Erosion Control Manual
Utilizing Organic Practices

PLANO PURE PRODUCTS

FEBRUARY 2003

ACKNOWLEDGMENTS

This manual is a part of the **Compost Market Development Project** and was prepared in cooperation with:

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Acronyms

Many acronyms are used throughout this manual and the accompanying PowerPoint Presentation. The acronyms and their meanings are listed below:

BMP: Best Management Practices

Permit condition used in place of or in conjunction with effluent limitations to prevent or control the discharge of pollutants. These may include schedule of activities, prohibition of practices, maintenance procedure, or other management practice. BMPs may include, but are not limited to, treatment requirements, operating procedures, or practices to control plant site runoff, spillage, leaks, sludge or waste disposal, or drainage from raw material storage.

Environmental Protection Agency

Common-sense actions required, by law, to keep soil and other pollutants out of streams and lakes. BMPs are designed to protect water quality and to prevent new pollution.

Idaho Forest Products Commission

EPA: Environmental Protection Agency

EPA's mission is to protect human health and to safeguard the natural environment — air, water, and land — upon which life depends. For 30 years, EPA has been working for a cleaner, healthier environment for the American people.

NPDES: National Pollutant Discharge Elimination System

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. See Section VIII of the manual for more information.

USDA: United States Department of Agriculture

USDA Mission: Enhance the quality of life for the American people by supporting production of agriculture:

- ensuring a safe, affordable, nutritious, and accessible food supply
- caring for agricultural, forest, and range lands
- supporting sound development of rural communities
- providing economic opportunities for farm and rural residents
- expanding global markets for agricultural and forest products and services
- working to reduce hunger in America and throughout the world.

USDA Vision: A healthy and productive Nation in harmony with the land.

DEFINITIONS

CEC: Cation (cat-ion) Exchange Capacity: represents the sites in the soil that can hold positively charged nutrients, such as calcium, magnesium, and potassium. If CEC is increased, the soil can hold more nutrients and release them for plant growth. To increase CEC, increase organic matter.

Composting: controlled process of decomposition and recycling of raw organic material into small particles of stable organic matter.

Compost: acts as a storehouse for plant nutrients, is vital to productive soils and plant growth, & can increase CEC

I. INTRODUCTION

The **Compost Market Development** project, supported by the North Central Texas Council of Governments and developed by the City of Plano Solid Waste Division and Environmental Concepts & Designs, Ltd. will demonstrate the effectiveness and benefits of compost/mulch blend filter berms, filter tubes, erosion control blankets, and other organic techniques/methods specifically for erosion control. It will promote their use as a replacement or alternative to silt fencing, synthetic woven blankets, and straw bale waterway check dams on construction sites, roadsides, and highway projects. The **Compost Market Development** project will also illustrate utilization of organic materials/methods for turf establishment and maintenance. This project and subsequent demonstration/installations will be implemented in the City of Plano and Collin County, and contiguous counties.

In 2003, the National Pollutant Discharge Elimination System (NPDES) - Phase II will go into effect, which will impact many communities within the North Central Texas area. Phase II is the Environmental Protection Agency's (EPA) next step to preserve, protect, and improve the nation's water resources from polluted storm water runoff and sediments. Construction activities yield sediment, pesticides, petroleum products, chemicals, solvents, asphalts, and acids that can contaminate storm water runoff. Phase II will regulate construction activities that will disturb land equal to or greater than one acre and less than five acres that will discharge storm water runoff into a municipal separate storm sewer system or waters of the United States. *Under NPDES - Phase II, if the erosion/sediment control (BMP) selected is not properly installed or does not perform, holders of the permit may be subject to a $25,000 per day per violation and/or up to two years in jail.*

Compost, mulch, and compost/mulch blends **are more effective, less expensive, and better for the environment** than conventional erosion/sediment control BMPs (silt fence, straw bales, synthetic woven blankets), as illustrated in Section IV of this manual.

Often these BMPs are available at lower costs than conventional methods, are easily installed and maintained, and do not require removal or disposal, thus saving landfill space and contractor labor costs.

II. PURPOSE OF THIS MANUAL

The purpose of this manual is to provide planning and storm water professionals, design consultants, landscape architects, contractors, developers, and property owners assistance in selecting the most efficient and cost effective Best Management Practices (BMPs) to control erosion, sediment, and other pollutant runoff. This manual will illustrate the benefits of utilizing compost, mulch, and compost/mulch blends for Erosion Control and as a soil amendment and a growing media when utilized in Terraseeding, Topdressing and Organic Lawn Treatments.

This manual also supports the incorporation of these more effective Organic BMPs into the City of Plano's Soil Erosion and Sediment Control Manual as the preferred method**.** For example: behind the section for silt fence will be the Organic Filter Berm/Tube specifications and drawings.

Compost/mulch blends and other organic mulch materials perform much better, are less expensive, and are better for the environment than currently used erosion and sediment control techniques such as silt fences, straw bales, synthetic woven blankets, etc.

The use of these new Organic BMPs will promote sustainable economic development by lessening the negative environmental impacts and subsequent costs to our community associated with construction and by increasing the recycling of organic wastes.

III. The Impacts of Soil Erosion

Soil erosion is the detachment and movement of soil by moving water, wind, or ice. Sediment is eroded material suspended in water or the air. Sedimentation is the deposition of eroded material. Soil erosion/sediment transport drastically and negatively impacts our environment by:

- Contributing to/increasing turbidity, chemical oxygen demand (COD), total solids, and total suspended solids (TSS) in our waterways.
- Carrying fertilizers, pesticides, and other contaminants that are attached to the soil into waterways.
- Eroding and depleting natural, nutrient-rich topsoil, making the re-establishment of vegetation difficult.
- Filling culverts, detention ponds, and storm drains which increases flooding, maintenance and re-construction costs.
- Decreasing the recreational and aesthetic value of our water resources.
- Tremendously increasing expenditures at water treatment plants to clean the water. This is a cost borne by the public.

The natural process of erosion cannot be totally stopped, but erosion is greatly accelerated by human activities. Erosion results in:

- higher project costs
- reduced water quality
- negative industry public relations
- loss of business and jobs
- higher property taxes
- lower shorefront property values
- damage to aquatic habitat

The U. S. Department of Agriculture states that more than 2 billion tons of topsoil is lost through erosion annually. EPA reports that sediment contamination of our surface waterways is the greatest threat to our nation's water resources and siltation is the number one water pollutant.

Construction activities can have erosion rates 2,000 times greater than those for forested land and 10 times greater than those for cropland.

Costs associated with these erosion/sedimentation impacts can be either obvious or subtle. Some are difficult to quantify, such as the loss of aesthetic values or recreational opportunities. But for contractors, the loss or filling of ponds from siltation can result in thousands or tens of thousands of dollars in added costs, which are passed on to the property owner making properties harder to sell and lowering profit margins. The maintenance costs of man-made structures and harbors are readily quantifiable and taxpayers pay repeatedly for these avoidable costs. More and more, these costs are being passed back to contractors.

IV. BENEFITS OF USING COMPOST, MULCH & COMPOST/MULCH BLENDS

Compost, mulch, and compost/mulch blends have many benefits when utilized for terraseeding, topdressing and erosion control. Composts and mulches are excellent examples of utilizing the 3 R's:

- **Reduces** the amount of organic and wood wastes being landfilled.
- **Reuses** beneficial organics and woods.
- **Recycles** the organics and wood into useful, cost effective, and environmentally beneficial end-products (**compost/mulch**).

Economic Benefits:

- Results in significant cost savings by reducing the need for water, fertilizers, and pesticides, thus reducing contractor labor/costs.
- Compost can retain many times its weight in water, thereby conserving water and associated water costs.
- A low-cost alternative to artificial/chemical soil amendments.
- One cost produces multiple benefits.
- Produces a marketable commodity from organic wastes/resources.
- Initial Costs for Organic BMPs are usually less than conventional methods.
- Reduces or eliminates maintenance costs.
- Reduces the need for re-grading of soils or cutting /filling slopes.
- Reduces the need to clean out culverts or remove materials from properties downstream.

Soil Enrichment:

- Increases organic matter content of soil - providing greatly enhanced growing media
- Improves soil structure, porosity, and bulk density of soil.
- Helps suppress plant diseases and pests - reduces or eliminates the need for fertilizer, pesticides and other chemicals.
- Increases water infiltration and permeability of heavy soils, improving drainage and reducing storm water runoff and subsequent erosion.
- Improves light soil's water holding capacity, promoting water conservation.
- Supplies significant quantities of organic matter, which help stabilize and hold soil particles together, reducing erosion.

<u>Pollution Prevention and Remediation</u>:

- Prevents storm water runoff pollutants from reaching water resources.
- Prevents erosion and silting on embankments parallel to waterways.
- Prevents erosion and turf loss on roadsides, hillsides, playing fields and golf courses.
- Can bind and degrade specific pollutants preventing them from entering waterways.

A. Benefits For Erosion Control Utilizing Organic Materials

Many State Department of Transportation (DOT) officials, highway, commercial and residential contractors, and government entities are having tremendous success utilizing compost, mulch, and/or compost/mulch blends for erosion control. Some of these successes are documented in Section VIII: Supporting Research and Resources. One study demonstrated that:

(1) Compost application reduced soil loss by 86% compared to bare soils, and

(2) Sediments reaching nearby surface waters decreased by 99% when compared to silt fences and 38% when compared to hydroseeding applications.

The overall benefits of utilizing Organic BMPs for erosion control include:

- Immediate impact on the reduction of soil movement.
- Economically competitive with and more effective than current erosion and sediment control techniques and products.
- Organic matter, when utilized as a soil amendment, enhances and stimulates plant growth.
- Provides immediate and effective erosion control with no seasonal restrictions.
- Increases water infiltration into the soil surface.
- Increases the water holding capacity of soil.
- Binds and degrades specific chemical contaminants.
- Can sequester airborne carbon and slow the "greenhouse" effect.
- Reduces or eliminates disposal costs following construction since compost can be tilled into the soil during landscaping activities.
- Reduces/diminishes soil compaction.
- Buffers soil pH, which can increase vegetation establishment and growth.

The cost-effectiveness of compost, mulch, and compost/mulch blends should be considered for both the short-term and the long-term benefits. **One application cost provides multiple benefits ranging from the construction stage to the final landscaping and establishment and maintenance of turf.**

B. Benefits For Turf Establishment and Maintenance

Organic materials can also be utilized for turf establishment and maintenance and to enhance existing turf. Organic turf establishment and maintenance methods are more cost effective than conventional turf establishment methods i.e. hydroseeding and sod, and are better for the environment. Their many potential benefits include:

- **Increased water conservation:** Numerous studies have shown an *increase in the moisture holding capacity (the amount of water soil can hold) and moisture retention capacity (the length of time soil can retain water)* of soil that has been amended with compost. **LESS WATERING MEANS LOWER COSTS.**

- **Improved turf growth:** Studies have shown that turf grown on compost-amended soil "greened up" more quickly than turf grown on unamended-soil during initial turf establishment. It was also observed that 100% turf coverage occurred more rapidly in compost-amended plots.

- **Reduced fertilizer applications:** Compost is a very valuable source of organic matter and can supply many of the nutrients necessary for turf growth and development for up to an entire year and possibly longer.

- **Provides disease suppression:** Turf grown on compost-amended soil is typically healthier than turf grown on unamended soils. Healthier turf is more resistant to diseases, weeds, insects, and fungus, which result in an overall reduction in pesticide and herbicide applications. **LESS NEGATIVE ENVIRONMENTAL IMPACT AND LOWER COSTS.**

- **Improved storm water retention:** Compost-amended turf increases the storm water retention of a lawn/surface through increased absorption. Studies have also shown that turf grown on compost-amended soil reduced peak and total water discharge, reducing run-off, erosion and the required size of water retention areas.

The beneficial properties of using compost-amended soils are not limited to new site development alone. Very similar results and savings are seen when compost is used as a topdressing to enhance existing turf. Both the developer and the homeowner realize these benefits.

Soil amended by compost is healthier and requires less water, is more drought and disease resistant, and can greatly reduce fertilizer, pesticide, and other chemical usages.

V. COST

Beginning in 2003, a NPDES permit will be required for all construction activities that disturb more than one acre of land. If BMPs are not properly installed, continually maintained, or do not perform, the permit holder may be subject to fines up to $25,000 per day per violation and/or incarceration for up to two years.

With the implementation of NPDES - Phase II, it is more important than ever that design consultants, contractors, builders, landscape architects, and engineers choose/specify BMPs that will provide the best protection at the best price.

For this reason, a major paradigm shift needs to occur to change the way we think about controlling erosion, moving from old standards ("the way it has always been done") to a "full cost" mentality, which would include costs associated with the project beyond the initial cost of material and installation.

A. What are the "Full" Costs of Current Erosion Control Methods/Techniques?

Current erosion control methods/techniques have numerous hidden, hard to quantify costs, making it very difficult to accurately determine the contractor's cost. Outlined below are components that should be included in the "full" costs associated with the current erosion control methods. These components represent the costs for the entire construction period.

1. **Cost of Material**

Aggregate
Straw bales
Fabric
Staples, stakes, etc.
Delivery/transportation charges (to place material at site)
Labor costs

2. **Cost of Installation**

Labor costs
Equipment - purchase/rental

3. **Cost of Maintenance**

Additional materials (including staples, stakes, more bales, fabric, etc)
Additional labor

4. **Cost of Removal**

Labor costs
Disposal costs
Re-grade of disturbed land
Re-vegetation of disturbed land

B. What are the "Full" Costs of Organic BMPs?

The cost of Organic BMPs is a simple budget line item. There are virtually no hidden costs. These components represent the costs for the entire construction period.

1. **Cost of Material, Installation, Labor, and Equipment**

One price based on cost per linear foot as installed by pneumatic blower.

2. **Cost of Maintenance**

When organic BMPs are utilized on contractor sites, extra material (compost, mulch, compost/mulch blends) or extra linear feet of organic filter tube is placed for patching in case of any disturbances or breaching. Our experience shows the costs assigned to the extra material is generally less than 5% of total installation. As this material is utilized a second time (see #3 below), we assign **no maintenance cost.**

3. **Cost of Removal**

There is no cost for removal. Organic materials can be utilized a ***second time*** as a soil amendment to enhance topsoil, thus producing a better growing media for turf establishment or sod establishment ***at no additional cost.***

4. **When compost is incorporated into topsoil, seed has much higher (>90%) germination rate for vegetation establishment, requiring up to 40% less water and less fertilization.**

The following cost comparisons illustrate the cost savings that can be achieved by utilizing organic materials for erosion control methods/techniques. The cost figures for conventional BMPs are from EPA and *Grading & Excavation Contractor* magazine. **These prices represent the costs for the entire construction period.**

Practice	Cost	Useful Life (years)	Effectiveness*
Silt Fence	$2.75 - $ 5.50 lin. ft.	.5	0 - 40%
Organic Filter Berm	$1.90 - $3.00 lin. ft.	.5	99%
Organic Filter Tube	$1.40 - $1.75 lin. ft.	.75	99%

*pertains to reducing sediment in runoff waters

Practice	Cost	Useful Life (years)	Effectiveness*
Straw Bale	$2 - $6 lin. ft.	.25	0 - 10%
Organic Filter Berm	$1.90 - $3.00 lin. ft.	.5	99%
Organic Filter Tube	$1.75 - $2.75 lin. ft.	.75	99%

*pertains to reducing sediment in runoff waters

Practice	Cost	Useful Life (years)	Effectiveness *
Rock Check Dams	$10 /per lin. ft.	not available	0 - 10%
Organic Check Dam - Filter Berm	$3.00 - $6.00 lin. ft.	.5	99%
Organic Check Dam - Filter Tube	$2.75 - $4.75 lin. ft.	.75	99%

*pertains to reducing sediment in runoff waters

Practice	Cost	Useful Life (years)	Effectiveness**
Rolled Erosion Control Products	$1.50 - $9.05 yd^2	not available	80 - 90%
ERC Blankets	$0.11/sq. ft. per 1" depth (unseeded) $0.12/sq. ft. per 1" depth (seeded)	2	90 - 99%

**pertains to minimizing erosion from rainfall, runoff, or wind

Practice	Cost	Useful Life (years)	Effectiveness**
Sod	$0.20 - $0.40/ sq. ft.	2	90 - 99%
Hydroseeding	$0.08 - $0.12/per sq. ft.	not available	80 - 94%
Terraseeding	$0.12 sq. ft. per 1" depth	2	90 - 99%
Topdressing	$0.06 sq. ft. per 1/2" depth	2	90 - 99%
Organic Lawn Treatment	$0.055 sq. ft. per 3/8" - 1/2" depth	2	90 - 99%

**pertains to minimizing erosion from rainfall, runoff, or wind

VI. MATERIAL SPECIFICATIONS

The following are the Physical **Requirements for Compost** set forth by the United States Department of Agriculture, the United States Composting Council *"Test Methods for the Examination of Composting and Compost"* (TMECC), and the Texas Department of Transportation.

- **Particle Size:** 95% passing 5/8 in., 70% passing 3/8 in. in accordance with TMECC 02.02-B, *"Sample Sieving for Aggregate Size Classification"*.
- **Heavy Metals:** Pass in accordance with TMECC 04.06, *"Heavy Metals and Hazardous Elements"*.

  04.06-As, Arsenic 04.06-Pb, Lead 04.06-Ni, Nickel
  04.06-Be, Beryllium 04.06-Hg, Mercury 04.06-Se, Selenium
  04.06-Cd, Cadmium 04.06-Mo, Molybdenum 04.06-Zn, Zinc
  04.06-Cu, Copper

- **Soluble Salts:** 5.0 max* dS/m in accordance with TMECC 04.10-A, *"1.5 Slurry Method, Mass Basis"* (* a soluble salt content up to 10.0 dS/m for compost used in compost manufactured topsoil (CMT) will be acceptable).
- **pH:** 5.5 - 8.5 in accordance with TMECC 04.11-A, *"1.5 Slurry pH"*.
- **Maturity:** Greater than 80% in accordance with TMECC 05.05-A, *"Germination and Root Elongation"*.
- **Organic Matter Content:** 25 - 65% (dry mass) in accordance with TMECC 05.07-A, *"Loss-On-Ignition Organic Matter Method"*.
- **Stability:** 8 or below in accordance with TMECC 05.08-B, *"Carbon Dioxide Evolution Rate"*.
- **Fecal Coliform:** Pass in accordance with TMECC 07.01-B, *"Fecal Coliforms"*.

Plano Pure Compost meets the above specifications.

Organic BMPs

Organic Filter Berm

Organic Filter Tube

Erosion Control (ERC) Blanket

Organic Filter Berm Check Dam

Organic Filter Tube Curb
Inlet Sediment Barrier

Organic Filter Tube Area/Drop
Inlet Sediment Barrier

VII. BMP SPECIFICATIONS

A. Organic Filter Berms/Tubes

Organic Filter Berms/Tubes eliminate the need for plastic silt fencing. No matter what the terrain, Organic Filter Berms/Tubes can be installed with minimal effort as compared to silt fence and other methods requiring ditching and reinforcement. These tested and proven techniques have revolutionized erosion and sediment control by providing an option that is environmentally friendly and highly effective.

Advantages of Organic Filter Berms/Tubes

- Over 99% effective: Organic filter berms/tubes have proven to be 99% effective in reducing erosion as compared to silt fences, which is only 40% effective.
- Cost Competitive with Existing BMPs: Organic filter berms/tubes have lower costs because they eliminate costs associated with the removal and disposal of silt fences. .
- Consistent Installation: Single step pneumatic application creates a dependable system that ensures the berm/tube is installed to meet specified dimensions and installed with 100% ground/soil contact, conforming to all terrains.
- Biofiltration Capabilities: The compost/mulch blend used to make organic filter berms/tubes greatly enhances the ability of the material to bind and degrade hydrocarbons as water flows through its three dimensional matrix.
- Organic, Recycled & Reusable: Organic filter berms/tubes use over 98% biodegradable materials in its construction. The fibrous matrix it forms gives the necessary structure needed with little or no non-biodegradable reinforcements. Made with recycled organics, the compost/mulch blend can be used as an earth friendly soil amendment at the completion of a project bringing multiple benefits and cost savings.
- Other Advantages of Organic Filter Berms/Tubes:
  - May be seeded if left as a permanent part of the surrounding landscape.
  - Little, if any, ditching, staking or reinforcement necessary for filter tubes.
  - Low impact to surrounding area (physically, visually, and environmentally).
  - Acts as an effective physical barrier in sheet flow conditions.
  - Slows the flow of water over the surface of the soil.
  - Retains large volumes of sediment in its mass (pore spaces).

1. Organic Filter Berm Specifications - Figure 1

Description: Organic filter berms are contoured runoff and erosion filtration methods usually used for steep slopes with high erosive potential.

Purpose:

- Allows runoff water to penetrate it and continue to flow through it while filtering sediment and pollutants from the water. The filter berm also slows the flow down, allowing soil particles to settle out.
- Reduces the transport of coarse sediment from construction site by providing a temporary physical flow barrier to sediment and reducing velocities of overland flow.
- Controls and filters runoff, protecting areas sensitive to erosion and sedimentation.
- Reduces water pollution and can be used in bioremediation of soils.
- Improves soil, amending it organically.

Conditions of Use/Limitations:

- Organic filter berms may be used downslope of all disturbed areas of less than one-quarter acre.
- Do not place single organic filter berm in runoff channels (single concentrated flow).
- Organic filter berms are not intended to treat concentrated flows *(such as ditches or streams)*, nor are they intended to treat substantial amounts of overland flow. The only circumstance in which overland flow can be treated solely by an organic filter berm is when the area draining to the organic filter berm is small.
- Organic filter berms work best when installed on contours (level with horizon).
- Organic filter berms work well in many of the same areas as, or in conjunction with, erosion control blankets but are the preferred method if the slope exceeds a 4:1 gradient with a maximum of a 3:1 gradient.
- Organic filter berm size and construction/mix may vary based on slope severity and the amount of expected flow; larger/multiple berms are recommended for steeper slopes.
- An organic filter berm may be used on the shoulder contour of steeper slopes for added protection.
- Organic filter berms may be windrow or trapezoidal (allows maximum water penetration) in shape and should be placed uncompacted on bare soil as soon as possible. Organic erosion control blankets may be used in front/above or behind/below the organic filter.
- Organic filter berms can be planted and seeded at the time of application for permanent vegetation establishment. The berm can also be spread out and planted or seeded at the end of the project. Either way, organic filter berms can be left at the site with little or no waste product or clean up. Organic matter will help to amend on-site soils.

- Locations where other types of BMPs should be used:
  - At low points of concentrated runoff
  - Below culvert outlet aprons
  - Where a previous stand-alone erosion control mix application has failed, unless multiple controls are installed

Design & Material Specifications:

- Flow Rate (into devices): average flow rate 0.3 (gal./sq. ft./minimum) or not greater than 1cfs.
- Drainage Area: contributing drainage area not to exceed 1/4 acre per 100 ft. of barrier length; the maximum slope above the barrier is 50 ft.; and the maximum gradient behind the barrier is 50% (2:1).
- Height: 1 ft. (minimum) to 3 ft. (maximum)
- Width: 2 ft. (minimum) to 5 ft. (maximum)
- Material:

  - Particulate sizes should be a mix of fine-screened compost (1/4 to 1/2 in.) and coarse grade wood mulch with no particulate sizes exceeding 3-1/2 inches in length. The mixture ratio should be or may include a greater fraction of coarser blend material (1:2) (fine:coarse).

Installation Specifications:

- On slopes less than 5% *or* at the bottom of steeper slopes, less than or equal to a 3:1, up to 20 ft. long, the barrier (filter berm) must be *a minimum of* 12 in. high and *a minimum of* two ft. wide as measured on the uphill side of the barrier. *On longer or steeper slopes*, the barrier should be larger in both height and width to accommodate the higher flow rate.

- Place berm perpendicular to slope for affected areas, maintaining as level as installation as possible. Construct a 1 to 1-1/2 ft. high by 2 to 3 ft. wide berm of compost/mulch blend.

- Maximize water filtration ability by constructing a 1-1/2 to 3 ft. high trapezoidal berm that is 2 to 3 ft. wide at the top and 3 to 5 ft. wide at the base. In general, the base of the berm should be twice the height of the berm.

- Windrow shaped berms should be between 1 to 2 ft. high and 2 to 4 ft. wide with a maximum of 3 ft. high by 5 ft. wide.

- The minimum dimensions of the organic filter berm are 1 ft. high by 2 ft. wide.

- On steep or excessively long slopes, a second berm may be placed at the top of the slope or a series of organic filter berms may be constructed down the profile of the slope.

- Organic filter berms may be seeded for more permanent vegetation.

- The organic filter berm must be placed on a relatively smooth or level surface. It may be necessary to cut tall grasses or woody vegetation to avoid creating voids and bridges that would enable fines to wash under the barrier through the grass blades or plant stems.

- Good locations for stand-alone use without reinforcement by other BMPs are:
  - At toe of shallow slopes
  - On frozen ground, outcrops of bedrock and very rooted forested areas
  - At the edge of gravel parking areas and areas under construction

Maintenance Standards:

- The contractor shall maintain the organic filter berm in functional conditions at all times and it shall be routinely inspected. Silt may be raked or removed from construction side of device to accomplish this.

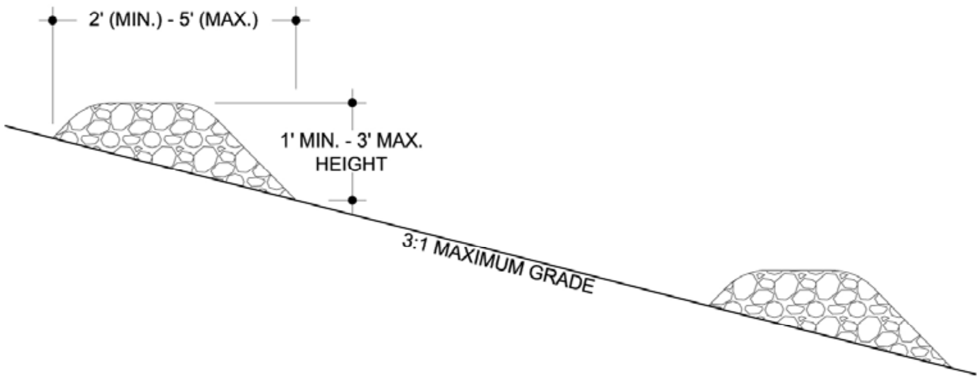
- There shall be no signs of erosion or concentrated runoff under or around the organic filter berm.

- If concentrated flows are bypassing or breeching the berm, it must be expanded, enlarged or augmented with additional BMPs.

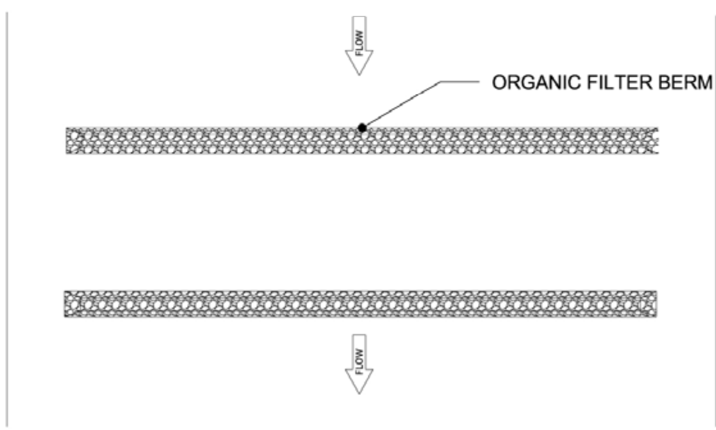
- Dimensions of the barrier must be maintained.

- Contractor shall immediately correct all deficiencies, rebuilding berm, if necessary, in accordance with original specifications.

FIGURE 1: ORGANIC FILTER BERM



SECTION VIEW



PLAN VIEW

2. Organic Filter Tube Specifications - Figure 2

Description:
Organic filter tubes are temporary erosion and sediment control barriers consisting of compost and compost/mulch blends that are contained in tubular mesh material.

Organic filter tubes are mesh bags of various sizes filled with specific blends of organic materials designed to filter and detain flows and sediments generated from drainage situations. **See Figure 9.**

Purpose:

- Allows runoff water to penetrate it and continue to flow through it while filtering sediment and pollutants from the water. It also slows the flow down, allowing soil particles to settle out.
- Minimizes the transport of sediment from construction, land disturbance, and other sites by providing a temporary physical barrier to sediment and reducing runoff velocity.
- Reduces the transport of coarse sediment from listed sites by providing a temporary physical flow barrier to sediment and reducing velocities of overland flow.
- Controls and filters runoff, protecting areas sensitive to erosion and sedimentation.
- Can be used when performing bioremediation of soils.

Conditions of Use/Limitations:

- Organic filter tubes should only be installed on contours.
- Organic filter tubes work well in many of the same areas as, or in conjunction with, erosion control blankets but are the preferred method if the slope exceeds a 4:1 gradient.
- Organic filter tubes size and construction/mix may vary based on slope severity and the amount of expected flow; larger/multiple tubes are recommended for steeper slopes. Organic filter tubes are typically contoured to the base of the slope but a second organic filter tube may be used on the shoulder contour of steeper slopes for added protection. Organic filter tubes should be placed uncompacted on bare soil as soon as possible. ERC blankets may be used in front or above the organic filter tubes.
- Organic filter tubes can be planted and seeded at the time of installation for permanent vegetation establishment. The tube can also be spread out and planted or seeded at the end of the project. Either way, organic filter tubes can be left at the site with very little waste product or cleaning up.
- It may be necessary to stake organic filter tubes on steeper slopes, generally at 6 - 8 ft intervals.

- In some jurisdictions, it is required to place the tube in a slight depression.

- A sediment trench 1 to 2 in. deep should be constructed immediately upgrade of the filter tube.

- Locations where other types of BMPs should be used:
  - At low points of concentrated runoff
  - Below culvert outlet aprons
  - Where a previous stand-alone erosion control mix application has failed, unless doing multiple controls
  - At the bottom of steep perimeter slopes that are more than 50 feet from top to bottom (i.e., a large up gradient contributing watershed)

Design & Material Specifications:

- Drainage Area: contributing drainage area not to exceed 1/4 acre per 100 ft. of barrier length; the maximum slope above the barrier is 25 ft; and the maximum gradient behind the barrier is 50 % (2:1).
- Material:
  - Chipped site vegetation, composted mulch, or wood-based mulch can be used to construct organic filter tubes.
  - Particulate sizes should be a mix of fine-screened compost (1/4 to 1/2 inch) and coarse grade wood mulch with no particulate sizes exceeding 3 inches in length. The mixture ratio should be or may include a greater fraction of coarser blend material (1:2) (fine:coarse).

Minimum Tube Material Specifications:

5" Diameter - 17 Pillar, White
Weight - gm/ft: 7.8 grams
Stretch width: 8"
Coarse count: 9.0
Pillar spacing: 1/2"
HDPE netting
UV stabilizer
Fade resistant color

8" Diameter - 25 Pillar, Orange
Weight - gm/ft: 21.02 grams
Stretch width: 12"
Coarse count: 9.0
Pillar spacing: 1/2"
HDPE netting
UV stabilizer
Fade resistant color

8" Diameter - 22 Pillar, White
Weight - gm/ft: 4.1 grams
Stretch width: 14 - 1/2"
Coarse count: 4.0
Pillar spacing: 7/16"
HDPE netting
UV stabilizer
Fade resistant color

10" Diameter - Black
Weight - gm/ft: 4.12 grams
Stretch width: 20"
Strand count: 40
Diamond size: 1/2"
HDPE netting
UV stabilizer
Fade resistant color

12" Diameter - Black
Weight - gm/ft: 4.3 grams
Stretch width: 24"
Stand count: 40
Diamond size: 5/8"
HDPE netting
UV stabilizer
Fade resistant color

18" Diameter - Black
Weight - gm/ft: 5.0 grams
Stretch width: 36"
Strand count: 40
Diamond size: 3/4"
HDPE netting
UV stabilizer
Fade resistant color

Installation Specifications:

- On slopes less than 5% *or* at the bottom of steeper slopes, less than or equal to 2:1 up to 25 ft. long, the barrier (filter tube) should be minimum of 10 in. to 12 in. in diameter or as specified on plan. *On longer slopes*, the barrier should be a larger diameter to accommodate the higher flow rate.

- Place tube parallel to the base of the slope or other affected areas; use a minimum 10 in. to 12 in. diameter filter tube.

- Use a filter tube up to 18 inches in diameter in areas with greater flows or where maximum sediment control is desired. In high volume application or on projects requiring longer than normal construction periods, maximize water filtration ability by using a greater than 12 in. diameter filter tube and a higher ratio of wood mulch.

- On steep or excessively long slopes, a second tube(s) may be placed at the top of the slope or a series of organic filter tubes may be constructed down the profile of the slope.

- The organic filter tube must be placed on a relatively smooth or level surface. It may be necessary to cut tall grasses or woody vegetation to avoid creating voids and bridges that would enable fines to wash under the barrier through the grass blades or plant stems.

- Good locations for stand-alone use without reinforcement by other BMPs are:
  - At toe of shallow slopes
  - On frozen ground, outcrops of bedrock and very rooted forested areas
  - At the edge of gravel parking areas and areas under construction

Maintenance Standards:

- There shall be no signs of erosion or concentrated runoff under or around the organic filter tube. If concentrated flows are bypassing the tube, it must be expanded or augmented by trenching into grade.

- Dimensions of the barrier must be maintained.

FIGURE 2a: ORGANIC FILTER TUBES

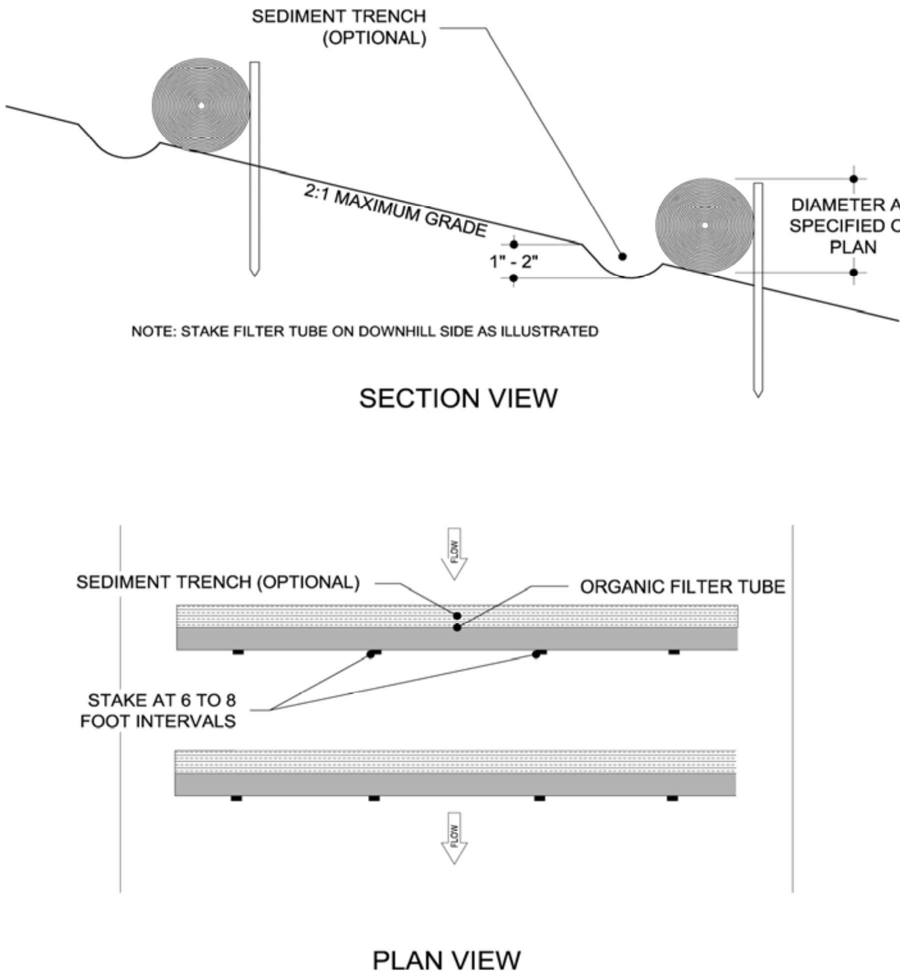


FIGURE 2b: ORGANIC FILTER TUBES

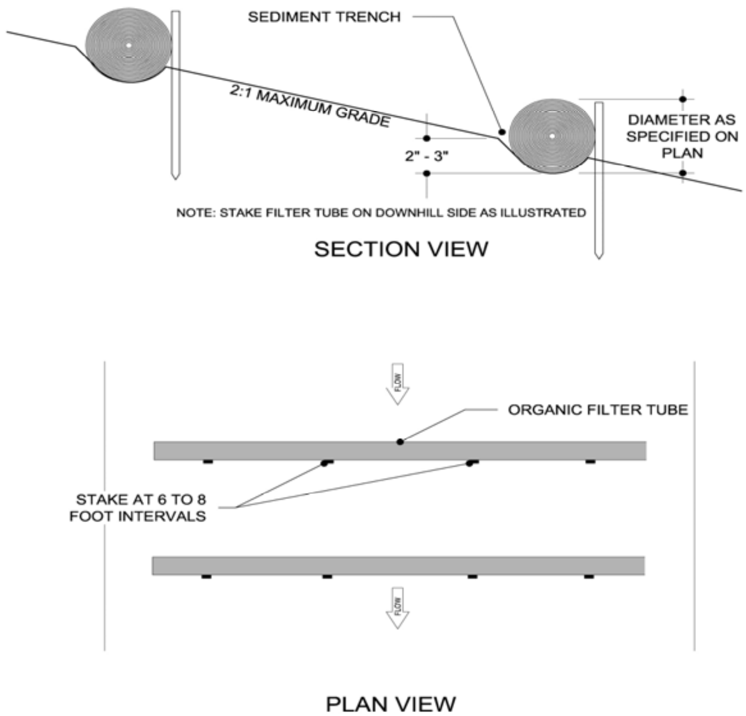
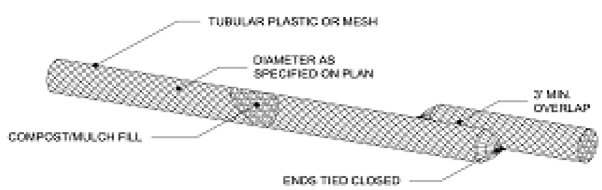


FIGURE 9: ORGANIC FILTER TUBE DETAIL



B. Erosion Control (ERC) Blankets

Erosion Control (ERC Blankets) comprised of compost and compost/mulch blends replaces /replenishes the natural layer of humus that protects our undisturbed soils. ERC blankets are easily installed in one step with pneumatic equipment and can be applied to many terrains.

Advantages of ERC Blankets

- Over 99% effective in reducing soil loss as a soil erosion control.

- 100% soil coverage: ERC blankets completely cover the bare soil with a matrix of natural organic material active with beneficial microorganisms. The pneumatic application conforms to the various contours of the soil surface providing an interlocking blanket that holds soil particles in place.

- Can be combined with a one step terraseeding process: To establish permanent vegetation, the ERC blanket can be injected with seed (grass, wildflower, native plants, etc.) during the application process. The ERC blanket is an excellent growing media for seed while providing immediate erosion control.

- 100% organic, recycled & reusable: ERC blankets use no plastic materials in its construction and do not require netting. Made with recycled organics, the compost/mulch blend can be used as an environmentally beneficial soil amendment at the completion of a project or left as a permanent stabilizing organic layer that will incorporate into the topsoil over time. **No landfilling - Saves money in solid waste disposal fees, time, and cost to buy erosion control materials**.

- Other advantages of ERC blankets:

    - Establishes a buffer to absorb rainfall energy
    - Slows velocity of water run off, allows for natural percolation of rain water into soil
    - Improves existing soil structure and biology
    - Pneumatic blower provides accessibility to remote and difficult to reach areas
    - Captures and retains moisture, reducing soil moisture loss, expediting plant growth
    - Immediately reduces wind and water erosion
    - Prevents soil compaction and crusting, facilitating percolation
    - Stimulates microbial activity to increase decomposition of organic materials in soils which improves soil structure

1. Erosion Control (ERC) Blanket Specifications - Figure 3

Description:

Erosion Control (ERC) Blankets are surface applications (ground cover/blanket) of designated high quality composts on areas with erosive potential.

Purpose:

- ERC blankets stabilize the soil, prevent splash, sheet, and rill erosion, and removes suspended soil particles and contaminants from water moving off the site and into adjacent waterways or storm water conveyance systems.

- Controls erosion on disturbed areas such as construction sites, state DOT development and planting projects, exposed stream banks, and any disturbed or excavated land area with a 4:1 slope or less, 3:1 maximum grade up to 20 ft. in length, or up to maximum of 2:1 slope when used in conjunction with organic filter berm/tube.

- Primary purpose of the compost erosion control blanket is to protect the soil surface until vegetation is established.

Conditions of Use/Limitations:

- Do not use compost erosion control blankets in ditches, streams, or other areas of concentrated flow unless used in conjunction with, and adequately protected by, filter berms/tubes or check dams.

Design & Material Specifications:

- Particulate sizes should be a mix of screened fine compost 1/4 to 1/2 in.) and coarse grade wood mulch (2 to 3 in.)
- A mixture ratio of 3:1 (fine:coarse) has been recommended. On thicker applications greater than 2 in. a mix ratio of 2:1 (fine:coarse) may be used.
- Erosion control blankets may be seeded for temporary or long-term vegetation.

Installation Specifications:

- Erosion Blankets are <u>most</u> efficiently applied using a pneumatic blower**.**

- ERC blankets are typically placed on up to 4:1 maximum grade or 3:1 grade up to 20 ft. in length or slopes up to 2:1 in conjunction with organic filter berms/tubes at an application rate of 2 to 5 in. depths. The lower application rates are typically used in areas of lower potential water flow and on less severe slopes.

- Application depths should be a minimum of 1-1/2 in. depth (up to 4 to 5 in. on more severe slopes) and 3 ft. over the top of the slope overlapping any existing vegetation wherever possible

- Application rates most generally should be between 1-1/2 to 3 inches in depth (200 to 400 cu. yd. per acre) with the higher rates for steeper slopes.

- Long slopes in excess of 50 ft. may require up to 4 to 5 in. depth.

- It is best to apply the compost layer on the slope contour, starting at the top, to prevent water from sheeting between the compost material and soil surface.

- If possible, apply compost at least 3 ft. over the shoulder of the slope or into existing vegetation to prevent rill formation and transport of the compost.

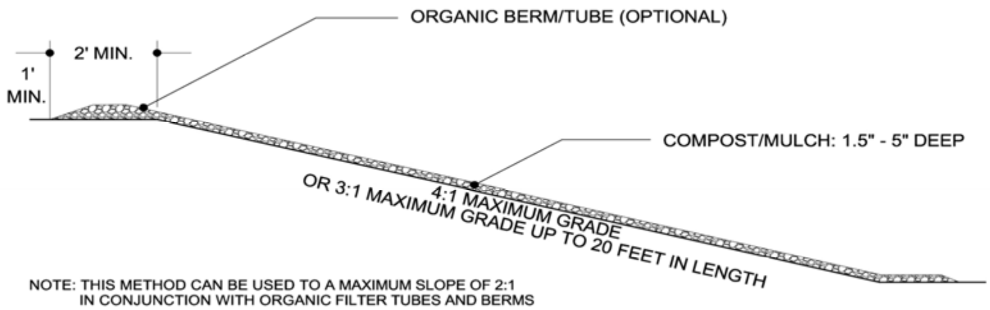
- Application depths may be modified for site-specific conditions, such as existing vegetation, climate, characteristics of soil, etc.

- ERC blankets may be seeded for temporary or long-term vegetation.

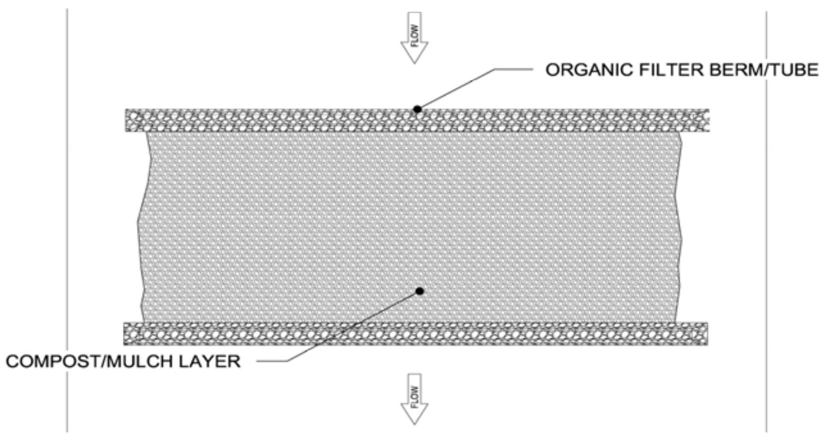
Maintenance Standards:

- Contractor shall make periodic inspections of the ERC blanket and make any repairs as necessary including adding additional materials
- Contractor shall inspect the installation before, during and after significant rain events.
- Where deficiencies exist, additional ERC blanket material shall be installed immediately to the required depth.

FIGURE 3: EROSION CONTROL (ERC) BLANKET



SECTION VIEW



PLAN VIEW

C. Organic Check Dam Specifications

Figure 4: Organic Filter Berm Check Dam
Figure 5: Organic Filter Tube Check Dam

Description: Organic check dams are small, temporary, or permanent dams constructed across a swale or channel to lower the speed of concentrated flows for a certain design range of storm events. Organic check dams may be Organic Filter Tube Check Dams or Organic Filter Berm Check Dams.

Purpose:

- To reduce the velocity of the water flowing through a swale or channel thereby reducing the erosion in the swale or channel.
- Organic check dams also can be used to catch sediment from the channel itself or from the contributing drainage area as storm water runoff flows through the structure.
- Reduces the velocity of the water in a channel and allows sediments and other pollutants to settle out and be retained.

Conditions of Use/Limitations:

- Organic check dams are most effective when used in combination with other storm water, erosion, and sediment control measures.
- Organic check dams should not be used in continuous, flowing streams.
- Organic Filter Tube Check Dams should be used only in small open channels that drain 8 to 10 acres or less
- Organic Filter Berm Check Dams should be used only in small open channels that drain 4 to 5 acres or less.

Design & Material Specifications:

Organic Filter Berm Check Dam

- Height: 1-1/2 ft. (minimum) to 3 ft. (maximum)
- Width: 2-1/2 ft. (minimum) to 5 ft. (maximum)
- Flow velocities: should not exceed 4 to 5 fps along a swale of 200 ft. in length during a water quality design storm
- Material:
  - Particulate sizes should be a mix of fine-screened compost (1/4 to 1/2 in.) and coarse grade wood mulch with no particulate sizes exceeding 3-1/2 inches in length. The mixture ratio should be or may include a greater fraction of coarser blend material (1:2) (fine:coarse).

Organic Filter Tube Check Dam

- Height: 12 in. minimum

- Flow velocities: should not exceed 4 to 5 fps along a swale of 200 ft. in length during a water quality design storm
- Material:
  - Particle sizes should be a mix of fine-screened compost (1/4 to 1/2 in.) and coarse grade wood mulch with no particle sizes exceeding 3 inches in length. The mixture ratio may include a greater fraction of coarser blend material (1:2) (fine:coarse).
- Tube Material Specifications: See Organic Filter Tube Specifications

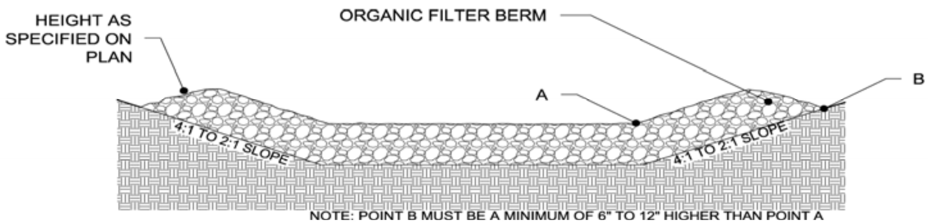
Installation Specifications:

- Keep centers of organic check dams at least 6 to 12 in. lower than the outer edges of natural ground elevation.
- Maximum height should be 3 ft.
- This design creates a weir effect that helps to channel flows away from the banks and prevent further erosion.
- Additional stability can be achieved by trenching the dam material into the sides and bottom of the channel.
- Organic filter tube check dam should be staked at 6 to 8 ft. intervals.
- Construct a 1 to 2 in. deep trench immediately upstream of check dams for storage of settled sediment to reduce maintenance.

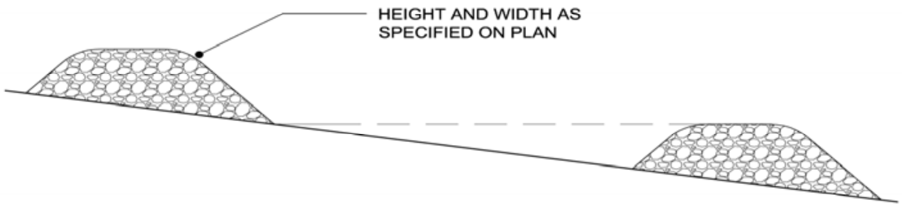
Maintenance Standards:

- Organic check dams should be monitored for performance and sediment accumulation
- Remove accumulated leaves and sediments from behind dam when they reach a depth of 1/2 the original height of the dam
- Restore materials as necessary for the organic check dams to maintain their correct height.

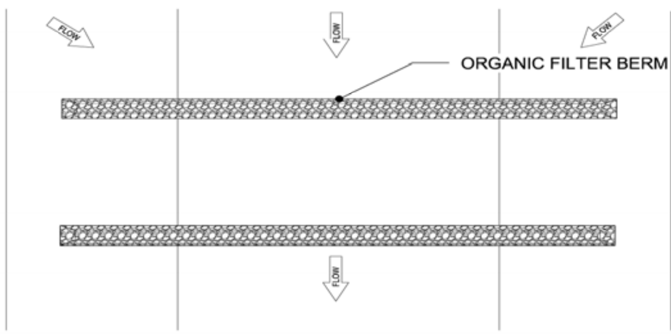
FIGURE 4: ORGANIC CHECK DAM (FILTER BERM)



SECTION VIEW

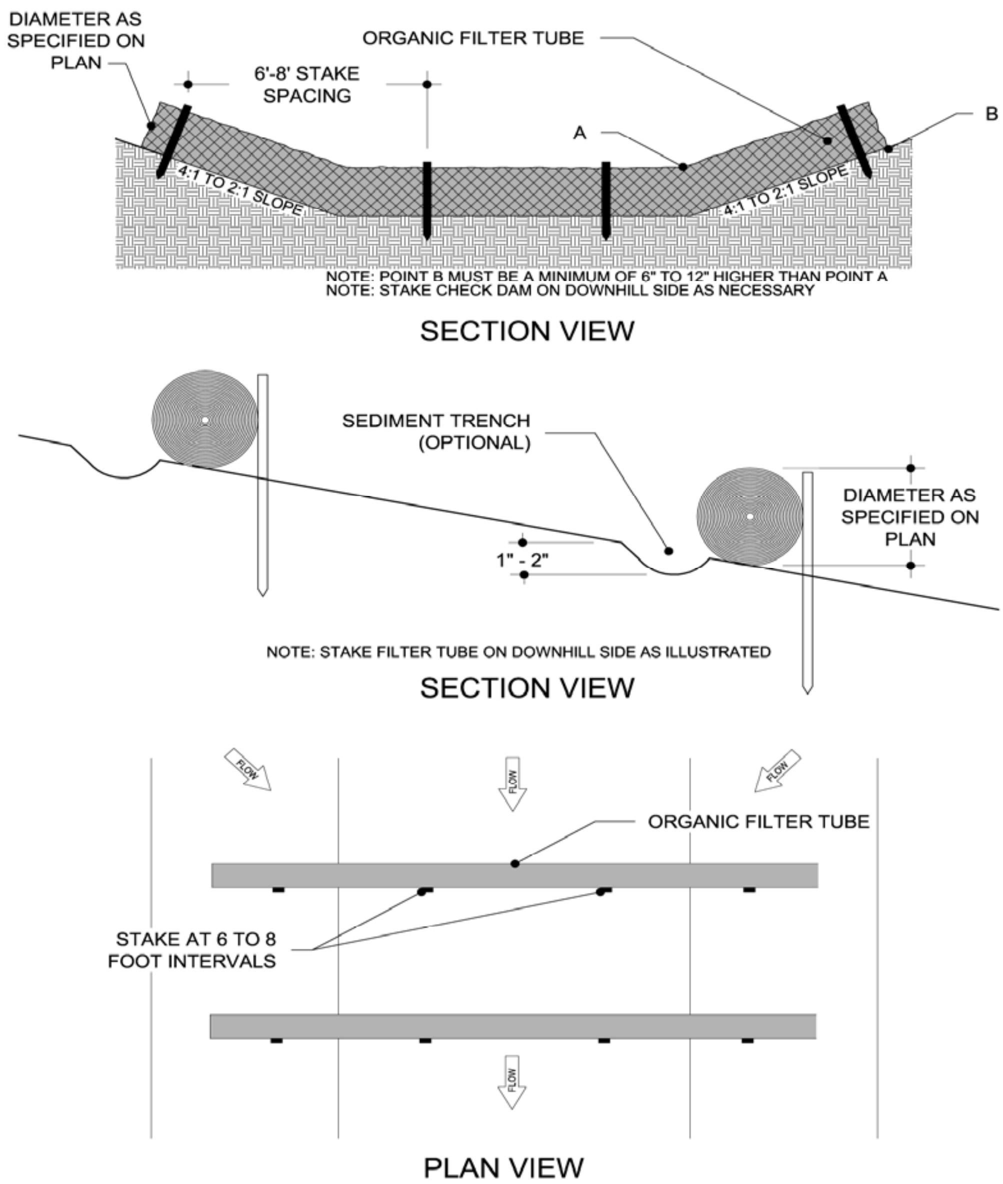


SECTION VIEW



PLAN VIEW

FIGURE 5: ORGANIC CHECK DAM (FILTER TUBE)



D. Organic Sediment Inlet Barrier Specifications
Figure 6: Curb Inlet Sediment Barrier
Figure 7: Area/Drop Inlet Sediment Barrier

Description:
Row of anchored/staked mesh bags or continuous organic filter tube placed around a storm drain inlet to reduce and/or prevent sediments from entering the storm drain.

Purpose:
- Reduces the amount of sediment from entering the storm drain system, reduces the amount of sediment leaving the site.

- Prevents coarse sediment from entering storm drainage systems by filtering runoff and retaining sediment before it reaches a drainage inlet or storm sewer system.

Applications:
- May be used in front of curb/gutter storm water inlet or placed around area storm water drain.
- At the outlet of slope drain
- To protect inlets along paved streets or area inlets

Conditions of Use/Limitations:
- Suitable where flow rates are low
- Drainage area less than 1 acre

Design Parameters
- Slope gradient should be 5% or less

Organic Filter Berm Sediment Barriers

Organic Filter Tube Sediment Barrier Material Specifications:
- Particulate sizes should be a mix of fine-screened compost (1/4 to 1/2 in.) and coarse grade wood mulch with no particulate sizes exceeding 3 inches in length. The mixture ratio should be or may include a greater fraction of coarser blend material (1:2) (fine:coarse).

Tube Material Specifications:

5" Diameter - 17 Pillar, White
Weight - gm/ft: 7.8 grams
Stretch width: 8"
Coarse count: 9.0
Pillar spacing: 1/2"
HDPE netting
UV stabilizer
Fade resistant color

8" Diameter - 25 Pillar, Orange
Weight - gm/ft: 21.02 grams
Stretch width: 12"
Coarse count: 9.0
Pillar spacing: 1/2"
HDPE netting
UV stabilizer
Fade resistant color

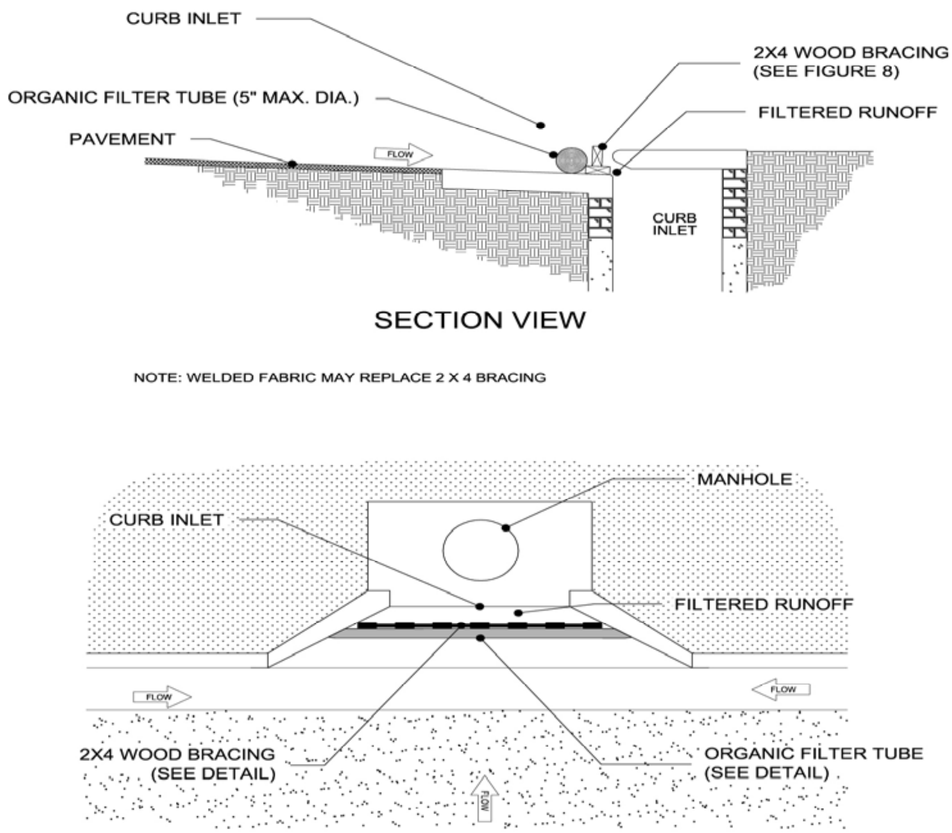
Organic Filter Tube Sediment Barrier Installation Specifications:

- Use tubes 5 to 18 inches in diameter or as specified on plans.
- Place inlet protection in areas where water can pond and where ponding will not have adverse impacts.
- Inlet protection must allow for overflow in a severe storm event.
- Ends of the tube should be secured.
- Additional measures must be considered depending on soil type or flow rates, such as 2 by 4 frame in front of curb/gutter inlet for support. **See Figure 8.**

Organic Filter Tube Sediment Barrier Maintenance Standards:

- Inspect once per week at active sites and once every two weeks at inactive sites and within 24 hours of a .5-inch rain event.
- After each storm, clean and remove sediment from behind inlet protection.
- Repair or replace materials as need to ensure proper functioning.

FIGURE 6: CURB INLET SEDIMENT BARRIER



PLAN VIEW

FIGURE 7: AREA/DROP INLET SEDIMENT BARRIER

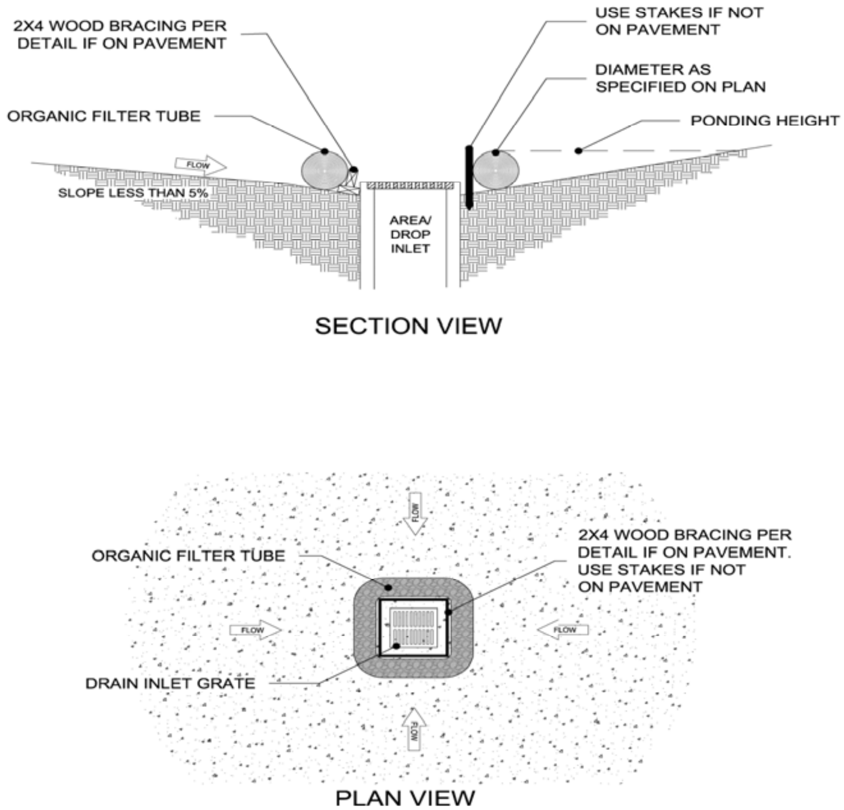
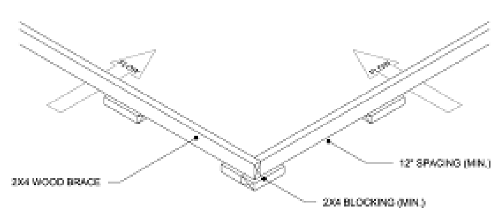


FIGURE 8: WOOD FRAME BRACING DETAIL



E. Terraseeding, Topdressing & Organic Lawn Treatments

Terraseeding, Topdressing, and Organic Lawn Treatments with compost are extremely helpful in resuscitating lawns/turf previously damaged by chemical use or heavy traffic. They can be used on established or new lawns/turf.

The most important benefit of Terraseeding, Topdressing and Organic Lawn Treatment is that each application adds beneficial organic matter to the soil. Organic matter is essential for "healthy soil". Healthy soil acts as a "biofilter", binding and degrading a variety of pollutants as water carries them through the soil profile. A 5% increase in organic matter quadruples the soil's ability to hold water. Improving soil structure through the incorporation of compost into the soil also reduces erosion and sediment movement.

In heavier soils (clay), the use of compost will reduce the bulk density of the soil, which improves moisture penetration and reduces soil crusting. In lighter (sandy), the compost can improve soil aggregation making it less likely to blow and improving moisture retention. Soil aggregation improves gas exchange, stabilizes the soil structure and increases permeability.

Terraseeding, Topdressing, & Organic Lawn Treatment Benefits include:

- Protects seed through planting rather than leaving the seed exposed on the surface.
- Increases germination through improved turf rooting and durability.
- Increases oxygen and cation exchange - more nutrients are available for plant uptake.
- Increases water rate of infiltration and the soil's water holding capacity equating to water conservation.
- Improves soil porosity, soil structure, and soil percolation rate.
- Improves soil's aeration for better root establishment and plant health.
- Supplies nutrients to the soil.
- Reduces the need for watering by up to 40%.
- Reduces the need for and the negative impact of chemical-based pesticides, herbicides, and fertilizers on the ecosystem.
- Reduces soil compaction.

1. Terraseeding

Terraseeding is the process of applying compost and seed in one quick and easy application with a pneumatic blower. **One easy step - saving time and valuable labor costs.** The system actually meters seed throughout the compost layer, thus the majority of the seed is placed below the compost layer surface, greatly improving seed protection, germination rates, and root establishment. Most average sized lawns/surfaces can be terraseeded in two hours or less. If it rains before germination, the compost/seed mixture resists erosion better than most soils.

Terraseeding stabilizes the soil, prevents or reduces splash, sheet and rill erosion, and removes suspended soil particles and contaminants from water moving off the site and into adjacent waterways or storm water systems. The need for chemical usage will be eliminated or reduced.

Terraseeding vs. Dry Seeding

- Terraseeding has a higher percentage of seed germination.
- Terraseeding has a quicker germination rate.
- Terraseeding does not contain weed seed.
- Terraseeding allows for custom tailoring of seed for the application.
- Terraseeding requires less watering than dry seeding.

Terraseeding vs. Hydroseeding

- Terraseeding has a higher germination rate than hydroseeding.
- Terraseeding is not 1/8 in. thick paper but is a productive soil amendment.
- Terraseeding does not require fertilizer (optional).
- Terraseeding requires less water than hydroseeding.

Terraseeding vs. Sod

- Terraseeding is 2 to 3 times less than the cost of sod.
- Terraseeding has no soil compatibility issues.
- Terraseeding requires less watering than sod.

Terraseeding procedure: Apply minimum 1 to 2 in. depth compost with seed with pneumatic blower.

2. Topdressing

Topdressing applies a thin uniform layer of compost and seed (optional) over an established turf area. Topdressing adds organic matter to the soil, which improves its physical, chemical, and biological characteristics. This enhances turf quality and vigor, allows for less watering, and improves turf's resistance to stress.

Topdressing is often used for maintenance on turf areas that are overused or on the decline. Topdressing with compost has become popular because of the cost effectiveness over conventional topdressing materials (i.e., sand, peat moss). Topdressing with compost improves sandy soil's moisture holding capacity, increases cation exchange capacity, and improves soil's microbiology. In clay or heavier soils, compost topdressing will reduce bulk density of the soil and improve soil percolation.

Continued topdressing with compost will improve turf grass stand, lessen reactions to drought and increase resistance to disease.

Topdressing procedure:

- Apply 1/2 to 3/4 in. of compost in a uniform layer.
- **(Optional)** Seed injected/applied with compost using a pneumatic blower.
- Water thoroughly. The water helps compost move through the thatch layer to the soil surface and into optional aeration holes where it can help retain valuable moisture.

3. Organic Lawn Treatment

Organic Lawn Treatment adds productive organic matter to rejuvenate an existing turf. Organic Matter stimulates turf growth by providing beneficial microorganisms and nutrients to the soil.

Organic Lawn Treatment

- improves the soil percolation rate,
- adds nutrients that are slowly made available for root uptake,
- increases plant's water gathering capacity, and
- reduces erosion by stabilizing and holding soil particles together.

Organic Lawn Treatment Procedure:
Apply 3/8 in. to 1/2 in. of compost in a uniform layer.

4. Recreational Fields (Golf Courses & Athletic Fields)

Turf managers are realizing the importance of adding organic matter (compost) to the soil. Organic matter is essential for “healthy soil” and serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, increases turf’s resistance to many common turf diseases (such as snow mold) and increases water infiltration into the soil. Additionally, organic matter (compost) greatly improves soil’s water retention ability, promotes seed germination and vegetative growth, reduces erosion by stabilizing and holding soil particles together, and reduces water, fertilizer, herbicide, and pesticide usage. Topdressing of recreational fields with compost is growing due to compost’s many benefits and its availability. The cost savings utilizing compost vs. sand and/or peat moss is tremendous.

For example, the Michigan Department of Environmental Quality states that one Michigan golf course makes compost from its own yard trimmings. The final product is screened and about 20% of the compost is used in the soil mix for greens construction (the rest is used in flowerbeds and as mulch). Savings related to just compost use are estimated at $1,750 each year for replacement of topsoil and peat moss.

Soil compaction is a persistent problem at recreational fields. Traditional methods of alleviating soil compaction (aeration, re-seeding, or complete re-sodding) are labor intensive, expensive, have negative environmental impacts, and provide only a short-term solution. Turf growing in less compacted soils uses 25 - 50% less water in comparison to compacted areas.

VIII. SUPPORTING RESEARCH & RESOURCES

SUPPORTING RESEARCH & RESOURCES

The use of composted material and/or mulch to reduce erosion and sediment transport has been well documented. Soil erosion has been controlled with these organic materials in the vineyards of Europe for years and in numerous other general applications.

Specifically, Ballif and Herre researched the effect of composted material on preventing erosion of soil in a vineyard in the Champagne area of France. The experiment compared the erosion rates of soil with and without compost. The results showed that applying compost to an area caused a decrease of two orders of magnitude in the amount of eroded material on a weight basis.

Numerous other studies/research have been conducted relative to the use of compost, wood mulch, and/or compost/mulch blends as soil erosion control BMPs. We have included a summary of the following research reports in this manual:

- *"Use of Wood Waste Materials for Erosion Control"*, prepared in April 2000 for the New England Transportation Consortium

- *"Field Evaluations of Source-Separated Compost and CONEG Model Procurement Specifications for Connecticut DOT Projects"*, prepared in December 1998 for Joint Highway Research Advisory Council of the University of Connecticut and Connecticut Department of Transportation in cooperation with the Connecticut Department of Environmental Protection.

- *"Demonstration Project Using Yard Debris Compost for Erosion Control - Final Report"* prepared in June 1993 for Metropolitan Service District.

- *"Summary of Projects Using Yard Debris Compost for Erosion Prevention & Control - Final Report"* prepared in June 1994 by the Solid Waste & Planning Department of Portland, Oregon.

- A more recent study conducted for Rexius Forest By-Products, Inc. of Eugene, Oregon at San Diego State University, Soil Erosion Research Laboratory. The Rexius trademarked system utilizes specific compost with a Microblend™ additive applied with a pneumatic blower truck and specific application hardware. However, as you can see by the graphs and summary test results, the Rexius system again supports the use of compost and mulch utilized as soil erosion control BMPs.

The research performed illustrates that compost, mulch, and compost/mulch blends have been successfully utilized for soil erosion control in different parts of the nation with numerous different soil types. The data demonstrates that compost, mulch, and compost/mulch blends consistently outperformed conventional soil erosion techniques, such as silt fence, straw bale barriers, synthetic woven blankets.

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"Use of Wood Waste Materials for Erosion Control"

by K. Demars, R. Long, and J. Ives - April 2000
Prepared for New England Transportation Consortium

This study examined the effects of different wood waste materials as erosion control mulch. Wood waste material was used for filter berms and compared to conventional hay bales and geosynthetic silt fence as erosion control barriers.

The wood waste and chip materials used in this study were placed over the soil and not blended. Three types of wood waste material were evaluated for use as erosion control mulch and one type was used as an erosion control filter berm. Each of the materials was subjected to large-scale erosion control testing at a field site with a slope of 1 vertical to 2 horizontal. Fourteen tests cells (5 ft. wide by 30 ft. in length each) were prepared with different wood waste treatments; nine contained erosion control mulch applications at thicknesses of 3/4 to 3 in. Two cells were left untreated as reference cells and three other cells were untreated but contained erosion control structures including wood waste filter berm, geosynthetic silt fence, and hay bale silt barrier. The erosion control performance of each cell treatment was evaluated for eleven storm events of varying rainfall magnitude and intensity. Calibrated tipper buckets were used to measure the runoff from each cell and collection buckets were used to sample runoff and determine the mass of sediment eroded from each cell. Total rainfall and intensity of each storm was measured with an electronic rain gauge.

The test cells and materials were as follows:

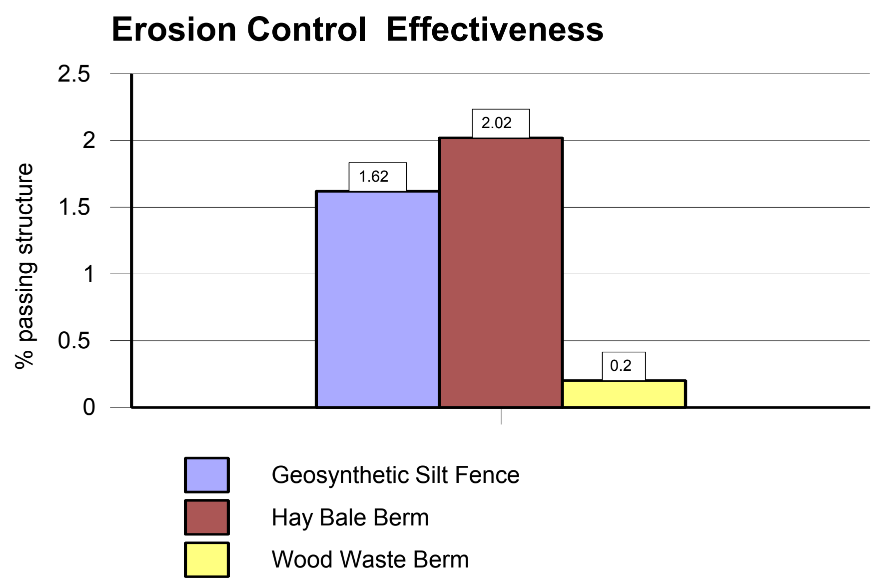
Cell Number	Surface Treatment
1	Paper Mill Wood Waste at 3.0"
2	Paper Mill Wood Waste at 1.5"
3	Paper Mill Wood Waste at 0.75"
4	Control (untreated)
5	Pine Bark Mulch at 3.0"

Cell Number	Surface Treatment
6	Pine Bark Mulch at 1.5"
7	Pine Bark Mulch at 0.75"
8	Geotextile Silt Fence
9	Hay Bale Barrier
10	Filter Berm of Paper Mill Wood Waste
11	Control (untreated)
12	Stump Grinding Mulch at 3.0"
13	Stump Grinding Mulch at 1.5"
14	Stump Grinding Mulch at 0.75"

The amount of runoff was measured with tipping buckets at the bottom of each cell. The volume of water to cause one tip was known from the calibration, and the number of tips was recorded with a digital counter attached to the tipper. The total runoff was adjusted for the amount that fell on the plastic sheet at the bottom of each cell, because this amount of rain could not erode any soil. Rainfall ranged from .27 in. to 4 ft. 4 in. (Hurricane Floyd) with the intensity ranging from .339 in. to 2 in.

Tests showed that the cells covered with wood waste materials experienced little soil erosion compared to the control cells. This illustrates that wood waste material is effective in preventing erosion. As expected, the larger storm increased the soil erosion from the control cells proportionally more than from the protected cells. During all storm events, the wood waste filter berm was more effective in retaining erosion products than either the hay bale barrier or the silt fence.

The chart on the next page shows the effectiveness of the wood waste filter berm compared to the silt fence or hay bale berm.



The silt fence was more effective than the hay bale berm but the wood waste filter berm reduced the amount of eroded soil that passed the erosion control structure by nearly an order of magnitude.

Study Conclusions:

- Wood waste materials are effective in minimizing erosion when applied to the soil surface as an erosion control mulch with a thickness of 0.75 in. or more. An untreated soil surface produced over 50 times more sediment than the treated soil surface.

- Wood waste materials are particularly effective in reducing runoff during storms under 0.5 in. by absorbing rainwater and by promoting percolation.

- Layers of wood waste materials of 0.75 in. allow vegetation to root and grow through it.

- The wood waste erosion control filter berm was more effective than either the hay bale barrier or the geosynthetic silt fence at controlling erosion. While all erosion control structures were effective compared to the control (untreated) structures, the hay bale barrier and geosynthetic silt fence released about an order magnitude more sediment than wood waste filter berm.

"Field Evaluation of Source-Separated Compost and CONEG Model Procurement Specifications for Connecticut DOT Projects".

By K. Demars and R. Long - December 1998

Sponsored by Joint Highway Research Advisory Council of the University of Connecticut and Connecticut Department of Transportation in cooperation with the Connecticut Department of Environmental Protection

This report documents a laboratory and field-testing program using source-separated compost and wood mulch for erosion control applications.

Samples of compost and mulch were obtained from eight producers in Connecticut. The samples were subjected to laboratory tests to determine their physical and chemical properties for comparison with CONEG model procurement specifications for source-separated compost. Three of the products were selected to test their effectiveness in erosion control at the field site; these included (1) yard trimmings compost from leaves and grass - screened [Manchester]; (2) mulch from chipped and shredded wood and brush, 2 to 3 in. screened [Glastonbury]; and (3) yard trimmings compost from leaves, grass, and shredded brush - screened [Earthgro]. Compost was used in this project as a mulch; it was placed over the soil and not blended.

A field site with an erodible soil having a slope of 2 horizontal to 1 vertical was selected because it had a steep slope and the base soil was a silty-sand. Eight parallel test cells (10 ft. wide x 35 ft. in length each with 3 ft. apron to collect runoff) were prepared with different surface treatments including an untreated reference cell and a standard ConnDOT hay and seed preparation. Cells were separated from each other and the surrounding area by 1 in. by 6 in. boards recessed into the soil about 1.5 in. The compost products were used as erosion control berm material and erosion control mulch - with and without seeding. The surface runoff was collected in buckets at the base of the slope for eight storm events over a one-year period from fall of 1996 to summer 1997. Two simple rain gauges were used to measure the amount of precipitation falling on the immediate area during each storm. Following each storm, the runoff from each cell was analyzed for total solids concentration, conductivity, pH, and nutrients.

The surface treatment used in the test cells were as follows:

Cell Number	Surface Treatment
1	Manchester Compost used as a mulch
2	Hay & Seed (standard DOT treatment)
3	Manchester Compost used a mulch & seeded
4	Glastonbury mulch
5	Control - no treatment
6	Berm made with Glastonbury mulch -freestanding at the base of the slope nest to the test cells
7	* (see below)
8	Earthgro Compost used a mulch & seeded

* #7 cell was originally to be treated with hydro mulch & seed applied with spray on machine. It was determined too expensive for such a small amount. #7 remained untreated bare ground until the latter part of the study when a 1-1/2 in. layer (thinner than required by specifications) of composted material was applied to determine the effectiveness of thinner treatments of composted material in preventing erosion.

The filter berm was tested in two ways. A quantitative arrangement was set up in Cell #6. A plywood riser was attached to 1 in. x 6 in. boards to develop support for the sides and jute mesh was applied at the end to support the berm, which was placed between the risers to form a slope similar to that specified by CONEG. The end of the cell had the same polyethylene covering of the natural soil as the other cells so any of the eroded materials and runoff water passing through the berm could be collected and analyzed. Also, a qualitative installation was used at the base of the slope of the west of Cell #1. This berm was approximately 15 in. high, 48 in. wide, and 50 ft. long. This installation was constructed to observe the behavior of the berm in an environment that approximates its normal use.

Eight rainfall events with rainfall totals from .02 to 3 in. were sampled. Suspended solids were very high in the untreated cells in comparison to the treated cells. The compost filter berm contained the eroded soil very successfully and analysis of the berm showed little or no soil material had penetrated the berm beyond the first one to two inches.

Study Conclusions

Based on the laboratory and field test results obtained in this study, the following may be concluded:

- The filter berm showed no visual evidence of eroded material coming through the berm. After the field tests were complete, the berm was carefully dissected in the vicinity of the erosion containment. Little to no soil was found to have penetrated the berm beyond the first one to two inches. **The erosion control filter berm was completely successful. This application appears to be an alternative to using the geosynthetic silt fence for erosion control.** Maintenance of the berm was minimal.

- For compost used as erosion control mulch (with or without seeding), a 3-inch application reduces erosion by more than an order of magnitude compared to an untreated slope with no significant release of nutrients or soluble salts with runoff.

- All of the chemical tests on source-separated compost products showed that they are not hazardous and are safe for the environment in erosion control applications.

- There was no significant release of nutrients or soluble salts with runoff and the levels of heavy metals in both the compost and the test site runoff were within acceptable limits.

- Some qualitative test results obtained for the performance of thinner (1.5 in. and 0.75 in.) applications of compost as an erosion control mulch. These results show that thinner applications may achieve a high level of erosion protection.

- The cells with compost treatment that were seeded produced turf that exceeded the DOT minimum specifications.

"Demonstration Project Using Yard Debris Compost for Erosion Control - Final Report"

By: W&H Pacific, in association with CH2M-Hill - June 1993

This report documents the testing of yard debris compost as a means of controlling soil erosion. The types of compost tested were: (1) mixed yard debris compost - medium grade; (2) mixed yard debris compost - coarse grade; and (3) leaf compost. The compost was tested both as uniform slope cover and as a barrier at the base of the test plots. In addition, two conventional methods of erosion control were also tested: (1) sediment fences and (2) wood fiber hydro-mulch with tackifier. Untreated control plots were used as a basis of comparison for measuring the effectiveness of the compost and conventional applications.

Runoff samples were taken following five storm events. These samples were analyzed for basic erosion indicators - settleable solids, total solids, total suspended solids, and turbidity.

Test plots were placed at two locations. The application sequence for each location was as follows:

Test Site 1: St. Johns Landfill - North Portland, Oregon - 34% Slope

Cell Number	Surface Treatment
1	Mixed Yard Debris Compost (MYD) - Medium
2	Leaf Compost
3	Sediment Fence
4	Control
5	MYD Barrier
6	Hydromulch
7	Leaf Barrier
8	MYD Coarse

Test Site 2: Murray Boulevard - Beaverton, Oregon - 42% Slope

Cell Number	**Surface Treatment**
1	Control
2	Mixed Yard Debris Compost (MYD) - Medium
3	Leaf Compost
4	Sediment Fence
5	MYD Coarse

Data was collected at each site for five sampled storm events. St. John's Landfill received 4.6 in. and Murray Boulevard received 3.7 in. Four of the five storm events were minor producing between 0.5 and 0.8 in. of rain; the fifth storm was a large event with rainfall at Murray Boulevard measuring 1.25 in. and rainfall at St. Johns Landfill measuring 1.6 in.

From the data available, the composts tested performed very well as erosion control agents - reducing the amount of soil particles, measured as settleable solids and total suspended solids from the test plots. Chart 1, on the following page, shows the mean values for Total Suspended Solids for the five storm events at the St. Johns Landfill site.

Chart 1. TSS from St. Johns Landfill site.

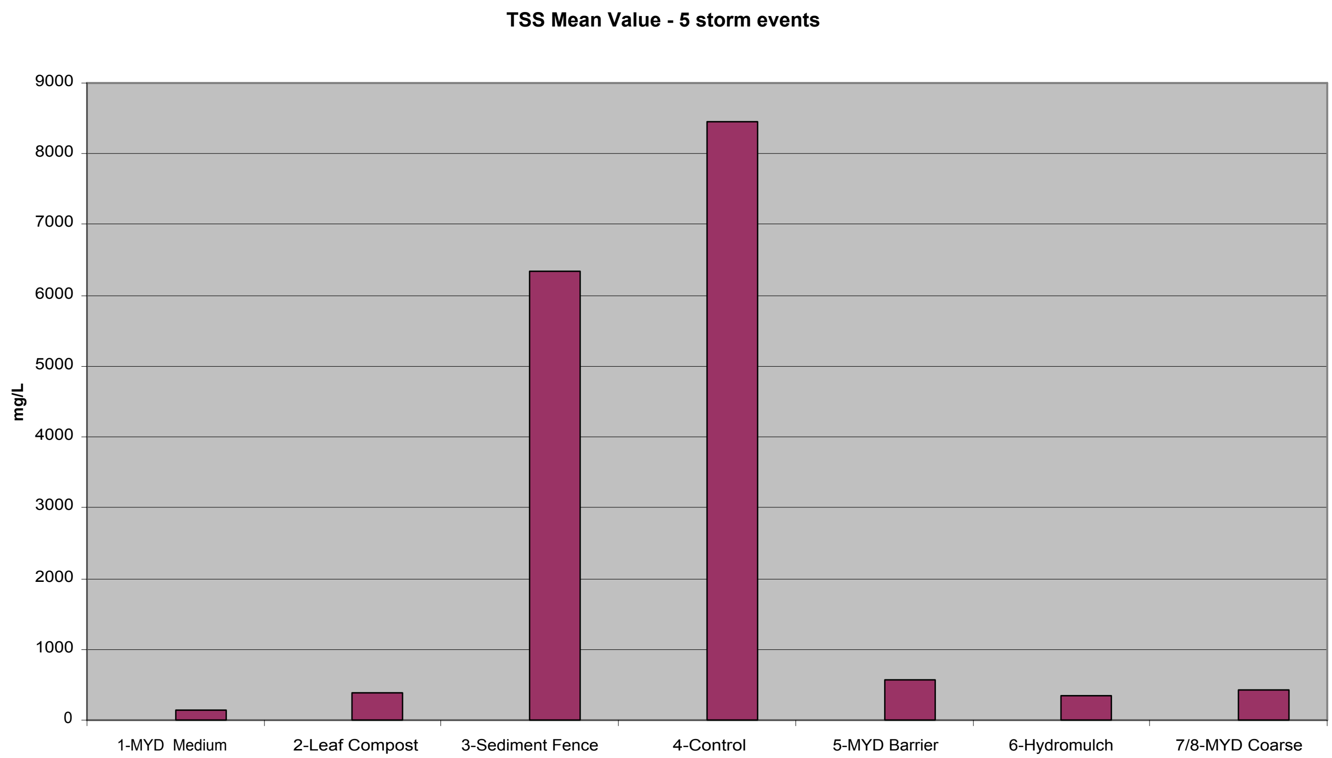
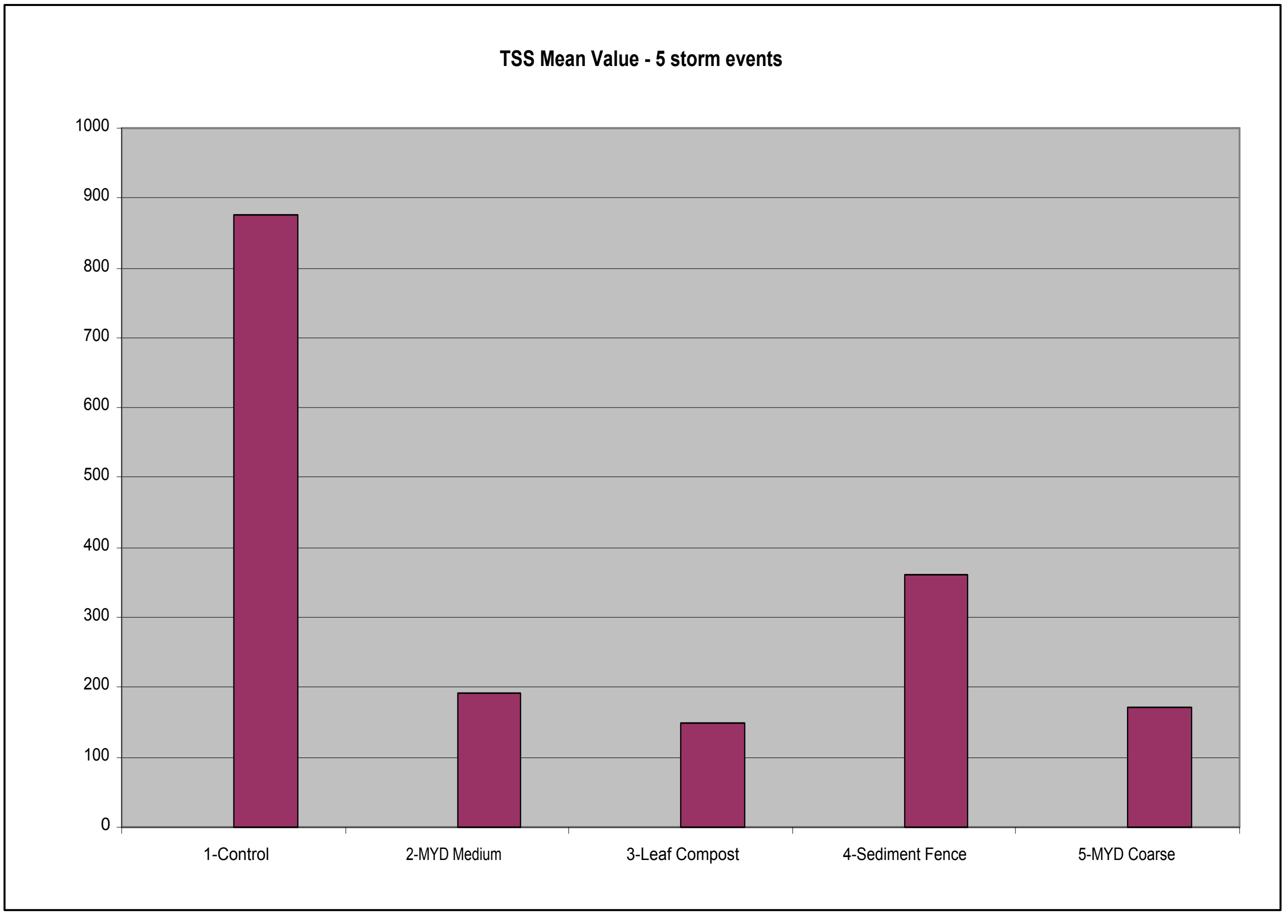


Chart 2 shows the mean values for Total Suspended Solids for the five storm events at the Murray Boulevard site.

Chart 2. TSS from Murray Boulevard site.



Based on these results, erosion control effectiveness of the composts, measured in terms of soil loss (suspended solids), was better than that measured from the sediment fences, and similar in most cases to areas treated with hydro-mulch. Good results were experienced with the application of compost to the entire test plots (prevention), as well as with the compost barrier (treatment).

Additionally, the compost applications demonstrated the capability of controlling loss of heavy metals and phosphorous.

"Summary of Projects Using Yard Debris Compost for Erosion Prevention & Control - Final Report"

By Solid Waste & Planning Department of Portland Oregon - June 1994
In cooperation with Unified Sewerage Agency, City of Lake Oswego & Oregon DOT

This report summarizes three projects using yard debris compost for erosion prevention and control. The test sites represented road construction, home building, and mobile home development. Two sites were private developments and one was public.

At the conclusion of this project, Unified Sewerage Agency agreed to use yard debris compost as an approved method for erosion prevention and control within its jurisdiction (Washington County area). The site coordinator from ODOT recommended in his summary that ODOT continue to use yard debris compost for erosion control.

Summaries of the study areas including site description, any unique aspects, compost application, and observations, as follows:

Springwood Site - Beaverton, Oregon

<u>Site description</u>: Long, narrow slope, 200 to 250 ft. wide, 25 ft. down slope, with a slope of 5% at the top to 25% at the bottom. The site is a private mobile home development.

<u>Unique aspect</u>: The site is immediately adjacent to an existing wetland and the slope of interest drains into this wetland.

<u>Compost application</u>: Slope was final graded before compost was applied. Seventeen units of 5/8 in. minus compost were applied. The slope only had a uniform cover of approximately three inches. An existing silt fence at the top of the slope was left in place to control runoff due to the contractor not building compost filter berms as instructed.

<u>Observations</u>: Compost application provided a major benefit for erosion prevention at this site and effectively stabilized the slope. The application of a 4 ft. berm along the top of the slope would have reduced the impact of run-off. The site coordinator plans to use compost as often as possible on future projects.

Marylhurst Site - Lake Oswego, Oregon

Site description: 50 acres along a long, sloping hillside. Berms and contours were constructed to create barriers and provide home sites. The area contained various slopes and drainage areas from 0 - 58%.

Compost application: Slope was final graded before compost was applied. Sixty-one units of compost (5/8 in. minus and 1-1/2 in. minus) were applied in a 3 in. uniform cover.

Observations: The compost controlled the flow of water by absorbing and holding the water, then letting it out slowly, thereby mitigating erosional effects. The compost on gentler slopes "held its own". Steeper slopes were affected by point flow from area upslope of the test sites. The site coordinator recommends extending the compost layer above the slope and/or placing compost berms at strategic points above the slope to reduce sheet flow.

McLoughlin Site - Portland, Oregon

Site description: Four slopes, two gentle and two steep - all were adjacent to concrete roadways constructed as a part of a new overpass. Slope A: very steep at about 70%, 275 ft. wide and varied from 10-25 ft downslope. Slope B: 155 ft. wide and varied from 50-60 ft. downslope. Slope C: 27%, 110 ft. wide and 15 ft down slope. Slope D: 35 to 50 ft. wide and 160 ft. downslope, varying in slope for 1-9%.

Unique aspect: This site is adjacent to Johnson Creek and is in the City of Portland's environmental overlay zones. Since this is an environmentally sensitive area, care was taken to design effective erosion control for this project, including use of compost as a protective ground cover to hold easily eroded soils in place.

Compost application: Slopes had been graded and sloped away from the concrete roadways prior to compost application. Twenty-one units of compost (screened to 3/4 in. minus) were applied to the slopes.

Observations: Overall the compost held up extremely well. It held up to very heavy rains exceeding two inches in 24 hours with no sign of failure. Compost effectively stabilized Slopes A, B, and C. It worked well even on very steep slopes of 70%. Slope D, a nearly level basin, had some ponding occur at the toe of the slope.

The site coordinator liked the fact that there was virtually no maintenance of the compost after the applications. He was pleasantly surprised to find the compost would remain in place on steep 70% slopes even after major storm events of two inches in 24 hours. He recommends a minimum uniform cover of 3 in. of compost to ensure erosion protection and allow natural re-seeding of the slope. **When combined with proper construction practices and effective planting, compost is a highly effective and cost-efficient method of erosion control.**

Overall Observations

When comparing the cost of yard debris compost to conventional erosion control methods, it is important to consider the whole project, not just compost use as a front-end erosion control cost. Because compost used for erosion control can be used as soil amendment during the landscaping phase of the project, one cost can be applied to two tasks. Labor and disposal costs incurred in removing conventional erosion control methods are avoided by using compost.

Substantial plant growth occurred on the slopes from seeds blowing in from adjacent areas within three months of compost application.

Application of compost by hand is time consuming and tedious, especially on steep slopes. Application by pneumatic equipment would be preferable, when possible.

"Runoff Characteristics and Sediment Retention Under Simulated Rainfall Conditions - Results from a Study of EcoBlanket ™ and EcoBerm ™"

Tested and Reported by San Diego State University, Soil Erosion Research Laboratory,
Prepared for Rexius Forest By-Products, Inc. - January 2002

> **Note:** The Rexius trademarked system utilizes a specific compost with a Microblend™ additive applied with a pneumatic blower truck and specific application hardware.

There are numerous materials and products on the market that are applied to the soil surface to reduce erosion and off-site sedimentation. These BMPs run from the most common applications of straw mulches to more complex, man-made materials such as rolled erosion products or hydraulic applications of bonded fiber matrices.

Designers and specifiers select erosion and sediment control BMPs based, in part, on criteria that are more important for site conditions. These criteria might include: erosion control effectiveness, ease of installation, water quality impact, runoff characteristics, and cost.

At the San Diego State University Soil Erosion Research Laboratory (SDSU/SERL) rainfall simulation tests were conducted to quantify the erosion control effectiveness, runoff characteristics, and water quality impact of existing and emerging soil erosion control technologies.

While most of the commonly used erosion control BMPS (tackified straw, RECPS, BFMs) are highly effective in controlling soil erosion; few possess the ability to modify the fertility of a soil and thereby influence plant establishment and growth. Soil amendments and fertilizers are usually considered as a separate step that must be added or incorporated into the erosion control practice.

By comparison, compost applications, when applied at appropriate rates and configurations, provide beneficial and immediate erosion control as well as positively influence soil fertility for eventual plant establishment. While the beneficial effects of compost application for plant growth and long term soil health have been documented, the purpose of the compost blanket and berm study was to establish the erosion control effectiveness and runoff characteristics derived from (1) An EcoBlanket™ applied to the soil surface as a uniform blanket cover and (2) Construction of an EcoBerm™ at the base of a slope for sediment control.

Three replicate storms were applied to each EcoBerm™ test condition and the EcoBlanket™ test conditions had two consecutive storm events applied. The intensity and duration of the storm events were:

Period 1: 5 millimeters per hour of rain for 30 minutes

Period 2: 40 millimeters per hour of rain for 40 minutes

Period 3: 5 millimeters per hour of rain for 30 minutes

The test slope for the EcoBlanket™ was 1V:2H and 1V:3H for the EcoBerm™.

Results

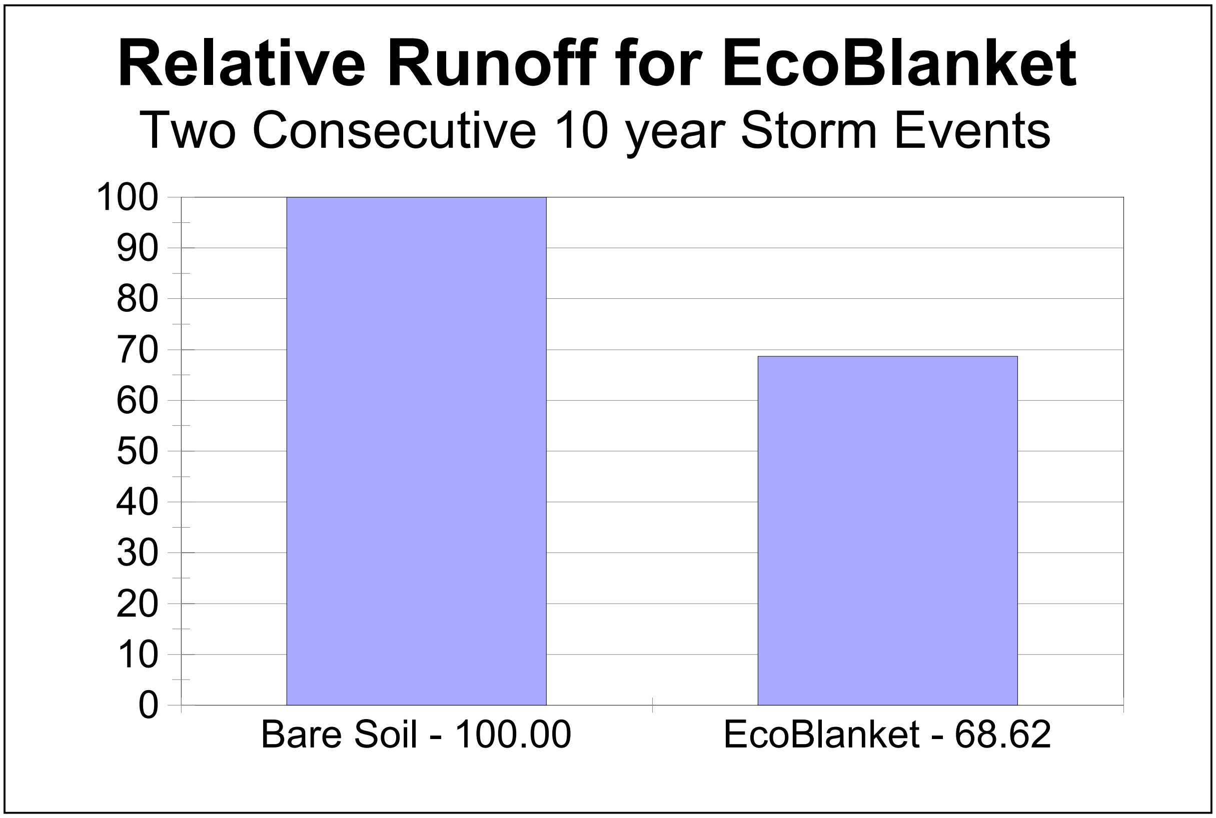
The Rexius EcoBerm™ constructed at the top of the slope reduced runoff volume an average of 25.79% when compared to bare soil. The Rexius EcoBerm™ had a 99.47% reduction in sediment delivery when compared to bare soil losses. (See attached Chart 1)

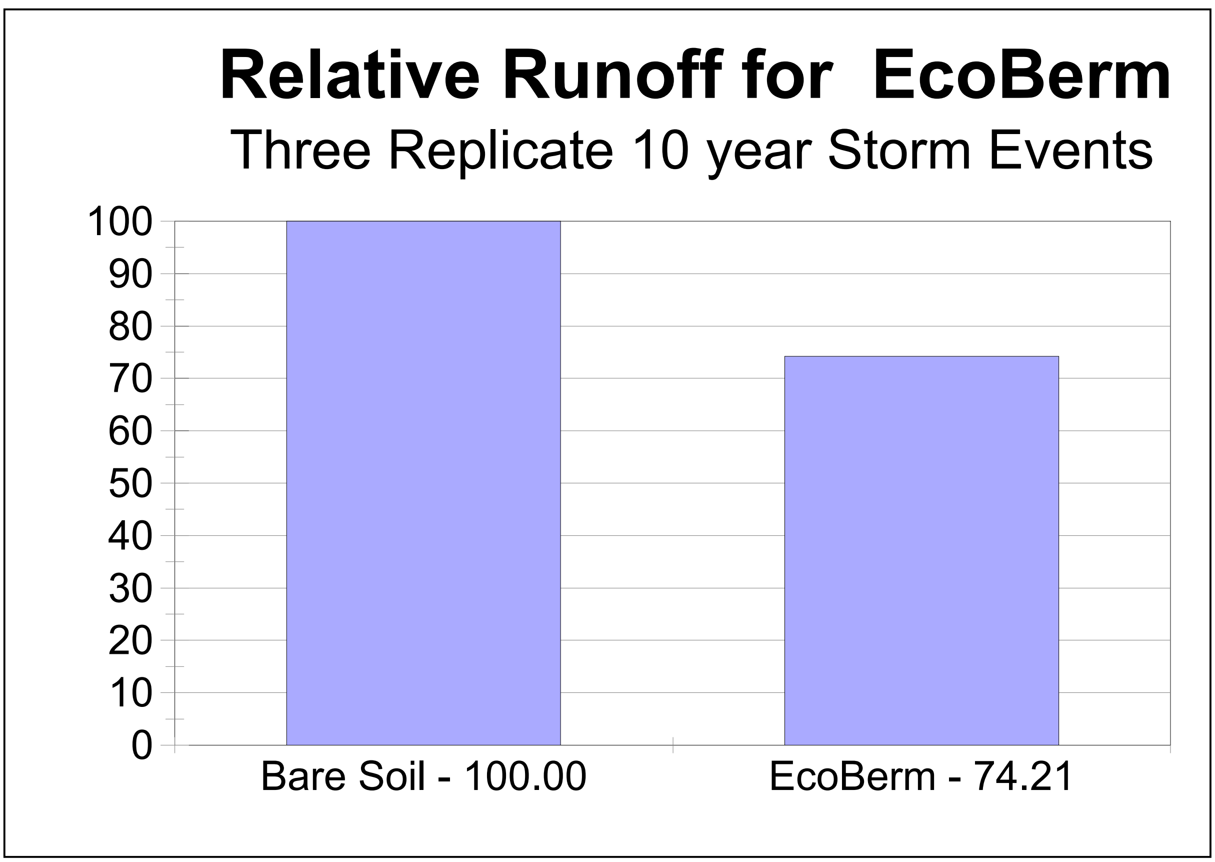
The Rexius EcoBlanket™ applied in a 2-inch layer on soil test bed reduced run-off volume by 21.38% when compared to bare soil. The Rexius EcoBlanket™ reduced off-site sediment delivery by 99.76% when compared to bare soil losses. (See attached Chart 2).

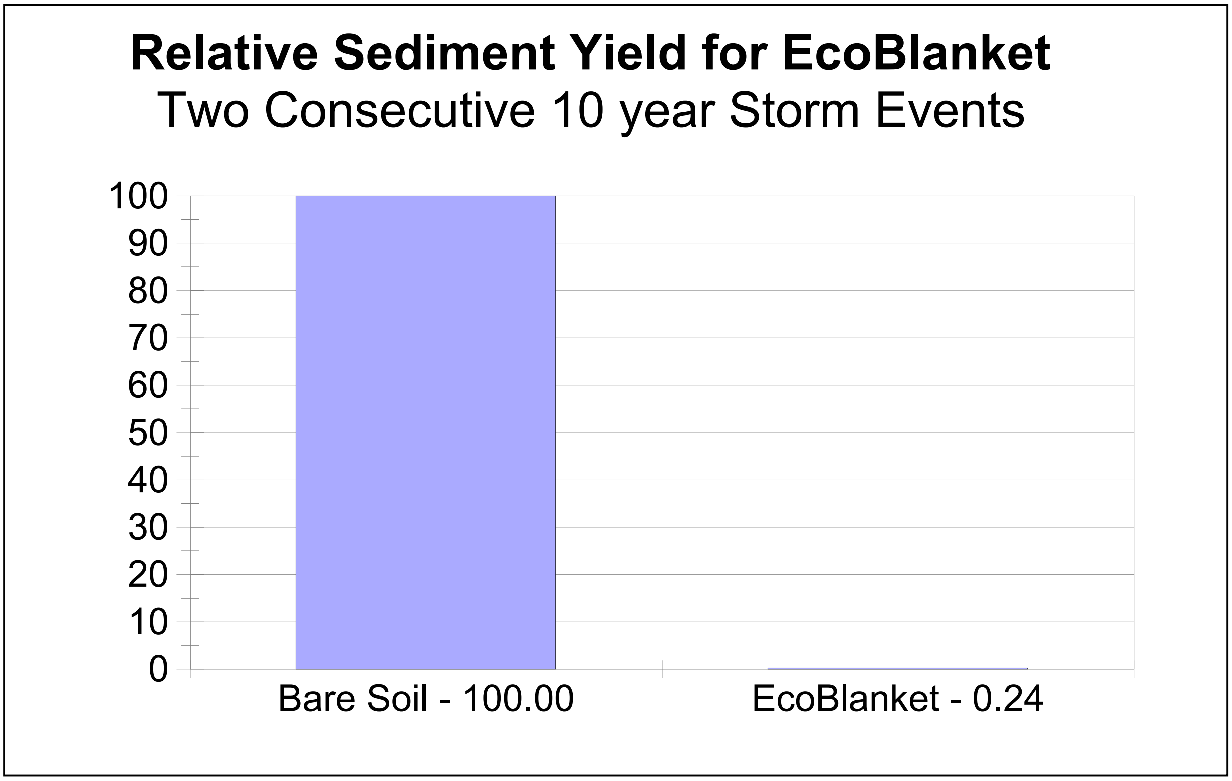
The data from this series of tests appear to support the use of EcoBlanket™ and EcoBerm™ to reduce runoff and off-site delivery of sediment from steep slopes. A modest reduction in runoff water volumes - approximately 26% for the EcoBerm™ and 31% for the EcoBlanket™ - illustrates that one of the beneficial functions of compost is to slow runoff water velocities and retain a certain amount of water within its organic matrix. The data supports a conclusion that compost, once saturated, releases water at a steady rate. This is important because with some soils, total absorption of runoff water might not be beneficial for slope stability or establishment of vegetation.

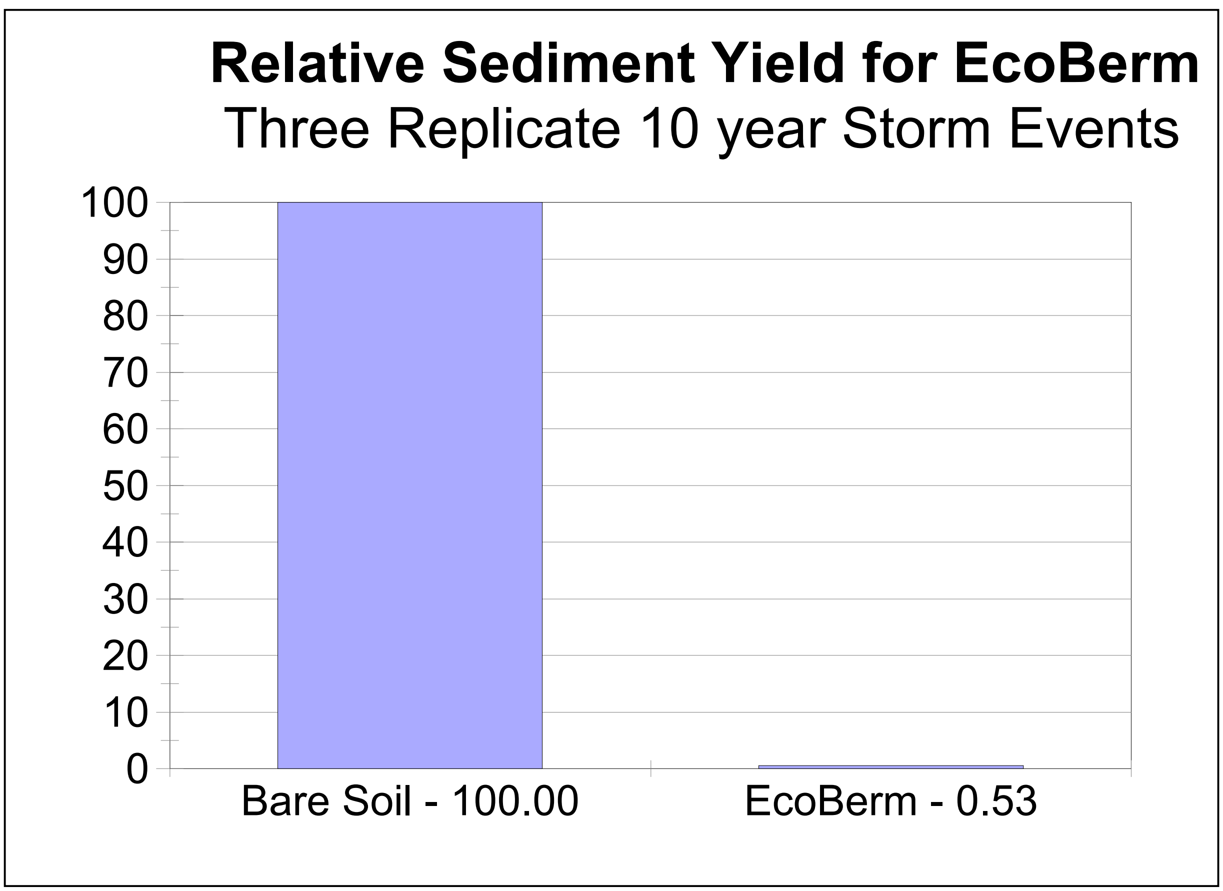
The data also illustrates that the specified Rexius compost/mulch blend, as tested, reduced off-site sediment delivery by nearly 100% for both the EcoBerm™ and EcoBlanket™. The results of this study illustrate that a proper application of an

EcoBlanket™ and/or the construction of an EcoBerm™ at the toe of slopes can accomplish the same level of erosion control performance as many other conventional erosion control technologies.


Relative Runoff for EcoBlanket
Two Consecutive 10 year Storm Events
100
90
80
70
60
50
40
30
20
10
0
Bare Soil - 100.00
EcoBlanket - 68.62


Relative Runoff for EcoBerm
Three Replicate 10 year Storm Events
100
90
80
70
60
50
40
30
20
10
0
Bare Soil - 100.00
EcoBerm - 74.21


Relative Sediment Yield for EcoBlanket
Two Consecutive 10 year Storm Events
100
90
80
70
60
50
40
30
20
10
0
Bare Soil - 100.00
EcoBlanket - 0.24


Relative Sediment Yield for EcoBerm
Three Replicate 10 year Storm Events
100
90
80
70
60
50
40
30
20
10
0
Bare Soil - 100.00
EcoBerm - 0.53

IX. FEDERAL REGULATIONS

The Federal Water Pollution Control Act, as amended by the Clean Water Act (CWA) of 1977, was enacted with the intent of restoring and maintaining the chemical, physical, and biological integrity of the waters of the United States. The Act established a number of requirements, prohibitions, and programs to achieve this end as described below. The agency having regulatory authority over the Clean Water Act is the Environmental Protection Agency (EPA).

Section 401 of the Clean Water Act requires that any applicant for a federal permit to conduct any activity, including the construction or operation of a facility, which may result in the discharge of any pollutant, must obtain certification of those activities from the state in which the discharge originates.

Section 402 of the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to regulate the discharge of pollutants from point sources. The EPA administrates the NPDES permit program and the responsibility for administration and enforcement of the program at the state level has been delegated to certain agencies in states that have primacy responsibility.

Section 402 (p) of the Clean Water Act has among its requirements that EPA establish regulations setting forth NPDES permit applications for storm water discharges for industrial sources and municipal separate storm sewer (drain) systems. EPA published draft regulations addressing storm water discharges in December 1989 for review and comment. The final rule for NPDES permit application regulations for storm water discharges was published on November 16, 1990, and was effective December 17, 1990. The regulations are administered through the existing storm water management plans and specifies who is covered by the regulations, the nature of the requirements, and a one-to-two year time schedule for compliance with the permit application requirements. The regulations also set forth application requirements for industries. Included are requirements for a storm water permit for all construction activities that disturb an area of 5 acres or greater. Some states have NPDES permitting authority; for those who do not, authority is through the EPA regional offices.

Phase I & II

In 1990, EPA published its Final Rule for regulation of storm water discharges. The rule (40 CFR 121.26), known as the “Phase I Rule”, established requirements for the permitting and management of storm water discharges from large (serving a population of 250,000 or more) and medium-sized (serving a population of 100,000 to 250,000) municipalities, numerous industries (based on SIC code), and construction sites disturbing five (5) acres or more. The permits are administered by the EPA (or certain delegated state agencies) under the NPDES program.

Under the Phase I Rule, coverage under an EPA Construction General Permit must be sought by the operator of a construction activity that:

- Will disturb five acres or greater, or will disturb less than five acres but is part of a larger common plan of development or sale whose total land disturbing total five acres or greater (or is designated by the NPDES permitting authority)

  AND
- Will discharge storm water runoff from the construction site into a municipal storm sewer system (MS4) or waters of the United States.

In December 1999, EPA finalized the "Phase II" regulations, which require controls on storm water discharges from a broader sector of municipalities, industries, and construction sites. Specifically for construction, the Phase II Rule requires construction sites disturbing equal to or greater than one acre and less than five acres to control pollutants in storm water runoff. Construction activity disturbing less than one acre requires a permit if it is part of a large common plan of development or sale disturbing a total of one acre or greater, or is individually designated for permit coverage by the NPDES permitting authority.

The Phase II Rule requires, nationally, operators of Phase II construction sites to obtain an NPDES permit and implement best management practices (BMPs) to minimize pollutant runoff. For the Phase II construction program, EPA has taken an approach similar to the Phase I approach where the program requirements are not fully defined in the rule but rather a NPDES storm water permit issued by the NPDES permitting authority.

The Phase II requirements are similar to the following three main requirements of EPA's Construction General Permit for Phase I:

- Submittal of a Notice of Intent (NOI) that includes general operator and site information;
- The development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) with appropriate BMPs to minimize the discharge of pollutants from the site; and
- Submittal of Notice of Termination (NOT) when final stabilization of the site has been achieved as defined in the permit, or storm water runoff is no longer being discharged when another operator has assumed control of the site.

Phase II Municipal Requirements

Phase II municipalities must

- Apply for an NPDES Storm Water Permit
- Develop a Storm Water Management Plan (SWMP) that includes the six minimum control measures
- Implement the SWMP using appropriate BMPs
- Develop measurable program groups
- Evaluate program effectiveness

The applicable standards for Phase II municipalities are to reduce the discharge of pollutants to the "maximum extent practicable" (MEP), protect water quality, and satisfy the water quality requirements of the Clean Water Act. The six minimum control measures are:

- **Public Education and Outreach:** This measure includes distributing educational materials and performing outreach to inform citizens about the impacts polluted storm water runoff discharges can have on water quality.

- **Public Participation/Involvement:** Provides for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen representatives to participate on a storm water management panel.

- **Illicit Discharge Detection and Elimination:** Developing and implementing a plan to detect and eliminate illicit discharges to the storm drain system; including developing a system map and informing the community about hazards associated with illegal discharges and improper waste disposal.

- **Construction Site Runoff Control:** Developing, implementing, and enforcing a program to address discharges of post-construction storm water runoff from new development and redevelopment areas.

- **Pollution Prevention/Good Housekeeping:** Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures (e.g. street sweeping, catch basin cleaning, and pesticide use reduction).

Additional information is available on the EPA website: www.epa.gov or http:cfpub.epa.gov/npdes/stormwater/swphase2.cfm