# Wrightsville Beach Stormwater Design Manual

## Part I – Contractor Manual

### Wrightsville Beach Stormwater Services

# May 2008

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# Acknowledgment

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Engineering criteria and formulas were provided by Norris, Kuske & Tunstall Consulting Engineers.

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# SECTION 1 – GENERAL PROVISIONS

**1.1. Stormwater Impacts.** Post-Construction stormwater management in areas undergoing development or redevelopment is essential to maintaining and attempting to improve the quality of the waters that receive runoff from these areas. The impacts from construction are primarily focused on two areas: water quality and quantity. Water quality is impacted when stormwater runoff flows over areas altered by development. As the runoff flows toward the receiving water body, it picks up harmful sediment and chemicals, such as oil, grease, pesticides, heavy metals and nutrients. These pollutants become suspended in runoff and are carried to the surrounding streams, channels and oceanfront. Once deposited, they enter the food chain through small aquatic life and eventually enter the tissue of fish and humans.

In addition to the increase of pollutants, water quantity is also increased as the amount of impervious surface increases. Impervious surfaces disrupt the natural cycle of gradual percolation of water through vegetation and soil. The water that once filtered through the soil is now collected on surfaces such as asphalt and concrete and routed to drainage systems. Since the storm drains empty directly into the surrounding water bodies without any treatment, the large volumes of runoff quickly add to the nearest receiving waterbody resulting in possible loss of aquatic life and damage to property.

**1.2 Applicability.** All development activity that occurs on a land parcel within the jurisdictional limits of Wrightsville Beach after the adoption of this manual must comply with the impervious applicability limits.

**1.3 Stormwater Quality.** Water quality measures are required for all development and redevelopment that affects at least 500 square feet of impervious surface. The first 1.5" of runoff or the difference in runoff from all surfaces between the predevelopment and post-development conditions for a one-year, 24-hour storm, whichever is greater, is required to be treated and controlled by an accepted water quality measure per this manual to achieve 85% removal of Total Suspended Solids (TSS). (Updated 5/22/2008)

**1.4 Stormwater Quantity.** All properties are required to limit the post-construction peak discharge rate to no greater than the pre-development discharge rate for the 1-yr, 24-hr storm event.

**1.5 Adequate Drainage.** A drainage plan demonstrating adequate conveyance of the 10-yr storm event to the public drainage system or a receiving waterway is required for all development that creates at least 2,500 square feet of impervious surface. The storm intensity will be the current rainfall data for Wilmington, NC as reported by the National Oceanic and Atmospheric Administration.

**1.6 Designer Qualifications.** The designer shall be a registered Professional Engineer in the state of North Carolina competent in stormwater management.

**1.7 Design Methods.** Design methods are at the option of the design engineer. The methods described in this manual will be used to review proposed stormwater management systems.

**1.8 System Performance.** Systems that fail to perform up to the minimum standards required by this manual, regardless of the design methods used, will be in violation of these requirements.

**1.9 Inspections and Maintenance.** All stormwater systems shall be inspected every 6 months and after significant rainfall events ($\geq$ 2") to verify that the system is performing adequately. The Town of Wrightsville Beach Stormwater Services will inspect systems annually to insure compliance. Stormwater features designed to retain water shall be cleaned out to the original design volume if the volume has been reduced by 25%. Vegetated slopes shall be stabilized if erosion occurs.

**1.10 Access.** Adequate access must be provided to all stormwater features to allow for periodic inspection and maintenance.

**1.11 Variances.** Variances may be granted for post-construction stormwater control if the applicant provides sufficient data and acceptable justification. Justification may include:

- Proposed land development will reduce stormwater runoff or discharge of pollutants
- Pre-development land use condition has not changed as a result of construction activity
- An alternative stormwater plan is provided which fulfills the intent of the local ordinance.
- Exceptional circumstances exist such that strict adherence to the ordinance could result in unnecessary hardship and not fulfill the intent of the ordinance.

# SECTION 2 – Design Standards For BMPs

2.1. **Infiltration systems.**

2.1.1. Soil testing. Soil testing is required in any location where an infiltration system is proposed to determine the seasonal-high water table and infiltration rate used for the design calculations.

2.1.2. System invert. The invert of infiltration systems shall be above the seasonal high water table for the proposed location.

2.1.3. Underground infiltration systems. Underground infiltration systems are to be filled with #57 washed stone or other suitable material and wrapped in non-woven geo-textile fabric. A sumped inlet or other suitable settling device shall be used to reduce introduction of fines into the system. Water shall be adequately distributed through the system using perforated plastic pipe or other commercially available underground infiltration chamber. The bottom of the infiltration system shall be a minimum of two feet above the seasonal high water table.

2.1.4. Infiltration time. The system shall be designed to completely draw down the design storage volume to the seasonal high water table under seasonal high water conditions within five (5) days. (Updated 5/22/2008)

2.1.5. Minimum Hydraulic Conductivity. Soils must have a minimum hydraulic conductivity of 0.52 inches per hour. (Updated 5/22/2008)

2.1.6. Overflow. The system shall have an overflow capable of conveying the 10-yr storm to an adequate outlet.

2.1.7. System Location. Infiltration systems shall be a minimum of 30 feet from surface waters and 50 feet from SA waters. (Updated 5/22/2008)

2.1.8. Observation/inspection Well. One observation well shall be inserted for each individual infiltration bed to provide for ready inspection of the system (Updated 5/22/2008)

2.1.9. Allowable Deviations from Carolina Division of Water Quality Stormwater Best Management Practices Manual. For properties that are 10,000 square feet or less that have a seasonal high water table at a level that makes it impractical to locate the bottom of the infiltration trench 2 feet above the water table, the engineer can request a waiver from the stormwater manager to install a system in which the bottom of the infiltration trench will be no less than 12” above the seasonal high water table. The waiver will be granted in writing and attached to the final stormwater engineering calculations. This is in keeping with the spirit and intent of the stormwater ordinance. (Updated 5/22/2008)

**2.2 Bio-retention Areas.**

2.2.1. Infiltration. If designed as an open infiltration basin, the infiltration system design criteria will apply.

2.2.2. Retention. If designed as a planted dry retention area, design drawdown of the temporary pool shall be 2-5 days. Drawdown in less than 2 days may be permitted if sufficient evidence is provided that 85% TSS removal is accomplished with the proposed design. (Updated 5/22/2008)

2.2.3. Plantings. Plantings shall be as recommend by a landscape architect, arborist, or urban forester as being appropriate to the area and tolerant of temporary ponding of water. Plantings are required to be maintained appropriately and replanted if necessary.

**2.3. Permeable Pavement.**

2.3.1. There are four types of permeable pavement that can receive credit when calculating the amount of impervious area during development and redevelopment:

- Pervious Concrete
- Permeable interlocking concrete pavers
- Pervious Asphalt
- Plastic grid reinforced grass pavement

(Updated 5/22/2008)

2.3.2. Credit. Areas using permeable pavement will be given credit such that a portion of the permeable pavement will not be included in impervious surface calculation for the purpose of this manual when installed in accordance with manufacturer's recommendations and properly maintained. Credit received for various permeable pavement systems will be determined with reference to the North Carolina Division of Water Quality's *Stormwater Best Management Practices Manual*. (Updated 5/22/2008)

2.3.3. Infiltration. Pervious concrete and asphalt may be used as an infiltration area to control runoff from other impervious surfaces. If used in this way, infiltration design criteria will apply. (Updated 5/22/2008)

**2.4. Gravel and Crushed Stone**. Because gravel and crushed stone introduces large amounts of fine particulate matter (suspended solids) into stormwater runoff, use of these surfaces is discouraged. In accordance with State standards, these types of surfaces will be considered impervious for the purposes of this manual. All redevelopment that changes the surface from an unconsolidated surface (e.g. gravel, crushed stone, etc) to a consolidated surface (i.e. concrete or asphalt) will be considered as meeting required quality control measures for the removal of fine particulate matter. However, additional BMPs may be required to comply with the removal of other suspended solids. (Updated 5/22/2008)

**2.5. North Carolina Department of Water Quality Methods.** Any methods and design criteria stipulated in the current edition of the North Carolina Department of Water Quality Stormwater Best Management Practices Manual capable of providing 85% TSS removal is permitted. Installed Best Management Practices (BMP) for stormwater control must adhere to the guidelines of the latest edition of the North Carolina Division of Water Quality Stormwater Best Management Practices Manual unless specific deviations are authorized in this manual or if a variance is granted in accordance with §50.150 of the Wrightsville Beach Stormwater Ordinance. (Updated 5/22/2008)

**2.6. Alternative Methods.** Alternative methods capable of providing 85% TSS removal may be considered on a case-by-case basis. (Updated 5/22/2008)

# SECTION 3 - DRAINAGE SYSTEMS Standards

## 3.1 Piped Drainage Systems.

3.1.1. Design Storm. Design shall be for the Wilmington 10-yr storm as currently reported by NOAA. Calculations may be based on Manning's equation for gravity flow in pipes or Bernoulli's equation for fluid flow. If Bernoulli's equation is used, the hydraulic grade line must remain below the rims of the inlets for the design storm.

3.1.2. Inlet Design. Inlets for public roads shall be designed so that gutter spread does not exceed 8 feet during the design storm.

3.1.3. Minimum Size. Minimum pipe size shall be 12".

3.1.4. Materials. Minimum of Class III Reinforced Concrete Pipe (RCP) shall be used for public systems. Reinforced concrete, high-density polyethylene, or corrugated metal pipe may be used for private systems.

3.1.5. Cover. Pipes shall be designed to support water loading. Minimum cover for public pipe systems and recommended cover for private RCP systems is 1 feet. Recommended cover for private systems using other materials is 2 feet.

3.1.6. Road Culverts. Culverts shall be designed for the 25-year storm and checked for both inlet and outlet control conditions.

3.1.7. Pipe Lengths. Manholes or inlets are required at all pipe junctions. Maximum spacing between drainage structures shall be 400 feet.

3.1.8. Easements. Systems carrying public drainage shall be located in the public right-of-way when possible. Any systems outside the public right-of-way will require a recorded easement calculated as follows, rounded to the nearest 5 feet increment, with a minimum width of 20 feet:

Width = 2 x depth + Diameter + 12 feet

The easement shall be contiguous to the public right-of-way.

3.1.9. Inlets. Inlets to piped systems shall be drainage structures, flared-end sections, or headwalls.

3.1.10. Outlets. Outlets shall be flared-end sections or headwalls and shall have an energy dissipation device sized for the 10-year event.

3.1.11. Velocity. Minimum velocity is 2.5 feet/second for the design storm.

3.1.12. Positive Drainage. All pipe systems shall have positive slope in the proposed direction of flow.

**3.2. Open Drainage Systems.**

3.2.1. Design Storm. Open channels shall be capable of conveying the 10-year storm within the proposed banks. Calculations may be based on Manning's equation for gravity flow in open channels or Bernoulli's equation for fluid flow.

3.2.2. Side Slopes. Maximum side slopes for vegetated channels shall be 3:1 (horizontal:vertical).

3.2.3. Channel linings. Channels shall be vegetated and analyzed to ensure that the maximum permissible velocity is not exceeded for the lining during the 10-year event. The maximum velocity shall be as established in the North Carolina Department of Environment and Natural Resources Land Quality Section.

3.2.4. Easements. Channels carrying public drainage shall be located in the public right-of-way when possible. Any systems outside the public right-of-way will require a recorded private drainage easement. The easement width shall include the entire channel (bank-to-bank), 5 feet minimum strip along one bank, and 15 minimum strip along the other bank. The 15 foot strip shall be contiguous to a public right-of-way.

3.2.5. Positive Drainage. All open drainage systems shall have positive drainage in the proposed direction of flow.

# SECTION 4 – Description Of Selected Best Management Practices (BMPs)

**4.1 General.** BMPs for stormwater control may be structural or non-structural. This section describes some of the best management practices that may be appropriate for stormwater management in Wrightsville Beach.

**4.2 Non-Structural Best Management Practices (BMPs).** There are very few non-structural BMPs which may be effective in controlling post-construction water quality at Wrightsville Beach due to the density of development and the limited parcel sizes. However, some non-structural BMPs which may assist in stormwater control include:

- Vegetated Conveyance Systems
- Disconnected Impervious Areas

4.2.1. <u>Vegetated Conveyance Systems</u>. Vegetated conveyances improve water quality by providing partial pollutant removal as water is filtered by vegetation and infiltrates into the soil. These systems may also help reduce flow velocities of stormwater runoff. Velocity must not be erosive according to the criteria established by the North Carolina Department of Environment and Natural Resources Land Quality Section.

4.2.1.1. Installation. Construct vegetated conveyance with triangular, trapezoidal, or parabolic cross section with a minimum side slope of 3H:1V. Stabilize the channel during construction either with a temporary grass cover or by using erosion control products until the turf has been established.

4.2.1.2. Inspection and Maintenance. The following are required inspection and maintenance measures:

- Maintain a dense, healthy grass cover; reseed and water as necessary.
- Mow periodically to heights above the design flow depth.
- Control for weeds.
- Minimize the application of pesticides/fertilizers.
- Remove sediment buildup.
- Repair all channel damage.

4.2.2. Disconnected Impervious Areas. This system involves directing stormwater runoff from impervious areas to pervious areas where it can infiltrate the soil and be filtered by vegetation. This system can be used to reduce runoff flow rates and provide water quality benefits in developed areas.

**4.3. Structural Best Management Practices (BMPs).** Structural water quality controls have demonstrated the ability to effectively treat runoff volume and assist in the reduction of pollutants discharged to downstream water bodies.

The following are some of the structural BMPs that may be used at Wrightsville Beach:

- Underground Detention Systems
- Bioretention Areas
- Infiltration trenches
- Pre-fabricated Control Devices
  - Separation Devices
  - Filtration Devices
- Vegetated Filter Strips
- Grass Pavers and Pervious Surfaces

4.3.1. Underground Detention.

4.3.1.1. Description. Underground detention systems consist of detention tanks and vaults which are used to attenuate peak storm water flows through detention of stormwater runoff. The design and material selections should consider the potential loading from vehicles on the vault or pipe. Due to the costs associated with construction and maintenance of underground detention systems, these systems are used when space is limited and there are no other practical alternatives.

4.3.1.2. Inspection and Maintenance. The following are required inspection and maintenance measures:

- Remove any trash/debris and sediment buildup in the underground vaults or tanks annually by pumping them out, or as directed by the manufacturer.
- Perform structural repairs to inlet and outlets as needed based on inspection results.

4.3.2. Bio-retention Areas.

4.3.2.1. Description. Bio-retention areas, also referred to as rain gardens, are designed to mimic natural forest ecosystems. They appear as landscaped or natural areas giving this BMP an appealing image. Bio-retention areas are designed to temporarily store water in a shallow pool. The stored water slowly filtered down through the planting soil layer and is absorbed by the plants. As the excess water filters through the system, it either infiltrates into the ground or is drained by an underdrain system. Bio-retention areas provide stormwater benefits through a combination of infiltration, adsorption of contaminants onto plant roots and soil particles, and transpiration by the plants.

Bio-retention areas are applicable for small sites where storm water runoff rates are low and are typically directed to the bio-retention area as sheet flow. The design should prevent excessive debris and sediment from collecting in the bio-retention area. This BMP is sensitive to fine sediments and should not be placed on sites where the contributing area is not completely stabilized or is periodically being disturbed.

4.3.2.2. Inspection and Maintenance. Regular inspection and maintenance is critical to the effective operation of bioretention areas. The surface of the ponding area may become clogged with fine sediments over time. Core aeration or cultivating unvegetated areas may be required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Conduct pruning and weeding to maintain appearance as needed.
- Replace or replenish mulch as needed.
- Remove trash and debris as needed.

4.3.2.3. Summary of Maintenance Requirements

| **Required Maintenance** | **Frequency** |
|---|---|
| Pruning and weeding | As needed |
| Remove trash and debris | As needed |
| Inspect inflow points for clogging. Remove any sediment | Semi-annual (every 6-months) |
| Repair eroded areas. Re-seed or sod as necessary | Semi-annual (every 6-months) |
| Mulch void areas. | Semi-annual (every 6-months) |
| Inspect trees and shrubs to evaluate their health | Semi-annual (every 6-months) |
| Remove and replace dead or severely diseased vegetation | Semi-annual (every 6-months) |
| Removal of evasive vegetation | Semi-annual (every 6-months) |
| Nutrient and pesticide management | Annual, or as needed |
| Water vegetation, shrubs and trees | Semi-annual (every 6-months) |
| Remove mulch, reapply new layer | Annual |
| Test planting mix for pH | Annual |
| Apply lime if pH < 5.2 | As needed |
| Add iron sulfate + sulfur if pH >8.0 | As needed |
| Place fresh mulch over entire area | As needed |
| Replace pea gravel diaphragm | Every 2 to 3 years if needed |

4.3.3. Infiltration Trenches.

4.3.3.1. Description. Infiltration trenches may be open basins or underground reservoirs filled with stone. The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a maximum period of 72 hours (three days), and eventually reaches the water table. By diverting storm water runoff into the soil, an infiltration trench not only treats the water quality volume, but it also preserves the natural water balance by recharging groundwater and preserving channel baseflow. Using natural filtering properties, infiltration trenches remove a wide variety of pollutants from the runoff through adsorption, precipitation, filtering, and bacterial and chemical degradation.

Infiltration trenches are limited to areas with highly porous soils where the water table and or bedrock are located well below the trench bottom. (Due to the water table at Wrightsville Beach, this BMP may not work for all parcels.) They are only applicable for soils that have a minimum infiltration rate of 0..5 inches per hour. Infiltration trenches are not intended to trap sediment and are designed with a sediment forebay or other pre-treatment measure to prevent clogging the gravel. They are most applicable for impervious areas where there are low levels of fine particulates in the runoff, the site is completely stabilized and the potential for possible sediment loads is very low. Infiltration trenches are designed to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches are adapted to many different types of sites and are utilized in retrofit situations. Unlike some water quality BMPs, infiltration trenches can easily fit into margin, perimeter or other unused areas of development sites.

4.3.3.2. Inspection and Maintenance. Regular inspection and maintenance is critical to the effective operation of infiltration trenches.

Typical maintenance responsibilities include:

• Keeping a record of the average de-watering time of the infiltration trench to determine if maintenance is required.

• Clear debris and trash from all inlet and outlet structures monthly.

• Check the observation well after three consecutive days of dry weather after a rainfall event. If complete de-watering is not observed within this period, there may be clogging within the trench requiring proper maintenance.

• Remove trees, shrubs, or invasive vegetation semi-annually if they interfere with the function of the infiltration basin.

- If complete failure is observed, perform total rehabilitation by excavating the trench walls to expose clean soil, and replacing the gravel, geotextiles, and topsoil.

4.3.3.3. Summary of Maintenance

| **Required Maintenance** | **Frequency** |
|---|---|
| Ensure that the contributing area is stabilized with no active erosion | Monthly |
| Grass filter strips should be mowed and grass clippings should be removed | Monthly |
| Wells should be empty after this time period. If wells have standing water, the underdrain system or outlet may be clogged | Semi-annual (every 6- months) |
| Remove evasive vegetation | Semi-annual (every 6- months) |
| Inspect pretreatment structures for deposited sediment | Semi-annual (every 6- months) |
| Replace pea gravel, topsoil and top surface filter fabric | When clogging or surface standing water is observed |
| Perform total rehabilitation of infiltration trench | Upon observed failure |

4.3.4. Pre-Fabricated Control Devices.

4.3.4.1. Description. Pre-manufactured products combine settling, filtration, and various biological processes into one controlled system. By combining these different processes, these BMPs are designed to focus on removing many different types and concentrations pollutants. Even where pre-fabricated control devices are not able to meet the 85 percent TSS removal goal alone, they can provide excellent pre-treatment in a series of water quality control BMPs. Post construction pre-fabricated storm water quality BMPs are designed to filter and trap trash, floatable contaminates, sediment, oil and grease, and other pollutants. These BMPs are incorporated into stormwater conveyance systems for pretreatment of stormwater runoff. In some instances, pre-fabricated storm water quality BMPs serve as the only treatment mechanism before the runoff is discharged. Post construction pre-fabricated storm water quality BMPs are normally classified in to three separate categories:

- Catch Basin Inserts
- Separation Devices
- Filtration Devices

Pre-fabricated control devices may be used to treat runoff as long as they are designed to treat the first 1 ½ inch of runoff and/or are proven to provide 85 percent TSS removal. Pre-fabricated control devices include the following beneficial attributes for water quality control over conventional water quality BMPs:

- Pre-fabricated control devices are placed almost anywhere on a site where they can receive concentrated flows from storm drainage pipes.
- Pre-fabricated control devises are safe to the public because storm water is treated within the unit and no surfaces are open to the environment, unlike the permanent pool detention pond or storm water wetland.
- Minimal on-site construction is required because pre-fabricated control devices are typically assembled before they reach the site.

(Updated 5/22/2008)

4.3.4.1.1. Catch Basin Inserts. Catch Basin Inserts are BMPs designed to be installed directly into storm drain catch basins to treat the runoff before it enters the primary conveyance system. There are three basic Catch Basin Inserts available: tray, bag, and basket. These inlets typically are made of a stainless steel or a high strength corrugated plastic frame that supports a sedimentation chamber and filter media designed to absorb specific pollutants such as oil, grease hydrocarbons, and heavy metals. Catch Basin Inserts sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events. Pollutant removal efficiencies are variable and highly dependent on storm frequency, influent pollutant concentrations, rainfall intensity and other factors. Catch Basin Inserts exhibit the following properties:

- Utilize settling, separation, swirling, centrifugal force, and filtering techniques to remove pollutants from storm water runoff.
- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.
- Have posted data from third party test results.

4.3.4.1.2. Separation Devices. Separation Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Separation Devices contain a sump for sediment deposition and a series of chambers, baffles, and weirs to trap trash, oil, grease and other contaminants. These BMPs are designed as flow-through structures where the inflow rate into the structure is regulated. These structures are not designed to store the entire water quality volume. Separation Devices sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events. Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity, and other factors. Separation Devices exhibit the following properties:

- Utilize settling, separation, swirling, and centrifugal force techniques to remove pollutants from storm water runoff.

- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.

- Have posted data from third party test results.

4.3.4.1.3. Filtration Devices. Filtration Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Filtration Devices are used in areas with impaired receiving waters where high pollutant removal efficiencies are required. Filtration Devices usually contain a sedimentation chamber and a filtering chamber. These devices may contain filter materials or vegetation to remove specific pollutants such as nitrogen, phosphorus, copper, lead, or zinc. Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity and other factors. Filtration Devices shall exhibit the following properties:

- Utilize filtering techniques to remove pollutants from storm water runoff.

- Have posted data from third party test results.

4.3.4.2. Installation. Installation shall be in accordance with the Manufacturer's written installation instructions and in compliance with all OSHA, local, state, and federal codes and regulations. A Manufacturer's representative is required to certify the installation of all post construction pre-fabricated storm water quality BMPs. Proper site stabilization is essential to ensure that post construction prefabricated storm water quality BMPs function as designed. These structures are not intended to trap eroded sediment from during construction operations. Post construction pre-fabricated storm water quality BMPs are the last storm water runoff structures installed on-site, or shall remain off-line until final stabilization is achieved.

4.3.4.3. Inspection and Maintenance. The following are required inspection and maintenance measures:

- Inspect and maintain in accordance with the Manufacturer's written recommendations.

- The specific maintenance requirements and schedule prepared by the Manufacturer is signed by the owner/operator of the BMP.

- Require frequent inspection and maintenance to maximize pollutant removal.

- Maintain BMPs at least bi-annually to ensure that the BMPs are working properly.

- Keep a maintenance log to track routine inspections and maintenance.

- Remove accumulated sediment and other trapped pollutants when the BMP becomes full.

4.3.4.4. Summary of Maintenance Requirements

| **Required Maintenance** | **Frequency** |
|---|---|
| Inspect separation and filtration units | Quarterly |
| Clean out sediment, oil and grease, and floatables. Manual removal of pollutants may be necessary | As needed |
| Perform requirements obtained from manufacturer | As needed |
| Inspections | Frequency of inspection and maintenance is dependent on land use, accumulated solids climatological conditions, and design of pre-fabricated device |

4.3.5. Vegetated Filter Strips.

4.3.5.1. Description. Vegetated Filter Strips (VFS) are zones of vegetation where pollutant-laden runoff is introduced as sheet flow. VFS may take the form of grass filters, grass filter strips, buffer strips, vegetated buffer zones, riparian vegetated buffer strips, and constructed filter strips.

Applicable in areas where filters are needed to reduce pollutant impacts to adjacent properties and water bodies. VFS are used to remove pollutants from overland sheet flow but are not effective in removing sediment from concentrated flows. There are two main classifications of VFS:

• Constructed filter strips: Constructed and maintained to allow for overland flow through vegetation that consists of grass-like plants with densities approaching that of tall lawn grasses.

• Natural vegetative strips: Area where pollutant-laden flow is directed in an overland manner, including riparian vegetation around drainage channels. Vegetation ranges from grass-like plants to brush and trees with ground cover.

VFS remove pollutants primarily by three mechanisms:

1. Deposition of bedload material and its attached chemicals as a result of decreased flow velocities and transport capacity. This deposition takes place at the leading edge of the filter strip.

2. Trapping of suspended solids by the vegetation at the soil vegetation interface. When suspended solids settle to the bed, they are trapped by the vegetated litter at the soil surface instead of being resuspended as would occur in a concentrated flow channel. When the vegetated litter becomes inundated with sediment, trapping no longer occurs by this mechanism.

3. Trapping of suspended materials by infiltrating water. This is the primary mechanism by which dispersed clay sized particles are trapped.

VFS effectiveness fluctuates considerably depending on vegetation type, vegetation height and density, season of the year, eroded particle characteristics, size of drainage area, and site topography.

4.3.5.2. Inspection and Maintenance. The following are required inspection and maintenance measures:

• Ensure that flow does not short circuit the practice.

• Inspect vegetation for rills and gullies annually and correct. Seed or sod bare areas.

• Inspect grass after installation to ensure it has established. If not replace with an alternative species.

• Inspect to ensure that grass has established annually. If not, replace with an alternative species.

• Mow grass to maintain a height of 3- to 4-inches.

- Remove sediment build-up from the bottom when it has accumulated to 25% of the original capacity.

4.3.5.3. Summary of Maintenance

| Required Maintenance | Frequency |
|---|---|
| Mow grass to maintain design height | Regularly (frequently) |
| Remove litter and debris | Regularly (frequently) |
| Inspect for erosion, rills and gullies and repair | Annual, or as needed |
| Repair sparse vegetation | Annual, or as needed |
| Inspect to ensure that grass has established. If not, replace with an alternative species | Annual, or as needed |
| Nutrient and pesticide management | Annual, or as needed |
| Aeration of soil | Annual, or as needed |

4.3.6. Grass Pavers and Porous Pavement**.** Porous pavement options include porous asphalt, pervious concrete, and grass pavers. The ideal application for porous pavement is to treat low-traffic or overflow parking areas. Since porous pavement is an infiltration practice, do not apply it on storm water hot spots due to the potential for ground water contamination.

4.3.6.1. Grass Pavers. Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. Grass pavers allow water quality benefits by allowing storm water to infiltrate into the underlying soils and by the filtering of storm water as it flows through the grass. Grass pavers provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces. Grass pavers should not be used for frequently traveled or parked in areas. Grass pavers reduce the runoff volume and extend the time of concentration for a particular site. Some pavers provide enough infiltration to be considered a pervious area.

4.3.6.2. Porous Paving. Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing storm water to infiltrate directly and receive water quality treatment, and also reducing runoff from the sit

4.3.6.3. Inspection and Maintenance:

- Porous pavement requires extensive maintenance compared with other practices.
- Avoid sealing or repaving with non-porous materials.
- Ensure that paving area is clean of debris, paving dewaters between storms, and that the area is clean of sediments monthly.
- Mow upland and adjacent areas, and seed bare areas as needed.
- Vacuum sweep frequently to keep the surface free of sediment as needed.
- Inspect the surface for deterioration or spalling annually.
- Perform high pressure hosing to free pores in the top layer from clogging as needed.

# SECTION 5 - SUBMITTALS

**5.1 Submittals for Installation Permit** (Updated 5/22/2008). One set of site plans shall be submitted to the Wrightsville Beach Public Works Stormwater Services Office and shall include the following:

5.1.1. EXISTING SITE DATA.

5.1.1.1 owner's name, address, and phone number

5.1.1.2. project name

5.1.1.3. boundary and topography survey map including 1-ft contours

5.1.1.4. general location map showing orientation of the project with relation to at least two references (numbered roads, named streams/rivers, etc.) and showing the receiving water (a USGS map preferable)

5.1.1.5. delineation of relevant boundaries including drainage areas, seasonal high water table, wetlands, property/project boundaries and drainage easements;

5.1.1.6. existing and proposed built-upon area including roads, parking areas, buildings, etc.

5.1.1.7. soil types and hydrologic group

5.1.1.8. existing tree types and sizes

5.1.1.9. soil test report, including infiltration rate and seasonal-high water table

5.1.1.10. any other information deemed necessary by Public Works

5.1.2. PROPOSED SITE IMPROVEMENTS. Narrative and supporting calculations describing:

5.1.2.1. impervious surface area

5.1.2.2. any required water quality features

5.1.2.3 any required drainage systems

5.1.2.4. adequate point of discharge to the public drainage system or waterway

5.1.2.5. proposed grades in 1-ft increments

5.1.2.6 technical information showing all pre-installation numbers, calculations, assumptions, drawing and procedures associated with the stormwater management measures including but not limited to: built-upon area, runoff coefficients, runoff volume, runoff depth, flow routing, inlet and outlet configuration (where applicable), other applicable information as specified. (Updated 5/22/2008)

**5.2 Submittals for Discharge Permit.** The following documents and information shall be submitted to the Wrightsville Beach Public Works Stormwater Services Office:

5.2.1. two sets of detailed "as-built" plans and specifications for the project in paper copy and one copy of the plans in electronic format. (The electronic plans can be in either CAD or PDF format.) Plans and specifications must be dated and sealed, showing the revision number and date

5.2.2. technical information showing all final numbers, calculations, assumptions, drawing and procedures associated with the stormwater management measures including but not limited to: built-upon area, runoff coefficients, runoff volume, runoff depth, flow routing, inlet and outlet configuration (where applicable), other applicable information as specified;

5.2.3. certification that completed project is in accordance with approved stormwater management plans and designs

5.2.4. operation and maintenance plan signed by responsible party;

5.2.5. recorded deed restriction and protective covenants.

# SECTION 6 – PLAN REVIEW PROCESS

The design engineer will need to prepare both a "concept" plan, and a final stormwater management plan. The concept plan identifies basic site information, locations of proposed development features, and preliminary locations and sizing of stormwater treatment practices. The final plan provides more detailed design information for stormwater practices, and includes much greater detail in terms of hydrologic conditions and site features. The concept plan is also typically reviewed in conjunction with a preliminary plan or site plan. The following steps can help in this process:

*Step 1. Determine what permits are required for this site, and what waivers are applicable?*

No land owner or land operator will receive any of the building, grading or other land development permits required for land disturbance activities without first meeting the requirements of the stormwater ordinance prior to commencing the proposed activity. Unless otherwise excepted by the ordinance, a permit application must be accompanied by all items in Section 5 of this manual in order that the permit application be considered.

*Step 2. Review the plan to determine if it incorporates Better Site Design techniques to meet stormwater objectives.*

The items required in Section 5 of this manual can assist in this process.

*Step 3. Ensure the selected practices are appropriate for the site.*

Given the building density of Wrightsville Beach, ponds, wetlands and wet swales are not considered viable stormwater treatment practices. Filters may be used in most cases and infiltration will depend on the particular parcel.

*Step 4. Ensure the practices are designed to meet minimum performance criteria.*

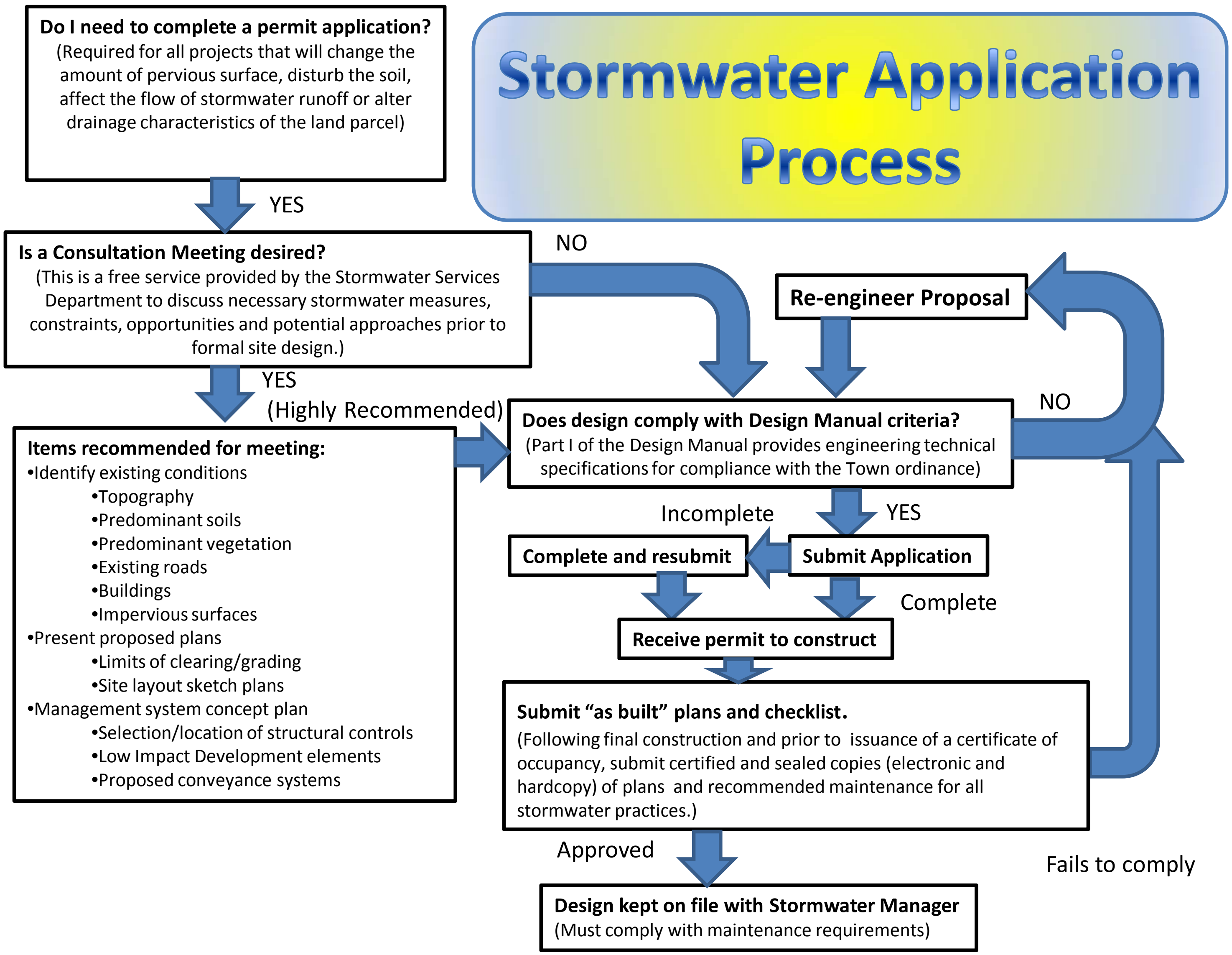
Ensure sizing of the stormwater treatment practices will prevent flooding and meet pollutant removal goals.

*Step 5. Ensure the Plan meets other resource protection requirements.*

Ensure the plan complies with CAMA regulations, the Town Land Use Plan and New Hanover County's Soil and Erosion Control ordinance.

*Step 6. Ensure the As-Built Designs satisfy construction specifications.*

*Step 7. Ensure provisions for long-term maintenance are addressed.*


Stormwater Application Process
Do I need to complete a permit application?
(Required for all projects that will change the amount of pervious surface, disturb the soil, affect the flow of stormwater runoff or alter drainage characteristics of the land parcel)
YES
Is a Consultation Meeting desired?
(This is a free service provided by the Stormwater Services Department to discuss necessary stormwater measures, constraints, opportunities and potential approaches prior to formal site design.)
NO
YES
(Highly Recommended)
Items recommended for meeting:
•Identify existing conditions
•Topography
•Predominant soils
•Predominant vegetation
•Existing roads
•Buildings
•Impervious surfaces
•Present proposed plans
•Limits of clearing/grading
•Site layout sketch plans
•Management system concept plan
•Selection/location of structural controls
•Low Impact Development elements
•Proposed conveyance systems
Re-engineer Proposal
Does design comply with Design Manual criteria?
(Part I of the Design Manual provides engineering technical specifications for compliance with the Town ordinance)
NO
Incomplete
YES
Complete and resubmit
Submit Application
Complete
Receive permit to construct
Submit “as built” plans and checklist.
(Following final construction and prior to issuance of a certificate of occupancy, submit certified and sealed copies (electronic and hardcopy) of plans and recommended maintenance for all stormwater practices.)
Approved
Fails to comply
Design kept on file with Stormwater Manager
(Must comply with maintenance requirements)

# APPENDIX A – GLOSSARY

BEST MANAGEMENT PRACTICES (BMPs) – Techniques designed to reduce the impact of stormwater runoff. These can be structural or non-structural features designed to protect water quality, protect downstream areas from flooding, or both.

PRE-DEVELOPMENT CONDITION - The pre-development condition is the condition of the site prior to the currently proposed development.

TOTAL SUSPENDED SOLIDS (TSS) - Particles suspended in stormwater runoff which typically originates from erosion of construction sites or build-up on impervious surfaces during dry periods. When deposited in receiving water, these sediments may limit light penetration or upset aquatic reproductive processes. Other pollutants often become attached to suspended solids and are carried in stormwater run-off; therefore; a suspended solids measurement is often used as a primary indicator of stormwater pollution[1].

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[1] Akan, A.O, Houghtalen, R.J., Urban Hydrology, Hydraulics, and Stormwater Quality, 2003, John Wiley & Sons, Inc., Hoboken, NJ.