The North Carolina Coastal Federation

Watershed Restoration Planning Guidebook

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North Carolina
Coastal Federation
Working Together for a Healthy Coast

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INTRODUCTION

PURPOSE OF THIS GUIDEBOOK

North Carolina is known for its pristine waters and beautiful beaches. Yet, 2,446,218 acres of marshes, sounds and lakes in the state, and 2,222,694 acres of coastal shellfish and swimming waters are listed as legally impaired on the EPA 303(d) list due to bacteria in runoff pollution. That accounts for over 98 square miles of coastal waters that are closed for their designated uses for the harvest of shellfish, and in need of restoration. This problem is not unique to N.C. and many coastal communities around the United States struggle with the same coastal water quality impairments.

The purpose of this guidebook is to provide clear and detailed guidance for the development of a watershed management plan that aims to replicate the pre-impairment surface water hydrology and thereby improves coastal water quality.

Use of Best Management Practices (BMPs) for stormwater runoff reduction to decrease pollutant loads in coastal watersheds is the focus of this guidebook. Stormwater runoff volume has increased since naturally vegetated landscapes have been made more impervious by land use changes. With an increase in surface runoff volume comes an increase in the amount of bacteria, nutrients, and other pollutants carried into coastal waters. Restoring the natural hydrology can reduce bacteria and pollutant loads, thereby improving coastal water quality.

The methods and philosophy presented in this guidebook were initially developed by the N.C. Coastal Federation to complete and implement three watershed management plans (White Oak River, Lockwood Folly River, and Bradley and Hewlett's Creek) and have been further refined by testing the methodology in three other subwatersheds (Howe Creek, Williston Creek, and Mattamuskeet Drainage Association).

GUIDEBOOK OBJECTIVES

A watershed management plan is used to protect and restore water quality. This guidebook provides detailed instruction for coastal watershed managers to devise a management plan that will:

1. Establish long-term goals for improving or protecting coastal waters and subwatersheds;
2. Develop strategies to accomplish these goals;
3. Ensure stakeholder participation;
4. Identify and analyze pollutant characteristics;
5. Measure water quality goals; and
6. Result in management measures to meet the desired objectives.

HOW TO USE YOUR PLAN IN LIEU OF A TMDL

When surface waters no longer comply with assigned water quality classifications and standards, the federal Clean Water Act (CWA) mandates that steps be taken to remove the water quality

impairment and restore water quality to acceptable levels. This normally involves conducting a Total Maximum Daily Load (TMDL) study to determine how much pollutant loads should be reduced to restore water quality. Once the TMDL is completed, then a watershed restoration plan is devised to accomplish the desired reductions in pollutant loads.

TMDL studies typically cost many thousands of dollars and can take several years to complete. For many coastal subwatersheds where pollution is caused by stormwater runoff and not discharges of industrial or domestic wastewater, scientific monitoring has shown repeatedly that altered watershed hydrology creates additional surface runoff that then washes bacteria into downstream coastal waters. This methodology allows managers to estimate how much additional surface runoff has been created as a result of hydrologic modifications, and establishes a numerical goal for how much runoff must be reduced to restore impaired water quality. This numerical volume reduction goal, which forms the basis for a watershed management plan, can serve in lieu of preparing a TMDL where there are ample water quality monitoring data and documentation of the relationships among: intensity of land uses, greater hydrologic modifications, and increasing bacteria levels.

The TMDLs and watershed management plans for the Lockwoods Folly and White Oak Rivers were approved by EPA and N.C. Department of Environmental and Natural Resources (DENR). These plans provided guidance for the City of Wilmington to follow in developing the Bradley and Hewletts Creeks Watershed Management Plan, which was approved by the DENR to serve in lieu of a mandatory TMDL. This voluntary plan gives the city time to accomplish restoration efforts without facing a legal mandate from EPA. This guidebook provides step-by-step instructions for how to devise volume-based TMDLs and/or a watershed management plan. The methods outlined can be used to satisfy mandatory requirements in coastal watersheds for a TMDL, or to devise a watershed management plan that will serve as a voluntary effort to address water quality impairments.

OTHER USES OF THIS GUIDEBOOK

In areas where a TMDL assessment has already been completed or will be performed, a watershed management plan can complement restoration efforts. A watershed management plan can present strategies to control non-point source pollution that is not readily addressed through the TMDL process.

Plans developed according to this guidebook can also be effective in improving water quality in areas that are not considered legally impaired. These are areas where one or more uses for the water (e.g., shellfish or swimming) did not exist when the Antidegradation Policy pursuant to the federal Clean Water Act was established in 1975 (see Chapter 2). If waters are not legally impaired, there may be no state or federal requirements to improve water quality. However, a community may want to establish or regain uses of these waters and may do so by constructing a plan according to the guidance provided herein.

HOW THIS GUIDE COMPARES TO THE EPA WATERSHED HANDBOOK

Many elements of this guidebook were adapted from the EPA Handbook for Developing Watershed Plans to Restore and Protect Our Water. Similarities and differences include:

1. This guidebook concentrates specifically on coastal subwatersheds with swimming and shellfish water quality impairments.

This allows implementation of management strategies tailored to the differing land use patterns and natural hydrology of coastal area. By having a small project scope, in many cases even smaller than the 12-digit Hydrologic Unit Code (HUC) *subwatersheds*, planning efforts can become more focused and more easily implemented.

2. Instead of attempting to eliminate sources of bacteria, the methods in this guidebook seek to reduce the transport of bacteria by reducing the volume of surface runoff.

Previous projects that tested these methods, including those on the White Oak River, Lockwood Folly River, and Hewlett and Bradley Creeks, show that one of the best ways to restore coastal water quality is to mimic natural hydrology and to reduce the overall rate and volume of stormwater runoff. This technique reduces the overall pollutant loads deposited into watersheds. This guide helps set volume reduction goals and develop management strategies for meeting those goals in order to improve water quality. This is effective because impairment of waters is predominantly due to the alteration of hydrology within these very small watersheds.

3. Following the methodology outlined in this guidebook will ensure your plan incorporates all nine elements of a watershed management plan as required by EPA as necessary to qualify for 319 funding that is used to restore impaired waters.

Incorporation of these nine elements will increase the likelihood that your plan can serve in lieu of a TMDL. The EPA's nine minimum elements will be discussed frequently throughout this guidebook, and include:

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.
2. An estimate of the load reductions expected from management measures.
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.
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.
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.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
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.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the established criteria.

Purpose of Targeting Small Coastal Watersheds

Although this guidebook is designed to be adaptable for use in any coastal watershed, it focuses on devising management plans for watersheds that flow directly into shellfish or swimming waters. These are small drainage areas that are usually much smaller than the 12-digit HUC watersheds that are typically used in watershed planning. Planning on this very small watershed scale allows local leaders to influence change in their area through feasible community-level actions. These small-scale and frequently low-cost actions can have significant positive benefits for the community, including the reopening of closed shellfish waters and a reduction in the frequency of swimming advisories issued for local waters.

Adapting This Guidebook to Your Watershed

While this guidebook is tailored to N.C. coastal subwatersheds, it can easily be used to create a watershed management plan in any coastal watershed throughout the nation where impairments are the result of polluted runoff. The partners and agencies mentioned in this document may not be directly relevant to states outside of N.C., but they can act as suggestions for where to look to find similar information.

There are a handful of state-specific guidebooks that include these elements, so be sure to check if your state already has a planning guidebook. This guidebook provides N.C. specific resources, organizations, and data sources to ease the planning process. A successful and effective watershed restoration plan will include, at minimum, the EPA's nine components but should also include the critical other steps outline in the nine chapters. It is important to revisit the steps throughout the planning, implementation, and evaluation process, always with the intent of improving the project and achieving restoration goals.

Extensive Water Quality Monitoring Eases Planning Efforts in Coastal N.C.

In N.C., the Shellfish Sanitation and Recreational Water Quality Section (Shellfish Sanitation) 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 Section monitors bacterial water quality conditions at over a thousand of stations for shellfishing and 240 stations for swimming. In addition, every three years Section staff walk the entire shoreline of shellfish growing areas to document current and potential pollution sources during their shoreline survey. The data resources available on the N.C. coast give managers and planners excellent information to affect change without the need for extensive data collection and monitoring.

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ACRONYMS, ABBREVIATIONS AND GLOSSARY

319	A grant program funded by EPA and administered by DENR to study impaired waters.
AEC	Area of Environmental Concern
APNEP	Albemarle Pamlico National Estuary Program
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 through the use of vegetated depressions engineered to collect, store, and infiltrate runoff.
BMP	Best Management Practice
CFU	Colony Forming Unit used to measure fecal coliform concentrations.
CONDITIONALLY APPROVED CLOSED	An area subject to predictable intermittent pollution that may be used for harvesting shellfish for direct market purposes when management plan criteria are met generally during drought conditions.
CONDITIONALLY APPROVED OPEN	An area subject to predictable intermittent pollution that may be used for harvesting shellfish for direct market purposes when management plan criteria are met, generally during low rainfall conditions.
CRC	Coastal Resources Commission
CWA	Clean Water Act
DCM	N.C. 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 below).
DENR	N.C. Department of Environment and Natural Resources
DMF	N.C. Division of Marine Fisheries
DOD	Department of Defense
DOT	N.C. Department of Transportation
DENR	N.C. Department of Environment and Natural Resources
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FECAL COLIFORM	Bacteria that originate in the intestines of warm-blooded animals. Bacteria of the coliform group which will produce gas from lactose in a multiple tube procedures liquid medium (EC or A-1) within 24 plus or minus two hours at 44.5 degrees C plus or minus 2 degrees C in a water bath.
FLOW	The volume of water, often measured in cubic feet per second (cfs), flowing in a stream or through a stormwater conveyance system.
GROWING WATERS	Waters that support or could support shellfish life.
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.
HYDROGRAPH	A graph showing changes in the discharge of a surface water river, stream or creek over a period of time.

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	For the purposes of this Guidebook, any saltwater classified for shellfish harvest (SA) that is not managed as an "Approved Area" by the Division of Environmental Health, or any saltwater classified for swimming (SB) 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.
LID	Low Impact Development is integration of site ecological and environmental goals and requirements into all phases of urban planning and design from the individual residential lot level to the entire watershed.
MAXIMUM EXTENT PRACTICABLE	According to EPA, available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purpose.
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PROHIBITED AREA	An area unsuitable for the harvesting of shellfish for direct market purposes.
RETROFITTING	Structural stormwater management measures for urban watersheds 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
SA	Saltwater classified by the EMC for shellfish harvesting. These are waters that should support aquatic life, both primary and secondary recreation (activities with frequent or prolonged skin contact), and shellfishing for market purposes.
SB	Saltwater classified by the EMC for swimming.
SC	Saltwater classified by the EMC 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.
SHELLFISH SANITATION	Shellfish Sanitation and Recreational Water Quality Section, N.C. Division of Marine Fisheries, N.C. DENR. In 2011 the N.C. General Assembly transferred the shellfish and recreational water quality functions of this agency from DEH to DMF.
STORMWATER	Water from rain that flows over the land surface, picking up pollutants that are on the ground.
TMDL	Total maximum daily load.
USGS	United States Geological Survey
WATERSHED	The topographic boundary within which water drains into a particular river, stream, wetland, or body of water.
WQ	Water quality
WQS	Water quality standards

GUIDEBOOK OVERVIEW

This guidebook is separated into three parts and nine chapters that guide you through the watershed planning and implementation process. Part I gives a brief introduction on the purpose of targeting coastal watersheds and explains the logic behind using stormwater runoff volume reduction as a goal for watershed management planning. Part II details the necessary watershed characterization steps necessary before developing the watershed management plan. Part III provides instruction on how to successfully create, implement, and evaluate a watershed management plan. The appendices offer additional resources and worksheets that might be helpful throughout the planning process.

PART I: INTRODUCTION AND BACKGROUND

Chapter 1: Volume Reduction Philosophy discusses the bacteriological source of impairment in coastal N.C. waters and why stormwater volume reduction works to reduce this degradation while traditional solutions do not.

Chapter 2: Regulatory Background and Guidelines gives a brief overview of the Clean Water Act, North Carolina coastal water classifications, and a list of criteria to be included in a watershed management plan.

PART II: STEPS TO DEVELOP A WATERSHED RESTORATION PLAN

Chapter 3: Build Partnerships and Community Support provides guidance on identifying and integrating partners and stakeholders, forming a project team, and building community support through outreach and education.

Chapter 4: Set Planning Goals and Define Your Watershed discusses primary and secondary goals and includes data sources to aid in defining the geographic extent of your watershed.

Chapter 5: Gather Existing Data and Create a Watershed Inventory includes how to obtain data for watershed characterization including data needed to determine base flow and data organization.

Chapter 6: Establish Volume Reduction Goals provides instructions on how to formulate final and interim volume reduction goals by calculating the change in total runoff in your target watershed that has occurred over time due to increasing land use intensity.

Chapter 7: Identify Management Techniques introduces both the theory behind low impact development as well as various LID techniques. Also addresses various factors to consider when evaluating which techniques may be right for your watershed management plan.

PART III: CREATING, FUNDING, AND IMPLEMENTING THE PLAN

Chapter 8: Create the Plan and Implementation Program provides direction for bringing all of the pieces together and developing an implementation schedule in preparation for drafting the plan in Chapter 9. This chapter includes selecting management strategies, criteria for measuring progress, milestones, monitoring. Also in this chapter is a description of how to use partners and stakeholders to identify funding and technical resources required to implement the plan, and addresses the need to constantly evaluate the process.

Chapter 9: Draft the Plan includes instructions for how to organize the watershed management plan based on the volume reduction goals. It will provide a detailed outline of critical information to include in the plan and suggestions for where to incorporate the EPA elements.

APPENDICES

Appendix A: Quick Guide is a checklist of steps for developing a watershed management plan.

Appendix B: Potential Stakeholders provides a list of local, state, and federal organizations and websites that can provide help in your watershed planning effort.

Appendix C: General Info for Identifying and Integrating stakeholders

Appendix D: Additional Outreach Information

Appendix E: Data Resources is an expanded list of online locations to obtain relevant watershed and water quality data.

Appendix F: Bradley and Hewletts Creeks Watershed Management Plan Objectives Table is an example of the above implementation worksheet. This table outlines the six objectives of the plan, along with detailed actions to achieve objectives, partners involved, costs, and an implementation timeline.

Appendix G: "Green Street" Stormwater Management Devices provides example designs of typical stormwater runoff reduction practices that can be used within the public right of way.

Appendix H: About the North Carolina Coastal Federation briefly summarizes the Federation's history and credentials as a coastal N.C. non-profit

TABLE 1-1

Table 1-1. This table shows where we have discussed the six steps of watershed planning outlined in the EPA Handbook for Watershed Planning and where we have included the nine elements of a watershed management plan as required by EPA as necessary to qualify for 319 funding that is used to restore impaired waters.

Guidebook Chapters		**Steps in the EPA Handbook for Watershed Planning**	**Where We Have Included the EPA Nine Minimum Elements**
1	Volume Reduction Philosophy		
2	Regulatory Background and EPA Guidelines		
3	Build Partnerships and Community Support	Build Partnerships	Develop Information and Education Component
4	Define Your Watershed and Set Planning Goals	Characterize the Watershed	Identify Causes and Sources of Pollution that Need to be Controlled
5	Gather Existing Data and Create a Watershed Inventory		
6	Establish Volume Reduction Goals	Set Goals	Determine Load Reductions Needed
7	Identify Management Techniques	Identify Solutions	Develop Management Measures to Achieve Goals
8	Create the Plan and Implementation Program	Design Implementation Plan Implement Watershed Plan Measure Progress and Make Adjustments	Develop Interim Milestones to Track Management Measures
			Develop Criteria to Measure Progress Toward Meeting Watershed Goals
			Identify Technical and Financial Assistance Needed to Implement Plan
			Develop Implementation Schedule
			Develop Monitoring Component
9	Draft the Plan		

1 VOLUME REDUCTION PHILOSOPHY

1.1 CAUSES FOR IMPAIRMENT OF COASTAL WATERS

Coastal areas of N.C. have undergone significant alterations in the last century as land use changes have intensified through the increase in agriculture, forestry, and development. Historically, bacterial degradation of coastal waters was limited as there were very few pathways through which bacteria were transported off the landscape. Before the modification of the coast, nearly all rainwater was absorbed into the ground, evaporated, or was used by vegetation. In the groundwater, natural bacteria were removed while the water slowly moved through the soils and eventually was discharged into coastal waters through groundwater seepage. Traditional land use practices circumvent these natural hydrologic processes by moving water off the landscape as quickly as possible through connected conveyance systems, including ditches, pipes, parking lots, and even yards. The result is that during and after storm events, rainwater passes quickly over the landscape picking up bacteria, nutrients, and other non-point source pollution before flowing directly into coastal waters (Figure 1-1).

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Figure 1-1 Surface runoff increases with intensifying land use (courtesy of the State of Maryland's StormwaterPrint).

1.1.1 Traditional Solutions Are Ineffective

N.C. first established stormwater management rules in 1988. Unfortunately, they did not curtail additional bacteriological pollution from spreading to new waters along the N.C. coast. This was recognized in 2008 by the N.C. Environmental Management Commission (EMC) when more stringent rules were adopted. The new rules increased the amount of stormwater that must be controlled in all 20 coastal counties significantly, especially within one-half mile of SA waters. Practically, this means that to sufficiently protect shellfishing and swimming waters, stormwater management systems in places that were developed prior to or under the old regulations need to be retrofitted to further reduce the amount of polluted runoff that is discharged into coastal waters.

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 include:

1. The two bacteria used as indicators of water quality, fecal coliform and enterococcus, are naturally occurring across the terrestrial landscape. They originate in the feces of warm-blooded animals, such as birds, deer, raccoons and domestic pets. Although prudent measures should be taken to reduce their sources, these efforts alone will not result in satisfactory improvements in coastal water quality as long as unnatural levels of stormwater runoff are occurring after rainfalls.
2. Treating runoff to remove bacteria pollution before it flows into shellfishing and swimming waters is impractical. Although some technology exists for lowering bacteria levels in runoff, it is not able to reduce levels to ensure the pristine water quality necessary to allow shellfish harvest and swimming.

3. Treated runoff can easily be re-contaminated. Because of the ubiquitous nature of bacteria on the landscape, if runoff were to be treated, any that is discharged back on the landscape will simply pick up more bacteria. The result is that treatment is not very successful overall.

1.2 Philosophy Behind Stormwater Volume Reduction

To address the issues of non-point bacterial pollution, rather than focusing on reducing the sources of contamination or attempting to treat and remove bacteria from stormwater runoff, *the management techniques used in this guidebook focus on reducing the overall volume of stormwater runoff so that it does not convey bacteria from the land into coastal waters.* Low Impact Development (LID) practices can achieve this goal by replicating the natural hydrology and increasing infiltration of water into soils. The result is that fewer total bacteria are transported off the land and into coastal waters.

Restoration of natural hydrology leads to fewer bacteria in the estuary due to discharges from the landscape after rainfall. There are several mechanisms through which this occurs, each predicated on both the natural mortality of the bacteria and the reduction in the velocity of waters traveling off the landscape resulting from lower flows. First, infiltration of rainfall into the ground provides extremely effective removal of bacteria before it seeps from the ground into surface waters. This is nature's natural treatment filter, and it can't be beaten in terms of how effectively and cheaply it cleans waters of contaminants. Second, once bacteria are deposited on the landscape they are subject to higher rates of mortality due to the bombardment of solar radiation. Attachment to sediments in water can provide bacteria some protection from these effects. However, by reducing the amount of the water flowing off the landscape, the bacteria spend more time subject to the harsh effects of sunlight. Thus, less living bacteria reach coastal waters. Finally, while enterococci can survive the elevated salinity levels present in estuarine waters, fecal coliform bacteria will perish. This means that, because flow velocity of stormwater is slower off an unmodified or restored landscape, fecal coliform bacteria will reside longer in headwater areas of estuaries and not travel downstream into actual shellfish and swimming waters before they die.

2 Regulatory Background and Guidelines

2.1 Regulatory Background

2.1.1 Clean Water Act

Congress enacted the federal Clean Water Act (CWA) in 1972 to establish "…a basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters" with a purpose of keeping surface waters fishable and swimmable. "Through the CWA, EPA set water quality standards for many contaminants in surface waters as well as established pollution control programs.

The CWA made it illegal to degrade and eliminate "existing uses" of surface waters that were occurring as of November 24, 1975. Along the N.C. coast, existing uses include the ability to harvest shellfish and swim without fear of getting sick from polluted waters. If waters have become

polluted since 1975, *Section 303(d)* of the Clean Water Act requires that they be listed as impaired waters. Once this list is developed, priority rankings for removing the impairments in these waters must be developed, and in many cases total maximum daily loads (TMDLs) of the problem pollutant must be devised. Impaired waters can be found by state and watershed through the EPA TMDL National Summary.

Section 305(b) of the CWA that requires states like North Carolina to prepare a report describing the status of their water quality every two years to inform Congress and the public on the status of the nation's waters. These reports detail specifically which waterbodies have met water quality standards, the extent of any progress made in restoring water quality, and the problems that still need to be addressed. This information can be found through the National Water Quality Report to Congress [305(b) report].

Section 319 of the CWA established the Nonpoint Source Management Program that provides guidance to institute pollution management programs focused on nonpoint source pollution. The program provides grant money to support various activities designed to assess the success of specific nonpoint source management projects. This can include technical and financial assistance, education, training, technology transfer, demonstration projects, and monitoring. Current guidelines and guidance from the EPA can be found here.

2.1.1.1 Impaired Waters

Consistent with the CWA, water quality classifications and standards are set by N.C. and are based on how clean a water body should be *for its existing uses*. A waterbody's existing use is one that has been available since 1975 when the regulation was adopted by the EPA. Water quality criteria are set to protect a water body's existing use and can take three forms: numeric, narrative "free form," or narrative biological. A water body that does not meet the water quality standards for its existing use is considered *impaired*. Impaired waters are included on the 303(d) list.

2.1.1.2 Total Maximum Daily Load (TMDL)

A TMDL is the amount of a given pollutant that a water body can assimilate while meeting its water quality standards. The TMDL is distributed among all current sources (point, nonpoint, and background), a margin of error, and sometimes the potential for future growth. "Typical steps for developing a TMDL include:

1. Identify the problem
2. Identify water quality indicators and target values
3. Identify linkages between water quality problems and pollutant sources.
4. Source assessment
5. Estimate total acceptable loading rate that achieves water quality standards.
6. Allocate acceptable loading rates between sources.
7. Package the TMDL for EPA approval." (From the "Handbook for Developing Watershed Plans to Restore and Protect Our Waters")

States are required to establish TMDLs for all pollutants that prevent waters from attaining water quality goals. The TMDL helps regulators devise the limitation necessary to meet water quality standards by identifying and quantifying the individual sources contributing to a particular water quality problem. Existing TMDL reports for North Carolina waters are found through the North Carolina TMDLs section of the N.C. DENR website.

In 2002, the EPA began to encourage states, territories, and tribes to submit combined 303(d) and 305(b) reports. In these integrated reports, states may use Categories 1-5 to delineate the current stage within the TMDL process. Categories 4 and 5 are considered impaired or threatened, with Category 5 waters being included on the State's 303(d) list. It is possible for waters to be reclassified from Category 5 to 4 and this process is described in section 2.3.

2.1.2 Enforcing the Clean Water Act in N.C.

2.1.2.1 Water Quality Standards and Surface Water Classifications

Water quality standards vary depending on the characteristics and uses of surface waters. DENR maintains a water quality standards book (Redbook) for the state. In N.C., the Shellfish Sanitation and Recreational Water Quality section of the Division of Marine Fisheries monitors coastal water quality and manages closures of shellfish harvesting waters as well as swimming areas such as ocean beaches and estuaries.

In addition to maintaining the State's Redbook, DENR is also responsible for classifying surface waters. Surface water classifications are, with few exceptions, attached to all waterbodies in North Carolina with the purpose of identifying each waterbody's designated use. Classifications may have the intent to protect water quality, fish and wildlife, or other special characteristics and each classification has an associated set of water quality standards that apply to waterbodies carrying that classification. Because the classifications are designed to protect various uses and/or characteristics of a waterbody, some areas may have two or more overlapping classifications. Classifications of individual waterbodies are available on the DENR website.

The shellfish harvesting water quality standard is stricter than the standards used to issue swimming advisories because shellfish, which are often eaten raw, are filter feeders that concentrate bacteria present in the water column.

Classification Keys

Table 2-1. North Carolina surface water classifications and short descriptions. Full descriptions available on DENR website.

Primary Classifications	
SC:	Aquatic Life, Secondary Recreation, Salt Water
SB:	Primary Recreation, Salt Water
SA:	Market Shellfishing, Salt Water
SWL	Wetlands, Salt Water
Supplemental 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)

Table 2-2. Classifications used by N.C. Shellfish Sanitation for shellfish harvesting waters.

N.C. 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.

Bacteriological Water Quality Standards

Shellfishing

As stated in the rules and regulations to be approved as an area of harvest for direct consumption the following criteria must be met:

(1) the shoreline survey has indicated that there is 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)

According to the rules and regulations, the following standards apply to coastal N.C. 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

2.2 EPA Guidance for Watershed Plans

The "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," released by the EPA in March of 2008 details various guidelines and *nine minimum components* that watershed plans must contain in order to receive federal funding for the plan implementation. Although the EPA handbook targets watershed-based planning, the guidance provided is directly applicable to the creation and implementation of a watershed plan.

2.2.1 Creating a Plan for a Watershed without a TMDL

While TMDLs are valuable tools to employ when setting goals in your watershed plan, they are not a required element of watershed management plans. If there are not TMDLs for your watershed, it is important to design the management plan to accomplish water quality standards as well as environmental goals. This means that the plan should include sources of water quality impairment as well as specific pollutants and their sources. If the plan adequately addresses water quality, a TMDL may not be necessary. Also, it is possible that through the creation of the plan, a TMDL could be developed and approved by the EPA. If this occurs, the management plan should be modified to reflect the TMDL.

2.3 N.C. DENR Guidance for Re-categorizing Impaired Waters, Bypassing the Need for TMDL Development

If the watershed plan is being created for waters that are Category 5/impaired but for which a TMDL has not been developed yet, this plan can be used to change the categorization of the watershed to a Category 4b. Category 4b waters are those that are impaired but have pollution control measures in place to resolve the pollution problems and do not require a TMDL. Through this process, the necessity of creating a TMDL may be avoided.

> "The level of detail needed to address the nine key elements of watershed management plans listed above will vary in proportion to the homogeneity or similarity of land use types and variety and complexity of pollution sources."

The N.C. DENR has guidance for plans that hope to achieve recategorization of Category 5 waters to Category 4b. Many of these guidelines overlap with the EPA requirements so it is possible that a plan can satisfy both EPA and DENR requirements. The full guidance document can be found on the Category 4b (TMDL Alternative) portion of the N.C. DENR website. *The DENR recommends that before pursuing this TMDL alternative, participants review the guidance document as well as meet with DENR's Modeling and Assessment Branch (MAB).*

2.3.1 Process and Timeline to Request Category 4b Designation

Participants are required to create the "demonstration" showing that a 4b designation is appropriate for the waters in question. Requests for Category 4b consideration can be submitted to DENR at any time and must include the six elements established by EPA/DENR. Department of Environment and Natural Resources will determine whether the request will be submitted for EPA approval. Once submitted to EPA, the decision by the State to move the specified water to Category 4b will be evaluated on a case-by-case basis. *A waterbody is not designated Category 4b until EPA approval is achieved*. After EPA approval of 4b categorization, DENR may request periodic reports to track progress.

2.4 COMBINED EPA AND N.C. DENR GUIDELINES

Below is a compiled list of criteria that is required by the EPA and N.C. DENR.

I. Identification of impairment, pollutant, and causes and sources of pollution that need to be controlled. Pollution sources that need control measures should be identified by subcategory level and include estimates of their presence in the watershed (e.g. "X number of dairy cattle feedlots needed upgrading, including a rough estimate of the number of cattle per facility…")
   A. Include a map of the watershed that identifies the major causes and sources of impairment
   B. Point vs. Nonpoint sources
   C. Natural background levels
   D. NOTE: If a TMDL exists, this element may already be available

II. Load reductions needed to meet water quality standards
   A. Based on the existing source loads estimated in component I
   B. Estimates should be on the same scale as component I
   C. Incorporate TMDLs (including downstream TMDLs) if applicable

III. Detailed management measures to achieve necessary load reductions determined in component II
   A. Describe critical areas needing management measures (e.g. agricultural land)
      i. Can be supplemented by the identification of critical areas on a map
   B. Address numeric load reduction goals as well as any additional pollution prevention goals (e.g. habitat conservation)
   C. Existing commitments by pollution sources to implement controls

IV. Plan implementation schedule
   A. Time frame for meeting of WQS
   B. Should be "reasonably expeditious"
   C. Should reflect any milestones developed

V. Interim, measurable milestones to track implementation of management measures
   A. Assesses whether management measures are implemented *on time* as opposed to the effectiveness of the measures implementation

VI. Criteria to measure progress toward meeting watershed goals
   A. Interim criteria to determine whether load reductions are being achieved
   B. Can be direct measurements (such as bacterial counts) or indirect measurements (such as number of beach closings)
   C. Should address how to proceed/modify strategies if interim goals are not being met

VII. Monitoring component to evaluate the effectiveness of implementation over time
   A. Based on monitoring criteria developed in component VI

VIII. Information/education component
   A. Used to enhance public understanding of the project
   B. Encourages early and continued involvement in selecting, designing, and implementing nonpoint source management measures to be put into practice

IX. Identification of technical and financial assistance needed to implement as well as long-term operation and maintenance measures
   A. Estimate amount of technical and financial assistance needed
   B. Document relevant authorities that may have a role in management plan
   C. Identify federal, state, local, and private funds or resources that could potentially assist

D. Identify and address any shortfalls between needs and resources

X. Commitment to revise pollution controls, as necessary, if progress toward WQS is not shown through the monitoring

A. Identify how any revisions to the original demonstration will be reported to DENR

3 IDENTIFY AND INTEGRATE PARTNERSHIPS

All major interests within your coastal subwatershed should be included in the planning and implementation in order for your management plan to be a success. Connecting with community leaders, elected officials, government and non-government organizations, local businesses, and academics will provide you with a solid framework for the planning effort. For example, the Hewlett's & Bradley Creek Watershed Plan involved partnerships between the City of Wilmington, Town of Wrightsville Beach, N.C. Coastal Federation, Withers & Ravenel Engineers, N.C. Department of Environment and Natural Resources, New Hanover County Soil and Water District, Shellfish Sanitation Program, and the University of North Carolina at Wilmington. Such partnerships strengthen a management project by connecting the community with the work being done.

The N.C. Coastal Federation, authors of this guidebook, will be a strong partner for your subwatershed restoration. With over three decades of experience in assisting groups with coastal water stewardship efforts, the NCCF has vast experience with coastal N.C water quality impairments and restoration. The Federation can provide information, guidance, access to volunteers, and support in order to do as much as is feasible to help with the success of your restoration.

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3.1 PARTNER INTEGRATION

Partners are those individuals and organizations who take an active role in helping you realize volume reduction goals. Partners will be vital to the ease with which you navigate planning and implementation processes. On the N.C. coast, major partners include any local government agency (or person) involved with the project, for example, the city of Wilmington, N.C. employs a watershed coordinator to educate the public about stormwater issues and best practices. Some local governments also employ engineers who can be most helpful in the planning and implementation of a subwatershed restoration. The Shellfish Sanitation Section of the Division of Marine Fisheries is responsible for shoreline surveys and shellfish water monitoring and will be a major contributor to your restoration. It will be beneficial to involve the Shellfish Sanitation Section as early as possible in order to coordinate planning and monitoring efforts. Local Soil and Water Conservation district agents can provide valuable information which will assist in understanding the nature of subwatershed impairments and in focusing restoration work on the most appropriate areas. The Department of Environment and Natural Resources is charged with plan approval and with providing financial assistance to implement the plan through Section 319 grant funds. DENR can also serve as advisors during planning stages, providing valuable information about local water quality. You will also want to contact your county NC .Cooperative Extension agent for assistance in public outreach projects and dissemination of information about your project. If a watershed coordinator or similar entity exists in your project area, they should also be included in order to help with education and with other appropriate plan components such as in kind contributions.

The partners mentioned above will form the core project team of your restoration efforts. Other partners can be included as necessary, but if you integrate the above entities into planning and

implementation processes, you should be able to successfully restore your subwatershed. Do not assume that all members of this project team will be well informed about the benefits of stormwater volume reduction to the health of coastal subwatersheds. You may need to educate your project team about the methods described in this guidebook. Representatives from the Shellfish Sanitation Section or NC Cooperative Extension may be willing to discuss the effects of volume reduction with the rest of your project team at initial meetings. Once your team possesses the facts about volume reduction and its correlation with improved water quality, it is time to meet with other stakeholders.

3.2 Stakeholder Integration

Once your core project team has been established, you should hold a public information session in order to present the problems with the subwatershed and to assess goals, needs and concerns of all community stakeholders in regard to the project. All stakeholders should have the opportunity to voice their opinions during this preliminary meeting. This is also an opportunity to acquire local knowledge about the subwatershed and surrounding communities. For example, longtime residents may know the location of drainage ditches which cannot be seen in aerial photography.

Community input should be respectfully considered when the project team reconvenes to draft the restoration plan. Although not all community concerns can be addressed within the scope of the plan, any feasible community recommendations should be included.

Once the plan has been drafted, a second meeting should be arranged with stakeholders. This meeting should be informational in nature, the community should be presented with the finalized subwatershed restoration plan, but no further input should be elicited. This will likely be the first of several public information meetings that will take place over the life of the restoration. Additional outreach activities should also be conducted in order to keep stakeholders abreast of the progress of the restoration.

3.3 Building Community Support through Outreach and Education

Continued community involvement is essential for project success. Collaborating with the groups

For more general information about identifying and integrating partners, see Appendix C.

and individuals willing to work toward healthy water quality will link the project with those who care most about the watershed. Educational and outreach messages are one of the most influential ways to establish this connection. Outreach can be used to provide understanding on stormwater, generate excitement about your project, and promote action for restoring the watershed.

Within the nine minimum EPA components, element VIII focuses upon **developing information and education components**, and is used to:

- Enhance public *understanding* of the project
- Encourage early and continued *involvement* in selecting, designing, and implementing nonpoint source management measures to be put into practice

To *enhance public understanding*, create outreach messages, which relate your coastal watershed to stormwater runoff. Tailor messages in ways that clearly represent how reducing runoff volumes will benefit target audiences. Remember to tie in the overarching goals and to communicate volume reduction.

To *encourage involvement*, provide messages that highlight simple ways others can join project efforts.

There are likely standing educational programs in your community that foster water quality protection. Working alongside these programs early on can be beneficial in maintaining outreach efforts within the community.

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When developing an outreach program, follow these six steps provided by the EPA handbook (Section 12.2.2).

- Define Outreach goals
- Identify and analyze the target audiences
- Create the messages for each audience
- Package the messages for various audiences
- Distribute the messages

Evaluate the Information/Education program

3.3.1 Define Goals

To begin, create outreach goals that are clear, focused, measurable, and specific. This will make it easier to evaluate your program and to track progress along the way. An example outreach goal may be to promote behavior changes toward LID and BMPs within the community. Make sure goals also reflect and support the overall project goals. Start by looking at your project goals (discussed in Chapter 4) and then decide how outreach will be beneficial in reaching them.

Sample goals may include:

- Educate stakeholders and community members about their watershed and how stormwater runoff is generated.
- Encourage outside involvement in reducing the amount of stormwater entering the waterways.
- Engage the public in helping to identify opportunities to reduce the volume of stormwater and in measuring progress in accomplishing plan goals

3.3.2 Identify Audience

Next, decide which groups of people your efforts will target or focus on. Think about what types of people live and work within the watershed; for example, homeowners, decision-makers, developers, farmers, fishermen, or business owners. From there, determine who you want to reach and reasons why you should educate them.

3.3.3 Create, Package and Distribute Messages

Since watershed planning incorporates environmental, economic, and health related aspects, people may be interested in your project for different reasons. Choose messages that are relatable to your audience, and emphasize things that will motivate them to take action. For example, highlighting time or money savings with LID outreach may relate well with people who have economic mindsets. Or promoting cleaner water for shellfish habitats may resonate with fishermen.

When you know what motivates your audience, decide which outlets you will use to send the message along. Consider mediums that cater specifically to the target audience, since certain groups may be more receptive to phone calls or personal contact rather than to emails or social media. For example, you will likely want to present information to developers differently than you would fishermen.

Example Outreach Outlets Include:

-Television and Radio
-Internet and Social Media
-Displays at Community Events
-Newspaper and Magazines
-Slideshow Presentations
-Signage at Project Sites
-Tours or Fieldtrips to Project Sites
-Presentations to Appointed and Elected Boards
-Direct Communication with the Homeowners Association
-Printed Materials: Mailings, Brochures, Factsheets, Posters, and Flyers

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Using public places, like parks, schools, or museums, to present LID designs is another great way to reach the community. The federation uses projects such as rain gardens, bio-retention areas, and additional LID techniques to showcase how people can positively influence water quality when working together. Educational signage at the sites help to share outreach messages with those who visit. The volunteers engaged in creating sites often carry that momentum to the larger community, which can spark a chain reaction influencing the way others value their watershed.

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Figure 3-1. The N.C. Coastal Federation partnered with students, parents, and teachers at White Oak Elementary School (Left) and with the Town Hall of Cedar Point (Right) to create showcase rain gardens. These rain gardens provide educational displays and encourage Best Management Practices for visitors.

3.3.4 Evaluate Outreach Efforts

Lastly, it is important to evaluate the outreach messages. Proper evaluation will give an idea of how well the intended audience received messages and if the messages actually achieved their goals. Evaluation should be included in the beginning of outreach planning to make sure insightful feedback is received after messages are delivered. Evaluations will show which aspects worked and which did not. This, in turn, can help you adjust and tailor messages to better reach your goals.

Methods of Evaluation

- Track the number of participants
-Survey participants (before, during, and after programs)
-Conduct interviews
-Track the number of site visits if using a web source

More guidance on outreach and education can be found in Appendix D*: Additional Outreach Information.*

3.4 Define Concerns and Goals

The primary goal of creating this watershed management plan is to restore water quality through stormwater volume reduction, with special regards to shellfish harvesting (SA) waters and swimming (SB) waters. Class SA and SB are the highest possible uses of a coastal waterbody and are subject to strict water quality standards to protect public health. Achieving volume reduction goals can yield benefits beyond realizing the highest attainable uses. Depending on the characteristics of your watershed, you may also have one or more secondary goals that can be reached through volume reduction. For example, if the community identifies flood control as a secondary concern, it can be addressed through volume reduction as well.

3.4.1 Primary Goals

Using the theory and philosophy outlined in Chapter 1, the ultimate goal for the use of this guidebook is to improve water quality through stormwater volume reduction, with a specific focus on shellfish harvesting and swimming waters. If you have shellfish growing waters that are classified for shellfish harvest (SA) but are impaired and unable to be used for their purpose, the goal of creating a watershed management plan should include reopening these areas to harvest. Likewise, if you have swimming (SB) waters with swimming advisors, your goal should be to reduce pollutant-laden stormwater runoff to prevent these closures.

A way to quantify success toward this goal is to improve water quality over time so that the existing N.C. Shellfish Sanitation shellfish growing water harvest classifications are revised from "Prohibited Area" or "Conditional Areas" to "Approved Areas" that can be opened to harvest more and more frequently. Once growing waters are managed as "Approved Areas" they will no longer be listed as "impaired" by EPA. The plan you create will also work to reduce the need for swimming advisories within your watershed, with a goal of removing these waters from being listed as "impaired".

The primary goal of stormwater volume reduction is a very broad and all-encompassing goal. In order reach it, you will have to divide this goal into smaller, more specific objectives. For instance in the Bradley and Hewletts Creeks Watershed Management Plan described in Chapter 1, six objectives were created to meet the primary goal of stormwater volume reduction:

1. Continue existing programs that address water quality impairments.
2. Determine appropriate water quality classifications and designated uses where water quality impairment exists.
3. Track the reduction of the transport of bacteria from land to water.
4. Promote/ focus stormwater reduction efforts.
5. Form and maintain partnerships.
6. Evaluate success and modify plan based upon results.

These six objectives are steps toward meeting the larger primary goal of volume reduction. We will use them as a framework for developing a management plan and will discuss their inclusion in Chapter 9. Each of these six objectives has smaller actions associated with their completion. These stepping stone actions will be discussed further when it is time to develop the implementation schedule in Chapter 8.

3.4.2 Secondary Goals

In addition to the primary goal of water quality improvements for shellfishing (SA) and swimming (SB) waters through volume reduction, it is also important to integrate stakeholder concerns and incorporate existing management efforts. Doing so may bring up secondary goals that will be relevant to the restoration process. Some examples of secondary goals may include minimizing:

- Flooding
- Sediment erosion
- Recreational hazards
- Eutrophication

It is important not to take on too many secondary goals in the planning process, as too many goals can distract from the main purpose, and goals harder to attain. Make sure the goals are detailed, specific, and address your main concerns. Special Consideration should also be made regarding what can be achieved within a certain timeline, as well as within the budget. Funding and budgetary concerns will be addressed in Chapter 8.

Using information from Chapter 3, you should have assembled a team of stakeholders including local and state agencies, environmental organizations, academic experts, business leaders, and surrounding landowners. It is important to gather topics of concern from the stakeholders in the community because these comments may provide key information for the creation of primary and secondary goals. Stakeholders may bring up issues that were not thought of or recognized previously in the planning process, such as sedimentation, flooding, or recreational concerns. It is critical that you maintain partnerships throughout the planning, implementing, and monitoring steps.

In addition to stakeholder knowledge, it is vital to incorporate any past and current watershed management efforts. If you have past watershed management plans or prior TMDLs in your watershed, incorporate those goals and issues into your current plan to make sure you are continuing other management efforts. Looking at other plans helps prevent overlapping, encourages progress, and saves you time. Once you incorporate stakeholder concerns and existing management effects to create secondary goals, you can begin to think about indicators for these goals.

3.5 Incorporate Indicators

Because our primary goal is already defined as restoring coastal shellfish and swimming waters through stormwater volume reduction, the primary indicator is already known. For shellfish waters, fecal coliform is the legal reason for certain waters being closed for shellfish harvest and is therefore the main indicator criterion that is measured. For swimming waters, water quality is measured by enterococci levels. Recall from Chapter 2 that based on bacteria such as fecal coliform and enterococci there are the following classifications:

- SA- Shellfish harvesting, fecal coliform ≤14 colonies per 100mL
    - Closed
    - Conditionally approved closed
    - Conditionally approved open
    - Approved
- SB- Swimming, enterococci ≤ 35 colonies per 100mL

Fecal coliform will be the main indicator criterion.

The legal impairment for closed shellfish harvesting, swimming and recreational areas is bacteria. Other pollutants may be present, and cause issues, but these are secondary concerns, and not the cause of legal impairment. These secondary concerns can be incorporated into the plan through secondary goals.

Indicators should be determined for the secondary goals as well. For these goals it is important to choose indicators of progress that are quantifiable. Without a way to measure progress for the specific problems of your watershed, you may never know if your efforts are working. For example, if a secondary goal is to decrease sedimentation in the subwatershed through stormwater volume reduction, you will need to measure turbidity or total suspended solids (TSS). Further examples can be seen in Table 4-1.

Table 4-1. Identifying and linking concerns, causes and indicators. This can be used as a worksheet to help plan your goals. (Adapted from the EPA "Handbook for Developing Watershed Plans to Restore and Protect Our Waters")

What are the problems/ concerns in the watershed?	What do you think caused the problems?	What would you like to see for your watershed (Goals)	How can you quantify these conditions (Indicators)
Not suitable for shellfish harvesting or swimming	Bacteria from stormwater runoff	Meet water quality standards for class SA & SB waters	Fecal coliform & enterococci levels, shellfish & beach closure data, waterbody classifications
Eroding banks	High Peak Flow due to stormwater from impervious surfaces	Stabilize banks	Hydrographs, water velocity
Sediment in water	Sediments from stormwater runoff	Attain clear water	Turbidity, TSS

Once you have incorporated indicators of progress into your goals you will have a much clearer picture of the steps required for successful subwatershed management. Knowing these indicators will also help you create a thorough management plan.

3.6 UNDERSTANDING HOW TO DELINEATE YOUR WATERSHED

Hydrologic and topographic features that define areas upland or upstream from a specific drainage point on a river or stream characterize a watershed. All water within this area will flow into this specific point. By delineating these areas, it becomes easier to determine possible upland pollution sources since we know all water from a drainage area will flow to the river or stream. Depending on the scope, other management projects might focus on a whole subbasin or large watershed. However, coastal communities and local governments can have a greater influence in decreasing the volume of stormwater runoff entering our rivers and streams by focusing efforts at the small tidal watershed level.

3.6.1 Hydrologic Unit Codes

Defining the geographical extent of your watershed planning effort ensures a focused, efficient, and effective management plan. Most federal and state agencies use the USGS categorization of hydrological units to distinguish these drainage areas. The United States is divided into 21 major geographic drainage regions. Each regional drainage basin is then subdivided into successively smaller hydrologic units in the following order: subregions, basins, subbasins, watersheds, subwatersheds. A unique hydrologic unit code (HUC) defines a hydrologic unit.

The smallest delineated planning unit is a 12-digit HUC. There are six levels of designation nested within a full 12-digit HUC: watersheds (10 digits), subbasins (8 digits), basins (6 digits), subregions (4 digits), and major drainage regions (2 digits).

This standard coding system defines watershed drainage areas and allows for cooperation and mutual understanding between agencies in regard to boundaries, landscape functions, and water quality impairments. However, 12-digit subwatersheds typically drain areas from 5 to 10 square miles and the watersheds targeted in this guidebook will usually be even smaller and not officially delineated with a planning unit by USGS. Figure 5-1 is a pictorial representation of the scale of an example project site in relation to the 12-digit subwatershed.

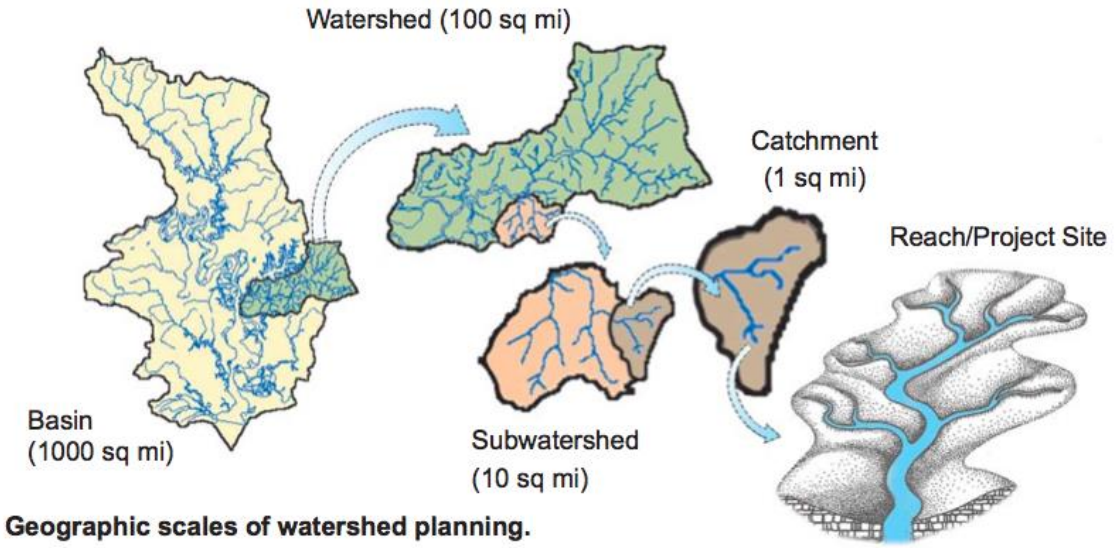


Figure 5-1. Courtesy of the State of New York's Guidebook for Watershed Plans to Protect and Restore Water Quality.

The shellfish harvesting water quality standard is stricter than the standards used to issue swimming advisories because shellfish, which are often eaten raw, are filter feeders that concentrate bacteria present in the water column.

3.6.2 Use My WATERS Mapper to Locate Your 12-Digit Subwatershed HUC

The easiest way to spatially locate your 12-digit HUC is via the EPA's My WATERS Mapper. The My WATERS Mapper is a dynamic interface that displays select EPA Office of Water program data and watershed boundaries for the entire United States.

Use the navigation functions to zoom to your general area of interest. Alternatively, you can use the "Go To:" function to zoom to N.C. or to your particular zip code. Once you are zoomed to the area of interest, open the "Other EPA Water Data" dropdown menu in the right column and check the box next to "Watershed Boundaries (WBD)". The My WATERS Mapper sometimes takes a moment to load. Be patient and allow the watershed boundaries time to draw.

Use the navigation tools or pan option to adjust the screen to your area of interest and simply click somewhere in that area. A popup window will open displaying the 12-digit HUC and subwatershed name. You can use this HUC and/or name throughout out planning process to delineate the project location. See the example below for a search of the subwatershed that includes Beaufort, N.C.

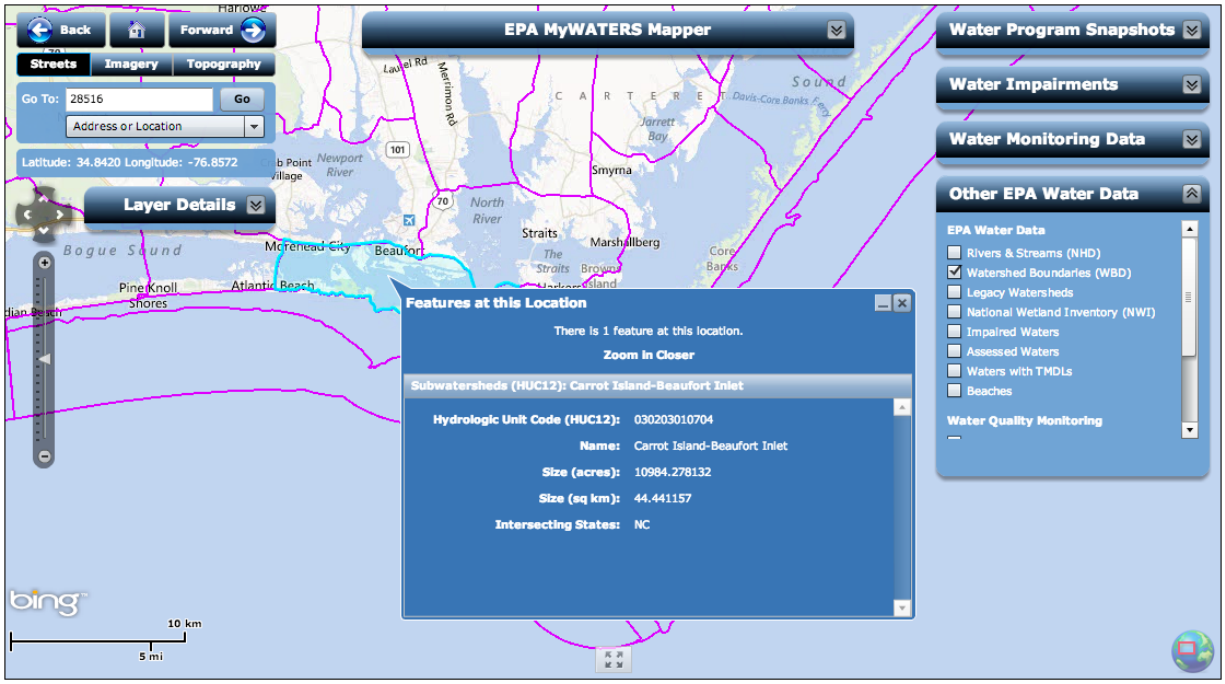


Figure 5-2. EPA MyWATERS Mapper search results for zip code "28516" and selection of the 12-digit HUC subwatershed around Beaufort, N.C.

As of July 2013 the Water Impairments for "pathogens" in N.C. is incomplete. We recommend you refer to the Shellfish Sanitation and Recreational Water Quality impairment data to obtain more comprehensive data specific to coastal N.C.

Remember, you can determine the level of detail you are working with by simply counting the numbers in the code. Once you have located your 12-digit HUC, you can proceed with the following step and download the existing boundary data.

3.6.3 Obtain 12-Digit Watershed Boundaries Data Using GIS

For specific data on water quality boundaries and indicators, the USGS maintains a user-friendly Watershed Boundary Dataset (WBD) that allows you to obtain geospatial data by state, county, or other area. These data delineate hydrologic boundaries throughout the nationwide drainage network and include the geographic extent of the 12-digit HUC subwatershed. The WBD also has data on precipitation, temperature, existing easements, elevation, geology, hydrography, land use & land cover, and soils. Thus, even though you are interested in smaller tidal creek watersheds, the WBD will be mentioned again in Chapter 5 as you begin to gather existing data and characterize the land use changes that have taken place in your watershed to alter the natural hydrology.

Using the Geospatial Data Gateway

If your organization has GIS capabilities, use these steps to obtain data using the Watershed Boundary Dataset (WBD) available through the Geospatial Data Gateway.

Step 1: In the right column, under "I Want To…", click "Order by County/Counties"

Step 2: Select "North Carolina" as the state

Step 3: Select county/counties of interest, for example "Beaufort", and add that county to the desirable list by clicking the >> arrow

Step 4: Click "Submit Selected Counties"

Step 5: In the central column, select desired variables, specifically the box next to "12 Digit Watershed Boundary Dataset in HUC8, 5 maps 1/643 MB" under "Hydrologic Units"

The down side to the WBD is that you have to know what data you need and what time period you require. You have to download several maps and layers at once in order to obtain the small piece of relevant data. The best way to avoid these extraneous data is by selecting by county or counties, or selecting by place. As opposed to selecting by the entire state, this method yields a more reasonable number of map layers to sift through (1-10 instead of 50+).

You also need GIS software, such as ArcMap, and some amount of GIS knowledge to analyze the data. If your organization has GIS capabilities, the WBD is the best means to obtain all of the preliminary baseline watershed hydrology and soils data explained further in the next chapters.

3.7 How to Delineate a Watershed Boundary Smaller than the 12-digit HUC

The USGS StreamStats website has a link to an Interactive Map that you can use to delineate a tidal watershed at the scale appropriate for this guidebook. StreamStats was created using digital geospatial data and GIS technology to estimate peak flows and drainage off impervious surfaces. Given the ample data available on the Interactive Map, remember to remain patient and allow the data to load each time you make a change to the map. If you ever get lost, there is a Help function

available on the StreamStats interface, pointed at in Figure 4-3. When you first open the link, the interactive map interface should look similar to this:

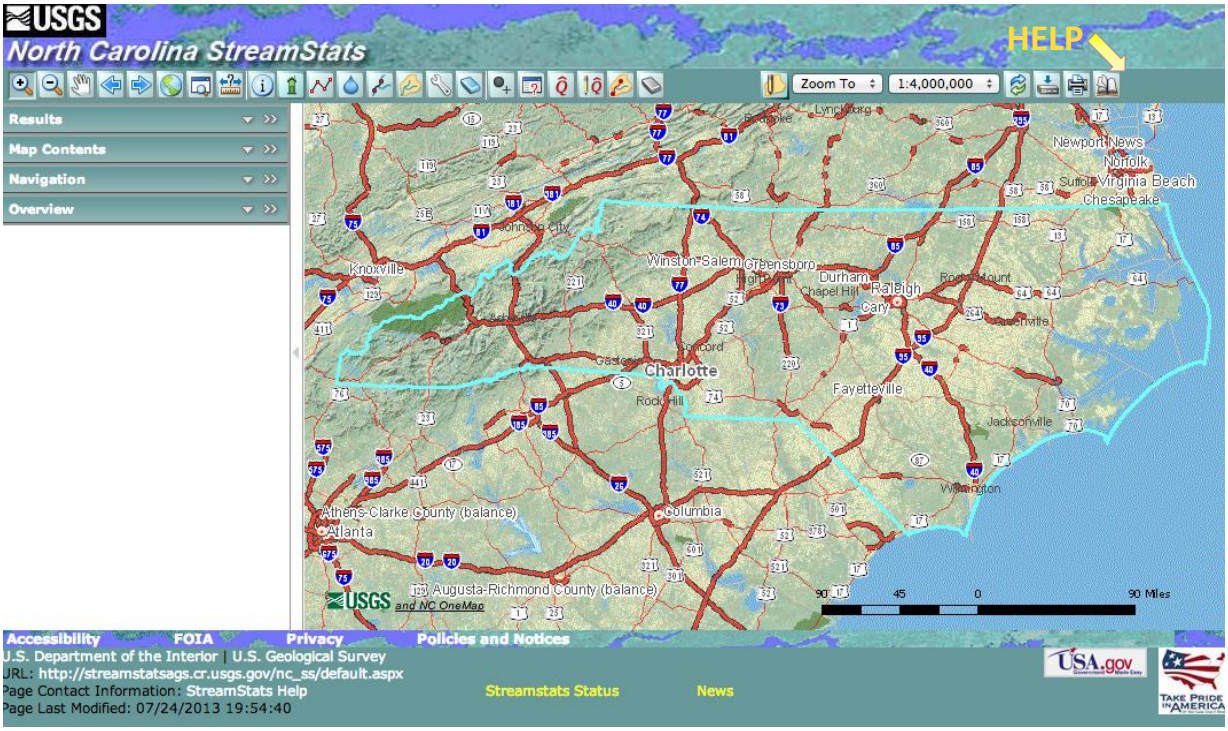


Figure 5-3. The default interface for the N.C. StreamStats Interactive Map with the Help function emphasized. Contained within the Help is a StreamStats Tutorial.

3.7.1 Step-By-Step How To Draw Your Watershed Boundary and Calculate Drainage Area

This section will guide you step-by-step how to use the StreamStats interface to draw a watershed boundary around your tidal watershed and calculate the drainage area of that area. For ease and clarity, these instructions will detail how to delineate the watershed of Bradley Creek in Wilmington, N.C.

Step 1: Zoom to your general area of interest. The interface allows you to draw a black box around the area using the mouse cursor and zoom to that area. Continue to zoom in until the map is at a scale of 1:24,000 or smaller. The "Watershed Delineation from a Point" tool, the tool necessary to draw the watershed boundary for your project area, does not work until the map is zoomed to at least this scale. Center the map on your tidal creek of interest using the pan tool.

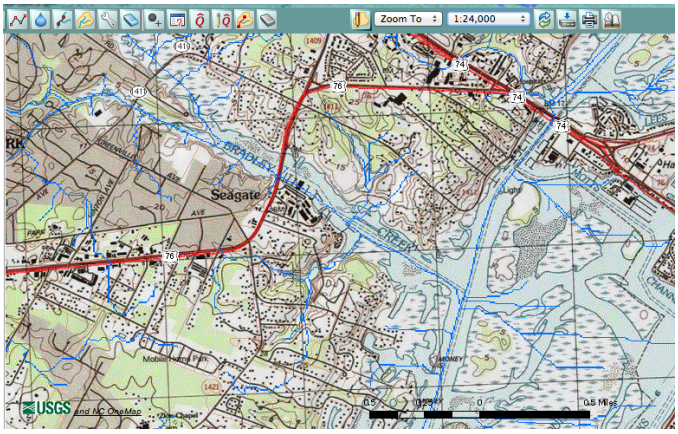


Figure 5-4. This map centers on Bradley Creek in Wilmington, N.C. at the 1:24,000 scale.

Remember: The map MUST be zoomed to 1:24,000 to use the "Watershed Delineation from a Point" tool.

For clarity, this step zooms in even further, to the 1:10,000 scale, in order to show exactly where to click to delineate the boundary but for your purposes this may not be necessary.

Step 2: Using the "Delineate Watershed from a Point" tool, click *directly* on the **blue** vector for the creek, pointed out in Figure 5.5. Since the tool draws the boundary of the watershed upland (landward) from the point you click, it is critical to click the tool on a location toward the mouth of the creek (seaward). The tool takes a minute to draw the boundary so be patient and make sure to ***only click on the vector once***. If you move the mouse away from the area you clicked it will be obvious that the image is loading. The watershed boundary results of using this tool are shown in Figure 5-6.

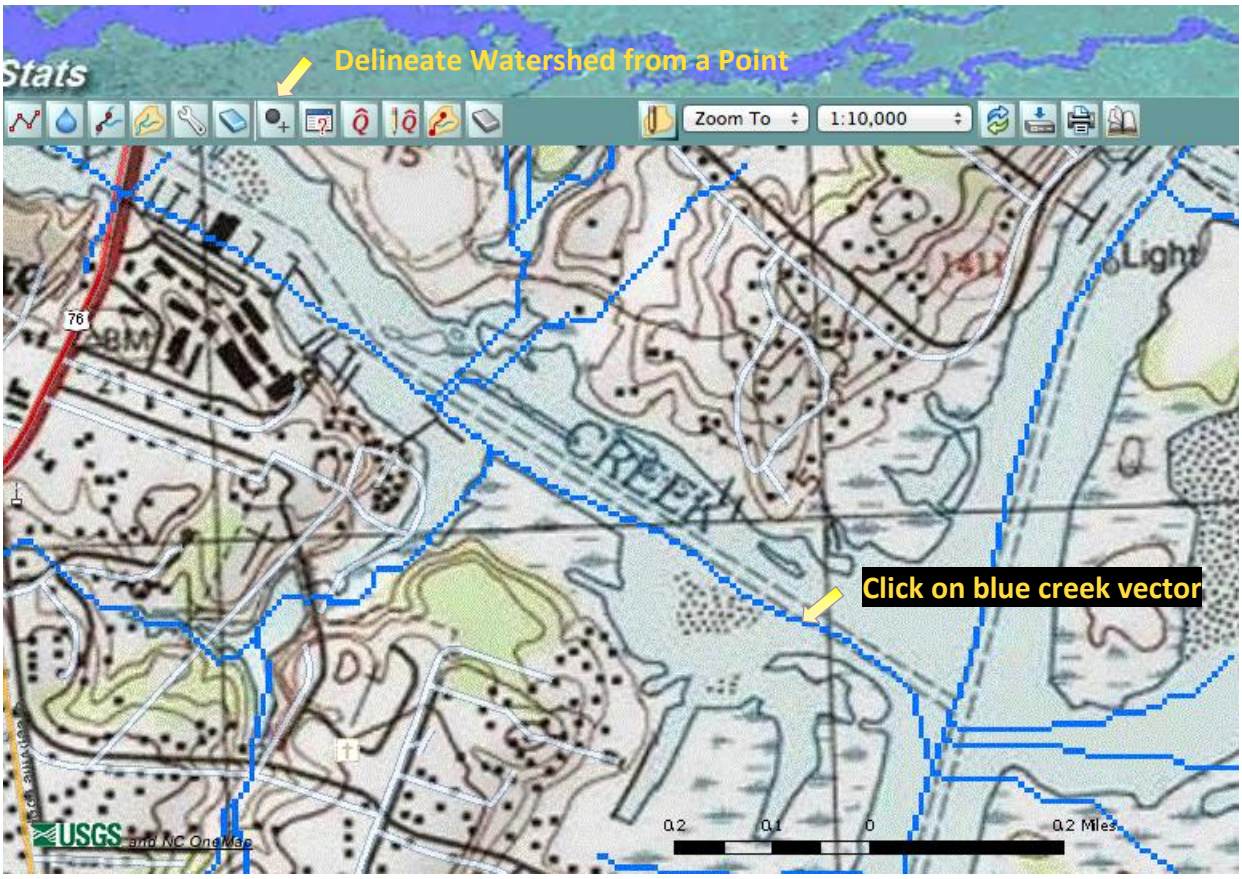
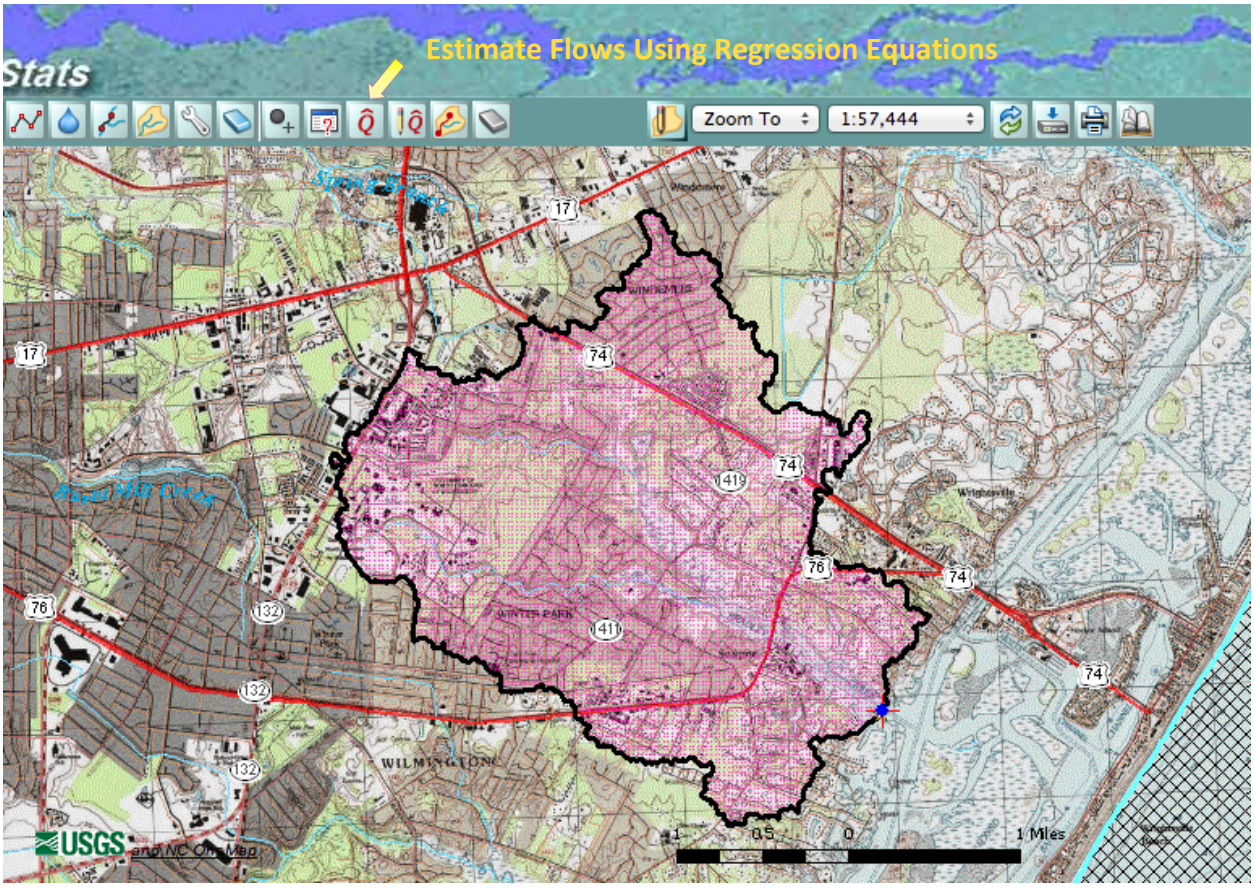


Figure 5-5. This figure shows where to select the "Delineate Watershed from a Point" tool and where to click the mouse using that tool to draw a watershed boundary for Bradley Creek.

Step 3: Now that you have used the StreamStats "Delineate Watershed from a Point" tool to draw a boundary around your watershed, you can determine the drainage area of that watershed by using the "Estimate Flows Using Regression Equations" tool, shown in Figure 5-6. A portion of the tool's results is shown in Figure 5-6 where you can see the drainage area for the Bradley Creek watershed is 6.59 square miles. This information will be vital when you estimate runoff volume reductions in Chapter 6.



USGS
North Carolina StreamStats

Streamstats Ungaged Site Report

Date: Fri Jul 26 2013 09:20:54 Mountain Daylight Time
Site Location: North_Carolina
NAD27 Latitude: 34.2083 (34 12 30)
NAD27 Longitude: -77.8232 (-77 49 24)
NAD83 Latitude: 34.2085 (34 12 31)
NAD83 Longitude: -77.8229 (-77 49 23)
Drainage Area: 6.59 mi2
Percent Urban: 62.0 %
Percent Impervious: 18.6 %

Figure 5-6. The results of the "Delineate Watershed from a Point" tool show the boundary of the Bradley Creek watershed. The tool needed in Step 3 is highlighted. Additionally, the results of the "Estimate Flows Using Regression Equations" tool show the total drainage area of the Bradley Creek watershed is 6.59 square miles.

Error! Reference source not found.NOTE: Often, particularly in developed areas, there are additional pipes or drainage ditches that were not present in the natural topography or hydrology that flow into your watershed. This additional flow will alter your runoff volume and water quality impairment results if not taken into account. Unless you have stakeholder or partner knowledge about these manmade flow sources, the best method to identify them is via aerial photography. Chapter 5 will go into further detail on ways to obtain aerial photography, but it is crucial that you keep these other possible sources in mind when planning. IMPORTANT: Be sure to include the entire area that drains into these pipes, drainage ditches, etc. into your watershed's drainage area, even if the area itself is not contained within your watershed boundary. All the surface water flow running into the pipe or ditch will ultimately flow into your tidal creek watershed so it is important to keep that additional bacterial input in mind when planning.

4 GATHER EXISTING DATA AND CRATE A WATERSHED INVENTORY

After identifying primary goals, some preliminary research must be conducted to characterize your subwatershed, and become familiar with the activities and related pollutants that occur. In order to effectively assess the needs of the target watershed, the baseline water quality and watershed information must be determined. The amount of stormwater runoff will be calculated in Chapter 6, and the data described below will aid in runoff modeling and interpretation. Many state, federal, and local agencies have established monitoring sites and have detailed data available. These data can be used as a building block and can help to identify priority contaminants within the watershed. Although a vast amount of data may exist for the target watershed, only some will be pertinent to achieve the flow reduction goals of the watershed management plan.

4.1 INITIAL RESEARCH

Before you begin to research specific characteristics of your subwatershed, it is imperative to fist define the watershed or area of interest as was described in Chapter 4. Some other important preliminary data must be gathered as well. You should also determine any applicable classifications for your waterbody, if it is listed on the 303d impaired list and if a TMDL has been established for your subwatershed. Then you can begin to characterize your watershed more fully through additional research.

Based upon the primary and secondary goals of the project, determine the type of data that are necessary to meet the preliminary goals. It is important to focus on pertinent data, as time resources are likely limited. For example, since the major goal of the watershed plan is to improve water quality for shellfish harvesting through flow reduction, it is important to gather data on water quality such as fecal coliform and sanitary shoreline surveys that have been conducted. Similarly, to achieve this goal, it is unlikely you will need extensive demographic data or stream geomorphology. However, to achieve these reductions through Low Impact Development (LID) techniques you will also need to research soil, aerial photographs, parcels, the drainage area of your sub watershed, and statistics on the 1-year, 24-hour storm in the area. In this step, it is also essential to research issues of importance to the stakeholders and secondary goals so you can sufficiently address all concerns. Once you know what data you require, you can begin to compile a preliminary dataset from various sources.

4.1.1 Sources of Data

Data are available from many local, state, and governmental agencies and are found in a variety of reports, management plans, and raw data. The data for calculating stormwater runoff will likely be found at the local and state level. Local organizations can include nearby universities, town agencies, environmental groups, and other NGOs. State sources of information can often be obtained from environmental agencies, with most states having agencies dedicated to water quality and coastal states generally having a coastal management department. North Carolina has an extensive Department of Environment and Natural Resources (DENR) which includes:

Department of Environment and Natural Resources (DENR)

Division of Coastal Management (DCM)

Division of Marine Fisheries (DMF), which includes a section for Shellfish Sanitation and Recreational Water Quality

If your watershed is not located within North Carolina, there are likely similar agencies for your state. It will be helpful to familiarize yourself with these agencies in order to find relevant data in a timely manner.

The N.C Shellfish Sanitation and Recreational Water Quality within DMF is one of the most important sources of data for shoreline surveys, fecal coliform levels, and water monitoring. This data is integral in calculating the amount of runoff and establishing flow reduction. Depending on the state, other divisions may also prove helpful such as North Carolina's divisions of Waste Management (DWM), Water Resources (DWR), as well as Conservation Planning and Community Affairs (CPCA). The NC Department of Agriculture and Consumer Services (NCDA&CS) also has data on chemical use, weather data, and locations of animal and plant farming operations. Within other coastal states, corresponding state agencies are usually found, or may be included within other divisions.

Federal agencies also have a plethora of data sets that are generally broad, but can be more specific in certain areas. The main agencies for obtaining relevant data are the:

Environmental Protection Agency (EPA)

U.S. Department of Agriculture (USDA)

U.S. Geological Survey (USGS)

Federal Emergency Management Agency (FEMA)

For achieving desired results through flow reduction, it will be necessary to acquire data to calculate runoff, as well as to characterize your subwatershed and interpret the activities that occur within your area of interest.

4.2 Finding the Data Needed for Determining Base Flow

Before a management plan can be created, the flow regime of your subwatershed should be researched. The best way to characterize and understand the ebbs and flows of your watershed is to calculate the amount of stormwater runoff. If desired, the amount of runoff may be used to create a hydrograph. A hydrograph is merely a graphical interpretation of the flow levels of your subwatershed over time. For calculating stormwater runoff volume, the most important sources of data are:

- Historical and current water quality data from the Shellfish Sanitation section of DMF
- Aerial photography
- Parcel Data
- Soils
- Model storm parameters for a 1-year, 24-hour storm.

4.2.1 Historical and Current Water Quality Data

In order to establish volume reduction targets, you must first know the baseline conditions within your subwatershed. Baseline conditions in this instance refer to water quality data such as bacteriological counts, temperature, pH, salinity, dissolved oxygen, turbidity, fecal coliform, and toxicity. Ideally, this baseline will be based on information from a time before there was significant impairment in your subwatershed. However, due to limited data availability, it may not be possible to obtain data on pristine water characteristics in your subwatershed. Instead, baseline information is often taken from a year with available data that will still represent satisfactory water quality progress.

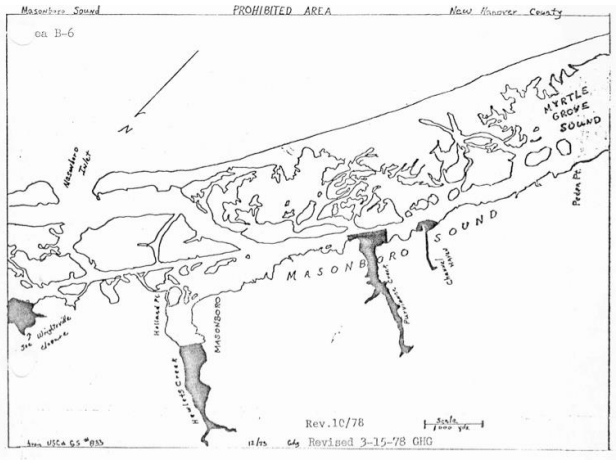


Figure 6-1. Map of Shellfish Sanitation closed shellfish harvesting areas as of 12/73. The dark areas represent those that are closed for shellfish harvesting. From Bradley and Hewletts Creek Watershed Restoration Plan. Note: This image is not oriented with North facing upwards.

The N.C. DMF has a sector for Shellfish Sanitation and Recreational Water Quality, which collects data on water quality and is in charge of beach and shellfish harvest area closings. The main pollutants of concern monitored by Shellfish Sanitation are bacteria such as fecal coliform. There are also shoreline survey data, reports on persistent organic pollutants, and basin wide reports. This data is collected once every three years for a specific waterbody. This monitoring

data is the basis for listing specific waters as impaired. The Shellfish Sanitation and Recreational Water Quality site contains the most pertinent data for North Carolina. If your subwatershed is outside of North Carolina, your state may have a division comparable to N.C.'s Shellfish Sanitation and Recreational Water Quality.

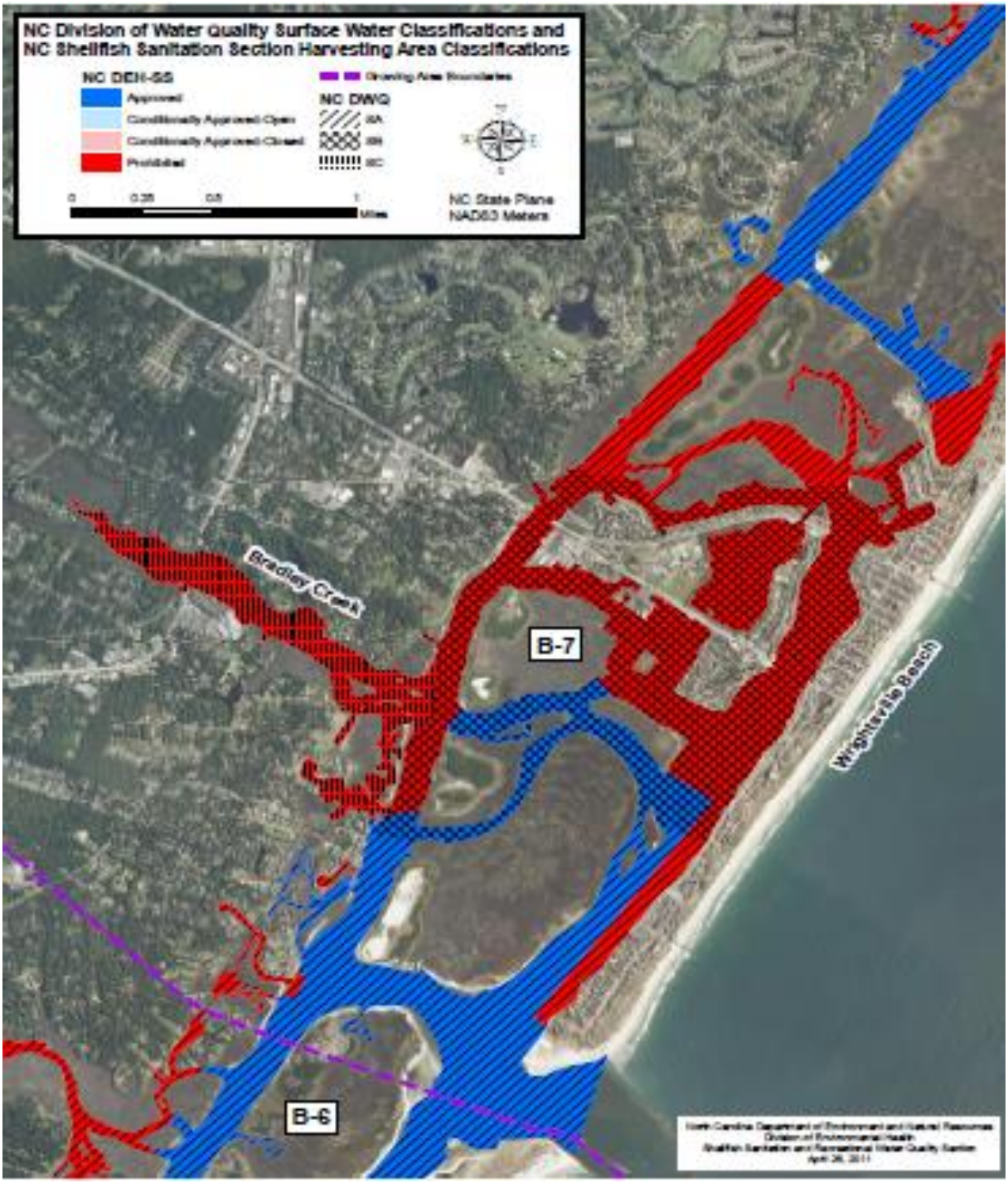


Figure 6-2. Shellfish harvest classifications by Shellfish Sanitation overlaid with water quality surface water classifications assigned by the EMC as of April 26, 2011. From Bradley and Hewletts Creeks Watershed Restoration Plan.

The EPA has a large database of all ground and surface water quality data called STORET. This includes data for water quality, as well as biological and physical parameters. The EPA also has the Watershed Assessment, Tracking & Environmental Results System (WATERS), which includes an interactive mapping tool and web services to perform analysis on data. Additionally, federal level beach monitoring through the EPA website can give insight into the quality of nearby waters.

4.2.2 Aerial Photography

Aerial photographs called orthophotographs are useful for inferring land use and land cover including the amount of impervious surfaces at a given time. They can also be used to show the progression of development through time. It is important to obtain aerial photographs for before significant impairment occurred in the subwatershed, current conditions, as well as for time periods in between. This will allow for baseline conditions to be compared to existing circumstances, will help calculate interim goals and volume reduction. It is likely that more detailed and thorough aerial photography will be available through local data sources. Aerial photographs are available through county offices as well as at the state level through N.C. OneMap and the USGS National Map-Orthoimagery.

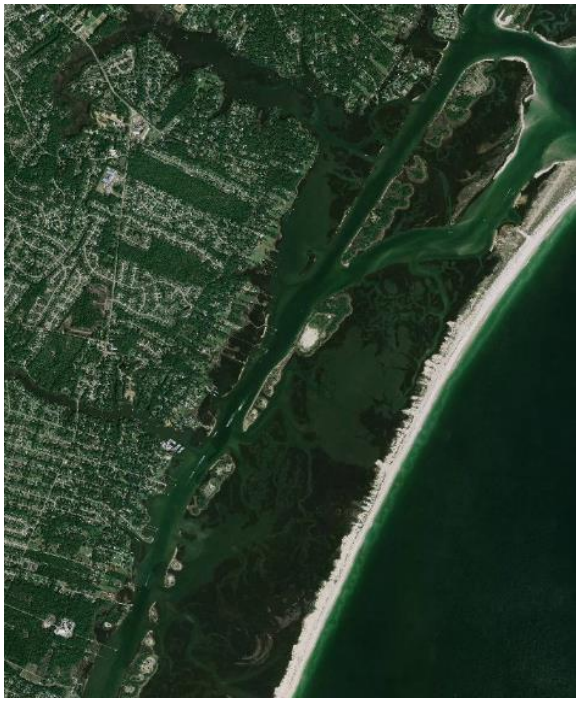


Figure 5-3. Orthophotography for Masonboro Sound and creeks in New Hanover County, N.C. obtained from the National Map. Scale:1:36,112

4.2.3 Parcels

In addition to aerial photography, parcel data is an important piece of information in order to determine right-of-ways and boundaries. This information is available at the county level, but is not always free of cost. Carteret County has this information available through the Carteret County ConnectGIS system.

4.2.4 Soils

Data regarding soils are useful for determining drainage issues and rates and are an important component of thorough watershed modeling. It is useful for determining water infiltration rates, and subsequently the amount of runoff that is occurring. Most counties have online interactive GIS systems with data pertaining to soils, floodplains, and other environmental information. Local sources of data such as county websites will generally be more detailed than state or federal information. For instance, Carteret County N.C. has very comprehensive information on soils through the Carteret County GIS Service. If your county does not have soils data, or if you would like to download layers for use in GIS, the USDA NRCS has soil data available through the web soil survey, the

Figure 5-4. Soils data from the NRCS Web Soil Survey 7/2013. Purple= Class A soil, Green= Class A/D soil, Blue= Class B soil, Red=Class D soil

world soil resources map and the Geospatial Data Gateway. The world soil resources map gives a very broad scale look at soil regions, while the web soil survey can show finer detail. Data is also be available through the USDA NRCS Soil Data Mart, but may be discontinued soon.

4.2.5 Model Storm Parameters

In order to determine runoff estimates and subsequent hydrographs, it is essential to obtain information on local storm parameters. In N.C., the EMC and DENR has established a design storm that is necessary to protect marketable shellfishing waters (SA class). This is based on the 1-year, 24-hour storm event. The parameters of this storm represent the quantity and rate of precipitation in a storm that occurs, on average, once a year in a 24-hour period. The parameters for this storm are available through NOAA's Precipitation Frequency Data Server. At this site you will be able to choose your location through an interactive mapping platform. Once you have chosen the location of your subwatershed in the map, below you will find a table showing the rainfall amounts for each of a number of possible storms. Find the value for the 24-hour storm that has reoccurs on average once a year.

4.3 Finding Data to Understand the Stormwater Runoff Calculations

Once you have calculated total stormwater runoff in Chapter 6, you will need data to interpret the stormwater runoff calculations and help form the management plan. The most important data for this step are water quality standards, existing land management strategies, and pollutant sources.

4.3.1 Existing Land Management Strategies

Determining existing land management practices is an important consideration as it can help to categorize current watershed threats, as well as to identify management strategies that may work within your target subwatershed. Management practices may take the form of legal agreements, such as environmental easements, as well as state and federal laws, stormwater projects, and resource management plans.

States as well as municipalities generally have ordinances and management plans to address problems. Many states or regions have nonpoint source pollution programs. For example, some coastal states have extensive stormwater laws applicable to all state waters and some specifically geared towards certain watersheds, such as the N.C. Stormwater Laws. Stormwater management systems have been required in N.C. since 1988, and coastal requirements were revised in 1995 and 2008. It is important to note when stormwater systems were installed, as many prior to 2008 are considered ineffective. Additionally, under Section 319 of the CWA, states, territories and tribes can obtain grant funds to improve water quality. It may be helpful to see if there are any 319 grants for your subwatershed, or if any are under management plans under the NPDES.

A management practice that is growing in popularity is an environmental easement, which is a legally binding agreement where a landowner agrees to give up certain rights for development or other activities on their land. Environmental easement boundaries are available through the USDA, the Geospatial Data Gateway, as well as through local land conservation organizations. In N.C., organizations such as the N.C. Coastal Land Trust help protect coastal waterways from impacts of development through numerous conservation easements. Public lands, however, are generally managed through a Bureau of Land Management (BLM) Resource Management Plan (RMP).

4.3.2 Pollutant Sources

Pollutants can reach waterbodies through many different outlets and pollution sources can be divided into point and nonpoint. Point sources are those that come from a single outflow, or source, such as a pipe. In contrast, nonpoint sources of pollution do not come from a discernible point, but generally from processes such as runoff or atmospheric deposition. Stormwater runoff is an example of nonpoint source pollution and is the largest source of pollution. It is important to determine what pollutants may be contaminating your subwatershed in order to adequately manage the water quality.

4.3.2.1 Point Sources

Point source pollutants are generally regulated through the National Pollutant Discharge Elimination System (NPDES), a permitting system in which individuals or companies must acquire a permit to discharge pollutants into a surrounding water body. Permits are typically for wastewater or stormwater. Although stormwater itself is a nonpoint source of pollution, once a permit is obtained, the stormwater exiting from that specific permitted area is considered a point source. Active state stormwater permits for N.C. as well as NPDES stormwater permits within the state can be found through the DENR. The DENR also has a Stormwater Permitting Interactive Map for N.C. The EPA also has information on the NPDES stormwater permitting program.

Wastewater permits are another large point source of pollution. Permitted N.C. wastewater discharge locations can be found at the DENR website. North Carolina Waste Management has an interactive map for N.C. waste sites including active disaster debris staging sites, brownfields, underground storage tanks, dry cleaning solvent cleanup act sites, hazardous waste treatment storage and disposal, and other waste management facilities. The EPA also has a nationwide list of waste water permits and an interactive map through the permit compliance system and integrated compliance information system.

4.3.2.2 Nonpoint Sources

The nature of nonpoint sources of pollution makes the data more difficult to ascertain. Unlike point sources, nonpoint sources cannot be traced to a single outflow. Nonpoint source pollution can include sources from livestock, cropland, urbanization, silviculture, onsite wastewater systems, and wildlife.

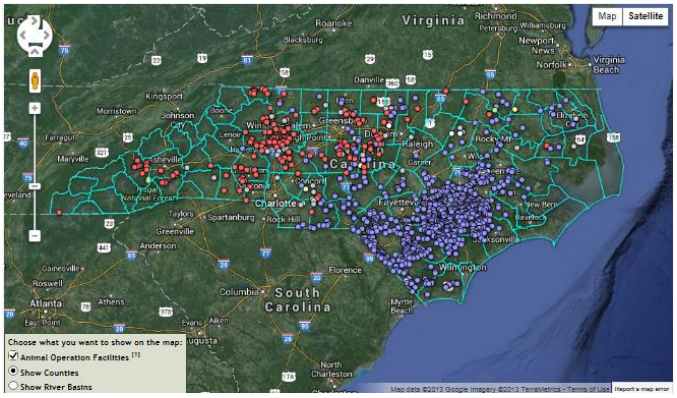


Figure 5-5. N.C Interactive map for confined animal feeding operations.

Livestock operations, especially in high densities within a watershed, can lead to excess nutrients and bacteria in surrounding waterways. Livestock may also trample vegetation leading to increased erosion rates and sediment transport. Most states have online resources for locating animal facilities. North Carolina has an interactive map of all animal feeding operations in N.C. The USDA Census of Agriculture also has current and historical information on animal operations in the U.S. Local information is generally of much

greater detail, and may work best for your subwatershed plan.

Croplands have typically altered the hydrology of the land and are another important source of po llutants to the system which may add excess nutrients in the form of chemicals from pesticides, and sediments. When precipitation occurs, these chemicals can run off the land and can travel long distances to reach surrounding waterbodies. Information regarding N.C. agricultural lands can be found through the N.C. Department of Agriculture and Consumer Services. The USDA Census of Agriculture has broad level statistics on farming operations, and the USDA-CropScape site has an interactive cropland data map with data from 1997 to present day.

Urban areas are another category that adds a great deal of nonpoint source pollution to our waterways. Most of this pollution is due to the increased amount of runoff from impervious surfaces. Precipitation events on areas of high impervious surface cause a large surge of water, overwhelming natural infiltration systems. This water carries pollutants that have been deposited on roadways and parking lots such as mercury and other heavy metals, oil, sediment, trash and persistent organic pollutants such as PBDEs and PCBs. High levels of impervious surface can also lead to thermal pollution due to the high temperatures of pavement from solar radiation. Urbanized areas contribute nutrients from pet waste and chemicals from pesticides. Identifying the level of impervious surface in or around your subwatershed is important for knowing the potential contaminants of stormwater runoff. Onsite wastewater systems such as residential septic systems can add to urban pollution as well. Information on N.C. septage and N.C. wastewater land applications can be found through the DENR. Maps of N.C. septic system density are available from the N.C. Department of Health and Human Services. Federal septage data are available through the U.S. Census Bureau.

Wildlife populations are a naturally occurring source of pollution. Knowing where large populations reside is important for knowing what might be present in runoff. Local and state wildlife agencies are useful for determining local animal populations. For North Carolina, the WRC, the DENR, and local offices of the USFWS are good places to look for this information. If you are located in a different state, you can find your offices in this list of state and federal wildlife agencies.

4.4 Other Potential Data to Include

Based on the goals you established for you watershed, it might also be necessary to obtain additional information before creating your management plan. For example if you are interested in restoring water quality for shellfish harvesting, and believe that wildlife may be contributing significant amounts of bacteria to the water, then it will be useful to collect data on wildlife populations.

4.4.1 Data Types

There are five types of useful data: physical and natural properties, land use and population characteristics, waterbody & watershed conditions, pollutant sources, and waterbody monitoring. Some of these data categories will sound familiar as we discussed some of these topics earlier in the chapter. Physical and natural properties include watershed boundaries, hydrology, and wildlife data (Fig. 5-1). Land use and population characteristics consist of information about how people have changed the land and include land use and demographics. Water conditions are the physical and chemical properties of the water itself and include water quality standards such as pH,

nitrogen, phosphorous, and temperature. Pollutant sources are all point and nonpoint sources that are in existence.

Table 5-1. Types of potentially useful data for establishing initial research for a watershed management plan (Adapted from EPA, 2008).

Types of Useful Data				
Physical and Natural Properties	Land Use and Population Characteristics	Waterbody and Watershed Conditions	Pollutant Sources	Waterbody Monitoring
Watershed boundaries **Hydrology** **Topography** **Soils** **1 yr./ 24 hr. storm** **Habitat** **Wildlife**	Aerial photography Land use and land cover Existing management strategies Demographics	Water quality standards 305(b) report 303(d) list TMDL report Source Water Assessments	Point sources Animal operations Wastewater Nonpoint sources Stormwater	Water quality Flow Biology Geomorphology

4.4.2 Where to Find Additional Data

There are an overwhelming number of places to find such information on your subwatershed. The main sources of information are summarized in the table below.

Table 5-2. Sources of useful data for watershed planning.

Sources of Useful Data for Watershed Planning			
Category	Data Type	Data	Common Sources
Physical & Natural Properties	Watershed Boundaries	HUC & Watershed Boundaries	EPA My Waters Mapper, USGS Watershed Boundary Dataset (WBD), USGS Stream Stats
	Hydrology	Stream Shapefiles	N.C. DENR
		Hydrography	USGS National Hydrography Dataset, USGS National Map
	Topography	GIS Topo Layers	N.C. OneMap, USGS National Map
	Soils	County Soil Data	Carteret County GIS
		Federal Soil Data	USDA NRCS: Web Soil Survey, World Soil Resources Map, Geospatial Data Gateway
	Storm Events	1 yr/24 hr Storm	NOAA
	Habitat	Wetlands	N.C. DENR Coastal Wetlands, USFWS NWI, National Heritage Program
		Protected Areas & Habitat Conservation Plans	N.C. WRC Conservation, USFWS Conservation, USGS GAP
		Rare, Threatened, Endangered Species	NHP, USFWS Endangered Species
		Biological Assessment	N.C. DENR Community and Macroinvertebrate Assessments

Land Use and Population Characteristics	Land Use and Land Cover	Aerial Imagery	County Offices, N.C. OneMap, DCM Land Management, USGS National Map Orthoimagery
		Land Cover	USGS National Map, USGS GAP
	Existing Land Management	Nonpoint Source Programs	N.C. Stormwater Laws, NPDES
		319 Grants	EPA 319
		Environmental Easement Boundaries	N.C. CLT, USDA Easements
		Resource Management Plans	N.C. WRC Conservation, USFWS Conservation
	Demographics	Census Data	N.C. Office of State Budget, U.S. Census Bureau TIGER
Waterbody and Watershed Conditions	Water Quality Standards	Water Quality Designations	N.C. DENR Designations
		Water Quality Standards	EPA Standards
	305(b) & 303(d) Reports	-	N.C. DENR Reports, EPA 303(d), EPA 305(b)
	Existing TMDL Reports	NC TMDL	N.C. DENR TMDL
		National TMDL	EPA TMDL
	Source Water Assessments	NC SWA	N.C. DENR SWA
Pollutant Sources	Point Sources	Hazardous Waste	N.C. DENR Wastewater, N.C. DWM Facilities, EPA Wastewater
		Stormwater Permitting	N.C. Stormwater Permits, EPA NPDES
	Nonpoint Sources	Livestock Sources	N.C. Livestock, USDA Census of Agriculture
		Croplands	N.C DA&CS Ag Lands, USDA Census of Agriculture, USDA CropScape
		Wildlife	N.C. WRC, N.C. DENR, Local USFWS Office, Wildlife Agencies
Waterbody Monitoring	Water Quality and Flow	Shellfish/Beach Closures	N.C. DMF Shellfish Sanitation
		Ambient Monitoring Stations	N.C. DENR AMS, USGSW Ambient AWQ and Flow, USGS STORET, EPA WATERS
	Biology	Shellfish and Beach Closures	N.C. DMF Shellfish Sanitation
		Stream/Fish Assessments	N.C. DENR-SFCAP
		Invertebrate Assessments	N.C. DENR Bio Assessment
		Fish Kill Events	N.C. DENR Fish Kills
	Geomorphology	Fluvial Geomorphology	USGS Fluvial Geomorphology

More information on these topics can be found in Appendix E, which describes the importance of each data category, as well as explanations of various sources where these data are found.

4.5 Organize Your Data

Now that you have gathered all of the existing data needed for your watershed management plan, it is time to organize and think critically about the data collected thus far. The first step in this process is to create a data inventory to organize and keep track of the important data in your watershed. This inventory should be kept updated as new data are acquired. Table 5-3 shows types of information to include in your data inventory.

Table 5-3. What to include in your data inventory

Tabular Datasets	• Data type (monitoring, geographic, etc.) • Source of data (agency) • Number of monitoring stations • Collection start date • Collection end date • Number of samples/observations • Parameters • Frequency • Known quality assurance issues with the data • Special comments/notes
Reports & Anecdotal Information	• Document title • Date • Source/Author • Description • Web site (if applicable)
GIS Data	• Type (land use, soils, station locations, etc.) • Source/agency • Date (date or original date on which the coverage is based) • Scale (1:24,000 for example) • Projection (UTM, state plane, etc.) • Description

Once the data inventory is complete you should ensure that there are no spatial, temporal, or informational gaps in your data inventory (Table 5-4).

Table 5-4. Types of data gaps

Informational	A lack of data to inform a specific goal set by stakeholders or for an indicator that was selected to evaluate present watershed conditions. Ex. No baseline data exists against which to measure improvements.
Temporal	The timeframe the existing data were collected in is not relevant to the analysis. Ex. Data is too old or not collected during the correct season.
Spatial	Data have not been collected at the necessary locations or the proper spatial distribution required for conducting the analyses. Ex. Data is needed from upstream and downstream regions to effectively compare restoration efforts.

Some important questions to ask include:

- Do you have data for all of the essential indicators that you selected in Chapter 4?
- Are you missing data from a certain time frame or area?
    - Ex. Shellfish Sanitation may have closed areas for monitoring in or around your watershed. In this case, you should submit a request to have these areas reopened for monitoring.
- Is your data accurate?
    - Ex. Is your waterbody classified correctly? If you believe your waterbody is classified incorrectly you should request sampling from DENR to consider reclassification.

Because the bulk of sampling for the primary goal is conducted by Shellfish Sanitation, you are unlikely to have significant data gaps for the primary goal of your watershed plan. If there is still data that you are lacking for secondary goals you should either find where to obtain this information (Appendix E), or create a sampling plan to collect relevant data. The EPA provides information and guidance for designing a sampling plan in their Guidance on Choosing a Sampling Design for Environmental Data Collection. Before creating a sampling plan for secondary goals, it is important to remember that collecting data is usually a time consuming process and therefore sampling should only be conducted to address concerns of great importance.

Once you have all of the data you will need, you can begin to use this data to estimate runoff values in Chapter 6. This will help you to understand the water flow within your watershed and set volume reduction goals.

5 ESTABLISH VOLUME REDUCTION GOALS

One of the most important steps in the planning process is the establishment of numeric stormwater volume reduction goals. To formulate these goals you will consider how the total runoff in your target area has changed with intensifying land use. This chapter will guide you through the data preparation and calculations necessary to determine total runoff for current and historical land use conditions in your watershed. The difference between the total runoff over the historical land conditions and current land conditions in your watershed will define your volume reduction goals.

5.1 FORMALIZE A BASELINE YEAR

Ideally, the baseline year you should use is 1975, as this represents the time when the uses of your waters were first determined by the mandate of the Clean Water Act (see Chapter 2 for more detail). However, you may not be able to acquire the necessary data to determine land use (aerial photography) this far in the past. If this is the case, you will need to establish a baseline based on the information you have available.

5.2 GATHER NECESSARY DATA

For this process, you will need the following types of data:

1. Your target area boundary
2. Current & historical aerial photography
3. Parcel data for your area
4. Hydrologic Soil Group Soil Data
5. Parameters for the 1-year, 24-hr storm in your area

Determination of your watershed boundary is discussed in Chapter 4 and the sources of the other necessary data are discussed in Chapter 5. You will need to collect aerial photography from your baseline year, as well as from intermediate years. You will use the data derived from intermediate aerial photographs to establish intermediate volume reduction goals.

5.3 OVERVIEW OF THE PROCESS

The methods to calculate total runoff generated from the 1-year, 24-hour storm are relatively straightforward. For each land use scenario (i.e. each year of land use data), you will summarize the land use and underlying soil characteristics using a parameter called the runoff curve number (CN). Using this parameter and the rainfall depth of the 1-year, 24-hour storm, you will use a formula developed by the Natural Resources Conservation Service (NRCS) to calculate the depth of the total runoff at any point in the watershed. This value can be converted to a total runoff volume for the subwatershed by multiplying the depth by the area. You will end up with total runoff volumes for each land use scenario that you will use for targets. To compute the volume reduction needed to reach each target, you will use simple subtraction.

Most of the work involved with this method is in the preparation of the data needed to calculate the CN for your watershed. Although this process can be completed using paper maps and manual tabulation, GIS capabilities greatly improve the efficiency of the process. The specifics of this

process using a GIS (specifically, ArcMap by ESRI) are presented below, while the specifics relating to the use of paper maps are presented in Box "Using Paper Maps".

5.4 DETAILED METHODS

The first part of the process is to use aerial photography to estimate the amount of area that is covered by impervious surfaces, open space, right-of-way (ROW), or marsh and water for each year. These areas are further broken down by how much of each land use covers each of the five hydrologic soil groups (A, B, C, D, W).

Note that the italic segments of a filename are meant to designate your own input. For example, the instructions tell you to create a new feature class called "Land_Use_*Year*" for your 2002 data. This means you will name your file "Land_Use_2002."

5.4.1 Mapping Steps

1. Import & organize data
    a. Create a File Geodatabase to store your vector data in
        i. Define the coordinate system of your data
        ii. Add feature datasets for organization
            1. Base data (soils, parcels, watershed boundary)
            2. ROW (this will be empty to begin with)
            3. Land Use (this will be empty to begin with)
            4. Aerial photography (you may choose to keep rasters out of the geodatabase if you encounter problems)
    b. Import data
        i. Import the watershed boundary layer into the geodatabase
        ii. Import the soil data into the geodatabase
        iii. Import parcel data into the geodatabase
        iv. Import aerial photography
    c. Georeference, project, and / or rectify data as necessary
    d. Use the "Clip" Tool to clip data by the watershed boundary
        i. Input your watershed boundary layer into the "Input Features" box
        ii. Input your parcel data into the "Clip Features" box and name the feature class "parcel_clip"
        iii. Repeat with your soil data and name the feature class "soil_clip"

2. Create a template right-of-way (ROW) dataset
    a. Add most current aerial photos and clipped parcel data to the display, with the parcel data overlaying the aerial photos
    b. Use "Select by attributes tool" and select all polygons that are described by an attribute ROW (you may need to open the attribute table first to discover which field describes this and what the name of the attribute is that describes ROW)
    c. Right click on the layer and select "Export Data"
    d. Choose "Selected features" in the box next to "Export:"
    e. If all data are in the same coordinate system, you should not need to change the next selection
    f. Choose an appropriate location for the export and name the file "ROW_template"
    g. Add the new layer to the map

h. Clear the selection and turn off the "parcel_clip" layer, so that only the ROW areas are showing
i. Select symbology for ROW_template that has no fill (you may want to select an outline color such as bright yellow to help you see the shapes)
j. Verify visually that all ROW polygons displayed in ROW_template exist in your most recent aerial photo
k. If there are areas of ROW in "ROW_template" that are do not exist in your most recent aerial photo, start an edit session and delete those polygons. If there are parts of a ROW polygon that existed when the aerial was created, and parts that didn't, you can use the "Cut Polygons" tool on the editing toolbar to break those polygons into pieces, which you can subsequently remove. When you are finished, save your edits and stop editing.

3. Characterize current land use
    a. Create a new feature class in the Land Use feature dataset (name: "Land_Use_Current")
    b. Add a field to the attribute table called "Impervious"
    c. Add a field to the attribute table called "Land_Use"
    d. Begin an editing session
    e. Create polygons surrounding areas of homogenous land use (you do not need to exclude ROW). Assign each polygon one of the four following types and add the corresponding letter to the "Land_Use" field in the attribute table:
        i. Residential (Enter "R" in attribute table)
        ii. Commercial (Enter "C" in attribute table)
        iii. Water and marsh (Enter "W" in attribute table)
        iv. Forested or open space (Enter "O" in attribute table)
    f. As you create polygons, zoom to a lot in each polygon and estimate the percent of impervious area (driveways, rooftops, etc.) in increments of 5%
    g. Add this value to the attribute table in the "Impervious" field for each polygon
    h. When you are finished drawing polygons around all the areas in the watershed, save your edits and stop editing
    i. Make a copy of "ROW_template" in your geodatabase and rename it "ROW_Current"
    j. Add the "ROW_Current" dataset to the map and use the "Dissolve" tool to merge all polygons into a single polygon
    k. Use the "Erase" tool to remove "ROW_Current" (Enter into the "Erase Features" box) from your "Land_Use_Current" file (Enter into the "Input Features" box) and name the file "Land_Use_Current_ROW"

4. Characterize past land use - for each year that you have aerial photography follow these steps
    a. Begin with a new map and add the aerial photographs from the year of interest
    b. Make a copy of ROW_template in your geodatabase and rename it "ROW_*Year*_Inspect"
    c. Add the "ROW_*Year*_Inspect" dataset to the map and turn it on
    d. Start an editing session
    e. Inspect whether each ROW polygon represents a true ROW on the aerial photo. Where necessary, delete any ROW polygons or portions of polygons from the "ROW_*Year*_Inspect" dataset that did not exist at the time the photographs were taken
    f. Once finished, save your edits and stop editing
    g. Merge all the polygons using the "Dissolve" tool and name the resulting file "ROW_*Year*"
    h. Make a copy of the "Land_Use_Current" dataset and rename it "Land_Use_*Year*"
    i. Open the "Land_Use_*Year*" dataset in the map

j. Select this dataset for editing
k. Systematically inspect each polygon to determine if the size and shape of the polygon is applicable and if the land use classification and percent impervious value are appropriate
    i. Change the size and shape (the "Edit Vertices" and "Cut Polygons" tools are useful for this"), the land use classification, and / or the percent impervious value if necessary for each polygon
l. Save your edits and stop editing
m. Remove "ROW_*Year*" (Enter into the "Erase Features" box) from your "Land_Use_*Year*" (Enter into the "Enter Features" box) dataset using the "Erase" tool and name the file "Land_Use_*Year*_ROW"

5. Intersect soil type with land use
    a. Add the soil type data ("soil_clip") to the map
    b. Start an editing session and for all polygons in this dataset that are defined with a combination HSG (e.g. A/D, B/D, C/D), reassign them the lower of the two classes (e.g. HSG D if the initial classification was HSG A/D)
    c. Save your edits
    d. For each ROW clipped land use file (those named "Land_Use_Current_ROW" or "Land_Use_*Year*_ROW"):
        i. Use the "Intersect" tool (Add both the "soil_clip" and "Land_Use_Current_ROW" or "Land_Use_*Year*_ROW" to the "Input Features" box)
        ii. Name the output either "Land_Use_Current_Soil" or "Land_Use_*Year*_Soil"
        iii. Keep the remaining defaults
        iv. The output file should consist of the polygons from the "Land_Use_Current_ROW" or "Land_Use_*Year*_ROW" datasets that have been broken up by the borders of the soil group polygons. Each of the new polygons should retain the attributes from both of the input datasets

Before exporting the tables, you should have: a polygon file of the ROW for each year that consists of a single polygon and a polygon file of the land use for each year that has been intersected with the soil data.

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6. Export attribute tables
    a. For each of the land use datasets ("Land_Use_Current_Soil" and each "Land_Use_*Year*_Soil") and the ROW datasets ("ROW_Current" and each "ROW_*Year*"):
        i. Open the attribute table
        ii. Add a field called "Area_acres"
        iii. Right click the field heading and select "Calculate Geometry" from the list
        iv. Choose units of "Acres US [ac]" and click OK
        v. Click the table drop down and select "Export…"
        vi. Choose your location and choose the same name as your dataset. Make sure to use the dBASE Table format

Using Paper Maps

If you do not have GIS capabilities you can still complete this process, however, you will need large printed copies of the available aerial photographs with soils data and watershed boundary delineated.

The basic method is as follows:

1. Delineate polygons on the aerial photographs that have homogenous land use (excluding right-of-ways) in each of residential, commercial, water/marsh, and forest or open space categories
2. Estimate the percent impervious cover for each of these polygons
3. Using a clear grid with boxes that represent a simple unit relevant to the map, note the area of each polygon being careful to note the portion of each soil type in each polygon
4. Using calculations similar to those described in Step 7 under Tabulations, form values that fit in the Land Use Summary table, shown in Figure 1.
5. Continue with the steps outlined in the main document

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5.4.2 Tabulations

For these calculations, spreadsheet tools are provided here.

1. Summarize land use for each year
    a. Open the "Runoff Calculation Tool" and select the "Land Use" tab
        i. In the "Runoff Calculation Tool," you will enter information in all of the yellow shaded cells. White cells display either headings or have the output of formulas in them. The blue cells show the total runoff generated in each particular land use scenario
        ii. Note that many of the white cells will display an error when you open the file, this is simply because there is nothing in the input. Once you enter in the land use information, the formula fields will automatically fill in
    b. Fill in one of the "Land Use Summary Tables" for each year of data you have (sample table shown in Figure 6.1)
        i. Open the appropriate "ROW_Current.dbf" or "ROW_*Year*.dbf" dBASE table in Excel (note that from when opening dBASE tables in Excel, you will need to change the type of file that the program is looking for to either "All" or ".dbf")
        ii. Add the value under the "Area_acres" column to the yellow cell next to "ROW" in the "Land Use Summary Table"
        iii. Close your ROW dBASE table
        iv. Open the appropriate "Land_Use_Current_Soil.dbf" or "Land_Use_*Year*_Soil.dbf" in Excel
        v. Sort the data by "Land_Use" and then by hydrologic soil type
            1. Remember that you have coded the land use type with letters, as described above
        vi. For all commercial and residential records, multiply the "Area_acres" by the value in "Impervious" and divide this value by 100 in the next column (title this "Impervious area acres")

vii. For all commercial and residential records, take the difference between the "Impervious area acres" and the "Area_acres" in the next column (title this column "Open Space acres")
viii. Sum the area of all records in the "water/marsh" land use type and insert the value in the corresponding cell in the "Land Use Summary Table"
ix. Calculate the sum of "Impervious area acres" by each land use type and soil type and insert these values into the corresponding cells in the "Land Use Summary Table"
x. Calculate the sum of "Open Space acres" by each land use type and soil type and insert these values into the corresponding cells in the "Land Use Summary Table"

Make sure that when you copy cells from one excel sheet to another in the steps above that you select "Paste Special" from the "Edit" menu and choose "Values Only"

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2. Calculate Total Runoff for each year
    a. The "Runoff Calculation Tool" will perform nearly all of the intermediary steps automatically. You will only need to input the rainfall depth for the one-year, 24-hr storm next to "Precipitation" in the "Land Use Summary Table"
    b. The total stormwater runoff will be displayed as acre-feet in the blue cell

3. Calculate Volume Reduction Goals
    a. Copy each of the resulting volumes into the table in the "Volume Reduction Goals" sheet
        i. Transfer the values next to "Runoff Volume (acre-feet)" from each "Land Use Summary Table" into the "Volume Reduction Goals" worksheet. Be sure to put the runoff values from the most recent data in the first row and runoff values from earlier datasets in subsequent rows. Note that depending on how many years of data you have, you may not fill the entire table
        ii. The tool will calculate your volume reduction goals in acre-feet, cubic feet, and gallons
        iii. The goal displayed in the row of your baseline year is your total volume reduction goal. Interim goals are displayed in the rows of the associated intermediate years

Year	**Land Use Summary Table**

Soil Group	Residential Open Space	Residential Impervious	Commercial Open Space	Commercial Impervious	Total Area
A					
B					
C					
D					
W					

Water / marsh	
ROW	

Total Area	0.00

Precipitation	

Runoff Volume (acre-feet)	0

Figure 6.1 Land Use Summary Table

Through the data analysis and calculations you performed, you have generated quantified volume reduction goals. These will provide targets to shoot for as you implement your plan.

6 IDENTIFY MANAGEMENT TECHNIQUES

Past efforts to manage runoff throughout the coast have failed to prevent increased bacterial contamination of shellfish and swimming waters. Some of the reasons that this increase has occurred include:

1. Most coastal communities have no comprehensive program to reduce the volume of stormwater generated by existing development; and
2. Past regulations for new development have not prevented increased discharges of polluted runoff.

In 2008, DENR revised its coastal stormwater rules for new development to address the need to control larger volumes of stormwater. Although these new rules should prevent increased pollution from new development, they have no impact on pollution caused by existing development. The management techniques discussed below focus on volume reduction of stormwater runoff for both new development and retrofits of existing development. It is recommended that LID techniques be used for *all* new development projects and in all feasible retrofitting situations.

6.1 LOW IMPACT DEVELOPMENT (LID)

Low impact development (LID) is an approach to stormwater management that makes use of a variety of techniques to replicate the natural hydrologic function of the landscape. The goal of LID is to mimic a site's natural hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain stormwater runoff close to its source, which can help prevent runoff and minimize the flow of stormwater from existing development and land uses. The use of LID techniques can reduce the volume of runoff that is generated and maximize the treatment capabilities of the landscape runoff as close to the source as possible. LID techniques are versatile and can be applied to all types of existing land uses and new development including industrial, commercial, residential, mixed use development, individual lots, public lands, roads and parking facilities, and other areas.

These techniques include creative site planning and small, decentralized treatment and infiltration techniques that minimize stormwater runoff. While this guidebook gives an overview of various LID techniques, it is important for you to look at your states best management practices (BMP) guidebook related to stormwater regulation for specific guidelines. The N.C. DENR has a "Stormwater Best Management Practices Manual" available for download.

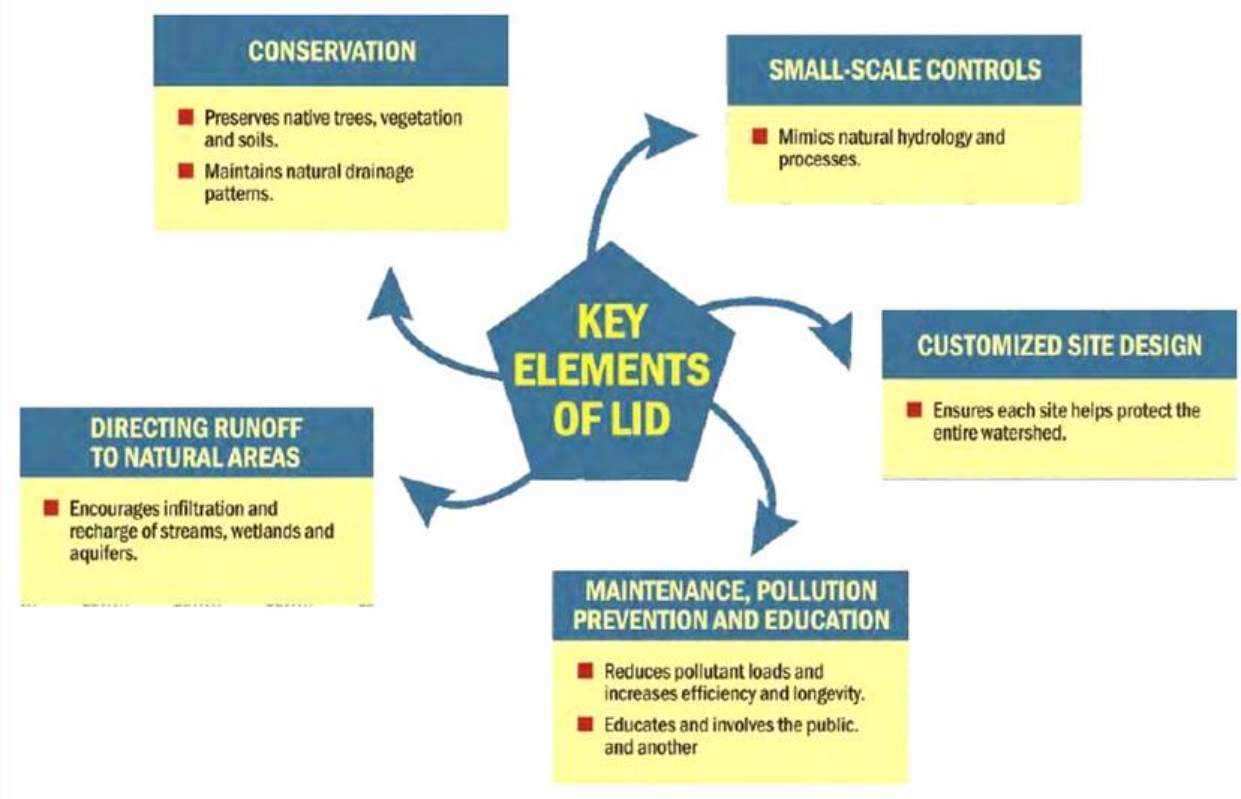


Figure 7-1. The "Key Elements" of low impact development.

6.1.1 LID Principles

1. *Focus on prevention*: protect streams, wetlands, floodplains and coastal habitats, maintain slopes and flow paths, and minimize grading and tree clearing
2. *Work with the landscape*: Identify environmentally sensitive areas, outline a development plan that protects those areas and use hydrologic features of the site
3. *Keep it simple*: use lower-cost approaches to decentralize, micromanage stormwater close to where it falls and direct runoff from impervious surfaces to landscaped areas and other small-scaled devices for infiltration
4. *Practice multi-tasking*: Create a multifunctional landscape that can provide open space, wildlife habitat and stormwater treatment. Such landscapes can provide filtration, treatment, and infiltration while also providing curb appeal. The distribution and small scaled nature of LID practices means that multiple devices are working as a team to reduce the impacts of stormwater runoff
5. *Maintain and sustain*: maintain LID features for effectiveness and long-term success

When trying to preserve the health of the local watershed, the best place to start is to enhance and preserve the natural stormwater treatment areas such as marshes, wetlands, and coastal forests.

6.1.2 Site Design: LID for New Development

LID site design for new development includes identifying important natural features, strategically placing buildings, roads and parking areas, as well as designing a stormwater management system that works with the site to maintain or mimic the predevelopment hydrology. The attention to natural hydrology, stormwater "micromanagement," and integrated use of the landscape results in a more attractive, multifunctional landscape. Unlike conventional strategies that treat stormwater as a secondary component of site design, LID incorporates the natural slope, soils and hydrology as an integrating framework for site design starting at the project concept level. The following techniques are ones that are generally more suited for use when incorporating LID into new development projects, although some are viable techniques for retrofit projects as well.

6.1.3 Retrofitting: Simple Solutions for Existing Development

Promote installation of stormwater reduction measures on City streets in future capital improvement projects that involve city-owned streets, rights-of-way and other public property. Examples of possible ways to do this are included in Appendix G.

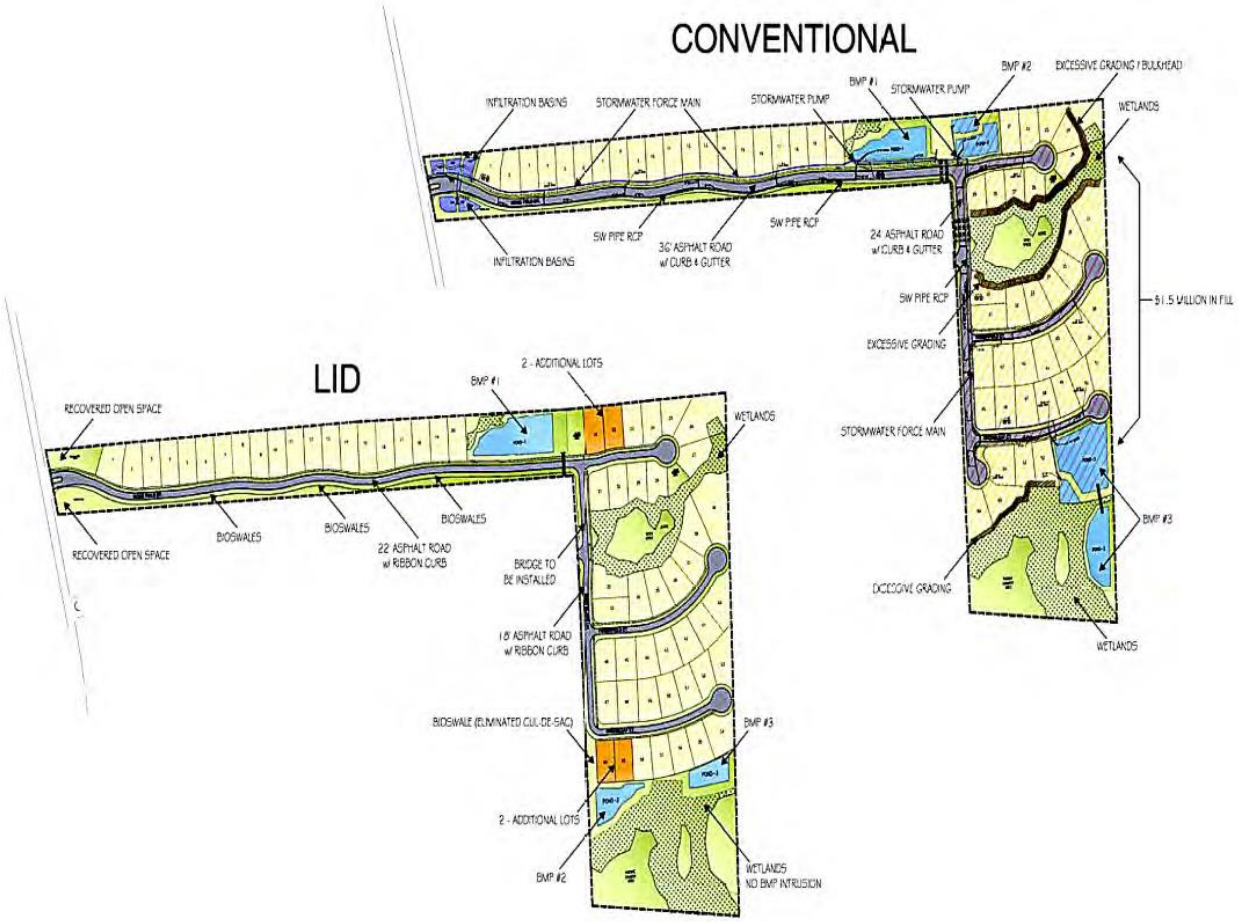
The goal of simple stormwater reduction measures is to use the soil, plants and stormwater collection techniques to capture the rain *before* it has a chance to become polluted runoff. Some techniques, such as rain gardens, absorb the runoff, while others, such as rain barrels, catch the runoff for later use. LID retrofits can be used on individual lots, throughout residential subdivisions, on commercial and institutional facilities, and incorporated into capital improvements projects, roads and parking areas. These techniques are not only applicable to fixing existing stormwater problems on an individual site but can also be incorporated into a new development site.

6.1.4 LID Techniques

It is important to note that many of the techniques discussed below complement one another and may be implemented concurrently, such as the creation of a rain garden and the use of native vegetation.

6.1.4.1 Site Fingerprinting

Site Fingerprinting is a practice that uses the site design as a stormwater management tool by reducing land disturbance, preventing soil structure, and make use of suitable natural areas for runoff management. Rather than grading land to fit a desired development type, the type of development is dictated by the existing conditions of the site, resulting in developed sites which use the land to maintain and protect the natural balance of the surrounding ecosystem. Site Fingerprinting can be done during the planning process for no additional cost and can often lead to lower infrastructure costs.



Error! Reference source not found.*Figure 7-2. Schematics of the Ridgefield Redesign in New Hanover County using various techniques, including site fingerprinting. From converting to LID techniques, the project was able to gain 4 additional lots, save $1 million in fill and grading, eliminate 5 infiltration basins and 5 monitoring wells (and save the money needed to create them), as well as cut down on construction traffic.*

6.1.4.2 Native Landscaping

Native landscaping includes the use of plants that occur naturally in the northeast coastal region, which have adapted to the geography, hydrology, and climate of the region. Native plants are well suited to our soils and will require little care once established. In addition, native plants are part of our coastal natural heritage.

Figure 7-3. A house with a rain garden utilizing native landscaping. Also, notice the curb cut that allows street runoff to reach the rain garden.

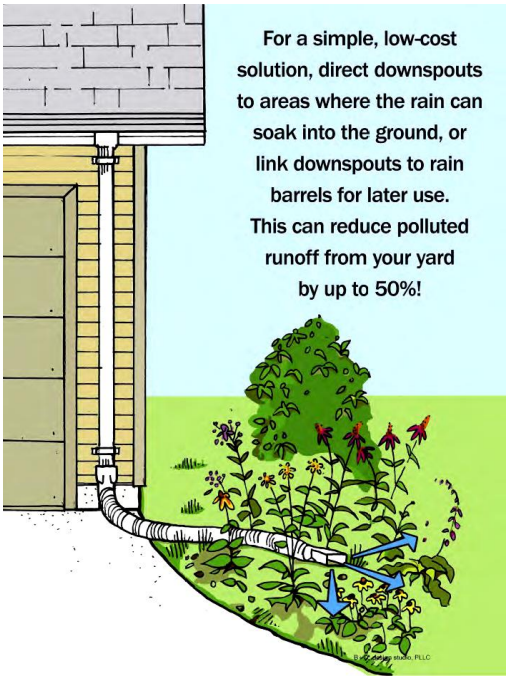
6.1.4.3 Disconnect Impervious Surfaces

Rooftops, parking lots, and other impervious surfaces often drain directly to pipe systems or ditches, increasing runoff and preventing rainwater from soaking into the ground. Disconnected impervious areas are those that divert or direct stormwater to naturally vegetated areas. This reduces pollution by slowing down the runoff and increasing filtration allowing the runoff to filter through vegetation. Sloping parking lots, roofs, and sidewalks into landscaped areas can do this. During small storms, disconnected impervious areas can reduce runoff volume by 30-100%. In addition to reduced runoff, disconnected impervious surfaces can also reduce the need for irrigation, provide better aesthetics, and lower infrastructure costs.

Portland, Oregon: Between 1993 and 2011, Portland's Downspout Disconnection Program disconnected over 56,000 downspouts, accounting for removal of *1.3 billion gallons per year* of stormwater for the city's combined sewer system.

As a retrofit, it is sometimes possible to add "curb cuts" in the edge of a parking lot to allow for runoff flow into vegetation as well as disconnecting building downspouts.

6.1.4.4 Reroute Downspouts



Downspouts directed to driveways, sidewalks or parking lots increase the amount of polluted runoff by an average of 50% or more. Instead of contributing to stormwater pollution, you can put rain water to good use by rerouting downspouts for use in lawn and garden maintenance. Rerouting downspouts is a simple retrofit that disconnects impervious surfaces. Make sure to direct downspouts to areas that water can infiltrate the ground at least five feet from a structure's foundation.

Figure 7-4. An example of rerouting a downspout that dumps onto an impermeable surface so that it dispels water onto vegetation.

6.1.4.5 Rain Barrels

Rain barrels are containers that collect and store rainwater from your roof that would otherwise be lost to runoff. They typically include the drum, a vinyl hose, PVC couplings and a screen to keep debris and insects out. A quarter inch of rain produces enough runoff to fill a typical rain barrel hooked up to one downspout and one 55 gallon rain barrel holds a week's worth of water for a 10 foot by 10 foot garden. Not only does using a rain barrel cut down on runoff, but it can also reduce water bills as well as provide water for plants during drought.

Figure 7-5. An example of a rain barrel receiving water from a downspout

6.1.4.6 Cisterns

Cisterns are large water harvesting systems that collect rainwater and store it for later use. In contrast with a rain barrel, cisterns are sized to capture large volumes of water and can be installed above or below ground. The captured water can be reused for larger scale irrigation, industrial processes, and/or commercial reuse. There are many benefits to cisterns, including lower water bills, reduced runoff, as well as access to water during drought conditions. For high water consumption users, cisterns can be a financially profitable investment, paying for themselves by reducing or even eliminating water bills for non-potable uses. Be sure to check local building codes before construction/installation.

For every inch of rain that falls on a 1,200 square foot area, approximately 748 gallons of stormwater runoff is produced.

Cisterns can be used as a retrofit, but if rainwater is to be used inside a building for non-potable uses, dual plumbing systems are needed.

6.1.4.7 Permeable Pavement

Permeable pavement is any paving material that allows rainwater to soak through the pavement and infiltrate the soil. Permeable paving comes in various forms – pervious concrete, pervious asphalt, and concrete pavers are some of the most popular materials. The permeable paving system requires a washed stone base that aids in adding runoff storage volume as well as structural support. Permeable pavements can be used in conjunction with underground detention or rainwater harvesting systems to gain additional stormwater benefits.

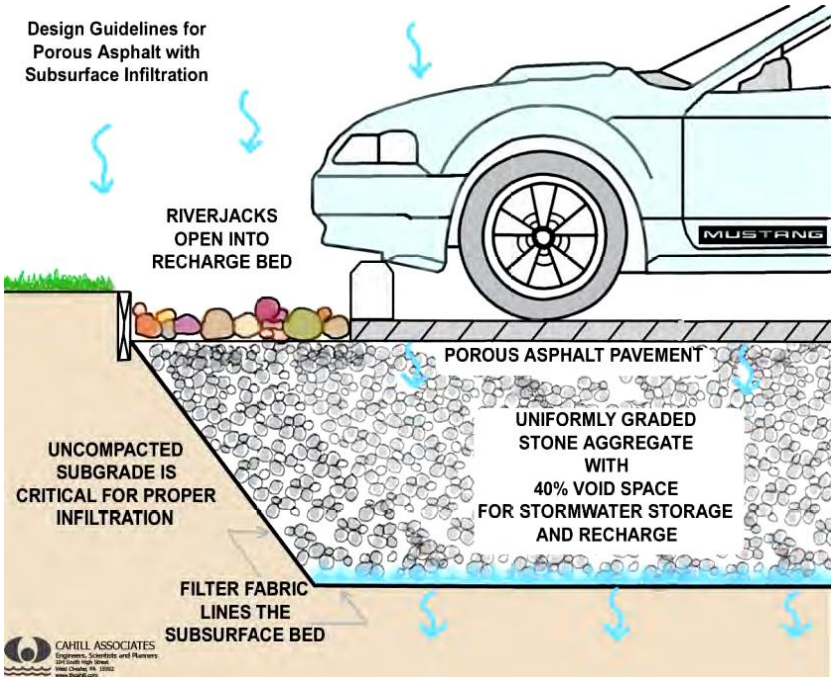


Figure 7-6. Diagram of the use of porous asphalt pavement in a parking lot.

Benefits of permeable pavement are reduced runoff through increased infiltration, reduced runoff without loss of parking, and the option of artistic design with pavers.

Permeable pavement is a great option for a retrofit project.

6.1.4.8 Planter Boxes

Planter boxes use high flow rate soil infiltration media to control and treat runoff from small parking lots or roadways. Runoff flows through the sandy soil mix, which traps solids and pollutants. As their name suggests, planter boxes also use vegetation to help absorb the water trapped by the soil. The plants also create a mini ecosystem within the soil, fostering healthy microbes that aid in breaking down of oil and grease. There is also the added aesthetic benefit of more trees, flowers, and shrubs.

Planter boxes make a great retrofit that needs very little land; however, assistance from a contractor will likely be required.

6.1.4.9 Rain Gardens

A rain garden is a small, shallow, vegetated area where rainwater collects during storms. Rain gardens are typically 4-8 inches lower than the surrounding lawn and act as a "bowl" that collects runoff. The plants and soil soak up the rain water before it becomes polluted runoff. Rain gardens can reduce stormwater runoff by 90% or more and over 25% of the population lists gardening as a hobby. For maximum benefit, observe water flow patterns during rain events to determine potential areas for rain gardens, use native plants for low maintenance, and make sure that water from rooftops and driveways is directed to the garden. Rain gardens can also increase the visual appeal of an area.

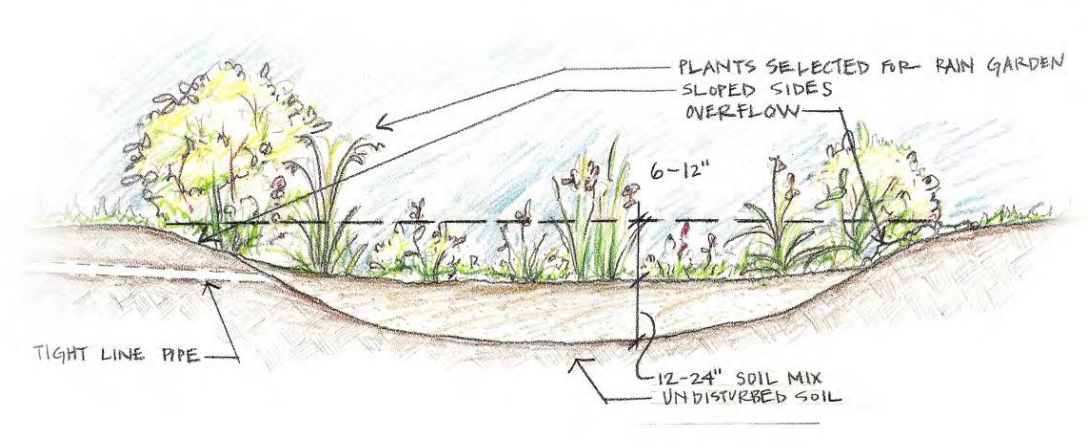


Figure 7-7. Diagram of a rain garden

6.1.4.10 Backyard Wetlands

Backyard wetlands are depressed wet areas that are planted with native wetland plants. They are designed to capture and treat stormwater similar to a rain garden but in locations with high water tables and soggy soil, such as areas of your yard that are usually wet for several days following a rain event. In addition to runoff capture and filtration, backyard wetlands also enhance the landscape and can provide bird and butterfly habitat.

Properties with trees are estimated to be valued 5-15% higher than comparable properties without trees.

6.2 Evaluate Options and Management Strategies

You will likely be choosing multiple LID techniques to implement throughout the life of your plan. Different techniques are more feasible for certain situations and some techniques may be received by your community better than others. In order for LID techniques to be effective, they have to be utilized, and community support of the chosen technique(s) will go a long way in the success of the implementation of your plan. The LID techniques that you choose to employ will be affected by many variables, such as the timeline of your management plan, cost effectiveness of various techniques, the extent/magnitude of your impairment, and land cover and types of development present. It is also important to prioritize your LID implementation efforts for optimal effectiveness. Since all of these factors will play into which LID techniques are most likely to be effective, the planning process should considered them all. No matter which techniques you choose to employ, it is important to make sure that the overall flow reduction goal determined in Chapter 6 are met. Chapter 8 provides a tool that will assist in determining which techniques or combination of techniques will reach your reduction goal.

6.2.1 Timeline for Your Management Plan

LID techniques can have a wide range of potential timelines for completion and/or implementation. Simple solutions such as rerouting downspouts, installing rain barrels, and creating rain gardens can be done on short timescales, while techniques such as site fingerprinting or cistern installation entail longer, more complicated processes. Also of note, some of the larger scale techniques may

require permits before implementation, which could further increase the timelines of their implementation.

6.2.2 Extend/Magnitude of Impairment

LID techniques have different levels of effectiveness in stormwater runoff reduction. The table below shows some common LID techniques along with their effectiveness in different scenarios.

Table 7-1. Various LID techniques, 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	Works with High Water Table?	Works with Poorly Drained Soils?
Rain garden	High	No	No
Backyard Wetland	High	Yes	Yes
Rainwater harvesting	Medium	Yes	Yes
Reroute downspout	Medium	Yes	Yes
Permeable pavement	Low	No	Yes

6.2.3 Cost Effectiveness

Different LID techniques have very different monetary requirements for implementation. Some techniques, such as cisterns, can potentially save money in the long run, but may have higher initial cost. Techniques such as rerouting downspouts are relatively inexpensive (on a per unit basis) but have a smaller overall effect on stormwater flow reduction than some other techniques.

Table 7-2. Approximate cost per unit of various LID techniques.

LID Technique	Cost per unit
Rain garden	\$3-\$12 per ft^2
Backyard wetland	\$170-\$550 depending on surface area
Rainwater harvesting	\$200/rain barrel, \$1,000/1400 gal cistern, \$10,000/10,000 gal cistern
Reroute downspout	\$9/downspout
Permeable pavement	\$8-\$12/ft^2 of pavement

6.2.4 Land Cover and Types of Development

The type of land cover that an area has can greatly affect the types of pollutant that are found in the resulting runoff as well as the feasibility of various LID techniques. For example, if your watershed is largely agricultural land, the use of cisterns may be a feasible option, while techniques such as planter boxes would be less effective. If your watershed is largely developed into residential plots,

utilization of techniques like rain gardens and rain barrels are practical, but cisterns (at least as a retrofit) are not. If the development present is more industrial or shopping centers, techniques such as permeable paving, planter boxes and disconnecting impervious surfaces may be effective.

6.2.5 Prioritization

The two main variables to consider when prioritizing your LID efforts are soil type and proximity to the coast. If the soil type at a location is not conducive to water infiltration there will be little effect on runoff volume with the implementation of LID techniques. Category A and B soils are the best at infiltrating water and if possible should be focused on for LID implementation while category D are the worst and should be avoided. Spatially, areas closest to the coast should be prioritized over areas that are farther inland and areas close to high runoff sources on soils that could be infiltrating stormwater should be given high priority.

7 DESIGN THE WATERSHED MANAGEMENT PLAN AND IMPLEMENTATION PROGRAM

7.1 PUTTING THE PIECES TOGETHER

Now that you have fully characterized your subwatershed and have learned about different types of management techniques you can begin to combine all of this knowledge to create a watershed management plan. This chapter will explain how to put all of the pieces together, plan for implementation, and develop an implementation schedule.

At this point in the planning process you have likely gathered a large quantity of data and information regarding your subwatershed and have calculated stormwater runoff values for your area of interest. The next step is to combine all of the pieces in order to select management strategies, establish criteria for measuring progress, and develop measureable milestones and monitoring components.

7.1.1 Select Management Strategies

As discussed in Chapter 7, there are many community and environmental concerns that you need to consider when choosing what management strategies to use. Next, decide which of these strategies, or combination thereof, will sufficiently reduce your runoff to accomplish your goals. To assist with this determination, an Excel toolset has been provided. The first tool is a "Scenario Tool" that will help you optimize the combinations of strategies that you use by providing an estimate of volume reduction and associated costs. The second tool is a "BMP Accounting Tool" and allows you to keep a running total of the volume reduction achieved through successful implementation of your chosen management strategies.

7.1.2 Establish Criteria to Measure Progress toward Meeting Watershed Goals

One of the EPA's key elements for a watershed management plan is to establish criteria with which to measure progress toward meeting watershed goals. This simply means that you need to determine what you are measuring and be able to directly relate the measurement to the goals of the project. Because the main focus of this guidebook is stormwater runoff volume reduction for restoring water quality, it is likely that the criteria to measure progress toward meeting water quality standards will be quite simple to establish. If your subwatershed management plan is in the state of N.C., then the main criteria for measuring progress will be the Shellfish and Sanitation data pertaining to fecal coliform and related water quality standards and shellfish closures. This can be quantified in the classification of water (SA, SB, SC) as well as through the four different levels of class SA waters. You can track success of your watershed management plan through the progression of waters from being closed to shellfish harvesting, conditionally approved closed, conditionally approved open, to approved. The other important criteria will be the amount of volume reduction as calculated from the LID activities installed as compared to the original stormwater runoff values.

You may also choose to consider important secondary goals when setting criteria to measure progress. For example if a significant secondary goal is to decrease the amount of erosion and subsequent sediment present in a waterbody the criterion could include measures of turbidity.

Once you have established the important criteria, you can then develop measurable milestones for tracking the progress of your watershed plan.

7.1.3 Develop Measureable Milestones to Track Management Measures

Another EPA key element of a watershed plan is a description of interim, measurable milestones for determining whether nonpoint source pollution management measures are helping to achieve goals. A milestone in this context can be seen as a sub-goal that shows your progression through the life of the plan. These are generally impressive achievements that will show the community and the stakeholders that actions are being implemented. It is important to develop milestones that are specific, measureable and achievable. Because the main goal of the watershed management plan is to restore water quality through volume reduction of surface runoff, primary milestones can be:

- A certain number of gallons reduced
- The number of shellfish harvesting areas reopened
- The number of acres no longer impaired
- The number of citizens educated on stormwater runoff and LID techniques

Additional milestones may also be created for important secondary concerns within the watershed. Milestones should be incorporated over the short-term (<2 years), mid-term (<5years), and long-term (≥*5* years). Short-term projects should be highly visible in order to demonstrate early success, but should also be achievable.

It is also crucial to determine how the milestones will be evaluated, and how this data will be collected and maintained. It would be meaningless to set a milestone of educating 10,000 citizens, if no one is keeping track of the number of participants in workshops and constantly updating the data. Similarly, there should be a system in place for when milestones are not being met, to re-evaluate the progress of the management plan.

7.1.4 Develop Monitoring Component

The next step in the process is to develop a monitoring component using the criteria that was just selected. Due to the specific nature of this guidebook, most of the monitoring component has already been developed. The Shellfish Sanitation Section of the N.C. DMF is responsible for monitoring the waters of the state with a special focus on shellfish harvesting and swimming waters. Areas that exceed the bacterial standard, or are adjacent to a known threat of pollution are closed to shellfish harvest by the state.

The shoreline surveys done by Shellfish Sanitation are redone every three years. You may request additional monitoring sites from Shellfish Sanitation in order to monitor progress in your watershed. Remember to keep track of the amount of volume reduction has been done in the watershed with the Scenario Tool discussed in 8.1.1.

Do not forget any monitoring components related to important secondary goals, if you choose to highlight them. For example, if sediment reduction is an important secondary goal in your subwatershed, do not forget to develop a monitoring component for turbidity. The EPA provides information and guidance for designing monitoring and sampling plans through their Guidance on Choosing a Sampling Design for Environmental Data Collection.

7.2 PLANNING FOR IMPLEMENTATION

7.2.1 Define Partner Responsibilities

Now that you've identified the techniques you will use to establish and monitor your watershed plan, it will be crucial to identify the roles that partners will play during the process. These roles will include resource and financial assistance, as well as ongoing management of the restored subwatershed. The Shellfish Sanitation Section may be able to conduct long term monitoring of the shellfish waters you wish to restore. Cooperative extension agents and storm water utility personnel can continue to educate stakeholders about the ongoing progress of the restoration and monitoring efforts. Any additional partners, such as the N.C. Coastal Federation, can assist in several ways including: assistance in drafting the implementation plan, in-kind volunteer hours, smaller scale LID installation, and navigating the implementation process.

7.2.2 Create an Implementation Budget

After selecting management strategies and designating partner responsibilities, you will have all the information needed in order to generate a budget for your plan. If you do not have sufficient financial knowledge to create a budget, you can again reach out to partners for assistance; one of more of your partners should be able to provide you with appropriate information or services. Your budget may not be a perfect reflection of the costs associated with your plan, but it will be necessary for defining the scope of your project and for acquiring funding for implementation.

In order to ensure the funding you have obtained will cover all expenses, you will need to allocate appropriate funds and to each step in the process, including permitting fees, staffing, labor, equipment, education/ outreach activities, and any outsourced work. You can use the Scenario Tool to estimate the cost of the LID techniques that will be installed as part of the implementation.

Remember that financial needs do not end with the completion of your restoration work. Monitoring costs can continue on for several years after implementation. Costs for long-term management can be difficult to foresee, but their inclusion in fund allocation will be critical to the success of your restoration project. Experienced partners, such as the N.C. Coastal Federation, can assist in estimating long term and overlooked costs for the life of your project.

7.2.3 Identify Necessary Technical Assistance

In conjunction with cost estimates, you should obtain technical assistance that will be required for implementation and long term monitoring of the subwatershed. In order to maintain the cost effective nature of this restoration, it will be necessary to reach out to partners for support before taking on any unnecessary and potentially costly tasks. Some resources, which partners can provide, such as access to implementation tools, education/outreach materials, and monitoring data, are discussed in Chapter 3 and Appendix C.

If you will be undertaking any large construction projects as part of your plan, turn again to partners and stakeholders, as some may have existing relationships with companies who can assist with such projects. When these resources cannot be obtained through partnerships, it may be

Figure 8-1. A contractor places the domes into the sound as part of a project in 2011.

necessary to entertain bids for the work. In fact, federal funding typically requires a competitive bid process be completed before the grantee can disburse project funds.

One technique to secure data necessary for the grant submission is to conduct the competitive bid process for work to be done during the project (if funded) prior to submission of the grant request. A stipulation in that bid process could be that the organization is willing to complete some of the baseline work needed in order to apply for funding. For example, if large amounts of water quality data are missing, a local organization may be willing to use their resources to conduct the necessary baseline sampling if they are chosen to be the designated grant project partner that will be compensated for water quality monitoring during the life of the management plan. If you will be entertaining bids, be forthcoming about the scope of the work, and rely on partners with appropriate expertise to oversee the bidding. This will decrease the chances of incurring unforeseen costs due to miscommunication or mishandling of the process.

7.2.4 Identify Funding Resources and Opportunities

Locating funding opportunities will be a crucial element of implementation planning. The majority of the funds for your project will come from 319 grant funds allocated by the N.C. DENR. However, this funding may not cover all expenses associated with your restoration. In addition, 319 funds are not guaranteed for all acceptable restoration plans.

Examples of other potential funding sources are listed below. This is not an exhaustive list and funding for environmental projects constantly change. Descriptions of some sources are taken verbatim from the source's website.

- N.C. DENR 319 Funding
  - Established by Section 319 of the Clean Water Act, this grant provides funding for efforts to reduce nonpoint source pollution.
- Community Resource Information System (CRIS)
  - "Helps local communities in North Carolina obtain information about state government financial assistance and other services."
- EPA Catalog of Federal Funding Sources for Watershed Protection
  - "The Catalog of Federal Funding Sources for Watershed Protection is a searchable database of financial assistance sources (grants, loans, cost-sharing) available to fund a variety of watershed protection projects."
- Grants.gov
  - Unified source to find and apply for federal grants. You can complete basic and advanced searches as well as search by grant category and agency. In addition, you can sign up to receive daily emails containing newly released grant notices that meet advanced settings set by you.
- National Fish and Wildlife Foundation (NFWF)
  - NFWF offers grants to promote conservation ("thematic and geographically based").
- N.C. DENR: Financial Resources for Watersheds
  - A source for water quality grants, cost shares, and loans.
- N.C. DENR Financial Assistance
  - Provides a list of grant opportunities, tax credits, and other financial assistance available from the N.C. DENR.
- NOAA Fisheries Office of Habitat Conservation Grant Database

- "NOAA awards grants and cooperative agreements to support research and conservation initiatives coordinated by state and local governments, non-profits, colleges and universities."

- UNC Environmental Finance Center Resource
  - PDF summary of N.C. water, wastewater and stormwater funding programs.

Remember: If you take on larger scale projects, check with relevant government agencies to ensure you have all required permits before work begins.

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7.3 Develop the Implementation Schedule

If you have followed the steps presented in this guidebook, you should have identified most of the pertinent information to include in your subwatershed restoration plan. A critical subset of the overall plan is to develop a sound implementation schedule that identifies responsible parties' level of involvement, financial and technical needs, monitoring efforts, and timeline. Having a good implementation schedule might also be helpful in securing funds for implementation. The schedule will lay out a detailed plan for meeting the goals and objectives of your subwatershed restoration.

7.3.1 What to Include

The implementation schedule should encompass all the essential elements of the restoration. Ultimately, it will map out your plan for reestablishing coastal water quality through surface runoff reduction techniques. For the implementation schedule, you will need to break down the management objectives described in Chapter 4 into specific, achievable actions that will guide you through the restoration process. Remember, you can incorporate other objectives into your plan, but the six provided in this guidebook are a good starting point for a successful plan. An example of an approved implementation schedule based on these six objectives can be found in Appendix F.

When developing your specific actions, keep in mind the milestones and ultimate goals that you have outlined for the restoration plan. This will serve to keep actions focused and specific. Each action should be assigned a timeline, which can be ongoing, yearly or over the course of several years. Furthermore, the partners who will assist in accomplishing each action should be included in the schedule. Be as precise and realistic as possible when drafting this schedule. Entering this information into a matrix format will be helpful in development; it will also make the schedule easier for partners, stakeholders and the EPA to follow.

Although the Bradley and Hewletts Creek Plan focuses only on the actions, timeline and partners, some plans may also include the cost, funding source, and educational aspect for each action. When properly executed, the implementation schedule will act as a guide for measuring the progression and ultimately the success of your restoration.

7.3.2 Measuring Progress

In order to track the progress of your restoration, you will need to compare the reality of subwatershed conditions to the timeline of the implementation schedule. In order to make these comparisons, regularly obtain new data for your subwatershed over the course of the restoration.

It will be imperative to know of changes in shellfish area designations, swimming closures and volume reduction throughout the subwatershed.

7.3.2.1 Shellfish Sanitation Data

The Shellfish Sanitation Section releases new shoreline survey data every three years; this data should be obtained as it is available and analyzed for any improvements that might be attributed to your restoration. One indication of improved water quality will be a decrease in the size of currently prohibited shellfish waters. As shellfish waters become contaminated and are subsequently closed, the closures typically begin upstream and gradually expand downstream. Look for shellfish waters to show improvement in the opposite direction, beginning downstream and slowly expanding upstream as water quality improves.

Additionally, changes in management strategies of shellfish beds will be an indicator of improved water quality. For example, The N.C. Shellfish Sanitation Section classifies shellfish waters into four categories: Approved, Conditionally Approved – Open, Conditionally Approved – Closed, and Prohibited. In some cases, waters which are classified as Approved are in reality managed as conditionally approved areas. Therefore, an improvement in the quality of these waters will not result in a change in classification, but rather a change in how they are managed. In order to determine if water quality has improved in these areas, you will need to ask Shellfish Sanitation if there have been changes in management practices.

Six Management Objectives

1. **Continue existing programs that address water Quality Impairments.**
2. **Determine appropriate water quality classifications and designated uses where water quality impairment exists.**
3. **Track the reduction of the transport of bacteria from land to water.**
4. **Promote / focus stormwater reduction efforts.**
5. **Form and maintain partnerships.**
6. **Evaluate success and modify plan based upon results.**

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Shellfish Sanitation has a number of monitoring sites that have been abandoned over the years due to prolonged water quality impairments. As part of the monitoring component of your plan, coordinate with Shellfish Sanitation to reopen any abandoned stations. Data from these stations can provide further evidence of water quality improvement in the vicinity of your watershed.

The Recreational Water Quality Program, part of the Shellfish Sanitation Section, conducts regular water quality testing along N.C. shorelines. As an additional part of the monitoring component of your watershed plan, you should track the number of swimming advisories posted near your restoration site. A reduction in the number of advisories within the vicinity of your project will serve as an indication that your restoration efforts are having a positive effect on coastal water quality.

7.3.2.2 Volume Reduction Data

Based on the methods put forward in this guidebook, reductions in the volume of runoff entering your subwatershed will be a key indicator for determining the success of your restoration. While it may take decades to meet water quality improvement goals, significant decreases in the volume of runoff entering the subwatershed can be realized more quickly. To determine the level of reduction achieved by the landscape changes made during your restoration, use the Scenario Tool associated with this handbook. This is the same tool that was presented in Section 8.2.2 to assist with formulation of a restoration budget. In addition to providing cost estimates, the tool measures the reduction in surface runoff associated with several landscape modifications; for example, a single rain garden can absorb 100 cubic feet of surface runoff. The tool also measures percent of volume reduction in relation to project goals. As LID techniques are installed, you can track the volume of water that is no longer reaching the surface waters of the subwatershed during storm events. These features facilitate the evaluation of actions, milestones and ultimately restoration goals.

If you have the resources, you may be interested in developing more complex tracking tools that provide greater functionality. Tools of this nature have been developed during the implementation of other watershed management plans. For example, for the Bradley & Hewletts Creek plan, engineers from Withers & Ravenel developed a GIS based BMP Atlas that is available online. This website allows the City of Wilmington's Watershed Coordinator to add projects at any stage of development and track the progress toward volume reduction goals in any of the catchments in the region. This tool also allows the public to see what progress is being made and allows anyone to submit a project that they are undertaking. If you are interested in producing a more complex tool like the Atlas, you will need technical support and the monetary and staffing resources to run and maintain the program.

8 DRAFT THE PLAN

8.1 THINGS TO CONSIDER WHEN DRAFTING THE PLAN

The key to an effective watershed management plan is to keep the plan realistic. Given available resources, the plan should indicate plausible solutions that are citizen-focused and partnership-based. A comprehensive plan will address all the possible stormwater runoff bacterial inputs and take into consideration the varying range of conditions found within the watershed. It is important that the plan be specific on volume reduction targets and management goals.

The best watershed management plans include photographs and maps of the project area. You should have already obtained aerial photographs in Chapter 5 and used them to determine volume reduction goals in Chapter 6. Embedding a visual representation within the plan allows managers, stakeholders, and community members to understand the scope of the project. Your plan should also include methods to reduce stormwater runoff volume and to improve water quality. Refer back to Chapter 7 for LID management techniques.

8.2 INTEGRATING THE EPA AND N.C. DENR REQUIREMENTS

Before you begin writing, recall the two separate lists of federal and state requirements considered integral to a watershed management plan that were discussed in Sections 2.2 and 2.3.

First, the EPA recommends integrating the nine elements of a watershed management plan that are required to qualify for EPA 319 funding, discussed in detail in Section 2.2. These nine elements are best assimilated within the actual watershed management plan. In order for a watershed management plan to serve in lieu of a TMDL, the EPA and DENR recommend including the six elements below. Incorporating these six elements in the management plan now is beneficial even if your community does not intend to use this plan in lieu of a TMDL. If it should be required to prepare a TMDL sometime in the future for your watershed, then including the EPA suggestions today will allow your plan to be used as an alternative management measure to obviate the need for a TMDL.

Six Elements for TMDL Exemption – N.C. DENR Requirements

1. Identification of segment and statement of problems causing the impairment.
2. Description of pollution controls and how they will achieve water quality standards.
3. An estimate or projection of the time when water quality standards will be met.
4. Schedule for implementing pollution controls.
5. Monitoring plan to track effectiveness of pollution controls.
6. Commitment to revise pollution controls, as necessary.

8.2.1 Combined Elements that Satisfy Both EPA and N.C. DENR Requirements

To satisfy both the federal and state requirements for watershed restoration plans, your plan should include the following elements:

1. Identify impairment and causes of pollution that need to be controlled. .Include a map of the watershed that identifies the major causes of impairment (increased volume of stormwater runoff) and address natural background levels of fecal coliform.
2. Volume reductions of stormwater needed to meet water quality standards. Established by using the tools outlined in Chapter 6.
3. Detailed management measures to achieve necessary load reductions determined in Step 2 above. Address numeric volume reduction goals as well as any secondary goals (e.g., flood control).
4. Plan implementation schedule spread over five year periods.
5. Interim, measurable milestones or benchmarks to track implementation of management measures.
6. Criteria to measure progress toward meeting watershed goals:
    a. The indicator criteria will be fecal coliform (for shellfishing waters) or enterococci (for swimming waters)
    b. Direct measurements (such as bacterial counts) or indirect measurements (such as number of swimming advisories).
    c. Should address how to proceed/modify strategies if interim goals are not being met.
7. Monitoring component to evaluate the effectiveness of implementation over time.
8. Information/education component:
    a. Used to enhance public understanding of the project.
    b. Encourages early and continued involvement in selecting, designing, and implementing nonpoint source management measures to be put into practice.
9. Identification of technical and financial assistance needed to implement as well as long-term operation and maintenance measures:
    a. Estimate amount of technical and financial assistance needed.
    b. Document relevant authorities that may have a role in management plan.
    c. Identify federal, state, local, and private funds or resources that could potentially assist.
    d. Identify and address any shortfalls between needs and resources.
10. Commitment to revise pollution controls, as necessary, if progress toward achieving water quality goals is not shown through the monitoring. Identify how any revisions to the original demonstration will be reported to DENR.

8.3 MAJOR SECTIONS TO INCLUDE IN THE PLAN

Now that you have revisited the critical elements to include in the watershed management plan, is finally time to begin drafting the plan. Most plans typically include six main sections:

- Executive Summary
- Introduction
- Characterization of the Watershed
- Management Recommendations
- Implementation Strategy
- Monitoring and Measuring Progress

8.3.1 Executive Summary

As with all executive summaries, it is important to provide a clear and concise highlight of your watershed characterization, numeric target goals, and the proposed management recommendations. You should also include a brief summary of the purpose for creating this plan

(e.g., to reopen shellfishing waters or decrease the number of beach closures) and mention all partners involved in the planning process.

8.3.2 Introduction

The introduction should provide a project manager a comprehensive overview of the targeted project. The goal of this section is to give the reader a basic understanding of the plan. Included should be information on the watershed, surrounding communities, and major stormwater runoff problem areas. You want to also identify stakeholders and partners involved and acknowledge their critical role in the planning and implementation process. Finally, be sure to discuss the vision for the watershed and how this project will improve on that vision.

8.3.3 Characterization of the Watershed

Chapters 4 and 5 took you through the process of gathering a watershed inventory to characterize your watershed. You should provide a description of this inventory and analysis of the current state of your watershed in the management plan. This ought to include: a history the project area, physical description of the watershed, land use and land cover changes that have altered the natural hydrology, water quality impairments and bacteria levels of concern, causes for impairment (e.g., stormwater runoff from X land use), and current/past restoration efforts. It should describe the exact location of the watershed and include specific volume reduction goals to improve water quality. The characterization should include: (1) Identify impairment and causes and sources of pollution that need to be controlled and (2) Volume reductions needed to meet water quality standards.

8.3.4 Management Recommendations

This section should identify all existing management strategies that the plan recommends be continued, and it should identify additional actions intended to reduce runoff volume and improve water quality. The overall objectives and management actions you want to take should be clearly described. For each objective, there should be a list of specific management actions identified. A timeline for carrying out each management action and who will partner to perform the task should also be identified. The following six objectives may provide a useful framework to organize management actions:

- Continue Existing Programs that Address Water Quality Impairments
- Determine Appropriate Water Quality Classifications and Designated Uses Where Water Quality Impairments Exist
- Track the Reduction of the Transport of Bacteria from Land to Water
- Promote Stormwater Reduction Efforts
- Form and Maintain Partnerships
- Measure Success and Adapt Plan Based Upon Results

An example of this format as it was used by the City of Wilmington in the Bradley and Hewletts Creeks Watershed Restoration Plan is discussed in Chapter 4, section 4.1.1, and a summary table of these management actions are provided in Appendix F.

8.3.5 Implementation Strategy

Within this section you should explain who will be responsible for carrying out the recommended actions in the plan. This section should identify technical and financial assistance that will be

needed, how the public will be educated and engaged in the plan, and the overall schedule for implementing it.

8.3.6 Monitoring and Measuring Progress

Methods of monitoring and measuring progress are usually elaborated on within the implementation schedule. This section should outline a long-term monitoring plan. Included should be ways you intend to use indicators to track milestones and overall progress. Remember to allow for flexibility within the plan so that it can be improved as new information or data arises.

CONCLUSION

Overall, this guidebook:

- Provides instruction for understanding your subwatershed;
- Prepares you to connect with the community; and
- Outlines steps to repair water quality through runoff reduction measures.

Previous chapters supply a comprehensive framework for the setup and implementation of watershed restoration in a simple yet effective way. The techniques described focus on reducing stormwater runoff volume and explain how to replicate natural hydrology in a timely and cost efficient manner. Fittingly, procedures outlined meet EPA requirements, and using the steps provided will set the tone for successful water quality restoration along the N.C. coast. In addition, these measures can be used to protect coastal water quality that is not yet impaired by pollution.

Reflected throughout the guidebook are lessons learned from previously prepared and implemented watershed restoration plans that the N.C. Coastal Federation has helped to develop (Bradley and Hewletts Creeks, Lockwoods Folly River, White Oak River and Mattamuskeet Drainage Association plans). These plans provide real-world and tangible examples of how diverting stormwater to restore natural hydrology can positively influence coastal water quality.

As observed with these projects, to successfully reach restoration goals it is necessary to:

- Research and gain an understanding of your subwatershed;
- Encourage outside participation and incorporate outreach efforts;
- Pool together quality data;
- Generate realistic goals for stormwater volume reduction;
- Identify management techniques;
- Plan ahead for project implementation; and
- Monitor and Evaluate efforts along the way.

RESEARCH AND GAIN AN UNDERSTANDING OF YOUR SUBWATERSHED

In order to restore the water quality within your watershed you must first know how its waters and surrounding environments work. Take time to determine environmental features, land uses, and current and natural hydrologies so you can prepare for restoration. (*Chapters 4 & 5*)

ENCOURAGE OUTSIDE PARTICIPATION AND INCORPORATE OUTREACH EFFORTS

Be willing to spend quality time gaining outside support for your project. Reaching out to stakeholders and partners will set a foundation for both planning and implementation. Partners may also provide vital funding and information that can support the needs and resources of your project. (*Chapter 3*)

Keep the lines of communication open through strong education and outreach efforts. Once the watershed plan has been developed it is important to continue education and outreach to ensure both public and partner knowledge and involvement. Doing so will strengthen support for the project and keep others updated on progress. (*Chapter 3*)

POOL TOGETHER QUALITY DATA

Work alongside partners to find relevant data. This data will provide a baseline for future monitoring and assist in defining goals. (*Chapter 5*)

GENERATE REALISTIC GOALS FOR STORMWATER VOLUME REDUCTION

Formulate clear, measurable, and realistic goals that can easily be evaluated once project implementation begins (*Chapter 4*). Primary goals should center on stormwater volume reduction by restoring or mimicking natural hydrology. Secondary goals may allude to alternative benefits such as flood or erosion controls. Once you have calculated the historic and current runoff volumes, you can then subtract the two to define volume reduction goals (*Chapter 6*).

IDENTIFY MANAGEMENT TECHNIQUES

Decide which Low Impact Development (LID) and best management strategies will work in your watershed. Using these measures to infiltrate, filter, store, or evaporate stormwater can protect water quality in a smart, efficient way. (*Chapter 7*)

PLAN FOR PROJECT IMPLEMENTATION

Begin putting the pieces of your plan together by combining knowledge gained from runoff calculations, and data collection. This information linked with project goals can be used to develop an implementation schedule that prepares for project delivery. (*Chapter 8*)

MONITOR AND EVALUATE EFFORTS ALONG THE WAY

Keep track of project efforts by monitoring progress throughout. Your plan should become a "living document" that follows an adaptive management methodology. Evaluation should be used to highlight things that are working in addition to areas that need improvement. Utilizing the information gained in evaluations and applying it toward overall project improvements will supplement management efforts (*Chapter 8*).

Once you have included the components listed above, you can then begin to compile and draft your plan while integrating key requirements (*Chapter 9*).

With 320 miles of ocean beaches and more than 12,000 miles of shoreline around our coastal sounds, rivers and creeks, the N.C. coast is one of the largest, most productive and spectacular

coastal areas in the United States. While the coast remains in relatively good shape, water quality impairments are spreading due to changes in hydrology caused by land use practices that create more polluted runoff. Being intentional to restore these environments now will help ensure their health for future generations. Since traditional uses, such as fishing and swimming, are increasingly threatened, it has become ever pressing to find efficient solutions for restoring our waters. The methods illustrated in this guidebook can be used to reduce the volume of stormwater entering watersheds in both urban and rural landscapes, and provide meaningful opportunities for coastal communities to work together for a healthy coast.

APPENDIX A: QUICK GUIDE

Below is a checklist of steps for developing a watershed management plan. This is a very brief checklist, and more information regarding each portion of the process can be found within the guidebook itself.

- ☐ Identify potential partnerships (Chapter 3)
  - Develop a core project team
  - Identify other stakeholders
  - Stakeholder integration/public information session
  - Consider community input
- ☐ Build support through outreach and education (Chapter 3)
  - Enhance public understanding of the project
  - Encourage early and continued involvement in selecting, designing, and implementing nonpoint source management measure to be put into practice
  - Define outreach goals
  - Identify and analyze the target audience
  - Create the messages for each audience
  - Package the messages for various audiences
  - Distribute the messages
  - Evaluate the information/education program
- ☐ Set planning goals (Chapter 4)
  - Primary goal: To improve water quality through stormwater volume reduction, with a specific focus on shellfish harvesting and swimming waters
    - Indicators are fecal coliform and enterococci
  - Develop secondary goals (ex. flooding, sediment erosion, recreational hazards, eutrophication)
    - Develop indicators (ex. Sedimentation, indicators could be turbidity or TSS)
- ☐ Characterize your watershed (Chapter 4 & 5)
  - Delineate your watershed
  - Determine the applicable classifications for your waterbody
  - Is your waterbody on the 303d impaired list?
  - Has a TMDL has been established for your watershed?
- ☐ Find Data (Chapter 5)
  - Historical and current water quality data from the Shellfish Sanitation Section of DMF
  - Aerial photography
  - Parcel Data
  - Soils
  - Model storm parameters for a 1—year 24—hour storm
  - Existing land management strategies
  - Pollutant sources
    - Point sources
    - Nonpoint sources
  - Other data as needed
- ☐ Organize Data (Chapter 5)

- Make a data inventory
- Do you have data for all the essential indicators that you selected?
- Are you missing data from a certain time frame or area?
  - Ex. Shellfish Sanitation may have closed areas for monitoring in or around your watershed. In this case, you should submit a request to have these areas reopened for monitoring.
- Is your Data Accurate?
  - Ex. Is your waterbody classified correctly? If you believe your waterbody is classified incorrectly you should request sampling form DENR to consider reclassification.

- Establish volume reduction goals (Chapter 6)
  - Formalize a baseline year
  - Characterize current and historic land use
  - Use the Volume Reduction Goals Excel tool to calculate volume reduction goals
- Identify potential management techniques (Chapter 7)
  - Low Impact Development (LID)
    - Site fingerprinting
    - Native landscaping
    - Disconnect impervious surfaces
    - Reroute downspouts
    - Rain barrels
    - Cisterns
    - Permeable pavement
    - Planter boxes
    - Rain gardens
    - Backyard wetlands
- Evaluate options and management strategies and select using the Excel tool (Chapter 7 & 8)
  - Extent of impairment
  - Cost effectiveness
  - Land cover and types of development
  - Soil type
  - Effectiveness
  - Prioritization of LID techniques
- Design the watershed management plan (Chapter 8)
  - Establish criteria to measure progress toward meeting watershed goals
  - Develop measurable milestones to track management measures
  - Develop a monitoring component if necessary
  - Define partner responsibilities
  - Create an implementation budget
  - Identify necessary technical assistance
  - Identify funding resources and opportunities
- Develop the implementation schedule (Chapter 8)
  - Create management objectives
  - Develop achievable actions
  - Plan for measuring progress throughout the project
- Draft the plan (Chapter 9)

- Include the following EPA and N.C. DENR requirements
  - Identify impairment and causes and sources of pollution that need to be controlled
  - Load reductions needed to meet water quality standards
  - Detailed management measures to achieve necessary load reductions determined in component II
  - Plan implementation schedule
  - Interim, measurable milestones to track implementation of management measures
  - Criteria to measure progress toward meeting watershed goals
  - Monitoring component to evaluate the effectiveness of implementation over time
  - Information/education component
  - Identification of technical and financial assistance needed to implement as well as long-term operation and maintenance measures
  - Commitment to revise pollution controls, as necessary, if progress toward WQS is not shown through the monitoring
- Major sections to include in the plan
  - Executive summary
  - Introduction
  - Characterization of the watershed
  - Management Recommendations
  - Implementation strategy
  - Monitoring and measuring progress

APPENDIX B: WATERSHED PLANNING CONTACTS

In this section you will find a variety of potential stakeholders for your watershed management project. Websites are included and potential needs they could fulfill are italicized. Every organization on this list will not need to be involved in every watershed management project, and the list is not a complete list of all possible stakeholders, but is a good resource to get you started in stakeholder identification. Likewise, the potential roles of these organizations are not limited to the roles identified herein.

LOCAL

Access to local government sites can provide links to possible stakeholders such as local officials and department agency staff.

LANDOWNERS

A list of landowners can be requested from the county register of deeds in which your project will take place. You can search for local offices within your subwatershed & coordinate landowner communication efforts.
http://www.ncard.us/

- *Active participants*
- *Opponents*
- *Local knowledge*

LOCAL BUSINESSES

Local N.C. Chambers of Commerce can connect you with businesses in your area.

http://www.ncchamber.net/mx/hm.asp?id=localchambers

- *Potential Volunteers*
- *Funding*
- *Local knowledge*

LOCAL GOVERNMENTAL

Elected officials & Agency staff

North Carolina General Assembly – Who Represents Me?

http://www.ncleg.net/representation/WhoRepresentsMe.aspx#byRegistration

N.C. (State) Representatives

N.C. (State) Senators

N.C. United States Representatives

(2) N.C. United States Senators

- *Administrative Policy*
- *Funds appropriation*
- *Public education*

Public Works
http://www.sog.unc.edu/node/723.

Parks & Recreation Programs

- *Informational resource*

Stormwater Management Programs

- *Informational resource*

Solid Waste Programs

- *Outreach partner*

Planning & Zoning Programs

- *Informational resource*
- *Identification of critical water resources*

Water & Sewer Programs

- *Locate water supplies & discharge sites*
- *Outreach partner*

N.C. Cooperative Extension Offices
http://www.ces.ncsu.edu/local-county-center/(Click on County)

- *Coordination & planning*
- *Water quality informational resources*
- *Public education*

N.C. Conservation Districts (Contact info & links)
http://www.nacdnet.org/north-carolina/

- *Technical assistance*
- *Informational resources*
- *Public education*
- *Potential volunteers*

N.C. Natural Resources Conservation Service
http://www.nc.nrcs.usda.gov/

- *Informational resource on conservation practices*

N.C. Coastal Resources Advisory Council
http://portal.ncdenr.org/web/cm/coastal-resources-advisory-council-members

- *Regulatory information & assistance*

- *Technical Advice*

N.C. Coastal Resources Commission
http://portal.ncdenr.org/web/cm/crc-members

- *Regulatory information*

LOCAL NON-GOVERNMENTAL CONTACTS

Volunteer Monitoring Programs & Watershed Organizations
Albemarle-Pamlico Citizens' Monitoring Network

http://portal.ncdenr.org/web/apnep/cmn

Cape Fear River Watch

http://www.capefearriverwatch.org/

Pamlico-Tar River Foundation

http://www.ptrf.org/index.php

- *Coordination & planning*
- *Water quality data*
- *Informational resource*
- *Potential volunteers*
- *Outreach partner*

N.C. Association of Conservation Districts
http://www.ncaswcd.org/

- *Informational resource*
- *Assist in protection of natural resources, including waters*

STATE

State Grant Database
http://data.osbm.state.nc.us/cris/cris_new.html

- *Info on N.C. grants*

N.C. Source Water Assessment and Protection (SWAP) Programs
http://swap.deh.enr.state.nc.us/swap/pages/swap.htm

- *Informational resource*
- *Funding / resource partner*

N.C. Division of Water Resources
http://www.ncwater.org/

- *Informational resource*

- *Financial assistance through grants and loans*
- *Public education*

N.C. Department of Environment and Natural Resources
http://www.ncdenr.gov/web/guest

- *Provides information on environmental regulations*
- *Partner for grants*

N.C. Ecosystems Enhancement Program
http://portal.ncdenr.org/web/eep

- *Provides information on wetland and waterway restoration*

N.C. Division of Coastal Management
http://dcm2.enr.state.nc.us/about_dcm.htm

- *Provides information on coastal zone regulations*
- *Provides GIS data on wetlands in the coastal plain*
- *Monitoring*
- *Public outreach & participation*

N.C. Department of Transportation
http://www.ncdot.gov/

http://www.ncdot.gov/programs/environmental/

- *Infrastructure information*

N.C. Wildlife Resources Commission
http://www.ncwildlife.org/

- *Informational resource*
- *Potential volunteers*
- *Monitoring*

N.C. Division of Marine Fisheries
http://portal.ncdenr.org/web/mf/

- *Information on oyster shell sanctuaries & restoration*
- *Data source*

N.C. Division of Public Health
http://publichealth.nc.gov/

- *Informational resource*

N.C. TMDL Program
http://portal.ncdenr.org/web/wq/ps/mtu/tmdl

- *Water impairment information*

N.C. Nonpoint Source Management Program
http://portal.ncdenr.org/web/wq/ps/nps

- *Technical assistance*
- *Potential funding source*

Shellfish Sanitation Program
http://portal.ncdenr.org/web/mf/shellfish-sanitation-and-recreational-water-quality

- *Informational resource*
- *Monitoring*

N.C. Department of Environment and Natural Resources
http://portal.ncdenr.org/web/wq

http://portal.ncdenr.org/web/mf/recreational-water-quality

- *Baseline data*
- *Monitoring*

USDA Wetland Reserve Program (MOVE TO FEDERAL GOVT)
http://www.nc.nrcs.usda.gov/programs/WRP/

- *Outreach partner*
- *Monitoring coordination*

N.C. National Estuarine Research Reserve System (NERRS)
http://dcm2.enr.state.nc.us/about_dcm.htm

- *Outreach partner*
- *Monitoring*

N.C. Coastal Land Trust (move to NGO List)
http://www.coastallandtrust.org/

- *Acquire land for restoration projects*

N.C. Coastal Federation (Move to NGO List)
http://www.nccoast.org/

- *Coordination & planning*
- *Outreach partner*
- *Potential volunteers*
- *Active participants*

N.C. REGIONAL

N.C. Regional Councils of Government
http://www.nctomorrow.org/regional-councils/

(For coastal councils, click on regions O, P, Q and R)

Southeast N.C. Coast
North Carolina Resource Conservation & Development
http://www.capefearrcd.org/welcome.html

- *501c(3) Grant Fiscal Agent*
- *Project Management*
- *Grant Research*
- *Grant Administration / Bookkeeping*
- *Technical Assistance with funded project*
- *Grant Writing*
- *Project Planning*

Cape Fear River Watch
http://www.capefearriverwatch.org/

- *Public education about watershed restoration efforts*
- *Public engagement*
- *Water quality data / monitoring*

Museum of Coastal Carolina
http://museumplanetarium.org/museum-of-coastal-carolina/

- *Venue for public education / outreach*

CENTRAL N.C. COAST

Neuse River Foundation, Inc. (Move to NGO List)
http://neuseriver.org/

- *Public education about watershed restoration efforts*
- *Public engagement*
- *Water quality data / monitoring*

NORTHEAST N.C. COAST

-

FEDERAL GOVERNMENT

The Online Catalog of Federal Domestic Assistance
https://www.cfda.gov/

- *Lists federal programs that can be used for grant and funding opportunities*

Environmental Protection Agency
http://water.epa.gov

- *Guidelines*
- *Grants*

- *Informational resource*

EPA Stormwater Program
http://cfpub.epa.gov/npdes/home.cfm?program_id=6

- *Guidelines*
- *Informational resource*

NOAA Coastal Service Center
http://www.csc.noaa.gov/

- *Geospatial tools*
- *Training tools*
- *Informational tools*
- *Nonpoint source pollution program information & tools*
- *Technical assistance*

NOAA Habitat Restoration Center
http://www.habitat.noaa.gov/restoration/index.html

- Information on federal projects
- Possible grant opportunities

NOAA / EPA Smart Growth Program
http://coastalsmartgrowth.noaa.gov/

http://www.epa.gov/smartgrowth/sg_implementation.htm#noaa

- *Informational resources*

FWS Coastal Program
http://www.ncwildlife.org/

http://www.fws.gov/raleigh/cp.html

- *Informational resource*

US Department of Agriculture
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/

- *Current programs*
- *Possible funding / grants*

US Department of Transportation
http://www.fhwa.dot.gov/environment/

- *Informational resource*

USGS Coastal Restoration
http://www.nwrc.usgs.gov/about/crab/crab.htm

- *Informational resource*

Bureau of Land Management
http://www.blm.gov/wo/st/en/prog/more/land_records.html

- *Land records (informational / data resource)*

US Fish and Wildlife (Coastal Program)
http://www.fws.gov/coastal/

- *Informational resource*

NATIONAL NON-GOVERNMENTAL

The Wetlands Regulation Center (Env. Technical Services Co.)
http://www.wetlands.com/regs/tlpge00a.htm

- *Regulatory information resource*

National Fish & Wildlife Foundation
http://www.nfwf.org/Pages/default.aspx#.UbYc9ECyDg8

- *Informational resource*
- *Grants (ex: Conservation Partners Program)*

Sea Grant (N.C.)
http://www.ncseagrant.org/home/coastal-connections

- *Informational resource*
- *Outreach*

Association of Clean Water Administrators
http://www.acwa-us.org/#!partnerships-&-collaboration

- *Informational resource*
- *Outreach partner*

EDUCATIONAL INSTITUTIONS

Many times local community colleges and state universities can support the subwatershed plan by gathering or collecting data and by aiding in implementation and evaluation processes. Academic institutions can also serve as venues for outreach opportunities, and supply volunteers. Faculty from environmental and science related departments may also have access to useful data and/or technology.

Coastal Community Colleges

College	Location	Website
Beaufort County Community College	Washington, N.C.	http://www.beaufortccc.edu/

Brunswick Community College	Supply, N.C.	http://www.brunswickcc.edu/
Cape Fear Community College	Wilmington, N.C.	http://www2.cfcc.edu/
Carteret Community College	Morehead City, N.C.	http://www.carteret.edu
Coastal Carolina Community College	Jacksonville, N.C.	http://www.coastalcarolina.edu/
Craven Community College	New Bern, N.C.	http://www.cravencc.edu/
College of the Albemarle	Elizabeth City, N.C.	http://www.albemarle.edu/
Pamlico Community College	Grantsboro, N.C.	http://www.pamlicocc.edu/
Roanoke-Chowan Community College	Ahoskie, N.C.	http://www.roanokechowan.edu/

Major N.C. Universities

University	Location	Website
Appalachian State University	Boone, N.C.	http://www.appstate.edu/
Duke University	Durham, N.C.	http://duke.edu/
East Carolina University	Greenville, N.C.	http://www.ecu.edu/
Elizabeth City State University	Elizabeth City, N.C.	http://www.ecsu.edu/
Fayetteville State University	Fayetteville, N.C.	http://www.uncfsu.edu/
High Point University	High Point, N.C.	http://www.highpoint.edu/
Meredith College	Raleigh, N.C.	http://www.meredith.edu/
North Carolina A & T State University	Greensboro, N.C.	http://www.ncat.edu/
North Carolina Central University	Durham, N.C.	http://www.nccu.edu/

North Carolina State University	Raleigh, N.C.	http://www.ncsu.edu/
Shaw University	Raleigh, N.C.	http://www.shawu.edu/
University of North Carolina at Asheville	Asheville, N.C.	http://unca.edu/
University of North Carolina at Chapel Hill	Chapel Hill, N.C.	http://unc.edu/
University of North Carolina at Charlotte	Charlotte, N.C.	http://www.uncc.edu/
University of North Carolina at Greensboro	Greensboro, N.C.	http://uncg.edu/
University of North Carolina at Pembroke	Pembroke, N.C.	http://uncp.edu/
University of North Carolina at Wilmington	Wilmington, N.C.	http://uncw.edu/
Wake Forest University	Winston Salem, N.C.	http://www.wfu.edu/
Western Carolina University	Cullowhee, N.C.	http://www.wcu.edu/

The following institutions also have water resource or coastal and marine programs. These institutions may be of interest when planning subwatershed management in coastal specific environments:

Coastal/Marine or Water Resource Programs
Duke University *Nicholas School of the Environment: Marine Lab* *Address: 135 Duke Marine Lab Rd, Beaufort, N.C. 28516* *Phone:(252) 504-7503* http://www.nicholas.duke.edu/marinelab/

*Inter-university research institute

Coastal Studies Institute

Mailing Address: PO BOX 699, Manteo, N.C. 27954

Research & Education Campus: 850 N.C. 345, Wanchese, N.C. 27981

Phone:(252) 475-5400

http://csi.northcarolina.edu/

North Carolina State University

Center for Marine Sciences and Technology

Address: 303 College Cir, Morehead City, N.C. 28557

Phone: (252)222-6302

http://www.cmast.ncsu.edu/

Water Resources Research Institute

Address: 1575 Varsity Drive, Module 7, NCSU Campus Box 7912,

Raleigh, NC 27695

Phone:(919) 515-2815

http://www.ncsu.edu/wrri/

University of North Carolina at Chapel Hill

UNC Institute of Marine Sciences

Address: 3431 Arendell St, Morehead City, N.C. 28557

Phone:(252) 726-6841

http://ims.unc.edu/

University of North Carolina Wilmington

UNCW Center for Marine Science

Address: 5600 Marvin K Moss Ln, Wilmington, N.C. 28409

Phone:(910) 962-2301

http://uncw.edu/cms/

APPENDIX C: GENERAL INFO FOR IDENTIFYING AND INTEGRATING STAKEHOLDERS

Stakeholders, as defined by the EPA's "Handbook for Developing Watershed Plans to Restore and Protect our Waters" are those who make and implement decisions, those who are affected by the decisions made, and those who have the ability to assist or impede implementation of the decisions. When stakeholders agree to be actively involved in your project, they become partners. Partners will contribute resources that may have been otherwise lacking, such as access to essential personnel or technology, which are employed to create and implement the plan more effectively. Other potential benefits from partners include local knowledge and financial support. Box C-1 contains a list of common partner contributions. Some partner organizations may be involved in similar projects that can complement yours to form a larger combined effort. Partnerships should be forged early and continuously throughout the process in order to obtain optimal results. The main points of your plan should be expressed to partners (ie. repairing water quality for recreational or shellfish uses) and together a common vision of the management should be created.

Box C- 1: Potential Partner Contributions

- Technical assistance (GIS, water quality testing)
- Legal expertise
- Financial assistance / Fundraising
- Accounting
- Grant writing techniques
- Conflict mediation
- Public relations
- Media contacts
- Access to volunteers
- Local knowledge
- Relationships with local organizations
- Access to meeting venues
- Data collection & analysis

Identifying Partners

Partners can be involved throughout the duration of the project or at specified stages and ally identification should begin at the onset of the planning process. This can seem like an overwhelming task, so it is best to have a strategy in place. A list of some potential partners can be found in Appendix D. A good place to start is organizations that have a water quality focus. These groups may already be involved in projects that encompass your subwatershed. Furthermore, these groups may have established relationships with other relevant stakeholders in your area. You also want to start locally; community groups and local lawmakers should be contacted before moving up to the state and national level.

Once identified, you can begin to make contact with stakeholders. Coordinate which members of your planning team would be best suited to contact which groups. Don't underestimate the importance of meeting with stakeholders in person; arrange meetings to discuss the importance of the work you are seeking to do and the necessity of their support in order to complete the project. It will be advantageous to discuss expected community benefits of the proposed project such as healthier shellfish and swimming waters along the coast. Partnerships are more likely to be forged if stakeholders can perceive direct benefit to themselves, their organization or their community. It may also be useful to distribute a short summary of your proposed project including coastal water

quality impairments, general goals of the project and planned meetings or site visits. From the beginning, be clear and honest with your stakeholders about what their roles in the process will be. Establishing specific roles and responsibilities early will help reduce confusion and potential conflicts as the project progresses.

Not all stakeholders will have equal knowledge about watershed management or the hydrology of their neighborhood. Some may oppose your efforts for a variety of reasons. Therefore, it is vital to educate stakeholders on the relationship between a community and its subwatershed as well as to develop a clear, concise and detailed vision of your project.

Integrate

Once partners have agreed to take part in the management plan process, begin organizing stakeholder group meetings. Meetings can be as informal or formal as you deem appropriate and should be open to all interested parties, not just those you have identified as stakeholders or partners. The level of decision-making power given to stakeholders should be addressed before meetings begin; some councils allow stakeholders broad decision-making powers while others maintain stakeholders as advisors and supporters with no decision-making power.

At initial meetings, it is important to ask attendees to identify any groups they perceive to be stakeholders that are not currently represented. Any identified stakeholders should be contacted and included in the process. At these meetings, you will need to establish the structure of your management council. The structure should be worked out before meetings begin; you may decide to organize members into a general advisory committee or specialized subcommittees in order to lead the management effort, or you may organize partners more loosely without an established hierarchy. The responsibilities involved with serving at a committee or subcommittee level should be clearly laid out for partners prior to the selection process. Again, honesty will be imperative at this stage. Be careful not to downplay the level of commitment expected from your partners. Advisory committees should include representatives from each of your key stakeholder groups. However broad your representation, do not assign committees responsibilities that are outside member abilities. A list of possible committee responsibilities can be found in Box C-2. Allow stakeholders the freedom to be involved in the process as little or as much as they prefer and be prepared to work with partners to determine the level of involvement that best suits their capabilities and interests.

Box C-2: Possible responsibilities of a watershed committee:

- **Organize meetings to update stakeholders on project progress**
- **Keep political leaders and municipal officials abreast of project progress**
- **Engage new partners and volunteers for the management project**
- **Ensure that the project is meeting established milestones & announce milestones that are met.**
- **Mediate conflicts**
- **Delegate project tasks**

Regardless of how you choose to organize your partners, it will be important to encourage teamwork, even between those who do not agree on all aspects of the plan. The EPA recommends using team-building exercises to build camaraderie. Remember the importance of honesty and transparency during the stakeholder process and remain open to differing opinions on the issues involved in watershed planning. Conflicts are likely to arise and you

should have a plan in place for mediating conflicts and fostering an atmosphere of cooperation and collaboration between stakeholders.

APPENDIX D: ADDITIONAL OUTREACH INFORMATION

ADDITIONAL OUTREACH INFORMATION

Outreach at the *beginning* of the planning process should help:

- Inform the community about their watershed and the project
- Breed awareness of issues the project will address
- Educate others on the planning process
- Encourage community involvement

Whoever holds interest in the plan needs to be included throughout the entire process. Thus, outreach activities and messages should also carry forward to help keep stakeholders, partners, policy-makers and the public informed about progress. Periodic progress reports can be created to educate others on current endeavors and about ways they may continuously be involved. Ongoing educational messages that reach a variety of audiences and provide opportunities for participants to work at differing involvement levels works best. Applying an array of outreach messages will supplement the overall project by gaining continuous support and promoting healthy water quality.

- Outreach should be used *throughout* the project to
- Update stakeholders, partners, and the public on project progress
- Continue to encourage involvement and participation
- Promote behavior changes towards best management and LID practices

ADDITIONAL OUTREACH RESOURCES

EPA Getting in Step: A Guide to Effective Outreach in Your Watershed

http://cfpub.epa.gov/watertrain/pdf/modules/NEWgettinginstep.pdf

Creating a Public Outreach Plan: Iowa DNR

http://www.iowadnr.gov/portals/idnr/uploads/water/watershed/files/ieguidepart2.pdf

Example Outreach Plan for the Codornices Creek Watershed in California:

http://www.codornicescreekwatershed.org/Outreach%20Plan%20for%20Codornices%20Watershed.pdf

N.C. Coastal Federation Smart Yards Handout:

http://nccoast.org/uploads/documents/Media%20Room/Special%20publications/SmartYards_online%20version.pdf

City of Wilmington Stormwater website:

http://www.wilmingtonnc.gov/public_services/stormwater

APPENDIX E: DATA RESOURCES

PHYSICAL AND NATURAL PROPERTIES

The physical and natural features of a subwatershed are the first data you must gather when developing your management plan. These data will allow you to characterize your subwatershed and learn about the complexities of the system. The physical and natural features of a watershed can include data such as watershed boundaries, hydrology, topography, soils, climate, habitat, and wildlife.

Watershed boundaries

The first step in learning about the physical features of the target subwatershed is to determine its boundaries as well as the Hydrologic Unit Code (HUC). This process was outlined in Chapter 4.3 using the EPA's My WATERS Mapper, the USGS Watershed Boundary Dataset, USDA Geospatial Data Gateway and the USGS StreamStats. Knowing the physical boundaries is extremely important for any subwatershed plan, as it may shed new light on tributaries contained within the subwatershed in addition to potential sources of pollution. This is extremely important in coastal regions because it is vital to know which tributaries ultimately outflow to important estuarine waters and eventually to the ocean.

Hydrology

Determining the hydrology of the target subwatershed is also important for determining management strategies. The hydrology of the subwatershed can show the spatial relationship between water bodies as well as connectivity between them. This information can help create a picture of how the system of water bodies interacts to create a single watershed.

Stream shapefiles for N.C. are available through the NCDENR Department of Water Quality. These GIS data include all primary surface water classifications, as well as supplemental classifications and special designations given by DENR. This site also has a hydrologic list of waterbodies for each N.C. river basin with respective classifications.

The National Hydrography Dataset is another invaluable source of information regarding waterbodies such as lakes, ponds, rivers, canals, dams, and stream gauges. This can help to trace water discharge and water quality and link them with downstream effects. The data can be downloaded, by state, subregion, watershed, or subwatershed. The USGS National Map-hydrography data is another helpful source of information. Floodplain maps can be obtained through FEMA. These maps are intended for insurance providers, but give a detailed view of past and present floodplain areas.

Topography

Topography, or the mapping of surface features, can be used to determine elevation changes and find areas that are unstable. Topographic GIS layers are available for N.C. through the N.C. OneMap. This site contains both data compatible with GIS software and data that is presented as an interactive online map. Additional data that will be discussed later is also available from N.C. OneMap including coastal imagery, orthophotography, parcel data and street vector data. Topographic data may also be obtained from the USGS National Map-US Topo. These data are available for most of the United States and can be viewed in contiguous quadrangles, and is useful for watersheds that are located in more than one state or region.

Habitat

Habitat data are useful for identifying areas of conservation, and for preserving important areas that are not yet protected. Having protected areas can help improve water quality through decreased runoff as well as maintaining infiltration of stormwater, which reduces the amount of pollutants that enter a waterbody. These data may also be used for the protection of critical species that use certain habitats. For example, diamondback terrapins inhabit salt marshes, which serve to filter surface runoff. Therefore using habitat classifications to identify potential areas of habitat for this species is an important consideration.

Wetlands habitat data are available through NCDENR DENR Coastal Wetlands Mapping site, as well as through the U.S. Fish & Wildlife Service (USFWS) National Wetlands Inventory. The Coastal Wetlands Mapping site has an interactive mapping feature showing coastal wetlands including marshes, swamps, bottomland hardwoods, and pocosins and contains information about wetland site restoration and enhancement potential. The National Wetlands Inventory was created in 1974 to map the wetlands in the entirety of the contiguous United States. The data from the National Wetlands Inventory is viewable as GIS polygon data or through the interactive wetlands mapper. Broad level data is also available through the USDA National Resources Inventory-Wetland Dataset.

Other habitat data such as the status of rare, threatened, and endangered plants is available through the National Heritage Program. These data are available through an interactive map viewer, as a database, as well as GIS shapefiles. USFWS Habitat Conservation Plans are another source of habitat data showing areas important for conservation. States also have specific habitat conservation programs, which for the state of North Carolina can be found through the N.C. Wildlife Resource Commission- Habitat Conservation Program. Broad scale habitat information can be inferred through aerial photographs called orthophotographs, available through N.C. OneMap and the USGS National Map-Orthoimagery. Land use/land cover maps are valuable as well, and show the current land cover types derived from satellite imagery. Land use/land cover will be covered in more detailed later, and data can be downloaded from the USGS National Map-Land Cover dataset and from the USGS GAP-Land Cover and Protected Areas.

Wildlife

Wildlife data are crucial for watershed management plans in order to identify endangered, protected, and economically important species. Wildlife, especially waterfowl, may also contribute to nutrient and bacteria loading. Knowing the distribution of wildlife within the target watershed will allow for identification of potential sources of bacteria and nutrients.

Wildlife data can be found from some of the same sources used to find habitat data. A good place to start looking is the National Heritage Program, where you can look at what species are present down to a county level. These data also include state and federal statuses for each species, making it easy to determine if there may be any species in or around your subwatershed that are of importance. These data are available through an interactive map viewer, as a database, as well as GIS shapefiles. Federally listed endangered species can also be found through the USFWS, at the state and county level.

Habitat Conservation Plans for endangered or threatened species are also useful to determine if there are any plans already in place for important organisms within your watershed. N.C. Habitat Conservation Plans are available through the N.C. Wildlife Resource Commission (WRC). A

comprehensive list of wildlife agencies and organizations can be found through the USFWS, and are delineated by state.

Assessments of wildlife species such as fish, macroinvertebrates, and other important indicator species can be used not only for conservation reasons, but also as indicators of health. North Carolina Stream and Fish Community Assessments through DENR include more than 918 sites throughout the state where fish assessments are conducted and fish community data has been assembled by individual river basins. Similarly, DENR has Benthic Macroinvertebrate Assessment Data report that has been collected from every level-IV ecoregion, county, and river basin in the state. Like the fish community assessments, the macroinvertebrate data are also available for individual river basins in N.C. Macroinvertebrates may not seem like the most interesting organisms to look at when creating a watershed management plan, but they can give a great deal of insight into the health of a river or stream. Macroinvertebrates are important because they ingest leaf litter, algae and other small food sources and make this energy available to larger species through predator/prey interactions. Different types of macroinvertebrates are sensitive to different types of pollution, which may be a key piece of information when determining priorities for your subwatershed. In N.C., biological assessments are conducted for every river basin and include analyzed benthic macroinvertebrate data as well as rare taxa found.

GAP data available through the USGS aims to determine the extent with which plants and animals are being protected through conservation lands. These data are available for GIS software as well as through an interactive map data viewer. There are GAP data for species range, predicted habitat distribution, aquatic GAP analysis, land cover, and protected areas.

LAND USE AND POPULATION CHARACTERISTICS

Land use and population characteristics consist of behaviors and developments that alter the natural habitat. For instance, land use and land cover data can show where humans have altered the land in order to create farms, housing subdivisions, shopping complexes and other development, as well as which areas are viable habitat for certain species. Existing land management practices can give insight to the activities already occurring on the lands surrounding your subwatershed. Demographics of human populations can help inform planning as well since densely populated areas tend to have more impervious surface, stormwater runoff, and sources of pollution. With land use and population characteristics, it is extremely important to obtain current data given that coastal areas are developing quickly and many areas are experiencing rapid population growth.

Land Use and Land Cover (LULC)

Human alteration of the natural environment for various land usages can affect the hydrology of surrounding systems. For example, historically, wetlands were ditched and drained for agricultural purposes. Land use and related activities within a subwatershed directly affect the types of pollutants that enter the water. For instance, the creation of housing subdivisions may generate pollution from septic tanks, fertilizer, oil, or pet sources, agricultural lands may contribute fertilizer and pesticides, while urbanized areas may generate pollution from oil and heavy metals. Land use and land cover maps can be derived from satellite imagery through a few different GIS techniques, and some areas have existing maps that have already been classified.

State level data of LULC can be obtained through the N.C. DCM, who oversee local land use plans in the 20 coastal counties identified by CAMA. LULC data are also available through various federal agencies including the USGS National Map-Land Cover dataset discussed previously. These data are currently available for 1992, 2001, and 2006 and include LULC types such as urban, agricultural, rangeland, forest, surface waters, wetlands, barren lands, percent developed impervious surface, and percent tree canopy density. Land use and land cover data are also accessible from the USGS Multi-Resolution Land Characteristics Consortium (MRLC) and from the USGS GAP-Land Cover and Protected Areas datasets. These are based on satellite imagery, however survey based LULC data for agricultural and livestock purposes can be found from the USDA Census of Agriculture. There are also specialized datasets for the coast through the NOAA Digital Coast database.

Beyond land use and land cover maps, the National Resources Inventory has analyzed land use data into various reports. This includes information such as land use status and trends, development of non-federal rural land, soil erosion and cropland status, wetlands inventories, and rangeland assessments. This information may also be inferred from boundary data and orthoimagery from the USGS National Map.

Demographics

Demographic data are information about the human population within your subwatershed. This can include information such as raw population, spatial representation of the population, age, economic conditions, employment, education, income, and even road usage. Knowing this information about the people within your subwatershed can give insight into existing problems, as well as help to identify ways to prevent pollution through education and outreach.

Most states have this information available on the web through their census bureau. Data for N.C. is available through the N.C. Office of State Budget and Management-Census and Survey Data. Data is also available through the U.S. Census Bureau. This information is also provided as GIS data through the Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) program. TIGER data is also accessible through the Geospatial Data Gateway. TIGER data is useful for seeing spatial trends in demographic data, especially within a subwatershed.

WATERBODY AND WATERSHED CONDITIONS

Once you have thoroughly researched and understand the physical, natural, and land use properties within your subwatershed, you can begin to identify the WQ within your subwatershed. Water quality data can include designations for use, standards, 305(b) reports, 303(d) lists, TMDL reports, and Source Water Assessments (SWA). By identifying the water quality problems within your subwatershed, you can begin to understand the complexity of the system and pinpoint the most important issues.

Water Quality Standards

States have different water quality standards depending on the designated uses for the waterbody. Knowing the standards of your subwatershed is integral in determining if the water is in compliance. By comparing existing water quality parameters to these standards, the condition of the subwatershed will become clear. North Carolina has a plethora of water quality designations specific to potential uses discussed in Chapter 2. These designations have an accompanying set of water quality standards that the waterbody must meet. The EPA also has links to various state

water quality standards (Browse Federal Water Quality Standards section) through a clickable map, which also gives information on federal standards in place for each state.

Report
Under the CWA Section 305(b), individual states are required to submit a biennial report to inform Congress and the public on the status of the nation's waters. These reports detail specifically which waterbodies have met water quality standards, the extent to which any progress has been made in restoring water quality, and the problems that still need to be addressed. This information can be found through the EPA National Water Quality Report to Congress (305(b) report).

303(d) List
Under CWA Section 303(d), states, territories, and tribes are required to maintain a list of impaired waters. Once this list is developed, each state, territory, or tribe must determine priority rankings for these waters and develop TMDLs. Impaired waters can be found by state and watershed through the EPA TMDL National Summary. In 2002, the EPA began to encourage states, territories, and tribes to submit combined 303(d) and 305(b) reports. In these integrated reports, states may use Categories 1-5 to delineate the current stage within the TMDL process. Categories 4 and 5 are considered impaired or threatened, with Category 5 on a state's 303(d) list. More information on 303(d) and 305(b) categories and procedures can be found at the EPA 303(d) and 305(b) sites.

Existing TMDL Reports
Existing TMDL reports that include your subwatershed may include much of the information needed for your management plan. Each state has its own TMDL list, most likely found through your state's DENR or similar department. A list of TMDLs for N.C. can be found through the DENR-TMDLs, or through a TMDL interactive map. A list of regional and interstate TMDL websites is available through the EPA-TMDL Links site.

Source Water Assessments (SWA)
Source Water Assessments (SWA) are conducted by states to provide a comprehensive look at the drinking water within each public water system. In North Carolina, SWAs are available from NCDENR-Source Water Assessments. Surface Water Assessments for other states are generally found through local water utility websites and links to other drinking water programs are found through the EPA-Drinking Water website.

WATERBODY MONITORING DATA

Some of the most important data to gather for your subwatershed are waterbody monitoring data such as that done by the Shellfish and Sanitation office described previously. Water monitoring data are also the most difficult to attain for specific locations and may include gaps in spatial or temporal coverage. For example, there may only be in stream data available in one location of your subwatershed, or there may only be monthly data spanning a few years. It is important to know what data is available in order to know what information is lacking.

Biology
Information regarding the species present within your subwatershed is a very important indicator of health. As noted earlier, macroinvertebrates are an important indicator of stream health and information can be found on DENR's Benthic Macroinvertebrate Assessment Data website. Different types of macroinvertebrates are sensitive to different types of pollution, which may be a key piece

of information when determining priorities for your subwatershed. In N.C., biological assessments are conducted for each river basin, and include analyzed benthic macroinvertebrate data, and rare taxa found. There are also data available on N.C. fish kill events and shellfish health.

Most of this information can only be found at the state or local level. At the federal level, some biological samples are taken with the water quality data, but in many cases it is not a priority. Some biological data may be found through the USGS water quality assessments.

Geomorphology

Geomorphologic data are those that give the physical characteristics (geological and morphological) of the system. This data is often not available for a specific location, but there is a chance that there will be some data in proximity to your watershed. Some studies and information on fluvial geomorphology can be found through the USGS.

APPENDIX F: BRADLEY AND HEWLETTS CREEKS WATERSHED MANAGEMENT PLAN OBJECTIVES TABLE

Objective 1. Continue Existing Programs that Address Water Quality Impairments in Both Watersheds			
Action #	**Specific Action**	**Timeline**	**Partners**
1-1	Implement and enforce existing stormwater requirements for new development and redevelopment	On-going	City of Wilmington – Stormwater Services, Engineering, Development Services; NC DENR, WB
1-2	Continue to promote LID designs	On-going	City of Wilmington – Stormwater Services, Engineering, Development Services; NC DENR, WB
1-3	Continue to cooperate with CCAP	On-going	City of Wilmington – Engineering, Development Services; NCCF, WB, New Hanover Soil & Water
1-4	Maintain existing educational programs	On-going	City of Wilmington - Stormwater Services; NCCF, New Hanover Soil & Water, WB
1-5	Reflect plan in other City plans and NPDES annual permit report	As plans are updated	City of Wilmington – Stormwater Services, Engineering, Development Services: WB, NCCF
1-6	Continue education and code enforcement programs that reduce and eliminate sources of bacteria and pathogens related to human and pet wastes	On-going	City of Wilmington – Stormwater Services; WB

Objective 2. Determine Appropriate Water Quality Classifications and Designated Uses Where Water Quality Impairment Exists			
Action #	**Specific Action**	**Timeline**	**Partners**
2-1	Work with SS, UNCW, WB and NCCF to conduct preliminary evaluations of water quality to determine where more intensive state (SS) water quality investigations are needed	Year 1, establish preliminary monitoring	City of Wilmington – Stormwater Services; UNCW, SS, WB, NCCF
2-2	Work with SS to establish new monitoring stations within impaired waters influenced by the Bradley Creek watershed	Year 2 based upon preliminary monitoring	City of Wilmington – Stormwater Services; UNCW, SS, WB, NCCF
2-3	Work with SS to establish new monitoring stations within impaired waters influenced by the Hewletts Creek watershed	Year 2 based upon preliminary monitoring	City of Wilmington – Stormwater Services; UNCW, SS, WB, NCCF
2-4	Evaluate the results of bacterial source monitoring in Banks Channel that is being conducted by UNC-CH	Study underway, evaluate results in Year 1	WB, UNC-CH, UNCW, NCCF
2-5	Request Use Attainability Study on SA waters along Wrightsville Beach shoreline in Banks Channel. These waters are automatically closed to Shellfish Harvest due to marinas, and have been polluted since 1947.	Year 2	WB, NCCF, NC DENR
2-6	Request Use Attainability Study on SB waters now "Approved" for shellfish harvest in waters influenced by the Bradley Creek Watershed	Year 2	City of Wilmington, WB, NCCF, NC DENR
2-7	Determine if there is potential to restore shellfish harvest in any additional waters classified as SB that are influenced by the Bradley Creek watershed	Years 4-5	City of Wilmington – Stormwater Services; UNCW, SS, WB, NCCF

2-8	Evaluate the status and trends in bacteria contamination within the entire Hewletts Creek watershed based upon more intensive data collected as part of plan implementation	Year 5	City of Wilmington – Stormwater Services; UNCW, SS, NC DENR, NCCF

Objective 3. Track the Reduction of the Transport of Bacteria from Land to Water			
Action #	**Specific Action**	**Timeline**	**Partners**
3-1	Secure and budget funds for retrofits in the Bradley Creek watershed, deter-mine volume that can be reduced with funds, and track actual reductions using measurement tools	Secure funds years 1 & 2, design retrofits year 3, install and track reductions years 4 & 5	City of Wilmington – Stormwater Services; UNCW, SS, NC DENR, NCCF
3-2	Secure and budget funds for retrofits in the Hewletts Creek watershed, deter-mine volume that can be reduced with funds, and track actual reductions using measurement tools	Secure funds years 1 & 2, design retrofits year 3, install and track reductions years 4 & 5	City of Wilmington – Stormwater Services; UNCW, SS, NC DENR, NCCF

Objective 4. Promote Stormwater Reduction Efforts			
Action #	**Specific Action**	**Timeline**	**Partners**
4-1	Promote use of GIS web based retrofit Atlas	Each year	City of Wilmington – Stormwater Services, Engineering, Development Services; WB, NCCF
4-2	Investigate cost effective methods of working with landowners to disconnect impervious surfaces	Year 1 & 2	NCCF, City of Wilmington, WB
4-3	Promote LID retrofits within private development	Each year	City of Wilmington – Stormwater Services, Engineering, Development Services; WB, NCCF. Use existing educational programs to promote retrofits for volume reduction
4-4	Promote tree planting and retention	Each year	Wilmington Tree Commission; City of Wilmington - Development Services, Stormwater Services; Keep New Hanover Beautiful, NCCF, Cooperative Extension, WB
4-5	Promote stormwater reduction measures on City streets in future capital improvement projects	Dependent on Capital Improvement schedule	City of Wilmington - Stormwater Services, Engineering, Streets Divisions, Development Services; WB, NCCF
4-6	Pursue strategy with NCDOT to incorporate retrofits into highway upgrades	Years 1 – 5	City of Wilmington - Development Services, Stormwater Services; NCDOT, NCCF, WB
4-7	Promote LID retrofits in future publicly funded maintenance or redevelopment of City owned buildings, parks, parking lots, and drainage systems	Based upon project schedules	City of Wilmington – Engineering, Stormwater Services, Community Services, Development Services; WB, NCCF

4-8	Promote and assist with LID retrofits at county schools	Ongoing based upon efforts at schools	NCCF, New Hanover County School System, CCAP
4-9	Encourage UNC-W to develop campus wide master plan to retrofit to reduce stormwater volume	Year 3	City of Wilmington - Stormwater Services, Development Services; UNCW, NCCF
4-10	Evaluate properties for retrofit or restoration potential.	Year 2	City of Wilmington - Stormwater Services, Development Services; WB
4-11	Evaluate existing stormwater ponds on public and private properties for potential volume reductions enhancements, and if feasible, retrofit them to achieve volume reductions	Years 3 - 5	Evaluation potential retrofits, funds to retrofit will come through annual budgeting or from outside grant sources. City of Wilmington - Stormwater Services; WB, NCCF

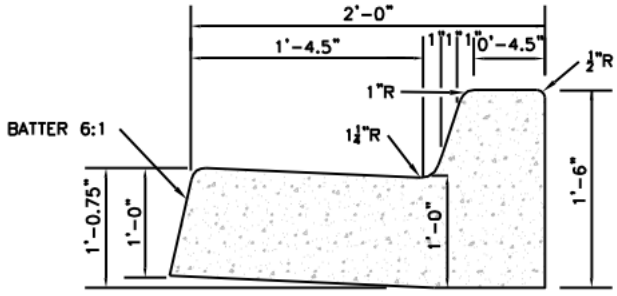
Objective 5. Form and Maintain Partnerships			
Action #	**Specific Action**	**Timeline**	**Partners**
5-1	Work with partners to educate stakeholders	Years 1 – 5	City of Wilmington - Stormwater Services, Development Services; NCCF, New Hanover Soil & Water, WB
5-2	Work with government agencies and NGOs to secure grants for retrofits and other programs	Years 1 – 5	City of Wilmington – Stormwater Services; Development Services; NCCF, WB, Cape Fear Public Utilities
5-3	Provide strategies and policies for city departments to carry out plan by incorporating runoff reduction strategies into the CIP process.	Years 1 – 5	City of Wilmington - Stormwater Services; Development Services, and Finance Depts.; NCCF
5-4	Promote use of atlas among key City departments in their routine business	Years 1 – 5	City of Wilmington - Stormwater Services, Development Services; NCCF, WB
5-4	Promote existing technical training opportunities to advance plan	Years 1 – 5	Special training arranged by partners using their own funds and grants, City of Wilmington - Stormwater Services, Development Services; WB, NCCF
5-5	Work with UNCW on retrofit projects	Years 1 – 5	grants, capital improvements - City of Wilmington - Stormwater Services; UNCW, NCCF

Objective 6. Measure Success and Adapt Plan Based Upon Results			
Action #	**Specific Action**	**Timeline**	**Partners**
6-1	Use atlas accounting system to track progress toward watershed goals.	Years 1 – 5	City of Wilmington - Stormwater Services, Development Services; NCCF, WB
6-2	Work with SS, WB, and UNCW to monitor water quality status and trends	Years 1 – 5	City of Wilmington - Stormwater Services, Development Services; NCCF, WB, UNCW
6-3	Conduct annual and five year assessment of plan's success and modify plan as needed	Yearly	City of Wilmington - Stormwater Services, Development Services; NCCF, WB, UNCW

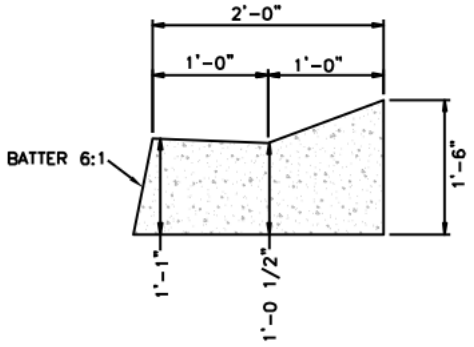
APPENDIX G: "GREEN STREET" STORMWATER MANAGEMENT DEVICES

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 prior to 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.



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

SIDEWALK SWALE WITH CURB & GUTTER

STANDARD DETAIL

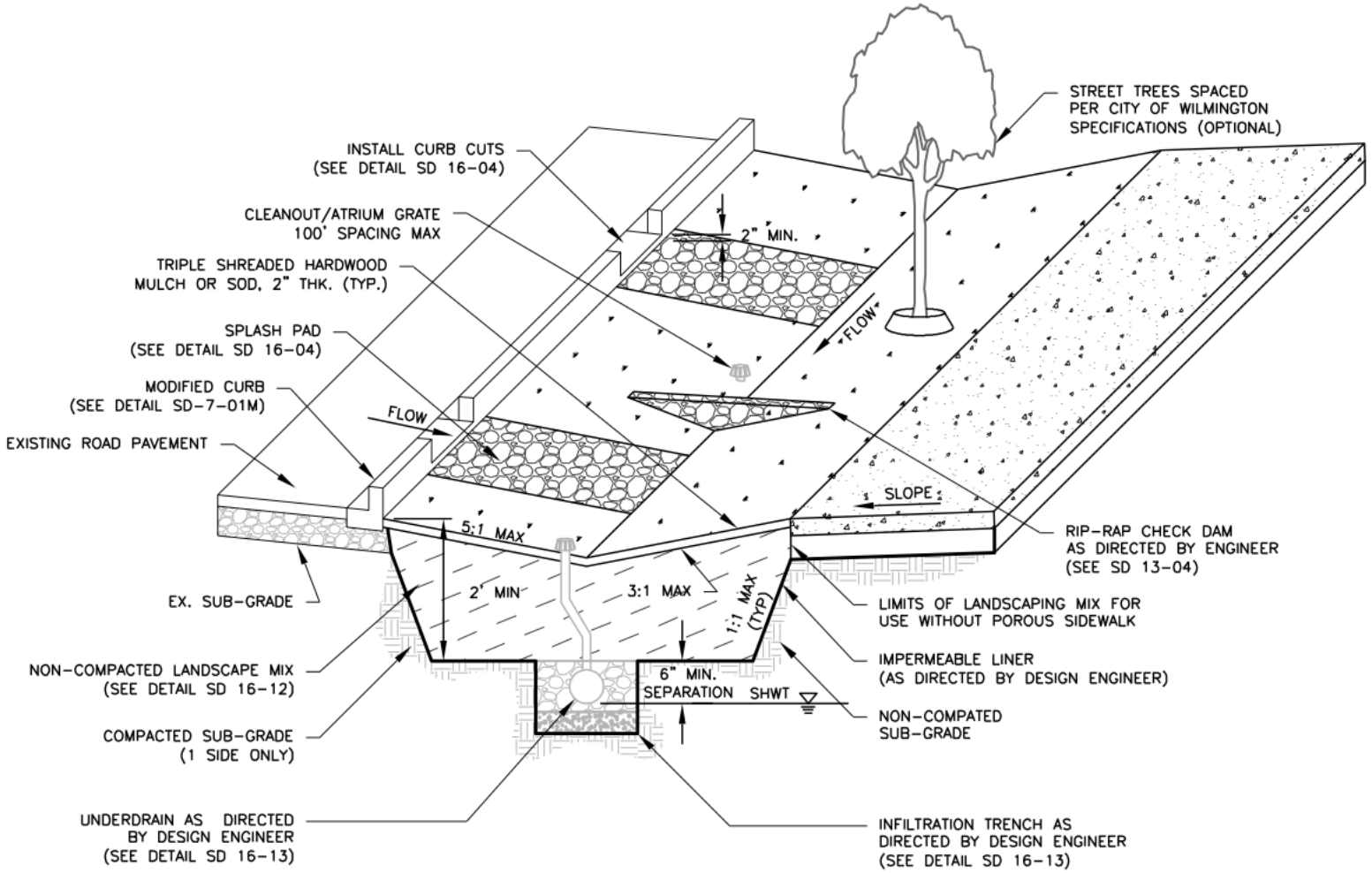
SD 16-01

DATE: 2012

DRAWN BY TLM

CHECKED BY HCF

SCALE NOT TO SCALE



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.

SIDEWALK SWALE WITHOUT CURB & GUTTER

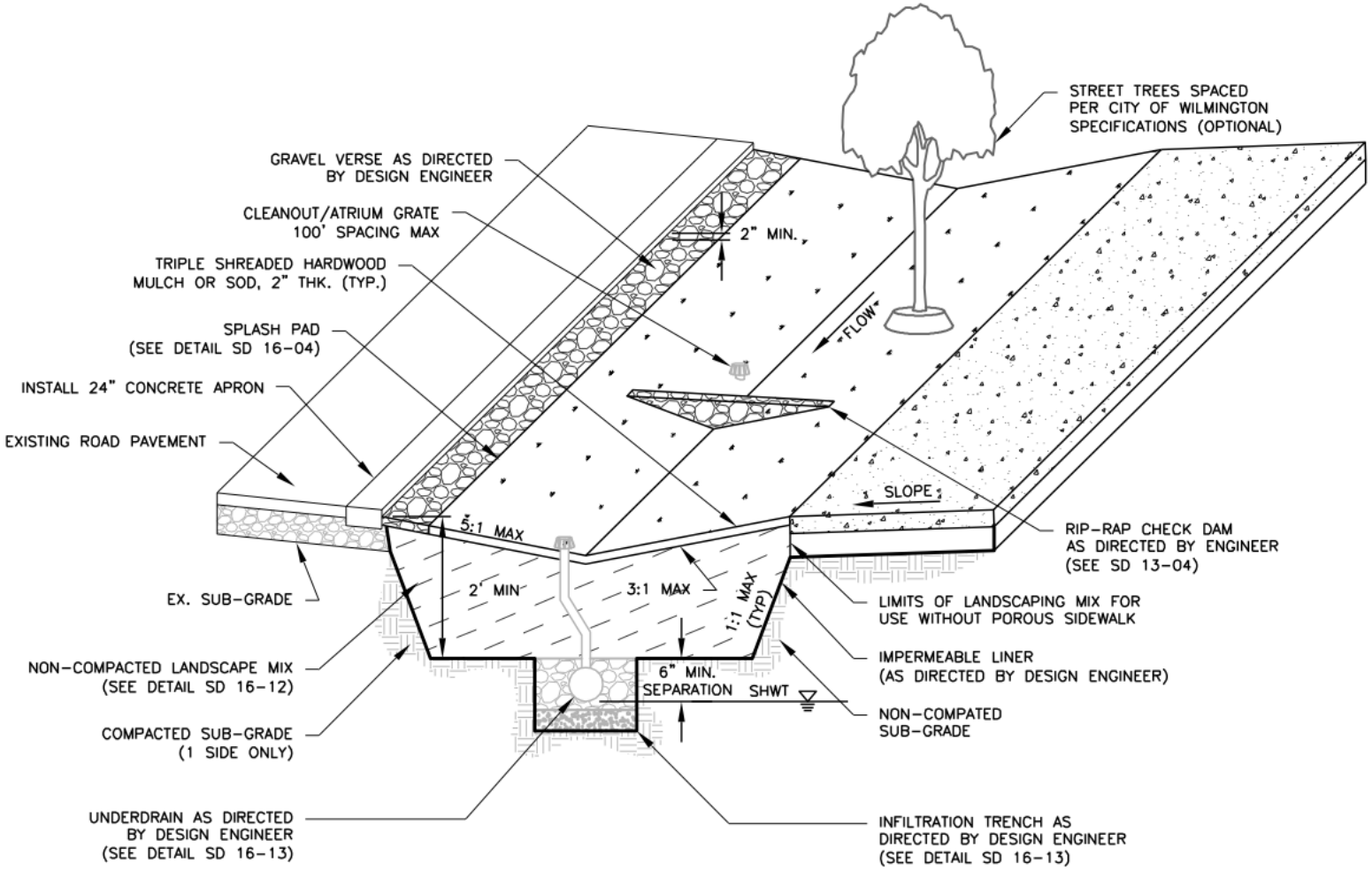
STANDARD DETAIL

DATE: 2012

DRAWN BY TLM

CHECKED BY HCF

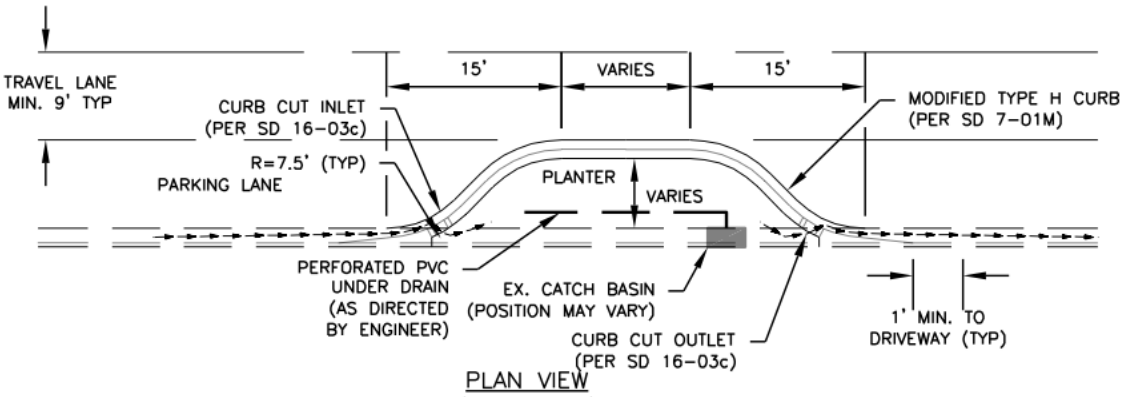
SCALE NOT TO SCALE



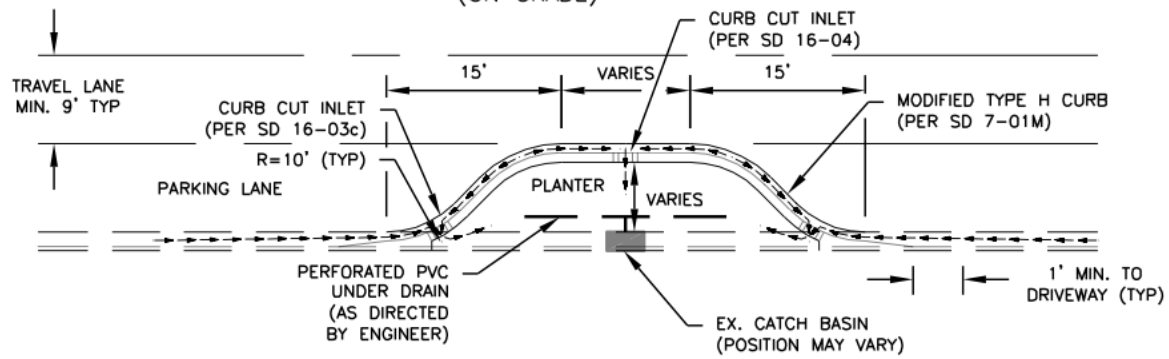
NOTES:

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.

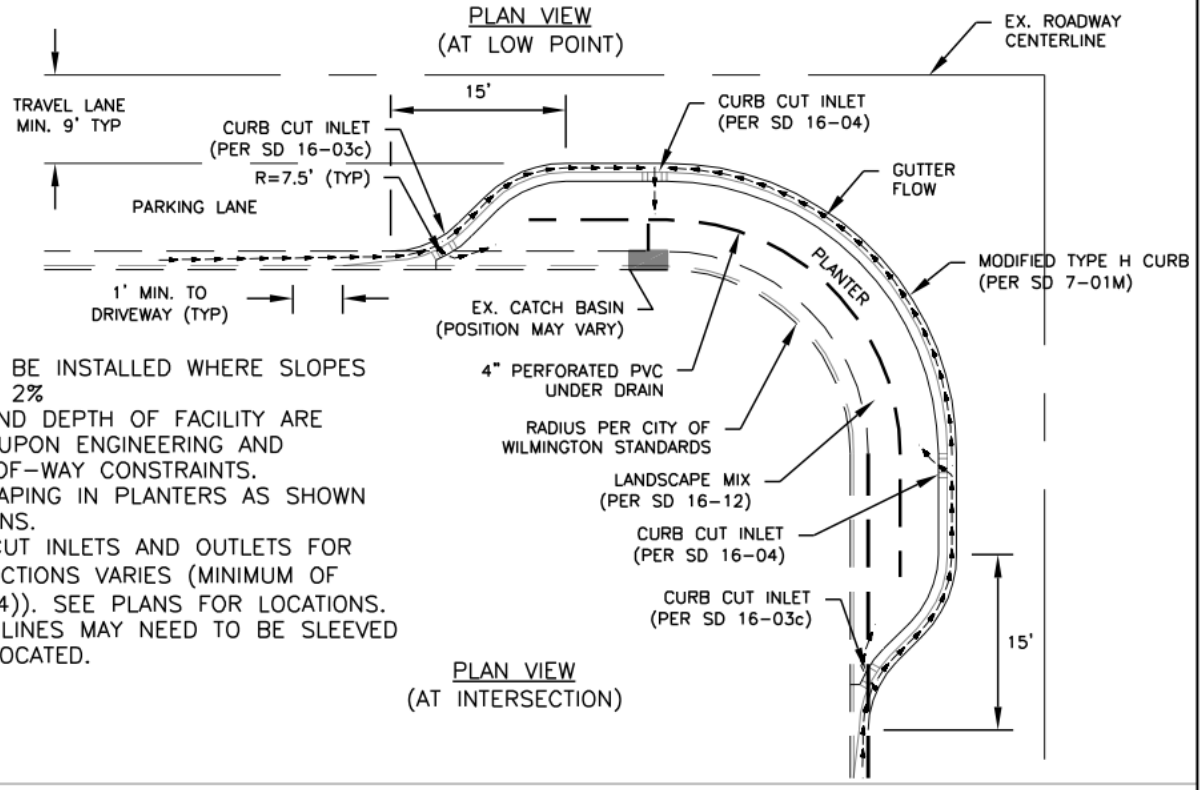
SD 16-02



PLAN VIEW
(ON GRADE)



PLAN VIEW
(AT LOW POINT)



PLAN VIEW
(AT INTERSECTION)

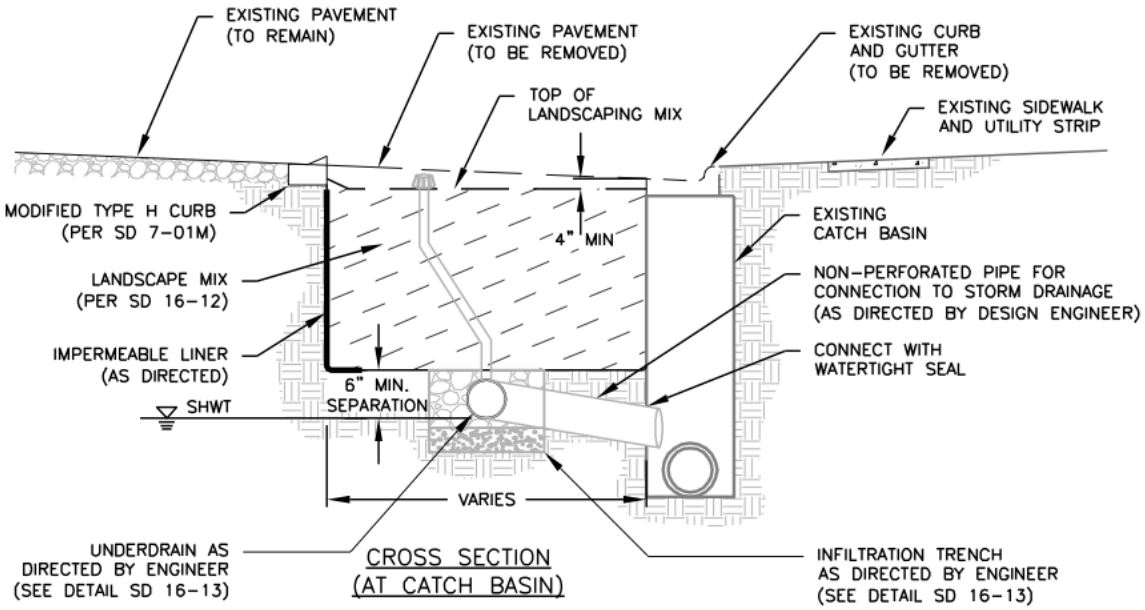
NOTES:

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		
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		

CURB EXTENSION
(1 OF 3)

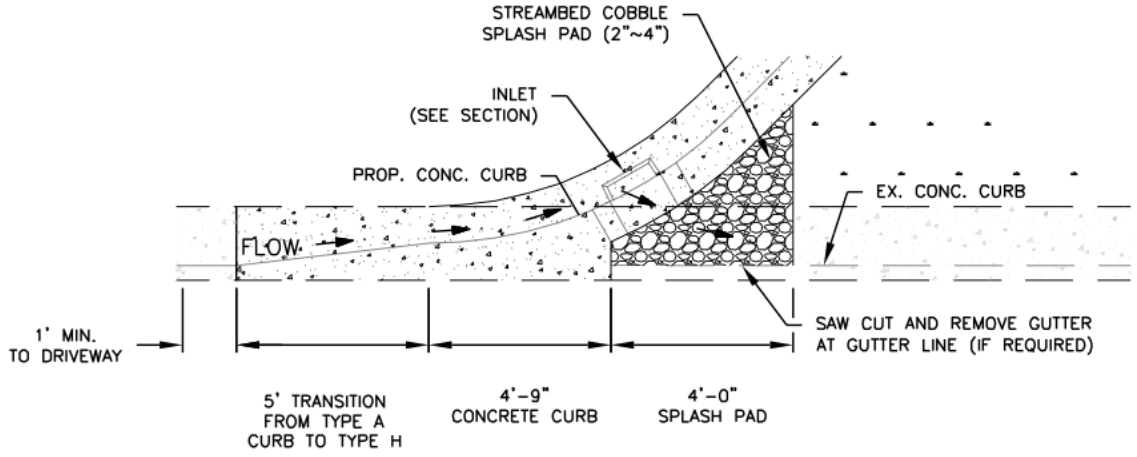
SD 16-03a



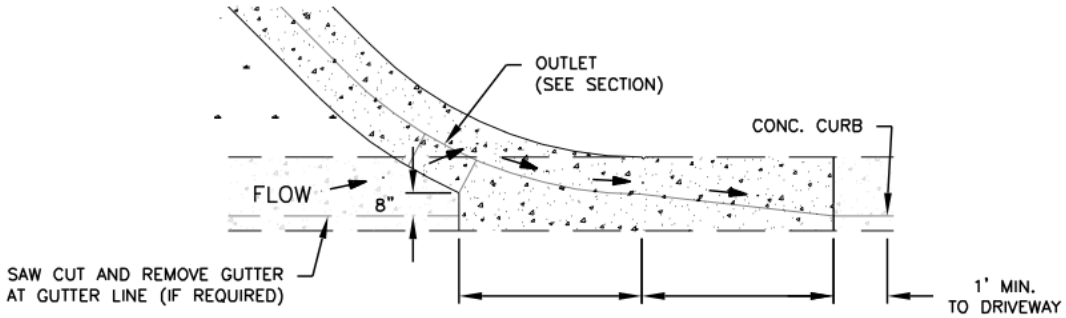
CROSS SECTION
(AT CATCH BASIN)

NOTES:
SOIL TESTING REQUIRED WHEN NOT USING UNDERDRAIN

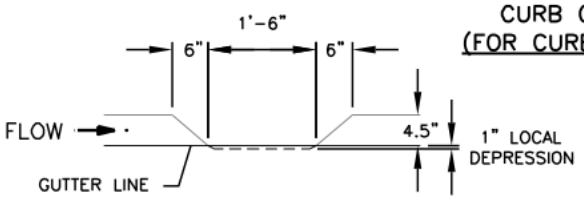
	STANDARD DETAIL	
DATE: 2012	CURB EXTENSION (2 OF 3)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-03b



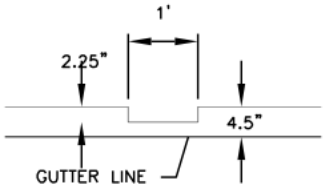
CURB CUT INLET
(FOR CURB EXTENSIONS)
NTS



CURB CUT OUTLET
(FOR CURB EXTENSIONS)
NTS



INLET SECTION
NTS



OUTLET SECTION
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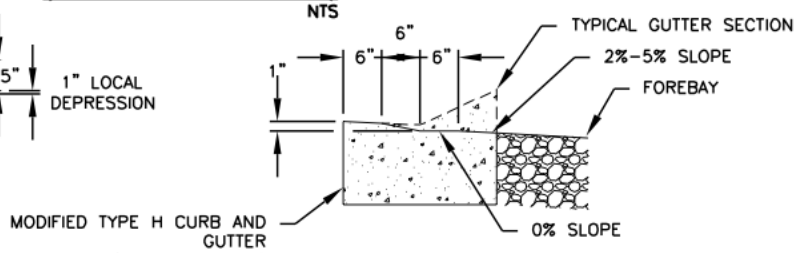


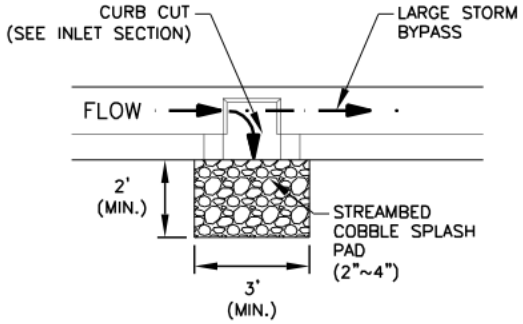
CURB CUT INLET PROFILE
NTS

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.

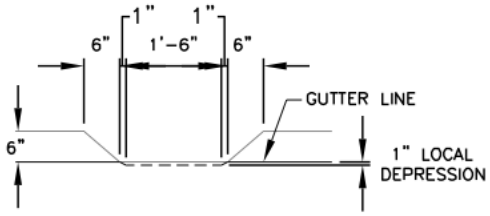
	STANDARD DETAIL	
DATE: 2012		
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		

CURB EXTENSION
(3 OF 3)

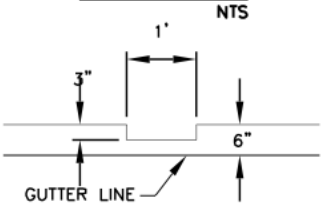
SD 16-03c



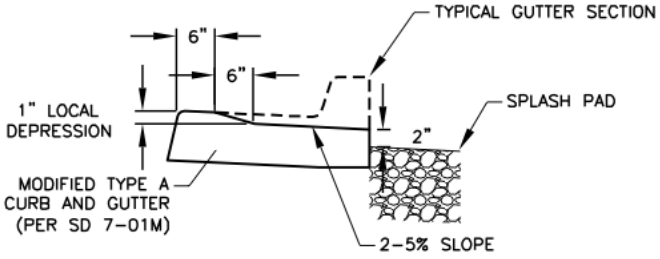
CURB CUT INLET PLAN
NTS



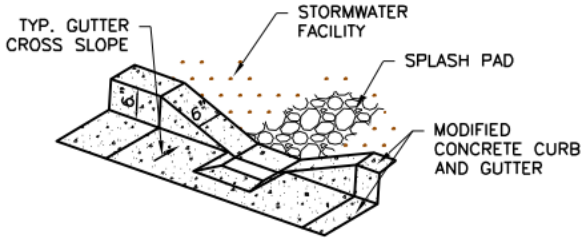
INLET SECTION
NTS



OUTLET SECTION
NTS

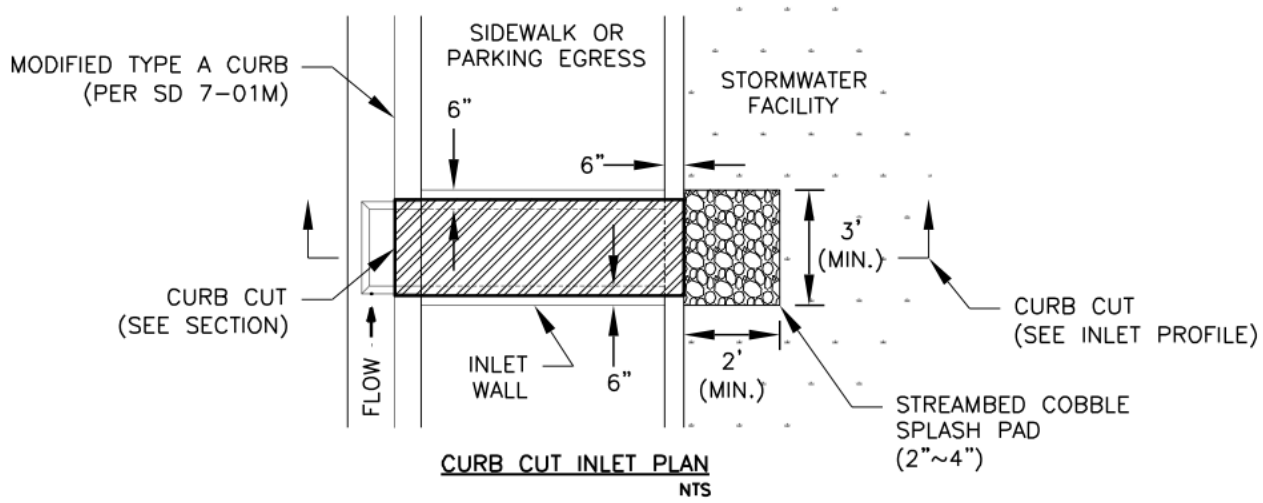


CURB CUT INLET PROFILE
NTS

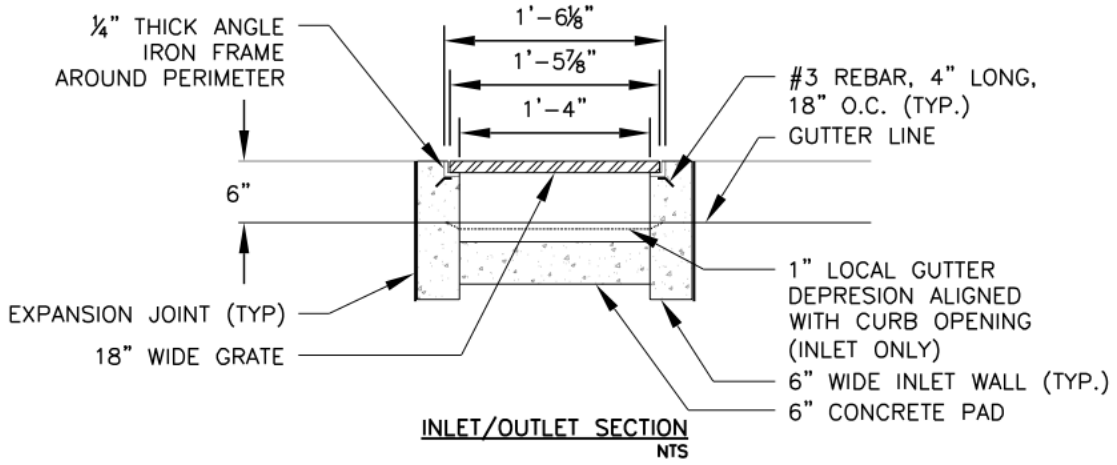


ISOMETRIC VIEW
NTS

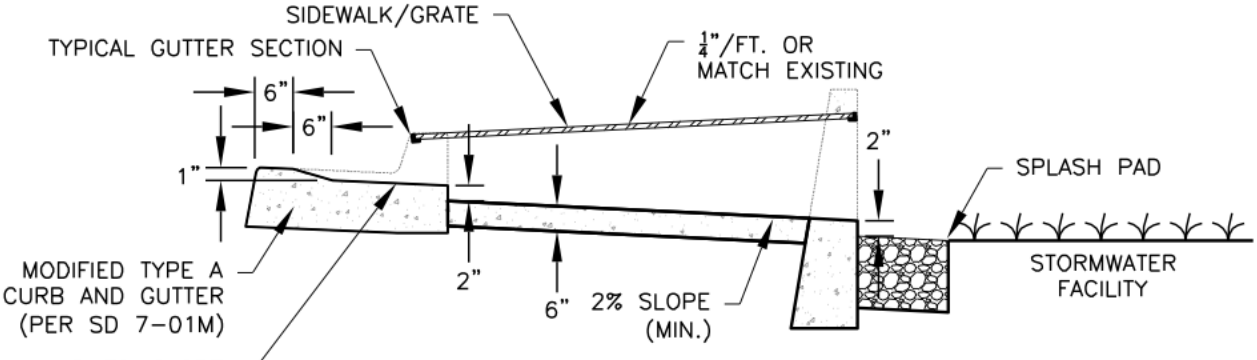
	STANDARD DETAIL	
DATE: 2012	CURB CUTS (GENERAL)	SD 16-04
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



CURB CUT INLET PLAN
NTS

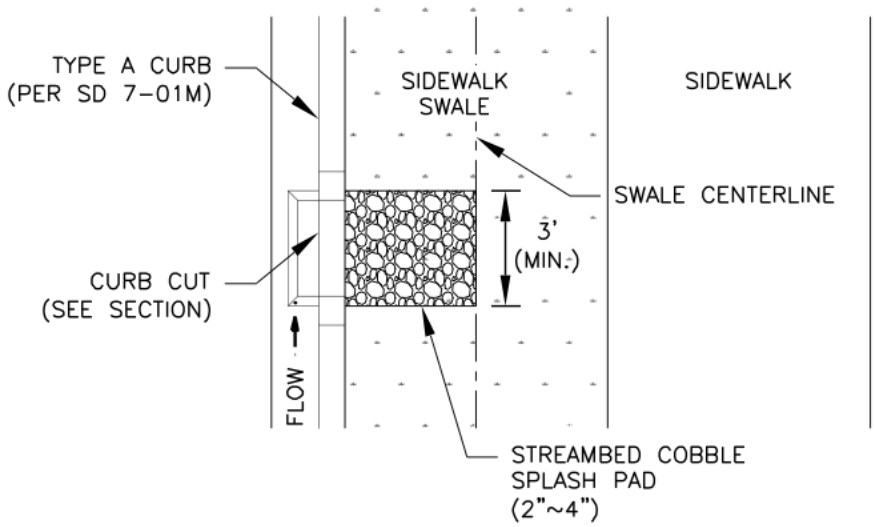


INLET/OUTLET SECTION
NTS

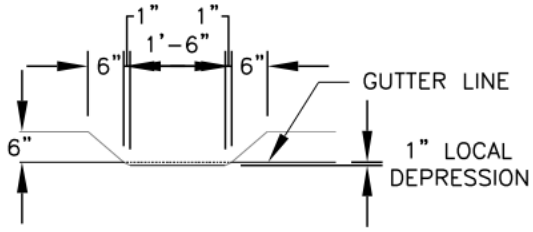


CURB CUT INLET PROFILE
NTS

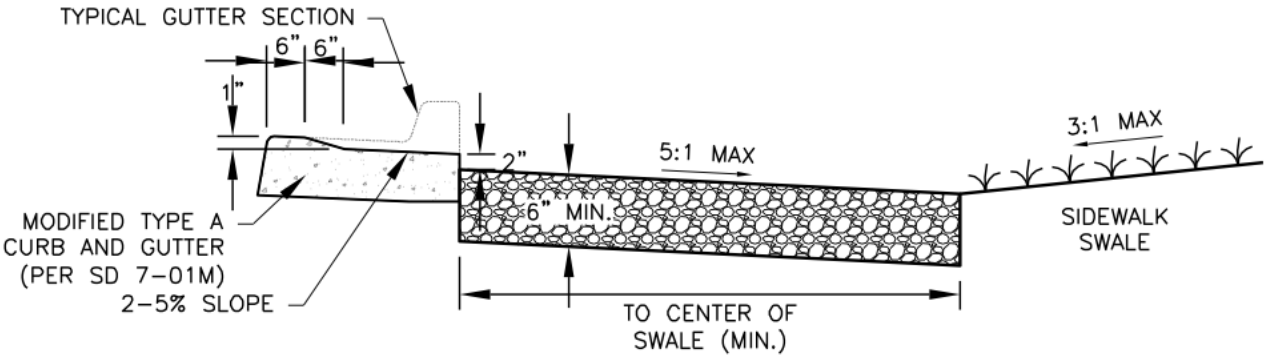
	STANDARD DETAIL	
DATE: 2012	CURB CUTS (CHANNEL AND GRATE)	SD 16-05
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



CURB CUT INLET PLAN
NTS

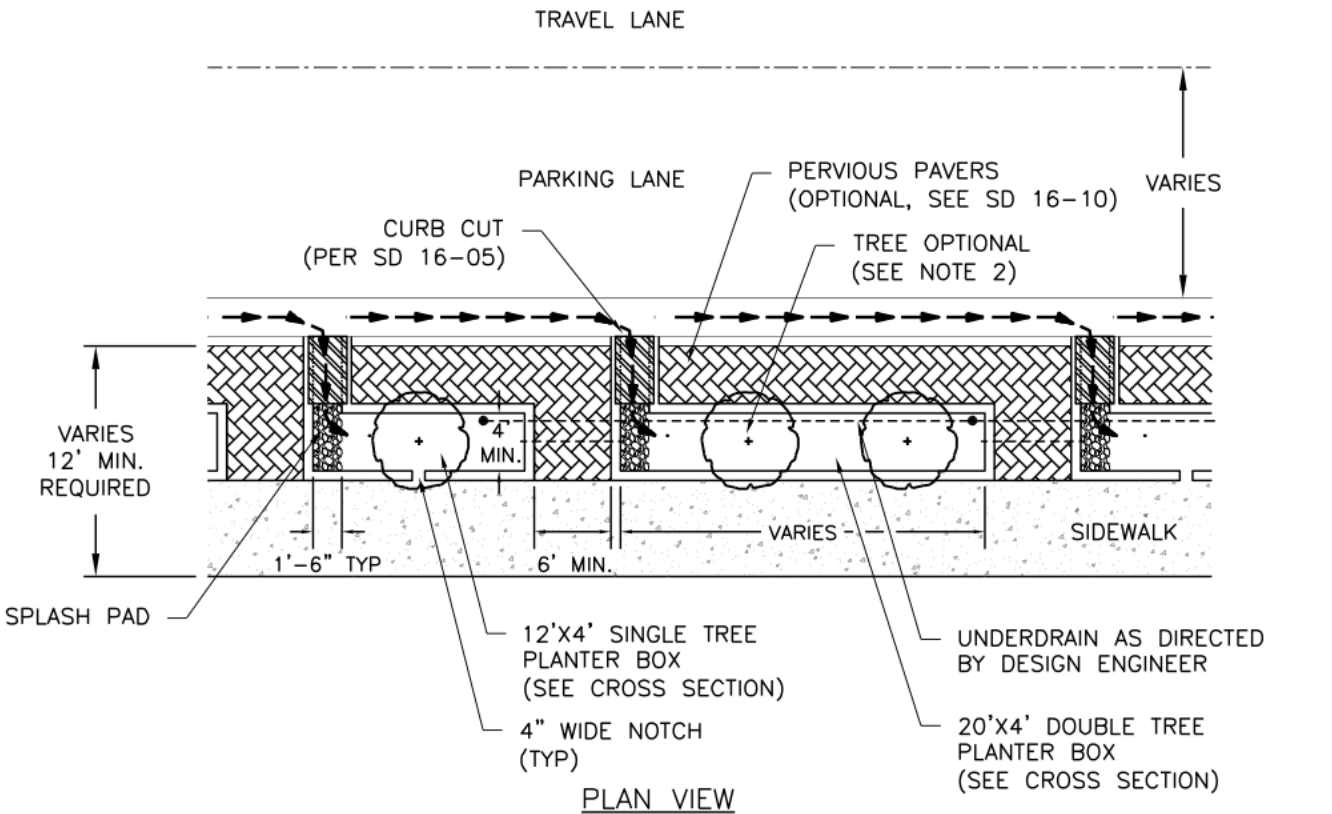


INLET SECTION
NTS

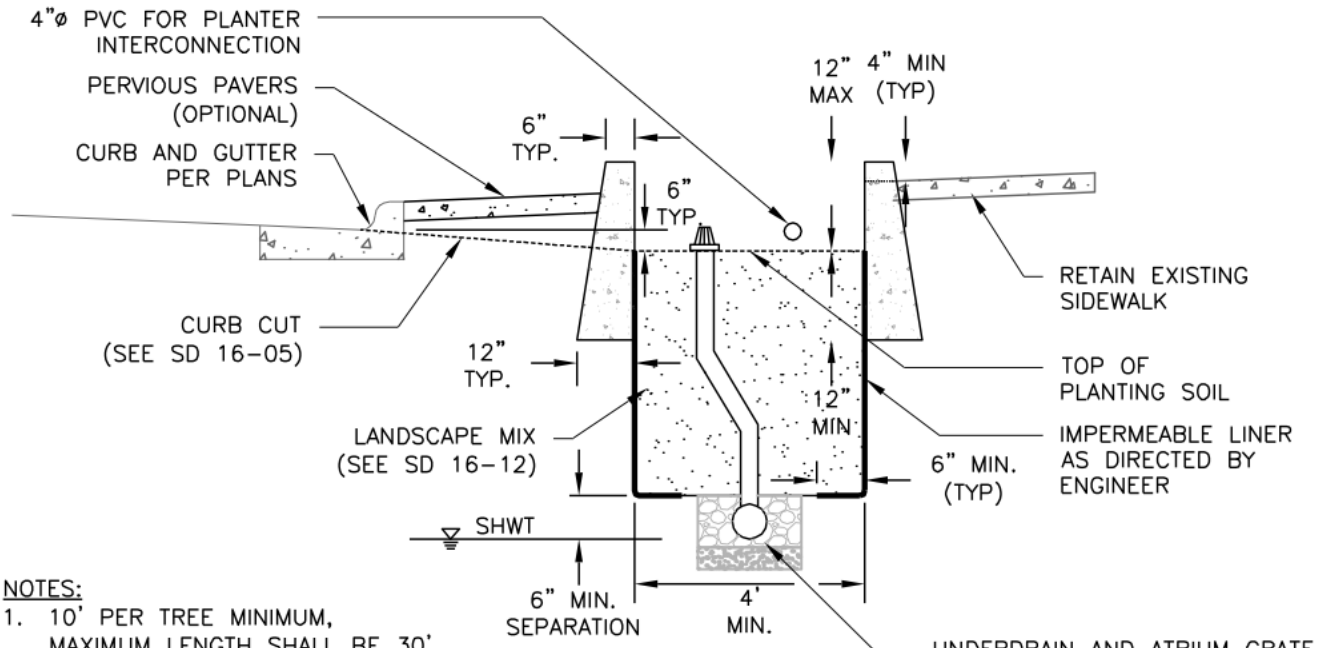


CURB CUT INLET PROFILE
NTS

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



PLAN VIEW

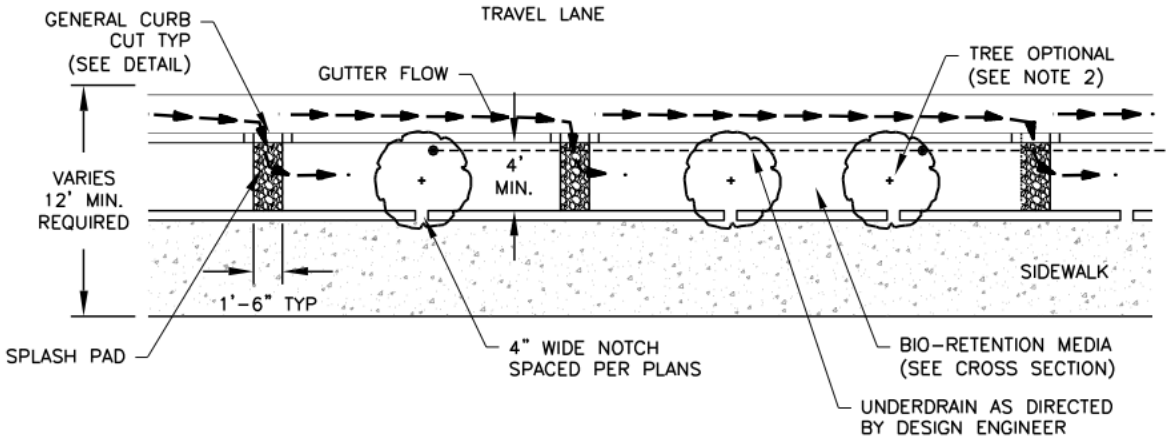


SECTION VIEW

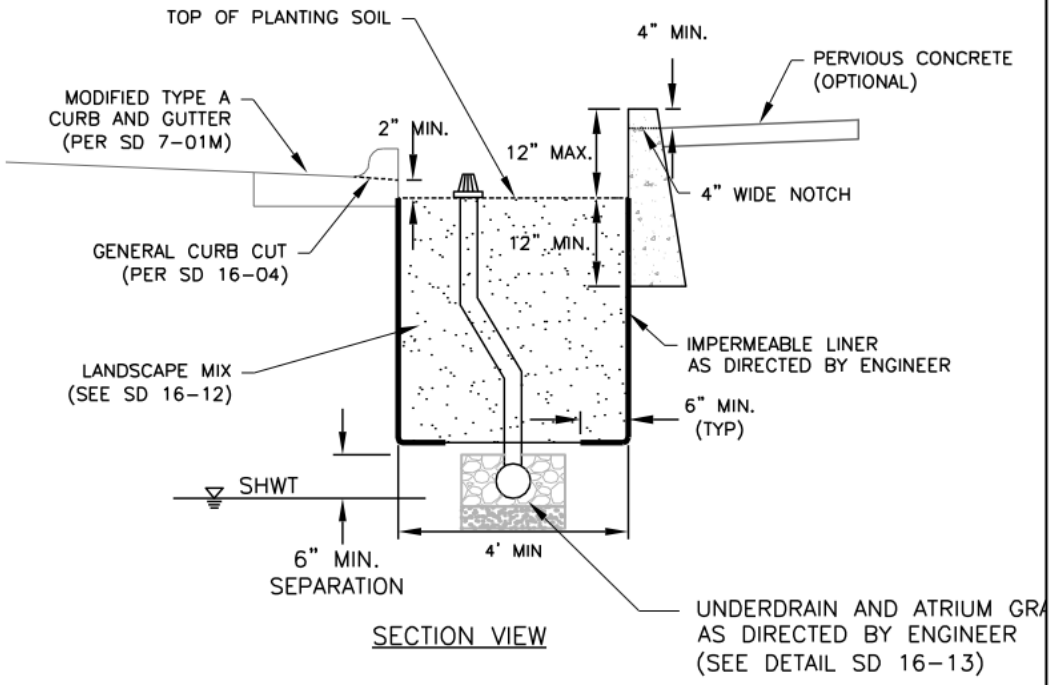
NOTES:

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	
DRAWN BY TLM	SIDEWALK RETENTION (WITH PARKING)
CHECKED BY HCF	
SCALE NOT TO SCALE	SD 16-07



PLAN VIEW

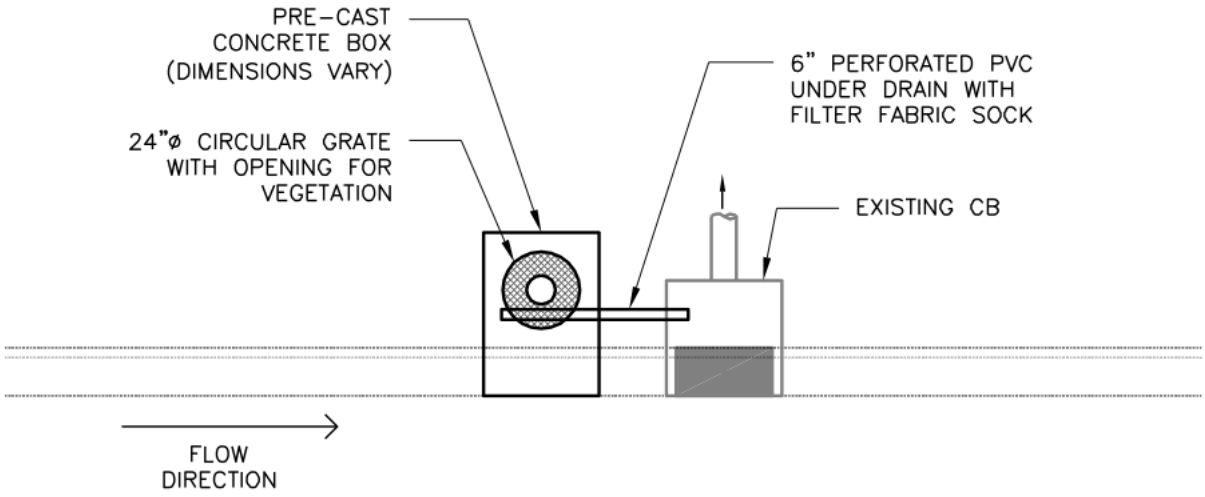


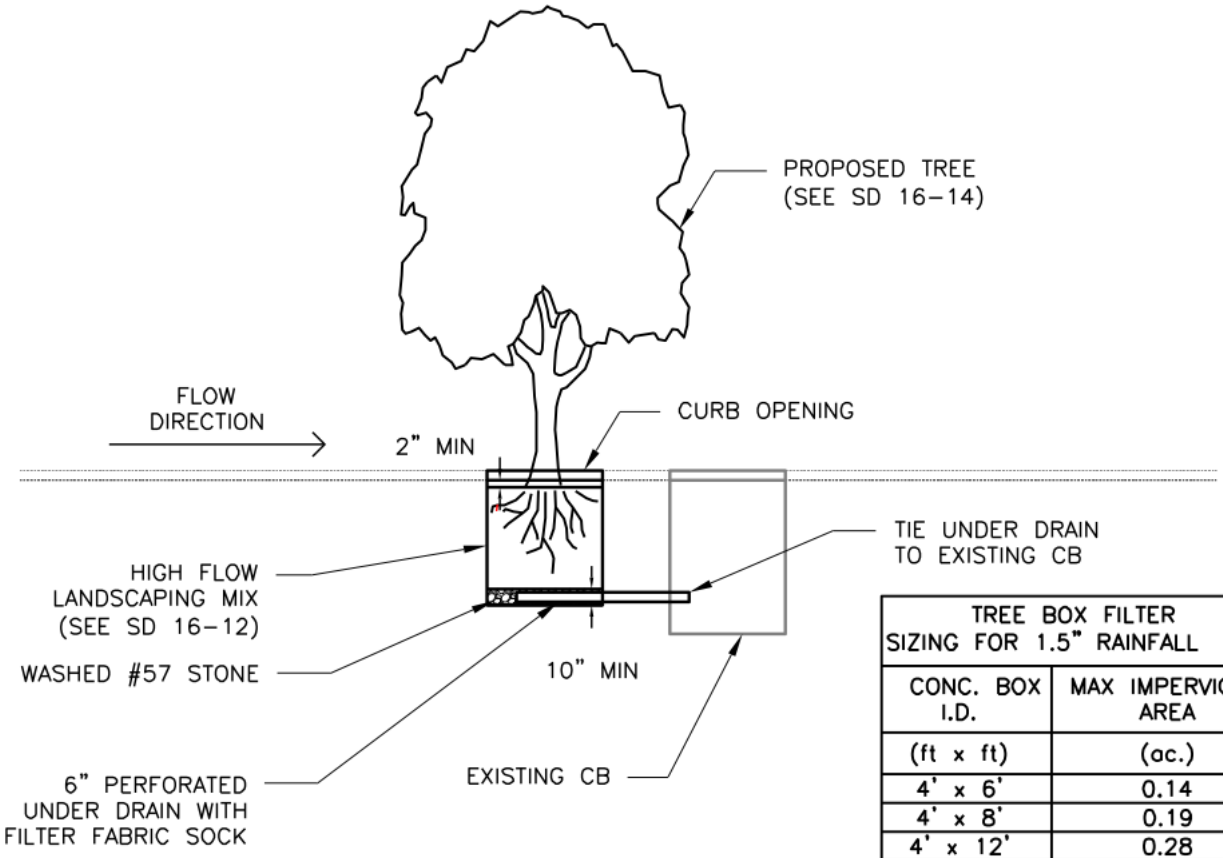
SECTION VIEW

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

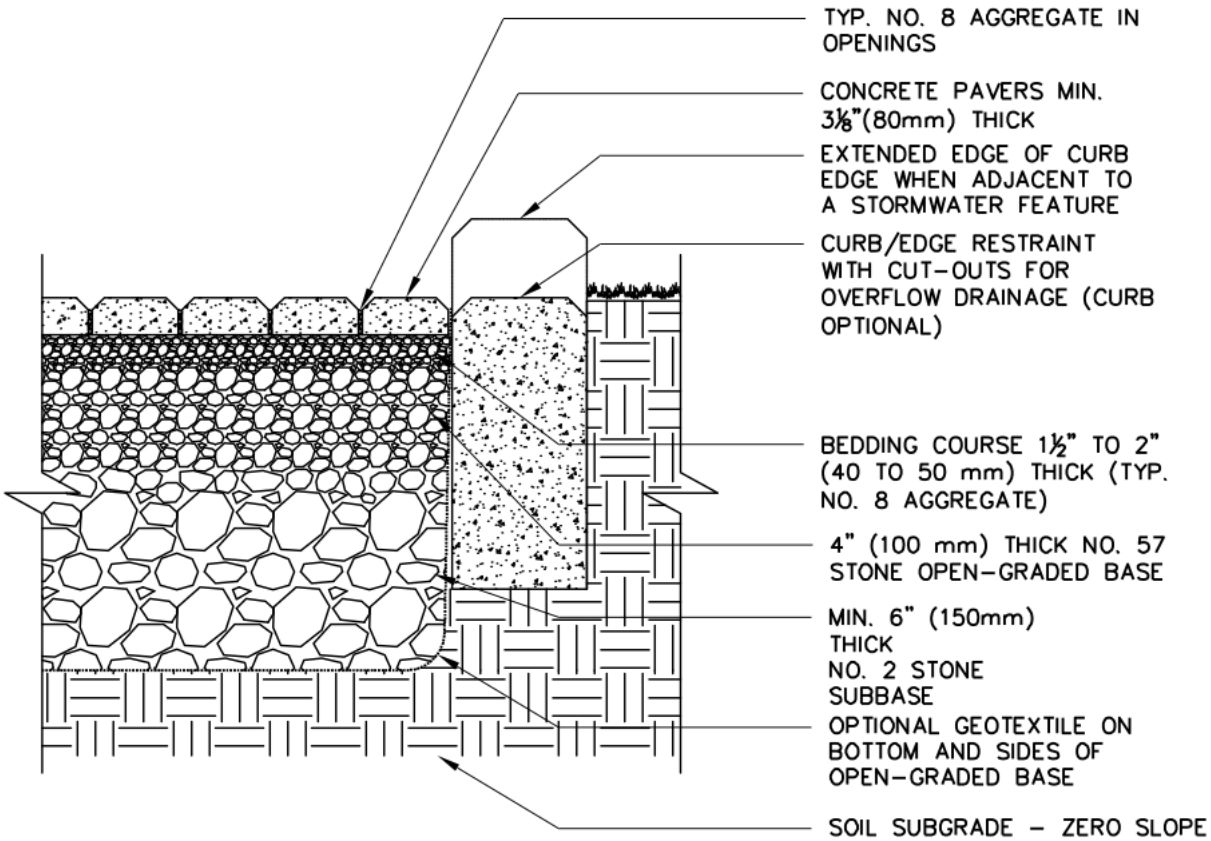
DRAWN BY TLM

CHECKED BY HCF

SCALE NOT TO SCALE

STANDARD
URBAN TREE PLANTER BOX

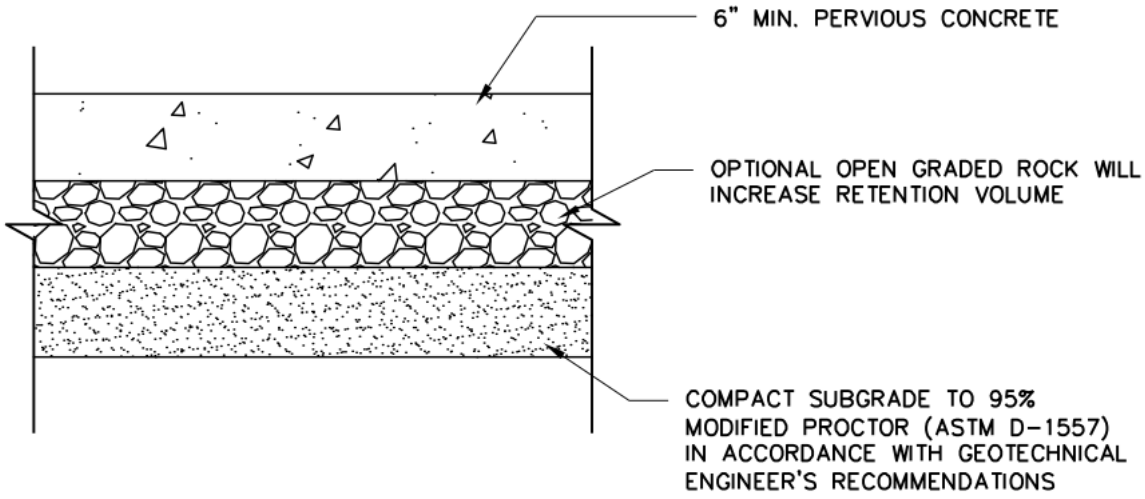
SD 16-09



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.

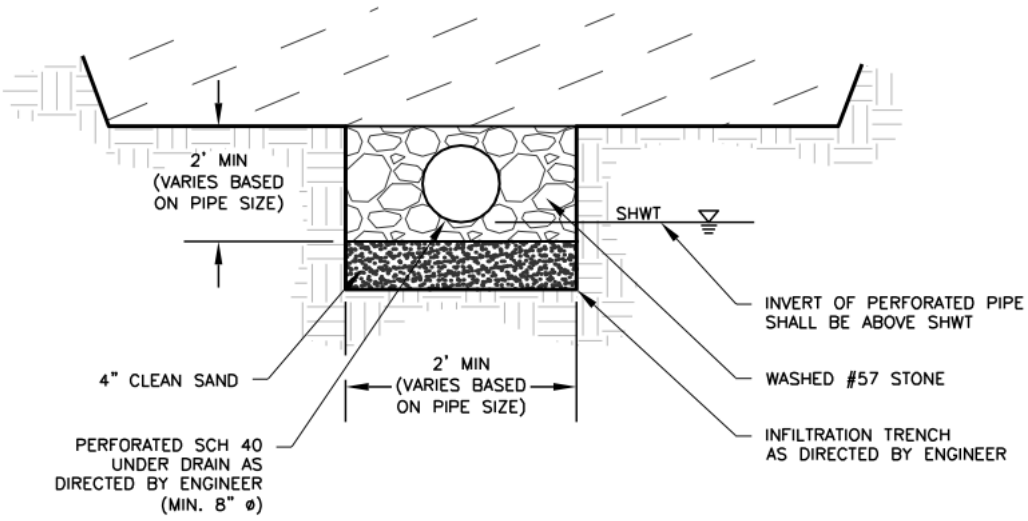
ENGINEERED HIGH FLOW MEDIA SHALL MEET THE FOLLOWING SPECIFICATIONS

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

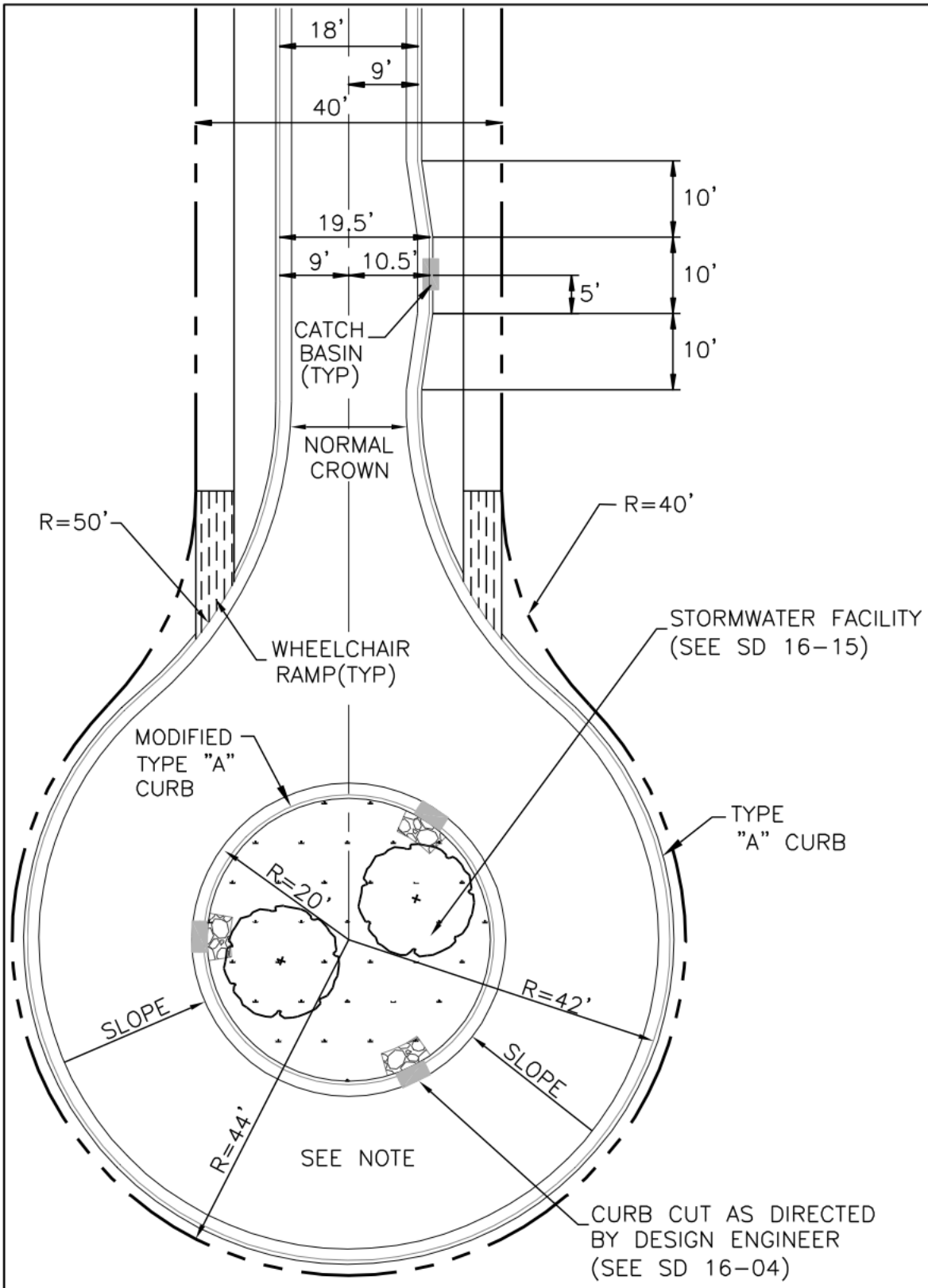
RECOMMENDED PLANTS LIST FOR ALL STORMWATER DETAILS:

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

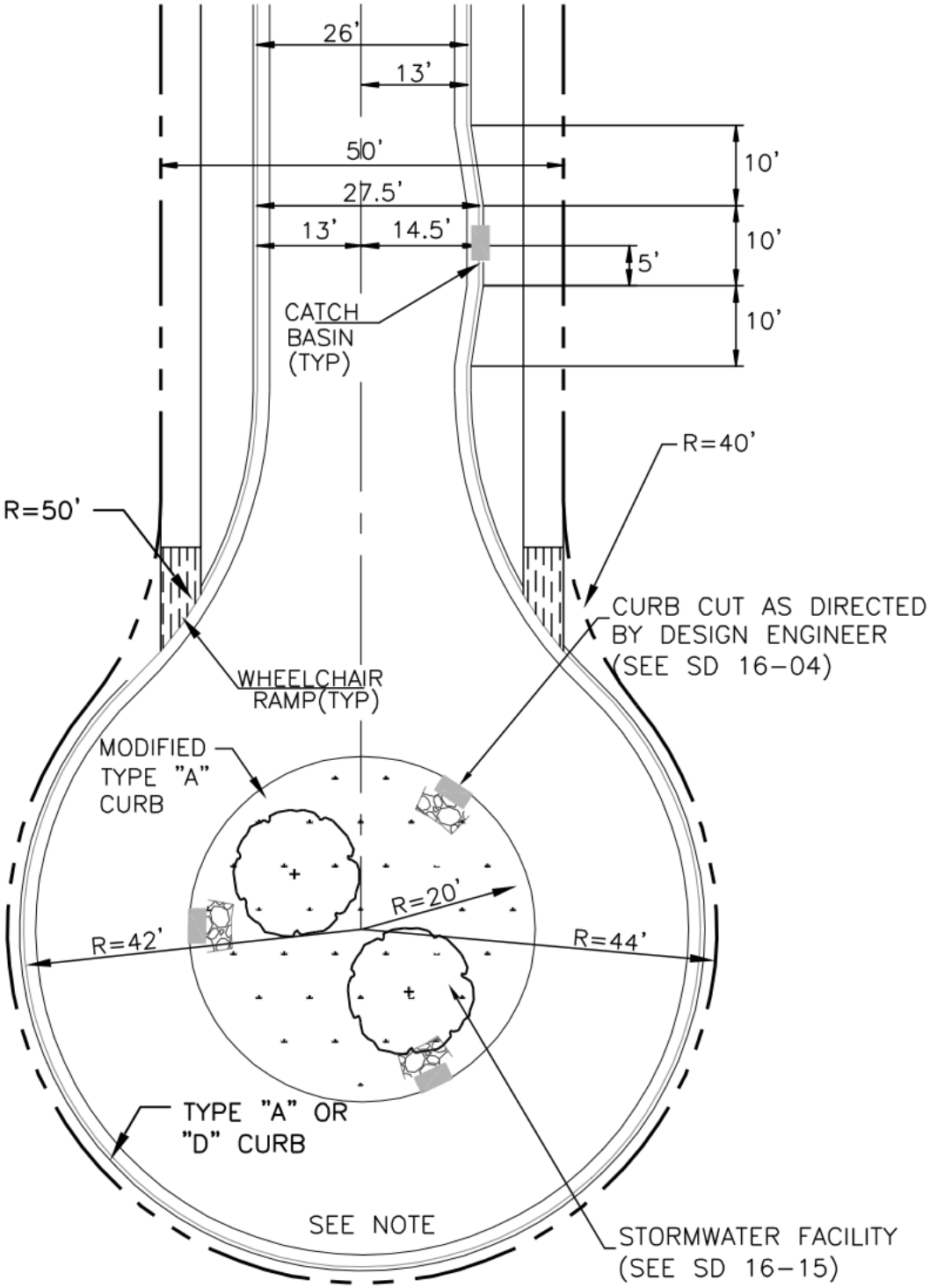
NOTE:

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



	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

STORMWATER ISLAND CROSS SECTION

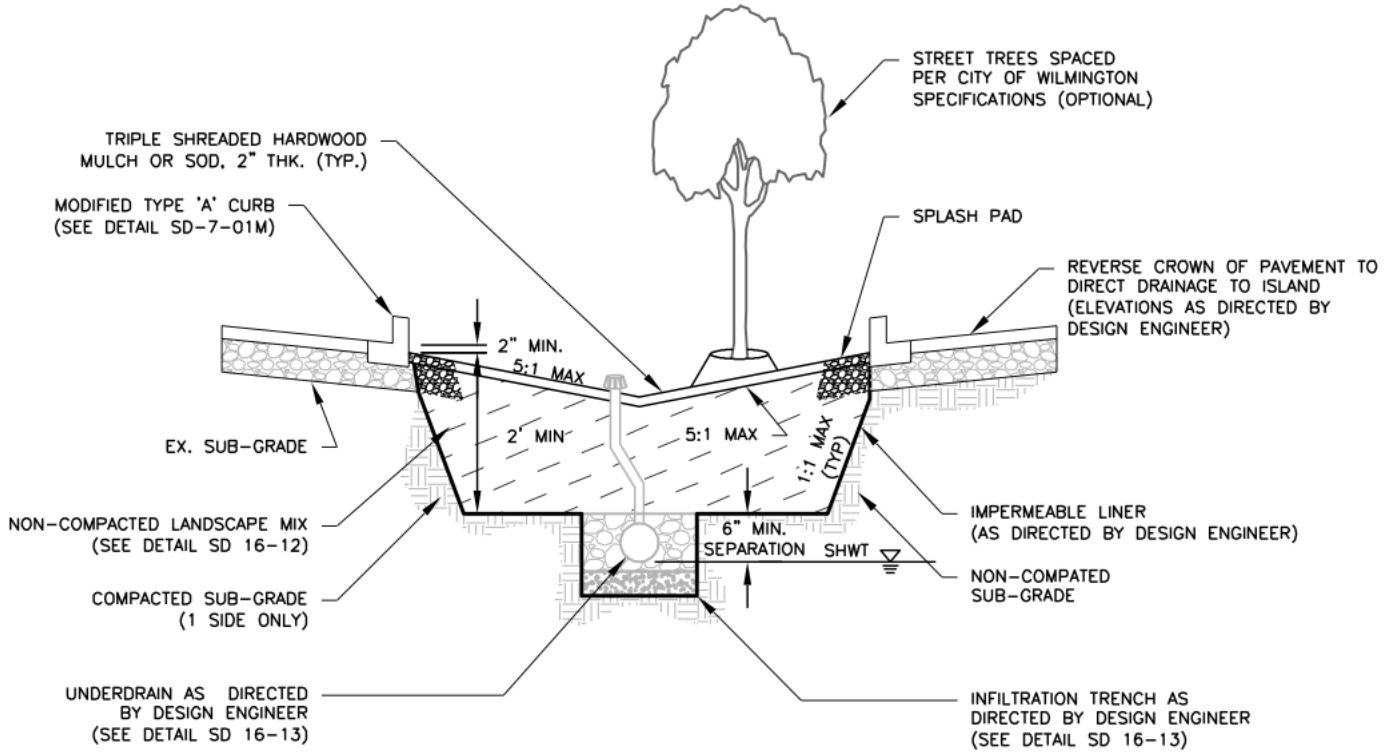
STANDARD DETAIL

DATE: 2012

DRAWN BY TLM

CHECKED BY HCF

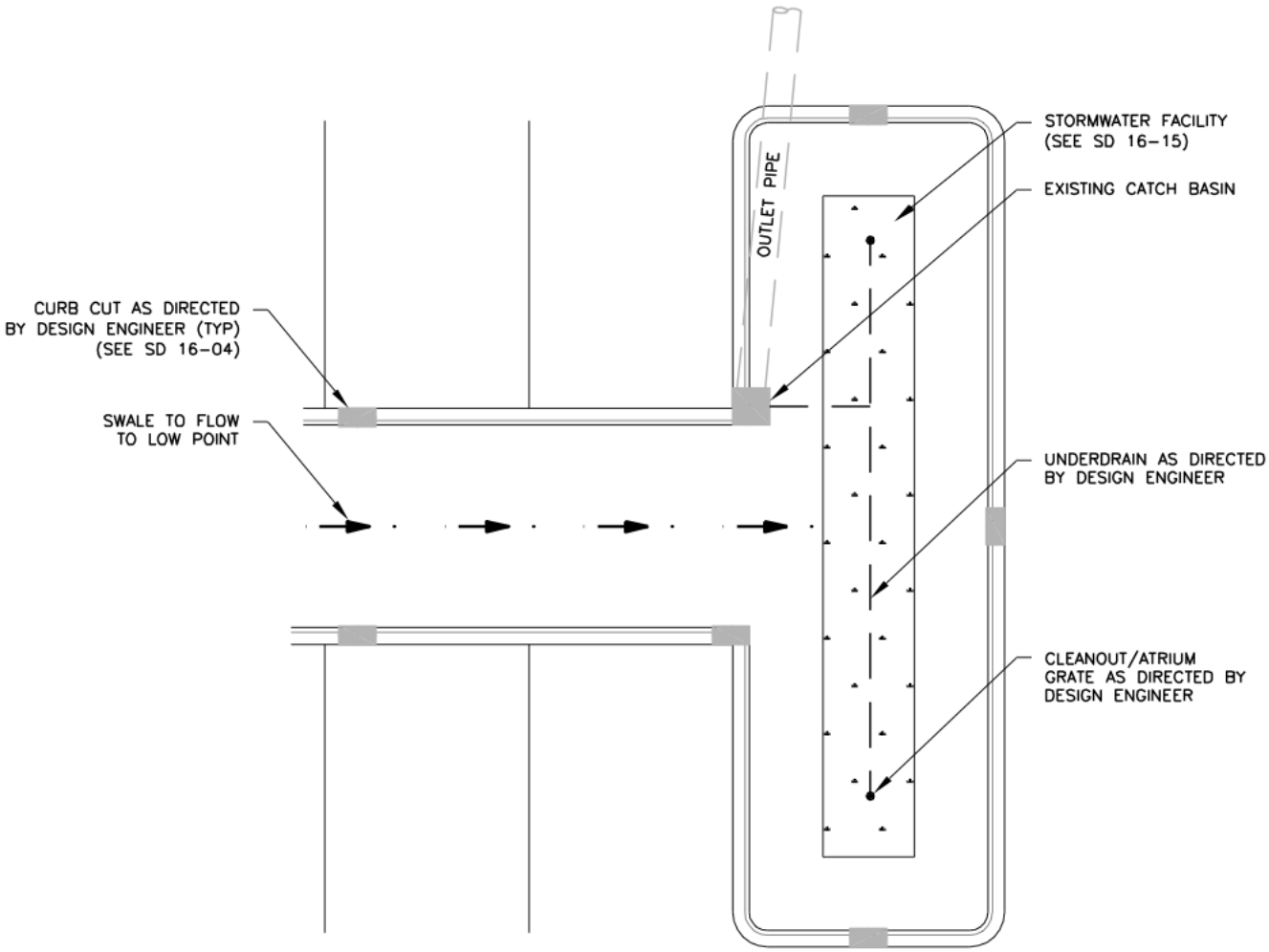
SCALE NOT TO SCALE



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.

SD 16-15



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

APPENDIX H: ABOUT THE NORTH CAROLINA COASTAL FEDERATION

Established in 1982 and working in 20 coastal counties, the North Carolina Coastal Federation works to protect and restore the coast through environmental restoration, preservation, education and advocacy. With over 10,000 members, the federation promotes active stewardship of NC's coastal water quality and natural resources by its residents and visitors. The federation has a long and successful track record protecting and restoring coastal habitats and water quality through projects that acquire land and conservation easements, restore wetlands, riparian shorelines and oyster reefs, and through projects that install stormwater reduction measures. Partnerships include federal and state agencies, local governments, universities, as well as community, business and homeowner groups. The federation's 22-member staff has solid expertise in the design, planning, permitting, building and administration of water quality protection and restoration projects.