

2.2 Filter Strip

PURPOSE & DESCRIPTION

Filtrex® Filter Strips are a **temporary or permanent vegetative filtration** practice used to reduce the amount of sediment and soluble pollutants, such as nutrients, heavy metals, and petroleum hydrocarbons, in storm water runoff prior to leaving a site or entering a receiving water or wetland. The primary purpose of a filter strip is to reduce sediment and pollutant loading of surface sheet flow runoff and subsurface flow (interflow) by:

- Reducing pollutant loads by reducing runoff volume,
- Reducing runoff volume through increased water holding capacity and infiltration,
- Increasing infiltration by reducing runoff velocity,
- Trapping and settling of pathogens and sediment by reducing runoff velocity,
- Chemical adsorption of nutrients and metals to humus colloids in compost,
- Recycling of nutrients and metals by plant uptake and microbial decomposition and uptake.

Filter strips consist of a 1 to 2 in (25-50mm) deep layer (135 to 270 cubic yards/acre, 257 to 513 cubic meters/ha) of Filtrex® GrowingMedia™ blended with a specified seed mix and applied to ground surfaces with pneumatic blower trucks. Planting of perennials such as shrubs and trees will also improve storm water infiltration and filtration of pollutants in storm water.

APPLICATION

Filter strips are generally used for post construction applications where permanent vegetation is established to increase infiltration of storm water and filtration of storm water pollutants. Locations where filter strips may be required or recommended to filter storm runoff include:

- From highways, streets, and parking lots,
- Prior to surface waters, riparian areas, and wetlands,
- Above stream bank or shoreline structural stabilization projects,
- Prior to channels and ditches,
- Prior to bioretention ponds, rain gardens, and storm water detention ponds,
- Around site perimeters where land disturbing/construction activities may occur,
- Prior to structural sediment control devices as a pretreatment practice,
- Around and prior to sediment detention ponds where land disturbing/construction activities may occur.

Filter strips can also be designed to reduce runoff velocity leaving or entering the locations described above. Reducing runoff velocity will increase infiltration of storm runoff, thereby reducing runoff volume and pollutant loading (by increasing the propensity for sediment deposition and decreasing the propensity for pollutant transport). Additionally, GrowingMedia in filter strips will further reduce pollutant loading in storm water by reducing runoff volume and increasing chemical adsorption of soluble pollutants.

Filter strips are generally used in permanent, post-construction applications where a variety of vegetation including legumes, grasses, shrubs and trees can be utilized; however, temporary applications that include fast establishing grasses on or near land disturbing/construction activities are acceptable.

Filter strips can be applied as part of a Low Impact Development design plan or to assist in point accrual in LEED

Green Building Certification programs (Filtrex® Tech Link #3301 and #3306).

ADVANTAGES AND DISADVANTAGES

Advantages

- Filter strips can be used to filter pollutants and infiltrate storm water entering or leaving areas where storm water may pass, collect, drain, or be stored.
- Filter strips remove pollutants from storm water by plant uptake and adsorption to humus colloids present in compost.
- Filter strips remove pathogens and pesticides from storm runoff preventing pollution of receiving water bodies.
- Filter strips can be used for permanent or temporary vegetation pollutant filtration applications.
- Filter strips slow runoff velocity, thereby increasing sediment deposition, reducing the erosive energy of runoff and the potential for soil erosion, and pollutant transport.
- Filter strips absorb rainfall and runoff water, thereby increasing infiltration and reducing runoff volume, sheet erosion, and pollutant loading.
- Filter strips have the ability to bind and adsorb soluble nutrients, metals, and hydrocarbons that may be in storm water runoff, thereby reducing loading to nearby receiving waters.
- Microorganisms in filter strips have the ability to degrade organic pollutants and cycle captured nutrients into beneficial and/or less toxic forms.
- Filter strips are easily applied and establish vegetation in difficult areas.
- Filter strips can easily be spot applied or used with rolled erosion control blankets (RECBs) and turf reinforcement mats (TRMs).
- Filter strips dissipate the energy of rainfall impact, thereby reducing splash erosion.
- Humus colloids and organic matter in filter strips provide physical structure for seed and establishing seedlings.
- Humus colloids and organic matter in filter strips provide increased water holding capacity and reduced water evaporation to aid in seed germination and the potential for reduced irrigation.
- Filter strips can increase ground water recharge by increasing infiltration and percolation.
- Filter strips are a good option for arid and semiarid regions where

ADVANTAGES			
	LOW	MED	HIGH
Installation Difficulty	✓		
Sediment Control		✓	
Solluable Pollutant Control			✓
Infiltration Reduction		✓	
Runoff Velocity Reduction		✓	
Vegetation Establishment			✓

germination, moisture management, and irrigation can be difficult.

- Filter strips provide organic nutrients that slow release for optimum efficiency to establishing vegetation.
- Filter strips provide organic nutrients that are less prone to runoff transport and pollution of surface waters relative to mineral nutrients supplied by fertilizers.
- Filter strips are organic, all natural, biodegradable, and locally manufactured.
- Filter strips increase soil organic matter which may reduce runoff and erosion, and increase plant sustainability through improved soil quality over the long term.
- Filter strips are easily designed and incorporated as one treatment in a treatment train approach to storm water management.
- Filter strips are used as an integrated management practice for Low Impact Development design and for possible point accrual in LEED Green Building Certification programs.
- Filter strips may assist in qualification for LEED® Green Building Rating and Certification credits under LEED Building Design & Construction (BD+C), New Construction v4. Awarded credits may be possible from the categories of Sustainable Sites, Water Efficiency, Materials & Resources, and Innovation. *Note: LEED is an independent program offered through the U.S. Green Building Council. LEED credits are determined on a per project basis by an independent auditing committee. Filtrex neither guarantees nor assures LEED credits from the use of its products. LEED is a trademark of the U.S. Green Building Council.*

Disadvantages

- If a filter strip does not use Filtrex® GrowingMedia™, performance may be diminished.
- If not installed correctly, maintained or used for a purpose or intention that does not meet specifications, performance may be diminished.
- If vegetation does not establish or cover density is low, performance will be diminished.
- Filter strips should not be the only form of site or watershed storm water management.
- Filter strips should not be used without structural reinforcement in areas of concentrated runoff flow.
- Filter strips should not be used without structural reinforcement on slopes greater than 4:1.
- Filter strips may need to be reapplied if significant runoff occurs prior to vegetation establishment or where vegetation fails.
- Filter strips require sufficient land area for optimum performance
- Filter strip performance is generally low prior to vegetation establishment and maturity.
- Filter strips may be difficult to establish in arid regions and drought prone seasons.
- Filter strips should not be used where contributing sediment loads are greater than 10 ton/acre/year (22.5 Mg/ha/yr).

GROWINGMEDIA™ CHARACTERISTICS

Filtrex® Filter Strips use only Filtrex® GrowingMedia™ which is a composted material that is specifically designed for rapid establishment and sustainability of vegetation growth and water absorption. GrowingMedia can be third party tested to meet minimum performance criteria defined by Filtrex International. Performance parameters include: percent cover of vegetation, water holding capacity, pH, organic matter, soluble salts, moisture content, biological stability, maturity bioassay, percent inert material, bulk density and particle size distribution. For information

on the physical, chemical, and biological properties of Filtrex GrowingMedia refer to Specifications in Section 5.2.

PERFORMANCE

QA/QC material testing of GrowingMedia to ensure specifications are met is conducted by the Soil Control Lab, Inc. Although performance testing and scientific research of Vegetated Filter Strips, Compost Erosion Control Blankets, and Compost Filter Socks has been conducted in the last 5 years, little has been conducted on Filter strips. Conservative assumptions can be made regarding filter strips in light of performance associated with the previously mentioned practices. For performance on these practices see Filtrex® Compost Erosion Control Blanket, Filtrex® Sediment Control, and supporting summaries of technical and research reports in the Appendices. Filtrex International is undergoing research to quantify the performance of filter strips to aid design professionals in the future. For a summary of current results from performance testing results see Table 2.2. *Note: the Contractor is responsible for establishing a working storm water management system and may, with approval of the Engineer, work outside the minimum construction requirements as needed. Where the filter strip deteriorates or fails, it shall be repaired or replaced with an effective alternative.*

DESIGN CRITERIA

Function

Filter strips are effective at filtering pollutants from storm runoff under sheet flow, subsurface flow, and shallow concentrated flow conditions due to physical trapping and runoff velocity reduction. Large particles are removed in greater efficiencies than suspended particles. Maintenance is a key consideration, as sediment build-up will significantly reduce the ability of the filter strip to remove pollutants from storm runoff. Pollutant removal efficiency has been correlated to the width of the vegetated filter strip, the density of the vegetation planted, absorption and infiltration characteristics the soil, slope degree, and slope length leading to the filter strip. The wider the filter strip, the denser the vegetative cover and/or the higher the water holding and infiltration properties of the soil – the greater the pollutant removal efficiency and performance of the vegetated filter strip.

Humus content within the compost GrowingMedia has the ability to chemically adsorb and bind soluble pollutants such as phosphorus, ammonium-nitrogen, heavy metals, and petroleum hydrocarbons, making them unavailable for plant or animal uptake (Filtrex® Tech Link #3307 and #3308). Additionally, many plants have the ability to take up excess nutrients and pollutants trapped in the vegetated filter, while microorganisms can decompose and/or incorporate these pollutants, making them less toxic to aquatic ecosystems. Organic matter supplied in GrowingMedia increases the water holding and infiltration properties of the soil/vegetation complex and increases diversity and population of microorganisms that can decompose and incorporate captured pollutants.

Planning Considerations

Filter strips should be used as one treatment in a treatment train approach to storm water management. Filter strips should be strategically located for connectivity of vegetation and wildlife habitat and corridors in the watershed. Runoff control and runoff diversion practices may be designed to help prevent seed washing and erosion control prior to vegetation establishment and to protect seedlings prior to mature establishment. Preconstruction meetings should be conducted to educate construction site personnel about the devices/practices used and acceptable traffic patterns that avoid

running over filter strips with vehicles and heavy equipment. Vehicular traffic and heavy equipment may reduce the effectiveness of filter strips and contribute to soil compaction, which may increase runoff and erosion and reduce vegetation establishment.

Vegetation Selection

Successful planning for any vegetation establishment project should consider climate, prevailing weather, temperature, sun exposure, prolonged moisture exposure, available moisture/irrigation requirements, topography, soil type, soil pH, soil amendments, nutrient requirements, drought tolerance, time/coordination with construction phases, site preparation/coordination with construction phases, protection from erosion and sedimentation, runoff velocity potential, and seed mix/plant selection (Fifield, 2001).

Quick establishing annual grasses and legumes are normally specified for temporary applications. Permanent vegetation is usually specified for areas that have undergone final clearing and grading and may require soil stabilization. Perennial grasses are typically specified and if possible native grasses and varieties should be utilized (Fifield, 2001; USDA-NRCS, 2004) as these will be better adapted to local climate, native soil, and hydrology. Permanent vegetated filter strips should also use a variety ecological stands, including legumes and densely planted deep rooted grasses, mid story shrubs, and tall woody tree species. If vegetated filter strips will be exposed to prolonged moisture, wetland species may be required. *Generally, tall and sturdy grasses are better at sediment removal than low growing, flexible grasses and legumes (Grismer et al., 2006; USDA-NRCS, 2004). Additionally, deep rooted grasses will be more stable under high sheet flow conditions or where concentrated flows may accumulate.*

Local landscape architects, NRCS, or cooperative extension should be consulted and used as resources for temporary and/or permanent vegetation establishment plant selection. Many state erosion and sediment control and storm water management manuals have specifications for seed and plant selection and planting requirements. VegSpec, a design program created by the USDA-NRCS, may be a helpful tool for seed and plant selection. It can be accessed at <http://plants.usda.gov>

Preparation and Application

The land area where filter strips will be applied shall be roughened by horizontal tracking, raking, disking, or harrowing prior to application. The filter strip shall be applied to 100% of the area where vegetation is required and applied at a depth of 1 to 2 in (25-50mm), or 135 to 270 cubic yards/ac (257-513 cubic meters/ha).

To increase infiltration and percolation rates, deep tillage or using a Filtrex® Engineered Soil is recommended; for more information see standard specifications and design.

To protect from ground water contamination and saturation of vegetation, vegetated filter strips should be separated from ground water from 2 to 4 ft (0.6-1.2 m) (USEPA, 2006).

Drainage Area and Slope Length

The principle design criterion for vegetated filter strips is length of slope, not the contributing area, as the slope length will determine whether concentrated runoff flows, interrill erosion, and destructive runoff velocities will undermine the performance of the vegetated filter strip. For impervious services, runoff concentrates at approximately 75 ft (23 m) of slope length, and for pervious surfaces at 150 ft (46 m) of slope length. Using these criteria, a 25 ft (8 m) wide vegetated filter 580 ft (177 m) long will treat 1 acre

(0.4 ha) of contributing runoff from an impervious surface (USEPA, 2006). Additionally, Filter strips should not be used where the contributing drainage area generates sediment loads greater than 10 tons/acre/year (22.5 Mg/ha/yr) (USDA-NRCS, 2004).

Alternatively, the USDA-NRCS (2004) recommends that if RUSLE R factors (soil erodability) are 0-35 the ratio of contributing area to filter strip should be 70:1; R factors between 35 and 175 should have a ratio of 60:1; and R factors above 175 should have a ratio of 50:1.

Slope Degree

Vegetated filter strips perform best on slopes between 2 and 6%. Slopes less than 2% may pond water. Slopes greater than 6% tend to concentrate runoff, which can reduce the effectiveness of the vegetated filter (USEPA, 2006). Vegetated filter strips are not recommended for slopes greater than 15% (Grismer et al., 2006).

Runoff Conditions

Filter strips should not be used in areas where runoff velocities will damage or undermine vegetation. *For most grasses a maximum velocity of 4 ft/sec (1.2 m/sec) or a maximum hydraulic shear stress of 2 lbs/ft² (10 kg/m²) is recommended (MD Storm Water Design Manual, 2000).*

Width

Pollutant removal efficiency of a vegetated filter strip increases with width. Where possible, vegetated filter strips should be constructed as wide as possible. The specifications in Table 2.1 should be used as a minimum requirement.

Table 2.1. Minimum Width Requirements by Slope Degree for Filter Strips

Slope	w/structural sediment control device	Minimum Width
1-3%	Yes	15 ft (5m)
1-3%	No	25 ft (5m)
4-7%	Yes	25 ft (5m)
4-7%	No	35 ft (5m)
8-10%	Yes	35 ft (5m)
8-10%	No	50 ft (5m)
11-15%	Yes	75 ft (5m)
11-15%	No	100 ft (5m)

Source: USEPA, 2006; USDA-NRCS, 2004.

Design Options

To maintain sheet flow conditions, reduce runoff velocity, and to act as a pretreatment system for sediment removal a shallow gravel trench (level spreader) may be constructed directly upslope from the vegetated filter strip (USEPA, 2006). The gravel trench should be a minimum of 12 in (300mm) wide and 12 in (300mm) deep and filled with pea gravel. Alternatively, a 12 or 18 in (300mm or 450mm) Filtrex® Sediment Control (SiltSoxx™) will provide the same function. Ponding depth should not exceed 12 in (300mm) (USEPA, 2006). Polypropylene shall be specified as the required Soxx material. At the down slope base of the vegetated filter strip another Filtrex® Sediment Control may be installed to slow runoff

velocity and increase the potential for settling of suspended solids in the filter strip.

Establishing & Sustaining Vegetation

Although filter strips increase water holding capacity and reduce evaporation, irrigation may be required to ensure successful establishment. Runoff diversion devices may be utilized to prevent storm runoff from washing seed prior to germination and establishment and reduce erosion prior to temporary stabilization.

Grasses should be mowed and maintained between 4 in. (100mm) and 10 in. (250mm) high. Taller grasses may have a higher sediment removal efficiency and sediment storage capacity than low growing or low maintained grasses.

Filter strips supply humus, organic matter, beneficial microbes, and slow release organic nutrients that can contribute to increased soil quality and plant health. In arid and semi-arid regions or hot and dry weather regular irrigation may be required.

Soil Amendment Function

Filter strips also amend the soil which can provide the following functional benefits: increased soil structure, increased soil aggregates, increased soil aeration, increased infiltration and percolation, increased moisture holding capacity, increased activity of beneficial microbes, increased availability of nutrients, decreased runoff volume and velocity, decreased erosion, and increased plant health and sustainability.

Organic vs. Fertilizer Nutrients

Although most specification and design manuals include fertilizer recommendations or requirements for vegetation, mineral nutrients from fertilizers may not be preferable where vegetation sustainability and water quality are a concern. Filter strips provide organic nutrients which are slow release, provide plant micronutrients, and are less likely to be transported in storm runoff to receiving waters – which can lead to pollution and eutrophication of waterways (Faucette et al, 2005).

Weed Establishment

The effects of mulching are known to suppress weed establishment. In addition, invasive weed growth has been more closely associated with mineral fertilizer than organic fertilizer fertility practices (Faucette et al, 2004).

INSTALLATION

1. Filter strips shall meet Filtrexx Filter Strip and Filtrexx Certified GrowingMedia Specifications.
2. Call Filtrexx at 877-542-7699 or visit www.filtrexx.com for a current list of installers and distributors of Filtrexx products.
3. Filter strips will be placed at locations indicated on plans as directed by the Engineer.
4. Filter strips shall be installed down slope and around areas contributing storm runoff polluted with sediment, nutrients, heavy metals, petroleum hydrocarbons, and/or pathogens.
5. Filter strips shall be applied to 100% of the area where a vegetated filter strip is required.
6. Filter strips shall be applied to the soil surface at a depth of 1 to 2 in (25-50mm) or 135 to 275 cubic yards/ac. (257-513 cubic meters/ha).
7. Filter strips designed for maximum infiltration may use Filtrexx® Engineered soil and should consult those installation specifications.
8. Seed shall be thoroughly mixed with the GrowingMedia prior

to application or surface applied with GrowingMedia at time of application.

9. Filter strips shall not be installed in areas of concentrated runoff flow.
10. Filter strips shall not be installed in areas where contributing sediment loads are greater than 10 tons/ac/yr (22.5 Mg/ha/yr).
11. Filter strips shall not be installed on slopes greater than 15%.
12. Filter strips shall be applied at a minimum width of 5 ft (4.5 m).

INSPECTION

Routine inspection should be conducted within 24 hrs of a runoff event for the first year after installation, until permanent vegetation has established, or as designated by the regulating authority. If sediment accumulation is 25% of the height of the vegetation, sediment removal is recommended. If rilling occurs or vegetation does not establish, the area of application should be reapplied with a filter strip. If failure continues, the use of runoff diversion devices, compost erosion control blankets, rolled erosion control blankets, or soil stabilizers should be considered. Vegetation practices should always be inspected for noxious or invasive weeds.

MAINTENANCE

1. The Contractor shall maintain the filter strip in a functional condition at all times and it shall be routinely inspected.
2. Filter strips shall be maintained until a minimum of 70% uniform cover of the applied area has been vegetated, permanent vegetation has established, or as required by the jurisdictional agency.
3. Filter strips may need to be irrigated in hot and dry weather and seasons, or arid and semi-arid climates to ensure vegetation establishment.
4. Where a Filter strips fails, rilling occurs, or vegetation does not establish the Contractor will repair or provide an approved and functioning alternative.
5. If a filter strip is damaged by storm water runoff, temporary runoff diversion devices installed above the filter strip may be required.
6. No additional fertilizer or lime is required for vegetation establishment and maintenance.
7. No disposal is required for this product/practice.
8. Regular mowing of filter strips to a minimum height of 4 in (100mm) and a maximum height of 10 in. (250mm) will deter invasive weeds, allow sunlight to kill captured pathogens, and provide maximum sediment removal efficiency and sediment storage capacity in the filter strip.
9. Sediment shall be removed once it reaches 25% of the height of the vegetation (mowed) to prevent diversion of storm runoff and reduction of vegetation health and cover.

METHOD OF MEASUREMENT

Bid items shall show measurement as 'Filtrexx® Filter Strip per square ft, per square yd, per square meter, per hectare, or per acre installed.

Engineer shall notify Filtrexx of location, description, and details of project prior to the bidding process so that Filtrexx can provide design aid and technical support.

FIELD APPLICATION PHOTO REFERENCES



Compost Vegetated Filter Strip Along Roadside



Filter Strip Applied During Construction



Filter Strip with a SiltSoxx™

ADDITIONAL INFORMATION

For other references on this topic, including additional research reports and trade magazine and press coverage, visit the Filtrexx website at filtrexx.com

Filtrexx International, Technical Support
877-542-7699 | www.filtrexx.com | info@filtrexx.com
Call for complete list of international installers and distributors.

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Table 2.2. Filter Strip Performance and Design Specifications

Performance & Design Reference	Width of Vegetated Filter	Vegetation Type	Slope	Pollutants Removed & Removal Efficiency
Parsons et al., 1991	14-17 ft (4-5 m)	Bermuda/ Crab Grass		Total P = 26% Total N = 50%
Barfield et al., 1992	15-30 ft (5-9 m)	Bluegrass/ Fescue Sod	9%	NH4-N = 92-100%
Young et al., 1980	45 ft (14 m)	Corn/Oat/ Orchard Grass	4%	Total P = 88% Total N = 87%
Young et al., 1980	45ft (14 m)	Sorghum-Sudan Grass	4%	Total P = 81% Total N = 84%
Doyle et al, 1997	13 ft (4 m)	Fescue	10%	Diss. P = 62% NO3-N = 68%
Dillaha et al., 1989	15-30 ft (5-9 m)	Orchard Grass	5-16%	Total P = 75-87% Total N = 61%
Patty et al., 1997	20-60 ft (6-18 m)	Ryegrass		TSS = 87-100% Soluble P = 22-89% NO3-N = 22-89%
Chi and Petrell, 2006				Iron = 95%
Ress, 1998	25 ft (8 m)			TS = 76-93%
Gilley et al., 2000	2.4 ft (0.7 m)			TSS = 50%
Desbonnette et al., 1994	15 ft (5 m)			TS = 50% Total N = 50% Total P = 50%
Desbonnette et al., 1994	100 ft (30 m)			TS = 70% Total N = 70% Total P = 70%
Yu et al., 1993	150 ft (46 m)			TSS = 84% Total P = 40% NO3+NO2-N = 20% Lead = 50% Zinc = 55%
Florida DOT, 1994				TSS = 70% Total P = 40-50% NO3+NO2-N = 10% Zinc = 40-50% Lead = 25%

Figure 2.1. Engineering Design Drawing for Filter Strip

