

SECTION 2: POST-CONSTRUCTION

Filtrex[®] Channel Protection (GroSoxx[®])

PURPOSE & DESCRIPTION

The **Filtrex[®] Channel Protection** soft armoring system is designed to stabilize and prevent erosion of channel beds and banks used for storm water conveyance and concentrated flow situations. The channel protection technology provides structural protection, erosion control, vegetation growth, and vegetation reinforcement in the same system. The channel protection weight and anchoring system can withstand storm runoff velocities and hydraulic shear stresses similar to traditional soft armoring devices (turf reinforcement mats, rip rap, cellular confinement systems). Channel protection uses GroSoxx[®] - Filtrex[®] Soxx[™] mesh, filled with composted Filtrex[®] GrowingMedia[™].

The vegetated channel protection system is specifically designed to reinforce vegetation against intense hydraulic pressure. Once permanent vegetation is established in the channel protection, the following storm water management parameters are increased:

- structural stability of the channel and protection system,
- reduction of bed and bank erosion,
- protection from scour erosion,
- control of runoff velocity,
- dissipation of runoff energy, and
- sediment, soluble pollutant, and pathogen removal efficiency.

APPLICATION

Channel protection is used where storm water is conveyed or channeled and soil erosion and/or vegetation stability is an issue. Channel protection can be used to establish, sustain, and reinforce vegetation in areas of concentrated flow and intense hydraulic pressure that typically undermine vegetation growth. Applications where channel protection is typically required include:

- storm water diversion channels and ditches,
- storm water conveyance channels and ditches,
- channel/ditch bed and bank protection, and

- outlet protection for storm drains, paved channels, and culverts.

Vegetated channel protection can be used to dissipate the energy of storm flows and reduce velocity leaving the locations described above. Reducing runoff velocity will decrease soil erosion and increase pollutant removal through trapping, sediment deposition and plant uptake.

Any storm water conveyance system should direct water outfall to any one of the following areas: storm water collection ponds, infiltration zones, densely vegetated fields, level spreaders, constructed wetlands.

ADVANTAGES AND DISADVANTAGES

Advantages

- Channel protection reduces erosion of storm water conveyance channels and ditches.
- Channel protection can be used to stabilize channel bed and banks.
- Channel protection can be used in hydraulic shear stresses up to 12 lbs/square ft (59 kg/square m).
- Channel protection can be used on channel bed slopes up to 10%.
- Channel protection can be used on channel bank slopes up to 2:1.
- Channel protection can be used on channel bank slopes up to 3:1 where mowing will be performed to maintain vegetation.
- Channel protection has greater surface contact with soil, channel bed, and channel banks,



Installation of channel protection



relative to rip rap, thereby providing greater protection from erosion.

- Channel protection soft armoring system includes GrowingMedia which establishes, sustains, and provides reinforcement for vegetation, unlike rip rap and other armoring devices.
- Channel protection can be direct seeded at the time of installation.
- Channel protection stability and channel protection/erosion prevention are increased with vegetation establishment within system.
- Vegetated channel protection filters sediment, soluble nutrients, heavy metals, petroleum hydrocarbons, pesticides, and pathogens from storm water flows.
- Vegetated channel protection slows runoff velocity, which can reduce erosion, increase infiltration, and increase sediment deposition and pollutant removal efficiency.
- Vegetated channel protection can remove pollutants from storm water by plant uptake.
- GrowingMedia in channel protection has 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 GrowingMedia have the ability to degrade organic pollutants and cycle captured nutrients into beneficial and/or less toxic forms.
- Contained GrowingMedia in channel protection creates an ideal system for biotechnical engineering projects.
- Humus colloids and organic matter in

GrowingMedia provide physical structure for seed, seedlings, and live stakes.

- Humus colloids and organic matter in GrowingMedia provide increased water holding capacity and reduced water evaporation to aid in seed germination, plant sustainability, and the potential for reduced irrigation.
- GrowingMedia provides organic nutrients that slow release for optimum efficiency to establishing vegetation.
- GrowingMedia provides organic nutrients that are less prone to runoff transport and pollution of surface waters, relative to mineral nutrients supplied by fertilizers.
- Channel protection is organic, all natural, biodegradable, and locally manufactured.
- Channel protection can be easily designed and incorporated as one treatment in a treatment train approach to site or watershed storm water management.
- Channel protection 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.*

ADVANTAGES			
	LOW	MED	HIGH
Installation Difficulty		✓	
Channel Protection			✓
Vegetation Establishment			✓
Maximum CFS/Shear Stress			✓
Runoff Velocity Reduction		✓	
Sediment Control		✓	
Soluable Pollutant Control		✓	

Disadvantages

- If Channel protection 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 may be diminished.
- Channel protection should not be the only form of site or watershed storm water management.
- Channel protection may need to be reseeded or reapplied if significant storm flow occurs prior to vegetation establishment or where vegetation fails.
- Channel protection performance is generally lower prior to vegetation establishment and maturity.
- Channel protection installation is a land



disturbing activity and can increase sediment loading if appropriate sediment control measures are not established during construction phase.

- Channel protection should not be used on channel bed slopes greater than 10%.
- Channel protection should not be used on channel bank slopes greater than 2:1.
- Channel protection should not be used on channel bank slopes greater than 3:1 where mowing will be performed to maintain vegetation.
- Channel protection may not function in hydraulic shear stresses over 12 lbs/square ft (59 kg/square m).

MATERIAL SPECIFICATIONS

Channel protection uses only Soxx photodegradable or biodegradable netting materials available from Filtrexx International, and are the only mesh materials accepted in creating Filtrexx Channel Protection for any purpose. For Soxx Material Specifications see Table 4.1

GROWING MEDIA CHARACTERISTICS

Filtrexx Channel Protection uses only Filtrexx® GrowingMedia™ which is a composted material that is specifically designed for stability within the system and establishment and sustainability of vegetation growth. GrowingMedia can be third party tested and certified to meet minimum performance criteria defined by Filtrexx 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 GrowingMedia refer to Specification 5.2 Filtrexx® GrowingMedia™.

PERFORMANCE

QA/QC material testing of Filtrexx GrowingMedia to ensure specifications are met is conducted by the Soil Control Lab, Inc. Research for channel protection is in progress. Performance testing and scientific research on related practices/technologies - vegetated filter strips, slope protection, and SiltSoxx™ has been conducted in recent years. Conservative assumptions can be made regarding channel protection in light of performance associated with the previously mentioned practices and applied field research. Filtrexx International has conducted research with the Texas Transportation Institute (TTI) of Texas A.M.



Installation After

University to quantify the performance and design limitations of Channel protection to aid engineering design professionals. See Table 4.3 for a summary of material specifications and Table 4.4 for a summary of performance testing results and design specifications. *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 channel protection fails, it shall be repaired or replaced with an effective alternative.*

DESIGN CRITERIA

Function

The primary functions of the channel protection (Figure 4.3) system are to prevent scouring and disperse energy of concentrated storm flow from outlets and culverts; and to stabilize drainage ditch and channel beds and banks to prevent erosion and reinforce vegetation against intense hydraulic pressure. Channel protection is unique in that GrowingMedia and seed are injected and contained within the structural armoring device. This system is ideal for biotechnical engineering and sustaining vegetation. The channel protection system is specifically designed to make contact with 100% of the soil surface in the channel bed and on channel banks, thereby protecting the structural integrity and preventing erosion.

Any storm water conveyance or drainage systems should be designed to lead or direct water outfall to any one of the following areas: storm water collection ponds, infiltration zones, densely vegetated fields, level spreaders, constructed wetlands.

Once vegetated, channel protection (Figure 4.3) is effective at filtering pollutants from storm runoff under sheet flow and concentrated flow conditions due to physical trapping and runoff velocity reduction by the vegetation. 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 vegetated channel protection to remove pollutants from storm runoff. Pollutant removal efficiency has been correlated to slope degree, area of vegetation, vegetation type, cover, height, and density.

Humus content within the 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 (Filtrexx Tech Link #3307 and #3308). Additionally, many plants have the ability to take up excess nutrients and pollutants trapped in the vegetation, while microorganisms can decompose and/or incorporate these pollutants, making them less toxic to aquatic ecosystems. Organic matter supplied in GrowingMedia increases the diversity and population of microorganisms that can decompose and incorporate captured pollutants.

Planning Considerations

Channel protection should be used as one treatment in a treatment train approach to storm water management. Preconstruction meetings should be conducted to educate construction site personnel about the devices/practices used and acceptable traffic patterns that avoid running over channel protection with vehicles and heavy equipment. Vehicular traffic and heavy equipment may reduce the effectiveness of channel protection and contribute to compaction, which may increase runoff and erosion and reduce vegetation establishment. *Note: any natural (not man-made) drainage ditch or channel stabilization and*

vegetation project requires permit and approval by the US Army Corp of Engineers.

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 and nurse crop applications. Perennial grasses are typically specified for permanent applications, and if possible native grasses should be utilized (Fifield, 2001; USDA-NRCS, 2004) as these will be better adapted to local climate, native soil, and hydrology. If Channel protection 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 storm flow velocity and shear stress.*

Local landscape architects, NRCS, or cooperative extension should be consulted and used as resources for seed and plant selection. Many state erosion and sediment control and storm water management manuals have specifications for seed and plant

Table 4.1. FHWA HEC 15 Retardance Class, Stand Height, and Permissible Shear Stress for Grasses used in Channels, Ditches, and Concentrated Flow Applications.

Class	Example of Vegetation	Stand Density	Average Stand Height	Permissible Shear Stress
A	Weeping Lovegrass, yellow bluestem	Excellent	>=76.2 cm (>= 30 in)	177 Pascal (PA) (3.7 lbs/ft ² , 18 kg/m ²)
B	Bermuda, blue grama, and native grass mixtures	Good	30.5 - 61 cm (12 - 24 in)	100 Pascal (PA) (2.1 lbs/ft ² , 10 kg/m ²)
C	Bermuda, Kentucky blue grass, centipede grass	Good	15 — 30.5 cm (6 - 12 in)	48 Pascal (PA) (1.0 lbs/ft ² , 5 kg/m ²)
D	Bermuda, buffalo, grass-legume mixture	Good	5 — 15 cm (2 - 6 in)	28 Pascal (PA) (0.60 lbs/ft ² , 3 kg/m ²)
E	Bermuda, native grass mixture	Good	<5 cm (< 2 in)	16 Pascal (PA) (0.35 lbs/ft ² , 2 kg/m ²)

(Source: ECTC - Erosion Control Technology Council, 2006)



selection, seeding rates, 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>

The hydraulic properties of grasses commonly used in ditches and channels have been characterized and grouped by the United States Department of Agriculture. Each class, A through E, is determined by height, density and stiffness of the vegetative stand. These properties affect the vegetation's surface roughness (Manning's "n") and its ability to withstand hydraulic pressure from concentrated flows (ECTC, 2006). Grass retardance classes and their corresponding permissible shear stress values are defined in the Federal Highway Administration HEC 15.

Runoff Velocity & Shear Stress

Channel protection should not be used in areas where runoff velocity or shear stresses will damage or undermine the system. 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) – unless vegetation reinforcement is utilized. Channel protection provides for a maximum shear stress of 12 lbs/square ft (59 kg/square m).

Traditionally, the flow velocity (ft/sec or m/sec) of a channel or ditch has been used to design for channel protection and stabilization. However, using ft/sec (m/sec) does not account for the pressure and stress created by depth of concentrated flow within the channel. Because the pressure created by flow depth is an important variable in channel bed erosion, using only ft/sec (m/sec) may not be the best criteria to design for channel bed and bank protection. Permissible shear stress (tractive or frictional force) on channel lining and protection devices may be a better design limit criteria, as shear stress determination includes depth of flow variables. Because shear stress within the area of a channel can be variable, generally the maximum shear stress is used as a design parameter rather than the mean. The area in a channel where shear stress is always greatest is where the depth of flow is greatest (and tractive or frictional force) – the channel bed. Therefore the maximum shear stress of a channel protection device reflects its performance and design limit in the channel bed, which should be sufficient for flow velocity and shear stress along the channel banks within the same channel.

To determine the maximum shear stress in a channel bed use:

$$T_{\max} = \gamma \times Y \times S$$

Where:

T_{\max} = maximum shear stress (lb/sq ft, kg/sq m)

γ = density of water (62.4 lb/cu ft, 1011 kg/cu m)

Y = depth of water (ft, m)

S = slope of gradient (ft/ft, m/m)

To determine the mean shear stress in a channel use:

$$T_{\text{mean}} = (\gamma \times A \times S)/P$$

Where:

T_{mean} = mean shear stress (lb/sq ft, kg/sq m)

γ = density of water (62.4 lb/cu ft, 1011 kg/cu m)

A = cross-sectional area (sq ft, sq m)

S = slope of gradient (ft/ft, m/m)

P = wetted perimeter

To determine velocity of flow in a channel use Manning's Equation:

$$V = (\alpha_1/n) \times R^{2/3} \times S^{1/2}$$

Where:

V = mean velocity of flow (ft/sec, m/sec)

R = hydraulic radius = A/P (ft, m)

A = cross-sectional area (sq ft, sq m)

P = wetted perimeter (ft, m)

S = slope of gradient (ft/ft, m/m)

n = roughness coefficient

α_1 = 1.0 for SI units, 1.496 for English units

Slope Degree

Channel protection can be used effectively in channel and ditch beds with slopes up to 10%. Typically channel and ditch banks do not exceed a 2:1 slope, however if mowing will be used to manage vegetation the maximum slope is typically 3:1. Channel protection can be used effectively for these slope applications.



Flow Dissipation

Storm flow dissipation from outlets for paved channels, culverts, and storm drains require the channel protection to be installed like an apron underneath, and around the sides of the outlet to prevent scour erosion. The channel protection apron should be at least 3 times the width of the diameter of the culvert pipe, and becoming wider down slope from the outflow following the width and shape of the channel. As a general rule, the larger the culverts size the wider the channel protection apron; and the higher the runoff velocity the longer the apron (KYTC, 2006).

Table 4.2. Flow Dissipater Sizing for Storm Outlets.

Culvert Size	Apron width at pipe	Apron length for low flow	Apron length for high flow
8 in (200mm)	2-3 ft (0.6-1m)	3-5 ft (1-1.5m)	5-7 ft (1.5-2.1m)
12 in (300mm)	3-4 ft (1-1.2m)	4-6 ft (1.2-1.8m)	8-12 ft (2.4-3.6m)
18 in (450mm)	4-6 ft (1.2-1.8m)	6-8 ft (1.8-2.4m)	12-18 ft (3.6-5.5m)
24 in (600mm)	6-8 ft (1.8-2.4m)	8-12 ft (2.4-3.6m)	18-22 ft (5.5-6.7m)
30 in (750mm)	8-10 ft (2.4-3m)	12-14 ft (3.6-4.3m)	22-28 ft (6.7-8.5m)
36 in (900mm)	10-12 ft (3-3.6m)	14-16 ft (4.3-4.9m)	28-32 ft (8.5-9.8m)
42 in (1050mm)	12-14 ft (3.6-4.3m)	16-18 ft (4.9-5.5m)	32-38 ft (9.8-11.6m)
48 in (1200mm)	14-16 ft (4.3-4.9m)	18-25 ft (5.5-7.6m)	38-44 ft (11.6-13.4m)

(Source: Kentucky Erosion Prevention and Sediment Control Field Guide)

Preparation and Application

Soils shall be cleared of large stones, roots, sticks, clumps, trash, and other debris. Soil surface should be extremely smooth and properly compacted using a vibratory plate compactor, or similar equipment, and graded prior to construction of channel protection. Sediment control devices should be installed around the perimeter of the construction/installation area (See Section 1.1. Sediment Control).

Channel protection shall be placed underneath culvert piping or other outfall piping devices to ensure point of water contact is on surface of channel protection. Channel protection shall be installed to

ensure dimensions of sock are 3 in (75mm) high by 12 in wide (300mm). Alternatively, channel protection may be formed using standard 8 in (200mm) or 12 in (300mm) diameter cones, and compressed once installed. Channel protection shall be placed parallel to flow, with edges fitting tightly together. Channel protection shall be slightly compacted and edges smoothed to create a seamless surface for water flow.

Stakes shall be installed through the middle of the channel protection on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Alternatively, L-shaped rebar may be installed through the middle of the channel protection on 10 ft (3m) centers, where the “L” shall be bent to form a hook over the top of the channel protection and pounded to fit snug. Stakes shall also be placed at the ends of the channel protection to hold it in place. Staking depth for sand and silt loam soils shall be 12 in (300mm), and 8 in (200mm) for clay soils. Channel protection may be seeded at the time of application, seed selection will be determined by the Engineer. Seeded channel protection should not be installed prior to seasons where growing vegetation is difficult. Seed shall be thoroughly mixed with the GrowingMedia prior to construction or injected into GrowingMedia at time of application.

Optional biotechnical engineering with seedlings, tubers, and/or live stakes should be planted after staking. The entire area should be thoroughly watered after seeding and planting. Additional irrigation may be required until vegetation is well established.

See Figures 4.1 and 4.2 for design drawing detail specifications and staking requirements.

Establishing & Sustaining Vegetation

Channel protection is seeded at the time of application by injection into GrowingMedia during channel protection construction. Grasses should be mowed and maintained between 4 and 10 in. high, unless otherwise specified. Taller grasses may have higher sediment removal efficiency and sediment storage capacity, and a greater ability to dissipate runoff energy and reduce storm flow velocity relative to low growing or low maintained grasses.

Although GrowingMedia typically has a higher water holding capacity than topsoil, irrigation may be required to ensure successful establishment. In arid and semi-arid regions or hot and dry weather regular irrigation may be required.

GrowingMedia supplies humus, organic matter, beneficial microbes, and slow release organic nutrients



that can contribute to increased fertility, 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. Channel protection provides 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

Invasive weed growth has been more closely associated with mineral fertilizer than organic fertilizer fertility practices (Faucette et al, 2004). Vegetation practices should always be inspected for invasive and noxious weeds.

INSTALLATION

1. Channel protection shall meet Filtrexx Specifications and use Filtrexx GrowingMedia.
2. Contractor is required to be a Filtrexx® CertifiedSM Installer as determined by Filtrexx International (877-542-7699). Certification shall be considered current if appropriate identification is shown during time of bid or at time of application. Look for the Filtrexx Certified Installer Seal.
3. Channel protection will be placed at locations indicated on plans as directed by the Engineer.
4. Channel protection must be installed and stabilized before flow is allowed from culverts and storm outlets.
5. Land surface shall be cleared of debris, including rocks, roots, large clods, and sticks prior to channel protection installation.
6. Channel bed shall be made smooth prior to installation of channel protection.
7. Soil bed may be compacted and graded prior to installation.
8. The upslope end of the channel protection shall be installed under the lip of the culvert or outlet drain to ensure initial storm flow contact is on top of the channel protection, not under or in front of the system.
9. Channel protection will be fabricated on-site or prefabricated and delivered to site for installation.
10. Channel protection will be fabricated to ensure



3 in (75mm) high by 12 in (300mm) wide Soxx construction configuration is met.

11. Channel protection shall be placed parallel to water flow, where socks are tightly abutted to prevent water seepage between and underneath the channel protection.
12. Once in place, channel protection shall be lightly compacted and abutting edges leveled to tighten seal between socks and encourage even water flow over channel protection system.
13. Channel protection shall not be installed on channel bed slopes greater than 10%.
14. Channel protection shall not be installed on channel banks greater than 2:1, and banks 3:1 if mowing will be conducted to manage vegetation.
15. Stakes shall be installed through the middle of the Channel protection on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Top of stakes should be cut off, leaving 3 in (75mm) above the top of the channel protection.
16. Alternatively, L-shaped rebar may be installed through the middle of the channel protection on 10 ft (3m) centers, where the “L” shall be bent to form a hook over the top of the channel protection and pounded to fit snug.
17. Stakes shall also be placed at the ends of channel protection to hold it in place.
18. Staking depth for sand and silt loam soils shall be 12 in (300mm), and 8 in (200mm) for clay soils.
19. Channel protection may be seeded at the time of application, seed selection will be determined by the Engineer.
20. Seeded channel protection should not be installed prior to seasons where growing vegetation is difficult.
21. Seed shall be thoroughly mixed with the GrowingMedia prior to construction or injected into GrowingMedia at time of application.
22. Optional biotechnical engineering with live stakes should be conducted after staking is complete.
23. Seeded channel protection shall be thoroughly watered after installation and allowed to settle for 1 week.

INSPECTION

Routine inspection should be conducted within 24 hours of a runoff event for the first year after installation, until permanent vegetation has established, or as designated by the regulating authority. If product dislodgement occurs, or vegetation does not establish, channel protection should be repaired and/or reseeded. If bank or bed erosion occurs, the area should be repaired



immediately. Vegetation practices should always be inspected for noxious or invasive weeds. If sediment accumulation is 25% of the height of the vegetation, sediment removal is recommended. Storm debris and trash should be removed immediately.

MAINTENANCE

1. The Contractor shall maintain the channel protection in a functional condition at all times and it shall be routinely inspected.
2. Seeded channel protection shall be maintained until a uniform 70% minimum cover of the applied area has been vegetated, permanent vegetation has established, or as required by the jurisdictional agency.
3. Seeded channel protection may need to be irrigated in hot and dry weather and seasons, or arid and semi-arid climates to ensure vegetation establishment.
4. Where channel protection fails or becomes dislodged, the contractor will ensure the product is in good contact with the soil, repair, and use additional staking if necessary.
5. Where bank or bed erosion occurs, the contractor will regrade the soil if necessary and repair or replace the channel protection.
6. Where vegetation does not establish the contractor will reseed, replant, or provide an approved and functioning alternative.
7. No additional fertilizer or lime is required for vegetation establishment and maintenance.
8. No disposal is required for this product/practice.
9. Channel protection shall be left on-site and become part of the permanent landscape, unless otherwise specified by the Engineer.
10. Regular mowing of grass vegetation on seeded channel protection 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 vegetation.
11. Storm debris and trash deposited on channel protection should be removed immediately.
12. Sediment shall be removed if 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® Channel Protection/GroSoxx® per square ft, per

square yard, or per square meter 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.

ADDITIONAL INFORMATION

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

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TABLES & FIGURES:

Table 4.3. Filtrex[®] Soxx[™] Material Specifications.

Material Type	Cotton BioSoxx [™]	5 mil High Density Polyethylene (HDPE)	5 mil High Density Polyethylene (HDPE)	Multi-Filament Polypropylene (MFPP, previously HDPP)	Multi-Filament Polypropylene SafteySoxx [™]	Multi-Filament Polypropylene DuraSoxx [®]	Multi-Filament Polypropylene DuraSoxx [®] (Heavy Duty)
Material Characteristic	Biodegradable	Oxo-degradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable
Design Diameters*	8 in (200mm), 12 in (300mm)	8 in (200mm), 12 in (300mm), 18 in (400mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm)	8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	8 in (200mm), 12 in (300mm), 18 in (400mm)	8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm)
Mesh Opening	1/8 in (3mm)	3/8 in (10mm)	3/8 in (10mm)	3/8 in (10mm)	1/8 in (3mm)	1/8 in (3mm)	1/8 in (3mm)
Tensile Strength	ND	26 psi (1.83 kg/cm ²)	26 psi (1.83 kg/cm ²)	44 psi (3.09 kg/cm ²)	202 psi (14.2 kg/cm ²)**	202 psi (14.2 kg/cm ²)	242 psi (16.99 kg/cm ²)
% Original Strength from Ultraviolet Exposure (ASTM G-155)	ND	ND	23% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr
Functional Longevity/ Project Duration***	up to 12 months**	6 mo-3.5 yr	9 mo-4 yr	1-4 yr	2-5 yr	2-5 yr	2-5 yr

* Channel protection is typically compacted to create a single Soxx[™] (as part of the entire system) dimension 3 in (75mm) high by 12 in (300mm) wide.

** Data based on Caltrans research and specifications.

*** Functional Longevity based on continual UV exposure without vegetation. Once vegetation is established longevity of the system is greatly increased. Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.



Table 4.3. Filtrexx® Soxx™ Material Specifications.

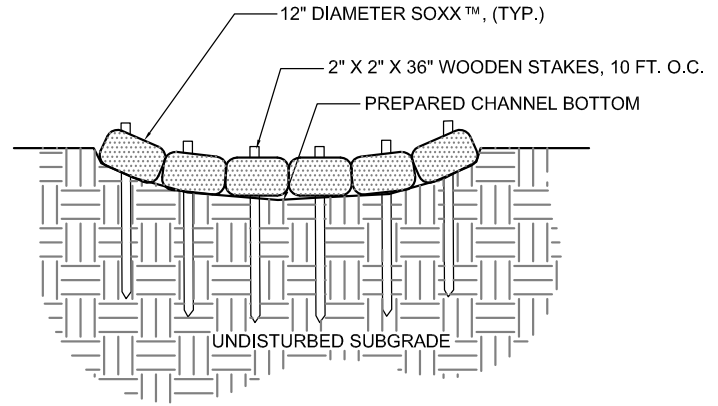
Design	8 in (200mm)	12 in (300mm)	18 in (450mm)	24 in (600mm)	32 in (800mm)	Testing Lab/Reference
Effective Height*	6.5 in (160mm)	9.5 in (240mm)	14.5 in (360mm)	19 in (480mm)	26 in (650mm)	Filtrexx International Field Lab
Effective Circumference	25 in (630mm)	38 in (960mm)	57 in (1450mm)	75 in (1900mm)	100 in (2500mm)	Filtrexx International Field Lab
Density	18 lbs/ft (27 kg/m)	45 lbs/ft (68 kg/m)	100 lbs/ft (151 kg/m)	240 lbs/ft (363 kg/m)	300 lbs/ft (450 kg/m)	Filtrexx International Field Lab
Air Space	Testing in Progress	Testing in Progress	Testing in Progress	Testing in Progress	Testing in Progress	Soil Control Lab, Inc
Maximum continuous length	unlimited	unlimited	unlimited	Unlimited	unlimited	
Staking Requirement	10 ft (3m)	10 ft (3m)	10 ft (3m)	10 ft (3m)	10 ft (3m)	Filtrexx International Field Lab
Max. Velocity (ASTM D-6460)	14.5 ft/sec (4.4 m/sec)	14.5 ft/sec (4.4 m/sec)	14.5 ft/sec (4.4 m/sec)	14.5 ft/sec (4.4 m/sec)	14.5 ft/sec (4.4 m/sec)	Texas Transportation Institute-TX A&M.
Max. Hydraulic Shear Stress (ASTM D-6460)	12 lbs/ft2 (59 kg/m2)	12 lbs/ft2 (59 kg/m2)	12 lbs/ft2 (59 kg/m2)	12 lbs/ft2 (59 kg/m2)	12 lbs/ft2 (59 kg/m2)	Texas Transportation Institute TX A&M.
Manning's n (roughness coefficient)	Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)	Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)	Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)	Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)	Non-vegetated (0.022); Grass (0.035); Grass + Live Stakes/young or thin (0.05); Grass + Live Stakes/mature or dense (0.075)	Texas Transportation Institute-TX A&M.
Slope	10%	10%	10%	10%	10%	Texas Transportation Institute- TX A&M.
Media Type	Growing Media™	Growing Media™	Growing Media™	Growing Media™	Growing Media™	Texas Transportation Institute TX A&M.
Sock Material	Multi-Filament Polypropylene 'SafetySoxx'™	Multi-Filament Polypropylene 'SafetySoxx'™	Multi-Filament Polypropylene 'SafetySoxx'™	Multi-Filament Polypropylene 'SafetySoxx'™	Multi-Filament Polypropylene 'SafetySoxx'™	Texas Transportation Institute TX A&M.
Vegetation Type	Triple Rye; Bermuda + Green Sprangletop	Triple Rye; Bermuda + Green Sprangletop	Triple Rye; Bermuda + Green Sprangletop	Triple Rye; Bermuda + Green Sprangletop	Triple Rye; Bermuda + Green Sprangletop	Texas Transportation Institute- TX A&M.
Vegetation Cover	70-100%	70-100%	70-100%	70-100%	70-100%	Texas Transportation Institute- TX A&M.

* Typical design height without compaction

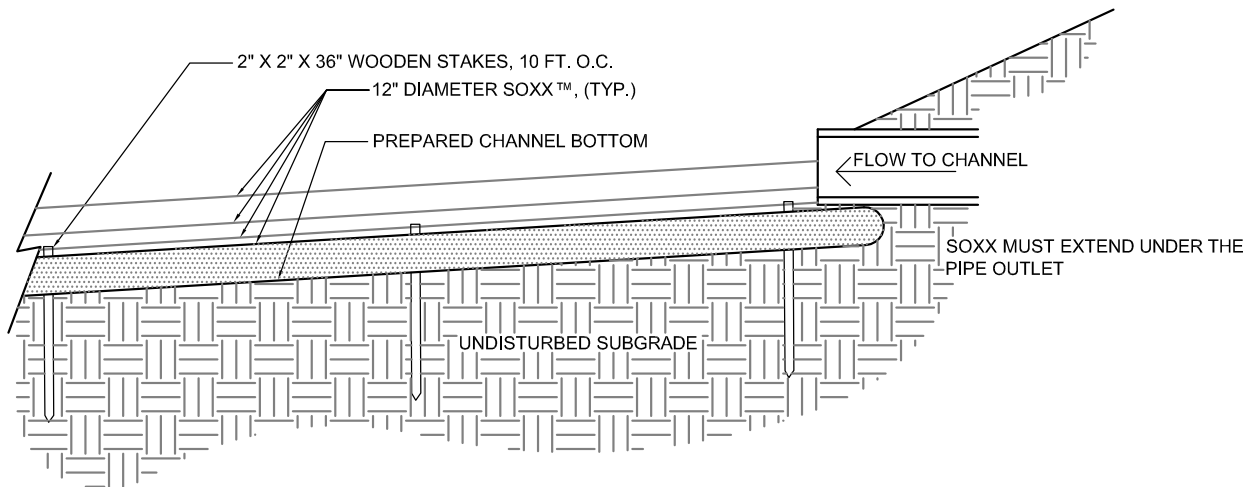


Figure 4.1. Engineering Design Drawings for Filtrex Channel Protection

1. SoxTM shall meet Filtrex SoxTM Specifications and use Filtrex GrowingMediaTM.
2. Contractor is required to be a Filtrex CertifiedTM Installer.
3. SoxTM must be installed and stabilized before flow is allowed from culverts and storm outlets.
4. Land surface shall be cleared of debris, including rocks, roots, large clods, and sticks prior to SoxTM installation.
5. Channel bed shall be made smooth prior to installation of SoxTM.
6. Soil bed may be compacted and graded prior to installation.
7. The upslope end of the SoxTM shall be installed under the lip of the culvert or outlet drain to ensure initial storm flow contact is on top of the SoxTM, not under or in front of the system.
8. SoxTM shall be placed parallel to water flow, where socks are tightly abutted to prevent water seepage between and underneath the SoxTM.
9. Once in place, SoxTM shall be lightly compacted and abutting edges leveled to tighten seal between socks and encourage even water flow over SoxTM system.
10. Stakes shall be installed through the middle of the SoxTM on 10 ft (3m) centers, using 2 in (50mm) by 2 in (50mm) by 3 ft (1m) wooden stakes. Top of stakes should be cut off, leaving 3 in (75mm) above the top of the SoxTM.
11. SoxTM may be seeded at the time of application, seed selection will be determined by the Engineer.



CHANNEL PROTECTION SECTION
NTS



CHANNEL PROTECTION PROFILE
NTS

FILTREXX[®] CHANNEL PROTECTION
NTS



Figure 4.2. Engineering Design Drawings for Filtrex Channel Protection - New Channel

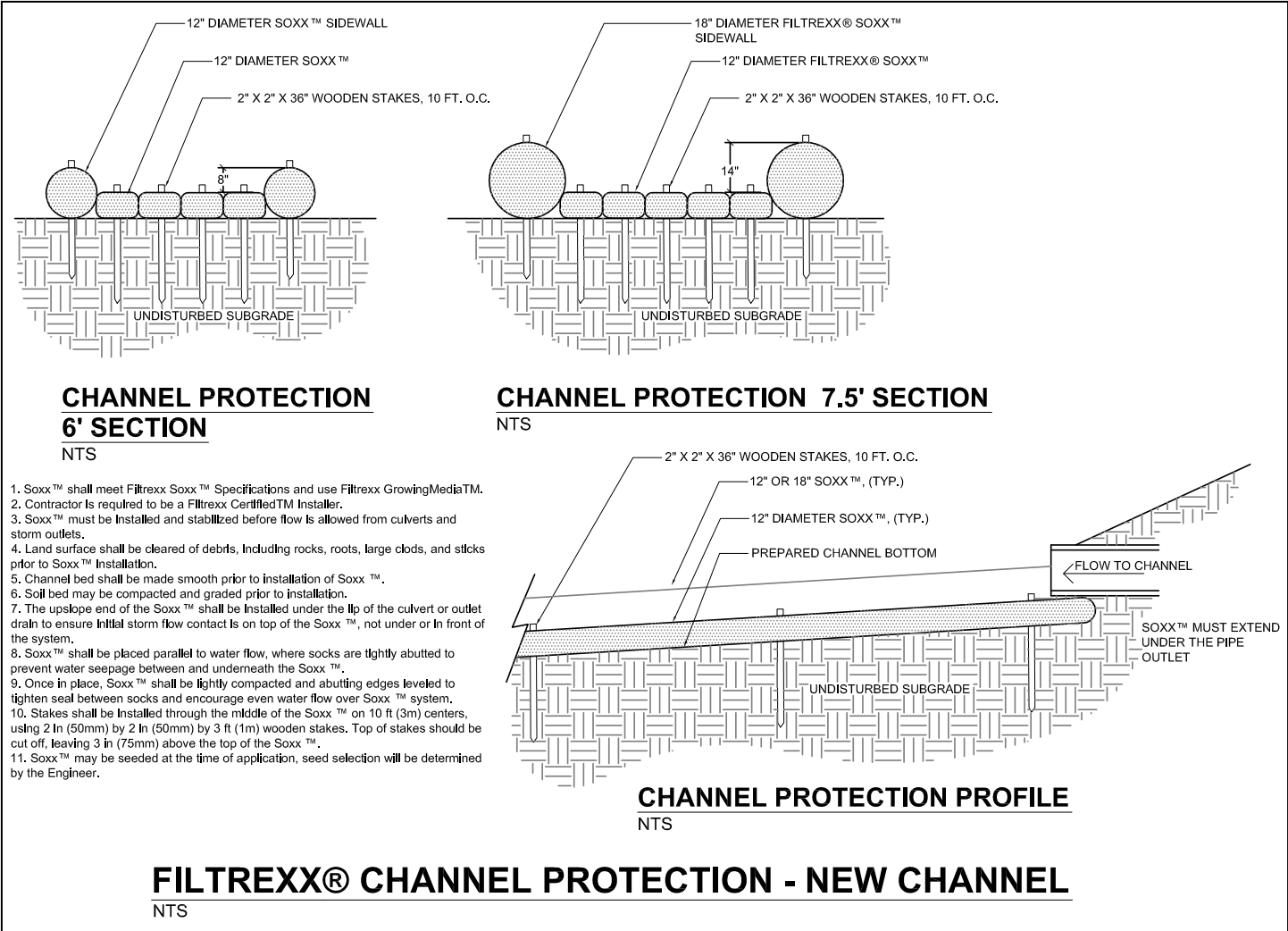


Figure 4.3. Staking Details for Filtrex[®] Channel Protection

