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Compost Blankets for Runoff and Erosion Control

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This technical note was developed by **Ray Archuleta,** Conservation Agronomist, National Soil Health and Sustainability Team, East National Technology Support Center, Natural Resources Conservation Service, Greensboro, North Carolina; and **Britt Faucette**, Director, Research and Technical Services, Filtrexx Foundation, Grafton, Ohio.

Cover photo: Vegetated compost blanket used to stabilize slopes of a landfill in North Carolina. Photo courtesy of EcoExpress.

Compost Blankets for Runoff and Erosion Control

Purpose

This technical note supports the application of NRCS Conservation Practice Standard Code 342, Critical Area Planting. It provides an alternative method to stabilize and revegetate a disturbed area.

Introduction

According to a national water quality assessment, 35 percent of streams in the United States are severely impaired and 75 percent of the population lives within 10 miles of an impaired water body (U.S. Environmental Protection Agency (EPA) 2000). Stormwater runoff is a leading pollutant of surface waters in the United States (EPA 1997), and commonly contains chemicals, nutrients, pathogens, metals, and fine sediment.

In natural watersheds, average runoff is 10 percent of the total precipitation volume. In urban areas with 10 to 20 percent impervious surface area (parking lots, roadways, and rooftops), average runoff increases to 20 percent; at 35 to 50 percent, impervious surface area average runoff increases to 30 percent; and at greater than 75 percent impervious surface area, average runoff increases to 55 percent (Tourbier and Westmacott 1981). Watersheds with greater than 10 percent impervious surface area have been directly correlated to impaired stream water quality (Schueler, 1995; Schueler, 2003), and watersheds with greater than 25 percent impervious surface have been correlated to long-term stream water quality impairment. This is because impervious surfaces in a watershed or site generate runoff more quickly, generate greater runoff volume, and carry more pollutants in runoff to receiving water bodies (Faucette 2008).

Construction and development projects where topsoil is disturbed or cleared of vegetation are particularly subject to erosion problems. Water-induced soil loss rates from construction sites can be 10 to 20 times that of agricultural lands (EPA 2000). Due to the loss of soil, nutrients, water, and reduced plant yields, it has been estimated that the onsite cost of soil erosion in the United States is more than $27 billion per year, while the annual offsite cost due to sedimentation of eroded soil is more than $17 billion per year, bringing the total cost of erosion and sedimentation to more than $44 billion per year (Brady and Weil 1996).

Figure 1 is an aerial photo (taken in 2008) of turbid water in Tom-A-Lex Lake after a rainfall-runoff event. This lake is located 7 to 14 miles southwest of Thomasville and High Point, North Carolina (combined population of 122,000). Soil erosion, sedimentation, and surface water turbidity can be increased by soil disturbance from agricultural tillage, construction, and urbanization. These human activities are leading contributors to sedimentation in our Nation’s waters.

The major functions of organic matter in soil ecosystems include absorption and infiltration of rainfall, protection and stabilization of soil, structure, and nutrition for plant communities,

Figure 1 Sediment contributing to high turbidity in Tom-A-Lex Lake after storm event

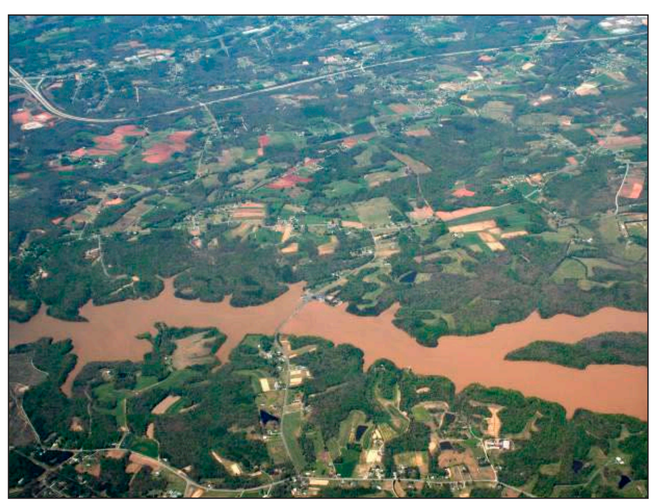

Photo courtesy of Ray Archuletta, USDA NRCS and habitat and food for soil organisms. When managed correctly at broad spatial scales, organic matter can influence local hydrologic patterns, thereby reducing stormwater and its associated pollutants; help stabilize erodible soils and slopes, reducing soil erosion; and help establish and sustain plant and soil biology, thereby helping to create a landscape and ecosystem that is more functional and resilient.

Compost blankets are one of the simplest methods to apply organic matter to a landscape or soil surface. Locally available, biobased management practices used for stormwater pollution prevention should be designed to reduce pollutant transport and loading to the Nation's surface waters in order to protect and preserve these valuable natural resources.

This technical note illustrates the effectiveness of compost blankets as a stormwater reduction and soil erosion control practice and provides guidance on proper utilization.

Description

A compost blanket is a 1- to 2-inch-thick layer of loose compost applied directly to the soil surface and is used for the purpose of runoff reduction, erosion control, and vegetation establishment (EPA 2012). It is commonly applied on hill slopes, bare soils, within degraded landscapes, and watershed drainage areas in both land-disturbing and post-development applications. Seed is typically blended with the compost prior to or during application, and the compost used should meet specific guidelines (table 1). Compost blankets protect the soil from splash erosion, absorb large amounts of rain water and sheet-flow runoff, reduce peak runoff flow rates, and provide an excellent medium for vegetation establishment and sustainability. It is a multifunctional stormwater management tool capable of holding large volumes of water. Spread across the land surface, compost blankets increase infiltration and reduce evaporation and help restore natural landscape and watershed hydrological patterns and cycles within treated areas. By increasing land surface roughness, compost blankets slow the rate of overland sheet runoff, allowing water to more readily infiltrate the soil surface. Through stable organic matter and humus additions, long-term soil biology, structure, aggregate stability, pH, and water-holding capacity essential to plant growth and sustainability are enhanced. Surface-applied compost blankets have advantages over soil incorporation with compost, including no tillage required, no soil disturbance during application, no additional soil stabilization or erosion control measures required after application, can easily be applied to steeper slopes, and are often more cost effective (fig. 2). Currently, more than 40 State environmental protection agencies and departments of transportation, as well as the EPA and U.S. Army Corps of Engineers, have approved and published specifications for compost blanket use in these applications.

Table 1 Compost quality guidelines

Parameter	Unit of Measure	Compost
pH	pH units	6.0 – 7.5
Soluble salt concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5
Moisture content	%, wet weight basis	30 – 60
Organic matter content	%, dry weight basis	25 – 65
Particle size	% passing a selected mesh size, dry weight basis	2 in. (50 mm),100% passing; 1/2 in. (12.5 mm), 60% passing
Biological stability Carbon dioxide evolution rate	mg CO_2-C per gram of organic matter per day	<8
Physical contaminants (human-made inerts)	%, dry weight basis	<1

Source: EPA 2012

Applications

Compost blankets can be used in a variety of erosion control and stormwater management applications. Recommended applications include—

- Slope stabilization, temporary, or permanent erosion control.
- Plant establishment and long-term sustainability and health.
- Reduction of pollutant transport in storm runoff.
- Reduction in the size of stormwater collection or bioretention ponds.
- Soil quality improvement.
- Above and below ground ecosystem enhancement.

Limitations

Although compost blankets are quite versatile, this management practice does have limitations. If compost quality is substandard, particularly for biological stability and particle size distribution, performance may be severely diminished. Compost blankets should not be placed in areas of concentrated flow. Heavy equipment moving over the compost blanket will lead to compaction and may greatly diminish field performance and capacity. Compost blankets should not be used on slopes greater than 2:1 (H:V) without additional stabilization practices, such as erosion control netting. Finally, if installation guidelines are not followed or maintenance is not conducted, the compost blanket may not perform at an optimum level.

Figure 2 Slope application of compost blanket

Photo courtesy of Filtrexx International

Effectiveness

Compost blankets have been extensively researched and evaluated at land grant university research institutions. Research literature has shown that this management practice can reduce soil erosion, stormwater and pollutant loads, and increase soil quality and plant cover.

A university study conducted in Georgia evaluated the stormwater and water quality effects of 2-inch-thick compost blankets and conventional erosion control and vegetation establishment practices in field research plots 15-feet long by 3-feet wide for a 1-year period. On sandy clay loam soils, on a 10-percent slope, exposed to 3 inches of total rainfall in 1 hour, compost blankets, relative to hydromulch, reduced runoff volume by 50 percent, peak runoff rate by 36 percent, total sediment loads by 80 percent, nitrate-nitrogen loads by 88 percent, and total and soluble phosphorus loads by 83 percent (Faucette et al. 2005). A similar study conducted in Iowa by Persyn et al. (2004) examining 2-inch compost blankets relative to a loamy sand topsoil on a 3:1 slope, under 4 inches per hour of rainfall for a 2-hour duration, found that, under these site-specific conditions, runoff volume was reduced by 90 percent, peak runoff rates were reduced by 79 percent, total sediment by 96 percent, and total nitrogen, total phosphorus, and soluble phosphorus were reduced by 99 percent.

On disturbed soils, similar to construction sites, vegetative growth (percent cover and biomass of weeds and seeded grasses) and soil quality characteristics were evaluated over 18 months. Results showed compost blankets provided nearly three-times-greater vegetative cover than conventional seeding applications and approximately five-times-less weed biomass (Faucette et al. 2006). Compost blankets increased underlying soil organic matter between 0.02 and 1.10 grams per kilogram (g/kg) of soil, while conventionally seeded field plots showed a reduction in soil organic matter (-0.04 to -0.1 g/mg) 18 months after application (Faucette et al. 2006). Faucette et al. (2006) reported that the increase in organic matter from compost blankets was likely due to natural incorporation from microbial migration. With conventionally seeded plots, organic matter degraded faster than the natural replacement rate leading to a temporary decline in soil quality. Faucette et al. also reported that microbial carbon in the soil (as extractable organic carbon) was 60 percent greater under the compost blankets than conventionally seeded soils (Faucette et al. 2006). Soil microbes are responsible for cycling nutrients and making those nutrients available for plants, increasing soil aggregates that reduce erosion, and are the foundation of a healthy soil and plant ecosystem that provides the functionality, stability, and resiliency for long-term stormwater management.

A similar study, conducted on construction site soils, reported that once exposed to 4 inches of cumulative rainfall in a 1-hour period, compost blankets absorbed 80 percent of the simulated rainfall, reduced cumulative storm runoff volume by 60 percent, and reduced average peak runoff flow rate by 43 percent compared to bare soils. Relative to seeded straw blankets, compost blankets reduced total sediment loads by 81 percent, total suspended solids load by 90 percent, total nitrogen by 92 percent, and total phosphorus by 97 percent (Faucette et al. 2007). A study conducted in Texas evaluating compost blankets relative to seed and fertilizer for erosion control reported that compost blankets reduced total sediment by 99 percent, total nitrogen by 88 percent, nitrate-nitrogen by 45 percent, total phosphorus and soluble phosphorus by 87 percent, and total runoff between 35 percent and 67 percent (Mukhtar et al. 2004). A study conducted for the Federal Highway Administration found that 3-inch compost blankets applied to a disturbed, bare clay soil on a 3:1 slope reduced peak runoff rates tenfold under a 3.45 inches per hour simulated rainstorm for a 3-hour duration (Kirchhoff, Malina, and Barrett 2003).

A study conducted in California evaluated 14 different erosion control practices in a lab-based 30 square meter tilting soil bed on a 2:1 slope under rainfall intensities of 2 inches per hour, 4 inches per hour, and 6 inches per hour for 1-hour duration. The compost blanket reduced runoff between 29 and 94 percent and soil erosion between 67 and 99 percent, generating less runoff and erosion than any stand-alone management practice evaluated, including a variety of rolled erosion control products, tackifiers, and polyacrylamides (Faucette et al. 2009).

Compost Quality

Compost quality is extremely important for the function and performance of compost blankets. Adherence to parameters presented in table 1 on page 2 of this technical note will ensure compost material used for compost blanket applications will meet associated design criteria and the advantages attributed to this management practice. It is recommended that compost is analyzed for these parameters utilizing the Test Methods for the Examination of Composting and Compost (TMECC) guidelines, test methods uniquely designed for evaluating compost quality. Furthermore, compost that has the U.S. Composting Council (USCC) Seal of Testing Assurance (STA) label or third-party testing and certification is preferred.

All compost should be odor free and have no recognizable original feedstock materials. Composts should adhere to 40 CFR Part 503, which ensures safe standards for pathogen reduction and heavy metals contents.

Siting and Design

Planning

Compost blankets are most effective when part of a well-planned site design. Avoid running over compost blankets with vehicles and heavy equipment, as this will reduce effectiveness and contribute to soil compaction, which may increase runoff and erosion and reduce vegetation establishment. Successful planning for any vegetation establishment project should consider climate, prevailing weather, temperature, sun exposure, available moisture and irrigation requirements, topography, soil type, soil pH, soil amendments, nutrient requirements, drought tolerance, site preparation and coordination with construction phases, time to establishment and coordination with construction phases, protection from erosion and sedimentation, and seed mix and plant selection (Fifield 2001).

Temporary vegetation is typically designed for disturbed soils that will undergo future disturbance, such as cut-and-fill slopes under construction, soil storage areas and stockpiles, permanent vegetation establishment that requires a nurse crop, stabilization of temporary runoff diversion devices, dikes, and sediment containment systems (Fifield 2001). Quick-establishing annual grasses and legumes are normally specified for these applications. Permanent vegetation is usually specified for slopes where erosion control blankets are required, drainage ditches and channels, and areas that have undergone final clearing and grading and require soil stabilization. Perennial grasses are typically specified, and, if possible, native grasses should be utilized (Fifield 2001).

In regions or seasons prone to high-velocity wind conditions (such as arid and mountainous regions, and regions with distinct hurricane seasons), it is recommended that erosion control netting be installed on top of the compost blanket to prevent wind erosion and movement of the compost blanket.

Function

Compost blankets cover 100 percent of the soil surface and therefore provide the beneficial affects characteristic to mulches, including reduced raindrop impact and splash erosion, reduced runoff energy and sheet erosion, buffered soil temperature for plants, decreased moisture evaporation, increased moisture-holding capacity at the soil surface, reduced runoff volume and velocity, increased infiltration, and suppression of weed establishment.

Compost blankets also amend the soil, which can provide the following functional benefits: increased soil structure, increased soil aggregates, increased soil aeration, increased infiltration and percolation, increased moisture-holding capacity, increased activity of beneficial microbes, increased availability of nutrients, decreased runoff volume and velocity, decreased erosion, and increased plant health and long-term sustainability (fig. 3).

Compost blankets provide nutrients that are slow release, provide plant micronutrients, and are less likely to be transported in storm runoff to receiving waters. Compost blankets can release less than 1/10 of the nutrient load compared to conventional seeding and fertilization practices, thereby preventing pollution and protecting waterways (Faucette et al. 2005). In one university study, invasive weed growth had a stronger positive correlation with mineral fertilizers than with organic fertility practices (Faucette et al. 2006).

Runoff Conditions

Compost blankets should not be used in areas where concentrated flow exists or where runoff velocities (distance/time) will damage or undermine vegetation. For most grasses, a maximum velocity of 4 feet per second (1.2 meters per second) or a maximum hydraulic shear stress of 2 pounds per square foot (10 kg per square meter) is recommended before additional reinforcement measures are recommended (*Maryland Stormwater Design Manual* 2000).

Compost blankets are designed to absorb water and reduce site runoff. Compost blankets typically hold approximately 40 gallons (0.15 cubic meters) of water per cubic yard (0.76 cubic meter) of compost or 5,400 gallons (722 cubic feet, 20 cubic meters) of water per acre inch (0.01 ha meter, 103 cubic meter) of compost applied.

Compost blankets have been used in drainage and watershed area design applications when estimating site runoff volume for stormwater ponds and containment systems, bioretention systems, or achieving low-impact development (LID), hydrological, or stormwater reduction goals or local ordinances. Runoff curve numbers are typically used for these applications, a standard runoff curve number for a vegetated compost blanket is 55 (Faucette et al. 2006). Compost blankets can be used with the rational formula (Q = CIA), used to predict peak flow rates typically for open channel, swale, and ditch-design applications. The runoff coefficient for compost blankets is 0.30 (Faucette et al. 2005).

Figure 3 Establishing vegetation in a compost blanket

Photo courtesy of Filtrexx International

Compost blankets can also be used to predict soil loss from agricultural or construction sites with the Revised Universal Soil Loss Equation version 2.

Installation

- Following installation guidelines is essential for proper field function and optimum performance of compost blankets.
- Land or soil surface must be roughened prior to application of compost blankets, preferably by light scarifying parallel to the surface contours.
- Compost blankets must be applied to 100 percent of the land surface area where stormwater reduction, erosion control, or permanent vegetation is required. No native soil may be visible in or through the compost blanket.
- Compost blankets must be applied at a depth of 1 to 2 inches (25 to 50 mm) or at a rate of 135 to 270 cubic yards per acre (257 to 513 cubic meters per ha) depending on slope steepness and 24-hour rainfall accumulation (table 2).
- Seed must be thoroughly mixed with the compost prior to application or surface applied to the compost at time of application to ensure grass seed can easily establish through depth of compost blanket.
- Compost blankets must not be installed in areas of concentrated storm runoff flow, including channels and ditches.
- Compost blankets must be installed at least 10 feet (3 meters) over and beyond the shoulder of a slope or into existing vegetation to ensure runoff does not undercut the blanket.
- Compost blankets installed on slopes 4:1 or steeper must be tracked; steeper than 2:1 must use additional slope stabilization practices, such as erosion control netting.
- Slope interruption devices may be installed on slopes 2:1 or steeper to reduce runoff velocity. Reducing runoff velocity can reduce seed wash prior to and during germination and reduce stress on young plants during the establishment phase.
- Irrigation may be required to ensure successful vegetation establishment. In arid and semiarid regions or during hot and dry weather, regular irrigation may be required.
- Generally, no additional fertilizer or lime is needed for vegetation establishment and growth in compost blankets.

Table 2 Recommended thickness for compost blanket based on slope angle and 24-hour rainfall event

Slope Angle (≤) 4:1 (H:V)	Compost Blanket Thickness 24-Hour Rainfall Total			
	1 inch (25 mm)	**2 inch (50 mm)**	**3 inch (75 mm)**	**4 inch (100 mm)**
	1.0	1.0	2.0	2.0
3:1	1.0	1.0	2.0	2.0
2:1	1.0	2.0	2.0	2.0
1:1	1.0	2.0	2.0	2.0

Note: Compost blankets were evaluated at rainfall intensities of 2 in/hr, 4 in/hr, and 6 in/hr, according to ASTM Standard D-6459, in the development of this table (Faucette et al. 2009).

Maintenance

Compost blankets should be inspected regularly after runoff events to ensure proper function and performance and should be maintained until a minimum 70-percent uniform vegetated cover of the applied area has been achieved or as required by the jurisdictional agency. Compost blankets may need to be irrigated during hot and dry weather or in arid and semiarid climates to ensure vegetation establishment. Where the compost blanket fails, rills appear, or vegetation does not establish, it should be repaired or reapplied immediately. If gullies form in the compost blanket, the area should be regraded prior to reinstallation. If the practice is damaged by stormwater runoff, runoff diversion devices installed above the compost blanket may protect against further or future damage. No fertilizer or lime amendments are required for vegetation establishment and maintenance.

Conclusion

Organic matter is perhaps the key component to nature's high-performance stormwater management system. This natural material absorbs rainfall and runoff, increases infiltration and percolation, slows sheet-flow runoff, provides habitat for soil organisms, is the foundation of a healthy soil ecosystem, and provides structure and nutrients for establishing and sustaining vegetation systems.

Proper planning and the utilization of low-impact development will limit soil disturbance and reduce transport of nonpoint source pollutants to surface waters. *The Sustainable Site: Design Manual for Green Infrastructure and Low Impact Development,* provides preventative guidelines, methods, and practices for building soils and reducing nonpoint source pollutants (Tyler, Marks, and Faucette 2010).

Compost blankets should be applied as part of a comprehensive systems approach to site stormwater management. Although no single management practice can mitigate the impacts of urbanization or soil disturbance, the compost blanket is an excellent tool to prevent and control site stormwater, runoff pollutants, and soil erosion and improve soil ecosystems, plant health, and water quality.

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