/2016	160
4/19/2016	85
5/25/2016	85
6/22/2016	1
7/20/2016	187
8/18/2016	31
9/27/2016	336
12/13/2016	85

Appendix B – Land Use Tables

16A-09	Area (ac)	Percent of Area
Open Water	**197.3**	**15.6**
Developed	39.4	3.1
Barren Land	0.9	0.1
Forest	149.2	11.8
Pasture/Hay	5.1	0.4
Forested Wetlands	48.7	3.9
Non-forested Wetlands	**822.4**	**65.1**
Total	1263.0	100.0

16A-18	Area (ac)	Percent of Area
Open Water	55.2	3.9
Developed	133.4	9.4
Barren Land	1.6	0.1
Forest	322.5	22.7
Pasture/Hay	**342.0**	**24.1**
Cultivated Crops	2.2	0.2
Forested Wetlands	202.2	14.2
Non-forested Wetlands	**361.2**	**25.4**
Total	1420.2	100.0

16A-19	Area (ac)	Percent of Area
Open Water	48.7	2.3
Developed	**735.7**	**35.1**
Barren Land	0.7	0.0
Forest	**883.1**	**42.2**
Pasture/Hay	44.7	2.1
Forested Wetlands	191.0	9.1
Non-forested Wetlands	191.0	9.1
Total	2095.0	100.0

16A-23	Area (ac)	Percent of Area
Open Water	109.9	12.4
Developed	82.5	9.3
Barren Land	0.2	0.0
Forest	**164.8**	**18.5**
Pasture/Hay	21.3	2.4
Forested Wetlands	97.0	10.9
Non-forested Wetlands	**413.4**	**46.5**
Total	889.13105	100

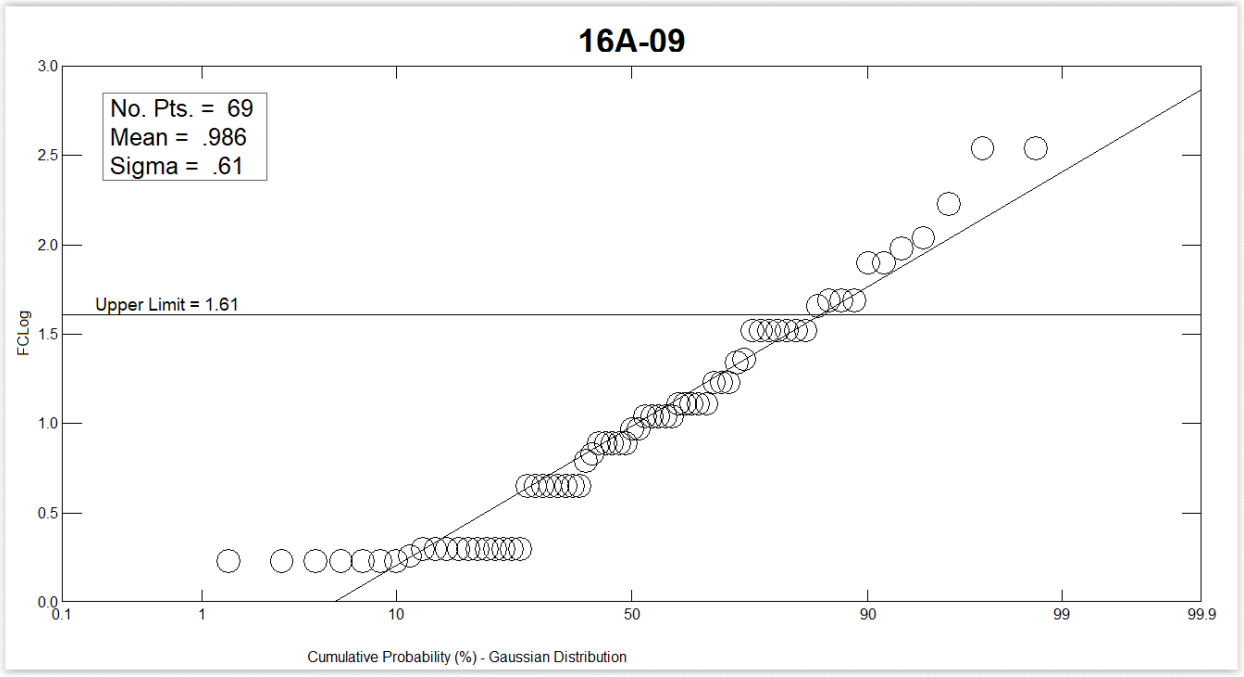
16A-27	Area (ac)	Percent of Area
Open Water	**109.6**	**18.4**
Developed	49.8	8.4
Barren Land	4.0	0.7
Forest	86.5	14.5
Pasture/Hay	6.0	1.0
Forested Wetlands	9.6	1.6
Non-forested Wetlands	**329.6**	**55.4**
Total	595.1	100.0

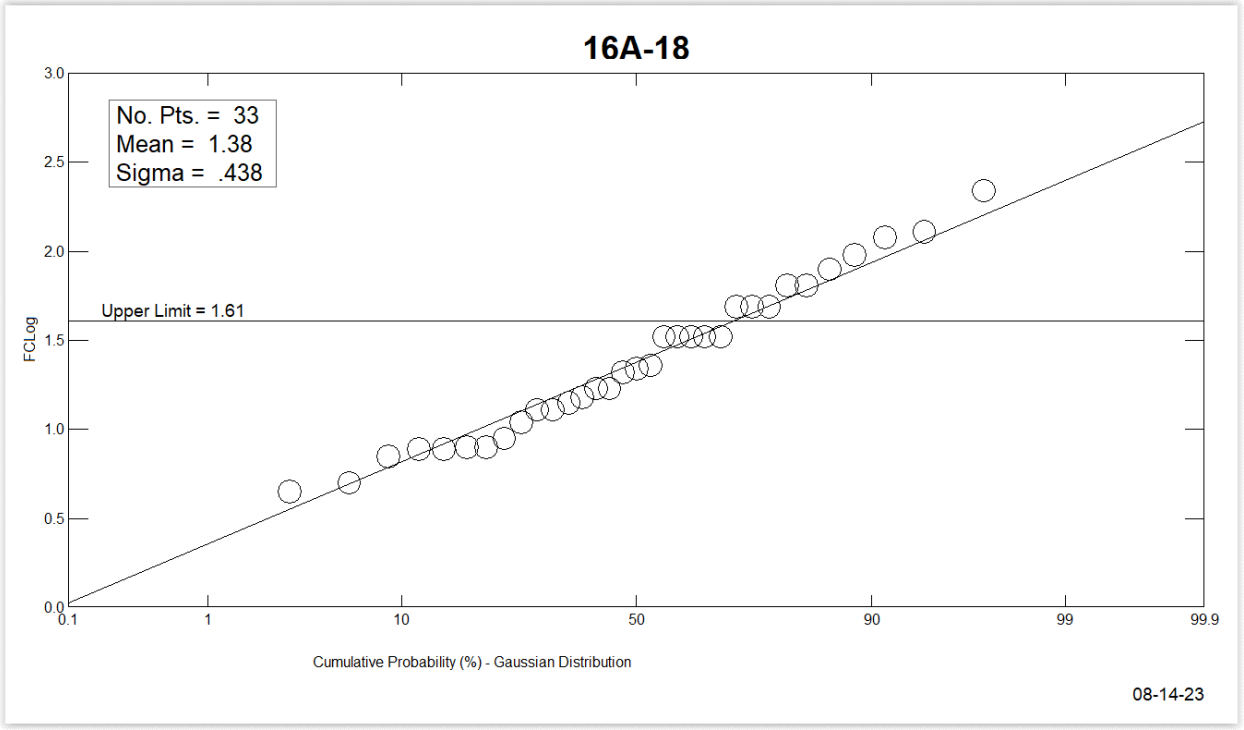
16A-28	Area (ac)	Percent of Area
Open Water	18.5	10.0
Developed	**31.1**	**16.8**
Barren Land	0.7	0.4
Forest	**51.6**	**27.9**
Pasture/Hay	1.1	0.6
Forested Wetlands	8.0	4.3
Non-forested Wetlands	73.8	4.3
Total	184.8	64.4

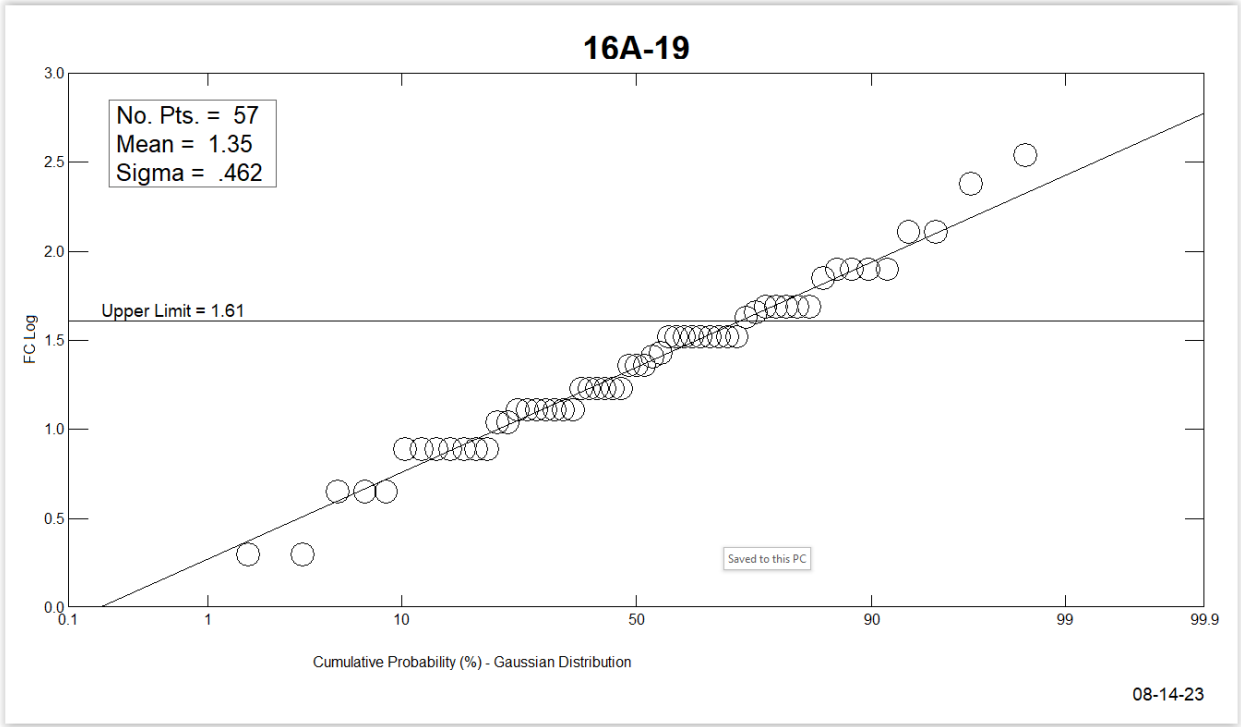
16A-38	Area (ac)	Percent of Area
Open Water	230.2	5.7
Developed	460.4	11.3
Barren Land	0.2	0.0
Forest	**1627.5**	**40.0**
Pasture/Hay	148.8	3.7
Cultivated Crops	0.7	0.0
Forested Wetlands	781.3	19.2
Non-forested Wetlands	**823.3**	**20.2**
Total	4072.3	100.0

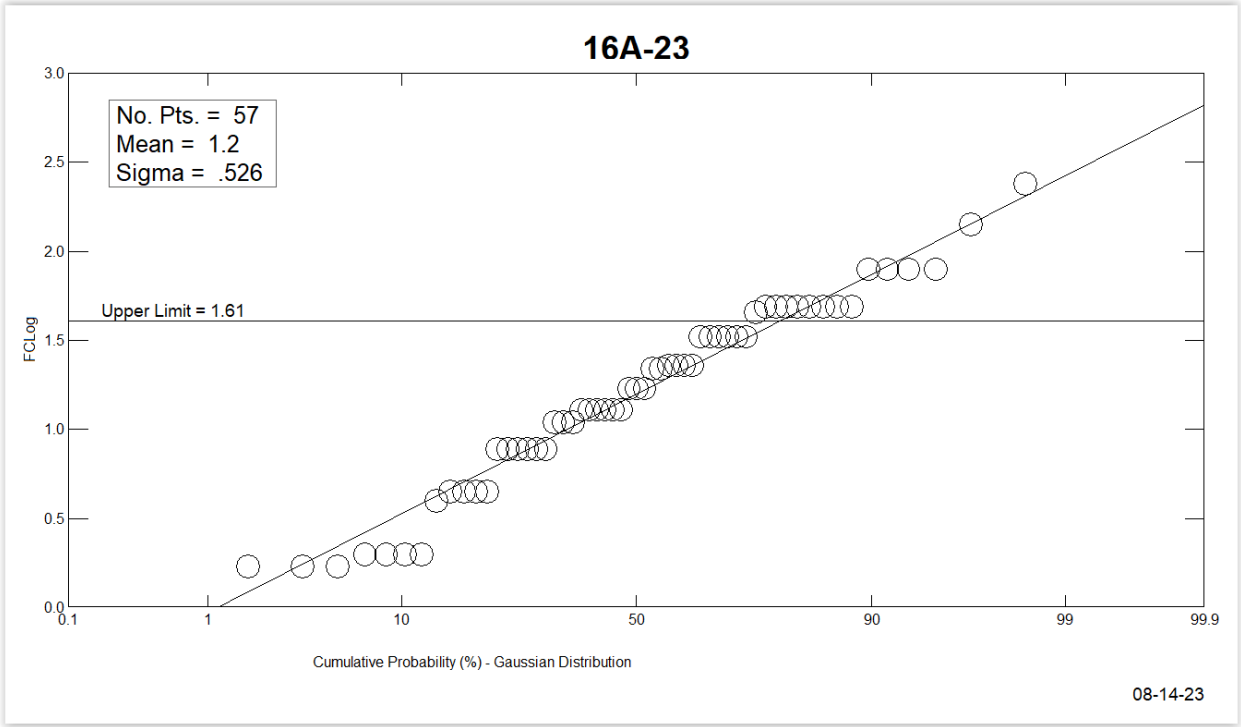
RT-16131	Area (ac)	Percent of Area
Open Water	13.8	2.0
Developed	**126.1**	**18.0**
Forest	**348.9**	**49.7**
Pasture/Hay	30.0	4.3
Forested Wetlands	92.1	13.1
Non-forested Wetlands	90.5	12.9
Total	701.4	100.0

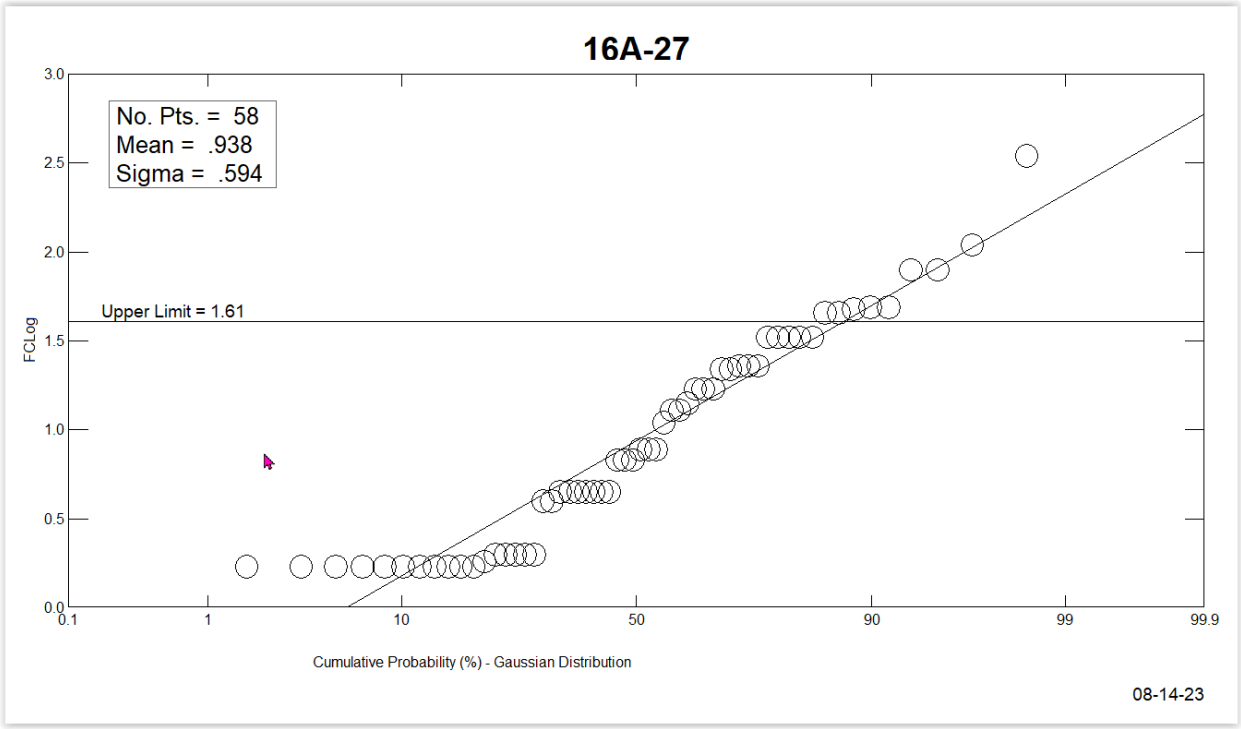
Appendix C – Cumulative Probability Graphs

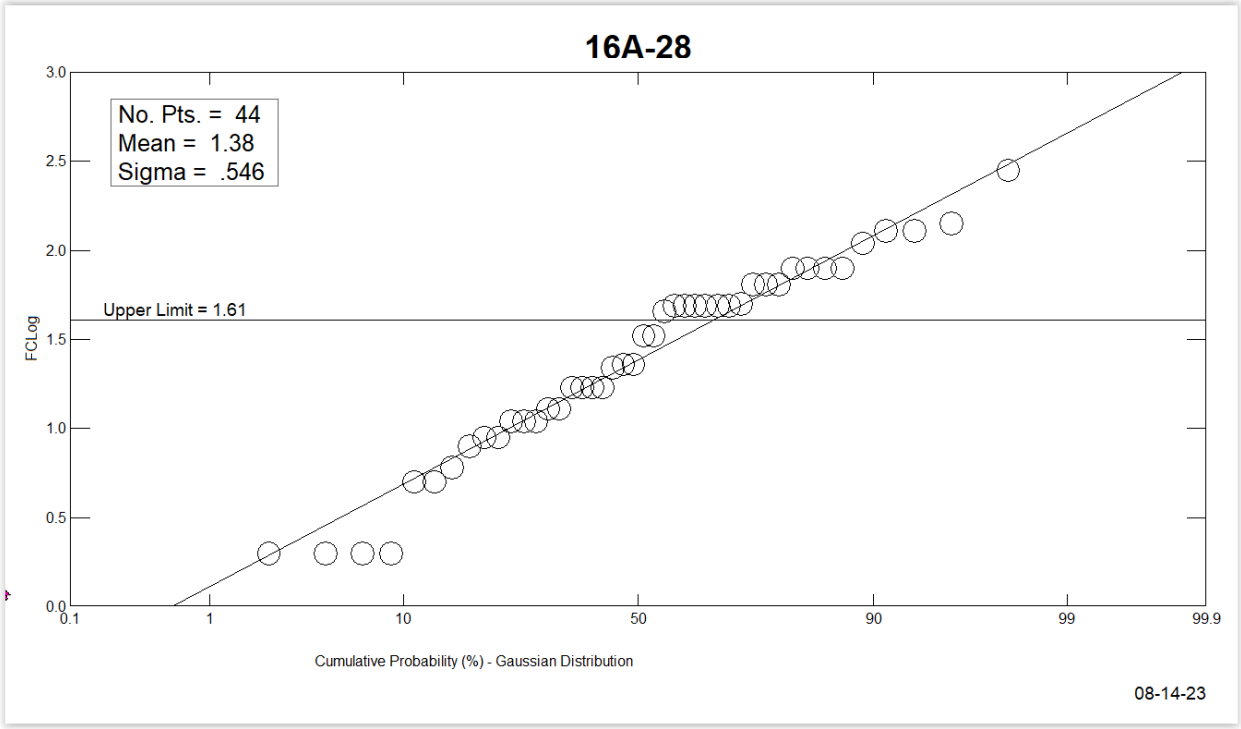


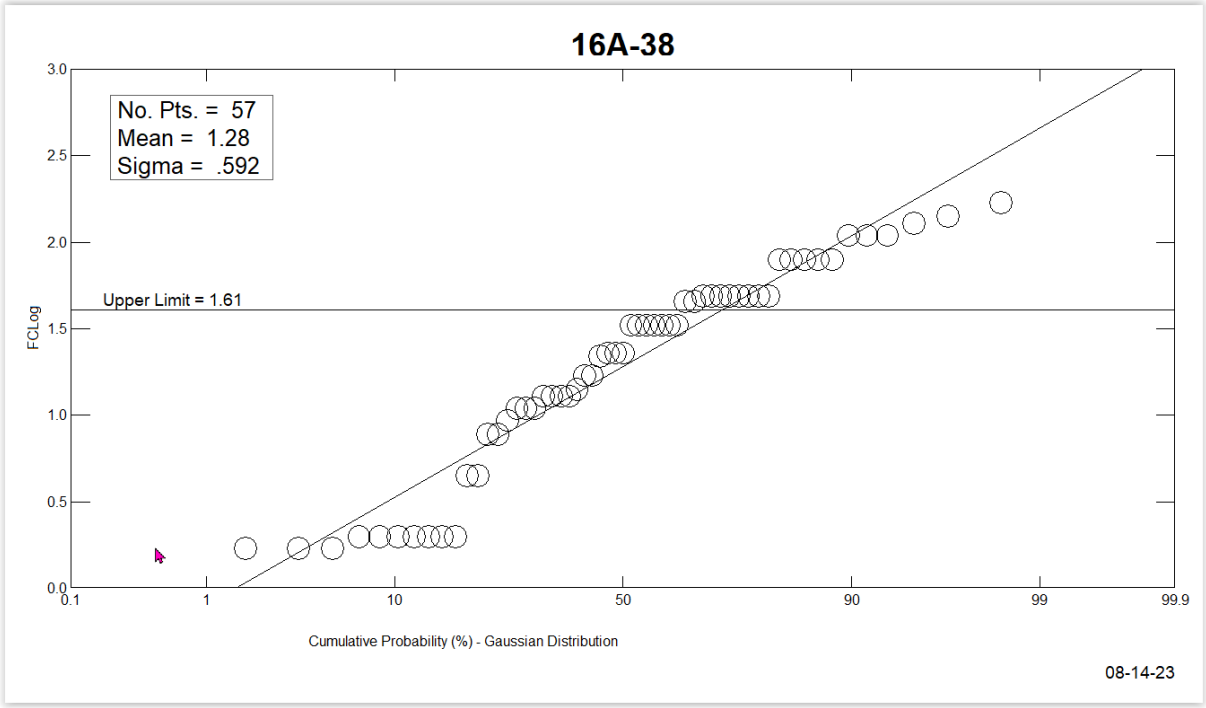


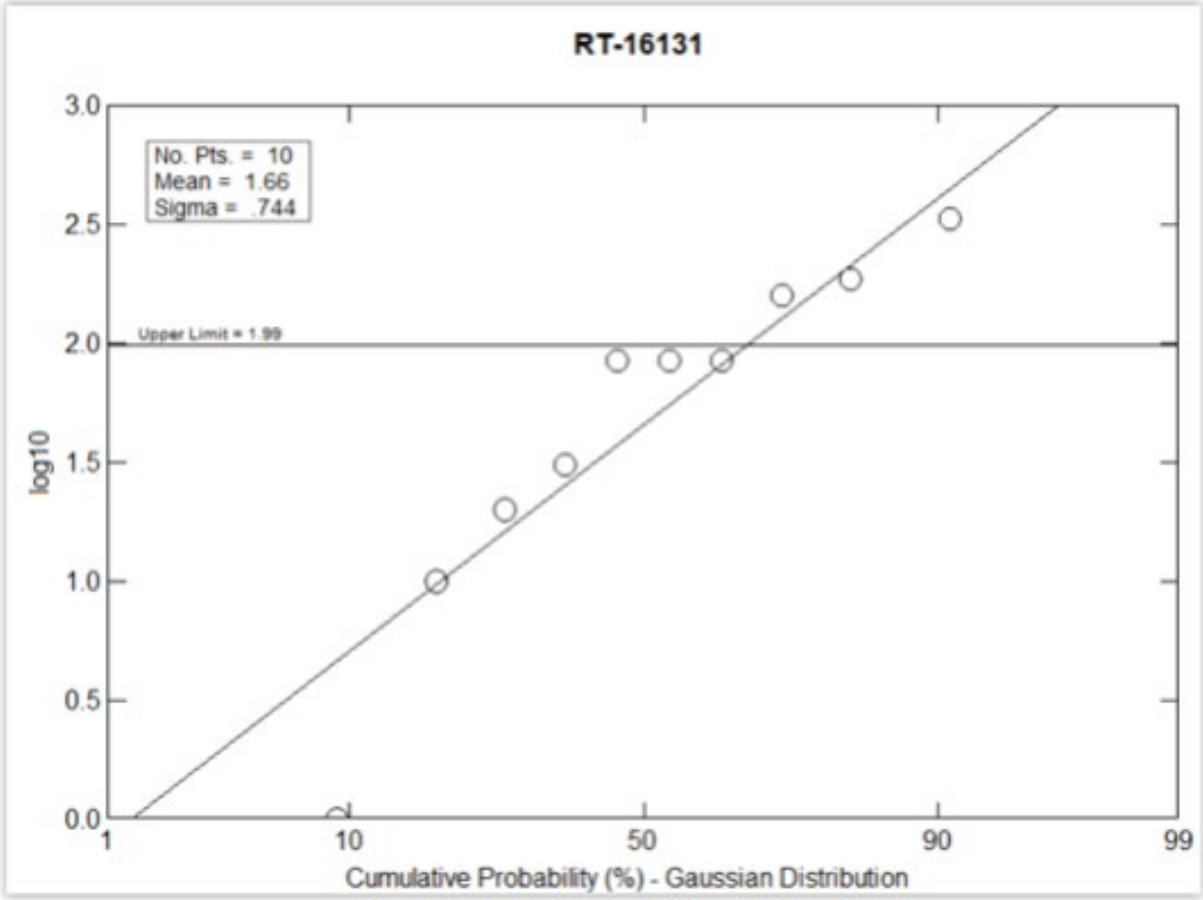

16A-19
No. Pts. = 57
Mean = 1.35
Sigma = .462
Upper Limit = 1.61
FC Log
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%) - Gaussian Distribution
08-14-23


16A-23
No. Pts. = 57
Mean = 1.2
Sigma = .526
Upper Limit = 1.61
FCLog
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%) - Gaussian Distribution
08-14-23


16A-27
No. Pts. = 58
Mean = .938
Sigma = .594
Upper Limit = 1.61
FCLog
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%) - Gaussian Distribution
08-14-23


16A-28
No. Pts. = 44
Mean = 1.38
Sigma = .546
Upper Limit = 1.61
FCLog
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%) - Gaussian Distribution
08-14-23


16A-38
No. Pts. = 57
Mean = 1.28
Sigma = .592
Upper Limit = 1.61
FCLog
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%) - Gaussian Distribution
08-14-23


RT-16131
No. Pts. = 10
Mean = 1.66
Sigma = .744
Upper Limit = 1.99
log10
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
10
50
90
99
Cumulative Probability (%) - Gaussian Distribution

Appendix D – The method used to calculate target load.

Calculating a daily target load begins with the determination of average tidal flow. First, the average cross-sectional area of the waterway at the sampling station is estimated using the mean tidal range, average depth at low tide, the average width of the channel, and channel geometry (rectangular vs triangular).

Figure 7. Eddings Creek depths (ft).

Lacking site-specific data, average depth at low tide and average widths may be obtained from navigation charts, satellite imagery, topo maps, etc. (Figure 7 and Figure 8).

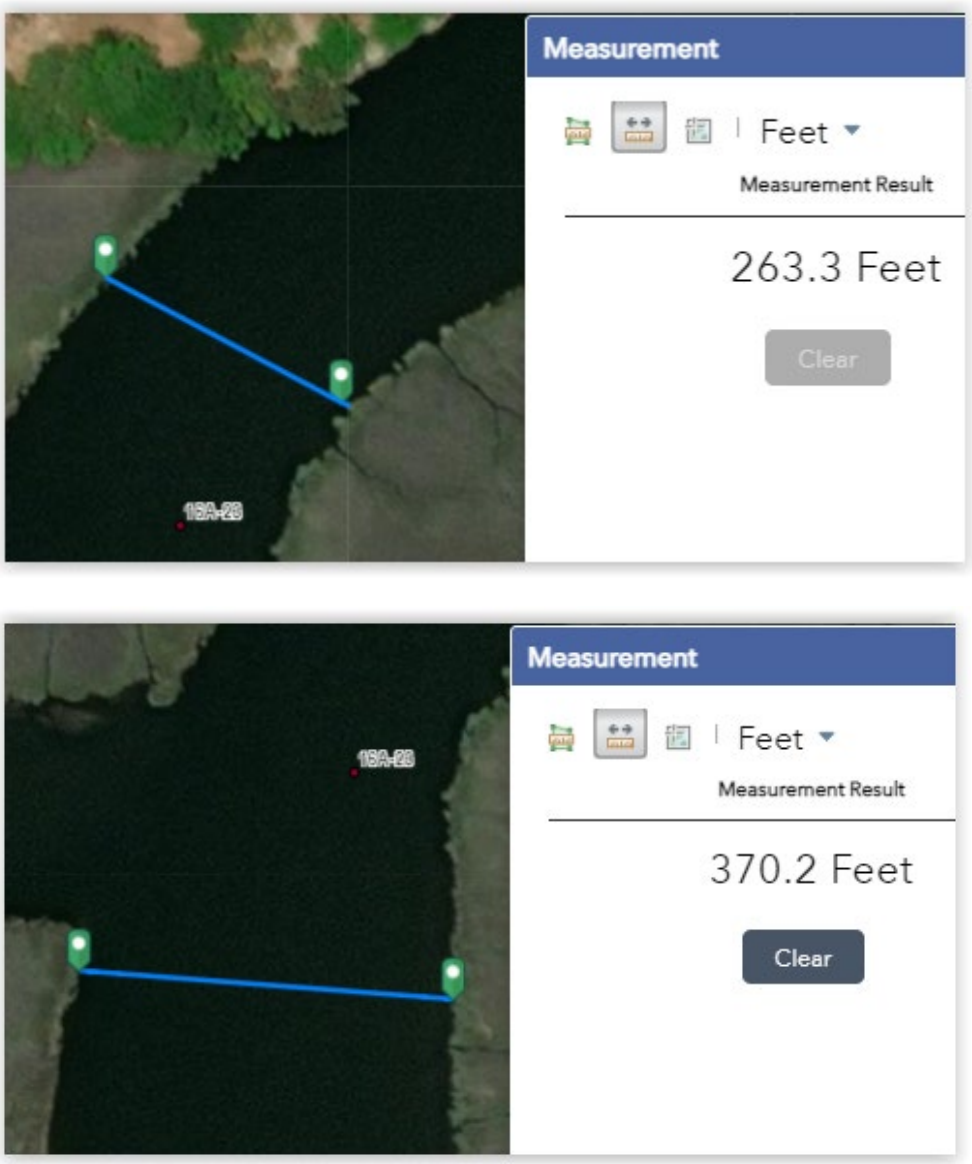


Figure 8. The two measured widths were averaged.

Mean tidal range is determined as the difference between mean high and mean low water levels and is retrieved from NOAA's Tides and Currents web page using the NOAA station most appropriate for the sampling location. Though infrequently, mean tidal range may also be readily available for some stations (Figure 9). Where available, tidal velocity is determined from the time of travel or flow study data. Usually, these data are not available and default ranges are used (Table 7).

Elevations on Mean Lower Low Water

Station: 8667972, EDDINGS POINT CREEK, SC
T.M.: 75
Epoch: 1983-2001
Status: Accepted (Jun 2 2003)
Datum: MLLW
Units: Feet
Control Station: 8667999 BEAUFORT, SC

Datum	Value	Description
MHHW	6.98	Mean Higher-High Water
MHW	6.62	Mean High Water
MTL	3.41	Mean Tide Level
MSL	3.68	Mean Sea Level
DTL	3.49	Mean Diurnal Tide Level
MLW	0.21	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAVD88	3.86	North American Vertical Datum of 1988
STND	-5.80	Station Datum
GT	6.99	Great Diurnal Range
MN	6.41	Mean Range of Tide
DHQ	0.36	Mean Diurnal High Water Inequality
DLQ	0.21	Mean Diurnal Low Water Inequality
HWI	1.03	Greenwich High Water Interval (in hours)
LWI	7.13	Greenwich Low Water Interval (in hours)
Max Tide	8.69	Highest Observed Tide
Max Tide Date & Time	07/19/1978 20:06	Highest Observed Tide Date & Time
Min Tide	-2.79	Lowest Observed Tide
Min Tide Date & Time	01/29/1979 02:54	Lowest Observed Tide Date & Time

Figure 9. NOAA tidal station information.

Table 7. Default velocities to be used in the absence of site-specific data.

Velocity (ft/sec)	Waterbody Characteristic
0.5 – 1.0	Relatively slow, constricted estuaries
1.0 – 2.0	Moderate, free-flowing estuaries
2.0 – 3.0	Rapid, highly tidal estuaries

Average tidal flow is calculated by multiplying velocity by the cross-sectional area of the waterbody at the sampling station.

The TMDL loads are based on the WQS and multiplying the resulting concentration by average tidal flow and a conversion factor (24,465,758.4 sec*ml / ft^3*day) as demonstrated below.

This method provides an estimate of the target daily load based on average tidal flow. Actual tidal flows and loads are highly variable at this location. Therefore, the TMDL expression includes concentration and percent reduction targets for implementation.

Example calculations for 16A-23 on Eddings Point Creek:
Average depth at low tide: 17.5 ft
Average width: 316.75 ft
Mean tidal range: 6.41 ft
Channel shape: triangular
Channel area = 2{(316.75/2) * [0.5 (17.5' + 6.41'/2)]} = 2641.78 ft^2
Average tidal flow = 2641.78 ft^2 * 2 ft/s = 5283.56 cfs
WLA + LA = 40.85 mpn/100 mL
WLA + LA load = 40.85 mpn/100 ml * 5283.56 ft^3/sec * 24,465,758.4 sec*ml/ft^3*day = 5.6 x 10^{12} mpn/day = 5.55x10^{11}
MOS Load = 2.15 mpn/100 ml * 5283.56 ft^3/sec * 24,465,758.4 sec*ml/ft^3*day = 5.6 x 10^{12} mpn/day = 2.78x10^{11}
TMDL = 5.83x10^{12}

Morgan River TMDL Addendum

1. In tables Ab1 and 6, intermittent MS4 percent reductions were inadvertently allocated zero. There are no permitted intermittent point sources in the TMDL area at this time. The edited tables include percent reductions for any future permitted intermittent MS4 sources.

Response to Comments – Morgan River TMDL

The following comments were received from SCDOT, and Jack Watts, Coffin Creek resident.

SCDOT Comment 1:

Section	Public Notice Draft Language	SCDOT Requested Language	Justification
Section 5.7, Table 6, Note 4, Page 29	"As long as the conditions within the SCDOT MS4 area remain the same the Department deems the current contributions from SCDOT negligible and no reduction of FC bacteria is necessary. SCDOT must continue to comply with the provisions of its approved NPDES stormwater permit."	"The Department deems the current contributions from SCDOT negligible and no reduction of fecal coliform or Enterococcus bacteria is necessary. SCDOT must continue to comply with the provisions of its approved NPDES stormwater permit."	• This TMDL is for the conditions at the time of the study, therefore the language "*As long as the conditions within the SCDOT MS4 remain the same*" is not needed and is a great concern. • SCDOT is altering conditions via maintenance and construction projects continually. The phrase "*As long as the conditions within the SCDOT MS4 remain the same*" would never be applicable. This would place the SCDOT, SCDHEC and the State of South Carolina at risk for third party law suits for non-compliance with the TMDL. • The TMDL is for both fecal coliform (FC) and Enterococci, but only fecal coliform is referenced in Note 4 of Table 6. The SCDOT MS4 permit compliance plan references bacteria as a general group to include all bacteria indicators used by SCDHEC.

Responses to the three points in the "Justification" column above:

Footnote 4 for tables Ab1 and 6 has been replaced with: "The total developed area in this TMDL watershed is currently less than 5% and the Department deems the contributions from SCDOT negligible, and no reduction of bacteria is necessary at this time. If the total developed area in this TMDL watershed increases to 5% and above, SCDOT will comply with applicable WLA to the MEP as required by its NPDES MS4 permit".

To reflect this change, stations 16A-08 and -09 have been allocated loadings to be used should the cumulative developed land use based on the latest NLCD data increase to 5% and above.

SCDOT Comment 2:

Section	Public Notice Draft Language	SCDOT Requested Language	Justification
Section 5.7, Table 6, Note 6, Page 29	"By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address FC, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit."	"By implementing the best management practices that are prescribed in either the SCDOT annual SWMP or the SCDOT MS4 Permit to address bacteria, the SCDOT will comply with these TMDLs and its applicable WLA to the maximum extent practicable (MEP) as required by its MS4 permit."	The TMDL is for both fecal coliform and Enterococci, but only fecal coliform is referenced. The SCDOT MS4 permit compliance plan references bacteria as a general group to include all bacteria indicators used by SCDHEC.

Response 2:

In footnote 6, "FC" has been replaced with "bacteria"

Email comment from Jack Watts, resident of Coffin Creek:

“I live adjacent to Coffin Creek in area RT-16131 and am very interested in the water quality here. Having lived here more than 50 years, I have seen tremendous growth, docks added, and am concerned that the water quality is unsafe to consume shellfish from, maybe not even clean enough to eat crabs from.

Please send me the results of the upcoming study, and any other pertinent information available.

Thank you in advance for your assistance, and for your hard work to preserve our valuable resources.”

Response to Jack Watts:

Thank you for your message and for expressing your concerns about the water quality in Coffin Creek. We understand your longstanding connection to the area and your interest in maintaining its environmental health, and ensuring public health is a top priority for us.

We recognize the changes you've witnessed over the past 50 years, including increased development and the addition of docks, which could potentially impact water quality.

In response to your inquiry, we would like to provide you with the following information. You can access an overview of our shellfish monitoring program at: Shellfish Monitoring Program Overview. Through this link, you can find contact information for the Department's Office of Law Enforcement Lowcountry Beaufort office. Additionally, you can access the most recent monitoring station reports, shellfish maps, shellfish safety, and harvest classifications, among other resources.

We appreciate your engagement and support in maintaining the environmental integrity of Coffin Creek and its surroundings.