Swansboro Watershed Restoration Plan

Halls Creek • Ward/Hawkins Creek • Foster Creek

Hammocks • Historic

2017

Contributing Partners

Town of Swansboro
North Carolina Coastal Federation

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Acronyms and Definitions

303(d) List	A list of waterbodies in each state that are too polluted or degraded to meet water quality standards. States are required to update their lists every two years.
319	A grant program funded by EPA and administered by DEQ to study and find solutions to impaired water.
APPROVED AREA	An area determined suitable for the harvest of shellfish for direct market purposes.
BIORETENTION AREAS	Also, known as rain gardens, these provide onsite retention of stormwater using vegetated depressions engineered to collect, store, and infiltrate runoff.
BMP	Best Management Practice of stormwater management; also, commonly referred to as *Stormwater Control Measure (SCM)* or *Stormwater Infiltration Practice (SIP)*.
CAFO	Confined Animal Feeding Operation
CATCHMENT	A geographic unit within a subwatershed made up of a singular river, stream, or branch that contributes to a larger watershed.
CFU	Colony Forming Unit, used to measure fecal coliform bacteria concentrations.
CONDITIONALLY APPROVED CLOSED	This management strategy by North Carolina Shellfish Sanitation, refers to shellfishing-growing waters that are closed to harvest because of high bacteria concentrations but can be opened temporarily, usually during periods of drought, when bacteria levels are low enough to make the shellfish safe to eat.
CONDITIONALLY APPROVED OPEN	This management strategy by North Carolina Shellfish Sanitation, refers to shellfish growing areas that are open to harvest nut are temporarily closed after periods of moderate or heavy rain.
CWA	Clean Water Act
DCM	North Carolina Division of Coastal Management
DEGRADED WATERS	General description of surface waters that have elevated pollution levels, could include high bacteria levels, pathogens, sediment, low

	dissolved oxygen, and/or high nutrient levels. This is not a legal description of impairment (see impaired waters definition).
DEQ	North Carolina Department of Environmental Quality
DESIGNATED USE	A Clean Water Act term referring to the use, such as swimming, shellfish harvesting or aquatic life support, that a waterbody has been designated with by the state. The waterbody may not actually be able to support its designated use.
DOT	Department of Transportation
EPA	Environmental Protection Agency
EXISTING USE	A Clean Water Act term referring to all current uses and any use the waterbody has supported since November 28, 1975.
FDA	U.S. Food and Drug Administration
FECAL COLIFORM	These bacteria are found in the intestines of warm-blooded animals. They are not normally harmful to humans, but if found in a waterbody they could indicate the presence of harmful bacteria. Because they are easy to detect in the environment, these bacteria have been used for decades to determine the suitability of shellfish-growing waters.
FLOW	The volume of water, often measured in cubic feet per second (cfs), flowing in a stream or through a stormwater conveyance system.
GIS	Geographic Information Systems
GROWING WATERS	Waters that support or could support shellfish life.
HUC	Hydrologic Unit Code
HYDROGRAPH	A graph showing changes in the discharge of a surface water river, stream or creek over a period of time.
HYDROLOGIC CYCLE	The cycle by which water evaporates from oceans and other bodies of water, accumulates as water vapor in clouds, and returns to the oceans and other bodies of water as precipitation or groundwater. Also, known as the water cycle.
HYDROLOGY	The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, flow to the seas, etc.

IMPAIRED WATERS	This Clean Water Act term refers to waters that no longer meet their designated uses. That would include conditionally approved and conditionally closed waters and any water where swimming advisories are being issued. These waters have been listed as impaired on the state's 303(d) list for EPA.
IMPERVIOUS COVER	A hard surface area, such as a parking lot or rooftop, that prevents or retards water from entering the soil, thus causing water to run off the surface in greater quantities and at an increased rate of flow.
INTERTIDAL	Area of land that is submerged during high tide and exposed at low tide.
LAND USE	The management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods.
LID	Low Impact Development refers to management strategies that attempt to mimic conditions to reduce the flow of stormwater. To be successful, they should be integrated into all phases of urban planning and design from the individual residential lot level to the entire watershed.
LULC	Land use/land cover
MAXIMUM EXTENT PRACTICABLE	This term appears in many state and federal pollution regulations. It generally refers to pollution controls that are technologically available and capable of being done after taking into consideration cost and logistics.
MS4	Municipal separate storm sewer systems
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source, diffused sources of pollution, where there is no singular distinct outflow point.
NRCS	Natural Resources Conservation Service
NSSP	National Shellfish Sanitation Program

RETROFITTING	Structural stormwater management measures for preexisting development designed to help reduce the effect of impervious areas, minimize channel erosion, reduce pollutant loads, promote conditions for improve aquatic habitat, and correct past efforts that no longer represent the best science or technology.
ROW	Right of Way
RUNOFF CURVE	A runoff curve number is a numeric parameter derived from combining the effects of soil, watershed characteristics, and land use.
SA	This is a state water classification for saltwater intended for shellfish harvesting. These are waters that should also support aquatic life, both primary and secondary recreation (activities with frequent or prolonged skin contact), and shellfishing for market purposes. It is one of the highest water classifications in the state.
SB	This is a state water classification for saltwater intended for swimming.
SC	This is a state water classification for saltwater intended for fish propagation and incidental swimming. The waters are safe for swimming but have a higher risk of pollution and human illness than SB waters.
SCM	Stormwater Control Measure, also more commonly known as a Best Management Practice (BMP) of stormwater management; also, commonly referred to as *Stormwater Infiltration Practice (SIP)*
SHELLFISH SANITATION	Shellfish Sanitation and Recreational Water Quality Section, N.C. Division of Marine Fisheries, N.C. DEQ.
SIP	Stormwater Infiltration Practice, also more commonly known as a Best Management Practice (BMP) of stormwater management; also, commonly referred to as *Stormwater Control Measure (SCM)*.
STORMWATER	Water from rain that flows over the land surface, picking up pollutants that are on the ground.
SUBWATERSHED	A geographic unit within a watershed made up of individual minor rivers, streams, or branches that contribute to a larger watershed.
TMDL	Total maximum daily load, the maximum amount of a pollutant that can be found in a waterbody and still meet federal Clean Water Act standards.

USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WATERSHED	All areas that drain to a waterbody, whether that be a lake, mouth of a river, or ocean.
WQS	Water quality standards
WWTP	Wastewater Treatment Plant

Table of Contents

Guide to Nine Minimum Elements

This table serves as a quick reference guide to where the Environmental Protection Agency (EPA) Nine Minimum Elements can be found within this watershed restoration plan.

	EPA Nine Minimum Elements	Location in Plan
1	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.	Section 2. 1 Water Quality Section 2.2 Source Assessment
2	An estimate of the load reductions expected from management measures.	Section 3.1 Volume Reduction Methodology Section 3.2 Runoff Reduction Load Calculations Section 3.3 Calculation Methodology
3	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan.	Section 4.1 Primary Goal Section 5.1 Reduction Techniques Section 5.2 Present Stormwater Strategies Section 5.3 Education and Outreach Appendix D Potential Stormwater Incentives Appendix E Green Street designs
4	Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	Section 5.1 Present Stormwater Strategies Section 6.1 Potential Project Ideas Schedule Section 6.5 Cost and Technical Needs
5	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Section 4 Goals, Objective 6 Section 5.3 Education and Outreach

6	Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Section 4 Goals Section 6 Implementation Program Section 6.1 Project Implementation Schedule
7	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 4 Goals Section 6.1 Project Implementation Schedule Section 6.2 Milestones
8	A set of criteria that can be used to determine whether load reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.	Section 2 Water Quality Section 4 Goals, Objective 5 Section 6.4 Evaluation
9	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the established criteria.	Section 2 Water Quality Section 4 Goals, Objective 5 Section 6.3 Monitoring

Executive Summary

The Town of Swansboro has proactively developed a watershed restoration plan to reduce the effects of stormwater runoff and enhance its environmental stewardship of the White Oak River and surrounding waters. This document provides an overview of the current and historical conditions of the major Swansboro watersheds and proposes methods and strategies intended to reduce the flow of stormwater runoff to improve water quality in the river and its watersheds. The Swansboro Watershed Restoration Plan emphasizes the application of the Environmental Protection Agency (EPA) Nine Minimum Elements, the North Carolina Department of Environmental Quality (DEQ) Section 319 office guidelines, and practiced coastal watershed restoration methods developed by the plan's partners.

Introduction

This watershed restoration plan provides a comprehensive framework to address water quality in a portion of the Swansboro region, encompassing much of the southern half of the Town of Swansboro, North Carolina in Onslow County. This plan focuses specifically on Halls Creek, Ward/Hawkins Creek, and Foster Creek watersheds along with minor areas that drain directly into Queens Creek or the delta region of the White Oak River. Combined, these watersheds receive the vast amount of the town's stormwater runoff, contributing to the frequency of bacteriological impairments due to increased volumes of polluted stormwater runoff. The focus of this plan is to reduce the transport of bacteria by reducing the volume of stormwater runoff from developed areas within the watersheds. The primary goal is to restore or mimic the natural, pre-development hydrology of the watersheds before development.

The Swansboro watersheds have tremendous value for water-based recreation and tourism. Integral natural areas, such as Hammocks Beach State Park, the Croatan National Forest, and bird nesting islands in Bogue Sound, are within portions of the watershed or are nearby. All of them are affected by water quality within the watershed. These areas, particularly Hammocks Beach State Park, are important habitat for a multitude of species and are valued as recreational areas. In recent years, increased stormwater runoff following large rain events has resulted in more frequent water quality impairments, indicating that stormwater runoff is likely transporting pollutants.

Improvements in water quality will be realized using stormwater reduction techniques that reduce the volume of stormwater runoff thereby effectively treating stormwater runoff from existing and new developments. This plan combines low-cost, high-yield strategies such as community outreach initiatives and small retrofit projects with large scale endeavors aimed at reducing large swaths of impervious surface. Additionally, the Town is willing to develop guidelines in its ordinances that encourage low impact development practices. By focusing on techniques that reduce, slow, and treat stormwater runoff, the plan can mimic the natural hydrology of the area that existed before urban expansion and development.

This document provides a framework for the restoration of Swansboro watershed water quality, by reducing the volume of stormwater flows from existing and new land uses.

1 Watershed Descriptions

The plan contains five watersheds: **Halls Creek**, **Ward/Hawkins Creek (the names are interchangeable)**, **Foster Creek**, and the plan designates as **Hammocks**, and **Historic watersheds** (Fig. 1.1). All five watersheds are within the town limits of Swansboro and the surrounding areas. The Hammocks watershed encompasses the peninsula of Hammocks Beach State Park. This represents an area that has direct drainage into Queens Creek and the delta of the White Oak River. Historic watershed, which comprises much of the downtown and contains some of the oldest areas of Swansboro, drains directly into the White Oak River. Though the Swansboro region has many more watersheds, only those listed here are the subjects of this plan.

The Swansboro watersheds encompass the Town of Swansboro and its extended jurisdiction and Onslow County (Figure 1-2). The watersheds span over 2,400 acres. Residential and commercial development over the past two decades has resulted in an increase in impervious surfaces throughout the watershed, which has increased the amount of stormwater runoff that is transported to the White Oak River delta estuaries, which are part of the White Oak River Basin.

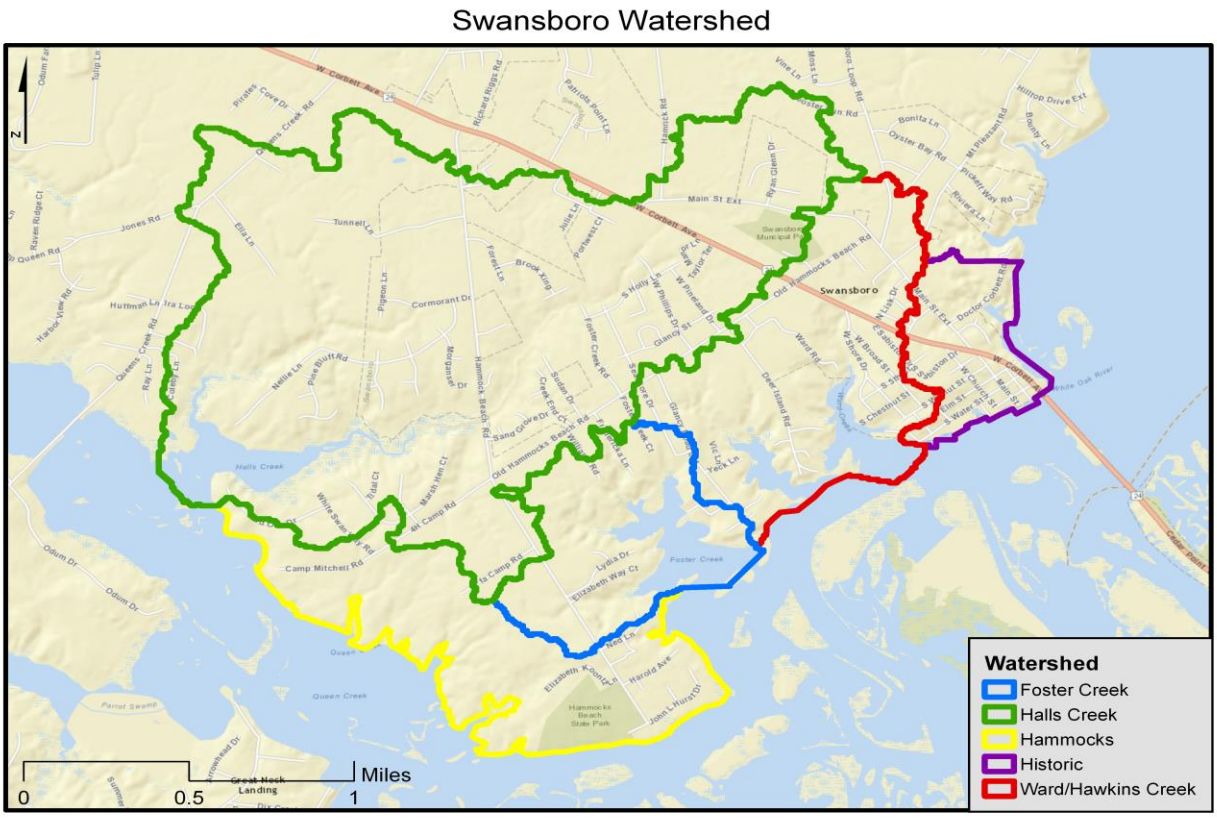


Figure 1-1. Map of Swansboro Watersheds. Note: Ward Creek is also known as Hawkins Creek.

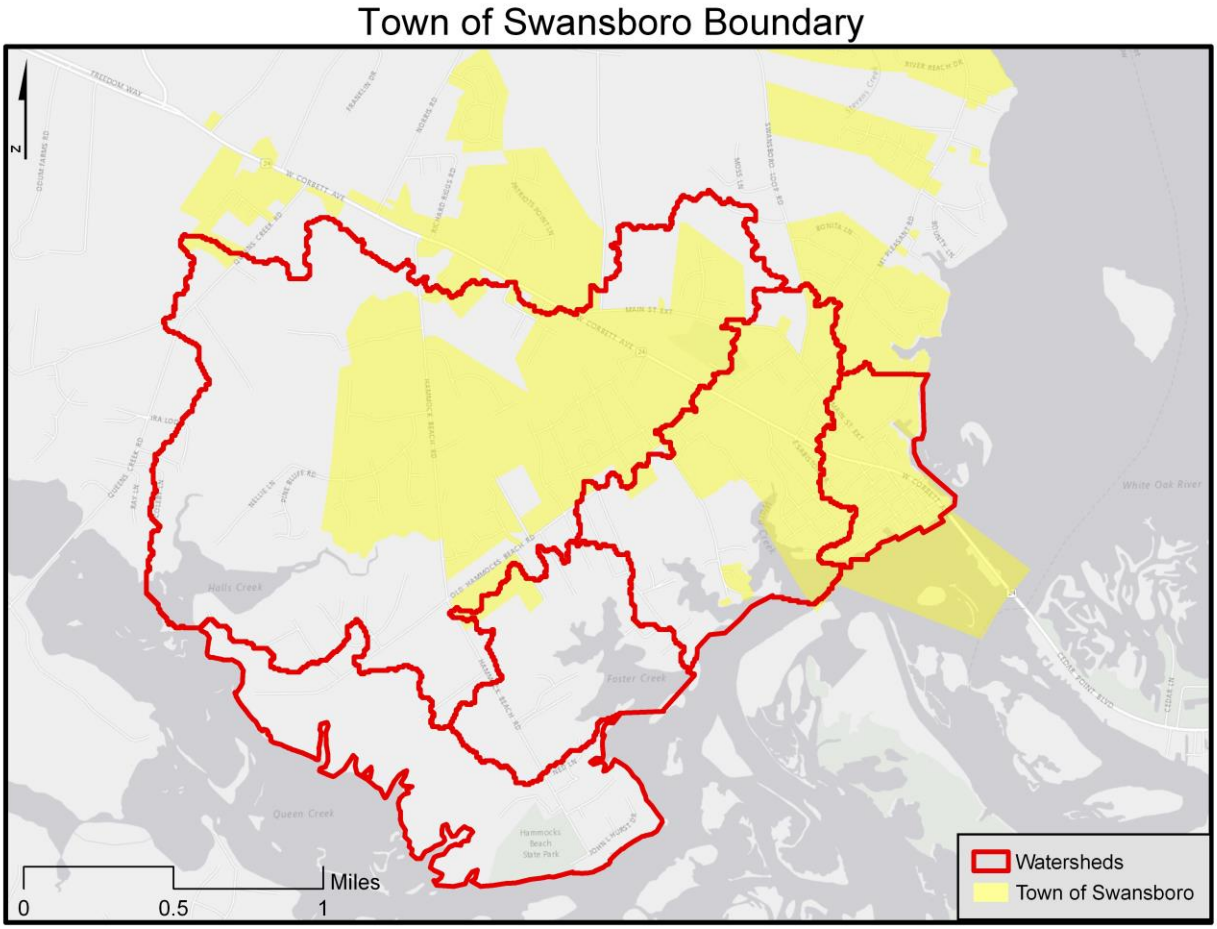


Figure 1-2. Map of Town of Swansboro boundaries.

1.1 PHYSICAL AND NATURAL FEATURES

Foster Creek, Halls Creek, Ward/Hawkins Creek, and Hammocks watersheds flow into the White Oak River delta, which is tidally influenced. Average elevation is about 20 feet above sea level. The highest area of elevation within the watershed is about 35 feet above sea level (Figure 1-3). Swansboro is unique in that the area represents the convergence of three different 12-HUC Subwatersheds and some of Swansboro's watersheds are part of multiple 12-HUC Subwatersheds (see Table 1-1 for 12-HUC information).

Table 1-1.

Watershed 12-HUC codes.

	Watershed Name	12-HUC	12-HUC Subwatershed Name
1	Halls Creek	030203010301	*Queens Creek*
2	Foster Creek	030203010304	*Bogue Sound-Bogue Inlet*
3	Ward/Hawkins Creek	030203010304	*Bogue Sound-Bogue Inlet*
4	Hammocks	030203010301	*Queens Creek*
		030203010304	*Bogue Sound-Bogue Inlet*
5	Historic	030203010304	*Bogue Sound-Bogue Inlet*
		030203010206	*White Oak River*

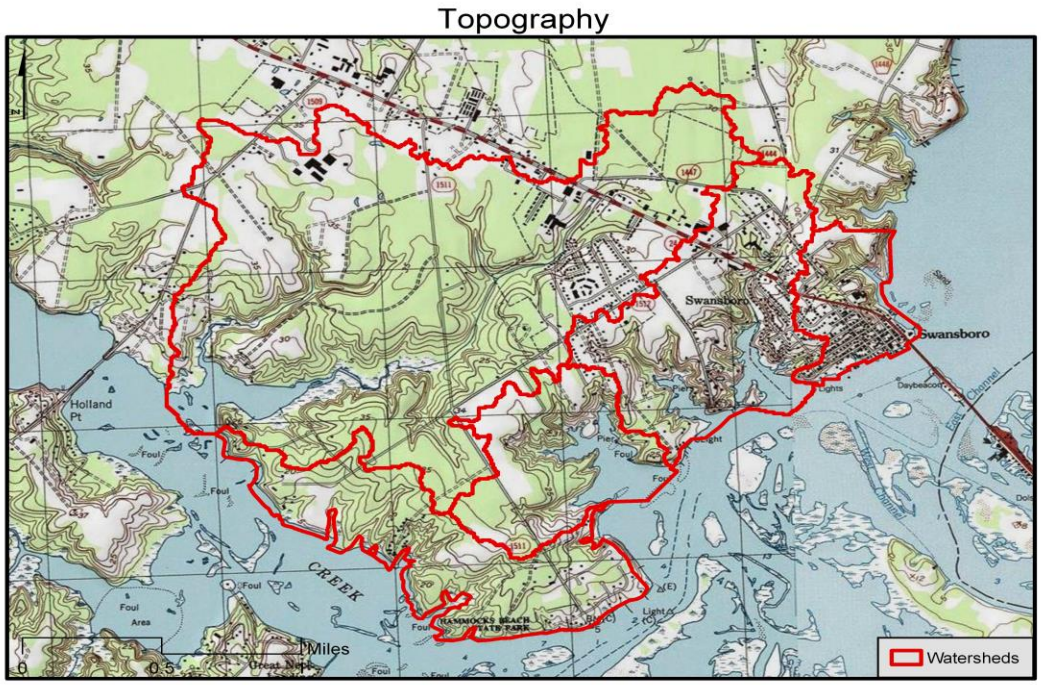


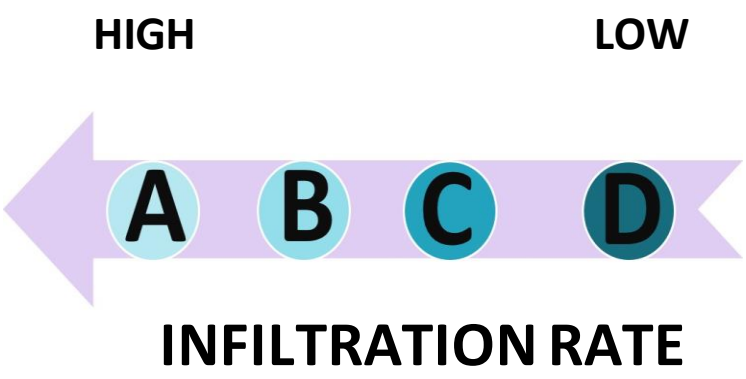
Figure 1-3. Topography map of Swansboro Watersheds.

1.1.1 **Soils**

The Swansboro watersheds are characterized by about 13 different soil types with a variety of characteristics (Figure 1-4). Baymeade fine sand and Onslow loamy fine sand are the two most prevalent soil types with the watersheds. Swansboro watersheds are predominated by Group A hydrologic soil, according to data from the U.S. Department of Agriculture Natural Resource Conservation Service's (NRCS) Web Soil Survey (Figure 1-5). Four hydrologic groups (HSG; Groups: A, B, C, D) exist with progressively decreased infiltration potential characteristics; soils classified under Group A have the highest infiltration potential and are often the quickest draining soils, while soils classified under Group D have the lowest runoff potential. It is possible to have a soil type that has characteristics from two hydrologic groups; for example, a soil can be designated as Group A/D, which means it has characteristics of both Group A and Group D. This is because of the changing nature of the soils when they are fully saturated by water. Once a hydraulic threshold is reached, the soil type converts to another hydrologic group because of the change of the available water capacity of the soil.

The following is the NRCS summary description for each soil group[1]:

- **Group A** soils are sands, loamy sands, or sandy loams. These soils have high infiltration rates even when thoroughly saturated. These soils consist of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- **Group B** soils are silt loams or loams. These soils have moderate infiltration rates when thoroughly saturated and consist of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
- **Group C** soils are sandy clay loams. These soils have low infiltration rates when thoroughly saturated and consist of soils with a horizon that impedes downward movement of water and possess moderately fine to fine texture.



- **Group D** soils are clay loams, silty clay loams, sandy clays, silty clays, or clay. These soils have the highest runoff potential. These soils have very low infiltration rates when thoroughly saturated and consist of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

HSG A predominates Swansboro watersheds and surrounding area. Some areas of Halls Creek watershed and surrounding area contain Group D soils, which can be indicative of wetland ecosystems. Some of the soil types in Swansboro possess two hydrologic group categories. In these instances, if a soil needs to be characterized by one soil group, the lowest infiltration rating should be used as this represents the likely infiltration performance in these areas during significant rain events. It's important to note that NRCS soil surveys are ideal for watershed scale analysis and determining runoff volume rates. These data are used to calculate the runoff volume rates in this plan.

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[1] Natural Resources Conservation Service. (n.d.). Updated Hydrologic Soil Group. *United States Department of Agriculture Natural Resource Conservation Service*.

Soil survey data can be used when trying to determine which areas have the most ideal combined characteristics for retrofit projects. HSG, as with any characteristic, should always be tested through field surveys to determine the extent of characteristics at a project site. The partners' previous experiences installing retrofits along the coast have shown that a simple handheld auger tool samples to assess soils may not be sufficient and it may be necessary to take a deeper sample to break through a confining layer of Group D soil covering Group A soils. Refer to Appendix A for the list of soils and their associated HSG.

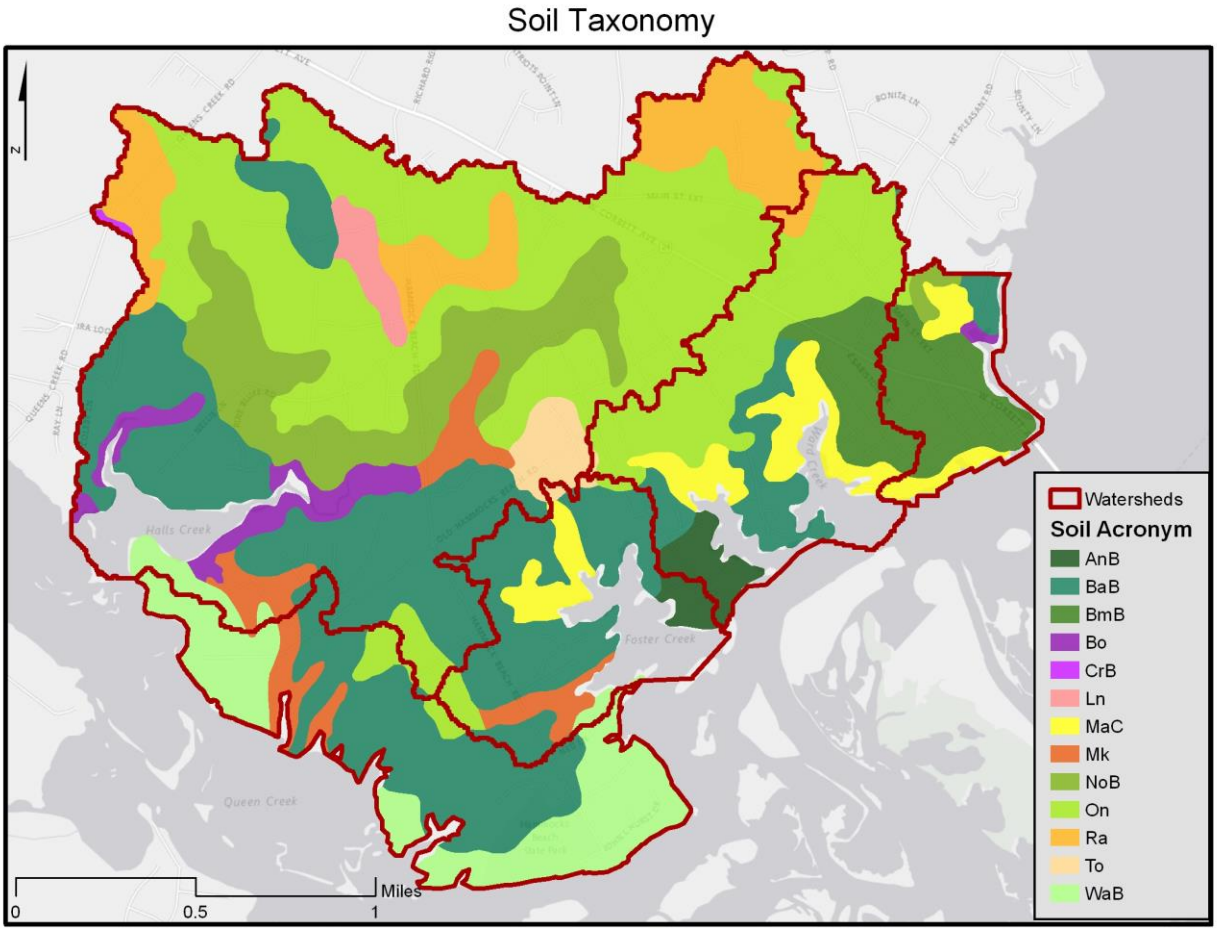

Figure 1-4. Map of soil taxonomy in Swansboro Watersheds. Coloring of this map follows similar color coding groups to that of Figure 1-5 HSG map where: Greens = HSG A, Pinks = HSG A/D, Yellows = HSB B, Orange = HSG B/D, Purple = HSG D. Refer to Appendix A for the full names of each soil.

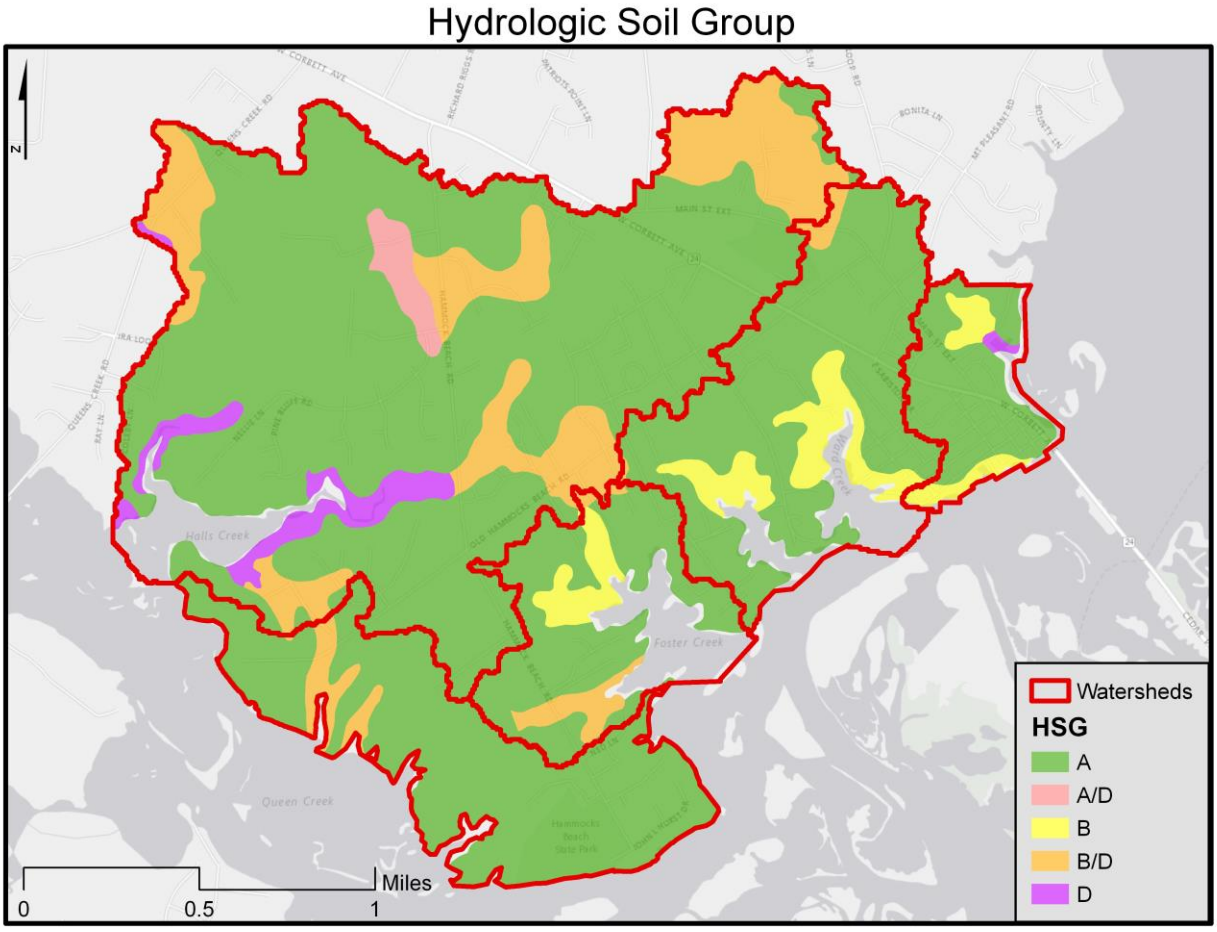

Figure 1-5. Map of Hydrologic Soil Group (HSG) in Swansboro Watersheds.

1.1.2 **Natural Characteristics**

The North Carolina Natural Heritage Program (NCNHP) of the Department of Environmental Quality (DEQ) has identified areas that are of biodiversity significance; these are often areas where rare or significant species occur and significant natural communities occur (Figure 1-6). The identified areas contain both terrestrial and aquatic habitats. The boundaries of these areas are based on field surveys by NCNHP staff and other professional biologists. The intent of the NCNHP data was to assist government agencies and others in developing management strategies. DEQ targeted these conservation areas when planning for restoration projects.

As Figure 1-6 shows, the Swansboro watersheds do not contain any identified natural areas. However, several identified natural areas are within a mile radius of the watersheds or are upstream of the watershed, including Queens Creek tidal marshes, Bear Island (part of

Hammocks State Beach Park), and the White Oak River delta shore bird nesting area. Water quality of these watersheds affect these tidal areas, particularly aquatic and shoreline habitat. Identifying the location of critical habitat areas is relevant for planning and this information can be used to develop projects that can positively enhance these areas, in turn leading to potential funding opportunities.

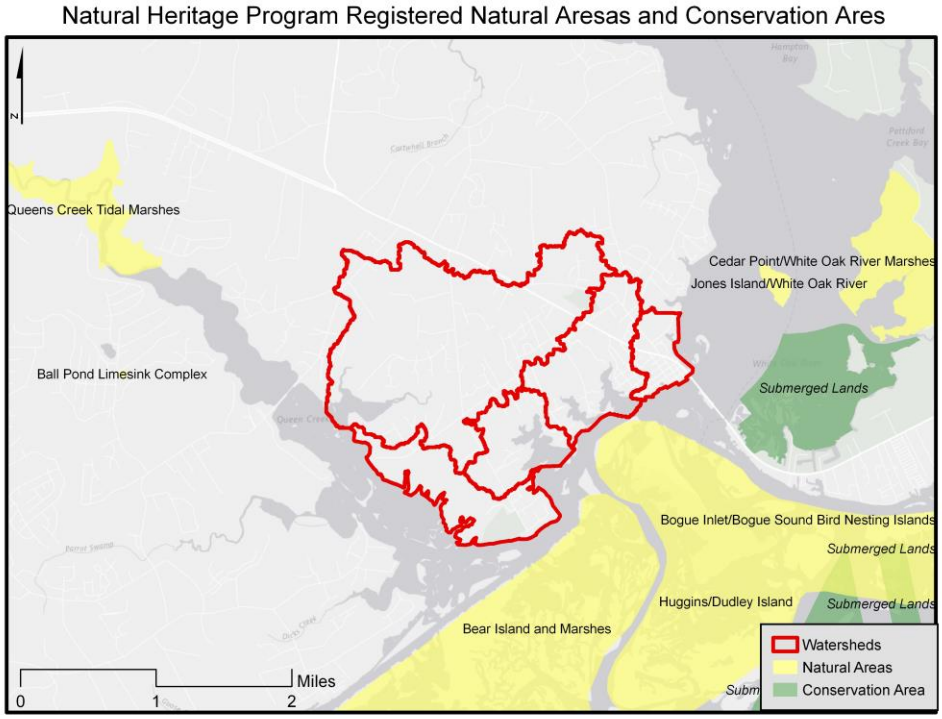

Figure 1-6. Map of important natural community areas. Data from October 2015.

Patches of submerged aquatic vegetation (SAV) are found within the Swansboro watersheds (Figure 1-7). Projects should be evaluated to ensure that that they do not negatively affect SAV, which play a critical role in estuarine habitat. Consideration should also be given to restoration projects that enhance water quality and improve the growth of SAV. These type of restoration projects may lead to funding opportunities. SAV serve as important nursery habitat for fish, are a food source, aid in absorbing wave energy, produce oxygen, and aid in improving water quality by absorbing nutrients and stabilizing and settling sediment. It is recommended that field surveys always be conducted for any offshore projects to ensure that there is no negative affect on SAV habitat.

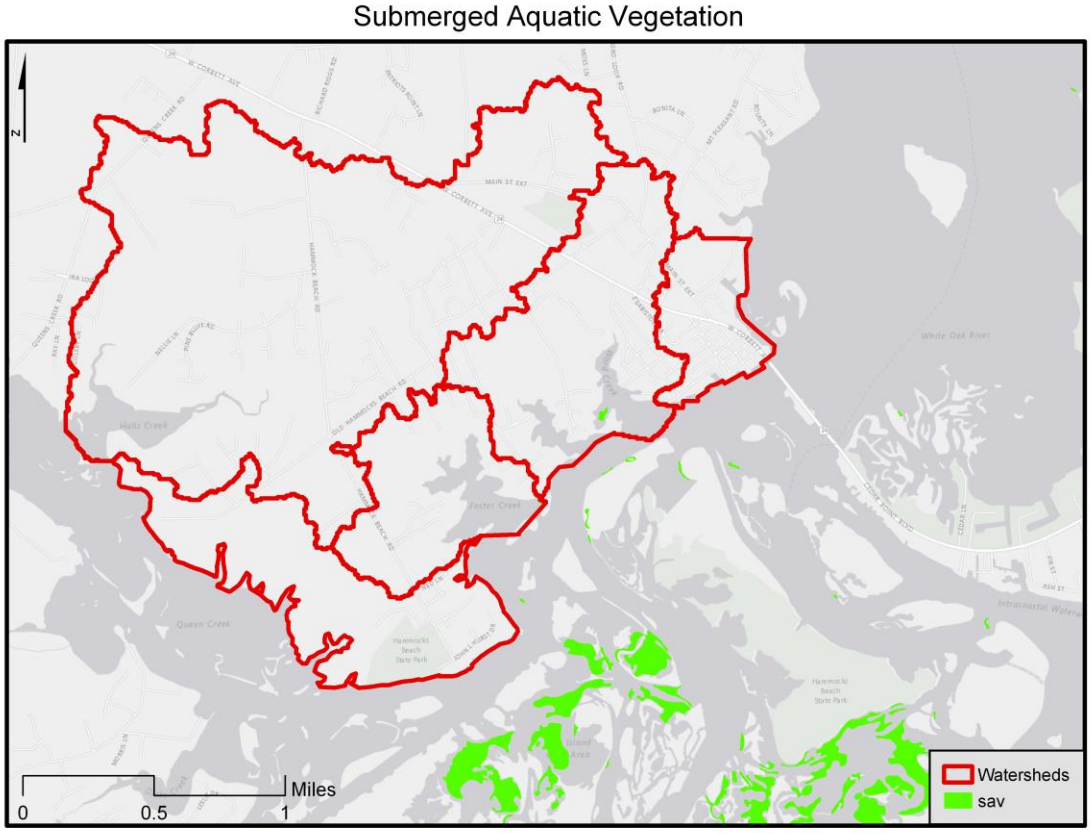

Figure 1-7. Submerged Aquatic Vegetation within the Swansboro watersheds. Data sourced from N.C. Division of Marine Fisheries and Albemarle-Pamlico National Estuary Partnership for 2008, which is the most up-to-date version at the time of this report.

Biodiversity and wildlife habitat assessment were created using July 2013 data from N.C. OneMap (OneMap, 2013), a program from DEQ's Natural Heritage Program. Conservation assessment values were rated on a scale of one (moderate conservation value) to ten (high priority conservation value) and includes some areas that are unrated. The Natural Heritage Program obtained the data used to develop this scale from various state and federal agencies including: N.C. Division of Coastal Management, U.S. Fish and Wildlife Services, N.C. Division of Water Quality, N.C. Division of Marine Fisheries, N.C. Wildlife Resources Commission, N.C. Chapter of the Audubon Society, and U.S. Environmental Protection Agency (North Carolina Department of Environmental Quality [DEQ], 2013).

Specifically, data included natural heritage areas, aquatic and terrestrial biodiversity, threatened and endangered species, Outstanding Resource Waters and High Quality Waters rankings, open and closed shellfish habitat, oyster sanctuaries, submerged aquatic vegetation, wetlands and National Wetland Inventory, and other datasets. The biodiversity and wildlife habitat assessment rankings were developed to provide support to state and local governments and agencies and conservation organizations to incorporate data for conservation, land use, and planning purposes. Coastal and riverine habitat are often of the highest conservation value; these areas are rated eight or higher (Figure 1-8).

Although substantial development has occurred within the Ward/Hawkins Creek watershed, it and Halls Creek watershed have high conservation values, particularly along the lower reaches of each watershed. Areas immediately downstream of the watersheds at the Bear Island marshes, Huggins and Dudley Island, Queens Creek, and Bogue Sound nesting area also have high conservation values.

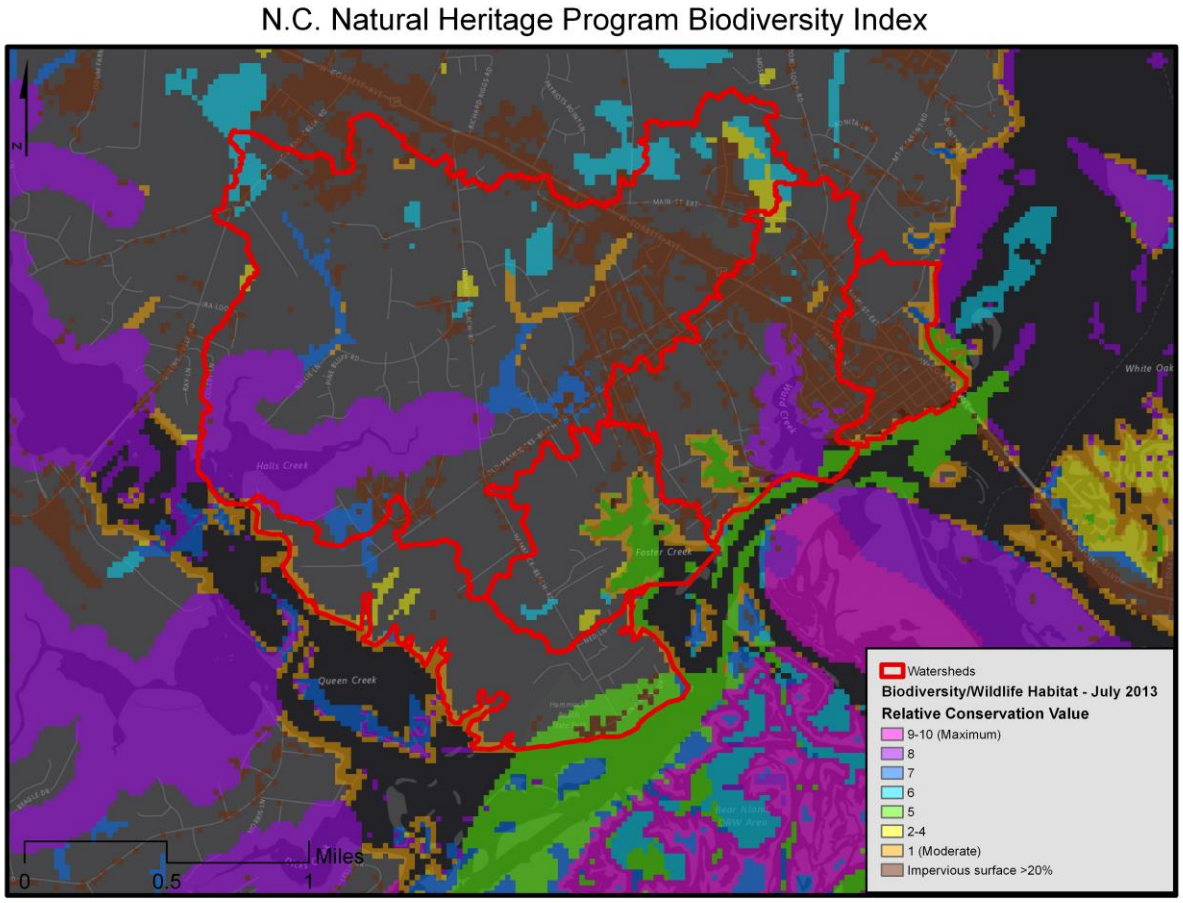

Figure 1-8. Map of Natural Heritage Program's areas of high biodiversity. Created using 2013 data, which is the most up-to-date version at the time of this report.

1.2 LAND USE

The Swansboro watersheds flow through the following local municipalities:

- Town of Swansboro
- Onslow County

The Swansboro watersheds are in Onslow County. Nearly half the Swansboro watersheds fall within the town boundaries or its extraterritorial jurisdiction, which extends a mile beyond those boundaries. The remaining portions of the watersheds falling under county jurisdiction (Figure 1-2).

Swansboro grew from an early port along the White Oak River. The oldest part of Swansboro found along the river were part of the former Indian village. The land was patented in 1713 for development, but it was not until 1730 that the Green family from Massachusetts settled in the area[2]. After the death of Jonathan Green in 1735, Grace Green married Theophilus Weeks. In 1770 weeks started the town, laying out six streets and 48 lots on his land. This area on the White Oak River was known as "Week's Wharf." Today's main street was the southern terminus of the old county road that was the only road from the wharf to the Onslow Courthouse.

The N.C. General Assembly approved the charter for Town of Swannsborough on May 6, 1783. The legislature named the town in honor of one of its own, Samuel Swann. A resident of New Hanover County, Swann had represented Onslow County in the legislature for 24 years. He was speaker of the House for much of that time. The spelling of the town's name was officially changed to its current form in the 1895[3]. The legislature in 1787 made the town the custom district headquarters for all the inlets in Onslow County. Beginning the late 1700s, shipbuilding was an important industry in Swansboro. Its most famous shipbuilder was Captain Burns who built the Prometheus in 1818 on the Swansboro waterfront. The ship was the first steamboat built in North Carolina. In the first, half of the 1800 Swansboro was home to leading merchants operating stores serving the residents of Onslow County.

During the Civil War, Swansboro was a center of Confederate activity, including the manufacturing of salt. After the Civil War the extensive shipping activity declined, and the economy shifted to lumber in the late 1800s and early 1900s. Commercial fishing also became a major industry, and still is an important industry within the region.

With the approach of the World War II, the economy shifted again when the federal government established Camp Lejeune, a Marine Corps base, nearby. Civil servants, active and retired military

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[2] Littleton, T. R. (1993). *Along the path of history: A self-guided walking tour of the old port town of Swansboro*. Swansboro, NC: Swansboro's 200th Anniversary Celebration Committee.

[3] Littleton, T. R. (1990). *Historic Swansborough seaport: Coastal sea breezes, historic old homes, quaint shops, good restaurants, friendly people*. Swansboro, NC: Swansboro Historical Association.

personnel began making Swansboro their home. Today the town continues to be attractive to tourist, retirees and wonderful community to call home.

Understanding the past and present land uses of the watersheds will enhance this plan's ability to address education and outreach and to tailor stormwater reduction techniques that address the community's needs. For example, if a watershed is predominately residential then it may be more effective to develop strategies that address stormwater and future growth from a residential perspective.

Swansboro's watersheds are used for various purposes but are predominated by commercial (any business, commercial, or industrial usage), residential, rural use (primarily areas designated Rural Agriculture (RA) designated by the county for business, residential, or agriculture), and institutional uses (state or federal land uses) (Table 1-2, 1-3; Figure 1-9, 1-10). To aid in visualizing how the lands within the watershed are used, a simplified usage category has been created using these four categories. Figure 1-9 represents the full description of the classifications based on county and town usages. These land uses represent the current designated land uses and do not mean that the land has been developed.

Halls Creek watershed, the largest of the watersheds, has the most acreage designated for commercial, residential, and agriculture purposes (Figure 1-10, Table 1-3). Hammocks watershed, which contains Hammocks Beach State Park, has the most land designated for institutional use, Overall, residential land use predominates the watersheds making up about 1,100 acres of 2,400 acres of the Swansboro watersheds.

Table 1-2.
Simplified usage categories acreages of the Swansboro Watersheds as of 2016.

Designated Land Use	Summarized Description	Simplified Use Category
B-1	Highway Business. The purpose of this district shall be to provide for the proper grouping and development of roadside business uses, and for uses not basically related to central or neighborhood business areas.	Commercial
B-2	General Business. The purpose of this district shall be to provide for the proper grouping and development of those uses which are related to central or neighborhood business districts. Such uses might include shopping centers and retail uses.	Commercial
B-2 HDO	B2 Historic District Overlay. The purpose of the B-2 Historic District Overlay is to provide for a mixture of permitted and special uses that are consistent in protecting and preserving the heritage of the Town's	Commercial

	historic business district while providing a wide range of retail and professional services to residents and visitors.	
B-3	Traditional Business. The purpose of Traditional Business District is to provide for a district with the characteristics of traditional business areas, including relatively high density retail development and pedestrian-oriented design, mixed with office and residential development located primarily on the upper stories of buildings.	Commercial
CON	Conservation – To preserve and protect valuable natural resource areas.	Institutional*
G/E	Government and Educational institutions **Note: For the purposes of these categories, "Institutional" includes all lands under ownership of the state of North Carolina, Onslow County, or the Town of Swansboro*	Institutional*
MHS	Manufactured Home Subdivision	Residential
R-10 SF	Residential 10 – Developed for medium-density stick-built housing communities; both single-family and duplexes uses are permitted. The purpose of this district shall be only single-family structures shall be permitted in this district.	Residential
R-20 SF	Residential 20 – To stabilize low-density for stick-built single-family residential areas. The purpose of this district shall be only single-family structures shall be permitted in this district.	Residential
R-40 SF	The purpose of this district shall be only single-family structures shall be permitted in this district.	Residential
R-6	Residential 6- The purpose of this district shall be to provide for single-family up to and including multi-family structures and recreational purposes. This district shall provide areas for apartments, townhouses, PUD's, and PRD's.	Residential
R-6 SF	The purpose of this district shall be only single-family structures shall be permitted in this district.	Residential
R-8 SF	Residential 8 – Accommodates manufactured homes and manufactured home parks and small multi-family developments. RV parks are also allowed as a special use.	Residential
RA	Rural Agricultural – To maintain a rural development pattern with a mixture of housing types, agricultural and business uses.	Rural

***Note**: Other Special Uses in all Residential Districts include but are not limited to: Cemeteries, private or public; Churches; Country Clubs; Libraries; Schools; public, private and colleges; and Utility Substations*
****NOTE**: For the purposes of these categories, "Institutional" includes all lands under ownership of the state of North Carolina, Onslow County, or the Town of Swansboro. Even if the land has a designated use or special use in another category,*

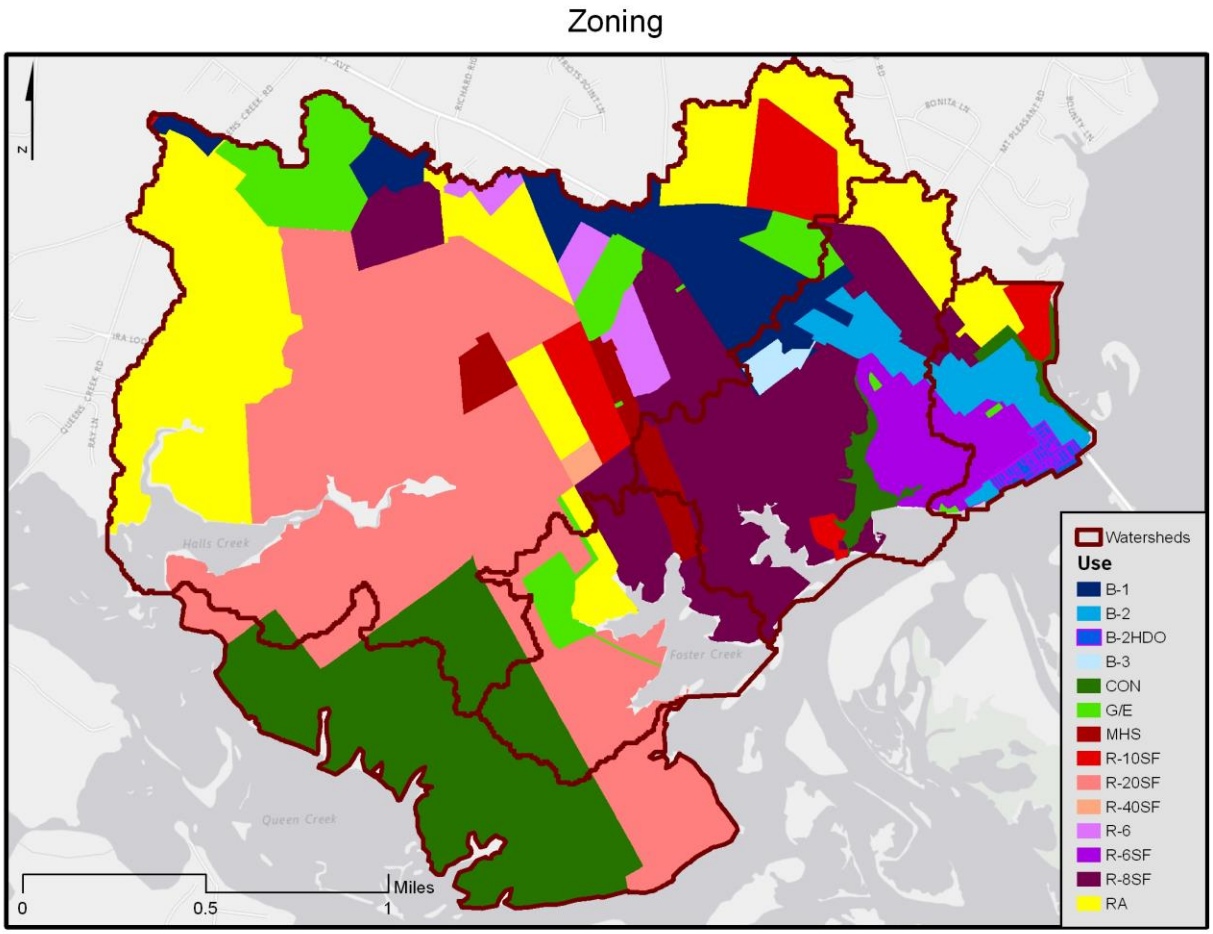

Figure 1-9. Designated Use classifications of the region based on local and county codifications.

Table 1-2.
Simplified usage categories by acreages of in each watershed.

Simplified Usage Categories	**Commercial** (acres)	**Institutional** (acres)	**Residential** (acres)	**Rural** (acres)	**Watershed Total** (acres)
Foster Creek Watershed	--	50	126	16	**193**
Halls Creek Watershed	110.3	149.8	670.3	342.2	**1,272.60**
Hammocks Watershed	--	245.9	84.9	--	**330.8**
Historic Watershed	48.3	9.8	47.1	15.9	**121.1**
Ward/Hawkins Creek Watershed	53	18.5	257.3	38.1	**366.9**
Total (acres)	**211.6**	**474**	**1185**	**411.8**	

Note: Rights of Ways have been removed and are not included as part of the totals. Additionally, these numbers include conservation areas which have an HSG category of "water" because they are part of a waterbody or have intertidal (area that is covered by water during high tide and uncovered during low tide) acreage that is designated as "water." As such, these totals will vary from other acreages listed within this plan, particularly with the acreage totals listed in Section 3 Runoff Calculations.

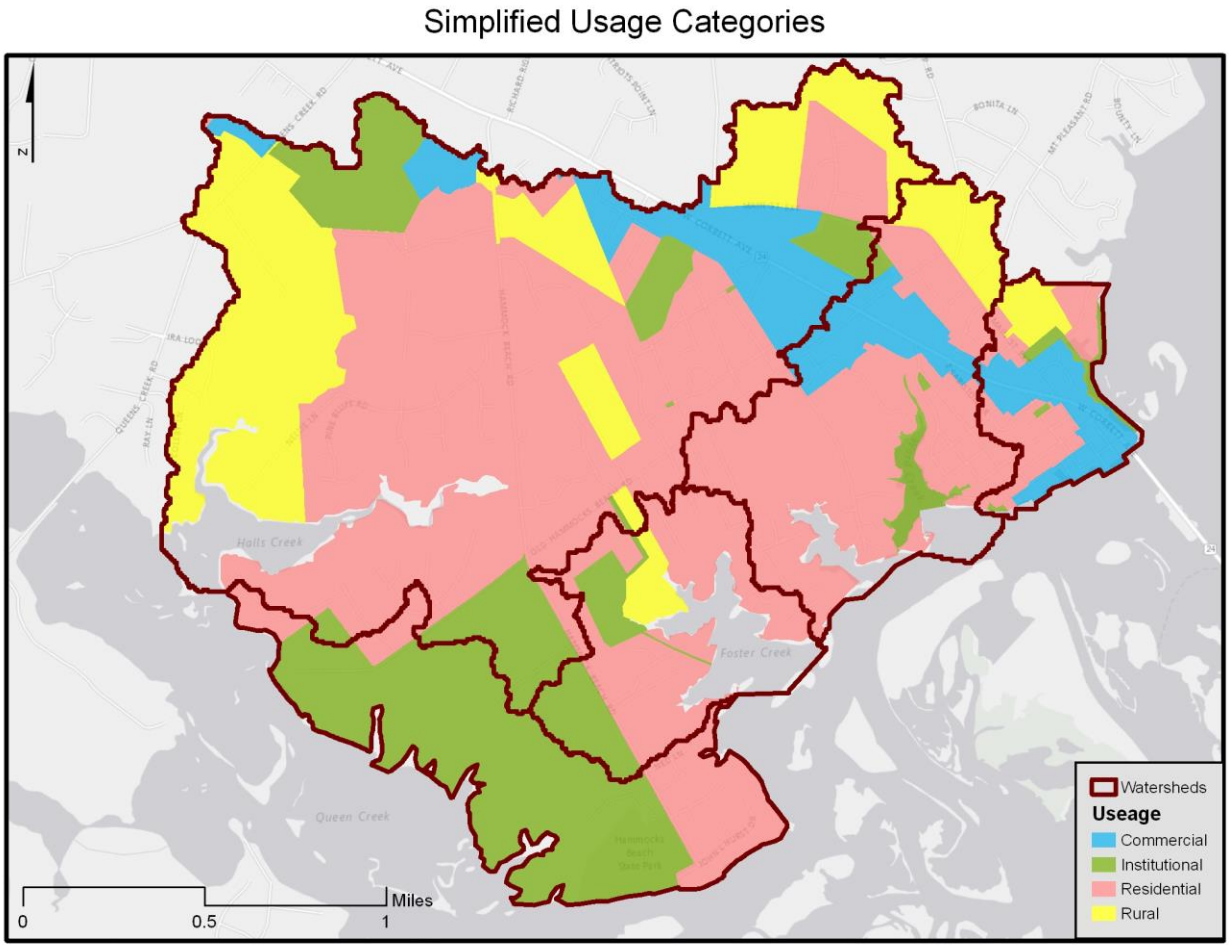

Figure 1-10. Simplified usage classification of the Swansboro watersheds based on designated uses of the area.

The N.C. Natural Heritage Program lists several protected areas in the vicinity of the watersheds (Figure 1-11), but only two are within their boundaries: properties managed by Onslow County and state-owned Hammocks Beach State Park. These areas are mixed use and have different degrees of conservation value (see Figure 1-6 and 1-7) and may have buildings or structures on the premises (Figure 1-12).

No conservation easements were found during preliminary research within the boundaries of the watershed, though a conservation easement exists upstream along Queens Creek.

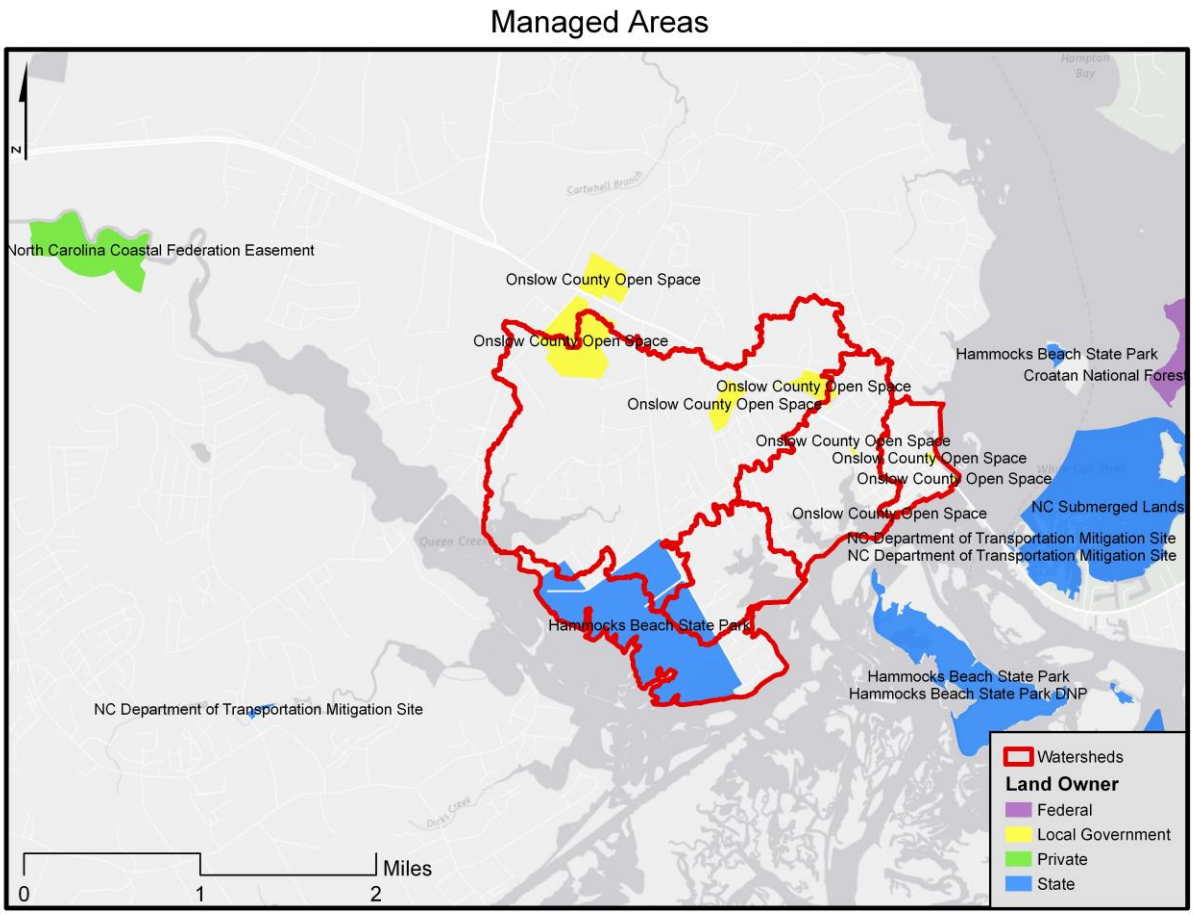

Figure 1-11. Locations of managed areas within and surrounding the Swansboro watersheds. N.C. Natural Heritage Program Managed Area dataset from October 2015.

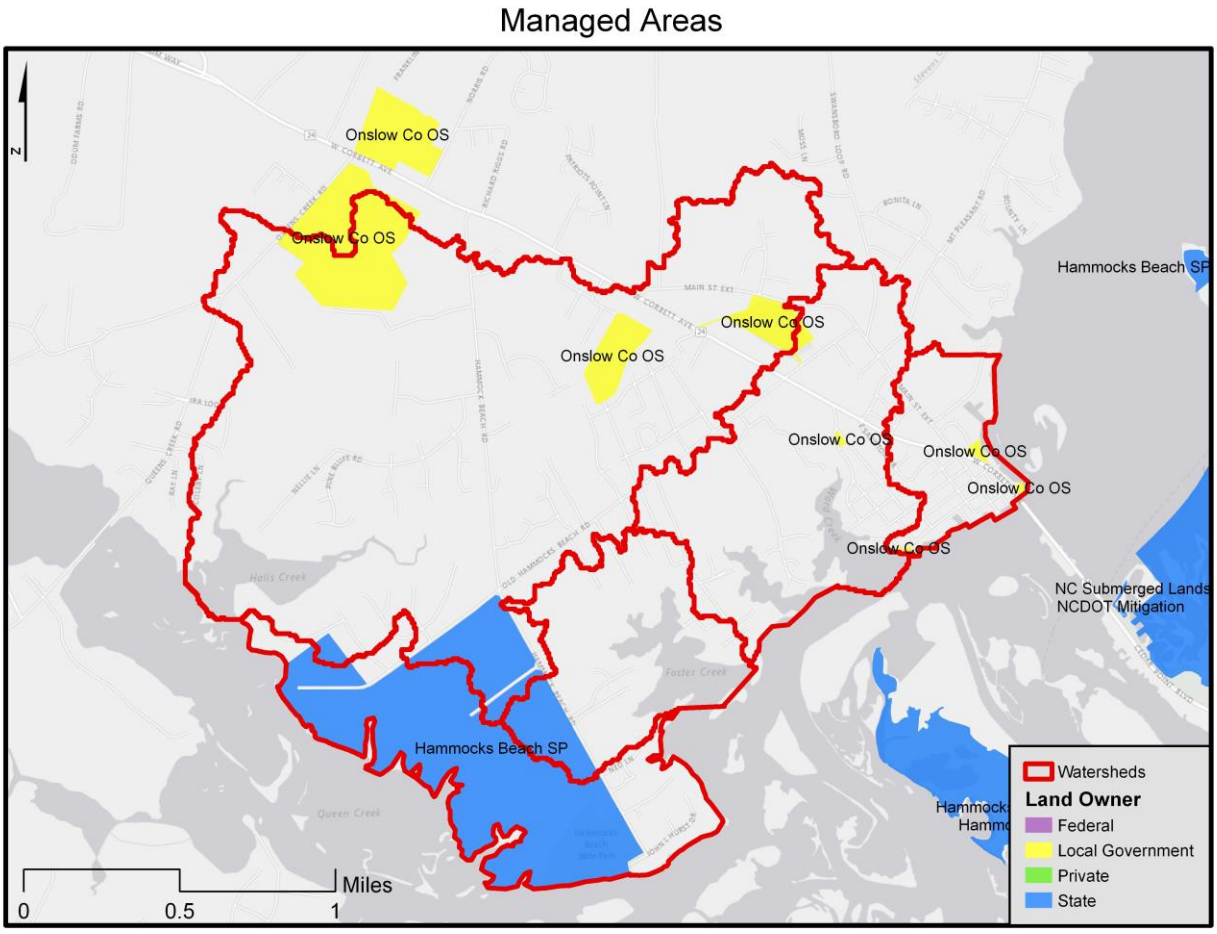

Figure 1-12. Managed areas that are managed by the county or town.

1.3 REGULATORY

When implementing projects, consideration should be given to the North Carolina Coastal Area Management Act (CAMA). Some projects may require CAMA permits, consideration of this should be given when developing a timeline for project completion.

Congress enacted the federal Clean Water Act (CWA) (33 U.S.C. §1251 et seq. (1972)) to establish regulations on water quality standards for waters with a purpose of protecting surface waters for drinking, fishing, and recreation. The EPA set water quality standards for many contaminants in surface waters and established pollution control programs. The CWA establishes use designations that mandate that waters maintain their designated usage. In North Carolina, the state Department of Environmental Quality's Division of Water Resources is

responsible for delegating water quality designations. When they do not meet their designation, waters are listed on the 303(d) list.

1.3.1 **Combined EPA and N.C. DEQ Guidelines**

In North Carolina, the Nonpoint Source Planning section in the DEQ Division of Water Resources (DWR) manages the state's 319 program. For proposals to qualify to be reviewed, watershed restoration plans in North Carolina must include the EPA watershed restoration plan nine minimum elements and any additional requirements from North Carolina.

Below is a list of criteria that is required by the EPA and N.C. DEQ. All the criteria listed are addressed within this watershed management plan.

1. Identification of impairment, pollutant, causes, and sources of pollution that need to be controlled. Pollution sources that need control measures should include estimates of their presence in the watershed
    a. Include a map of the watershed
    b. Identifies the major stressors and sources of impairment, spatial visualize the information in map form
    c. Identify point vs. nonpoint sources
    d. Identify the indicators to be measured
    e. Review existing water quality or biological data
    f. Perform a field assessment, this can be initially conducted at areas of greatest concern.
2. Identify and detail reduction load and the measures necessary to meet water quality standards
    a. Indicate the quantitative reduction load
    b. Prioritize proposed activities/projects and identify critical areas that need management
    c. Describe future and current management measures within the watershed
    d. Document relevant authorities that may have a role in management plan
    e. Management activities should address the indicators
3. Detailed management activities and the expected outcome
    a. Describe what the indicators will be for each management measure

b. Establish what the expected potential pollutant load reductions by each project will be

4. Identification of technical and financial assistance needed to implement and long-term operation and maintenance measures

    a. Estimate amount of technical assistance needed

    b. Estimate amount of financial assistance needed, ideally using a detailed cost list

    c. Identify federal, state, local, and private funds or resources that could potentially assist

5. Education and information plan for the watershed

    a. Clearly identify stakeholders

    b. Programs should have multifaceted involvement from local, state and federal programs and agencies; there should be a range of information and education options available

6. Plan implementation schedule

    a. Identify timeline of implementation of actions with specifics on what entity will accomplish the actions including monitoring

    b. Schedule should address short-, mid- and long-term actions

7. Implementation and tracking of measurable milestones to ensure benchmarks of success are being addressed

    a. Milestones should be measurable and have a clear timeframe on when the milestone should be measured

8. Indicator to measure progress toward meeting watershed goals

    a. Direct measurements (such as bacterial counts) and indirect measurements (such as number of beach closings, photographs, etc.) that can indicate whether substantial progress is being made

    b. Should address how to proceed/modify strategies if interim goals are not being met

9. Monitoring component to evaluate effectiveness of plan

    a. Monitoring should be of the load reduction goals to measure progress towards water quality improvement

2 Watershed Conditions

Swansboro and its partners have chosen to proactively develop a plan to restore the water quality in the Swansboro watersheds by using reducing the volume of stormwater runoff transporting pollutants to waterways. Previous projects, such as the Bradley and Hewletts Creek, White Oak River and Lockwoods Folly River restoration plans, used this method. It aims to mimic or restore natural hydrology, which gradually allows for the improvement of water quality by reducing the volume of stormwater runoff. This methodology can be applied by disconnecting stormwater conveyance systems and creating pathways that runoff can permeate into the ground. A reduced volume of runoff flowing over the land in the watersheds will lead to less pollutants entering the water.

2.1 WATER QUALITY

North Carolina has various methods to measures of water quality. This plan uses two: the state's water classification system, which is reported on the303(d) list, and swimming usage tier scale system (refer to Appendix B for detailed guide of water quality classification).

The tier scale effects the prioritization of sampling and the minimum water quality in swimming waters with Tier 1 being the highest priority and are locations that are used daily, Tier 2 are not used as heavily and see the most use on the weekend, and Tier 3 sites are used less frequently (refer to Table 2-1). These Tiers coincide with sampling requirements and maximum observation of bacteria. Ward/Hawkins Creek area is designated as a **Tier III swimming area**; this means that two consecutive samples shall not exceed 500 enterococci per 100 milliliters of water (**Swimming Area Monitoring Site: C27A; Station Name: Wards Shore Public Access of South Waters St**).

Table 2-1. Bacteriological Water Quality Standards for North Carolina Quick Guide. Refer to Appendix B for a complete guide to water quality standards.

Bacteriological Water Quality Standards for North Carolina Quick Guide

Shellfishing

For waters to be approved as Class SA area of harvest for direct consumption the following criteria must be met:

(1) the shoreline survey has indicated that there are no significant sources of contamination;

(2) the area is not so contaminated with fecal coliform that consumption of the shellfish might be hazardous;

(3) the area is not so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous; and

(4) the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed **14 per 100 milliliters**, and the 90th percentile shall not exceed 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during most unfavorable hydrographic conditions.

Swimming

("swimming season" April 1 – October 31)

The following standards apply to coastal North Carolina waters:

- **Tier I**
  "*A swimming area used daily during the swimming season, including any public access swimming area and any other swimming area where people use the water for primary contact, including all oceanfront beaches*"
  A geometric mean of at least five samples in 30 days that results in **35 enterococci per 100 ml** of water ***OR*** a single sample of **104 enterococci in a 100-ml** sample
- **Tier II**
  "*A swimming area used an average of three days a week during the swimming season*"
  Single sample of **276 enterococci in a 100-ml** sample
- **Tier III**
  "*A swimming area used an average of four days a month during the swimming season*"
  Two consecutive samples of **500 enterococci in each 100-ml** sample

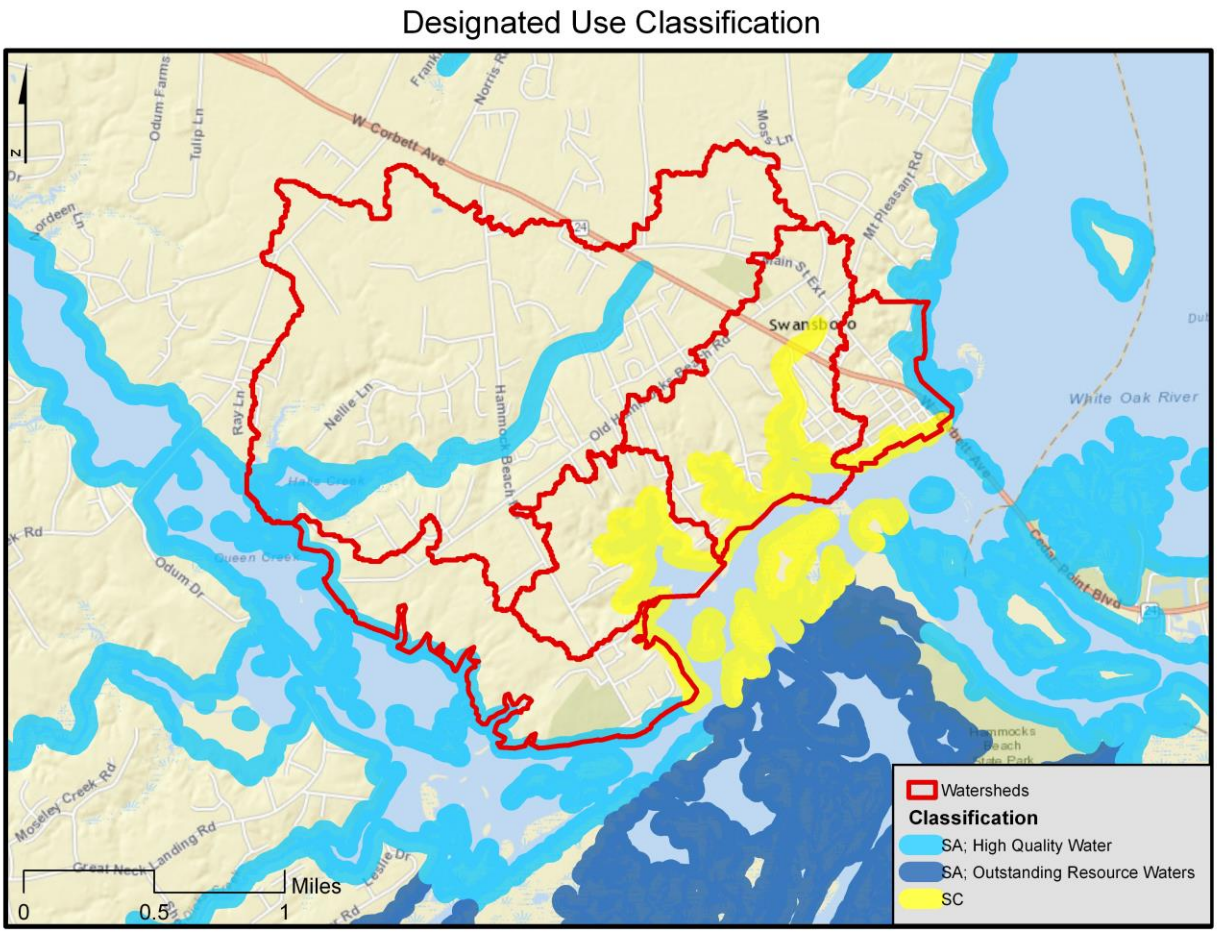

Figure 2-1. Designated uses water quality classifications for the Swansboro Watersheds.

There are two distinct designated uses set by N.C. Department of Environmental Quality in the Swansboro watersheds: **Class SA and Class SC** (Figure 2-1; Table 2-2; Appendix B). The watersheds fall within the state's designated **Shellfish Harvesting Area D-2 and D-3** and will be in the Sanitary Survey Reports for D-2 and D-3. The waters of Halls Creek watershed are designated as Class SA waters. That's one of the state's highest water classifications. Such water should be clean enough to allow swimming and other types of recreation, fishing, and shellfishing harvesting. Ward/Hawkins Creek, Foster Creek, Historic, and Hammocks watersheds are designated as Class SC, except for the most westerly portions of Hammocks watershed, which is Class SA and most northerly portion. Class SC waters should be able to support secondary recreation activities such as fishing, boating, and other activities that involve minimal skin contact, fishing, aquatic life propagation and survival and wildlife. It is relevant to note

that since 1944 the area now designated as Class SC and areas along Queens Creek were originally restricted due to the presence of a sewage treatment plant (now closed) just north of the bridge in the Historic watershed and a stormwater treatment plant along Fosters Creek. Sanitation Reports of the region by Shellfish Sanitation appear to show that these areas that were originally restricted were grandfathered into the designation of Class SC in 1977 when designated use classifications were developed to meet the Clean Water Act. Since this time, one treatment plant was closed and the Swansboro Wastewater Treatment Plant that discharged treated water into Fosters Creek discontinued the discharge of water in 2008. When the Swansboro Wastewater Treatment Plant discontinued the discharge, water quality improved in Fosters Creek enough to allow for some previously restricted sections of the creek and bay-area to be reopened for used. Refer to Table 2-2 for a summary of each watersheds swimming, designated use classification, and harvest area.

Table 2-2. Summary of swimming and designated use classifications.

Watershed	Nearest Monitoring Site Swimming Tier	Nearest Swimming Area Monitoring Site	Designated Use Classification	Shellfish Harvesting Area
Foster Creek	Tier III	C27A	SC	D-3
Halls Creek	Tier III	C27A	SA	D-2
Hammocks	Tier III	C27A	SA, SC	D-2, D-3
Historic	Tier III	C27A	SA, SC	D-3
Ward/Hawkins	Tier III	C27A	SC	D-3

Stormwater runoff results in high bacterial counts. Persistently high counts have degraded water quality to a level that no longer meet the standards for the water's designated uses. This has led to waters within the watersheds being placed on the 303(d) list (Appendix B). Shellfish closures and swimming advisories are indicators of poor water quality from bacteria contamination. Stormwater runoff is the primary conveyor of polluted water. The increase of impervious surfaces the use of connected ditches and pipes to move runoff have altered the natural hydrology in many areas of the watersheds. These alterations to surface hydrology have reduced the amount of natural cover and replaced this natural cover with impervious surface and a connected conveyance system. Instead of rainfall soaking into the ground, stormwater runoff flows quickly over these hard surfaces and through these pipes and ditches to the nearest waterbody. As the water travels across these impervious surfaces, bacteria and other pollutants are collected within the stormwater runoff. Table 2-3 is a summary of the water quality for all the watersheds and Figure 2-2 depicts the shellfish closure boundaries:

Table 2-3.

Current water quality summary of Swansboro Watersheds.

Watershed	*Designated Use*	*Shellfish Sanitation Closure Year*	*Current Shellfish Status*	*Nearest Monitoring Station*
Foster Creek	SC	1944	Prohibited	D-3 Stations • 23 • 46
Halls Creek	SA	(Between 1944-1990 part of Swansboro restriction area)	Conditionally Approved Closed	D-2 Stations: • 5 • 3 • 36 • 2
Hammocks	SA, SC	SC Area: 1944	SC Area: Prohibited SA Area: Open	D-3 Stations: • 23 • 46 D-2 Stations: • 17 • 31 • 16 • 7 • 5A
Historic	SA, SC	1944	Prohibited	D-3 Stations: • 21 • 47
Ward/Hawkins Creek	SC	1944	Prohibited	D-3 Stations: • 47

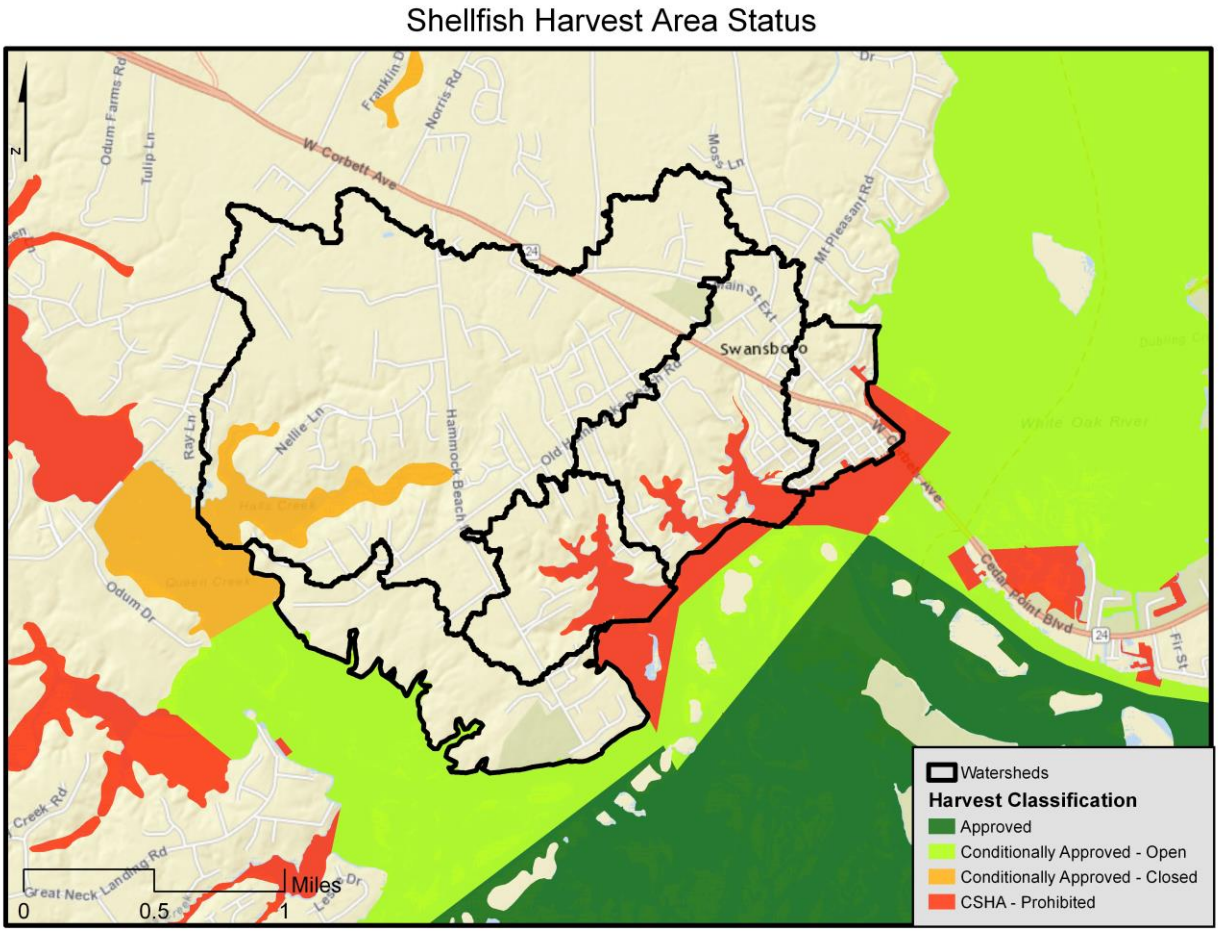

Figure 2-2. Map of shellfish harvesting closure areas.

All watersheds within the Swansboro region have waters that are impaired or flow directly into impaired waters (Figure 2-3). Figure 2-4 is a spatial visualization of the designated uses and impairment status.

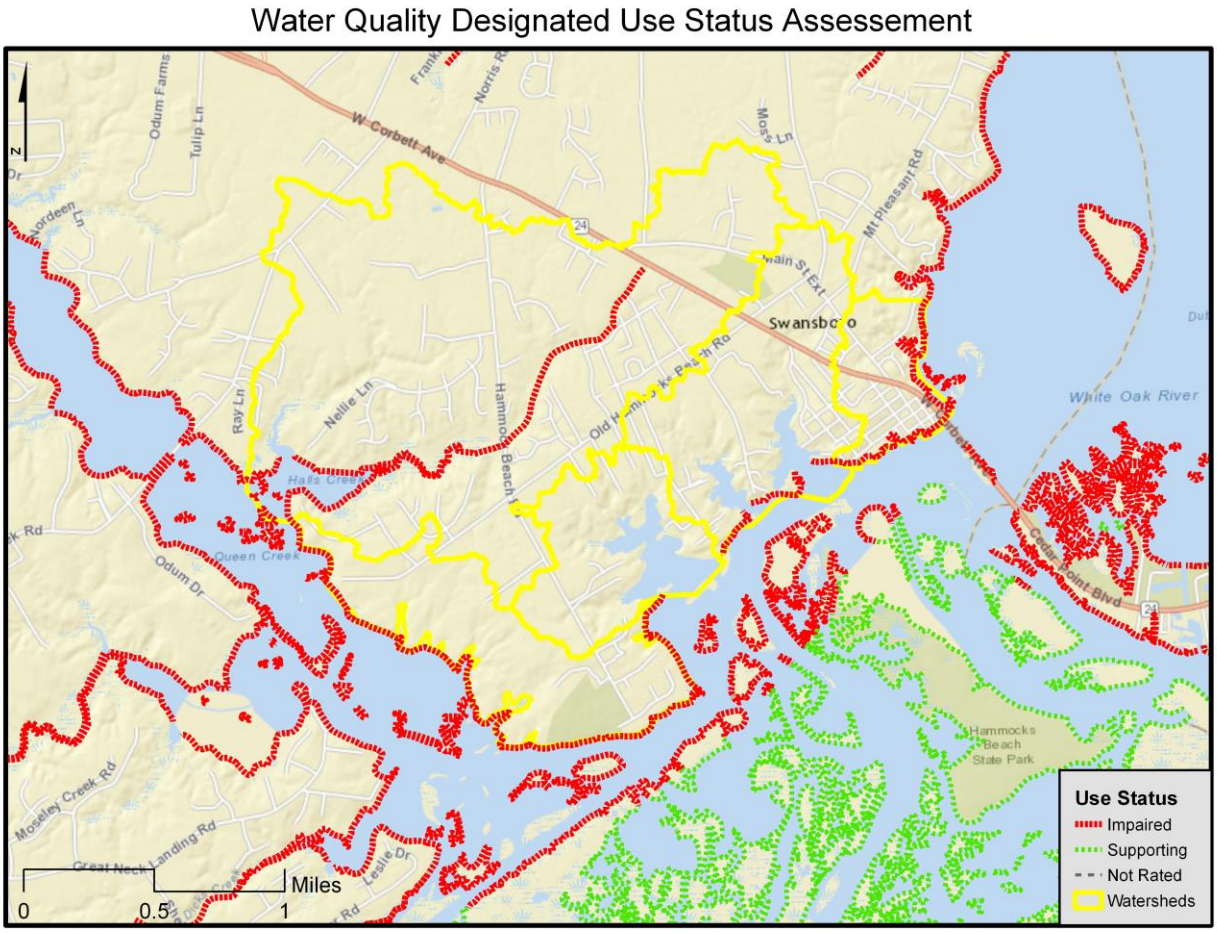

Figure 2-3. Map of impaired waters.

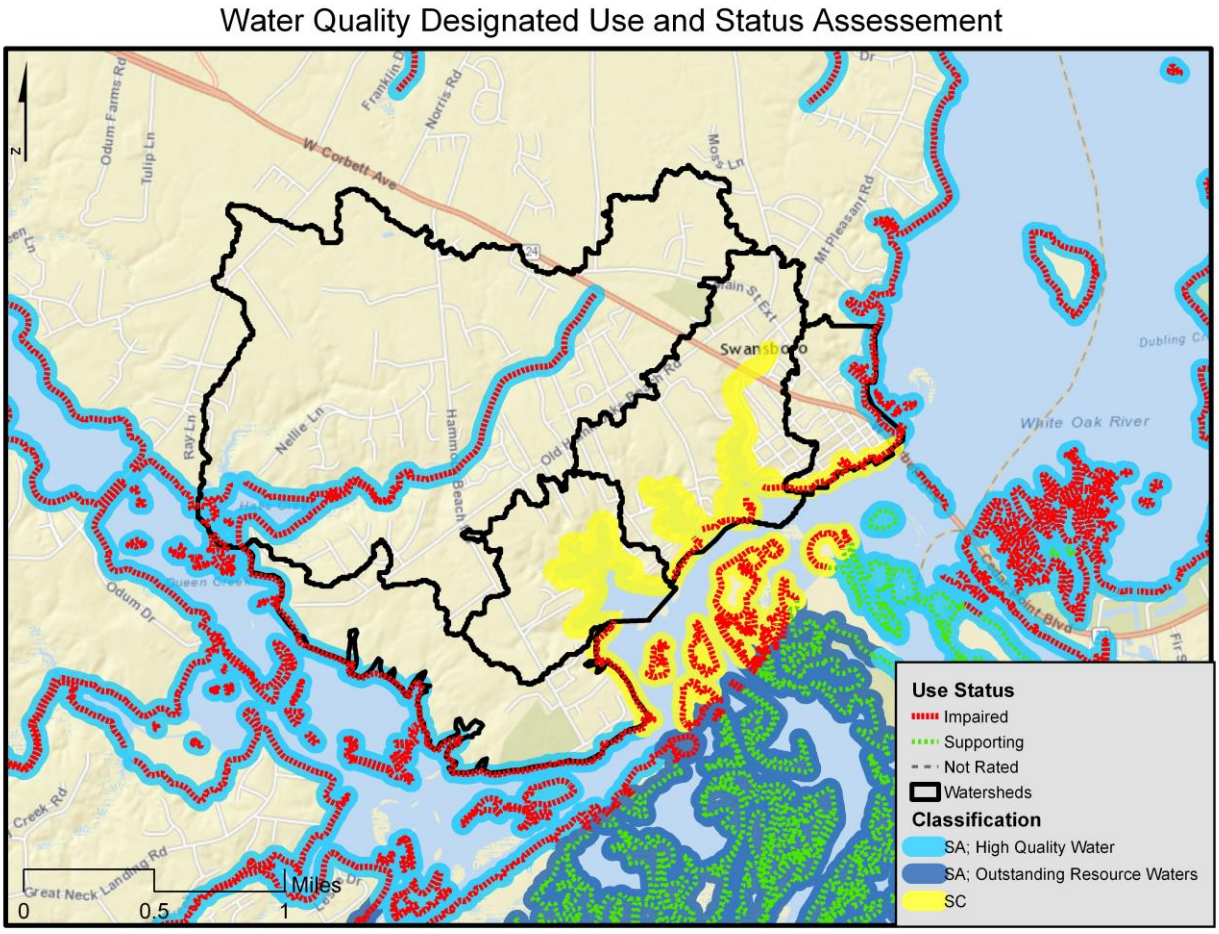

Figure 2-4. Map of impaired waters and designated use categorizations.

The Clean Water Act (CWA) requires that steps be taken to remove impaired waters from the 303(d) list (Appendix B). Removal usually includes a study of, what the CWA calls the Total Maximum Daily Load (TMDL). These technical reports detail the amount of pollution that must be removed from the water to restore water quality. Often, time and financial resources are not sufficient to allow for TMDL development in smaller waterbodies dominated by nonpoint source pollution. There is currently no TMDL reports completed for the impaired waters of the Swansboro watersheds.

A TMDL was done for **Queens Creek (TMDL ID: 40541)**[4] in 2011, which included Halls Creek. The Queens Creek study was done to limit excessive fecal coliform pollution and found that the target load is 38/100 ml CFU, which is 10% lower than the water quality criteria of 43/100 ml CFU. The Queens Creek TMDL is applicable to certain portions of the Halls Creek and Hammocks watersheds. A TMDL was also prepared the main stem of the **White Oak River**[5] **(TMDL ID: 39140)** in 2010, which is applicable to certain portions of the Historic watershed. The White Oak River TMDL study was also done to limit fecal coliform and found that the target load is 38/100 ml CFU, which is 10% lower than the water quality criteria of 43/100 ml CFU. The Swansboro watersheds are also included in a statewide TMDL for mercury. That study was completed in October 2012.

Records from the N.C. Division of Water Quality and Shellfish Sanitation show that increased pathogenic loading in the creeks corresponds to water quality impairments within the watersheds. Partners and stakeholders agree that reduction of stormwater volume is the most beneficial and cost effective way to eliminate bacteriologic pollutants.

According to the EPA Waterbody Quality Assessment Reporting, the water bodies listed below are required to have a TMDL to study bacteria impairing waters from their designated uses. The following list should be kept up-to-date as it will likely be used regularly when applying for funding and grants. The following is a list of waterbodies in the Swansboro region currently on the 2014 303(d) list and draft 2016 303(d) List waterbodies:

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[4] Queens Creek TMDL Study Report:
http://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=73536

[5] White Oak River TMDL Study Report:
http://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=73400

Assessment Unit Number	Name	Description	Acres	Year Placed on 303(d)	Cause	TMDL
19-41-16-3	Halls Creek	From source to Queens Creek	26.9	2002	Fecal	Queens Creek TMDL
19-41-61b1	Queens Creek	From DEH Conditionally Approved closed line at Queens Creek Road Bridge to DEH Conditionally Approved Open line at northeast mouth of Parrot Swamp.	150.8	2002	Fecal	Queens Creek TMDL
19-41-61b2	Queens Creek	Conditionally Approved closed line at Queens Creek Road Bridge to DEH Conditionally Approved Open line at northeast mouth of Parrot Swamp.	11.59	2002	Fecal	Queens Creek TMDL
19-41-61c	Queens Creek	From DEH Conditionally Approved Open line at northeast mouth of Parrot Swamp to Intracoastal Waterway.	283.82	2002	Fecal	Queens Creek TMDL
19-41-15.5a	Intracoastal Waterway	From the southwest mouth of Queens Creek to the west side of the White Oak River Restricted Area	0.25	2002	Fecal	--
20-32	White Oak River Restricted Area	That portion of White Oak River within an area bounded by a line running in an easterly direction from a point below Foster Creek to east end of Swansboro Bridge (N.C. Hwy. 24)	267.64	2012	Fecal	--
20-(18)c6	White Oak River	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line. Directly adjacent to the north of Swansboro Bridge	31.3	2002	Fecal	White Oak River TMDL
19-41-18b1	Bear Island ORW	All waters within an area north of Bear Island defined by a line from the western most point on Bear Island and running along the eastern shore of Sanders Creek to the northeast	24.0	2002	Fecal	--

The following is a list of existing water monitoring stations identified through Storage and Retrieval for Water Quality Data (STORET) system and N.C. Shellfish Sanitation (Table 2-2). This is not a comprehensive list. More water quality monitoring stations may exist that do not participate in the STORET system or data share with Shellfish Sanitation. Additional monitoring stations may exist through local non-profits, academia, or private companies that may be willing to share data. The region contains multiple monitoring stations near the Swansboro watersheds; Figure 2-3 shows the closest stations.

It is recommended that monitoring efforts be focused on monitoring data from the stations closest to the watersheds listed in Table 2-2 and shown in Figure 2-3. These stations are monitored regularly by Shellfish Sanitation and are an ideal source of information. Additional water monitoring stations should be incorporated for regular monitoring, especially to monitor improvement of water quality if there are in proximity to areas with stormwater retrofits.

Table 2-4. Water quality monitoring stations.

Watershed	Station Name	Station No	Organization
Fosters Creek	200 Yards West Southwest Of Flashing Beacon #59	**D-3 #23***	NC Shellfish Sanitation
Fosters Creek, Hammocks	300 Yards North of Beacon #49 - ICWW	D-3 #46	NC Shellfish Sanitation
Hammocks	Fl. Beacon #49, ICWW	D-2 #17	NC Shellfish Sanitation
Hammocks	By Ferry Dock (The Hammock)	**D-2 #31***	NC Shellfish Sanitation
Hammocks	900 yds. From Sta. #30, at 60° M by mouth of creek	**D-2 #16***	NC Shellfish Sanitation
Hammocks	600 yds. From Sta. #11, at 68° M by oyster rock	D-2 #7	NC Shellfish Sanitation
Hammocks	200 yards south of station #5 off 4H Camp outside closure line	**D-2 #5a***	NC Shellfish Sanitation
Hammocks	765 yds. From Sta. #11 at 24° M in cove	**D-2 #5***	NC Shellfish Sanitation
Halls Creek	Queens Creek Bridge	D-2 #2	NC Shellfish Sanitation
Halls Creek	1100 yds. From Sta. #11, at 334° M in slough	D-2 #36	NC Shellfish Sanitation
Halls Creek	1233 yds. From Sta. #11, at 0° M, mouth of creek	**D-2 #3***	NC Shellfish Sanitation
Historic	By Old STP West of Bridge	D-3 #21*	NC Shellfish Sanitation
Ward/Hawkins Creek, Historic	West Channel at Mouth - Northwest End	**D-3 #47***	NC Shellfish Sanitation
Note: * (asterisk) denotes stations located within or on watershed boundary			

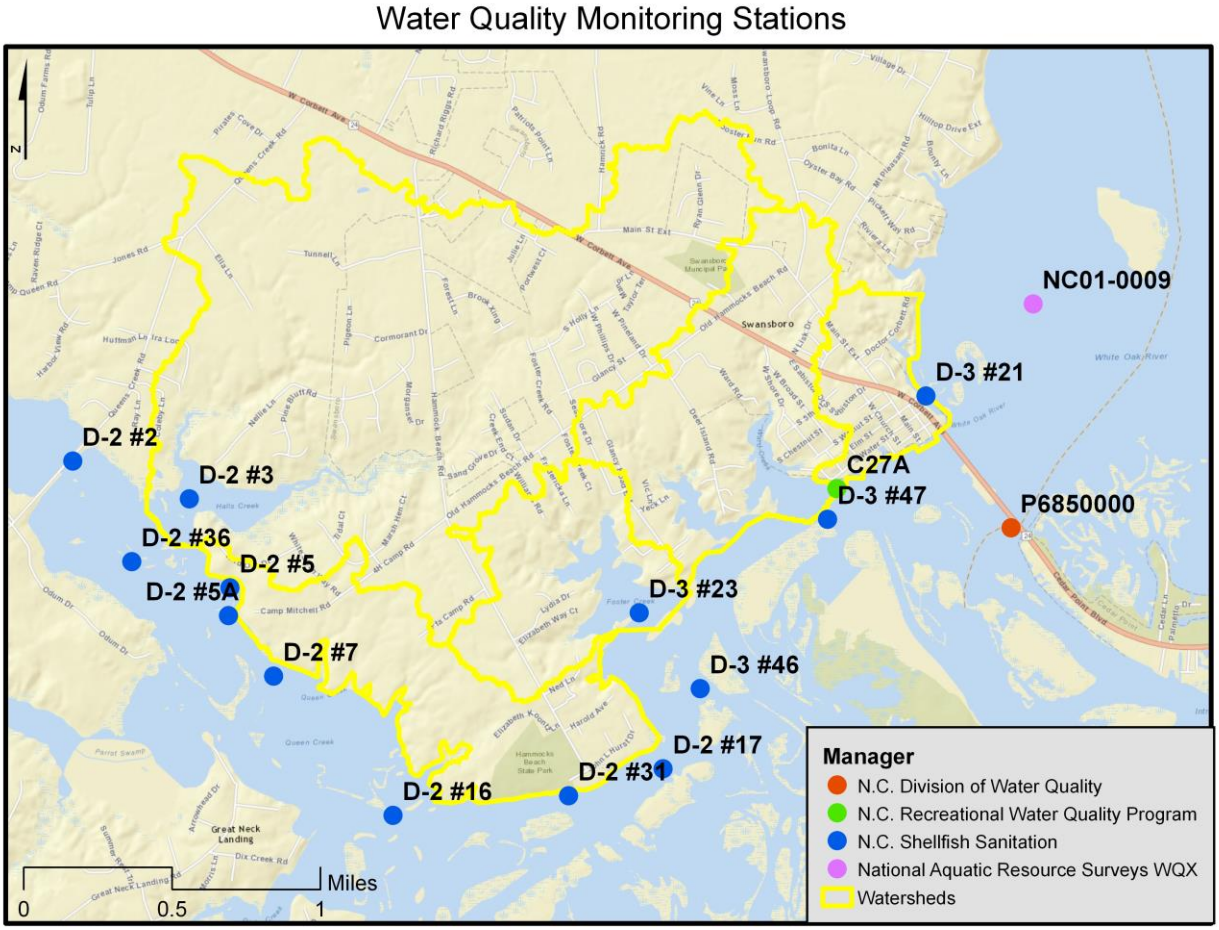


Figure 2-5. Location of monitoring stations within the area as registered through Shellfish Sanitation's system.

Within the Swansboro watersheds, stations exceeding fecal coliform levels of Class SA (GM >14/100 ml; specifically, fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions; Appendix B) appear to either maintain or increase in frequency over the course of the last two decades. Understanding how often water quality stations have exceeded a single sample reading of 14/100 ml aid in the development of milestones and assist in the monitoring of progress.

Survey Report Cycle	1996-2001	2001-2006	2005-2010	2009-2014
Station No.	Percent of samples station exceeded 14/100 ml out of 30 samples			
D-2 #2	30%	60%	50%	53%
D-2 #3	47%	70%	80%	63%
D-2 #5	47%	36%	30%	40%
D-2 #5a	--	--	--	--
D-2 #7	13%	20%	23%	33%
D-2 #16	13%	26%	13%	6%
D-2 #17	3%	17%	10%	13%
D-2 #31	13%	10%	3%	0%
D-2 #36	30%	10%	23%	17%
Survey Report Cycle	**1999-2003**	**2001-2006**	**2005-2010**	**2009-2014**
Station No.	Percent of samples station exceeded 14/100 ml out of 30 samples			
D-3 #21	6%	36%	20%	20%
D-3 #23	--	--	--	14% (3 of 22 samples)
D-3 #46	20%	23%	6%	13%
D-3 #47	13%	10%	6%	0%

>50% of samples exceed SA standard	25-49% of samples exceed SA standards	10-24% of samples exceed SA standards	<10% of samples exceed SA standards

Note: These numbers represent a single sample in which 14/100ml was exceeded.
Note: D-2 Station #5a is a new station and no historic data exists for this station and reports from this station should be included in the future. D-3 Station #23 was a new station and does not have historical data before 2009. Reporting cycles were not standardized in all Shellfish Harvest Areas until 2001.

Within the Swansboro watersheds, fecal coliform levels should not to exceed a geometric mean of 43/100 ml (MF count; Appendix B). This is part of Class SA standards for water quality in which "fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."

Survey Report Cycle	1996-2001	2001-2006	2005-2010	2009-2014
Station No.	Percent of time station exceeded 43/100 ml out of 30 samples			
D-2 #2	6%	33%	20%	20%
D-2 #3	13%	50%	60%	27%
D-2 #5	10%	13%	10%	17%
D-2 #5a	--	--	--	--
D-2 #7	0%	10%	13%	10%
D-2 #16	6%	0%	3%	3%
D-2 #17	0%	0%	0%	3%
D-2 #31	3%	6%	0%	0%
D-2 #36	13%	6%	3%	3%
Survey Report Cycle	1999-2003	2001-2006	2005-2010	2009-2014
Station No.	Percent of time station exceeded 43/100 ml out of 30 samples			
D-3 #21	6%	10%	0%	0%
D-3 #23	--	--	--	14% (3 of 22 samples)
D-3 #46	3%	3%	3%	6%
D-3 #47	0%	0%	3%	0%

>50% of samples exceed 43/100 ml	25-49% of samples exceed 43/100 ml	10-24% of samples exceed 43/100 ml	<10% of samples exceed 43/100 ml

Note: These numbers represent a single sample in which 43/100ml was exceeded.
Note: D-2 Station #5a is a new station and no historic data exists for this station and reports from this station should be included in the future. D-3 Station #23 was a new station and does not have historical data before 2009. Reporting cycles were not standardized in all Shellfish Harvest Areas until 2001.

There is only one swimming area station within the Swansboro watersheds, Station C27 Wards Shore Public Access (off South Waters Street). Station C27 is a Tier III station. The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliters of water (Appendix B). A Tier III swimming area with a water sample result of 500 enterococci per 100 milliliters or higher on the first sample shall be resampled the following day. If the laboratory results of the second sample exceed 500 enterococci per 100 milliliters a swimming advisory shall be issued by the Division (Table 2-5). This station has only exceeded Tier III standards once since its installation in 2010. In contrast, if C27 is reviewed at Tier II or Tier I standards, there are higher rates of standards being exceeded.

Table 2-5. Station C27 Water Sample History.
**Note: Data extends to 2010 when the station was installed.*

Year	Number of Samples exceeding 500 (standard for Tier III)
2010	0
2011	0
2012	0
2013	0
2014	1
2015	0
2016	0

Year	Number of Samples exceeding 276 (standard for Tier II)
2010	0
2011	0
2012	0
2013	0
2014	1
2015	1
2016	0

Year	Number of Samples exceeding 104 (standard for Tier I)
2010	2
2011	0
2012	0
2013	0
2014	4
2015	1
2016	1

NOAA precipitation frequency models state that a 1-year, 24-hour storm for Swansboro results in **3.67 inches of precipitation** and the results for a **2-year, 24-hour storm is 4.46 inches** (Table 2-6). The 1-year, 24-hour storm and 2-year, 24-hour storm estimations are used to develop hydrographs of the watershed. Precipitation from the 1-year, 24-hour storm is used in this study because it forms the basis of the state stormwater regulations in shellfish waters (Class SA). The 2-year, 24-hour storm event depth of precipitation will also be necessary as part of developing hydrographs of the data.

Table 2-6.

NOAA precipitation frequency table for Swansboro Watersheds.

PRECIPITATION FREQUENCY ESTIMATES (Time/years) IN INCHES										
Duration	**1**	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min:	0.49	0.58	0.66	0.75	0.84	0.92	1	1.07	1.17	1.26
10-min:	0.78	0.92	1.06	1.2	1.34	1.47	1.59	1.7	1.85	1.98
15-min:	0.98	1.16	1.35	1.51	1.71	1.86	2	2.15	2.33	2.48
30-min:	1.34	1.6	1.91	2.19	2.53	2.8	3.07	3.35	3.71	4.02
60-min:	1.67	2.01	2.45	2.85	3.36	3.79	4.23	4.69	5.32	5.87
2-hr:	2.04	2.47	3.1	3.68	4.46	5.15	5.87	6.65	7.75	8.73
3-hr:	2.21	2.67	3.36	4.03	4.93	5.76	6.63	7.6	9.02	10.3
6-hr:	2.69	3.25	4.1	4.91	6.05	7.07	8.18	9.41	11.21	12.86
12-hr:	3.17	3.84	4.87	5.87	7.27	8.56	9.96	11.53	13.86	16.01
24-hr:	**3.67**	**4.46**	5.77	6.88	8.55	10	11.61	13.41	16.13	18.48
2-day:	4.26	5.17	6.63	7.9	9.81	11.49	13.35	15.45	18.64	21.41
3-day:	4.53	5.48	7	8.29	10.2	11.85	13.68	15.71	18.82	21.52
4-day:	4.79	5.79	7.36	8.67	10.59	12.22	14.01	15.97	19.01	21.65
7-day:	5.55	6.69	8.41	9.83	11.89	13.62	15.47	17.48	20.4	22.86

2.2 SOURCE ASSESSMENT

The primary source being addressed through this restoration plan will be stormwater runoff, which carries pollutants such as bacteria, the most predominate water quality impairment as identified by state reports and TMDL studies.

2.2.1 Nonpoint Source Pollution

Due to rapid urban development and alteration of natural hydrology within the watershed, bacterial pollutants have been found to be the primary issue as reported in water quality assessments and Shellfish Sanitation reports. The difficulty in preventing violations of bacteria standards for coastal waters caused by stormwater runoff is compounded by the unique challenges related to coastal hydrology and bacteria pollution. These are:

1. The two bacteria used as indicators of water quality, fecal coliform and enterococcus, naturally occur across the terrestrial landscape. These bacteria are found in the feces of warm-blooded animals, such as birds, deer, raccoons and domestic pets. Although prudent measures should be taken to reduce the sources of bacteria, these efforts alone will not result in satisfactory improvements in coastal water quality due to unnatural levels of stormwater being discharged.
2. Treating stormwater runoff to remove bacteria pollution before it flows into shellfishing and swimming waters is impractical. Although some technology exists for decreasing bacteria levels in runoff, it is not able to reduce levels to ensure water quality necessary to allow shellfish harvest and swimming.
3. Treated runoff can easily be re-contaminated. Due to the ubiquitous nature of bacteria on the landscape, treated runoff, once discharged back on the landscape, will simply pick up more bacteria. The result is ineffective and costly treatment.

A more practical approach would be to reduce the amount of stormwater entering waterways. Stormwater runoff can convey a variety of nonpoint source pollutants from a variety of causes. Potential nonpoint sources range from animal sources to connected conveyance systems.

A variety of potential non-point animal sources exist within the watersheds that can contribute to degradation of water quality (Figure 2-6). Within the watersheds, Shellfish Sanitation surveys have identified three identified non-point sources of concern by directly from animal sources (one source was a horse within the Ward/Hawkins Creek watershed but at the time of the survey the horses were no longer present). There is one property with cows, a rural area property with chickens, and a domesticated duck population. There are also approximately five sources not within the boundaries of the watershed but may affect the waters surrounding the watersheds because the sources are directly upstream. These animal sources can be a contributing factor to bacteria pollution; however, it is unlikely that these small-scale stables and farms are a major factor.

Additionally, wildlife was identified as prevalent throughout the entire region. These non-point animal sources locations should be monitored, like the rest of the watersheds, for growth or expansion that affect a watershed. This monitoring is currently conducted by Shellfish Sanitation and the findings are released every five years within its reports for Area D-2 and D-3. It may be worthwhile to build partnerships with owners to encourage the use of management practices that reduce the risk of water quality effects.

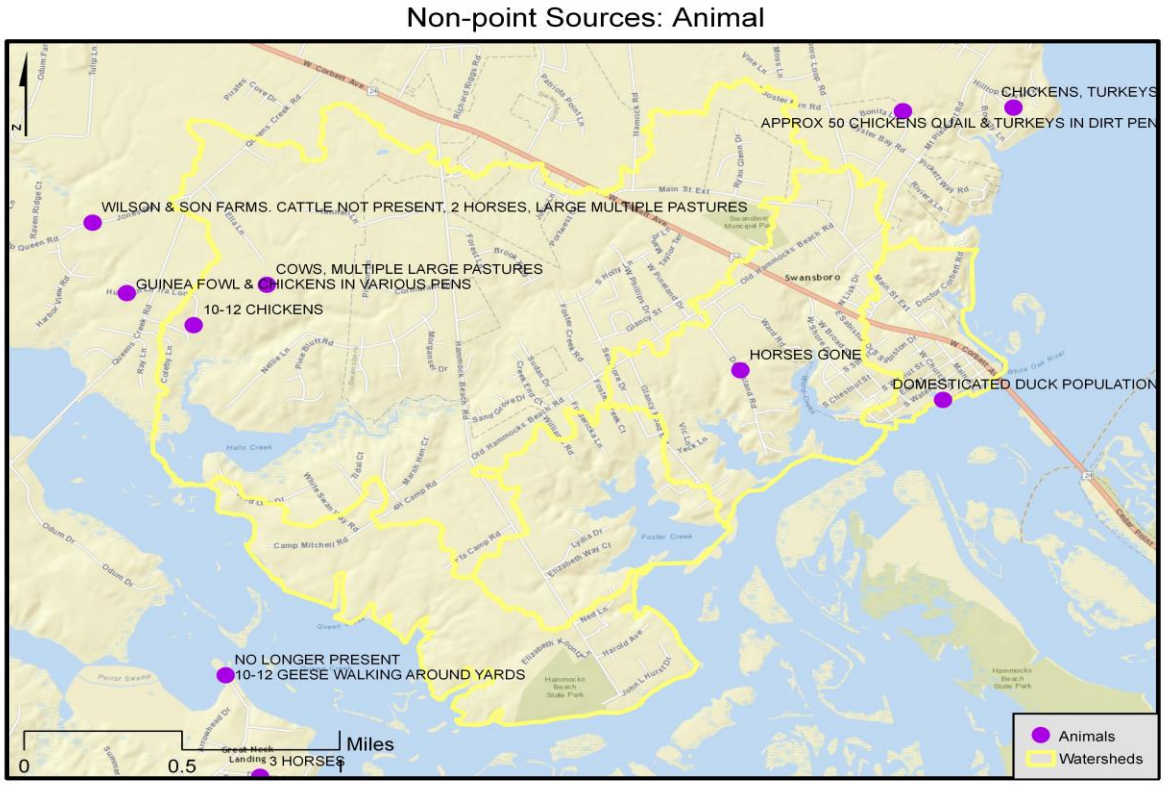


Figure 2-6. Potential non-point animal sources.

There are two noted areas of concern within and near the watersheds (Figure 2-7). One site has debris and materials that can pose a risk for trash and chemical pollution. A camp ground adjacent to Halls Creek Watershed can pose a risk of trash pollution and discharge from onsite wastewater. These areas pose both short-term and long-term risks to water quality as noted by Shellfish Sanitation. This monitoring is currently conducted by Shellfish Sanitation and the findings are released every five years in its reports for Area D-2 and D-3. For these specific sites, it is recommended that they continue to be monitored and to partner with property owners to discover if there are any practices that can be implemented to minimize the potential risk.

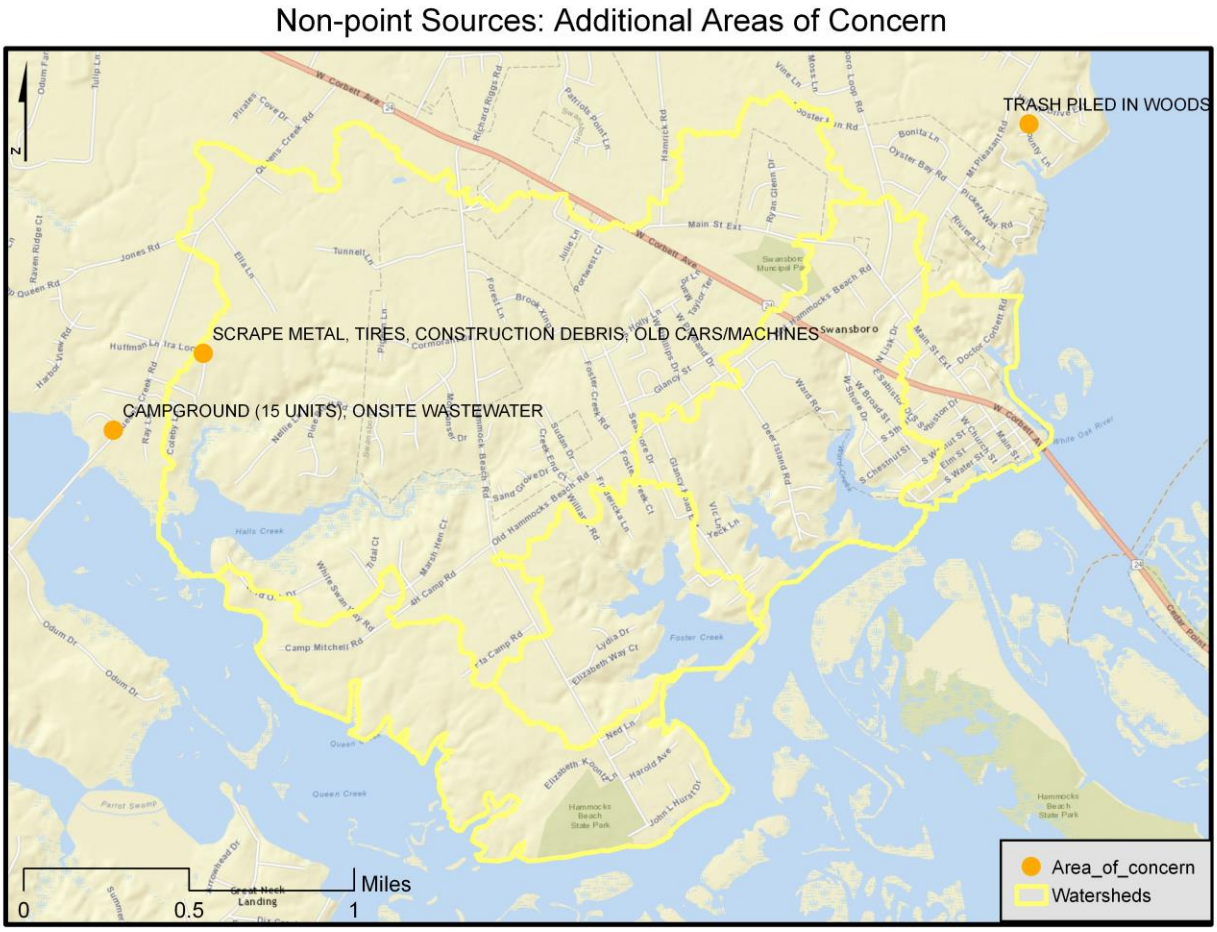


Figure 2-7. Potential non-point source areas of concern.

There are numerous docks and boat ramps within Swansboro Watersheds (Figure 2-8). Issues concerning non-point source pollution from dockages stem from boat cleaners, litter, and fuel discharge. These are being noted here if they become issues in the future. There is also one marina within the Historic Watershed (Caspers Marina) and one adjacent to the Swansboro Watersheds (Dudleys Marina) (Note: Marinas are defined by state regulations as having more than 10 boat slips) (see Appendix C for definition of each dockage). Deer Island Harbor is one of the newest dockages within the Swansboro Watersheds and is associated with a newly developing subdivision. Expansion and risks are monitored by Shellfish Sanitation, which publishes its every five years in the reports for Area D-2 and D-3. It may be worthwhile to consider working closely with dock and marina managers to promote best management practices to ensure that potential risks are minimized.

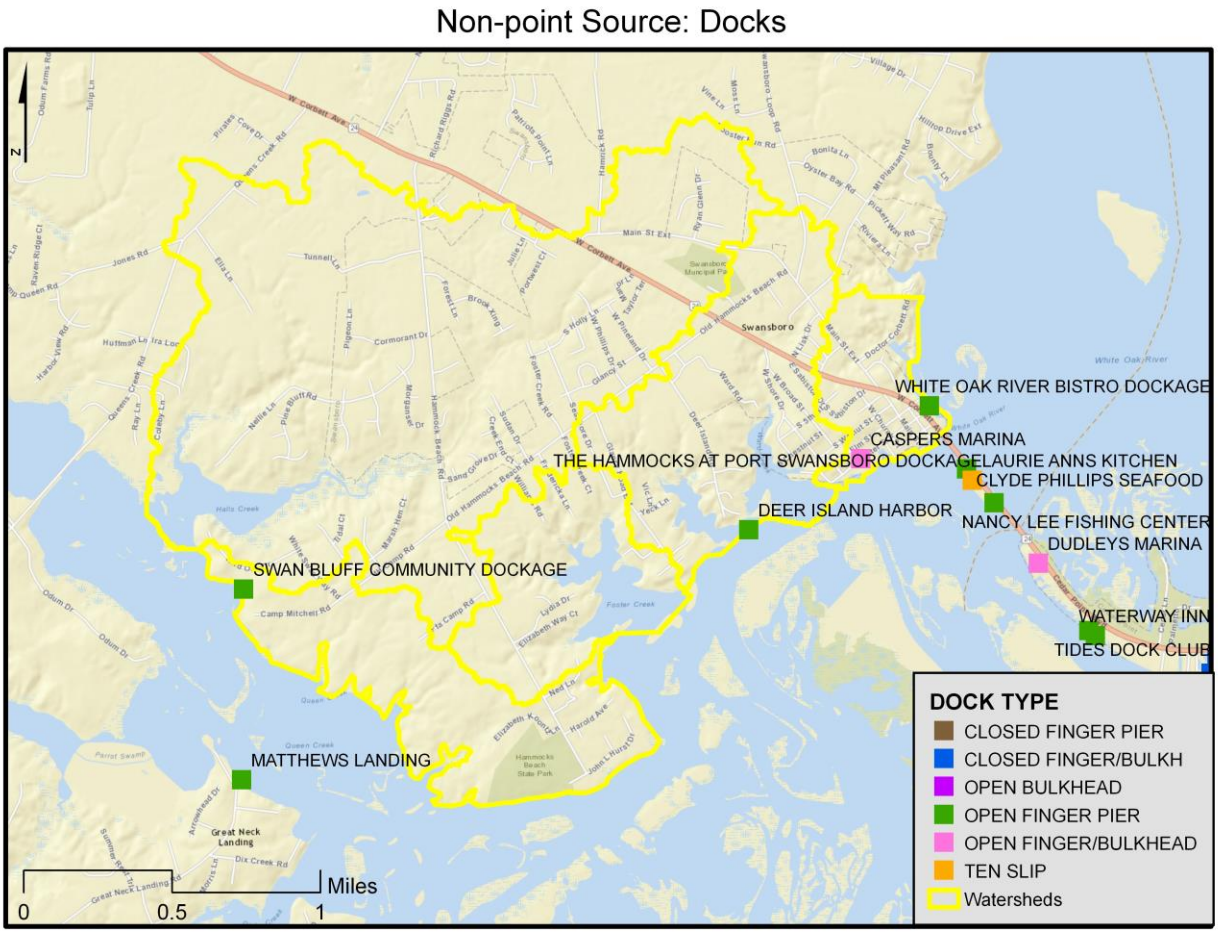


Figure 2-8. Potential non-point dockage sources. See Appendix C for definition of dock type.

There are various connected conveyance systems that enable direct access of stormwater to the waterbodies of the watershed (Figure 2-9) (see Appendix C for definition of Conveyance type). These access points include curb and gutters, connected ditches, connected swales, and pipe systems that quickly transport stormwater runoff. In total, there are over 118 sites within the watersheds; of these, roughly 10 have the potential to discharge high fecal coliform loads into the watershed, according to Shellfish Sanitation. This monitoring is currently conducted by Shellfish Sanitation and the findings are released every five years in the reports for Area D-2 and D-3. Disconnecting connected conveyance systems are some of the most effective measures to reduce the volume of stormwater runoff reaching waterways. It is recommended that future projects should consider further review of these points for solutions.

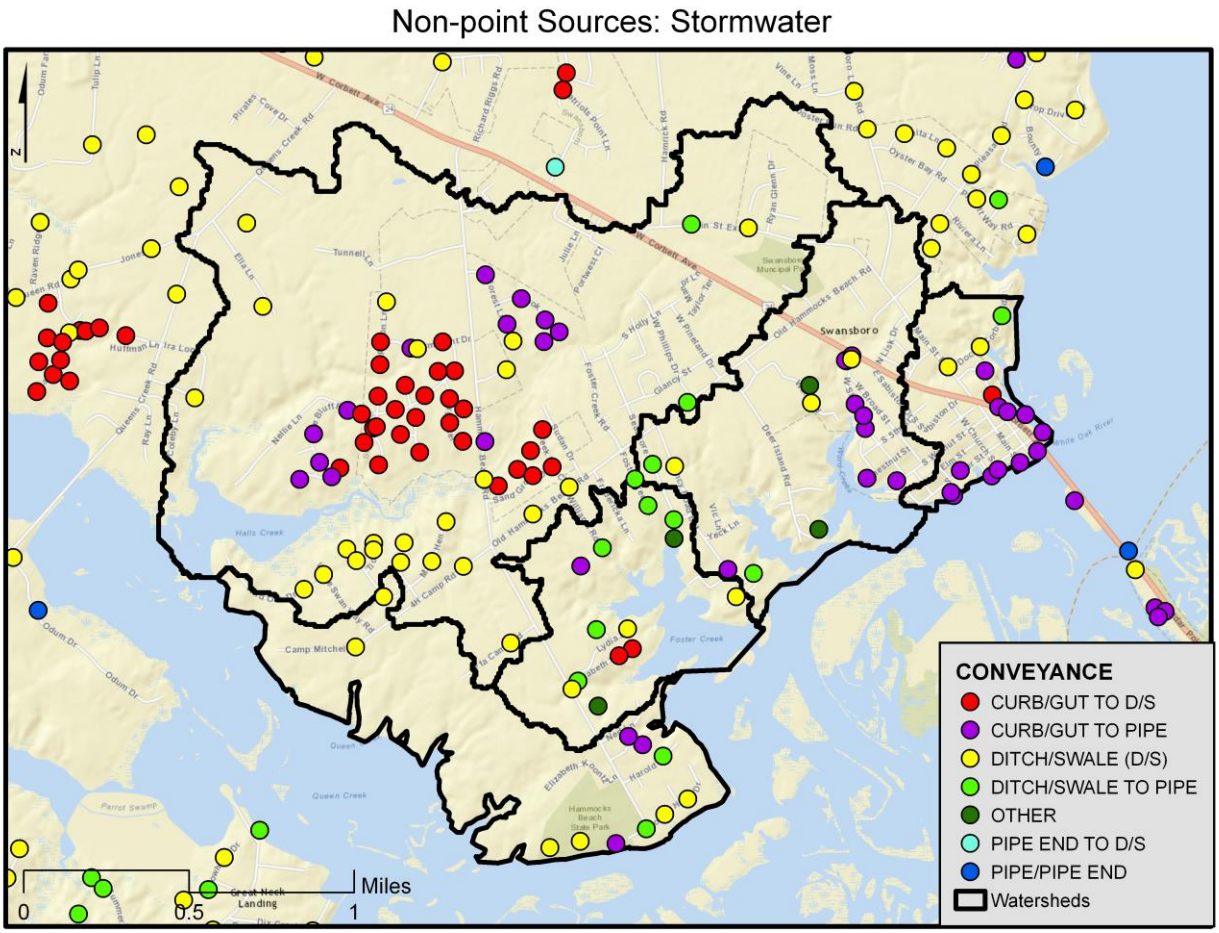


Figure 2-9. Potential non-point stormwater access point sources. See Appendix C for definition of conveyance type.

There are 24 subdivisions that are potential sources of non-point source pollution (Figure 2-10). Pollutants from subdivisions have the potential to be concentrated due to the number of residences in a small area and significant hydrology alteration. Subdivisions can often be a source of concentrated loads of pollution from fertilizer nutrients, pesticides, yard debris, and bacteria from domestic pets. Subdivisions often use conventional stormwater management such as downspouts to impervious surfaces and connected conveyance systems. Monitoring is currently conducted by Shellfish Sanitation and the findings are released every five years in the reports for Area D-2 and D-3. It is recommended that future partnerships be developed with home owners associations and that an education and outreach program be designed that emphasizes residential based solutions as many watersheds, particularly in the Hammocks and Halls Creek watersheds, which have substantial residential development.

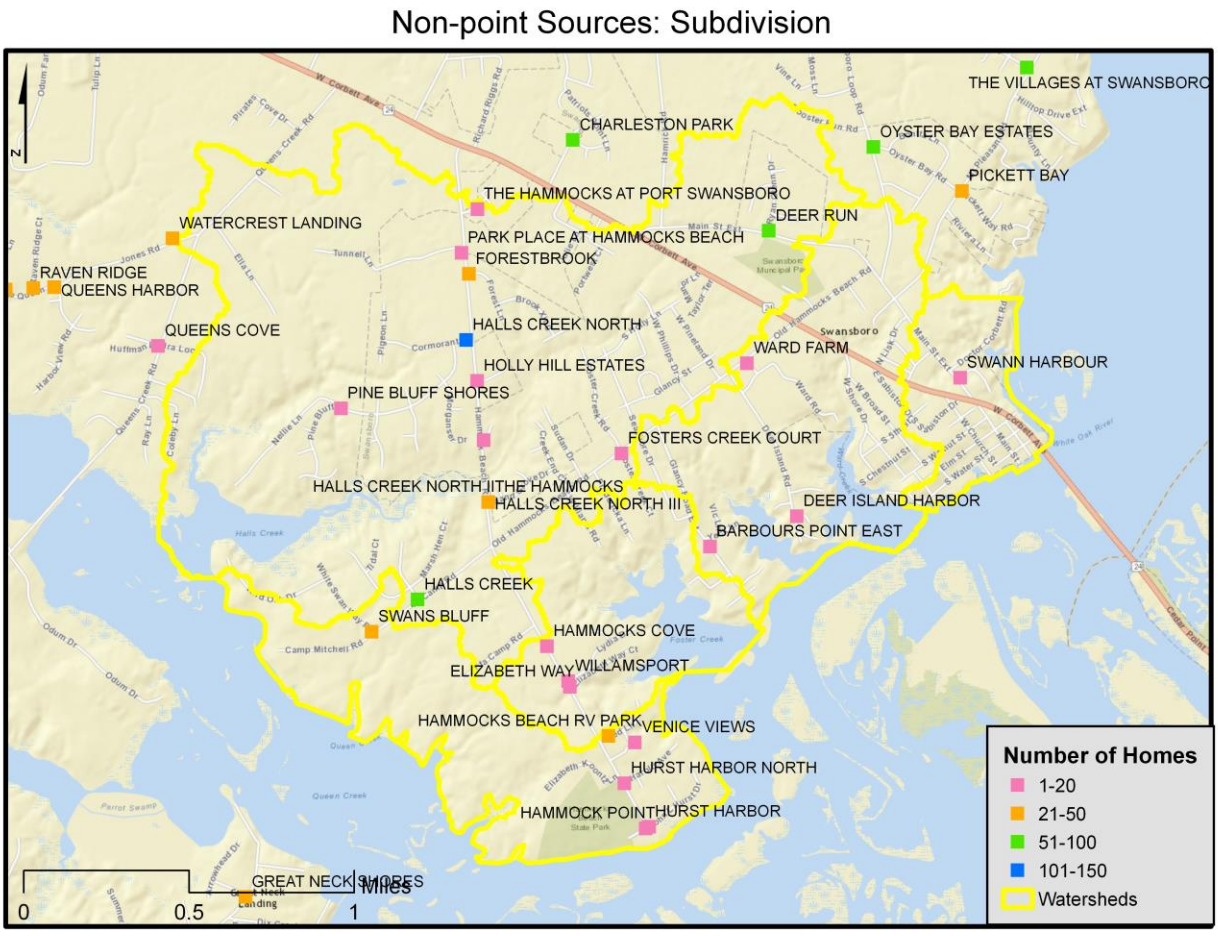


Figure 2-10. Potential non-point subdivision sources.

The following lift stations and wastewater discharge facilities exist with the watersheds (Figure 2-11). It is important to be aware of the locations of wastewater stations and facilities. There are noted septic failures within the watersheds; two of three septic failures are considered an active issue as of the 2016 survey of the area. Monitoring is currently conducted by Shellfish Sanitation and the findings are released every five years with the reports for Area D-2 and D-3.

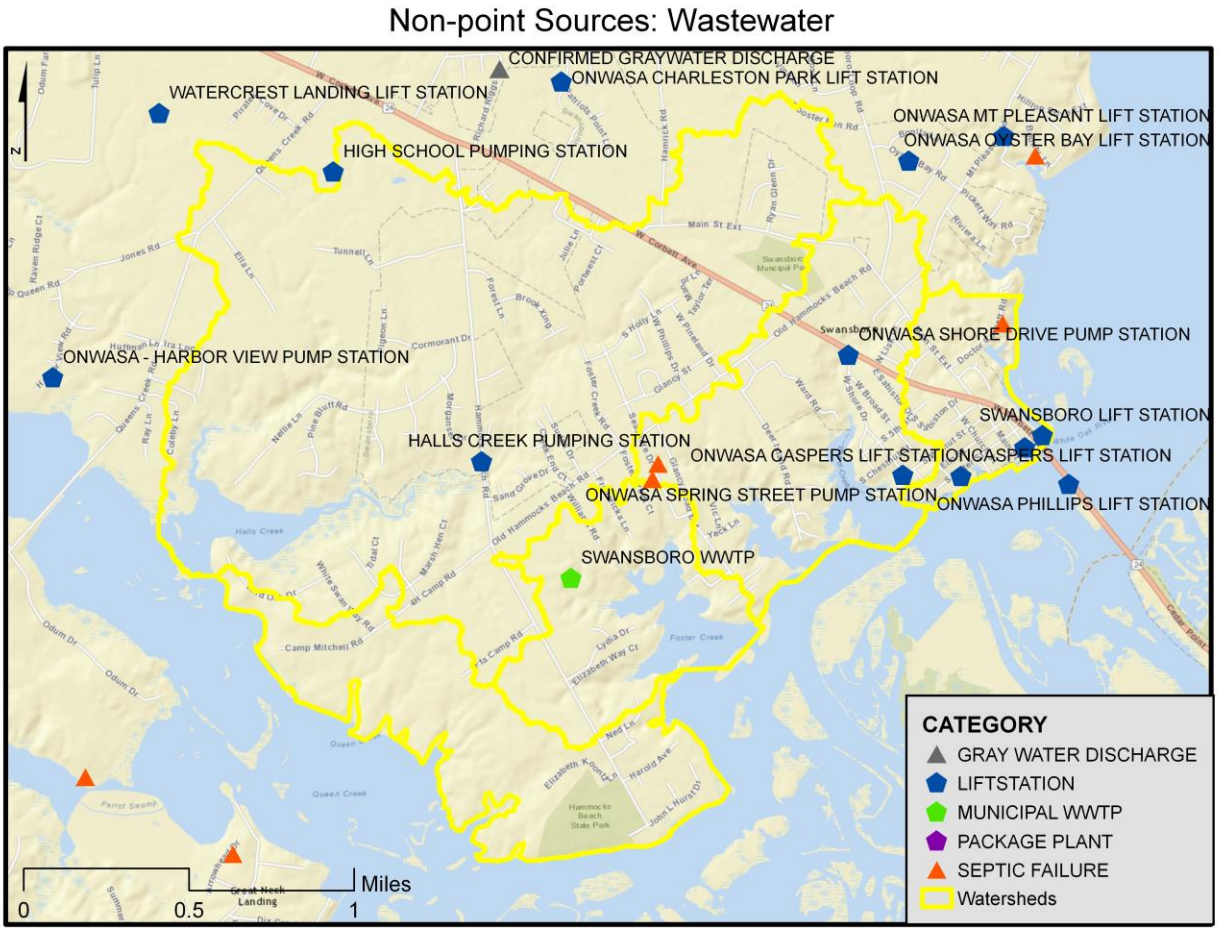


Figure 2-11. Potential non-point wastewater sources.

2.2.2 **Point Sources**

Point sources of pollution, unlike the diffuse non-point sources, are any single identifiable source of pollution from which pollutants are discharged, such as a pipe or ditch. They can pollute the water, but their effects can often be lessened or eliminated through management strategies. No permitted point sources National Pollutant Discharge Elimination System (NPDES) Wastewater Facilities are found upon within the Swansboro watersheds.

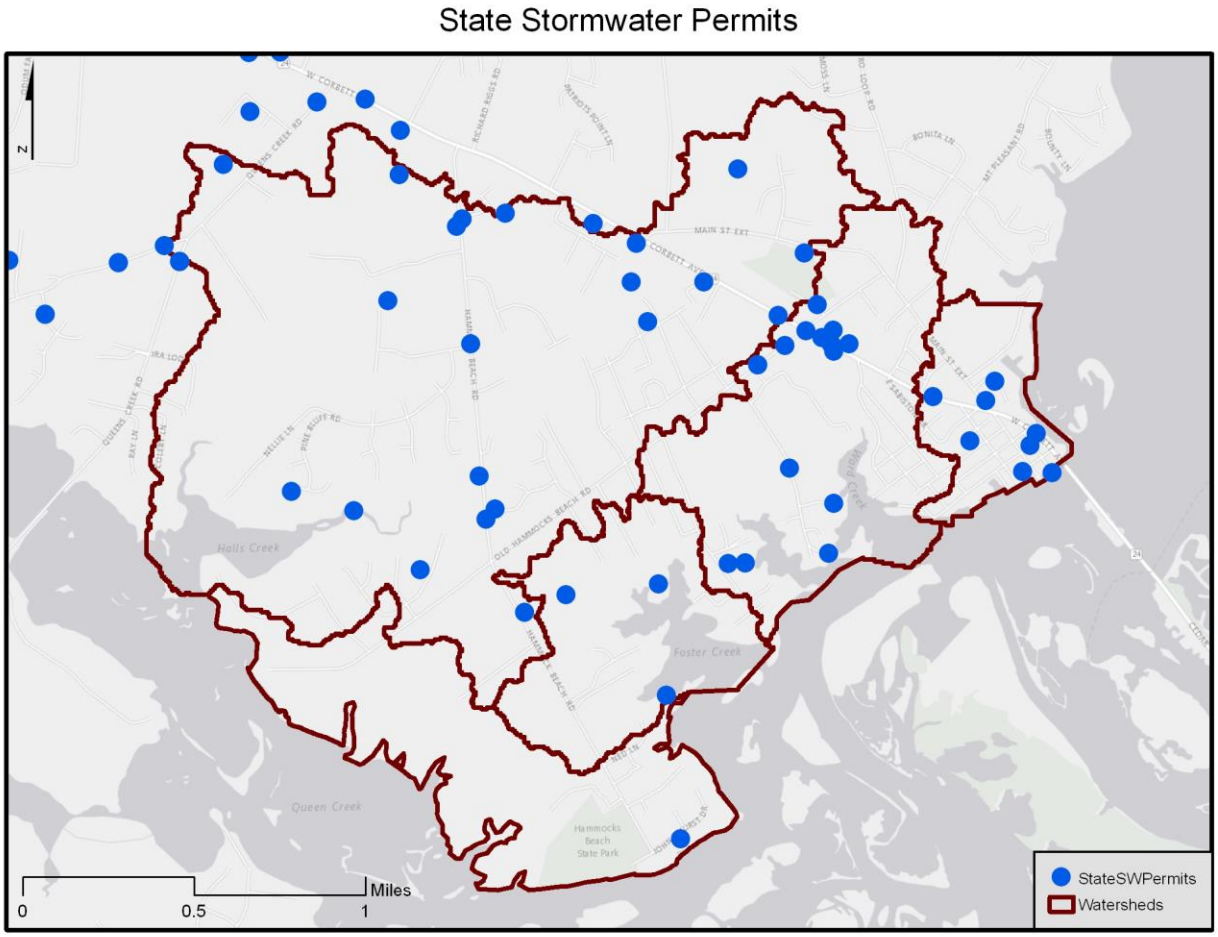


Figure 2-11. State and nationally permitted stormwater facilities.

There are 52 state stormwater permits and two NPDES Stormwater Discharge Permit are within the watershed (Figure2-11):

Facility Name	Permit No.	Receiving Stream
Casper Marine Service & Marina - Swansboro	NCG190037	White Oak River
NC Division of Parks & recreation Hammocks Beach State Park	NCG190091	White Oak River

2.2.3 **Additional Sources**

Upon research, brownfield sites are known to be within the Swansboro watersheds. There is only one Resource Conservation and Recovery Act (RCRA) permit, which inventories hazardous waste handlers. Reports indicate that this site is not an imminent issue affecting water quality within the watershed. The following additional potential source issues were found, no information was found on the status of concern for these sources:

Facility	Location	Report	Summary
Coastal Dry Cleaners	628 W Corbett Ave	• RCRA: NCR000145037	• Small Quantity Generator
Swansboro Dump	SR 1559 Glancy Road	• NONCD0000476	• Pre-Regulatory Landfill (no longer in use)
Go Gas 18	1403 W Corbett Ave	• UST: 0-035663	• Underground Storage Tank Registered Tank
Swansboro High School	161 Queens Creek Rd	• UST: 0-032514	• Underground Storage Tank Registered Tank
HAMMOCKS BEACH STATE PARK	1572 HAMMOCKS BEACH ROAD	• UST: WI-2322; WI-170 • Incident No. 0	• Unknown risk; closed out 2003
ANNESE PROPERTY (THERESA)	608 WEST SPRING ST.	• UST: WI-7048 • Incident No. 32197	• Low risk; closed out 2005
HUMMINGBIRD CAFÉ	108 W CORBETT Ave	• UST: WI-218 • Incident No. 32916	• Low risk; closed out 2015
STANLEY OIL CO.	CORBETT ST., HWY 24	• UST: WI-1116 • Incident No. 11608	• Intermediate risk
USRP 13115 (Former Gant 802)	905 West Corbett Street	• UST: WI-7125 • Incident No. 32282	• Low Risk; close out 2006
PROS AUTOMOTIVE	915 W. CORBETT AVE.	• UST: WI-1538 • Incident No. 18280	• Low Risk; close out 2000

3 Runoff Volume Reduction

3.1 Volume Reduction Methodology

Coastal areas have undergone significant change as land use practices have intensified through the increase in agriculture, forestry, and development. Before human alteration, more rainwater was absorbed into the ground, evaporated, or used by vegetation through natural hydrologic processes. Specifically, when rainwater is absorbed through the ground, bacteria and other pollutants are substantially filtered or eliminated through percolation. Conventional land use practices circumvent natural hydrologic processes. Stormwater runoff has increased along coastal shorelines as natural, vegetated environments are been developed, increasing the amount of impervious surface. Rainwater is transported rapidly over impervious surfaces through connected conveyance systems, including ditches, pipes, parking lots, and open grassy areas like yards that are circumventing natural hydrologic processes. This excess surface water from a rain event is known as stormwater. The result is that during and after storms, rainwater passes quickly over the landscape collecting bacteria, nutrients, chemical and physical pollution before flowing directly into coastal waters. Polluted water bodies negatively affect the environment, human health and coastal fishing and tourism industries. Restoration and management techniques that rely on stormwater reduction volume and that mimic or restore natural hydrology can reduce stormwater and pollutant loads.

Intensive land uses overwhelm the effectiveness of conventional stormwater treatment systems. Conventional methods rely on peak flow storage but do not mitigate pollution and cannot keep up with increased pressure from usage. As impervious surfaces and stormwater runoff increase, hydrology is altered and can lead to an increase in sedimentation and erosion, ecosystem degradation and loss of aquatic biodiversity, degradation of water quality, and increased flooding.

Rather than focusing on reducing sources of contamination or attempting to treat and remove bacteria and other pollutants from stormwater runoff, ***the management techniques used focus on reducing the overall volume of stormwater runoff to limit the conveyance from the land into coastal waters.*** Low impact development (LID) stormwater reduction practices can achieve this goal by replicating the natural hydrology and increasing infiltration of water into soils. LID practices are a form of land planning and engineering that primarily focus on mimicking natural hydrology of the area to limit stormwater runoff. For already developed locations stormwater reduction techniques can reduce the amount of stormwater entering waterways. The result of implementing stormwater reduction practices is that less bacteria and pollutants are transported off the land and into water systems.

Restoration of pre-development, natural hydrology leads to less bacteria and other pollutants in coastal waterways from discharges from the landscape after rainfall. Bacteria is affected by

the following factors: the natural mortality of fecal coliform and enterococcus bacteria, the prevention of bacteria and pollutants from entering waterbodies and the reduction in the velocity of waters traveling off the landscape resulting from lower flows. Infiltration of rainfall into the ground serves as an extremely effective filtration system of bacteria and pollutants. Additionally, once bacteria enter the landscape they are subject to higher rates of mortality due to bombardment by ultraviolet radiation from sunlight. By reducing the flow velocity of stormwater, the dissemination of bacteria and other pollutants downstream into shellfishing and swimming waters will be reduced. Using this guidebook to aid in the development of a coastal watershed management plan can assist in the overall reduction of stormwater runoff, in turn reduce pollutants that enter coastal waterways.

3.2 Sources and Indicators

The primary issue to be addressed through the stormwater runoff volume reduction methodology is the reduction of fecal coliform contamination caused by urban development within the watershed (Table 3-1). Stormwater runoff is the direct cause of increased fecal coliform contamination within the Swansboro watersheds.

Table 3-1. Identifying and linking concerns, causes and indicators.

Issue	Source of Issue	Quantify Issue Indicators
Not suitable for Designated Use of shellfishing in areas with Class SA designation	Non-point source bacteria transported by stormwater runoff	• Fecal coliform cannot exceed median MF of 14/100 ml
Currently Class SC water that are currently opened to shellfishing may need to be appropriately reclassed as Class SA	Non-point source bacteria transported by stormwater runoff	• Fecal coliform cannot exceed median MF of 14/100 ml
Determine if a more appropriate classification of Class SC water be reclassed to Class SB is necessary	Non-point source bacteria transported by stormwater runoff	• Quality Standards applicable to Class SB waters: ○ Organisms of coliform group: fecal coliforms not to exceed a geometric mean of 200/100 ml (MF count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 ml in more than 20

		percent of the samples examined during such period.

3.1 Calculation Methodology

The process of calculating the amount of runoff that could be achieved has been standardized using instructions developed by the North Carolina Coastal Federation, a non-profit organization dedicated to preserving and protecting North Carolina's coast, and WithersRavenel, a civil and environmental engineering firm. Using aerial photography to document land-use types, the partners characterized land uses during the baseline year, 1993, (or the earliest available aerial imagery of the watershed) and during subsequent years, land characterization was conducted by delineating parcel information, development (pervious, impervious), and soil characteristics (HSG) for each land use scenario (each aerial imagery year). The delineated land use parcels were then analyzed to estimate the average percent impervious coverage. Summations were calculated of overall percent coverage based on land use and soil. From this information, the runoff curve number is calculated then runoff depth is calculated for the 1-year, 24-hour depth of precipitation using formulas developed by the United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) in the *TR-55 Manual*. A runoff curve number (commonly referred to as CN) is a numeric parameter derived from combining the effects of soil, watershed characteristics, and land use. The following curve numbers were used in the hydrographs:

Land Use Classification	HSG			
	A	B	C	D
Impervious	98 CN	98 CN	98 CN	98 CN
Open Space	39 CN	61 CN	74 CN	80 CN
Woods	30 CN	55 CN	70 CN	77 CN

The following designations were utilized to categorize land use:

Land Use	Designation
Impervious	Areas with distinctive impervious coverage from paved parking lots, roofs, driveways, curbs, storm sewers etc.
Open Space	Grassy areas where there is 75% or more grassy space such as from lawns, parks, golf courses, cemeteries, fields, pastures, etc.
Woods	Forested areas with thorough coverage, these areas are often protected from grazing, and forest litter and brush adequately cover the soil.

The 2-year, 24-hour depth of precipitation is used to develop a hydrograph. The resulting value is then multiplied by the area of the watershed, which will give the total estimated stormwater runoff volume anticipated in response to the prescribed depth of rainfall over a 24-hour period. The volume difference between the baseline year and the analyzed year is calculated to determine the estimated volume of stormwater runoff that needs to be reduced to replicate pre-impairment conditions.

3.2 Swansboro Watersheds Runoff Calculations

Table 3-2. Summary of the overall changes in all Swansboro watersheds of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014, based on geospatial analysis.

Swansboro Watersheds								
1993				2014				Change
Soil Type	Land Use	Total Area (acres)	% of total watershed	Soil Type	Land Use	Total Area (acres)	% of total watershed	Difference between years (acres)
A	Impervious	207.6	9%	A	Impervious	405.9	17%	+198.3
A	Open	949.6	41%	A	Open	1114.9	48%	+165.3
A	Woods	718.4	31%	A	Woods	353.6	15%	-364.8
B	Impervious	11.2	0.5%	B	Impervious	10.6	0.5%	-0.6
B	Open	61.2	3%	B	Open	64.7	3%	+3.5
B	Woods	27.8	1%	B	Woods	24.4	1%	-3.4
C	Impervious			C	Impervious			
C	Open			C	Open			
C	Woods			C	Woods			
D	Impervious	24.05	1%	D	Impervious	35.2	2%	+11.2
D	Open	114.9	5%	D	Open	241.7	10%	+126.8
D	Woods	208.8	9%	D	Woods	70.7	3%	-138.1

Table 3-3. Total land usages based on previously created simplified land use categories (see Section 1). These totals do not include lands associated with ROWs.

Simplified Land Use Category	Impervious (acres)	Wood (acres)	Open (acres)
Commercial	144	2	181
Institutional	39	253	76
Mixed Used	18	44	188
Residential	146	79	923

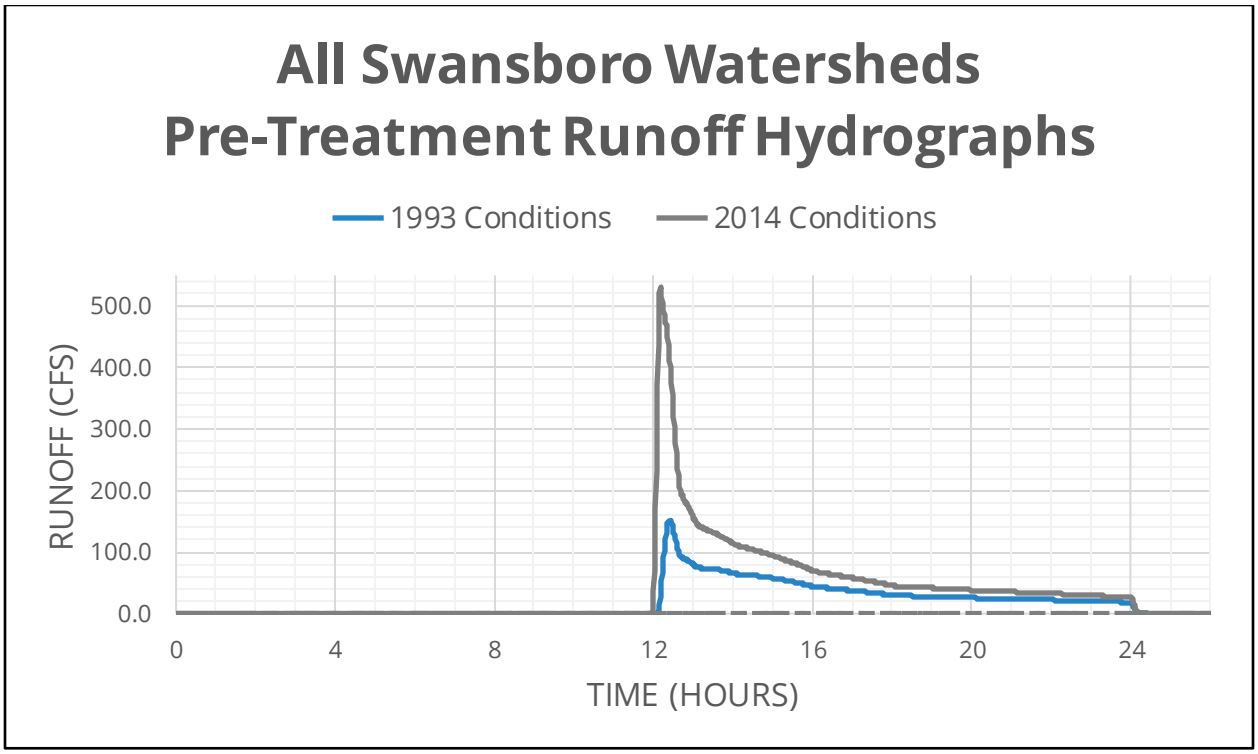


Figure 3-1. Pre-treatment runoff hydrograph of Swansboro Watershed comparing 1993 to 2014.

Table 3-4. Summary of the total runoff volume reduction goals of all of Swansboro Watershed.

Swansboro Watersheds				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft²)
1993	151.37	40.77	--	--
2014	531.03	78.41	37.65	0.12
Total Acres		2,324		
Reduction Goal for the entire watershed (Gallons)		**13,368,590**		

3.2.1 **Foster Creek Watershed**

Table 3-5. Summary of the overall changes in Foster Creek Watershed of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014, based on geospatial analysis.

Foster Creek Watershed						
1993			2014			Difference
Soil Type	Land Use	Total Area (acres)	Soil Type	Land Use	Total Area (acres)	Difference between years (acres)
A	Impervious	4.0	**A**	Impervious	18.3	+14.3
A	Open	68.7	**A**	Open	108.1	+39.4
A	Woods	78.1	**A**	Woods	23.7	-54.4
B	Impervious	0.6	**B**	Impervious	1.2	+0.6
B	Open	7.1	**B**	Open	0	-7.1
B	Woods	16.0	**B**	Woods	22.4	+6.4
C	Impervious		**C**	Impervious		
C	Open		**C**	Open		
C	Woods		**C**	Woods		
D	Impervious	0.65	**D**	Impervious	2.2	+1.5
D	Open	2.6	**D**	Open	12.8	+10.2
D	Woods	15.8	**D**	Woods	4.0	-11.8

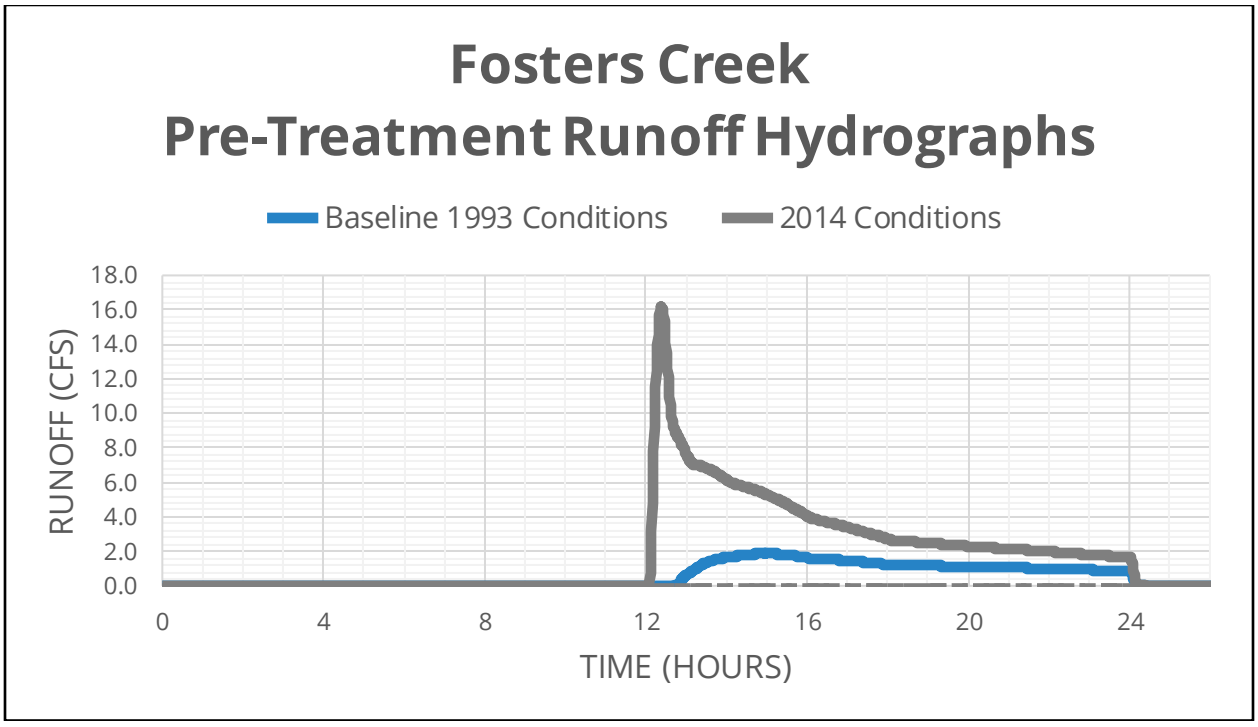


Figure 3-2. Pre-treatment runoff hydrograph of Fosters Creek Watershed comparing 1993 rates to 2014.

Table 3-6. Summary of the total runoff volume reduction goals of Fosters Creek Watershed.

FOSTERS CREEK WATERSHED				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft²)
1993	1.87	1.17	--	--
2014	16.19	3.84	2.67	0.10
Total Acres of the watershed		193		
Reduction Goals Gallons		840,700		

3.2.2 **Halls Creek Watershed**

Table 3-7. Summary of the overall changes in Halls Watershed of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014.

Halls Watershed						
1993			2014			Difference
Soil Type	Land Use	Total Area (acres)	Soil Type	Land Use	Total Area (acres)	Difference between years (acres)
A	Impervious	99.3	**A**	Impervious	204.8	+105.5
A	Open	564.6	**A**	Open	669.1	+104.5
A	Woods	368.6	**A**	Woods	158.6	-210.0
B	Impervious	0	**B**	Impervious	0	0
B	Open	0.3	**B**	Open	0.3	0
B	Woods	0	**B**	Woods	0	0
C	Impervious		**C**	Impervious		
C	Open		**C**	Open		
C	Woods		**C**	Woods		
D	Impervious	22.0	**D**	Impervious	29.5	+7.5
D	Open	106.4	**D**	Open	221.6	+115.2
D	Woods	168.6	**D**	Woods	45.86	-122.7

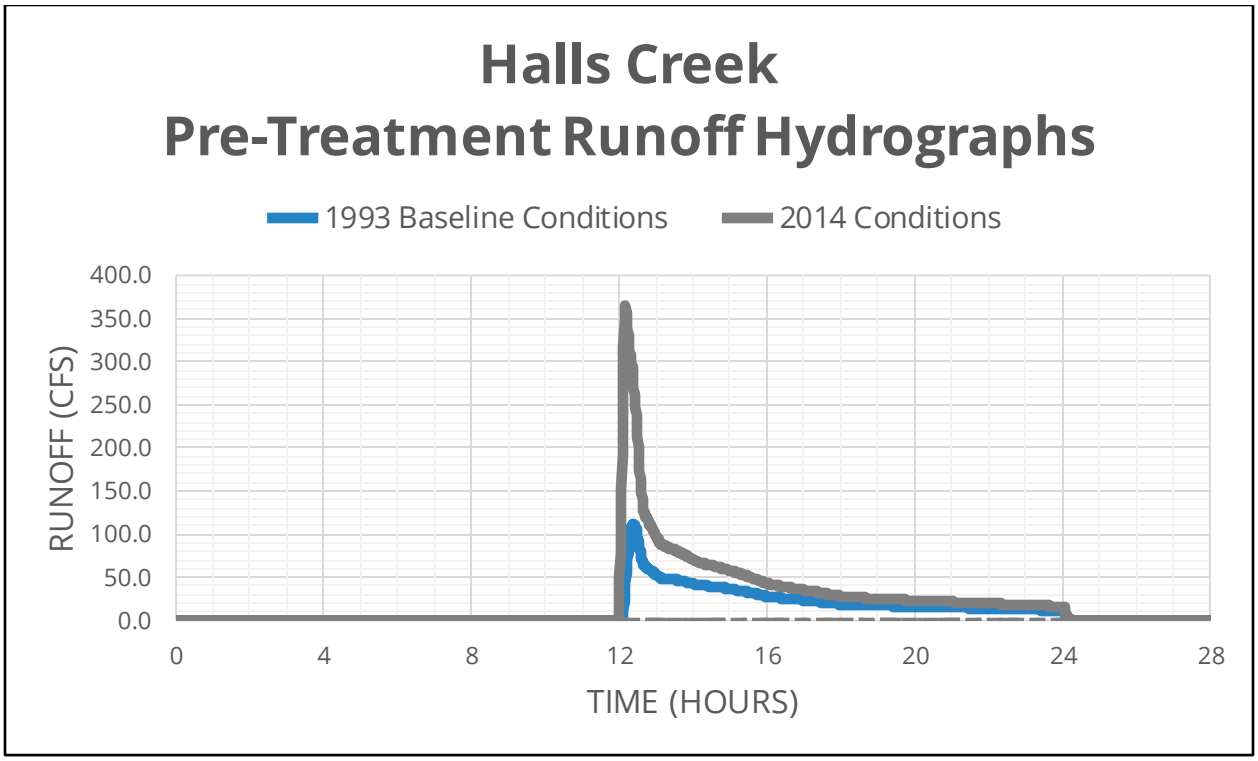


Figure 3-3. Pre-treatment runoff hydrograph of Halls Creek Watershed comparing 1993 rates to 2014.

Table 3-8. Summary of the total runoff volume reduction goals of Halls Creek Watershed.

Halls Creek Watershed				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft^2)
1993	111.7	26.51	--	--
2014	365.1	49.07	22.56	0.13
Total Acres of the watershed		1,329		
Reduction Goals Gallons		7,525,830		

3.2.3 **Hammocks Watershed**

Table 3-9. Summary of the overall changes in Hammocks Watershed of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014.

Hammocks Watershed						
1993			2014			Difference
Soil Type	Land Use	Total Area (acres)	Soil Type	Land Use	Total Area (acres)	(acres)
A	Impervious	13.06	**A**	Impervious	61.4	48.34
A	Open	33.9	**A**	Open	87.3	53.4
A	Woods	263.3	**A**	Woods	161.5	101.8
B	Impervious		**B**	Impervious		
B	Open		**B**	Open		
B	Woods		**B**	Woods		
C	Impervious		**C**	Impervious		
C	Open		**C**	Open		
C	Woods		**C**	Woods		
D	Impervious	0.5	**D**	Impervious	1.3	0.8
D	Open	0	**D**	Open	2.4	2.4
D	Woods	20.6	**D**	Woods	17.4	3.2

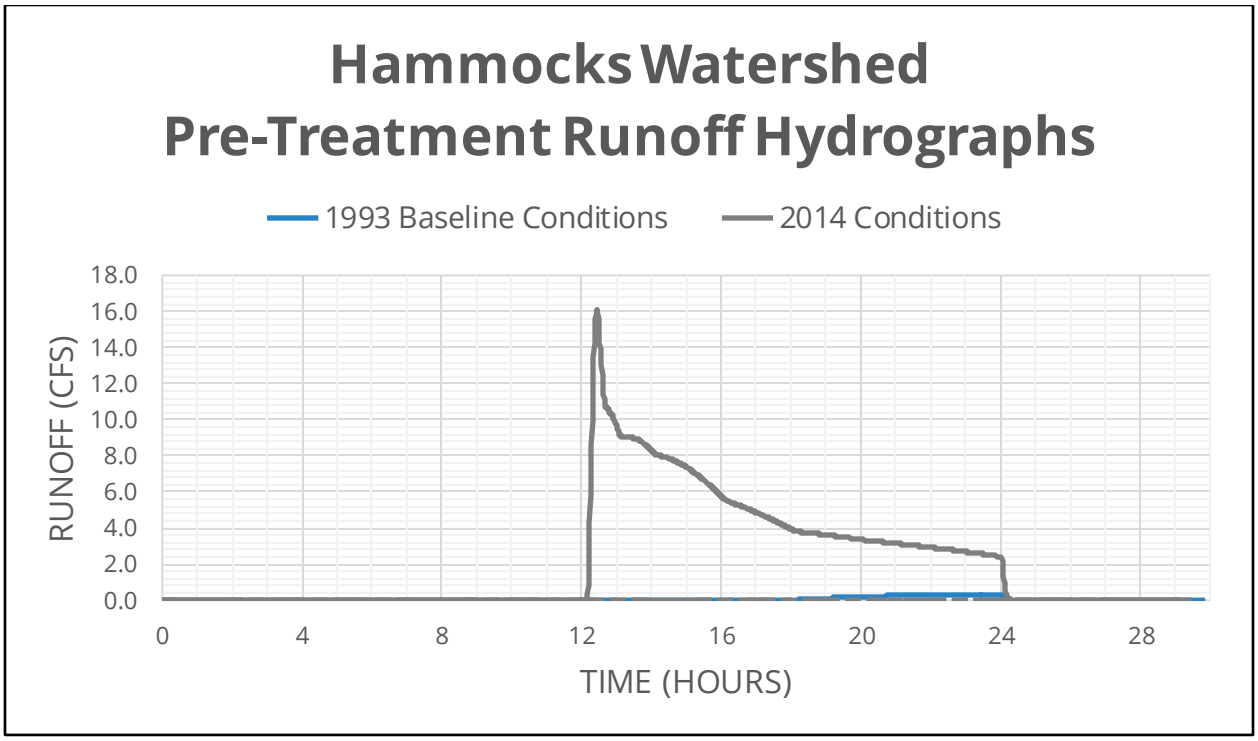


Figure 3-5. Pre-treatment runoff hydrograph of Hammocks Watershed comparing 1993 rates to 2014.

Table 3-10. Summary of the total runoff volume reduction goals of Hammocks Watershed.

Hammocks Watershed				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft^2)
1993	0.29	0.10	--	--
2014	16.09	5.06	4.96	0.11
Total acres within the watershed		331		
Reduction Goals Gallons		1,586,200		

3.2.4 **Historic Watershed**

Table 3-11. Summary of the overall changes in Historic Watershed of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014.

Historic Watershed						
1993			2014			Difference
Soil Type	Land Use	Total Area (acres)	Soil Type	Land Use	Total Area (acres)	(acres)
A	Impervious	36.3	**A**	Impervious	45.4	9.1
A	Open	54.8	**A**	Open	45.7	9.1
A	Woods	0.4	**A**	Woods	0	0.4
B	Impervious	6.3	**B**	Impervious	4.4	1.9
B	Open	8.6	**B**	Open	15.8	7.2
B	Woods	5.3	**B**	Woods	0	5.3
C	Impervious		**C**	Impervious		
C	Open		**C**	Open		
C	Woods		**C**	Woods		
D	Impervious	0	**D**	Impervious	0.7	0.7
D	Open	2.4	**D**	Open	1.6	0.8
D	Woods	0	**D**	Woods	0	0

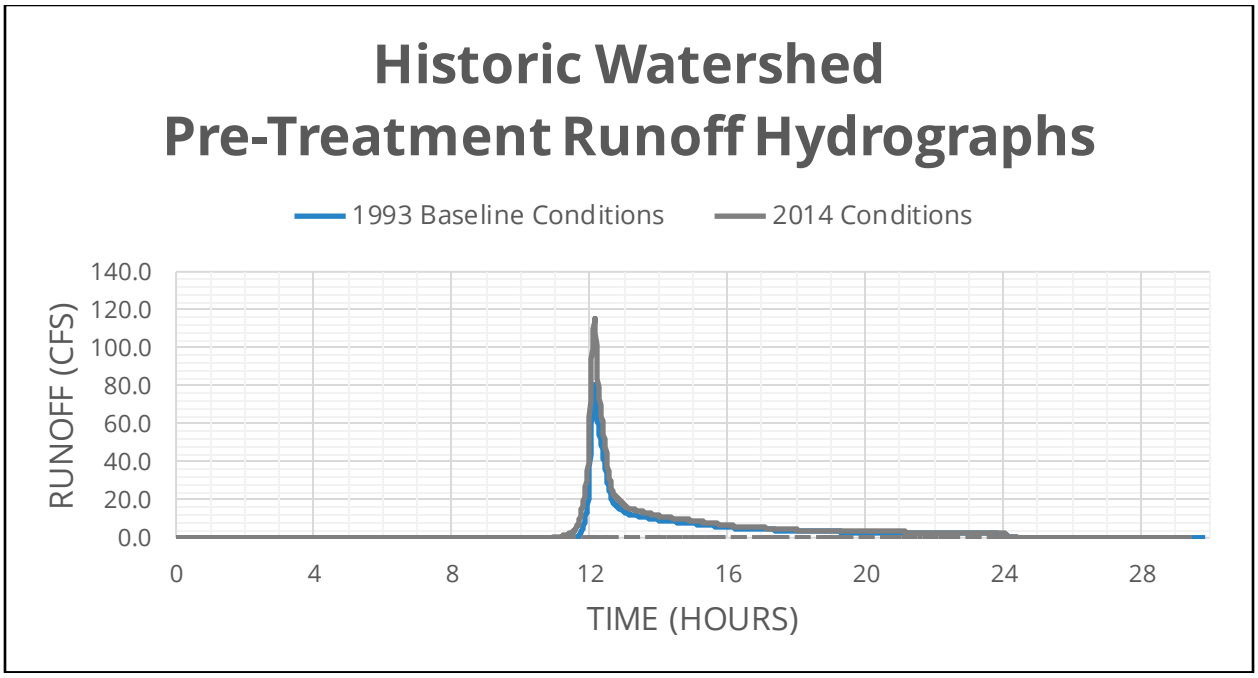


Figure 3-6. Pre-treatment runoff hydrograph of Historic Watershed comparing 1993 rates to 2014.

Table 3-12. Summary of the total runoff volume reduction goals of Historic Watershed.

Historic Watershed				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft^2)
1993	80.56	7.55	--	--
2014	115.39	10.02	2.47	0.16
Total acres of the watershed		114		
Reduction Goals Gallons		2,394,560		

3.2.5 **Ward/Hawkins Creek Watershed**

Table 3-13. Summary of the overall changes in Ward/Hawkins Watershed of each soil type based on land use and total right of way for the baseline year of 1993 compared to 2014.

Ward/Hawkins Creek Watershed						
1993			2014			Difference
Soil Type	Land Use	Total Area (acres)	Soil Type	Land Use	Total Area (acres)	(acres)
A	Impervious	54.9	**A**	Impervious	75.9	21.0
A	Open	227.6	**A**	Open	204.6	23.0
A	Woods	8.0	**A**	Woods	9.8	1.8
B	Impervious	4.3	**B**	Impervious	5.0	0.7
B	Open	45.2	**B**	Open	48.6	3.4
B	Woods	6.5	**B**	Woods	2.0	4.5
C	Impervious		**C**	Impervious		
C	Open		**C**	Open		
C	Woods		**C**	Woods		
D	Impervious	0.9	**D**	Impervious	1.5	0.6
D	Open	3.5	**D**	Open	3.3	0.2
D	Woods	3.8	**D**	Woods	3.4	0.4

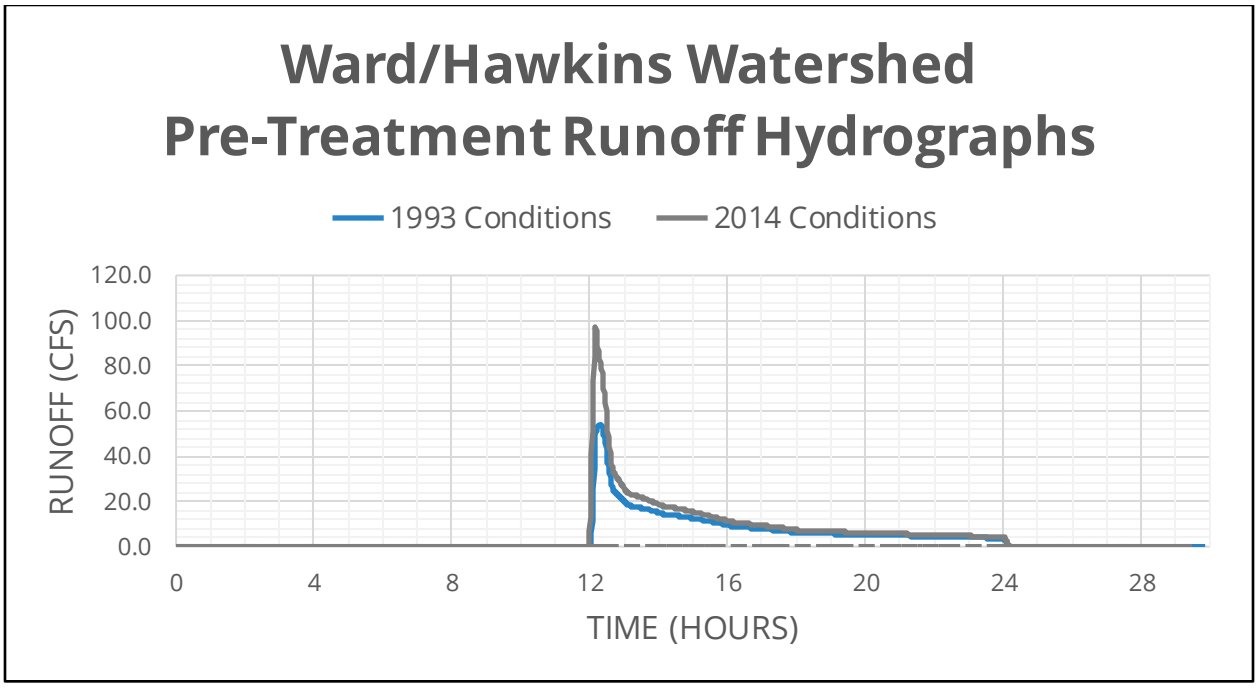


Figure 3-7. Pre-treatment runoff hydrograph of Ward/Hawkins Watershed comparing 1993 rates to 2014.

Table 3-14. Summary of the total runoff volume reduction goals of Ward/Hawkins Creek Watershed.

Ward/Hawkins Creek Watershed				
Year	Condition Peak Flow (CFS)	Reduction Goals		
		Runoff Volume (AC-FT)	Volume Change from Baseline Conditions (ac-ft)	Target Volume Reduction (gal/ft^2)
1993	53.71	9.89	--	--
2014	97.21	13.07	3.18	0.07
Total Acres of the watershed		354		
Reduction Goals Gallons		1,021,300		

4 Goals

The Swansboro Watersheds partners plan to use various techniques to reduce stormwater runoff by a total of **13,368,590 gallons**. This will be achieved by targeted stormwater retrofits that will infiltrate stormwater before it reaches surface waters. By addressing stormwater, this plan will directly mitigate pathogenic pollution. The plan relies on community involvement from partners and the community. The plan therefore includes community education opportunities to demonstrate how surface runoff pollutes the waterways and how volume reduction will work to restore water quality.

4.1 Primary Goal

The goal of this plan is to reduce water quality impairments within the Swansboro region, and will be accomplished by reducing the bacterial load entering the waterways of the watersheds. **This goal will be accomplished over 20 years by achieving the objectives and management actions identified below.** Over time, reductions in the volume of stormwater runoff will be achieved through implementation of this plan and should result in measurable water quality improvements, signified by gradual increases in open shellfish waters and more recreational activity. This restoration plan relies on reducing runoff volumes within the Swansboro watersheds to reduce existing water quality impairments and restore water quality. As with other plans that incorporate this volume reduction philosophy, this plan emphasizes six management objectives to accomplish its goals (Table 4-1).

Table 4-1. The primary goal of the watershed management plan and the objectives.

Primary Goal ***Restore impaired water quality in five Swansboro watersheds.***	
OBJECTIVES	
1	New development and redevelopment does not create additional water quality impairments.
2	The targeted volume of stormwater runoff is reduced from existing private land uses.
3	The targeted volume of stormwater runoff is reduced from existing public land uses and paired with capital improvement projects.
4	Water quality is appropriately classified by existing uses.
5	Periodic monitoring and review is conducted.
6	Community is educated about stormwater pollution and engaged in accomplishing objectives.

4.1.1 **Objective 1**

This objective serves to address future changes within the watershed. Strategies aimed at preventing further degradation of water quality by emphasizing a proactive approach to new development and redevelopment through sustainable stormwater management.

Objective 1. New development and redevelopment does not create additional water quality impairments.	
Action #	**Specific Action**
1-1	Review existing town codes and ordinances to determine impediments to low impact stormwater designs for new development and redevelopment. Present findings and suggested amendments as necessary and potential incentives.
1-2	The town will determine the need for a locally adopted stormwater management program to supplement gaps in the state's stormwater program and the town's needs. Some gaps identified thus far include: • Adequacy of designed storm standards • Redevelopment • Smaller projects not covered under the state's stormwater program • Oversight of installation and maintenance of state permitted systems See Appendix D for various engagement programs.
1-3	Seek funding to conduct a thorough reevaluation of the areas soil to determine region's potential for infiltration, which will be a value to both existing and new development stormwater reduction projects. Use soil research findings to promote development practices that emphasize usage of soils of better quality.

4.1.2 **Objective 2**

This objective addresses the current state of the watershed. The volume of stormwater runoff that is currently being transported over land to waterways needs to be reduced to restore water quality. The objective is to reduce the volume of stormwater being conveyed to levels that occurred before the baseline year of 1993.

Objective 2. The targeted volume of stormwater runoff is reduced from existing private land uses.	
Action #	**Specific Action**
2-1	Develop a list of proposed targeted retrofit sites, prioritizing existing sites by cost-benefit, such as sites identified as exceptional because of the physical and natural characteristics, accessibility, cost, public outreach opportunity, and current land uses.
2-2	Evaluate existing stormwater systems on private properties for potential volume reduction enhancements, and if feasible, retrofit them to achieve volume reduction.
2-3	Seek funding to pay for stormwater retrofit projects that have been identified.
2-4	Work with governmental agencies and non-governmental organizations to secure grants to reach large numbers of landowners to enable them to install lot-level, low-cost retrofits that disconnect impervious surfaces and enhance stormwater infiltration.
2-5	Provide landowners incentives to disconnect impervious surfaces or minimize stormwater runoff from their property (see Appendix D for various program strategies).
2-6	Develop beautification program, include native tree planting and vegetation retention/minimal clearing on private land.
2-7	Continue to cooperate with Community Conservation Assistance Program (CCAP).

4.1.3 **Objective 3**

This objective emphasizes the potential effect that the town itself can have on the community through championing and demonstrating the solutions and practices that can result in volumetric reduction to stormwater.

Actions

Objective 3. The targeted volume of stormwater runoff is reduced from existing public land uses and paired with capital improvement projects.

Action #	Specific Action
3-1	Secure funds for retrofits in Swansboro watersheds and determine the volume that can be reduced with funds.
3-2	Review capital improvement projects that are planned for the next five years to consider the incorporation of stormwater reduction designs.
3-3	Prioritize retrofits for public town buildings that can serve as demonstration sites for stormwater retrofits.
3-4	Incorporate where practical, "green street" designs (see Appendix E) into future capital improvements to town streets.
3-5	Install stormwater reduction measures on town streets, rights-of-way, buildings, parks, parking lots and drainage systems and other public properties.
3-6	Pursue strategy with NC Department of Transportation to incorporate retrofits into highways. Pursue strategy with North Carolina DOT that any new road upgrade or maintenance plans include plans for reducing runoff.
3-7	Evaluate existing stormwater systems on public properties for potential volume reduction enhancements, and if feasible, retrofit them to achieve volume reduction.

4.1.4 **Objective 4**

To ensure that progress continues to be made within the watersheds, the partners will need to ensure that water quality is currently and in the future, is appropriately classified based on the existing uses and conditions.

Actions

Objective 4. Water quality is appropriately classified by existing uses.

Action #	Specific Action
4-1	Monitor Shellfish Sanitation Sanitary reports when they become available every 3 years).
4-2	Seek reclassification by the N.C. Environmental Management Commission of the Class SC classified estuarine waters that are currently approved by Shellfish Sanitation for shellfish harvest.
4-3	Partner with the state's Shellfish Sanitation and Recreational Water Quality Section to determine if additional monitoring station are necessary to reflect water quality improvements resulting from carrying out this plan.
4-4	Partner with the state's Shellfish Sanitation and Recreational Water Quality Section to determine if additional monitoring is necessary and the appropriateness of the Tier designation, for example C27 Ward Shore.

4.1.5 **Objective 5**

Progress made in achieving water quality improvements will be measured. Data should be monitored and the plan should be reviewed. This plan will be adapted as necessary based upon the results of this monitoring.

Actions

Objective 5. Periodic monitoring and review is conducted.	
Action #	**Specific Action**
5-1	Maintain an inventory and then monitor performance of stormwater reduction retrofits that have been installed because of this plan.
5-2	Conduct yearly, scheduled assessment of water quality data and the plan with project team, followed by review by planning board, and the town commissioners.
5-3	Update the plan every five years based upon findings from water quality data and the status of implementation and findings from yearly assessment review of plan implementation (see Action 5-1).
5-4	Keep records of the volume of stormwater reduced by each retrofit by using the Runoff Reduction Calculator tool.

4.1.6 **Objective 6**

The primary purpose of conducting education and outreach within the watersheds is to expand and improve environmental literacy to ensure that the community maintains a vested interest in the protection and improvement of the watershed as stakeholders. Education and outreach should enhance public understanding of how stormwater runoff affects coastal waters and how reducing runoff volumes will benefit target audiences.

Actions

Objective 6. Community is educated about stormwater pollution and engaged in accomplishing objectives.

Action #	Specific Action
6-1	In addition to stormwater retrofits, include education signage regarding installed retrofits.
6-2	Work with Hammocks State Beach Park to continue the stormwater education program at Visitor Center.
6-3	Seek funds to develop and implement education and outreach plan for the following primary community groups: • Residents (renters and owners) • Business owners and land owners • Students including: Swansboro Elementary, Middle, and High School students and Queens Creek Elementary School, Coastal Carolina Community College
6-4	Provide technical training opportunities for planners, engineers, developers, landscapers and local government staff on techniques to reduce volume of stormwater within the town.
6-5	Work with local tourism business to incorporate stormwater education within their tours.

5 Management Solutions

Conventional management methods rely on peak flow storage and the mitigation of onsite flooding by removing stormwater from the site as quickly as possible. In this approach, stormwater is quickly moved through curb and gutter systems, often over impervious surfaces, where the untreated runoff is conveyed to the nearest receiving water. This approach is effective at deterring onsite flooding but the downstream effects result in an increase in the magnitude and frequency of flooding. Conventional efforts to manage runoff throughout the coast have failed to prevent stormwater runoff pollution; particularly from increased bacterial pollution, which causes contamination of shellfish and swimming waters.

Treating or removing bacteria and harmful constituents from stormwater runoff can be expensive and impractical due to:

1. The bacteria and harmful constituents can be from common sources. Bacteria comes from warm-blooded animals, including pets, waterfowl, and wildlife. While bacteria can be a health risk, it can be difficult and costly to narrow down the sources specifically responsible for contributing to declining water quality.
2. Improving water quality by using stormwater runoff treatment systems to meet the requirements of the N.C. Department of Environmental Quality, US Environmental Protection Agency, and other governmental organizations is not practical for many towns and is costly. Most shellfishing areas need near pristine conditions to allow for the commercial harvest and consumption of shellfish.
3. Recontamination of treated stormwater is a common occurrence and problematic. Even if polluted stormwater runoff is treated it is often susceptible to recontamination downstream.

Using the framework of the Watershed Restoration Planning Guidebook and restoration plans developed for other watersheds, a series of potential solutions for the Town of Swansboro have been compiled. This includes general strategies the town can consider incorporating to improve stormwater management practices and plans. These strategies also include examples of potential actions and retrofits to infrastructure within the town.

The management solutions, strategies, and techniques within this section and Section 6 are strictly intended to be identified, proposed solutions that the town can consider based on the information compiled during the development of this restoration plan. The solutions listed are intended to serve as inspiration and these solutions are not actual projects that are being planned for implementation. Before implementing any management solution presented here, further consideration and research is recommended on the feasibility of the project being considered. Additionally, consider consultations with engineers and other relevant professional,

the effects the project could have on the community and watershed, and the true economic costs of implementing a project.

5.1 REDUCTION TECHNIQUES

Various stormwater management techniques are available that can be used in the watershed. The town will consider amending or adding ordinances to better address stormwater runoff. Possible changes and amendment could include maintaining trees and vegetated areas and the consideration of ordinances to minimizing the amount of clearing and tree removal that can occur. Similar regulations have been used in other nearby coastal communities. The town will also consider landscaping policies that emphasize the use of native plants and reduce the use of fertilizers and pesticides. Pet waste regulations and the installation of waste cleanup stations will also be considered at public spaces used by per owners. Future maintenance and capital improvement projects at town-owned buildings, parks, parking lots, and drainage systems will consider the incorporation of LID techniques and other Green Street Designs (Appendix E).

Retrofits that manage stormwater runoff will be the primary measure taken to reduce the amount of stormwater runoff reaching waterways. For residential areas, emphasis will be placed on various single family home retrofits, such as downspout retrofits, native plant gardens, backyard wetlands, rain barrels and other residential level retrofits. Businesses can easily incorporate small-scale features like native plant, shade tree plantings or box planters to begin decreasing the amount of impervious surface and slow the flow rate of runoff. Businesses can then consider incorporating stormwater retrofit techniques into future developments or improvement projects (see Appendix D for various incentive program solutions).

Table 5-1 and Figure 5-1 presents a variety of potential projects that can be considered as funding becomes available. The list represents potential ideas for projects and can be used as the basis for future projects. The list will likely evolve to suit the condition and needs the watersheds. In addition to this list, the town is developing and maintaining a list of potential collaborative opportunities with local businesses and commercial properties that will be added to the runoff reduction load volume upon completion of a project. The total number of indicators or specific details of each project can vary based on funding and future needs that develop. The proposed management solutions, strategies, and techniques are based on the information compiled during the development of this restoration plan. These solutions are not actual planned projects, but are meant to illustrate the types of actions that could be taken. Before implementing any project or management solution, further consideration and research is recommended on the feasibility, consultation with engineers and other relevant professional, consideration of the effects of the proposed project on the community and watershed, and true economic costs of implementing a project.

Table 5-1. List of potential watershed project ideas with proposed number of retrofits and the approximated lifespan of projects[6].

Potential Watershed Restoration Projects	Number of Potential Projects	Lifespan (approx. years)
When possible, align current or future walking tours or trails to incorporate nearby stormwater retrofit demonstration sites (based on a similar concept to Wrightsville Beach's Walk the Loop), include projects at Bicentennial Park, Town Hall, Old Town Hall, Ward Shore Park, and other locations, where signs can be installed that educate hikers on the retrofit.	1	20-30
Create a stormwater retrofit demonstration display within Swansboro Municipal Park/Recreation Center and potentially at Hammock State Beach Park (refer to Anne McCrary Park in Wilmington, NC).	1	20-30
Install rain garden at Town Hall, Bicentennial Park, Swansboro Municipal Park/Recreation Center, and Ward Shore Park.	4	30
Install French drains or other Green Street Designs (Appendix E) at right of way street ends within the historic region of Swansboro; particularly at the ends of potentially: Water Street, Chestnut Street, Church Street, Walnut St, and Bicentennial Park.	4	30
Install downspout retrofits: at schools (4), Swansboro public buildings (including Town Hall, Swansboro Fire Department, Swansboro Police Department, etc.) and incorporate education signage at select locations.	+10	25
Develop a downspout disconnection programs for residential areas of Swansboro.	+10	25

6 Lifespan average approximation derived from:

Green Values Stormwater Calculator [Program tool]. (2016). Center for Neighborhood Technology. Retrieved from http://greenvalues.cnt.org/

Install planter boxes, swale islands, curb cuts, and other Green Street Designs (see Appendix E) in parking lots, particularly large impervious lots.	+1	25
Upon capital improvement, replace parking lots with permeable pavement at public buildings and public parks.	+10	30
Install rock sill flow dissipaters (also known as rock check dams) and other Green Street Designs (Appendix E) along areas of ditching and connected conveyance systems.	1	30
Plant shade trees along N.C. 24.	1	50
Plant shade trees with planter boxes along Front Street and Water Street.	1	30
Install cistern at Town Hall, Public Works, and Fire Department.	2	30
Install native plants at Town welcoming signs and parks.	+5	30
Install living shorelines projects at Riverview Park.	1	30

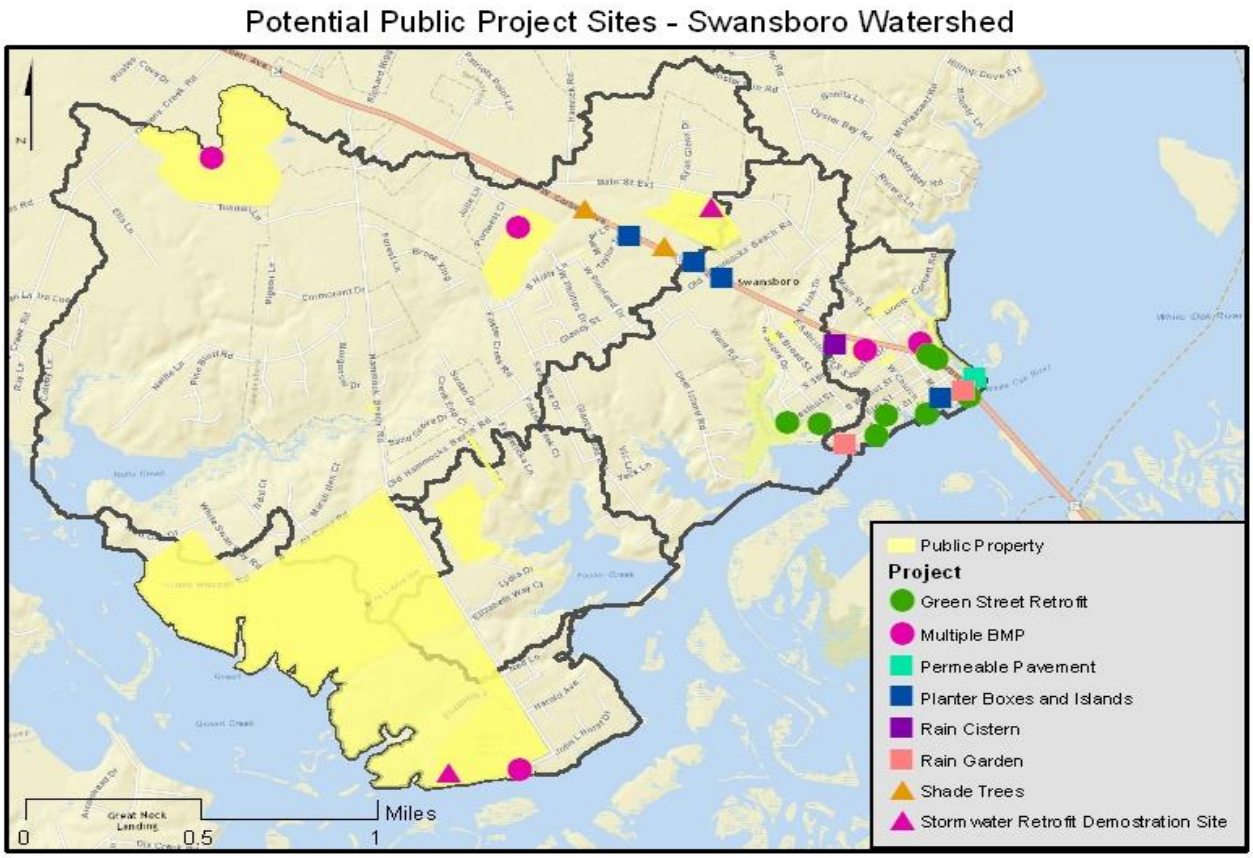


Figure 5-1 Potential projects sites for structural controls.

Table 5-2 and 5-3 present further information regarding a variety of stormwater retrofit options (these tables are not exhaustive, instead they present information regarding commonly used practices). Table 5-2 and 5-3 utilize information derived from national averages by Green Values National Stormwater Management Calculator Center for Neighborhood Technology. The cost and effectiveness of stormwater reduction retrofits varies between techniques. Before implementing any project or management strategy, details regarding specific siting, design, funding and maintenance should be researched. These factors and site specific factors, such as soil characteristics, ease of access, water table height, and other factors at the site should be considered. For example, some techniques, such as permeable paving can potentially save money in the long run but may have higher upfront cost compared to traditional asphalt paving. Techniques such as rerouting downspouts are relatively inexpensive (on a per unit basis). LID techniques often cost less overall when consideration is given to factors like life cycle cost, such as planning, design, installation, operation and maintenance.

Table 5-2. Various techniques and their effect on stormwater flow reduction and their ability to be used with a high water table as well as with poorly drained soils.

LID Technique	Effect on Stormwater Flow	Effective with High Water Table	Effective with Poorly Drained Soils	% Volume Reduction Range*[7]
Amend Soil	Medium	Yes	Yes	--
Bioswale (for parking lot or roadside)	High	No	Yes	0-40%
Constructed Wetland	High	Yes	Yes	25-40%
Curb Cuts	High	No	Yes	30-100%
Disconnect Impervious Surfaces	Medium	Yes	Yes	30-100%
Permeable Pavement	Low	No	Yes	20-100%
Planter Boxes	Medium	Yes	Yes	5-100%

[7] North Carolina Stormwater Design Manual 2009-2016. (2016). North Carolina Department of Environmental Quality. Retrieved from https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/stormwater-bmp-manual/archive

Rain Garden	High	No	No	30-100%
Rainwater Harvesting	Medium	Yes	Yes	100%
Reroute Downspout	Medium	Yes	Yes	30-100%
Riparian Buffer	Medium	No	No	9-100%[8]
Tree Box Filter	Medium	No	No	10-30%
Trees	Low	No	No	--
Vegetated Filter Strips	Medium	Yes	No	10-30%

*Note: Numbers derived from *North Carolina Stormwater Design Manual* and U.S. Environmental Protection Agency.

Table 5-3. Approximate cost per unit of various LID BMP techniques.

LID BMP Technique	Approximate Cost per Unit[9]	Maintenance Cost[9]
Amend Soil	$15-$60 per cubic yard	$.02 per cubic yard
Curb Cuts	$5-$25 per ft^2	$.30-$.60 per ft^2
Bioswale (for parking lot or roadside)	$6-$24 per ft^2	$.06-$.21 per ft^2
Native Plants	$.02-$.15 per ft^2	$.03-$.08 per ft^2
Permeable pavement	$5-$12 per ft^2	$.01-$.22 per ft^2
Planter Boxes	$.55-$24 per ft^2	$.04-$1 per ft^2
Rain garden	$5-16 per ft^2	$.30-$.60 per ft^2
Rainwater harvesting	$200/rain barrel $1,000/1400 gal cistern $10,000/10,000 gal cistern	$0 $0 $0

[8] Helmers, M. J., Isenhart, T., Dosskey, M., Dabney, S., and Strock, J. (2015). *Buffers and Vegetative Filter Strips.* US Environmental Protection Agency. Retrieved from https://www.epa.gov/sites/production/files/2015-07/documents/2006_8_24_msbasin_symposia_ia_session4-2.pdf

[9] Cost average approximation derived from:
Green Values Stormwater Calculator. (2016). Center for Neighborhood Technology. Retrieved from http://greenvalues.cnt.org/national/cost_detail.php

Reroute downspout	$9/downspout	$0
Tree Box Filter	$70-$600 per ft^2	$3-$14 per ft^2
Trees	$100-400 each	$20 each
Vegetated Filter Strips	$.03-$3.33	$.07 per ft^2

Note: Estimations from Green Values National Stormwater Management Calculator based on national averages.

5.2 PRESENT STORMWATER STRATEGIES

The following Table 5-4 is a list of existing stormwater retrofit and supporting projects in the area. The volume reduction rates from these projects have not been included in the volume reduction calculations. Plan partners intend to gather the information regarding the specifications of each project so that the volume reduced by each project can be calculated and incorporated into the tabulations that will be kept on the total reduction that has occurred in the watersheds.

Table 5-4. List of Present Stormwater Reduction Projects.

Project Location	Year Installed	Description
Front Street Swale	2010	Grassy swale captures water from front street to the park was installed with a $214,000 grant from the N.C. Clean Water Management Trust Fund and a $7,000 grant from the Community Conservation Assistance Program administered by the Onslow County Soil and Water Conservation office.
Downtown Filterras	2010	Four Filterra structures were installed with a $214,000 grant from the N.C. Clean Water Management Trust Fund and a $7,000 grant from the Community Conservation Assistance Program administered by the Onslow County Soil and Water Conservation office.
Swansboro Elementary School Rain Garden Program	2012	Rain garden installation and grassy curbless medians within school parking lot.
Hammocks Beach State Park Living Shoreline		Living shoreline along maintenance area dock of the park.
Hammocks Beach State Park		Parking lot retrofit along the old ferry parking lot area.
Queens Creek Elementary School*		Two rain garden installations. *NOTE: This project is outside of the watershed boundaries of this plan; however, this along with other projects within the community show a vested

		interest and commitment by the community to install and continue upkeep of projects.
Ward/Hawkins Creek Residential Living Shoreline Project	2017	Living shoreline project currently being installed along a homeowner's property.

5.3 EDUCATION AND OUTREACH

Residents of the watersheds, business owners, and students of the areas schools will be the targeted audiences of the education and outreach program. The following subsections of section 5.3 represent a potential outline that partners can build upon. The solutions listed are intended to serve as inspiration and these solutions are not actual planned projects being implemented. Before implementing any management solutions presented here, further consideration and research is recommended be conducted on the feasibility, effectiveness, impact to the community and watershed and true economic costs of implementing a strategy. Partnerships with organizations that specialize in education and outreach can be used to develop a robust and successful outreach program.

5.3.1 **Partnerships and Community Building**

The Swansboro Watershed Restoration Plan involves many key participants. Town officials will be key players in the application of the actions laid out in this plan. Being aware of the critical role of maintaining water quality and appropriate stormwater management, the Swansboro officials chose to proactively develop a watershed restoration plan. To maintain a flourishing town, stormwater management will be critical. Town officials and representatives can help by implementing examples of stormwater runoff reduction techniques in public spaces and promoting the implementation of reduction techniques within the community. Swansboro relies on clean coastal waters for tourism and to maintain its fishing and shellfishing industry. Various partnership opportunities exist, and any projects associated with the plan can always consider the incorporation of partners to increase engagement, community investment, and impact of a project. Potential partners range from engagement of government agencies, nonprofit organizations, volunteer groups, local clubs and organizations, educational and scientific institutes, and businesses. A list of potential partnerships has been developed and will be maintained by the town as a list to refer to when collaborative projects present themselves.

Developing partnerships with schools can be an effective means of engaging the community and addressing education and outreach implementation. Although not within the Swansboro watersheds, local colleges can be valuable partners to assist with research, monitoring, updating management strategies, and developing outreach material.

Additionally, the area contains four public schools that service the greater Swansboro and Hubert region. Schools can be a great location to conduct education and outreach and implementation of retrofit projects at schools can receive a lot of public visibility. Swansboro Elementary School and Swansboro High School fall within the watersheds of this plan, many students from the remaining schools live within the watersheds or surrounding area, presenting an opportunity to engage students and their families.

The following schools are within the Swansboro Watersheds:

- Swansboro Elementary School (Number of students: 587)
- Swansboro Middle School (Number of students: 805)
- Swansboro High School (Number of students: 1,070)
- Queen's Creek Elementary School (Number of students: 608)

Hammocks State Beach Park, in the Hammocks Watersheds, could be another valuable partner. Thousands of people visit the park annually. Its Visitors Center could be the site of stormwater educational program and the park's planned extension into 300 undeveloped acres may lead to opportunities for innovative stormwater runoff controls., located within Hammocks Watersheds. The Visitor Center is a high traffic publicly accessible center reaching thousands of individuals yearly.

Community outreach and engagement are critical to the long-term success of any watershed management plan. The community is comprised of individuals who experience the effects of the watershed restoration plan and they can be encouraged to become interested in the plan and resulting stormwater reduction projects. This makes community outreach and engagement a critical component of the plan. There are several community groups within the Swansboro watersheds that can be engaged in various parts of the plan. These include town residents, businesses, and those who work, go to school, or visit the watersheds.

Knowing something about the demographics of the people who live in the watersheds can inform the development of education and outreach program. Swansboro's population is about 3,074, according to the United States Census Bureau. Their median age is 38 years. Nearly 361 households, or about 31 percent of households, have children under the age of 18. Nearly 63% of current residents own their home. From these statistics, it would be worth considering education and outreach material that focuses equally on residential solutions that are also renter-friendly, such as non-permanent retrofits like down spout disconnections, and homeowner residential retrofits, such a pervious driveway retrofits. In addition to children and family oriented stormwater education and outreach, it would be worthwhile to consider education and outreach suite that emphasizes adult and tourist education and outreach.

5.3.1.1 *Community Outreach*

Education and outreach to the community can encourage the use of residential stormwater retrofits such as disconnecting downspouts, planting native plants, installing rain barrels, and other techniques. Residents, whether renting or homeowners, can be encouraged to understand how their homes and properties contribute to the water quality of the watersheds.

This information can potentially be disseminated to residents through the following techniques, further research and collaboration with environmental educators should be considered before beginning an outreach project:

1. Distribution of the *Smart Yards* informational booklet developed by the North Carolina Coastal Federation. The *Smart Yards* booklet can be mailed directly to all residents or can be made available at public buildings like the Town Hall.
2. Presentations on residential solutions at public town meetings on a regular basis.
3. Encourage residents to attend or participate in project demonstrations and installation at public buildings to learn how to install retrofits.
4. Survey residents to determine the number of retrofits that have been installed, which can be helpful in determining volume reduction. Surveys can also help to determine if the community's knowledge on stormwater has expanded.
5. Install educational signs about stormwater at public areas such as: parks, Town Hall, town parks, and other areas that are frequented by residents.
6. Present an article about residential stormwater issues in the town paper, social media, or newsletter. See Figure 5-1 as an example of what can be presented.
7. Outreach to subdivision homeowners associations to encourage stormwater and water quality education and disconnecting impervious surfaces.

5.3.2 **Businesses, Developers, and Commercial Land Owners Within the Swansboro Watersheds**

There are many businesses, developers, and commercial land owners within the Swansboro watersheds. These businesses include locally owned and chain operated. Business is a mix of retail -- groceries, restaurants, gas stations – and service oriented like banks and doctors' offices. Commercial areas account for some of the largest continuous, non-disconnected areas of impervious surfaces. Businesses could be encouraged to participate in retrofits at public and commercial properties and consideration can be given to developing an incentive program (see Appendix D).

5.3.2.1 ***Outreach***

Education and outreach to businesses, developers, and commercial land owners can focus on the disconnection of impervious surfaces and LID techniques for new development. The town could offer incentives to encourage businesses to install these techniques. Various methods could be used to educate the business community. Collaboration with environmental educators should be considered before beginning an outreach plan:

1. Encourage businesses to host *Smart Yards* or other stormwater information for distribution to the community.
2. Meet with businesses to encourage participation and discuss potential retrofits that align with their capital improvement plans.
3. Conduct meeting for businesses and commercial land owners to educate them on stormwater issues and to promote LID techniques.
4. Invite businesses to participate or sponsor events, such as stormwater retrofit installations, to encourage community involvement and cooperation.
5. Encourage those who are interested in retrofits that increase green space and permeable surfaces. Retrofits can vary from small-scale solutions like planting shade trees, installing box planters or installing rain gardens to large-scale solutions like converting retention ponds into constructed wetlands.
6. Encourage businesses with large parking lots to remove curbed medians and replace them with rain gardens, swales, or permeable pavement.
7. Encourage businesses to install signs of their retrofit accomplishments.
8. Survey businesses, developers, and commercial land owners to determine the number of retrofits that have been installed. Determine if resident knowledge has expanded.

The town can consider determining the most meaningful strategies to reach businesses, developers, and commercial land owners. Various stormwater incentive program techniques exist that the town can use. The EPA has identified five basic program categories that can be used to encourage the reduction of stormwater (shown in Table 5-5)[10]. Specific examples of

[10] *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

strategies and examples of programs implemented by other towns and cities can be found under Appendix D.

Table 5-5. EPA categories for stormwater incentive programs.

Program Type	Description
Stormwater Fee Discount	The town currently has a stormwater enterprise fund that offers small discounts to property owners who have installed state-approved controls. The town could expand the discounts to include property owners who reduce impervious area and the volume of runoff discharged from the property.
Development Incentives	Offered to developers during the process of applying for development permits. Examples include: zoning upgrades, expedited permitting, reduced stormwater requirements and increases in floor area ratios.
Grants	Provide direct funding to property owners and/or community groups for implementing a range of green infrastructure projects and practices.
Rebates & Installation Financing	Provide funding, tax credits or reimbursements to property owners who install specific practices. Often focused on practices needed in certain areas or neighborhoods.
Awards & Recognition Programs	Provide marketing opportunities and public outreach for exemplary projects. May include monetary awards. Emphasize LID projects on website, at Council meetings and in utility mailers.

5.3.3 **Swansboro Students**

Swansboro elementary school and high school are in the watersheds and would be ideal locations for several educational projects. Local businesses can even be encouraged to sponsor student projects such as rain gardens. This program can emulate and expand upon the program that is currently being implemented at the Swansboro and Queens Creek elementary schools.

5.3.3.1 ***Outreach***

Education and outreach to students can focus on stormwater, water quality, and non-structural BMPs that students can do on their own. Students can be encouraged to understand their role within the watersheds. This information can effectively be disseminated to students through the following techniques. Collaboration with environmental educators should be considered before beginning an outreach plan:

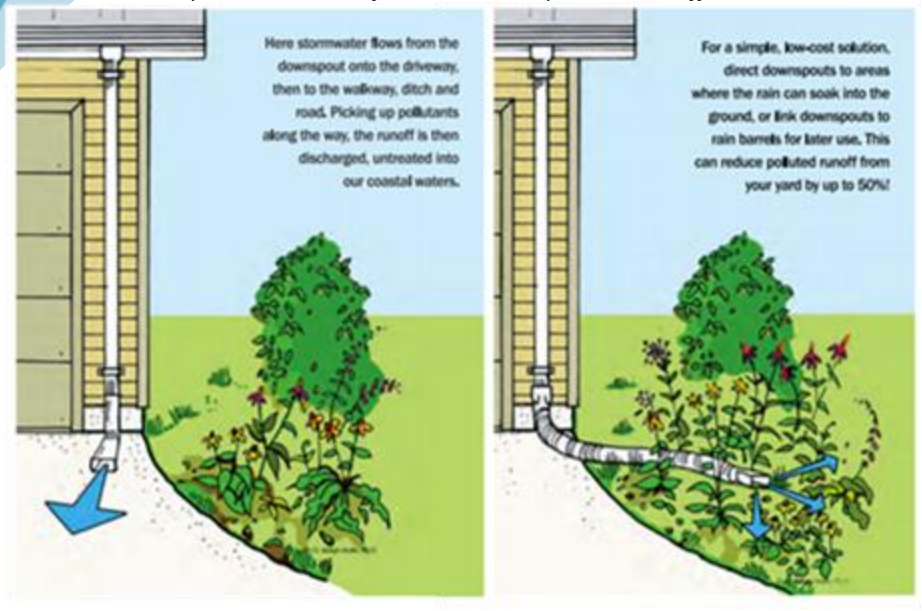
1. Development of age appropriate lessons associated with demonstration sites in the watershed.
2. Encourage class participation in the installation of rain gardens, downspout retrofits and other LID and BMP techniques as service projects or field trips.
3. Present an article in the school's newsletter to parents to encourage family discussion.

What is stormwater runoff and how does it affect me?

Each time it rains, rainwater flows along rooftops, driveways, and other developed surfaces into streets, gutters and ditches, where it eventually flows into our coastal waters. Along the way, this rainwater collects pollutants and bacteria that can make our rivers and coasts unsafe for swimming, shellfishing, and other activities. During heavy rain, stormwater runoff can also cause flooding and erosion. Addressing this problem not only creates a healthier and safer environment for us all to enjoy, but can also provide economic and other benefits to your property

What can I do about it?

The Town of Swansboro is working to reduce stormwater runoff on municipal property. But, there are also many simple and low-cost actions that Town residents can take to help direct stormwater on their property to places where soil, plants, or containers can capture the rain before it becomes polluted runoff.



Downspout disconnectors: *If a downspout from a gutter empty into a driveway, sidewalk, or parking lot, simply* ***re-directing the downspout*** *to an area that can filter the water naturally will reduce polluted runoff. A flexible downspout extension can be purchased at a local home improvement store for* ***less than $10****, and used to direct water to vegetated areas. Directing rainwater to a lawn or garden that normally needs watering could result in* ***savings on your water bill****.*

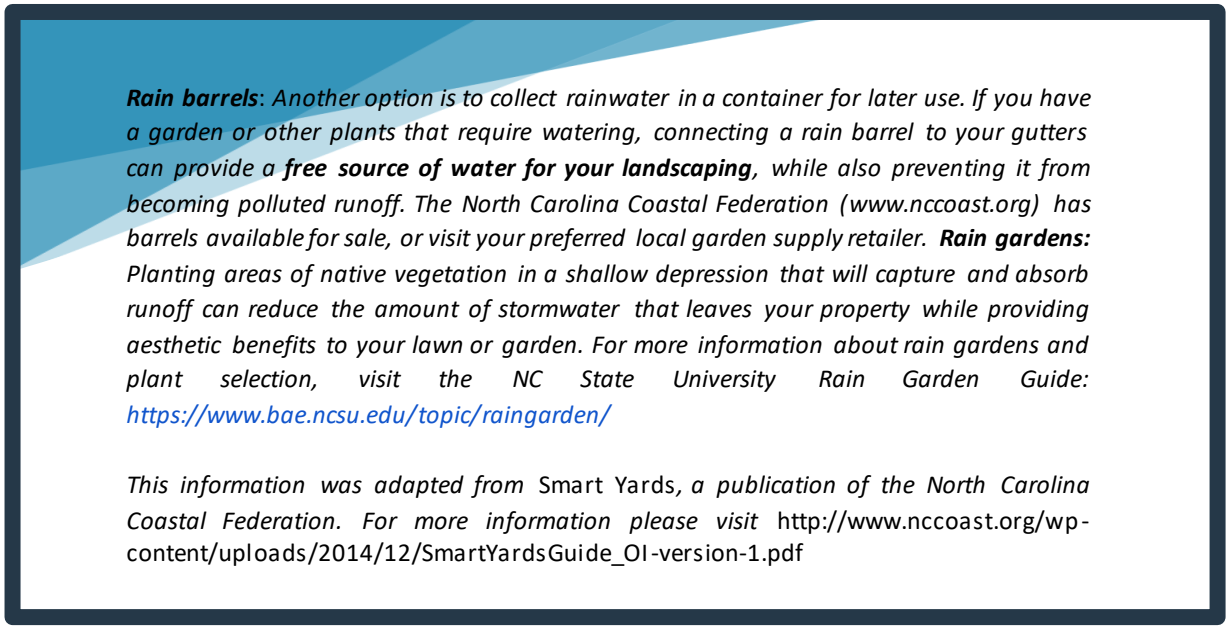


Figure 5-1. Example Education and Outreach flyer discussing residential retrofits.

6 Implementation Schedules

The management solutions, strategies, and techniques in this section and in Section 5 are proposals that the town could consider. The solutions presented here are not actual planned projects. Before implementing any management solution presented here, the town should research its cost and feasibility and consult with engineers and other relevant professionals.

Swansboro will manage the implementation of any goals, objectives, and actions associated with this restoration plan. The town will determine what partners should be included on a project. The town can attempt to maximize partnerships opportunities by aligning projects with those being conducted by others in the area.

The Town will convene a group to determine funding actions, education and outreach material, tools, and best method to approach the application and implementation of the proposed actions listed in Table 6-1. Ultimately, decision on how to best approach and carryout actions to meet the plan's objectives should be determined by the town.

The following discusses a potential implementation schedule of projects, milestones and monitoring work to occur. Table 6-1 is an overview of the general implementation schedule describing the actions that can potentially be taken over the course of the next 20 years.

Table 6-1. Overview of general Implementation Schedule.

Proposed Action	Timeframe
Review Town's current planning, new development and land management strategies (e.g. landscape policies, etc.), policies and regulations to maximize stormwater reduction and stormwater management program (Obj. 1-1, Obj. 1-2, Obj. 2-6).	Year 1
Review capital improvement projects (Obj. 3-2, Obj. 3-3, Obj. 3-4, Obj. 3-5).	Year 1
Evaluate stormwater retrofit solutions (Obj. 2-2, Obj. 3-7).	Year 1
Develop landowner incentives to disconnect impervious surfaces (Obj. 2-5)	Year 1
Develop a list of proposed targeted retrofit sites (Obj. 2-1, Obj. 5-1).	Year 1, reevaluate every few years
Seek grant funds (Obj. 1-3, 2-3, 2-4 3-1, 6-3).	Annually
Seek reclassification of waters (Obj. 4-2).	Year 1

Develop education and outreach (Obj. 6-1, Obj. 6-2, Obj. 6-5).	Year 1, as necessary with projects
Provide training opportunities (Obj. 6-4).	Year 1, as deemed necessary
Partner with agencies regarding monitoring (Obj. 4-3, Obj. 4-4).	Year 3
Review water quality data, plan, and stormwater volume (Obj. 4-1, Obj. 5-2, Obj. 5-4).	Annually
Update plan every 5 years (Obj. 5-3).	Year 5, 10, 15
Final Assessment. Review entire plan and implementation successes and failures, lessons learned, and strategies to improve future planning.	Year 20

6.1 Potential Project Ideas Schedule

The following is the suggested stormwater runoff reduction techniques and watershed education projects with the implementation schedule based on national averages from Neighborhood Technology's Green Values Stormwater Calculator[11] (Table 6-2). The Maintenance Schedule column of Table 6-2 should be taken into consideration as part of the technical considerations of the plan.

The list represents potential ideas for projects and can be used as the basis for future projects. The list will likely evolve to suit the condition and needs the watersheds. The total number of indicators or specific details of each project can vary based on funding and future needs that develop. The proposed management solutions, strategies, and techniques are based on the information compiled during the development of this restoration plan. These solutions are not actual planned projects, but are meant to illustrate the types of actions that could be taken. Before implementing any project or management solution, further consideration and research is recommended on the feasibility, consultation with engineers and other relevant professional, consideration of the effects of the proposed project on the community and watershed, and true economic costs of implementing a project.

[11] Average estimated cost approximation derived from Green Values and from national averages. Prices may vary based on local averages and cost of labor.
Green Values Stormwater Calculator [Program tool]. (2016). Center for Neighborhood Technology. Retrieved from http://greenvalues.cnt.org/

Table 6-2. Potential Project Ideas Implementation schedule matrix table format. 'Completed By' represents the year that the project should be completed. 'Indicators' represent the measurable indication that the project has been completed.

Potential Project Ideas	Completed By	Maintenance Schedule	Indicator
Printing and mailing of *Smart Yard* (or similar outreach material designed for the Town) to residents with additional prints made available at public buildings such as Town Hall.	Year 5	Annually, provide additional prints to public buildings over the course of 20 years.	# of 1,000 residents mailed
Install downspout retrofit at schools and other public buildings (such as Town Hall, Swansboro Fire Department, Swansboro Police Department, etc.).	Year 5	Annually, incorporate with regular landscape maintenance.	# of 5 installations
Develop a downspout disconnection program for residential areas of Swansboro.	Year 5	Annually, incorporate into residential related activities.	# of 1 programs
Shade tree planting along HWY 24.	Year 5	Annually, incorporate with regular landscape maintenance.	# of 50 trees planted
Install rain gardens as part of an educational demonstration site at Town Hall.	Year 5	Annually, incorporate with regular landscape maintenance.	# of 1 project
Install Stormwater runoff management signs at all public docks and parks.	Year 5	Annually, assess of signage, incorporate with regular landscape maintenance schedule.	# of 10 signs installed
When possible, align current or future walking tours or trails to incorporate nearby stormwater retrofit demonstration sites (based on a similar concept to Wrightsville Beach's Walk the Loop), include projects at Bicentennial Park, Town Hall, Old Town Hall, Ward Shore Park, and other. locations, where signs can be installed that educate hikers on the retrofit.	Year 10	Annually, incorporate with regular landscape maintenance.	# of 1 program

Create a stormwater retrofit demonstration display within potentially Swansboro Municipal Park/Recreation Center and potentially at Hammock State Beach Park (refer to Anne McCrary Park in Wilmington, NC).	Year 10	Annually, incorporate with regular building maintenance schedule.	# of 2 sites
Install rain garden at Bicentennial Park, Swansboro Municipal Park/Recreation Center, and Ward Shore Park.	Year 10	Annually, incorporate with regular landscape maintenance.	# of 3 gardens
Install planter boxes, swale islands, curb cuts, and other Green Street Designs (see Appendix E) in parking lots, particularly large impervious lots.	Year 10	Annually, incorporate with regular landscape maintenance.	# of 5 parking lots
Rock sill flow dissipaters and other Green Street Designs (Appendix E) along areas of ditching and connected conveyance systems.	Year 10	Annually, incorporate with regular landscape maintenance.	# of 5 ditches
Install planter boxes and shade trees along Front Street and Water Street.	Year 10	Annually, incorporate with regular landscape maintenance schedule.	# of 25 trees and/or planter boxes
Install cistern at Town Hall and Fire Department.	Year 15	Annually, incorporate with regular landscape maintenance schedule.	# of 2 cistern locations
Install French drains or other Green Street Designs (Appendix E) at right of way street ends within the historic region of Swansboro; particularly at the ends of potentially: Water Street, Chestnut Street, Church Street, and Bicentennial Park.	Year 20	Annually, incorporate with regular landscape maintenance.	# of 4 installations
Rain garden or manmade wetland at the intersection of HWY 24 and W. Shore Drive.	Year 20	Annually, incorporate with regular landscape maintenance.	# of 1 installations
Install planter boxes or curb cut swale islands and other Green Street Designs (Appendix E) in parking lots, particularly large impervious lots along HWY 24.	Year 20	Annually, incorporate with regular landscape maintenance.	# of 2 projects

Install rock sills and other Green Street Designs (Appendix E) along ditches throughout town	Year 20	Annually, incorporate with regular landscape maintenance	# of 1 projects
Installation of living shoreline demonstration at Riverview Park	Year 20	Annually, incorporate replanting, structure enhancement as necessary	# of 1 living shoreline projects
Replace parking lot with permeable pavement and other Green Street Designs (Appendix E) at public areas such as town hall, parks, elementary school in coordination with capital improvement	Year 20	Annually, incorporate with regular building maintenance schedule	# of 5 parking lots installed

6.2 MILESTONES

Some measurable milestones are indicated under project indicators in Table 6-2. Primary milestones of the Swansboro watersheds for restoring water quality through volume reduction of surface runoff are:

6.2.1 **Short-Term (< 5 years)**

- Reducing stormwater runoff by 25% (3,342,147.5 gallons) of 13,368,590 gallons through the implementation of stormwater reduction techniques.
- Petition for the reclassification of waters currently open for shellfishing and classified as Class SC to Class SA.
- Develop an education program for the target groups (residents, students, and business owners) including lesson plans and materials.
- Hold quarterly education and outreach event.
- Source funding for at least 5 stormwater reduction projects.

6.2.2 **Mid-Term (< 10 years)**

- Reducing stormwater runoff by 50% (6,684,295 gallons) of 13,368,590 gallons through the implementation of stormwater reduction techniques.
- Hold quarterly education and outreach event.
- Source funding for at least 5 additional stormwater reduction projects.

6.2.3 **Long-Term (< 20 years)**

- Reducing stormwater runoff by 100% (13,368,590) gallons through the implementation of stormwater reduction techniques to reach 1993 conditions.
- Hold quarterly education and outreach event.
- Source funding for at least 5 additional stormwater reduction projects.

6.3 MONITORING

In North Carolina, Shellfish Sanitation and Recreational Water Quality section of the Division of Marine Fisheries (DMF) is responsible for monitoring the bacteria levels in coastal waters and has the authority to close waters to shellfishing and issue swimming advisories when bacterial levels are unacceptable. This is accomplished through monitoring water quality conditions at over a thousand stations for shellfishing and 240 stations for swimming. In addition, every three years N.C. Shellfish Sanitation staff survey the entire shoreline of shellfish growing areas to

document current and potential pollution sources. The data collected by Shellfish Sanitation is publicly available and is a source of historical and present day information regarding water quality of an area. By using data that has already been collected, communities can research and develop plans without implementing extensive and costly data collection and monitoring programs. Shellfish closure area information can be used by communities to determine what waterways are impaired and to what extent the waterway is being affected. These up-to-date surveys and monitoring station data will be the primary source of information.

Monitoring will be conducted by using the indicators listed in Table 6-3 that are both qualitative and quantitative measures of changes within the watershed.

Table 6-3. The primary goal of the watershed management plan and the indicators and how to measure the indicators.

Primary Indicators **Reduce stormwater runoff volume to restore water quality**				
	Indicator	**Measured by**	**Collected by**	**Collection Cycle**
1	Bacteria	Comparing numerical before and after measurements of the water quality indicator parameter or pollutant loads that is appropriate for the watershed, until non-impaired levels are reached. Data is collected by Shellfish Sanitation and the data will be used by the town to keep track of changes in water quality.	Shellfish Sanitation	Yearly; reports released every 3 years
2	Stormwater Runoff Volume	Applying stormwater reduction techniques and determining how much stormwater is reduced by the techniques; these measures should attempt to reduce current stormwater runoff volume to the levels of the baseline year. This method uses the Runoff Reduction Scenario Tool, developed by the N.C. Coastal Federation.	Town	Upon completion of a project; Annual assessment

6.4 EVALUATION

To ensure that the Swansboro Watershed Restoration Plan is meeting the needs of the watershed and community, the restoration plan should be evaluated on a regular basis to determine effectiveness (Table 6-4).

Record keeping will be imperative to the long-term success of this plan and organized and meticulous records shall be kept. Record keeping will include: tracking events, project development, maintain a list of potential projects, staff and volunteer hours, running totals of project runoff reduction, updating monitoring records, funding, and so on. A record of projects will be maintained by the Town.

Table 6-4. Evaluation of the Swansboro Watershed Management Plan.

Evaluation	Indicator	Timeframe
Load reduction calculation for installed stormwater runoff projects.	Utilize N.C. Coastal Federation *Watershed EZ Tool* and *Runoff Reduction Scenario Tool.*	Pre/Post implementation of projects
Publicize and evaluate successes.	During education and outreach events update stakeholders on watershed successes.	As necessary
Publish quick report updating stakeholders on watershed.	Publish report on watershed health. Recognize past, current and future projects for the year.	As necessary
Scheduled Assessment.	Conduct yearly, scheduled assessment of water quality data and the plan with project team, followed by review by planning board, and the town commissioners.	Annually
Update plan.	Update the plan every 5 years based upon findings from water quality data and the status of implementation and findings from yearly assessment review of plan implementation (Obj. 5-3).	Years 5, 10, 15
Final Evaluation.	Determine whether to extend current plan.	Year 20

6.5 FUNDING COST AND TECHNICAL NEEDS

The total cost to implement a project varies greatly due to parameters such as location of the project, size of project, design complexity, labor and materials, and other parameters. As such, once a project is selected, the town will likely need to seek estimates to complete a project. Annual maintenance should always be considered and budgeted for accordingly. Project partners can explore appropriate funding sources on a project by project basis. The information compiled within this plan will serve as a useful source when developing funding proposals.

Presently, technical needs for all projects include receiving true project estimates based on site conditions and input of professional construction or engineering knowledge as some projects will require this level of expertise. Additional technical needs include the need for partnerships with state agencies, local organizations, or academia professionals who can provide expertise and knowledge on the development of education and outreach programs. The Maintenance Schedule column of Table 6-2 should be taken into consideration as part of the technical considerations of the plan as maintenances requires forethought to ensure funding and technical skills are available for the duration of the life cycle of the projects. Table 5-3 should be taken into consideration when determining maintenance costs of each project. Several projects rely on using the in-kind services of volunteers to complete projects. Projects such as downspout retrofit installation, rain garden installation, and living shoreline installation; can utilize in-kind volunteer services to build and conduct maintenance, which can potentially decrease project costs. Additionally, consideration should be given to the amount of staff time that will be dedicated by the town and its partners on each project. Potential technical and funding needs for each project have been discussed in Table 6-5.

Other various project based needs includes interest in seeking funding to conduct soil surveys of the region to accurately determine the region's potential for water infiltration, this will aid in more accurately determining how well certain retrofits will perform at certain sites (this need has been addressed via Objective 1-3). Having an accurate assessment of the regions soils will also aid in accomplishing Objective 2-1 and Objective 3-3 to develop a list of proposed retrofit sites; as the restoration plan matures and changes occur in the region, the plan will be assessed regularly (Objective 5), which will necessitate new projects be added to the plan. Seeking funding for retrofit projects is an important part of this plan and is addressed through Objective 2-3, 2-4, 3-1, 3-2, and 3-6.

Table 6-5. Potential project technical and funding needs assessment.

Potential Watershed Restoration Projects	Technical Needs	Funding Needs
When possible, align current or future walking tours or trails to incorporate nearby stormwater retrofit demonstration sites (based on a similar concept to Wrightsville Beach's Walk the Loop), include projects at Bicentennial Park, Town Hall, Old Town Hall, Ward Shore Park, and other locations, where signs can be installed that educate hikers on the retrofit.	Town and partners can utilize internal resources to plan routes and incorporate education signage to achieve this education program.	Minimal needs, most retrofits will likely include signage already. Consideration to develop factsheets/brochures or walking route signs.
Create a stormwater retrofit demonstration display within Swansboro Municipal Park/Recreation Center and potentially at Hammock State Beach Park (refer to Anne McCrary Park in Wilmington, NC).	Town and partners can utilize internal resources and volunteers to design, permit, and construct, and incorporate education signage as these projects are intended to be easy for residents to implement.	Minimal cost needs. Efforts will be made to secure grants.
Install rain garden at Town Hall, Bicentennial Park, Swansboro Municipal Park/Recreation Center, and Ward Shore Park.	Town and partners can utilize internal resources and volunteers to design, permit, and construct and incorporate education signage at select locations.	Minimal cost needs. Efforts will be made to secure grants.
Install French drains or other Green Street Designs (Appendix E) at right of way street ends within the historic region of Swansboro; particularly at the ends of potentially: Water Street, Chestnut Street, Church Street, Walnut St, and Bicentennial Park.	Town and partners can utilize a combination of internal resources and contractors to design, permit, and construct Green Street designs; some such as French drains may require engineering contractors.	High cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Install downspout retrofits: at schools (4), Swansboro public buildings (including Town Hall, Swansboro Fire Department, Swansboro Police Department, etc.) and incorporate education signage at select locations	Town and partners can utilize internal resources to design, permit, and construct and incorporate education signage at select locations.	Minimal cost needs. Efforts will be made to secure grants.
Develop a downspout disconnection programs for residential areas of Swansboro.	Town and partners can utilize internal resources to develop a program.	Moderate cost potential. Efforts will be made to secure grants to start the program and consideration will be given to determine if

		stormwater budget will align with this program.
Install planter boxes, swale islands, curb cuts, and other Green Street Designs (see Appendix E) in parking lots, particularly large impervious lots.	Town and partners can utilize a combination of internal resources and contractors to design, permit, and construct Green Street designs; some advanced designs may require engineering contractors.	High cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Upon capital improvement, replace parking lots with permeable pavement at public buildings and public parks.	Town and partners can utilize construction contractors to implement this project.	High cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Install rock sill flow dissipaters (also known as rock check dams) and other Green Street Designs (Appendix E) along areas of ditching and connected conveyance systems.	Town and partners can utilize a combination of internal resources and contractors to design and implement Green Street designs; some advanced designs may require engineering contractors.	Moderate cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Plant shade trees along N.C. 24.	Town and partners can utilize internal resources to implement project. Efforts will be made to partner with N.C. DOT on this project.	Low cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Plant shade trees with planter boxes along Front Street and Water Street.	Town and partners can utilize internal resources to implement project.	Moderate cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Install cistern at Town Hall, Public Works, and Fire Department.	Town and partners can utilize internal resources to implement project.	Moderate cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.
Install native plants at Town welcoming signs and parks.	Town and partners can utilize internal resources and volunteers to implement project.	Low cost needs. Efforts will be made to secure grants and consideration will be given to align costs with

		capital improvement budgets.
Install living shorelines projects at Riverview Park.	Town and partners can utilize internal resources and volunteers to design, permit, and construct project. Consideration will be given to the unique permitting prosses for living shorelines.	Moderate cost needs. Efforts will be made to secure grants and consideration will be given to align costs with capital improvement budgets.

Appendix A Soil Taxonomy

Table Appendix A. Soil taxonomy and Hydrologic Soil Group

Acronym	Name	Hydrologic Soil Group (HSG)
AnB	Alpin fine sand, 1 to 6 percent slopes	A
BaB	Baymeade fine sand, 0 to 6 percent slopes	A
BmB	Baymeade-Urban land complex, 0 to 6 percent slopes	A
Bo	Bohicket silty clay loam	D
CrB	Craven fine sandy loam, 1 to 4 percent slopes	D
Ln	Leon fine sand	A/D
MaC	Marvyn loamy fine sand, 6 to 15 percent slopes	B
Mk	Muckalee loam	B/D
NoB	Norfolk loamy fine sand, 2 to 6 percent slopes	A
On	Onslow loamy fine sand	A
Ra	Rains fine sandy loam, 0 to 2 percent slopes, Atlantic Coast Flatwoods	B/D
To	Torhunta fine sandy loam	B/D
WaB	Wando fine sand, 0 to 6 percent slopes	A

The following is the USDA NRCS summary description for each soil group:

- **Group A** soils are sands, loamy sands, or sandy loams. These soils have high infiltration rates even when thoroughly saturated. These soils consist of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- **Group B** soils are silt loams or loams. These soils have moderate infiltration rates when thoroughly saturated and consist of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
- **Group C** soils are sandy clay loams. These soils have low infiltration rates when thoroughly saturated and consist of soils with a horizon that impedes downward movement of water and possess moderately fine to fine texture.
- **Group D** soils are clay loams, silty clay loams, sandy clays, silty clays, or clay. These soils have the highest runoff potential. These soils have very low infiltration rates when thoroughly saturated and consist of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

Appendix B Water Quality Standards

Further information regarding 303(d) List and its reporting categories[12]:

> *"The term "303(d) list" or "list" is short for a state's list of impaired and threatened waters (e.g. stream/river segments, lakes). States are required to submit their list for EPA approval every two years. For each water on the list, the state identifies the pollutant causing the impairment, when known. In addition, the state assigns a priority for development of Total Maximum Daily Loads (TMDL) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors (40 C.F.R. §130.7(b)(4)).*
> *In general, once a water body has been added to a state's list of impaired waters it stays there until the state develops a TMDL and EPA approves it. EPA reporting guidance provides a way to keep track of a state's water bodies, from listing as impaired to meeting water quality standards. This tracking system contains a running account of all the state's water bodies and categorizes each based on the attainment status. For example, once a TMDL is developed, a water body is no longer on the 303(d) list, but it is still tracked until the water is fully restored."*

Table 1. EPA 303(d) List Integrated Report Categories

Category/Subcategory	Description
Category 1	**Meets tested standards for clean waters.** All designated uses are supported, no use is threatened.
Category 2	**Waters of concern.** Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	**Insufficient data.** There is insufficient available data and/or information to make a use support determination.
Category 4	**Polluted waters that do not require a TMDL.** Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
Category 4a	**Has a TMDL.** A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
Category 4b	**Has a pollution control program.** Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.

[12] Environmental Protection Agency. Retrieved from https://www.epa.gov/tmdl/program-overview-303d-listing

Category 4c	**Is impaired by a non-pollutant.** The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
Category 5	**Polluted waters that require a TMDL or other WQI project.** Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

DWR PRIMARY SURFACE WATER CLASSIFICATIONS

All surface waters in North Carolina are assigned a primary classification by the NC Division of Water Resources (DWR). All waters must at least meet the standards for Class C (fishable / swimmable) waters. The other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water (Water Supply Classes I through V). To find the classification of a water body you can either use the BIMS database or contact Adriene Weaver of the Classifications & Standards/Rules Review Branch. To view the regulatory differences between the currently implemented classifications for freshwaters, click here for the freshwater classifications table. To view the regulatory differences between the currently implemented classifications for tidal saltwaters, click here for the tidal saltwaters classifications table.

Table 2. North Carolina surface water classifications. Full descriptions available on DEQ Website.

Primary Use Classifications	
SA	Commercial Shellfishing
SB	Class SC and Primary Recreation in tidal salt water
SC	Aquatic Life, Secondary Recreation, and Fishing in tidal salt water
SWL	Coastal wetlands
Supplemental Use Classifications	
HQW	High Quality Waters
ORW	Outstanding Resource Waters
NSW	Nutrient Sensitive Waters
CA	Critical Area

UWL	Unique Wetland
+, @, #, *	Special Designations (variable based on river basin)

Class C

Waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, survival and maintenance of biological integrity, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner.

Class B

Waters protected for all Class C uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.

Water Supply I (WS-I)

Waters protected for all Class C uses plus waters used as sources of water supply for drinking, culinary, or food processing purposes for those users desiring maximum protection for their water supplies. WS-I waters are those within natural and undeveloped watersheds in public ownership. All WS-I waters are HQW by supplemental classification. More information: Water Supply Watershed Protection Program Homepage

Water Supply II (WS-II)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I classification is not feasible. These waters are also protected for Class C uses. WS-II waters are generally in predominantly undeveloped watersheds. All WS-II waters are HQW by supplemental classification. More information: Water Supply Watershed Protection Program Homepage

Water Supply III (WS-III)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a more protective WS-I or II classification is not feasible. These waters are also protected for Class C uses. WS-III waters are generally in low to moderately developed watersheds. More information: Water Supply Watershed Protection Program Homepage

Water Supply IV (WS-IV)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I, II or III classification is not feasible. These waters are also protected for Class C uses. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas. More information: Water Supply Watershed Protection Program Homepage

Water Supply V (WS-V)

Waters protected as water supplies which are generally upstream and draining to Class WS-IV waters or waters used by industry to supply their employees with drinking water or as waters formerly used as water supply. These waters are also protected for Class C uses. More information: Water Supply Watershed Protection Program Homepage

Class WL

Freshwater Wetlands are a subset of all wetlands, which in turn are waters that support vegetation that is adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. These waters are protected for storm and flood water storage, aquatic life, wildlife, hydrologic functions, filtration and shoreline protection.

Class SC

All tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

Class SB

Tidal salt waters protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.

Class SA

Tidal salt waters that are used for commercial shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification.

Class SWL

These are saltwaters that meet the definition of coastal wetlands as defined by the Division of Coastal Management and which are located landward of the mean high water line or wetlands contiguous to estuarine waters as defined by the Division of Coastal Management.

DWR SUPPLEMENTAL CLASSIFICATIONS

Supplemental classifications are sometimes added by DWR to the primary classifications to provide additional protection to waters with special uses or values.

Future Water Supply (FWS)

Supplemental classification for waters intended as a future source of drinking, culinary, or food processing purposes. FWS would be applied to one of the primary water supply classifications (WS-I, WS-II, WS-III, or WS-IV). Currently no water bodies in the state carry this designation.

High Quality Waters (HQW)

Supplemental classification intended to protect waters which are rated excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

The following waters are HQW by definition:

- WS-I,
- WS-II,
- SA (commercial shellfishing),
- ORW,

Primary nursery areas (PNA) or other functional nursery areas designated by the Marine Fisheries Commission, or

Waters for which DWR has received a petition for reclassification to either WS-I or WS-II.

Outstanding Resource Waters (ORW)

All outstanding resource waters are a subset of High Quality Waters. This supplemental classification is intended to protect unique and special waters having excellent water quality and being of exceptional state or national ecological or recreational significance. To qualify, waters must be rated Excellent by DWR and have one of the following outstanding resource values:

- Outstanding fish habitat and fisheries,

- Unusually high level of water based recreation or potential for such kind of recreation,
- Some special designation such as North Carolina Natural and Scenic River or National Wildlife Refuge,
- Important component of state or national park or forest, or
- Special ecological or scientific significance (rare or endangered species habitat, research or educational areas).

For more details, refer to the Biological Assessment Branch homepage.

Nutrient Sensitive Waters (NSW)
Supplemental classification intended for waters needing additional nutrient management due to being subject to excessive growth of microscopic or macroscopic vegetation.

Swamp Waters (SW)
Supplemental classification intended to recognize those waters which have low velocities and other natural characteristics which are different from adjacent streams.

Trout Waters (Tr)
Supplemental classification intended to protect freshwaters which have conditions which shall sustain and allow for trout propagation and survival of stocked trout on a year-round basis. This classification is not the same as the NC Wildlife Resources Commission's Designated Public Mountain Trout Waters designation.

Unique Wetland (UWL)
Supplemental classification for wetlands of exceptional state or national ecological significance. These wetlands may include wetlands that have been documented to the satisfaction of the Environmental Management Commission as habitat essential for the conservation of state or federally listed threatened or endangered species.

Table 3. North Carolina water quality classification and standards.

Classification	Description
Class SA	Tidal salt waters that are used for commercial shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification. The following water quality standards apply to surface waters that are used for shellfishing for market purposes and are classified SA. Water quality

	standards applicable to Class SC waters as described in Rule .0220 of this Section also apply to Class SA waters. (1) Best Usage of Waters. Shellfishing for market purposes and any other usage specified by the "SB" or "SC" classification; (2) Conditions Related to Best Usage. Waters shall meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services and shall be suitable for shellfish culture; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard; (3) Quality Standards applicable to Class SA Waters: a. Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes or other wastes; b. Sewage: none; c. Industrial wastes, or other wastes: none which are not effectively treated to the satisfaction of the Commission in accordance with the requirements of the Division of Health Services; d. **Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.**
Class SB	Tidal salt waters protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis. The following water quality standards apply to surface waters that are used for primary recreation, including frequent or organized swimming, and are classified SB. Water quality standards applicable to Class SC waters are described in Rule .0220 of this Section also apply to SB waters. 1. Best Usage of Waters. Primary recreation and any other usage specified by the "SC" classification; 2. Conditions Related to Best Usage. The waters shall meet accepted sanitary standards of water quality for outdoor bathing places as specified in Item of this Rule and will be of sufficient size and depth for primary recreation purposes; any source of water pollution which precludes any of

	these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard; 3. Quality Standards applicable to Class SB waters: a. Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes or other wastes; b. Sewage; industrial wastes; or other wastes: none which are not effectively treated to the satisfaction of the Commission; in determining the degree of treatment required for such waters discharged into waters which are to be used for bathing, the Commission shall take into consideration quantity and quality of the sewage and other wastes involved and the proximity of such discharges to the waters in this class; discharges in the immediate vicinity of bathing areas may not be allowed if the Director determines that the waste cannot be treated to ensure the protection of primary recreation; c. **Organisms of coliform group: fecal coliforms not to exceed a geometric mean of 200/100 ml (MF count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 ml in more than 20 percent of the samples examined during such period.**
Class SC	All tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife. The water quality standards for all tidal salt waters are the basic standards applicable to Class SC waters. Additional and more stringent standards applicable to other specific tidal salt water classifications are specified in Rules .0221 and .0222 of this Section. 1. Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, fish and functioning PNAs), wildlife, secondary recreation, and any other usage except primary recreation or shellfishing for market purposes. 2. Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, and secondary recreation; Any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard. 3. Quality standards applicable to all tidal salt waters:

a. Chlorophyll a (corrected): not greater than 40 ug/l in sounds, estuaries, and other waters subject to growths of macroscopic or microscopic vegetation; the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

b. Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayments, or estuarine bottom waters may have lower values if caused by natural conditions;

c. Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes or other wastes, as shall not make the waters unsafe or unsuitable for aquatic life and wildlife, or impair the waters for any designated uses;

d. Gases, total dissolved: not greater than 110 percent of saturation;

e. Organisms of coliform group: fecal coliforms not to exceed geometric mean of 200/100 ml (MF count) based upon at least five consecutive samples examined during any 30 day period; not to exceed 400/100 ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the MF technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results the MPN 5-tube dilution method shall be used as the reference method;

f. Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines pursuant to 40 CFR 110.4(a)-(b);

g. pH: shall be normal for the waters in the area, which generally shall range between 6.8 and 8.5 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;

h. Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;

i. Radioactive substances: (i) Combined radium-226 and radium-228: The maximum average annual activity level (based on at least four samples, collected quarterly) for combined radium-226, and radium-228 shall not exceed five picoCuries per liter; (ii) Alpha Emitters. The average annual gross alpha particle activity (including radium-226, but excluding radon and uranium) shall not exceed 15 picoCuries per liter; (iii) Beta Emitters. The maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other

naturally occurring radio-nuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;

j. Salinity: changes in salinity due to hydrological modifications shall not result in removal of the functions of a PNA; projects that are determined by the Director to result in modifications of salinity such that functions of a PNA are impaired will be required to employ water management practices to mitigate salinity impacts;

k. Temperature: shall not be increased above the natural water temperature by more than 0.8 degrees C (1.44 degrees F) during the months of June, July, and August nor more than 2.2 degrees C (3.96 degrees F) during other months and in no cases to exceed 32 degrees C (89.6 degrees F) due to the discharge of heated liquids;

l. Turbidity: the turbidity in the receiving water shall not exceed 25 NTU; if turbidity exceeds this level due to natural background conditions, the existing turbidity level shall not be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202(6) of this Section] recommended by the Designated Nonpoint Source Agency (as defined by Rule .0202 of this Section). BMPs must be in full compliance with all specifications governing the proper design, installation, operation and maintenance of such BMPs;

m. Toxic substances: numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all tidal saltwaters: (i) Arsenic, total recoverable: 50 ug/l; (ii) Cadmium: 5.0 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators. (iii) Chromium, total: 20 ug/l; (iv) Cyanide: 1.0 ug/l; (v) Mercury: 0.025 ug/l; (vi) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge; (vii) Nickel: 8.3 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in

	approving the use of metal translators. (viii) Pesticides: (A) Aldrin: 0.003 ug/l; (B) Chlordane: 0.004 ug/l; (C) DDT: 0.001 ug/l; (D) Demeton: 0.1 ug/l; (E) Dieldrin: 0.002 ug/l; (F) Endosulfan: 0.009 ug/l; (G) Endrin: 0.002 ug/l; (H) Guthion: 0.01 ug/l; (I) Heptachlor: 0.004 ug/l; (J) Lindane: 0.004 ug/l; (K) Methoxychlor: 0.03 ug/l; (L) Mirex: 0.001 ug/l; (M) Parathion: 0.178 ug/l; (N) Toxaphene: 0.0002 ug/l. (ix) Polycholorinated biphenyls: 0.001 ug/l; (x) Selenium: 71 ug/l; (xi) Trialkyltin compounds: 0.002 ug/l expressed as tributyltin. 4. Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall be required to monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph may be limited as appropriate in the NPDES permit if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to: "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance For Calculating a Total Recoverable Permit Limit From a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators. (a) Copper: 3 ug/l; (b) Silver: 0.1 ug/l; (c) Zinc: 86 ug/l.

Shellfish Sanitation Classifications

Table 4. Classifications used by Shellfish Sanitation for shellfish harvesting waters.

North Carolina Shellfish Sanitation Growing Area Classifications	
Approved	These areas are always open to shellfish harvesting and close only after rare heavy rainfall events such as hurricanes. The median fecal coliform Most Probable Number (MPN) or geometric mean MPN of water shall not exceed 14 per 100 milliliters, and the estimated 90th percentile shall not exceed an MPN of 43 per 100 mL for a five-tube decimal dilution test.

Conditionally Approved-Open Shellfish Areas	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period of time, and the pollutant event is known and predictable and can be managed with a plan. These areas are open to harvest much of the year, but are immediately closed after certain sized rainfall events.
Conditionally Approved-Closed Shellfish Areas	Sanitary Survey indicates an area can meet approved area criteria during dry periods of time, and the pollutant event is known and predictable and can be managed with a plan. This growing area classification allows harvest when fecal coliform bacteria levels are lower than the state standard in areas that otherwise might be closed to harvesting. These areas are regularly monitored to determine if temporary openings are possible.
Prohibited Shellfish Harvest Areas	Sanitary Survey is not routinely conducted because previous sampling data did not meet criteria for Approval or Conditional Approved. Area may also be closed as a matter of regulation due to the presence of point source discharges or high concentrations of boats with heads.

Recreational Water Quality Standards

Tier	Description
Tier I	"Tier I swimming area" means a swimming area used daily during the swimming season, including any public access swimming area and any other swimming area where people use the water for primary contact, including all oceanfront beaches. 1. The enterococcus level in a Tier I swimming area shall not exceed either: a. A geometric mean of 35 enterococci per 100 milliliter of water, that includes a minimum of at least five samples collected within 30 days; or b. A single sample of 104 enterococci per 100 milliliters of water. Tier I Swimming areas: (1) A swimming advisory shall be issued by the Division when samples of water from a swimming area exceeds a geometric mean of 35 enterococci per 100 milliliters during the swimming season. (2) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 104 enterococci per 100 milliliters and does not exceed 500 enterococci per 100 milliliters during the swimming season. (3) A swimming advisory shall be issued by the Division when a sample of water from a swimming area exceeds a single sample of 500 enterococci per 100 milliliters during the swimming season.

	(4) A swimming advisory shall be issued by the Division when at least two of three concurrent water samples collected at a swimming area exceeds 104 enterococci per 100 milliliters during the swimming season. A Tier I swimming area advisory shall be rescinded when two consecutive weekly water samples and the geometric mean meet the bacteriological limits in Rule 18A .3402(a) of this Section. A swimming alert shall be rescinded within 24 hours of compliance with Rule 18A .3402(a)(2) of this Section.
Tier II	"Tier II swimming area" means a swimming area used an average of three days a week during the swimming season. The enterococcus level in a Tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliters of water. Tier II swimming areas: (1) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 276 enterococci per 100 milliliters and does not exceed 500 enterococci per 100 milliliters during the swimming season. (2) A swimming advisory shall be issued by the Division when a single sample of water from a swimming area exceeds 500 enterococci per 100 milliliters during the swimming season. A Tier II or Tier III swimming area advisory or alert shall be rescinded after water samples meet the bacteriological standard in Rule 18A .3402(b) or (c) of this Section.
Tier III	"Tier III swimming area" means a swimming area used an average of four days a month during the swimming season. Tier III swimming area with a water sample result of 500 enterococci per 100 milliliters or higher on the first sample shall be resampled the following day. If the laboratory results of the second sample exceed 500 enterococci per 100 milliliters a swimming advisory shall be issued by the Division. A Tier II or Tier III swimming area advisory or alert shall be rescinded after water samples meet the bacteriological standard in Rule 18A .3402(b) or (c) of this Section.
Swimming Season	April 1 through October 31 of each year. The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliters of water.
Winter Season	November 1 through March 31 of each year.

Appendix C Shoreline Survey SOP

The following are direct excerpts from *Shoreline Survey Program Standard Operating Procedure* created by Shellfish Sanitation and Recreational Water Quality Section on June 2011. These are the standardized definitions used to designate nonpoint sources[13].

Dockage

In accordance with North Carolina Division of Environmental Health rules, and with guidance from the United States Food and Drug Administration and the National Shellfish Sanitation Program that marinas be considered as potential sources for contamination of shellfish, the North Carolina Shellfish Sanitation and Recreational Water Quality Section adopts the following policy to be used in the classification of shellfish harvesting waters with respect to marinas, docking facilities, and other mooring areas.

Definitions

- **Marina** - A marina shall be defined as any water area with a structure (dock, basin, floating dock, etc.) which is used for docking or otherwise mooring vessels and constructed to provide temporary or permanent docking space for more than 10 boats.
- **Open System** – An open-system marina is a marina constructed in an area where tidal currents have not been impeded by natural or man-made barriers.
- **Closed System** – A closed-system marina is a marina constructed in a canal, basin, tributary, or other area with restricted tidal flow.
- **Commercial Marina** – A commercial marina is defined as a marina that offers one or more of the following services: Fuel, transient dockage, haul-out facilities, or repair services.
- **Private Marina** – A private marina includes any marina that is not defined as a commercial marina.
- **Entrance Canal** – The entrance canal will be defined as the canal which is created or significantly altered during marina construction to provide access for boats to that facility.
- **Cabin** – An enclosed space on board a boat that can provide overnight shelter.

[13] Shellfish Sanitation. (2015). *Shoreline Survey Program Standard Operating Procedures*. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Shellfish Sanitation and Recreational Water Quality Section.

Defining Slips

When conducting a marina inspection, the following items will be counted as slips, in the manner defined below:

1) Finger Pier Dockage -- A narrow pier; may project from the shore, larger pier or dock.
2) Linear Dockage – Typically, a slip will be counted for every 25 feet of linear dockage available. However, in cases where all boats using the facility are greater than 25 feet in length, a reasonable estimate of typical boat length can be substituted to determine the slip count.
3) Dockage Areas For Fueling Or Sewage Pump out Use – A slip will be counted for every 50 feet of linear dockage at any fueling dock or sewage pumpout dock.
4) Moorings associated with the marina, or within 100 feet of the last slip

****Note**: In open-system marinas subject to significant wave or wake action, cleats or tie-ups not associated with defined boat slip structures such as pilings or finger piers will not be included in the total slip count unless it can be shown that the area in question is being used for the dockage of boats. If a boat is seen tied up in one of these areas, confer with DCM officials to determine if this situation warrants further investigation.****

When conducting a marina inspection, the following items will not be counted as slips:

1) Temporary Tie-Ups Associated With A Boat Ramp - Temporary tie-ups associated with boat ramps will be considered as any areas where the permanent dockage of boats would prohibit or significantly impede the use of an active boat ramp.
2) Staging Areas Associated With Haul Outs or Dry Stack Drop Zones – Staging areas will be considered as any areas where the permanent dockage of boats would prohibit or significantly impede the use of an active haul-out or drop zone.
3) Moorings not associated with the marina that are more than 100 feet from the last slip
4) Jet Ski Slips

****Note**: If there is evidence at a marina that any of these docking types are being used for permanent dockage, then they will be considered slips and will be included in the total slip count for the marina.****

Stormwater Conveyance

Stormwater conveyances evaluated during the shoreline survey include any ditches, swales, or pipes that drain residential areas, roads, farms, golf courses, or other human-altered landscapes into shellfishing waters. Conveyances not evaluated include small ditches dug by individual homeowners, pipes draining single-home gutter systems, or any drainage not

reaching shellfishing waters. Photographs of each conveyance should be taken indicating the type of conveyance and the type of land use(s) drained.

Definitions

- "Conveyance" – Indicate the type(s) of stormwater conveyance that drain to the area being evaluated. Select from: "Ditch/Swale to Pipe," "Ditch/Swale," "Curb/Gutter to Pipe," "Curb/Gutter to Ditch/Swale," "Pipe to Pipe End," "Pipe End to Ditch/Swale," or "Other." If "Other" is selected, describe the conveyance system in the comments section
- "Diameter" – If applicable, indicate the diameter of the last pipe the stormwater flows through before discharging (including culvert pipes). If more than one pipe is used, indicate the combined diameter of all pipes. The most common pipe diameters are available from the drop down menu, or you can select "Other" and indicate the pipe diameter in the comments section. If a pipe is present but you cannot determine its diameter, select "Unknown." If no pipe is present, select "Not Applicable"
- "Ditch Size" – If applicable, enter the depth and width, in feet, of the ditch or swale here
- "Sys Size" – This data field serves as an indicator of the size of the area drained by the conveyance being evaluated. If a pipe diameter can be determined, then the following criteria will be used to determine system size:
    - Low = ≤ 18 inches
    - Medium = 19-35 inches
- High = ≥ 36 inches
- If no pipe is present, use best professional judgement to determine the relative size of the drainage area.
- "FC Conc" – This data field serves as an indicator of the potential peak bacteria concentration discharged by the conveyance being evaluated. It is a subjective measure based on your experience, although some relative guidelines are provided:
    - Low = Drains a small area or an area with low-impact land uses; good buffers;
        - little to no potential inputs; good filtering before discharge
    - Medium = Drains a larger area or an area with mixed impact land-uses; some
        - buffers; some potential inputs, none major; little filtering before
        - discharge
    - High = Drains a large area or an area with predominantly high impact land-uses; little to no buffer; numerous potential sources or major sources; little to no filtering before discharge
- "FC Load" – This data field is a composite of the "System Size" and "FC Concentration" fields, and indicates the relative contribution of this particular stormwater conveyance to the total bacterial load within the growing area. Average the values determined for "System Size" and "FC Concentration" to determine this value.

- "Rain 24 Hr" – Select "Yes" if there has been rainfall in the area within the last 24 hours, or "No" if not
- "Flow" – If there is a flow moving through the conveyance, select "Yes"
- "Illicit" – If there has not been a recent rainfall, but there is flow moving through the conveyance, it could be an indicator of an illicit discharge. If you have reason to believe that the flow through this conveyance is the result of an illicit discharge, select "Yes." If not, select "No," or if it is unclear, select "Maybe/Uncertain"
- "Source" – Indicate the primary potential or actual pollution source drained by the conveyance. Select from "Agricultural Runoff," "Animal Operations," "Dog Pens," "Leaking Sewer Pipes," "Roadway/Residential," "Septic Failure," "Sewer Overflow," "Wildlife," "Other," or "Unknown"
- "Visible" – If there are any pollution sources visibly impacting the stormwater conveyance being evaluated, select "Yes"

Appendix D Potential Stormwater Incentive Strategies

The following is an outline of potential stormwater incentive strategies that municipalities could consider to encourage early LID implementation.

Begin by reviewing the town's codes and ordinances using the following worksheet:

https://www.scdhec.gov/HomeandEnvironment/docs/ModelOrdinances/CodesandOrdinances Worksheet.pdf

Program Categories

The EPA has identified five basic program categories that can be used to encourage the reduction of stormwater[14]:

Program Type	Description
Stormwater Fee Discount	Require a stormwater fee that is based on impervious surface area. If property owners reduce need for service by reducing impervious area and the volume of runoff discharged from the property, the municipality reduces the fee.
Development Incentives	Offered to developers during the process of applying for development permits. Examples include: zoning upgrades, expedited permitting, reduced stormwater requirements and increases in floor area ratios
Grants	Provide direct funding to property owners and/or community groups for implementing a range of green infrastructure projects and practices.
Rebates & Installation Financing	Provide funding, tax credits or reimbursements to property owners who install specific practices. Often focused on practices needed in certain areas or neighborhoods
Awards & Recognition Programs	Provide marketing opportunities and public outreach for exemplary projects. May include monetary awards. Emphasize LID projects on website, at Council meetings and in utility mailers.

[14] *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

Basic Strategies

The following is a compiled list of basic strategies and descriptions (summarized or quoted directly from Slo County[15] and EPA[16]; see Reference):

Strategy	Description
Adjustments to the Required Parking	Reducing parking is both an LID technique for reducing impervious surfaces as well to encourage more projects.
Dedicated Review Team	Create an LID review team that is familiar with and dedicated to LID projects.
Density bonuses	Allow greater residential densities with the implementation of LID techniques.
Disconnect of rooftop runoff credit	A credit is given when rooftop runoff is disconnected and then direction to a vegetated area where it can either infiltrate into the soil or filter over it. The credit is typically obtained by grading the site to promote overland filtering or by providing bioretention areas on single family residential lots.
Disconnection of Non-Rooftop Runoff Credit (aka Impervious Area	This credit may be granted when impervious areas are disconnected from the stormwater control system via overland flow filtration/ infiltration (i.e., pervious) zones. These pervious areas are incorporated into the site design to receive runoff small impervious areas (e.g., driveways, small parking lots, etc.). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or "rain garden" areas.

[15] Slo County. n.d. *List of Potential Municipal LID Incentive Programs.* Retrieved from http://www.slocounty.ca.gov/Assets/PW/stormwater/Potential+LID+Incentives.pdf

[16] *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

Disconnection Credit)	
Environmentally Sensitive Large Lot Neighborhood Credit (aka Environmentally Sensitive Development Credit)	This credit is targeted toward large lot residential developments that implement several Better Site Design practices to reduce stormwater discharges from the development. This credit may be granted when a group of environmental site design techniques are applied to low and very low density residential development (e.g., 1 dwelling unit per 2 acres [du/ac] or lower). The credit can eliminate the need for structural stormwater controls to treat water quality volume requirements. The project must have a total impervious cover (including streets) of less than 15% of the total area. use grass channels to convey runoff versus curb and gutter, etc.
Exemptions from local stormwater permitting	Allow redevelopment projects from being exempt from local stormwater permitting requirements if they can: • reduce the total impervious cover by 40% from existing conditions • Where site conditions prevent reduction in stormwater practices, implement controls for at least 40% of the site's impervious area, or Where a combination of impervious area reduction and implementation of stormwater practices is used for redevelopment projects, the combination of impervious area reduction and area controlled by stormwater management practices is equal to or exceeds 40%.
Fast track of review process	Provide priority status to LID projects with decreased time between receipt and review.
Green Roof Bonus	Add one square foot of additional floor area for each square foot of green roof, if green roof covers at least 50% of roof area and at least 30% of the garden contains plants.
LID Point system	Require a certain number of LID points and provide points when using approved LID IMP practices.
Managed Conservation Area Credit	A credit may be granted when areas of managed open space, typically reserved for passive recreation or agricultural practices, are conserved on a site. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements.

Modify building and inspection codes to include LID	Municipal entities that enforce building and inspection standards can also modify these standards in ways that acknowledge LID. In this subsection, we list sources of information on modifying building and inspection codes to make them more LID friendly. The list includes sources specific to Oregon and the Pacific Northwest, as well as from outside the region. http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf
Natural Area Conservation Credit	Credit may be granted when undisturbed, natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements.
Property tax reduction	Reduce or waive property taxes on an LID project for a given number of years.
Reduction of municipal submittal fees	Projects that infiltrate 100 percent of stormwater receive up to 50% reduction in the stormwater utility fee
Steam and Vegetated Buffer Credit (aka Stream Buffer Credit or Sheet flow to Buffer Credit)	This credit may be granted when stormwater runoff is effectively treated by a stream buffer or other vegetated buffer. Effective treatment constitutes treating runoff as overland sheet flow through an appropriately vegetated and forested buffer. Under the proposed credit, a designer would be able to subtract areas draining via overland flow to the buffer from total site area when computing water quality volume requirements.
Tree canopy credit	Reduce stormwater treatment volume requirements as a ratio of the number of acceptably sized trees planted on the project
Vegetated Channel Credit (aka Grass Channel Credit (in lieu of Curb and Gutter)	This credit may be granted when vegetated (grass) channels are used for water quality treatment. Site designers will be able to subtract the areas draining to a grass channel and the channel area itself from total site area when computing water quality volume requirements.

Education Programs	• Municipal sponsored public workshops on how to build rain gardens and emphasizing the increase in property value and curb appeal of LID landscaping • Municipal sponsored public workshops on how to make your own rain barrels • Municipal public education and outreach on how to conserve water and save money using rain barrels, rainwater harvesting water tanks, cisterns, and rain chains • Municipal sponsored contests with giveaways using rain barrels, rain harvesting water tanks, cisterns, and rain chains • Municipal sponsored gardening workshops promoting the value of rainwater harvesting, rain gardens, etc.
Business Outreach	Communication about grant opportunities, partnerships, awards, competitions, and regulations via email, newsletter, website, etc. directed directly at business owners and commercial land owners to encourage participation and encourage a vested interest in the community

Examples of LID-friendly Regulatory Language

"Several cities and counties list LID-friendly stormwater ordinances on their web sites. A recent Google search of "LID regulation" found the following LID ordinances:

- City of Sammamish, Washington: Ordinance 02008-236 Low Impact Development Regulations. An ordinance of the City of Sammamish, Washington, amending the City of Sammamish Municipal Code to create a Low Impact Development Chapter, and amending certain other Chapters of the City of Sammamish Municipal code to ensure consistency with the Low Impact Development Chapter. http://www.ci.sammamish.wa.us/Ordinances.aspx?ID=107 (accessed January 5, 2009).
- Fauquier County, Virginia: A zoning ordinance text amendment to Sections 5-006.5, 12-610 and 15-300 related to utilization of Low Impact Development techniques with site development. http://www.fauquiercounty.gov/government/departments/BOS/past agendas/02-14-08/lid_ord.htm (accessed January 5, 2009).
- Township of Lower Makefield, Pennsylvania: Ordinance No. 364. An ordinance of the Township of Lower Makefield, Bucks County, Pennsylvania, amending the Lower Makefield Township Codified Zoning Ordinance of 1996, as amended, to provide for Low

Impact Development Standards. http://www.lmt.org/LID%20-%20ZONING%20v%206%20_4_.pdf (accessed January 5, 2009)."[17]

- Vermont uses a suite of stormwater regulations http://acrpc.org/files/2012/04/LID_For_VT_Towns.pdf

Discussion of challenges faced by developers and how municipalities can maximize the effectiveness of stormwater programs:

http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

List of Cost savings from installed LID stormwater controls:

http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/guidance/factsheets/Documents/Incorporating%20ESD%20into%20Municipal%20SW%20Programs.pdf

https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/IncorporatingLID.pdf

[17] ECONorthwest. 2009. Low Impact Development at the local level: Developer's experiences and city and county support. Retrieved from http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

Examples of Specific Stormwater Program Strategies

The following is a compiled list of specific program strategies and descriptions that are summarized or directly quoted from the EPA[2]:

Program Type Color Code				
Stormwater Fee Discount Programs	Development Incentive Programs	Grant Programs	Rebates & Installation Financing Program	Awards and Recognition Programs

Stormwater Fee Discount Programs	
Program Name	**Description**
Stormwater fee equitability[18]	Fees are based on actual impervious area at each site as determined by aerial photography, so the less impervious surface, the lower the fee charged. All properties.
Stormwater Management Utility Exemption[2]	Gainesville's Stormwater Management Utility reduces monthly fees for nonresidential properties with privately maintained, onsite stormwater management retention systems. The utility's base fee is established per the property's impervious area and one-half its pervious parking areas. Credits of up to 100% are available based on the volume of onsite retention provided. Detention volume is not considered because that stormwater is discharged. Most credits range from 15% to 35%. Non-residential.
Stormwater Utility Discount[2]	Orlando's stormwater utility provides a lower rate for commercial and multifamily residential properties with onsite stormwater management facilities. Properties with approved onsite retention or detention get a 42% credit on the rate charged per equivalent residential unit. Beneficiary: Commercial and multi-family residential

[18] *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

	Flow Chart for Rate Determination: http://www.cityoforlando.net/public_works/Stormwater/Utility%20Fee/FLOWC HART%20FOR%202008%20BILLING%20YEAR.pdf FAQs: http://www.cityoforlando.net/public_works/Stormwater/faq.htm#04.3
Stormwater Credits Program[2]	The County provides stormwater credit to landowners who install four types of practices: watershed stewardship, water quality, peak flow and channel protection. The total maximum credit for any property is 40%. Watershed stewardship practices include: public participation, low impact parcels, farmland deep tillage, stream restoration / streambank stabilization, watershed improvement project participation, conservation easements, conservation use valuation, assessment (CUVA) properties, county approved training programs, stream buffers that exceed 75' standards, fencing livestock out of streams, rain barrels, automatic sprinkler sensors, direct discharges, septic tank maintenance, and connection to sanitary sewers. Water quality credits of up to 10% are earned by property owners who install facilities that capture pollutants, thereby providing treatment of stormwater before it enters streams. There are several practices to accomplish this available to all property owners. Porous pavement, roof gardens and green roofs are acceptable practices to receive this credit. Residential property owners can install rain gardens to earn this credit. Channel protection credit (maximum 10%) is earned by property owners who provide protection of stream channels from bank and stream bed erosion by detaining and reducing the volume of stormwater from their properties. Peak flow credit (maximum 10%) is earned by property owners who install basins that delay the system, thereby protecting downstream of the highest flows from reaching the drainage properties. Beneficiary: Property owner in Gwinnett County.
Utility Fee Credit[2]	Credits are available for eligible properties that install, alter, or conduct activities that reduce the costs of services provided by the County. A 10% reduction of the stormwater fee is allowed for property owners; a 1% reduction is allowed for each percent of stormwater directed to rain garden. If all stormwater is treated on site, no fee is charged. Beneficiary: All properties

Stormwater Fee Discount[2]	Wichita's stormwater utility offers two types of credits only for properties with 50 or more equivalent residential units. Up to a 40% credit is available for detention that equals or exceeds the city's new development standards, which are based on a 100-year storm. An 80% credit is available for retention of all runoff 8 from the site. Wichita has not issued any credits, because the standards are difficult to achieve. Beneficiary: Residential
Drainage Charge Credit[2]	The Louisville and Jefferson County Metropolitan Sewer District (MSD) provides credits primarily for commercial properties with onsite detention for controlling peak flows. The credit amount depends on how the detention basin functions. Basins must be sized for 2-, 10-, or 100-year storms, and limit discharges to predevelopment runoff rates. Credits are available for each type of storm, with an 82% maximum credit if all criteria are met. Currently, MSD is evaluating ways to incorporate stormwater quality measures into its credit approach. Stormwater Fee Discount Beneficiary: Commercial
Storm Water Surcharge Credit[2]	Any non-residential property owner who has either installed an approved on-site post-construction storm water control facility, implemented an approved best management practice (BMP), or developed and implemented an approved education program, may apply for a reduction of the Surcharge applied to that specific parcel. The District will evaluate each case individually in determining the appropriate level of credit. A total maximum of an 80% credit against the Surcharge may be granted: • The credit is applied by reducing the number of billable equivalent residential units. • The property parcel can qualify for both water quantity and water quality credits. • The maximum allowable water quantity credit percentage = 35%. • The maximum allowable water quality credit percentage = 50% Beneficiary: Commercial
Stormwater Enterprise Fund Fee Abatement[2]	The City allows single and two-family residential properties to abate up to 50% of the total fee if they install and maintain infiltration systems or other means to reduce runoff. Commercial/industrial/multi-family properties are allowed this abatement if they install and maintain "state-of-the-art" stormwater treatment and infiltration systems.

	Typical devices that qualify are drywells, infiltration chambers, detention ponds. Drinking water filtration systems and rain barrels do not qualify. The stormwater abatement continues if the impervious surface does not change. Beneficiary: Property owner in Reading, Massachusetts.
Stormwater Quality Credit[2]	Residential storm water fee credit determined by the percent of a property's impervious area that drains to a stormwater management tool/practice (BMP). The maximum credit allowed is equal to 50% of the total percentage of impervious area draining to a BMP. Beneficiary: Residential
NC CHARLOTTE **Storm Water Services Credit**[2]	A credit toward reducing a ratepayer's storm water user fee. The storm water fee is proportional to the amount of impervious area on a given property. The credit is also developed to be proportional to the effective reduction in impervious area. The credit is allowed for all properties except single-family residential properties, except in extraordinary situations. Credit will only be allowed for properties that maintain their structural controls in fully functional condition and per maintenance criteria and BMP standards. Credit will be allowed for previously constructed controls. A maximum of 100 percent of the user fee can be granted in credit with a maximum of 40% for peak reduction and 60% for volume reduction. Beneficiary: Commercial and Some Residential
NC CHARLOTTE **Stormwater Credit Fee**[2]	Charlotte provides one or more credits to commercial, industrial, institutional, and multifamily residential properties and homeowner associations that provide stormwater management measures. Eligibility for credits is proportional to the extent that the measures address the impacts of peak discharge, total runoff 12 volume, and annual pollutant loading from the site. • Up to 100% credit is available as follows: • Up to 50% credit for reducing peak discharge from a 10-year, 6-hour storm; • Up to 25% credit for reducing total runoff volume from a 2-year, 6-hour storm; • Up to 25% credit for reducing annual pollutant loading. Each credit is conditional on continued compliance with the Charlotte/Mecklenburg Land Development Standards Manual and may

	be rescinded for noncompliance with those standards. Beneficiary: Commercial, industrial, institutional, multifamily residential
NC DURHAM **Stormwater credit**[2]	Durham provides up to a 25% pollution credit for selected structural stormwater controls on nonresidential properties. The city first offered credits for onsite retention basins based on the pool volume for retention. Later, the city offered credits for onsite extended detention and extended detention-retention basins based on drawdown time. Currently, the maximum pollution credit goes to standard basin designs that achieve maximum pollutant removal efficiency under North Carolina's performance standards. For other structural controls listed in the state's standards, the city's pollution credit is linearly variable, with a maximum 25% credit for a removal efficiency of 85% of total suspended solids. The city recently approved the use of sand filters in addition to approved onsite basin designs, but no pollution credits have been established yet for their use. Durham receives few applications for credits. Beneficiary: Nonresidential properties
NC Raleigh **Stormwater Facility Credit**[2]	A maximum 50% credit against stormwater fees for installing Stormwater Facilities exceeding City requirements specified in the Stormwater Ordinance. To qualify, customers must demonstrate that their existing Stormwater or New Stormwater Facility manages stormwater generated from their immediate property and/or upstream tributary areas.
Clean River Rewards Incentive and Discount Program[2]	Portland, OR. Provides financial incentives to property owners who manage stormwater on their site through a discount on their monthly stormwater utility charge. The Portland City Council instituted a two-part rate—35% of the charge for providing drainage services to the property and 65% of the charge to provide drainage services to the public right of way that served the property. Not only did the charge breakdown reinforce that street drainage is an issue the City must deal with, it also allowed a portion of the rate to be discounted for properties providing onsite stormwater management. So, with 35% of the stormwater rate up for a potential discount, some properties could be encouraged to make retrofit changes. The CRID has a simplified discount program for residential properties based on volume control, and a more complex commercial property program that requires water quality and flow control for the full discount. Beneficiary: Residential and Commercial

Sixty-Five-Ten Discount[2]	Discount on fee assessment if your property is at least 65% forested, has no more than 10% effective impervious area and BMP for dispersing and infiltrating runoff are being met. Other conditions may apply and at least one site visit will be required for approval, but qualification for this discount would lower your assessment by one-rate category. Residential parcels meeting this condition will receive a discount equal to half the residential fee, or $51.00. Both residential and commercial properties are eligible. This discount may not be combined with other runoff mitigation discounts Beneficiary: Residential / Commercial
Surface Water Utility Reductions[2]	The surface water utility rate can be reduced by a minimum of 10 percent for any new or remodeled commercial building that uses a permissive rainwater harvesting system properly sized to use the available roof surface of the building. Rate reductions more than 10 percent will be considered dependent upon the amount of rainwater harvested divided by the mean annual runoff volume generated by the total impervious surface area at the parcel. Additionally, properties using low impact development techniques as recommended in the Marysville Municipal Code may be eligible for a reduction in their surface water utility rate. Commercial properties

Development Incentive Program	
Program Name	**Description**
Green Building and Green Development Program[2]	Green buildings or green developments shall qualify for expedited permitting and priority inspections. Green buildings and developments shall be defined and certified as appropriate by the U.S. Green Building Council (i.e. Leadership in Energy and Environmental Design (LEED) certification) or the Florida Green Building Coalition. The County discontinued the permit fee rebate previously offered to these projects as well on December 28, 2007. Beneficiary: Qualified developer in Sarasota County.
Green Permit Program[2]	Chicago's Department of Construction and Permits (DCAP) has created an incentive that encourages inclusion of environmentally conscious design elements by promising developer's savings of both time and money. Architects, developers and building owners can be part of an expedited permit process by adding elements of green building strategies and technologies from a menu of items created by DCAP. Projects admitted into the Green Permit Program can receive permits in less than 30 business days as opposed to the 60 to 90 that are normally allotted for permit issuance. Participants that display a particularly high level of green strategy can possibly have consultant code review fees waived as well. A team of green building design experts compiled by the city help applicants navigate the permit process to ensure timely implementation of these technologies. Beneficiary: Architects, developers, and building owners
Floor Area Ratio Bonus[2]	Projects that install ecoroofs in the Central City Plan District are eligible for a floor area ratio bonus, which increases the building's allowable area, and can use ecoroofs to conform to the Central City Design Guidelines. Buildings can receive bonus FAR based on three ranges of ecoroof coverage in relation to the building's footprint: 10-30%, 30-60% and 60% or greater earns one, two and three square feet of additional floor area per square foot of ecoroof respectively. Beneficiary: Commercial buildings in the Central City area of Portland. http://www.portlandonline.com/shared/cfm/image.cfm?id=53363, see 510-28

Stream and Vegetated Buffers Credit[2]	Credit may be granted when stormwater runoff is effectively treated by a stream buffer or other vegetated buffer. Effective treatment constitutes treating runoff as overland sheet flow through an appropriately vegetated and forested buffer. Beneficiary: Developer
Use of Vegetated Channels[2]	This credit may be granted when vegetated (grass) channels are used for water quality treatment. Site designers will be able to subtract the areas draining to a grass channel and the channel area itself from the total site area when computing water quality volume requirements. Beneficiary: Developer
Impervious Area Disconnection[2]	This credit may be granted when impervious areas are disconnected from the stormwater control system via overland flow filtration/infiltration (i.e., pervious) zones. These pervious areas are incorporated into the site design to receive runoff from rooftops or other small impervious areas. If impervious areas are adequately disconnected in accordance with the criteria listed below, they can be deducted from the total site area when computing the water quality volume requirements. Beneficiary: Developer
Water Quality Volume Credits[2]	Allows for a reduction in the water quality treatment volume (WQv). The credit system directly translates into cost savings to the developer by reducing the size of structural stormwater control and conveyance facilities. If a developer incorporates one or more of the credited practices in the design of the site, the requirement for capture and treatment of the WQv will be reduced. Site designers are encouraged to use as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnecting rooftops and protecting natural conservation areas). Beneficiary: Developer

Grant Program	
Program Name	**Description**
Sustainable Landscape Grant Program[2]	Grants are awarded for up to 50% of the cost of the project, not to exceed $5,000, including a maximum of $3,500 for qualified irrigation equipment and a maximum of $1,500 for climate-appropriate plants defined as very low, low, and medium water use plants. No turf or high water using plants or invasive plants will be funded. In addition to the $5,000, applicants may also apply for rebates for specific irrigation

	equipment including weather-based irrigation controllers, rotary nozzles for sprinklers and synthetic turf. The grant is a reimbursement grant, paid upon completion of the approved project. Invoices to substantiate costs will be required for all reimbursements. This grant is a first come, first served program available until funds run out. Projects in the parkway will receive priority funding. Projects must be completed within 180 days of grant award to receive funding. Partial funding for incomplete projects will not be permitted. Beneficiary: Individuals, property owners, businesses, non-governmental organizations and public agencies who are water customers in Santa Monica; new construction and major remodel projects are not eligible.
Green Roof Improvement Fund[2]	A one year pilot redevelopment program to provide financial assistance for the installation of Green Roofs on certain eligible commercial facilities. Eligible Applicants can receive a grant for up to 50% of Eligible Costs, with a maximum assistance of $100,000 per project and per applicant. All grants shall be in the form of reimbursement funding to be awarded only after the Green Roof is installed and all other requirements for funding are met. Beneficiary: Commercial
Community Watershed Stewardship Grant[2]	Watershed stewardship grants provide up to $10,000 to schools, churches, businesses and other community organizations for projects that protect and enhance watershed health at the local level. Groups can use grant money for supplies, materials, equipment, room rentals, feasibility studies or technical assistance. Past projects include education and monitoring, ecoroofs, stormwater features, restoration, and naturescaping. Community organizations
Impervious Surface Cost Share and Credit Program[2]	As an incentive to reduce impervious surface, the county is making funds available for sharing the costs of converting impervious surface to (1) native vegetated landscape, (2) compost-amended lawn or (3) grassed, modular-grid pavement. To qualify, a plot plan, technical information and description must be submitted to county engineers who will work with the customer to develop the plan. 50% of costs up to $20K will be reimbursed after the job is complete and inspected. Reducing impervious surface could potentially place the property into a lower rate category, reducing the surface water fee. Beneficiary: Commercial

Aquatic Habitat Matching Grant[2]	Seattle Public Utilities provides matching grants for individuals or groups to help improve Seattle's aquatic habitat along creeks and shorelines. Award amounts begin at $2,000 per project, with $300,000 in total awards available. Projects require a one-to-one match. Projects considered are those that improve, preserve, and/or restore aquatic habitat and/or ecological diversity and enhancement; address water flow and/or quality; or improve/prevent impacts from the City's drainage system. Beneficiary: Individuals or groups

Rebate/Installation Program	
Program Name	**Description**
Rain Gutter Downspout Redirect Rebate, Rain Barrel Rebate, Cistern Rebate[2]	1. Rain Gutter Downspout Redirect Rebate (rainwater percolation): Up to $40 per qualified rain gutter downspout (up to and including all downspouts on one's property), includes labor and materials. Rebates are available for the cost of redirecting rain gutter downspouts to permeable surfaces, such as landscaped areas. 2. Rain Barrel Rebate (rainwater storage): Rebates up to $100 per barrel (limited to 125-gallon maximum capacity), includes design, labor and materials. 3. Cistern Rebate (rainwater storage): Up to $500 per cistern (limited to cisterns over 500 gallons each), includes design, labor and materials. Beneficiary: Any property owner (resident, institution or business) in the City of Santa Monica and any tenant of said property with the permission of the owner.
City of Palo Alto Innovative Stormwater Measures Rebate Program[2]	1. Rain Barrel Rebate: $50 rebate for purchase and installation of a rain barrel to collect and harvest rainwater runoff from rooftops. 2. Permeable Pavement Rebate: Rebate of $1.50 per square foot for installation of permeable pavement (porous asphalt concrete, pervious Portland cement concrete, or permeable interlocking concrete pavers) to reduce storm water runoff from driveways, walkways, patios, and parking lots. 3. Cistern Rebate: Rebate of 15 cents per gallon for purchase and installation of a cistern to collect and harvest rainwater runoff from rooftops and site runoff

	4. Green Roof Rebate: Rebate of $1.50 per square foot for the installation of a green (vegetated) roof to minimize storm runoff from rooftops. Rebates are limited to a maximum of $1,000 per single-family residential property and $10,000 for commercial/industrial and multi-family residential properties. Beneficiary: Residential, commercial, or governmental property owner in the City of Palo Alto, California.
River Smart Homes[2]	This program offers incentives to homeowners interested in reducing stormwater pollution from their properties. Homeowners receive up to $1,200 to adopt one or more landscape enhancements, including shade trees, above-ground cisterns/rain barrels, permeable/porous pavers, rain gardens, and Bay Scaping. Beneficiary: Residential properties
City of Maitland Incentive Programs[2]	The City has three stormwater/water quality incentive programs. Through the Shoreline Revegetation Program, the City will reimburse qualified residents up to 50% of the cost to purchase and install aquatic plants along their property shoreline. A maximum one-time reimbursement of $200 is being offered. The Wetland Tree Planting Program provides lakefront homeowners up to three, 8- 10-foot-tall, bald cypress trees at a cost of only $25 per tree. A City representative works with the homeowner to establish the ideal location for the trees to ensure that the trees will benefit the lake and the shoreline. Finally, the City has an Environmental Swale Program which pays for 20% of the cost to grade and sod a swale, or $500 per property whichever is less. A City representative helps establish the best location for the swale to ensure that the lakes/canals have maximum water quality benefit. Beneficiary: Property owner in Maitland, Florida
Roll Out the Barrel Events[2]	Events held where rain barrels sold at discounted prices ($15 - $20) to residents. Barrels were built by the City's ex-offender job training program by retrofitting recycled 55-gallon plastic barrels. City provided information on installing and maintaining rain barrels, as well as information on stormwater management and water conservation. Pilot program cost ~$40K excluding city labor. Beneficiary: Residential
Rain Gardens for Rock Island[2]	City reimburses residents $4/square foot of rain garden space and if a rain is incorporated into the design the City will supply one for free. The City must approve the design before installation and inspect the rain garden upon completion before paying the incentive payment. Beneficiary: Residential property owner in Rock Island, Illinois.

RainScapes Rewards[1]	Up to $1,200 is offered per single-family lot or up to $5,000 per multi-family or commercial lot for installation of rain gardens, cisterns green roofs, native plants, shade trees and permeable pavement. Beneficiary: Residential and commercial properties
Rain Garden Retrofit Project[2]	$150K project to target homeowners in a specific neighborhood near Crystal Lake to compel residents to build rain gardens in their yards to reduce stormwater runoff. An architect met w/ residents free of charge to design the gardens and residents helped to build them. The city installed 6-ft. curb cuts w/ 2- ft. tapering sections on either side to direct stormwater off the streets and into the gardens. The project reduced runoff by 90% compared to neighboring control area. Homeowners maintain gardens w/ city assistance if needed. Beneficiary: Residential
Street Redesign and Reconstruction[2]	As part of large-scale redesign of existing streets and utilities, the City offered to construct standard-size rain gardens in the public boulevard right-of-way on the front edge of residential properties. These gardens handle drainage from yards, rooftops, driveways and some runoff from the street. Residents volunteer to have the garden built by the City and are responsible for planting the provided plants and maintaining the gardens with free technical assistance from the City. Beneficiary: Residential RESOLVE. 2007. Public Funding Incentives for Private Residential and Commercial Watershed Protection Projects: Report on Key Case Studies and Community Workshop. http://www.resolv.org/rainscapesworkshop/Report.pdf.
Rain Barrel Discount Program[2]	2,000 rain barrels made available to Minneapolis households at a reduced cost ($45). Barrels made available thanks to a $100,000 grant from the EPA's Region 5 Great Cities Program and in partnership w/ Minnesota/Metro Blooms and the Green Institute. Beneficiary: Residential
Reverse Bidding Auction[2]	Reverse auction to encourage the installation of rain barrels and rain gardens. Bids were received from qualified residents which outlined what rain catcher projects they agreed to have installed and the incentive payment they requested to do so. The bids were selected based upon the project(s) they agreed to install, their scoring within an Environment Benefit Index and the amount of the incentive payment

	requested. The selected project(s) were installed for free and the residents were paid the bid amount as a one-time incentive payment. The first round of the reverse auction in 2007 resulted in 50 rain gardens and 100 rain barrels installed at 67 of the approximately 350 residential properties in the watershed. In 2008, the auction was repeated and an additional 35 rain gardens and 74 rain barrels were installed. Beneficiary: Residential property owner in the Shepherd Creek watershed.
Downspout Disconnection Program[2]	Targets property owners to disconnect roof downspouts onto lawns and flowerbeds, or use onsite stormwater mgmt. facilities such as drywells and soakage trenches. The City's Plumbing division works directly with homeowners to disconnect downspouts without the homeowner having to get a plumbing permit. A target area of CSO basins is selected and Disconnection Program staff go to work, door-to-door canvassing to get voluntary agreement from property owners to complete the disconnection. Owners then complete the disconnection themselves and receive a $53 per downspout incentive, or have the City complete the disconnection for them free of charge. The program is funded primarily by a mixture of capital and operating funds due to this ability to remove enough stormwater from the CSO system, that collection pipes may be able to be downsized providing significant pipe construction cost savings. Beneficiary: Residential

Grant Program	
Program Name	**Description**
Mayor Daley's GreenWorks Awards[2]	Mayor Daley's GreenWorks Awards promote a green city by recognizing businesses, non-profits, schools and government agencies whose buildings, practices, and products or services are environmentally responsible. The GreenWorks Awards are presented annually. Beneficiary: Projects/buildings must be in the city of Chicago. The award program is open to businesses, non-profits, schools, and government agencies.
Businesses for an Environmentally Sustainable Tomorrow (BEST) [2]	Since 1993, the BEST Awards have been presented annually to Portland area companies demonstrating excellence in business practices that promote economic growth and environmental benefits. The BEST Awards recognize businesses with significant and unique achievements in the following categories: (1) BEST Practices for Sustainability for Small, Medium and Large companies, (2) Sustainable Products or Services, (3) Innovations in Resource Conservation, (4) Green Building, and (4) Sustainable Food Systems. Beneficiary: Local businesses
Eco-logical Business Program[2]	A certification and recognition program to highlight environmentally friendly businesses. After a certification visit, participating shops receive a shop display package, press coverage, listing on the program web site, and promotion on the radio and at public events. Beneficiary: Commercial
Stormwater BMP Recognition Program[2]	The BMP Recognition Program recognizes innovative stormwater Best Management Practices (BMPs) in the southeastern region of Pennsylvania. The program is looking for projects such as rain gardens, green roofs, infiltration swales, and treatment wetlands. Those who are recognized will receive a certificate and/or award from top officials of the Department of Environmental Protection (DEP) and the City of Philadelphia; recognition at an awards ceremony; and region-wide media exposure, such as in partner newsletters and the PWD newsletter, which reaches over half a million households and businesses in the region, in addition to acknowledgment on the PWD website. Beneficiary: Landscape architects, engineers, developers, university students, neighborhood residents and others

Reference

Slo County. n.d. *List of Potential Municipal LID Incentive Programs.* Retrieved from http://www.slocounty.ca.gov/Assets/PW/stormwater/Potential+LID+Incentives.pdf

Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

Doll, A., and G. Lindsey. 1999. Credits Bring Economic Incentives for Onsite Stormwater Management. Watershed and Wet Weather Technical Bulletin, January 1999, Water Environment Federation. http://stormwaterfinance.urbancenter.iupui.edu/PDFs/LindseyDoll.pdf

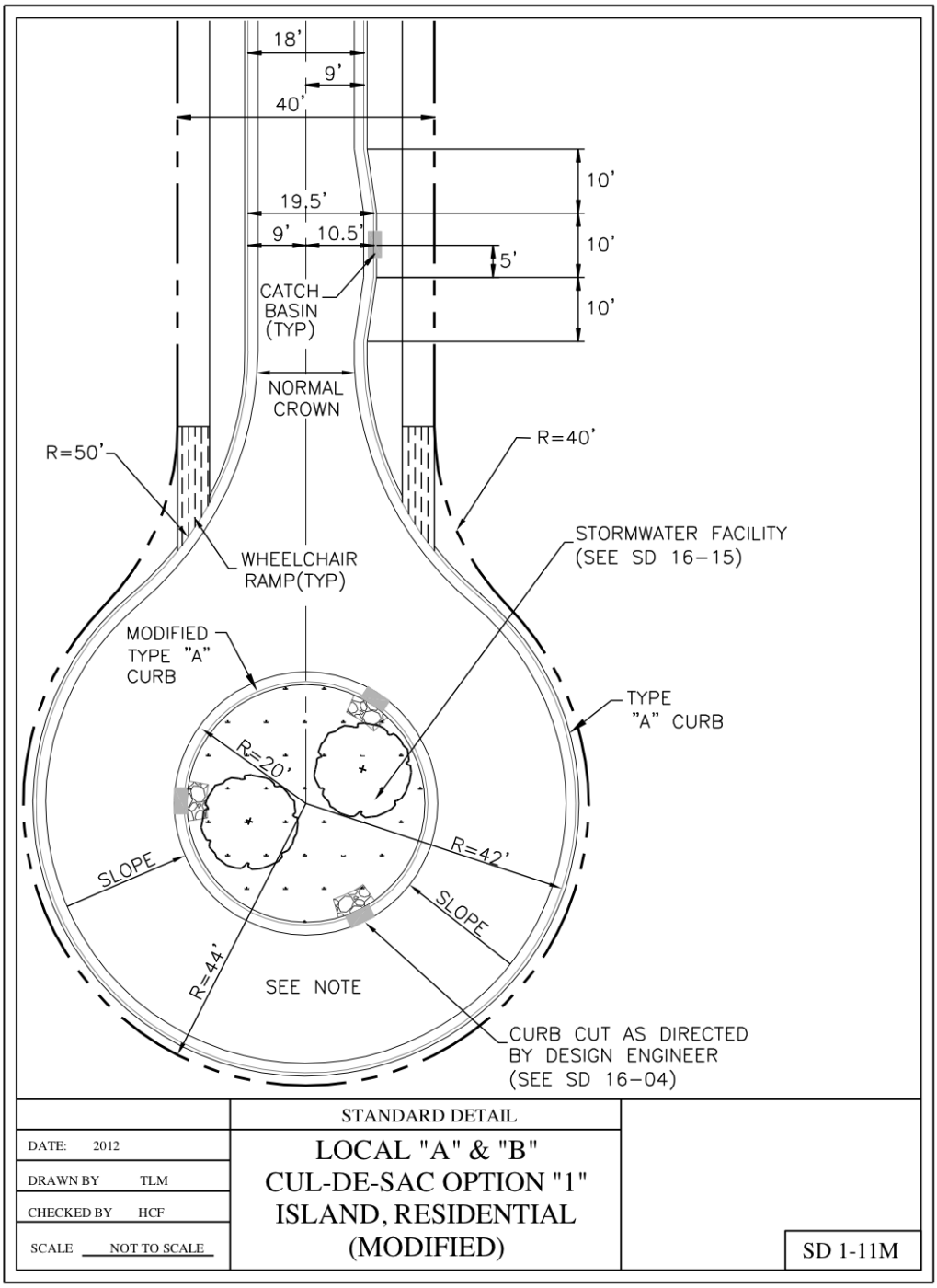
ECONorthwest. 2009. Low Impact Development at the local level: Developer's experiences and city and county support. Retrieved from http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

Appendix E *Green Street* Stormwater Management Devices

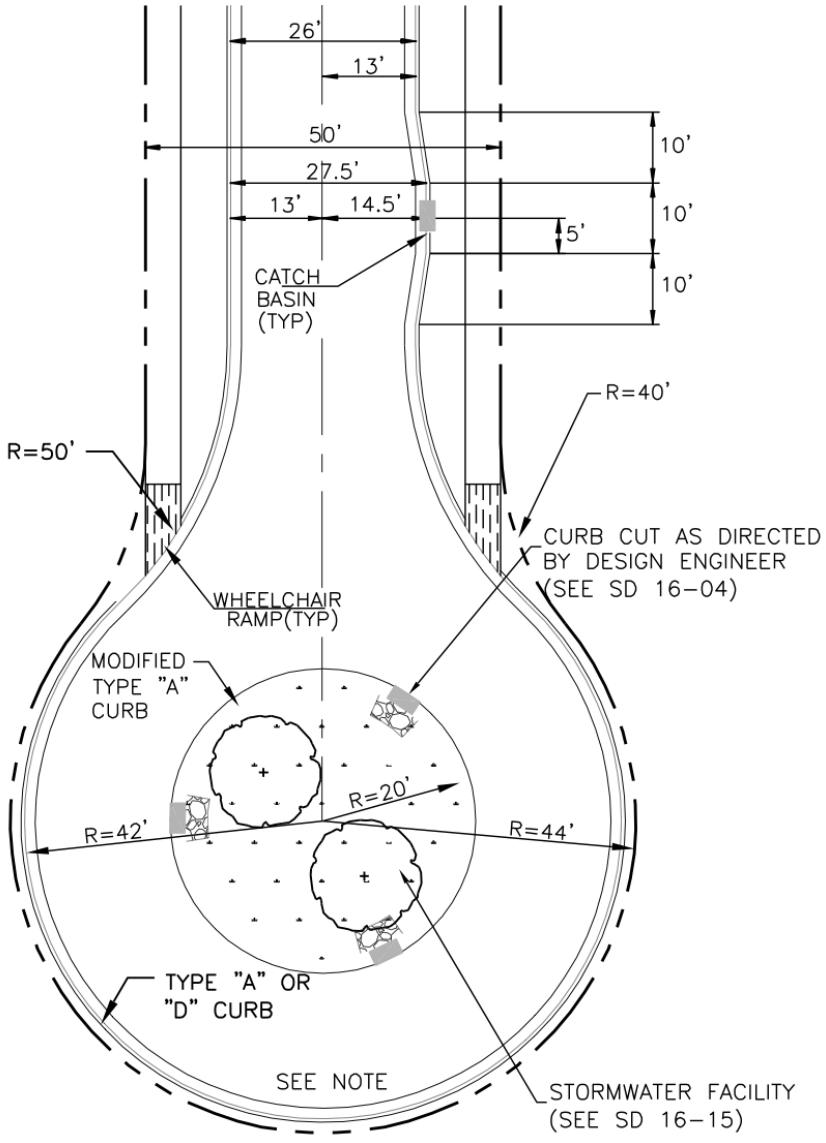
Green Street Stormwater Management Devices

The purpose of this appendix is to provide example designs of typical stormwater runoff reduction practices that can be used within the public right of way. The measures shown are examples of the techniques and processes encouraged with the watershed management plan.

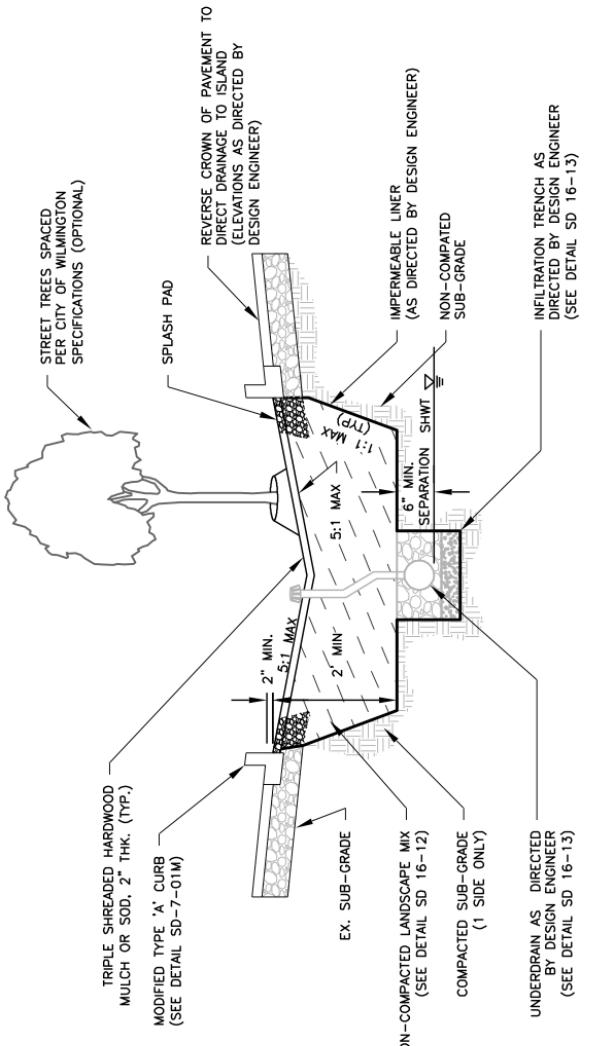
These details are intended to serve as the starting point for stormwater retrofits alongside active roadways. These details outline the major design elements of curbside stormwater management facilities. Roadside safety, pedestrian safety, maintenance, gutter spread and other factors must still be evaluated before implementation. Additionally, existing utilities or environmental conditions may make it necessary to modify or revise the standard designs to fit each individual BMP location. Curbside stormwater management may not be feasible in all locations.



	STANDARD DETAIL	
DATE: 2012	LOCAL "A" & "B" CUL-DE-SAC OPTION "1" ISLAND, RESIDENTIAL (MODIFIED)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 1-11M

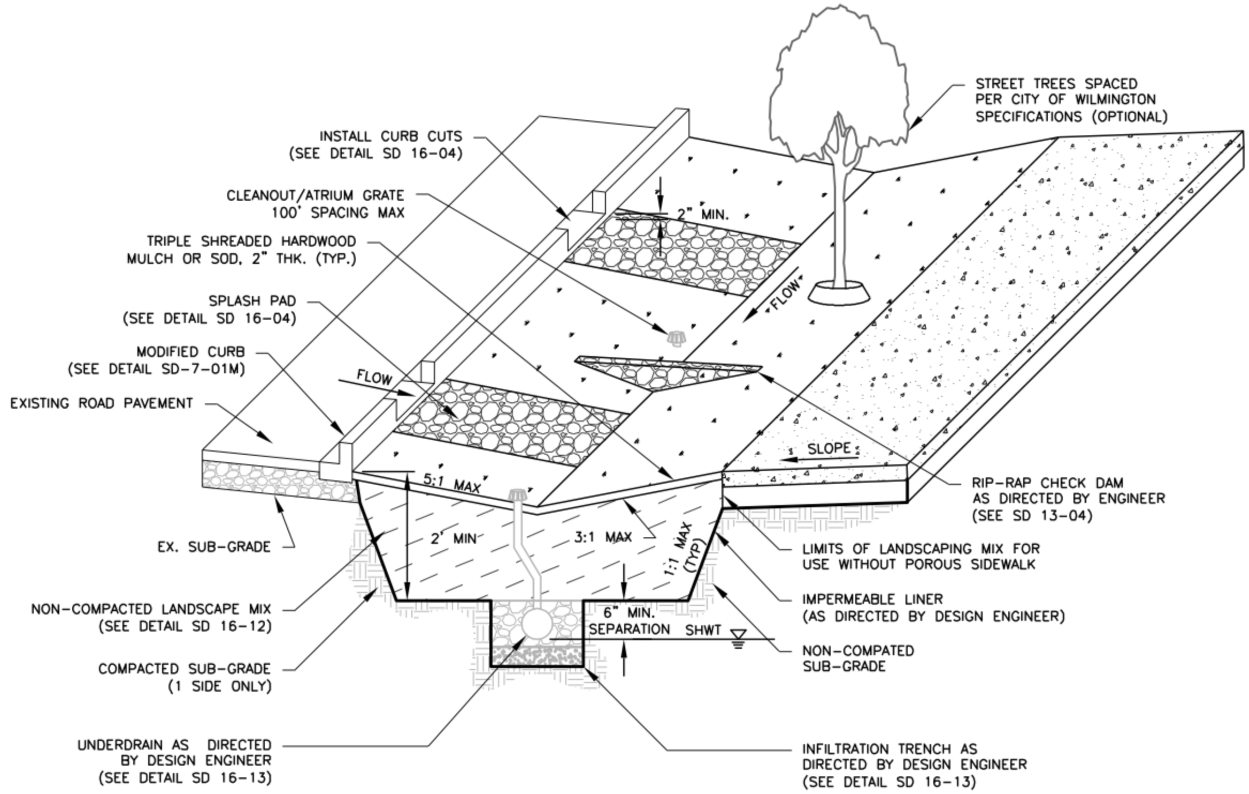


	STANDARD DETAIL	
DATE: 2012	LOCAL "A" & "B" CUL-DE-SAC OPTION "2" ISLAND, RESIDENTIAL (MODIFIED)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 1-13M



NOTES:
1. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
2. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
3. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO ISLAND.
4. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
5. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.
6. DRAINAGE STRUCTURE MAY BE REQUIRED TO PREVENT FLOODING DURING LARGE STORMS.

	STANDARD DETAIL	
DATE: 2012	STORMWATER ISLAND CROSS SECTION	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-15



NOTES:

1. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
2. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
3. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
4. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
5. USE THE RAISED AREAS OF NEAR TREE PLANTINGS AS A BARRIER TO ENCOURAGE SHALLOW PONDING.
6. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
7. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE GUTTER LINE.
8. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
9. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.

STANDARD DETAIL

DATE: 2012

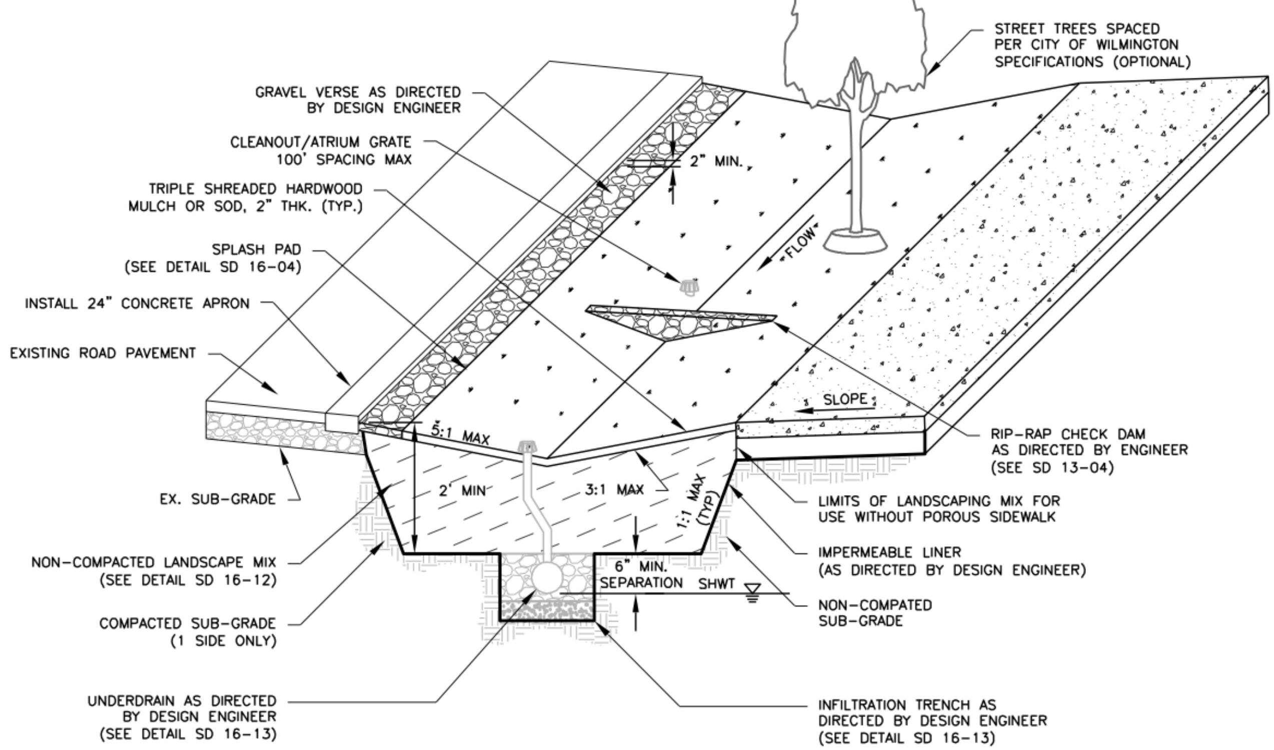
DRAWN BY TLM

CHECKED BY HCF

SCALE NOT TO SCALE

SIDEWALK SWALE WITH CURB & GUTTER

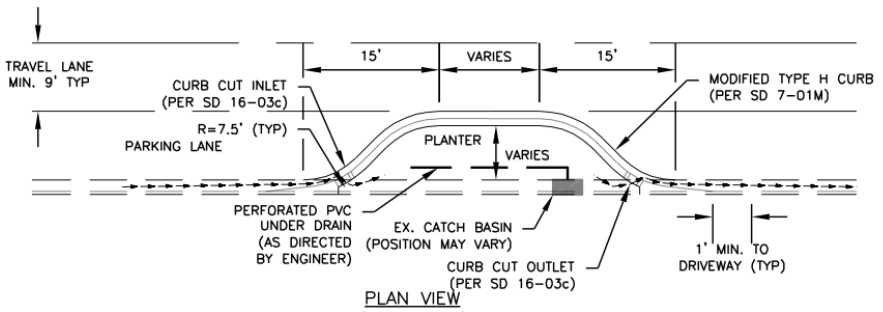
SD 16-01



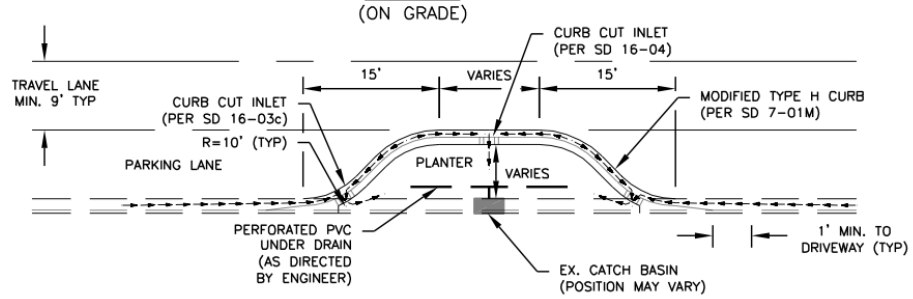
NOTES:

1. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
2. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
3. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
4. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
5. USE THE RAISED AREAS OF NEAR TREE PLANTINGS AS A BARRIER TO ENCOURAGE SHALLOW PONDING.
6. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE CONCRETE APRON TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
7. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE CONCRETE APRON.
8. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
9. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.

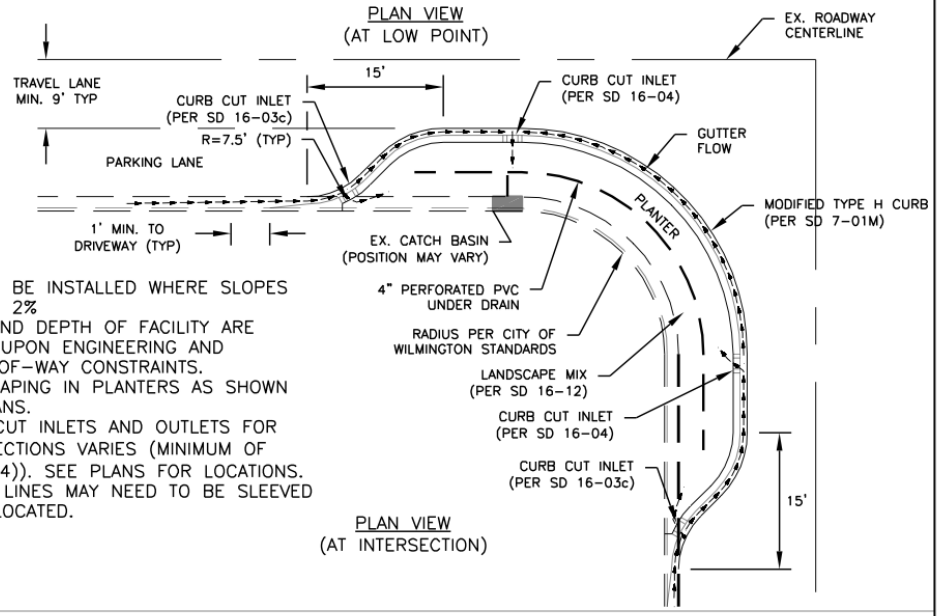
DATE: 2012	STANDARD DETAIL
DRAWN BY TLM	SIDEWALK SWALE WITHOUT CURB & GUTTER
CHECKED BY HCF	
SCALE NOT TO SCALE	SD 16-02



PLAN VIEW
(ON GRADE)



PLAN VIEW
(AT LOW POINT)

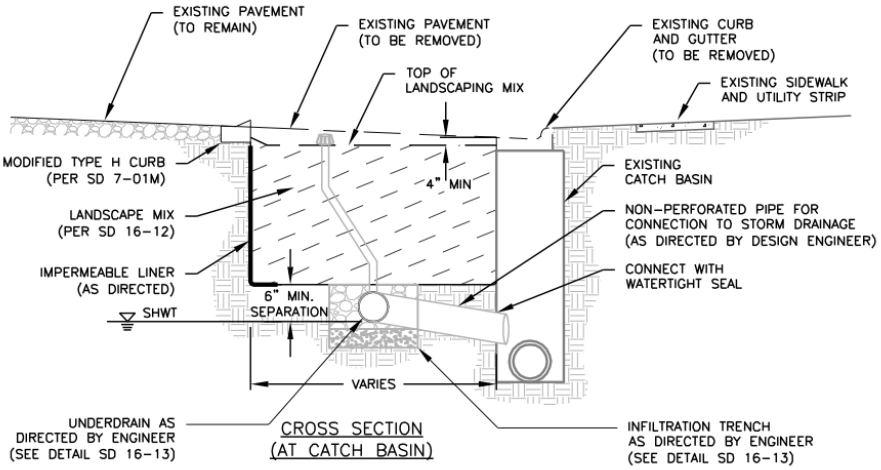


PLAN VIEW
(AT INTERSECTION)

NOTES:

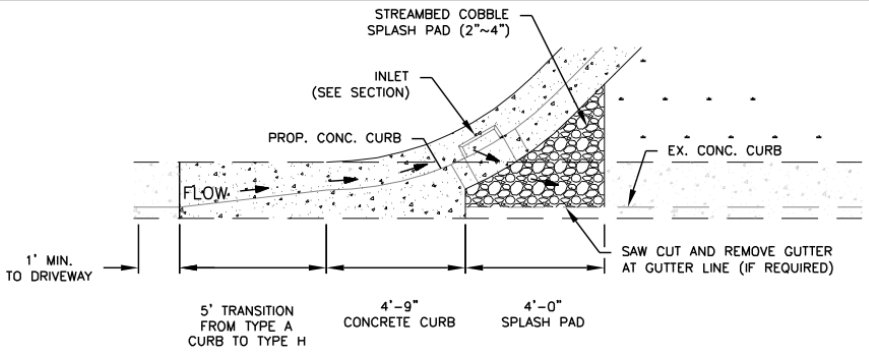
1. NOT TO BE INSTALLED WHERE SLOPES EXCEED 2%
2. AREA AND DEPTH OF FACILITY ARE BASED UPON ENGINEERING AND RIGHT-OF-WAY CONSTRAINTS. LANDSCAPING IN PLANTERS AS SHOWN ON PLANS.
3. CURB CUT INLETS AND OUTLETS FOR INTERSECTIONS VARIES (MINIMUM OF FOUR (4)). SEE PLANS FOR LOCATIONS.
4. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.

	STANDARD DETAIL	
DATE: 2012	CURB EXTENSION (1 OF 3)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-03a

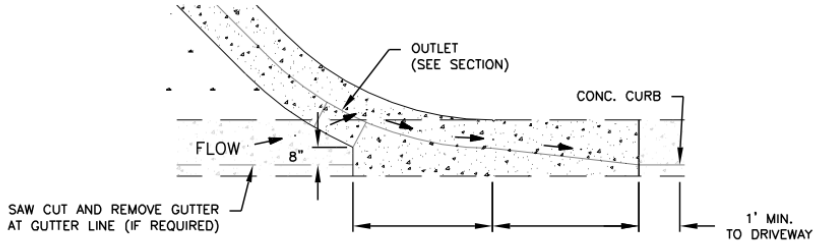


NOTES:
SOIL TESTING REQUIRED WHEN NOT USING UNDERDRAIN

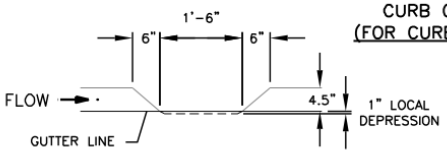
	STANDARD DETAIL	
DATE: 2012	CURB EXTENSION (2 OF 3)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-03b



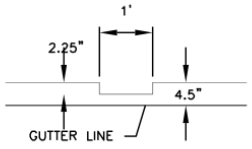
CURB CUT INLET
(FOR CURB EXTENSIONS)
NTS



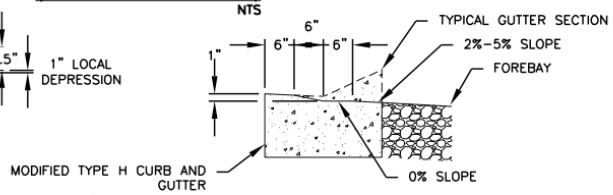
CURB CUT OUTLET
(FOR CURB EXTENSIONS)
NTS



INLET SECTION
NTS



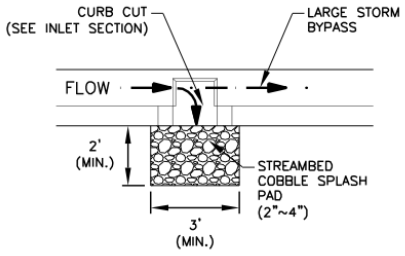
OUTLET SECTION
NTS



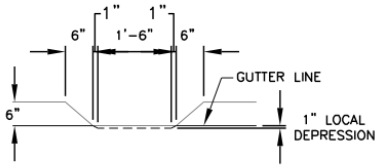
CURB CUT INLET PROFILE
NTS

NOTES:
1. TO PREVENT PONDING, POSITION INLET CLOSER TO EXISTING CURB IF THE STREET CROSS-SLOPE IS >2%. ADDITIONAL INLETS CAN BE ADDED AS APPROVED BY THE CITY OF WILMINGTON.

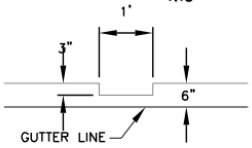
	STANDARD DETAIL	
DATE: 2012	CURB EXTENSION (3 OF 3)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-03c



CURB CUT INLET PLAN
NTS



INLET SECTION
NTS



OUTLET SECTION
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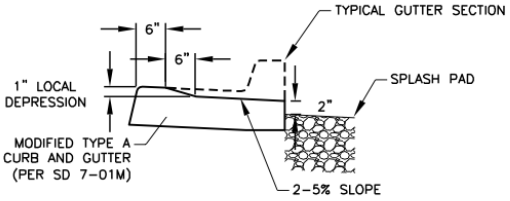
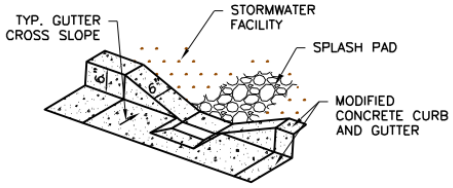
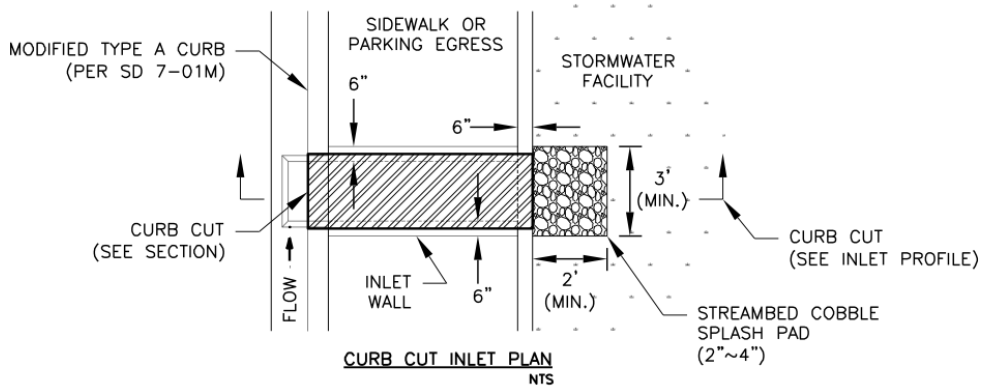


CURB CUT INLET PROFILE
NTS

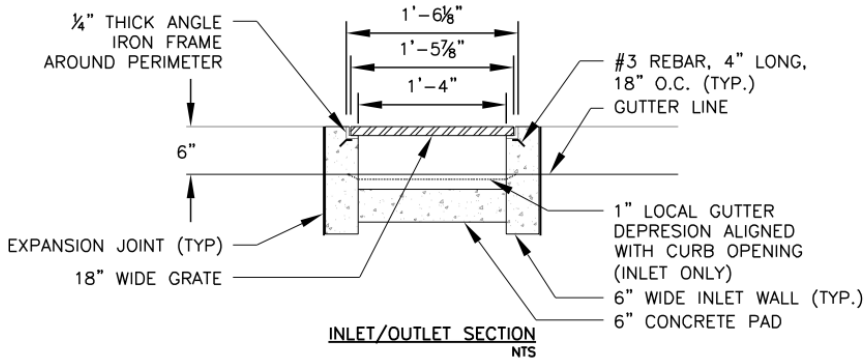


ISOMETRIC VIEW
NTS

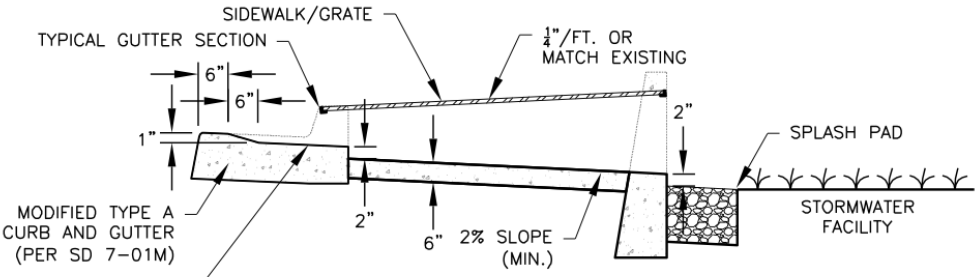
	STANDARD DETAIL	
DATE: 2012	CURB CUTS (GENERAL)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-04



CURB CUT INLET PLAN
NTS

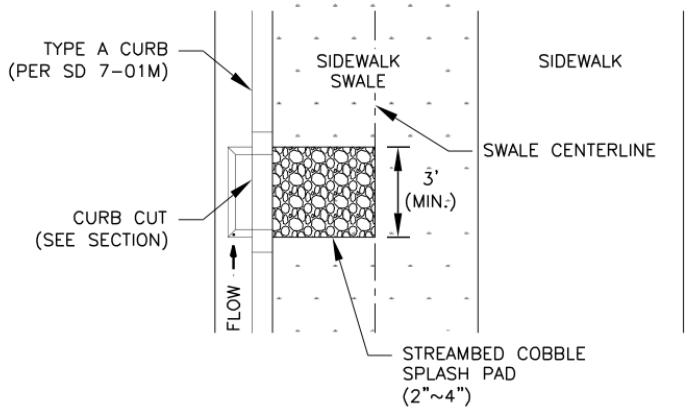


INLET/OUTLET SECTION
NTS

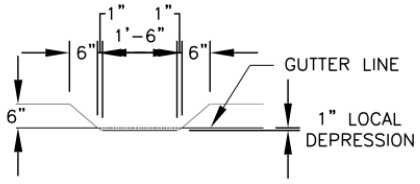


CURB CUT INLET PROFILE
NTS

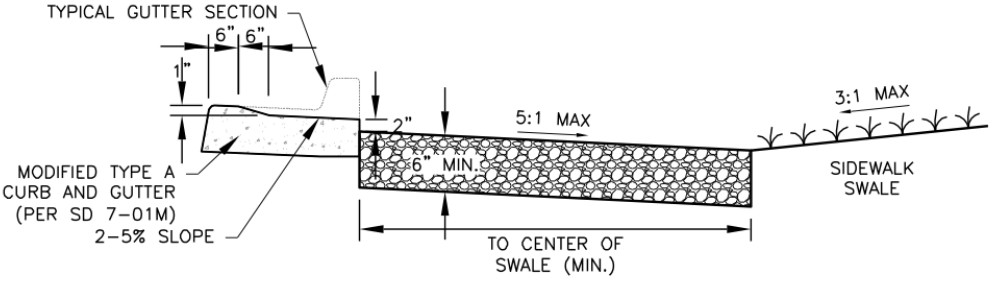
	STANDARD DETAIL	
DATE: 2012	CURB CUTS (CHANNEL AND GRATE)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-05



CURB CUT INLET PLAN
NTS

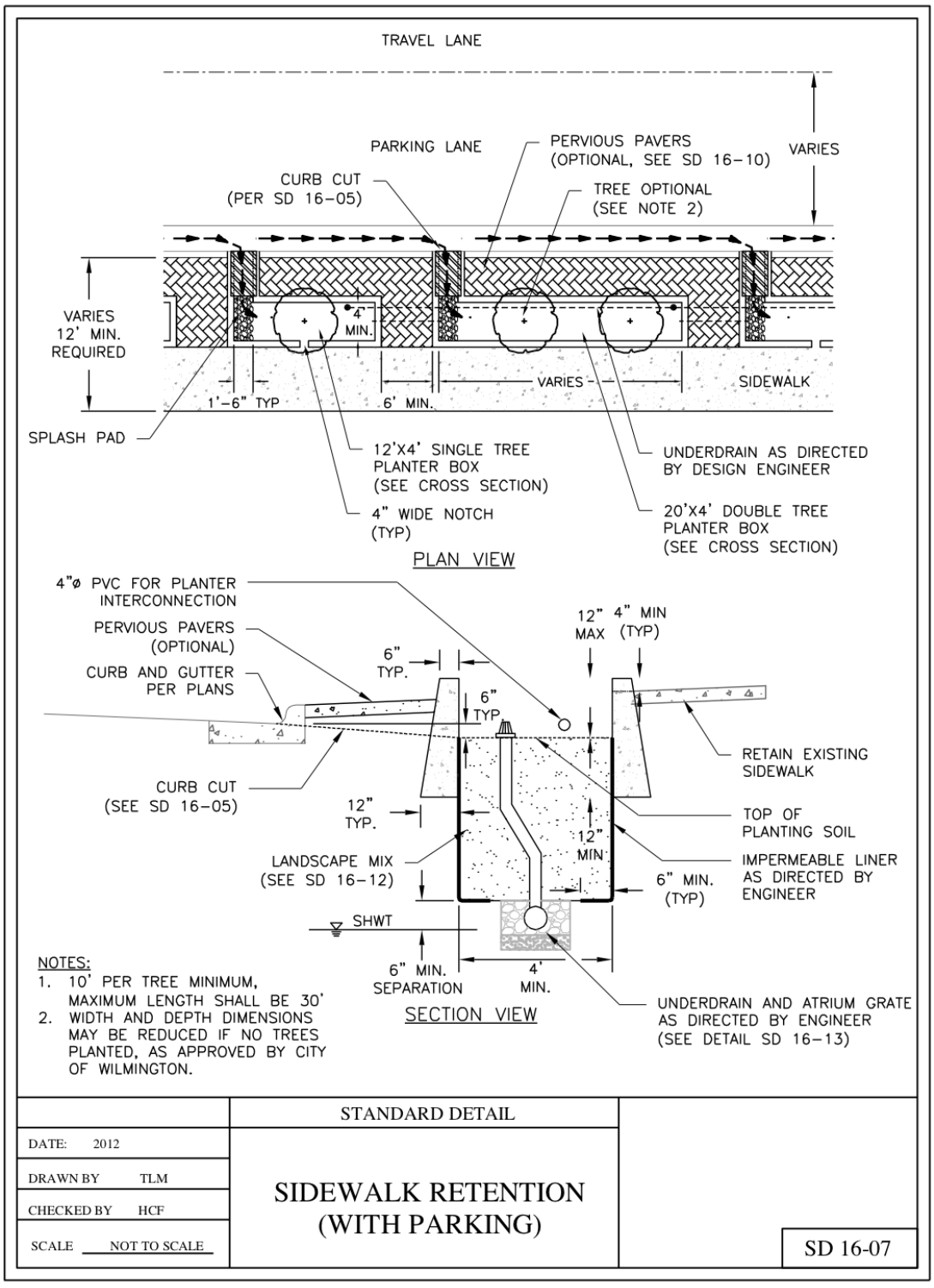


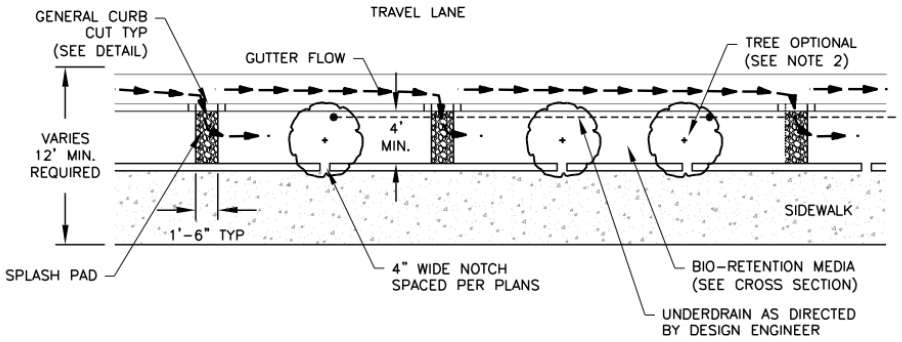
INLET SECTION
NTS



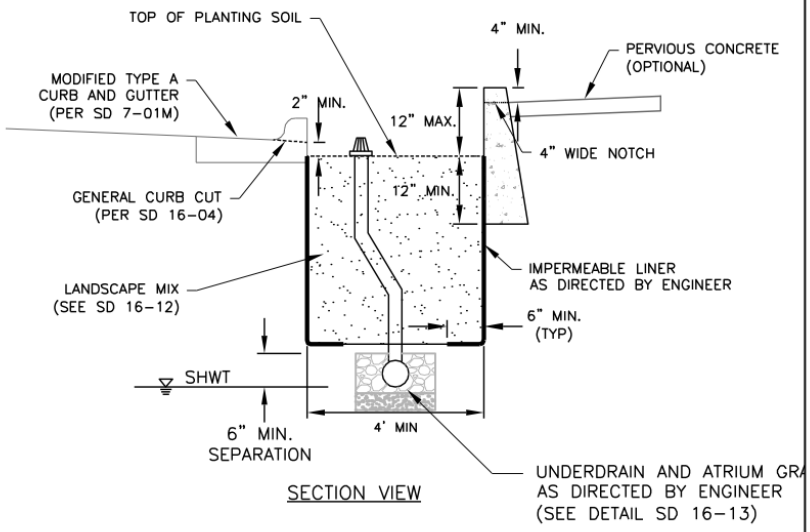
CURB CUT INLET PROFILE
NTS

	STANDARD DETAIL	
DATE: 2012	CURB CUTS (CHANNEL AND GRATE)	SD 16-06
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		


TRAVEL LANE
PARKING LANE
PERVIOUS PAVERS
(OPTIONAL, SEE SD 16-10)
VARIES
CURB CUT
(PER SD 16-05)
TREE OPTIONAL
(SEE NOTE 2)
VARIES
12' MIN.
REQUIRED
4'
MIN.
1'-6" TYP
6' MIN.
VARIES
SIDEWALK
SPLASH PAD
12'X4' SINGLE TREE
PLANTER BOX
(SEE CROSS SECTION)
4" WIDE NOTCH
(TYP)
UNDERDRAIN AS DIRECTED
BY DESIGN ENGINEER
20'X4' DOUBLE TREE
PLANTER BOX
(SEE CROSS SECTION)
PLAN VIEW
4"ø PVC FOR PLANTER
INTERCONNECTION
PERVIOUS PAVERS
(OPTIONAL)
CURB AND GUTTER
PER PLANS
6"
TYP.
6"
TYP
12" 4" MIN
MAX (TYP)
RETAIN EXISTING
SIDEWALK
CURB CUT
(SEE SD 16-05)
12"
TYP.
TOP OF
PLANTING SOIL
12"
MIN
LANDSCAPE MIX
(SEE SD 16-12)
IMPERMEABLE LINER
AS DIRECTED BY
ENGINEER
6" MIN.
(TYP)
SHWT
6" MIN.
SEPARATION
4'
MIN.
SECTION VIEW
UNDERDRAIN AND ATRIUM GRATE
AS DIRECTED BY ENGINEER
(SEE DETAIL SD 16-13)
NOTES:
1. 10' PER TREE MINIMUM,
MAXIMUM LENGTH SHALL BE 30'
2. WIDTH AND DEPTH DIMENSIONS
MAY BE REDUCED IF NO TREES
PLANTED, AS APPROVED BY CITY
OF WILMINGTON.
STANDARD DETAIL
DATE: 2012
DRAWN BY TLM
CHECKED BY HCF
SCALE NOT TO SCALE
SIDEWALK RETENTION
(WITH PARKING)
SD 16-07



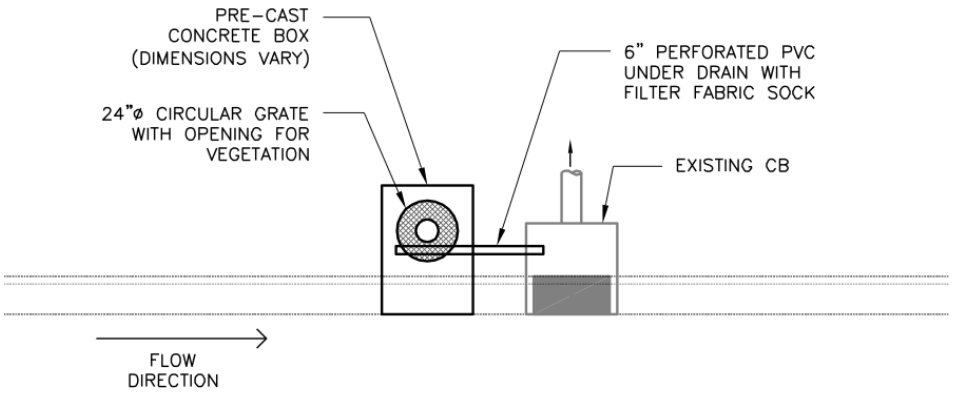
PLAN VIEW

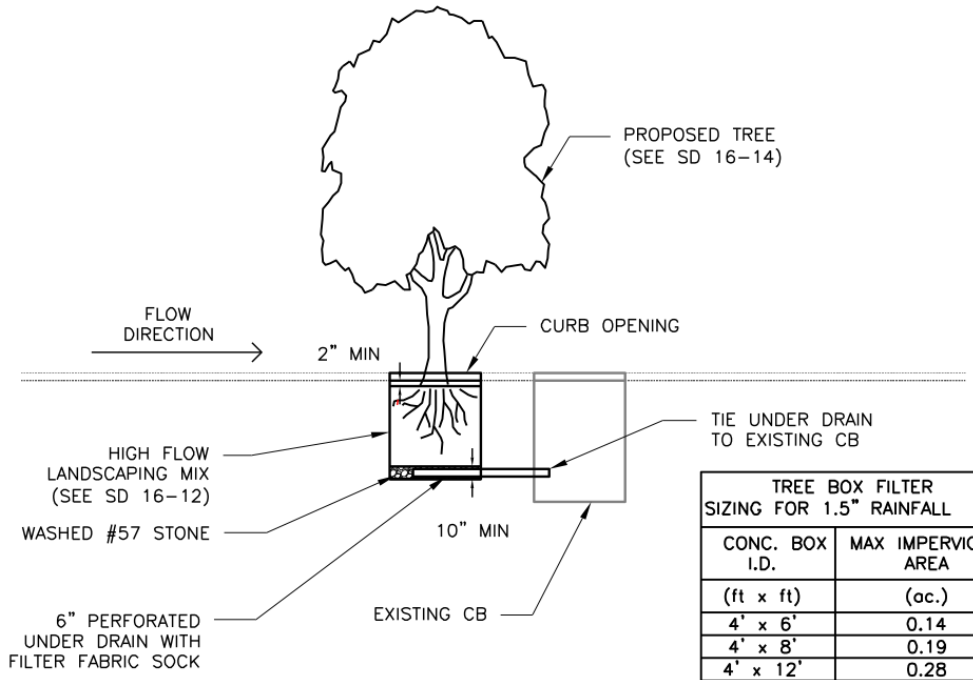


SECTION VIEW

NOTES:
1. 10' PER TREE MINIMUM, MAXIMUM LENGTH SHALL BE 30'
2. WIDTH AND DEPTH DIMENSIONS MAY BE REDUCED IF NO TREES PLANTED, AS APPROVED BY CITY OF WILMINGTON.

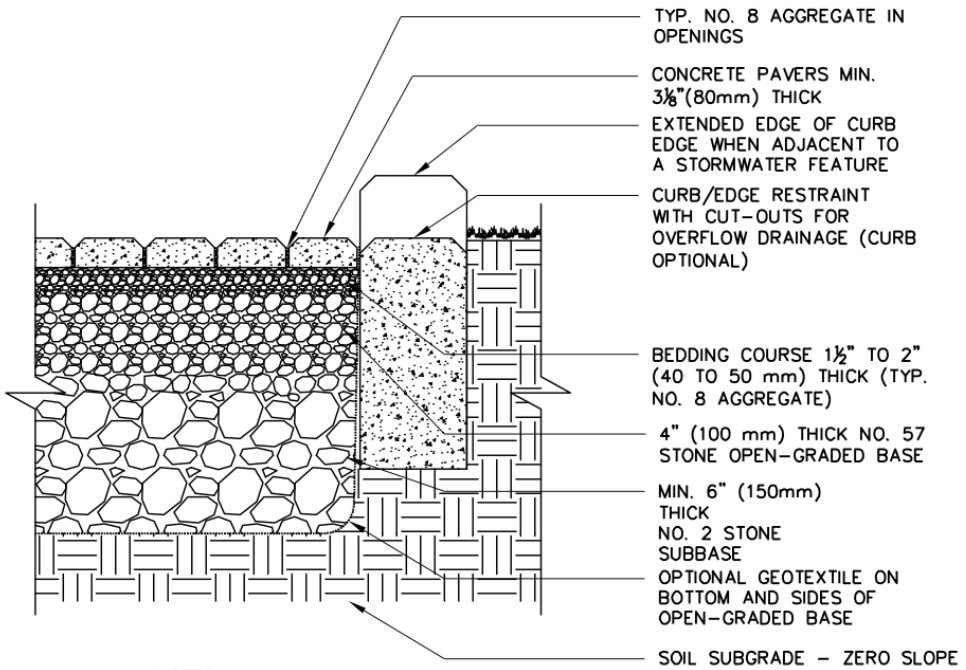
	STANDARD DETAIL	
DATE: 2012	SIDEWALK RETENTION (WITHOUT PARKING)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-08





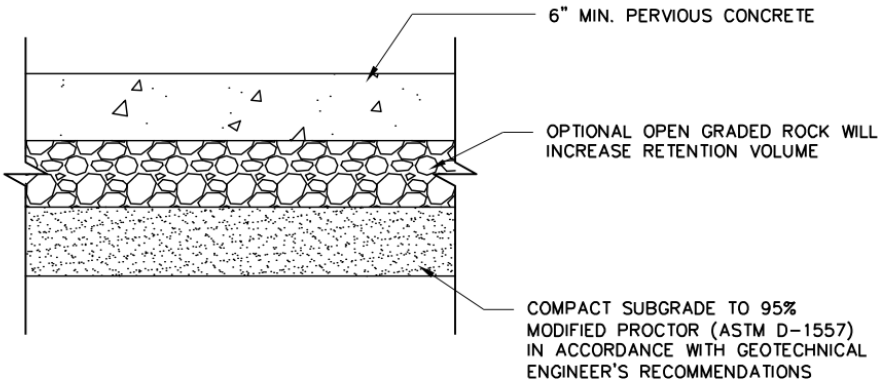
TREE BOX FILTER SIZING FOR 1.5" RAINFALL	
CONC. BOX I.D.	MAX IMPERVIOUS AREA
(ft x ft)	(ac.)
4' x 6'	0.14
4' x 8'	0.19
4' x 12'	0.28
6' x 6'	0.21
6' x 8'	0.28
6' x 10'	0.35
6' x 12'	0.42
7' x 13'	0.54

	STANDARD DETAIL	
DATE: 2012	STANDARD URBAN TREE PLANTER BOX	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-09



NOTES:
1. 2⅜" (60mm) THICK PAVERS MAY BE USED IN PEDESTRIAN APPLICATIONS.
2. NO. 2 STONE SUBBASE THICKNESS VARIES WITH DESIGN. CONSULT ICPI PERMEABLE INTERLOCKING CONCRETE PAVEMENT MANUAL.
3. CURB EDGE MAY EXTEND 6" ABOVE GRADE WHEN ADJACENT TO STORMWATER FEATURE.

	STANDARD DETAIL	
DATE: 2012	STANDARD POROUS PAVERS	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-10



	STANDARD DETAIL	
DATE: 2012	STANDARD POROUS CONCRETE	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-11

NATURAL SOIL INFILTRATION

IN-SITU INFILTRATION MEDIA SHALL MEET THE REQUIREMENTS FOR INFILTRATION SYSTEMS AS DEFINED BY NCDWQ IN THE CURRENT VERSION OF THE BMP MANUAL. SOIL TESTS SHALL BE COMPLETED AND SUBMITTED WITH THE DESIGNS TO CONFIRM COMPLIANCE WITH THE SEPCIFICATIONS.

IN SITU SOIL SHALL MEET THE FOLLOWING SPECIFICATIONS

1. INFILTRATION RATE SHALL EXCEED 0.52 IN/HR, >3 IN/HR PREFERRED
2. P INDEX SHALL BE BETWEEN 10 AND 30
3. PARTICLE SIZE DISTRIBUTON
   a. COARSE / VERY COARSE SAND 70% TO 80%
   b. GRAVEL 10% TO 20%
   c. CLAY / SILTS < 10%
4. SOIL SHALL BE FREE OF CONTAMINATION FROM HEAVY METALS
5. SEASONAL HIGH WATER ELEVATION SHALL BE AT LEAST 2' BELOW FINISHED SURFACE
6. AREAS USED FOR EROSION CONTROL SHALL BE CLEANED OF ALL ACCUMULATED SILTS, FINES, SEDIMENTS, AND DEBRIS PRIOR TO CONVERSION

LOW FLOW MEDIA MIXES

FOR INSTALLATIONS REQUIRING ENGINEERED MEDIA WITH INFILTRATION RATES BETWEEN 0.52 IN/HR AND 10 IN/HR, THE GENERAL STANDARDS OF "BIORETENTION MIX" AS DEFINED IN THE CURRENT VERSION OF THE NCDWQ BMP MANUAL SHALL APPLY.

THE ENGINEER SHALL PROVIDE SOILS SAMPLES, AND RESULTS OF LABORATORY SOIL TESTS DOCUMENTING COMPLIANCE WITH THE SOIL SPECIFICATIONS PRIOR TO FINAL PROJECT APPROVAL.

HIGH FLOW MEDIA MIXES

FOR URBAN INSTALLATIONS OR OTHER INSTALLATIONS WHERE HIGHER INFILTRATION RATES ARE NECESSARY, ENGINEERED HIGH FLOW MEDIA MIXES MAY BE REQUIRED. HIGH FLOW FILTER MEDIA IS SPECIALLY DESIGNED TO OPTIMIZE THE CAPTURE AND REMOVAL OF NUTRIENTS FROM URBAN RUNOFF THROUGH THE USE OF A HIGH PERFORMANCE PEAT / SAND FILTER MEDIA. THE MEDIA SUPPORTS MICROBIOLOGICAL ACTIVITY THAT CAPTURES NUTRIENTS FROM STORMWATER RUNOFF TO SUPPORT PLANT LIFE WHILE ALLOWING RUNOFF TO FLOW THROUGH THE MEDIA LAYERS AT A HIGH RATE.

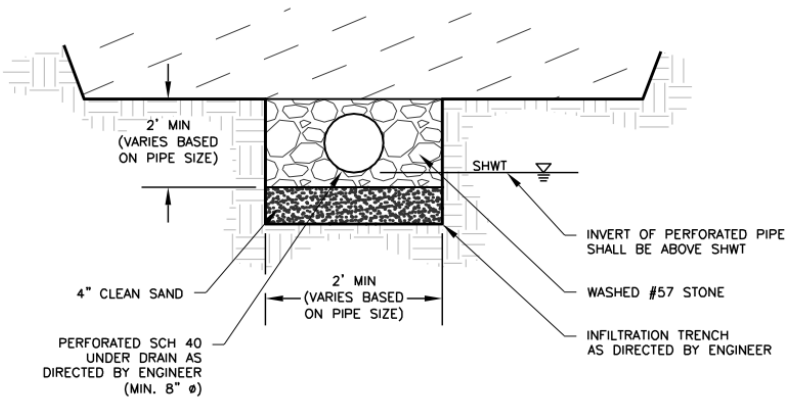
ENGINEERED HIGH FLOW MEDIA SHALL MEET THE FOLLOWING SPECIFICATIONS

1. PEAT MOSS 15% BY VOLUME
   a. LISTED BY ORGANIC MATERIALS REVIEW INSTITUTE
   b. 100% NATURAL PEAT (NO COMPOSTED, SLUDGE, YARD OR LEAF WASTE)
   c. TOTAL CARBON >85%
   d. CARBON TO NITROGEN RATIO 15:1 TO 23:1
   e. LIGNIN CONTENT 49% TO 52%
   f. HUMIC ACID >18%
   g. PH 6.0 TO 7.0
   h. MOISTURE CONTENT 30% TO 50%
   i. 95% TO 100% PASSING 2.0MM SIEVE
   j. > 80% PASSING 1.0MM SIEVE

2. POLLUTANT REMOVAL MINIMAL PERFORMANCE
   a. TSS 80%
   b. TOTAL NITROGEN 43%
   c. HEAVY METALS 58-82%
   d. PHOSPHORUS 50 %
   e. BACTERIA > 95%

3. GENERAL SAND PARTICLE SIZE DISTRIBUTION NECESSARY TO SUPPORT FLOW RATES OF > 50INCHES / HOUR AT THE TIME OF INITIAL INSTALLATION.
   a. SAND - FINE <5%
   b. SAND - MEDIUM 10%- 15%
   c. SAND - COARSE 15% TO 25%
   d. SAND - VERY COARSE 40 % TO 45%
   e. GRAVEL 10% TO 20%
   f. CLAY / SILTS < 2%

	STANDARD DETAIL	
DATE: 2012	LANDSCAPE MIX SPECIFICATIONS	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-12



	STANDARD DETAIL	
DATE: 2012	STANDARD UNDERDRAIN AND TRENCH	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-13

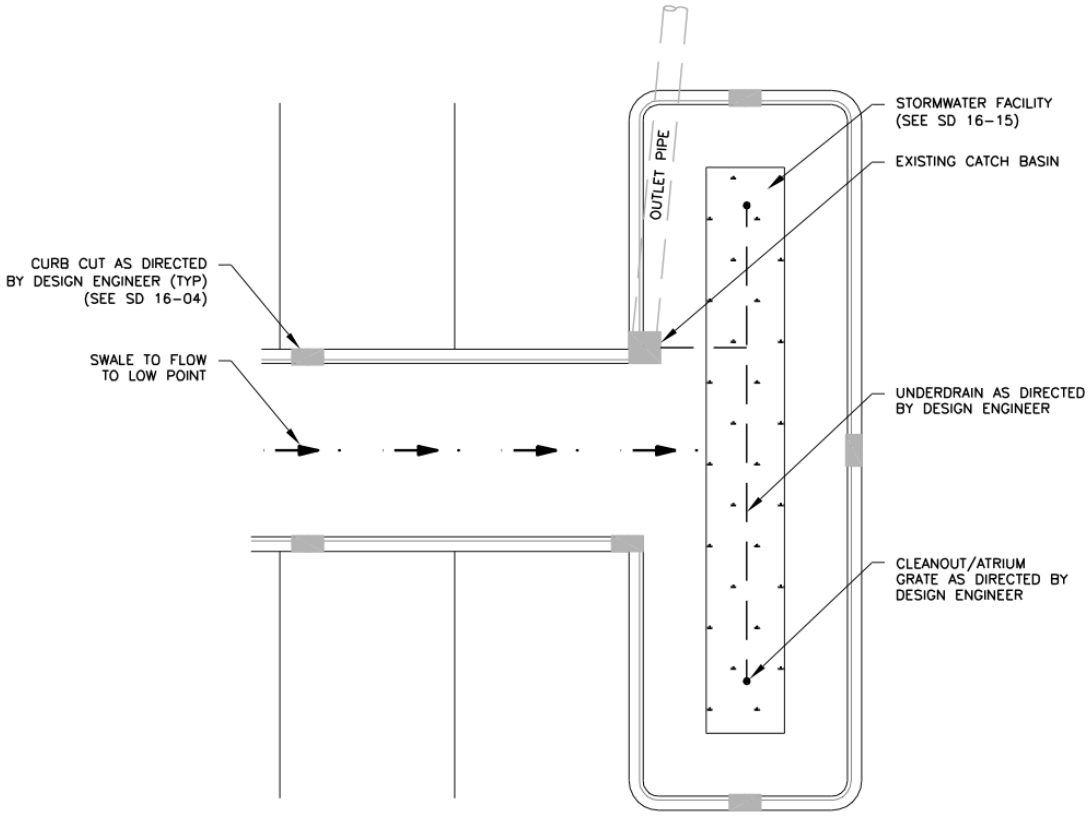
RECOMMENDED PLANTS LIST FOR ALL STORMWATER DETAILS:

SCIENTIFIC NAME	COMMON NAME
CERCIS CANADENSIS	RED BUD
CORNUS FLORIDA	DOGWOOD
ILEX ATTENUATA	FOSTER'S HOLLY
ILEX VOMITORIA	YAUPON HOLLY
LAGERSTROEMIA INDICA	CRAPE MYRTLE
MAGNOLIA SOULANGIANA	SAUCER MAGNOLIA
MAGNOLIA STELLATA	STAR MAGNOLIA
NYSSA SYLVATICA	BLACK GUM
TAXODIUM DISTICHUM	BALD CYPRESS

NOTE:

OTHER PLANTS, INCLUDING TREES, SHRUBS, AND GROUND COVERS, MAY BE PERMITTED ON A CASE BY CASE BASIS AS APPROVED BY CITY STAFF.

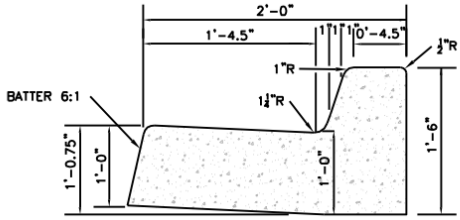
	STANDARD DETAIL	
DATE: 2012	RECOMMENDED STORMWATER PLANTING LIST	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-14



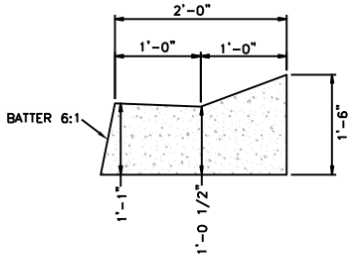
NOTES:

1. DESIGN ENGINEER TO PROVIDE DIMENSIONS OF ISLANDS.
2. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
3. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
4. MAXIMUM PONDING DEPTH SHALL BE 6".
5. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
6. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
7. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
8. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE GUTTER LINE.
9. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
10. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.

	STANDARD DETAIL	
DATE: 2012	STORMWATER PARKING ISLAND	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-16



MODIFIED TYPE "A" CURB AND GUTTER



MODIFIED TYPE "H" CURB AND GUTTER

NOTES:
1. MODIFIED CURB AND GUTTER TO BE USED WHEN ADJACENT TO SURFACE STORMWATER FACILITIES.
2. CURB EXPOSURE IS 6". VARY ONLY AS SHOWN ON PLANS OR AS APPROVED.

	STANDARD DETAIL	
DATE: 2012	MODIFIED CURB AND GUTTER TYPES "A" AND "H"	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 7-01M