DESIGN SPECIFICATION

2.3 Engineered Soil

PURPOSE & DESCRIPTION

Filtrexx® Engineered Soil is a **permanent storm water infiltration practice** used to reduce storm runoff volume and loading of sediment and soluble pollutants, such as nutrients, heavy metals, and petroleum hydrocarbons, from a contributing watershed or drainage area. Engineered soil is manufactured on site using using Filtrexx® GrowingMedia™ and native soil. Engineered soils manage storm water by:

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

Engineered soil is manufactured on site by incorporating 2-4 in (50-100mm) of GrowingMedia with the native soil to a depth of 6-12 in (150-300mm) to create a functional soil designed for high infiltration, filtration, and plant sustainability. Engineered soils improve infiltration by increasing water absorption (water holding capacity), soil porosity, and soil structure through the incorporation of organic matter and humus. Storm water runoff volume reduction is closely correlated to reduction of sediment and soluble pollutant loading to receiving waters. Organic matter and humus in GrowingMedia is known to bind or adsorb soluble water pollutants such as phosphorus, ammonium-nitrogen, heavy metals, and petroleum hydrocarbons. Microorganisms in GrowingMedia tm can decompose these pollutants to less toxic and even beneficial forms, while plant uptake can further reduce pollutant concentrations in soil solution. Soil amendments used to construct engineered soils can be easily applied with a pneumatic blower truck, spreader truck or equivalent equipment.

APPLICATION

Engineered soils are used in post-construction applications with permanent vegetation to increase infiltration and reduce sediment and soluble pollutant loading to receiving waters. Typically engineered soils are constructed for vegetated storm water collection systems; however, engineered soils can be used in any landscape where overland sheet flow and subsurface flow (interflow) exists. Applications where engineered soils may be required include:

- Bioretention ponds and rain gardens,
- Storm water and sediment retention ponds,
- Parking lot infiltration islands,
- Vegetated (green) roof systems,
- Upslope from storm water receiving or conveyance systems, including channels, ditches, streams, rivers, lakes, and wetlands,
- Runoff receiving areas from impervious surfaces, hardscapes, and source pollutant landscapes, including roads, highways, parking lots, and land disturbing activities.

Engineered soil can also be used to reduce runoff velocity leaving or entering 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).

Engineered soils are generally used in permanent, post-construction applications where a variety of plant material including legumes, grasses, shrubs and trees can be utilized.

Engineered soil is ideal as part of a Low Impact Development design plan or to assist in point accrual in LEED Green Building Certification programs (Filtrexx® Tech Link #3301 and #3306).

ADVANTAGES AND DISADVANTAGES

Advantages

- Engineered soil is used to filter pollutants and infiltrate storm water entering or leaving areas where storm water may pass, collect, drain, or be stored.
- Engineered soils reduce peak runoff flows and runoff volumes by increasing soil porosity, water holding capacity, and infiltration rates.
- Engineered soils store and maintain more water on-site helping to reduce storm pressure and maintain base flows to receiving waters.
- Engineered soils have the ability to bind and adsorb soluble nutrients, metals, and hydrocarbons in storm water runoff, thereby reducing loading to nearby receiving waters.
- Engineered soils can remove pathogens and pesticides from storm runoff preventing pollution of receiving water bodies.
- Engineered soils remove pollutants from storm water through plant uptake.
- Engineered soils slow down runoff velocity, thereby increasing sediment deposition, reducing the erosive energy of runoff and the potential for soil erosion, and reducing pollutant transport.
- Engineered soils increase biological activity and diversity in the soil complex.
- Microorganisms in engineered soils have the ability to degrade organic pollutants and cycle captured nutrients into beneficial and/or less toxic forms.
- Engineered soils can establish vegetation in difficult areas.
- Humus colloids and organic matter in engineered soils provide physical structure for seed, establishing seedlings, and live stakes.
- Humus colloids and organic matter in engineered soils provide increased water holding capacity and reduced water evaporation to aid in seed germination and the potential for reduced irrigation.
- Engineered soils can increase ground water recharge by increasing infiltration and percolation.
- Engineered soils are a good option for arid and semiarid regions where germination, moisture management, and irrigation can be difficult.
- Engineered soils provide organic nutrients that slow release for

ADVANTAGES			
	LOW	MED	HIGH
Installation Difficulty		✓	
Runoff Volume Reduction			✓
Soluble Pollutant Control			✓
Sediment Control			✓
Vegetation Establishment			✓
Runoff Velocity Reduction		✓	

optimum efficiency to establishing vegetation.

- Engineered soils provide organic nutrients that are less prone to runoff transport and pollution of surface waters relative to mineral nutrients supplied by fertilizers.
- Engineered soils buffer soil pH creating favorable conditions for biological activity, nutrient availability and vegetation growth.
- Engineered soils increase soil organic matter which may reduce runoff and erosion, and increase plant sustainability through improved soil quality over the long term.
- Engineered soils can be easily designed and incorporated as one treatment in a treatment train approach to watershed storm water management.
- Slope protection, rolled erosion control blankets, and turf reinforcement mats can easily be used with engineered soils to prevent soil erosion and help stabilize vegetation.
- Engineered soils are organic, all natural, biodegradable, and locally manufactured.
- Engineered soils can be used as a integrated management practice for Low Impact Development design and for possible point accrual in LEED Green Building Certification programs.
- Engineered soil 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. Filtrexx 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 an engineered soil does not use Filtrexx® 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.
- Engineered soils should not be the only form of site or watershed storm water management.
- Engineered soils should not be used without structural reinforcement in areas of concentrated runoff flow.
- Engineered soils should not be used without structural reinforcement on slopes greater than 4:1.
- Engineered soils should not be used on slopes greater than 3:1.
- Engineered soils may need to be reapplied if significant runoff occurs prior to vegetation establishment or where vegetation fails.
- Engineered soils require sufficient land area for optimum performance.
- Engineered soil performance is generally lower prior to vegetation establishment and maturity.
- Engineered soil installation is a land disturbing activity and can increase sediment loading if appropriate sediment control measures are not established during construction phase.

GROWINGMEDIA™ CHARACTERISTICS

Filtrexx® Engineered Soils use only Filtrexx® GrowingMedia™ which is a composted material that is specifically designed for water absorption, infiltration, 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 GrowingMediatm 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 little research has been conducted on Engineered soil, performance testing and scientific research on organic soil amendments, Compost Erosion Control Blankets, and Compost Filter Socks has been conducted in recent years. Conservative assumptions can be made regarding engineered soils in light of performance associated with the previously mentioned practices. For performance on these practices see Filtrexx® Compost Erosion Control Blanket, Filtrexx® Sediment Control (SiltSoxx™), and supporting technical and research reports in the Appendices. Filtrexx International is undergoing research to quantify the performance of Engineered soils to aid design professionals in the future. For a summary of current results from performance testing see Table 3.1.
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 Engineered soil fails, it shall be repaired or replaced with an effective alternative.

DESIGN CRITERIA

Function

Engineered soils 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 by established 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 the Engineered soil to remove pollutants from storm runoff. Pollutant load reduction has been correlated to soil water absorption and infiltration characteristics, soil pollutant adsorption and 'fixing capacity', slope degree, area of the engineered soil, area draining to the engineered soil, and vegetation type, cover, and density.

Humus content within the compost GrowingMedia has the ability to chemically adsorb and bind soluble pollutants such 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 Engineered soil, 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

Engineered soils should be used as one treatment in a treatment train approach to storm water management. Engineered soils should be strategically located for connectivity of infiltration zones, vegetation, and wildlife habitat and corridors in the watershed. Runoff control and runoff diversion practices may be designed to help prevent seed washing and soil erosion prior to vegetation establishment and to protect seedlings prior to maturity. Preconstruction meetings should be conducted to educate construction site personnel about the devices/practices used and acceptable traffic patterns that avoid running over engineered soils with vehicles and heavy equipment. Vehicular traffic and heavy equipment may reduce the effectiveness of engineered soils and contribute to soil compaction, which may increase runoff and erosion and reduce vegetation establishment.

On-site composite soil sampling and testing should be completed prior to plant selection and construction of engineered soil. Tests should include infiltration rate, organic matter content, bulk density, pH, and nutrient characterization. Tests may reveal additional amendment requirement for lime, gypsum, or specific nutrient. Additionally, if soil will be engineered to achieve a specific infiltration rate or organic matter content, evaluation of preexisting soil conditions will be necessary. Consult your local cooperative extension service for soil testing.

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).

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. Plant material selection should include a variety ecological stands, including legumes and densely planted deep rooted grasses, mid story shrubs, and tall woody tree species. If Engineered soils 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 seed and plant selection. Many state erosion and sediment control and storm water management manuals have specifications for seed and plant 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

Runoff Conditions

Engineered soils should not be used in areas where runoff velocities will damage or undermine vegetation. *For most grasses a maximum runoff 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).*

Preparation and Application

Soils shall be cleared of large stones, roots, sticks, clumps, trash, and other debris prior to tillage. Care should be taken to avoid destruction of tree roots, existing vegetated buffers, and unnecessary tillage and soil disturbance. Sediment control devices should be installed around the perimeter of the Engineered soil construction/installation area (See Section 1.1. Sediment Control). If soil is severely compacted soil ripping may be necessary prior to application and incorporation. Two passes with a roto-tiller may be required to prepare and loosen soil to a depth of 6-8 in (150-200mm).

A 2-4 in (50-100mm) GrowingMedia blanket ((270-540 cubic yds/ac (513-1060 cubic m/ha)) should be applied to 100% of the soil surface using a pneumatic blower, spreader, or similar equipment. After application the entire area should be roto-tilled or disked and harrowed to a minimum depth of 6 in. (150mm) (2-3 in [50-75mm] of GrowingMedia) and a maximum depth of 12 in (300mm). (3-4 in [75-100mm] of GrowingMedia). As an alternative, 4 in. (100mm) of subsoil may be scarified prior to incorporation. If this method is chosen, incorporation with roto-tiller should be 6-8 in (150-200mm) and GrowingMedia application should be 2-3 in (50-75mm). Shallow tillage (2-4 in, 50-100mm) may be utilized around tree roots. GrowingMedia application should be reduced to 1 in (25mm). for shallow till applications. Additional amendments such as lime or gypsum should be included during tillage.

Alternatively, if a target soil organic matter content is known (typically 5%), and test results are available for soil and compost organic matter and bulk density, the quantity of compost needed to achieve the organic matter goal can be calculated (see Organic Matter Content section). This calculation should include any Compost Vegetated Cover (Temporary Seeding) or Compost Erosion Control Blanket applications. Specifications for these practices can be found in Sections 1.7 and 1.8 of the Filtrexx® Design Manual.

Several passes with a rototiller may be required to sufficiently mix the materials within the soil profile. After tillage, a ½-1 in (15-25mm) seeded Compost Erosion Control Blanket should be applied to the surface for erosion control. If seedlings, tubers, and live stakes are specified they should be planted after seeding. The entire area should be thoroughly watered after seeding and planting. Fine grading, raking, and hand rolling may be done after seeding. Additional irrigation may be required until vegetation is well established.

To protect from ground water contamination and saturation of vegetation, Engineered soils should be at least 2 to 4 ft (0.6-1.2 m) from ground water resources (USEPA, 2006).

Water Holding Capacity

Engineered soils are designed to increase the organic content of the existing soil. Increasing soil organic content will increase the water holding capacity of the soil. Native soil organic matter contents typically range from 0.5 to 5.0%. Hot and humid climate zones, and areas where rainfall-runoff events are high generally have soils with lower soil organic content. Consequently, it can be difficult to maintain soil organic matter levels in these regions. For every 1% of soil organic matter, the soil will hold approximately 16,500 gal (2206 cubic ft, 62 cubic m) of water per acre ft (1233 cubic m) of soil (Breedlove, 2006). Alternatively, GrowingMedia typically holds approximately 1.6 oz (45 g) of water per 3.6 oz (100 g) of GrowingMedia (dry weight); 1 gal (0.004 cubic m) of water per 20 lbs (9 kg) of GrowingMedia (dry wt) or per 30 lbs (14 kg) of GrowingMedia (wet wt). This equates to approximately 40 gal (0.15 cubic m) of water per cubic yard (0.76 cubic m) of GrowingMedia and 5,400 gal (722 cubic ft, 20 cubic m) of water per acre inch (0.01 ha meter, 103 cubic m) of GrowingMedia, and

10,800 gal (1444 cubic ft, 41 cubic m) of water for a 2 in (50mm) GrowingMedia; An acre inch (0.01 ha meter) of GrowingMedia requires approximately 135 cubic yards (103 cubic meters) of material.

Organic Matter Content
Soil organic matter content for Engineered soils designed to manage storm water and planted with turf grass is typically 5%. Average organic matter content of GrowingMedia is approximately 25% (or 50% by dry weight; average water content of GrowingMedia is 50%) and weighs approximately 1000 lbs per cubic yard (593 kg/cubic m) (wet weight). Soil weighs approximately 2000 lbs per cubic yard (1187 kg/cubic m) (wet weight). For each 1% of organic matter increase 80 lbs (36 kg) of GrowingMedia (20 lbs [9 kg] of organic matter) should be added to 1 cubic yard (0.76 cubic m) of soil.

Alternatively, if you assume the top 6 in (150mm) of soil weighs approximately 1000 tons/acre (2250 Mg/ha) (dry weight) you need to add 10 tons (9 Mg) of organic matter to increase soil organic matter 1%. 10 tons of organic matter (9 Mg) (dry weight) is equivalent to 40 tons (36 Mg) of GrowingMedia (wet weight), or 80 cubic yards (61 cubic m) (wet weight). As a conservative estimate, one should assume a 25% decline in organic matter after the first year of application. This can very between 10-50% depending on the climate zone. Once vegetation is mature and healthy, soil organic matter levels may stabilize.

If soil and GrowingMedia test results for organic matter content and bulk density are available, and the targeted soil organic matter content is known, the following equation can be used to determine GrowingMedia application rate (WDOE, 2005):

CR = D x (SBD x [SOM% - FOM%]) /
(SBD x [SOM% - FOM%] – CBD x [COM% - FOM%])

Where:

CR = compost application rate (to determine final soil organic matter content goal)
D = depth of finished incorporation (in)
SBD* = soil bulk density (lbs/ cubic yard, dry wt.)
SOM% = initial soil organic matter content (%)
FOM% = final target soil organic matter content (%)
CBD** = compost bulk density (lbs/cubic yd, dry wt.)
COM% = compost organic matter (%)

Assumptions: This equation calculates compost rate using an additive approach. For example, a 3 in (75mm) compost rate incorporated to an 8 in (200mm) depth will be a final mix containing 3/8 compost and 5/8 soil by volume. Organic matter measurements are based on the commonly used "loss-on-ignition" method.

* SBD: to convert Soil Bulk Density in g/cm3 units to lb/cubic yard, multiply by 1697.
** CBD: to convert Compost Bulk Density from lb/cubic yard "as is" to lb/cubic yard dry weight, multiply by solids content.

Infiltration Rate
Meyer et al. (2000) found that by incorporating 15 to 30 tons/ac (18-36 Mg/ha) of compost into the top 4-8 in (100-200mm) of soil, infiltration rates were approximately 0.125-0.158 cm/sec.

Slope Degree
Engineered soils *should not be used on slopes greater than 3:1.* Soil tillage and deep soil disturbance on steep slopes can lead to instability and mass sliding once soils have reached saturation. Slopes less than 2% may pond water once the soil has reached field capacity. Slopes greater than 6% typically form rills of concentrated runoff, which can increase erosion (USEPA, 2006). Slopes greater than 4:1 should select deep rooted vegetation and consider using slope stabilization practices, such as Slope protection or rolled erosion control blankets.

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 Engineered soil (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 (300 or 450mm) Filtrexx® 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 for any permanent application. At the down slope base of the engineered soil another Soxx may be installed to slow runoff velocity and increase the potential for settling of suspended solids and infiltration. Filtrexx® Slope Interruption may be installed across the runoff flow path of the Engineered soil to increase infiltration and settling of solids. Refer to Filtrexx Design Manual Section 1.1 and 1.5 for standard specifications and design information for these practices.

Establishing & Sustaining Vegetation
Although Engineered soils increase water holding capacity and reduce evaporation, irrigation may be required to ensure successful vegetation establishment. In arid and semi-arid regions, or hot and dry weather, regular irrigation may be required. Runoff diversion devices may be utilized to prevent storm runoff from washing seed prior to germination and establishment and reduce erosion prior to stabilization.

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

Engineered soils supply humus, organic matter, beneficial microbes, and slow release organic nutrients that can contribute to increased soil quality, fertility, and plant health.

Soil Amendment Function
Engineered soils 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. Engineered soils 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

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. Engineered soils shall meet Filtrexx Engineered Soil 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. Engineered soils will be placed at locations indicated on plans as directed by the Engineer.
4. Engineered soils shall be installed down slope and around areas contributing overland and subsurface storm water flows.
5. Engineered soils shall not be installed in areas of concentrated runoff flow without soil stabilization or armoring devices.
6. Engineered soils shall not be installed on slopes greater than 3:1.
7. Engineered soils installed on slopes greater than 4:1 may include slope stabilization practices.
8. Engineered soils should not be installed in wet or frozen soils or prior to seasons where growing vegetation is difficult.
9. Care should be given to existing root systems of trees and shrubs during construction of Engineered soil.
10. Seed shall be thoroughly mixed with the GrowingMedia prior to construction of Engineered soil or surface applied with GrowingMedia at time of application.
11. Engineered soils shall be applied evenly to 100% of the area where Engineered soil is required.
12. Land surface shall be cleared of debris, including rocks, roots, large clods, and sticks prior to Engineered soil installation or tillage.
13. Soil may be prepared prior to GrowingMedia application by roto-tilling the native soil.
14. If soil is too dense for roto-tiller soil ripping map be used as a prerequisite.
15. Subsoil may be scarified to a depth of 4 in. (100mm) prior to GrowingMedia application.
16. GrowingMedia shall be evenly applied to the soil surface at a depth of 2-4 in (50-100mm) or 270-540 cubic yards/ac (513-1026 cubic meters/ha) using a pneumatic blower, spreader,or similar device (small installations may be done manually) and thoroughly roto-tilled into the native soil (several passes my be required); or
17. GrowingMedia shall be mixed with native soil prior to construction using a loader, soil mixer, or similar equipment.
18. Soil incorporation and tillage shall be to a minimum of 6 in (150mm) (unless restricted by tree roots or other natural constraints) and a maximum of 12 in (300mm); or
19. If subsoil is scarified to 4 in (100mm)., soil incorporation should be 6-8 in (150-200mm).
20. Engineered soil shall be thoroughly watered after installation and allowed to settle for 1 week.
21. Fine grading and hand rolling of engineered soil may be required after installation.

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 rilling occurs or vegetation does not establish, the area of application should be reapplied with an Engineered soil. If failure continues, the use of runoff diversion devices, compost erosion control blankets, rolled erosion control blankets, or soil stabilizers should be considered until vegetation has been established. Vegetation practices should always be inspected for noxious or invasive weeds. Periodic infiltration rate tests may be performed to ensure the system is performing correctly. If sediment accumulation is 25% of the height of the vegetation, sediment removal is recommended.

MAINTENANCE

1. The Contractor shall maintain the engineered soil in a functional condition at all times and it shall be routinely inspected.
2. Heavy equipment should be limited on and near the engineered soil to prevent compaction that will reduce infiltration and permeability.
3. If soil complex becomes compacted, or infiltration and permeability rates diminish significantly, engineered soil shall be reinstalled or replaced with a functioning alternative.
4. Engineered soil shall be maintained until a minimum uniform cover of 70% of the applied area has been vegetated, permanent vegetation has established, or as required by the jurisdictional agency.
5. Engineered soils may need to be irrigated in hot and dry weather and seasons, or arid and semi-arid climates to ensure vegetation establishment.
6. Where engineered soil fails, rilling occurs, or vegetation does not establish the Contractor will repair or provide an approved and functioning alternative.
7. If Engineered soil is damaged by storm water runoff prior to vegetation establishment, temporary runoff diversion devices installed above the engineered soil may be required.
8. No additional fertilizer or lime is required for vegetation establishment and maintenance.
9. No disposal is required for this product/practice.
10. Regular mowing of grass vegetation on Engineered soil 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. Organic debris and clippings should be left on-site to maintain soil organic content.
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® Engineered Soil 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

Industrial Site Remediation

Roadside Applications of a Engineered Soil

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.

REFERENCES CITED & ADDITIONAL RESOURCES

American Association of State Highway Transportation Officials. 2003. Standard Specification for Transportation Materials and Methods of Sampling and Testing, Designation M10-03, Compost for Erosion/ Sediment Control. Washington, DC.

Barfield, B., R. Blevins, A. Flofle, C. Madison, S. Inamder, D. Carey, and V. Evangelou. 1992. Water quality impacts of natural riparian grasses: Empirical studies. American Society of Agricultural Engineers Meeting Paper No. 922100, St Joseph, MI.

Breedlove, M. 2006. Final Technical Advisory Planning Committee Report to Revise Manual for Erosion and Sediment Control in Georgia. Georgia Soil and Water Conservation Commission.

Chi, D., and R. Petrell. 2005. Denbow Environmental Services Testing. Bioengineering Department, University of British Columbia. Unpublished.

Demars, K., R. Long, and J. Ives. 2000. Use of Wood Waste Materials for Erosion Control. New England Transportation Consortium & Federal Highway Administration – NETCR 20. Conducted by University of Connecticut Department of Civil and Environmental Engineering.

Demars, K.R., and R.P. Long. 1998. Field Evaluation of Source Separated Compost and Coneg Model Procurement Specifications for Connecticut DOT projects. University of Connecticut and Connecticut Department of Transportation. December, 1998. JHR 98-264.

Desbonette, A., P. Pogue, V. Lee, and N. Wolff. 1994. Vegetated Buffers in the Coastal Zone: A Summary Review and Bibliography. Coastal Resources Center. University of Rhode Island, Kingston, RI.

Dillaha, T., R. Reneau, S. Mostaghimi, and D. Lee. 1989. Vegetated filter strips for agricultural nonpoint source pollution control. Transactions of American Society of Agricultural Engineers, 32:2: 513-519.

Doyle, R., G. Stanton, and D. Wolfe. 1997. Effectiveness of forest and grass buffer filters in improving the water quality of manure-polluted runoff. American Society of Agricultural Engineers Meeting Paper No. 77-2501, St Joseph, MI

Faucette, L.B., and A. Vick. 2006. LEED Green Building Credits using Filtrexx® Organic BMPs. Filtrexx® Tech Link #3301

Faucette, L.B. A. Vick, and K. Kerchner. 2006. Filtrexx®, Compost, Low Impact Development (LID), and Design Considerations for Storm Water Management. Filtrexx® Tech Link #3306

Faucette, B. 2006. How Important is Particle Size in Specifications for Compost Erosion Control Blankets. Filtrexx® Tech Link #3310

Faucette, B. 2006. C Factors for Compost and Rolled Erosion Control Blankets. Filtrexx® Tech Link #3303

Faucette, B., K. Kerchner, and A. Vick. 2006. Determining Runoff Curve Numbers for Compost Erosion Control Blankets. Filtrexx® Tech Link #3305

Faucette, L.B., J. Governo, C.F. Jordan, B.G. Lockaby, and H.F. Carino. 2006. Storm water quality, C factors, and particle size specifications for compost and mulch blankets relative to straw blankets with PAM used for erosion control. Under Peer Review. Filtrexx® Library #706.

Faucette L.B., C.F. Jordan, L.M. Risse, M. Cabrera, D.C. Coleman, and L.T. West. 2006. Vegetation and soil quality effects from hydroseed and compost blankets used for erosion control in construction activities. Journal of Soil and Water Conservation, to be published Nov/Dec 2006.. Filtrexx® Library #705

Faucette, L.B., N. Strazar, and A. Marks. 2006. Filtrexx® Polymer and Flocculent Guide. Filtrexx® Library #601.

Faucette, L.B., C.F. Jordan, L.M. Risse, M. Cabrera, D.C. Coleman, and L.T. West. 2005. Evaluation of storm water from compost and conventional erosion control practices in construction activities. Journal of Soil and Water Conservation. 60:6:288-297.

Faucette, L.B., C.F. Jordan, L.M. Risse, M. Cabrera, D.C. Coleman, and L.T. West. 2004. Evaluation of Environmental Benefits and Impacts of Compost and Industry Standard Erosion and Sediment Control Measures used in Construction Activities. Doctoral Dissertation, Institute of Ecology, University of Georgia, Athens, GA. Filtrexx® Library #112.

Faucette, L.B., M. Risse, M.A. Nearing, J. Gaskin, and L. West. 2004. Runoff, erosion, and nutrient losses from compost and mulch blankets under simulated rainfall. Journal of Soil and Water Conservation. 59:4: 154-160.

Fifield, J. 2001. Designing for Effective Sediment and Erosion Control on Construction Sites. Forester Press, Santa Barbara, CA.

Florida Department of Transportation. 1994.Water Quality Impact Evaluation Training Manual. Course No. BT-05-009. Florida DOT.
Gilley, J., B. Eghball, L. Kramer, and T. Moorman. 2000. Narrow grass hedge effects on runoff and soil loss. Journal of Soil and Water Conservation. 55:2:190-196.

Grismer, M., A. T. O'Green, and D. Lewis. 2006. Vegetative Filter Strips for Nonpoint Source Pollution Control in Agriculture. University of California Division of Agriculture and Natural Resources. Publication 8195.

Hallock, B., A. Power, S. Rein, M. Curto, and M. Scharff. 2006. Analysis of compost treatments to establish shrubs and improve water quality. 2006 International Erosion Control Conference Proceedings, Long Beach, CA.

Harrison, R., M. Grey, C. Henry, and D. Xue. 1997. Field Test of Compost Amendment to Reduce Nutrient Runoff. University of Washington, College of Forest Resources, Ecosystem Science and Conservation Division. Prepared for City of Redmond, WA.

Kirchhoff, C.J., J. Malina, and M. Barrett. 2003. Characteristics of composts: moisture holding and water quality improvement. University of Texas: Austin, Federal Highway Administration, and Texas Department of Transportation. TX DOT – 04/0-4403-2.

KY TC, 2006. Kentucky Erosion Prevention and Sediment Control Field Guide. Kentucky Transportation Cabinet.

Marks, A., R. Tyler, and B. Faucette. 2005. The Filtrexx® Library. Digital publication of support tools for the erosion control industry. filtrexx.com.

Marks, A., and R. Tyler. 2003. Filtrexx® International Company Website. Specifications, CAD drawings, case histories. www.filtrexx.com.

Maryland Storm Water Design Manual Vol I and II. 2000. Appendix D.12. Critical erosive velocity for grasses and soil. Maryland Department of Environment and the Center for Watershed Protection.

Meyer, V., E. Redente, K. Barbarick,, and R. Brobst. 2001. Biosolids applications affect runoff water quality following forest fire. Journal of Environmental Quality. 30:1528-1532.

Mukhtar, S., M. McFarland, C. Gerngross, and F. Mazac. 2004. Efficacy of using dairy manure compost as erosion control and revegetation material. 2004 American Society of Agricultural Engineers/Canadian Society of Agricultural Engineers Annual International Meeting, Ontario, CA. Paper # 44079.

Parsons, J., R. Daniel, J. Gilliam, and T. Dillaha. 1991. The effect of vegetation filter strips on sediment and nutrient removal from agricultural runoff. IN: Proceedings of Environmentally Sound Agriculture Conf. Orlando, FL, April, 324-3322.

Patty L., B. Real, and J.J. Gril. 1997. The use of grassed buffer strips to remove pesticide, nitrate, and soluble phosphorus compounds from runoff water. Pesticide Science, 49:243-251.

Persyn, R. T. Glanville, T. Richard, J. Laflen, and P. Dixon. 2004. Environmental effects to applying composted organics to new highway embankments, Part 1: Interrill runoff and erosion. Transactions of the American Society of Agricultural Engineers. 47:2: 463-469.

Reinsch, C., D. Admiraal, and B. Dvorak. 2005. Use of yard waste compost: erosion reduction for storm water quality protection. Water Environment Federation. WEFTEC 2005.

Ress, S. 1998. Additional research shows promise for buffer strips. Water Current. Nebraska University. December

Tyler, R.W., and A. Marks. 2004. Erosion Control Toolbox CD Kit. A Guide to Filtrexx® Products, Educational Supplement, and Project Videos. 3 CD set for Specifications and Design Considerations for Filtrexx® Products.

Tyler, R.W., J. Hoeck, and J. Giles. 2004. Keys to understanding how to use compost and organic matter. IECA Annual Meeting Presentations published as IECA Digital Education Library, Copyright 2004 Blue Sky Broadcast.

Tyler, R.W. 2004. International PCT Patent Publication #: WO 2004/002834 A2. Containment Systems, Methods and Devices for Controlling Erosion.

Tyler, R.W., and A. Marks. 2003. Filtrexx® Product Installation Guide. Grafton, Ohio.

Tyler, R.W., and A. Marks. 2003. A Guide to Filtrexx® Products. Product Descriptions and Specifications for Filtrexx® Products.

Tyler, R.W. 2001. Filtrexx® Product Manual. Specifications and Design Considerations for Filtrexx® Products, Grafton, OH.

Tyler, R.W. 1996. Winning the Organics Game – The Compost Marketers Handbook. ASHS Press, ISBN # 0-9615027-2-x..

USDA-NRCS. 2004. Standards and Specifications No. 393, USDA-NRCS Field Office Technical Guide.

USEPA NPDES Phase II. 2006. Vegetated Filter Strip. National Menu of Best Management Practices for Post-Construction in Storm Water Management in New Construction and Post Construction. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=76

USEPA NPDES Phase II. 2006. Compost Blankets: Construction Site Storm Water Runoff Control. National Menu of Best Management Practices for Construction Sites. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm.

WDOE, 2005. Guidelines and resources for implementing soil quality and depth BMP T5.13. Washington Department of Ecology Stormwater Management Manual for Western Washington.

Woods End Research Lab, Inc. 2003. Stormwater monitoring, Collection and Analysis of Test Plot Runoff: Kents Hill School Project 319. Maine Department of Transportation.

Young, R., T. Huntrods, and W. Anderson. 1980. Effect of vegetated buffer strips in controlling pollution from feedlot runoff. Journal of Environmental Quality, 9:483-487.

Yu, S., S. Barnes and V. Gerde. 1993. Testing of Best Management Practices for Controlling Highway Runoff. FHWA/VA 93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Table 3.1. Filtrexx® Engineered Soil Performance and Design Specifications Summary

Reference / Performance & Design	Harrison et al, 1997	Meyer et al., 2001	Reinsch et al., 2005	Mukhtar et al., 2004
Runoff Volume Reduction	53%	44-77%	69%	32%
Infiltrate Rate		0.125-0.158 cm/sec		
Rainfall Absorption	43%	86-95%	88%	
Water storage Increase	40%			
Pollutant & Removal Efficiency	Total P = 20%	TS = 53-59%	TS = 96%	TS = 73% TSS = 65% TKN = 72% NH4-N = 54% Total P = 76% Dissolved P = 89%
Compost Application Rate	1:2, 1:3, 1:4 (soil:compost)	40-80 Mg/ha	2 in (50mm)	25% or 1:3 (compost:soil)
Depth of Tillage	Mixed off-site	4-8 in (100-200mm)		3 in (75mm)
Vegetation Type	Turf grass	Wheatgrass & needlegrass	Fescue	
Vegetation Cover		69-70%		
Rainfall Intensity -Duration	0.3-0.6 in (8-15mm)/hr for 2-8 hr	4 in (100mm)/ hr for 30 min.	2.6 in (66mm)/ hr for 45 min	3.6 in (91mm) /hr for 35 min
Soil Type		Gravelly clay-loam, gravelly sandy-loam	Clay	Clay
Slope		10-16%	3:1	3:1
Research Institution	University of Washington	Colorado State University	University of Nebraska	Texas A&M University

Figure 3.1. Engineering Design Drawing for Filtrexx® Engineered Soil