Town of Fort Mill, South Carolina

Stormwater Utility Fee Credit Manual

October 2014

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1.0 Introduction

In June 2014, the Town of Fort Mill's Council adopted a Stormwater Utility to fund the Town's stormwater management program. The utility will provide the Town with the authorization to establish and collect fees for the stormwater services provided by the Town. The utility will provide a dedicated funding source for addressing stormwater related issues such as flooding, erosion and water quality problems.

It is the intent of the Town of Fort Mill to encourage property owners to proactively manage stormwater on their property by incorporating sustainable stormwater management practices that offset, to some extent, the negative impact of land development on the drainage system.

By establishing a fee credit process, the Town may make an adjustment to the utility fee paid by any property owner that provides value-added stormwater management activities that support and complement the Town's stormwater management efforts.

The following goals were established for the development of the credit policy:

- to provide an incentive to Town property owners to reduce their stormwater utility bills;
- to encourage property owners to incorporate sustainable stormwater management practices on their properties;
- to be easy for property owners to use and not overly complicate the stormwater utility fee billing system; and
- to enhance the equity of the stormwater utility fee's rate structure.

The purpose of this manual is to describe policies set forth by the Town of Fort Mill concerning stormwater utility fee credits (the credit).

1.1 Stormwater Management

In the Town of Fort Mill, as in other municipalities, the large amount of impervious surface (hard surfaces, such as buildings areas, asphalt, cement, and heavily compacted areas) reduces the amount of stormwater that could be naturally absorbed under natural conditions. The runoff from these areas transports materials such as de-icing salt, metals & petrochemicals from cars, excess fertilizer, pet waste and trace amounts of other common chemicals to receiving bodies of water. This is a major source of water pollution in urban areas. In an urban environment, the amount of impervious area on a property is the most significant factor affecting the quality and quantity of stormwater runoff.

The increase in runoff produced by developed properties creates a variety of negative impacts on both the stormwater drainage system and natural drainage ways through:

- Increasing peak discharge rate;
- Increasing total volume of runoff; and
- Increasing pollutant loadings.

Large or intense storm events or rapid snowmelt can produce significant quantities of runoff from urban areas with high levels of impervious surfaces. For example, it was calculated that a one-inch rainfall event on a one-acre meadow would produce 218 cubic feet of runoff, while a parking lot the same size would produce 3,460 cubic feet. As excessive amounts of runoff are conveyed rapidly from the urban landscape and discharged to receiving streams, downstream flooding and channel erosion can occur. As runoff flows over areas altered by development, it also picks up harmful sediment and chemicals such as oil and grease, pesticides, heavy metals, and nutrients. These pollutants become suspended in runoff and are carried to receiving waters. Once deposited, these pollutants enter the food chain through small aquatic life, eventually entering the tissues of fish and humans.

Stormwater Management is the practice of managing stormwater runoff in order to avoid water quantity and quality problems. By mapping, planning, constructing, operating, cleaning, regulating and maintaining natural and constructed stormwater management facilities, the Town reduces the adverse effects of stormwater and improves the quality of groundwater, streams, rivers, and lakes in and around the Town.

1.2 Stormwater Utility

In order to provide a stable source of funding for the Town to provide stormwater services, which benefit all citizens, the Town has established a stormwater utility. A stormwater utility is administered similar to a water or sewer utility.

Since impervious area is the single most important factor affecting the peak rate of runoff, the total volume discharged, and pollutant loadings of stormwater that flows from a property, property owners pay a fee that is directly proportional to the amount of impervious surface found on their properties.

The Town defines an impervious area as any area composed of any material that significantly impedes or prevents the natural percolation of water into soil. Common impervious surfaces include, but are not limited to, roof tops, sidewalks, walkways, patio areas, driveways, parking lots, storage areas, brick or concrete pavers, compacted gravel surfaces (roads, driveways, parking, and storage areas), and other surfaces which prevent or significantly impede the natural infiltration of storm water into the soil.

The Town measures the amount of impervious surface using the number of **Equivalent Residential Unit (ERU)** per property. **As the billing unit, one ERU is equal to the median amount of impervious area found on a typical single-family residential property.** It was found that a typical single-family residential property in the Town contains approximately 3,473 square feet of impervious area. Therefore, one ERU equals 3,473 square feet of impervious area.

All single-family residential properties are charged one ERU. Other properties are charged in proportion to this billing unit based on the calculated number of ERUs for the existing impervious area multiplied by the ERU rate. For example, if your property has four (4) times the amount of impervious area of one ERU, you will be charged four (4) times the base rate of $xxx per month (i.e. 4 ERUs or $xx). This billing methodology is typical for other stormwater funding programs in the United States.

1.3 Credit Options

As part of the Stormwater Ordinance, a provision was made for the Stormwater Management Utility Fee structure to offer a system of adjustments, or credits, to the fee for properties that implement **Stormwater Control Measures (SCMs). A SCM is an activity, measure or facility that prevents or reduces the flow of pollutants and reduces stormwater runoff (peak flow rate and/or total volume discharged) to the stormwater drainage system or surrounding bodies of water.** These measures can include onsite practices such as bioretention and ponds that manage stormwater at its source or offsite activities such as participating in the Town's Adopt-A-Stream program.

A credit is an ongoing reduction in the amount of stormwater fees assessed to a parcel in recognition of on-site systems, facilities, or other activities taken to reduce the impact of stormwater runoff, in compliance with this manual. Property owners may qualify for credit when they can demonstrate that their existing or new stormwater facility provides cost savings the Town would otherwise incur as part of Town stormwater management efforts.

Table 1-1 summarizes the potential credits available to property owners within the Town of Fort Mill. Each credit is explained in further detail later in this manual.

Table 1-1: Summary of the Town of Fort Mill Potential Stormwater Utility Credits

Type	Term	Potential Credit	Applications Need to be Prepared by a Qualified Individual*?
Structural SCM Credits			
Specific SCM Credits			
Rain Barrel Credit	Bi-annually	Up to 20% per ERU	N
Rain Garden Credit	Annually	Up to 25%	N
Impervious Surface Reduction Credit	Annually	Up to 25%	N
Pervious Pavement Credit	Annually	Up to 25%	Y
Vegetated Filter Strip Credit	Annually	Up to 25%	Y
Peak Discharge Rate Reduction Credit	Annually	Up to 30%	Y
Runoff Volume Reduction Credit	Annually	Up to 50%	Y
Quality Treatment Credit	Annually	Up to 10%	Y
Non-Structural SCM Credits			
Low Impact Parcel Credit	Annually	Up to 20%	N
Watershed Stewardship Credit	Annually	Up to 10%	N
Education Credit	Annually	Up to 25%	N
Individual NPDES Permit Credit	Permit Term	Up to 20%	N

**Calculated report needs to be signed and sealed by a registered professional engineers or a landscape architects*

The Town will evaluate each case individually in determining the appropriate level of credit. Before submitting an application, we encourage you to contact the Town with questions regarding eligibility.

In addition to describing those activities which may qualify for a credit, this manual outlines the basis for determining the extent of the credit, the procedure by which the policy is to be administered, and the conditions required to remain eligible for a stormwater utility fee credit.

1.4 Definitions

Bioretention is the process in which contaminants and sediment are removed from stormwater runoff. Stormwater is collected into the treatment area which consists of a grass buffer strip, sand bed, ponding area, organic layer of mulch layer, planting soil, and plants. Runoff passes first over or through a sand bed, which slows the runoff's velocity and distributes it evenly along the length of the ponding area. Water is ponded to a depth of approximately 6 inches and gradually infiltrates into the bioretention area or is evapotranspired. Stored water in the bioretention area exfiltrates over a period of days into the underlying soils. Rain gardens are a bioretention technique.

Bioswales are landscape elements designed to remove silt and pollution from surface runoff. They consist of a swaled drainage course with gently sloped sides and filled with vegetation, compost and/or riprap. The water's flow path, along with the wide and shallow ditch, is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt. Biological factors also contribute to the breakdown of certain pollutants. A common application is around parking lots, where substantial automotive pollution is collected by the paving and then flushed by rain. The bioswale, or other type of biofilter, wraps around the parking lot and treats the runoff before releasing it to the storm sewer.

Credit means on-going reductions in the stormwater service charge applicable to a given property in recognition of onsite or off-site systems, facilities, measures, or other actions taken by property owners to reduce or mitigate the impact of their property(s) or actions on the quantity or quality of stormwater run-off that would otherwise be managed in the public system. Credits shall be conditioned on the continuing performance of the systems, facilities, measures, or other actions in reference to standards adopted by the Town Council upon which the credits are granted, and may be revised or rescinded.

Design Storm refers to a rainfall event of a certain size or intensity, duration, and return frequency that is used to calculate the peak stormwater discharge. For example, a 10-YR storm refers to a rainfall event expected to occur an average of once every 10 years or an event which has a 10% chance of occurrence within any given year.

Equivalent Residential Unit (ERU), also referred to as equivalent runoff unit, is the average amount of imperious surface area, which is 3,473 square feet, on a single-family residential property in the Town of Fort Mill. 3,473 square feet is the statistical median value for impervious surface area on a single family parcel in the Town of Fort Mill. The stormwater fee is based on the number of ERU for each parcel.

Impervious Surface is a surface composed of any material that significantly impedes or prevents the natural percolation of water into soil, which includes, but is not limited to, rooftops, buildings, streets and roads, and standard concrete or asphalt surface.

Land Development is any land change, including, but not limited to, clearing, digging, grubbing, stripping, removal of vegetation, dredging, grading, excavating, transporting and filling of land, construction, paving, and any other installation of impervious cover.

Maintenance Agreement is a written agreement providing for the long-term inspection and maintenance of stormwater management facilities and practices on a site or with respect to a land development project, which, when properly recorded in the deed records of the York County Courthouse constitutes a restriction on the title to a site or other land involved in a land development project.

Peak discharge is the maximum rate of flow for water entering or exiting a drainage system or stormwater facility. Discharge is typically measured in cubic feet per second (cfs) and associated with a specific design storm.

Post-Developed Conditions means the conditions which exist following the completion of the land disturbing activity in terms of topography, vegetation, land use and rate, volume or direction of stormwater runoff.

Pre-Developed Conditions means the conditions which existed prior to the initiation of the land disturbing activity in terms of topography, vegetation, land use and rate, volume or direction of stormwater runoff.

Property owner is the person or entity financially responsible for the stormwater fee associated with a given account and the stormwater facility to be credited.

Stormwater means the run-off from precipitation that travels over natural or developed lands to the nearest stream, other conduit, or impoundment and appears in lakes, rivers, ponds, or other bodies of water.

Stormwater Control Measures (SCMs) is an activity, measure or facility that prevents or reduces the transport of pollutants and reduces stormwater runoff (peak flow rate and/or total volume discharged) to the stormwater drainage system or surrounding bodies of water.

Stormwater Fee is the charge established by the Town to cover the cost of operating the Town's Stormwater Utility. The charge is based on the impervious surface area associated with the property and the average impervious surface area for a single-family residential property within the Town limits (Equivalent Residential Unit – ERU).

Stormwater Management is the practice of managing stormwater runoff in order to avoid water quantity and quality problems.

Peak Flow Reduction Best Management Practices are the use of physical stormwater management controls, such as detention ponds, to reduce the post-development peak runoff rates. The use of low impact development techniques, such as impervious footprint reduction and the use of green infrastructure, may also reduce peak runoff rates from developed properties.

Pervious Pavements are a range of materials and techniques for paving roads, cycle paths, parking lots and pavements that allow the movement of water and air around the paving material. Although some porous paving materials appear nearly indistinguishable from traditional nonporous materials, their environmental effects are qualitatively different. Whether pervious concrete, porous asphalt, paving stones or bricks, all these pervious materials allow precipitation to percolate through areas that would traditionally be impervious.

Rain Barrels are used to collect, store, and reuse rooftop runoff from rainfall events that would otherwise drain directly to the stormwater system or streams. The collected rainwater can be used to water plants, trees or lawns during dry periods. The barrels are connected directly to downspouts for collection. The storage capacity is typically 50 gallons or more. The barrels are equipped with spigots for release of the stored water. This process is also referred to as rainwater harvesting.

Rain Gardens are landscaped areas built in a depression that are designed to capture and filter stormwater runoff from a roof or other impervious surface. The plants and soil of the rain garden provide an easy, natural way of allowing stormwater from individual properties to soak into the ground (as opposed to flowing into storm drains and surface waters which causes erosion, pollution, flooding, and diminished groundwater).

Total Volume Reduction Best Management Practices are the use of infiltration techniques to reduce post-development runoff volumes. The use of low impact development techniques, such as impervious footprint reduction and the use of green volumes from developed properties.

Water Quality Best Management Practices, as used in this context, would be for projects that target the removal of specific pollutants form stormwater runoff and that provide general stormwater pollution prevention awareness through educational activities, such as drain marking events.

1.5 List of Acronyms

BMP Best Management Practice
ERU Equivalent Residential Unit
EPA US Environmental Protection Agency
LID Low Impact Development
MS4 Municipal Separate Storm Sewer System
NPDES National Pollutant Discharge Elimination System
SCDHEC South Carolina Department of Health and Environmental Control
SCMs Stormwater Control Measures

2.0 General Policies

This section outlines the general policies for stormwater utility credits.

2.1 Eligibility

Any property that is subject to the stormwater utility fee may be eligible for a reduction in the fee through stormwater fee credits. In order for a property to be eligible to receive a stormwater fee credit, the credit must apply to developed land containing a Town-approved **Stormwater Control Measure (SCM)** eligible for the credit. These measures can include on-site practices such as rain gardens, bioretention cells, vegetated swales, and other practices that manage stormwater at its source.

Credits are available to all qualifying SCMs, whether constructed before or after initiation of the Town's stormwater utility.

Accounts with past-due balances shall not be eligible to apply for stormwater fee credits. Credited accounts not paying stormwater charges will be deemed ineligible, resulting in revocation of credits.

2.2 Transfer of Credit

The stormwater credits issued applies only to the property owner. Credits do not transfer when ownership changes**. A new application must be submitted by the new property owner(s) to continue receiving the credit.**

2.3 Coverage

Credits will only be allowed for the portion of the impervious area that is in the drainage area of a qualifying stormwater control facility. The following formula will determine the amount of credit earned by a SCM:

Credit Earned = (% Credit eligible for a SCM) * (Stormwater Fee) * (% of impervious area treated)

For example, if a site has a detention pond installed which qualifies the site for a 10% credit towards its Stormwater Utility fees, but only 60% of the impervious area on the site drains to the pond, then the site can only be granted a 6% credit (10%*60%).

2.4 Credit Limit

Property owners can apply for credits from any or a combination of the categories listed in this manual. **The maximum allowable credit is 70% of the gross billing amount**, **regardless of how many individual credits for which the property qualifies.** It is based on the concept that even if all property owners were able to mitigate the impacts of impervious surfaces on their properties, the Town would still have to maintain the drainage system associated with public properties and incur cost for programs mandated by the NPDES MS4 permit, such as routine system inspection and maintenance, illicit discharge detection and elimination, and construction site inspections.

2.5 Community Requirements

A stormwater fee credit is only applicable for Stormwater Control Measures (SCMs) that are allowed by the member community in which the property is located. **SCMs must meet all applicable building,**

subdivision and planning, zoning code requirements of member communities including downspout disconnection, landscaping, and property setbacks requirements.

2.6 Application Procedure

To apply for a credit, the property owner or his/her representative must submit a completed Credit Application Form (**Appendix A**) and a Right-of-Entry form (**Appendix C**) to the Stormwater Utility. To be considered complete, all applications must include all required owner contact information, property information, the "type" of credit selected, and a brief description of the proposed credit. It is recommended that you provide all supporting calculations, plans, sketches, photos, and other documentation which may assist the Stormwater Department in reviewing the credit application. All credits will be verified by the Stormwater Department to ensure compliance with this manual.

Applications must be submitted before May 1 and approved by August 1 in a given year for any awarded credits to be applied on the next billing cycle. The Town will issue a letter of acceptance or denial of the credit renewal request within 30 business days. Denied requests may be resubmitted addressing Town comments and must be received no later than 5:00pm on July 1.

2.7 Maintenance Requirements

All stormwater management facilities require proper maintenance in order to perform as designed and to prevent a public nuisance. A property owner must agree to adhere to an approved and executed inspection and maintenance plan for the SCM which qualifies for the credit.

For new or retrofitted SCMs, the maintenance agreement (**Appendix D**) provided as part of the plan review and approval process will provide the maintenance plan for the SCM(s) and should be submitted as part of the credit application. For existing SCMs, a maintenance agreement will need to be submitted and approved as part of the credit application process.

In addition to providing the proper inspection and maintenance for the SCM, the recipient of a stormwater credit is responsible for notifying the Town in writing if the SCM is compromised or damaged in any way. The Town should also be notified in writing of any work that takes place (repair or alteration) that will impact how the SCM operates.

2.8 Renewal

The terms of credits vary from 1 to 5 years, depending on the type of credit. At the end of the credit term, the credit will automatically expire. It is the property owner's responsibility to insure that an application is made prior to the credit expiring. The property owner must submit the Town's renewal application to continue to receive credits. Failure to submit renewal information by the required deadline, May 1, will result in elimination of the credit.

The required documentation consists of the following:

- Renewal Form (**Appendix B**)
- Inspection report(s).
- Recently dated photographs showing the condition (including any known damage) of a SCM.

- Records demonstrating that required maintenance activities and/or repairs have been completed.

2.9 Inspections

Each property owner that has applied for and received a credit for a SCM has the responsibility to inspect and repair their SCM to ensure that it is functioning as credited. In addition, the Town reserves the right to inspect the SCM receiving a credit and audit inspection/maintenance records from property owners at any time. As a condition of receiving a credit, a property owner must agree to allow the Town unrestricted Right-of-Entry or an easement to inspect the SCM(s) associated with the stormwater fee credit.

2.10 Enforcement

If a facility exhibits the need for repair or maintenance, a Notice of Violation will be sent to the property owner stating that improvements and/or corrections need to be made. If adequate improvements and/or corrections to the facility are not completed or addressed within the time frame specified in the Notice of Violation, the forthcoming credit will be forfeited. No future credit will be considered for the next five years for the subject property.

If the field inspection proves that any of the annual documentation submitted for continuation of the credit is not accurate, the credit will be immediately forfeited. No future credit will be considered for the next five years for the subject property.

3.0 Stormwater Fee Credit Options

This section provides an overview of credit options for all property owners. The credit amount will be determined based on the type of SCM and percentage of the impervious area of the site that drains to the SCM. **The maximum allowable credit is 70% of the gross billing amount**, regardless of how many individual credits for which the property qualifies. This may be achieved through the use of one or more features or activities eligible for a stormwater credit under the stormwater credit policy, but under no circumstances shall the total credit exceed the maximum stormwater fee credit established by Town Council. The property owner must show that a Town-approved SCM has been effectively implemented on the property to maintain the credit.

It should be noted that the Town wishes to encourage the installation of these types of SCMs to increase the effectiveness of the utility. Instead of a blanket 'one size fits all' approach, the Town has determined that it would be better for the individual property owner to determine what kinds of SCMs they desire. Property owners seeking a credit may request unique opportunities of approaches to improving on-site stormwater management. The Stormwater Manager will review and evaluate these types of unique requests on a case-by-case basis to determine the credit value for a site to which the SCM is being applied. In each case, the Town will be using the EPA, DHEC or other published industrial standards on stormwater management technologies to evaluate the SCM and its eligibility.

In addition, this manual is not meant to replace the services of experienced, professional installers. It is recommended that a qualified installer be consulted for applications using any of these options to ensure desired results.

3.1 Structural SCM Credits

There are a wide variety of structural SCMs in use for stormwater management. Structural SCMs include engineered and constructed systems that are designed to reduce the stormwater runoff issues mentioned in **Section 1** (peak discharge rate, volume and quality) flowing from their properties to the stormwater system or surrounding water bodies. This section outlines the Town-approved structural SCMs that may be qualified for Structural SCM Credits.

3.1.1 Specific SCM Credit

3.1.1.1 Rain Barrel (Full Credit: 20%)

Rain barrels are used to collect, store, and reuse rooftop runoff from rainfall events that would otherwise drain directly to the stormwater system or streams. The collected rainwater can be used to water plants, trees or lawns during dry periods. The barrels are connected directly to downspouts for collection. The storage capacity is typically 50 gallons or more. The barrels are equipped with spigots for release of the stored water. This process is also referred to as rainwater harvesting.

A full credit of 20% is available for every 50-gallon rain barrel installed per ERU. For example, a residential house has one ERU and therefore is qualified for a 20% credit for the stormwater fee if a 50-gallon rain barrel is installed on this property. A commercial property that has 4 ERUs will be qualified for a 5% credit (20%/4) for each 50-gallon rain barrel installed.

Credit may be approved if the following criteria are met:

- The minimum capacity acceptable shall be 50 gallons.
- Rain barrels must be covered with a lid or fine mesh screen that prevents mosquitoes from entering the storage container.
- Water shall not be allowed to stand in the barrel for more than seven days.
- Rain barrels must be equipped with an overflow or bypass mechanism to divert rainwater to the storm drainage systems when the storage structure is full. These mechanisms cannot cause erosion or property damage.
- Stormwater overflows from rain barrels or the draining of rain barrels must be directed to appropriate outlets to the storm drainage system or to vegetated areas, and away from neighboring properties, sidewalks, steep slopes, or retaining walls.

Rain barrels need to be maintained according to the schedule specified in **Table 3-1**:

Table 3-1: Maintenance Activities for Rain Barrels

Activity	Schedule
Clean roof and gutters to reduce debris	As Needed
Remove any debris that has accumulated on the lid that might block the screen mesh. Clear off any screens.	As Needed
Clean the inside of the rain barrel. Check the over-flow hose and connections to ensure the barrel is in proper working condition.	Routinely
Check any hoses associated with the rain barrels to clear any debris.	Routinely
To winterize, disconnect and return the downspout to its original configuration. Remove the hoses and mesh screen and store them. Make sure to drain the container to prevent it from freezing and cracking. If possible, store it upside down, so no water or materials will be able to enter.	Annually/As Needed

Interesting Fact about Rain Barrels: *1-inch of rain on a 1,000 sqft yields 623 gallons of water. Calculate the yield of your roof by multiplying the square footage of your roof by 623 and divide by 1,000. Depending on your roof area, a rain barrel can fill up when there has been as little as 1/10th-*

inch of rain. To collect twice this volume from the same downspout, connect the overflow hose from the first rain barrel to a second rain barrel.

3.1.1.2 Rain Garden (Full Credit: 25%)

Rain gardens or bioretention areas are landscaped areas built in a depression that are designed to capture and filter stormwater runoff from a roof or other impervious surface. They are landscaped with native plant species to add aesthetic value to a property while simultaneously recharging groundwater supplies and providing onsite treatment and storage of stormwater runoff. The plants and soil of the rain garden provides an easy, natural way of allowing stormwater to soak into the ground (as opposed to flowing into storm drains and surface waters which causes erosion, pollution, flooding, and diminished groundwater).

To obtain this credit, the rain garden must meet the following criteria:

- At least 25% of a property's impervious surface area must drain to the rain garden.
- Stormwater overflows from the rain garden must be directed to appropriate outlets or areas and away from neighboring properties, sidewalks, steep slopes, or retaining walls.
- The rain garden must be sized and constructed according to the Rain Garden Manual from Clemson Public Service (see **Appendix E**). Any alternate design must be pre-approved.

Rain gardens must be maintained to ensure continued function according to tasks listed in **Table 3-2**. The credit application and renewal processes will require documentation (including photographs) to demonstrate that the rain garden was built to standard and continues to function as approved. Rain gardens need to be maintained in accordance with the guidelines in the table below:

Table 3-2: Maintenance Activities for Rain Gardens

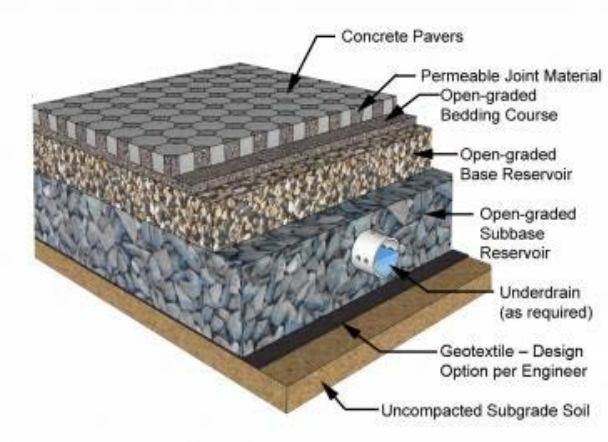
Activity	Schedule
Mulch void areas	As needed
Treat diseased trees and shrubs	As needed
Mow turf areas	As needed
Water plants daily for 2 weeks	At project completion
Inspect soil and repair eroded areas	Monthly
Remove litter and debris	As needed
Remove and replace dead and diseased vegetation	Twice per year
Add mulch	Once per year
Replace tree stakes and wires	Once per year

3.1.1.3 Impervious Surface Reduction (Full Credit: 25%)

The Town desires to promote the reduction of impervious cover in the watersheds in Town and has developed this credit for all property owners who voluntarily choose to reduce the amount of existing impervious surface on their properties. The removal of impervious surfaces from a property will result in a reduction of runoff and will therefore be eligible for a credit.

A property owner who can show that he/she has removed at a minimum of 10% AND no less than 300 Square Feet (sqft) of the existing impervious surfaces on the property and replaced it with a vegetated or other type of pervious surfaces shall qualify for a credit up to 25%.

3.1.1.4 Pervious Pavement (Full Credit: 25%)



Pervious pavement is designed to allow percolation or infiltration of storm-water through the surface into the soil below where the water is naturally filtered and pollutants are removed. Pervious pavement may include paving blocks, grid pavers, or pervious concrete. Pervious pavements can be used for driveways and patios with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the soil below the stone reservoir. Runoff is infiltrated directly into the soil and improves water quality. Compacted gravel driveways are not considered a type of pervious pavement and are not available for any stormwater fee credit.

Credit may be approved if the following criteria are met:

- The pervious pavement is installed for the purpose of runoff infiltration.
- Area of pervious pavement is at least 1,000 square feet.
- The installation meets the local building and zoning standards for driveway installations.
- The pervious pavement must be sized and constructed according to the SCDHEC Structural Control Design Standards (see **Appendix F**). Any alternate design must be pre-approved.

Pervious pavement needs to be maintained in accordance with the guidelines in the table below:

Table 3-3: Maintenance Activities for Pervious Pavement

Required Maintenance	Frequency
Ensure pervious pavement system is draining and there are no visible signs of standing water on the surface.	As Needed
Do not apply salt or sand during winter months.	Winter Months
Use a professional vacuum service to remove sediment accumulation and organic debris on the pavement surface.	Annually
Remove accumulated leaves and debris from pavement surface	In Fall/As Needed

Application for this credit must be prepared by a qualified individual who is a licensed professional engineer or landscape architect.

3.1.1.5 Vegetated Filter Strip (Full Credit: 25%)

Vegetated filter strips are uniform strips of dense turf, meadow grasses, trees or other vegetation with a minimum slope to treat the water quality of small sheet flows from impervious surfaces.

Credit may be approved if the following criteria is met:

- The vegetated filter strip has enough capacity to treat at least 50% of the property's impervious area.
- Filter strips are fully vegetated and vegetation is healthy and there are no areas of bare soil or mulch.
- Filter strips must be at least 50 feet long and 10 feet wide with slopes less than 5%.
- Runoff from roof downspouts must be dispersed using splash block.
- The vegetated filter strip must be sized and constructed according to the SCDHEC Structural Control Design Standards (see **Appendix F**). Any alternate design must be pre-approved.

The vegetated filter strip needs to be maintained according to the guidelines in table below:

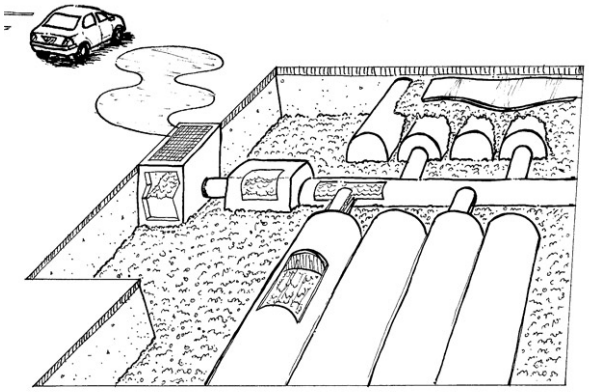
Table 3-4: Maintenance Activities for Vegetated Filter Strip

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

Application for this credit must be prepared by a qualified individual who is a licensed professional engineer or landscape architect.

3.1.2 Stormwater Peak Rate Reduction Credit (Full Credit: 30%)

Peak Rate Reduction Credit is available to property owners who have Town-approved SCMs that reduce the peak rate of stormwater runoff discharged from the property owner's property. **Only the impervious surfaces of a particular site that drain through the SCM are eligible for a credit.**



Detention basins are designed to intercept a volume of storm water, temporarily impound the water and release it shortly after the storm event. The main purpose of a detention basin is quantity control by reducing the peak flow rate of storm water discharges. They are designed to not retain a permanent pool volume between runoff events, and most basins are designed to empty in a time period of less than 24 hours. Detention basins can limit downstream scour and loss of aquatic habitat by reducing the peak flow rate and energy of storm water discharges to the receiving stream, but their removal of pollutant can be limited.

The peak rate reduction credit applies to properties with a SCM that reduces post-development peak runoff rates for the 5-year, 10-year, 25-year, 50-year and 100-year design storms to pre-development levels. **Table 3-5** shows the credit opportunities.

Table 3-5: Stormwater Peak Rate Reduction Credit Structure

Controlling 5-YR Storm	Controlling 10-YR Storm	Controlling 25-YR Storm	Controlling 50-YR Storm	Controlling 100-YR Storm
10%	15%	20%	25%	30%

The credit may be approved if the SCMs are designed, constructed and maintained according to the SCDHEC Structural Control Design Standards (see **Appendix F**). Any alternate design must be pre-approved.

Application for this credit must be prepared by a qualified individual who is a licensed professional engineer or landscape architect.

3.1.3 Stormwater Volume Reduction Credit (Full Credit: 50%)

Volume reduction refers to the volume that enters a SCM that does not discharge to surface water. This water is considered retained. The key volume reduction mechanisms can be categorized as follows:

- Infiltration below the SCM and through the side walls and percolation to groundwater or shallow interflow pathways
- Evaporation of ponded water
- Evapotranspiration of water stored in the root zone below the surface of the SCM
- Demand for stored water, generally either for irrigation or other non-potable uses such as toilet flushing

The relative magnitude of each mechanism is expected to vary by SCM type, underlying soil types, groundwater conditions and connectivity to receiving water, climate, and non-potable water demand.

By installing SCMs to reduce runoff volume, property owners may be eligible for a credit of up to 30%. To qualify, property owners must demonstrate that their existing or new SCM manages stormwater generated from their immediate property and/or upstream tributary areas. In addition, the SCM must exceed design criteria outlined in the Stormwater Ordinance. The SCM must also meet all DHEC Stormwater Best Management Practices standards.

For each of the design storms discussed in the following sections, the stormwater facility must be designed to control the storm event from the Post-Developed conditions back to the Pre-Developed conditions, as defined as "good" hydrologic conditions for a woods-grass combination land cover. The structure of the Stormwater Facility Credit is explained below.

The credit may be approved if the SCMs are designed, constructed and maintained according to the SCDHEC Structural Control Design Standards (see **Appendix F**). Any alternate design must be pre-approved.

Table 3-6 shows the credit opportunities for property owners with a SCM that controls on-site stormwater runoff and/or runoff from an upstream tributary area.

Table 3-6: Stormwater Volume Reduction Credit Structure

Controlling 5-YR Storm	Controlling 10-YR Storm	Controlling 25-YR Storm	Controlling 50-YR Storm	Controlling 100-YR Storm
30%	35%	40%	45%	50%

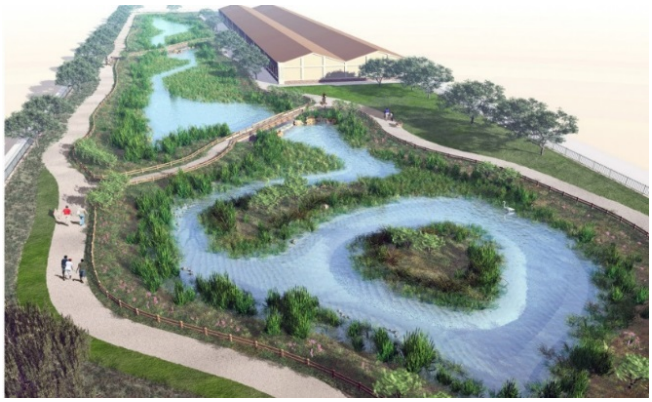
Applications for this credit must be prepared by a qualified individual who is a licensed professional engineer or landscape architect.

3.1.4 Stormwater Quality Credit (Full Credit: 10%)

Properly designed, constructed and maintained SCMs can effectively remove a wide range of pollutants from urban runoff. A Stormwater Quality credit of up to 10% is available to property owners who have installed a Town-approved SCM that provides s permanent reduction of pollutants, specifically suspended solids (TSS), from the stormwater runoff leaving their property. The credit is only available

for the impervious surfaces that drain to each SCM. Town-approved SCMs that are qualified for a Stormwater Quality Credit include:

- Wet Detention Ponds
- Dry Detention Ponds
- Underground Detention Systems
- Storm Water Wetlands
- Bioretention Areas
- Infiltration Trench
- Enhanced Dry Swales
- Pre-Fabricated Control Devices
- Vegetated Filter Strips
- Porous Surfacing



NOTE: a detention pond that is being used for a Stormwater Peak Rate and Volume Reduction Credit may also be approved as a SCM for a Stormwater Quality Credit if properly designed.

In order to be eligible for the credit, the engineering certification or calculations must be provided to show that the SCM has the ability to remove 85 percent of the total suspended solids (TSS) based on 25-yr, 24-hr storm events. This credit will be based upon hydrologic data, water quality data, design specifications, and other pertinent data supplied by qualified, licensed professionals on behalf of property owners.

The amount of credit earned by a property is determined by the type of SCM installed, the number of SCMs installed and the percentage of the impervious area on the site that drains to the SCM. The amount of credit earned by a property is determined by the percentage of the impervious area on the site that drains to the SCM(s). The following formula will determine the amount of credit earned by a Quality SCM:

Credit Earned = (10% Credit) * (Stormwater Fee) * (% of impervious area treated)

The credit may be approved if the SCMs are designed, constructed and maintained according to the SCDHEC Structural Control Design Standards (see **Appendix F**). Any alternate design must be pre-approved.

Application for this credit must be prepared by a qualified individual who is a licensed professional engineer or landscape architect.

3.2 Non-Structural SCM Credits

Non-structural SCMs include institutional and pollution-prevention type practices designed to prevent pollutants from entering storm water runoff or reduce the volume of stormwater requiring management. Non-structural SCMs can be very effective in controlling pollution generating at the source, which in turn can reduce or eliminate the need for costly end-of-pipe treatment by structural SCMs.

3.2.1 Low Impact Parcel (Full Credit: 20%)

A low impact parcel is one that has reduced land disturbance and minimal impervious surfaces, manages stormwater runoff on-site, and is less than 7% impervious. **Table 3-7** shows credit opportunities associated with different percentage of imperious surface on the site:

Table 3-7: Low Impact Parcel Credit Opportunities

Percentage of Impervious Surface	Credit Opportunity
<=5%	20%
>5% but <=6%	15%
>6% but <=7%	10%

In order to qualify for this credit, the property owner should submit the following:

- Site map showing the entire parcel;
- All impervious areas on the property; and
- Calculation of the percent impervious.

Credit shall be applied per parcel basis. Adjacent properties owned by the same entity may not be included in the calculation of percent impervious for the specific parcel against which the credit is to be applied.

3.2.2 Watershed Stewardship (Full Credit: 10%)

NSFR property owners are eligible for a stormwater credit if the customer participates in a Town-approved local watershed stewardship event. Eligible events are set up, organized, and executed through a partnership with citizens and local groups.

In general, eligible watershed stewardship activities will include community programs such as Adopt-A-Stream or Stormwater Drainage Stenciling that require participation in at least 2 events per year. Other eligible programs may be added in the future, but property owners should verify activity eligibility with the Town Stormwater Manager in advance.

A 10% credit is available for watershed stewardship.

3.2.3 Education Credit (Full Credit: 25%)

The Town of Fort Mill is required by the NPDES Permit to educate the public about watershed pollution and protection, surface and groundwater resources, the effects of urbanization on these resources, and the impact of their actions on preserving and restoring the physical, chemical, and biological integrity of the Town's water resources. The stormwater education credit is intended to encourage both public and private schools to educate students and support the Town's education outreach goals. Consequently, the public or private schools that teach eligible stormwater related curriculums to all students may receive a stormwater credit of up to 25%. The rationale behind this credit is that the information provided by the schools will translate into appreciation and stewardship of water resources and thereby reduce negative impacts (usually pollutant impacts) on local streams, ponds and lakes that can result from uninformed citizens.

The credit is subject to the following conditions:

- The education outreach is designed to reach every student on the property annually.
- The credit requires submittal of both an application and attendance at an annual meeting with the Town to review the success of the program. The application need to be completed annually, and requires a description of the educational program, list of educational tools used, estimated number of students that will receive or have already received the education, and the length of the education program.
- The credit will only be applied to the qualified school property(s) where the curriculum is taught, not the entire Fort Mill School District.
- In order to qualify for this credit, the educational program would need to be pre-approved by the Town and documentation provided by the schools to certify that the program had been carried out as approved in the credit application. Documentation would also be required to confirm the students' attendances.

3.2.4 Individual NPDES Permit (Up to 20%)

By complying with National Pollution Discharge Elimination System (NPDES) Stormwater Permit requirements for industrial facilities, NSFR property owners are helping the Town address potential water quality issues onsite before they are discharged into the public drainage system and/or natural waterways. Therefore, these properties are eligible for a stormwater utility credit. A 20% credit may be given for sites which are subject to Individual NPDES Stormwater Permits through DHEC. In order for a site to receive this credit, it must be individually permitted and maintain its permit in good standing. Proof of a valid permit, as well as copies of annual reports shall be submitted to the Town in order for a property owner to receive or renew the credit.

Appendix A: Application Form

FORT MILL

Stormwater Utility Fee Credit Application Form

Stormwater Department

Instructions

Fill out this form completely. One application must be submitted for each separate property location. Multiple **Stormwater Control Measures (SMCs)** may be included in the application for a single property location. Please insure all SCMs are in a proper state of repair and maintained. Attach all appropriate documentation to support this request. Documentation shall include:

- Site plan with SMCs and contributory drainage area.
- Description of SMCs.
- Documentation that SMCs meet one or more criteria for the fee credit (technical report).
- Seal by professional engineer licensed in South Carolina (only apply to Peak Discharge Rate Reduction, Runoff Volume Reduction and Quality Treatment Credits).
- Fill out and attach a Right-of-Entry Form.

Mail the completed application package to:

Stormwater Department
131 E Elliott Street
Fort Mill, SC 29715

Questions and comments can be directed to the Stormwater Department, at (803) 396-9730 or by zwiley@fortmillsc.gov.

Property owner Information

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone: (___)_____-_____

Owner's Representative

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone: (___)_____-_____

Registration Number (PE or RLA):_____

Property Information

Business Name (if applicable): _____
Address: _____
PIN: _____
Property Size (ac): _____
Utility Account Number: _____

Credit Applied

Place a check next to the credit being applied for and specify the percent of fee reduction applied with this application:

	Type Credit	% Reduction Applied
	Rain Barrel	
	Rain Garden	
	Impervious Surface Reduction	
	Pervious Pavement	
	Vegetated Filter Strip	
	Peak Discharge Rate Reduction	
	Runoff Volume Reduction	
	Quality Treatment	
	Low Impact Parcel	
	Watershed Stewardship	
	Education	
	Individual NPDES Permit	

Narrative

Provide a narrative describing proposed/existing measures for which credit is being applied in detail. The Town reserves the right to require additional information as it deems necessary to support the proposed fee credit.

Supporting Calculations

Attach all supporting calculations and/or documentation required by the Credit Manual. The Town reserves the right to require additional information as it deems necessary to support the proposed fee credit.

Operation & Maintenance Requirements

( ) A Maintenance Agreement has been previously recorded for this property, have been sufficient for continued maintenance, and are up to date as of the time of this application.
O&M Agreement is recorded as follows:
Book:_____ Pages:_____-_____ County: York

( ) A Maintenance Agreement has not been recorded for this property. Attach a completed and signed Maintenance Agreement for review and execution by the Town of Fort Mill. This application will be held until these items are approved and recorded.
Book:_____ Pages:_____-_____ County: York

To be signed by Financially Responsible Party

Name: _____Title:_____
Mailing Address: _____

By signing below, I understand that receipt of a stormwater utility fee credit is contingent upon my actions as follows:

1. I (or my representative) must operate and maintain the SCM as described in the recorded Operation & Maintenance Agreement.
2. I must submit an annual SCM inspection report to the Stormwater Engineer by September 30 each year. This report must be certified by a SC registered professional engineer, landscape architect or land surveyor.
3. I (or my representative) must correct any deficiencies identified in the annual SCM inspection report.
4. I must submit an annual credit renewal application along with the SCM inspection report.
5. I have read the Stormwater Utility Fee Credit Manual. I understand that I must abide by all terms and conditions described in the manual to maintain credit eligibility.

Signature: _____ Date: _____

STATE OF SOUTH CAROLINA
COUNTY OF YORK

I, _____, a notary public in and for said county and state, certify that _____ personally appeared before me this day, stated that he/she is _____ of _____, and acknowledged the execution of the foregoing instrument on behalf of said authority.

Witness my hand and official seal, this is the _____ day of _____, 20_____.

My Commission Expires _____

_____
Notary Public (Signature)

(Seal)

_____
Notary Public (Printed Name)

Town of Fort Mill Only: (For Structural SCMs)

Design approval granted on _____

Stormwater Manager _____

Post Construction

As-Built Drawings:

( ) Provide as-built drawings of structural SCMs per Town of Fort Mill Engineering Department Specifications.

Post Construction Certification:

For newly constructed structural SCMs or retrofits for which credit is sought, a competent registered professional must sign and seal the following statement after construction or installation of retrofits:

I hereby certify that the stormwater management system of _____ has been constructed substantially per the design described in the Stormwater Utility Fee Credit Application approved by the Town of Fort Mill on _____. I further certify that any discrepancies between the as-built condition and the approved design are incidental and have no effect on the system meeting the approved design intent.

Name (Print): _____

Signed: _____

Date: _____ (SEAL)

Town of Fort Mill Use Only

Final approval granted on _____

Stormwater Manager _____

Appendix B: Renewal Form

FORT MILL

Stormwater Utility Fee Credit Renewal Form

Stormwater Department

Instructions

For properties with ongoing stormwater fee credits: Complete this form and submit to the Town of Fort Mill Stormwater Department with your Annual Inspection Report and photos of the structural SCMs. Once approved by the Stormwater Manager, no further action *is necessary* for the continuation of stormwater fee credit until the next Annual Inspection Report. In the case of facilities utilizing non-structural SCM's, complete this form and attach supporting information showing that the non-structural SCM's remain in place (i.e. copy of annual report for Public Education activities, copy of Adopt-A-Stream semiannual cleaning activity photos and data sheets, etc.). If additional maintenance is required, or the submitted supporting document is insufficient, a copy of this form will be marked as such and returned to the property owner/applicant. It is the property owner's responsibility to take necessary corrective action prior to May 1st to ensure that eligibility for utility fee credit does not lapse.

All submittals shall be sent to:

Stormwater Department
131 E Elliott Street
Fort Mill, SC 29715

Questions and comments can be directed to the Stormwater Department, at (803) 396-9730 or by zwiley@fortmillsc.gov.

Property owner Information

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone: _(___)_____-_____

Owner's Representative (Engineer/Landscape Architect)

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone: _(___)_____-_____

Registration Number (PE or RLA):_____

Property Information

Business Name (if applicable): _____
Address: _____
Parcel ID: _____ Property Size (ac): _____
Impervious Surface (ac): _____

To be signed by Financially Responsible Party

Name: _____ Title: _____
Mailing Address: _____

By signing below, I understand that receipt of a stormwater utility fee credit is contingent upon my actions as follows:

1. I (or my representative) must operate and maintain the SCM as described in the recorded Operation & Maintenance Agreement

2. I must submit an annual SCM inspection report to the Stormwater Engineer by September 30 each year. This report must be certified by a SC registered professional engineer, landscape architect or land surveyor.

3. I (or my representative) must correct any deficiencies identified in the annual SCM inspection report.

4. I must submit this annual credit renewal application along with the SCM inspection report.

5. I have read the Stormwater Utility Fee Credit Manual. I understand that I must abide by all terms and conditions described in the manual to maintain credit eligibility.

Signature: _____ Date: _____

Town of Fort Mill Use Only

( ) The Annual Inspection Report for the referenced SCM is acceptable.
( ) The Annual Inspection Report is not acceptable. Contact the Town of Fort Mill Stormwater Department at (803) 396-9730 as soon as possible to discuss necessary maintenance requirements or remedial actions. This annual renewal is considered incomplete until such time as all issues are resolved.
( ) The necessary corrections were made on _____

Approved : _____
Stormwater Manager

Appendix C: Right-of-Entry Agreement

RIGHT-OF-ENTRY AGREEMENT
FOR INSPECTION OF PRIVATE STORM DRAINAGE SYSTEM

Parcel Number(s): _____

Site Address: _____

Grantor(s) Names(s): _____, hereinafter termed "Owner"

Grantee(s) Name(s): The Town of Fort Mill, South Carolina, hereinafter termed "Town"

"Owner" hereby grants to "Town", its employees, agents, consulting engineers, contractors and other representatives the right to enter upon the above described real estate on and after, _____, for the purpose of inspecting on-site stormwater controls which work shall be completed strictly in accordance with the standard practice of engineering. The "Town" shall, as soon as practicable after completion of the work as above described, cause all affected property of the "Owner" to be restored to its original condition as nearly as reasonably possible.

"Owner" hereby covenants with "Town" that he/she is/they are the true and lawful owner of the above described real estate and has/have lawfully seized of the same in fee simple and has/have the right and full power to grant this right of entry, which right of entry shall cease to be effective on completion of the above described inspection.

"Owner" will not charge "Town" any compensation during the period of time "Town" occupies the said real estate for purposes aforesaid under the provisions of this right of entry.

DATED this _____ day of _____, 20____

Printed Owner's Name (s) _____

Signature(s) _____

Mailing Address: _____

Phone Number: _____

STATE OF SOUTH CAROLINA)
) ACKNOWLEDGEMENT
York County)

The foregoing instrument was acknowledged before me this _____ day of _____, 20___ by _____, (Owner's name).

Notary Public for South Carolina
My Commission Expires: _____

Appendix D: Maintenance Agreement

State of South Carolina	)	**Permanent Stormwater Facility Maintenance**
	)	**and Responsibility Agreement**
Town of Fort Mill	)	**Tax Map No. _____**

This Agreement is entered into this _____ day of _____, 20____, by and between _____, (hereinafter referred to as Landowner) and the Town of Fort Mill, a Municipal Corporation and political subdivision of the State of South Carolina (hereinafter referred to as Town).

It is agreed as follows:

Landowner Responsible for Stormwater Facility:

The South Carolina Stormwater Management and Sediment Reduction Act of 1991 (§48-14-10, et. seq.) and Regulation 72-308 provide that a Landowner shall adequately establish and maintain stormwater management/Best Management Practices (BMP) facilities upon making certain improvements to the Landowner's property. This law applies to any individual, partnership, corporation or other entity, constructing a stormwater facility. It also applies to all subsequent owners of the property. The obligation applies to the maintenance of all pipes, equipment, and channels built to convey stormwater to a retention facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater on the property. (All fixtures and graded or excavated improvements for controlling stormwater are herein the "Facility"). Adequate maintenance is herein defined as keeping the Facility in good working condition so that the Facility is performing all of its design functions in accordance with the purposes for which it is designed.

Maintenance Required:

The Landowner, its successors and assigns, will perform the maintenance, repair, and replacement necessary to keep the Facility in good working order. The maintenance schedule for the Facility (including sediment removal) that is outlined on page 4 of this agreement must be followed.

Inspection Required:

The Landowner, its successors and assigns, shall regularly and periodically inspect the Facility in its entirety. Records shall be kept to identify the dates and maintenance performed and shall be made available to the Town at the Town's request. The purpose of the inspection is to assure safe and proper functioning of the Facility. The inspection shall cover all parts of the Facility including, but not limited to, berms, outlet structures, pond areas, and access roads. The Landowner's failure to inspect shall be treated as a breach of this Agreement just as much as a failure to repair if repair is needed after inspection.

Access Permitted:

The Landowner grants permission to the Town, its authorized employees and agents, to enter upon the Property and to inspect the Facility whenever the Town deems necessary. The purpose of the

inspection is to follow-up on reported or observed deficiencies, to respond to citizen complaints, or to make an inspection if a significant time has passed after the last inspection. The Town shall provide the Landowner a copy of the inspection findings and a directive to commence with the repairs if necessary. In the case of multiple Landowners of a single property, notice to one shall suffice as notice to all.

No Duty on the Town:

This Agreement creates no affirmative duty on the Town to inspect, and it imposes no liability of any kind whatsoever on the Town for omissions in inspecting. The Landowner agrees to hold the Town harmless from any liability in the event the Facility fails to operate properly due to the Landowner's failure to abide by the terms of this Agreement.

Landowner Covenants:

The Landowner accepts responsibility for ownership and proper maintenance of the stormwater system, the Facility (pond, swales, etc.) on the _____ site located at _____, Town of Fort Mill, South Carolina, per the approved maintenance plan. Landowner will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

Landowner understands that the maintenance plan may be amended or revised at any time by the Town in order to address changed conditions or to address conditions not being effectively met by the Facility. Following the Town's sending notice, Landowner will abide by any prescribed changes.

This covenant to maintain the Facility shall run with the land. Landowner will continue to own and maintain the Facility until the Town is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility which will become effective upon the Town's receipt of a letter of acceptance from the new owner. Notwithstanding the provision for a letter of acceptance, any new Landowner shall be responsible for all duties and obligations created by this Permanent Stormwater Facility and Maintenance Responsibility Agreement upon it being executed and filed in the Register of Deeds Office for York County.

Landowner understands that failure to adhere to the signed Maintenance Agreement may result in fines of up to $1,000.00 per day, per violation and /or the institution of a court action, or such other and additional penalties, fines, or assessments as shall be enacted and provided for by the general law of the state or by local regulation lawfully enacted.

(Signatures contained on the next page)

IN WITNESS our hand and seal this ____ day of _____, 20___.

WITNESSES:

_____

_____

LANDOWNER:

_____
(Printed Name)

_____
(Signature)

Mailing Address: _____

_____

Phone Number: _____

WITNESSES:

_____

_____

Town of Fort Mill

BY: _____
Paul Mitchell

ITS: Engineering Director

STATE OF SOUTH CAROLINA)
) ACKNOWLEDGEMENT
TOWN OF FORT MILL)

The foregoing instrument was acknowledged before me this _____ day of _____, 20___ by _____, (Landowner's name).

_____
Notary Public for South Carolina
My Commission Expires: _____

STATE OF SOUTH CAROLINA)
) ACKNOWLEDGEMENT
TOWN OF FORT MILL)

The foregoing instrument was acknowledged before me this _____ day of _____, 20___ by Paul Mitchell, Engineering Director for the Town of Fort Mill.

_____
Notary Public for South Carolina
My Commission Expires: _____

[PROJECT NAME]

SEDIMENT AND EROSION CONTROL MAINTENANCE PLAN

TOWN OF FORT MILL, YORK COUNTY, SC

RESPONSIBLE PARTY: [COMPANY OR INDIVIDUAL NAME]

REQUIRED MAINTENANCE	**FREQUENCY**

Appendix E: Clemson Extension Rain Garden Design Manual

CLEMSON
PUBLIC SERVICE
Carolina Clear

RAIN GARDENS

A RAIN GARDEN MANUAL FOR SOUTH CAROLINA

GREEN SOLUTIONS TO STORMWATER POLLUTION

As development increases, so does the area of impervious surface. Impervious surfaces include roadways, rooftops, parking lots and sidewalks. Without planning and appropriate management, water that runs over these surfaces picks up pollutants along the way and carries them directly to our lakes, rivers and estuaries. These pollutants include bacteria, nutrients, litter, sediment, oils and metals. Water that heats up on parking lots and roadways also can lead to warmer than normal water entering nearby waterways. This runoff, called "stormwater," is generated by precipitation, snow melt and irrigation water that runs off the land. **Stormwater is the greatest threat to our nation's surface waters.**

As well as creating hard surfaces where pollutants can be washed into waterways, impervious surfaces also prevent the natural infiltration process that occurs in forests, fields and open areas. Instead of adding to the groundwater supply, stormwater flushes the landscape, often leading to increased flooding, erosion, sedimentation and damage to wetlands, ecosystems and waterways.

Rain gardens have become a popular and attractive method for property owners to decrease the impact of their impervious surfaces. Rain gardens are landscaped depressions that receive stormwater runoff and allow the runoff to slowly infiltrate to the groundwater table. As well as intercepting stormwater runoff that could have added to flooding problems, the rain garden allows nature to play a role, removing some of the pollutants that would have otherwise affected water quality. During infiltration, plants use excess nutrients for growth, sediment is trapped in the garden and biological processes remove pathogens. Dissolved metals and nutrients bind or adsorb to soil particles, and are removed temporarily out of the system. Rain gardens, like any garden, also become habitat for bees, birds and butterflies.

> Many other stormwater management techniques address only a portion of the problems caused by stormwater runoff. Rain gardens, however, have the potential to solve all of the problems of stormwater runoff before they occur.
>
> Kevin Beutell,
> *Stormwater*, October 2008

SITING YOUR RAIN GARDEN

MAKING THE BEST OF A DEPRESSED SITUATION

Rain gardens should be located in an area to which rain water typically flows. If a depression already exists in your yard, this could be a good candidate for siting your rain garden. If not, a depression in the ground could be easily dug. Remember, the depression in the landscape should NOT have a seasonally high water table. This would inhibit the amount of infiltration that would take place and restrict the variety and potential success of the plants you use in your rain garden. Often, rain gardens are built down slope of the downspout and ***at least 10 feet away from the home.***

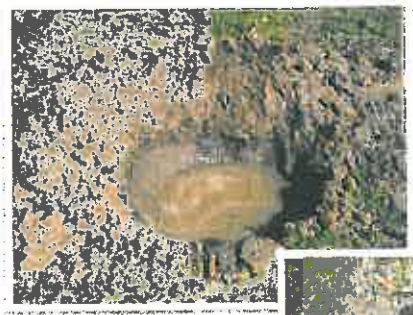
SIMPLE TIPS FOR RAIN GARDENING SUCCESS:

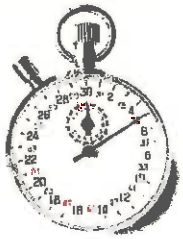
- Be aware of utility lines before you dig. Call P.U.P.S. at 811 or 1-888-721-7877 to request information before digging.
- To help envision the shape and layout of your rain garden, lay a rope or garden hose in the shape and size of your rain garden. Keep this outline as your digging boundary until complete.
- A curved shape makes the rain garden look more interesting and natural. The longest length of the rain garden should be perpendicular to the slope of the property.
- Remember, if you have a septic system, you should be sure that water is not routed to the drainfield area, which could reduce the effectiveness of your drainfield and lead to system failure!
- Trees are primarily for large rain gardens (at least 150 square feet) and should be planted at least 8 feet apart. Consult your Horticulture Agent or nursery for more advice.

SIZING YOUR RAIN GARDEN YOUR INNER ENGINEER

The size of your rain garden is dependent on the area that runs off into the garden, the volume of water it will need to temporarily store, and the soils that will do the infiltrating. The Center for Watershed Protection recommends that the rain garden area be between 20 and 30 percent of the drainage area directed to the depression. For best results and plant growth, it is also recommended that the rain garden depression be approximately 6 inches deep.

Rain gardens are typically designed to store and infiltrate a 1-inch storm. In cases where a storm will produce more than 1 inch of rain in 24 hours, excess water should be able to leave the rain garden without eroding soils and carrying away mulch and soil. Your rain garden design should include an overflow so that excess water from larger storms can be diverted out of the rain garden. To prevent overflow from eroding the soils around the rim of the rain garden, stones or turf reinforcement can be used. A berm will also keep water in the rain garden so that it has the time to infiltrate.





Since rain gardens are supposed to reduce the amount of runoff and encourage infiltration of stormwater, soils play a major role in their effectiveness and success. **Soil mix and drainage piping are two decisions the designer makes in determining drainage capabilities of your rain garden.** The soil mix selected must have a balance of clay soils that will support plant growth and fix pollutants within the soil, as well as sandy soils that will encourage infiltration. ***Sandy loam to loamy sand is the most recommended mix*** for rain gardens, resulting in permeability rates of 1 to 6 inches per hour. If possible, start with the native soils from the depression and amend them to get the results your rain garden requires.

To find out if your soil needs to be amended, you should do two things - conduct a soil perk test and have your native soil tested. For

the perk test, dig a hole in the area where the rain garden will be installed. The hole should be approximately the size of a coffee can. Fill the hole with water. How many inches does it drop in an hour? Ideally, it should be 1 to 6 inches. Given that the site's soils are well-drained, have the soils tested by your local extension office. The results will recommend any necessary amenities to include in the soil mix so that your plants will have the best conditions for success.

To correctly size your rain garden, determine the area of imperviousness that drains to the depression. For gutters with a downspout at each end of the sloped roof, simply divide the size of the roof in half. Then estimate 20 and 30 percent of that roof area; the rain garden should be sized to meet that range in area. The sandier your soils in the depression, the closer to the 20 percent size estimate for your rain garden.

Installing an underdrain is a way to ensure that your rain garden infiltrates if a large volume of water will be draining to the depression, or if the native soils prevent proper infiltration. Drainage pipes are plastic and range from 4 to 8 inches in diameter and may be corrugated. The pipe should be installed 3.5 to 5 feet below the surface, enveloped in *washed* gravel and overlaid with geotextile fabric.

PLANTING OPTIONS

THE FUN PART

Once the depression has been established with ample drainage, the next step is installing plants. Rain garden ***vegetation should be able to withstand brief periods of standing water, yet thrive between rain events under dry conditions***. Plants by region of South Carolina are listed on the following pages. Native plants are plants that are natural to a region, and therefore may be better suited for the soils and seasons and may also provide the best habitat for birds, bees and butterflies natural to that area.

There are a few rules of caution and advice when choosing vegetation for your rain garden.

1. In situations where an underdrain is installed, plants such as willows will aggressively send roots down to reach water, leading to clogged drainage pipes. ***Therefore, whenever underdrains are in place, shrubs and trees with overly aggressive roots should not be planted.***
2. Cherry trees should also be avoided in rain garden designs. Under flooded conditions, cherry tree roots will release a poison that will kill the tree.
3. Finally, other rain gardeners suggest that you keep the planting design simple by using *fewer varieties of plants that are most suited to the conditions of the site*. This will also allow you to find out what works best in your rain garden, and then plant more when needed.

For more assistance with selecting the appropriate trees, consult the Home and Garden Information Center's Fact Sheet "Tree Selection (HGIC 1004)" available at www.clemson.edu/extension/hgic.

After the plants are installed, the rain garden should be mulched with ***3 to 4 inches of hardwood mulch***. A pine bark mulch is too lightweight and could float out with the next storm.

It is important to remember that a rain garden is still a garden and requires some maintenance. The plants have their own horticultural needs, and not all plants will survive the conditions within the rain garden. ***Plants should be inspected seasonally, and the rain garden itself should be inspected after major rainfalls to ensure that the plants, soil and mulch are stable within the depression. Weeding will be necessary to reduce unwanted competition in your rain garden. Finally, any debris that flows into the rain garden should be removed.***

LOCATION, LOCATION, LOCATION

ADDITIONAL RAIN GARDEN POSSIBILITIES

Typically, rain gardens are installed to treat rooftop, lawn and driveway runoff at residences. From a rooftop's downspout, rain gardens should be sited down-gradient, and water can travel through a 1 percent sloped ditch (1 foot drop in elevation over 100 feet of distance), gutter extender, or from a hose connected to a rain barrel. Partnering rain barrels with rain gardens makes sense, as the barrel will act as a settling basin for any solids running off of the rooftop.

If having a gutter extender over the lawn troubles you, it can be buried underground until it reaches the rain garden.

Rain gardens can be installed at almost any property or facility with an impervious surface and some area that will be used for the treatment from that impervious runoff. The following are some examples of how rain gardens can be used within the landscape:

- Corner of barns to capture and infiltrate runoff.
- Recessed parking lot islands.
- Schools where the rain garden can double as an outdoor classroom.
- Highway medians.

Cornus florida (Flowering Dogwood)
Andy & Sally Wasowski, Lady Bird Johnson Wildflower Center

Photo by Sarah L. Voisin, published in *The Washington Post* on 7/12/2008

Mosquitoes require 7 to 12 days in standing water to lay and hatch eggs. Typically, rain gardens will drain in under 24 hours, therefore removing any mosquito concerns.

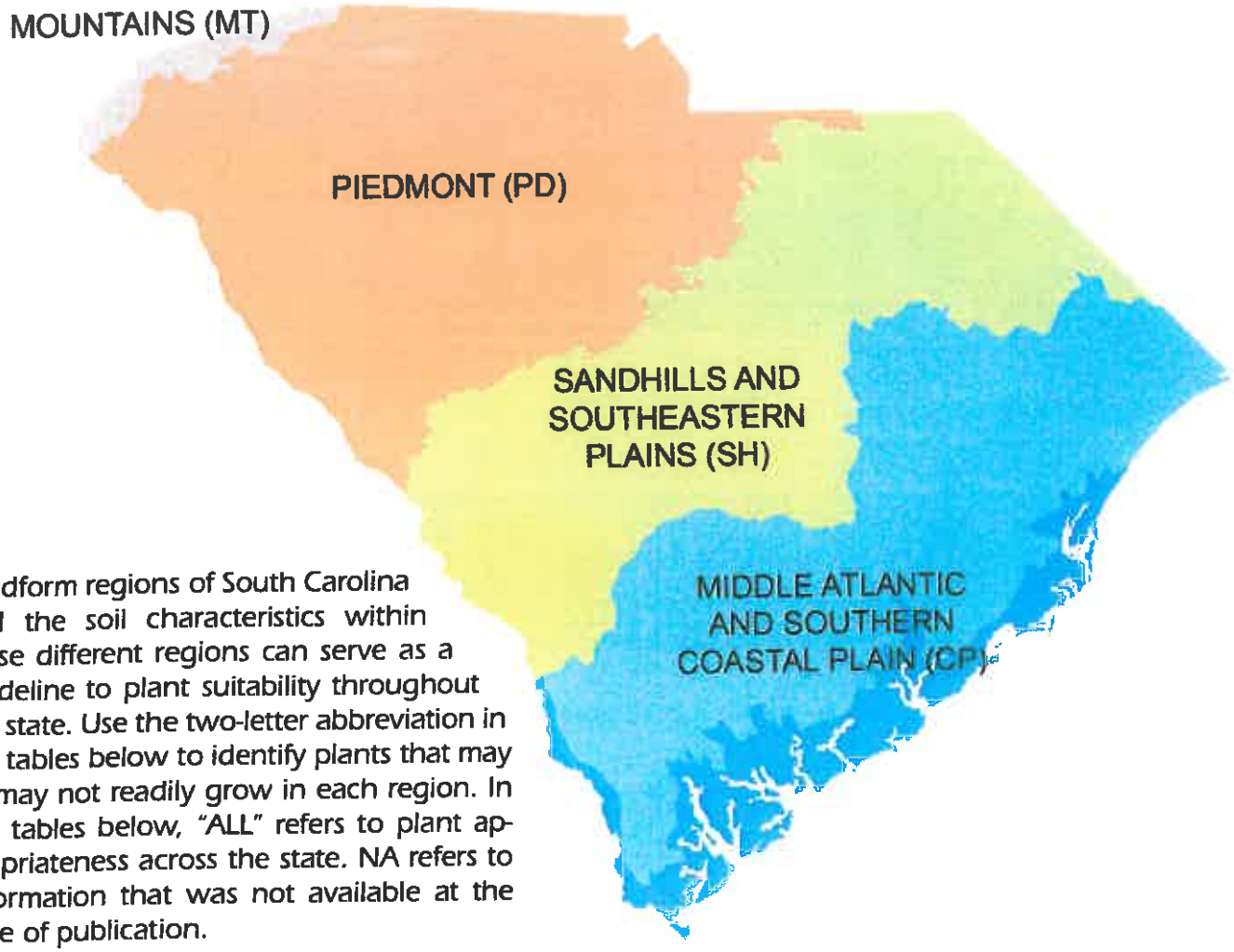
MOSQUITO CONCERNS AND OTHER FREQUENTLY ASKED QUESTIONS

Observe how long it takes for your rain garden to completely drain and monitor how that may change each season. As for keeping mosquitoes at bay, rain gardens also attract dragonflies which feed on mosquitoes.

Many homeowners ask about the cost of rain gardens. Rain gardens can be inexpensive features in your landscape. Ask for help from family and friends in the installation of your rain garden - you can always help them build theirs, too! The main cost will be plants. Remember, rain gardens do not need to be crowded with plants, and many of the plants recommended in the following pages grow in a clumping style, which will fill in more each season.

In times of drought, your rain garden may need to be irrigated.

LANDFORM REGIONS OF SC



Landform regions of South Carolina and the soil characteristics within these different regions can serve as a guideline to plant suitability throughout the state. Use the two-letter abbreviation in the tables below to identify plants that may or may not readily grow in each region. In the tables below, "ALL" refers to plant appropriateness across the state. NA refers to information that was not available at the time of publication.

Polygonatum biflurom (Solomon's Seal)
Norman G. Flaigg, Lady Bird Johnson Wildflower Center

PERENNIALS & GRASSES

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
SH to CP	Native	*Aletris farinosa*	Unicorn Root	Yellow-green, grass-like leaves for 2-3.5', sturdy stem at top holds spike-like cluster of small white, urn-shaped flowers.
ALL	Native	*Andropogon gerardii*	Big Bluestem	Blue-green color, deep roots, drought-resistant, tawny color in fall; full sun; tall, reaching 6-8'.
ALL	Native	*Aquilegia canadensis*	Columbine	Erect branching perennial, up to 2' tall; showy flowers with yellow stamens; best in shade and well-drained soils; 3-5 year lifespan, but re-seeds easily.
CP and PD	Native	*Asclepias incarnata*	Swamp Milkweed	Pink bloom in mid-summer, valuable to butterflies; suitable for coast and piedmont; sun; 2-4' tall; small rose-purple flowers.
ALL	Native	*Asclepias tuberosa*	Butterfly Milkweed	Striking and rugged plant with orange flowers; attracts butterflies. Slow to establish; easy to grow from seed. Full sun and 2-3' tall.
NA	Native	*Aster novae-angliae*	New England Aster	Deep violet flowers in fall, fuzzy seedheads; drought-tolerant; can be 2-6' tall; may have 40 flowers at one time.
ALL	Native	*Athyrium filix-femina*	Lady Fern	18-36", yellow-green to medium-green fronds, part to full shade, clump-forming. Great in background and more moist areas of the rain garden. Should be watered under dry conditions.
CP and SH	Native	*Canna glauca*	Canna Lily	Grows approximately 3-4' high. Blooms from April through October in red, orange, and yellows. Very tropical looking.
ALL	Native	*Carex stricta*	Tussock Sedge	Clump-forming, grass-like, emergent plant; used by waterfowl.
ALL	Native	*Chasmanthium latifolium*	River Oats	Tolerates dry soils, shade; dangling oats are ornamental and copper in fall; clump forming.
ALL*	Native	*Chelone glabra*	White Turtlehead	Snapdragon-type white flowers, often lavendar-tinged. Robust perennial, 1-4' tall; attractive to hummingbirds and butterflies; suitable for piedmont; sun.

SC REGION	NATIVE TO SC?	LATIN NAME	COMMON NAME	PLANT CHARACTERISTICS
MT	Native	*Chelone lyonii*	Pink Turtlehead	Snapdragon-type pink flowers. Robust perennial, 1-4' tall; attractive to hummingbirds and butterflies; suitable for piedmont; sun.
MT	Native	*Dennstaedtia punctilobula*	Hayscented Fern	Spreads rapidly; fragrant foliage, light green turning yellow in fall.
PD and MT	Native	*Dryopteridaceae marginalis*	Evergreen Wood Fern	Grows to 36", full shade, bluish-green blades.
SH to CP	Native	*Eupatorium coelestinum*	Blue Mist Flower	Misty blue flowers; spreads quickly; tolerates many soils, especially suited to heavy textured and highly organic soils; salt-tolerant; up to 3' tall; full sun to part shade.
ALL	Native	*Eupatorium fistulosum*	Joe Pye Weed	Rapid growers can be 6' tall with wide heads of pink or purple flowers that attract butterflies; no salinity tolerance.
ALL	Native	*Geranium maculatum*	Spotted Geranium	Lavender to pink flowers; semi-evergreen, low fragrant foliage; 1-3' tall.
ALL	Native	*Helianthus angustifolius*	Swamp Sunflower, Narrowleaf Sunflower	Tall yellow daisies with maroon centers; good seed source; salt-tolerant.
ALL	Non-Native	*Hemerocallis spp. any hybrids*	Daylily	Many types of daylilies, and their colors and height vary. Require well-drained soil and 1" of water per week in summer months. Clump-forming and can be divided in spring and fall. Full sun.
SH to PD	Native	*Heuchera americana*	Alumroot, Coral bells	Semi-evergreen groundcover with wine color in winter; airy flowers.
NA	Native	*Hibiscus coccineus*	Scarlet Rosemallow; Texas Star Mallow	4-7' tall. Divided blooms greater than 6" in width, July through September. Full sun.
ALL	Native	*Hibiscus moscheutos*	Rose Mallow; Marsh mallow hibiscus	Shrubby and 3-8' tall, with huge white to pink flowers; can grow near water; salt-tolerant; numerous sturdy stems from a single crown. Strikingly showy.

LEFT: *Lobelia cardinalis* (Cardinal Flower), Joseph A. Marcus, Lady Bird Johnson Wildflower Center
BELOW: *Helianthus angustifolia* (Swamp Sunflower), Andy & Sally Wasowski, Lady Bird Johnson Wildflower Center

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
CP and MT	Native	*Liatris spicata*	Gayfeather, Blazing Star	Easy to grow; spikes of lavender flowers, nectar and seed valuable; salt-tolerant; straight and slender perennial, reaching 3-4'. Tall spike of rayless, rose-purple flower heads.
ALL	Native	*Lobelia cardinalis*	Cardinal Flower	Brilliant red flower spikes, loved by butterfly and hummingbirds; sun to shade; 1-6'; showy red flowers in 8" terminal spikes.
ALL	Native	*Lobelia siphilitica*	Blue Lobelia	Bright blue flowers attractive to hummingbirds, sun to shade, 2-3' in height.
ALL	Native	*Lysimachia ciliata*	Fringed loosestrife	Yellow, erect to sprawling, sometimes branched perennial, usually 1-2' tall. Yellow flowers droop from stalks.
NA	Native	*Monarda didyma*	Beebalm	Fragrant foliage, red to purple flowers, hummingbirds and butterflies; dense, rounded clusters of flowers. 3' tall; leaves have a minty aroma; vigorously colonizes.
MT	Native	*Monarda fistulosa*	Wild Bergamot; Horsemint	Fragrant foliage, lavender flowers, hummingbirds and butterflies; sun to part shade; ensure good circulation to avoid mildew problems. Vigorously colonizes. 1-3' tall.
CP	Native	*Monarda punctata*	Spotted mint	Fragrant foliage, dusty pink flowers, attractive to hummingbirds and butterflies; salt-tolerant; ranges from 6" to 3' tall.
ALL	Native	*Onoclea cinnamomea*	Cinnamon Fern	3-4' tall. Part sun to shade. Ideal for back drop and more moist areas of the rain garden.
ALL	Native	*Onoclea sensibilis*	Sensitive Fern	Spreads easily; lush green, rusty-gold in fall, spore heads persist.
ALL	Native	*Osmunda regalis*	Royal Fern	Suitable for coast to mountains; 2-3' tall; part shade to shade.



ABOVE LEFT: *Geranium maculatum* (Spotted Geranium), William Justice, courtesy of Smithsonian Institution; ABOVE MIDDLE: *Veronia noveboracensis* (Ironweed), Stefan Bloodworth, Lady Bird Johnson Wildflower Center; ABOVE RIGHT: *Eupatorium coelestinum* (Mist-flower), William Justice, courtesy of Smithsonian Institution

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Panicum virgatum*	Switch Grass	Very tolerant of flooding; fuzzy flower heads; good erosion control; suitable for coast to mountains; sun.
ALL	Native	*Physostegia virginiana*	Obedient Plant	Pink or purple spikes of tubular flowers; spreads rapidly in moist soils.
ALL	Native	*Polygonatum biflorum*	Great Solomon's Seal	Lily family; graceful arching stem, pendulous flowers (often hidden) greenish-white and bell-like; blue berries follow flowers; 1-3' full shade.
ALL	Native	*Rudbeckia laciniata*	Tall Coneflower; Cutleaf Coneflower	Great for stream banks; yellow daisies with green center; seed source.
ALL	Native	*Schizachyrium scoparium*	Little Bluestem	2-3' in height, clumping warm-season grass; full sun; attracts birds and mammals. Suitable for coast; ornamental, slender blue-green stems turn radiant mahogany-red with white shining seed tufts in the fall, color remains all winter.
CP and coastal zone	Native	*Solidago sempervirens*	Seaside Goldenrod	Yellow flowers in August through November; tight clump of narrow, evergreen basal leaves; 2-8' tall; dense flower heads.
ALL	Native	*Sorghastrum elliotti*	Slender Indiangrass	Evergreen grass with a green-white colouring year-round.
ALL	Native	*Tradescantia virginiana*	Virginia Spiderwort	Long-blooming with purple or white flowers, lightly fragrant; grass-like foliage; iris-like leaves; can form larger colonies when in full sun.
ALL	Native	*Tridens flavus*	Purpletop	Clump-forming; full sun; 4' tall in flower.
ALL	Native	*Vernonia noveboracensis*	Ironweed	Tall red-purple flowers attract butterflies; tolerates inundation; clump forming, growing 5-8' in height. Deep green leaves and small flower heads occur in larger, loosely-branched clusters.

* Best documented in the Coastal Plain, though should thrive across the state.

SHRUBS

Cephalanthus occidentalis (Buttonbush) Jeff McMillan @ USDA-NRCS PLANTS Database

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Aronia arbutifolia*	Chokeberry	Up to 8', medium shrub. Red berries persist in winter, scarlet fall color, bank stabilizer.
ALL	Native	*Baccharis halimifolia*	Groundsel Tree; Salt Myrtle	Up to 10'. Salt-tolerant, white flowers become fuzzy seed heads in fall; sun to shade.
ALL	Native	*Callicarpa americana*	Beautyberry	Up to 6'. Striking purple berries on new growth, yellow fall color, sun to part shade; well-suited for mountains.
ALL	Native	*Cephalanthus occidentalis*	Buttonbush	Up to 8'. Tolerates flooding, white button flowers persist, attracts hummingbirds; salt-tolerant.
ALL	Native	*Clethra alnifolia*	Summersweet, Sweet Pepperbush	Up to 8'. Extremely fragrant white or pink flowers in summer, yellow in fall; salt-tolerant.
ALL	Native	*Hypericum prolificum*	Shrubby St. John's Wort	Small shrub with yellow flowers; sun to part shade; place on upper edges of rain garden in drier areas.
PD	Native	*Ilex decidua*	Possumhaw	Up to 15', deciduous, red to yellow berries persist through winter; attracts birds; suitable for coast.
MT and PD	Native	*Ilex glabra*	Inkberry Holly	Medium shrub, 6-8'; white flowers, black berries; sun to shade.
ALL	Native	*Ilex verticillata*	Winterberry Holly	Medium shrub, 6-10'; white flowers with red berries; sun to part shade; well-suited for mountains.
ALL	Native	*Ilex vomitoria*	Yaupon Holly	Up to 20'. White flowers, red berries, long lasting translucent scarlet berries, many cultivars, evergreen; full sun to part shade; suitable for coast.
ALL	Non-Native	*Indigofera amblyantha*	Pink Indigo Bush	4-6' tall. Pink flowers with seed pod; full sun to part shade.
ALL	Native	*Itea virginica*	Virginia Sweetspire	Medium shrub. Fragrant white tassel flowers, deep red or purple fall foliage; sun to shade; well-suited for piedmont.
PD	Native	*Lindera benzoin*	Spicebush	Up to 8'. Very early chartreuse flowers, fragrant leaves, pale yellow fall color; part shade to shade; suitable for coast.

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
PD to CP	Native	*Myrica cerifera*	Waxmyrtle	15-20'. Fragrant evergreen leaves, berries for candles, can prune as hedge; sun to part shade.
SH	Native	*Philadelphus inodorus*	Mock Orange	6-12' globular shrub with upright branching. Older bark is orange-brown and exfoliating. Large, white, sweet scented flowers.
PD to MT	Native	*Rhododendron maximum*	Rosebay Rhododenron; great laurel	Large shrub. Found in northwest corner of SC in piedmont and mountains; evergreen, thicket-forming shrub or tree with short, crooked trunk, large white blossoms; largest leaves of all rhododendrons, also one of the hardiest.
ALL	Native	*Rhododendron viscosum*	Swamp Azalea	Up to 6'. Very sweet fragrant white flowers in summer; part shade.
PD, SH, southern CP	Native	*Rosa carolina*	Carolina Rose	Small shrub; pink to white flowers, red hip; full sun.
SH to CP	Native	*Sabal minor*	Dwarf Palmetto	Up to 5'. Native palm that slowly spreads; black berries; drought-tolerant; suitable for coast.
ALL	Native	*Sambucus canadensis*	Elderberry	Up to 10'. Large white flowers and edible purple berries, fast growing thickets (new growth of American elder can be fatal to livestock).
SH to CP	Native	*Serenoa repens*	Saw Palmetto	5-12' tall. White flowers, purplish-black drupe; sun to part shade.
MT to PD	Native	*Vaccinium corymbosum*	Highbush Blueberry	5-12' tall. White to pink flowers, blue berry; sun to part shade; salt-tolerant.
CP	Native	*Viburnum dentatum*	Arrowwood	Up to 10'. White flowers, bright blue berry clusters, very tolerant of many soils.

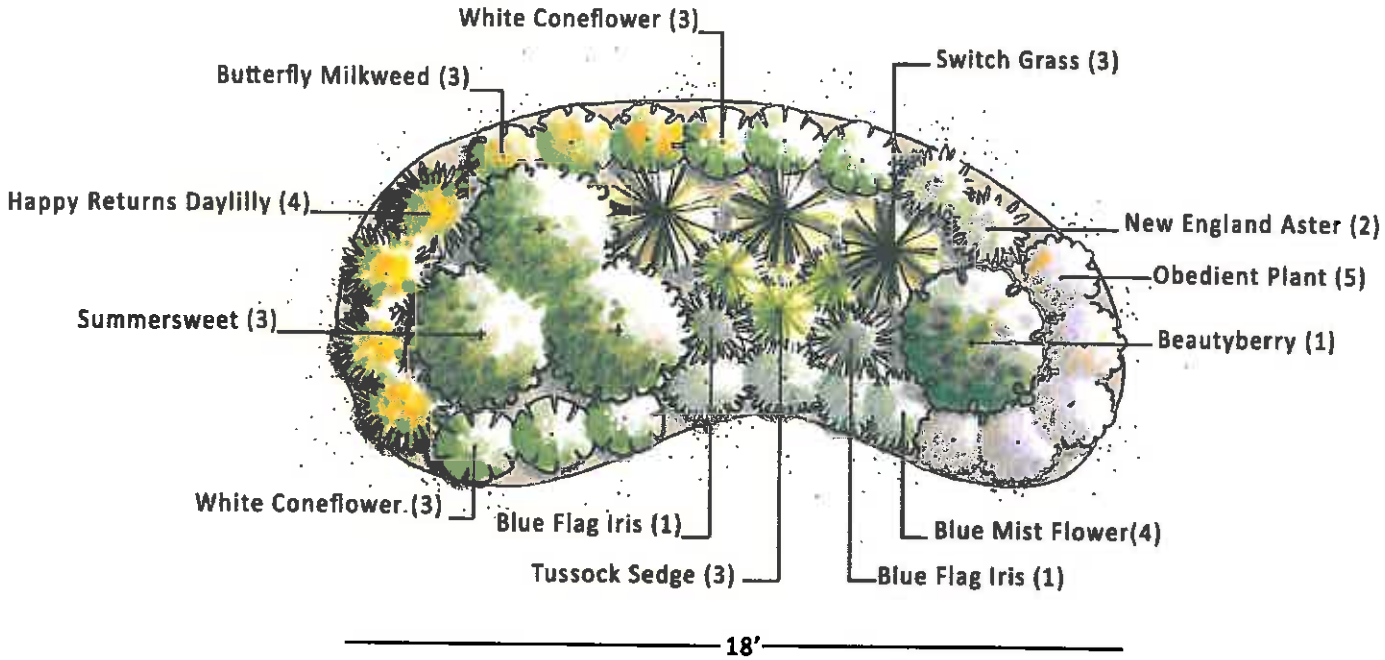
ABOVE:
Ilex vomitoria (Yaupon Holly)
Joseph A. Marcus, Lady Bird Johnson Wildflower Center
LEFT:
Calicarpa americana (Beautyberry)

TREES

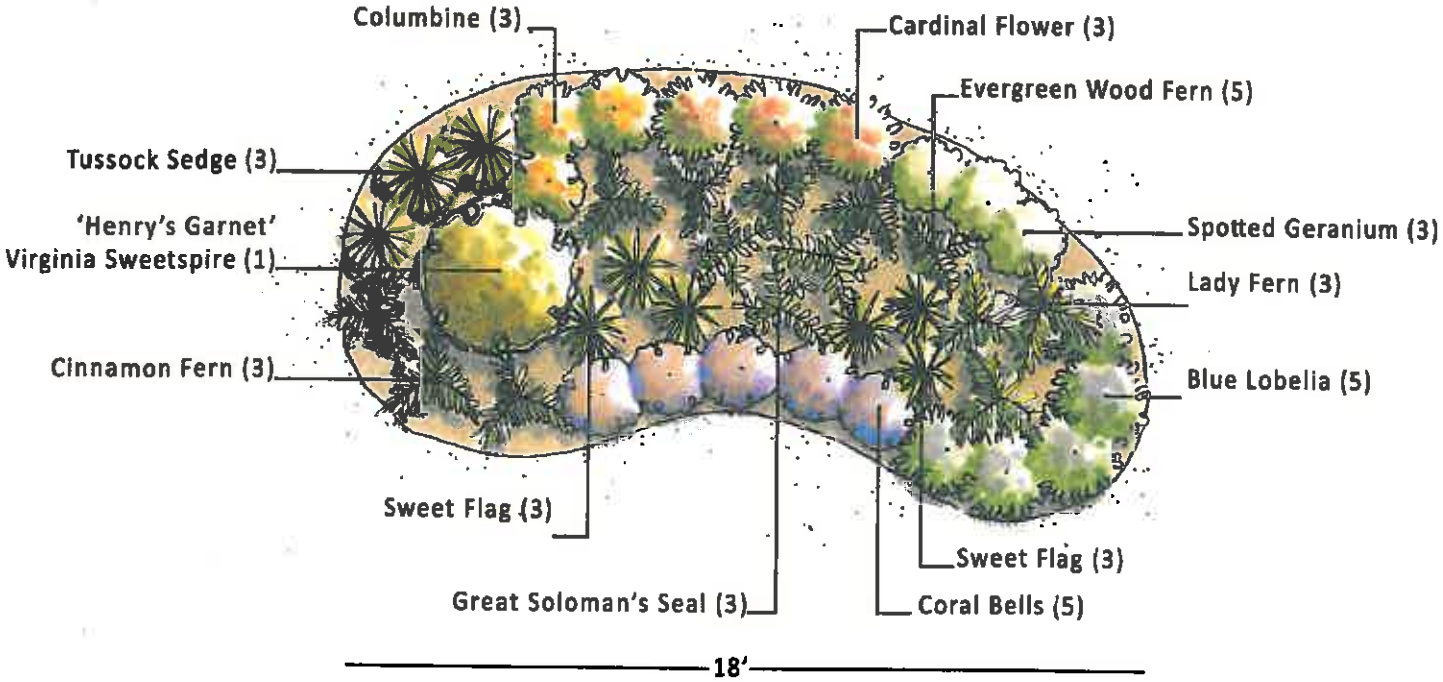
SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Amelanchier canadensis*	Serviceberry	Up to 15'. Multi-stem grey bark, white flowers, early purple berries, red in fall; salt-tolerant.
ALL	Native	*Betula nigra*	River Birch	Up to 50'. Good bank stabilizer, beautiful peeling bark, yellow fall color; salt-tolerant.
ALL	Native	*Carpinus caroliniana*	American Hornbeam	Up to 30'. Shade-tolerant, takes inundation, unique silver fluted trunk.
ALL	Native	*Celtis occidentalis*	Hackberry	Up to 40'. Tolerates poor soils and salt, excellent stabilizer, yellow fall color.
ALL	Native	*Chamaecyparis thyoides*	Atlantic White Cedar	Up to 40-50'. Full sun; red or yellow (male) or green (female) flowers; coastal habitat is suitable, though adaptable across the state.
ALL	Native	*Chionanthus virginicus*	Fringetree	Up to 20'. Can be shrubby; fragrant pendulous white flowers and gold fall color.
ALL	Native	*Cornus florida*	Flowering Dogwood	Height is 20-40'. Single or multi-trunked tree with spreading crown and long-lasting white and pink spring blooms. Red fruits and scarlet autumn foliage.
ALL	Native	*Crataegus aestivalis*	Mayhaw, May Hawthorn	Up to 20'. Thorns attractive to nesting birds, red fruit, purple to scarlet in fall.
ALL	Native	*Ilex opaca*	American Holly	Up to 40-50'. Sun to shade; evergreen, slow growing, ornamental red berries on female plants, white flowers.
ALL	Native	*Magnolia virginiana*	Sweetbay Magnolia	Up to 20'. Semi-evergreen, fragrant flowers, bright red berries, often multi-stem; sun to part shade.
ALL	Native	*Nyssa sylvatica*	Black Gum, Black Tupelo	Up to 30-50'. Tolerates flooding or dry rocky uplands, spectacular scarlet in fall; sun to part shade; suitable for coast.
NA	Native	*Sassafras albidum*	Sassafras	Up to 30-60';. Full sun to part shade; yellow flowers, attracts birds.

SAMPLE RAIN GARDEN DESIGNS

FULL SUN RAIN GARDEN

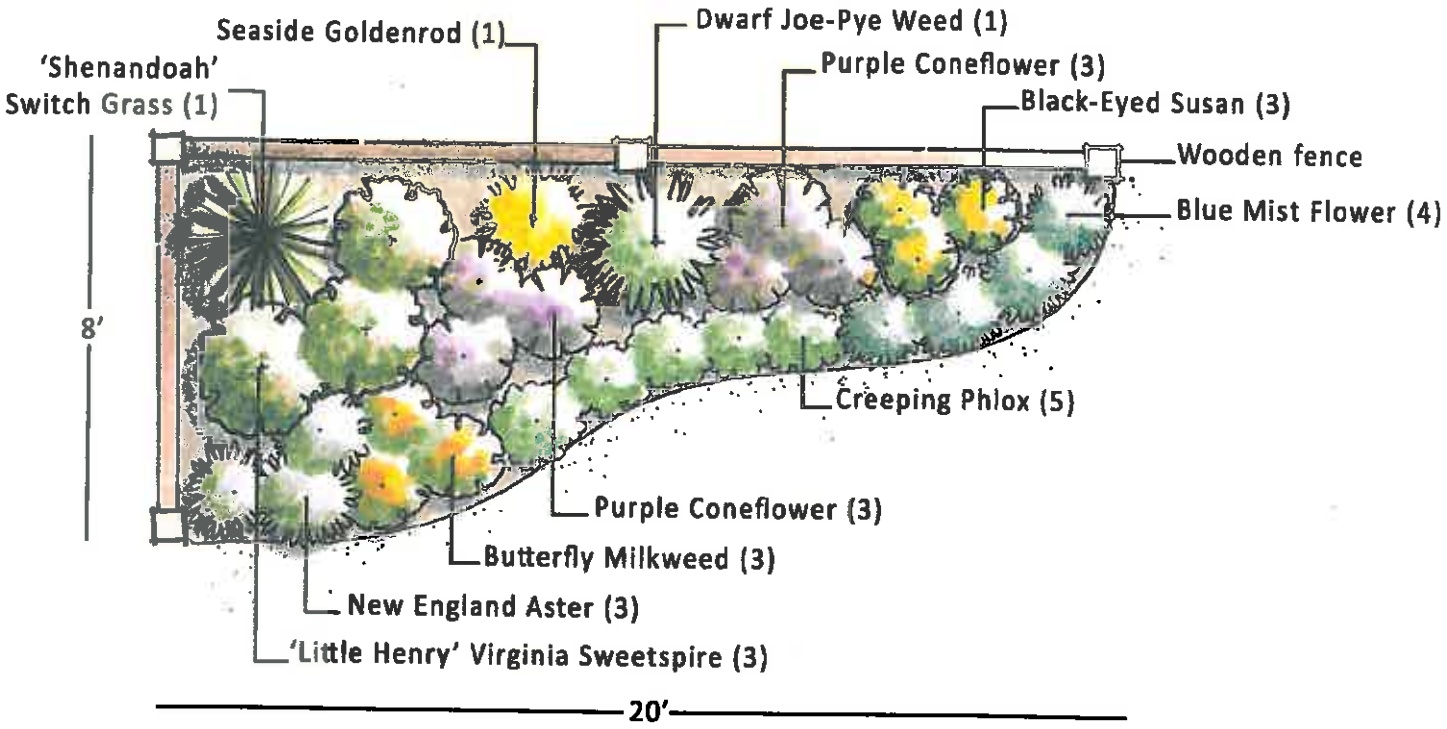


WOODLAND RAIN GARDEN



Rain Garden Illustrations by Renee Byrd

BUTTERFLY BORDER RAIN GARDEN



Rain Garden Illustrations by Renee Byrd

HOW MUCH MULCH DO I NEED?

To calculate the total cubic yards of mulch needed for your rain garden project, follow these steps:

1. Multiply the length of your rain garden by the width to find the square footage.
2. Multiply that square footage by 0.25, which will equate to 3 inches of mulch.
3. Divide that value by 27 to yield cubic yards of mulch needed for your project.

The table to the right can be used to quickly estimate the necessary amount of mulch to purchase based on various depths of mulch.

Remember not to pile mulch alongside the stem of plants. Mulch is moist and can lead to rotting around the stem.

Also, remember to break up any mulch that may be dry or clumped together as you spread it over your rain garden.

Cubic Yards of Mulch	Rain Garden Square Feet and Mulch Coverage based on Depth		
	1"	2"	3"
1	338 sq. ft.	158 sq. ft.	108 sq. ft.
2	676 sq. ft.	316 sq. ft.	216 sq. ft.
3	1014 sq. ft.	474 sq. ft.	324 sq. ft.
4	1352 sq. ft.	632 sq. ft.	432 sq. ft.
5	1690 sq. ft.	790 sq. ft.	540 sq. ft.
6	2028 sq. ft.	948 sq. ft.	648 sq. ft.
7	2366 sq. ft.	1106 sq. ft.	756 sq. ft.
8	2704 sq. ft.	1264 sq. ft.	864 sq. ft.
9	3042 sq. ft.	1422 sq. ft.	972 sq. ft.
10	3380 sq. ft.	1580 sq. ft.	1080 sq. ft.
11	3718 sq. ft.	1738 sq. ft.	1188 sq. ft.
12	4056 sq. ft.	1896 sq. ft.	1296 sq. ft.

* Using the table above, 1 cubic yard of mulch will cover 108 sq. ft. with 3" of mulch.

ADDITIONAL RESOURCES

More information about stormwater and Clemson University's involvement in stormwater education in South Carolina can be found online at www.clemson.edu/carolinaclear.

Your local cooperative extension office can also provide important soil sample, plant and pest information. To find the contact information for your local extension office, check www.clemson.edu/extension.

For information on suppliers of native plants in South Carolina, please consult the South Carolina Native Plant Society website at www.scnps.org.

Documents and websites consulted in the development of this document include the USDA PLANTS Database (http://plants.usda.gov); Lady Bird Johnson Wildflower Center (www.wildflower.org); *Rain Gardens* tri-fold brochure (Hitchcock, 2008); *Designing Rain Gardens (Bio-Retention Areas)* (Hunt and White, 2001); *Rain Gardens: A How-To Manual for Homeowners* (Bannerman and Considine, 2003).

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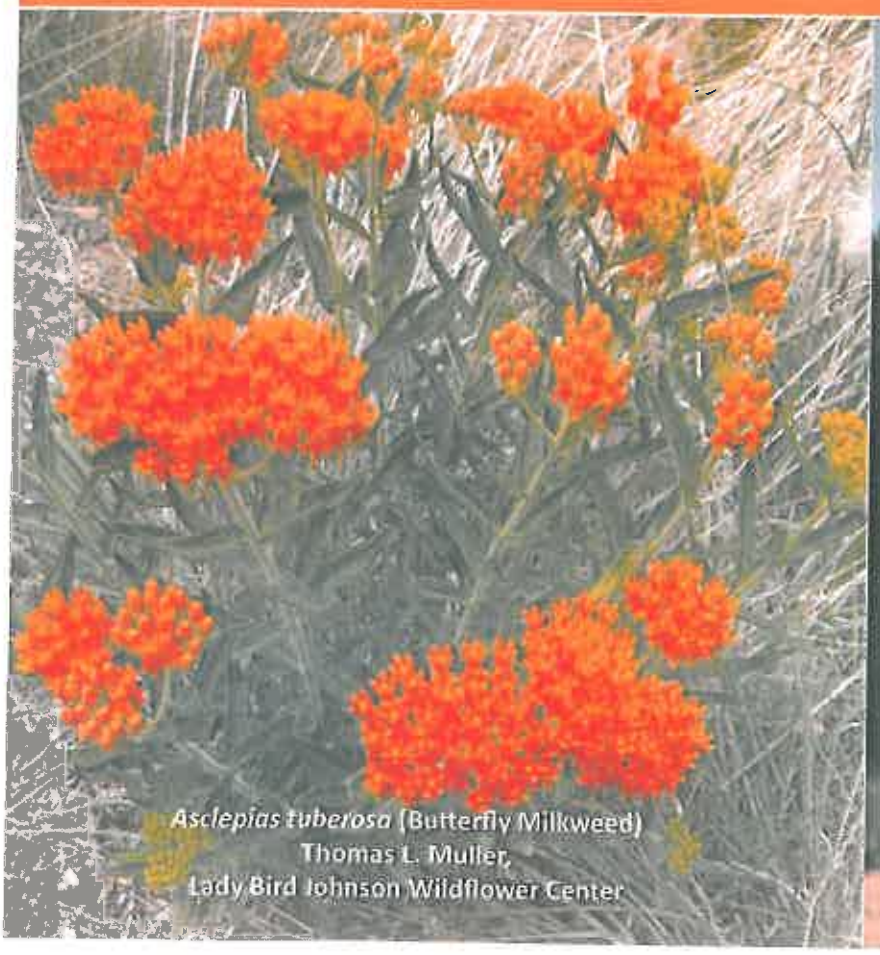
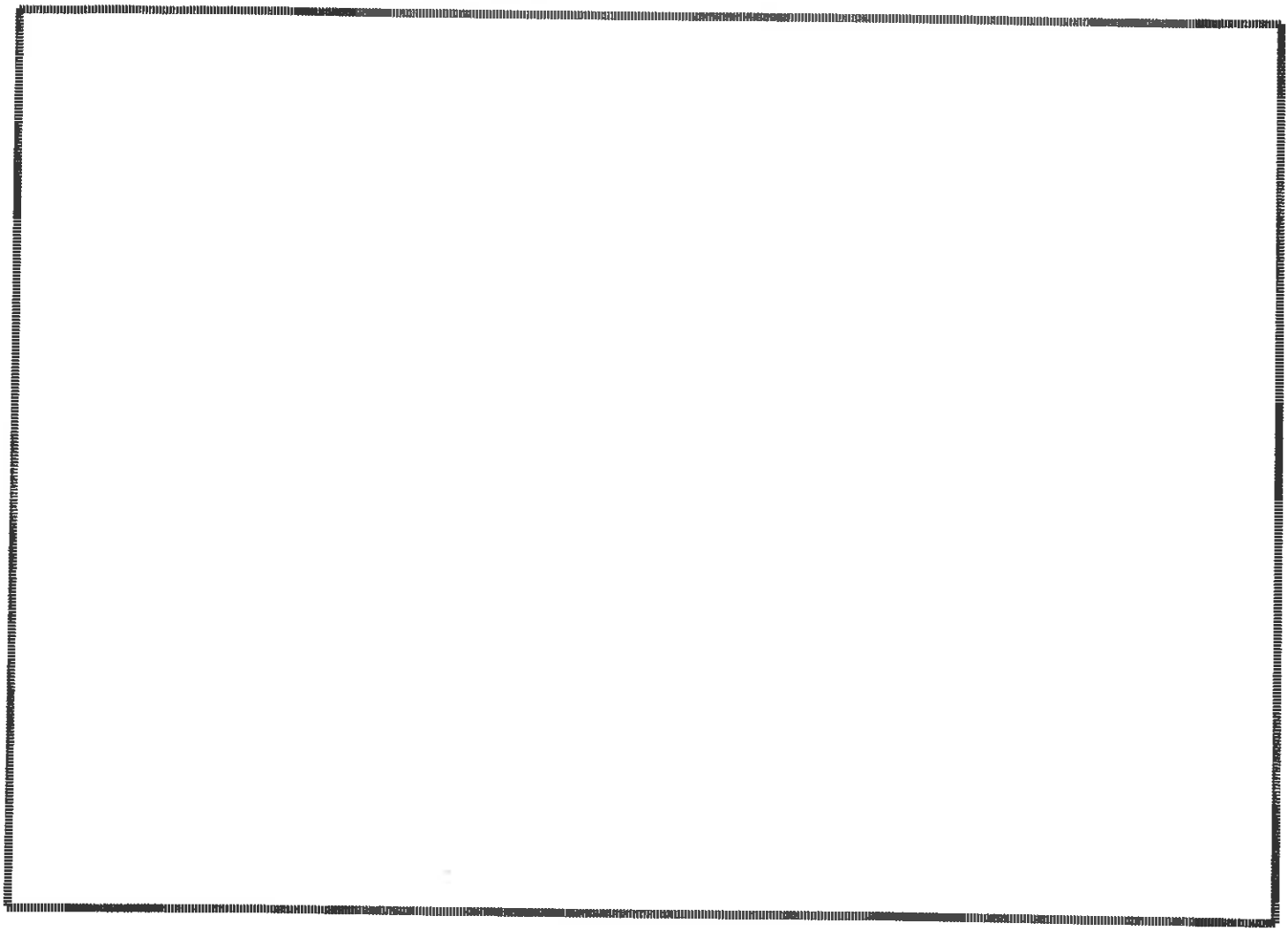
Rain Garden Drawings
Renee Byrd, Clemson University Department of Horticulture, The Cliffs Communities Botanical Garden



Asclepias tuberosa (Butterfly Milkweed)
Thomas L. Muller,
Lady Bird Johnson Wildflower Center

Panicum virgatum (Switch Grass)
Andy & Sally Wasowski,
Lady Bird Johnson Wildflower Center

Use this space for your planting design and notes. You may want to include a scale bar and direction of morning and afternoon sun.



Appendix F: SCDHEC Structural Control Design Standards

Structural Controls

Structural water quality control structures are recommended for use with a wide variety of land uses and development types. These controls have demonstrated the ability to effectively treat runoff volume to reduce the amounts of pollutants discharged to the downstream system. Structural storm water quality controls are classified into the following categories:

General Application Controls

General application structural controls are recommended for use in a wide variety of application situations. These structural controls have demonstrated the ability to effectively treat water quality volumes and are presumed to be capable of removing 80 percent of the total suspended solids (TSS) load typically found in urban post-development runoff.

Limited Application Controls

Limited application structural controls are those that are recommended only for limited use for special site or design conditions. Generally, these practices can not alone achieve 80 percent TSS removal goal and are intended for hotspots for specific land use constraints or conditions. Limited application controls may be used within a system of water quality controls and are very effective pre-treatment structures for the General Application Controls. Limited application structural controls should be designed and used only in development situations where regular maintenance is guaranteed.

Wet Detention Ponds

Description

A wet or permanent pool detention pond is one of the most commonly used BMPs to meet water quality protection requirements. The advantages of permanent pool ponds have over other water quality treatment controls are:

- Ponds are durable and require less maintenance than other applicable water quality controls.
- Ponds required for water quantity control are easily modified to treat storm water runoff for water quality.
- Well designed ponds are effective in treating storm water runoff for water quality control.

Wet storm water detention ponds are classified as being:

- Wet Detention Pond. Wet ponds have a permanent (dead storage) pool of water equal to the water quality volume. Temporary storage (live storage) may be added above the permanent pool elevation for larger flows.
- Wet Extended Pond. A wet extended pond is a wet pond where the water quality volume is split evenly between the permanent pool and extended detention storage provided above the permanent pool. During storm events, water is stored above the permanent pool and released over 24-hours. The design has similar pollutant removal efficiencies as traditional wet ponds, but consumes less space.
- Micropool Extended Pond. The micropool extended pond is a variation of the wet extended detention pond where only a small "micropool" is maintained at the outlet to the pond. The outlet structure is designed to detain the water quality volume for 24-hours. The micropool prevents resuspension of previously settled sediments and prevents clogging of the low flow orifice.

When and Where to Use It

Permanent pool ponds improve storm water quality by detaining storm water runoff for an extended period of time to allow pollutants that are suspended in the runoff to settle out. During any given storm event, runoff enters wet ponds and replaces the "treated" water in the permanent pool that has been detained from the previous storm event. As runoff enters the pond, the velocity is significantly decreased, allowing suspended pollutants to settle out of the runoff. Many pollutant particles suspended in storm water runoff are very small in size, therefore the pond must be designed to provide adequate detention time to allow the smaller particles to settle out.

Design Criteria

The components of wet detention ponds that help increase the pond's pollutant removal efficiency are:

- Permanent wet pool
- Temporary pool or overlaying zone
- Aquatic bench
- Forebay
- Flow length
- Low flow orifice
- Emergency spillway.

Permanent Wet Pool

A permanent wet pool is the design feature with the single greatest effect on water quality. Permanent pools have the following design requirements:

- For Wet Detention Ponds, the design permanent pool volume is equal to 1-inch of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- For Wet Extended Ponds with an Aquatic Bench, the design permanent pool is equal to ½- inches of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- For Micropool Extended Ponds, the design permanent pool volume is equal to 0.1-inches of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- An average pool depth of 4 to 6 feet is optimal for water quality treatment. The depth of the permanent pool prevents particles that have settled to the pond bottom from re-suspending when runoff enters the pond.

Temporary Pool

The temporary pool is the designed storage above the permanent pool that controls the designed water quality volume. Consider storm water quantity management when designing the temporary pool volume. To increase the detention time of the runoff, the temporary pool is slowly released through a low flow orifice.

Aquatic Bench

Aquatic vegetation can play an important role in pollutant removal in a storm water pond. Vegetation can enhance the appearance of the pond and stabilize side slopes. The selection of the proper plant species and planting locations is an integral part in designing a successful aquatic bench in the wet detention pond. Prepare a planting plan by a qualified landscape architect or wetland ecologist for the aquatic bench.

Forebay

Provide a forebay for all inlets to a wet water quality pond and place the forebay upstream of the main wet pond area. Design the forebay to trap the majority of the coarse fractions of the suspended solids in the runoff before it enters the main wet pond area. The forebay is separated from the larger wet detention pond area by barriers or baffles that may be constructed of earth, stones, riprap, gabions, or geotextiles. Design the top of the forebay barrier ranging from foot below the normal pool elevation up to an elevation above the permanent pool. A forebay may be designed using manufactured treatment devices.

Flow Length

Optimizing the wet pond flow shape and flow distance through the pond promotes better water quality treatment. For maximum water quality benefits, design the ratio of flow length to flow width in the wet pond at least 3L:1W. Due to site constraints, the minimum allowable design ratio of flow length to flow width is 1.5L:1W. To increase the pond's flow length, the pond may be configured with baffles.

Low Flow Orifice

Design a low flow orifice to slowly release the water quality volume over a period of 24-hours or longer depending upon the design criteria for the water quality structure. These structures are prone to becoming clogged. Protect the low flow orifice from clogging by designing appropriate trash guards. Acceptable trash guards include:

- Hoods that extend at least 6-inches below the permanent pool water surface elevation.
- Reverse flow pipes where the outlet structure inlet is located below the permanent pool water surface elevation.
- Trash boxes made of sturdy wire mesh.

Emergency Spillway

Design emergency spillways to safely pass the post-development 100-year 24-hour storm event without overtopping any dam structures. Design the 100-year water surface elevation a minimum of 1-foot below the top of the embankment.

Inspection and Maintenance:

Regular inspection and maintenance is critical to the effective operation of storm water ponds as designed. Maintenance responsibility for a pond and its buffer should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval. The agreement may contain but is not limited to the following items:

- Mow side slopes of the pond monthly.
- Since decomposing vegetation captured in the wet pond can release pollutants, especially nutrients, it may be necessary to harvest dead vegetation annually. Otherwise the decaying vegetation can export pollutants out of the pond and also can cause nuisance conditions to occur.
- Clear debris from all inlet and outlet structures monthly.
- Repair all eroded or undercut areas as needed.
- Place a sediment marker in the forebay to determine when sediment removal is required.
- Monitor sediment accumulations in the main pond area and remove sediment when the permanent pool volume has been significantly filled and/or the pond becomes eutrophic.

Average Pollutant Removal Capability

Total Suspended Solids:	65-80%	Metals:	35-75%
Copper:	40-65%	Lead:	60-85%
Zinc:	50-75%	Total Phosphorus:	50-70%
Total Nitrogen:	30-45%	Pathogens/Bacteria:	45-75%

Wet Pond

Wet Pond

Summary of Maintenance Requirements

Required Maintenance	Frequency
Clean and remove debris from inlet and outlet structures.	Monthly, or after large storm events
Mow side slopes.	Monthly, or as needed
Removal of invasive vegetation.	Semi-annual
Inspect for damage to control structure.	Annual
Inspect sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair embankment, side slopes, undercut or eroded areas.	Annual, or as needed
Perform wetland plant management and harvesting.	Annual
Remove sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Dry Detention Ponds

Description

A dry (extended) detention pond provides temporary storage of storm water runoff. Dry ponds have an outlet structure that detains runoff inflows and promotes the settlement of pollutants. Unlike wet ponds, dry detention ponds do not have a permanent pool.

A dry pond is designed as a multistage facility that provides runoff storage and attenuation for both storm water quality and quantity. Design dry detention ponds as either single-stage or two-stage. Single-stage ponds are normally used strictly for flood control and are not recommended for water quality benefits. A two-stage pond contains a water quality volume in the lower stage, and has an upper stage for detention of larger storms for flood control.

The lower stages of a dry pond are controlled by outlets designed to detain the storm water runoff for the water quality volume for a minimum duration of 24-hours, which allow sediment particles and associated pollutants to settle out. Higher stages in the pond detain the peak rates of runoff from larger storms for flood and erosion control. Dry detention ponds are designed for complete drawdown of runoff and normally remain dry between storm events.

When and Where to Use It

Apply dry detention ponds to new or existing developments. Dry ponds are considered permanent, year-round control measures. Use dry detention ponds at sites where significant increases in runoff are expected from site development. Use dry detention ponds for residential, commercial, or industrial development sites.

Do not use dry ponds in areas with a high water table. A permanently wet bottom is a mosquito breeding ground.

While dry extended detention ponds are widely applicable, they have some limitations that may make other storm water management options preferable. Dry pond limitations include:

- Possible nuisance due to mosquito breeding.
- While wet ponds can increase property values, dry ponds may detract from the value of a home.
- Dry detention ponds have only moderate pollutant removal when compared to other structural storm water practices, and have limited effectiveness in removing both particulate and soluble pollutants.

Design Criteria

Items to incorporate in dry pond design are: pretreatment, pond shape, pond volume, low flow channel, outfall, emergency spillway, and anti-seep collar.

- Ponds shall be designed for the 2 and 10-year storms
- The 10-year storm should not pass through the emergency spillway
- A minimum 6-inch freeboard between the 10-year water surface and emergency spillway is required
- The 100-year storm should not overtop the embankment

Pretreatment

Pretreatment extends the functional life and increases the pollutant removal capability of dry ponds. Pretreatment reduces incoming velocities and captures coarser sediments, trash, and debris, extending the life of the pond and reduce the frequency of long-term maintenance requirements.

Pretreatment is accomplished with vegetative filters, forebays, or manufactured treatment devices. Size the pretreatment to capture and hold the sediment volume expected between scheduled maintenance clean-outs.

Pond Shape

Design dry ponds with a high length to width ratio and incorporate other design features to maximize the flow path effectively increases the detention time in the system by eliminating the potential of flow to short circuit the pond. A dry pond relies on the process of sedimentation for removal of runoff pollutants. Therefore, design the pond to maximize the degree of sedimentation. Design flow path lengths with long, narrow pond configurations with length to width ratios of 2:1. Ponds that are shallow and have larger surface area to depth ratios provide better pollutant removal efficiencies than smaller, deeper ponds. Designing ponds with relatively flat side slopes also helps to lengthen the effective flow path.

Do not design dry pond inside side slopes should not be more than 2H:1V. The recommended inside pond slopes is 3H:1V with a 2H:1V maximum.

The pond floor should have a minimum slope of 0.5% toward the outlet or underdrain system. The recommended slope is 2.0% to ensure that the pond fully drains between storm events.

Provide adequate maintenance access for all dry detention ponds.

Pond Volume

Dry detention ponds are sized to temporarily store the runoff volume to provide normal peak flow reduction (reduce the post-development peak flow of the design storm event to the pre-development rate). Routing calculations must be used to demonstrate that the storage volume is adequate.

A properly designed dry pond will accumulate sediment over time, leading to the loss of detention volume, runoff quality control and quantity control. An increase in a dry detention pond's maximum design storm storage volume should be considered to compensate for this expected loss of storage volume.

Low Flow Channel

A low flow channel is recommended to prevent standing water conditions. Protect this channel with a TRM or other stabilization method to prevent scouring. Design the remainder of the pond to drain toward this channel. Where recreational uses are desired, design the low-flow channel to one side instead in the middle of the pond.

Outfall

Size the outlet structure for water quality control and water quantity control (based upon hydrologic routing calculations.) The outlet may consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

Provide a low flow orifice capable of releasing the water quality volume over 24 hours. The water quality orifice has a minimum diameter of 2-inches and is adequately protected from clogging by an acceptable external trash rack.

Stabilize the outfall of dry ponds to prevent scour and erosion. If the pond discharges to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance.

Emergency Spillway

Design an emergency spillway to pass the 100-year storm event. The spillway prevents pond water levels from overtopping the embankment and causing structural damage. Design the spillway to protect against erosion problems.

Anti-seep Collars

Provide seepage control or anti-seep collars for all outlet pipes.

Inspection and Maintenance

A Pond Maintenance Plan/Agreement is required before approval.

Regular inspection and maintenance is critical to the effective operation of dry ponds as designed. Maintenance responsibility for a pond should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Conduct inspections semi-annually and after significant storm events to identify potential problems early. Direct maintenance efforts toward vegetation management and basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the pond dewaters completely to prevent mosquito and other habitats.

Average Pollutant Removal Capability

Total Suspended Solids:	45%-68%	Metals:	26%-54%
Copper:	15%-38%	Lead:	31%-67%
Zinc:	15%-45%	Total Phosphorus:	14%-25%
Total Nitrogen:	19%-29%	Pathogens/Bacteria:	20%-50%

Dry Pond

Dry Pond

Summary of Maintenance Requirements

Required Maintenance	Frequency
Note erosion of pond banks or bottom	Semi-Annual Inspection
Inspect for damage to the embankment Monitor for sediment accumulation in the facility and forebay. Ensure that inlet and outlet devices are free of debris and operational	Annual Inspection
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance
Seed or sod to restore dead or damaged ground cover.	Annual Maintenance (As needed)
Removal of sediment form the forebay	5 to 7 year Maintenance
Monitor sediment accumulations, and remove sediment when the pond volume has been reduced by 25%.	25 to 50 year Maintenance
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance

Underground Detention Systems

Description

Detention tanks and vaults are underground structures used to attenuate peak storm water flows through detention or extended detention of storm water runoff. They are constructed out of concrete pipe (RCP), corrugated metal pipe (CMP), High Density Polyethylene Pipe (HDPE) or concrete vaults. The design and material selections considers the potential loading from vehicles on the vault or pipe.

When and Where to Use It

Due to the costs associated with underground detention systems for construction and maintenance, these systems are used when space is limited and there are no other practical alternatives.

In the ultra-urban environment, costs for developable land may be high enough that these systems become a feasible alternative.

Relatively expensive to construct, use concrete vaults in areas where system replacement costs are high.

Less expensive, use CMP or HDPE systems to control significant volumes of runoff in parking lots, adjacent to rights-of-way, and in medians, where they is replaced or maintained if necessary.

Design Criteria

Locate underground detention systems downstream of other structural storm water controls providing treatment of the water quality volume.

The maximum contributing drainage area to be served by a single underground detention vault or tank is 25-acres.

Size underground detention systems to mitigate flows from the 2- and 10 –year design storm event and up. Design the systems to meet detention and water quality requirements set forth in local and state regulations.

Use routing calculations to demonstrate that the storage volume is adequate.

Inspection and Maintenance

- Design the system for easy access for inspection and maintenance.
- Remove any trash/debris and sediment buildup in the underground vaults or tanks annually by pumping them out.
- Perform structural repairs to inlet and outlets as needed based on inspections.

Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals:	NA
Copper:	35%-70%	Lead:	50%-90%
Zinc:	35%-90%	Total Phosphorus:	55%-70%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	10%-60%

CMP Underground Detention

HDPE Underground Detention

Storm Water Wetlands

Description

Storm water wetlands remove pollutants primarily through physical filtration and settling, by biological processes of wetland plants, and bacteria in substrates. The storm water wetland is similar in design to the wet pond but has significant vegetation differences. The major difference in the wetland design is the creation of varying depth zones in the shallow marsh area of the wetland to support emergent wetland vegetation. Because consideration must be paid to creating various depth zones and establishing a plant community that can survive in the different zones, the design, construction, and maintenance of storm water wetlands is more complex than wet ponds. There are several different wetland applications including:

- Storm Water Wetland. Constructed shallow marsh system that is designed to treat both urban storm water runoff and control runoff volume. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and uptake by marsh vegetation.
- Shallow Wetland. Most of the water quality treatment takes place in the shallow high marsh or low marsh depths. The only deep sections of the wetland are the forebay and the micropool at the outlet. A disadvantage of shallow wetlands is that a relatively large amount of land is required to store the desired water quality volume.
- Extended Detention Shallow Wetland. This design is similar to the shallow wetland, but part of the water quality treatment volume is provided as extended detention above the surface of the marsh and is released over a period of 24-hours. This application can treat a greater volume of storm water in a smaller space than the shallow wetland design. Plants that can tolerate both wet and dry periods are required in the extended detention area.
- Pond/Wetland System. The system has two separate cells, a wet pond and a shallow marsh. The wet pond is designed to trap sediment and reduce runoff velocities before the runoff enters the shallow marsh. The primary water quality benefits are achieved in the shallow wetland. Less land is required for the pond/wetland system than the shallow wetland and the extended detention shallow wetland.
- Pocket Wetland. A pocket wetland is intended for smaller drainage areas of 5 to 10 acres, and requires excavation down to the water table for a reliable source of water to support the wetland vegetation.

Design Criteria

Do not convert natural wetlands to storm water wetlands. Do not remove natural wetland soils and vegetation to provide a "seedbank" for a constructed storm water wetland without the regulating approval from the US Army Corps of Engineers by obtaining a Section 404 permit. Water quantity storage can be incorporated into the vegetated wetland if the vegetation selected can withstand being submerged for the depth and duration of the water quantity storage time.

Design the wetland with a minimum 2:1 length to width ratio, with 3:1 being the preferred ratio. Maximize the distance between the storm water wetland inlet and outlet to increase the flow length. The flowpath within the wetland is increased through the use of internal berms and shelves used to create the desired varying depth zones within the wetland.

Creating varying depth zones within the wetland increases the pollutant removal efficiency. These depth zones are classified as deep-water zones, which consist of the forebay and outlet micropool, and the shallow water zone that consists of the high marsh, and low marsh area of the wetland. Designing the wetland with varying depth zones prevents the wetland from being taken over by a dominant plant species such as cattails.

Shallow Water Zones

The shallow water zone is defined as being the zones within the constructed storm water wetland that have water depths ranging from 0 to 18 inches. The shallow water zone is designed to promote the growth of emergent wetland plantings and variations in depth allow for a diversity species to survive. Design a level bottom elevation across the width of a wetland cross-section to promote sheet flow and prevent short circuiting or the creation of stagnate dead areas.

High Marsh

Design one-half (½) of the total shallow water zone as high marsh. This zone extends up from 6-inches below the permanent pool water level (6-inches deep). This zone supports a greater density and diversity of wetland species than the low marsh zone.

Low Marsh

Design one-half (½) of the total shallow water zone as low marsh. This zone extends from a depth of 18- to 6-inches below the permanent pool water level. This zone is suitable for the growth of several emergent wetland plant species.

Deep Water Zones

The deep water zones ranges from a depth of 1.5- to 6-feet and includes the forebay, low flow channels, and the outlet micropool. This zone supports little emergent wetland vegetation, but may support submerged or floating vegetation.

Forebay

Design the forebay to reduce the incoming velocities into the wetland. The forebay provides initial settling for sediments, minimizing the amount of suspended sediments that enter the constructed wetland area. Design the forebay as a level spreader distributing the flow evenly and equally across the width of the wetland area. Construct the forebay of an earthen berm no lower than the normal permanent pool depth. Design all inlets to the constructed storm water wetland to discharge to the forebay, and be protected with a properly designed Turf Reinforcement Mat.

Low Flow Channels

A minimum dry weather flowpath is required from the inlet to the outlet for storm water wetlands.

Outlet Micropool.

Design an outlet micropool allowing adequate depth for the extended detention outlet to function properly. Design a drain in the outlet micropool to drain the wetland when needed. Design the outlet micropool 4- to 6-feet deep.

Semi-Wet Zones

The semi-wet zones includes the areas above the permanent pool that will be submerged during larger storm events. This zone supports vegetation that can survive during flooding.

Wetland Planting Plan

Design a wetland planting plan and submit it as part of all constructed wetland design submittals. The selection of the proper plant species and planting locations is an integral part in designing a successful storm water wetland. Have a qualified landscape architect or wetland ecologist prepare a wetland planting plan.

Water Quality Treatment Orifice

Design a low flow orifice to slowly release the water quality volume over a period of 24-hours. Place additional orifice at outlet structures above the temporary water quality pool to provide water quantity control. Protect the water quality orifice from clogging by incorporating an appropriate trash guard. Select a durable trash guard that extends at least 6-inches below the normal pool surface of the wetland.

Acceptable trash guards include:

- Hoods that extend 6-inches below the permanent pool water surface elevation.
- Reverse flow pipes where the outlet structure inlet is located 6-inches below the permanent pool water surface elevation.
- Trash boxes made of sturdy wire mesh.

Principle Spillway

Design the principle spillway of the constructed storm water wetland to safely pass the 2- and 10-year 24-hour storm event. Equip the spillway with a trash rack.

Emergency Spillway

Design the emergency spillway of the constructed storm water wetland to safely convey discharges resulting from the 100-year 24-hour storm event. Design the 100-year water surface elevation a minimum of 1-foot below the top of the embankment. The emergency spillway may be incorporated into the principle spillway where accommodating the emergency spillway elsewhere is not feasible for the given site characteristics.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of storm water wetlands. Maintenance responsibility for the constructed storm water wetland should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

- Maintenance requirements for constructed wetlands are particularly high while vegetation is being established. Monitoring during the first year is critical to the success of the wetland.
- Monitor wetlands after all storm events greater than 2-inches of rainfall during the first year to assess erosion, flow channelization and sediment accumulation. Inspection should be made at least once every six months during the first three years of establishment.
- Place a sediment cleanout stake in the forebay area to determine when sediment removal is required.
- Debris should be removed from the inlet and outlet structures monthly.
- Monitor wetland vegetation and replaced as necessary once every 6-months during the first three years of establishment.
- Annually inspect and maintain the depth of the zones within the wetland.
- Annually remove invasive vegetation.
- Repair all eroded or undercut areas as needed.

Average Pollutant Removal Capability

Total Suspended Solids:	66%-78%	Metals:	14%-72%
Copper:	29%-50%	Lead:	62%-76%
Zinc:	32%-52%	Total Phosphorus:	42%-53%
Total Nitrogen:	28%-39%	Pathogens/Bacteria:	58%-78%
Hydrocarbons:	80%		

Storm Water Wetland

Summary of Maintenance Requirements

Required Maintenance	Frequency
Replace wetland vegetation to maintain at least 50% surface area coverage in wetland plants.	Once every 6-months during the first three years of establishment
Clean and remove debris from inlet and outlet structures.	Frequently (3 to 4 times/year)
Mow side slopes.	Frequently (3 to 4 times/year)
Monitor wetland vegetation and perform replacement planting as necessary.	Semi-annual (every 6-months)
Examine stability of the original depth zones.	Annual
Inspect for invasive vegetation, and remove where possible.	Annual
Inspect for damage to the embankment and inlet/outlet structures.	Annual, repair as necessary
Monitor for sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair undercut or eroded areas.	As needed
Harvest wetland plants that have been "choked out" by sediment buildup.	Annual
Removal of sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Bioretention Areas

Description

Bioretention areas are designed to mimic natural forest ecosystems with a combination of soil filtration and plant uptake by utilizing a planting soil layer, mulch, plantings, and an underdrain system. Bioretention areas appear as landscaped or natural areas giving this BMP an appealing image. Storm water runoff enters the Bioretention area and is temporarily stored in a shallow pond on top of the mulch layer. The ponded water then slowly filters down through the planting soil mix and is absorbed by the plantings. As the excess water filters through the system it is temporarily stored and collected by an underdrain system that eventually discharges to a designed storm conveyance system.

When and Where to Use It

Bioretention areas are applicable for small sites where storm water runoff rates are low and typically are received into the Bioretention area as sheet flow. Bioretention drainage areas range from 1-2 acres and are well stabilized to prevent excessive debris and sediment from collecting in the Bioretention area. Because Bioretention areas are sensitive to fine sediments, they are not be placed on sites where the contributing area is not completely stabilized or is periodically being disturbed. Applicable sites include:

- Parking lots,
- Individual residential home sites, and
- Small commercial facilities.

Design Criteria

Bioretention areas work best when constructed off-line, capturing only the water quality volume. Divert excess runoff away from Bioretention areas or collect it with an overflow catch basin. Design Bioretention areas to fit around natural topography and complement the surrounding landscape. Design Bioretention areas with any reasonable shape that fits around sensitive areas, natural vegetation, roads, driveways, and parking lots. The minimum width of Bioretention areas is 10 feet in order to establish a strong healthy stand of vegetation.

Surface Area

The Bioretention surface area may be calculated by the following equation from research by the North Carolina Extension Service, 1999:

$$BSA = \frac{(DA)(Rv)}{D_{avg}}$$

Where:

BSA	=	Bioretention surface area (feet^2)
DA	=	Contributing drainage area of Bioretention area (feet^2)
R_v	=	Runoff volume (feet) 0.083-feet (1-inch) for SCDHEC
D_{avg}	=	Average ponding water depth above ground (feet)

The Bioretention surface area may also be calculated by the following equation from research by Prince George's County, MD:

$$BSA = 0.1(Rv)(DA)$$

Where:

BSA	=	Bioretention surface area (feet^2)
0.1	=	Empirical conversion factor
R_v	=	Runoff volume (inches) 1-inch for SCDHEC
DA	=	Contributing drainage area of Bioretention area (feet^2)

Pre-treatment

Pre-treatment of storm water runoff is required to reduce the incoming velocities, evenly spread the flow over the entire Bioretention area, and provide for removal of coarse sediments. The pre-treatment may consist of the following:

- Gravel, landscape stone, or geotextile level spreader located along the upstream edge of the Bioretention area.
- Gently sloping vegetated filter areas along the upstream edge of the Bioretention area.
- Vegetated swale along the upstream edge of the Bioretention area.

The level spreader option is the most desirable because level spreaders successfully reduce incoming energy from the runoff and convert concentrated flow to sheet flow that is evenly distributed across the entire Bioretention area.

Planting Mix

Install the planting mix of the Bioretention area at level grade (0%) to allow uniform ponding over the entire area. The maximum ponding depth should be set at 6-inches to 12-inches to allow the cell to drain within a reasonable time and to prevent long periods of submerging the plantings. The planting mix provides a medium for physical filtration for the storm water runoff plus a source of water and nutrients for plant life. Select a soil mixture with a minimum hydraulic conductivity or permeability of 0.5 in/hour. The planting mix has a significant amount of organic content to support plant life. The average porosity of the planting mix is 0.45.

The planting mix is approximately 60-75 percent sand, 25 percent silt or topsoil, and 10 percent organic or leaf compost. The maximum clay content is less than 5 percent. The minimum depth of the planting mix is based on the following:

- 1.5-foot Bioretention areas utilizing grass as the only vegetative media,
- 3.0-feet for Bioretention areas that utilize shrubs, and
- 4.0-feet for Bioretention areas that utilize trees.

Mulch Layer

The mulch layer provides an environment for plant growth by reducing erosion of the filter bed, maintaining soil moisture, trapping fine sediments, and promoting the decomposition of organic matter. The mulch layer plays an important role in pollutant removal. Liberally apply shredded hardwood mulch 2- to 3-inches deep. Shredded hardwood mulch is the mulch of choice because it resists floatation better than other landscape covers. Pine needles are also applicable for certain situations. Avoid pine bark mulch due to its ability to float.

Water Draw Down Time

The under drain system is designed using the draw down time. The general equation used to determine draw down time is Darcy's Equation:

$$Q = 2.3e^{-5}\ K\ A\frac{\Delta H}{\Delta L}$$

Where:

Q	=	Flow rate through Bioretention (cfs)
K	=	Hydraulic conductivity of the planting mix (in/hr) This value will vary based on the actual planting mix used
A	=	Surface area of Bioretention (feet^2)
ΔH	=	Maximum ponding depth above bottom of soil mix (feet)
ΔL	=	Depth of soil mix (feet)

General Hydraulic Conductivity of Soils

Determining the total draw down time is a three-step process.

1. Determine the time it takes to drain the ponded water.
- Utilize Darcy's Equation to calculate the flow rate (cfs).
- Calculate the total ponded water volume (feet^3) by multiplying the Bioretention area (feet^2) by the ponded water depth (feet).
- Divide the total ponded water volume (feet^3) by the flow rate (cfs) to calculate the time to drain the ponded water (seconds)

2. Determine the time it takes to drain the saturated planting mix.
- Calculate the total volume of water contained in the planting mix (feet^3) by multiplying the Bioretention area (feet^2) by the planting mix depth (feet) by the porosity (dimensionless) of the planting mix.
- Divide the planting mix water volume (feet^3) by the flow rate from Darcy's Equation (cfs) to calculate the time to drain the ponded water (seconds).

3. Add up the time to drain the ponded water with the time that it takes to drain the planting mix to calculate the total Bioretention area draw down time.

Under Drain System

Many of the native soils found in South Carolina do not allow for adequate infiltration. Therefore, all Bioretention cells require an under drain system placed beneath the planting mix.

The under drain system consists of a minimum 4-inch diameter perforated PVC pipe (AASHTO M 252), an 8-inch minimum gravel jacket filter layer, and non-woven geotextiles to separate the piping from the native soils and the gravel from the planting mixture. Design the under drain system to safely pass the peak draw down rate calculated.

Select perforated, continuous closed-joint conduits of corrugated plastic pipe, placed on top of an underlying geotextile fabric. The longitudinal slope of the drain pipe is a minimum of 0.5 percent. The

Select perforated, continuous closed-joint conduits of corrugated plastic pipe, placed on top of an underlying geotextile fabric. The longitudinal slope of the drain pipe is a minimum of 0.5 percent. The perforated drain pipe may be connected to a structural storm water conveyance system or receiving natural water system.

Place filter gravel around the drainage pipe at a minimum depth of 8-inches. Place a geotextile between the boundary of the gravel and the planting mix to prohibit the planting mix from filtering down to the perforated drain pipe.

Several non-perforated PVC pipes should vertically connect to the under drain pipe and extend to the surface of the planting mix to provide access to clean out the perforated drainage pipe.

Overflow System

Design an overflow system to pass runoff volumes greater than the water quality volume away from the Bioretention area. If the Bioretention area collects sheet flow from a parking area, design a catch basin at the elevation of the maximum 6-inch to 12-inch ponding depth of the Bioretention area to carry the excess runoff from the Bioretention area to the storm sewer system or receiving natural water system.

Planting Plan

A Bioretention landscape plan includes all vegetation types, total number of each species, and the location of each species. A description of the contractor's responsibilities including a planting schedule, installation specifications, initial maintenance, a warranty period, and expectations of plant survival. Include long-term inspection and maintenance guidelines in the planting plan. Have a qualified landscape architect, botanist or qualified extension agent prepare the planting plan.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of Bioretention areas as designed. Maintenance responsibility of the Bioretention area should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

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.

Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals	NA
Total Phosphorus:	55%-70%	Lead:	50%-90%
Pathogens/Bacteria:	10%-60%	Copper:	35%-70%
Total Nitrogen:	35%-55%	Zinc:	35%-90%

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

Infiltration Trenches

Description

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for storm water runoff. 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.

When and Where to Use It

Infiltration trenches are limited to areas with highly porous soils where the water table and or bedrock are located well below the trench bottom. They are only applicable for Hydrologic Soil Group A soils, or soils that have a minimum infiltration rate of 0.3-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 in the gravel. Infiltration trenches are used for medium- to high- density residential, commercial, and institutional developments. They are most applicable for impervious areas where there are low levels of fine particulates in the runoff and the site is completely stabilized and the potential for possible sediment loads is very low. Do not use Infiltration trenches for manufacturing and industrial sites where there is potential for high concentrations of soluble pollutants and heavy metals. 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.

Design Criteria

- The maximum drainage area for any one infiltration trench is five (5) acres.
- Direct runoff from areas draining to infiltration practices thorough stabilized vegetated filters at least 20-feet in length.
- Underlying soils have an infiltration rate of 0.3-inches per hour or greater determined from site-specific field soil boring samples.
- Do not place infiltration practices in fill material because piping along the fill-natural ground interface may cause slope failure.
- The area of the infiltration trench is determined from the following equation:

$$A = \frac{V}{\left(nd + \frac{kT}{12}\right)}$$

Where:

A = Surface area of infiltration trench (feet^2)
V = Water Quality volume (1-inch)
n = Porosity of stone in infiltration trench (0.3 to 0.5 depending on stone)
d = Depth of trench (ft)
K = Percolation rate of soil (in/hour)
T = Fill time (hours) (A fill time of 2 hours is recommended for most design calculations).

- Use a conservative porosity value (n) of 0.32 in volume calculations unless an aggregate specific value is known.
- Design at least (½)-feet between the bottom of the infiltration trench and the elevation of the seasonally high water table, whether perched or regional.
- Determine the seasonally high water table using on-site soil borings and textural classifications to verify the actual site and seasonal high water table conditions.
- The minimum depth of the excavated trench is 3-feet, the maximum depth is 8-feet, and the trench is lined with a permeable geotextile filter fabric.
- Locate infiltration practices greater than 3-feet deep at least ten feet from basement walls.
- Locate infiltration practices a minimum of 150-feet from any public or private water supply well.
- The maximum width of the infiltration trench is 25-feet.
- The stone fill media consists of 1.0- to 2.5-inch D_{50} crushed stone with 6-inches of pea gravel located on top separated by a permeable geotextile filter fabric. This filter fabric prevents sediment from passing into the stone media, and should be easily separated from the geotextiles that protect the sides of the excavated trench.
- Install a 6-inch sand filter or permeable filter fabric on the bottom of the trench.
- The maximum slope bottom of the infiltration practice is 5 percent.
- Design the infiltration trench to fully de-watered within a 24- to 72-hour period depending on trench dimensions and soil type.
- Install an observation well spaced a maximum of 100-feet. The well is made of 4- to 6-inch PVC pipe. Extend the well to the bottom of the trench. The observation well shows the rate of de-watering after a storm event, and helps predict when maintenance is required. Install the observation well along the centerline of the trench, and flush with the ground elevation of the trench. Cap the top of the well and lock it to discourage vandalism and tampering.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of infiltration trenches as designed. Maintenance responsibility for the infiltration trench should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of the Storm Water Management Permit approval. Typical maintenance responsibilities include:

- Keep a record of the average de-watering time of the infiltration trench to determine if maintenance is required.
- The top 6-inch layer of pea gravel and geotextile separating the pea gravel from the stone media serve as a sediment barrier and require replacement when full of sediment.
- 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 complete failure is observed, perform total rehabilitation by excavating the trench walls to expose clean soil, and replacing the gravel, geotextiles, and topsoil.

Average Pollutant Removal Capability

Total Suspended Solids:	80%-90%	Metals:	70%-85%
Copper:	50%-60%	Lead:	80%-90%
Zinc:	80%-90%	Total Phosphorus:	50%-60%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	90%-98%
Hydrocarbons:	85%		

Infiltration Trench

Summary of Maintenance Requirements

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
Check observation wells after 72 hours of rainfall. 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

Enhanced Dry Swales

Description

Enhanced dry swales are conveyance channels engineered to capture, treat, and release the storm water quality runoff volume from a particular drainage area. Enhanced swales are different from normal drainage swales in that they have a designed structure implemented in them to enhance detention and storm water pollutant removal. Enhanced dry swale systems are designed primarily for storm water quality and have only a limited ability to provide storm water runoff volume control and downstream channel protection. Enhanced dry swales are vegetated channels designed to include a filter bed of prepared soil that overlays an underdrain system. Dry swales are sized to allow the entire water quality storage volume to be filtered or infiltrated through the swale bottom. Because these swales are predominantly dry, they are preferred in residential settings.

When and Where to Use It

Enhanced swales are applicable in moderate to large lot residential developments and industrial areas with low to moderate density where the impervious cover (parking lots and rooftops) of the contributing drainage areas is relatively small. Enhanced swales are also useful along rural roads and highways that have driveway entrances crossing the swale.

Design Criteria

Design enhanced swales with minimal channel slope, forcing the flow to be slow and shallow. This aspect of the enhanced swale allows particulates to settle out of the runoff and limits the effects of erosion. Place berms, check dams, weirs, and other structures perpendicular to the swale flow path to promote settling and infiltration.

- Enhanced swales are open conveyance channels that have a filter bed of permeable soils overlaying an underdrain system. Runoff is detained in the main swale section where it filters through the filter bed. The runoff is then collected and conveyed to the desired outlet through a perforated pipe and gravel system.
- The maximum designed de-watering time is 48 hours, with the recommended de-watering time being 24-hours.
- Enhanced swales have a contributing drainage area less than five (5) acres.
- Design the swale to capture the required water quality runoff volume, and safely pass larger flows. Flow enters the swale through a pretreatment forebay or along the sides of the swale as sheet flow produced by level spreader trenches along the top of the bank.
- Limit swale slopes between 1 and 2 percent, unless site topography dictates larger slopes. In this instance, place drop structures in the swale to limit the slope of a particular section of the swale. Set the spacing between drop structures a minimum of 50-feet. Add energy dissipation techniques on the downstream side of the drop structures.
- The maximum overall depth of the water quality runoff volume detained in the channel is 1.5-feet.
- The bottom width of the swale ranges between 2- and 8-feet where applicable to ensure an adequate filtration area. Wider channels may be designed to increase the filtration area, but consideration must be given to prevent uncontrolled sub-channel formation.
- The maximum side slopes of the swale are 2H:1V, and 4H:1V is recommended for ease of maintenance and for side inflow to remain as sheet flow.
- Design the peak velocity for the 2-year 24-hour storm event to be non-erosive for the soil and vegetation selected for the swale.

Filter Bed

The filter bed for an enhanced dry swale consists of a permeable soil layer at least 2.5-feet deep. The drainage pipe is a minimum 4-inch diameter perforated PVC pipe (AASHTO M 252) in a 6-inch gravel layer. Select a soil media that has a minimum infiltration rate of 1.0-foot per day, and a maximum infiltration rate of 1.5-feet per day. Place a permeable geotextile filter between the gravel and the overlaying permeable soil.

Forebay

Protect flow inlets to an enhanced dry swale forebay to reduce erosive forces of the runoff. The preferable material is a TRM. Riprap may also be used. Provide swale pretreatment with a sediment forebay. The pretreatment volume is equal to 0.1-inches per impervious acre of the drainage area. The forebay is typically provided by designing a check dam at the inlet of the swale.

Outlet Structures

The underdrain system of the enhanced dry swale discharges to the storm drainage system on site, or discharges to a stable protected outlet point.

Overflows

For maximum performance, enhanced dry swales are recommended to be off-line structures. If a swale is designed to be an online structure, it must be able to safely pass the 25-year 24-hour storm event.

Landscape Plan

Design the enhanced dry swale landscape plan to include the type of turf grass species required along with a permanent maintenance guideline. Have the planting plan prepared by a qualified landscape architect, botanist or qualified extension agent.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of enhanced swales. Maintenance responsibility should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

The surface of the filter bed may become clogged with fine sediments over time. Light core aeration is required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Mowing to maintain storage volume and appearance as needed.
- Remove trash and debris as needed.

Average Pollutant Removal Capability

Total Suspended Solids:	70%-80%	Hydrocarbons:	65%
Total Phosphorus:	35%-50%	Lead:	60%-70%
Pathogens/Bacteria:	10%-60%	Copper:	15%-45%
Total Nitrogen:	40%-60%	Zinc:	40%-65%

Enhanced Swales

Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height and remove clippings.	As needed (frequent/seasonally)
Nutrient and pesticide management.	Annual, or as needed
Inspect side slopes for erosion and repair.	Annual, or as needed
Inspect channel bottom for erosion and repair.	Annual, or as needed
Remove trash and debris accumulated in forebay.	Annual
Inspect vegetation. Plant an alternative grass species if original cover is not established.	Annual (semi-annually first year)
Inspect for clogging and correct the problem.	Annual
Roto-till or cultivate the surface of the bed if swale does not draw down in 48 hours.	As needed
Remove sediment build-up within the bottom of the swale.	As needed, after 25% of the original design volume has filled

Pre-Fabricated Control Devices

Description

The need for urban water quality BMPs that are very efficient and present less space constraints has produced the industry of innovated storm water BMP technology and products. These 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 80 percent TSS removal goal alone, they can provide excellent pre-treatment in a series of water quality control BMPs or inlet to permanent pool detention basins or storm water wetlands.

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 storm water conveyance systems for pretreatment of storm water 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 classified in to three separate categories:

1. Catch Basin Inserts
2. Separation Devices
3. Filtration Devices

When and Where to Use It

Pre-fabricated control devices may be used to treat runoff as long as they are designed to treat the first 1-inch of runoff and/or are proven to provide 80 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.

Design

Catch Basin Inserts

Catch Basin Inserts are defined as 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.

Catch Basin Insert Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals	NA
Copper:	35%-70%	Lead:	50%-90%
Zinc:	35%-90%	Total Phosphorus:	55%-70%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	10%-60%

Catch Basin Inserts

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.

Separation Devices

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.

Filtration Device

Separation and Filtration Device Average Pollutant Removal Capability

Total Suspended Solids:	80%	Metals	60%
Copper:	50%	Lead:	60%
Zinc:	70%	Total Phosphorus:	40%
Total Nitrogen:	30%	Hydrocarbons:	80%

Products

There are many pre-fabricated water quality structures on the market that may be used as water quality control BMPs.

Installation

Install 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 pre-fabricated storm water quality BMPs function as designed. These structures are not interned 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.

Inspection and Maintenance

- 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. Lack of maintenance is the most common cause of failure for post construction pre-fabricated storm water quality BMPs.

- Remove accumulated sediment and other trapped pollutants when the BMP becomes full. Typical removal of pollutants requires the use of a Vactor truck.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Inspect separation and filtration units.	Regularly (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

Vegetated Filter Strips

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.

When and Where to Use It

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 re-suspended as would occur in a concentrated flow channel. When the 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.

Design Criteria

Select a vegetation type, a ground slope, filter strip width, and strip length. Locate VFS on the contour perpendicular to the general direction of flow. Select vegetation to be dense, turf-forming grass in order to minimize water channelization. Never assume that natural vegetation is adequate for VFS. Design a ponding area at the leading edge of the VFS for bedload deposition.

General Design Requirements

a. Select an applicable area for the VFS
   Minimum Ground Slope = 1 percent
   Maximum Ground Slope = 10 percent
b. Select a vegetation type.
c. Select the design life and maximum allowable sediment deposition. A design life of 10 years and deposition of 0.5-feet is recommended.
d. Estimate the long-term sediment yield entering the filter strip and a 10-year 24-hour design single-storm sediment yield.
e. Determine desired Trapping Efficiency- 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.
f. Estimate the filter length necessary to prevent deposition within the filter greater than 0.5-feet. (Assume filter width is equal to disturbed area width but no smaller than 15-feet.)
g. Use the filter length to calculate Trapping Efficiency for the design storm.
h. Repeat (d) and (e) until the lengths match.

Inspection and Maintenance

- Maintenance is very important for filter strips, particularly in terms of ensuring that flow does not short circuit the practice. They require similar maintenance to other vegetative practices.
- 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.

Average Pollutant Removal Capability

75 feet in length		150 feet in length		Average	
Total Suspended Solids:	54%	TSS:	84%	TSS:	70%
Lead:	16%	Lead:	50%	Metals	40%-50%
Zinc:	47%	Zinc:	47%	Total N:	30%
Total Phosphorus:	- 25%	Total Phosphorus:	-40%	Total P:	10%
Nitrate Nitrogen:	-27%	Nitrate Nitrogen:	-20%	Nitrate Nitrogen:	0%
				Pathogens/Bacteria:	NA

Roadside Vegetated Filter Strip

Summary of Maintenance Requirements

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

Grass Paving and Porous Paving Surfaces

Description

Grass Paving

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used such as fire lanes and overflow parking where applicable. A variety of grass paving materials are available on the market. 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.

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 parking lot storm water to infiltrate directly and receive water quality treatment, and also reducing runoff from the sit

When and Where to Use It

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. Porous pavement also has highway applications where it is used as a surface material to reduce hydroplaning.

Porous pavements are a good option in ultra-urban areas because they consume no space since there is very little pervious area in these 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. The best application of porous pavement for retrofits is on individual sites where a parking lot is being resurfaced.

Design Criteria

Take soil boring to a depth of at least 4 feet below bottom of stone reservoir to check for soil permeability, porosity, depth of seasonally high water table, and depth to bedrock.

Not recommended on slopes greater than 5% and best with slopes as flat as possible.

Minimum setback from water supply wells: 100 feet.

Minimum setback from building foundations: 10 feet down gradient, 100 feet upgradient.

Not recommended where wind erosion supplies significant amounts of sediment.

Use on drainage areas less than 15 acres.

Minimum soil infiltration rate of 0.3-0.5 inches per hour.

Typically design for storm water runoff volume produced in the tributary watershed by the 6-month, 24-hour duration storm event.

A typical porous pavement cross-section consists of the following layers:

1) Porous asphalt course 2-4 inches thick,
3) Reservoir course of 1.5 to 3 inch stone,
2) Filter aggregate course, and
4) Filter fabric.

Use a geotextile meeting AASHTO M288 Class 1, 2, or 3 in all cases as a filter to protect the long-term performance of the system.

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.

Grass Paver

Porous Paving