Greenville County Technical Specification for:

WQ-12 VEGETATED FILTER STRIP

1.0 Vegetated Filter Strip

1.1 Description

Vegetated Filter Strips are gently sloping, densely vegetated areas that filter, slow, and infiltrate sheet flowing Stormwater. Filter strips are best utilized to treat runoff from roads, highways, roof drainage, and pervious surfaces. In highly impervious areas, filter strips should be used for pretreatment for other Best Management Practices (BMPs) such as a Bioretention areas and Infiltration Trenches. Vegetated Filter Strips can consist of turf grasses, or natural vegetation.

The use of indigenous vegetated areas that have surface features that disperse runoff is encouraged, as the use of these areas will also reduce overall site disturbance and soil compaction. Indigenous areas that have surface features that concentrate flow are not acceptable. Runoff must be distributed as sheet flow so that erosive conditions cannot develop. The vegetation in Vegetated Filter Strips must be dense and healthy.

1.2 Design

1.2.1 General Design Requirements

The slope of the Vegetated Filter Strip should not exceed 8%. The minimum flow length of the Vegetated Filter Strip is **35 feet.** Ensure the water quality runoff discharges to a 35-foot minimum vegetated filter area width (or a width that achieves 85% TSS removal through the use of a pollutant loading model such as IDEAL that is acceptable to County).

For an effective Vegetated Filter Strip, it is essential to prepare the soils properly and plant and maintain a dense, vigorous stand of turf grass sod. Use Tall Fescue or Common Bermuda grass as the main permanent turf-type vegetation for engineered Vegetated Filter Strips.

Natural vegetation can be used as cover for Vegetated Filter Strips when:

- The natural vegetation consists of an existing dense herbaceous buffer,
- The herbaceous buffer has an existing minimum ground cover of 90%, and
- The area is validated by Greenville County during a field site visit.

Vegetated Filter Strips will not contain any natural draws or channels. If the buffer is herbaceous in nature but does not contain a thick stand of vegetation, then add additional turf-type vegetation species to stabilize the ground surface.

A shallow or seasonally high groundwater table will inhibit the opportunity for infiltration. Therefore, the lowest elevation in the Vegetated Filter Strip is at least 2 feet above the water table

Do not remove trees to create the necessary Vegetated Filter Strip area.

Vegetated Filter Strips may be designed to discharge to a variety of features, including natural buffer areas, vegetated swales, infiltration basins, or other structural BMPs.

Vegetation must be established prior to receiving flow. A temporary Stormwater diversion is necessary until the vegetation in the Vegetated Filter Strip is stabilized. The Vegetated Filter Strip will retain the capacity to pass flow without erosion. Since stable vegetation must be established in the Vegetated Filter Strip before it can be put on-line, consider the time of year as construction may be limited to the growing season in order to ensure that a vegetated cover is established.

It is crucial that the slope and vegetation of the proposed natural herbaceous Vegetated Filter Area be surveyed in the field to ensure that the vegetation and slopes comply with requirements of this Specification.

1.2.2 Sheet Flow Requirements

Level spreading devices or other measures are required to provide uniform sheet flow conditions at the interface of the Vegetated Filter Strip and the adjacent land cover. Ensure concentrated flows do not discharge to the Vegetated Filter Strip, as they lead to erosion and failure of the system. Completely impervious drainage areas with flow lengths greater than 25 feet discharging directly to Vegetated Filter Strips require a level spreader meeting the requirements of the Level Spreader Specification.

Other level spreading applications can be used for flow lengths less than 25 feet when contributing drainage areas are graded to provide sheet flow runoff into the Vegetated Filter Strip. Examples of level spreader applications with flow lengths less than 25 feet include:

- A gravel-filled trench, installed along the entire up gradient edge of the Vegetated Filter Strip. Use gravel having a size range of ASTM D 448 size No. 6 (1/8-inch – 3/8-inch). Trenches are typically 12 inches wide and 24 inches to 36 inches deep, and are lined with a non-woven geotextile. When placed directly adjacent to an impervious surface, provide a drop (between the pavement edge and the trench) of 1 to 2 inches in order to inhibit the formation of the initial deposition barrier.

- Curb stops with cut outs. The cut out height is no greater than 1-inch with a maximum length of 6 inches. Space cutouts no less than 6 feet apart on center.

1.3 Variations

Vegetated Filter Strip effectiveness may be enhanced through the addition of a pervious berm at the toe of the slope. A pervious berm allows for greater runoff velocity and volume reduction resulting in better pollutant removal ability, by providing a very shallow, temporarily ponded area.

The berm has a height of 6 to 12 inches and is constructed of sand, gravel, and sandy loam to encourage vegetative cover. Provide an outlet pipe(s) or overflow weir to ensure that the area drains within 24 hours, or to convey larger storm events. The berm is erosion resistant under the full range of storm events. The ponded area is planted with vegetation that is resistant to frequent inundation. Check dams may be implemented on Vegetated Filter Strip with slopes exceeding 5%.

Construct check dams of durable, nontoxic materials such as rock, brick, wood, not more than 6 inches in height, and placed at appropriate intervals to encourage ponding and prevent erosion. Care must be taken to prevent erosion around the ends of the check dams.

1.4 Installation

Begin Vegetated Filter Strip construction only when the up-gradient site has been sufficiently stabilized and temporary erosion and sediment control measures are in place. The Vegetated Filter Strip will be installed at a time of the year when successful establishment without irrigation is most likely. However, temporary irrigation may be needed in periods of little rain or drought.

Grade the Vegetated Filter Strip (if required) to the design slope using a box blade or similar equipment. Avoid driving heavy equipment through the Vegetated Filter Strip to prevent compaction.

Vegetated Filter Strip soils will not be compacted. Loosen the soil by raking, tilling or using a field cultivator. After the Vegetated Filter Strip soils have been loosened, add topsoil or compost. Add lime and fertilizer based on the results of a soil test. Establish a permanent stand of vegetation preferably by sodding.

Construct level spreader device at the up-gradient edge of the Vegetated Filter Strip. For gravel trenches, do not compact the subgrade.

The preferred installation of surface cover for Vegetated Filter Strip is Sodding with turf grass sod. The Vegetated Filter Strip may be seeded and protected with an Erosion Control Blanket, but sodding is the preferred installation methods. Additional vegetation such as trees and shrubs may be planted, if proposed. Follow these steps to install sod for filter strips:

1. Make sure the soil is moist (but not overly wet) before laying sod. Irrigating the soil several days before delivery is often adequate.

2. Install the Sod within 24 hours of delivery. Plan to un-stack and unroll the sod if it cannot be laid within 48 hours.

3. While installing, keep sod in the shade to lessen the chance of heat buildup.

4. Start Sodding from a straight edge (driveway or sidewalk), and butt strips together, staggering them in a bricklike pattern

5. Avoid stretching sod. Use a knife or sharp spade for trimming to fit irregularly shaped areas.

6. Lay sod lengthwise across the face of slopes, and peg or stake the pieces to prevent slippage. After the sod has been placed, roll the lawn to ensure good sod-to-soil contact.

7. Begin watering.

Once the Vegetated Filter Strip is sufficiently stabilized, remove temporary erosion and sediment controls. It is very important that Vegetated Filter Strip vegetation be fully established before receiving upland Stormwater flow. One full growing season is the recommended minimum time for sod establishment.

Frequent watering is essential for the first week after placing Sod. Ensure the short roots on the Sod do not dry out. After root establishment, watering becomes less frequent but longer, encouraging the roots to grow deeper without stressing the plant. Any drought at this point can severely diminish the health of the placed sod. Gradually increasing the length of time between watering is important to develop a deep root system that can reach the moisture and nutrients needed to sustain long-term growth. Frequent light applications of watering results in a shallow-rooted plant, that is vulnerable to drought.

1.5 Maintenance

1.5.1 Preventive Maintenance and Operation Activities

The following list included reoccurring maintenance and operation activities that are required to maintain a functional filter strip.

- Once a year, re-seed the Vegetated Filter Strip with primary turf- type vegetation to maintain a dense growth of vegetation
- Maintain a stable ground cover in the drainage area to reduce the sediment load to the vegetation.
- Mow Vegetated Filter Strip as needed during the growing season. Turf grass should not be cut shorter than 3 to 5 inches and may be allowed to grow as tall as 12 inches depending on aesthetic requirements
- Aerate the Vegetated Filter Strip once a year.
- Once a year perform a soil test and add lime and fertilizer as required.

1.5.2 Intermittent Maintenance and Repairs

Table 1 includes typical intermittent maintenance needs and repairs with remediation suggestions for each potential problem.

Table 1: Intermittent Maintenance and Repairs

BMP Element:	Potential problem:	How to remediate the problem:
Level Spreader-VFS system	Trash/debris is present.	Remove the trash/debris.
Flow splitter device (if applicable)	The flow splitter device is clogged.	Unclog the conveyance and dispose of any sediment off-site.
	The flow splitter device is damaged.	Make any necessary repairs or replace if damage is too large for repair.
Level Spreader	The swale is overgrown with vegetation.	Mow vegetation. Re-grade and vegetate if the swale has become silted in.
	The level lip is cracked, settled, undercut, eroded or otherwise damaged.	Repair or replace lip.
	There is erosion around the end of the level spreader that shows Stormwater has bypassed it.	Re-grade the soil to create a berm that is higher than the level lip, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Trees or shrubs have begun to grow on the swale or just downslope of the level lip.	Remove them.
Bypass channel	Areas of bare soil and/or erosive gullies have formed.	Re-grade the soil if necessary to remove the gully, and then reestablish proper erosion control.
	Turf reinforcement is damaged or riprap is rolling downhill.	Study the site to see if a larger bypass channel is needed (enlarge if necessary). After this, reestablish the erosion control material.
Vegetated Filter Strip	Grass is too short or too long (if applicable).	Maintain grass at a height of approximately 3 to 6 inches.
	Areas of bare soil and/or erosive gullies have formed.	Re-grade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Sediment is building up on the filter strip.	Remove the sediment and re-stabilize the soil with vegetation if necessary. Provide lime and a one-time fertilizer application.
	Grass is dead, diseased, or dying.	Determine the source of the problem: soils, hydrology, disease, etc. Remedy the problem and replace plants. Provide a one-time fertilizer application.
	Nuisance vegetation is choking out grass.	Remove vegetation by hand if possible. If pesticide is used, do not allow it to get into the receiving water.

1.6 Marking Permanent Vegetated Filter Strips and Final Plat Requirements

Clearly mark the Vegetated Filter Strip area during construction to prevent unnecessary disturbance. Prior to the initiating of land disturbing activities, ensure construction layout surveys include staking and labeling of the Vegetated Filter Strip area. Use a combination of staking, flagging, construction fencing and/or other methods to ensure adequate visibility of the Vegetated Filter Strip area during construction activities.

Ensure the final plat shows the exact boundary of the Vegetated Filter Strip prepared by a registered surveyor.

Ensure the final plat contains the following statement:

"This property contains a Vegetated Filter Strip Stormwater BMP that must be maintained in perpetuity in accordance with the recorded Operations and Maintenance Agreement by the responsible property owner. No clearing, grading, construction or disturbance is permitted in the Vegetated Filter Strip.

1.7 IDEAL Modeling

The County's preferred method of demonstrating compliance with its water quality standard is to use the IDEAL model. To facilitate use of this model, Table 2 shows how to represent this BMP and BMPs similar to this one in the IDEAL model. It lists the parameters needed to successfully run the model and the parameters that affect the trapping efficiency of the BMP.

Table 2: IDEAL Modeling Guide

<table>
<tr><th colspan="3">Vegetative Filter Strip Modeling in IDEAL</th></tr>
<tr><td>What to Model as in IDEAL</td><td colspan="2">Vegetative Filter Strip; if a gravel trench is to be used before the VFS, it should be modeled in IDEAL as a separate infiltration trench.</td></tr>
<tr><td>Similar BMPs</td><td colspan="2">Permanent Water Quality Stream Buffers</td></tr>
<tr><td rowspan="4">Specifications Needed for IDEAL</td><td colspan="2">Dimensions, slope, and % peak flow for routing of the filter strip</td></tr>
<tr><td colspan="2">Direct loading of bacteria that will be entering the filter strip</td></tr>
<tr><td colspan="2">Land use and type of vegetation</td></tr>
<tr><td colspan="2">Direct loading of bacteria that will be entering the filter strip</td></tr>
<tr><td rowspan="4">Parameters that Drive Performance</td><td>Feature</td><td>How Value Affects Sediment Trapping Efficiency (TE)</td></tr>
<tr><td>Width (perpendicular to flow)</td><td>Increasing width slows velocity and increases TE</td></tr>
<tr><td>Slope</td><td>Flatter slope slows velocity and increases TE</td></tr>
<tr><td>Underlying Soil Texture</td><td>Soils with higher infiltration capabilities increase TE</td></tr>
</table>

1.8 References

NCDENR Stormwater BMP Manual, Chapter 8 Level Spreader Grass Filter, Chapter Revised 03-09-10

City of Pennsylvania, Stormwater Best Management Practices Manual, Chapter 6 – Vegetated Filter Strip

New Jersey Stormwater Best Management Practices Manual, Chapter 9.10 – Standards for Vegetative Filters