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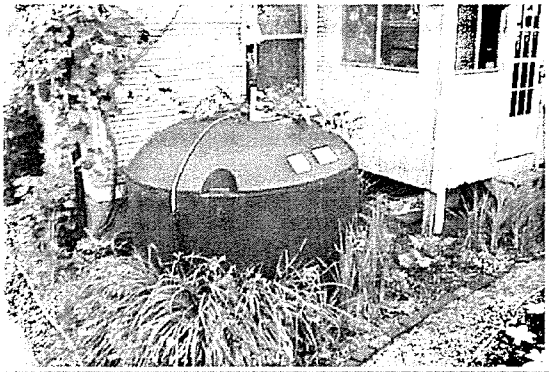
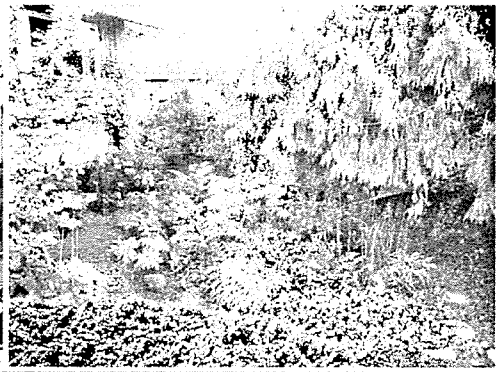
An Assessment of

Outer Banks Coastal Environmental Conditions, Existing Stormwater Management Strategies, and the Local and State Regulatory Context to Help Local Communities Effectively Implement Low Impact Development

Outer Banks, North Carolina





BLUE

An Assessment of Outer Banks Coastal Environmental Conditions, Existing Stormwater Management Strategies, and the Local and State Regulatory Context to Help Local Communities Effectively Implement Low Impact Development – Outer Banks, NC

Completed for the Outer Banks Hydrology Management Committee With UNC-CSI

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FINAL REPORT

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Executive Summary

This study provides an overall assessment of the feasibility of using LID methods as part of a regional integrated stormwater management program on the Outer Banks.

Based on a review existing stormwater policies for communities within the Outer Banks LID Study Area, limited impediments to LID were identified in existing ordinances. Several recommendations are made to modify general ordinances to facilitate the use of LID. To embrace LID, a shift from the current philosophy (of conveying stormwater from a site) will be required to eliminate stormwater runoff from the site, maximizing retention and treatment within each lot. A *Model Ordinance for Stormwater Management in the Outer Banks* was developed and is intended to serve as a framework for all communities within the study area.

The majority of potentially developable properties along the Outer Banks have been subdivided and platted for residential housing and associated real estate development. In Dare County, approximately 22% of potentially developable parcels have not been constructed upon; in Currituck County, approximately 54% of developable parcels have not been constructed upon.

Two major factors impede the implementation of LID in the Outer Banks. The first, the presence of a high water table, is a physical constraint. The second, property boundaries, is a legal constraint. For LID techniques to have significant positive benefits, these must be undertaken through retrofit projects within existing residential developments and associated areas. Both LID Site planning techniques and structural stormwater measures may be applied in the Outer Banks. Site planning techniques include clustering of structures, reducing impervious surfaces and grading to conform to natural topography. Structural measures which are recommended in the Outer Banks include bioretention areas, vegetated filter strips, cisterns, vegetated open channels, permeable pavement.

Several organizational options exist for developing and implementing LID strategies for storm water management. It is recommended that LID be promoted through a two pronged approach whereby:

1. Existing municipal and county stormwater programs and ordinances be revised to provide incentives, remove impediments and strongly encourage LID practices for new development and redevelopment; and

2. In cooperation with the Dare and Currituck County Soil and Water Conservation District (SWCD) s and UNC-CSI, communities work to (a) develop pilot projects for educational purposes, (b) facilitate LID workshops and (c) seek state and federal support to retrofit existing properties.

Public workshops and pilot projects illustrating the benefits and use of LID will be instrumental in achieving public support and implementation. UNC-CSI and SWCD should continue to facilitate workshops which provide a platform for the public and site developers to learn more about LID practices.

1.0 Introduction

In 2005, the Outer Banks Hydrology Management Committee was convened to review issues related to flooding and stormwater problems facing Dare and Currituck counties. The Committee identified problems linked to stormwater management in the Outer Banks including flooding, closing of shellfish beds, property damage and threatened water quality of the receiving waters. Based on stakeholder input, the committee outlined a number of action items to address stormwater and water quality issues in the Outer Banks. Recommendations by the Committee were outlined in a Report of Findings (University of North Carolina Coastal Studies Institute (UNC-CSI), 2005).

A key recommendation by the Committee was to remove barriers and develop incentives for the use of Low Impact Development (LID) in the Outer Banks. LID's goal is to mimic a site's predevelopment hydrology by using techniques that infiltrate, filter, store, evaporate and detain runoff close to its source.

This study is a follow-up to the efforts by the Outer Banks Hydrology Management Committee, conducted for UNC-CSI in partnership with Dare and Currituck Counties. This study was undertaken to assess the feasibility of using LID methodologies as part of a regional integrated stormwater management program in the Outer Banks. Specific study objectives are to:

(a) Review existing stormwater policies for communities within the Outer Banks LID Study Area and identify impediments to LID;
(b) Provide a review of existing land use and soil conditions and planned development and identify what LID strategies may be applied in the Outer Banks;
(c) Develop a model stormwater ordinance which may be used as the framework for all communities in the Outer Banks & identify appropriate performance ordinances (hydro curve numbers) and
(d) Review organizational options for regional stormwater management and identify a strategy for implementation of LID practices.

The LID Study Area encompasses all of the Outer Banks portions of Dare and Currituck Counties (Exhibit 1).

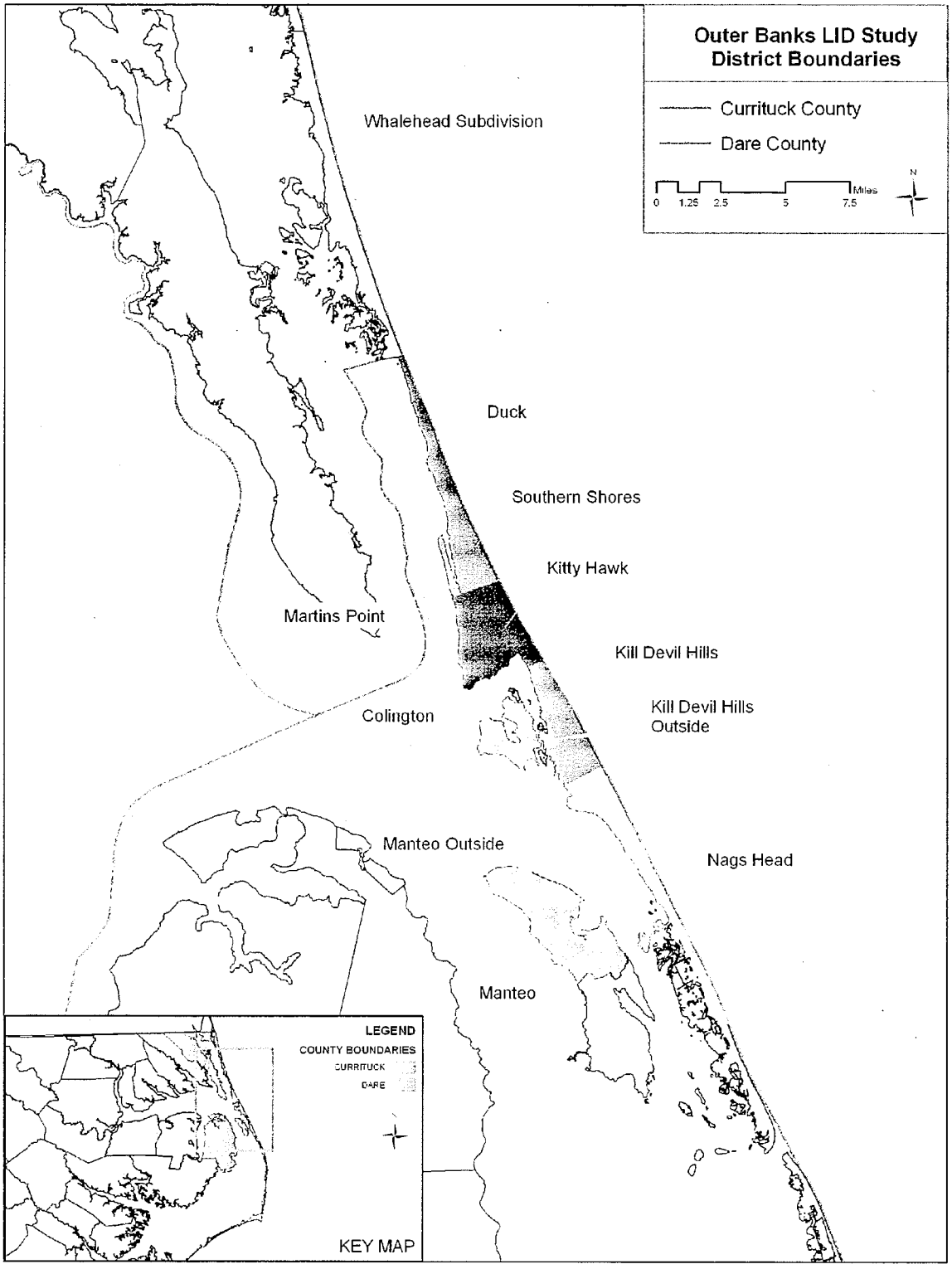

Exhibit 1. Outer Banks LID Study Area

2.0 Overview of LID

2.1. Definition

Low Impact Development (LID) is the implementation of real estate development in such a manner that the postdevelopment hydrologic response mimics the predevelopment hydrologic response (quantity, character, and constituents). Other components such as landscape aesthetics, wildlife habitats, and temperature buffers are sometimes included.

2.2. Outer Banks Real Estate Development and Stormwater Management

Prior to real estate development along the Outer Banks, most precipitation reaching the ground surface outside wetland areas would infiltrate into the soil. Surface waters (creeks, streams, sounds, and ocean) were well buffered by wetlands and high infiltration potential soils. These areas provided natural treatment of stormwater constituents which can negatively affect the surface waters. Prior to real estate development along the Outer Banks, such constituents were generally limited to fecal coliform from birds and mammals. Other common stormwater constituents which can negatively affect surface waters include nutrients (nitrogen, phosphorous, etc), petroleum products (greases, oils, etc), heavy metals (lead, copper, mercury, chromium, cadmium, zinc, etc), and biological control agents (herbicides, pesticides). Significant sources of these stormwater constituents were not present along the Outer Banks prior to real estate development.

As real estate development has increased along the North Carolina Outer Banks, significant loadings of stormwater constituents which can negatively affect surface waters have also increased. Nitrogen loadings have significantly increased from landscape fertilizer use and automobile exhaust. Phosphorus loadings have significantly increased from landscape fertilizer use and vehicle washing. Petroleum product loadings have significantly increased from automobile fluid leaks, automobile fluid dumping, and automobile fuel pump discharges. Heavy metal loadings have increased from automobile tire wear, automobile part deterioration, automobile brake pad wear, automobile exhaust, and asphalt pavement deterioration. Other sources of these stormwater constituents also exist.

Real estate development increases the amount of impervious surfaces and compacts soils. When rainwater reaches ground surfaces of impervious cover and compacted soils, the amount of stormwater which infiltrates into the soil is reduced. Stormwater does not infiltrate impervious surfaces and infiltrates slower into compacted soils. This produces more stormwater runoff.

Stormwater runoff comes in contact with various pollutants (bacteria, viruses, nitrogen, phosphorous, greases, oils, lead, copper, mercury, chromium, cadmium, zinc, herbicides, pesticides, etc). The polluted stormwater flows along various paths until reaching a receiving water body. Unless the polluted stormwater is managed such that the undesirable constituents are adequately treated (bound, removed, or transformed), the stormwater runoff can negatively affect the surface waters to which it flows. Real estate development also results in a reduction in the

extent and size of natural areas, including areas which buffer surface waters. These areas provided natural treatment of stormwater constituents which can negatively affect the surface waters.

In addition to increased pollutant loadings, the stormwater runoff also increases in terms of volume and rate. This increased stormwater runoff can produce undesirable erosion and flooding unless the stormwater is managed such that the quantity and rate are adequately restrained.

Post World War II real estate development stormwater approaches have focused on collection of stormwater at the project site and conveyance of the stormwater from the site to the nearest discharge location. Facilitating rapid surface drainage was the primary goal, usually without consideration of off-site affects. Most requirements for managing stormwater have been limited to preventing direct capital damage and loss-of-life. Largely beginning in the mid-1970s, efforts have been undertaken to address pollution from stormwater runoff. More recently, these efforts have begun to be applied in a more widespread manner, including throughout the 20 coastal counties of North Carolina (see Section 4, Summary of Existing Ordinances).

Common current "high-density" real estate development techniques for addressing stormwater management requirements focus on an "end of pipe" approach, employing hardened components (channels and pipes) to direct stormwater runoff into detention basins. Common current "low-density" real estate development techniques for addressing stormwater management requirements focus on limiting impervious area below a maximum limit (generally a percentage of the total project area) and employing vegetated open channels to convey stormwater runoff from the site. Such efforts have produced limited success and have failed to prevent significant degradation of water resources, including economically important fisheries.

There is a significant need for an approach to real estate development stormwater management which protects water resources as well as public health, safety, and welfare while maintaining and improving life quality and economic development. LID is such an approach.

2.3. The LID Approach

LID offers real estate developers a cost effective means to address stormwater management. The approach involves five key elements: Natural Area Conservation, Stormwater Management Measures, Site Specific Design, Stormwater Treatment Train, and Beneficiary Involvement. These elements provide tools to ensure the postdevelopment hydrologic response mimics the predevelopment hydrologic response (quantity, character, and constituents). Including all of these elements is not required to implement a LID project, but all of these elements must be considered and addressed when undertaking a LID approach.

As opposed to common stormwater management practices which focus on "end-of-pipe" solutions, the LID approach emphasizes infiltration and treatment of stormwater as close to the location of precipitation reaching the ground as possible as well as along the various stormwater runoff pathways. LID affords a way to mesh aesthetically pleasing landscape features with stormwater management. Employing the LID approach can significantly reduce stormwater infrastructure costs while meeting or exceeding regulatory requirements.

2.4. The Five Key LID Elements

(a) **Natural Area Conservation** - Conserving natural areas includes locating important natural areas to be preserved, siting features to reduce natural area negative impacts, and minimizing disturbance to natural areas. Natural area conservation should receive particular attention during the planning stages of a real estate development project.

(b) **Stormwater Management Measures** - Stormwater management measures may be either: 1) structural (comprised of various physical, biological, and chemical components); or 2) behavioral (comprised of various activities, manners, and methods). Structural measures directly restrain or treat stormwater. These include implementation of bioretention areas, detention ponds, vegetated swales, and others. Behavioral measures prevent or reduce pollution of stormwater. These include approaches to fertilizer application, oil dumping, vehicle washing, automobile maintenance, groundcover selection, and others. Each is important to stormwater management, though behavioral measures are much more difficult to successfully implement.

(c) **Site Specific Design** - Each real estate development project site is different. Site soil conditions (ecology, texture, etc), vegetation characteristics (native/nonnative, survival, etc), hydrologic/hydraulic inputs, and pollutant inputs (spills, nutrients, etc), as well as the proposed built features affect the hydrologic response of a site. As each site is unique, the manner in which stormwater is managed must be specific to each site and each project.

(d) **Stormwater Treatment Train** - A treatment train is a series of management measures along a stormwater flow path which address various aspects of hydrologic response. The treatment train approach is a standard aspect of water and wastewater treatment facilities. By providing several types of stormwater management measures across the site, particular components of stormwater are more effectively addressed. Additionally, by including several stormwater management measures, the potential for system failure is reduced as failure of individual measures does not result in overall system failure.

(e) **Beneficiary Involvement** – Stormwater management is not a "fire and forget" operation. System maintenance and pollution prevention as well as awareness and education are important to ensure stormwater management is adequate over the project lifetime, which may extend for many decades.

2.5. LID Site Planning Techniques

An integral part of LID is site planning. Once a conceptual site plan has been developed, it guides the remaining process. Below are basic concepts which should be employed for LID.

(a) **Clustering Structures** - Increasing density of structures on a parcel and across a region improves the efficiency of the space. This reduces the magnitude of required basic infrastructure; not only stormwater, but also wastewater collection, water supply, and transportation facilities. Such clustering of structures also allows preservation of open space. This open space can be utilized for active and passive recreation; sound, sight,

wind, and temperature buffers; as well as wildlife habitat. The combination of clustering and open space facilitates contact between neighbors and provides marketable amenities.

(b) **Reducing Impervious Surfaces** - Impervious surfaces are the largest contributors to stormwater runoff. Less impervious surface directly reduces the amount of stormwater runoff, reducing the degree of structural stormwater management measures which must be employed. Reducing the width and maximizing the efficiency of vehicular and pedestrian transportation routes is often a key aspect of impervious surface reduction. Utilizing shared driveways, flag lots, and open cul-de-sacs are other common methods for reducing impervious surfaces.

(c) **Landform Conformance** - Modifying natural landforms often increases the amount of runoff. Working with the natural landforms of a site directly reduces the cost of project earthwork, the extents of land disturbance, and removal of topsoil. Berms and channels can be utilized to transform natural areas into effective stormwater runoff retention and detention components.

(d) **Disconnected Impervious Surfaces** - Connected impervious surfaces convey stormwater runoff without the potential for treatment while increasing the magnitude of stormwater which must be treated once the runoff reaches a structural stormwater management measure. By disconnecting impervious surfaces, structural stormwater management measures may be employed along the path of stormwater runoff. Disconnecting impervious surfaces can also reduce the velocity of stormwater runoff, which reduces the cost of conveyance measures.

2.6. Structural Stormwater Management Measures

A key LID element is implementation of structural stormwater management measures. Such measures are central components of site specific design and an overall stormwater management system. Stormwater management measures are the foundation of a treatment train. Stormwater management measures readily included in LID are indicated below. A summary regarding the application, potential conflicts and opportunities for each of the structural stormwater management measures is included in Appendix A.

(a) **Bioretention Areas** – These are vegetated depressions which retain stormwater, allowing the water to infiltrate and evapotranspirate (Exhibit 2). Bioretention areas are generally 12 inches to 36 inches deep, with 18 inches being a common depth. Appropriate native herbaceous and woody vegetation is preferred and typically utilized, though suitable turf grasses can be employed. Bioretention areas do not maintain standing water. Water in bioretention areas should remain above the surface no more than about 3 days, allowing volume recovery for subsequent storms and preventing mosquito breeding. Highly concentrated infiltration may require soil water mounding analysis.

(b) **Vegetated Filter Strips** - These are narrow measures generally placed at the edges of impervious surfaces with relatively nonconcentrated flow, such as parking lots, to provide an area for stormwater treatment by infiltration, filtering, sedimentation, and sorption (Exhibit 3). These are often employed as the first component of a treatment train.

(c) **Cisterns** - Cisterns have been used for thousands of years to collect and store rainwater (Exhibit 4). The primary function of cisterns relative to LID is detention, retaining direct runoff from impervious surfaces during and following precipitation events. Cisterns are typically connected to roof drains. The water is often utilized for irrigation and sometimes for drinking (though treatment prior to such use is generally needed). These are high maintenance systems and should only be implemented where proper regular maintenance will be undertaken.

(d) **Vegetated Open Channels** - Wherever stormwater must be conveyed on a site, it is generally preferred that such occurs along a vegetated open channel (Exhibit 5). These allow treatment of stormwater by infiltration, filtering, sedimentation, and sorption. These are often placed along roadways and innervating through sites.

(e) **Permeable Pavement** - Surfaces intended for vehicular and pedestrian traffic can be constructed from a variety of materials. Such surfaces are almost always impermeable and usually constructed of asphalt or concrete. These surfaces can be pervious (allowing stormwater to infiltrate) and constructed of pavers or other materials (Exhibit 6). These are high maintenance systems which are expensive to patch and repair compared to asphalt and concrete. These should only be implemented where proper regular maintenance will be undertaken. These should not be implemented in areas of high vehicular traffic or other areas where fine particles and other clogging pollutants could degrade performance.

(f) **Vegetated Roof** - This is a measure intended to reduce or eliminate runoff from roofs. The roof is generally covered with a planting matrix and vegetation installed densely across the surface (Exhibit 7). A high density polyethylene membrane or similar material serves as moisture barrier over the base roof structure.

Exhibit 2. Bioretention Area (Photo from website www.bioretention.com)

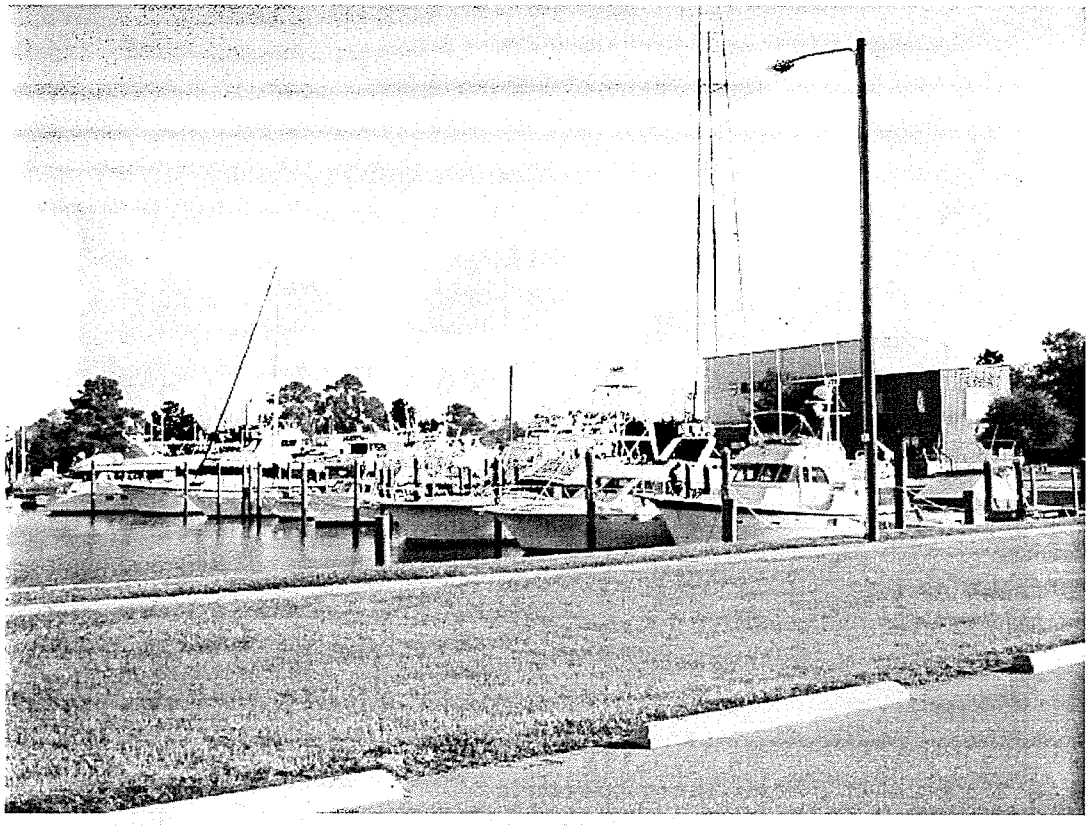

Exhibit 3. Vegetated Filter Strip (Photo from website http://www.psat.wa.gov/)

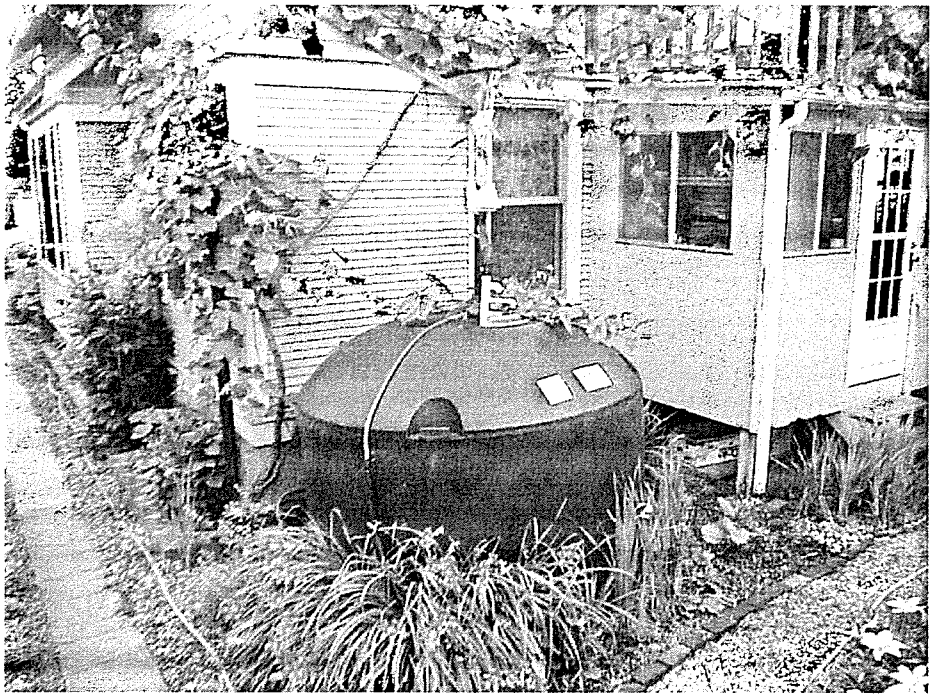

Exhibit 4. Cistern (Photo from website http://www.harvestingwater.com/)

Exhibit 5. Vegetated Open Channel (turf cover) (Photo from website http://www.psat.wa.gov/)

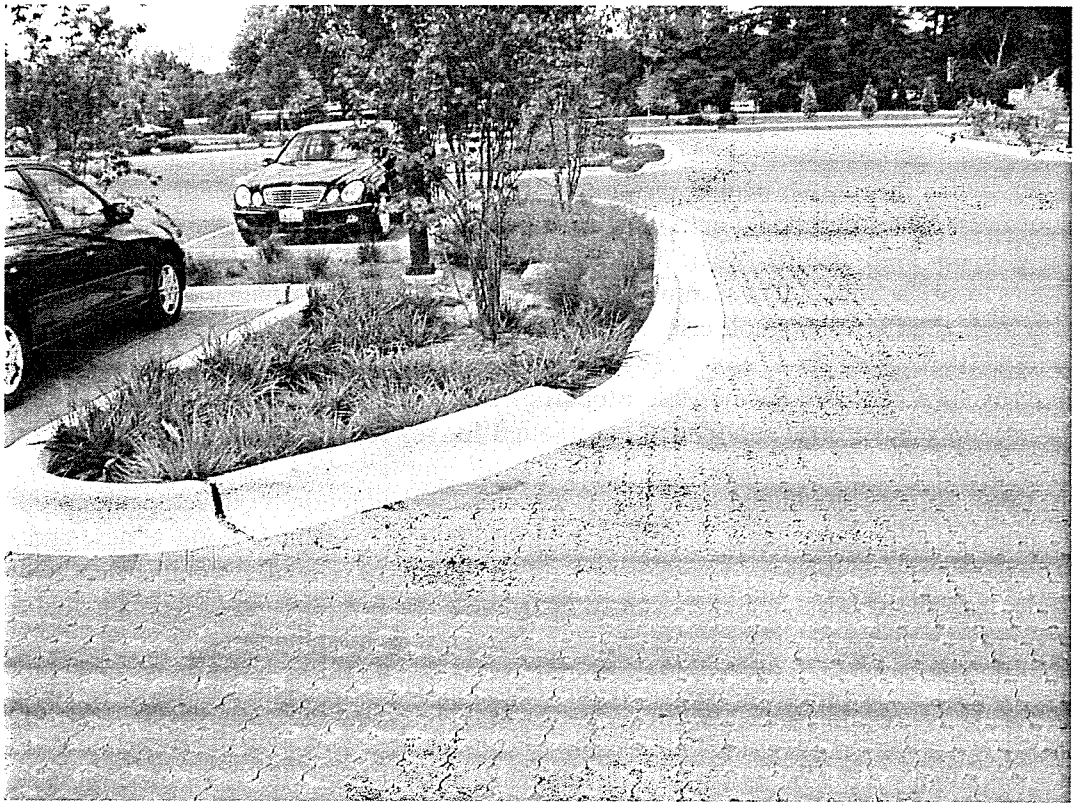

Exhibit 6. Permeable Pavement (Photo from website www.bioretention.com)

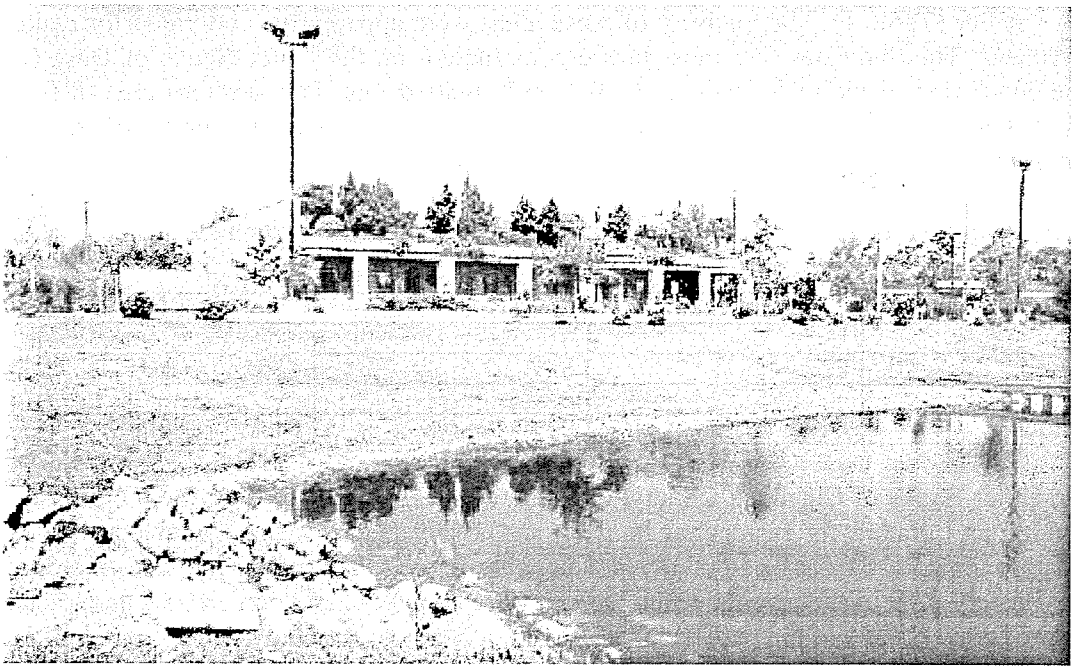

Exhibit 7. Vegetative Roof (Photo from website http://www.bae.ncsu.edu/workshops/ashevillegreenroof/greenroof.html)

3.0 Review of Real Estate Development and Application of LID

3.1. Real Estate Development on the Outer Banks

The Outer Banks has drawn people to the area for beautiful beaches, excellent fishing, and a variety of other water dependent activities. The economy of the North Carolina Outer Banks is dependent upon high quality water resources. The character and economy of the area is inseparable from the waters that surround the Outer Banks. Proper management of stormwater is central to high quality water resources.

The majority of potentially developable properties along the Outer Banks of Currituck County and Dare County have been subdivided and platted for residential housing and associated real estate development. Land owned by government entities and environmental nonprofit organizations is not considered potentially developable. Potentially developable properties include any privately held land, regardless of jurisdictional wetlands, flood zones, and other typical real estate development impediments on the property. Given the high property value relative to mitigation costs for such constraints, these are not seen as preventing real estate development (though associated regulations may limit such development).

On the Outer Banks of Dare County, construction has occurred on the majority of land subdivided and platted for residential housing and associated real estate development. In this area, approximately 22% of potentially developable parcels have not been constructed upon. Approximately 87% of the parcels which have not been constructed upon are one acre or smaller; approximately 72% of the parcels which have not been constructed upon are one-half acre or smaller (Table 1). The majority of these areas were apparently subdivided for residential development. This indicates that most future construction on the Outer Banks of Dare County will be comprised of individual houses on currently platted lots. The northern area of the Dare County Outer Banks is more developed than the southern area in terms of real estate construction.

Table 1. Approximate Development of Potentially Developable Properties.

County	Percent of Parcels Not Constructed Upon		
	Total	Less Than 1.0 Acre	Less Than 0.5 Acre
Dare	22%	87%	72%
Currituck	54%	92%	81%

On the Outer Banks of Currituck County, construction has not occurred on the majority of land subdivided and platted for residential housing and associated real estate development. In this area, approximately 54% of potentially developable parcels have not been constructed upon. Approximately 92% of the parcels which have not been constructed upon are one acre or smaller and approximately 81% of the parcels which have not been constructed upon are one-half acre or smaller. The majority of these areas were apparently subdivided for residential development. This indicates that most future construction on the Outer Banks of Currituck County will be comprised of individual houses on currently platted lots. The southern area of the Currituck

County Outer Banks is more developed than the northern area in terms of real estate construction.

3.2. LID on the Outer Banks

The naturally high infiltration potential of soils on the Outer Banks provides an excellent opportunity for LID. Two major factors impede the implementation of LID techniques in areas of the Outer Banks of Currituck County and Dare County. The first, high water table, is a physical constraint. The second, property boundaries, is a legal constraint. Each of these can be successfully addressed.

Much of the higher areas have been utilized (or will likely be utilized) for construction of vertical structures (housing, in particular). On-site wastewater systems (septic tanks, nitrification leachfields, and associated components) are also sited (or will likely be sited) in higher areas of properties. The sandy nature of the area allows a high infiltration potential for stormwater. The proximity of water table to the surface in some areas limits, however, the volume of stormwater which can be infiltrated. The high water table also hinders various biological and chemical treatment processes for stormwater. Ditches and canals constructed to manage the water table present short circuiting issues for stormwater that has been infiltrated. Stormwater management must be assessed and addressed on a site-by-site basis relative to water table. Such site specific design, however, is a key element of LID.

Though many areas of the Outer Banks contain relatively high dunes, many other areas of the Outer Banks are within a two or three feet of mean sea level. Approximately 19% of the undeveloped area along the Outer Banks of Currituck County and Dare County has water table depths of at least 6 feet below the ground surface throughout the year. Approximately an additional 3% (21% total) of the undeveloped area on potentially developable parcels, along the Outer Banks of Currituck County and Dare County, maintain water table depths of at least 5 feet below the ground surface throughout the year. Approximately 13% of the undeveloped area on potentially developable parcels has water table depths of between 1.5 feet and 3.0 feet generally during wetter portions of the year. Approximately 8% of the undeveloped area on potentially developable parcels has a slightly shallower water table, from about 1 foot to 2 feet below the ground surface. The remaining 57% of undeveloped area on potentially developable parcels along the Outer Banks of Currituck County and Dare County has water table depths of less than 1 foot during wetter portions of the year.

Table 2. Approximate Water Table Depths on Potentially Developable Properties.

Status	High Water Table Location (Depth Below the Surface)				
	at Least 6 Feet	5 to 6 Feet	1.5 Feet and 3.0 Feet	1 Feet and 2 Feet	Less than 1 Foot
Developed	68%	1%	10%	9%	13%
Undeveloped	19%	3%	13%	8%	57%

Approximately 68% of the real estate developed area along the Outer Banks of Currituck County and Dare County has water table depths of at least 6 feet below the ground surface throughout

the year. Approximately an additional 1% (69% total) of the real estate developed area along the Outer Banks of Currituck County and Dare County water table depths of at least 5 feet below the ground surface throughout the year. Approximately 10% of the real estate developed area has water table depths of between 1.5 feet and 3.0 feet generally during wetter portions of the year. Approximately 9% of the real estate developed area has a slightly shallower water table, from about 1 foot to 2 feet below the ground surface. The remaining 13% of real estate developed area along the Outer Banks of Currituck County and Dare County has water table depths of less than 1 foot during wetter portions of the year.

Nearly all of the undeveloped area with water table depths of less than 1 foot during wetter portions of the year would be classified as jurisdictional wetlands. Approximately 68% of the potentially developable area is comprised of hydric (wet) soils. Approximately 46% of the real estate developed area contains hydric (wet) soils. Most of these wetlands would be directly regulated by both the US Army Corps of Engineers (USACE) and the NC Division of Coastal Management (NCDCM). The Army Corps of Engineers regulates primarily through the Federal Water Pollution Control Act (commonly known as the Clean Water Act) as an agent of the US Environmental Protection Agency (USEPA). The Division of Coastal Management regulates through the North Carolina Coastal Area Management Act (CAMA). Though such regulation is not necessarily an impediment to the implementation of LID techniques on the Outer Banks of Currituck County and Dare County, such regulation does directly affect the magnitude and character of real estate development in these areas.

Ground infiltration potential is an important component of stormwater management. In natural areas of the Outer Banks where the ground is not saturated, rainfall can often enter the ground where the raindrops hit the surface. Most of the soils in these natural areas have about 40% of their volume available for this rainfall.

A 2-year 24-hour storm over most of the Outer Banks of Currituck County and Dare County produces approximately 3.8 inches of rain. If this rainfall infiltrates into the ground without runoff (common on the Outer Banks in natural areas where the ground is not saturated), the rainwater would require about 10 inches of ground above the water table in a typical natural Outer Banks sandy soil. The maximum allowable impervious surface along the Outer Banks of Currituck County and Dare County is 30%. If the rainfall from a 2-year 24-hour precipitation event (3.8 inches total) is to be infiltrated with 30% impervious surface on a site, at least 14 inches of ground would be required above the water table in a typical natural Outer Banks sandy soil. Some additional soil depth would also be required as the natural soil volume available for rainwater is reduced from compaction during construction operations. To retain stormwater on-site for infiltration, a depression of some type must generally be formed. This depression reduces the available depth for stormwater in the soil. Additional depth is also often required to treat pollutants in the stormwater before reaching the water table.

Soils outside mucky wetland areas along the North Carolina Outer Banks are very sandy. The dominant limiting factor for stormwater infiltration potential in these sandy areas is the high water table. This limitation is significantly reduced as the area of stormwater infiltration increases. At existing elevations, approximately 21% of the undeveloped area is generally highly favorable for infiltrating large volumes of stormwater and approximately 69% of the real estate

developed area is generally highly favorable for infiltrating large volumes of stormwater. This indicates that most areas of existing real estate development are highly favorable for stormwater infiltration retrofits. Future real estate development has less opportunity for high stormwater infiltration at existing elevations.

At existing elevations, approximately 13% of the undeveloped area is moderately favorable to unfavorable for infiltrating stormwater and approximately 10% of the real estate developed area is moderately favorable to unfavorable for infiltrating stormwater. Unfavorable stormwater infiltration potential due to high water table can be addressed in areas of future real estate development through the proper use of fill material at the site. Importing off-site fill material has become a common component of most construction along the Outer Banks of Currituck County and Dare County. Importing fill along with appropriate siting of structures and associated earthwork (grading, soil preparation) can provide significant additional depth between ground surface and the high water table. This would, in essence, create an area highly favorable for infiltrating large volumes of stormwater. Properly employed, the use of off-site fill can provide significant benefits without causing stormwater problems for adjacent property owners. Builders, designers, and property owners should employ a combination of detention and retention to manage site stormwater. Several potential management measures are outlined in this document.

Two locations which illustrate the range of terrain that exists within the study area are depicted in Exhibits 8 & 9. Exhibit 8 is a photo taken at the Tuckahoe Ridge Subdivision in the Town of Duck. Adjacent to the Tuckahoe Ridge subdivision, North Carolina State Road 12, has a history of frequent flooding problems (VHB, 2006). The subdivision is located in an area with significant topography and excess groundwater storage available (also present at First Flight Ridge). This is good an example where retrofit of existing lots with structural best management practices (such as bioretention) could be performed at a low cost to reduce flooding. Exhibit 9 taken in the Martins Point subdivision, illustrates the high water table and limited storage capacity (also present at Frisco, Whalehead) which exists in approximately 57% of the remaining undeveloped lots. These areas will be more problematic for bioretention, but larger surface area, shallower systems may be viable. In areas where the population is permanent, cisterns may be another good option.

As nearly all potentially developable properties along the Outer Banks of Currituck County and Dare County have been platted for residential housing and associated real estate development, property boundaries of the subdivided parcels and associated structures control the location, magnitude, and type of stormwater management measures. Roadways, houses, driveways, and utilities (including on-site wastewater) have been constructed relative to property boundaries. Stormwater management must be assessed and addressed on a site-by-site basis relative to each of these as well as required legal easements.

For LID techniques to have significant positive benefits along the Outer Banks of Currituck County and Dare County, these must be undertaken through retrofit projects within existing residential developments and associated areas.

Exhibit 8. Photo taken at Tuckahoe Ridge Subdivision, Town of Duck (5/24/06)

Exhibit 9. Photo at Martin's Point Subdivision (5/24/2006)

4.0 Review of Existing Ordinances

The Moffatt & Nichol project team reviewed existing stormwater policies and ordinances for the following communities in the LID Study Area: Dare County, Manteo, Town of Nags Head, Town of Kill Devil Hills, Town of Kitty Hawk, Southern Shores, Duck, Currituck County and various subdivisions (Colington Harbor, Martin's Point and Whalehead). The policies were reviewed to identify (a) potential impediments to LID within the existing rules and (b) opportunities to augment the use of LID. A detailed summary of the existing policies and ordinances was compiled and is included in Appendix B. A discussion of key points regarding LID implementation and preliminary recommendations are identified below.

4.1. General Stormwater Requirements

The overarching objective of several of the stormwater ordinances is to facilitate stormwater drainage from the site. For example, pursuant to Currituck County ordinances, "All developments shall be provided with a drainage system that is adequate to prevent undue retention of surface water on the development site." The Town of Kill Devil Hills requires that "Surface water leaving the site shall be channeled to points of approved discharge...." Dare County ordinance states "where feasible the subdividers shall connect to an existing storm drainage system."

The conceptual basis of LID is to eliminate stormwater runoff from the site, maximizing retention and treatment within each lot. Underlying goals of an LID program would be to:

- Minimize increase in stormwater runoff from development or redevelopment
- Minimize increase in sources of non-point pollution caused by stormwater runoff by treating on-site
- Minimize total volume of surface water runoff that flows from a specific site in order to replicate, to maximum extent possible, predevelopment hydrology
- Maintain stormwater on-site controls

The more LID techniques that are applied, the closer to natural hydrologic function a site becomes. Where there are known flooding problems, however, a hybrid approach may be needed to reduce liability and provide a sense of safety. LID does not demand isolation from conventional technology.

In keeping with LID, the Town of Manteo requires "Appropriate stormwater management facilities shall be used for all new developments and redevelopments in order that stormwater runoff on one parcel of land must enter adjacent property with the same characteristics of predevelopment hydrology".

Preliminary Recommendation:

- ***Develop general stormwater goals consistent with LID practice.***

4.2. Applicable Property/Exemptions

Storm water rules and regulations are applied, in most communities, to multi-family and commercial lots. Exemptions are often made to single family dwellings and other properties. For example, in Dare County, "Stormwater regulations are for subdivisions only which are defined as any division or tract or parcel of land into two or more lots, building sites."

Land use within the project area is predominantly single family residential. It is also anticipated that much of the redevelopment which will occur in the Study Area will be single family residential structures. Please refer to Section 3.0 for a more detailed description. It should also be noted that current "typical" lot values range from $200,000 to $1,000,000 depending on lot size and location.

A few sets of ordinances specifically identify that storm water rules are applicable to both redevelopment as well as new development. For example, the Town of Nags Head identifies "Regulations apply to all new development and/or redevelopment within the town jurisdiction."

Preliminary Recommendations:

- ***Consider tightening the regulations to reduce exemptions and extending stormwater regulations to explicitly include single family residential lots with a minimum square footage.***
- ***Explicitly require compliance of stormwater regulations for both new development and redevelopment plots.***

4.3. Stormwater Management Requirements & Methods

In Currituck County, "unsubdivided developments utilize curb and gutter and storm drains to provide adequate drainage...". This is an impediment to LID practices because it precludes design and construction of rain gardens or filter strips adjacent to the road. One set of ordinances (Manteo) explicitly encourages use of LID stormwater devices. The use of "rain barrels, cisterns, porous pavement systems, vegetated swales, level spreader, filter strips, and bioretention" is recommended. Although encouraged, there are no incentives provided for implementation of LID practices.

Drainage requirements differ widely among the varying ordinances. Several communities require retention of runoff from 4.3 inches of rainfall whereas, in Manteo, the first 1.5 inches of a storm is required for retention. A performance based retention requirement should be established for residential and commercial lots that would be consistent for all communities.

Based on prior experience, three performance based methods are suggested for estimating stormwater runoff which will provide for protection of natural resources. Further research is required to evaluate the suggested methods. Methods are described in the model stormwater ordinance (refer to Section 4 of Appendix C), and identified as follows:

(a) Simple Method - Storage of a 2-Year 24-Hour (4.15 inches) precipitation event; applicable to lots less than 1 acre or minor modifications to existing homes.
(b) Standard Method – Post-development runoff for 10-Year 24-Hour precipitation event (6.38 inches) shall be equivalent to the pre-development runoff for the same event; applicable to lots not eligible for simple method and not employing the advanced method.
(c) Advanced Method – Post-development runoff for 5-Year 24-Hour runoff event shall be equivalent to the pre-development runoff for the same event; applicable to lots not eligible for simple method and not employing the standard method.

A follow up study to assess proposed design criteria is recommended. Multiple sites which are representative of the variability in land cover (e.g. residential, commercial) and physical terrain (e.g. elevated lot on sand dune, low lying terrain, soil characteristics) in the Outer Banks are recommended for evaluation. Temporary wells would be constructed at each of the sites to evaluate infiltration rates for the in situ soils. Stormwater design criteria will be applied to estimate storage required for representative sites. The practicality and effectiveness of the draft performance based ordinances will be assessed.

Preliminary Recommendations:

- ***Conduct a follow-up study to verify stormwater design criteria are appropriate for commercial and residential development in the Outer Banks.***
- ***Consider developing water quality in conjunction with quantity performance based criteria (e.g. TSS removal, minimum drawdown time for water quality purposes).***
- ***Remove any requirements for curb and gutter system.***
- ***Identify appropriate LID practices and consider development of incentives based program for implementation of LID.***

4.4. Fill Practices

Several ordinances are established regarding fill placement. Ordinances limit height, location of placement with respect to property lines, placement within floodplains and within road right of way. However, most of the regulations allow for loose interpretation on a lot by lot basis. There is no consistency among the ordinances.

A maximum height of fill is explicitly identified only within the subdivision under one ordinance. For the Colington Harbor development, it is limited to 18 inches. Within Currituck County and the Town of Duck, fill is not allowed to be placed within 10 feet and 5 feet of any property line, respectively.

There are not any ordinances which explicitly preclude filling a new lot to an elevation greater than that of adjacent properties. In practice new homeowners are filling in lots, in some areas by constructing bulkheads, to elevation greater than existing properties and grading the site such that surface water drains to adjacent properties.

The Town of Nags Head has an ordinance which allows for fill placement up to the base flood elevation in flood hazard zones; in non flood hazard areas fill is allowed to be placed to construct a septic field. The Town recently adopted an ordinance in an effort to limit the amount of fill brought on site be restricting the use of structures. The fill ordinance was amended to include the following:

The construction and use of bulkheads, walls, and other structural controls to retain the placement of fill on property shall only be permitted (1) in the immediate area of the on-site sewage disposal system as approved by the Dare County Health Department for the installation of such system, and (2) in only those areas of the property where the naturally occurring slope is 3:1 or greater in steepness.

In the Town of Kill Devil Hills, filling of stormwater natural lakes, ponds, ditches and drainage systems is permitted so long as "the project will not diminish the town's ability to manage stormwater."

Preliminary Recommendation:

- ***Consider developing one consistent set of regulations regarding fill placement which may be easily enforced on a site by site basis. Consider onsite fill grades within and away from the lots and fill grades relative to adjacent lot elevations.***

4.5. Land Disturbing Setbacks, Minimum Building Setbacks and Lot Coverage

Setback requirements for land disturbing activities are established in several ordinances. Within Dare County, a 30 foot setback between all road improvements and defined surface waters of Dare County is required. Similarly, in Currituck County a setback of 10 feet is required from any property line with the exception of drainage and stormwater improvements. Manteo requires that a 100 foot buffer be maintained, allowing for development within the buffer "as long as stormwater is managed on site".

Building setbacks are established in conjunction with maximum lot coverage as identified in Table 1. A more detailed summary is included in Appendix A. As noted in the table several communities reduce lot coverage requirements for use of Turfstone™ or equivalent.

Currituck County allows total coverage to increase by 15% if 50% of allowable coverage is in Turfstone™ or equivalent, or if the development is served by a functional stormwater management plan.

Preliminary Recommendations:

- ***Modify land disturbance setback requirements to explicitly allow for LID improvements within the setback area.***
- ***Consider providing incentives for implementing on-site stormwater practices by reducing the setbacks with adjacent properties.***

Table 3. Summary of Building Setback Requirements

	Building Setback			Lot Coverage	
Organization	Front (feet)	Side (feet)	Rear (feet)	Residential	Commercial
Dare County	25	10	20% depth or 20 ft		
Manteo	15	10	20% depth or 20 ft	30% +8% detached	55%
Town of Nags Head	30 res./15 comm.	8-12	20% depth or 30 ft	33%; 45% with TurfstoneTM	55%; 65% openface paving
Town of Kill Devil Hills	15-30	6-10	20% depth or 30 ft	40-50%, f(wetland soils)	
Kitty Hawk	25 res./15 comm.	10	20% depth or 20 ft	30%	60%
Southern Shores	25	15	25	30%	60%
Duck	25 res./15 comm.	10	20	30%	60%
Currituck County	20	15	20	35%	60%
Colington Harbor	25	8	20% depth		
Martin's Point	40	12.5	25		
Whalehead Subdivision	20	15	30		
Note: Setbacks identified are for "typical" for commercial and residential lots.					

4.6. Parking Requirements and Materials

Ordinances related to parking lot design requirements do not preclude the use of LID practices. Several ordinances encourage the use of permeable blocks and Turfstone^{TM}. Incentives are in place for the use of permeable pavement. Southern Shores excludes the porous parking areas from lot coverage calculations.

Permeable pavement requires regular maintenance in order to perform as designed. While permeable pavements have the potential to significantly reduce runoff, they are susceptible to surface sealing and pore clogging. It is generally recommended for use in low traffic use areas and dedicated pedestrian pathways.

Generally, permeable pavements are not recommended for high traffic areas or areas susceptible to clogging. Where regular traffic loading exceeds 10 vehicles per day (irrespective of vehicular weight) and areas exposed to heavy loadings of fine sediment (clay, silt, dust), permeable paving is not recommended for use. It is not recommended for areas where there is significant potential for surface sealing or clogging or dedicated maintenance.

Preliminary Recommendations:

- ***Clearly identify consistent specifications to encourage porous pavement materials in applicable locations and discourage use in non-applicable locations.***

4.7. Landscaping Buffers and Natural Buffers

Landscaping

In neither Dare County nor Currituck County do specific landscaping/buffer ordinances exist. Zoning regulations require a visual buffer where a commercial use or zone abuts a residential use or zone. However, regulations do not specify that the buffer be planted with native plants or drought tolerant vegetation.

Several ordinances within communities are more explicit in the location and extent of buffer types. For example in the Town of Nags Head, all large residential dwellings shall comply with one of the following requirements:

(a) The preservation of a minimum of ten percent of the lot's total area with existing natural vegetation and/or dune elevations or
(b) The planting of a minimum of 15 percent of the lot's total area. The minimum lot area for large residential dwellings shall be 16,000 square feet. At minimum 50 percent of the required landscaping shall consist of locally adapted live evergreen tree species. The remainder of the buffer may be live forbs and shrubs.

In other communities, native species are encouraged.

Natural Water Bodies

Within Dare County, buffers are established around existing water bodies. No structure, paved area, or any part of a ground absorption wastewater treatment system shall be located within 50 feet of any marsh, stream, pond, or wetland.

Preliminary Recommendations

- ***Develop consistent set of ordinances requiring preservation and use of native vegetation.***
- ***Consider establishing buffers around all natural water bodies and drainage ditches to enhance water quality.***

4.8. North Carolina State Regulations

In addition to the above ordinances, the State of North Carolina regulates stormwater runoff and sediment and erosion control.

Sediment and Erosion Control

Statewide regulation of sediment and erosion control is performed in compliance with 1973 North Carolina Sediment and Erosion Control Act. The law covers all land-disturbing activities, regardless of the size of the disturbance, except those involving agriculture, forestry, and mining, which are addressed in other legislation. The law and the rules do not specify a rigid set of practices; rather, they require the land developer to prepare an erosion and sedimentation control plan and employ appropriate measures to meet the performance standards.

The law requires installation and maintenance of sufficient erosion control devices and practices to retain sediment within the boundaries of the site. Under the law, compliance is determined by assessing performance. It prohibits visible off-site sedimentation from construction sites but permits the owner and developer to determine the most economical, effective methods for controlling erosion and sedimentation.

Several communities in the Outer Banks, including the Towns of Nags Head, Kill Devil Hills, and Kitty Hawk have developed their own ordinances and enforcement programs in compliance with the State sediment and erosion control program. In the remainder of the Outer Banks study area, State staff is responsible for permitting and enforcement of the sediment and erosion control regulations.

Water Quality

Development located in the 20 coastal counties must comply with North Carolina Administrative Code (NCAC) 02H. Projects subject to permitting are either classified as low or high density management alternatives. For low density sites, development is permitted where (a) the built-upon area is limited to 30% or less (25% or less within one half mile of and draining to SA waters), (b) stormwater is conveyed by vegetated conveyances and (c) there is a 30 ft wide vegetative buffer. High density areas require the use of stormwater controls to meet specific performance requirements for stormwater runoff. Infiltration practices are mandated for areas draining to SA waters.

The following state Division of Water Quality (DWQ) regulations apply within 30 feet of the normal high water line along public trust waters, 75 feet of the normal high water line along estuarine waters. Along Outstanding Resource Waters, the rules apply within 575 feet of the normal high water line.

- Hard surfaces, such as buildings, paved parking lots and roads, must cover no more than 30 percent of the project area within the Area of Environmental Concern, unless you can show that the design of your project limits runoff equally well. All projects should limit hard surfaces to the smallest area necessary.

- Redevelopment of areas exceeding the 30 percent limit may be permitted if hard surface areas are not increased and the project meets the rule to the maximum extent feasible.

- If your project is located on the shoreline of an Outstanding Resource Water (ORW), you may build on only 12 percent of the project area located within the AEC, and you may not use a stormwater collection system.

Universal Stormwater Management Program

The initial draft set of modifications to State stormwater rules, the Universal Stormwater Management Program (USMP), has been developed and is currently under review. The USMP would be a voluntary program which local communities can chose to adopt to replace existing state stormwater regulations. Similar to existing State regulations, local communities can elect to defer to the Division of Water Quality in whole or in part for enforcement.

The following are excerpts from the current draft rules which are planned to be submitted for review by the Environmental Management Commission, July 2006:

All development activities located in one of the twenty (20) Coastal Counties that disturb 10,000 square feet or more of land shall control the runoff from the first one and one half inch of rainfall to the level specified in Paragraph (f) of this Rule. In addition, all impervious surfaces, except for roads, paths, and water dependent structures, shall be located at least 30 feet landward of all perennial and intermittent surface waters. Redevelopment activities that meet the provisions of 15A NCAC 02H .1002(14) shall not be required to comply with the requirements of this Paragraph.

Structural stormwater controls required under Paragraphs shall meet the following criteria:
(1) Remove an 85% average annual amount of Total Suspended Solids.
(2) For wet detention ponds draw down the treatment volume no faster than 48 hours, but no slower than 120 hours.
(3) Discharge the storage volume at a rate equal or less than the pre-development discharge rate for the 1-year, 24-hour storm.
(4) Meet the General Engineering Design Criteria set forth in 15A NCAC 02H .1008(c).

In coastal communities where there are currently low density and high density management options, under the USMP there would be one consistent set of State regulations. A key change from the existing management of stormwater in shellfish waters is that the cap for impervious area which is currently at 25% (without stormwater controls) in low density would increase to 35% with stormwater controls required as identified above.

There is some concern regarding the effectiveness of the proposed rules as compared to existing regulations for watersheds in Shellfish Waters. Further assessment of the draft rules in relation to the potential effectiveness in the Outer Banks is recommended.

5.0 Model Stormwater Management Ordinance

Based on a review of the existing ordinances and assessment of geographic constraints, a draft *Model Ordinance for Stormwater Management in the Outer Banks* was developed and is included in Appendix B. It is intended that this ordinance will provide flexibility to builders, designers, planners, and regulators and facilitate the implementation of LID (LID) and similar approaches to real estate development of the Outer Banks.

The model ordinance is intended to serve as a framework for all communities within the study area. Upon refinement, it would replace existing local stormwater ordinances. The model ordinance is designed to compliment and be used in conjunction with the State stormwater regulations.

The model ordinance addresses several of the key points identified in Section 2.0 of this report. Consistent with the recommendations outlined in Section 2.0, further effort will be required to modify general ordinances to address issues of design storm criteria, fill placement, setback requirements, and use of native vegetation and buffers.

6.0 Management & Implementation

6.1. Organizational Options for Stormwater Management

Several organizational options exist for developing and implementing LID strategies for storm water management and water quality improvement in the Outer Banks. Options range from working within existing governmental organizations to creating a new entity for water resource management.

The legal authority for organizations to manage stormwater and water quality is established under N.C.G.S. 160A-311 (10). Programs are defined as a public enterprise including "Stormwater management programs designed to protect water quality by controlling the level of pollutants in, and the quantity and flow of, stormwater and structural and natural stormwater and drainage systems of all types."

Based on correspondence with the University of North Carolina, Chapel Hill (UNC-CH) Institute of Government, (Hughes, 2006), the authority and structure of stormwater management alternatives is similar to that for water and sewer services. The institutional options for stormwater management in the Outer Banks (and supporting North Carolina General Statutes (G.S.)) are identified as follows:

- Municipality (G.S. 160A, Art. 16)
- Counties (G.S. 153A, Art. 15)
- Water Authority (G.S. 162A, Art. 1)
- Interlocal Agreement (G.S. 160A, Art. 29, Part 1)
- Joint Management Agency (G.S. 160A, Art. 20, Part 1)
- Water Districts

Individual municipalities and counties have the authority to establish ordinances and manage separate LID programs. Alternatively, a regional institutional approach could be undertaken to establish a consistent set of LID ordinances and a management strategy throughout the Outer Banks. Such an approach could be undertaken via interlocal agreement, or by creating a new regional authority or water district. Table 2 summarizes the range of options and authority which may be granted under the various organizational strategies.

Table 4. Power/Authority Which May Be Designated to Specific Organization

	Type of Organization/Structure			
Power/Authority	**City/County Utility**	**Interlocal Contract**	**County Service District**	**Management District/Authority**
Corporate Powers	Yes	yes	No	yes
System Ownership	Yes	yes	Yes	yes
Construct Systems	Yes	Under contract	County	yes
Establish Rates & Charges	Yes	by unit	County	yes
Levee Property Taxes	Yes	City/county	County	no
Zoning	Yes	City/county	County	no

Considerations for selecting a LID implementation & management strategy include:

- Clear, consistent goals & objectives
- Political support
- Financing & funding
- Inspection/permit fees
- Construction maintenance
- Integration with existing organizational bodies/utilities

A key advantage of a new regional stormwater district or authority would be the establishment of a clear and consistent set of policies and ordinances, applicable to the entire watershed area. A regional organization could work with the existing planning and engineering utilities to implement a LID program.

Local political support is a prerequisite to establishing a new governing organization. Based on initial input from the technical advisory committee, there appears to be neither political support for development of a regional planning body, nor support for an interlocal agreement of stormwater management in the Outer Banks.

Given the local political environment, it is recommended that LID be promoted through a two pronged approach whereby:

1. Existing municipal and county stormwater programs and ordinances be revised to provide incentives, remove impediments and strongly encourage LID practices for new development and redevelopment; and

2. In cooperation with the Dare and Currituck County Soil and Water Conservation District (SWCD) s and UNC-CSI, communities work to (a) develop pilot projects for educational purposes, (b) facilitate LID workshops and (c) seek state and federal support to retrofit existing properties.

The County SWCDs are state agencies with an elected Board of Supervisors. Current responsibilities include promoting conservation and carrying out North Carolina Agricultural cost share program (set up in 1985) to address non-point source pollution. The SWCD partners with federal, state and local agencies to assist and educate the land users (farmers, homeowners, developers) in care of and use of land as it relates to soil and water conservation. In June 2006, the Dare County filled a full-time staff position; that staff member will be responsible for water resources and water quality education programs. Based on initial discussion with Dare County SWCD staff, it is anticipated that they will support the education and implementation of LID.

6.2. Implementation of LID

Key elements for successful stormwater management and implementation of LID practices in the Outer Banks are identified below.

1. Public Education - Public workshops and pilot projects illustrating the benefits and use of LID will be instrumental in achieving public support and implementation. UNC-CSI and SWCD should continue to facilitate workshops which provide a platform for the public and site developers to learn more about LID practices.

   It is recommended that multiple sites which are representative of the varying physical conditions and political jurisdictions be selected for LID retrofit pilot projects. Each of the sites should be sited in locations of high visibility with easy public access. A variety of sites should be considered including (a) residential retrofit (bioretention), (b) commercial retrofit (several small structural measures), and educational awareness (signage) at existing sites.

2. Ordinances – A general stormwater management ordinance has been developed for the Outer Banks to facilitate LID practices (Appendix B). The stormwater management ordinance serves as a framework which may be tailored to meet the specific objectives of individual communities in the Outer Banks.

3. Administrative Structure – The county and municipalities currently administer stormwater policies through planning and engineering departments. Roles and

responsibilities of the respective departments can be expanded to include LID implementation as outlined in the model stormwater program. Additional staff and training may be required to develop an in-house expertise to promote LID and implement the stormwater management program.

Several references are available or in development which serve as good resources for developers and regulators to review and apply LID practices. The LID Manual for Prince George's County (Prince George's County MD, 1999) provides a comprehensive review of the general design practices of LID. The existing *Stormwater BMP Manual* (NC Division of Water Quality, Draft July 2005) and the *LID Manual* (currently being developed by NCDWQ) may be used as guidance for LID design practices.

4. Financing – Responsibility for construction and implementation will be delegated to the developer. Additional administrative costs may be financed through stormwater permit application fees, as identified in the model ordinance.

   Additional financing for retrofit of existing lots and development of pilot projects may be obtained through alternative funding sources. It is recommended that UNC-CSI and SWCD submit applications for Clean Water Management Trust Fund and United States Environmental Protection Agency (EPA) 319 grants as the primary source of funding to establish LID pilot projects including the design, construction, maintenance and monitoring. Once the initial projects are in place, secondary sources for grant funding should be pursued including but not limited to:

   - United States Department of Commerce (USDoC) (National Oceanic and Atmospheric Administration (NOAA))
   - United States Department of Interior (USDoI) (US Fish and Wildlife Service)
   - United States Department of Defense (USDoD) (United States Army Corps of Engineers (USACE))

   It is anticipated that successful pilot projects will serve as a seed to initiate the public and development community's interest in LID practices.

5. Mechanisms for Implementation

(a) Regulatory Enforcement - Currently, several communities (Kitty Hawk, Nags Head, and Kill Devil Hills) have a mechanism in place for reviewing land disturbing activity and sediment and erosion control practices. There is also a procedure in place for review of commercial and multifamily residential stormwater plans.

It is recommended that a stormwater inspection review process be established to review new development and redevelopment of all lots. The framework for permit review, inspection, monitoring and enforcement is identified in the *Model Ordinance for Stormwater Management*. This process will be independent of sediment and erosion control permitting.

(b) Voluntary Programs – Implementation of LID retrofits on lots may be initiated by the individual lot owners. Assistance for planning and design may be provided through Master's gardeners, NC SWDC and NC Cooperative extension.

(c) Incentives Program - LID may be promoted through community awards and increased enhanced public relations for participants. Additional consideration may be provided by modifying ordinances to implement LID practice (e.g. modification of percent imperviousness requirement).

7.0 Summary and Recommendations

This study provides an overall assessment of the feasibility of using LID methods as part of a regional integrated stormwater management program in the Outer Banks.

Based on a review existing stormwater policies for communities within the Outer Banks LID Study Area, limited impediments to LID were identified in existing ordinances. Several recommendations are made to modify general ordinances to facilitate the use of LID. To embrace LID, a shift from the current philosophy (of conveying stormwater from a site) will be required to eliminate stormwater runoff from the site, maximizing retention and treatment within each lot.

A *Model Ordinance for Stormwater Management in the Outer Banks* was developed and is included in Appendix B. It is intended that this ordinance will provide flexibility to builders, designers, planners, and regulators and facilitate the implementation of LID and similar approaches to real estate development of the Outer Banks. The model ordinance is intended to serve as a framework for all communities within the study area.

Based on prior experience, three performance based methods are suggested for estimating stormwater runoff which will provide for protection of natural resources. A follow up study to assess proposed design criteria (hydro curves) is recommended.

The majority of potentially developable properties along the Outer Banks have been subdivided and platted for residential housing and associated real estate development. In Dare County, approximately 22% of potentially developable parcels have not been constructed upon; in Currituck County, approximately 54% of developable parcels have not been constructed upon.

Two major factors impede the implementation of LID in the Outer Banks. The first, high water table, is a physical constraint. The second, property boundaries, is a legal constraint. For LID techniques to have significant positive benefits, these must be undertaken through retrofit projects within existing residential developments and associated areas.

Both LID Site Planning techniques and structural stormwater measures may be applied in the Outer Banks. Site Planning techniques include clustering of structures, reducing impervious surfaces and grading to conform to natural topography. Structural measures which are recommended in the Outer Banks include bioretention areas, vegetated filter strips, cisterns, vegetated open channels, permeable pavement.

Several organizational options exist for developing and implementing LID strategies for storm water management. Given the local political environment, it is recommended that LID be promoted through a two pronged approach whereby:

3. Existing municipal and county stormwater programs and ordinances be revised to provide incentives, remove impediments and strongly encourage LID practices for new development and redevelopment; and

4. In cooperation with the Dare and Currituck County Soil and Water Conservation District (SWCD) s and UNC-CSI, communities work to (a) develop pilot projects for educational purposes, (b) facilitate LID workshops and (c) seek state and federal support to retrofit existing properties.

Public workshops and pilot projects illustrating the benefits and use of LID will be instrumental in achieving public support and implementation. UNC-CSI and SWCD should continue to facilitate workshops which provide a platform for the public and site developers to learn more about LID practices.

It is recommended that UNC-CSI and the SWCD submit applications for Clean Water Management Trust Fund and EPA 319 grants as the primary source of funding to establish LID pilot projects including the design, construction, maintenance and monitoring. Once the initial projects are in place, secondary sources for grant funding should be pursued.

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Appendix A

Summary of Structural LID Stormwater Management Measures

Structural LID Stormwater Management Measures

Name

Bioretention Area

Description

Bioretention Areas are vegetated depressions which retain stormwater, allowing the water to infiltrate and evapotranspirate. Bioretention areas are generally 12 inches to 36 inches deep, with 18 inches being a common depth. Appropriate native herbaceous and woody vegetation is preferred and typically utilized, though suitable turf grasses can be employed. Bioretention areas do not maintain standing water. Water in bioretention areas should remain above the surface no more than about 3 days, allowing volume recovery for subsequent storms and preventing mosquito breeding. Highly concentrated infiltration may require soil water mounding analysis.

Potential Solutions

Erosion - reduce the velocity of stormwater runoff from a site and can decrease downslope erosion.
Drainage - provide landscape depressions to which stormwater runoff can be directed.
Flooding - reduce the amount of stormwater runoff from a site and decrease associated flooding potential.
Irrigation - can be incorporated into vegetated landscape features, reducing or eliminating the need for irrigation of such.

Potential Conflicts

On-site wastewater (septic systems) - bioretention areas can reduce the depth to water table near the infiltration area, conflicting with requirements for on-site wastewater disposal.
Water table - bioretention areas are not feasible when adequate depth to water table is not available.
Utilities - bioretention areas may reduce the required ground cover over water supply, sanitary sewer, and other utilities, requiring ductile iron or other conduit to be utilized for these utilities.

Potential Opportunities

Shared Bioretention Areas - bioretention areas can be implemented along property boundaries to serve two or more adjoining parcels.
Residential gardens - Residential gardens, especially for wildflowers and showy shrubbery are excellent opportunities for bioretention areas which can provide an aesthetically pleasing amenity.
Landscape buffers - Areas of required landscape buffers can readily include bioretention areas.
Site fill - bioretention areas can be employed to take advantage of additional ground water storage volume and depth to water table afforded by site filling and associated grading operations

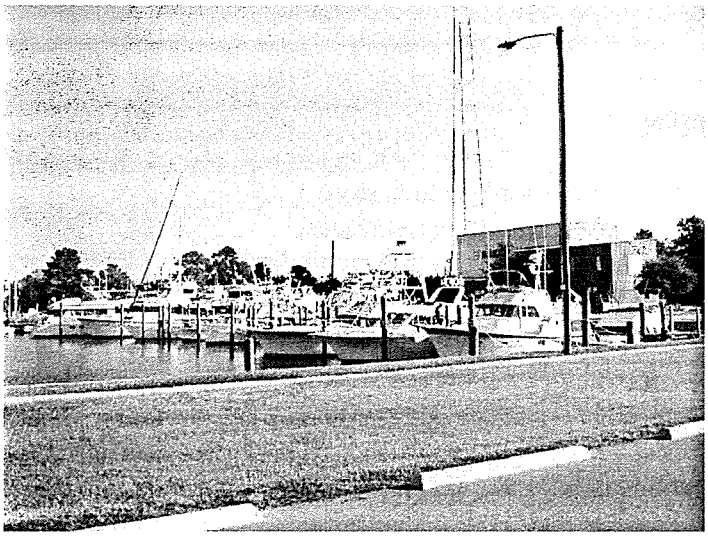
Potential Locations

Bioretention areas are readily located throughout a site. In most all areas where vegetation can be planted, a bioretention area can be implemented. Bioretention areas can be large or small.

Structural LID Stormwater Management Measures

Name

Vegetated Filter Strip



Description

Vegetated Filter Strips are narrow measures generally placed at the edges of impervious surfaces with relatively non-concentrated flow to provide an area for stormwater treatment by infiltration, filtering, sedimentation, and sorption. Appropriate native herbaceous and woody vegetation is preferred, though suitable turf grasses can be employed. These are often employed as the first component of a treatment train.

Potential Solutions

Erosion - reduce the velocity of stormwater runoff from a site and can decrease downslope erosion.
Irrigation - can be incorporated into vegetated landscape features, reducing or eliminating the need for irrigation of such.

Potential Conflicts

No typical conflicts.

Potential Opportunities

Pathways - Ingress and egress areas to parking lots can be can be combined with vegetated filter strips if wear resistant turf (such as zoysia grass) or other suitable land cover is employed.
Landscape buffers - Areas of required landscape buffers can readily include vegetated filter strips.

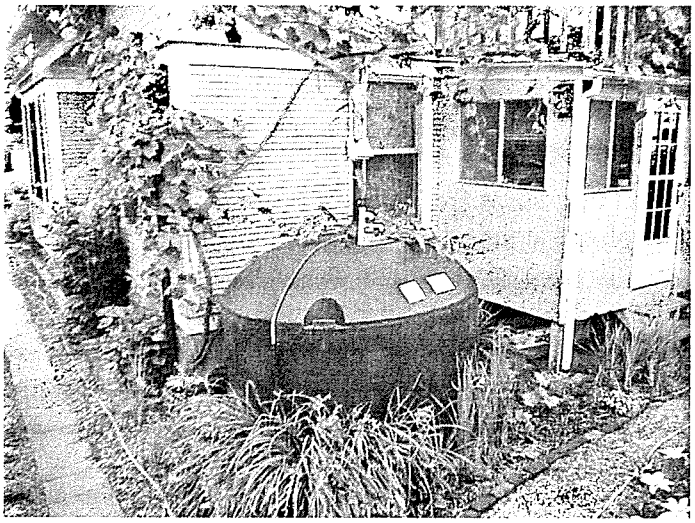
Potential Locations

Vegetated Filter Strips are readily located at the edge of walkways, driveways, parking lots, and similar surfaces. Vegetated Filter Strips are often comprised of turf, but can consist of other suitable dense, low growing, leaf retaining vegetation (such as *Vaccinium crassifolium* - Creeping Blueberry or *Gaultheria procumbens* - Teaberry).

Structural LID Stormwater Management Measures

Name

Cistern



Description

Cisterns are storage tanks which store precipitation from impervious surfaces, generally roofs. These structures retain direct runoff from impervious surfaces during and following precipitation events. Cisterns are often located underground, but may be placed at ground level or on elevated platforms. Cisterns can be located within buildings or in the landscape. Cisterns may be constructed of many materials, with polyethylene (PE), polyvinyl chloride (PVC), and concrete being the most common. These are high maintenance systems and should only be implemented where proper regular maintenance will be undertaken.

Potential Solutions

Erosion - reduce the velocity of stormwater runoff from a site and can decrease downslope erosion.
Flooding - reduce the amount of stormwater runoff from a site and decrease associated flooding potential.

Potential Conflicts

Water table - Cisterns placement below the ground surface may not be feasible when adequate depth to water table is not available.
Utilities - Cistern placement may interfere with routing and maintenance of cablevision, telephone, water supply, sanitary sewer, and other utilities.

Potential Opportunities

Irrigation - Cisterns are an excellent source of water for garden and yard irrigation.
Potable water - Though treatment prior to such use is generally needed, cisterns are readily adapted as a source of drinking water.
Vehicle washing - Cisterns can be utilized as a source of water for vehicle washing, especially when the storage tank is elevated to increase available pressure.
Water gardens - Cisterns can be employed to supply water for small ponds in the landscape, especially when the storage tank is elevated to increase available pressure.

Potential Locations

Cisterns are most easily located directly adjacent to buildings with roof drains that can direct water to the storage tank.

Structural LID Stormwater Management Measures

Name

Vegetated Open Channel

Description

Vegetated Open Channels convey stormwater runoff. It is generally the preferred measure for directing stormwater flow through the landscape. These allow treatment of stormwater by infiltration, filtering, sedimentation, and sorption. Appropriate native herbaceous and woody vegetation is preferred, though suitable turf grasses can be employed. Vegetated Open Channels are usually relatively wide and shallow.

Potential Solutions

Drainage - provide landscape depressions to which stormwater runoff can be directed and can include underdrains to increase drainage.
Irrigation - can be incorporated into vegetated landscape features, reducing or eliminating the need for irrigation of such.

Potential Conflicts

On-site wastewater (septic systems) - Vegetated Open Channels generally need to be located away from on-site wastewater disposal systems.
Utilities - Vegetated Open Channels may reduce the required ground cover over water supply, sanitary sewer, and other utilities, requiring ductile iron or other conduit to be utilized for these utilities.

Potential Opportunities

Shared Vegetated Open Channels - Vegetated Open Channels can be implemented along property boundaries to serve two or more adjoining parcels.
Landscape buffers - Areas of required landscape buffers can readily include Vegetated Open Channels.

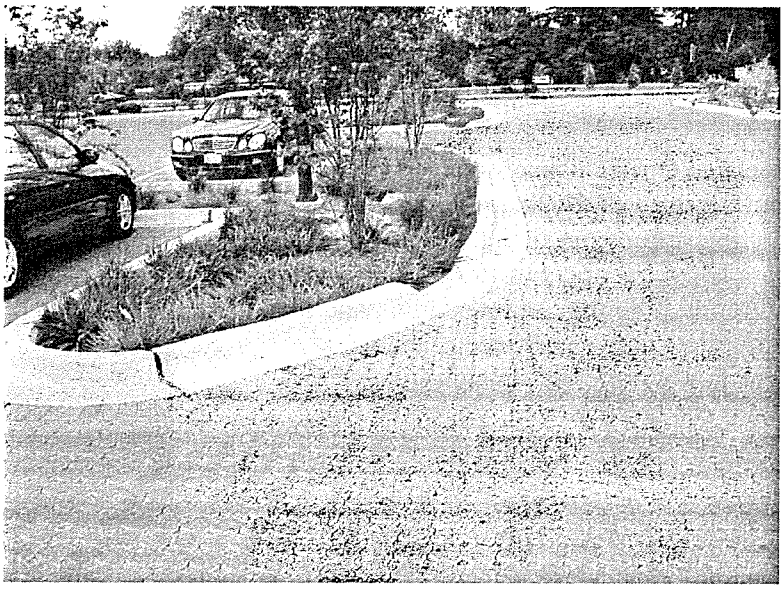
Potential Locations

These are often placed along roadways and innervating through sites.

Structural LID Stormwater Management Measures

Name

Permeable Pavement



Description

Permeable Pavements are employed for vehicular and pedestrian traffic. These are pervious surfaces (allowing stormwater to infiltrate) and constructed of pavers or other materials. These are high maintenance systems. These should only be implemented where proper regular maintenance will be undertaken. These should not be implemented in areas of high vehicular traffic or other areas where fine particles and other clogging pollutants could degrade performance.

Potential Solutions

Flooding - Permeable Pavements reduce the amount of stormwater runoff from a site and decrease associated flooding potential.

Potential Conflicts

Utilities - Permeable Pavements require special construction which makes standard compaction above subsurface utilities problematic. Permeable Pavements are also expensive to patch and replace when repairing utilities (compared to asphalt and concrete).

Potential Opportunities

Pedestrian walkways - Permeable pavements are well suited for low to moderate traffic pedestrian walkways.
Overflow parking - Permeable pavements can be utilized in areas where overflow parking is needed.

Potential Locations

Permeable pavements are utilized where alternatives to traditional impervious pavements are desired.

Structural LID Stormwater Management Measures

Name

Vegetated Roof

Description

Vegetated Roofs are measures which reduce or eliminate runoff from roofs. A high density polyethylene membrane or similar material serves as moisture barrier over the base roof structure. The roof is generally covered with a planting matrix and vegetation installed densely across the surface. Water is retained or detained in the planting matrix and evapotranspirated by the vegetation. Appropriate native herbaceous and woody vegetation is preferred, though suitable turf grasses can be employed and specialized vegetation is sometimes necessary.

Potential Solutions

Erosion - reduce the velocity of stormwater runoff from a site and can decrease downslope erosion.
Flooding - reduce the amount of stormwater runoff from a site and decrease associated flooding potential.

Potential Conflicts

Utilities - Vegetated Roofs may interfere with routing and maintenance of building mechanical components, including heating, venting, cooling, and plumbing.

Potential Opportunities

Insulation - Vegetated Roofs provide significant additional building insulation, moderating temperature changes and reducing energy costs.
Roof gardens - Vegetated Roofs can be combined with other roof top features to provide space for dining, recreation, or relaxation.

Potential Locations

Vegetated Roofs are, as the name indicates, located on roofs. Flat roofs or slightly inclined roofs are most suitable as Vegetated Roofs.

Appendix B

Summary of Existing Stormwater Ordinances

	General Stormwater Requirements	Applicable Property/Exemptions	Stormwater Control Design Requirements
Dare County	Where feasible, the subdivider shall connect to an existing storm drainage system.	Stormwater regulations are for Subdivisions only which is defined as any division of a tract or parcel of land into 2 or more lots, building sites, or other divisions.	
Manteo	Appropriate stormwater management facilities shall be used for all new developments and redevelopments in order that storm water runoff on one parcel of land must enter adjacent property with the same characteristics of the predevelopment hydrology.	Regulations apply to all new development requiring a Site Plan Review within the Town's Planning Jurisdiction. Exemptions include a development disturbing less than 5,000 square feet and single family residence with customary accessory dwelling units.	Recommend LID stormwater management. A list of recommended stormwater devices including rain barrels and Cisterns, Porous Pavement Systems, Vegetated Swales, Level Spreader, Filter Strips, Bioretention, etc. is provided. Design criteria is first 1.5 inches of total rainfall depth.
Town of Nags Head	Runoff shall be infiltrated on-site, or shall be disposed of on-site by a means acceptable to and approved by the town, and such other regulatory agencies having jurisdiction, in accordance with appropriate design, disposal and construction practice. Development in ocean overwash drainage districts shall provide swales, culverts, and other features to allow for drainage of ocean overwash flooding.	Regulations apply to all new development and/or redevelopment within town jurisdiction. Exemptions include detached single-family and duplex residential structures, which are not part of commercial or multifamily development or redevelopment of existing land uses which were lawful at the time of adoption of the ordinance from which this chapter derives.	All stormwater runoff resulting from the first 1 ½ - inch, two-hour rainfall shall be retained on any public or private commercial, group development or multifamily site, or commercial or residential subdivision. Either infiltrated or disposed of on-site. For new construction of single-family and duplex structures where the natural elevation has been increased by more than 3 feet by the deposit of fill material, on-site stormwater management facilities shall be designed and constructed to retain and infiltrate runoff from the first 2 inches of a storm event.
Town of Kill Devil Hills	Surface water leaving the site shall be channeled to points of approved discharge, including but not limited to, a natural or man-made watercourse, a lake, pond, ditch, stormwater drainage system, or other approved points of discharge. In all cases, including one- and two-family dwellings, the developer shall be required to provide culvert pipes, swales, any improvements in the right-of-way and other drainage improvements approved by the Public Works Division.	Regulations are applicable for all zoning districts as defined in the town code. Separate but similar storm drainage regulations existing within the code for subdivisions.	Systems shall be designed to retain, as a minimum, runoff expected from a ten-year, two-hour storm (4.3 inches of rainfall). Some situations may warrant a different requirement due to the size of the system.
Town of Kitty Hawk	No specific stormwater management regulations, however, various rules are defined for different development districts (e.g. low density residential). For existing streets and roads, all storm drainage shall be adequate to prevent flooding on private property from storm runoff of the design frequency	No specific stormwater management regulations, however, various rules are defined for different development districts (e.g. low density residential). These design criteria are for existing streets and roads.	Minimum design frequency for cross drainage is 25 years.
Southern Shores	No specific stormwater management regulations provided.		For all uses other than one and two family dwelling units, Town Council stormwater policy requires drainage for 10-yr, 2-hr, 4.3 inch rainfall event.
Duck	Drainage improvements and/or stormwater measures such as infiltration basins, swales or ditches my be placed within 5 feet of any side or rear property line.	Regulations apply to any land-disturbing activity.	
Currituck County	All developments shall be provided with a drainage system that is adequate to prevent undue retention of surface water on the development site.	Regulations apply to all Special Flood Hazard Areas, as defined by FEMA or through a Cooperating Technical State (CTS) agreement between the State and FEMA in its Flood Hazard Boundary Map or Flood Insurance Study and its accompanying flood maps such as the FIRM and/or Flood Boundary Floodway Maps, within the jurisdiction of Currituck County.	Private roads and access ways within unsubdivided developments shall utilize curb and gutter and storm drains to provide adequate drainage if the grade of such roads or access ways is too steep to provide drainage in another manner or if other sufficient reasons exist to require such construction.
Colington Harbor	Stormwater needs to be retained as much as possible on each individual property and not just dumped onto the roads or individual parcels. Lots that have poor percolation may be required to remove the bad material and get below the peat layer and install a curtain drain to eliminate standing water. A swale must be included on each side line to help drainage and to minimize dumping water onto abutting lots.		
Martin's Point	No specific stormwater regulations. Emphasize that development shall not impede roadside drainage.		
Whalehead Subdivision	No specific stormwater regulations.		

	Fill Allowances	Drainage Slope Requirements	Setback/Buffers/Easements
Dare County	No homeowner/lot owner/developer/contractor shall be allowed to fill in, alter, or pipe any roadside swales shown on the drainage plan approved in conjunction with the final subdivision plat.	Surface drainage course shall have side slopes of at least 3H:1V in feet	Subdivisions must maintain a minimum 30-foot wide setback between all road improvements and defined surface waters of Dare County
Manteo			If any portion of any lot proposed for development that includes a traditionally established drainage ditch, the developer shall dedicate for public use an area 10 feet wide of both sides of the centerline of the drainage ditch for pedestrian greenways. A contiguous 100 foot buffer must be maintained with a maximum slope of no more than two percent. Development may occur within this buffer as long as storm water is managed on site.
Town of Nags Head	Fill shall not be permitted to exceed base flood elevation and in areas in which there is no base flood, fill shall not exceed the amount required for wastewater permits required by the Dare County Health Dept. or two feet above natural elevation, whichever is higher.		
Town of Kill Devil Hills	Filling of a man-made watercourse, lake, pond, ditch, stormwater drainage system is permitted if it demonstrates that the project will not diminish the town's ability to manage stormwater.	For subdivisions, surface drainage courses shall have side slopes of at least three feet of horizontal distance for each one foot of vertical distance, and courses shall be of sufficient size to accommodate the drainage area without flooding, and designed to comply with the standards and specifications for erosion control of the North Carolina Sedimentation Pollution Control Act.	
Town of Kitty Hawk	In defined floodways, no encroachments, including fill, new construction, substantial improvements and other developments, shall be permitted unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels during the occurrence of the base flood.		Where a subdivision is traversed by a watercourse, drainageway, channel, or stream, there shall be provided a stormwater easement or drainage right-of-way conforming substantially with the lines of such watercourse, and such further width of construction, or both, as will be adequate for the purpose. Parallel streets or parkways may be required in connection therewith.
Southern Shores	No grading, filling, or other alteration of the topography or elevation of any unimproved lot shall be undertaken prior to granting of a permit by the Building Inspector.		
Duck	For land development, fill shall not be allowed within 5 feet of any side or rear property line except to directly match the grade at the street and to accommodate driveway improvements as approved by the Planning Director or Board of Adjustment.	Fill shall be established at a slope not to exceed 3H:1V. The toe of the slope shall meet the 5 feet property setback line.	Land disturbing activities, excluding necessary clearing and grubbing shall not be permitted within 5 feet from any property line with the exception of drainage and stormwater improvements and underground utilities.
Currituck County	No fill of any kind shall be allowed within 10 feet of any property line except as associated with a driveway improvements located within 10 feet of the front property line and/or a bulkhead for shoreline protection with the exception of lots within Planned Unit Developments.	All fill shall be established at a slope not to exceed 3H:1V. The toe of the slope shall meet the 10 foot setback requirement from all property lines.	Land disturbing activities excluding clearing, grubbing and vegetable gardens shall not be permitted within 10 feet from any property line with the exception of drainage and stormwater improvements and underground utilities.
Colington Harbor	Any build-up of material placed on a lot, other than the septic field, is hereby limited to a maximum 18 inches before the concrete pad is poured, and then graded accordingly to taper or slope to each side line. Lots may not be filled beyond the individual property lines, i.e. road right of way, without first getting approval from the ACC.		Easements are reserved unto the Developer for the purpose of conveying to public utility companies the necessary easements for utilities along and within 10 feet of the front, rear, and side lines of all original lots in the subdivision for the construction and perpetual maintenance of conduits, poles, wires and fixtures for electrical lights, telephones and other public and quasi public utilities and drainage.
Martin's Point	No fill material may be placed in the swale or any part of the Common Area other than that which is necessary under the driveway and then only after written approval by the Committee. No fill material may be placed on a Lot in the side setback areas unless the fill lies under a line with a vertical to horizontal slope of 1 to 3 or less.	Fill, where allowed must be established at a slope not to exceed 3H:1V.	The Association reserves unto itself a fifteen (15) foot easement surrounding all ponds and wet areas for the purpose of protection of said areas from erosion and the implementation of adequate draining and circulation of said ponds and wet areas.
Whalehead Subdivision			

	Driveway Crossings	Minimum Building Setbacks [1,2,3,4]	Exceptions to Building Setbacks
Dare County	Driveway improvements may be sloped to retain the shape of the retention basins in lieu of driveway culverts if approved by the Dare County Engineer. A culvert pipe shall be installed where any proposed driveway, roadway, walkway, or other improvement crosses an established drainage feature (e.g. roadside ditches, swales, streams, etc.). Minimum requirements for culverts are given.	For unzoned areas, minimum building setback must be 25 feet from the front property line, 10 feet from the side property lines, 20% of lot depth, not to exceed 20 feet from the rear property lines.	In those zoning districts that permit multifamily structures, an increase in the permitted dwelling density may be authorized according to the following table
Manteo		Varies by zoning district type. For most residential districts, setback must be 15 feet from the front property line, 10 feet from the side property lines, 20% of the lot depth, not to exceed 20 feet from the rear property lines. Maximum allowable lot coverage is 30% except that the lot may be increased by 8% for detached structures. Commercial uses allow for increased lot coverage, typically 55%.	
Town of Nags Head	A culvert shall be installed in any existing town ditch or swale prior to constructing a driveway over such ditch or swale. Culvert requirements are given.	Varies by zoning district type. For most residential districts, setback must be 30 feet from the front property line, 8-12 feet from the side property lines, 20% of the lot depth, not to exceed 30 feet from the rear property lines. Maximum allowable lot coverage is 30% plus 300 sq feet or 33%, whichever is greater. Coverage may be increased to a maximum of 40%-45% if open-face paving block or Turfstone us use in place of concrete or asphalt. Commercial uses are less stringent on front setback (15 feet) and allow for increased lot coverage, typically 55% or up to 65% with open-face paving.	
Town of Kill Devil Hills	A culvert shall be installed in any existing town ditch or swale prior to constructing a driveway over such ditch or swale.	Varies by zoning district type. For most residential districts, setback must be 15 or 30 feet from the front property line, 6-10 feet from the side property lines, 20% of the lot depth, not to exceed 30 feet from the rear property lines. Maximum allowable lot coverage varies by lot size but ranges between 40-55%. Allowable coverage is dependent on wetland soils on site. Commercial uses have similar setbacks but allow for 65% maximum allowable lot coverage.	
Town of Kitty Hawk		Kitty Hawk Zoning broken up into Kitty Hawk Woods, Kitty Hawk Village, and Kitty Hawk Beach. Kitty Hawk Woods district encourages low impact development, to preserve natural state. Other districts are subdivided into various residential/commercial zones. For most residential districts, setback must be 25 feet from front property line, 10 feet from side property line, 20% of lot depth, not to exceed 20 feet from the rear property lines. Maximum allowable lot coverage is 30%. Commercial uses have reduced front setbacks of 15 feet and allow for 60% lot coverage.	No yard or lot existing on August 18, 1986 shall be reduced in dimension or area below the minimum requirements. Yards or lots created after August 18, 1986 shall meet at least the minimum requirements established by this chapter.
Southern Shores		Varies by zoning district type. For most residential districts, setback must be 25 feet from front property line, 15 feet from side property lines, and 25 feet from rear property lines. Maximum allowable lot coverage is typically 30%. Commercial uses have slightly reduced setbacks and allow for 60% maximum lot coverage.	
Duck		Varies by zoning distinct type. For most residential districts, setback must be 25 feet from front property line, 10 feet from side property lines, and 20 feet from rear property line. Maximum allowable lot coverage is typically 30%. Commercial uses reduce the front setback to 15 feet and allow for 60% maximum lot coverage.	Allow for reductions in minimum yard requirements in residential districts, if approved by the zoning administrator for structures such as driveways, patios, swimming pools, etc. It was noted that the Town is looking at ordinance changes to include all driveways/parking areas in lot coverage regardless of composition to avoid conversion of driveways to pervious surfaces and transfer of the resulting extra lot coverage square footage into addl pool concrete or house footprint.
Currituck County		Setbacks defined for all residential structures: Street setback is 20 feet, side line setback is 15 feet, rear line setback is 25 feet. Maximum allowable lot coverage is 30% for general residential districts, 35% for residential lots between 10,000 to 19,000 sq feet, and 45% for lots less than 10,000 sq feet in area.	Total lot coverage may be increased by 15% if 50% of the maximum allowable coverage is in Turfstone or equivalent porosity, or if the development is served by an approved and functional stormwater management plan.
Colington Harbor		No resident structure shall be located nearer than 25 feet to front property line, 8 feet to any side lot line, and 20% of the depth of the lot for the rear setback. Colington Harbour was zoned single-family residential (R-4) in 1985 by Dare County and is subject to that designation under the Zoning Ordinances of Dare County.	
Martin's Point	Permanent driveways shall incorporate an asphalt, brick or concrete apron extending from the roadway edge to the lot line and a culvert, placed under the apron in the existing roadside swale.	No building, including porches, shall be located on any lot within 40 feet of the front lot line, closer than 12.5 feet to the sidelines, or 25 feet to the rear lot line.	
Whalehead Subdivision		For residential lots, no building or structure, including porches, shall be nearer than 20 feet to the front or side street line, 15 feet to any interior side line, or 30 feet to the rear lot line.	

Additional Notes:

[1] Setbacks defined above represent typical or average for residential and commercial uses.

[2] Side setbacks typically higher (typically +5 feet) when lot abuts a street.

[3] There are typically conditional uses/regulations for various zoning differences which may allow different setbacks.

[4] Frontage setback typically increased for lots on major roadways.

	Off-Street Parking Requirements	Materials For Parking	Drive Aisle Requirements
Dare County	Parking requirements are given for various uses.	Requirements typically specify that at least a percentage of the parking shall be an impervious surface. For example: One parking space for each authorized bedroom or bedroom equivalent shall be provided with 50% of the required parking spaces of an impervious surface. The remainder may be of a pervious surface. Concrete, asphalt, turf-stone and /or paving block installed over a clay sub-base are considered impervious surfaces. Gravel, stone, grassed or sodded areas, or turf-stone and/or paving block installed over a sand sub-base shall be considered pervious surfaces.	A drive aisle, minimum width of 10', shall be provided to facilitate emergency vehicle access and vehicle maneuvering. This drive aisle shall be constructed of an impervious surface.
Manteo	Parking requirements are given for 30 different uses. Parking lots shall not drain onto or across public sidewalks or into adjacent property, except into a natural watercourse or a drainage easement.	Parking lots shall be constructed with a surface which will permit safe and convenient passage of vehicles in all weather conditions. Suggested materials include porous asphalt, oyster shells, paving block similar to turf stone, or other materials approved by the Planning Board.	
Town of Nags Head	Parking requirements vary for different uses. Accessory buildings shall be included with principal buildings in measurement of gross floor area for determining parking requirements.	Required parking spaces shall be graded and paved with asphalt, concrete, gravel, porous paving as approved by the town engineer or an open-face paving block over sand and filter-cloth base, provided that the open-face paving block is equivalent to TurfstoneTM with regards to compressive strength, density, absorption and durability.	Residential drive aisles, minimum of 12 feet in width shall be provided.
Town of Kill Devil Hills	Parking requirements vary for different uses. In all zones, parking space dimensions will be 200 square feet, 10 feet by 20 feet. However, for commercial and multi-family residential, only 18 feet of the length need to be paved or constructed of turfstone. The remaining two feet of length shall remain pervious, and a concrete curb stop shall be placed at the front end of each space to accommodate vehicle overhang on the remaining two feet of length.	Commercial driveways, parking areas and turn-around areas shall be made of asphalt, concrete or permeable blocks. Single-family and duplex residential driveway and parking areas can utilize approved commercial materials above or a minimum of four inches of compacted Aggregate Base Course (ABC) with one inch of pea gravel as an approved surface.	Vehicle accommodation areas of all development shall be designed so that sanitation, emergency, and other public service vehicles can serve such developments without the necessity of backing unreasonable distances or making other dangerous or hazardous turning movements.
Town of Kitty Hawk	Parking requirements vary for different uses. Each parking space shall have a minimum length of 18 feet and width of 9.5 feet with the addition of an unpaved open area 2 feet in length beyond the concrete.	Required parking spaces and driveways, other than for single-family or two-family uses, shall be graded and improved with approved surfaces, such as concrete, asphalt, or turfstone. Grass, however, may be used as a parking surface if the town council approves it as a conditional use. Driveways shall be constructed of concrete, asphalt, or turfstone.	
Southern Shores	Parking requirements vary for different zoning uses. Each parking space shall have a minimum length of 20 feet and a minimum width of 10 feet. When a parking space abuts an open space, then 2 feet at the end of the space shall be left unpaved to allow for drainage. No parking spaces for residential use, except for single-family and two-family use, shall be located in the required front yard.	Required parking spaces and driveways, for other than single-family and two-family uses shall be graded, improved with concrete or I-2 asphalt. For large residential dwellings, the drive-aisle and one-half of the required parking spaces shall have an improved surface of concrete or asphalt. Other required and additional spaces may be either gravel, perforated paving blocks, or polymer open-cell soil stabilization systems. Such porous parking areas shall be excluded from lot coverage calculations.	For residential uses, a 10 foot wide drive aisle shall be provided.
Duck	Parking requirements vary for different zoning uses. Each parking space shall have a minimum length of 20 feet and minimum width of 10 feet. Accessory buildings shall be included with principal buildings in measurement of gross floor area for determining parking requirements. All space requirements which are based in part or in whole upon employment shall be computed on the basis of the greatest number of persons on duty at any one period during the day or night in the peak season.	Required parking shall be graded and improved with asphalt, concrete, gravel, or porous paving as approved by the zoning administrator or an open-face paving block (equivalent to Turfstone) over a pervious base.	Drive aisles shall be a minimum 12 feet in width and have same surface requirements as parking.
Currituck County	Parking requirements vary for different zoning uses. Each parking space shall contain a rectangular area at least 20 feet long and 10 feet wide. For single-family and two-family residences located in RO1 and RO2 district, minimum parking space shall be 8 feet in width and 15 feet in length.	Vehicle accommodation areas shall be graded and surfaced with asphalt, concrete, crushed stone, gravel, or other suitable material that will provide protection against potholes, erosion, and dust.	Drive aisles for residential use shall be a minimum of 15 feet in width.
Colington Harbor	A concrete or asphalt paved driveway or a parking pad for a minimum of two cars must be included for all residential structures. Paving must be continuous with the roadway.	Concrete or asphalt.	
Martin's Point	There are no specific parking requirements in the covenants. Driveway requirements include an asphalt, brick, or concrete apron extending from roadway edge to the lot line.		
Whalehead Subdivision	There are no specific parking requirements in the covenants, except that private garages are limited to two cars.		

	Erosion & Sedimentation	Landscaping	Landscaping Buffers
Dare County	No specific regulations for soil erosion and sedimentation control. Under subdivision regulations, state that stream banks and channels upstream from any land disturbing activity shall be protected in accordance with the NC Sedimentation Pollution Control Act.	There are no specific landscaping/buffer ordinances. The Zoning regulations require a visual buffer where a commercial use or zone abuts a residential use or zone. However, regulations do not specify that the buffer be planted with native plants. The Planning Board may recommend the use of a buffer strip adjacent to major roads and to commercial or industrial development which would be part of the platted lots but have the following restriction on the face of the plat: This strip reserved for the planting of trees or shrubs by the owner; the building of structures prohibited	Wetland buffer. Existing natural wetlands, ponds, and wetland swales shall not be dredged, filled or otherwise altered from their natural state. No structure, paved area, or any part of a ground absorption wastewater treatment system shall be located within 50 feet of any marsh, stream, pond, or wetland. Minor road crossing fill for property access shall be allowed only as authorized under the jurisdiction of the Army Corps of Engineers specifications for access roads.
Manteo	Require prior approval of an erosion and sedimentation control plan for any development that would cause land disturbing activity. Land disturbing activity means any use of the land by any person in residential, industrial, educational, institutional, or commercial development, highway and road construction and maintenance that results in a change in the natural cover or topography and that may cause or contribute to sedimentation except exempt activities.	Each development shall provide sufficient screening so that neighboring properties are shielded from any adverse external effects, the development is shielded from negative impacts of adjacent uses such as streets or parking lots.	Three buffer types are established: Parking/Traffic Buffer, Opaque Screen Buffer (req'd between commercial/residential use), and Setback Buffer (req'd between commercial uses). Recommended trees are given for different buffer types, based on hardiness, longevity, ease of maintenance, and long-term cost-effectiveness.
Town of Nags Head	Land disturbance above which sedimentation and erosion control devices are required is 5,000 square feet. Sediment must be retained within the boundaries of the tract during construction upon and development of said tract and plantings or otherwise permanent ground cover is required to restrain erosion after completion of construction.	All large residential dwellings shall comply with one of the following requirements: A) The preservation of a minimum of ten percent of the lot's total area with existing natural vegetation and/or dune elevations. Or B) The planting of a minimum of 15 percent of the lot's total area. The minimum lot area for large residential dwellings shall be 16,000 square feet. At minimum 50 percent of the required landscaping shall consist of locally adapted live evergreen tree species. The remainder of the buffer may be live forbs and shrubs. The above landscaping requirements may be altered due to unique and unusual physical conditions or characteristics of the property, including the reduction of landscaping requirements for oceanfront properties and other lots containing significant dune features that will be preserved in equal proportion.	Any new use of land shall provide a buffer yard if required under the pertinent zoning regulations. 10 buffer yard types are defined. Required type(s) is given for each zoning district.
Town of Kill Devil Hills	Land disturbance above which sedimentation and erosion control devices are required is 1/2 acre. Sediment must be retained within the boundaries of the tract during construction upon and development of said tract and plantings or otherwise permanent ground cover is required to restrain erosion after completion of construction.	A perimeter landscaped area, with a minimum depth of five feet may be required along property lines. Along property lines abutting any street, the minimum depth will be ten feet. Driveways, sidewalks and similar facilities may traverse perimeter landscaped areas. No more than 20% of a required perimeter landscaped area may be utilized for sidewalks, walkways, or private roads. Landscaping standards may be satisfied within required setbacks. The planting of drought-tolerant vegetation common to the immediate natural coastal environment is encouraged to ensure proper plant life development and maturation.	
Town of Kitty Hawk	Land disturbance above which sedimentation and erosion control devices are required is 1 acre. Sediment must be retained within the boundaries of the tract during construction upon and development of said tract and plantings or otherwise permanent ground cover is required to restrain erosion after completion of construction.	Buffer details including vegetation type and size, and fence details shall be submitted for planning board review and for approval by the town council. Plants shall be selected for their hardiness, growth potential and suitability to the particular site. Plants should be indigenous or drought and salt tolerant.	Three buffer types are established. Required type(s) is given for each zoning district.
Southern Shores	No specific regulations for soil erosion and sedimentation control.	Landscaping plans of the intended development shall be submitted and approved prior to the preliminary landscaping plan. Suitable plant types shall be those recommended for the coastal area by the U.S. Department of Agriculture which can be expected to reach a mature growth of eight (8) to ten (10) feet. The vegetation plan shall be approved by the Town Council. Buffers to be permitted in the town shall consist of berms, fencing and/or vegetation.	Where a commercial use abuts a residential zone, or where a conditional use is planned in a residential zone, a buffer of dense vegetative planting or natural vegetation is required. Three buffer types are defined.
Duck	Any lot requiring a land disturbance permit shall install erosion and sediment control measures to prevent sediment from leaving the site. A land disturbance permit shall be required for filling and/or grading a lot, any lot clearance, filling or grading activity prior to issuance of a building permit, any installation of gravel or pavers or accessory structures and similar site features whether or not subject to building permit requirements, and any removal or installation of site features such as septic systems, wells, and drainage systems that disturb the land.	Native species and related cultivars are encouraged.	Buffers are required as described for each zoning district. In general, landscape buffers shall measure no less than ten feet in width. Only landscaping and approved fences and walls shall be permitted within a required buffer or street yard area, except that sidewalks and other pedestrian walkways, bicycle paths, aboveground utilities, drainageways, and approved signs shall be permitted where they do not comprise more than 20 percent of the total area of the required buffer or street yard.
Currituck County	Any lot requiring a land disturbance permit shall install erosion and sediment control measures to prevent sediment from leaving the site. Land disturbing activity means any use of the land by any person in residential, industrial, educational, institutional or commercial development, highway and road construction and maintenance that results in a change in the natural may cause or contribute to sedimentation except activities that are exempt.	Each development shall provide sufficient screening so that neighboring properties are shielded from any adverse external effects, the development is shielded from negative impacts of adjacent uses such as streets or parking lots. When undeveloped land is subdivided and undeveloped lots only are sold, the subdivider shall not be required to install any landscaping. Screening shall be required, if at all, only when the lots are developed. There are no specific requirements to use native or drought-tolerant vegetation.	Four buffer types are established. Required type(s) is based on land use type (zoning district).
Colington Harbor			
Martin's Point			
Whalebead Subdivision			

Other Applicable Regulations

Standard For Most Towns & Counties Having Soil Erosion & Sedimentation Control Regulations:
No land-disturbing activity shall be permitted in proximity to a lake or natural watercourse unless a buffer zone is provided along the margin of the watercourse of sufficient width to confine visible siltation within the 25% of the buffer zone nearer the land-disturbing activity, provided that this subsection not apply to a land-disturbing activity in connection with the construction of facilities to be located on, over or under a lake or natural watercourse.

Town of Manteo From Pedestrian Greenways and Drainage Ditches Section of Zoning Ordinance:
Every multifamily residential development of 12 or more units or mixed use of 12 or more units shall be developed so that at least 5 % of the total area of the development remains permanently as public pedestrian greenways. Greenways mean areas which are not encumbered with a substantial structure, not devoted to use as a roadway or parking area, are left in natural undisturbed state except for cutting of trails or landscaping.

Appendix C

Draft Model Ordinance for Stormwater Management (Post-Construction) in the Outer Banks

Model Ordinance

for

Stormwater Management

(Post-Construction)

along the

North Carolina Outer Banks

2006 June 19
v1.0

Contents

Introduction

As this ordinance addresses a topic which is technical in nature, some portions of this document may appear complex relative to ordinances for signage, subdivisions, grading, zoning, and other aspects of real estate development. Effort has been put forth to present this ordinance in relatively non-technical terms understandable and necessary for individuals building, reviewing, and administering real estate development projects (typically home builders, infrastructure contractors, landscape installers, home buyers, government regulators, elected officials, and local citizens), while presenting key technical information in terms understandable and necessary for individuals planning, analyzing, designing, and certifying real estate development projects (typically civil engineers, land surveyors, and landscape architects). The purpose of this ordinance is to protect natural resources; to protect public health, safety, and welfare; and to maintain and improve life quality and economic development. It is intended that this ordinance will provide flexibility to builders, designers, planners, and regulators and facilitate the implementation of Low Impact Development (LID) and similar approaches to real estate development.

Section 1. General Provisions

1. Authority

In accordance with the provisions of Sections XXXX-XXX to XXXX-XXX and of Article XX of Chapter XXXX of the General Statutes of North Carolina, the [local government entity] hereby adopts this ordinance.

2. Background

The following is hereby acknowledged.

1. Real estate development projects and associated modifications to the natural landscape directly alter the hydrologic response (quantity, constituents, and character) of sites being developed, the watersheds containing sites being developed, and (to a lesser degree) areas outside the watersheds containing the sites being developed;

2. Real estate development without appropriate stormwater management increases stormwater runoff rates, volumes, flooding, stream pollutants, and infrastructure costs; and decreases stormwater infiltration, aquifer recharge, stream flow, surface water quality, and aquatic resources;

3. Appropriate stormwater management can be implemented to minimize the negative aspects of real estate development on hydrologic response (quantity, constituents, and character) through regulatory mechanisms.

Therefore, the [local government entity] establishes this set of policies to provide reasonable guidance for real estate development stormwater management with the purpose of protecting natural resources; protecting public health, safety, and welfare; and maintaining and improving life quality and economic development.

3. Purpose

The provisions of this ordinance have been prepared with regards to the hydrologic and real estate development character of the North Carolina Outer Banks. The purpose of this ordinance is to protect natural resources; to protect public health, safety, and welfare; and to maintain and improve life quality and economic development.

This ordinance seeks to meet that purpose through the following objective: The postdevelopment hydrologic response (quantity, constituents, and character) of each site having undergone real estate development construction shall mimic the predevelopment hydrologic response of each site (quantity, constituents, and character). This ordinance applies to new construction and redevelopment projects.

The primary aspects of hydrologic response which are of concern, include, but are not necessarily limited to:

1. Quantity. The postdevelopment total quantity (mass, volume) of stormwater infiltrating the soil surface at the site, evapotranspirating from the site, and flowing from the site by way of surface runoff (eg, open channel flow, sheet flow, pipe flow) shall mimic the predevelopment total quantity (mass, volume) of stormwater infiltrating the soil surface at the site, evapotranspirating from the site, and flowing from the site by way of surface runoff (eg, open channel flow, sheet flow, pipe flow).

2. Constituents. The postdevelopment instantaneous, event, and total mass of constituents transported from the site by surface flow (stormwater runoff) and subsurface flow (soil water) shall mimic the predevelopment instantaneous, event, and total mass of constituents transported from the site by surface flow (stormwater runoff) and subsurface flow (soil water).

3. Character. The postdevelopment character (instantaneous flow rates, site hydrograph shape) of stormwater runoff from the site shall mimic the predevelopment character (instantaneous flow rates, site hydrograph shape) of stormwater runoff from the site.

4. Applicability

This ordinance shall be applicable to all construction (residential, commercial, institutional, and others) of $10,000 or greater estimated total cost (material supplies, installation labor, government fees, professional fees, and other costs), unless granted a waiver by the [local government entity] under the specifications of Section 4 of this ordinance or eligible for an exemption as indicated below. The total cost is based upon the average value of the US Dollar during 2005 and shall be adjusted to the current value based on the US Federal Consumer Price Index (CPI) at the date on which the first construction permit application (subdivision, zoning, building, or other) was received by the [local government entity].

This ordinance applies to construction activities that are less than $10,000 total cost (as defined above) if such activities are part of a larger construction project, even though multiple separate and distinct construction activities may take place at different times and on different schedules.

The entire parcel (lot, tract, etc) or parcels (lots, tracts, etc) on which the construction is proposed to occur is subject to implementation of stormwater management as per the requirements of this ordinance. Stormwater management shall be undertaken either as a part of the proposed construction or as a separate retrofit, whether or not the proposed construction was proposed to include stormwater management for the entire parcel or portions thereof. All construction (residential, commercial, institutional, and others) of any type (parking expansion, room addition, interior remodeling, landscape improvement, and others) is subject to this ordinance.

All plans must be reviewed and approved by the [local government entity].

The following activities may be exempt from the requirements of this ordinance:

1. Logging and agricultural activities which are regulated by the State of North Carolina, have an approved soil conservation plan and/or timber management plan (as appropriate) prepared or approved by the appropriate agency (or agencies), and are in compliance with such plan(s).

2. Maintenance and repairs to stormwater management measures deemed necessary by the [local government entity].

Additions or modifications to existing structures (single family buildings and others), including such activities resulting from storm damage and other natural disasters, are not exempt from this ordinance.

5. Compatibility

This ordinance is not intended to interfere with, abrogate, or annul any ordinance, rule, regulation, statute, or other provision of law. The requirements of this ordinance should be considered minimum requirements, and where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule, regulation, statute, or other provision of law, whichever provisions are more restrictive shall be considered to take precedence.

6. Severability

If the provisions of any article, section, subsection, paragraph, subdivision or clause of this ordinance shall be judged invalid by a court of competent jurisdiction, such order of judgment shall not affect or invalidate the remainder of any article, section, subsection, paragraph, subdivision, or clause of this ordinance.

7. Guidance

The [local government entity] may furnish additional policy, criteria, and information including specifications and standards, for the proper implementation of the requirements of this ordinance. This may be provided in the form of a Stormwater Management Manual or other documents. Technical guidance provided in such a Manual and associated documents shall not supplant the judgement of appropriately licensed professionals with suitable background in stormwater management. Development of plans by licensed professionals without suitable background in stormwater management shall be subject to referral to the appropriate NC Licensing Boards. Not all stormwater management activities require professional licensure, however, unlicensed individuals undertaking analysis and design of stormwater management components which require licensure for such work shall be subject to referral to the appropriate NC Licensing Boards.

Section 2. Definitions

"Accelerated Erosion" means erosion caused by real estate development activities that exceeds the natural processes by which the surface of the land is worn away by the action of water, wind, or chemical action.
"Applicant" means a property owner or agent of a property owner who has filed an application for a stormwater management permit.
"Channel" means a natural or artificial watercourse with a definite bed and banks that conducts continuously or periodically flowing water.

"Dedication" (dedicate) means the deliberate appropriation of property by its owner for general public use.
"Detain" (detention) means the temporary storage of stormwater prior to controlled release as runoff. (Contrast with retention.)
"Developer" means a person who undertakes real estate development activities.
"Fee-in-Lieu" means a payment of money in place of meeting all or part of the stormwater performance standards required by this ordinance.
"Hydrologic Soil Group" (HSG) means a Natural Resource Conservation Service (NRCS) classification system in which soils are categorized into four groups of infiltration potential. The groups range from A soils, with high permeability and little runoff production, to D soils, which have low permeability and produce much more runoff.
"Impervious Cover" means those surfaces that cannot effectively infiltrate rainfall (e.g., building rooftops, pavement, sidewalks, driveways, etc).
"Infiltration Facility" means any structure or device designed to infiltrate retained water to the subsurface. These facilities may be above grade or below grade.
"Infiltration" means the process of water moving into the soil matrix from the soil surface.
"Jurisdictional Water" means a surface water under regulatory control of the local, state, or federal governments.
"Landowner" means the legal or beneficial owner of land, including those holding the right to purchase or lease the land, or any other person holding proprietary rights in the land.
"Maintenance Agreement" means a legally recorded document that acts as a property deed restriction, and which provides for long-term maintenance of stormwater management practices.
"Mimic" means significantly equivalent in nature.
"Nonpoint Source Pollution" (NPS) means pollution from any source other than from any discernible, confined, and discrete conveyances, and shall include, but not be limited to, pollutants from agricultural, silvicultural, mining, construction, subsurface disposal and urban runoff sources.
"Off-Site Facility" means a stormwater management measure located outside the subject property boundary described in the permit application for real estate development activity.
"On-Site Facility" means a stormwater management measure located within the subject property boundary described in the permit application for real estate development activity.
"Open Space" means a vegetated, unoccupied, space open to the sky, without vertical structures or surfaces covered with pavements or other relatively impervious materials.
"Recharge" means generally downward movement of water through the soil matrix to below the limits of active evapotranspiration effects.
"Retain" (retention) means to facilitate full infiltration and/or evapotranspiration of stormwater, not allowing runoff. (Contrast with detention.)
"Stop Work Order" means an order issued which requires that all construction activity on a site be stopped.
"Stormwater Management Measures" (SMMs) means components, either structural or nonstructural, that function to manage one or more components of hydrologic response (quantity, constituents, and character) from stormwater inputs.
"Stormwater Management" means the use of structural or nonstructural practices to manage one or more components of hydrologic response (quantity, constituents, and character) from stormwater inputs.

"Stormwater Retrofit" means stormwater management for an existing site that previously had no stormwater management measures in place, measures inadequate to meet the stormwater management requirements of the this ordinance, or measures inadequate to meet other stormwater management goals or requirements.
"Stormwater Runoff" means water flow across ground surface, resulting from precipitation.
"Stream" (Creek, River) means an open water system which carries sediment from higher elevation areas to lower elevations.
"Watercourse" means a permanent or intermittent stream or other body of water, either natural or man-made, which gathers or carries surface water.
"Wetland" means an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

Section 3. Stormwater Management Permit Procedures and Requirements

1. Permit Required

No land owner, land operator, or equivalent entity shall receive any signage, subdivision, grading, zoning, and other real estate development permits required by the [local government entity] without first meeting the requirements of this ordinance prior to commencing the proposed activity.

2. Application Requirements

Unless specifically excluded by this ordinance, any land owner, land operator, or equivalent entity desiring a permit for a real estate development activity shall submit to the [local government entity] a permit application on a form provided for that purpose.

Unless specifically excluded by this ordinance, a full stormwater management permit application package must include the following in order that the permit application be considered.

1. A completed stormwater management permit application form

2. A stormwater management plan (with associated supporting calculations and data, as appropriate)

3. A stormwater management maintenance agreement

4. A stormwater management performance bond (as required)

5. A nonrefundable stormwater management permit application review fee

The stormwater management plan shall be prepared to meet the requirements of Section 5 of this ordinance, the maintenance agreement shall be prepared to meet the requirements of Section 9 of this ordinance, and fees shall be those established by the [local government entity].

Prior to submission of a full permit application package, the requesting entity (land owner, land operator, or equivalent) may submit a stormwater management concept plan for review and comment by the [local government entity] prior to submission of a full stormwater permit application package. The stormwater management concept plan shall be prepared at a standard engineering scale and include, at a minimum: property boundaries, legal easements, existing landform and vegetation features, proposed landform and vegetation features, and proposed stormwater management features; each of which must be appropriately indicated by labels or a legend.

3. Application Review Fees

The fee for review of any real estate development application shall be based on: 1) the amount of land proposed to be disturbed at the site; and 2) the total estimated project cost. The fee structure shall be established by the [local government entity] and updated annually. All fees shall be credited to a [local government entity] account to support [local government entity] plan review, inspection, enforcement, and program administration, and shall be made prior to the issuance of any signage, subdivision, grading, zoning, and other real estate development permits.

4. Application Procedure

1. A full stormwater management permit application package shall be submitted to the [local government entity] on standard [local government entity] business days during regular business hours.

2. Three print copies of all documents shall be submitted.

3. One electronic copy of all documents shall be submitted in Portable Document Format (PDF). This may be emailed or submitted on appropriate media (compact disc, digital video disc, magnetic tape, other) as deemed appropriate by the [local government entity].

4. Within [XX] business days of receiving a full stormwater management permit application package, the [local government entity] shall inform the applicant of approval or disapproval of the stormwater management application components (completed application form, plan, supporting calculations and data (as appropriate), maintenance agreement, performance bond (as required), nonrefundable permit application review fee).

5. If any of the stormwater management application components are disapproved, the applicant may revise and resubmit the disapproved component without revising and resubmitting other components except as deemed necessary by the [local government entity]. No additional fee is required for the first resubmittal. An additional fee of 25% of the initial application fee is required for each subsequent resubmittal.

6. If stormwater management application components are resubmitted, the [local government entity] shall inform the applicant of approval or disapproval of the resubmitted stormwater management application components within [XX] business days of receiving the resubmitted components.

7. The stormwater management permit shall be issued upon approval of all stormwater management application components.

5. Permit Duration

Stormwater management permits shall be valid from the date of issuance through the date the [local government entity] notifies the permit holder that all stormwater management measures have passed the final inspection required under the permit conditions.

Section 4. Waivers to Stormwater Management Requirements

1. Minimum Conditions

Every applicant shall provide for stormwater management as required by this ordinance, unless a written request is filed to waive this requirement. Requests to waive the stormwater management plan requirements shall be submitted to the [local government entity] for approval. The minimum requirements for stormwater management may be waived in whole or in part upon written request of the applicant, provided that at least one of the following conditions applies:

1. It can be demonstrated that the proposed development is not likely to impair attainment of the objectives of this ordinance.

2. Provisions are made to manage stormwater by an off-site facility. The off-site facility is required to be in place, to be designed and adequately sized to provide a level of stormwater management that is equal to or greater than that which would be afforded by on-site stormwater management measures, or set forth in this ordinance, and there is a legally obligated entity responsible for long-term operation and maintenance of the stormwater management facility.

3. The [local government entity] finds that meeting the minimum on-site management requirements is not feasible due to legal or physical characteristics of the site.

2. Evaluation Criteria

In instances where one of the conditions above applies, the [local government entity] may grant a waiver from strict compliance with these stormwater management provisions, as long as acceptable mitigation measures are provided. However, to be eligible for a variance, the applicant must demonstrate to the satisfaction of the [local government entity] that the variance will not result in the following.

1. Deterioration of existing canals, culverts, ditches, bridges, dams, and other structures.

2. Degradation of local aquatic or terrestrial flora and fauna.

3. Impairment of downstream water quality.

4. Accelerated erosion or sedimentation.

5. Increased health risk, property damage, or community nuisance from flooding.

3. Mitigative Measures

Furthermore, where compliance with minimum requirements for stormwater management is waived, the applicant will satisfy the minimum requirements by meeting one of the mitigation measures selected by the [local government entity]. Mitigation measures may include, but are not limited to, the following:

1. The purchase and donation of privately owned lands; the grant of an easement to be dedicated for preservation, enhancement or rehabilitation; or similarly regarded activity which will directly offset impacts from existing stormwater runoff. In lieu of a monetary contribution, an applicant may obtain a waiver of the required stormwater management by entering into an agreement with the [local government entity] for the granting of an easement or the dedication of land by the applicant, to be used for the construction of an off-site stormwater management facility. The agreement shall be entered into by the applicant and the [local government entity] prior to the recording of plats or, if no record plat is required, prior to the issuance of the building permit.

2. The development and implementation of a stormwater management facility or other stormwater improvements on previously developed properties, public or private, that currently lack stormwater management facilities designed and constructed in accordance with the purposes and standards of this ordinance.

3. Monetary contributions (Fee-in-Lieu) to fund stormwater management activities such as research and studies (e.g., water quality and quantity monitoring, flora and fauna studies, hydrologic analysis, stormwater management monitoring, and others). The applicant shall be required to pay a fee in an amount as determined by the [local government entity]. All of the monetary contributions shall be credited to an appropriate capital improvements program project, and shall be made by the developer prior to the issuance of any building permit for the development. The fee shall be credited to a [local government entity] account to support [local government entity] plan review, inspection, enforcement, and program administration, and shall be received by made prior to the issuance of any signage, subdivision, grading, zoning, and other real estate development permits.

Section 5. Minimum Stormwater Management Hydrologic Performance Criteria

Unless judged by the [local government entity] to be exempt or granted a waiver, the following performance criteria shall be addressed for stormwater management at all sites.

1. Option A: Simplified Method

The Simplified Method may be employed for a project if either of the two conditions are met.

1. The total area of land to be disturbed is less than one acre.

2. The estimated total cost (material supplies, installation labor, government fees, professional fees, and other costs) of the project is $50,000 or less. The total cost is based upon the average value of the US Dollar during 2005 and shall be adjusted to the current value based on the US Federal Consumer Price Index (CPI) at the date on which the first construction permit application (subdivision, zoning, building, or other) was received by the [local government entity].

The Simplified Method is solely volume based, without consideration for stormwater infiltration or evapotranspiration during the precipitation event. The Simplified Method has one requirement: the total 2-year 24-hour precipitation event volume shall be retained on the project site and infiltrated and/or evapotranspirated within 48 hours of the precipitation event end.

2. Option B: Standard Method

The Standard Method shall be employed for any project not eligible for the Simplified Method and not employing the Advanced Method. The Standard Method may also be employed for any project eligible for the Simplified Method.

The Standard Method is event response based. The Standard Method has the following three requirements.

1. The site postdevelopment total volume of stormwater runoff from the 10-year 24-hour precipitation NRCS Type III design event shall not exceed the predevelopment total volume from the same design event.

2. The site postdevelopment total mass of nitrogen, phosphorous, sediment, and fecal coliform from the 10-year 24-hour precipitation NRCS Type III design event shall not exceed the predevelopment total quantity from the same design event.

3. The site postdevelopment character of stormwater runoff from the 10-year 24-hour precipitation NRCS Type III design event shall mimic the predevelopment character from the same design event relative to the Normalized Maximum Flow Residual (NMFR). The NMFR is the maximum difference between a specific postdevelopment hydrograph flow value and the predevelopment hydrograph flow value during the corresponding time interval over the range of time intervals divided by the maximum predevelopment flow value. NMFR = ((Maximum ($Qpost_i$ - $Qpre_i$))/$Qpre_{max}$). NMFR shall not exceed 5% (NMFR <= 0.05).

For the above parameter criteria, predevelopment and post development site response hydrographs shall be developed for 10-year 24-hour precipitation NRCS Type III design event. These hydrographs shall consist of at least 100 data pairs (time, flow) and shall have a temporal range extending from the beginning of the precipitation event to the time at which the flow rate decreases (on the falling limb of the hydrograph) to within 10% of the flow rate prior to the precipitation event.

3. Option C: Advanced Method

The Advanced Method may be employed for any project. The Advanced Method is continuous simulation based.

The Advanced Method has the following three requirements.

1. The site postdevelopment total volume of stormwater runoff from the 5-year 24-hour runoff event (volume basis) shall not exceed the predevelopment total volume from the same event.

2. The site postdevelopment total mass of nitrogen, phosphorous, sediment, and fecal coliform from the 5-year 24-hour runoff event (volume basis) shall not exceed the predevelopment total quantity from the same event.

3. The site postdevelopment character of stormwater runoff from the 5-year 24-hour runoff event (volume basis) shall mimic the predevelopment character from the same event relative to the Normalized Maximum Flow Residual (NMFR). The NMFR is the maximum difference between a specific postdevelopment hydrograph flow value and the predevelopment hydrograph flow value during the corresponding time interval over the range of time intervals divided by the maximum predevelopment flow value. NMFR = ((Maximum ($Qpost_i$ - $Qpre_i$))/$Qpre_{max}$). NMFR shall not exceed 5% (NMFR <= 0.05).

For the above parameter criteria, predevelopment and post development site response hydrographs shall be developed for at least a 15 year span. Historical precipitation data from the closest gaging station along the NC Outer Banks with 15 minute resolution data shall be employed for the simulation. The temporal resolution of the hydrograph during the 5-year 24-hour runoff event (volume basis) shall be 5 minutes or finer.

Section 6. Requirements for Stormwater Management Permit Application Package Approval

1. Preparer

The plan and supporting technical documents must be prepared by an individual with adequate knowledge and appropriate licensure to undertake the stormwater management planning, analysis, and design. In general, development of a stormwater plan employing Option A (as specified in Section 5) may not necessitate the preparer to be a licensed professional. Development of a stormwater plan employing Option B (as specified in Section 5) or Option C (as specified in Section 5) requires the preparer to be an appropriately licensed professional with suitable background in stormwater management. Unlicensed individuals undertaking analysis and design of stormwater management components which require licensure for such work shall be subject to referral to the appropriate NC Licensing Boards.

2. Stormwater Management Permit Application Form

A stormwater management permit application form shall be completed and included in the submittal package. This form shall be notarized by a Notary Public.

3. Stormwater Management Plan Minimum Requirements

A stormwater management plan shall be required with all permit applications. The plan shall include sufficient information (eg, calculations, maps, data, etc) to evaluate the characteristics of the project site; the potential impacts of all proposed construction (present and future) on water resources; and the effectiveness and acceptability of the measures proposed for managing stormwater at the project site. To accomplish this goal the following information shall be included in the stormwater management plan (which may be incorporated into other design/construction plan documents such as those for roadways, sanitary sewer collection, potable water supply, erosion/sedimentation control, landscaping, and others).

1. Introduction. The name and physical address of the project. The name, address, and telephone number of all entities having a legal interest in the project property (including utility providers) with associated legal references (deed, plat, etc). The parcel identification numbers of the project properties. A vicinity map indicating (at least) the project location, adjacent roads, and the nearest public road intersection.

2. Existing Conditions. Sheets or maps indicating the location of existing topographic features: buildings, elevations, landforms, parking areas, roadways, structures, subsurface utilities, surface utilities, surface waters, vegetation, and other significant elements. Elevation contours shall be depicted at 0.5 foot intervals for areas with slopes of less than 1%. Elevation contours shall be depicted at 1.0 foot intervals for areas with slopes of 1% to 5%. Elevation contours shall be depicted at 2.0 foot intervals for areas with slopes of more than 5%. Spot elevations shall depict depressions and peaks. Contours shall extend 15 feet beyond the property boundaries (if possible). All elevations shall be at North American Vertical Datum 1988 (NAVD88). A permanent benchmark which will not be damaged during construction shall be indicated. The project construction boundary shall be clearly depicted and labeled.

3. Proposed Conditions. Sheets or maps indicating location of proposed topographic features: buildings, elevations, pavement, structures, subsurface utilities, surface utilities, shrubs, trees, herbs, turf, and other significant elements. Stormwater management measures will be clearly depicted and labeled. Erosion/sedimentation control measures for stormwater management implementation will also be clearly depicted and labeled. Elevation contours shall be depicted at 0.5 foot intervals for areas with slopes of less than 1%. Elevation contours shall be depicted at 1.0 foot intervals for areas with slopes of 1% to 5%. Elevation contours shall be depicted at 2.0 foot intervals for areas with slopes of more than 5%. Spot elevations shall be sufficient to facilitate tracing the path of all surface water runoff on the site. All elevations shall be at North American Vertical Datum 1988 (NAVD88). The project construction boundary shall be clearly depicted and labeled.

4. Design Details. Plan sheets or shop drawings indicating finer resolution construction/installation information than can be clearly depicted on proposed conditions sheets or maps. Information level should be sufficient to construct/install all components in concert with proposed conditions sheets/maps.

5. Performance Conditions. A detailed written description of the maintenance, inspection, reporting, and repair requirements for all stormwater management measures. Information should relate routine and special operations for normal and long-term proper functioning on stormwater management measures. Any specific equipment and skills or training necessary for these operations shall be described. It is preferable that the performance conditions be submitted as a separate document from plan sheets and maps.

6. Design Calculations/Data. Sufficient analysis to relate the adequacy of proposed stormwater management measures relative to the requirements of this ordinance. Calculations and supporting data (with maps and other information as appropriate) for the predevelopment and postdevelopment site conditions/response. At a minimum, such shall include: 1) indication of minimum stormwater management hydrologic performance criteria option chosen (A, B, or C); 2) parameters (constants and variables) employed in the analysis (with appropriate British Imperial System units indicated), with references to the information sources; 3) results of the analysis; and 4) references for standard analysis methodologies employed and detailed description (with justification) of nonstandard analysis methodologies.

3. Stormwater Management Maintenance Agreement

The applicant shall execute a stormwater management maintenance agreement with an associated stormwater management easement binding on all subsequent owners of land served by an on-site stormwater management measure in accordance with the specifications of this ordinance. The beneficiary of the maintenance agreement and associated easement will be the [local government entity].

The applicant shall ensure access by the [local government entity] and its agents (consultants, contractors, others retained or employed by the [local government entity]) to all stormwater management measures at the site for the purposes of inspection, maintenance, reporting, and repair operations. The legal instruments conveying such rights to the [local government entity] shall be recorded in the [Dare/Currituck] County Registry and shall transfer with property interest to subsequent title holders.

The maintenance agreement shall specify when inspection, maintenance, reporting, and repair operations will occur, either on a periodic basis or as a result of particular conditions (severe storms, citizen complaints, other) to ensure proper function of the stormwater management measures. The property owner shall grant to the [local government entity] the right to enter the property at reasonable times and in a reasonable manner for the purpose of inspection. This includes the right to enter a property when there is a reasonable basis to believe that a violation of this ordinance is occurring or has occurred, to enter when necessary for abatement of a public nuisance, and for correction of a violation of this ordinance. The maintenance agreement shall contain a provision for increased inspection, maintenance, reporting, and repair operations if

deemed necessary by the [local government entity] to ensure proper functioning of the stormwater management measures.

The [local government entity] may, at its discretion, accept responsibility for inspection, maintenance, reporting, and repair operations of any existing or future stormwater management measures. Regardless of such provision, the maintenance agreement shall convey adequate and perpetual access as well as sufficient area, by easement or otherwise, for inspection, maintenance, reporting, and repair operations.

4. Stormwater Management Performance Bond

The [local government entity] may, at its discretion, require the submittal of a performance bond or similar security prior to issuance of a permit in order to insure that the stormwater management plan is implemented as required. The amount of the performance bond or similar security shall be the total estimated cost of implementing the stormwater management plan, plus 25%. The performance bond or similar security shall contain forfeiture provisions for failure to complete work specified in the stormwater management plan.

The performance bond or similar security shall be released in full only upon submission of final as-built maps and associated written certification by appropriately licensed professionals that the stormwater management plan has been properly implemented as per all permit requirements. The [local government entity] will make a final inspection of the site after receipt of the as-built maps and associated written certification. The [local government entity] will certify the stormwater management plan construction completion only after any outstanding items have been addressed. Provisions for partial pro-rata releases of the performance bond or similar security based on the completion of various development stages may be undertaken at the discretion of the [local government entity]. The additional 25% portion of the performance bond or similar security shall be retained by the [local government entity] until 18 months after the [local government entity] certifies the stormwater management plan construction completion. This portion of the performance bond or similar security shall be utilized as necessary by the [local government entity] to repair stormwater management measures functioning in an unsatisfactory manner.

5. Stormwater Management Permit Application Review Fee

The stormwater management permit application fee shall be tendered in the form of cash, check, or money order. Checks must be drawn on an account in a bank, credit union, or similar financial institution with primary offices registered in the United States.

Section 7. Construction Inspection

1. Notice of Construction Commencement

The stormwater management permit applicant must notify the [local government entity] no less than [XX] standard work days prior to the intended commencement of construction. Inspections of the stormwater management system construction on a regular or random basis may be conducted by the [local government entity] or its agents (consultants, contractors, others retained or

employed by the [local government entity]). Inspections shall be documented and written reports shall be prepared that contain the following information.

1. The date and location of the inspection

2. Whether construction appears in compliance with the approved stormwater management plan

3. Variations from the approved stormwater management plan

4. Any violations that exist

If any violations are found, the property owner shall be notified in writing of the nature of the violation and the required corrective actions. No added work shall proceed until any violations are corrected and all work previously completed has received approval by the [local government entity].

2. As-Built Map and Written Certification

All stormwater management permit holders shall submit as-built maps for any stormwater management measures on-site after final construction has been completed. The as-built maps should be prepared from a full topographic survey of the construction area by a board certified land surveyor licensed to practice in North Carolina. The as-built survey and associated map should include all elements indicated on the construction/design plans as well as other prominent physical surface features, subsurface utilities, vegetation (including all planted stock as well as dense vegetation groupings), drainage features, above ground utilities, as well as legal and regulatory boundaries (lots, zoning, easements, setbacks, wetlands, hazards, etc). The maps should include contours at the same interval as depicted on the stormwater management plan. Spot elevations should be indicated in areas depicted on the proposed conditions sheet or map. Contours shall extend 15 feet beyond the property boundaries (if possible). All elevations shall be at North American Vertical Datum 1988 (NAVD88). A permanent benchmark shall be indicated. The map shall contain a written certification by an appropriately licensed professional that the stormwater management plan has been properly implemented as per all permit requirements. It is preferable that the certifying licensed professional be the same entity that prepared the stormwater management plan if Option B or Option C of the minimum stormwater management hydrologic performance criteria were employed for the plan.

Three print copies of the as-built maps shall be submitted to the [local government entity]. One electronic copy of the as-built map shall be submitted in Portable Document Format (PDF). This may be emailed or submitted on appropriate media (compact disc, digital video disc, magnetic tape, other) as deemed appropriate by the [local government entity].

Section 8. Performance, Maintenance, Repair, Inspection, and Reporting

1. Performance of Stormwater Management Measures

Stormwater management measures should consistently function at (or above) the minimum stormwater management hydrologic performance criteria specified in this ordinance and employed for the project (Option A, B, or C).

2. Maintenance and Repair of Stormwater Management Measures

Maintenance may include, but is not limited to, the following.

1. Removal of sediment, litter, and debris

2. Replanting or reseeding vegetation

3. Trimming of vegetation

4. Removal of undesirable vegetation

5. Aerating or amending topsoil

6. Patching or sealing boxes, pipes, and other structures

7. Replacing soil and other porous media

Depending upon the type of stormwater management measures and the specific stormwater management maintenance agreement requirements, maintenance operations may be undertaken by the property owner, the [local government entity], or agents of the [local government entity] (consultants, contractors, others retained or employed by the [local government entity]). Relatively frequent maintenance operations may be required for some stormwater management measures, while other stormwater management measures may require little to no maintenance.

3. Inspecting and Reporting on Stormwater Management Measures

Inspecting and reporting may include, but are not limited to, the following.

1. Reviewing maintenance and repair records

2. Sampling discharges, surface water, groundwater, and material or water

3. Evaluating the condition of stormwater management measures and contributing watersheds

4. Photographing stormwater management measures and upslope areas

Depending upon the type of stormwater management measures and the specific stormwater management maintenance agreement requirements, inspections may be undertaken by the property owner, the [local government entity], or agents of the [local government entity] (consultants, contractors, others retained or employed by the [local government entity]). Entities responsible for inspecting and reporting on stormwater management measures shall prepare records of all inspection, maintenance and repair activities. These records shall be maintained for at least 5 years and shall be made available to the [local government entity] and its agents (consultants, contractors, others retained or employed by the [local government entity]) during inspection and at other reasonable times upon request.

Section 9. Enforcement, Violations, and Penalties

1. Violations

Any development activity that is commenced or is conducted contrary to this ordinance, may be restrained by injunction or otherwise abated in a manner provided by law.

If a responsible entity fails or refuses to meet the requirements of the this ordinance, the [local government entity], after reasonable notice, may correct a violation by performing all necessary work to place the stormwater management measures in proper working condition. In the event that a stormwater management measure becomes a danger to the health, safety, or welfare of the public, the [local government entity] shall notify the party responsible for maintenance of the stormwater management measures in writing. Upon receipt of that notice, the responsible entity shall have [XX] standard work days to effect necessary maintenance and repair operations for the stormwater management measures to function at (or above) the minimum stormwater management hydrologic performance criteria specified in this ordinance and employed for the project (Option A, B, or C). After proper notice, the [local government entity] may assess the owners of the property for all costs incurred during such maintenance and repair operations and levy penalties against the owners for the incident. The cost of the maintenance and repair operations shall be a lien on the property, or prorated against the beneficial users of the property, and may be placed on the tax bill and collected as ordinary taxes by the County in which the property is located.

2. Notice of Violation

When the [local government entity] determines that an activity is not being undertaken in accordance with the requirements of this ordinance, it shall issue a written Notice of Violation (NoV) to the owner of the property. The Notice of Violation shall contain, at a minimum, the following information.

1. A statement referencing this ordinance and indicating the [local government entity] has authority in the matter

2. The name and address of the property owner

3. The address of the property

4. A general or legal description of the property upon which the violation is occurring

5. A statement specifying the nature of the violation

6. A description of the management and repair operations required to bring the stormwater management measures into compliance with this ordinance

7. A time schedule for the completion of required management and repair operations

8. A statement of the penalties that may be assessed against the entity to whom the Notice of Violation is directed

9. A statement that the determination of violation may be appealed to the [local government entity] by filing a written notice of appeal within [XX] days of being served with the Notice of Violation.

3. Stop Work Orders

Entities receiving a Notice of Violation shall be required to halt all construction activities on the property on which the violation has been determined to be occurring immediately upon receipt of Notice of Violation. The Stop Work Order will be in effect until the [local government entity] determines that the stormwater management measures are in compliance with is ordinance and the violation has been satisfactorily addressed. Failure to address a Notice of Violation in a timely manner may result in civil, criminal, or monetary penalties in accordance with the enforcement measures authorized in this ordinance.

4. Civil and Criminal Penalties

In addition to, or as an alternative to, any penalty provided herein or by law, any entity which violates the provisions of this ordinance shall be levied a fine of not less than ($1,000) based upon the average value of the US Dollar during 2005 and shall be adjusted to the current value based on the US Federal Consumer Price Index (CPI) at the date on which the first Notice of Violation was served to the violating entity. Such entity shall be guilty of a separate offense for each day during which the violation occurs or continues.

5. Restoration of Lands

Any violator may be required to restore land to its undisturbed condition. In the event that restoration is not undertaken within a reasonable time after notice, the [local government entity] may take necessary corrective action, the cost of which shall become a lien upon the property until paid.

6. Holds on Certificates of Occupancy

Certificates of Occupancy shall not be granted until required management and repair operations required to bring the stormwater management measures into compliance with this ordinance have been completed and accepted by the [local government entity].

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http://www.bioretention.com

Center for Watershed Protection
http://www.cwp.org

Cooperative Research Centre for Catchment Hydrology
http://www.toolkit.net.au

Design: Low Impact Development Manual
http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

Extension Master Gardeners Volunteer
http://www.ces.ncsu.edu/depts/hort/consumer/masgar

International Stormwater Best Management Practices (BMP) Database
http://www.bmpdatabase.org

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http://www.lid-stormwater.net

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http://www.soil.ncsu.edu/assist

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http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-wintr55.html

VS2DI (USGS) - Soil Hydraulics
http://wwwbrr.cr.usgs.gov/projects/GW_Unsat/vs2di1.2/index.html

WASP (EPA, UGA-ERL, USACE, Tetra Tech) - Water Quality
http://www.epa.gov/athens/wwqtsc/html/wasp.html

WDMutil (Aqua Terra, EPA) - Hydrologic Data Manipulation
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