2018 Hog Inlet-Dunn Sound Creek Watershed Plan

A Multi-jurisdictional Strategy to Address Fecal Coliform Bacteria Impairments in Local Shellfish Harvesting Areas.

WACCAMAW REGIONAL COUNCIL OF GOVERNMENTS

Funded by SC DHEC through the Section 319 Non-point Source Pollution Grant Program

Developed by the Waccamaw Regional Council of Governments in partnership with Horry County, North Myrtle Beach and Horry Soil and Water Conservation District.

2018 Hog Inlet- Dunn Sound Creek Watershed Plan

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Abbreviations and Acronyms

The following is a list of abbreviations and acronyms utilized in the narrative of the Hog Inlet- Dunn Sound Creek Watershed Plan that are common terms related to water quality management in South Carolina.

ATV- All Terrain Vehicle

BMP- Best Management Practice

CCD- County Census Division

CDBG- Community Development Block Grant

CDC- Centers for Disease Control and Prevention

COG- Council of Governments

CORRI- Coastal Oyster Recycling and Restoration Initiative

CWSEC- Coastal Waccamaw Stormwater Education Consortium

FDA- United States Food and Drug Administration

GSATS- Grand Strand Area Transportation Study

HUC- Hydrologic Unit Code

LID- Low Impact Development

ml- milliliter

MPN- Most Probable Number

MS4- Municipal Separate Storm Sewer System

NPDES- National Pollutant Discharge Elimination System

NTU- Nephelometric Turbidity Unit

qPCR- Quantitative Polymerase Chain Reaction

SCDHEC- South Carolina Department of Health and Environmental Control

SCDNR- South Carolina Department of Natural Resources

SCDOT- South Carolina Department of Transportation

SCORE- South Carolina Oyster Restoration and Enhancement

SFH- Shellfish Harvesting Water

TMDL- Total Maximum Daily Load

US ACE- United States Army Corps of Engineers

US EPA- United States Environmental Protection Agency

Acknowledgements

It has been a great honor to be the lead author of the Hog Inlet/ Dunn Sound Creek Watershed Plan. The Waccamaw Regional Council of Governments is integrally involved with regional water quality planning and management activities in Horry, Georgetown, and Williamsburg Counties. Horry County, North Myrtle Beach, and Horry Soil and Water Conservation District are among many public and private stakeholders that we partner with in our region. Several representatives from each of these jurisdictions were pivotal to initiating this project and committing their time and resources throughout the planning process. Special thanks to Kevin Blayton, Travis Dupree, and Jay Beeson from North Myrtle Beach, Sam Ward from Horry Soil and Water Conservation District, and Dave Fuss from Horry County.

From the outset, collaboration and community support was key to the success of this project. Thanks to the City of North Myrtle Beach for providing a dependable and convenient meeting location for our planning team. Thanks also to Boulineau's Food Plus in Cherry Grove and the Future Farmers of America Camp in Little River Neck for hosting our public meeting events throughout the process. We also appreciate all of the other businesses and homeowners' associations who distributed information about the public meetings.

Information in the planning document came from many sources. Thanks to Mike Pearson, DHEC Shellfish Program Director, and his staff for providing monitoring data collected within Shellfish Management Area 01 as far back as 1992. The Hog Inlet Microbial Source Tracking Study, led by Coastal Carolina University- Environmental Quality Lab faculty Dr. Erin Burge and Dr. Susan Libes, was of tremendous value in assessing bacteria sources in Hog Inlet and developing recommendations for future management strategies. The load reduction estimates provided by Woolpert Associates was a critical component to finalizing our watershed plan and meeting all of the SCDHEC and EPA grant requirements Additional thanks goes to Dr. Keith Walters from Coastal Carolina University who provided guidance on oyster reef ecology and gave a presentation at our initial public meeting on the Coastal Oyster Recycling and Restoration Initiative. The general public also provided insightful feedback on their concerns within the watershed at our public meetings and via the public survey.

This project has been a tremendous learning experience for all parties involved. I am confident that the collective stakeholder interest exhibited during this planning process will result in successful water quality improvement projects in the future. I look forward to remaining an integral partner as these efforts move forward.

Daniel Newquist

Environmental Planner, Waccamaw Regional Council of Governments

Hog Inlet Dunn Sound Creek Watershed Plan- Executive Summary

The Hog Inlet- Dunn Sound Creek estuary is located in the far northeast portion of South Carolina. Hog Inlet drains directly into the Atlantic Ocean, while Dunn Sound Creek flows into Little River Inlet. The watershed is multi-jurisdictional with the majority of the land area lying within the city limits of North Myrtle Beach and the remainder in Horry County. While it is a relatively small watershed drainage area (11 total square miles), there are a variety of land use types ranging from undeveloped open space to high density residential neighborhoods. Six main catchment areas are assessed in this watershed plan, each with their own characteristics and hydrological dynamics.

Hog Inlet and Dunn Sound Creek are designated as Shellfish Harvesting Waters by SC DHEC. Both waterbodies are located within the Shellfish Program's Management Area 01. The primary water quality standard monitored by SC DHEC in Shellfish Harvesting Waters is fecal coliform bacteria. There are nine monitoring sites within Management Area 01 which are sampled on a monthly basis. The numerical standard to attain Approved harvesting status is to maintain a geometric mean of 14 Most Probable Number (MPN)/100ml and a 90th percentile of 43 MPN/100ml. The 2017 Shellfish Management Area 01 Annual Update reveals that none of the monitoring sites are meeting the standard.

To address the water quality concerns in Hog Inlet and Dunn Sound Creek, staff with Horry County, North Myrtle Beach, and Horry Soil and Water Conservation District sought the development of a watershed plan as an opportunity to analyze historical data trends, investigate the potential sources of bacteria, and to evaluate and discuss potential management options to ultimately reduce bacteria levels in the estuary. Because of the multi-jurisdictional nature of the Hog Inlet estuary, these partners solicited assistance from the Waccamaw Regional Council of Governments to facilitate the planning process.

An important step in the planning process was to assess the potential sources of bacteria entering the estuary and any transport mechanisms that exacerbate the problem. The planning team held public meetings and administered a ten question survey to solicit input from resident and business stakeholders in the community regarding their observations and concerns of water quality conditions in the estuary. Public participation was excellent throughout the planning process and very beneficial to the planning team. It was acknowledged that due to the diversity of development patterns in the watershed, each of the six catchment areas within the watershed would have varying sources of bacteria. The sanitary sewer system, pet waste, wildlife and bird populations, feral cat colonies, and septic systems were all evaluated as potential sources of bacteria. Other potential causes of the elevated bacteria levels such as land use changes, stormwater runoff, sedimentation, and boating were all discussed in the watershed plan.

As part of the data analysis portion of the plan, the partners reviewed data collected by SC DHEC at the nine monitoring sites dating back to as far as 1992. The median fecal coliform levels ranged from 7.8 MPN to 23 MPN for the entire period of record. The data does indicate that a noticeable increasing trend over the past three years of data is occurring. In the time period between February 2013 to February 2016 the median fecal coliform levels ranged from 15.5 MPN to 39.5 MPN. A scatter plot was created for each of the nine monitoring sites displaying all of the samples collected since 1992. Using Microsoft Excel trendline projections, seven of the nine sites did indicate an increasing trend in fecal coliform levels. Monitoring sites 01-07 and 01-17A were the two sites that indicated a decreasing trend in fecal coliform.

To complement the SC DHEC data analysis, the partners contracted with the Coastal Carolina University Environmental Quality Lab to perform a microbial source tracking study in Hog Inlet. The purpose of the study was to determine the animal source of origin of bacteria entering Hog Inlet. The study was designed using tracers to detect signals of human sourced bacteria. Eight sites were sampled in August and September of 2016. Samples were collected on three days with dry weather conditions and three days with wet weather conditions to assess the influence of storm events on bacteria levels as well as turbidity and salinity. The results indicated that currently human sourced bacteria is not a concern within Hog Inlet, but rather the bacteria entering the estuary is from non-human origin, potentially pets, birds, and wildlife. The study did confirm that bacteria levels do increase significantly after rainfall events with conditions most pronounced at monitoring sites near the shoreline. Overall the sites that were of greatest concern were at Jacks Circle Road and Sea Mountain Highway, even during dry weather periods.

Based on the findings of the DHEC data analysis and the Hog Inlet Microbial Source Tracking Study, the project team prioritized monitoring sites for future management purposes into three tiers. SC DHEC monitoring sites 01-07, 01-18, 01-06, 01-17A, and 01-17 have been designated as Tier One sites, the highest priority. Sites 01-07 and 01-18 were the

most recent to meet the Approved shellfish harvesting classification standards. The hope is that with concerted management efforts, these sites have a high potential to meet the standards once again within a five year period. Monitoring site 01-06 is closest to the Jack's Circle Road site and site 01-17 is closest to the Sea Mountain Highway site in the Microbial Source Tracking Study, both of which were identified as sites with water quality concerns. Site 01-17A should be closely monitored as it is located in close proximity to the Cherry Grove canal system, which was recently dredged in the fall and winter of 2016. SC DHEC sites 01-05 and 01-19 have been designated as Tier Two sites. Since SC DHEC sites 01-01 and 01-02 are located in the Little River Inlet drainage area, which is outside of our primary watershed focus area, they have been designated as Tier Three sites, the lowest priority.

Prior to outlining a set of future watershed management activities, the plan reviews ongoing projects and activities that watershed stakeholders are currently involved with. Activities associated with the MS4 permit, the Cherry Grove canal dredging project, pet waste campaigns, and other stormwater infrastructure projects are all highlighted. Element F outlines a total of 19 recommendations for future watershed management activities in Hog Inlet and Dunn Sound Creek. The strategies focus on a diverse range of issues and target stakeholder groups. Recommendations address proper pet waste disposal, feeding wildlife, concealing trash dumpsters, and controlling feral cat populations. Other strategies focus on BMPs that homeowners and businesses can consider implementing including rain barrels, pervious pavement installation, and maintaining a vegetated shoreline buffer. Other recommendations focused on neighborhoods relying on septic systems, sanitary sewer system maintenance, and stormwater infrastructure improvements. Another point of emphasis in the recommendations is the restoration of the oyster reef and marsh habitats within the estuary. All of the recommendations are evaluated based on the anticipated timeframe for implementation, the catchment area targeted for installation, and other barriers of implementation that need to be accounted for including project costs, partnership needs, and public acceptance.

The watershed management recommendations outlined in Element F are supplemented by chapters which focus on public outreach and education, future monitoring efforts, and potential funding sources. Each of these are critical supporting resources that are needed to ensure the long-term success of the watershed plan. Fortunately, there are excellent resources available throughout the state and within our immediate region to make strides on improving water quality. Both Horry County and North Myrtle Beach are active members of the Coastal Waccamaw Stormwater Education Consortium which focuses on public education initiatives in Georgetown and Horry Counties. The future monitoring element highlights resources available via Coastal Carolina University's Environmental Quality Lab. Both entities were pivotal in the watershed planning process, by assisting with the facilitation of public meetings and the completion of the microbial source tracking study.

The key to the success of developing this watershed plan has been the committed partnerships between Horry County, North Myrtle Beach, Horry Soil and Water Conservation District, and concerned citizens and local business owners. Reducing bacteria loads in Hog Inlet and Dunn Sound Creek is a challenging task, requiring a multifaceted approach. All watershed stakeholders have a role to play in the implementation of this watershed plan. Therefore partnership building will continue to be paramount as projects and initiatives are pursued. This watershed plan serves as a guide and supporting document to these partnerships with the ultimate goal of achieving the fecal coliform water quality standards in Hog Inlet and Dunn Sound Creek.

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Element A: Description of the Hog Inlet-Dunn Sound Creek Watershed

The Northeast coast of South Carolina is characterized by numerous tidal creeks, inlets, and estuaries that create unique marsh and oyster reef habitats. Hog Inlet and Dunn Sound Creek are tidally influenced estuaries just south of the Little River Inlet near the North Carolina state line. Hog Inlet drains directly into the Atlantic Ocean, while Dunn Sound Creek drains into the Little River Inlet. See **Figure A-1** for a general map of the watershed and surrounding area.

Both Hog Inlet and Dunn Sound Creek comprise SC DHEC Shellfish Management Area 01. There are currently nine monitoring stations sampled monthly which determine harvesting classifications designed to protect public health. As of the SC DHEC 2015 Annual Update report, all designated shellfish habitats within Management Area 01 are Restricted or Prohibited to shellfish harvesting. Local officials from Horry County and North Myrtle Beach, along with many concerned residents, recognize the need to identify the sources of the fecal coliform impairments and develop strategies to help improve water quality in the Hog Inlet- Dunn Sound Creek area. This watershed plan is an opportunity for all stakeholders to evaluate the existing conditions in the watershed, investigate available management resources, establish water quality goals, and develop specific improvement strategies in short and long-term timeframes.

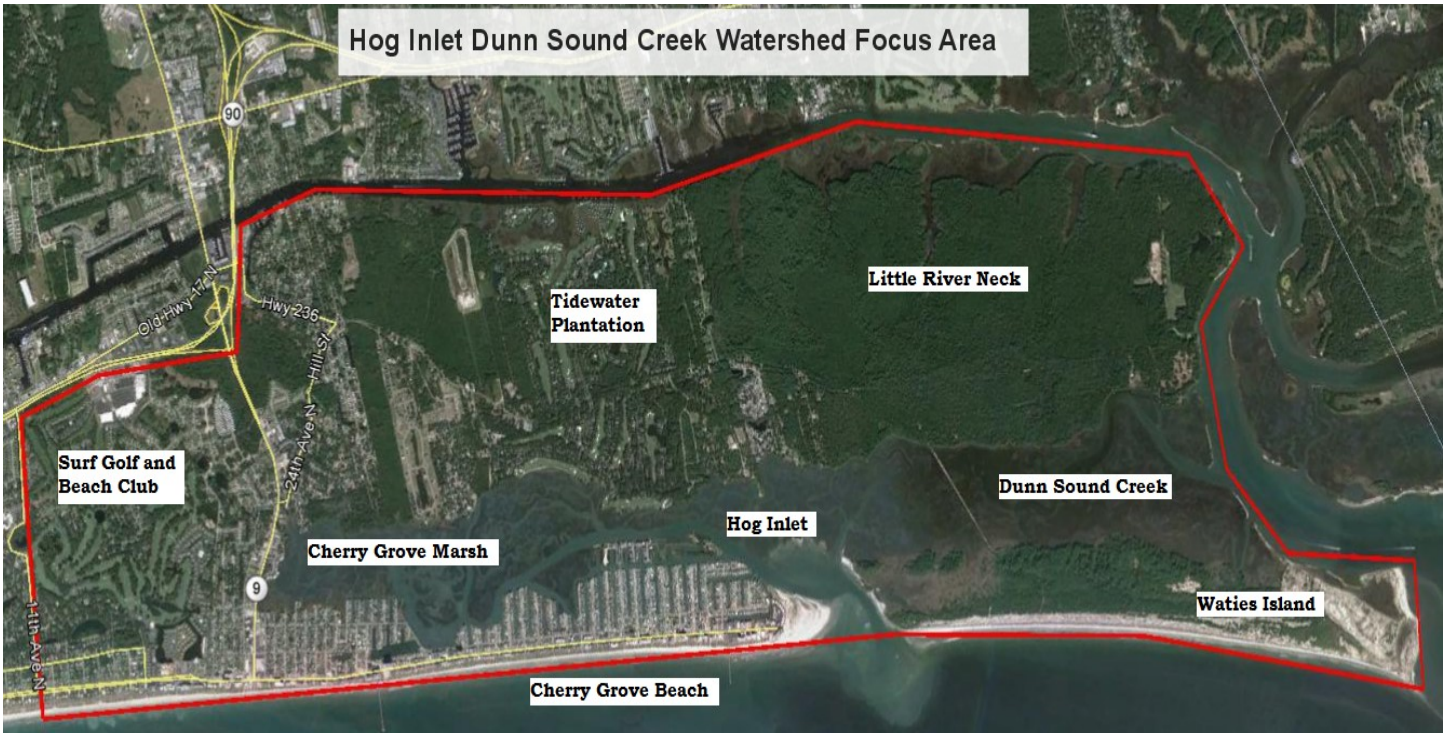


Figure A-1. Aerial view of the Hog Inlet- Dunn Sound Creek Watershed Area.

I. What is a Watershed?

In simplest terms, a watershed collects all precipitation which falls within a particular land area ultimately draining into a common waterbody outlet. Topography and the presence of water control structures are the primary determinants of the watershed boundaries for each stream, river, lake, or estuary. See **Figure A-2** for a illustrated depiction of a watershed. Watersheds can be observed on small scales such as a tidal creek draining into Hog Inlet. Watersheds can also be delineated on a very large scale such as the Pee Dee River, which encompasses a network of streams extending into the Piedmont area of North Carolina and Southwestern Virginia before flowing through the coastal region of South Carolina prior to entering Winyah Bay and finally out to the Atlantic Ocean. The Hog Inlet and Dunn Sound Creek are relatively smaller watersheds encompassing an area of approximately 11 square miles. While this watershed is small, the boundaries extend into both North Myrtle Beach and Horry County, requiring multi-jurisdictional cooperation and shared responsibilities to help protect water quality in Hog Inlet and Dunn Sound Creek. There are also many land use types within the watershed, varying from highly urbanized residential/commercial properties to completely undeveloped open space. This watershed plan will focus on a neighborhood scale examining six separate catchment areas, each with distinct features. A profile of each catchment area is profiled later in Element A.

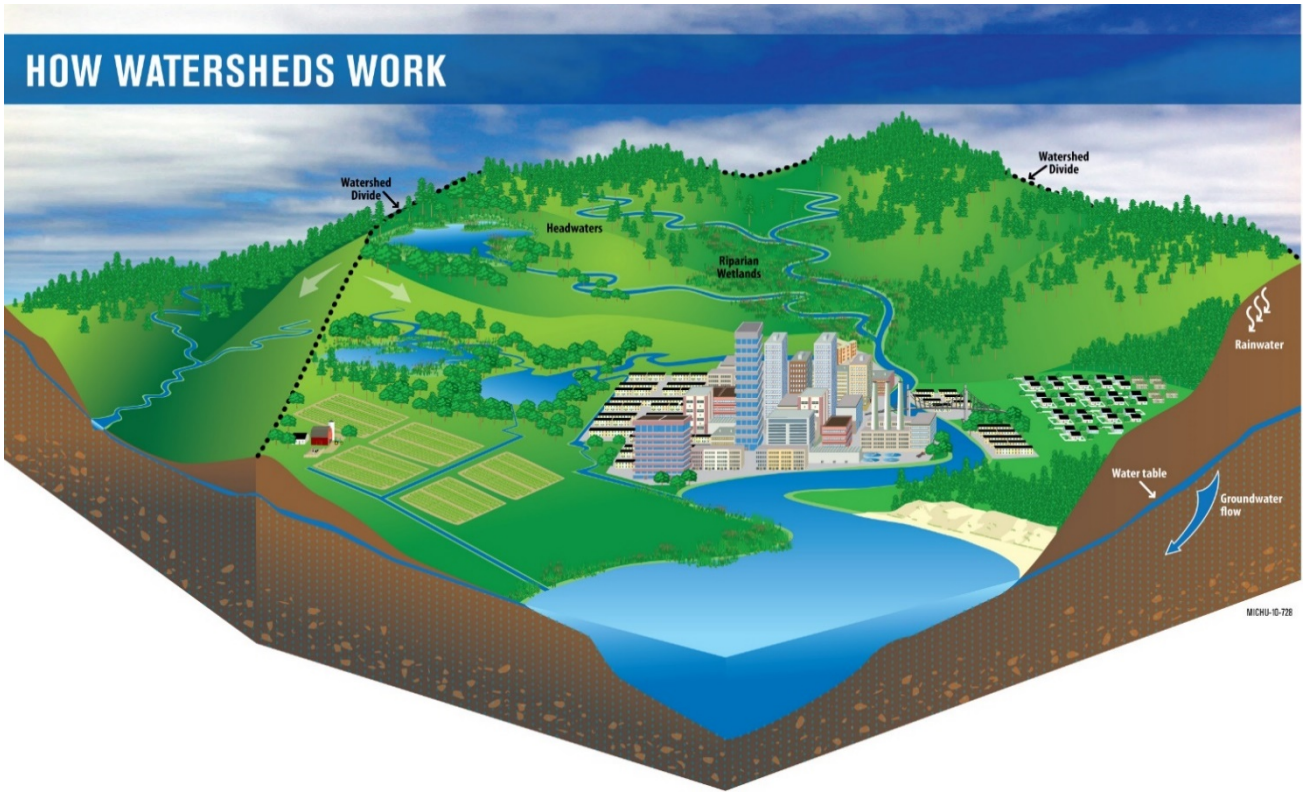


Figure A-2. Conceptual diagram of a watershed and the connections between a waterbody and surrounding land features. (Courtesy of Michigan Sea Grant)

II. Purpose of the Watershed Plan

This watershed plan is the final product of a collaborative stakeholder process to assess water quality conditions in Hog Inlet and Dunn Sound Creek and determine the proper course of action for long-term improvements and protection. The planning process itself is an invaluable learning opportunity to review available water quality data in the estuary, become aware of previous and current water resource management efforts, and to engage the general public to incorporate local knowledge and perceptions on regional watershed issues.

The plan expresses the water quality goals of Horry County, North Myrtle Beach, and the community residents that live in the watershed and their commitments to ensure the long-term protection of their estuary resources. Ultimately, the plan serves as a guiding resource for future implementation activities and will be critical when seeking partnership and funding opportunities with state and federal government agencies, universities, research institutions, and non-profit organizations. This watershed plan is intended to have a time horizon of 15-20 years but should be reviewed regularly and updated as necessary by all contributing stakeholders.

III. Fecal Coliform Bacteria: Parameter of Concern

The main water quality parameter that SC DHEC monitors within designated Shellfish Harvesting Waters is fecal coliform bacteria. Though fecal coliform is generally not thought to be harmful to humans, it originates from warm-blooded animal sources, and therefore serves as an indicator of other pathogenic bacteria, protozoans, and viruses that do pose public health risks. Because there are numerous species of pathogenic bacteria, testing for a single indicator organism such as fecal coliform minimizes the costs of testing for multiple parameters.

From a public health standpoint, the greatest concern associated with consuming contaminated shellfish is the transmission of waterborne diseases. The most common in the Southeast are *Giardiasis* and *Cryptosporidiosis*. The transmission of these illnesses can occur in a number of ways besides shellfish consumption including contaminated drinking water and improperly treated swimming pools. Typical symptoms of both of these diseases include dehydration, nausea, vomiting, fever, and diarrhea. The risk of exposure to these diseases is far greater when the shellfish product is

consumed raw. According to the Centers for Disease Control (CDC), in 2011 there were 16,868 reported cases of Giardia and 9,313 reported cases of Cryptosporidiosis, nationwide. In 2012, the incidents of both illnesses decreased to 15,223 reported cases of Giardia and 8,008 cases of Cryptosporidiosis. In establishing the water quality standard for Shellfish Harvesting Waters, SC DHEC utilized guidance from the US Food and Drug Administration's (US FDA) National Shellfish Sanitation Program Model Ordinance.

IV. Long-term Water Quality Goals for Hog Inlet-Dunn Sound Creek

The watershed planning committee, with input from the general public, developed the following long-term goals for the Hog Inlet- Dunn Sound Creek watershed. While these goals are by no means exhaustive, they provide aspirational guidance for all stakeholders that will share the responsibilities for improving local water quality. Additional specific goals are outlined in several other elements of the document, particularly in **Element G: Recommended Watershed Management Measures.**

- **Within 15-20 years, approximately 80% of all designated shellfish harvesting areas within Hog Inlet and Dunn Sound Creek will be Approved for harvesting by SC DHEC, which is the nationwide targeted goal established by the US EPA.**
- **Identify all common sources of bacteria entering Hog Inlet and Dunn Sound Creek so that specific management measures can be instituted to properly account for and mitigate each bacteria source at the point of origin.**
- **Ensure sustainable oyster reef habitats by establishing reef restoration sites and by limiting harvest to just recreational users to prevent the overharvesting of the oyster stock.**
- **As the Cherry Grove Beach and Little River Neck areas continue to grow, encourage sustainable development practices with a strong emphasis on protecting the natural resources within the Hog Inlet and Dunn Sound Creek watersheds.**

V. Land Use Patterns

For a relatively small watershed area, approximately 11 square miles in total area, there are a number of unique and diverse landscape features including an undisturbed barrier island, high density oceanfront residential, low density rural residential, golf course communities, and commercial retail corridors. Each of these distinct land use types has a unique influence on the hydrology of the watershed. Based on EPA published mapping data there are six main catchment or drainage areas within the watershed. It is suspected that the sources of bacteria entering Hog Inlet and Dunn Sound Creek will vary across the watershed and require specific management strategies for each of these catchment areas to effectively minimize bacteria loads.

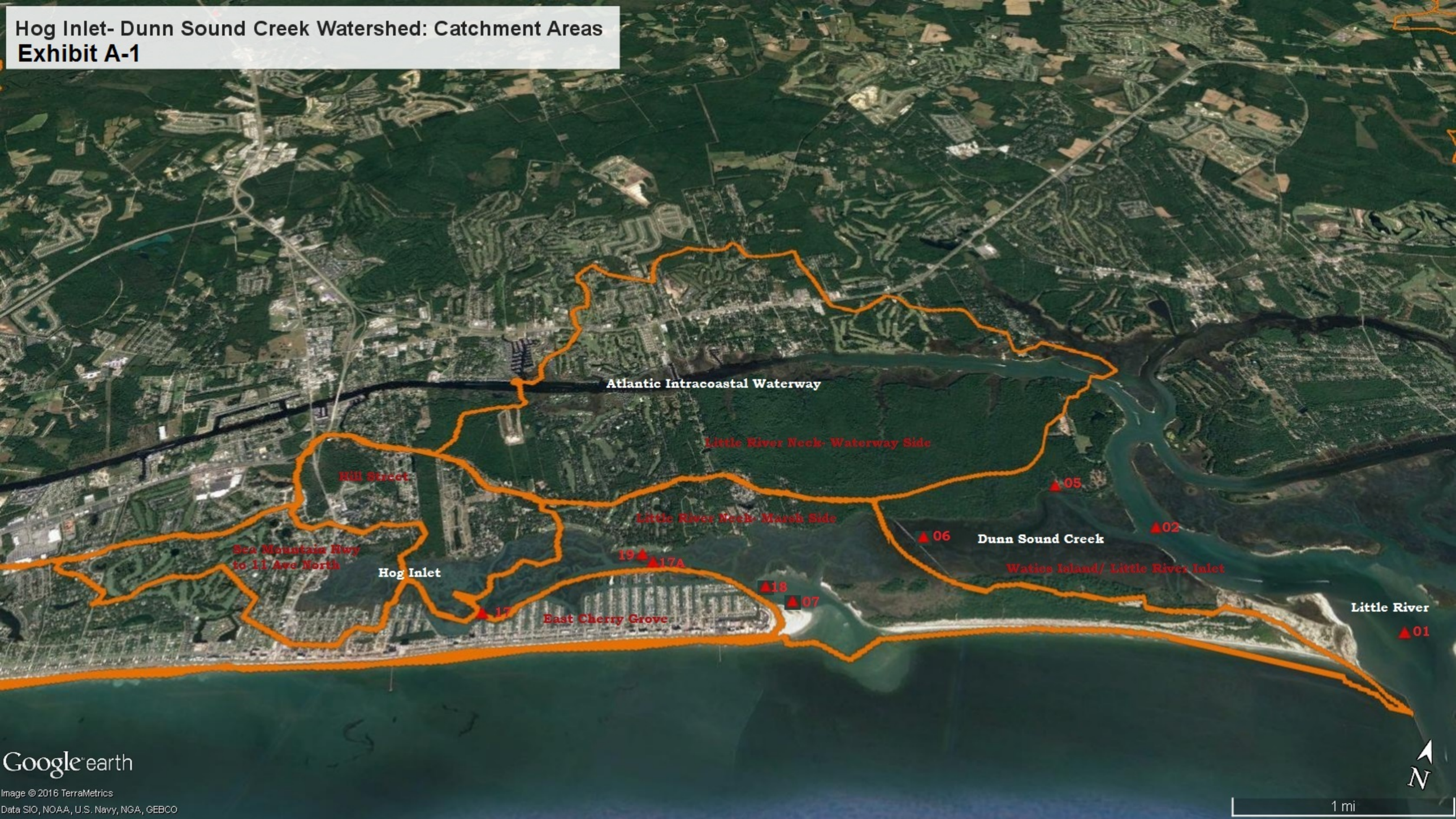
Below is a brief profile of each catchment area with a description of landscape characteristics and other notable features. **Exhibit A-1** is a map providing the boundaries of each catchment area:

Catchment Area 01 (Waties Island/Little River Inlet):

This catchment area is located where Dunn Sound Creek drains into the Little River Inlet. It includes portions of Waties Island, a 1,105 acre undeveloped barrier island owned and managed by Coastal Carolina University. This research reserve facility is comprised of an undisturbed coastal maritime forest, tidal creeks, saltwater marshes, and sand dune complexes. The other half of this catchment area includes the most northeastern portion of Little River Neck, referred to as Tilghman Point. This area is predominately rural residential with large areas of open space with a horse stable facility and a horseback riding and ATV tour operation. SC DHEC monitoring stations 01-02, 01-05, and 01-06 are all within the drainage basin of Catchment Area 01.

Figure A-3. Waties Island makes up a large portion of Catchment Area 01. This large undeveloped barrier island is utilized as a research facility by Coastal Carolina University

Hog Inlet- Dunn Sound Creek Watershed: Catchment Areas
Exhibit A-1



Catchment Area 02 (Little River Neck- Marsh):

This subbasin includes the remaining portions of Waties Island, directly along the Atlantic Ocean coastline. The catchment area extends southwest to include the Myrtle Beach RV Park, a high density development with approximately 200 residential units, several which directly abut the estuary. Also within the catchment area is a small portion of the Tidewater Plantation Golf Course development. Multiple golf holes are immediately adjacent to the marsh areas of Hog Inlet. SC DHEC monitoring sites 01-19 and 01-17A are both located in close proximity to Catchment Area 02 near the Tidewater Plantation Golf Course.

Figure A-4. Catchment Area 02 consists of diverse land uses including undeveloped open space and large residential developments.

Catchment Area 03 (East Cherry Grove):

The most urbanized portion of the watershed exists within Catchment Area 03, which comprises the majority of the Cherry Grove section in North Myrtle Beach. Cherry Grove forms a peninsula bordered by the Atlantic Ocean to the east and Hog Inlet to the west. From the Hog Inlet outlet into the Atlantic Ocean to the southern extent of the watershed at 11th Ave N is approximately 3.7 miles. A notable feature within the Cherry Grove area is the network of canals that extend along each residential street, beginning at 32nd Ave North to the northern end of Cherry Grove at 63rd Ave N. These canals ultimately drain into Hog Inlet. SC DHEC monitoring sites 01-17, 01-19, 01-17A, 01-18, and 01-07 are all adjacent to Catchment Area 03.

Figure A-5. The Cherry Grove area includes a number of high rise oceanfront buildings. The adjacent residential neighborhoods include a network of canals which have silted in over time. These canals were dredged in the fall of 2016 through the spring of 2017. The dredging project will dramatically change the hydrological dynamics within the estuary with one major ecological benefit being a greater extent of daily tidal flushing through all of the channels and upstream reaches of the system.

Catchment Area 04 (Hill Street):

This catchment area is a mix of residential housing and open space immediately south of Tidewater Plantation on the east side of Little River Neck Rd and along the Sea Mountain Hwy corridor. This drainage basin consists of mostly single family residential neighborhoods intermixed with a few larger undeveloped parcels. Sea Mountain Hwy is the main east to west commercial corridor from US Hwy 17 to Ocean Blvd in Cherry Grove Beach.

Figure A-6. Stormwater Pond in the Charleston Landing neighborhood

Catchment Area 05 (Sea Mountain Highway to 11th Ave North):

Land in this subbasin drains into the southern extent of Hog Inlet at Sea Mountain Hwy. In addition to the commercial land uses along Sea Mountain Hwy, the catchment area encompasses a small portion of Cherry Grove Beach and a large section of the Surf Golf and Beach Club development.

Figure A-7. Catchment Area 05 drains into the southern portion of the Hog Inlet estuary. The distance from the upstream portion of the watershed to the outlet point into the Atlantic Ocean is approximately 2.75 miles.

Catchment Area 06 (Little River Neck-Waterway):

For the purposes of this watershed plan, the Atlantic Intracoastal Waterway forms the western extent of this catchment area. The drainage area includes Tidewater Plantation Golf Course, excluding the portion that drains through Catchment Area 02 and the Little River Neck area, as well as the portion that is within Catchment Area 01. The majority of the area consists of undeveloped open space, large timber tracts, along with residential neighborhoods including Tidewater Plantation and Riverside Dr. This area is included in our watershed focus area however, it is suspected that a large portion of this catchment area drains west into the Atlantic Intracoastal Waterway, but very well could affect SC DHEC stations 01-02 and 01-01, which are located within Shellfish Management Area 01.

Figure A-8. Stormwater pond within the Riverside Dr. neighborhood.

VI. Soil Survey

An important step in the watershed assessment process is to inventory the underlying soils across the watershed. Soils play an important role in watershed dynamics in a number of different ways. First, soils have varying infiltration capabilities which impact the drainage patterns across a parcel and an entire subwatershed. Areas that have well-drained soils can absorb more precipitation on site, whereas poorly drained soils will pond easily and potentially runoff into nearby storm drains or ditches and ultimately into the estuary. Another important characteristic that varies between soil groups is the *k factor*, or erosion rate, of a particular soil type. Bacteria is known to bind to sediment particles, which serve as a pathway into the estuary as long-term erosion occurs. In addition, as sedimentation builds up within the channels of the estuary over time, the tidal dynamics become altered. As tidal exchange is reduced in the upper reaches of the estuary, salinity levels also tend to decrease. Salinity is known to kill off bacteria entering the estuary. Minimizing the frequency and extent of erosion occurrences across the watershed is important to maintaining consistent tidal flushing throughout the estuary, which is critical to the ecological health of oyster reef habitats.

A complete soil inventory is also important in determining the suitability of septic systems in the watershed. If a septic system is utilized on a parcel with poorly drained soils, the system can easily malfunction and potentially become a major source of bacteria entering the estuary. A starting point to prioritizing the need for sewer connections can be an examination of the soil types on the properties that are relying on septic systems. Finally, soil types are an important consideration when siting various stormwater Best Management Practices. Some stormwater BMPs rely on specific soil infiltration rates and can also require a minimal depth to the seasonally high water table.

Appendix A includes **Exhibit Appendix A-1,** a map of all the soil types located in the watershed area, and **Table Appendix A-1,** which provides a description of each soil type highlighting the specific characteristics of the soils found in the watershed.

VII. Importance of the Estuary to the Historical Development of the Watershed

The Little River Neck, Cherry Grove, and Waties Island areas have a rich history dating back as far as 700 AD as evidenced by the numerous shell middens that have been discovered in the area. Over time, numerous factors including commercial and residential development, infrastructure improvements, weather events, and natural coastal processes have shaped the landscape and hydrology of the estuary. These changes influence water quality conditions as well as the appropriate management strategies that are suitable for the existing and future anticipated landscape characteristics of the watershed. This section provides a brief overview of some of the notable events, features, and periods of development in the history of the watershed.

Tilghman Point- The very eastern end of Little River Neck is known as Tilghman Point, named after Horace Tilghman, Sr. who purchased property in the area in the 1920s. Within his property lies several historical points of interest including

Allston Plantation, the Randall Plantation, and Fort Randall. During the Civil War, Fort Randall was built as a Confederate battery at this site to protect Little River Inlet from invading Union forces. Today, some of the historic structures remain intact and the rest of this portion of the watershed remains primarily forested with only a few buildings present.

Waties Island- This 1,109 acre barrier island is an excellent example of an undeveloped complex of ocean frontage, fresh and saltwater marshes, tidal creeks, and upland forests. Originally it was included in a King's Grant deeded to William Allston. It is uncertain how the property was deeded to the Waties family who owned large tracts of land in the area and helped survey the boundary line between North Carolina and South Carolina. In 1995, the owner at the time Anne Tilghman Boyce, donated the property to the Coastal Education Foundation, which was subsequently protected under a conservation easement by the Nature Conservancy. Today, Coastal Carolina University utilizes the property as a research facility to study natural coastal habitats.

Cherry Grove Beach- Originally referred to as Minor's Island and then later Futch Island, this popular beach area was separated by Cherry Grove Inlet until it filled in around 1950. Since that time there is only one permanent tidal outlet to the Atlantic Ocean via Hog Inlet. Now the Cherry Grove area is a densely developed seasonal residential beach community, drawing many visitors to the area.

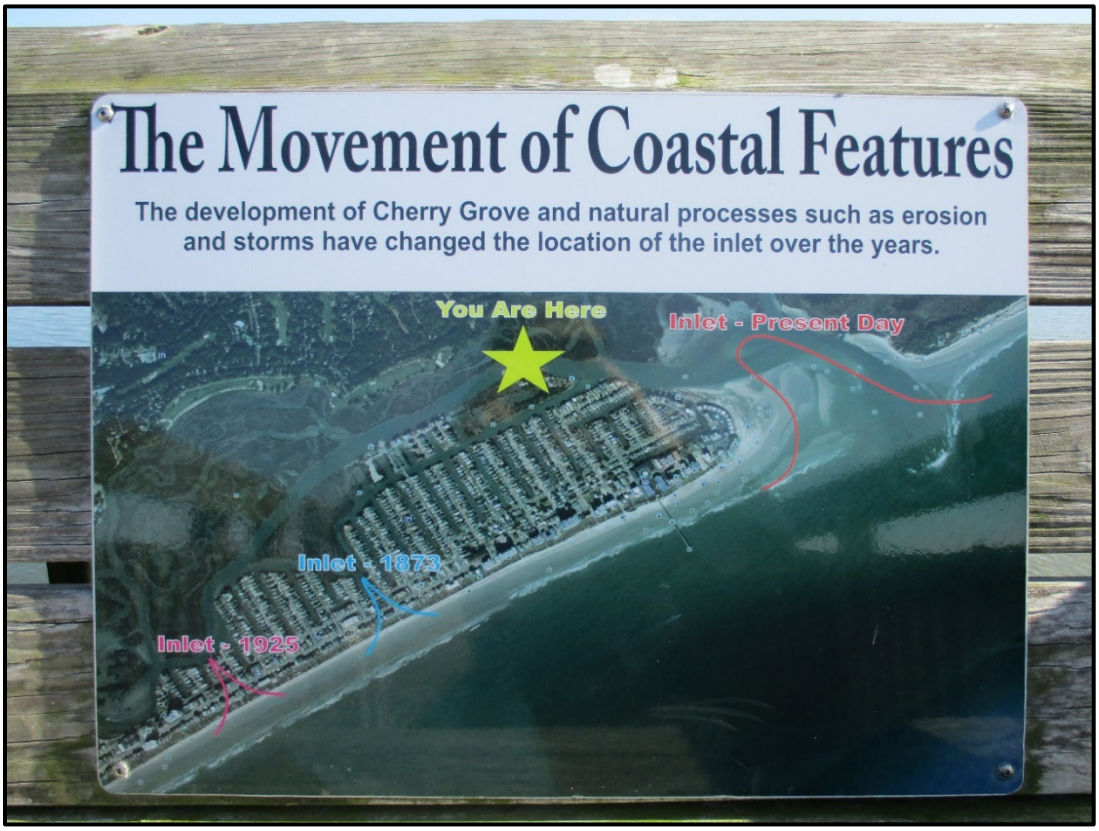


Figure A-9. This aerial image indicates how various coastal processes have shifted the location of the ocean inlets entering the estuary.

Tropical Storm Events- As a coastal region, North Myrtle Beach and Horry County are at risk to impacts from tropical storm events and have experienced several powerful hurricanes over the past half century. Three storms that have had a direct impact on Cherry Grove Beach and Little River Neck include Hurricane Hazel in 1954, Hurricane Floyd in 1999, and Hurricane Matthew in 2016. Hurricanes can have varying ecological impacts on coastal estuary systems. They commonly produce significant amounts of rainfall, as much as 20+ inches in a 48-72 hour period in some areas. A rainfall event of that magnitude inevitably leads to significant stormwater runoff conditions within any developed areas. It often becomes necessary for SC DHEC's Shellfish Program to close harvesting areas following major rainfall events. In the case of Hurricane Matthew in October 2016, shellfish beds remained closed to harvesting for nearly two months after the storm until oyster and clam tissue samples indicated that the product was safe to consume.

A unique characteristic of tropical storm events is the abnormally low barometric pressure readings, which provides an indication of the storm surge potential to the immediate coastline and adjacent low-lying areas. A large storm surge can result in widespread flooding as well as cause severe erosion that ultimately leads to drastic changes in the hydrology within the estuary system. Heavy rainfall and inundation from storm surge puts enormous strain on utility infrastructure systems including water and sanitary sewer. According to SC DHEC records, 124 sanitary sewer overflow occurrences were reported across the state between October 7, 2016 and October 12, 2016 following Hurricane Matthew.

Hurricane strength is generally determined by wind speed. Tropical storms with wind speeds between 74-95mph are classified as Category 1 Hurricanes while storms with wind speeds in excess of 157 mph are categorized as a Category 5 Hurricane. Obviously, wind hazards are an additional threat to public safety and property damage. The combination of wind, rain, and storm surge can cause major ecological disturbance and severely alter the coastal landscape. A community's capacity to prepare for these storms and adequately and promptly respond after a storm hits greatly affects their long-term social, economic, and environmental resiliency to coastal hazards such as tropical storms.

Figure A-10. Hurricane Hazel in 1954 caused significant damage to the Cherry Grove area. The picture on the left is the site of the Cherry Grove Post Office (courtesy of Ann Welborn- The Sun News). Coastal South Carolina was one of the most impacted areas in the Southeast United States during Hurricane Matthew, October 2016.

VIII. Cultural and Economic Impacts

Shellfish are a desired commodity for residents and visitors who enjoy seafood, especially people who value locally caught and harvested products. Seafood is an inherent part of the Grand Strand's cultural identity and a distinguishing aspect of the local tourism economy. Seafood festivals and oyster roasts are annual celebrations held throughout the region. Little River alone hosts the annual Blue Crab Festival in May and the Shrimp Fest in September both drawing large crowds.

Throughout this planning process, long-time residents recalled how abundant the oyster reefs were years ago and how common shellfish harvesting was as a family activity. Residents described how fast and large the oysters would grow in the estuary as well. As you might imagine many lament that the shellfish beds are now closed and expressed a deep desire to have them reopened. A strong consensus from the public is that if the fecal coliform standard is ever attained and the shellfish beds are approved for harvesting, only small scale recreational harvesting should be permitted. The concern is that if commercial harvesting is permitted, the oyster reef stock will be depleted much faster and more extensively than from recreational harvesting alone. Ultimately residents want to ensure that the oyster reefs are protected to the extent needed so that harvesting can occur in a sustainable manner. One of the recommendations outlined in **Element F** is to work with the Department of Natural Resources to designate all shellfish grounds within Hog Inlet and Dunn Sound Creek as State Shellfish Grounds where only recreational harvesting is permitted.

IX. Population Trends and Future Land Use Change

The greater Cherry Grove Beach and Little River Neck portions of North Myrtle Beach and Horry County have experienced a tremendous amount of change over the past 50 years and more. A likely reality is that growth will continue over time presenting ongoing challenges in protecting water quality within the Hog Inlet- Dunn Sound Creek estuary. Below are some population data obtained from the US Census from 1970 through 2010. Also provided is a table with population projections through 2035 by the Waccamaw Regional COG based off of county level projections provided by the SC Budget and Control Board.

The level of analysis for this population data is the County Census Division (CCDs). Horry County is comprised of eight CCDs, including Little River CCD which encompasses the Hog Inlet- Dunn Sound Creek watershed. **Exhibit A-3** is a reference map of the Horry County CCD and Census Designated Place boundaries. While the Little River CCD is noticeably larger than the Hog Inlet- Dunn Sound Creek watershed it is a consistent geographic boundary where population data has been collected for several decades. It serves as a good indicator of population trends that are occurring within the greater Cherry Grove Beach/Little River area. **Table A-1** provides population data of the Little River CCD from 1970 to 2010. Horry County populations are also provided for comparison.

Table A-1 Population Totals for the Little River CCD: 1970 to 2010

	1970	1980		1990		2000		2010	
Little River CCD	4,960	8,781	77.0% increase	17,988	104.8% increase	26,315	46.3% increase	33,652	27.9% increase
Horry County	69,992	101,419	44.9% increase	145,300	43.3% increase	196,630	35.3% increase	269,291	36.9% increase

Source: US Census Bureau

As the table indicates, there has been a consistent population growth within the Little River CCD over the past four decades with a pace of growth that has been greater than that of Horry County as a whole. **Table A-2** provides population projections in 5-year increments through 2035.

Table A-2 Population Projections for the Little River CCD: 2020-2035

	2020	2025	2030	2035
Little River CCD	46,228	49,975	53,845	57,754
Horry County	316,810	342,536	367,680	393,160

Source: US Census Bureau, SC Budget and Control Board, and the Waccamaw Regional Council of Governments- GSATS Long-Range Transportation Plan.

It is expected that growth will continue within the Little River CCD and Horry County at large. Another factor that water resource managers must account for is the large number of part-time residents and seasonal vacationers. An important consideration in developing this plan is to ensure that information and long-term recommendations presented in this plan complement goals and objectives outlined in the North Myrtle Beach and Horry County Comprehensive Plans along with any other planning related study focused on the Cherry Grove Beach/Little River Neck area. Further analysis of these documents will be covered in **Element F**.

Despite the anticipated challenges that will undoubtedly come with the prospects of ongoing growth, the field of water resources management has made incredible advances over time as well. Fortunately, research and applied knowledge has improved our understanding of the influence of urban development on stormwater runoff rates and the negative impacts associated with elevated bacteria levels and other pollutants. State and federal regulations have evolved over time to address these concerns, a notable example being the Municipal Separate Storm Sewer System (MS4) permit program which both Horry County and North Myrtle Beach must comply with. In addition, water quality monitoring is a key management resource which water resource managers can apply when identifying and prioritizing water quality concerns. Monitoring technologies have improved to more accurately determine the source of bacteria entering the estuary leading to a better evaluation of effective management strategies to consider implementing in the watershed. Finally, stormwater management technologies have advanced tremendously, with many approaches such as Low Impact Development (LID) practices capable of mimicking the natural hydrology in an area already fully developed. A key role of this watershed plan

is to evaluate all of the varying environmental and anthropogenic factors influencing water quality conditions in Hog Inlet and Dunn Sound Creek and comprehensively apply all available resources to address each of the known water quality issues.

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Element B: Shellfish Harvesting Waters- Water Quality Standards and Regulations

This element is an overview of the water quality standards and regulations in the State of South Carolina which apply to Hog Inlet and Dunn Sound Creek. It is important to be familiar with the requirements that are in place to determine the progress that will be needed to meet the state's water quality criteria in our local waterways. This element briefly reviews how the state designates each waterbody and what regulations are applicable to each designation. An overview of the annual reports that DHEC publishes, which summarizes the water quality monitoring data that has been collected in the Shellfish Management Area 01, is also provided.

I. Overview of South Carolina Water Quality Standards

Under the authority of the 1976 South Carolina Code of Laws, SC DHEC is tasked with instituting and enforcing regulations to assist in the implementation of the federal Clean Water Act. Regulation 61-68: Water Classifications and Standards, establishes water uses to be protected by meeting specific water quality criteria. Within Regulation 61-68 there are several general rules and standards which are applicable to all waters of the state. There are also specific standards that pertain to each water classification. Hog Inlet and Dunn Sound Creek are classified as Shellfish Harvesting Waters (SFH), which are defined as follows in the regulation:

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.

A full overview of the water quality standards for Shellfish Harvesting Waters is included in **Appendix A.** Below is an explanation of the numerical fecal coliform bacteria standards along with the corresponding shellfish harvesting classification. Under SC DHEC's Shellfish program, the following shellfish harvesting classifications are utilized to enforce the standards set forth in Regulation 61-68. The classification guidelines were developed in coordination with the US Food and Drug Administration using the National Shellfish Sanitation Program Model Ordinance.

Approved- Areas where a sanitary survey concludes that fecal material and pathogenic microorganisms are not present in concentrations that would render shellfish unsafe for human consumption. The numeric criteria for Approved areas is as follows:

- *Not to exceed a Most Probable Number (MPN) geometric mean of 14/100ml*
- *No more than 10% of samples collected can exceed an MPN of 43/100ml*

Note that in order to meet the Approved classification, both numeric criteria must be met.

Conditionally Approved- Areas designated with this classification are subject to temporary and predictable conditions of pollution, such as runoff resulting from a rain event. SC DHEC must adopt a management plan describing the conditions under which harvesting is allowed.

Restricted- Shellfish grounds are classified as Restricted when the water sample data exceeds the Approved standard too frequently and unpredictably to be feasibly classified as a Conditionally Approved area. SC DHEC does allow limited harvesting only for the purposes of relaying or depuration by special permit only. The following numeric water quality criteria do apply for relaying shellfish from Restricted Shellfish Areas:

- *Not to exceed a geometric mean of 88 MPN/100ml*
- *No more than 10% of the samples collected can exceed an MPN of 260/100ml*

Prohibited- SC DHEC administratively closes shellfish beds that are adjacent to facilities of potential pollution concern such as a wastewater treatment plant, industrial site, or a marina.

The next section outlines the classification trends within Hog Inlet and Dunn Sound Creek.

II. SC DHEC Shellfish Management Area 01

SC DHEC has established 25 shellfish management areas along the coast of South Carolina. Hog Inlet and Dunn Sound Creek are located within Shellfish Management Area 01. There are a total of approximately 3,289 acres of shellfish growing habitat in Area 01. Below is a breakdown of the harvesting classifications for Area 01 as of the 2017 Annual Update. Note that portions of shellfish harvesting waters are automatically classified as Prohibited in areas where marinas are located nearby. Typically, the Prohibited area is established by creating a 1,000 ft buffer surrounding the marina site. This is a precautionary measure and a permanent classification regardless of the fecal coliform measurements at nearby monitoring sites.

While DHEC does not currently allow harvesting of oysters and clams for direct marketing in any portion of Management Area 01, depuration and relaying of shellfish is allowed in Cherry Grove and Dunn Sound. Presently no commercial shellfish relay projects were permitted in the last review period.

Table B-1 SC DHEC Shellfish Management Area 01 2017 Annual Update Classification Summary	
Prohibited Areas- 1,146 acres total	1. All waters of the Atlantic Intracoastal Waterway
	2. All waters of Little River
	3. All waters of Calabash Creek
	4. All waters of Milliken Cove
	5. All waters of Little River Inlet north of the southeastern point of Little River Neck (Tilghman Point)
Restricted Areas- 2,143 acres total	1. Little River Estuary seaward of Tilghman's Point, including all portions of Dunn Sound and Hog Inlet
Source: SCDHEC, Shellfish Program. Shellfish Area 01- 2017 Annual Update	

Presently there are nine monitoring sites that are sampled monthly by SC DHEC within Shellfish Management Area 01. They are listed with a location description in **Table B-2** below. A full overview of the data trends observed at these monitoring sites is provided in **Element D: Fecal Coliform Data Trends**.

Table B-2 SCDHEC Shellfish Management Area 01, Monitoring Station Locations	
Site #	**Location**
01-01	Little River Jetty
01-02	Mouth of Dunn Sound Creek
01-05	Big bend up Dunn Sound Creek
01-06	Bridge to Waites Island
01-07	Hog Inlet
01-17	42nd Ave- Cherry Grove
01-17A	53rd Ave Bridge on Canal
01-18	Dunn Sound at Hog Inlet
01-19	53rd Ave at Main Creek
Source: SCDHEC, Shellfish Program. Shellfish Area 01- 2017 Annual Update	

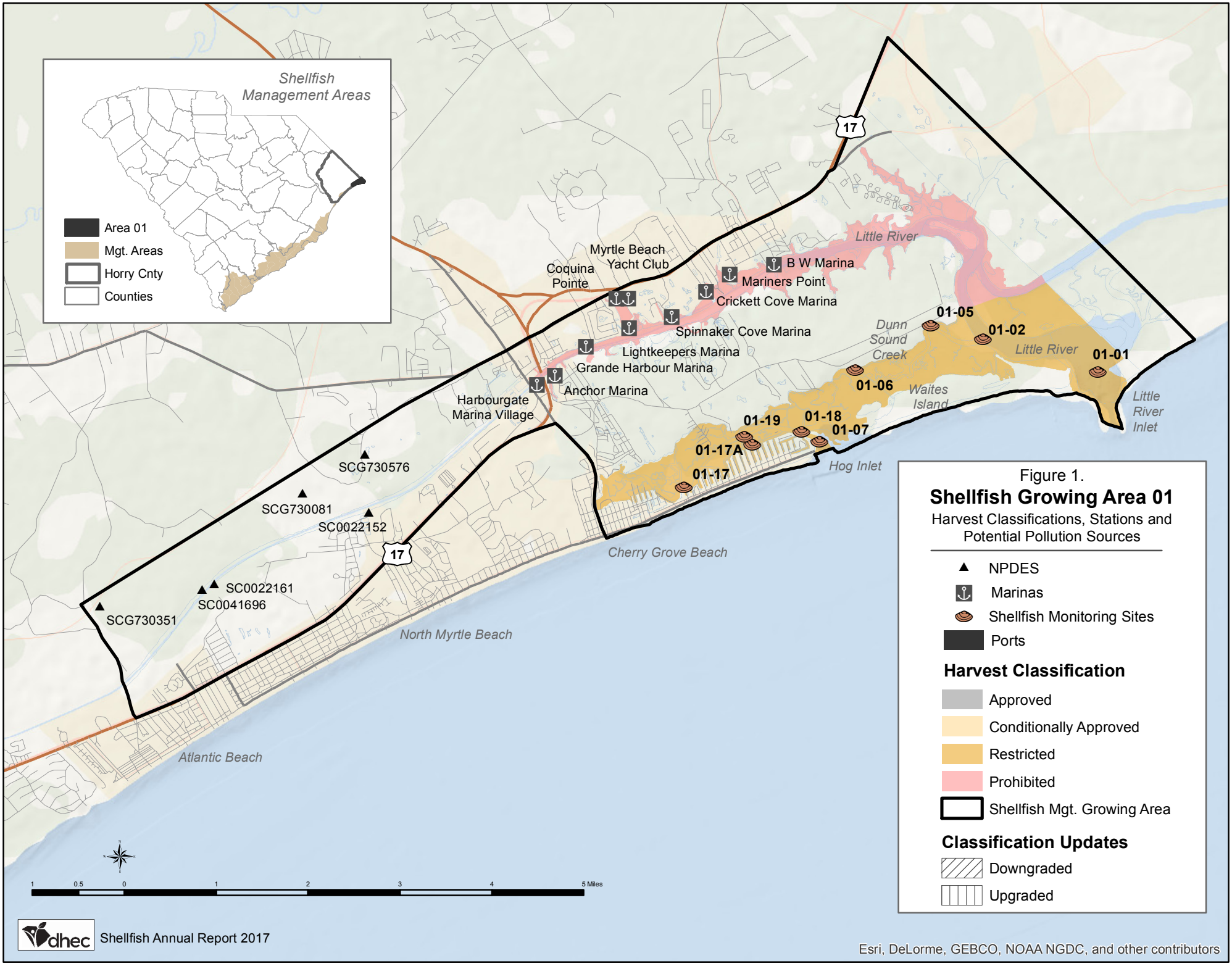
Shellfish Management Areas
Area 01
Mgt. Areas
Horry Cnty
Counties
Myrtle Beach Yacht Club
Coquina Pointe
B W Marina
Mariners Point
Crickett Cove Marina
Spinnaker Cove Marina
Lightkeepers Marina
Grande Harbour Marina
Anchor Marina
Harbourgate Marina Village
Little River
Dunn Sound Creek
Waites Island
Little River Inlet
Hog Inlet
01-05
01-02
01-01
01-06
01-19
01-18
01-07
01-17A
01-17
SCG730576
SCG730081
SC0022152
SC0022161
SC0041696
SCG730351
17
Cherry Grove Beach
North Myrtle Beach
Atlantic Beach
1 0.5 0 1 2 3 4 5 Miles
Figure 1.
Shellfish Growing Area 01
Harvest Classifications, Stations and Potential Pollution Sources
NPDES
Marinas
Shellfish Monitoring Sites
Ports
Harvest Classification
Approved
Conditionally Approved
Restricted
Prohibited
Shellfish Mgt. Growing Area
Classification Updates
Downgraded
Upgraded
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Figure 1 is a map from the 2017 Annual Update- Shellfish Management Area 01 indicating the current Shellfish Harvesting Classifications and the locations of each of the nine monitoring stations which are sampled monthly.

III. Implications of 303(d) impaired waters of the state listing

As required by the federal Clean Water Act, every two years SC DHEC publishes a list of impaired waterbodies throughout the state of South Carolina. The list identifies each of the monitoring sites that are exceeding the water quality standard for one or more pollutant criteria. The 303(d) list is a starting point for the state in acknowledging waterbodies that will require corrective action in order to improve water quality. The monitoring site will remain on the list until the water quality standard has been achieved or a Total Maximum Daily Load (TMDL) has been developed for the impaired stream. **Table B-3** summarizes the monitoring sites located within the Hog Inlet- Dunn Sound Creek watershed that have been listed on the 303 (d) list from 1998 through 2014.

Table B-3 Monitoring Sites on the 303 (d) list located within the Hog Inlet-Dunn Sound Creek Watershed- 1998-2014

Year	Monitoring Sites	Notes
1998	Little River Southeast of Tilgham's Point. All portions of Dunn Sound and Hog Inlet- 2,100.39 Acres	In 1998, impairments for Shellfish Harvesting Waters were listed by SC DHEC designated Management Area. Hog Inlet and Dunn Sound Creek were listed as a Priority One site, which means that the shellfish classification was Restricted and identified as one of the highest concerns by the State Shellfish Restoration Committee.
2000	Little River Estuary SE of Tilghman's Point including all portion of Dunn Sound and Hog Inlet- 2143.2 acres.	The impairments were listed in the same manner as 1998. However in 2000, it is listed as a Priority Two site again based on recommendations of the Shellfish Restoration Committee.
2002	Little River Estuary SE of Tilghman's Point including all portion of Dunn Sound and Hog Inlet- 2143.2 acres.	Same status as the 2000 listing
2004	01-02, 01-05, 01-6, 01-07, 01-17, 01-17A, 01-18, 01-19	Beginning with the 2004 303 (d) list, SC DHEC began listing the impairments within Shellfish Harvesting Waters by monitoring site versus geographically describing the area of impairment. For the 2004 303(d) listing, all of the monitoring sites within Management Area 01 were listed except for site 01-01.
2006	01-01, 01-02, 01-05, 01-06, 01-07, 01-17, 01-17A, 01-18, 01-19	In 2006, all nine of the monitoring sites within Management Area 01 were on the 303(d) list. This was also the first year that SC DHEC included a target TMDL date as part of the 303 (d) list. In 2006, the target TMDL date for these monitoring sites was 2008.
2008	01-01, 01-02, 01-05, 01-06, 01-07, 01-17, 01-17A, 01-18, 01-19	The TMDL target date for these monitoring sites was pushed back to 2011. The 303 (d) list does note that TMDL target dates are subject to change, based on the severity of pollution, designated use, the availability of site-specific information, or other factors the Department deems appropriate for scheduling TMDL development.
2010	01-01, 01-02, 01-05, 01-06, 01-07, 01-17, 01-17A, 01-18, 01-19	The TMDL target date for these monitoring sites was pushed back to 2014
2012	01-01, 01-02, 01-05, 01-17, 01-17A, 01-19	Monitoring sites 01-06, 01-07, and 01-18 were removed from the 2012 303(d) list. SC DHEC established a TMDL target date of 2015 for 01-01, 01-02, and 01-05, essentially the Dunn Sound Creek portion of Management Area 01. SC DHEC established a TMDL target date of 2018 for sites 01-17, 01-17A, and 01-19, essentially the upper portions of Cherry Grove Marsh.
2014	01-01, 01-02, 01-05, 01-06, 01-07, 01-17, 01-17A, 01-18, 01-19	All nine monitoring sites were back on the 303(d) list. The TMDL target date for both Dunn Sound Creek and Hog Inlet is now 2018.
2016	01-01, 01-02, 01-05, 01-06, 01-07, 01-17, 01-17A, 01-18, 01-19	All nine monitoring sites remain on the 303(d) list. SCDHEC no longer establishes TMDL target dates. Instead they provide a priority ranking. The sites within Management Area 01 are listed as priority 3 or long-term priority for TMDL development (after 2022)

Notes: For each listing period, Fecal Coliform was the cause of the impairment.
Source: SC DHEC, Bureau of Water

A Total Maximum Daily Load is a regulatory approach to ensuring that the pollutant loads are reduced in impaired waterbodies so that the water quality standard can once again be achieved. Conceptually, a TMDL is the maximum amount of a pollutant that can enter a waterbody on a daily basis and still meet the water quality standards set forth by the state. TMDLs entail an inventory of the known sources of the pollutant and are calculated as follows:

TMDL= Sum of Wasteload Allocations + Sum of Load Allocations + Margin of Safety

Wasteload allocations are pollutant loadings from permitted point sources, such as industrial sites or wastewater treatment plants. There are no known point source dischargers into Hog Inlet or Dunn Sound Creek. Load allocations account for all the remaining nonpoint sources of pollution that exist in the watershed area. It is suspected that the entire pollutant loading into Hog Inlet and Dunn Sound Creek are from nonpoint sources. A margin of safety is included to account for any uncertainty when inventorying the Load and Wasteload Allocations.

Fecal coliform bacteria are the most common impairments in South Carolina, accounting for 350 of the 400 sites managed under a TMDL. It is DHEC and EPA policy that once a monitoring site is included on the state's 303(d) list, a TMDL must be developed within a thirteen year period. It is unclear whether DHEC is going to extend the TMDL development date past 2022 as stated in the 2016 303(d) list. Therefore, it is imperative that stakeholders from Horry County and North Myrtle Beach, who will ultimately be accountable for meeting the TMDL requirements, remain proactive and fully engaged in the TMDL development process. The next element is an evaluation of potential sources of bacteria within the watershed, which may be causing the impairments at the SC DHEC monitoring stations located in Shellfish Management Area 01.

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Element C: Fecal Coliform Source Identification

Fecal Coliform and other pathogenic organisms come from a variety of sources and can enter the aquatic environment through a multitude of different pathways. A major challenge for water resource managers is to identify all of the potential sources of bacteria in the watershed and then prioritize efforts to address sources that are most likely to elevate fecal coliform levels at the SC DHEC monitoring stations. Another equally important approach is to mitigate the mechanisms by which bacteria is entering the estuary in circumstances where completely eliminating the actual source of bacteria is not practical. Managing bacteria in a watershed environment requires creativity and a multifaceted long-term approach. **Element F: Recommended Watershed Management Measures** details numerous management strategies that if executed will help to lower fecal coliform levels in the Hog Inlet- Dunn Sound Creek watershed.

One of the initial steps during this planning process was to assess the various sources of bacteria that likely exist in the Hog Inlet- Dunn Sound Creek watershed. An immediate observation which was highlighted in **Element A: Description of the Hog Inlet- Dunn Sound Creek Watershed,** is the diverse land uses present throughout the watershed. These contrasting development patterns can help narrow in on the types of bacteria sources that would likely occur within each section of the watershed. As an example, the main bacteria sources on Waties Island, a mostly undeveloped barrier island, will likely be from wildlife or waterfowl, whereas in the Cherry Grove Beach portion of the watershed pet waste may be more of a prominent bacteria source concern.

The planning team relied heavily on the general public during this phase of the planning process. Residents and local workers who have a strong familiarity of the watershed may observe issues that the planning team might not have been aware of. Long-time residents can be particularly helpful as they can share perspectives on how the watershed has changed over time. A public meeting was held on March 10, 2016 to provide information about the Hog Inlet- Dunn Sound Creek Watershed Plan. Another objective of the meeting was to solicit input from attendees regarding their local knowledge of the watershed and their specific concerns as direct stakeholders of the estuary. The planning team supplemented the insight gained from that meeting by administering a survey that was made available both in paper copy and online during the Spring and Summer of 2016. A copy of the survey with a breakdown of the responses is included in **Appendix D.**

Figure C-1 Stakeholders asking questions about the watershed planning process at a public meeting held March 10, 2016.

I. Potential Sources of Bacteria

In this next section, each source of bacteria identified as potentially contributing to the SC DHEC monitoring site impairments is discussed. If a particular source of bacteria is of concern to a specific area within the watershed the Catchment Area detailed in **Element A** is highlighted.

A. Residential Septic Systems

While the majority of the residential neighborhoods and commercial corridors within the watershed are connected to the sanitary sewer system, there are areas that rely on septic systems to meet their wastewater treatment needs. In the right conditions, septic systems can be a reliable solution to treating wastewater effluent. Regular inspection and proper maintenance is critically important to avoid malfunctions. Properly siting septic systems in areas with suitable soils and water table levels is also necessary. A concern across coastal South Carolina is the lack of ideal site conditions for the placement of septic systems.

While there are some areas suitable for septic system installations, the preferred means of treating domestic wastewater is via the sanitary sewer system. Once a septic system begins to malfunction, it not only can become a major source of bacteria impacting the estuarine environment, but also a serious public health hazard. Little River Neck Road was the most recent extension of the force main sewer line within the North Myrtle Beach sewer service area. While some residents and neighborhoods such as Tidewater Plantation and Charleston Landing have connected to the sewer system, there are several side streets and adjacent neighborhoods within the Waties Island Catchment Area, Little River Neck- Marsh Catchment Area, Little River Neck- Waterway Catchment Area, and the Hill Street Catchment Area that currently rely on septic systems.

B. Sanitary Sewer System

Throughout the Grand Strand, investments in wastewater treatment facilities and associated infrastructure have helped protect water resources throughout the region and improved the quality of life for residents and visitors of the area. North Myrtle Beach owns and operates a sanitary sewer utility which provides service to the Hog Inlet- Dunn Sound Creek watershed area. Wastewater collected from the sewered portions of the watershed is transported through a network of pump stations and sewer lines to the Ocean Drive Wastewater Treatment Plant, located off of 2nd Ave South on the western side of US Hwy 17. The sewer system in North Myrtle Beach was initially installed in 1975, including the Cherry Grove Beach area. There have been several sewer extensions since that time particularly along Little River Neck Road. Myrtle Beach RV Park (1987), Tidewater(1997), the Future Farmers of America Camp (2001), Creekside Mobile Home Park (1976), Charleston Landing (2002), and Church View Lane (2001) are now all connected to North Myrtle Beach's centralized sanitary sewer system. Any infrastructure system of this scale requires ongoing inspections, routine maintenance, and periodic upgrades in order for the system to operate as efficiently as possible. The system must also be designed to accommodate peak flows during the summer tourism season, when sanitary sewer demands are at their greatest.

Even with a comprehensive maintenance plan in place, extreme weather events can stress the sewer system leading to mechanical malfunctions that can cause untreated wastewater effluent to enter the drainage network and impact water quality in the estuary. As an example, during the October 2015 flood event, sanitary sewer overflows were reported throughout the state. Over the span of one week, October 1-7, 2015, 125 sanitary sewer overflows were reported to SC DHEC. Only one occurred within the North Myrtle Beach service area, resulting in an estimated 1,500 gallon wastewater effluent spill at a pump station near the corner of 26th Ave. N and Duffy St in Cherry Grove Beach. There were similar problems across the state following Hurricane Matthew in October 2016, however no sanitary sewer overflows were reported by the City of North Myrtle Beach following the storm. While sanitary sewer overflows are usually infrequent, given the substantial physical infrastructure associated with a sanitary sewer system, smaller malfunctions can also occur. North Myrtle Beach should continue to implement techniques such as televising or smoke testing sewer lines, prioritizing older neighborhoods to spot sections that need to be repaired or replaced.

Figure C-2 Typical pump station within the North Myrtle Beach sanitary sewer system

C. Pet Waste

A source of bacteria that, individually, we have the greatest ability to prevent from entering our waterways is from pet waste. While the majority of pet owners dispose of their pet's waste responsibly, it remains an environmental, social, and even a public health issue. Pet owners who neglect to pick up after their pets collectively become a significant source of bacteria entering our waterways. A potential cause for pet owner negligence is that they are unaware that pet waste left on the ground gets transported into the estuary following the next rain event. This connection is not necessarily widely understood by everyone. Public education and providing convenient disposal options in public areas is the best strategy to reducing pet waste as a source of bacteria in our aquatic environment. North Myrtle Beach has been proactive in addressing this issue by investing in pet waste stations throughout the community. As of August 2016, 48 pet waste stations are installed and routinely restocked by North Myrtle Beach staff throughout the community. The City has also adopted an ordinance requiring dog owners to pick up after their pets. Public parks and other open spaces along with residential neighborhoods are areas within the watershed where pet waste is most likely going to be a source of bacteria in the estuary.

Figure C-3 Examples of pet waste stations at Heritage Shores Nature Preserve (on right) and Russell Burgess Coastal Preserve (on left)

D. Wildlife and Bird Populations

Perhaps the most difficult source of bacteria to manage is from wildlife and birds that inhabit the watershed. Eliminating these sources is impractical, therefore it must be understood that there will always be a baseline level of bacteria from these natural sources. There are however ways to mitigate these sources particularly in urbanized areas. They include avoiding feeding birds and wildlife and by enclosing dumpsters, which can attract nuisance animals such as raccoons and similar wildlife species. An additional strategy is to encourage the establishment of vegetated buffers near the estuary shoreline and along the edge of stormwater ponds. The vegetated buffer helps to filter the stormwater runoff prior to draining into the estuary, while also discouraging waterfowl from congregating in and near the ponds.

Figure C-4 There is a wide diversity of wildlife species that inhabit the Hog Inlet- Dunn Sound Creek watershed.

E. Feral Cat Populations

A common problem in many areas throughout Horry County is the overpopulation of free-roaming cats. These cats congregate in sizable colonies and reproduce at significant rates. Given their tendency to live in urban/suburban areas, feral cats can be a source of bacteria within the Hog Inlet- Dunn Sound Creek Watershed. To date there have only been a few reports of observed feral cat colonies within the Cherry Grove Beach and Little River Neck communities.

There are efforts in Horry County that are focused on controlling the feral cat population using a non-lethal ethical approach. The Horry County Animal Care Center was recently awarded a Trap-Neuter-Return program grant from Petsmart Charities to focus efforts on identified feral cat colonies in the City of Conway. Sav-R-Cats International, Inc. is a no-kill feral cat shelter located in Surfside Beach focused on both trap-neuter-return initiatives as well as cat adoption.

F. Legacy Sources

In addition to the specific sources outlined above, there may be additional sources of bacteria from remnant infrastructure or contaminated sites that could still be impacting water quality in the estuary. A possible legacy source could be old septic systems in areas that are now connected to the public sanitary sewer system. Due to public safety and environmental concerns, there are recommended steps to disconnect septic systems that are no longer in use. They include disconnecting all of the piping, pumping out any remaining sewage, and filling the septic tank and field. Improper abandonment could leave behind a legacy source of bacteria that leaches into the aquatic environment over time. Areas to investigate would be Cherry Grove Beach and other older neighborhoods within the watershed that when originally constructed relied on septic systems, but are now connected to the North Myrtle Beach sanitary sewer system. It is also suspected that there are a few residences within Cherry Grove Beach that still rely on a septic system even though their street is served by sewer. These property owners may not even realize this because they receive a sewer utility bill from the City of North Myrtle Beach per city ordinance. Fortunately, initial findings from the microbial source tracking study conducted in 2016 do not indicate a signal for human- sourced bacteria in this area. The microbial source tracking study is outlined in much further detail in Element D.

II. Bacteria Transport Pathways into Estuary

Accounting for each of the sources of bacteria within the watershed is only one aspect of mitigating fecal coliform levels that are observed at SC DHEC's monitoring sites within the estuary. Another critical step is understanding how the bacteria migrates from its point of origin on the landscape all the way to its final drainage point into the estuary. The hydrology of the watershed influences both the quantity of stormwater and the rate at which it runs off various land surfaces and enters the estuary. The hydrologic dynamic can change considerably as development continues in the area.

This section further explains the influence of land use patterns and site design can have on drainage patterns within a watershed.

Figure C-5 There is a variety of land uses across the watershed ranging from large undeveloped forested parcels in Little River Neck (on left) to densely developed neighborhoods and corridors in Cherry Grove Beach (on right). Hydrologic conditions are strongly influenced by land use and development patterns requiring different management approaches depending on the site drainage characteristics.

A. Land Use Change

As coastal South Carolina continues to face growth pressures, land use changes are expected in the foreseeable future. The resulting urbanization entails an expansion of impervious surfaces including roadways, parking lots, driveways, houses, and commercial buildings. Each new development incrementally alters the hydrology of the watershed. There are numerous variables that ultimately influence the hydrology of a site. Even open space areas can differ significantly based on the site topography, underlying soils, and extent of vegetative cover.

B. Stormwater Runoff

Managing stormwater runoff is intrinsically linked to the land use or impervious surface coverage within a drainage basin. The typical storm sewer system found in most urbanized areas is designed specifically to minimize ponding and flooding along roadways, parking lots, and other portions of the built environment during and after storm events. As precipitation accumulates and runs off impervious surfaces or saturated ground surfaces, a system of curbs, gutters, pipes, and ditches carries stormwater downstream into receiving waters such as Hog Inlet and Dunn Sound Creek. This stormwater conveyance network can serve as a perfect transport mechanism for debris, sediment, and other pollutants such as bacteria and other pathogens. Most conventional stormwater systems are not equipped with treatment devices to remove or disinfect the contaminants entering the estuary.

Fortunately new approaches to stormwater management have advanced with a greater consideration towards protecting water quality in downstream portions of the watershed. One of the emerging strategies has been to reduce the stormwater runoff volumes generated at the parcel level. These concepts along with

Figure C-6 Typical storm drain adjacent to the Cherry Grove Canal

specific stormwater management recommendations are outlined in further detail in **Element F: Recommended Watershed Management Measures.**

C. Sedimentation

Sedimentation is a long-term process where soil that gets eroded off the upstream portions of the watershed settles out in the tidal creeks and channels of the estuary. Sedimentation is a natural process in any watershed system, however when it occurs at an excessive rate, a multitude of water resource management issues can arise. One of the most obvious issues within the Hog Inlet watershed is the sedimentation within the Cherry Grove Canal system. Presently, navigability in the canals is severely restricted raising the need for a major dredging operation which was completed in the Spring of 2017.

Figure C-7 The Cherry Grove Canal system is one of the more noticeable areas that have been affected by siltation. The sediment has built up in many sections of the canal network to a point where navigability is nearly impossible. A large scale dredging project was completed in the Spring of 2017 to improve navigability in this area.

From a water quality perspective, the following issues can arise due to excessive sedimentation:

- Bacteria along with other pollutants have a propensity to bind to sediment particles. As such, sediment can become a significant transport mechanism of bacteria entering the waterway.
- Oyster reefs provide tremendous ecosystem services and benefits in an estuarine environment. Perhaps most noteworthy is their role as prolific filter feeders leading to substantial water quality improvements, including a decrease in turbidity and an increase in dissolved oxygen. Silt can become a major stressor on oyster reefs if it buries oyster reefs faster than they can grow. Examining areas prone to siltation is important when selecting oyster restoration sites.

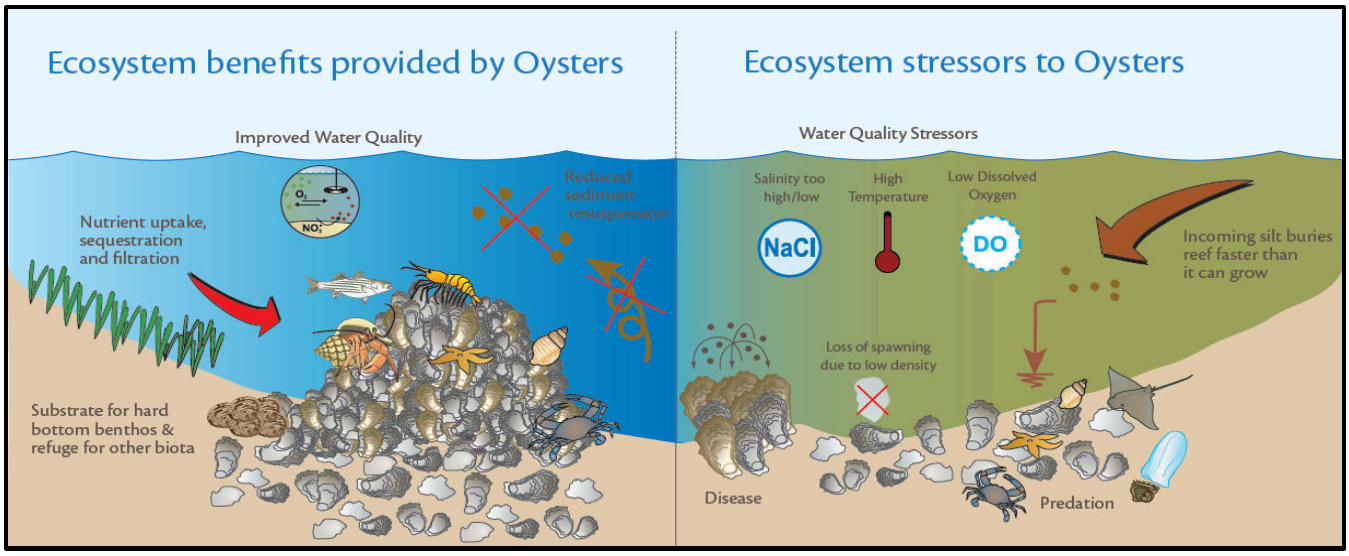

Figure C-8: Illustration showing that maintaining healthy oyster reef habitats can provide ecosystem wide benefits including improved water quality and reduced sediment resuspension. (Courtesy of NOAA)

- Sedimentation gradually alters the prevailing hydrology within the estuary. A regular and consistent daily tidal exchange is important for a healthy estuary ecosystem. The tides influence salinity levels across the estuary, which has an effect on marsh and oyster reef habitats. Maintaining a proper salinity balance is also essential to killing off bacteria that enter the estuary. Sedimentation can reduce the tidal exchange in the far reaches of the estuary near Sea Mountain Hwy and other tidal creeks that drain into the estuary. This diminished tidal exchange gives the bacteria entering the estuary a better chance to persist in the aquatic environment.

D. Boating:

Boating is a popular recreational activity in the Little River/ Cherry Grove area. While there are no marinas within Hog Inlet and Dunn Sound Creek, SC DNR maintains Cherry Grove Park and Boat Ramp, on 53th Ave North. This is a very popular boat ramp, providing direct access for boaters to Hog Inlet. The Cherry Grove canal system is designed to allow homeowners access to Hog Inlet via their private docks. SC DNR enforces the state's boating regulations which covers the illegal discharge of sewage from boating vessels. Given the shallow depths and narrow channels within Hog Inlet, boats that typically are big enough to have onboard sanitary sewer systems are generally uncommon. While this is an unlikely bacteria source in Hog Inlet, the suspicion of illegal discharge should be reported and all means of enforcing the regulations should be pursued when known incidents have occurred.

Another concern associated with boating is the generation of wakes near sensitive marsh areas. Wakes can exacerbate erosion rates along exposed shorelines and can also resuspend sediment particles in the water column. As noted in the subsection above, sediments are known to be a good medium for bacteria survival and propagation. Properly enforcing no-wake zones for boats and jet skis can help minimize these impacts.

Figure C-9: Boating is a popular activity in the Cherry Grove area. Following the state boating laws is important not only for public safety purposes but also to ensure the protection of the watershed environment.

III Conclusion:

The primary purpose of this element is to take a holistic view of the watershed and identify each of the potential bacteria sources that must be accounted for in pursuing water quality improvements within Hog Inlet and Dunn Sound Creek. For each management strategy discussed in **Element F: Recommended Watershed Management Measures,** part of the selection and design of each BMP should evaluate the source of bacteria that will be minimized or the transport mechanism that will be mitigated by the implementation of each specific BMP. The next element examines water quality trends within Hog Inlet and Dunn Sound Creek, primarily by reviewing water monitoring samples collected by SC DHEC's Shellfish Program.

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Element D: Fecal Coliform Data Trends

Water quality monitoring is an essential tool for water resource managers to help them understand the current health of a local waterbody and to detect trends that would require a management response. Water quality monitoring is also critical in evaluating the success of a water quality project or initiative. This element will review data collected by the SC DHEC Shellfish Program as well as provide a summary of a microbial source tracking study recently completed by the Environmental Quality Lab at Coastal Carolina University. The DHEC data provides the regulatory basis for shellfish harvesting classifications across the state. The purpose of the microbial source tracking study was to determine whether human sourced bacteria is present in the estuary and to also assess the influence of wet weather events on bacteria levels in Hog Inlet.

I. SC DHEC Shellfish Management Area 01 Data Review

Currently, SC DHEC collects water quality samples monthly at nine monitoring stations in Hog Inlet and Dunn Sound Creek as part of a regulatory program to ensure that shellfish resources are safe for the public to harvest and consume. In total, there have been 20 different monitoring site locations that have been sampled in this area since 1992. **Figure D-1** displays the number of sites that DHEC has monitored each year since 1992.

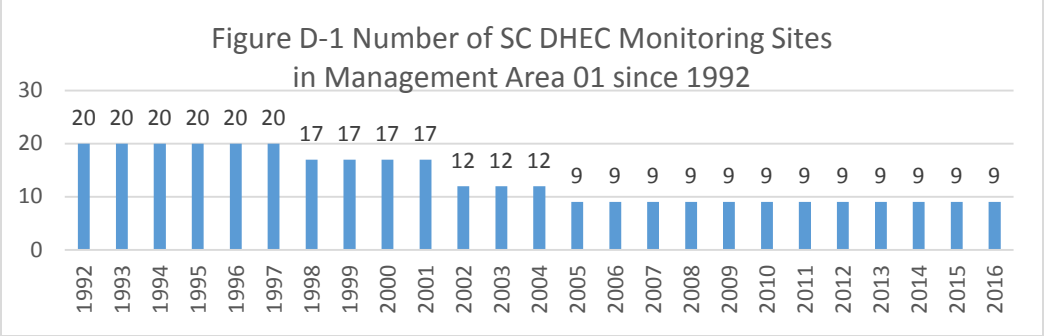


Table D-1 provides a list of all the monitoring stations that have been sampled as part of the SC DHEC Shellfish Management Program in Hog Inlet/Dunn Sound Creek along with the number of samples collected at each site since 1992. The majority of this element and the watershed plan as a whole will reference the nine active monitoring sites, as those sites determine the current shellfish harvesting restrictions within Management Area 01.

Table D-1 History of Sampling at Monitoring Sites Located within DHEC Shellfish Management Area 01

Monitoring Site #	Years Sampled	# of Samples Total
01-01	January 1992-present	278
01-02	January 1992-present	278
01-03	January 1992- January 2002	109
01-04	January 1992- October 2005	155
01-05	January 1992-present	278
01-06	January 1992-present	278
01-07	January 1992-present	278
01-08	January 1992- October 2005	155
01-09	January 1992- October 2005	155
01-10	January 1992- January 2002	109
01-11	January 1992 – June 1998	67
01-12	January 1992 – June 1998	67
01-13	January 1992 – June 1998	67
01-14	January 1992-January 2002	110
01-15	January 1992-January 2002	110
01-16	January 1992-January 2002	110
01-17	January 1992-present	280
01-17A	January 1992-present	281
01-18	January 1992-present	281
01-19	January 1992-present	280

Note: Information provided by SC DHEC Shellfish Program Staff

This element reviews the water monitoring data collected by SC DHEC and provides a summary of water quality trends since 1992. At the outset of the data analysis process the following pertinent questions were identified to help focus the scope of the data set review:

- **Which monitoring sites have had persistently high fecal coliform levels in the period of record?**
- **Which monitoring sites have the greatest chance of meeting the fecal coliform standard within the next 5-10 years?**
- **Is there a correlation between fecal coliform levels and other variables such as turbidity, salinity, and precipitation preceding the sampling date?**
- **Are there any unusual data trends at a particular monitoring site or during a period of sampling dates that stand out from the rest of the data set?**

This element will provide an interpretation of the available data to help answer these questions which will ultimately help to prioritize management efforts in the watershed. Appendix D provides a summary profile of the data collected at each monitoring site. The following section provides a series of tables comparing the monitoring sites across Management Area 01.

Table D-2 compares the median fecal coliform levels for each of the monitoring sites from 1992-2016 as well as 2013-2016, which is the period by which SC DHEC made its most recent management decision regarding shellfish harvesting classifications. Through the entire period of record, fecal coliform levels are relatively low. In fact Sites 01-01, 01-07, 01-17A, 01-18, and 01-19 are all within both the geometric mean (14 MPN/100ml) and the 90th percentile (43 MPN/100ml) standards. The 2013-2016 three year period indicates that higher levels of fecal coliform are being observed across the estuary. In that time period none of the monitoring sites are within the geometric mean threshold and each site had a higher median in the 3-year subset in comparison to the entire period of record. Site 01-01 saw the greatest increase in fecal coliform median levels over the past 3 years with a median of 32 MPN in comparison to a median of 13 MPN for the entire period of record. It is important to note that Site 01-01 is located at the mouth of Little River Inlet, which receives significant freshwater inputs upstream from Little River Inlet and the Atlantic Intracoastal Waterway. Site 01-01 only has a small hydrological connection with the Dunn Sound Creek.

Table D-2 Comparison of Median Fecal Coliform Levels at each Monitoring Site within Management Area 01

Monitoring Site	Median Fecal Coliform Level- 1992-2016	Median Fecal Coliform Level- Previous 3 Years, February 2013-February 2016
01-01	13 MPN	32 MPN
01-02	23 MPN	39.5 MPN
01-05	23 MPN	33 MPN
01-06	21 MPN	34.5 MPN
01-07	7.8 MPN	15.5 MPN
01-17	17 MPN	23 MPN
01-17A	13 MPN	19 MPN
01-18	8 MPN	19.5 MPN
01-19	13 MPN	17 MPN

Note: Based on samples taken by SC DHEC from January 1992 through February 2016
Fecal Coliform Standard for Approved Classification: Geometric mean: 14MPN/100ml 90th Percentile: 43MPN/100ml

Table D-3 summarizes the frequency of exceedingly high fecal coliform levels observed at the SC DHEC monitoring stations. A threshold of 260 MPN/100mL was selected for evaluation, because any sample above that level exceeds all regulatory standards established under SC DHEC's Shellfish Management program. Under a permit issued by DHEC, shellfish are allowed to be relayed and depurated from locations that have fecal coliform levels between 44 MPN/100mL and 260 MPN/100mL. Anything above that threshold is completely off-limits to any kind of harvesting. On the whole, the frequency of excessively high fecal coliform levels in Management Area 01 is relatively low. Even site 01-02 which had 19 samples above 260 MPN/100ml still only exceeded that threshold on average of less than one time per year. However, the data does suggest that high level readings are more regularly observed during the three year sampling

period of February 2013- February 2016. Although, site 01-07 did not have any samples above that threshold during that timeframe.

Table D-3 Comparison of % of Samples above 260 MPN at each Monitoring Site within Management Area 01		
Monitoring Site	**#/% of Samples Greater than 260 MPN/100 mL Fecal Coliform- 1992-2016**	**#/% of Samples Greater than 260 MPN/100 mL Fecal Coliform- 2013-2016**
01-01	14 samples/ 5.0% of total samples collected	3 samples/ 8.3% of total samples collected
01-02	19 samples/6.8% of total samples collected	4 samples/ 11.1% of total samples collected
01-05	16 samples/5.8% of total samples collected	3 samples/8.3% of total samples collected
01-06	15 samples/5.4% of total samples collected	5 samples/ 13.9% of total samples collected
01-07	4 samples/ 1.4% of total samples collected	No samples have exceeded 260 MPN/100mL
01-17	11 samples/3.9% of total samples collected	2 samples/ 5.6% of total samples collected
01-17A	11 samples/3.9% of total samples collected	2 samples/5.6% of total samples collected
01-18	5 samples/1.8% of total samples collected	2 samples/ 5.6% of total samples collected
01-19	8 samples/ 2.9% of total samples collected	2 samples/5.6% of total samples collected
Note: Based on samples taken by SC DHEC from January 1992 through February 2016 Shellfish harvesting is allowed for the purpose of relaying and depuration at monitoring stations with measurements between 44 MPN/100ml and 260 MPN/100ml. Shellfish harvesting is completely off limits at monitoring stations with measurements above 260 MPN/100ml		

The 23 samples that exceeded 260 MPN/ 100mL between February 2013 and February 2016 were obtained over nine sampling dates. Table D-4 analyzes the relationship between those sampling dates and the amount of precipitation that preceded the sampling date. It appears by the data reviewed, that rain is not always the sole determining factor in the fecal coliform levels observed. As an example on December 15, 2014, six of the nine sampling sites exceeded 260 MPN/100mL. However the last rainfall event preceding the sampling date was on December 9, 2014 and the rainfall totals were modest- 0.17 inches between December 6-9, 2014. All of the samples had salinity levels between 24-34 psu which is not indicative of a significant freshwater input that may have influenced bacteria levels.

Table D-4 Sampling Dates with Fecal Coliform Levels above 260MPN/100mL		
Sampling Date	**Monitoring Sites Exceeding 260/100mL**	**Precipitation prior to sampling**
April 15, 2013	01-02, 01-06	0.53in on 4/14-15 and 1.69in on 4/12
December 16, 2013	01-17, 01-18	0.25in on 12/13-14
August 18, 2014	01-01, 01-06	0.05in on 8/18 and 0.2in on 8/16
December 15, 2014	01-01, 01-02, 01-05, 01-17, 01-17A, 01-19	Last rain on 12/9- 0.01in. and 0.07in on 12/8
March 2, 2015	01-19	Last rain on 02/10- 0.04 in
May 13, 2015	01-17A	5.55in between 5/7-12
June 8, 2015	01-06	1.67 in between 6/3-5
July 6, 2015	01-01, 01-02, 01-05, 01-06, 01-18	0.97in on 7/3-4
February 8, 2016	01-02, 01-05, 01-06	1.11in on 2/7 and 3.17 in between 2/3-6.
Shellfish harvesting is allowed for the purpose of relaying and depuration at monitoring stations with measurements between 44 MPN/100ml and 260 MPN/100ml. Shellfish harvesting is completely off limits at monitoring stations with measurements above 260 MPN/100ml		

One of the immediate observations in analyzing a fecal coliform data set is the variability in measurements from one sampling date to the next. This can make it difficult to determine whether fecal coliform levels are increasing or decreasing over time. That is clearly evident when you look at the scatter plot graphs of each of the monitoring site profiles included in **Appendix B**. To help visualize the long-term fecal coliform trends a linear trendline was calculated in excel and displayed on each of the scatter plot graphs. Table D-5 summarizes the trendline patterns for each of the monitoring sites for the entire data set, February 1992-February 2016. The trendlines indicate that 7 of the 9 monitoring sites have shown trends of increasing levels of fecal coliform bacteria over the period of record. However, the increase appears to be modest at most of the sites.

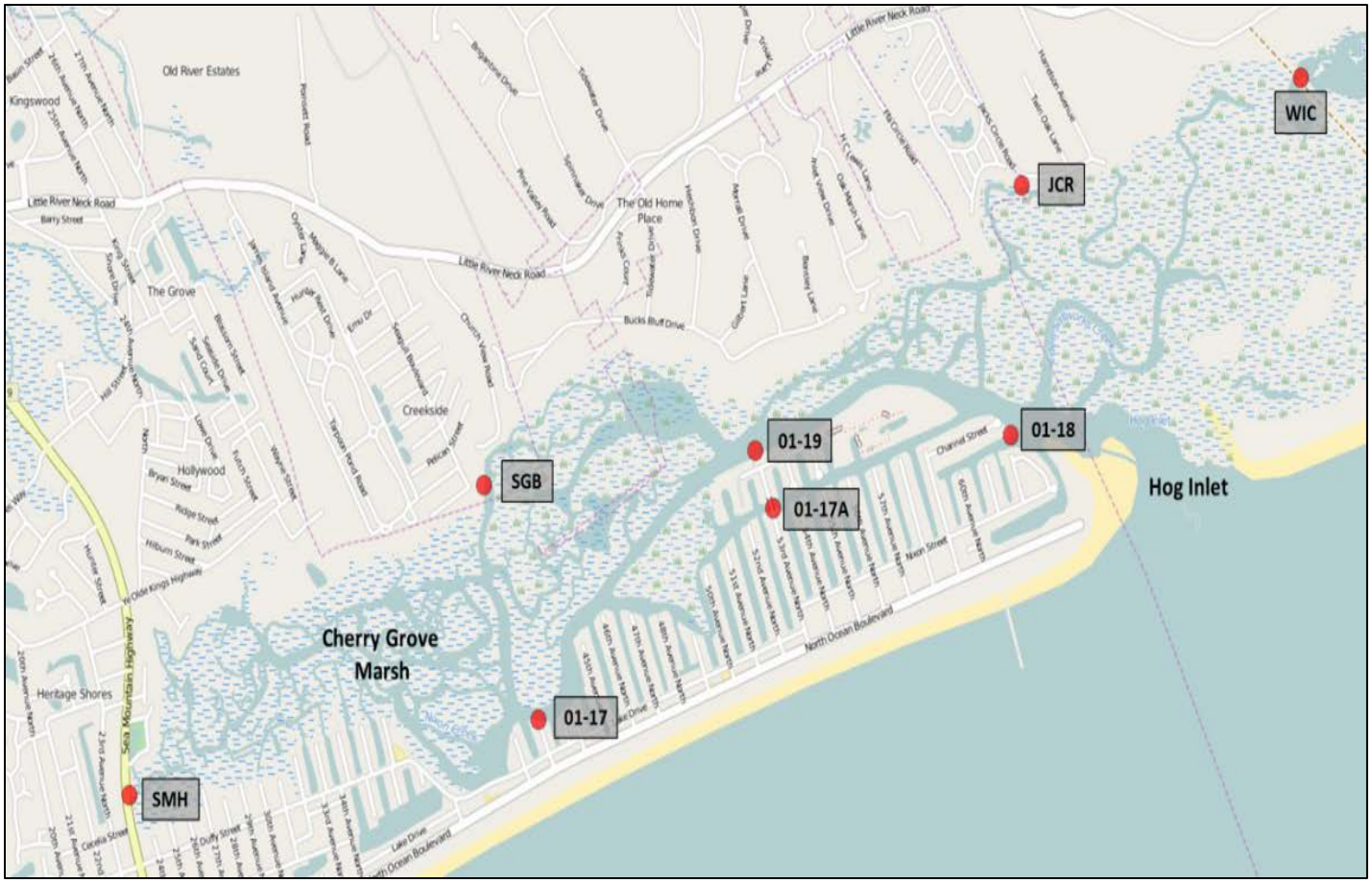
Table D-5 Summary of Linear Trendlines of Scatter Plot Graphs for Management Area 01 Monitoring Sites.	
Monitoring Site	**Trendline Direction**
01-01	Increasing
01-02	Increasing
01-05	Increasing
01-06	Increasing
01-07	Decreasing
01-17	Increasing
01-17A	Decreasing
01-18	Increasing
01-19	Increasing
Note: Based on samples taken by SC DHEC from February 1992 through February 2016. See Appendix D for scatter plot graphs of each of the monitoring site data sets.	

II. Summary Findings from the Hog Inlet Microbial Source Tracking Study

Prior to the Cherry Grove canal dredging project in the fall of 2016, North Myrtle Beach and Horry County stormwater management personnel wanted to get a baseline assessment of water quality conditions in Hog Inlet before dredging operations commenced. The Environmental Quality Lab at Coastal Carolina University was contracted to collect and analyze water samples in both antecedent dry and wet weather conditions. Samples were collected at eight sites throughout the estuary. Four of the sampling locations were at current SC DHEC sampling stations. Four additional sampling sites were utilized to obtain data from the northern extent of Hog Inlet at the Waties Island Causeway to the southern extent of the estuary at Sea Mountain Highway. These sites were also located close to the upland shoreline and selected to represent the variety of land use types within the watershed. **Table D-6** provides a location description for each of the sampling locations.

Table D-6. Sampling locations for the Hog Inlet - Cherry Grove Microbial Source Tracking Study.	
SC DHEC Shellfish Management Area Water Quality Sampling Stations	
01-17	42nd Avenue - Cherry Grove (collected at Fishermans Wharf dock)
01-17A	53rd Avenue Bridge on Canal- Cherry Grove (collected at East side of bridge)
01-18	Dunn Sound at Hog Inlet (collected at Doulaveris Retreat dock)
01-19	53rd Avenue at Main Creek- Cherry Grove (collected at Cherry Grove Boat Ramp dock)
Additional sampling stations	
JCR	Jack's Circle Road at House Creek (collected beside Creekside Clubhouse)
SGB	Sea Gull Boulevard at Williams Creek (collected on path at picnic tables)
SMH	Sea Mountain Highway at Nixon Creek (collected at Nixon Creek culvert)
WIC	Waties Island Causeway at Dunn Sound Creek (collected at east side of bridge)

A corresponding sampling location map is included in the Exhibit below:



Water samples were collected during three dry and three wet events, categorized using established US EPA stormwater protocols. For this study, dry weather events were defined as a 72 hour dry period with less than 0.1 inches of rainfall prior to sampling. Wet weather events were preceded by at least 72 hours of dry weather, with a minimum precipitation of at least 0.25 inches of rainfall within a 4 hour period before sampling. The wet weather samples were collected on 8/18/2016, 9/23/2016 and 9/27/2016. Dry weather samples were collected on 8/3/2017, 8/24/2016, and 9/7/2016.

Microbial source tracking analytical techniques were used to determine whether human-sourced bacteria are present in water samples collected from Hog Inlet. Seven chemical and biological tracers were used in a weight of evidence approach to evaluate and compare the water quality conditions at each of the eight monitoring sites. The tracers used are described in **Table D-7** below.

Table D-7 Tracers used during Hog Inlet Microbial Source Tracking Study

Tracer	Description/Purpose	Water Quality Standard
Human-sourced *Bacteriodes* (BacHum)	Samples for qPCR analysis were selected in consultation with Horry County and North Myrtle Beach officials. They were chosen based on the strongest evidence of fecal contamination. Out of the 53 total water samples, 26 were selected for qPCR analysis using the BacHum and GenBac assays. The BacHum assay detects human-sourced bacteria markers.	Measured as # genome copies/100 mL > 100 is considered very high < 10 is considered low
***Bacteriodes* (GenBac)**	Similar purpose as BacHum tracer described above. The GenBac assay detects a broader class of bacteria from warm-blooded animals.	Measured as # genome copies/ 100mL > 6250 is considered very high < 2275 is considered low

Table D-7 Tracers used during Hog Inlet Microbial Source Tracking Study, Continued		
Tracer	**Description/Purpose**	**Water Quality Standard**
Enterococci	This is the saltwater recreational water quality standard as established by SC DHEC.	Measured as Most Probable Number (MPN)/ 100mL The single sample standard is >104 MPN/100mL. Permanent advisories are posted at sites that have exceeded this level in more than 10% of samples collected over a 5 year period. Advisories are also issued if a single day maximum value of >500 MPN ml is measured.
Fecal Coliform	This is the regulatory standard for designated Shellfish Harvesting Areas as established by SC DHEC	Measured as Most Probable Number (MPN)/ 100mL To obtain Approved harvesting classification monitoring sites must have geometric means less than 14 MPN per 100mL and an estimated 90th percentile below 43 MPN mL.
Caffeine	This tracer is an indication of human wastewater as it is detectable in human urine.	Measured as # nanograms (ng)/mL Minimum detection limit is 0.175ng/ml > 0.4ng/mL suggests presence of significant human inputs
Turbidity	Turbidity provides an indication of the level of land derived sediment loads or resuspended sediments within the water column. Previous studies have indicated a correlation between fecal bacterial contamination and increased turbidity as fecal bacteria often bind to sediment particles. Turbidity levels are commonly higher during the wet-weather sampling dates.	Measured as NTU Nephelometric Turbidity Unit/100mL Considered elevated > 25 NTU. (SC DHEC regulatory standard for estuarine and saline waters)
Salinity	Analyzed to evaluate comparative levels of freshwater inputs throughout the system. Larger open water areas that are strongly tidally influenced generally have higher salinity levels than upstream smaller creeks and tributaries. Salinity levels are generally lower during the wet-weather sampling dates.	Measured as psu (practical salinity unit) >30 psu indicative of insignificant freshwater inputs <15 psu indicative of substantial freshwater inputs
Source: Hog Inlet, Horry County, Microbial Source Tracking Study- Final Report, Coastal Carolina University		

Below is a summary of the data observed for each of the parameters analyzed in this study.

A. Salinity: SC DHEC sites 01-17, 01-17A, 01-18, and 01-19 are all located in larger creeks within the estuary and are strongly tidally influenced. Therefore, salinity levels were comparable to ocean salinity values. Monitoring sites JCR and CVL are located at upstream creek sites, which are more likely to be influenced by freshwater inputs from stormwater runoff and groundwater flow. Site WIC has a hydrological connection with Little River Inlet which tends to have salinity levels more consistent with freshwater systems. The SMH site is influenced by an impoundment with lower salinity flows during periods of an ebb tide. All of the SC DHEC sites maintained salinity levels above 30.0 psu in both the dry and wet weather samples. This indicates that the influence of freshwater inputs is insignificant at these sites. Sites CVL and JRC maintained salinity levels above 30 psu except for the wet weather sample taken on 8/18/2016 (CVL measured 21.8 psu and JRC measured 19.9 psu on that sampling date). Site SMH consistently had the lowest salinity levels with a mean of

16.2 psu during the dry weather samples and 6.18 psu during the wet weather samples. As anticipated, the WIC site showed some influence of freshwater input especially during wet weather events. The mean was 26.5 psu for the dry weather samples and 21.0 psu for the wet weather samples.

B. Turbidity: A consistent finding across all sampling sites was that turbidity levels were considerably lower during the dry weather sampling dates. The JCR site showed the greatest levels of turbidity with a mean of 95.3 NTU during wet weather samples. The next highest levels were observed at the WIC site with a mean of 35.7 during the wet weather sampling dates. As indicated in **Table D-7** a turbidity measurement above 25 NTU is considered elevated and above the established water quality standard. The CVL site (33.3 NTU) was the only other sampling site with a mean above 25 NTU during the wet weather sampling dates.

C. Caffeine: Values above the reporting limit were inconsistent between dry and wet weather samples. Caffeine was detected in 9 of the 23 samples taken during the dry weather events. Caffeine was detected in all three dry weather samples collected at site 01-18. Only 3 of the samples were above the 0.4 ng/ml threshold of concern. Two of these samples were from the JCR site while the third was one of the samples from site 01-18. Only 4 of the 23 wet weather samples had detectable levels of caffeine and only one sample at site 01-18 was above the 0.4 ng/ml threshold.

D. Fecal Indicator Bacteria: Samples were analyzed for four indicators of bacteria. A summary of findings for each indicator is provided below.

Enterococcus: There was a stark difference between Enterococcus levels measured during the dry sampling events and the wet sampling events. During the dry weather events, all of the samples were consistently within the water quality standards except for monitoring sites SMH and JCR. At SMH, each of the samples was above the 104 MPN/100mL advisory standard and the sample collected on August 8, 2016 was 1,178 MPN/100mL, more than double the single day advisory standard of 500 MPN/100mL. At JCR, two of the three dry weather samples exceeded the 500 MPN/100mL standard. During the wet weather events 17 of the 24 total samples collected exceeded the 104 MPN/100mL standard and all 8 of the monitoring sites exceeded the standard at least once. On the August 18, 2016 sampling date, site 01-17A recorded a measurement of 4,352 MPN/100mL.

Fecal Coliforms: Measurements during wet weather events were also noticeably higher than dry weather events for Fecal Coliform bacteria as well. Sites JCR and SMH were once again noticeably higher than the remainder of the sampling sites. The dry sampling mean measurements for sites 01-17, 01-17A, 01-18, 01-19, and CVL were all within the geometric mean (14 MPN/100mL) and 90th Percentile (43 MPN/100mL) water quality standards for shellfish harvesting areas. During the wet weather samples only sites 01-18 (27 MPN/100mL) and 01-19 (29 MPN/100ml) had mean measurements within the 90th percentile regulatory standard.

GenBac MST Assay: Sources of fecal bacteria from warm-blooded animals were detected in all 26 of the samples selected for qPCR analysis. Similar to the fecal coliform and enterococcus levels observed in this study, the GenBac assay had stronger positive signals in the wet-weather sample subset. As before, the JCR, SMH, and WIC sites had the highest positive indication for the GenBac assay.

BacHum MST Assay: Out of the 26 water samples selected for qPCR analysis, only one sample yielded a positive detection for human-sourced bacteria. The sample that the BacHum assay detected positive was collected during the wet weather event on September 27, 2016 at the WIC site. It was a low level detection of 2 genome copies/ 100mL. Above 100 genome copies per 100mL is considered high.

The following are findings from the report that have implications on the prioritization of management efforts in Hog Inlet, which will guide many of the recommendations outlined in this watershed plan.

- The only monitoring site that had any detection of human-sourced bacteria from the BacHum assay was at the Waties Island Causeway location, and the level of detection was low. This site is located just outside of the main Cherry Grove/Hog Inlet watershed. Based on the lack of evidence of human bacteria and the strong evidence of

the GenBac marker data, it appears that the bacteria contamination observed in the estuary is of non-human origin.

- There appears to be a strong correlation between precipitation and bacteria levels. Smaller creeks and tributaries which are more likely to receive greater volumes of freshwater inputs from stormwater runoff are more likely to exceed the water quality standards for enterococcus and fecal coliform.
- The Jack Circle Road and Sea Mountain Hwy sites were consistently high for turbidity, fecal coliforms, Enterococcus, and warm-blooded animal feces (excluding human-sourced bacteria). Levels for each of these parameters was high, even during the dry weather sampling dates. It is worth evaluating the need to prioritize these areas of the watershed for future management activities.

III. Summary Review and Conclusions of Monitoring Results

The following section is a review of the questions posed at the beginning of the element. This analysis provides guidance on management implementation priorities. While this data analysis is thorough and very insightful there are still unknowns regarding water quality conditions in the Hog Inlet estuary. **Element I** outlines recommendations for future monitoring needs to continue to increase our knowledge of the estuary and to evaluate the impact of management strategies that are implemented.

- **Which monitoring sites have had persistently high fecal coliform levels in the period of record?**
  Currently all of the monitoring stations within Management Area 01 exceed both the geometric mean and the 90th percentile standards for Approved harvesting classification. However, sites 01-06, 01-07, and 01-18 all have met each of the standards within the past five years. Also, none of the sites appear to be elevated to a point where a concerted management effort cannot help improve water quality. With that said, sites 01-02, 01-05, 01-06, and 01-17 all have a median fecal coliform level above the geometric standard of 14 MPN/100mL through the whole data set. As noted in **Table D-2,** sites 01-01, 01-02, 01-05, and 01-06 all have median fecal coliform levels above 30 MPN/100mL over the most recent three years of available data and therefore should be monitored closely moving forward. On a positive note, the microbial source tracking study indicated that human sourced bacteria does not appear to be an immediate concern in the Hog Inlet estuary.

- **Which monitoring sites have the greatest chance of meeting the fecal coliform standard within the next 5-10 years?**
  Since monitoring sites 01-06, 01-07, and 01-18 all met both the geometric mean and 90th percentile standards as recently as 2011, it gives reason to believe that it is possible to return to those levels once again. The scatter plot graph trendline analysis also indicated that fecal coliform levels at sites 01-07 and 01-17A are decreasing over time, making each of those sites possible candidates to meet the Approved harvesting classification standard within a ten-year period.

- **Is there a correlation between fecal coliform levels and other variables such as turbidity, salinity, and precipitation preceding the sampling date?**
  The Hog Inlet Microbial Source Tracking Study was very beneficial in validating some of the suspected drivers of fecal coliform levels in the estuary. The study was designed to collect samples during dry conditions as well as during wet weather events. Bacteria levels were noticeably higher for both fecal coliforms and enterococcus at each of the sites during wet weather events, with the exception of Jack Circle Road where dry and wet weather samples were comparable. The study also indicated that turbidity levels were consistently higher in the wet weather samples and there was a positive statistical relationship between turbidity and the fecal coliform and enterococcus values measured. The study also revealed that monitoring sites that are located in upstream areas and tend to have lower salinity values can be prone to high fecal coliform levels. The Sea Mountain Highway site showed the strongest correlation between low salinity values and elevated bacteria levels. This site is adjacent to a freshwater impoundment that discharges into the southern end of Hog Inlet.

- **Are there any unusual data trends at a particular monitoring site or during a period of sampling dates that stand out from the rest of the data set?**

With such a large data set dating back to 1992 it is easy to find anomalies in a single sampling date, especially since fecal coliform bacteria can be so variable. As discussed earlier in the element, on some sampling dates the fecal coliform levels are noticeably high without any evidence of a correlating factor such as precipitation or salinity that would contribute to the high readings. The December 9, 2014 DHEC sampling date stands out as six of the nine sampling sites were well above 260 MPN/100mL. In fact, five of the sites measured over 1,600 MPN/100mL. There was little to no rain prior to the sampling date that would attribute to these numbers. This is why anecdotal evidence from active watershed users can be helpful in providing insight into unusual or suspicious water quality conditions that are observed.

IV. Prioritization of Monitoring Sites for Management Purposes

The SC DHEC monitoring data set, along with the microbial source tracking study results, provided the planning team with a wealth of information about current water quality conditions and past trends within Hog Inlet. An immediate challenge is determining where to begin management efforts in the watershed. Based on the analysis of the monitoring data, the planning team evaluated each DHEC site and prioritized them into 3 Tiers. A general description of each Tier is provided below:

Tier One Priority Sites: 01-07, 01-18, 01-19, 01-17A, 01-17

These are the highest priority sites for future management purposes. Sites 01-07, and 01-18 were two of the most recent sites to meet the Approved shellfish harvesting classification standards. As **Table D-2** indicates, Sites 01-07 and 01-18 have fairly low median fecal coliform levels, both historically and in the past three years. Reductions needed to achieve Approved status once again might be much more realistic than other sites within Management Area 01 that have a longer history of elevated bacteria levels. Site 01-17 is the closest sampling location to the Sea Mountain Highway site that was sampled during the microbial source tracking study. This site also had consistently high turbidity and bacteria indicators in both wet and dry weather sampling events. DHEC Monitoring Site 01-19 was also sampled in the microbial source tracking study. This site is located in the main channel of Hog Inlet near the SC DNR boat landing at 53rd Ave N, one of the busiest areas for water-based recreation in the estuary. Since this site is both highly visible and centrally located within the watershed, it is an important site to regularly sample and closely monitor water quality trends at this site. In both the DHEC data review and the microbial source tracking study, bacteria levels at this site seem to be fairly stable. The microbial source tracking study also indicated that among the four DHEC sites sampled, 01-19 had the highest mean salinity levels in both wet and dry sampling events and turbidity levels well within the regulatory water quality standards. Both of these parameters provide indication that issues with sedimentation and large volumes of stormwater runoff are less of a concern at this site. Finally, monitoring site 01-17A is located on the 53rd Ave bridge over the Cherry Grove canal. It is anticipated that the recent dredging in the fall of 2016 will likely have a significant impact on the hydrology within this portion of the estuary as well as the fecal coliform levels at this monitoring site. Regularly reviewing the data trends at site 01-17A will help watershed managers assess the impacts of dredging on water quality in Hog Inlet.

Tier Two Priority Sites: 01-05, 01-06

After a review of the available SC DHEC data set, the planning team decided to designate monitoring sites 01-05 and 01-06 as Tier Two Priority Sites. Site 01-05 is located in the far downstream portion of Dunn Sound Creek before it enters Little River. The site is adjacent to Tilghman Point, which is primarily undeveloped open space. New BMP options are limited in this area. Site 01-05 is particularly important because if it ever does meet the fecal coliform standards, it would open up a significant acreage of oyster reef habitat to harvesting. Site 01-06 is the closest SC DHEC site to the Jack Circle Road site in the microbial source tracking study which indicated some concerns related to bacteria, salinity and turbidity, likely requiring additional stormwater management measures along this portion of Little River Neck Road. However, it is suspected that site 01-06 is influenced primarily by wildlife sources of bacteria, limiting some of the stormwater management options that may be available in close proximity to the site.

It will be important for the planning team to closely review data trends at these sites in the future. If either site shows indications of significantly increasing fecal coliform levels, then the watershed plan implementation committee should consider redesignating them as Tier One sites. Also if significant progress is made on the Tier One sites listed above, then watershed managers can begin to shift their focus on these two sites. Also, it should be noted that BMPs will still be pursued in upstream drainage basins adjacent to these sites as opportunities present themselves.

Tier Three Priority Sites: 01-01, and 01-02

These are the lowest priority sites for future management purposes. The primary reason is due to their location within SC DHEC Shellfish Management Area 01. Site 01-01 is located near the mouth of Little River Inlet, therefore has very little hydrological connectivity with Hog Inlet and Dunn Sound Creek. Site 01-01 is more predominantly influenced by upstream flows from the Little River Inlet, Calabash River, and the Atlantic Intracoastal Waterway. The closest portion of the focus area of this watershed plan is Waties Island, which has a limited number of potential BMPs that can be implemented. Also with such a large upstream drainage area, it is difficult to determine whether an increase or decrease in fecal coliform levels can be attributed to a management practice implemented within the Hog Inlet and Dunn Sound Creek watersheds. Site 01-02 is similarly on the northern edge of the watershed and is significantly influenced by freshwater inputs from Little River Inlet and Atlantic Intracoastal Waterway.

This element provides a wealth of information to guide the recommendations for future watershed management strategies in Hog Inlet and Dunn Sound Creek. The next element describes existing management resources and partnership activities that are occurring within the watershed. The remainder of the document outlines long-term implementation activities designed to improve water quality within the estuary.

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Element E: Existing Water Resource Management Programs

While improving water quality in Hog Inlet and Dunn Sound Creek will entail numerous projects and initiatives, it will not be necessary to start completely from scratch. Both North Myrtle Beach and Horry County have made water quality protection a top priority in the provision of services, enforcement of regulations, and in the design of public infrastructure projects. There are also resources available throughout the region and state that can be utilized for public education purposes, research opportunities, and other beneficial partnerships. This element describes some of the programs and initiatives that are already in place or readily available to water resource managers working in the watershed.

I. Municipal Separate Storm Sewer System- MS4 Permit:

In an effort to reduce the negative impacts associated with stormwater runoff on nearby waterbodies, the EPA developed the MS4 permit program to address these challenges. Phase I of the MS4 permit program began in 1990 and initially focused on larger urban cities and regions with a population greater than 100,000. Currently, SC DOT, the City of Columbia, Greenville County, and Richland County are designated as Phase I MS4 jurisdictions, and must comply with an individual National Pollutant Discharge Elimination System (NPDES) permit. Phase II of the MS4 program took effect in 1999 and incorporated smaller urbanized areas into the program. Horry County and North Myrtle Beach are two of more than seventy regulated small MS4s in South Carolina. Each jurisdiction complies with the state General NPDES permit (SCR03000), which DHEC updates and renews every five years.

As a small MS4 permitted entity, Horry County and North Myrtle Beach must oversee a stormwater management program to address the following six minimum control measures. They are listed and briefly explained below:

1. **Public Education and Outreach:** MS4s are required to develop programs to educate the public about the impact of stormwater discharges on local waterways and steps that they can take as citizens or business owners to reduce contamination of stormwater.

2. **Public Participation and Involvement:** To further increase the positive impacts of public engagement, MS4 permit holders are required to develop initiatives that actively engage citizens in stormwater improvement programs. Both North Myrtle Beach and Horry County are members of the Coastal Waccamaw Stormwater Education Consortium which utilizes regional partners to plan and host events aimed at educating members of the public about stormwater related issues in our coastal region. Horry County has a Council-appointed Stormwater Advisory Board and both Horry County and North Myrtle Beach have Keep America Beautiful chapters which frequently host cleanup events meeting the criteria of this minimum control measure.

3. **Illicit Discharge Detection and Elimination:** The primary objective of this requirement is to develop mechanisms to identify and respond to incidents of contaminated non-stormwater discharges entering the storm drainage system. The MS4 must maintain a map of the storm drain system and establish enforcement mechanisms to hold known polluters responsible. Staff must be properly trained to detect common pollutants, such as oils, chemicals and sewage, as well as their sources.

4. **Construction Site Runoff Control:** This measure requires MS4s to enact ordinances or other regulatory mechanisms to control runoff from active construction sites that cause land disturbances of greater than one acre or less than one acre if the site is part of a larger common development plan. As a coastal county, this regulation applies to construction sites within a ½ mile of a receiving waterbody that cause a land disturbance of greater than ½ acre. One of the main concerns that needs to be addressed by developers is designing onsite controls to minimize erosion and stabilize disturbed soils.

5. **Post-construction Site Runoff Control:** MS4s are required to institute provisions within their development regulations to ensure that stormwater control measures be installed to minimize runoff volumes and protect water quality as part of the site design of a new development project.

6. **Pollution Prevention/ Good Housekeeping:** This measure establishes stormwater best management practices that the permitted MS4 entity pursues in the operation of services and/or management of municipal facilities and properties. It also outlines a plan for how each MS4 will maintain their respective drainage system.

II. Cherry Grove Canal Dredging Project

As a result of long-term siltation, the Cherry Grove canal system extending from 39th Ave N to 63rd Ave N has become unnavigable in many locations, especially during low tide conditions. An extensive dredging project was proposed and ultimately approved by North Myrtle Beach City Council and permitted by the Army Corps of Engineers. The dredging project commenced in October 2016 and was completed in the Spring of 2017.

In addition to the enhancements provided to boaters and property owners within the dredging project area, it is anticipated that there will be some ancillary long-term water quality improvements observed following the dredging project. As explained in **Element C: Fecal Coliform Source Identification**, sedimentation can create conditions favorable for the survival of bacteria in the aquatic environment. Bacteria tends to bind to sediment particles which can enter the estuary as erosion occurs. Sediment can shelter bacteria from UV light which can naturally disinfect bacteria. Finally, over time the hydrology within the estuary changes as sedimentation builds up and the channels within the Cherry Grove canal system become shallower. Salt water acts as another natural disinfectant but its effectiveness is reduced as the hydrology is altered, particularly in the upper reaches of the estuary where a full daily tidal exchange can become more limited as sedimentation increases.

The dredging project removed large volumes of sediment and opened up both the main channel of Hog Inlet as well as all of the finger canals within Cherry Grove, thereby significantly improving the tidal exchange throughout a substantial area of the estuary. SC DHEC monitoring sites that should be carefully analyzed for fecal coliform bacteria trends following the dredging project include 01-17, 01-19, 01-17A, 01-18, and 01-07. It is very likely that in the first 6-12 months, fecal coliform levels could be elevated since the dredging project will disturb and resuspend sediments into the water column. However, it is anticipated that long-term fecal coliform levels will decrease as long as bacteria sources continue to be mitigated.

Figure E-1: General Boundaries of the Cherry Grove Dredging Improvement District (courtesy of North Myrtle Beach)

Figure E-2 Pipeline directing dredged material from the project site extending ultimately to the spoils site west of Little River Neck Road.

As part of the dredging permit issued by the Army Corps of Engineers, an oyster reef mitigation plan has been developed and will be executed after the dredging has been completed. The mitigation plan is intended to ensure that any oyster reefs disturbed during the dredging process will be properly mitigated by the establishment of an oyster reef restoration site within Hog Inlet. A total of 2.5 acres of oyster reefs will be restored at candidate sites currently being explored along House Creek, Nixon Creek, and Williams Creek. Site selection will be assessed by Dr. Keith Walters from Coastal Carolina University and all necessary approvals for oyster shell sources used to restore the reefs will be obtained from SC Department of Natural Resources. Restoration work is scheduled to begin in the fall of 2017 and will be monitored for three years to ensure that they have been successfully established. In addition to the oyster reef restoration work, there will also be marsh mitigation work completed at a site in Heritage Shores Park.

III. Complementary Planning Initiatives

Both Horry County and the City of North Myrtle Beach engage in several planning initiatives within their respective jurisdictions. Both entities have Planning Departments along with appointed Planning Commissions and other relevant boards. Included in their scope of responsibilities is to oversee the development and implementation of the Comprehensive Plan as well as the administration and enforcement of the zoning ordinance and other land use regulations.

It is the intention of the Hog Inlet- Dunn Sound Creek Watershed Plan to complement and support those planning documents and efforts. This section highlights issues and strategies outlined within these planning documents that have relevancy to the objectives of this watershed plan.

A. North Myrtle Beach Comprehensive Plan

The 2010 North Myrtle Beach Comprehensive Plan Update highlights several long-term environmental issues within the Hog Inlet watershed and identifies numerous resources and long-term strategies to ensure that water quality and natural resources protection is an ongoing priority for the community. Below is a summary list of items outlined in the Comprehensive Plan that apply to the activities recommended in this watershed management plan. The majority of the items below are included in the Natural Resources element while a few are found in the Land Use, Community Facilities, and Priority Investment elements.

- The Natural Resources Element highlights the importance of public lands and preserved open space areas to the City of North Myrtle Beach, including Waties Island, Russell R Burgess Jr. Coastal Preserve, and Heritage Shores Nature Preserve. These areas provide critical habitat to sensitive plant and animal species, offer direct public access to the Atlantic Ocean and Cherry Grove Marsh, and feature extensive interpretive signage enhancing public education and awareness of local environmental issues.
- The Cherry Grove dredging project has been an identified need in North Myrtle Beach planning documents for several years. It is highlighted within the Natural Resources Element and describes the need to take protective measures for limiting and mitigating any negative impacts to sensitive marsh areas.
- Tree preservation was cited as a priority issue in the Natural Resources Element. Tree planting can provide excellent stormwater management benefits by intercepting rainfall and slowing down stormwater runoff rates. Trees help to reduce erosion and are particularly beneficial in stabilizing shoreline areas. North Myrtle Beach has been very proactive by creating a Tree Planting Master Plan in 1999 and adopting tree preservation standards into the Zoning Ordinance in 2002. Most recently in 2009, the City enacted a complete streets policy, which requires the planting of new trees along street corridors within newly developed areas. North Myrtle Beach has participated in the Tree City USA program since 2006 and has established a Tree City Board to oversee this program and other tree preservation and planting initiatives.
- The ocean outfall program was cited within the Natural Resources Element and includes the proposed outfall location at 18th Ave North, which is described in greater detail later in this element.
- One of the stated goals within the Natural Resources Element is: "Protect the City's sensitive natural areas, wetland habitats, and ecological diversity". A corresponding strategy to meet this goal is to hire a consultant to perform a natural resources and water quality study of Cherry Grove Marsh to determine methods to restore water quality and protect shellfish beds. This watershed plan for Hog Inlet and Dunn Sound Creek is a major step in meeting this stated goal for the City of North Myrtle Beach.
- A recommendation outlined in both the Natural Resources Element and the Priority Investment Element is to develop a Special Area Plan for Little River Neck. The goal of the study would be to ensure that future development in this area is carefully planned to accommodate new development while preserving the unique natural and cultural resources within this area. This watershed plan supports sustainable development practices along Little River Neck with a particular focus of ensuring the water quality in the adjacent marsh areas in Hog Inlet and Dunn Sound Creek are protected.
- An implementation strategy highlighted within the Community Facilities Element is to implement low impact development techniques to improve water quality.

B. Horry County Comprehensive Plan

The Horry County Comprehensive Plan identifies several planning related issues within the watershed plan focus area or that pertain to concerns outlined in this plan. The following is a summary list of issues and corresponding recommendations documented in the Horry County Comprehensive Plan:

- In the Natural Resources Element, degraded water quality within the salt marsh areas of Cherry Grove was recognized as a concern. Shellfish harvesting restrictions near Waties Island and Cherry Grove were specifically mentioned.
- Septic tank suitability is identified as a countywide problem. Approximately 88 percent of Horry County has severe limitations for septic tank absorption fields due to soil drainage and other site conditions. Note that site scale evaluation should be conducted to determine septic tank suitability for individual properties.
- Urban forestry efforts are encouraged as one strategy to help control stormwater runoff along with several other benefits. On the county level, a Tree Preservation and Landscape Buffer Ordinance is in place to protect mature trees across the county.
- Several goals and implementation strategies that were developed to protect water resources in Horry County are outlined throughout the Comprehensive Plan.

IV. Pet Waste Campaigns

The City of North Myrtle Beach is very proactive in addressing improper pet waste disposal in the community. As of August 2016, the City of North Myrtle Beach has installed and maintains 48 pet waste stations throughout the city. In addition, the city has enacted an ordinance requiring pet owners to properly remove waste from public property.

Figure E-3 Pet waste station in a prominent and convenient location in Heritage Shores Nature Preserve Park

V. Stormwater Infrastructure Projects

The City of North Myrtle Beach Public Works Department and the Horry County Stormwater Department have displayed innovative leadership implementing their MS4 permit programming within their respective communities. In addition to meeting the basic requirements of their MS4 permit, they have invested in significant infrastructure projects to improve both drainage and water quality in several locations, including many within the Hog Inlet and Dunn Sound Creek watershed. Below is a profile of some of the work projects completed or in progress to date.

A. Pervious Surface Parking Lots

Parking facilities are a priority public infrastructure need within the watershed, particularly in the Cherry Grove Beach area, where visitors seek convenient access to the beach. As a means to reduce stormwater runoff rates and volumes while still meeting the parking demand along the oceanfront, the City of North Myrtle Beach has installed several pervious parking lots to enable stormwater to infiltrate onsite. North Myrtle Beach has utilized pervious concrete, brick paver, and coquina, all proven materials, at these parking locations. **Table E-1** lists the locations and materials used for each of the pervious parking lots within the Cherry Grove area. The City of North Myrtle Beach has also invested in street sweeping vehicles and maintains a regular schedule for sweeping roadways and public parking lots.

Figure E-4 Pervious concrete pavement at a beach access parking lot at 53rd Ave North and Ocean Blvd.

Table E-1: Pervious Parking Lot Locations in the Cherry Grove Beach Area	
Location	**Material**
Heritage Shores Nature Preserve Parking lot- 53rd North & Boat Ramp	Brick Paver
53rd North & North Ocean Boulevard	Brick paver entrance and pervious concrete parking stalls
27th North Oceanfront	Brick paver walkway and brick paver golf cart parking area
2108 Ocean Park	Brick pavers between sidewalks in the park
Spring Street & 21st North	Brick paver entrance & brick paver parking stalls
12th Avenue North Street end	Coquina parking lot
13th Avenue North Street end	Coquina parking lot
14th Avenue North Street end	Coquina parking lot
15th Avenue North Street end	Coquina parking lot
16th Avenue North Street end	Coquina parking lot
17th Avenue North Street end	Coquina parking lot
18th Avenue North Street end	Coquina parking lot
Note: This list only includes the parking lots located within the Cherry Grove Beach area. North Myrtle Beach has installed 23 pervious parking sites across the entire city.	

B. Ocean Outfall Projects

A much larger scale project along the North Myrtle Beach coast involves diverting stormwater outfalls, which historically have discharged near the immediate shoreline of the beach areas, to a larger outfall device extending 1,300 ft offshore. Long-range capital improvement plans include diverting stormwater from a series of ponds within the Surf and Beach Club development to a new ocean outfall structure replacing the existing outfall at 18th Ave North. Currently these ponds drain into Hog Inlet near Sea Mountain Hwy and Duffy Street. This will reduce significant volumes of stormwater runoff from the southern reaches of the estuary. Each outfall structure is equipped with devices to contain sediment and debris as well as kill bacteria before discharging the stormwater. Further details of this project including estimated costs and timeframes is discussed in **Element F: Recommended Watershed Management Measures.**

VI. South Carolina Onsite Septic System Regulations

As assessed in **Element C: Fecal Coliform Source Identification**, septic systems are a potential source of bacteria within the Hog Inlet and Dunn Sound Creek watershed. The state of South Carolina enacted regulation 61-56- Onsite Wastewater Systems in 1976 to prevent public health hazards and protect local water quality in areas where public wastewater facilities are not available. The regulation includes a number of conditions on the placement and utilization of septic systems to ensure that domestic wastewater is properly treated and disposed of into the environment. Horry County and North Myrtle Beach need to work with SC DHEC to properly administer and enforce septic system regulations within the watershed.

VII. North Myrtle Beach Sanitary Sewer System

As highlighted in **Element C: Fecal Coliform Identification**, the installation and expansion of the sanitary sewer system throughout North Myrtle Beach has been a major infrastructure investment providing both public health and environmental benefits to the region. Sanitary sewer was initially installed in the Cherry Grove Beach area in 1975. Incremental extensions have occurred along the Little River Neck Road corridor ever since. Wastewater collected from businesses and residences within the Cherry Grove and Little River Neck Road area are transported via a system of gravity and force sewer main pipelines and pump stations to the Ocean Drive Wastewater Treatment Plant for final treatment and discharge. Extending the sanitary sewer to portions of Little River Neck Road and connecting residences with poorly performing septic systems will continue to be an important strategy in water quality protection efforts within the Hog Inlet and Dunn Sound Creek watershed.

The next element outlines recommendations to continue these best management practice efforts, examine ways to improve upon current activities, and explore new opportunities to further water quality protection accomplishments in the Hog Inlet and Dunn Sound Creek estuaries.

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Element F: Recommended Watershed Management Measures

Improving water quality within Hog Inlet and Dunn Sound Creek will require proactive and creative management practices amongst a multitude of stakeholders, both public and private. This element outlines recommended strategies to consider implementing in the watershed. The set of recommendations included in this element were developed based on the existing conditions observed in the watershed by the planning team as well as an analysis of the available SC DHEC water quality data reviewed in **Element D**. Findings from the microbial source tracking study conducted in the fall of 2016 were also helpful in determining appropriate management strategies to employ in various locations throughout the watershed.

This element is structured to distinguish various types of Best Management Practices as well as highlight considerations that need to be evaluated during BMP selection. The first section of this element outlines each of these key factors. In the second half of the element, specific BMP recommendations are outlined with notes evaluating the key factors that should be addressed during the implementation process.

I. Best Management Practice Location

One of the basic variables in Best Management Practice implementation is locating them within the watershed. A simple distinction is whether a BMP can be applied watershed-wide or if a particular BMP is site specific. The distinction is explained in further detail below:

Watershed-wide BMPs: These recommendations can apply to the entire watershed or at least a large portion of it. As an example, a goal could be to reduce pet waste as a source of bacteria. A possible implementation measure could be to increase public awareness regarding the water quality concerns related to pet waste in sensitive shellfish habitats such as Hog Inlet and Dunn Sound Creek. If implemented, the BMP measure would apply across the entire watershed. Another example could be to encourage property owners to install rain barrels at their place of residence or business to help reduce stormwater runoff volumes from their properties. An activity could be to host community workshops where attendees could purchase a rain barrel at a significantly reduced price. Technically, this BMP example would not apply across the entire watershed as there are very few buildings on Waties Island; however for the purposes of this watershed plan, this classification will be used as it could be applied across a large portion of the Hog Inlet Dunn Sound Creek watershed.

Site Specific BMPs: Many BMPs target site-specific locations within a watershed where an identified source of bacteria is present, a unique opportunity exists, or siting requirements limit the number of available locations to implement a particular type of BMP. As an example, a BMP recommendation to connect known failing septic systems to the centralized sewer system would obviously be limited to the street or building where the need is identified. An additional BMP example is to establish a shellfish restoration site within the estuary. Candidate sites will need to be prioritized based on a number of factors including access, marsh vegetation, hydrology, expectations of long-term benefit, etc.

II. Structural Best Management Practices vs. Non-Structural Practices

Effective watershed management involves all types of innovative strategies. Two broad categories of BMPs are described below.

Structural Best Management Practices: This category of management strategies are typically physical infrastructure devices or practices. Sometimes they can be stand-alone BMPs or be a sequence of BMPs within a larger drainage basin.

Non-Structural Best Management Practices: This category of management strategies focuses more on community level policy changes or public outreach efforts intended to change behavior or influence action to improve water quality. An example of a non-structural BMP would be to enforce a pet waste ordinance.

Oftentimes, the implementation of structural BMPs can be encouraged by the use of non-structural BMP mechanisms. As an example, a local government can encourage homeowners to install a BMP device such as a rain barrel by reducing their annual stormwater fees for a specified period of time.

III. Barriers to Implementation

With any watershed improvement project or activity there may be factors that must be addressed to ensure successful implementation. The following is a list of common constraints that may influence the feasibility of various BMP ideas.

Installation Costs: Stormwater and sewer utility infrastructure projects can entail significant capital costs. The long-term value to the direct beneficiaries and the community at large must justify the expense. It can be helpful to identify multiple reasons for a proposed project besides just water quality improvements. As an example, connecting sewer to residences with failing septic systems can eliminate a public health risk and improve the quality of life for those directly benefitting. In many cases, strong evidence from available water quality data can also enhance the merit of a proposed infrastructure project. When comparing one BMP alternative with another, the long-term costs associated with the project must be accounted for.

Maintenance Burden: Once a BMP is installed, resources may still be needed to ensure that it is being regularly maintained and functioning properly. Before installation is finalized, it should be clear as to who the maintenance responsibility falls on. If it is the local government, then funding should be included in the annual stormwater department budget. Stormwater department staff should be certain that recurring costs should be properly budgeted for if the proposed BMP will require an expensive specialized piece of equipment to maintain the BMP. Appropriate training should be offered to homeowners associations or individual homeowners who bear the responsibility of BMP maintenance.

Property Access/ Owner Agreements: Oftentimes the ideal location for a structural BMP is on private property or land owned and maintained by a state agency such as SC DOT. These circumstances will require a property easement which will likely require proactive communication with the property owner. A full explanation as to the purpose of the project and the extent of the area to be used for the BMP should be provided. Property owner willingness will inevitably vary, therefore identifying multiple alternative sites can be helpful if the preferred site becomes unfeasible. Since roadway corridors are common locations for stormwater management devices, a partnership with SC DOT should be pursued to ensure that necessary encroachment permits are obtained in a timely manner.

Site Limitations: As part of the due diligence of implementing any structural BMP, evaluating site conditions such as soil type, seasonally high water table level, and drainage patterns is critically important. The effectiveness of several different types of stormwater BMPs varies considerably depending on these factors.

Public Acceptance: A desired outcome of the planning process is to generate public interest and concern with water quality issues facing Hog Inlet and Dunn Sound Creek. Many of the BMPs included in the watershed plan require some level of public participation or buy in. The public survey distributed at the beginning of the planning process indicated that the respondents did support efforts to improve water quality, however willingness to support individual BMPs varied considerably. Utilizing this information, some BMPs might require further public outreach and education in order to garner the necessary support.

Partnership Commitments: Most, if not all, of the BMPs recommended in this watershed plan require some level of partnerships in order to come to fruition. Diverse stakeholders can contribute a variety of resources to a project including local knowledge, scientific expertise, volunteer time, available property, funding, etc. Therefore, it is important from the outset to determine what partnerships are needed for a project to commence and be sustainable.

IV. Implementation Timeframes

The management strategies outlined in this element each require their own specific partnerships and resources in order to be implemented in the watershed. For some initiatives, many of the resources already exist or are easily available. All that is needed is a committed lead entity to ensure that the effort is being executed and monitored. Other strategies entail more extensive capital improvement projects requiring larger funding sources. These types of projects may take up to ten years or longer to fully implement. Although the proposed "long-range" projects may seem like an unlikely wish list, documenting the project need in planning processes such as this one is a key initial step in obtaining the necessary support to having these projects come to fruition. Horry County and North Myrtle Beach should consider incorporating projects recommended in this watershed plan into future updates of their respective Capital Improvement Plan and Comprehensive Plan processes.

Immediate- Within three years: BMPs that can be implemented in this timeframe generally have few barriers to implementation and the resources such as funding, and/or committed partners, are reasonably available. BMPs that can be implemented within a short period of time following the adoption of the plan help to generate momentum for implementing other recommendations included in this watershed plan. These BMPs can also serve as demonstration sites providing public education opportunities on the purpose of each device and how it relates to the overarching goals of the watershed plan.

Intermediate- 3-5 years: In an ideal world, all of the BMPs recommended in this watershed plan would be started and finished within a few years. In practicality, implementation resources are not unlimited and many factors need to be addressed before a project can move forward. Providing realistic timeframes on each BMP recommendation is important in order to avoid false expectations when advocating for various watershed management strategies. Often, projects that can be completed in an intermediate timeframe may be relatively simple in scale and design but still require an allocation of funds, committed partners, and identified suitable sites.

Long-Range- Over 5 years: These BMPs are often very large in scale and entail significant capital investments, lengthy permitting processes, and/or widespread public support. The Cherry Grove canal dredging project is a prime example of a long-range project.

The next section outlines BMP strategies aimed at reducing bacteria loads entering Hog Inlet and Dunn Sound Creek or provide indirect benefits that will help improve the overall ecological health of the local estuary.

V. Watershed Wide Best Management Practices

The following section outlines best management practices that can and should be encouraged across the entire watershed. Most of them involve public education and outreach initiatives designed to influence individual behaviors and actions to protect the watershed.

Recommendation F-1: Increase efforts to discourage people from feeding birds and wildlife. Feeding wildlife can attract large populations of animals to urbanized portions of the watershed, where stormwater runoff can exacerbate the transport of bacteria sources into the estuary. Appropriate signage in public parks and other areas can help deliver this outreach message.

Anticipated Timeframe: Immediate and ongoing.

Potential Barriers: Public Acceptance. Feeding birds and animals can seem innocent; however, if left uncontrolled, issues with nuisance wildlife in developed portions of the watershed can arise and contribute to bacteria sources entering the watershed. Making the general public aware of this connection between this behavior and the impact on the environment can be challenging and require creative and targeted messaging.

Recommendation F-2: Continue to make proper pet waste disposal a priority public outreach initiative by enforcing local ordinances and maintaining existing pet waste stations throughout the community. The City of North Myrtle Beach has been proactive in addressing this issue. The City of North Myrtle Beach has installed and maintains pet waste stations at 48 locations across the community. Pet waste should be one of the most preventable sources of bacteria affecting water quality in the estuary.

Anticipated Timeframe: Continue existing efforts.

Potential Barriers: Maintenance of disposing and refilling bags at each pet station. Also public acceptance can be an issue. Outreach initiatives should be highly visible and focus messaging on the link between dog waste and the fecal coliform bacteria impairments within the estuary. Messaging should also be directed towards visitors to the area who likely have less familiarity with coastal ecological issues including water quality threats to local shellfish areas.

Recommendation F-3: Work closely with Horry County Animal Control Center and nearby animal shelters, such as the Humane Society of North Myrtle Beach, to periodically assess known areas with feral cat populations. As needed, pursue a spay-neuter and release program with the assistance of grant programs such as Petsmart Charities to ensure that feral cat populations remain level.

Anticipated Timeframe: Presently, feral cat populations are stable; however, this is a common issue along the Grand Strand. Once every three years, a general assessment should be conducted to determine if any management actions are required.

Potential Barriers: It is nearly impossible to completely eliminate feral cat colonies from urbanized neighborhoods. There are also public perception concerns related to managing colonies without harming individual cats. Spay, neuter and release programs have shown to be a humane and effective way to manage feral cat populations.

Recommendation F-4: Initiate a campaign to encourage property owners to secure their trash cans and dumpsters. In a windshield survey of the watershed at the beginning of the planning process it was evident that a large percentage of dumpsters were unsecure. This can attract nuisance wildlife such as raccoons and opossums in large groups. Dumpsters are typically located in parking lots or side streets which commonly experience runoff conditions following a storm event. These dumpster sites can easily become a source of bacteria if nuisance animals are frequently congregating in and around them. Stakeholder groups to contact and work with on this initiative include homeowner and property associations, particularly at high density condominium complexes, commercial businesses, and various municipal departments.

Figure F-1: Open and unscreened dumpsters can attract nuisance wildlife. Dumpsters are often located in parking lots with extensive impervious surfaces. As a result, dumpster sites can become sources of bacteria. While individually small, cumulatively can be an issue across the watershed.

Anticipated Timeframe: Immediate and ongoing. It will take a full year of concerted effort to identify and make contact with each entity in this targeted stakeholder group. In order for the campaign to be effective, periodic reminders perhaps once a year would be helpful.

Potential Barriers: Partnership commitments. With such a large inventory of dumpsters and trash cans throughout the watershed, it is difficult to reach out to all of the relevant contacts to make this campaign successful. An appropriate strategy could be to approach one targeted group at a time.

Recommendation F-5: Promote the installation of rain barrels and cisterns on private residences and businesses. Investigate strategies to distribute rain barrels at a discounted price. Target willing and interested audiences such as Keep North Myrtle Beach Beautiful volunteers or homeowners associations. Rain barrels are a simple and effective means of reducing stormwater runoff volumes from an individual property. The more rain barrels installed across the watershed the greater the cumulative impact.

Anticipated Timeframe: Immediate and periodic.

Potential Barriers: Partnership commitments. The key to success in implementing this recommendation will depend upon a commitment from a vendor which will supply the rain barrels at an attractive price point. In addition, these programs draw more attention when spotlighted at a public event and/or with endorsement and support of homeowners associations which can provide the pertinent details directly to the residents.

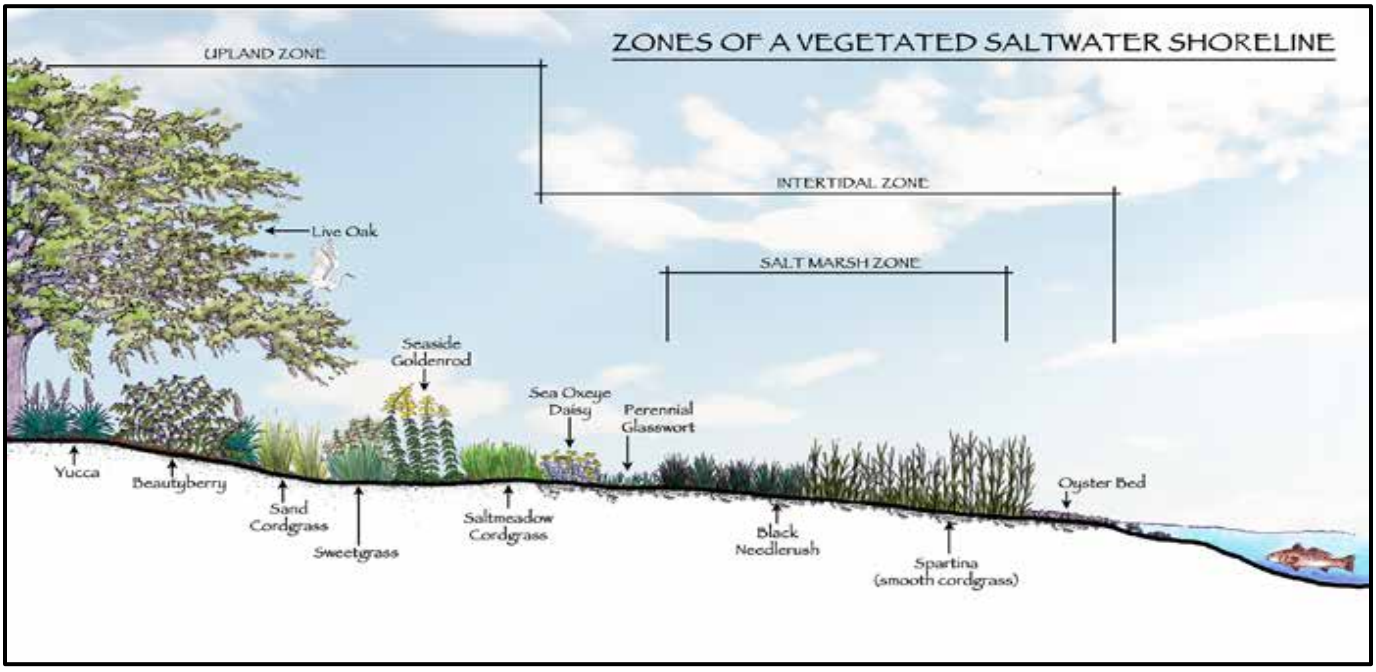
Figure F-2 Typical rain barrel setup for a small to medium sized residential building or a small commercial building.

Recommendation F-6: Consider regulatory and/or incentive based strategies to encourage property owners to establish a vegetated buffer along estuary shorelines as well as stormwater ponds and ditches. Vegetated buffers

help stabilize shorelines and decrease erosion. If the buffer is wide enough it can help filter stormwater prior to discharge into the receiving waterbody or stormwater pond. A well established buffer can also discourage waterfowl from congregating near ponds, thereby reducing the potential of essentially a direct source of bacteria into the estuary.

Anticipated Timeframe: Intermediate

Potential Barriers: Public Acceptance. In the real estate, restaurant, and accommodations markets, there is a high demand for waterfront properties. There are inherent challenges in convincing property owners to establish a vegetated buffer if there are perceptions that the waterfront views will be detracted or direct water access would become limited. There is also a perception that vegetated buffers are themselves unattractive. Property owners should be educated that proper design and alternative plant options can enhance the visual appeal of the shoreline site. Below is an illustration from Clemson University Extension Service depicting a healthy shoreline along a saltwater marsh habitat.



Recommendation F-7: Utilize resources of the City of North Myrtle Beach's Tree City USA program to strategically locate native trees and shrubs in areas that provide optimal stormwater management benefits or stabilize erosion near estuary or pond shorelines. Create an inventory of tree plantings and develop a 5-10 year plan of areas within the watershed to prioritize for new plantings.

Anticipated Timeframe: Intermediate and periodic.

Potential Barriers: Installation costs and maintenance burden. There are expenses involved with purchasing street trees and allocating staff time to oversee a large-scale urban forestry program. The ideal approach would be to make incremental investments and seek out grant opportunities to supplement the Tree City USA program.

VI. Site Specific/ Neighborhood Scale BMPs

The following section outlines best management practices that are intended to be implemented in specific locations within the watershed. Many of the recommendations focus on infrastructure improvements and habitat restoration projects. The catchment area(s) where the BMP is proposed is indicated under each recommendation.

A. Sanitary Sewer Extension

The majority of the commercial corridors and residential neighborhoods in the Hog Inlet/ Dunn Sound Creek watershed are connected to the North Myrtle Beach sanitary sewer system. The most recent force main sewer line extension made sanitary sewer available along Little River Neck Road to as far as the Myrtle Beach RV Resort. Several existing buildings and neighborhoods along with recent new developments have connected to the sanitary sewer system. However there

remain several buildings and streets in that area that have not connected to the main sewer line on Little River Neck Road. While sewer service is provided throughout the Cherry Grove Beach area, it is suspected that there may be a few isolated houses that never connected to the system and still rely on their own onsite septic system. Further investigation may be warranted to identify which residences in this area are not connected to the sewer system and work with the property owners to explain available options.

Recommendation F-8: Continue efforts to connect residences to North Myrtle Beach's centralized sanitary sewer system particularly along Little River Neck Road. Seek funding sources such as Community Development Block Grant (CDBG) or 319 Grant programs that may assist those who cannot afford the connection costs. If connecting to the sanitary sewer system is not feasible, explore other options such as septic system repair or replacement.

Anticipated Timeframe: Intermediate. It will likely take longer than 3 years to connect most of the candidate residences and businesses to the sanitary sewer system, however this effort should commence within 3 years with substantial progress achieved within 5-10 years.

Potential Barriers: Installation costs, public acceptance, property owner agreements.

Catchment Areas: Hill Street, Little River Neck-Marsh Side, Little River Neck- Waterway Side.

Recommendation F-9: Inventory residences within the Cherry Grove Beach area that still rely on a septic tank. Discuss costs and benefits of connecting to the sewer line or options to upgrade septic system with property owners of identified residences.

Anticipated Timeframe: Intermediate. Fortunately the microbial source tracking study revealed that no significant human sources bacteria were suspected in Cherry Grove. However, to completely eliminate the potential source, action should be taken as failing septic systems are encountered.

Potential Barriers: Installation costs, property owner agreements.

Catchment Areas: East Cherry Grove, and to a lesser degree Sea Mountain Hwy to 11th Ave. North.

Recommendation F-10: Continue maintaining the existing sanitary sewer system to ensure all components including pump stations and sewer lines are structurally sound and properly functioning.

Anticipated Timeframe: Immediate and ongoing. Regular inspection and maintenance of the entire sanitary sewer system should continue. A phased upgrade schedule should be implemented to replace older components within the sewer network.

Potential Barriers: Operation and maintenance costs. While ongoing maintenance can entail significant operational funds, the costs of responding to unanticipated malfunctions can be much more costly.

B. Septic System Management

It is possible that a fair percentage of the properties served by onsite septic systems have suitable site conditions for an onsite septic system and have no immediate need to connect to the sanitary sewer system. However, these property owners still have a responsibility to regularly inspect and properly maintain their septic systems. Below are recommendations on how North Myrtle Beach and Horry County can assist homeowners with ensuring that their septic systems are functioning properly.

Recommendation F-11: Inventory properties known to have existing septic systems and conduct preliminary site analysis on septic tank suitability based on soil types and water table level. Conduct periodic workshops with property owners demonstrating how septic systems function and provide guidance on inspecting and maintaining septic systems. Share information regarding who to contact if the system begins malfunctioning, and resources available to replace the septic tank or connect to the centralized sewer system.

Anticipated Timeframe: Immediate and ongoing.

Potential Barriers: Public acceptance and installation costs associated with septic system replacement or connection to sewer system.

Catchment Areas: Hill Street, Little River Neck- Marsh Side, Little River Neck- Waterway Side.

Recommendation F-12: Develop a comprehensive incident response plan to address occurrences of known septic system failure. Provide the public with a mechanism for reporting septic system complaints within their neighborhoods. Utilize a combination of enforcement strategies and incentive tools to remediate failing septic systems. As part of an assessment of each individual residence, inspect all plumbing fixtures for leaks which may be resulting in a higher than normal loading rate on the septic system drain field.

Anticipated Timeframe: Dependent upon receipt of complaints of failing septic systems.

Potential Barriers: Remediation costs, especially if the number of failing septic systems discovered is very high.

Catchment Areas: Hill Street, Little River Neck- Marsh Side, Little River Neck- Waterway Side.

C. Stormwater Infrastructure Improvements

As discussed at length in **Element C**, the predominant transport mechanism for bacteria entering the estuary is via stormwater runoff. Continued growth is anticipated in the watershed area, particularly along Little River Neck Road. As stormwater management technologies have advanced, implementation of LID principles should be encouraged and opportunities for retrofitting areas with conventional stormwater infrastructure should be evaluated.

Recommendation F-13: Construct an ocean outfall to divert stormwater entering the estuary at Sea Mountain Hwy near Cecelia St. offshore. The outfall would divert stormwater primarily from the Surf Golf and Beach Club as well as a portion of Sea Mountain Hwy. The Hog Inlet Microbial Source Tracking Study indicated a strong correlation between bacteria levels and freshwater inputs during wet weather events at the SMH sampling site.

Figure F-3 View of the sediment box and piping of the shoreline section of an ocean outfall project in Myrtle Beach. The large scale nature of this type of stormwater infrastructure project entails significant capital costs.

Anticipated Timeframe: Intermediate. This project is currently on the City of North Myrtle Beach's capital improvements plan and is scheduled to commence within 2-3 years.

Potential Barriers: By far the biggest hurdle is the capital costs necessary to construct the outfall**.**

Catchment Areas: Sea Mountain Hwy to 11th Ave North, and a portion of East Cherry Grove

Recommendation F-14: Identify candidate stormwater ponds for the installation of floating wetland devices. Floating wetlands have become more widely accepted stormwater management practices, providing many water quality benefits including reduction in nutrient levels, total suspended solids, and pathogenic bacteria. They also provide habitat for aquatic species. Many of the ponds within the watershed have brackish waters making plant selection for the floating wetland device challenging. The 39th Ave North pond could serve as a good demonstration site to help determine widespread applicability throughout the watershed.

Anticipated Timeframe: Intermediate.

Potential Barriers: Site limitations, installation costs, and maintenance requirements**.** The biggest initial hurdle is determining whether the brackish nature of many of the stormwater ponds are suitable for the installation of a floating wetland. A demonstration site would help managers determine design considerations and appropriate plant selection prior to widespread application of floating wetland BMPs in the future.

Catchment Areas: Initially, pursue the installation of a floating wetland at the 39th Ave N pond as a demonstration site, which is located in the East Cherry Grove catchment area.

Figure F-4 Example of a floating wetland stormwater BMP application.

Recommendation F-15: Utilize available mechanisms to continue installing pervious surface parking lots and streets throughout the watershed. As a long-term goal, install pervious pavement on the last 50-100 ft sections of each of the dead end streets in the Cherry Grove Beach area. The drainage system within the Cherry Grove Beach area does not have a conventional curb, gutter, and drainage ditch storm sewer system. Instead, during storm events, precipitation runs off as sheet flow across the landscape, particularly along impervious surfaces. By retrofitting the dead end streets with pervious pavement, stormwater runoff would have a better chance of infiltrating into the ground surface prior to reaching the estuary shoreline.

Anticipated Timeframe: Long-term.

Potential Barriers: Installation costs.

Catchment Areas: East Cherry Grove, Seas Mountain Highway, Hill Street, Little River Neck- Marsh.

Recommendation F-16: Work with property owners who keep livestock on their land to ensure that sources of bacteria from agricultural runoff are minimized. Provide consultation to interested property owners on Best Management Practice techniques and seek grant assistance for implementation strategies that may entail upfront capital costs.

Anticipated Timeframe: Intermediate.

Potential Barriers: Installation costs, property owner agreements.

Catchment Areas: Primarily Little River Neck- Marsh and Little River Neck- Waterway.

Recommendation F-17: Work with the Army Corps of Engineers to investigate the possibility of opening a second ocean inlet through Cherry Grove. Historically, there was an inlet between 39th Ave N and 42nd Ave N in Cherry Grove. The inlet closed as a result of natural hydrological processes and major tropical storm events, most notably Hurricane Hazel in 1954. The Army Corps of Engineers oversees restoration projects such as this one through the Section 206 Aquatic Ecosystem Restoration and the Estuary Restoration Act programs. Details about this funding source are provided in **Element H**. Restoring the second ocean inlet site at this location would improve the daily tidal circulation of the southern half of Hog Inlet. This daily flushing of high salinity ocean water would likely help lower fecal coliform levels especially in the upper reaches of the estuary.

Anticipated Timeframe: Long-term.

Potential Barriers: Installation costs, site design.

Catchment Areas: East Cherry Grove.

D. Oyster Reef Restoration

Studies have shown that there has been a loss of 85% of oyster reef habitats throughout the world over the past century. Product demand and coastal landscape changes along the South Carolina coast have put local oyster reef habitats at risk as well. There are many benefits to protecting the oyster reef habitats that exist in Hog Inlet and Dunn Sound Creek and identifying areas within the estuary that would be prime candidate sites for restoration. Oyster reefs help to stabilize shorelines, filter the water column, and serve as a critical nursery area for other marine species. Below is an overview of two programs in our region that can provide resources needed to pursue local initiatives in Hog Inlet and Dunn Sound Creek.

Coastal Oyster Recycling and Restoration Initiative (CORRI): Supported by Coastal Carolina University faculty and students, CORRI is an innovative partnership-based program designed to collect recycled oyster shells and then utilize the shells to reestablish oyster reefs in our regional estuaries. Since the program was initiated in 2013, CORRI has established oyster reef restoration sites in six tidal creeks throughout the Grand Strand including one in Hog Inlet. The success of the program is contingent upon a commitment from participating restaurants to separate the oyster shells from the rest of their daily waste stream. The program also relies on volunteers to bag the collected shell and assist on work days to place the shell at the selected restoration site.

SC DNR, SC Oyster Restoration and Enhancement Program (SCORE): SC Department of Natural Resources (SC DNR) manages a similar volunteer based program across coastal South Carolina. There is an oyster shell collection trailer located off of Sea Mountain Hwy where residents, visitors, and businesses can drop off their used shell, which is then used for future restoration sites. SC DNR has established 40 restoration sites throughout the state since 2001, however no sites have been located in Hog Inlet/ Dunn Sound Creek.

Figure F-5 Volunteer group working with the CORRI program to place bagged recycled oyster shells in Hog Inlet to restore the oyster reef habitat in this part of the estuary.

Recommendation F-18: Create partnerships with local restaurants and seafood businesses to establish a shellfish recycling program in the greater Little River/ Cherry Grove area. Through the recycling program, raise public awareness regarding the ecological role of oyster reefs in salt marsh habitats and the need to protect and restore local reefs.

Anticipated Timeframe: Immediate and ongoing. An oyster shell recycling program would be a highly visible initiative that would help garner attention to other aspects of the watershed planning effort. It might take five or more years for the recycling program to reach its maximum potential but it should be manageable to begin the initial steps of formalizing commitments within the first two years of the adoption of this watershed plan.

Potential Barriers: Partnership Commitments. This effort is highly dependent on commitments from restaurants and seafood markets/grocers to recycle oyster shells.

Recommendation F-19: Work with oyster reef ecology experts at Coastal Carolina University and other resource agencies such as SC Department of Natural Resources to identify appropriate restoration sites within Hog Inlet and Dunn Sound Creek. Recruit volunteers and schedule restoration work days on a yearly basis if possible. Work with the SC DNR SCORE program to establish a restoration site in Hog Inlet and Dunn Sound Creek especially if the oyster shell drop off trailer is being actively utilized.

Anticipated Timeframe: Intermediate and ongoing. Efforts between the CORRI program and the SCORE program should be coordinated. Restoration site selection should also factor in the oyster reef and marsh restoration project that is planned as part of the Cherry Grove canal dredging project mitigation agreement.

Potential Barriers: Partnership commitments and site limitations. An active dialogue between representatives from SCORE and CORRI will help to ensure that available resources are maximized and well coordinated. Restoration site selection is dependent upon adequate access and suitability in terms of tidal flow and established shoreline areas.

Recommendation F-20: As SC DHEC monitoring stations indicate that fecal coliform water quality standards are being attained, petition SC DNR to maintain shellfish beds within Hog Inlet and Dunn Sound Creek as state shellfish grounds for recreational harvest only. A consensus sentiment amongst public stakeholders during this watershed planning process was that the best strategy to ensure long-term sustainability of the oyster reef resources would be to limit commercial harvest and carefully permit recreational harvest. This would help preserve the cultural value of the oyster beds to the residents of the Cherry Grove/ Little River Neck area and position the community for ecotourism benefits associated with recreational shellfish harvesting opportunities.

Anticipated Timeframe: Intermediate. The formal petition to SC DNR is dependent upon the attainment of the water quality standards at the SC DHEC monitoring stations. As water quality trends improve, a dialogue between local watershed stakeholders and representatives from SC DNR's Shellfish Management Program should commence.

Potential Barriers: Public Acceptance. While there is initial public support to have the shellfish beds and Hog Inlet and Dunn Sound Creek designated as state shellfish grounds, sustained leadership and advocacy will likely be necessary to ensure that the designation request is granted by SC DNR.

The next element highlights additional Best Management Practices that focus on public outreach initiatives to educate residents and visitors on water quality issues concerning the Hog Inlet estuary and engage them in stewardship activities to preserve local natural resources.

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Element G: Public Outreach and Education Resources

A major point of emphasis throughout this plan is to convey to all stakeholders that in order to improve water quality in Hog Inlet and Dunn Sound Creek, a multifaceted management approach must be pursued. With that in mind, everyone that visits, lives, or works in the watershed has a role to play in achieving successful outcomes towards this ultimate goal. This element profiles organizations that can provide resources to assist with public outreach and educational efforts in the community. This element also provides specific guidance on various stakeholder groups where targeted messaging or outreach could improve the desired reach. Finally, a list of specific recommended public outreach and education strategies is outlined, focusing on the roles that the public can play in improving water quality within the Hog Inlet and Dunn Sound Creek watershed.

I. Public Education Resources

Below is a list of local and regional organizations that can provide resources needed to develop an effective public outreach and education program:

A. Keep North Myrtle Beach Beautiful: Supported by the North Myrtle Beach Parks and Recreation Department, a local chapter of Keep America Beautiful is engaged in education programs and stewardship activities to enhance the environment and quality of life in the North Myrtle Beach community. There are several opportunities for residents to get involved with Keep North Myrtle Beautiful, a few of which are outlined below:

- Keep North Myrtle Beach Beautiful organizes numerous clean up events at different times during the year. In the spring, the city participates in the Great American Cleanup, known as the largest community improvement program in the nation. Each September, a Beach/Creek litter sweep event is held as part of South Carolina's largest one-day volunteer cleanup, now in its 28th year.
- Keep North Myrtle Beach Beautiful maintains an Adopt-a-Park or Beach Access program which assigns volunteer groups to a location that is to be cleaned up twice a month in the summer and once per month through the remainder of the year.
- Keep North Myrtle Beach Beautiful has a strong partnership with five local schools to establish a Keep America Beautiful Kids youth affiliate. An after school club meets monthly to organize various educational and volunteer activities at their respective schools and in the community.

B. Keep Horry County Beautiful: Horry County also has a very active local chapter of the Keep America Beautiful Program. Coordination of activities between each chapter might be beneficial to maximize resources and end results. The Keep Horry County Beautiful chapter has a Community Cleanup Program which engages local organizations and citizen groups in regular cleanup events at designated areas. Organizing a cleanup group in the Little River Neck area would be worth pursuing. Several respondents to the watershed plan survey indicated the presence of significant litter along Little River Neck Road.

C. Coastal Waccamaw Stormwater Education Consortium (CWSEC): In 1999, the US EPA expanded the Municipal Separate Storm Sewer System (MS4) permit program to a second phase requiring approximately 6,700 smaller urbanized areas to obtain NPDES permit coverage for their stormwater discharges. North Myrtle Beach and the urbanized portions of Horry County along with several other coastal communities within the Grand Strand area were included under the MS4 Phase II program at that time. There are six minimum control measures that permittees must address with a heavy emphasis on public education and involvement. In an effort to maximize the efficiency and regional impact of these efforts, the CWSEC was formed in 2004

with support from Atlantic Beach, Surfside Beach, Conway, Myrtle Beach, Briarcliffe Acres, Georgetown County, Horry County, and North Myrtle Beach. Today, the CWSEC maintains a website, http://cwsec-sc.org/ providing information about stormwater related issues and news and events within the Grand Strand region. The Consortium also works with the participating jurisdiction members, as well as regional education provider partners, to plan and coordinate events and activities based on needs and issues identified by the Consortium. The CWSEC is a valuable resource to utilize as public education strategies are identified in the Little River Neck and Cherry Grove Beach communities.

D. Carolina Clear: A public service initiative of Clemson University, the mission of Carolina Clear is to educate communities about the significance of South Carolina's water resources and the role they play in the state's economy, environment, and overall quality of life. Numerous public outreach campaigns and programs are organized to raise awareness of stormwater related issues with the goal to change behavior that can have a positive impact in improving water quality. Specific focus areas include:

- Training responsible entities such as homeowners associations, property management companies, and waterfront residents on maintaining community stormwater ponds. Guidance on how to prevent and address common problems such as aquatic weeds, fish kills, shoreline erosion, poor water quality and nuisance wildlife is provided.
- Carolina Yards is a popular program across the state which encourages residents to create healthy, watershed-friendly landscapes by taking simple steps such as installing rain barrels for onsite irrigation, reducing runoff, selecting native plants, and proper use of lawn fertilizers.
- The South Carolina Low Impact Development (LID) Atlas is a tool used to highlight examples of specific sites which incorporate LID techniques. The LID Atlas serves as a way to provide recognition to entities for instituting conservation measures such as LID while also providing a database of project examples that developers and property owners can refer to when considering various LID options. The LID atlas is a joint effort between Carolina Clear, National NEMO Network (Nonpoint Education for Municipal Officials) SC NEMO, SC Sea Grant Consortium, and Clemson University's Center for Watershed Excellence.

The Carolina Clear website serves as an extensive information hub with factsheets, YouTube videos, and guidance documents that make for a great starting point in learning more about water quality issues that affect the state's waterways and possible solutions that can be applied within our communities. http://www.clemson.edu/public/carolinaclear/

II. Public Survey Results

A public survey was distributed in the Spring of 2016 to gauge stakeholder knowledge of the Hog Inlet- Dunn Sound Creek watershed and their level of concerns with regards to water quality and shellfish resources within the estuary. The full results are included in **Appendix D**.

The survey, along with public meeting attendance sheets, enabled the planning team to identify the various audiences that are engaged in the planning process and prioritize their concerns as implementation efforts commence.

There were also some public outreach and education needs that became obvious in a review of the survey results. Below are a few observations from the survey with some corresponding public outreach strategies.

- Question 4 asked respondents whether they thought water quality conditions have improved or degraded over the past decade. Nearly 50% of the respondents indicated that they were unsure/don't know. During discussions at a public meeting on October 25th, 2016 attendees elaborated, stating that resources such as SC DHEC's monitoring data were not readily available, making it difficult to determine whether water quality was improving or not. This indicates that a more deliberate effort to publicize SC DHEC data and reports is warranted as an initial step in informing the public of local water quality conditions.

- Question 7 asked respondents to indicate their willingness to implement various stormwater management practices, such as rain barrels, pervious pavement, rain gardens, etc on their own private property. Over 80% of private property owners who responded to the question indicated that they either already have BMPs installed or could be interested in installing BMPs. However a large portion of these respondents mentioned that their willingness is dependent on costs and maintenance requirements. Hosting homeowner workshops could be an effective way to explain various options to consider and provide specific cost and maintenance information so that homeowners can determine which BMPs are best suited for them.

Figure G-1 Resident providing the planning team insight on observed water quality concerns within the Hog Inlet estuary.

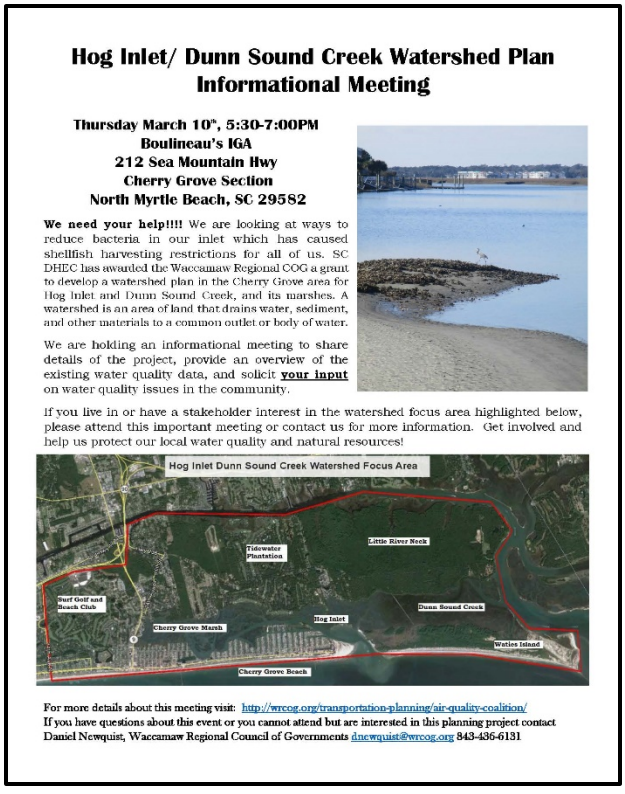
III. Targeted Outreach Messaging

The Hog Inlet/Dunn Sound Creek estuary supports numerous water-based activities attracting diverse stakeholders who value the estuary for varied reasons. There are also residents in the community who own dogs or rely on septic systems that have specific responsibilities to protect water quality within the watershed. This section spotlights different stakeholder groups within the watershed. Public outreach messaging can be tailored to each of these groups based on their typical activities or specific roles in water quality protection efforts.

A. Long-time Residents: Numerous residents who participated in our public meetings and completed our survey, indicated that they have been residents of the area for over twenty years. These residents can serve as a great resource of historical information about the estuary. Some long-time residents and visitors have intimate familiarity with the estuary and can identify changes that have been observed over time. The planning team needs to utilize the local knowledge of this stakeholder group and encourage their continued participation in future implementation activities.

B. Seasonal Residents: A large percentage of homeowners within the greater Little River Neck and Cherry Grove area are part-time residents or recent transplants from across the country. Coastal South Carolina has a unique natural environment with ecological sensitivities that may not be familiar to many residents who are not native to the region. Providing educational opportunities to this stakeholder group can help build local awareness of water quality issues and hopefully translate into continued engagement in various watershed protection activities and initiatives.

C. Local Businesses: Restaurants, seafood markets, grocery stores, and other retail shops and businesses interface with the general public every day and can be great partners in watershed planning efforts. As a small example, Boulineau's IGA in Cherry Grove Beach kindly allowed the planning team to utilize their meeting room to host two public outreach events during the planning process. Several businesses allowed the planning team to post flyers of these events in their storefront windows. Business partnerships



Hog Inlet/ Dunn Sound Creek Watershed Plan
Informational Meeting

Thursday March 10th, 5:30-7:00PM
Boulineau's IGA
212 Sea Mountain Hwy
Cherry Grove Section
North Myrtle Beach, SC 29582

We need your help!!!! We are looking at ways to reduce bacteria in our inlet which has caused shellfish harvesting restrictions for all of us. SC DHEC has awarded the Waccamaw Regional COG a grant to develop a watershed plan in the Cherry Grove area for Hog Inlet and Dunn Sound Creek, and its marshes. A watershed is an area of land that drains water, sediment, and other materials to a common outlet or body of water.

We are holding an informational meeting to share details of the project, provide an overview of the existing water quality data, and solicit **your input** on water quality issues in the community.

If you live in or have a stakeholder interest in the watershed focus area highlighted below, please attend this important meeting or contact us for more information. Get involved and help us protect our local water quality and natural resources!

For more details about this meeting visit: http://wrcog.org/transportation-planning/air-quality-coalition/
If you have questions about this event or you cannot attend but are interested in this planning project contact Daniel Newquist, Waccamaw Regional Council of Governments dnewquist@wrcog.org 843-436-6131

Figure G-2 Example of a public meeting flyer. Local businesses were very generous in distributing this to their customers.

should continue to be pursued with efforts such as oyster shell recycling, rain barrel installation, public outreach campaigns and other stormwater BMP improvements.

D. Residences with Septic Systems: Homeowners who rely on septic systems for their wastewater treatment needs should be cognizant of the potential public health and environmental risks that could occur if they are not properly maintained. Homeowners should be familiar with the exact location of their septic systems, as well as early indications of a malfunctioning system. They should also ensure that items that can clog their system or chemicals that disrupt the biological processes of a septic system are not disposed of when flushing toilets or using kitchen and bathroom faucets. As part of the inspection process, watershed managers should assist homeowners with assessing plumbing fixture leaks which may be over-taxing the septic system drain field. Finally, watershed managers need to work closely with these residents to assist them with septic system inspections, opportunities to repair or replace their systems, or connecting to the centralized sewer system at a reasonable cost.

E. Pet Owners: A common source of bacteria in most developed watersheds are household pets. It is important for pet owners to be cognizant of the connection between pet waste in the environment and the water quality implications on local shellfish resources. North Myrtle Beach has been proactive in installing pet waste stations in public areas to encourage pet owners to dispose of their pet waste properly. Responsible pet ownership is critical in minimizing this preventable source of bacteria in Hog Inlet.

F. Tourists: A challenging stakeholder group to engage with is the sizable seasonal tourist population. Collectively this stakeholder group can have a significant impact on the local environment. Families and individuals may only be visiting the area for a long weekend or a single week so the window of opportunity to convey important messaging pertaining to water quality issues in the Hog Inlet estuary is limited. The interpretive signage at Heritage Shores Nature Preserve is a great example of impactful messaging that effectively educates the public on the natural resources present within the estuary. Signage accompanying most of the pet waste stations throughout the area also conveys the importance of proper pet waste disposal in North Myrtle Beach and Horry County. Where possible, watershed managers should develop partnerships with real estate companies and other businesses who frequently interface with tourists to distribute pertinent information on local water quality issues within Hog Inlet and Dunn Sound Creek.

G. Recreational Fishermen and Boaters: These stakeholder groups are both direct users of the estuary who generally have a strong familiarity with the watershed. During the planning process, several residents recalled a time when shellfish resources were abundant and harvesting oysters was a local tradition. The interest in restoring oyster reefs within Hog Inlet appears to be very strong. These public stakeholders can be great allies in advocating for water quality improvements and assisting in future stewardship activities to protect and enhance local fishery resources. Cherry Grove Boat Landing on 53rd Ave N is a very popular boat launch with access to Hog Inlet. Signage should be prominently displayed to convey the importance of observing no wake zones in Hog Inlet. The Cherry Grove Boat Landing is a suitable site for additional interpretive signage that describes the estuary habitat and the water quality issues that impact local shellfish management.

IV. Recommended Public Outreach and Education Strategies

The following section outlines public education activities to consider as part of a comprehensive watershed management plan in the Hog Inlet-Dunn Sound Creek watershed.

Recommendation G-1: Inventory existing interpretive signs focused on natural resources within the Cherry Grove and Little River Neck area. Heritage Shores Park is an example where an effective and comprehensive interpretive sign package has been implemented. Identify other potential sites, perhaps in close proximity to pet waste stations, beach access areas, boat landings, parking lots, and other public areas. Important messaging could include oyster reef ecology and the importance of clean water quality conditions, potential bacteria sources within the watershed, and strategies and behaviors that individuals can participate in to support water quality protection efforts in the community.

Recommendation G-2: Work with the Horry County School District to educate students about the ecology of the Hog Inlet estuary and the concerns related to bacteria impairments within designated Shellfish Harvesting Areas. Partner with Keep North Myrtle Beach Beautiful to work with their established youth affiliate school partners to organize educational programs and hands-on stewardship activities in the community.

Recommendation G-3: Engage local residents in watershed restoration activities such as oyster reef restoration projects sponsored by CORRI or SCORE. CORRI relies on local business support to recycle oyster shell and community volunteers to bag the shell and place them at identified suitable restoration sites.

Recommendation G-4: Work with SC DHEC to disseminate information relevant to the Hog Inlet/ Dunn Sound Creek estuary in a timely and efficient manner. As the primary regulatory agency for water quality in the State of South Carolina, DHEC is responsible for numerous management and enforcement decisions that impact the use of the watershed for shellfish harvesting or other recreational purposes. Items that should be made readily accessible are the annual shellfish reports for management area 01, sanitary sewer overflow incident reports in the watershed, and resources to help improve water quality such as 319 non-point source pollution grant opportunities. In addition, seek permission from DHEC to supplement their shellfish harvesting restriction signs with educational signage that explains the possible sources of bacteria causing the restrictions along with information that citizens can use to improve local water quality.

Recommendation G-5: As Best Management Practices are implemented, utilize resources such as the Carolina Clear online LID Atlas and the Coastal Waccamaw Stormwater Education Consortium newsletter to share details of the project and the water quality benefits expected from each BMP.

Recommendation G-6: Host workshops with homeowners associations and the local business community to demonstrate various stormwater BMP options and factors that need to be considered prior to final selection, including site suitability, installation costs, and maintenance costs and requirements. In several communities along the Grand Strand Coastal Waccamaw Stormwater Education Consortium has offered assistance with some of these outreach efforts often with the support of undergraduate interns from Coastal Carolina University. Hog Inlet watershed partners should work closely with CWSEC to pursue these opportunities.

Recommendation G-7: The watershed plan implementation committee should identify candidate demonstration BMP sites as opportunities to bring attention to existing water quality issues in Hog Inlet. Selected demonstration sites should be reasonably accessible to the public and provide information regarding the purpose and function of the BMP. As suggested in Recommendation G-1 above utilize interpretive signage to convey information about a particular BMP application.

Recommendation G-8: Host workshops with property owners relying on septic systems to meet their wastewater treatment needs. Explain the importance of properly maintaining septic systems to ensure public health risks are minimized and nearby water quality is protected. Provide information on resources available to ensure that their septic systems are regularly inspected. Also, proactively pursue grant opportunities or other funding sources to assist homeowners with the costs of repairing or replacing septic systems or connecting to the centralized sewer system.

Recommendation G-9: Work closely with the Keep America Beautiful Chapters in North Myrtle Beach and Horry County on activities that fall within their core scope that will help improve water quality conditions in the estuary. Share information regarding water quality issues and management activities in the Hog Inlet watershed at sponsored community cleanup events. Additionally, establish a Community Cleanup Program along Little River Neck Road.

Recommendation G-10: Participate as an exhibitor to display information about the Hog Inlet watershed at community events in the Cherry Grove, Little River, and North Myrtle Beach area. Target events that draw environmental stewards such as the annual Beach Sweep/Creek Sweep, Great American Cleanup, and the Natural Awareness Festival. Partner with CWSEC to utilize the Enviroscape Model to educate citizens on watershed dynamics and the impacts of stormwater runoff on water quality in nearby waterbodies.

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Element H: Future Monitoring Needs

The removal of shellfish harvesting restrictions in Hog Inlet and Dunn Sound Creek is contingent upon meeting the fecal coliform standards at as many of the nine SC DHEC monitoring sites as possible. The more sites that meet the standard, the greater the area that can be designated as Approved for shellfish harvesting. Since monitoring data is the primary determinant in the designation and ultimate management of shellfish resources in Hog Inlet and Dunn Sound Creek, a regular review of published SC DHEC data is important. As SC DHEC's annual shellfish reports are released, observations such as any drastic increase or decrease in fecal coliform levels should be noted. If any alarming results occur, it may warrant the need to shift the priority of monitoring sites from the rankings outlined in **Element D**.

In addition, monitoring is the primary tool in determining progress made in achieving the goals outlined in this plan. If a significant decrease in fecal coliform levels is observed following the installation of a particular stormwater management practice, then water resource managers may want to consider other locations to install the same type of BMP.

Along with the SC DHEC shellfish monitoring program, Coastal Carolina University also provides monitoring program services, including both sample collection and data analysis. Below is a brief profile of some of their resources that may be useful in future monitoring efforts within the Hog Inlet/ Dunn Sounds Creek estuary.

I. Coastal Carolina University- Environmental Quality Lab:

An invaluable resource to watershed managers within the Grand Strand region is Coastal Carolina University. One of the services they provide is a SC DHEC certified Environmental Quality Lab. The lab has been utilized by local communities in a number of ways. Below is an outline of a few examples of the monitoring services that Coastal Carolina University's EQL has to offer which may be worth considering in the Hog Inlet/ Dunn Sound Creek watershed. Depending on the nature and purpose of the monitoring project, Coastal Carolina University staff will often serve in a technical advisory role in addition to collecting and processing water samples.

A. Bacteria Source Tracking: As noted in **Element C**, there are numerous potential sources of bacteria that can enter the Hog Inlet/ Dunn Sound Creek estuary. Determining the precise source of the bacteria can allow water resource managers to narrow their management focus to address the issue directly. Monitoring technologies such as qPCR can determine the animal origin of the bacteria detected in the water sample, distinguishing whether the bacteria originates from a human, canine, avian, or other animal source.

In the fall of 2016, Horry County and North Myrtle Beach hired CCU to perform a microbial source tracking study in the Hog Inlet- Dunn Sound Creek estuary. A full description of the study is provided in **Element D.** Water resource managers should utilize this study as a baseline for future monitoring efforts in the watershed. One of the clear findings was that the bacteria entering Hog Inlet does not appear to be from human sources. This means that while continued maintenance of the sanitary sewer system and residential septic systems are extremely important, no urgent action is needed to mitigate issues from these two potential sources. In the future, a follow up microbial source tracking study could be designed to utilize other tracers to detect signals of other species such as canine or avian that are potential sources of bacteria in the watershed. Presently CCUs Environmental Quality Lab does not have the capacity to detect feline sources of bacteria, but it may be feasible to develop the proper feline assay in the future.

B. Volunteer Monitoring Program: Under the direction of Coastal Carolina University faculty and staff, volunteer monitoring programs have been successfully established along the Waccamaw River, Murrells Inlet, and in Surfside Beach. Horry County has been a main partner in the Murrells Inlet and Waccamaw River volunteer programs, which were established in 2008 and 2006 respectively. The volunteers collect water samples twice monthly at each monitoring site. The parameters monitored are tailored to the specific concerns of each waterbody. In the case of Murrells Inlet, which would be most similar to Hog Inlet/Dunn Sound Creek, the parameters measured are dissolved oxygen, temperature, salinity, conductivity, pH, nutrients, turbidity, and E. Coli. Coastal Carolina University maintains a website, which makes the data available for review and analysis: http://bccmws.coastal.edu/volunteermonitoring/index.html

II. Future Monitoring Recommendations:

Below are recommendations on utilizing monitoring resources to further understand the water quality conditions and hydrological dynamics of the Hog Inlet/Dunn Sound Creek estuary. This section also outlines recommendations on using

monitoring data to evaluate the success of individual projects and track the overall progress of implementing this watershed plan.

Recommendation H-1: Establish a standing watershed plan implementation committee. The committee should consist of the primary watershed plan partners including Waccamaw Regional COG, North Myrtle Beach, Horry County, and Horry Soil and Water Conservation District. Other stakeholders should be included as implementation proceeds and new partnerships are developed. Meetings should be held as needed but at a minimum the committee should convene twice annually. The objective of the committee should be to monitor progress on all aspects of the watershed plan. On a consistent basis the committee should review available water quality data from SC DHEC and other sources to assess current water quality conditions in the estuary. The committee should also remain alert to case studies in other watersheds where positive results following watershed management actions have been observed.

Recommendation H-2: On a periodic basis, perhaps every 10 years, initiate a microbial source tracking study in Hog Inlet and Dunn Sound Creek. In order to accurately compare results, the same sites sampled during the 2016 microbial source tracking study should be utilized. In subsequent studies carefully analyze and compare trends from the initial 2016 study to determine if various animal sources of bacteria have been eliminated or have become more pronounced within the estuary. Additional sites could be added to the scope of the study as BMP implementation moves forward. Presently, microbial source tracking is the most useful and reasonably available monitoring tool to investigate the species of origin of bacteria present within the water column.

Recommendation H-3: Monitor the establishment of the oyster reef at the selected Cherry Grove canal dredging mitigation site. This restoration site should provide insight of favorable conditions for oyster reef production within the Hog Inlet estuary.

Recommendation H-4: Consider conducting a sediment assessment study in the Hog Inlet/ Dunn Sound Creek estuary. Sedimentation is a known transport mechanism of bacteria and other non-point sources of pollution in aquatic environments. If possible, collect samples from the recent Cherry Grove Canal dredging project as part of a baseline study of pollutant concentrations in the sediment profile of the estuary. Similar to the microbial source tracking study, it would be helpful to conduct a sediment survey once every ten years if feasible.

Recommendation H-5: Consider initiating a volunteer monitoring program in the Hog Inlet estuary. There are several community benefits to instituting a volunteer monitoring program. First, data is generated on a continuous and consistent basis at sites selected by the main program sponsors, typically local governments. This data can be especially useful in detecting abnormal levels of bacteria or another water quality parameter. A volunteer monitoring program can be particularly useful in assessing the effectiveness of recently implemented best management practices. In addition, the volunteer monitoring program is an excellent approach to meet the public education and engagement measures outlined in the MS4 stormwater permit. It is a hands-on interactive experience that brings concerned citizens directly to the estuary to learn about local water quality issues. The samples collected by volunteers informs watershed management decision making processes. Coastal Carolina University has provided lab analysis and onsite technical support to volunteer programs along the Waccamaw River, Murrells Inlet and in Surfside Beach.

Recommendation H-6: Work with SC DHEC and other management agencies to improve the accuracy and availability of precipitation data in the Cherry Grove Beach/ Little River Neck area. Rain events are known to influence bacteria levels measured at SC DHEC monitoring stations depending upon the severity of the storm event and the timing of the sample collection date. During the data analysis portion of the watershed planning process a review of the precipitation data collected at the designated NOAA weather station found that the data set was incomplete. For the 2015 data set, several months had multiple days with no weather observation data reported. As an example, only ten days were reported in February 2015. As a result, the planning team was unable to correlate bacteria measurements at the SC DHEC monitoring sites with a corresponding rain event during the watershed planning process. In the long-term, the lack of a reliable weather observation station in close proximity to the estuary would also be problematic if portions of Shellfish Management Area 01 were ever designated as Conditionally Approved, where precipitation data is used as one of the primary management criteria.

At the moment, the most reliable source of weather data to utilize in the watershed is the water quality and weather station located at the Cherry Grove Fishing Pier, managed as part of Coastal Carolina University's Long Bay Observation

System. Watershed managers from North Myrtle Beach and Horry County should utilize data available from this weather station and ensure that long-term support is provided for continued operation.

The next element identifies funding sources that may be pursued to facilitate the implementation of Best Management Practices recommended in this watershed plan. Opportunities to support supplemental watershed management activities such as public outreach and future monitoring are also discussed.

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Element I: Potential Funding Sources

As noted in **Element F- Watershed Management Recommendations**, one of the most immediate barriers to implementing projects and initiatives is the availability of funding for installation costs as well as expenses related to maintaining stormwater infrastructure. In Hog Inlet and Dunn Sound Creek, it is important to view watershed protection as an investment in local estuary resources which provide tremendous cultural and economic value to the Little River Neck and Cherry Grove Beach communities. The costs of implementing BMPs should be weighed against the loss of shellfish resources available for harvest. This element explains some of the economic benefits of watershed protection. An overview of various funding opportunities and financing strategies is also included.

I. Economic Benefits of Water Quality Protection

The coastal resources of the Grand Strand region attract hundreds of thousands of visitors every year, creating one of the most robust regional tourism economies on the East Coast. One of the main draws for people is the natural scenery including the expansive beach and tidal estuaries such as Hog Inlet. This coastal environment offers numerous outdoor recreation opportunities including swimming, sunbathing, fishing, boating, birding, and shellfish harvesting, among others. Numerous economic sectors benefit from this tourism-based economy including real estate, hotels, restaurants, retail businesses, arts and entertainment, etc. Cherry Grove Beach and the Hog Inlet estuary are ecologically sensitive resources that must be protected to ensure that they are a sustainable component of the regional tourism economy.

The remainder of the element explores potential funding sources that may be pursued to successfully implement the recommended management strategies outlined in **Element G** and in other sections of this watershed plan. It should be noted that this is not an exhaustive list of funding options. A regular review and evaluation of currently available opportunities is part of sound watershed management.

II. Local Government Funding Options

A. Stormwater Utility: Due to the construction, operation, and maintenance costs associated with managing a community drainage system, local governments, including both Horry County and North Myrtle Beach, have instituted stormwater utility fees. The stormwater utility provides a revenue stream to account for the costs incurred by various stormwater projects and programs. Horry County instituted an annual stormwater fee in 2000, while North Myrtle Beach approved theirs in 2007. The utility is structured to assess each property with a fee based on the approximate area of impervious surface. The City of North Myrtle Beach generates an annual budget of roughly $2,000,000 through the assessment of approximately 11,000 properties within the municipal boundaries.

III. State of South Carolina Funding Resources

A. SC DHEC- 319 Nonpoint Source Pollution Grant Program: The EPA recognizes nonpoint sources of pollution from stormwater runoff as the number one contributor to water pollution in the United States, ultimately establishing the Section 319 program as part of the federal Clean Water Act Amendments of 1987. As a strategy to help identify and reduce these pollutant sources, SC DHEC directs funding through the Section 319 program to support local community efforts to implement innovative stormwater management practices in impaired watersheds. The EPA and SC DHEC require an approved watershed plan as one of the main eligibility criteria for this grant program. Becoming eligible for this particular grant program is one of the immediate benefits of the Hog Inlet- Dunn Sound Creek Watershed Plan to Horry County and the City of North Myrtle Beach. More information can be found on the Environmental Grants and Loans webpage on SC DHEC's website: http://www.scdhec.gov/HomeandEnvironment/BusinessesandCommunities-GoGreen/EnvironmentalGrantsandLoans/

B. SC DHEC- Clean Water State Revolving Loan Fund: Local governments and water/sewer utility providers can secure low interest loan rates, as low as 1.0%, through the state revolving loan fund. The revolving loan fund supports

many types of infrastructure improvement projects, including sewer line and pump station upgrades as well as stormwater infrastructure projects that address known non-point source pollution concerns. More information can be found on the Environmental Grants and Loans webpage on SC DHEC's website: http://www.scdhec.gov/HomeandEnvironment/BusinessesandCommunities-GoGreen/EnvironmentalGrantsandLoans/

C. Community Development Block Grant (CDBG): The SC Department of Commerce administers the CDBG program allocation funded by the US Department of Housing and Urban Development. There are several categories of projects, including community infrastructure which typically comprises the largest percentage of the available funding. The objective of the community infrastructure project category is to address health concerns, meet regulatory standards and ensure community sustainability. One of the intentions of the CDBG program is to make improvements in neighborhoods or communities where at least 50% of the direct beneficiaries are low to moderate income households. Drainage and sewer projects are both eligible projects which could be pursued in the Hog Inlet- Dunn Sound Creek Watershed. More information can be found on their website at: https://www.cdbgsc.com/

D. South Carolina Sea Grant Consortium: Created in 1978, the SC Sea Grant Consortium is nationally certified under the National Sea Grant College Program and receives its support primarily from NOAA and the US Department of Commerce. Under its current FY2018-21 strategic plan, the Consortium focuses its programmatic efforts on five critical issue areas: 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. To achieve the goals outlined in the strategic plan, Sea Grant administers grant programs to fund research, outreach, and education projects. Information on current RFPs and other Sea Grant Consortium activities can be found on their website at: http://www.scseagrant.org/

IV. Federal Grant Programs

A. Army Corps of Engineers- Restoration and Enhancement Grants: The Army Corps oversees the Section 206 Aquatic Ecosystem Restoration and the Estuary Restoration Act programs. The Section 206 program generally involves some manipulation of a water body to restore it to its previous natural hydrologic condition. Historically, there was an ocean inlet into Cherry Grove Marsh at present day 39th to 42nd Ave N in Cherry Grove. The Section 206 program could potentially assist with reestablishing an ocean inlet connection near that location to help improve the tidal exchange and circulation throughout the southern half of Hog Inlet. The Estuary Restoration Act program has supported a variety of projects including oyster reef restoration site establishment. The Section 206 and Estuary Restoration programs both entail a 35% non-federal cost share formula. Information about potential project funding can be found on the Charleston District webpage at: http://www.sac.usace.army.mil/

B. US EPA Environmental Education Grants Program: Over the past 25 years, the EPA has placed a significant focus on public education and environmental stewardship activities across the country. In FY 2016, the program awarded roughly $3.5 million to over 3,600 grant recipients, most commonly local governments and educational institutions, to

enhance their environmental awareness initiatives. For more information including current grant opportunities visit: https:// www.epa.gov/education/environmental-education-ee-grants

C. US EPA Five Star and Urban Waters Restoration Grant Program: The Urban Waters Federal Partnership which is managed by the National Fish and Wildlife Foundation supports comprehensive watershed restoration projects which incorporate on the ground management activities, public education and outreach, post-project maintenance and monitoring, and strong community partners. More information can be found at: https://www.epa.gov/urbanwaterspartners

D. NOAA- Coastal and Marine Habitat Restoration Program: The main approach of this program is to recognize that habitat protection and restoration are critical for sustainable commercial and recreational fisheries. The program supports projects that utilize a habitat-based approach to conserve key marine species and promote healthy and resilient coastal ecosystems. Previous grant cycles have funded oyster restoration projects. More information can be found on NOAA's website at: http://www.habitat.noaa.gov/funding/coastalrestoration.html

Grants.gov is a useful online resource to keep track of funding announcements from all federal agencies.

V. Private Foundations

A. PetSmart Charities: Reducing bacteria loads from feral cat and stray dog populations is a challenging task. One of the most viable long-term solutions is to gradually reduce the size and reproduction rate of known colonies. Petsmart supports local initiatives in addressing this issue by awarding grants to governments or animal welfare organizations to institute trap, spay, neuter and release programs. The program is harmless to the animals and a proven means to keep feral cat colony populations from growing unsustainably. Petsmart has recently awarded grants to Coastal Carolina University in Conway and Coastal Animal Rescue in Murrells Inlet to institute programs to address this issue in their respective communities. More information on their grant programs can be found at: https://www.petsmartcharities.org/

It is important for watershed managers to pursue a diversity of funding sources as implementation activities move forward. Relying on a single funding source is very risky as many grant programs phase out depending on the current priorities of state and federal agencies. One of the main objectives of the watershed plan implementation committee should be to regularly review and assess potential funding sources that may support eligible projects in the Hog Inlet watershed.

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Element J: Timeline of Implementation Activities and Milestones

The goal of this watershed plan is for it to serve as a guidance resource for Hog Inlet estuary stakeholders to pursue water quality initiatives that will help meet the SC DHEC fecal coliform bacteria water quality standards for designated Shellfish Harvesting Areas. An important aspect of transitioning from the planning process into long-term implementation is to prioritize strategies and develop target milestones to strive for on a yearly basis as implementation moves forward. The following section outlines activities and corresponding timeframes that will serve as a series of measurable milestones that the project team can utilize to track implementation success.

Implementation Activities in 2018			
Activities	**Goals/ Milestones**	**Resources needed**	**Responsible Party**
Organize watershed implementation steering committee	**1.)** Identify stakeholder members. **2.)** Develop committee framework. **3.)** Hold 2 meetings annually.	**A.)** Staff time **B.)** Meeting location **C.)** Partnership coordination	Initially the WRCOG in conjunction with project partners- Horry County, North Myrtle Beach, and Horry Soil and Water Conservation District.
Develop watershed plan outreach strategy	**1.)** Distribute links to watershed plan via Waccamaw COG, Horry County, North Myrtle Beach websites and other avenues such as Coastal Waccamaw Stormwater Consortium email list. **2.)** Attend a minimum of two public meetings/events to present findings of watershed plan. **3.)** Develop outreach literature referencing watershed plan.	**A.)** Staff time **B.)** Available funding (as needed) **C.)** Partnership coordination	All Partners
Begin developing monitoring strategy	**1.)** Review and assess SC DHEC Management Area 01 Annual Report on an annual basis. Identify positive or negative trends that may impact the prioritization of implementation strategies.	**A.)** Staff time	All Partners
Begin pursuing SC DHEC and other state and federal grant opportunities	**1.)** Identify at least one suitable grant opportunity and submit application package.	**A.)** Staff time **B.)** Partner coordination **C.)** Grant match commitments	Depends on grant eligibility requirements, project scope, etc.
Identify stormwater demonstration project site to begin implementation process	**1.)** Identify at least one potential project that can serve as a demonstration site for the implementation of the watershed plan. Ideally, the project site should be fairly visible to the public for outreach and educational purposes. Include this identified project site as a candidate for available grant programs such as SC DHEC's Section 319 program.	**A.)** Staff time, including site visits **B.)** Partner Coordination **C.)** Preliminary engineering, depending on initial progress made	Depends on location of project site identified. Ideally it could be a multi-jurisdictional project so that all partners can be involved.

Implementation Activities in 2019			
Activities	**Goals/ Milestones**	**Resources needed**	**Responsible Party**
Continue monitoring efforts	**1.)** Utilize data in the Shellfish Management Area 01 annual report to prioritize management activities. Make note of any bacteria trends associated with the 2016 Cherry Grove Canal dredging. **2.)** Begin discussions on developing a volunteer monitoring program with support from Coastal Carolina University.	**A.)** Staff time **B.)** Partner Coordination	All Partners in coordination with Coastal Carolina University
Continue pursuing grant and other funding opportunities	**1.)** Within two years of watershed plan development a priority goal would be to secure a 319 implementation grant from DHEC or similar grant from another state/federal agency.	**A.)** Staff time **B.)** Partner coordination **C.)** Grant match commitments	Depends on grant eligibility requirements, project scope, etc.
Begin marsh and oyster reef restoration efforts	**1.)** Monitor success of the dredging marsh and oyster reef mitigation project. **2.)** Identify other sites that are appropriate for reef restoration. **3.)** Begin discussions with SC Dept. of Natural Resources and Coastal Carolina University regarding opportunities for oyster shell recycling via restaurant partnerships or drop off locations.	**A.)** Staff time **B.)** Partner coordination **C.)** Available funding (if needed) **D.)** Volunteer engagement	To be identified at later date. The project needs to be in coordination with resource agencies or institutions such as Coastal Carolina University and SC Dept. of Natural Resources.
Assess interpretive sign inventory within watershed.	**1.)** Identify locations of existing water quality related signs within watershed **2.)** Develop strategy to focus future sign messages on priority public outreach issues such as proper pet waste disposal, feeding wildlife, and importance of water quality protection. Install new signs as opportunities present themselves.	**A.)** Staff time **B.)** Available funding	All Partners
Begin hosting workshops with neighborhood groups, homeowners associations, and business groups	**1.)** The workshops can be tailored to the priority interests of each audience. Some neighborhoods may need assistance with septic system maintenance.. Other groups may have an interest in distributing rain barrels in their community. A reasonable initial goal should be organizing 1-2 workshops a year.	**A.)** Staff time **B.)** Partner Coordination	All Partners. Coordinate with available resources from Coastal Waccamaw Stormwater Education Consortium.
Partner with the North Myrtle Beach and Horry County Keep America Beautiful Chapters on cleanup activities in the watershed.	**1.)** The initial focus should be identifying areas with the most severe and recurring litter problems using a litter index as an evaluation tool. Keep America Beautiful has guidance materials to assist with establishing a litter index for the community.	**A.)** Staff time **B.)** Partner Coordination **C.)** Volunteer engagement	Watershed partner team in coordination with Keep America Beautiful Chapters, neighborhood organizations, business community, and all other interested groups.
Incorporate pervious pavement installations into the future North Myrtle Beach Capital Improvement Plan	**1.)** Identify specific streets in the Cherry Grove District to install pervious pavement over a ten year period	**A.)** Staff time **B.)** Available Funding	North Myrtle Beach staff with assistance from the project partner team.

Implementation Activities in 2020			
Activities	**Goals/ Milestones**	**Resources needed**	**Responsible Party**
Develop a campaign to encourage properly securing dumpster locations	**1.)** Develop literature that illustrates the role that insecure dumpsters play in attracting nuisance wildlife. Congregated wildlife can become a significant source of bacteria if left unmitigated. **2.)** Inventory dumpsters owned or contracted by the City of North Myrtle Beach and Horry County. Train public works personnel as part of the MS4 permit program's good housekeeping minimum control measure. **3.)** Develop contact list of local Property Owners Associations and business owners to ensure outreach efforts are directed towards proper target audience. **4.)** Explore regulatory options to address issue if public outreach efforts alone are not effective enough.	**A.)** Staff time **B.)** Funds for printed materials	North Myrtle Beach/ Horry County Stormwater staff.
Initiate a rain barrel sales program in the community	**1.)** Incorporate as a component of a watershed education workshop event as noted in the list of activities in 2019.	**A.)** Staff time **B.)** Partner coordination **C.)** Sales agreement with rain barrel vendor	Watershed project team in coordination with property owner associations, and local businesses. Utilize assistance from the Coastal Waccamaw Stormwater Education Consortium.
Begin identifying candidate stormwater ponds for the installation of floating wetlands or aerator fountains	**1.)** Select pond(s) based on proximity to priority monitoring sites. Consult with nearby communities such as Murrells Inlet to ensure proper floating wetland plants are selected and other site requirements are evaluated.	**A.)** Staff time **B.)** Consultation with nearby communities and/or reputable floating wetland vendors	North Myrtle Beach/ Horry County Stormwater staff
Begin installing sections of pervious pavement along selected streets in the Cherry Grove District	**1.)** Follow installation schedule that is outlined in the North Myrtle Beach Capital Improvements Plan.	**A.)** Staff time **B.)** Funding	North Myrtle Beach Public Works Staff with assistance from project partner team
Complete construction of the ocean stormwater outfall which is designed to divert stormwater flows from the Sea Mountain Hwy to 11th Ave North Catchment Area that currently drains into Hog Inlet.	**1.)** Once outfall is constructed, begin analyzing available water monitoring data for bacteria and salinity trend changes. Potential data sources include SC DHEC shellfish monitoring program, or the volunteer monitoring program if it is already established.	**A.)** Staff time **B.)** State and Federal permitting **C.)** Funding	North Myrtle Beach Public Works Staff with assistance from the project partner team, SC DHEC, and Coastal Carolina University as needed.

Implementation Activities in 2021			
Activities	**Goals/ Milestones**	**Resources needed**	**Responsible Party**
Pursue property owner commitments and secure funding for the installation of a floating wetland project	**1.)** Pursue the most viable location identified during the scoping phase of project selection. Use this as a demonstration site to evaluate success of the BMP and determine if it is suitable in other stormwater ponds within the watershed.	**A.)** Staff time **B.)** Funding **C.)** Agreement with property owner prior to installation	North Myrtle Beach/Horry County stormwater staff and committed property owner.
Promote and incentivize the protection and establishment of shoreline buffers along the estuary.	**1.)** Review relevant case studies on effective standards from other coastal communities in the Carolinas. **2.)** Identify demonstration sites similar to McLean Park on Main St in North Myrtle Beach to maintain desired vegetated buffer width, establish suitable native plant species, and incorporate interpretive signage in publicly accessible locations.	**A.)** Staff time **B.)** Funding as needed **C.)** Partner Coordination	All partners

Implementation Activities in 2022 and Beyond			
Activities	**Goals/ Milestones**	**Resources needed**	**Responsible Party**
Develop strategic plan for urban forestry program.	**1.)** Identify opportunities along roadway corridors and other public spaces for new tree plantings. **2.)** Encourage business and home owners to plant trees on their properties. **3.)** Coordinate events and activities through North Myrtle Beach's Tree City USA program	**A.)** Staff time **B.)** Partner Coordination with Tree City USA	North Myrtle Beach/Horry County stormwater staff and committed property owners.
Investigate opportunities to restore Hog Inlet estuary by creating a second ocean inlet	**1.)** Consult with Army Corps of Engineers on potential location, scale of project, funding options, and other stipulations of the Estuary Restoration Act. **2.)** Determine feasibility of project and identify next steps for implementation.	**A.)** Staff time **B.)** Funding **C.)** Partner Coordination with Army Corps of Engineers.	North Myrtle Beach with assistance from the project partner team. Coordination with Army Corps of Engineers and other applicable state and federal agencies.
Assess feral cat populations and pursue spay/neuter program as needed	**1.)** Conduct an assessment of feral cat colony locations and population estimates every five years **2.)** Depending on the findings of the five year assessment, pursue population control strategies such as a spay/neuter program**.**	**A.)** Staff time **B.)** Partner Coordination with a local veterinary clinic and/or Horry County Animal Care Center **C.)** Funding as needed through Pet Smart Charities grant or an alternative funding source.	North Myrtle Beach/ Horry County stormwater staff in coordination with committed partners.
Evaluate the performance of BMPs implemented since 2018	**1.)** Assess the effectiveness of each BMP strategy and determine the applicability of implementing the BMP in additional locations throughout the watershed.	**A.)** Staff time **B.)** Partner Coordination	All partners

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Appendix A: Watershed Soil Profile

Exhibit Appendix A-1 General Soil Classification Map of the Hog Inlet-Dunn Sound Creek Watershed Plan Focus Area

Table Appendix A-1 Soil types and main characteristics within the Hog Inlet- Dunn Sound Creek Watershed				
Soil Name	**Symbol**	**Acres/ % of Area of Interest**	**General Description**	**Hydrologic Group**
Beaches	**Bc**	339.6 acres/ 4.8%		Not provided
Blanton sand, 0 to 6 percent slopes	**BnA**	119.7 acres/ 1.7%	Permeability is moderate. Has a perched water table between 5 and 6 ft. from Dec to Feb and is well suited to most urban uses, however has moderate limitations to use as septic tank absorption fields because of wetness.	A
Bohicket silty clay loam	**Bo**	1,399.8 acres/ 19.6%	Permeability is very slow. It is not suited to urban uses due to flooding, ponding, low strength and shrink-swell potential.	D
Centenary fine sand	**Ce**	862.3 acres/ 12.1%	Permeability is rapid. Depth to the seasonal high water table (Dec-Feb) is 3.5 to 5.0 ft. Severe limitations to use as septic tank absorption fields because of wetness.	B
Echaw sand	**Ec**	6.4 acres/ 0.1%	Permeability is moderately rapid to rapid. Depth to the seasonal high water table (Nov-Apr) is 2.5 to 5.0 ft. Well suited to most urban uses however poorly suited to use as septic tank absorption fields because of wetness.	B
Johnston loam	**Jo**	104.3 acres/ 1.5 %	Permeability is moderately rapid in the surface layer and rapid in the substratum. The seasonal high water table (Nov-June) ranges from 1.0 ft above the surface to 1.5 ft below the surface. It is poorly suited to urban uses because of flooding and ponding and severe limitations to use as septic tank absorption fields.	D
Kenansville fine sand, 0 to 6 percent slopes	**KeB**	121.6 acres/ 1.7%	Permeability is moderately rapid. Seasonal high water table (Dec-Apr) ranges from 4.0 to 6.0 ft. well suited to most urban uses with moderate limitations to use as septic tank absorptions fields.	A
Lakeland sand, 0 to 6 percent slopes	**LaB**	1,115.4 acres/ 15.7%	Permeability is very rapid. Depth to the seasonal high water table is more than 6ft. The soil is well suited to most urban uses, with only slight limitations to use as septic tank absorption fields.	A
Leon fine sand	**Le**	1,052.3 acres/14.8%	Permeability is rapid in the upper part of the soil and moderate or moderately rapid in the lower part. The seasonal high water table (June-Feb) ranges from level at the surface to 1.0 ft below the surface. Poorly suited to urban uses. Wetness and the poor filtering capacity are severe limitations to use as septic system absorption fields.	B/D
Lynn Haven sand	**Ly**	276.4 acres/ 3.9%	Permeability is moderate or moderately rapid. The seasonal high water table (June-Feb) ranges from level at the surface to 1.0 ft below the surface. Poorly suited to urban uses. Wetness and the poor filtering capacity are severe limitations to use as septic system absorption fields.	B/D
Newhan fine sand, 0 to 6 percent slopes	**NhB**	515.4 acres/ 7.2%	Permeability is very rapid. The depth to the water table is more than 6 ft. Suited to most urban uses, however it has severe limitations for septic tank absorption fields because of the slowly permeable subsoil.	A
Ogeechee loamy fine sand	**Og**	154.0 acres/ 2.2%	Permeability is moderately slow. The seasonal high water table (Dec-May) ranges from level at the surface to 6 inches below the surface. Poorly suited to urban uses, wetness is a severe limitation to the use of this soil for septic tank absorption fields.	B/D
Rutlege loamy sand	**Ru**	99.7 acres/ 1.4%	Very poorly drained in small drainageways, in shallow depressions, and along floodplains. Permeability is rapid. Seasonal high water table (Dec-May) ranges from 2.0 ft. above the surface to 1.0 ft. below the surface. Poorly suited to use as septic tank absorption fields.	B/D
Udorthents and Udipsamments, well drained	**Ud**	249.8 acres/ 3.5%	Often associated with soils deposited as fill from excavation projects, most likely the Atlantic Intracoastal Waterway. Onsite investigations are needed to determine soil characteristics and suitable urban uses.	Not Provided
Water	**W**	538.5 acres/ 7.6%		Not Provided
Witherbee sand	**We**	37.7 acres/ 0.5%	Depth to the seasonal high water table (Nov-Apr) ranges from 1.0 to 2.0 ft below the surface. It is poorly suited to most urban uses. Wetness and the poor filtering capacity are severe limitations to the use of septic tank absorption fields.	A/D
Yauhannah fine sandy loam, 0 to 2 percent slopes	**YaA**	117.2 acres/ 1.6%	Permeability is moderate. The depth to the seasonal high water table (Dec-Mar) ranges from 1.5 to 2.5 ft. Poorly suited to most urban uses and severely limited to use as septic tank absorption fields because of wetness.	B
Yemassee loamy fine sand	**Ye**	14.2 acres/ 0.2%	Permeability is moderate. The depth to the seasonal high water table (Dec- Mar) ranges from 1.0 to 1.5 ft. Poorly suited to most urban areas. Wetness is a severe limitation for the use as septic tank absorption fields.	C
Total acres within Area of Interest		**7,124.3 Acres**		
Note: One of the soil classifications is by Hydrologic group. Classifications range from A to D and are grouped based on their runoff-producing characteristics or their inherent ability to permit infiltration when the soil is bare of vegetation. Group A- High infiltration rate when thoroughly wet and a low runoff potential, Group B- Water transmission through the soil is unimpeded, moderately low runoff potential when thoroughly wet. Group C- Water transmission through the soils is somewhat restricted, moderately high runoff potential when thoroughly wet. Group D- Very slow infiltration rate and a high runoff potential. There are cases when soils are assigned dual hydrologic soil groups. The default classification of D is given when soils are characterized by the presence of a water table within 24 inches of the ground surface. If adequately drained, the soils will exhibit characteristics of the alternative hydrologic group provided.				
Source: USDA Web Soil Survey http://websoilsurvey.sc.egov.usda.gov/, USDA- NRCS Part 630 Hydrology National Engineering Handbook- Chapter 7 Hydrologic Soil Groups.				

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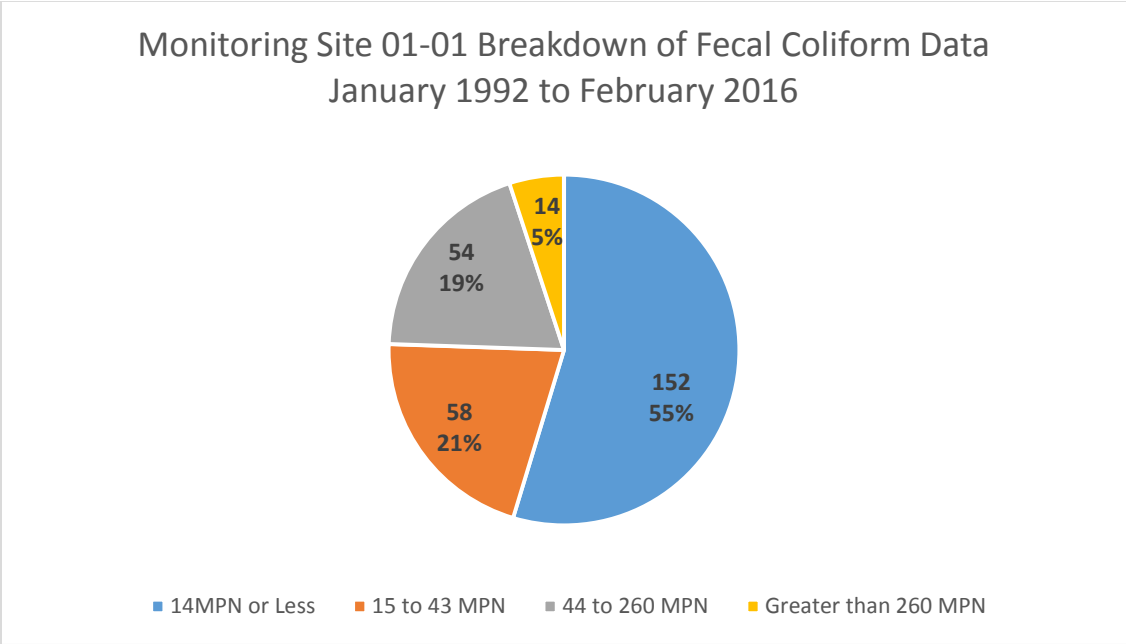
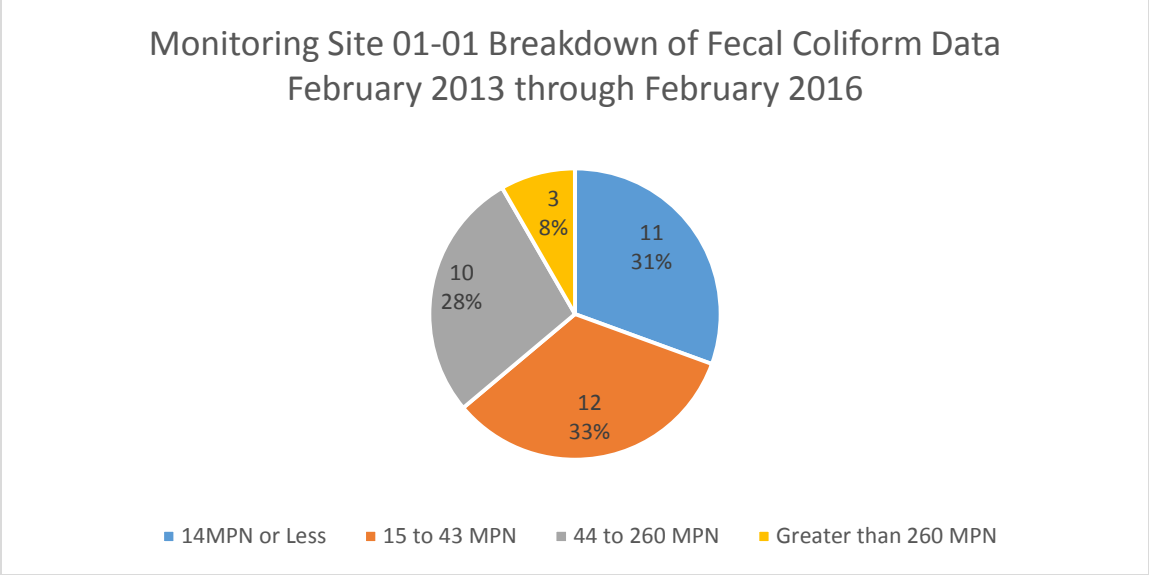
Appendix B: SC DHEC Monitoring Site Data Summaries

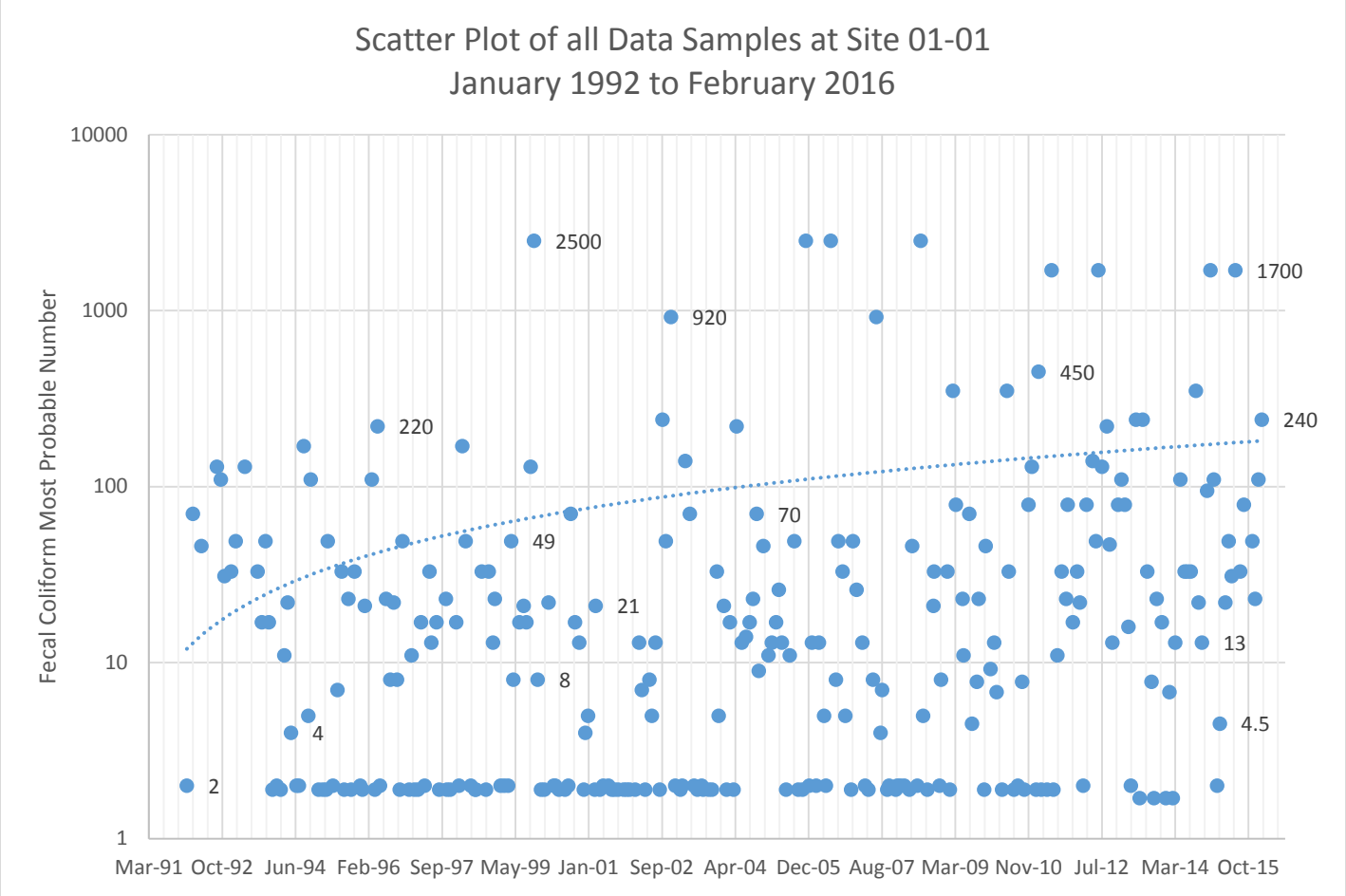
Monitoring Site 01-01 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-01 Sampling Data		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	152	54.7%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	58	20.8%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	54	19.4%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	14	5.0%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		



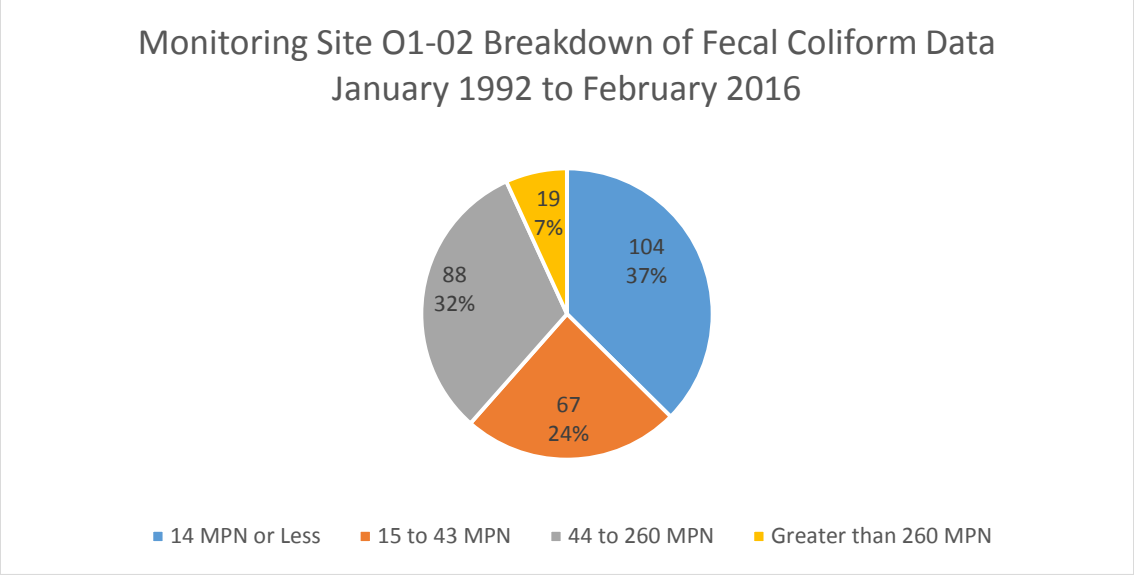
Summary of Monitoring Site 01-01 February 2013 through February 2016		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	11	30.6%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	12	33.3%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	10	27.8%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	3	8.3%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		


Monitoring Site 01-01 Breakdown of Fecal Coliform Data
February 2013 through February 2016
3
8%
11
31%
10
28%
12
33%
14MPN or Less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

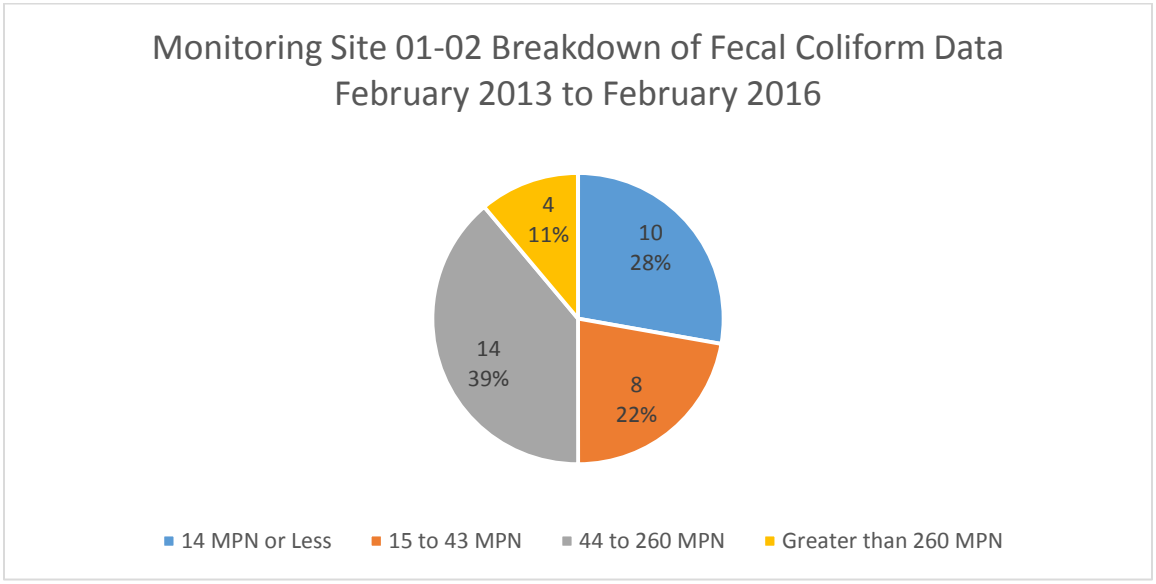

Scatter Plot of all Data Samples at Site 01-01
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
2500
1700
920
450
240
220
70
49
21
13
8
4
4.5
2
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15

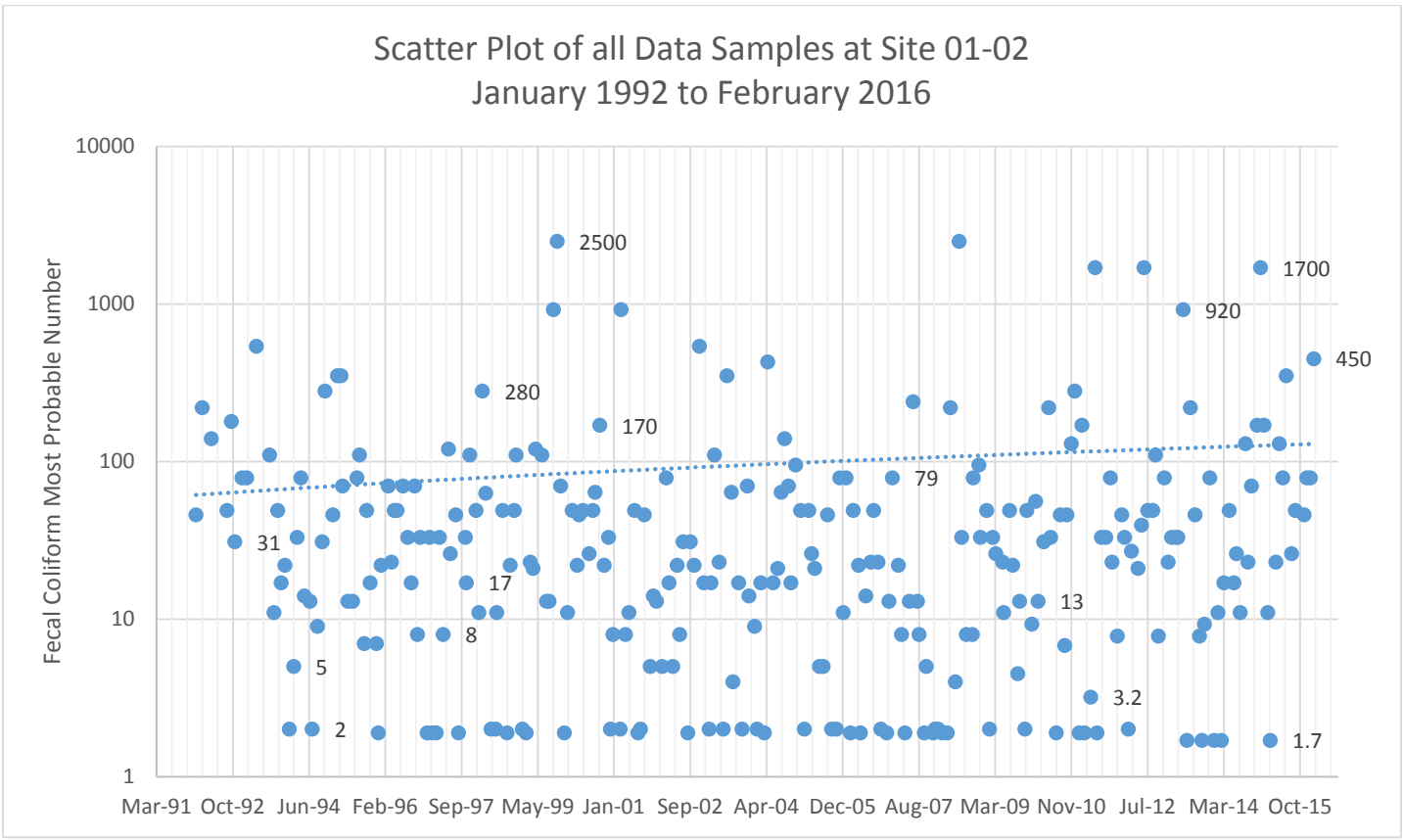
Monitoring Site 01-02 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-02 Sampling Data		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	104	37.4%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	67	24.1%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	88	31.6%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	19	6.8%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		



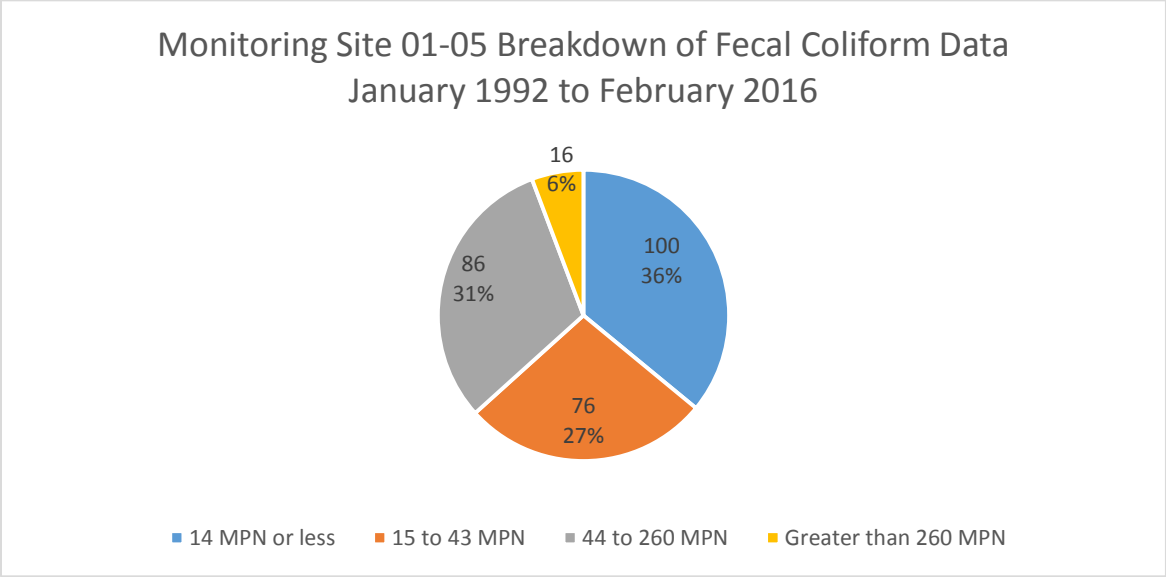
Summary of Monitoring Site 01-02 February 2013 through February 2016		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	10	27.8%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	8	22.2%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	14	38.9%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	4	11.1%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		


Monitoring Site 01-02 Breakdown of Fecal Coliform Data
February 2013 to February 2016
4
11%
10
28%
14
39%
8
22%
14 MPN or Less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

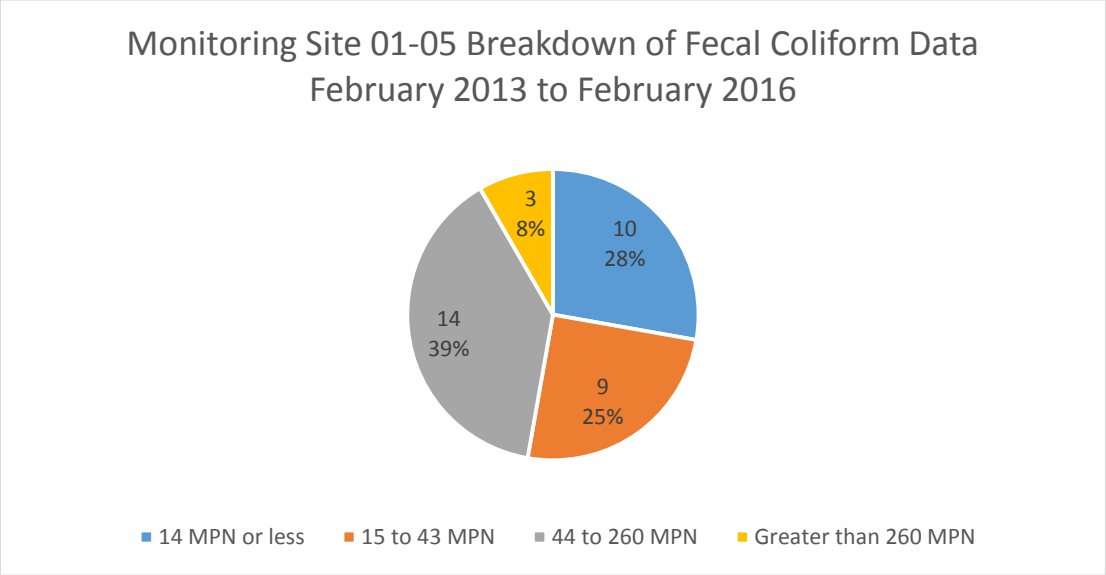

Scatter Plot of all Data Samples at Site 01-02
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15
2500
1700
920
450
280
170
79
31
17
13
8
5
3.2
2
1.7

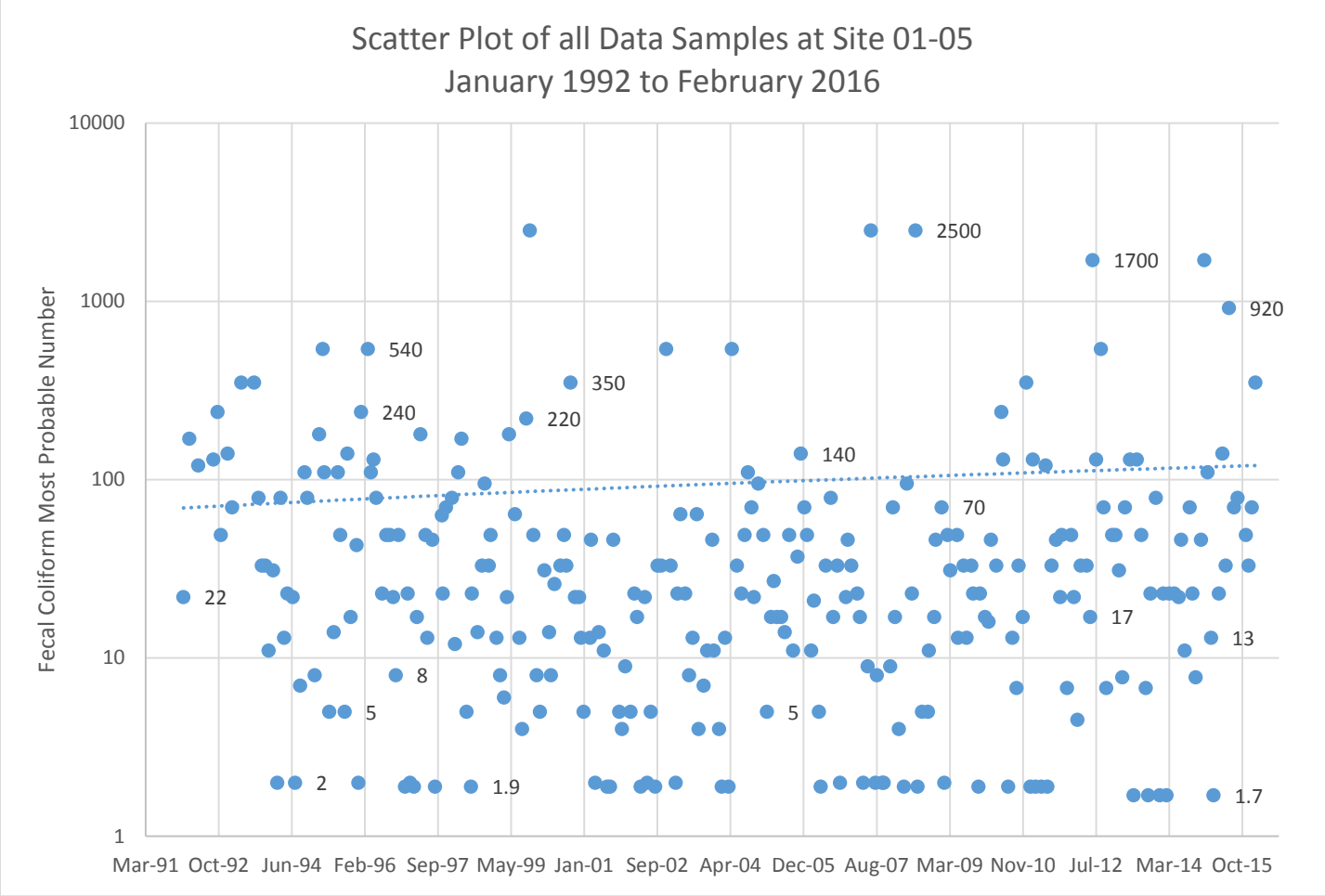
Monitoring Site 01-05 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-05 Sampling Data		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	100	36.0%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	76	27.3%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	86	30.9%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	16	5.8%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		



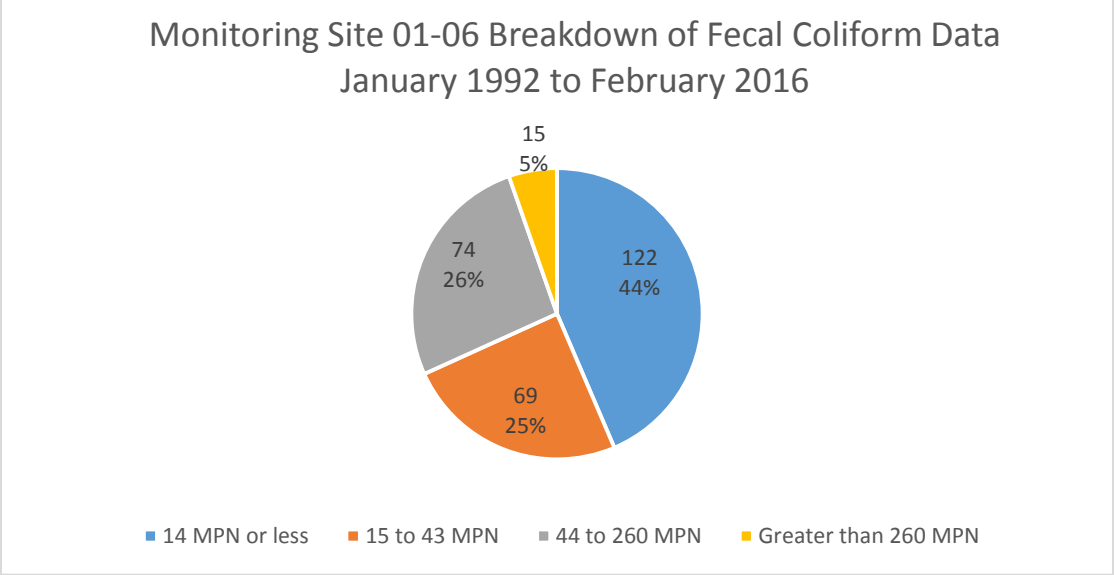
Summary of Monitoring Site 01-05 February 2013 through February 2016		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	10	27.8%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	9	25.0%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	14	38.9%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	3	8.3%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		


Monitoring Site 01-05 Breakdown of Fecal Coliform Data
February 2013 to February 2016
3
8%
10
28%
14
39%
9
25%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

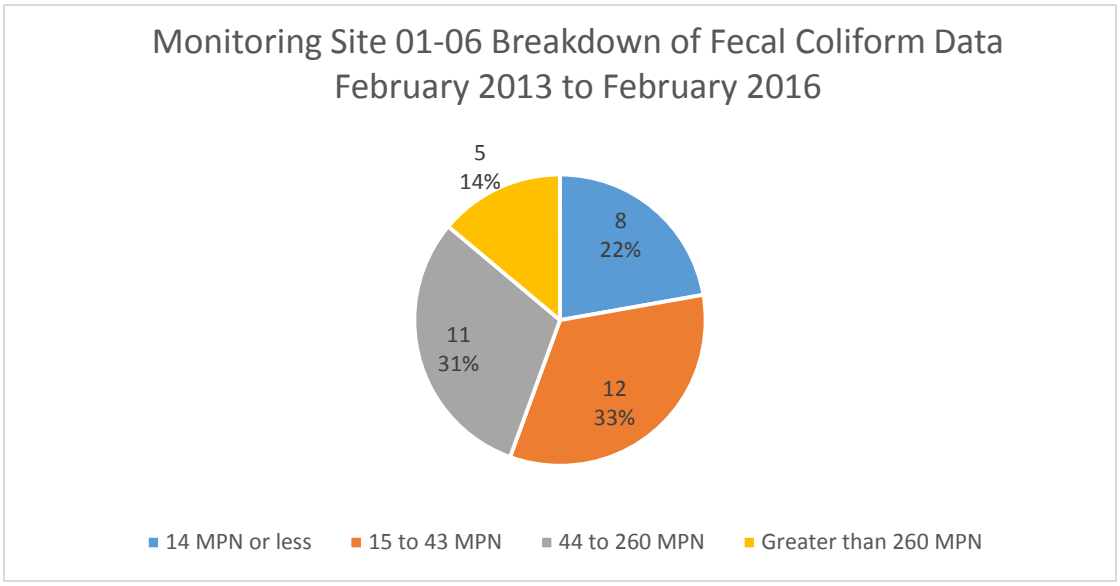

Scatter Plot of all Data Samples at Site 01-05
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15
2500
1700
920
540
350
240
220
140
70
22
17
13
8
5
5
2
1.9
1.7

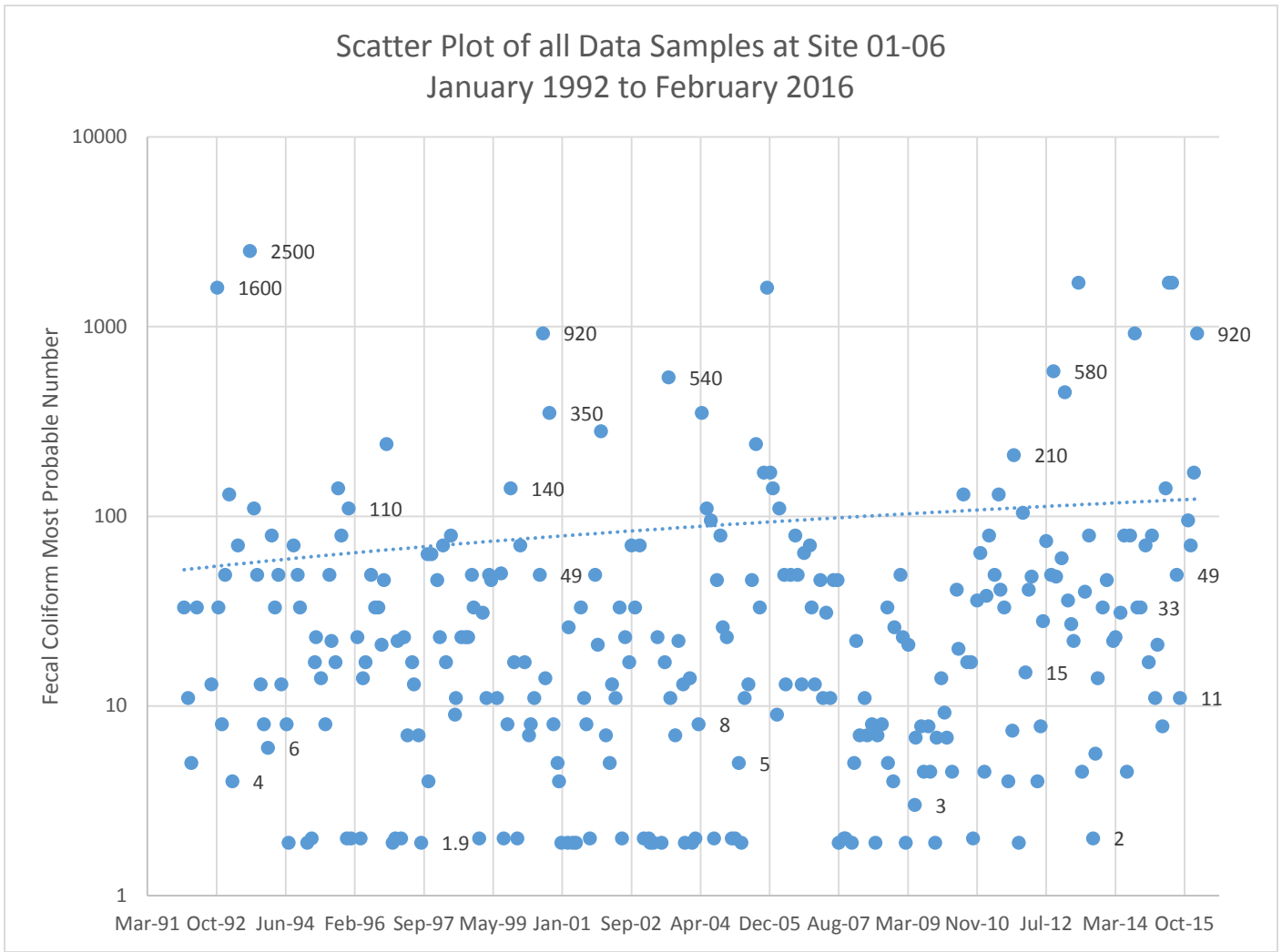
Monitoring Site 01-06 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-06 Sampling Data		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	122	43.9%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	69	24.8%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	74	26.6%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	15	5.4%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		



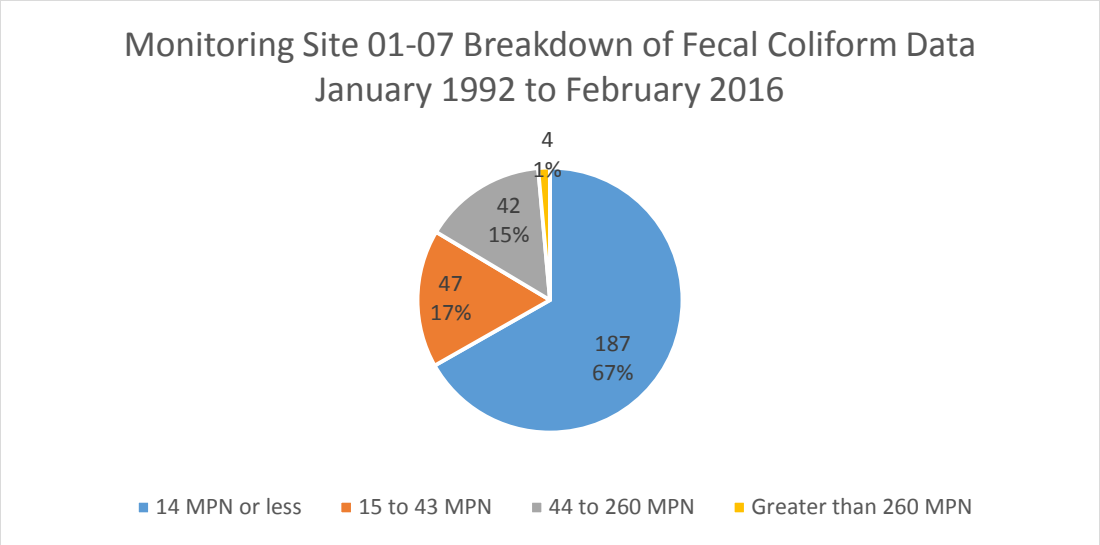
Summary of Monitoring Site 01-06 February 2013 through February 2016		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	8	22.2%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	12	33.3%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	11	30.6%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	5	13.9%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		


Monitoring Site 01-06 Breakdown of Fecal Coliform Data
February 2013 to February 2016
5
14%
8
22%
11
31%
12
33%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

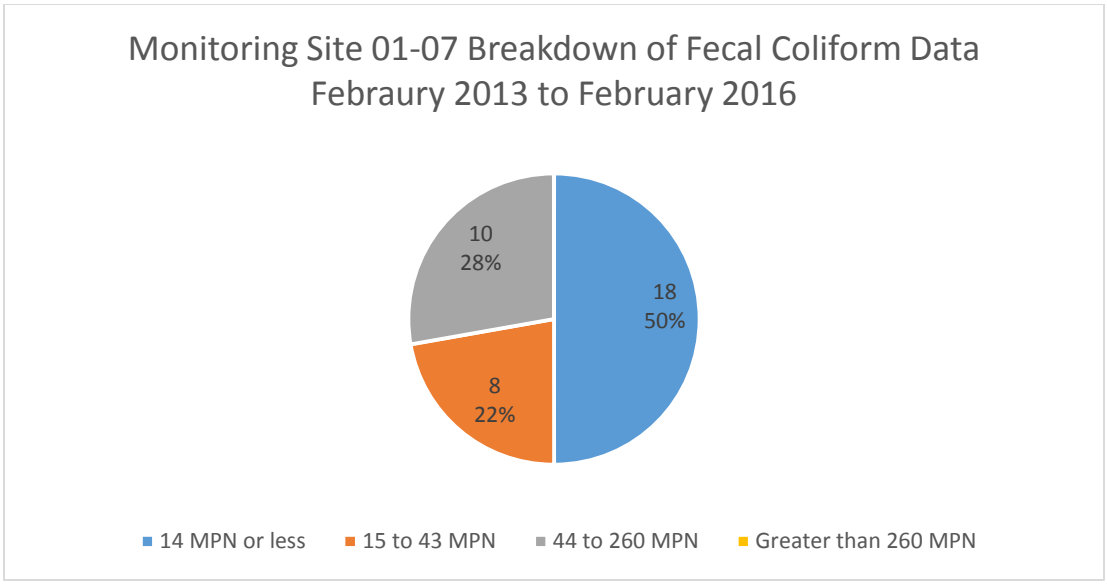

Scatter Plot of all Data Samples at Site 01-06
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15

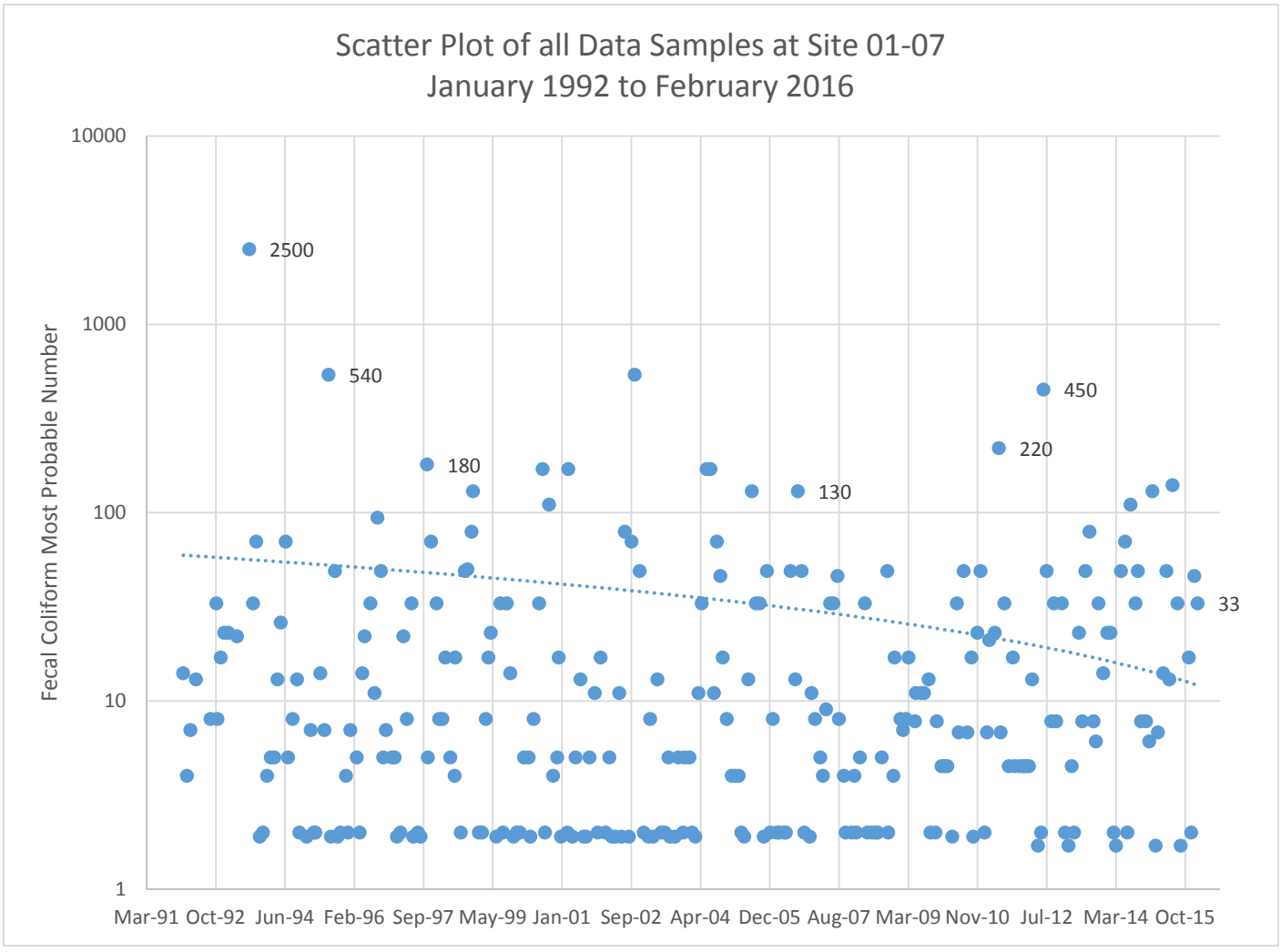
Monitoring Site 01-07 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-07 Sampling Data		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	187	67.3%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	47	16.9%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	42	15.1%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	4	1.4%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		



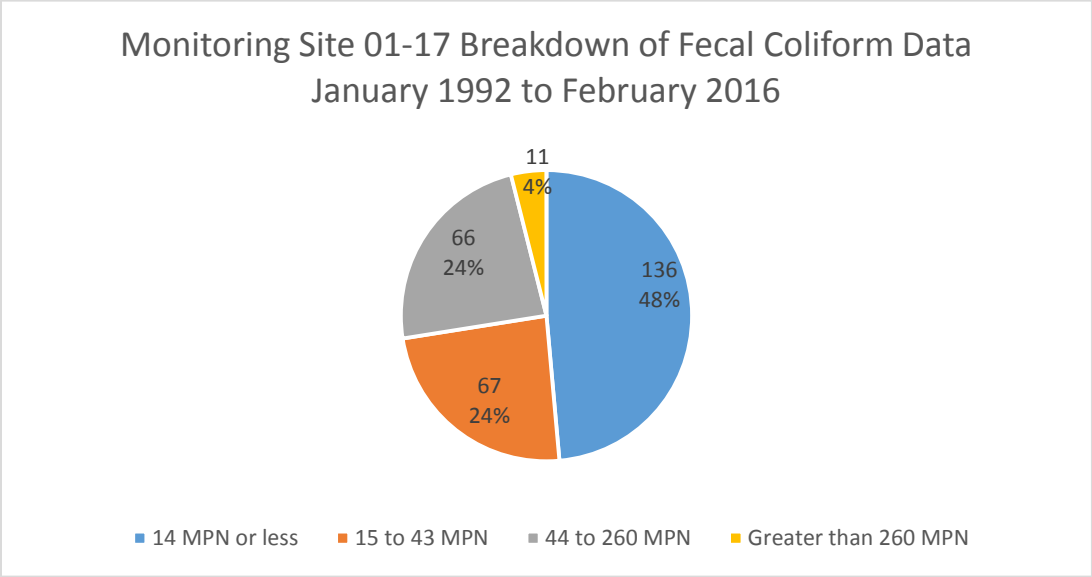
Summary of Monitoring Site 01-07 February 2013 through February 2016		
	# of samples	**% of samples**
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	18	50.0%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	8	22.2%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	10	27.8%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	0	0.0%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report. ***MPN- Most Probable Number is the standard measurement unit for Fecal Coliform***		


Monitoring Site 01-07 Breakdown of Fecal Coliform Data
Febraury 2013 to February 2016
10
28%
18
50%
8
22%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

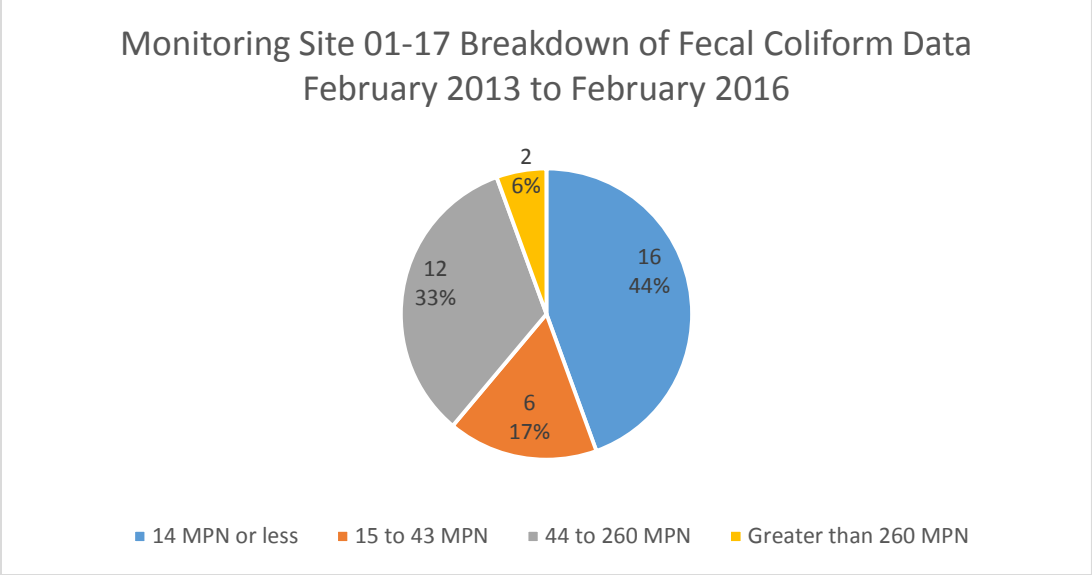

Scatter Plot of all Data Samples at Site 01-07
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
2500
540
180
130
450
220
33
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15

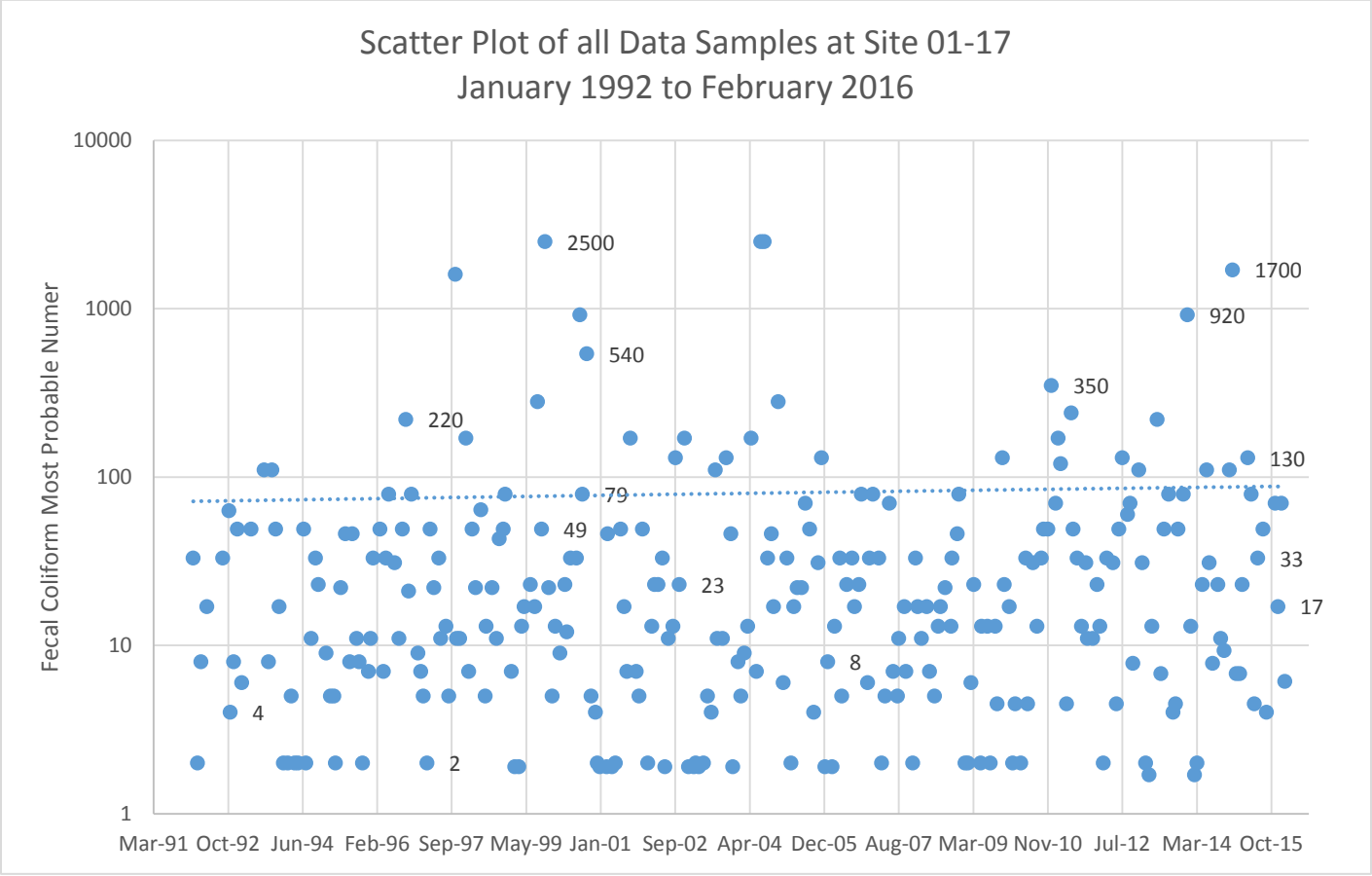
Monitoring Site 01-17 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-17 Sampling Data		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	136	48.9%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	67	24.1%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	66	23.7%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	11	3.9%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe.		



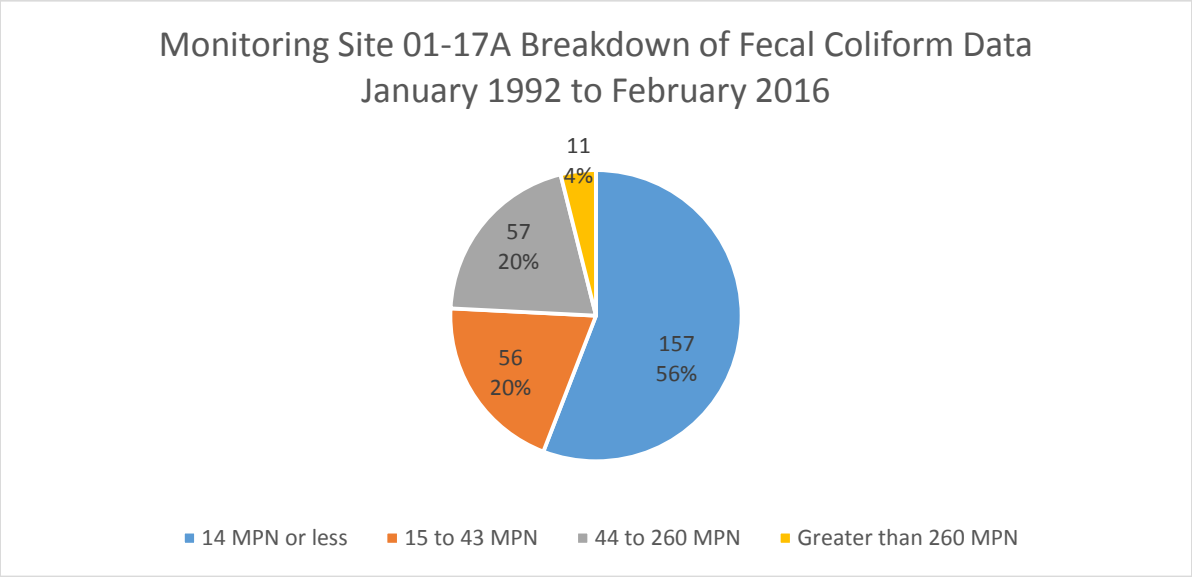
Summary of Monitoring Site 01-17 February 2013 through February 2016		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	16	44.4%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	6	16.7%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	12	33.3%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	2	5.6%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report.		


Monitoring Site 01-17 Breakdown of Fecal Coliform Data
February 2013 to February 2016
2
6%
16
44%
12
33%
6
17%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

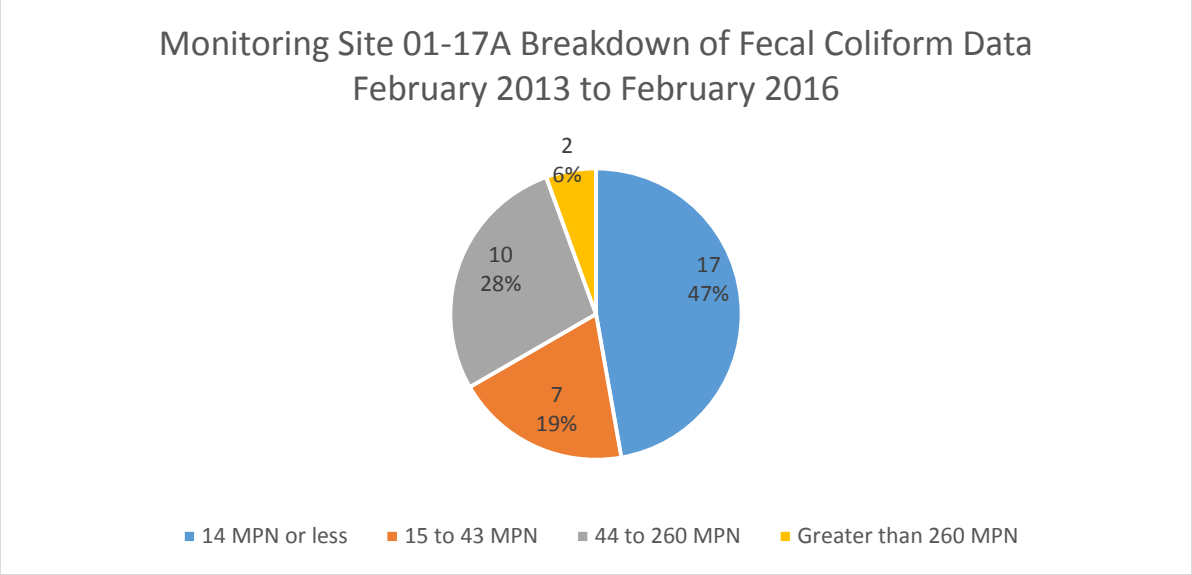

Scatter Plot of all Data Samples at Site 01-17
January 1992 to February 2016
Fecal Coliform Most Probable Numer
10000
1000
100
10
1
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15
2500
1700
920
540
350
220
130
79
49
33
23
17
8
4
2

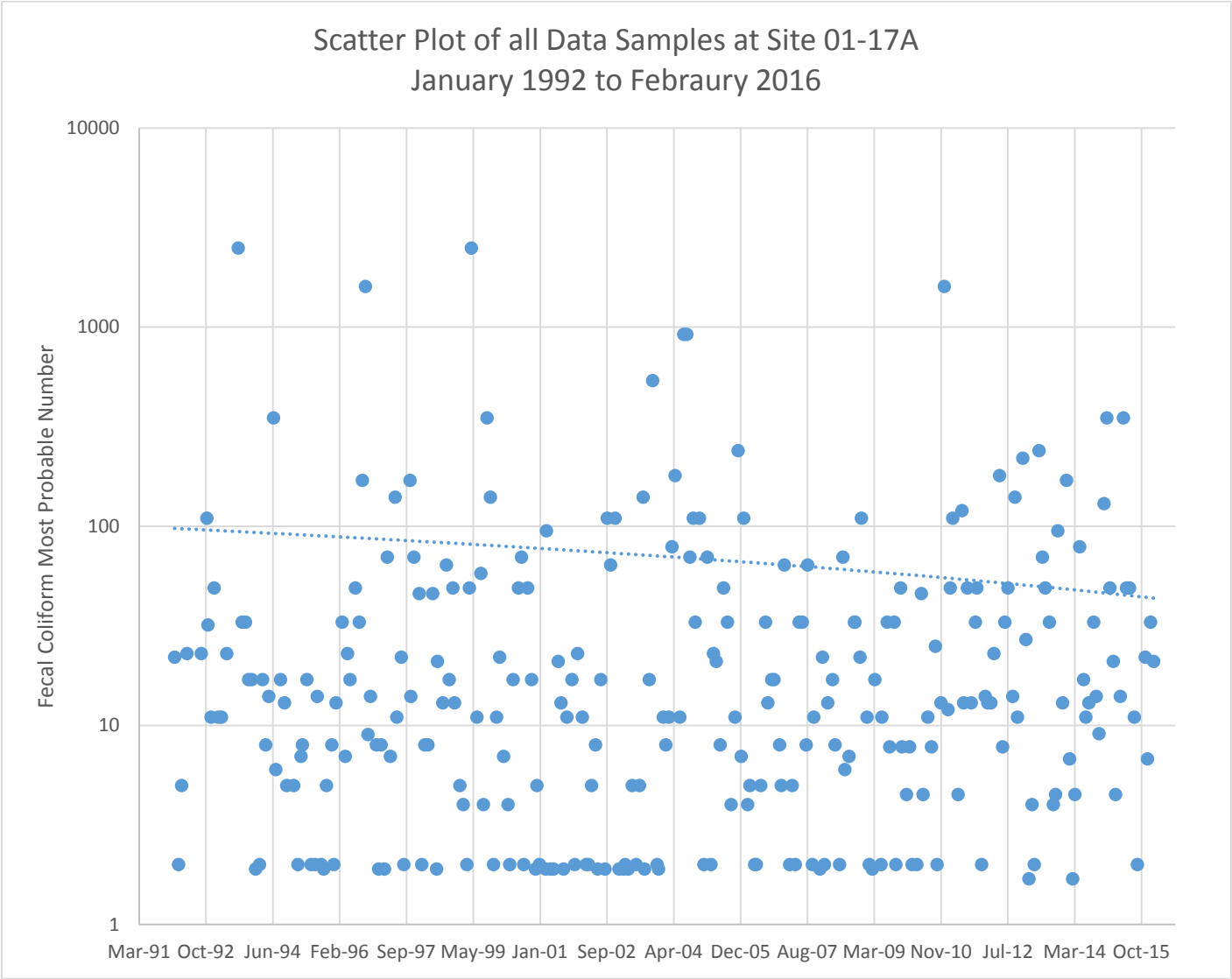
Monitoring Site 01-17A Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-17A Sampling Data		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	157	56.5%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	56	20.1%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	57	20.5%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	11	3.9%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe.		



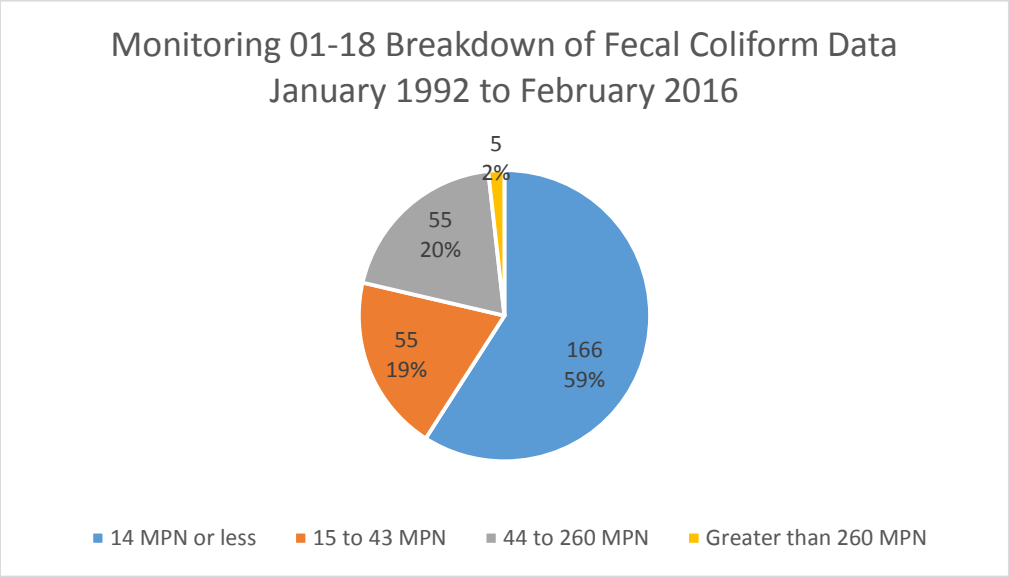
Summary of Monitoring Site 01-17A February 2013 through February 2016		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	17	47.2%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	7	19.4%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	10	27.8%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	2	5.6%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report.		


Monitoring Site 01-17A Breakdown of Fecal Coliform Data
February 2013 to February 2016
2
6%
10
28%
17
47%
7
19%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

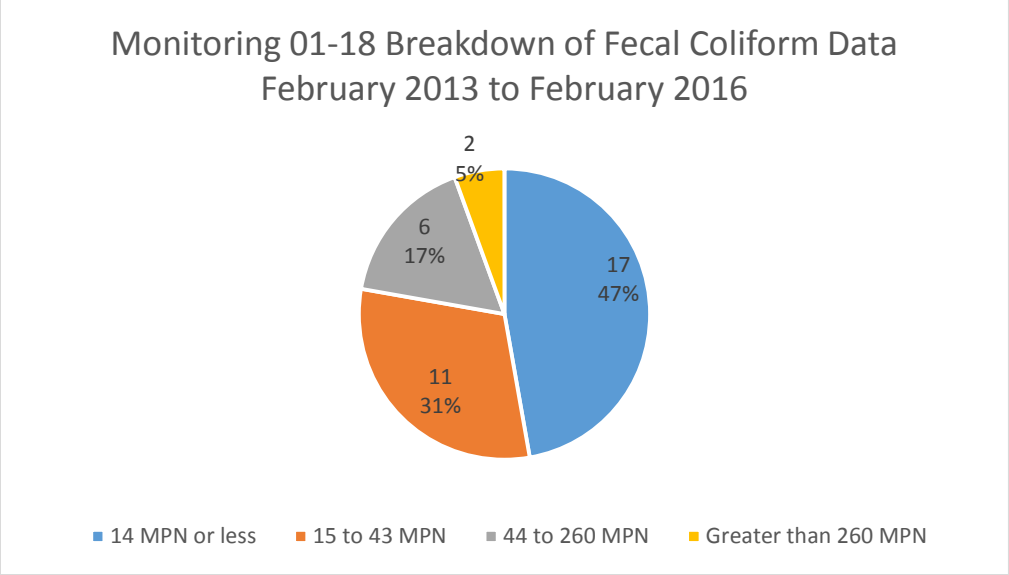

Scatter Plot of all Data Samples at Site 01-17A
January 1992 to Febraury 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15

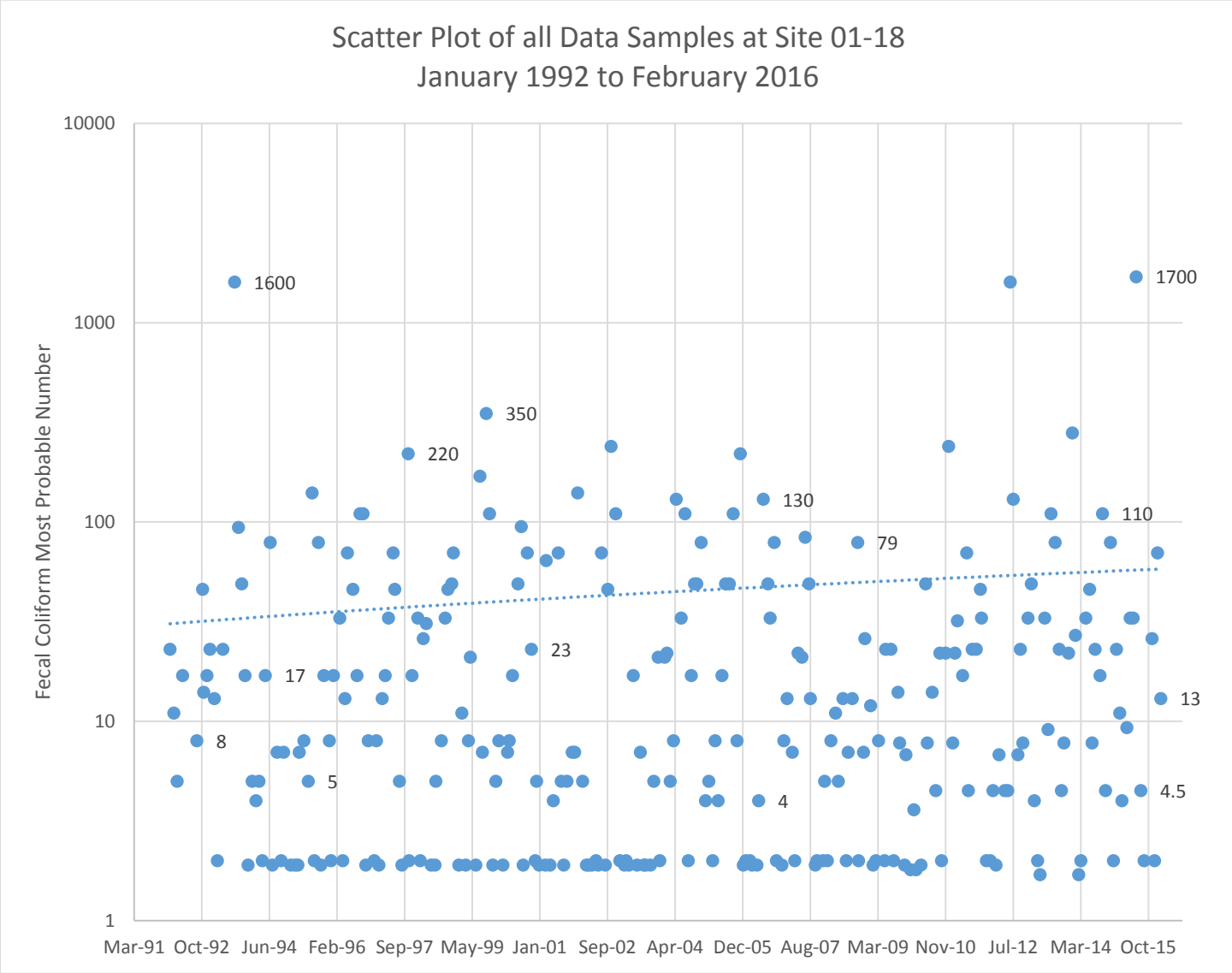
Monitoring Site 01-18 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-18 Sampling Data		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	166	59.7%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	55	19.8%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	55	19.8%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	5	1.8%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe.		



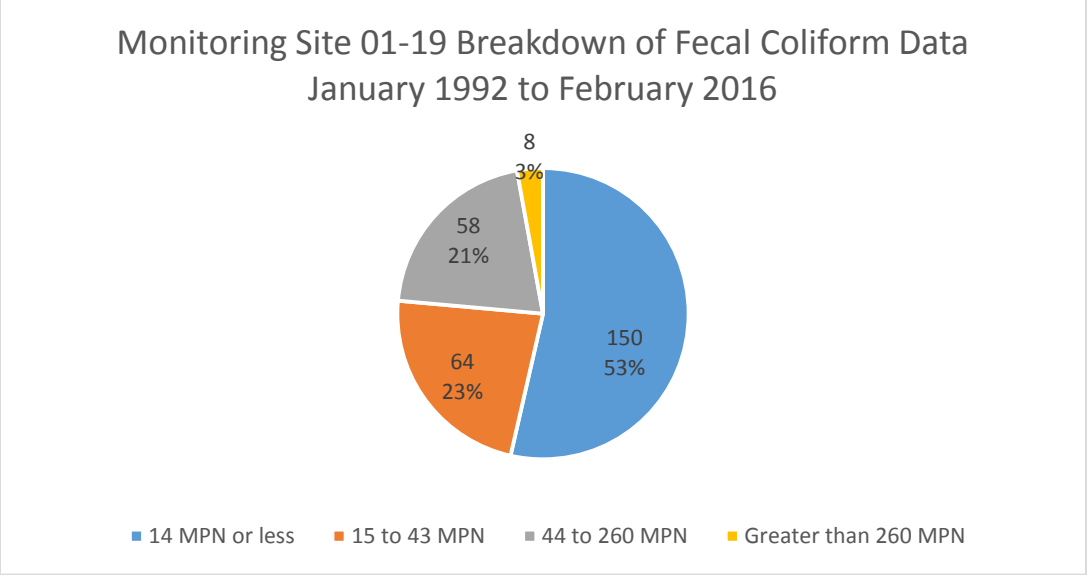
Summary of Monitoring Site 01-18 February 2013 through February 2016		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	17	47.2%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	11	30.6%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	6	16.7%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	2	5.6%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report.		


Monitoring 01-18 Breakdown of Fecal Coliform Data
February 2013 to February 2016
2
5%
6
17%
17
47%
11
31%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN

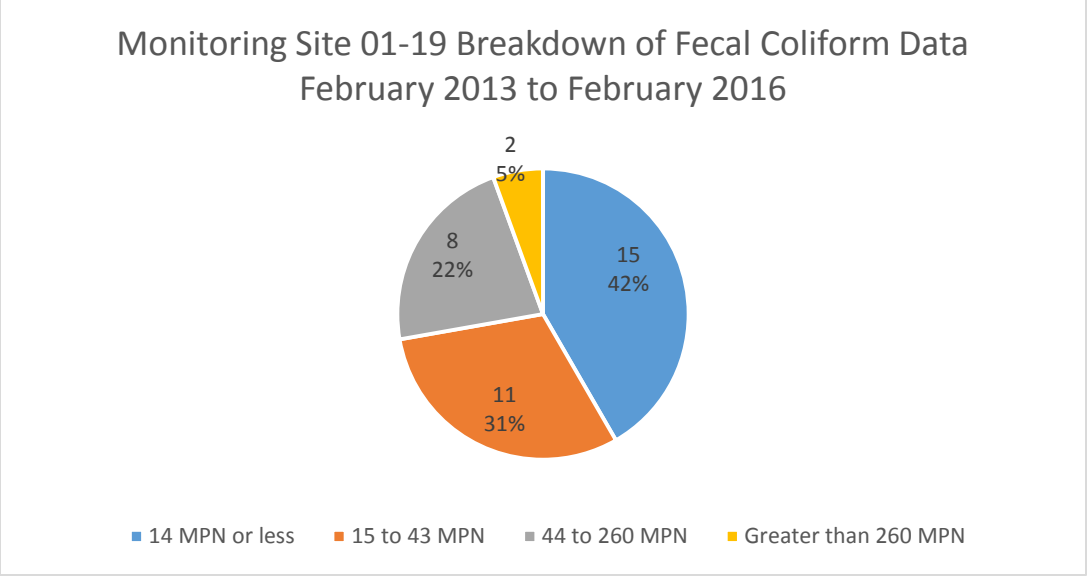

Scatter Plot of all Data Samples at Site 01-18
January 1992 to February 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
1600
1700
350
220
130
110
79
23
17
13
8
5
4
4.5
Mar-91
Oct-92
Jun-94
Feb-96
Sep-97
May-99
Jan-01
Sep-02
Apr-04
Dec-05
Aug-07
Mar-09
Nov-10
Jul-12
Mar-14
Oct-15

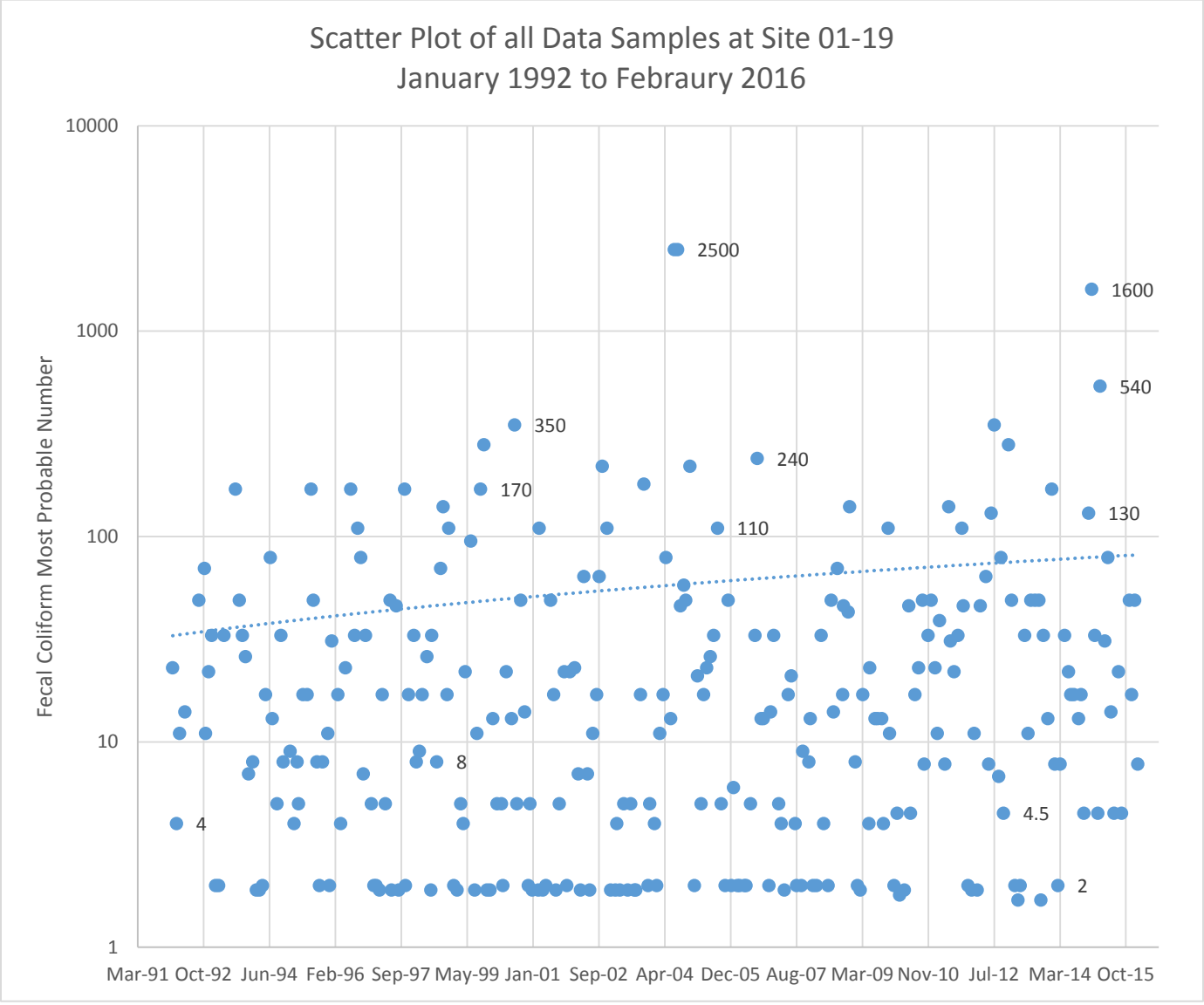
Monitoring Site 01-19 Summary Profile of SC DHEC Monitoring Data

Summary of Monitoring Site 01-19 Sampling Data		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	150	54.0%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	64	23.0%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	58	20.9%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	8	2.9%
Note: The period of record for this study is from January 1992 to Feb 2016. A total of 278 samples have been collected in that timeframe.		



Summary of Monitoring Site 01-19 February 2013 through February 2016		
	# of samples	% of samples
# of samples 14 MPN or less (below the geometric mean DHEC Standard)	15	41.7%
# of samples 15 to 43 MPN (Within the 90th Percentile DHEC Standard)	11	30.6%
# of samples 44 to 260 MPN (Within maximum standard limits for harvesting shellfish for purposes of relaying or depuration)	8	22.2%
# of samples greater than 260 MPN (Exceeds all SC DHEC Regulatory Standards)	2	5.6%
Note: The intention of this table is to examine the most recent 3 years' worth of data which is the basis of assessment in the annual SC DHEC Management Area 01 Shellfish Report.		


Monitoring Site 01-19 Breakdown of Fecal Coliform Data
February 2013 to February 2016
2
5%
8
22%
15
42%
11
31%
14 MPN or less
15 to 43 MPN
44 to 260 MPN
Greater than 260 MPN


Scatter Plot of all Data Samples at Site 01-19
January 1992 to Febraury 2016
Fecal Coliform Most Probable Number
10000
1000
100
10
1
2500
1600
540
350
240
170
130
110
8
4
4.5
2
Mar-91 Oct-92 Jun-94 Feb-96 Sep-97 May-99 Jan-01 Sep-02 Apr-04 Dec-05 Aug-07 Mar-09 Nov-10 Jul-12 Mar-14 Oct-15

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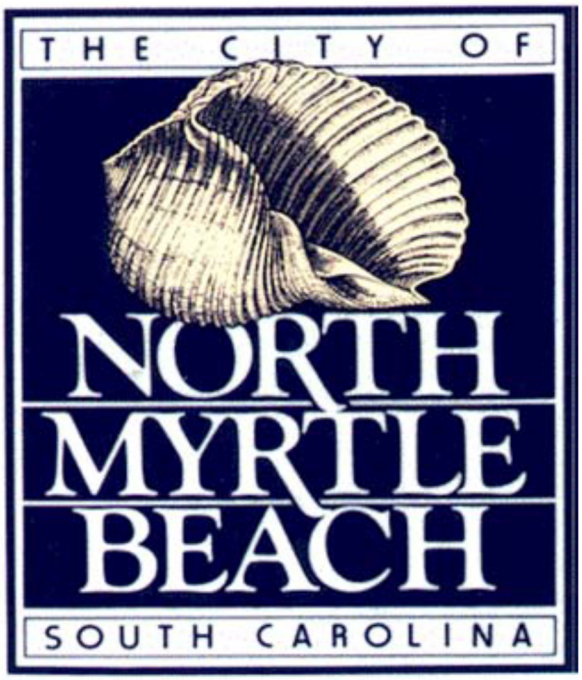
Appendix C: Watershed Pollutant Loading and BMP Implementation

One of the nine elements the EPA requires as part of a watershed plan development process is to estimate load reductions achieved by the implementation of the recommended watershed management activities. This can be one of the more technically challenging aspects of watershed plan development, especially when addressing fecal coliform bacteria, which is known to have a high variability. With the intention of developing realistic and accurate load reduction estimates, the project partners consulted with Woolpert Associates to calculate load reduction estimates for each of the management strategies outlined in **Element F**. As part of their report, Woolpert also developed annual pollutant loads for each of the catchment areas outlined in **Element A**. Below is the Watershed Pollutant Loading and BMP Implementation report completed by Woolpert Associates as part of the Hog Inlet Watershed Plan.



The City of North Myrtle Beach

Watershed Pollutant Loading and BMP Implementation

Analysis of Element F (Recommended Watershed Management Measures) in the 2017 Hog Inlet and Dunn Sound Creek Watershed Plan

April 2018

WOOLPERT
ARCHITECTURE | ENGINEERING | GEOSPATIAL

Table of Contents

1 Introduction

Hog Inlet and Dunn Sound Creek are designated as Shellfish Harvesting Waters by SCDHEC and both waterbodies are located within a monitoring area that is not meeting the water quality standard for fecal coliform bacteria. The City of North Myrtle Beach (the City) is committed to the challenging task of reducing bacteria in these watersheds. The 2017 Hog Inlet and Dunn Sound Creek Watershed Plan outlines future watershed management activities and strategies that may be implemented to improve water quality and ensure long-term success of the watershed plan.

Element F of the watershed plan discusses 19 recommended watershed management measures. These measures include both structural and non-structural BMPs which target a diverse range of topics across the watershed. The watershed is divided into six catchment areas, each with different landuse types. Each of these catchment areas was analyzed using GIS to determine the existing pollutant loading for bacteria and then an approximated load reduction was calculated based on each potential BMP implementation. The procedures and results of this study are discussed within this report.

2 Discussion

2.1 Catchment Areas

The catchment areas in the Hog Inlet-Dunn Sound Creek watershed are outlined on a map in Exhibit A-1 of the watershed plan. Table 1 provides a short description of each catchment area. The catchment areas were delineated using GIS and are displayed on a map in Figure 1 of this report.

Pollutant loads were calculated for five of the six catchment areas in the watershed plan. Catchment area 01 (Waties Island/Little River Inlet) is a completely undeveloped area. It was assumed that there will be no BMPs implemented in the undeveloped Catchment Area 01 at this time, so it was not included in this analysis.

Table 1. Catchment Area Information

Basin	Basin Name	Area (acres)
Catchment Area 01	Waties Island/Little River Inlet	1,377
Catchment Area 02	Little River Neck- Waterway	3,197
Catchment Area 03	Little River Neck- Marsh	1,639
Catchment Area 04	East Cherry Grove	1,152
Catchment Area 05	Hill Street	753
Catchment Area 06	Sea Mountain Highway to 11th Ave North	717

Figure 1. Hog Inlet-Dunn Sound Creek Watershed: Delineation of Catchment Areas

2.2 Pollutant Load Calculations

Landuse type is one of the main components of this analysis for calculating pollutant loads. Using GIS, each catchment area was divided into the following various landuse types:

- commercial,
- golf,
- multi-family residential,
- open (including water),
- single-family residential, and
- woods.

The calculations are heavily weighted by area and landuse based Event Mean Concentrations (EMCs). In 2011, Dr. Robert Pitt investigated the characteristics of stormwater discharges and discussed the outcomes of this study in *The National Stormwater Quality Database*. The database states that geographical area and landuse are identified as important factors affecting stormwater runoff quality. Pitt conducted detailed analyses to calculate concentrations for various stormwater characteristics for different landuses (shown by the EPA Rain Zone). Pitt calculated concentrations for fecal coliforms (cfu/100mL) from a specified number of events for different landuses and these EMCs were used in this analysis.

To calculate the annual pollutant load in each basin, a weighted runoff coefficient (C) and a weighted EMC were first calculated. The weighted runoff coefficient was multiplied by the annual basin runoff (based on an annual rainfall depth of 50 in/yr for North Myrtle Beach), which was then multiplied by the weighted EMC. The annual bacteria load for each catchment area is shown in Table 2. The annual loading values that were calculated for fecal coliform in each of the catchment areas were used to determine the potential bacteria reduction when several different BMPs are implemented. All of the recommended BMPs will be implemented differently in each basin, depending on the BMP type in relation to the specific landuse within each basin, which is accounted for in the reduction calculations.

Table 2. Annual Bacteria Loads

Basin	Annual Bacteria Load (cfu/yr)
Catchment Area 01	-
Catchment Area 02	2.7E+14
Catchment Area 03	2.6E+14
Catchment Area 04	3.5E+14
Catchment Area 05	1.2E+14
Catchment Area 06	1.4E+14

2.3 Watershed Management Recommendations

The Hog Inlet and Dunn Sound Creek Watershed Plan includes a list of 19 recommended watershed management measures in Element F, including both structural and non-structural BMPs. Each measure was carefully studied in order to obtain an acceptable value for the annual bacteria loading to use in calculating a load reduction for the catchment areas. Sections 2.3.1 through 2.3.14, provide the rationale for the load reductions for each recommended measure to be implemented in the basins.

Some recommendations in the watershed plan are dependent upon public acceptance and participation, which is hard to predict, making it difficult to quantify a load reduction. For these measures, an assumption was made that the annual load will be reduced by 0.5%.

2.3.1 Recommendation F-1

Recommendation F-1 focuses on increasing efforts to discourage people from feeding birds/wildlife to prevent nuisance wildlife and minimize unwanted fecal coliform bacteria from entering the estuary. This recommendation is based on public outreach, which solely depends on public participation, making it difficult to quantify a load reduction. With the assumption of a low participation level from the public, a reduction of 0.5% was used for all basins with these activities.

2.3.2 Recommendation F-2

This recommendation involves the installation of pet waste stations across the community to ensure proper pet waste disposal and continue to educate the public on the benefits that pet waste stations have on water quality. Clemson University's Research Extension performed a study of Georges Creek within the Upper Saluda River Basin and concluded that each pet waste station can reduce bacteria by 2.19E+12 cfu annually, which was the reduction value applied to these calculations for this BMP.

Catchment Area 02 contains a variety of landuse types. It was assumed that 30% of the entire basin contains public areas with the potential use of pet waste stations. As a result, approximately 20 pet waste stations were considered for calculating bacteria load reduction in Catchment Area 02.

The majority of Catchment Area 03 is open marshland. The remainder of the basin is heavily wooded with some single-family residential neighborhoods. For Catchment Area 03, 1 possible pet waste station was considered for load reduction.

According to a visitor's guide written by North Myrtle Beach Chamber of Commerce Convention and Visitors Bureau, North Myrtle Beach has 240 public beach access points along 9 miles of shoreline (estimated to have 26 access points per mile of shoreline). There is approximately 5 miles of shoreline in Catchment Area 04. It was assumed a pet waste station will be installed at every other public beach access point, resulting in potentially 65 stations. In addition to these shoreline stations, 5 stations were considered for possible parks, walking trails, and multi-family housing located in the remaining area of Catchment Area 04. A total of 70 pet waste stations were considered for load reduction calculations in Catchment Area 04.

Catchment Area 05 and 06 both consist of similar landuse types: single-family residential, woods, and open space. Most single-family residential neighborhoods do not have pet waste stations, unless there are neighborhood walking trails and/or residential parks. Catchment Area 05 and Catchment Area 06 were both considered to have 4 pet waste stations within each basin.

2.3.3 Recommendation F-3

This recommendation considers the bacteria loading from feral cat populations throughout the watershed. The City can manage the population of feral cats and potentially decrease bacteria loading in the watershed, but it is heavily dependent on public education and participation. This recommended measure was estimated to have a low participation level and to reduce fecal coliform bacteria by 0.5% in each catchment area.

2.3.4 Recommendation F-4

Recommendation F-4 is that the City will initiate an education campaign to encourage property owners to secure dumpsters to prevent dumpster leaks from occurring that could potentially enter stormwater runoff. In Chapter 8 of *Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices,* a study was performed that suggested the removal performance for trash management education and public outreach may be up to 35%. Due to the public participation component and the low bacteria impact from leaking dumpsters, a 0.5% fecal coliform reduction rate was applied to the catchment areas where dumpsters are used.

2.3.5 Recommendation F-5

This recommendation suggests a way to reduce bacteria in residential areas by promoting the use of rain barrels and cisterns by homeowners. A water quality publication from an advanced research site called *ResearchGate* discusses a study of organisms detected in rainwater harvesting. Results from the study show that "*the presence of coliforms, E. coli, and enterococci in [harvested] rainwater were found to be 80.3%, 40.9%, and 28.8%, respectively*." The average of these bacteria removal levels is 50%, which was used in the load reduction calculations for each basin with single-family residential areas. Assumptions for this BMP were based on a 10% participation of homeowners, an average 1,500 square foot roof size for all single-family homes in this watershed, and a bacteria EMC for roofs of approximately 4,531 cfu/yr.

2.3.6 Recommendation F-6

This recommendation suggests that implementing a wide vegetated buffer can help filter stormwater before entering the receiving waterbody. Many benefits can be achieved from vegetated buffers along estuary shorelines, stormwater ponds, and ditches; however, bacteria reduction is low for this BMP. A vegetated buffer has the potential to discourage migrating waterfowl, which would decrease bacteria loads. However, the migration of birds has already decreased in recent years in North Myrtle Beach. Therefore no reduction was assumed and a 0% reduction rate for fecal coliform was utilized for vegetated buffers in this analysis.

2.3.7 Recommendation F-7

This recommendation focuses on stabilizing erosion along pond or estuary shorelines. For this analysis, potential bacteria removal was calculated for the stabilization of pond shorelines in each basin. A 25% bacteria removal rate for stabilized channels was determined by a study discussed in Chapter 8 of *Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices.* This reduction percentage was applied to the average annual bacteria loading for the drainage area to each pond.

The total area of ponds for each basin was determined using GIS and the average drainage area for each pond was estimated to be approximately ten times the pond surface area. The analysis used total pond areas as follows: Catchment Area 02, 6.1 acres; Catchment Area 03, 6.9 acres; Catchment Area 04, 15.0 acres; Catchment Area 05, 8.3 acres; and Catchment Area 06, 9.2 acres.

2.3.8 Recommendation F-8, F-9, F-10, F-11, and F-12

These five recommendations focus on the repair, replacement, and maintenance of septic systems throughout the watershed. A study by Clemson University's Research Extension of Georges Creek within the Upper Saluda River Basin in South Carolina concluded that 2.42E+10 cfu of bacteria may be removed annually per household using the Spreadsheet Tool for Estimating Pollutant Load (STEPL) Model. This annual removal and an estimated number of residential dwellings that use septic tanks in each basin was used to calculate the annual bacteria reduction rate. The analysis used an estimated number of residential dwellings that use septic tanks as follows: Catchment Area 02, 800 homes; Catchment Area 03, 100 homes; Catchment Area 04, 200 homes; Catchment Area 05, 600 homes; and Catchment Area 06, 100 homes.

2.3.9 Recommendation F-13

This recommendation involves the construction of an ocean outfall to divert stormwater entering the estuary. The outfall would divert runoff from the Surf Golf and Beach Club, as well as a large portion of Sea Mountain Highway. The outfall would capture approximately 50% of Catchment Area 06, reducing the bacteria in that catchment by 50%. The bacteria reduction in the other catchments for this recommendation was 0%.

2.3.10 Recommendation F-14

This recommendation discusses the potential for bacteria loads to be reduced by installing floating wetland devices in stormwater ponds throughout the entire watershed. Louisiana State University performed a 27-month study on floating wetland devices that suggested a 58.9% reduction of fecal coliforms. This reduction averaged to am annual reduction rate of 26.2%. This annual reduction was used to calculate a load reduction dependent on the total drainage area that each pond collects. The total area of ponds in each catchment area is listed in Section 2.3.7 (Recommendation F-7).

2.3.11 Recommendation F-15

This recommendation suggests installing pervious parking lots and streets throughout the entire watershed and installing pervious pavement on the 50-100 foot sections of dead end streets in the Cherry Grove Beach area. Installing new areas of pervious pavement throughout the entire watershed will not increase bacteria loading, but will also not reduce it; therefore a 0% bacteria reduction was assumed in all basins except Catchment 04. Cherry Grove Beach is in Catchment 04 and contains approximately 21 dead end streets that will be converted to pervious pavement. A trapping efficiency of 98% bacteria for pervious pavements determined by an "*Environmental Benefits of Pervious Pavement*" study in Maryland and Virginia was used to complete the analysis of this BMP.

2.3.12 Recommendation F-16

This recommendation focuses on potential bacteria load reductions from agricultural land. A watershed plan for Georges Creek, written by Clemson University's Research Extension, included results from a study to minimize sources of bacteria from agricultural runoff using an agricultural BMP Bundle. A typical agricultural BMP Bundle includes fencing between the farm and streams, 600 feet of new waterline to an alternative livestock watering facility, and restoration of 0.23 acres of riparian buffer area. The results of the study determined an annual bacteria reduction of 1.86E+13 cfu per farm that implements an agricultural BMP Bundle. The number of farms were estimated for each basin based on landuse.

2.3.13 Recommendation F-17

Recommendation F-17 involves approval by the Army Corps of Engineers to open a second ocean inlet in Cherry Grove. All load reductions are accounted for before entering Cherry Grove, so this improvement will have a low impact on the reduction at the creek. A pollutant load reduction for opening the inlet was not calculated for this analysis.

2.3.14 Recommendation F-18 and F-19

These two recommendations have been grouped together because they both involve tasks to recycle shellfish and restore oyster reefs in the Hog Inlet and Dunn Sound Creek watershed. Volunteers and public participation will be one of the biggest hurdles for this activity. Also, the level of bacteria reduction is low for this activity. The percent removal of bacteria is based on the molluscan shellfish population and the concentration of bacteria in the water column. Studies show that the majority of bacteria are found adsorbed to sediment particles rather than free in the water column; therefore they are not available to be filtered by the molluscan shellfish. Because of the inaccessibility of the bacteria until the sediment is disturbed, the percent removal was assumed to be a 3% reduction.

3 Results

Results generated for each recommendation incorporated into each basin in the Hog Inlet and Dunn Sound Creek watershed are displayed in Table 3 and Table 4. Table 3 shows the total annual reduction in bacteria load for each BMP in each basin. Table 4 shows the percent removal of bacteria for each BMP in each basin. The total potential bacteria removal for each basin is displayed in Table 5.

Table 3. Annual Bacteria Reduction by Each BMP in Each Basin

	Annual Bacteria Reduction (cfu/yr)				
Recommendation	**Catchment Area 02**	**Catchment Area 03**	**Catchment Area 04**	**Catchment Area 05**	**Catchment Area 06**
F-1: Public Ed, Feeding Wildlife	1.35E+12	1.32E+12	1.73E+12	6.24E+11	7.11E+11
F-2: Pet Waste Stations	4.38E+13	4.38E+12	1.53E+14	8.76E+12	8.76E+12
F-3: Public Ed, Feral Cat Management	1.35E+12	1.32E+12	1.73E+12	6.24E+11	7.11E+11
F-4: Public Ed, Dumpsters	1.35E+12	1.32E+12	1.73E+12	6.24E+11	7.11E+11
F-5: Rainwater Harvesting	3.11E+12	1.65E+12	3.69E+12	2.01E+12	2.34E+12
F-6: Vegetated Buffers	-	-	-	-	-
F-7: Stabilizing Shorelines	1.29E+12	2.76E+12	1.12E+13	3.43E+12	4.55E+12
F-8, F-9, F-10, F-11, F-12: Septic System Management	1.94E+13	2.42E+12	4.84E+12	1.45E+13	2.42E+12
F-13: Ocean Outfall in Catchment 06	-	-	-	-	7.11E+13
F-14: Floating Wetlands	1.35E+12	2.90E+12	1.18E+13	3.59E+12	4.77E+12
F-15: Pervious Pavement in Catchment 04	-	-	8.33E+08	-	-
F-16: Agricultural Land BMPs	5.58E+13	3.72E+13	-	1.86E+13	-
F-17: Cherry Grove Ocean Inlet	-	-	-	-	-
F-18, F-19: Shellfish Habitat Restoration	8.12E+12	7.90E+12	1.04E+13	3.74E+12	4.26E+12

Table 4. Percent Bacteria Removal for Each BMP in Each Basin

	Bacteria Removal (%)				
Recommendation	**Catchment Area 02**	**Catchment Area 03**	**Catchment Area 04**	**Catchment Area 05**	**Catchment Area 06**
F-1: Public Ed, Feeding Wildlife	0.5%	0.5%	0.5%	0.5%	0.5%
F-2: Pet Waste Stations	16.2%	1.7%	44.3%	7.0%	6.2%
F-3: Public Ed, Feral Cat Management	0.5%	0.5%	0.5%	0.5%	0.5%
F-4: Public Ed, Dumpsters	0.5%	0.5%	0.5%	0.5%	0.5%
F-5: Rainwater Harvesting	1.1%	0.6%	1.1%	1.6%	1.6%
F-6: Vegetated Buffers	-	-	-	-	-
F-7: Stabilizing Shorelines	0.5%	1.0%	3.2%	2.7%	3.2%
F-8, F-9, F-10, F-11, F-12: Septic System Management	7.2%	0.9%	1.4%	11.6%	1.7%
F-13: Ocean Outfall in Catchment 06	-	-	-	-	50.0%
F-14: Floating Wetlands	0.5%	1.1%	3.4%	2.9%	3.4%
F-15: Pervious Pavement in Catchment 04	-	-	0.0002%	-	-
F-16: Agricultural Land BMPs	20.6%	14.1%	-	14.9%	-
F-17: Cherry Grove Ocean Inlet	-	-	-	-	-
F-18, F-19: Shellfish Habitat Restoration	3.0%	3.0%	3.0%	3.0%	3.0%

Table 5. Total Potential Percent Bacteria Removal for Each Basin

Basin	Basin Name	Total Removal (%)
Catchment Area 01	Waties Island/Little River Inlet	-
Catchment Area 02	Little River Neck- Waterway	51%
Catchment Area 03	Little River Neck- Marsh	24%
Catchment Area 04	East Cherry Grove	58%
Catchment Area 05	Hill Street	45%
Catchment Area 06	Sea Mountain Highway to 11th Ave North	71%

4 Resources

Amin, Collick, Karsten, and Veith. “Best Management Practices for Reducing Nutrient Loads in a Sub-Watershed of Chesapeake Bay.” Pennsylvania State University.
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Web.http://rpitt.eng.ua.edu/Publications/4_Stormwater_Characteristics_Pollutant_Sources_and_Land_Development_Characteristics/Stormwater_characteristics_and_the_NSQD/NSQD%203.1%20summary%20for%20EPA%20Cadmus.pdf

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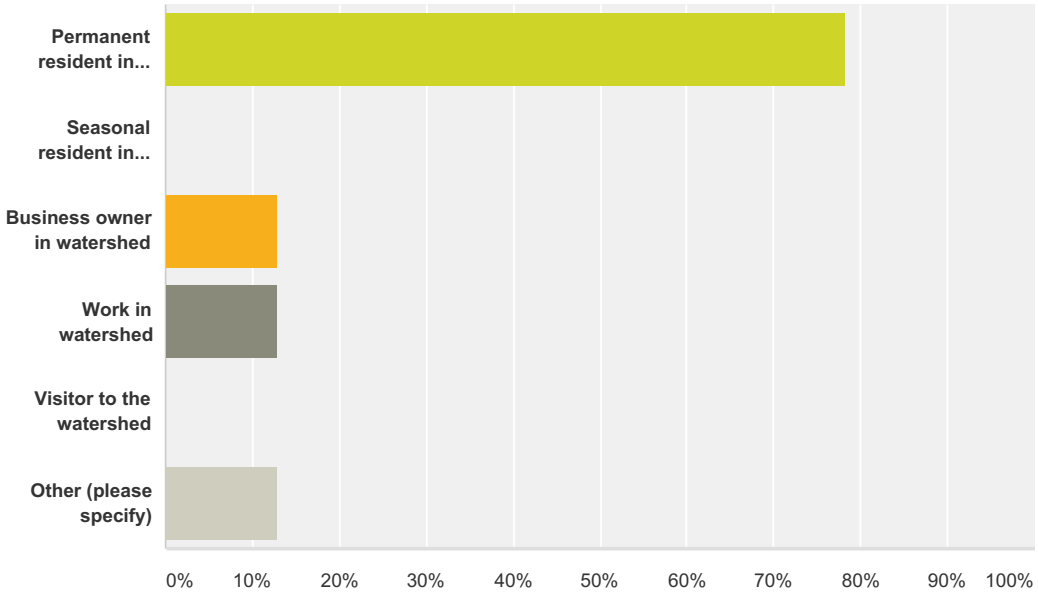
Appendix D: Public Survey Results

Q1 What is your connection to the Hog Inlet-Dunn Sound Creek Watershed? Select most applicable option:

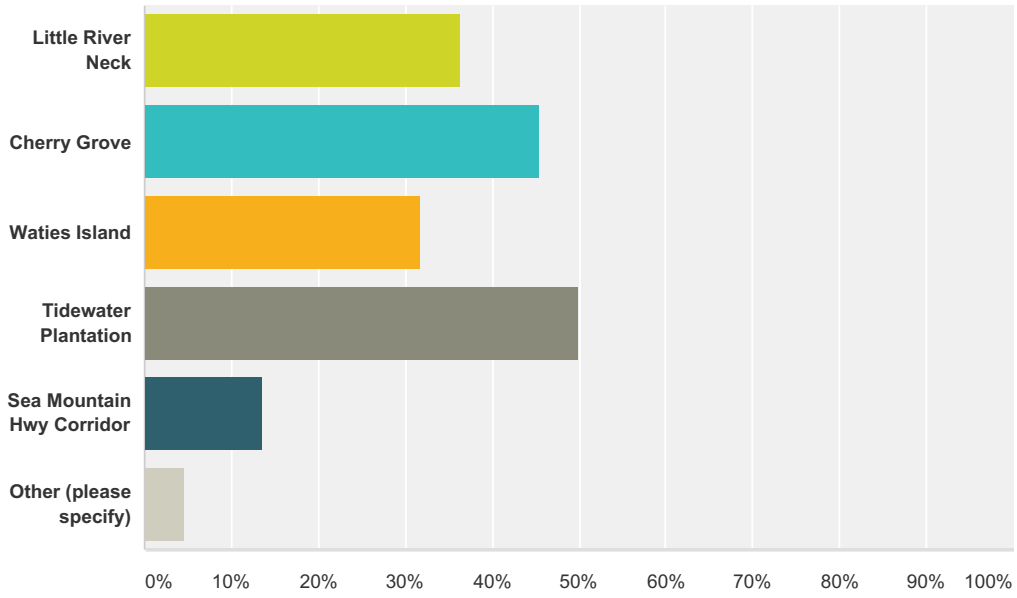
Answered: 23 Skipped: 1



Answer Choices	Responses	
Permanent resident in watershed	**78.26%**	18
Seasonal resident in watershed	**0.00%**	0
Business owner in watershed	**13.04%**	3
Work in watershed	**13.04%**	3
Visitor to the watershed	**0.00%**	0
Other (please specify)	**13.04%**	3
Total Respondents: 23		

Q2 What portion of the watershed are you most familiar with?

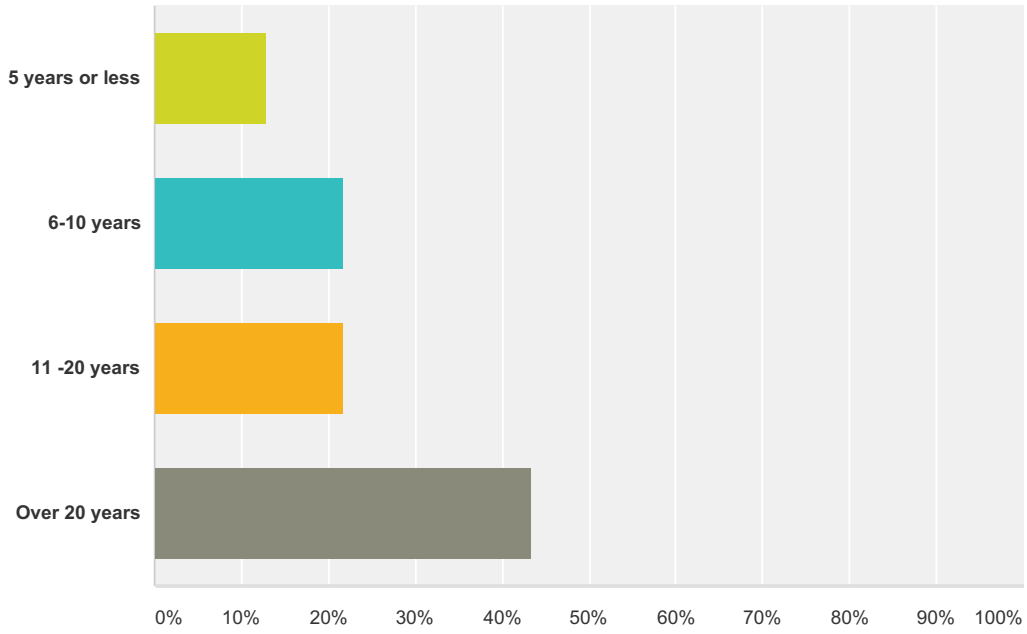
Answered: 22 Skipped: 2



Answer Choices	Responses	
Little River Neck	**36.36%**	8
Cherry Grove	**45.45%**	10
Waties Island	**31.82%**	7
Tidewater Plantation	**50.00%**	11
Sea Mountain Hwy Corridor	**13.64%**	3
Other (please specify)	**4.55%**	1
Total Respondents: 22		

Q3 How long have you been living in, working in, and/or visiting the watershed

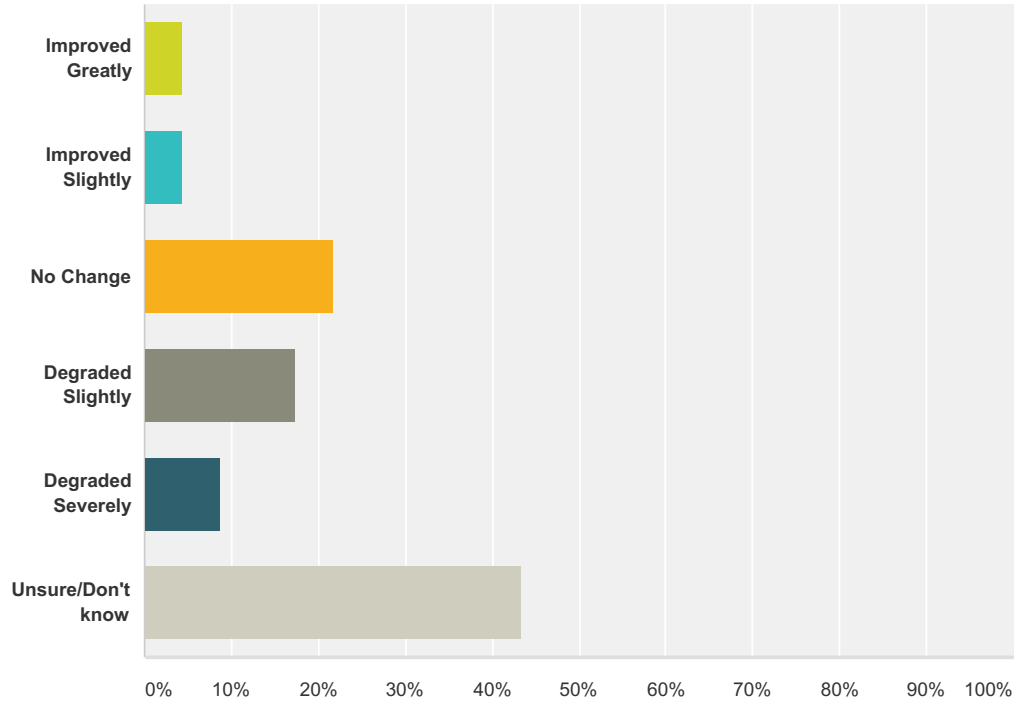
Answered: 23 Skipped: 1



Answer Choices	Responses	
5 years or less	**13.04%**	3
6-10 years	**21.74%**	5
11 -20 years	**21.74%**	5
Over 20 years	**43.48%**	10
Total		**23**

Q4 From your perspective, have water quality conditions changed over the past decade (or since the time you moved to or began working in/visiting watershed if less than 10 years)?

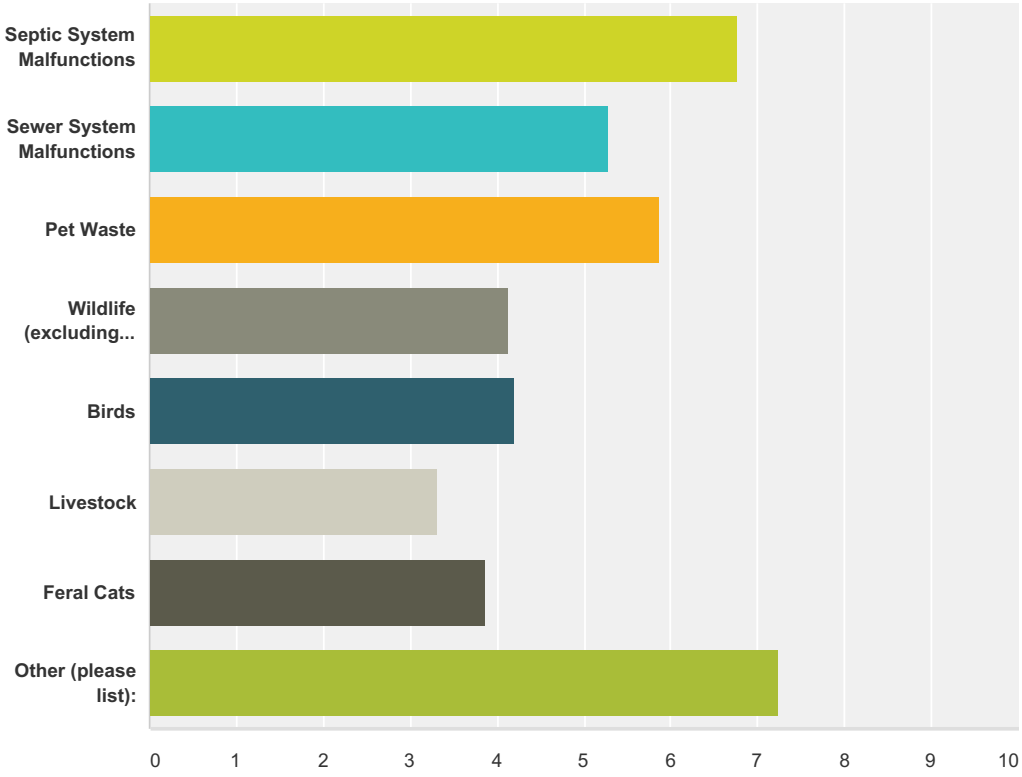
Answered: 23 Skipped: 1



Answer Choices	Responses	
Improved Greatly	4.35%	1
Improved Slightly	4.35%	1
No Change	21.74%	5
Degraded Slightly	17.39%	4
Degraded Severely	8.70%	2
Unsure/Don't know	43.48%	10
Total		23

Q5 Consider the following potential sources of bacteria. Please rank them from 1 through 8 with 1 being the biggest potential source of bacteria and 8 being the smallest potential source of bacteria affecting water quality in Hog Inlet and Dunn Sound Creek.

Answered: 20 Skipped: 4

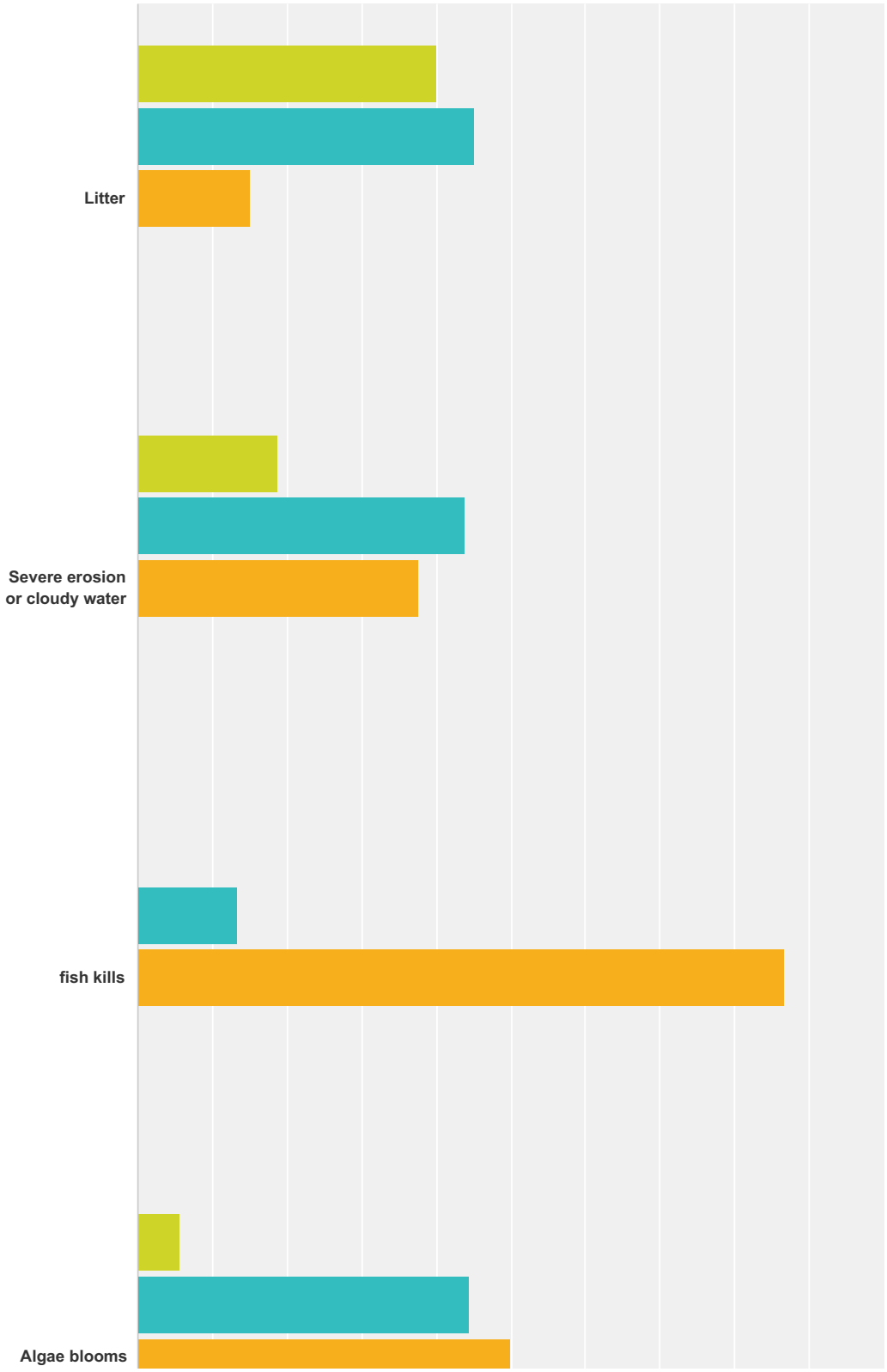


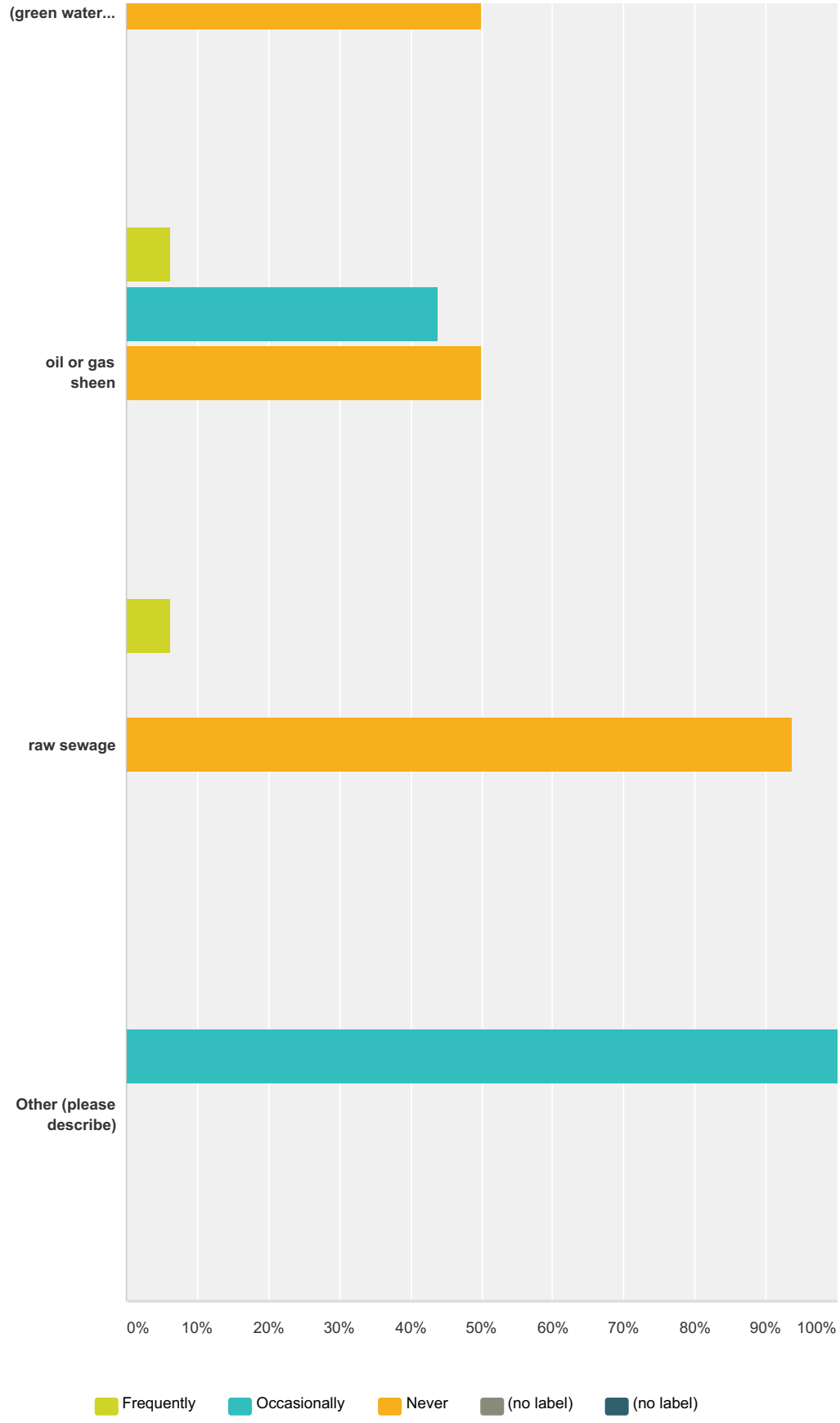
	1	2	3	4	5	6	7	8	Total	Score
Septic System Malfunctions	58.82% 10	17.65% 3	5.88% 1	0.00% 0	5.88% 1	5.88% 1	0.00% 0	5.88% 1	17	6.76
Sewer System Malfunctions	23.53% 4	23.53% 4	11.76% 2	5.88% 1	5.88% 1	5.88% 1	11.76% 2	11.76% 2	17	5.29
Pet Waste	20.00% 3	26.67% 4	20.00% 3	6.67% 1	6.67% 1	20.00% 3	0.00% 0	0.00% 0	15	5.87
Wildlife (excluding birds)	0.00% 0	0.00% 0	28.57% 4	28.57% 4	7.14% 1	7.14% 1	21.43% 3	7.14% 1	14	4.14
Birds	6.67% 1	13.33% 2	6.67% 1	13.33% 2	13.33% 2	26.67% 4	13.33% 2	6.67% 1	15	4.20
Livestock	0.00% 0	0.00% 0	0.00% 0	15.38% 2	23.08% 3	38.46% 5	23.08% 3	0.00% 0	13	3.31
Feral Cats	0.00% 0	6.67% 1	6.67% 1	26.67% 4	26.67% 4	0.00% 0	26.67% 4	6.67% 1	15	3.87

Other (please list):	**50.00%** 2	**25.00%** 1	**25.00%** 1	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	4	7.25

Q6 In the past year have you observed or noticed the presence of any of the following in local waterways? Mark one for each category

Answered: 22 Skipped: 2



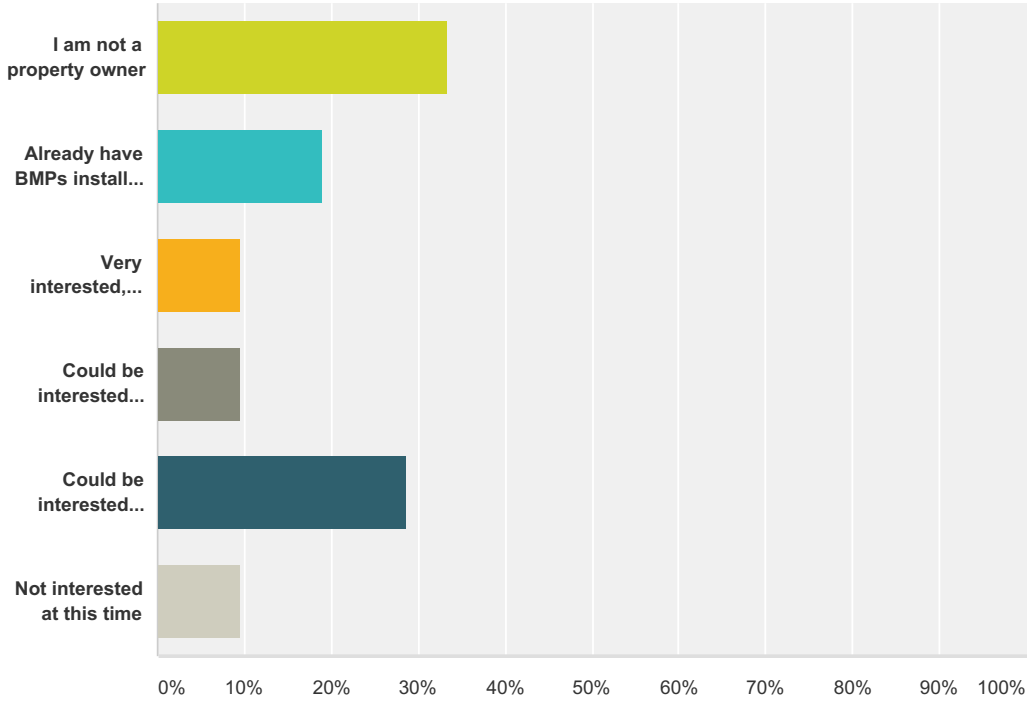


	Frequently	Occasionally	Never	(no label)	(no label)	Total

Litter	**40.00%** 8	**45.00%** 9	**15.00%** 3	**0.00%** 0	**0.00%** 0	20
Severe erosion or cloudy water	**18.75%** 3	**43.75%** 7	**37.50%** 6	**0.00%** 0	**0.00%** 0	16
fish kills	**0.00%** 0	**13.33%** 2	**86.67%** 13	**0.00%** 0	**0.00%** 0	15
Algae blooms (green water surface)	**5.56%** 1	**44.44%** 8	**50.00%** 9	**0.00%** 0	**0.00%** 0	18
oil or gas sheen	**6.25%** 1	**43.75%** 7	**50.00%** 8	**0.00%** 0	**0.00%** 0	16
raw sewage	**6.25%** 1	**0.00%** 0	**93.75%** 15	**0.00%** 0	**0.00%** 0	16
Other (please describe)	**0.00%** 0	**100.00%** 1	**0.00%** 0	**0.00%** 0	**0.00%** 0	1

Q7 If you are a property owner within the watershed indicate your willingness to implement one or more stormwater Best Management Practices on your property. Common individual property scale BMPs include Rain Barrels, Pervious Pavement, Rain Gardens, and Vegetated buffers.

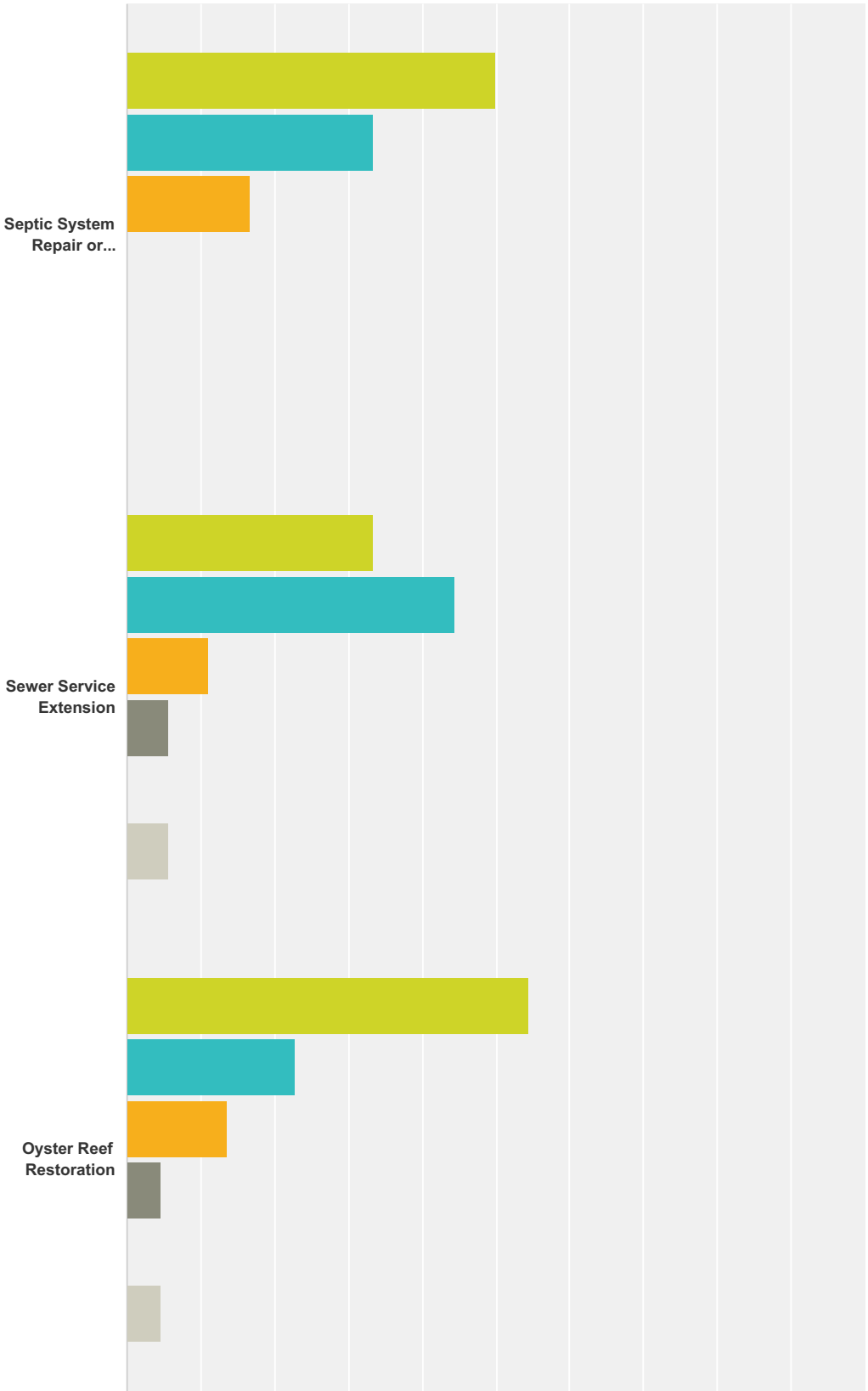
Answered: 21 Skipped: 3

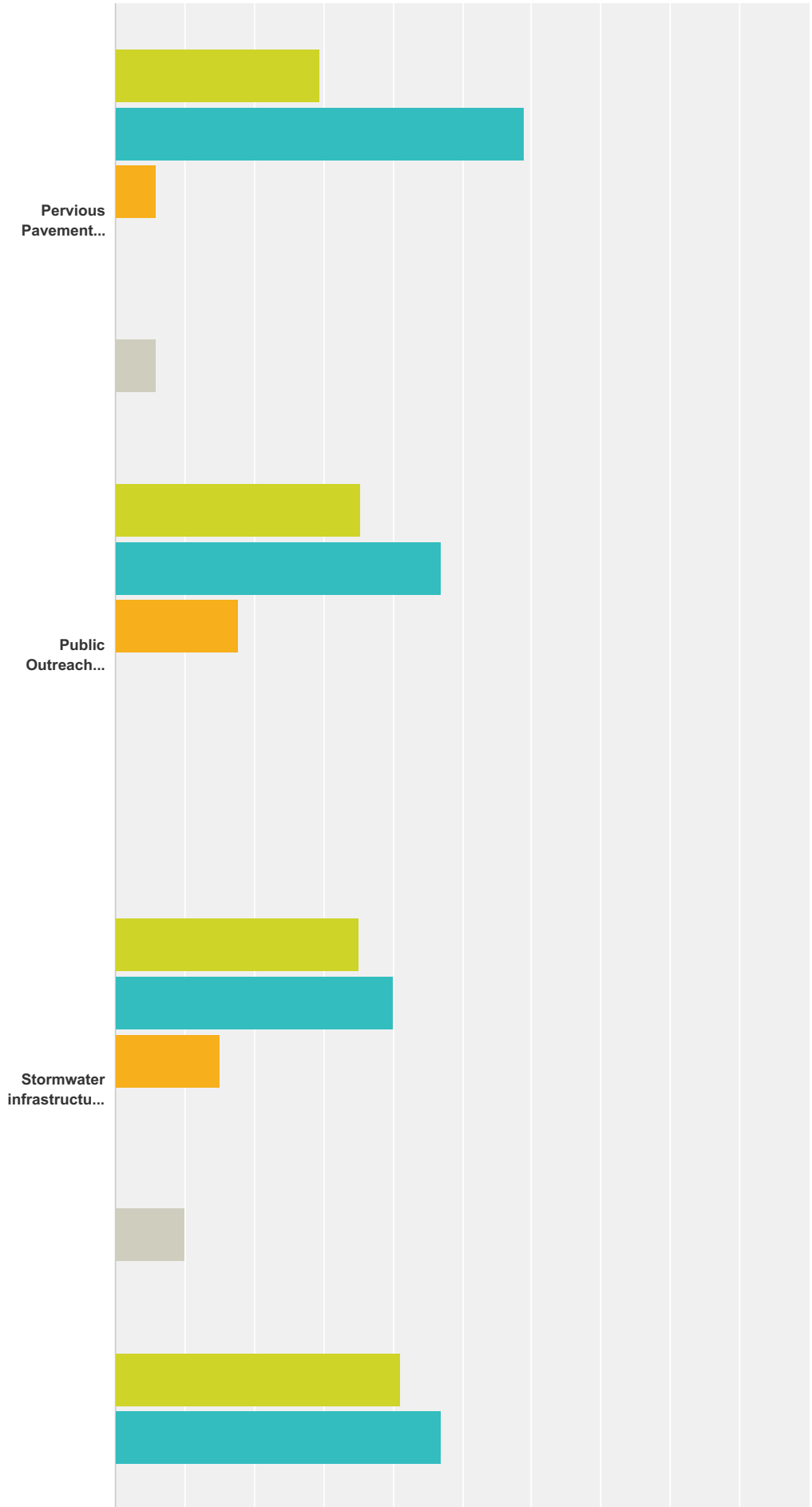


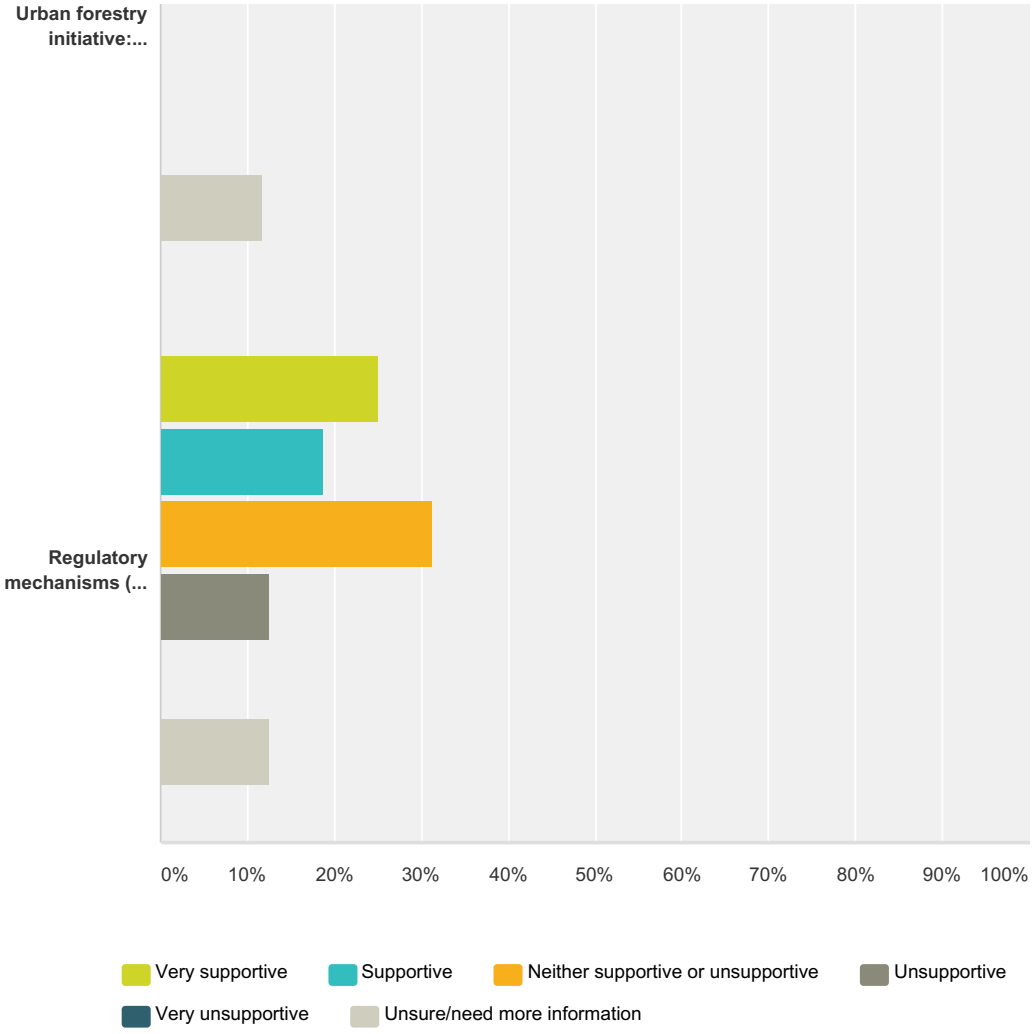
Answer Choices	Responses	
I am not a property owner	33.33%	7
Already have BMPs installed on my property. If so describe what type of BMP(s)	19.05%	4
Very interested, just need more information	9.52%	2
Could be interested depending on installation costs	9.52%	2
Could be interested depending on maintenance requirements and costs	28.57%	6
Not interested at this time	9.52%	2
Total Respondents: 21		

Q8 Indicate whether you would support the following community scale water quality initiatives

Answered: 23 Skipped: 1



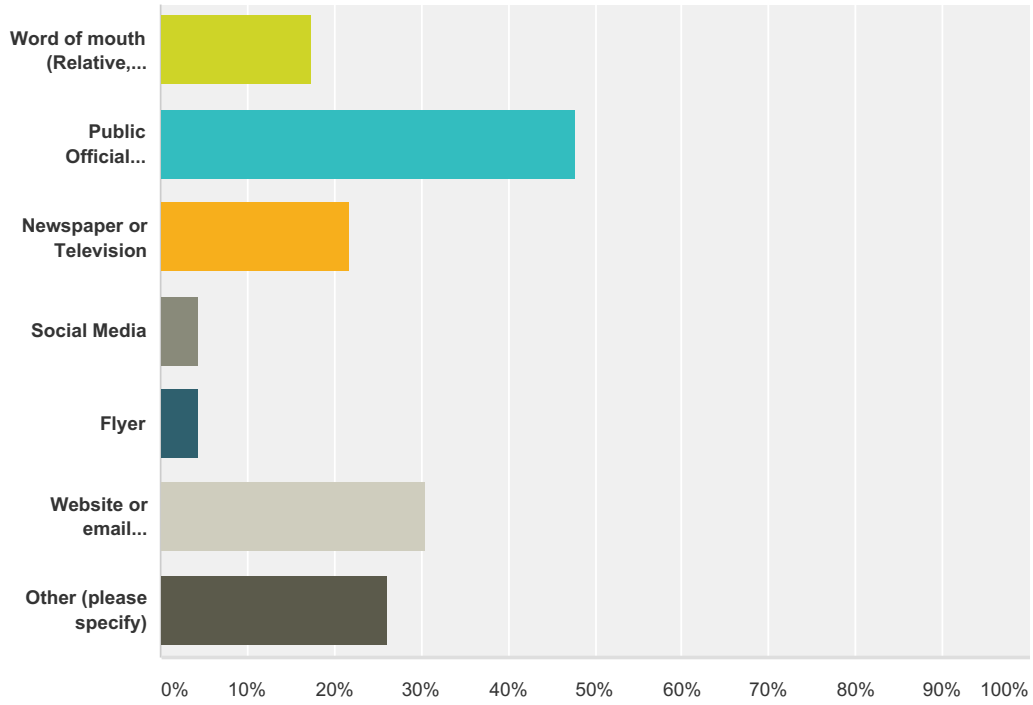

Pervious Pavement...
Public Outreach...
Stormwater infrastructu...



	Very supportive	Supportive	Neither supportive or unsupportive	Unsupportive	Very unsupportive	Unsure/need more information	Total
Septic System Repair or Replacement	**50.00%** 9	**33.33%** 6	**16.67%** 3	**0.00%** 0	**0.00%** 0	**0.00%** 0	18
Sewer Service Extension	**33.33%** 6	**44.44%** 8	**11.11%** 2	**5.56%** 1	**0.00%** 0	**5.56%** 1	18
Oyster Reef Restoration	**54.55%** 12	**22.73%** 5	**13.64%** 3	**4.55%** 1	**0.00%** 0	**4.55%** 1	22
Pervious Pavement Installation in public parking lots	**29.41%** 5	**58.82%** 10	**5.88%** 1	**0.00%** 0	**0.00%** 0	**5.88%** 1	17
Public Outreach Campaign	**35.29%** 6	**47.06%** 8	**17.65%** 3	**0.00%** 0	**0.00%** 0	**0.00%** 0	17
Stormwater infrastructure projects (i.e Constructed wetlands, floating treatment wetlands, stormdrain filters)	**35.00%** 7	**40.00%** 8	**15.00%** 3	**0.00%** 0	**0.00%** 0	**10.00%** 2	20
Urban forestry initiative: Tree planting, shoreline buffer establishment	**41.18%** 7	**47.06%** 8	**0.00%** 0	**0.00%** 0	**0.00%** 0	**11.76%** 2	17
Regulatory mechanisms (i.e zoning overlay district)	**25.00%** 4	**18.75%** 3	**31.25%** 5	**12.50%** 2	**0.00%** 0	**12.50%** 2	16

Q9 How did you become aware of the Hog Inlet- Dunn Sound Creek watershed planning project (check all that apply)

Answered: 23 Skipped: 1



Answer Choices	Responses	
Word of mouth (Relative, Friend, Coworker, Neighbor, etc)	17.39%	4
Public Official (Waccamaw Regional COG, North Myrtle Beach, Horry County, DHEC, etc)	47.83%	11
Newspaper or Television	21.74%	5
Social Media	4.35%	1
Flyer	4.35%	1
Website or email announcement	30.43%	7
Other (please specify)	26.09%	6
Total Respondents: 23		

Q10 In the section below, please share any concerns, ideas, and additional feedback you have on water quality related issues in the Hog Inlet- Dunn Sound Creek watershed that you would like to share with the planning team.

Answered: 8 Skipped: 16

I strongly think that Cherry Grove should be a recreational harvest area only

For question #5 listed Stormwater as the primary source. Keep permanent residents informed as well as second home owners.

Way too much trash being littered around little river neck road

Fix the sewage problem from Tidewater's raw sewage into the creek and you'll fix the problem with the fecal coliform in the water. Check all the drainage into the creek areas. Pipes are leaking causing the contamination. - Is the oyster recycling and restoration being done to benefit shellfish and oyster harvesting for the locals or commercial usage?

I believe the only way to clean out the creek is to dredge the extra sand from the inlet. - What would the planned dredging of the canals do to the oyster banks?

Develop and implement a plan to add an additional source of flushing out the watershed to the ocean, along with an inward flow. - When the area is opened back up, limit harvest to Recreation not commercial

It is hoped that the restoration project be restrictive- no commercial harvesting

After NMB residents and government paid for extension of sewer and water along river neck rd. very little has been done to determine number of residents have tied into sewer line and avail themselves to public water. These residents are on county jurisdiction and the county has not followed them on connections

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Appendix E: North Myrtle Beach and Horry County Council Resolutions

REQUEST FOR CITY COUNCIL CONSIDERATION

Meeting Date: February 1, 2016

Agenda Item: 6D	Prepared By: KEVIN D. BLAYTON, P.E. CITY ENGINEER
Agenda Section: New Business. Resolution	Date: January 25, 2016
Subject: Little River Neck Road Cherry Grove Marsh Watershed Plan	Division: PUBLIC WORKS DIVISION

Background

The Little River Neck and Cherry Grove areas drain to extensive salt marshes within the City and adjoining unincorporated Horry County. These marshes encompass productive fishing and shellfishing grounds commonly used by both residents and tourists. The goals of the watershed plan are to identify and address sources of fecal coliform impairment that have resulted in closed shellfish beds and to pursue strategies to reduce pollutant loads. The effort will be led by the Waccamaw Regional Council of Governments (WRCOG) with a grant from SC Dept. of Health and Environmental Control (SC DHEC) with lead partners including Horry County, City of North Myrtle Beach, and Horry Soil and Water Conservation District.

Long-term water quality monitoring has shown repeated exceedances of state water quality standards throughout the Cherry Grove marshes, Hog Inlet, and Dunn Sound Estuary that have resulted in SC DHEC's listing of nine sites as impaired for fecal coliform bacteria. The local communities have expressed concern about pollutant sources and the closing of the shellfish beds. SC DHEC's general permit for Small Municipal Separate Storm Sewer Systems (SMS4) requires Horry County and City of North Myrtle Beach to reduce fecal coliform loads to the estuary.

SC DHEC's Shellfish Sanitation reports merely list suspected sources of fecal coliform contamination. In order for the SMS4s to effectively address the pollution sources, a thorough understanding of those sources is needed. The WRCOG has been awarded a grant from SC DHEC to help fund the development of watershed management plan. Through involvement of the local community and technical experts, the watershed planning process aims to achieve that understanding and identify cost-effective strategies to reduce pollutant loads to the estuary. The long-term goals are to sustain the area's nature-based economy and identity and to re-open closed shellfish harvesting beds.

Recommendation

Approve Resolution endorsing the Watershed Plan.

Reviewed by Division Head	Reviewed by City Manager	Reviewed by City Attorney

COUNTY OF HORRY)
)
STATE OF SOUTH CAROLINA)

RESOLUTION IN SUPPORT OF THE DEVELOPMENT AND IMPLEMENTATION OF A LITTLE RIVER NECK AND CHERRY GROVE MARSH WATERSHED MANAGEMENT PLAN

WHEREAS, the Little River Neck and Cherry Grove communities in North Myrtle Beach and Horry County enjoy a thriving economy based on fishing and tourism and constitute a recreational destination for both residents and tourists; and

WHEREAS, the Cherry Grove marshes, Hog Inlet and Dunn Sound Estuary suffer from closed shellfish harvesting beds due to the frequency of state water quality standard exceedances; and

WHEREAS, the South Carolina Department of Health and Environmental Control (SCDHEC) lists these shellfish harvesting waters as impaired for fecal coliform bacteria; and

WHEREAS, the City of North Myrtle Beach must comply with provisions in its permit (#SCR030000) under the State of South Carolina NPDES (National Pollutant Discharge Elimination System) General Permit for Storm Water Discharges from Regulated Small Municipal Separate Storm Sewer Systems (MS4s), which requires that we take steps to monitor and identify pollutant sources leading to fecal coliform contamination in these waters and implement measures to reduce those pollutant sources; and

WHEREAS, the local communities have expressed concern about pollutant sources and the closing of these shellfish harvesting waters to recreational use; and

WHEREAS, the Waccamaw Regional Council of Governments has been awarded a grant from SCDHEC to help fund the development of a watershed management plan, which will include identification of pollutant sources, prioritization of appropriate best management practices to address those pollutant sources, and preparation of cost estimates for implementing those best management practices; and

WHEREAS, the intention of watershed management plan implementation will be to achieve compliance with state water quality standards, re-open closed shellfish harvesting beds, and sustain the area's nature-based economy and identity;

NOW, THEREFORE BE IT RESOLVED by the Mayor and City Council for the City of North Myrtle Beach, South Carolina that: North Myrtle Beach City Council commits to be a lead cooperator in the development and implementation of a watershed management plan for Little River Neck and Cherry Grove Marsh.

DONE, RATIFIED AND PASSED THIS THE FIRST DAY OF FEBRUARY, 2016.

Mayor Hatley

ATTEST:

City Clerk

R-2-2016

COUNTY OF HORRY)
)
STATE OF SOUTH CAROLINA)

RESOLUTION R-06-16

RESOLUTION IN SUPPORT OF THE DEVELOPMENT AND IMPLEMENTATION OF A LITTLE RIVER NECK AND CHERRY GROVE WATERSHED MANAGEMENT PLAN

WHEREAS, the Little River Neck and Cherry Grove communities in Horry County enjoy a thriving economy based on fishing and tourism and constitute a recreational destination for both residents and tourists; and

WHEREAS, the Cherry Grove marshes, Hog Inlet and Dunn Sound Estuary suffer from closed shellfish harvesting beds due to the frequency of state water quality standard exceedances; and

WHEREAS, the South Carolina Department of Health and Environmental Control (SCDHEC) lists these shellfish harvesting waters as impaired for fecal coliform bacteria; and

WHEREAS, Horry County must comply with provisions in its permit (#SCR035104) under the State of South Carolina NPDES (National Pollutant Discharge Elimination System) General Permit for Storm Water Discharges from Regulated Small Municipal Separate Storm Sewer Systems (MS4s), which requires that Horry County take steps to monitor and identify pollutant sources leading to fecal coliform contamination in these waters and implement measures to reduce those pollutant sources; and

WHEREAS, the local communities have expressed concern about pollutant sources and the closing of these shellfish harvesting waters to recreational use; and

WHEREAS, the Waccamaw Regional Council of Governments has been awarded a grant from SCDHEC to help fund the development of a watershed management plan, which will include identification of pollutant sources, prioritization of appropriate best management practices to address those pollutant sources, and preparation of cost estimates for implementing those best management practices; and

WHEREAS, the intention of watershed management plan implementation will be to achieve compliance with state water quality standards, re-open closed shellfish harvesting beds, and sustain the area's nature-based economy and identity;

NOW, THEREFORE BE IT RESOLVED that Horry County Council commits to be a lead cooperator in the development and implementation of a watershed management plan for Little River Neck and Cherry Grove.

AND IT IS SO RESOLVED this 9th day of February, 2016.

HORRY COUNTY COUNCIL

Mark Lazarus, Chairman

Harold G. Worley, District 1
Jimmy Washington, District 3
Tyler Servant, District 5
James R. Frazier, District 7
W. Paul Prince, District 9
Al Allen, District 11

Bill Howard, District 2
Gary Loftus, District 4
Cam Crawford, District 6
Johnny Vaught, District 8
Jody Prince, District 10

ATTEST:

Patricia S. Hartley, Clerk to Council

County Council Decision Memorandum

Horry County, South Carolina

Date: December 8, 2015
From: Stormwater Department
Division: Infrastructure and Regulation
Prepared By: Thomas Garigen, Stormwater Manager
Cleared By: Stormwater Advisory Board
Committee: Infrastructure and Regulation

ISSUE: Resolution in Support of the Development and Implementation of a Little River Neck and Cherry Grove Watershed Management Plan

The Little River Neck and Cherry Grove areas drain to extensive salt marshes along the northern coast of Horry County. These marshes encompass productive fishing and shellfishing grounds commonly used by both residents and tourists. Cherry Grove is a popular tourist destination. The goals of the watershed plan are to identify and address sources of fecal coliform impairment that have resulted in closed shellfish beds and to pursue strategies to reduce pollutant loads. The effort will be led by the Waccamaw Regional Council of Governments with a grant from SC Dept. of Health and Environmental Control (SC DHEC). Grant funding supports project coordination, mapping and analysis. Other lead partners include Horry County, City of North Myrtle Beach, and Horry Soil and Water Conservation District. These organizations have committed in-kind staff services as matching funds for the grant. No additional funding has been committed. A Resolution has been prepared to formally acknowledge Horry County's role in this important effort.

BACKGROUND

Long-term water quality monitoring has shown repeated exceedances of state water quality standards throughout the Cherry Grove marshes, Hog Inlet, and Dunn Sound Estuary that have resulted in SC DHEC's listing of nine sites as impaired for fecal coliform bacteria. The local communities have expressed concern about pollutant sources and the closing of the shellfish beds. SC DHEC's general permit for Small Municipal Separate Storm Sewer Systems (SMS4) requires Horry County and the City of North Myrtle Beach to reduce fecal coliform loads to the estuary.

SC DHEC's Shellfish Sanitation annual reports merely list suspected sources of fecal coliform contamination without further investigation. In order for the SMS4s to effectively address the pollution sources, a thorough understanding of those sources is needed. The Waccamaw Regional Council of Governments has been awarded a grant from SC DHEC to help fund the development of watershed management plan. Through involvement of the local community and technical experts, the watershed planning process aims to achieve that understanding and identify cost-effective strategies to reduce pollutant loads to the estuary. The long-term goals are to sustain the area's nature-based economy and identity and to re-open closed shellfish harvesting beds.

RECOMMENDATION

The Little River Neck and Cherry Grove Watershed Plan's multi-organizational steering committee, including Horry County Stormwater Management, seeks County Council support for its participation in the development and implementation of a watershed management plan.

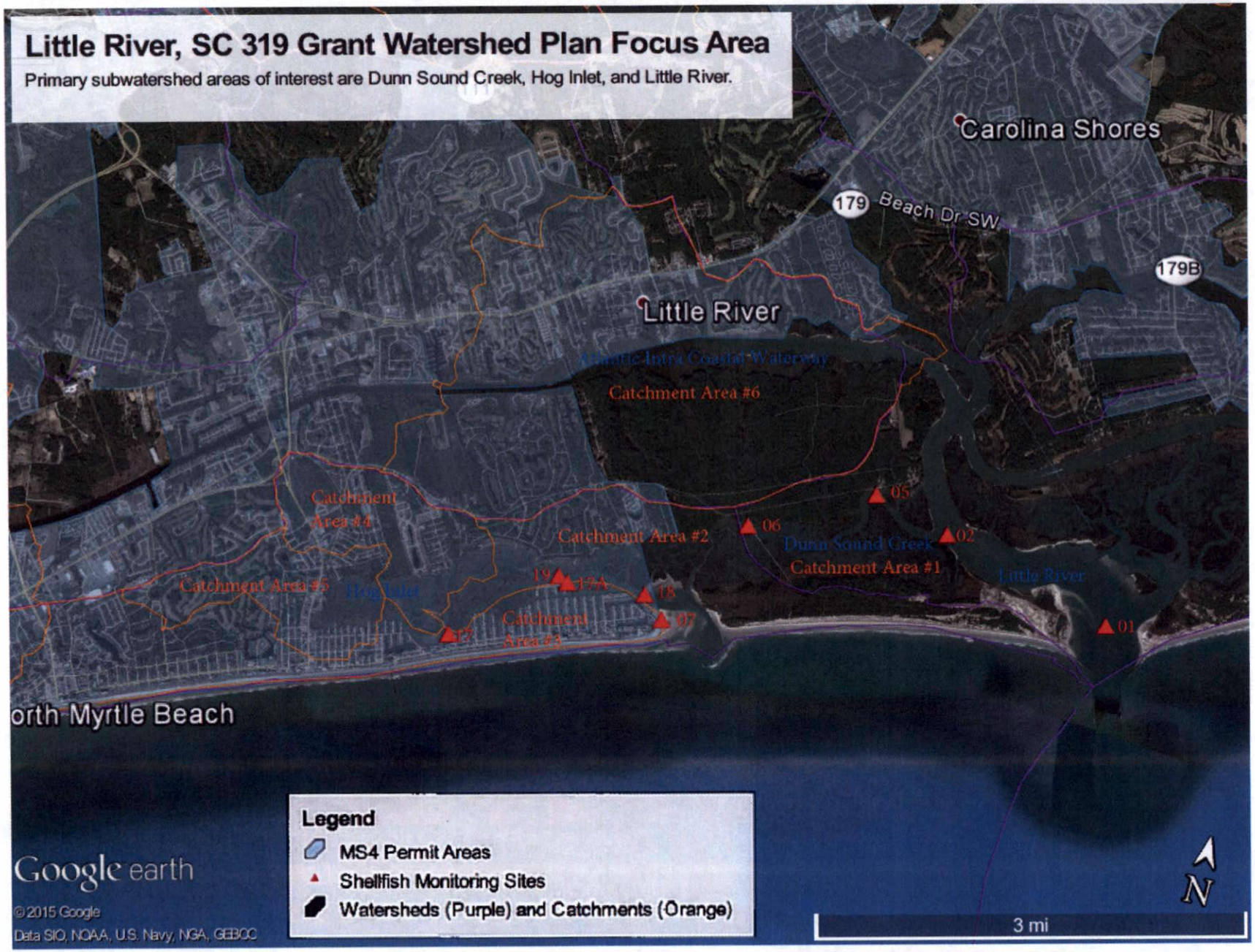

Figure 1. Focus area map showing catchment areas.

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