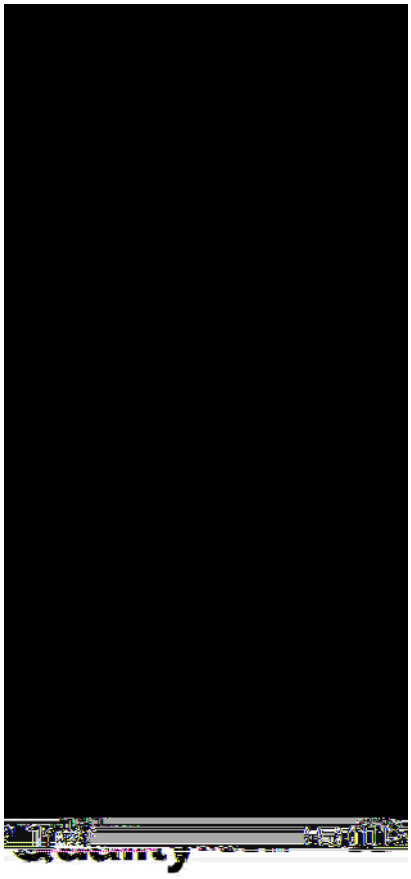
Restoring Soil Health To Urbanized Lands

The Crucial Link between Waste Prevention, Land Use, Construction, Stormwater Management and Salmon Habitat Restoration



July, 2001
DEQ Northwest Region

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Acknowledgment

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Summary

Construction activities disturb natural soils and hydrology and fish habitat. This document explains the link between land use planning, building and road construction, with pollution and waste prevention to improve endangered fish habitat. With a focus on stormwater management practices, it also provides current research on the benefits of amending soil with compost and information on technical sp

- Data demonstrate the effectiveness and the duration of the effectiveness of compost berms in controlling turbidity and total solids in runoff during construction activities.
- The use of compost for erosion and sediment control is beneficial and effective.
- Mulch and seeding results in 80% to 90% sediment reduction on construction sites.
- Compost berms can be more effective than sediment fences in controlling total solids in the stormwater runoff from a site. Additional research is needed to provide data on the ability of compost berms to control turbidity0 1 Tf12 0 lity of com

Efforts to Increase Healthy Soil and Low-Impact Development (LID) Standards in Oregon

Regional Land Use Planning

Most approaches to land use planning and zoning address rivers, waterways and stormwater control as components of land use plans; these components are where the Endangered Species Act are addressed. However, past land use practices on aquatic habitat have not adequately addressed cumulative impacts of either runoff or the pollutant stress currently being witnessed on waterways. *Designated critical and sensitive areas along with riparian areas need to be managed as ecological systems, not incremental parcels.*

New approaches to development are now being developed. Low Impact Development (LID) analyzes the cumulative effect of development patterns that change the movement and storage of water. LID is a rethinking of conventional stormwater control management standards to incorporate the natural groundwater storage of storm events in development. A coordinated regional planning of shorelines and critical salmon habitat areas is beginning. New standards need to be adopted for redevelopment and new subdivisions that incorporate less land clearing, retain more native vegetation and reduce impervious areas. In the metropolitan Portland area, Metro land use planners are now considering how best to incorporate LID and healthy soils into the land use documents and codes.

Construction Standards

When the earth is disturbed of its natural ability to absorb and infiltrate rainwater, stormwater then needs to be collected, channeled, stored and filtered. These are significant costs to a project. By incorporating Low Impact Development features into a construction project, the soil's ability to perform those functions can be retained. In many cases, compaction is required to prepare a site. Often the topsoil is removed and treated as a waste material. *By restoring the biotic life to the top 12 inches of compacted and other disturbed soils, the natural absorption, filtration, and evapotranspiration characteristics, for most rain events in Oregon, can be restored*.

A standard needs to be set for restoring the biotic life and natural retention and filtering characteristics back to each construction site. Tilling in about 4" of compost is a simple, cost-effective way to restore organic health to a site. Retaining and using native topsoil, minimizing the construction footprint and retaining buffer vegetation along waterways also contribute to healthy soil. In the metropolitan Portland area, education workshops are being planned to educate local jurisdictions on the need to increase construction standards to include restoring the health of the soil.

planned in the Metro region to demonstrate the uses and benefits of compost-related best management practices in stormwater management. See Appendix 3.

Pollution Prevention and Landscaping
Portland area Pollution Prevention Outreach Team (P2O) has developed a successful audit and best management practices (BMP) recognition program for the automobile industry called Ecobiz. The businesses that implement a desired number of BMPs get certified as a "green" business. This program is being expanded to provide an assessment and usage of BMPs for landscapers. The healthy soils and low impact development concepts will be included in the BMPs. The use of compost during construction can also benefit as prevention as well as control of pollution.

Natural Gardening
Many opportunities for preventing pollution exist in residential and commercial sectors. For both, natural gardening techniques can reduce the need for unnatural addition of pesticide and fertilizer on lawns and gardens. Many lawns and landscaped areas have been compacted over the years, thereby creating a surface that creates a direct pathway to the rivers when chemicals are applied near a rain event. *Aeration and compost provide for the biotic life necessary for healthy soils.* Healthy soils in turn provide for rainwater infiltration, plant nutrients and natural pesticides. This principle applies to existing landscaping as well as proposed. Use of compost during construction and in landscaping can also prevent or reduce runoff. Currently efforts include providing education materials the Natural Gardening programs on the benefits of healthy soil to healthy water and including a focus on the state grant programs that awards criterion points for natural gardening projects. Also considering ways to incorporate aeration and compost use in existing home composting programs.

Erosion & Sediment Control Manuals
State and local jurisdictions provide guidance for controlling sediment runoff and erosion. The concept of healthy soil needs to be incorporated into each agency field manual. Currently working with the Oregon Department of Transportation staff to amend their Erosion & Sediment Control Manual to include the restoration of the health of the soil and use of compost berms and blankets during construction activities.

Green Streets Handbook
Portland Metro Green Streets Handbook is an environmental design manual for transportation projects in the metropolitan Portland area. Healthy soil concepts and restoration of disturbed soils have been added in the implementation section providing standards for attaining healthy soils. Green Streets incorporates many LID principles. See Appendix 2.

Water Quality Model Code and Guidebook
The State of Oregon has a strong statewide land use planning law. This model code and guidebook provides some specific useful ordinances and plan language for incorporating some low-impact development standards into local plans and zoning codes. Work is now being done to include the healthy soil concept, as well as include the use of compost-

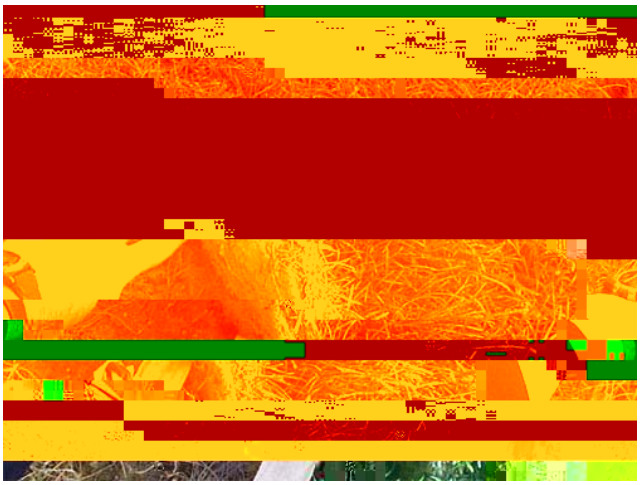
This depth of soil is called the rhizosphere. Compaction of the soil disrupts the established balance of the rhizosphere by destroying organisms, and since these are air-breathing organisms, eliminating or decreasing the amount of oxygen available for growth and color establishment.

Disruption of soil can kill most of the beneficial biota and remove the air spaces in the soil that the aerobic biota need in order to live and thrive. Surface plantings, fertilizer and other nutrient supplements typically only help the first few inches of soil to develop a new biota. Chemical fertilizer addition can actually kill or restrict the development of this biota. The biota is necessary for healthy vegetation.

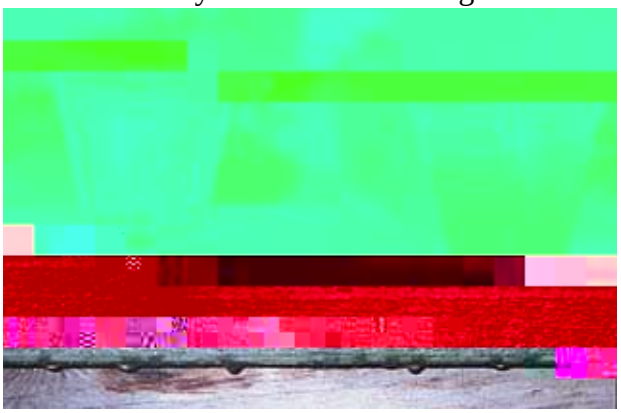
The Impacts of Human Activity on Soil

Disturbed soil occurs in

Effects of Soil Compaction



Impervious surfaces such as roof-tops, sidewalks, roadways and parking lots all have the effect of decreasing natural rainwater percolation and evapotranspiration and impervious surfaces increase stormwater runoff and velocity that leads to erosion. **Stormwater runoff** contains sediment, suspended solids, turbidity or dissolved solids, and other pollutants. Some of the sediment and suspended solids can usually be controlled using conventional methods including sediment traps (settling basins) or filters, such as sediment fences. **Pollutants** attach to soil particles. When sediment and suspended solids runoff is controlled, the remaining concern is the dissolved portion generally referred to as **turbidity,** which consists of submicron-sized soil particles. Reducing turbidity can be expensive to treat so is most cost effective to prevent it.



A Turbid Vs Clear Water Comparison

Sediment can silt over fish spawning beds and kill off aquatic animals that fish feed on. It can also raise stream temperatures to ranges in which the fish and other aquatic animals cannot survive. The impact of turbidity on fish and aquatic animals involves a relationship between the level of turbidity and the duration of the turbid event. This can be shown in the following graph.

Studies in the Pacific Northwest on salmonids show similar results. In many streams, there are periods when the water is relatively turbid and contains variable amounts of suspended solids. Larger juvenile and adult salmon and steelhead appear to be little affected by ephemerally elevated suspended solids associated with storms (Bjornn and Reiser 1991). However, older juveniles may avoid turbidity levels associated with severe erosion at 70 neophenlometric turbidity units (NTU). Berge and Northcoate (1985) reported that the

feeding and territorial behavior of juvenile Coho is disrupted by short-term exposures (2.5 - 4.5 days) at a turbidity of 60 NTU.

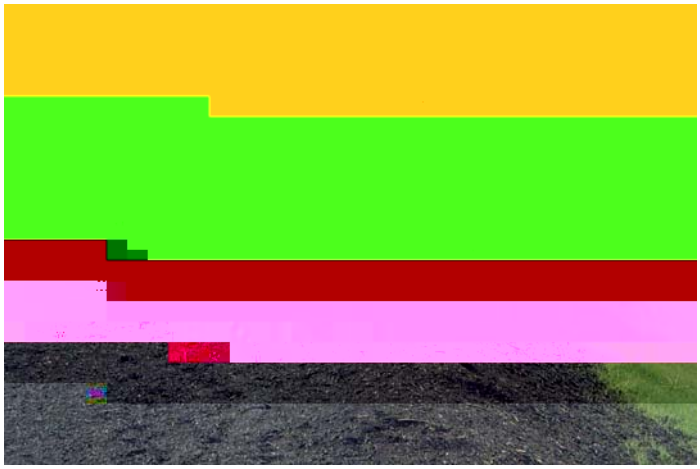
Studies reported by Lloyd et al. (1987) describe rainbow trout avoidance of turbid water above 30 NTU. The avoidance of turbid water has been documented by both field and laboratory studies. Bilby (1982) observed Coho salmon avoidance at water turbidity levels above 70 NTU. The

When applying compost in blankets of a thickness of four inches and greater, when seed is to be added, it is better to apply the compost in the top two inches. Seed mixed with compost in the top layer of compost will germinate, grow and usually provide good coverage well into the colder non-germinating season. This is probably due to the insulating aspect of compost. The benefits of using compost as a soil amendment are:

Incorporation of organic matter improves the structure of the soil;
Increased moisture holding capacity;
Increased moisture retention ability;
Source of nutrient supply for vegetation;
Vegetation greens up faster and better than in unamended soils;
Healthier vegetation established;
Increased stormwater retention;
Reduced irrigation requirement; and
Increased pollutant retention.

Additional benefits of compost include: reduced waste to landfills, reduced need for fertilizers and pesticides, reduced watering costs, improved plant appearance and increased natural rainwater filtration. It should be noted that in the Pacific Northwest, soil amendment with compost in excess of 30% by volume in poorly draining areas (shallow sloped) should not be attempted, as this will likely result in waterlogging and be detrimental to lawns or other vegetation. In poorly draining areas, a subsurface collection system (French drain) may have to be designed and installed to prevent this waterlogging. Excessively steep slopes may have to

ODOT on U.S. Highway 26 at Sylvan Hill



Eugene, Oregon

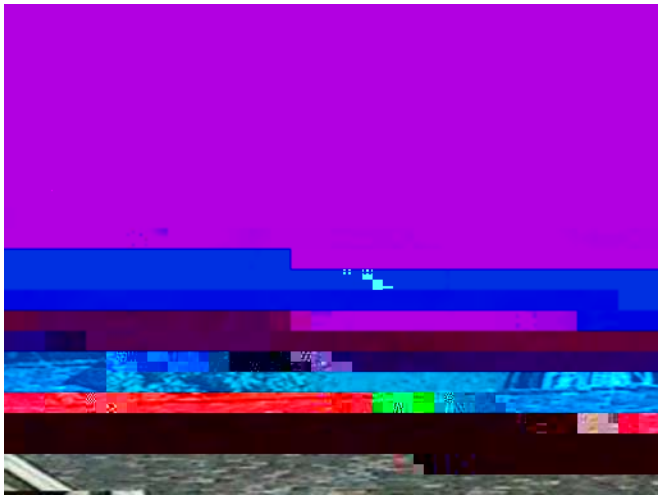
Compost Blankets:

Compost covers, blankets have been successfully used on slopes exceeding 1:1.4. In numerous applications around the U.S., blanketing a disturbed site with 4 inches of compost provides a number of benefits including reduced runoff, improved vegetation establishment, restored soil health and retained moisture. SoilDynamics applied an enhanced compost mixture called EssentialSoil^{TM} to a slope exceeding 100% in Medina, Washington to a depth of 12 to 15 inches with great success.

Amazon Creek, Oregon

Beef Bend Road, Oregon

Medina, Washington



Residential and Natural Gardening Use

Compost Tea:

Compost tea is the liquid that is derived from soaking compost in water. It is suspected that the use of compost tea can penetrate compacted soils and help reestablish the pores need for good infiltration. Further research is needed to establish or disprove this. The benefits of compost tea are:

Increased disease suppression;

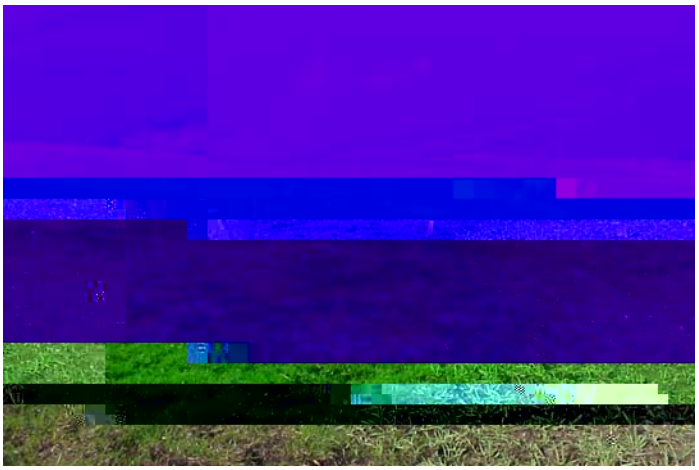
Nutrients for plants and food resources for microorganisms;

Injection of microorganisms into the soil which increases the retention of nutrients, recycles nutrients into plant-available forms, and accelerates decomposition of plant material and toxins:

Increased nutritional quality of plant produce and improved plant growth; and

Reduced negative impacts of chemical-based pesticides, herbicides, and fertilizers on beneficial microorganisms.

Most lawns and landscaping tend to get hard-packed if not aerated regularly. Hard-packed lawns and landscaping become impervious. A simple way to increase rain infiltration



(L)-Seeded Compost (R)-Seeded Clay

Rills Form on Surface w/out Compost

Lab Testing:

SoilDynamics tested the EssentialSoil™ mix at the San Diego State University's Soil Erosion Research Laboratory. A 12 inch depth of the enhanced compost was used on a 50% slope. Total solids were reduced from that of bare soil by 98%, and runoff as measured from three consecutive 10 year storm events (Los Angeles) was 77%. Turbidity results using compost have been mixed, due to testing problems. It should be noted that mature compost should be used when trying to control turbidity. The ionic capture of the colloidal soil particles which cause turbidity could be offset by the release of tannins or tannic acid from immature compost.

San Diego University Testing Apparatus

Compost Installation Methods

Compost can be applied to a site by mechanical/manual, conveyor, or blower methods. The moisture content of the compost can greatly effect some of these methods. An application of too wet compost can impair the ability to manually or mechanically spread the compost on-site.

Compost Blower

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Appendix 1 – Water Quality Model Code and Guidebook - Healthy Soil Standards (DRAFT)

Chapter 3

Healthy soils lead to healthy waters. Low-impact development (LID), which uses or restores the existing hydrological properties during construction equals more cost-effective management of stormwater on-site. LID management standards are available for improving land use plans and zoning codes. Endangered salmon are now the crucial link between land use planning, building and road construction, and pollution and waste prevention. New development should now address a coordinated assessment of waterways, riparian zones and critical areas before proceeding. Existing structures can be retrofitted to include porous parking surfaces, bioretention areas, vegetative rooftops, and natural gardening practices. Environmental protection can be enhanced by using compost-related techniques to more effectively control stormwater runoff during construction activities.

The cumulative adverse impacts on fish habitat by constructed areas and impervious surfaces are significant. Restoring the health to soil can aide in salmon recovery. Microbes and other living organisms contribute to the process of soil porosity, and nutrient availability for plants. The soil food web and organic matter decomposition process is vital to water quality. Native soil and soil amendments provide the necessary environment for living organisms.

Chapter 4

Chapter 5. Water Quality Protection Resources

Soils for Salmon

http://www.compostwashington.org/soilss2.asp
Includes information on education, government programs, and assistance programs. Includes *The Relationship Between Soil and water, How Soil Amendments and Compost Can Aid in Salmon Recovery*, an excellent guide to soil health.

http://www.deq.state.or.us/wmc/solwaste/composting.html
Includes a wide variety of information including facility contacts, technical and permitting information and links to rules and regulations. Includes *Restoring Soil Health to Urbanized Lands – The Crucial Link between Waste Prevention, Land Use, Construction, Stormwater Management and Salmon Habitat Restoration*, an excellent guide to low impact development and soil health.

Stormwater Best Management Practices

U.S. Environmental Protection Agency
http://www.epa.gov/owow/nps/urban2.html
The Office of Water has an on-line publication entitled *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures--Urban* containing technical information and methods for evaluating stormwater best management practices.

Water Research Commission
http://www.wrc.org.za/reports/tt95_98.htm
An online article entitled "The Removal of Urban Litter from Stormwater Conduits and Streams" includes information on the most appropriate and cost-effective methods for r43bo.9(li0.0.0599 -1.1497 TD0.wMce Ceclu)-4(dk Uecle4(i k

Appendix 2 Green Streets Healthy Soil Standards

D. Native Soils and Soil Amendments

After planning new development, a jurisdiction should review its development regulations to ensure construction activities contribute to the restoration or maintenance of a healthy watershed. This includes efforts to maintain a healthy soil structure by maintaining native soils where possible and using soil amendments where appropriate. Code language and contractor education materials should address consideration of the following best management practices.

1) Retaining Native Topsoil

- Minimize disturbance of native soils
- Reduce the removal of native topsoil
- Restore retained soils to original or higher level of porosity and water retention capacity by amending retained topsoil with 20% compost by volume to a depth of 8 inches.

2) Construction Practices

- Minimize compaction of soil by heavy equipment, especially by limiting the construction activity "footprint" on sites leaving as much area as possible undisturbed.
- Store topsoil on-site for replacing after construction.
- Process vegetative land-clearing debris and use on-site for mulching, where practical to do so.

3) Organic Amendments

- Incorporate 2-4 inches of compost into disturbed soils after construction during landscape development.
- Amend soils with compost prior to landscape development.
- Improve soil quality of disturbed/damaged soils by amending with 30% compost by volume to a depth of 8 inches.
- Restore surrounding native soils impacted by construction with 30% compost and mulching with wood debris.

4) Vegetation

- Retain native vegetation as much as possible.
- Cover soil during re-vegetation efforts using mulch materials from 0n-site materials or imported materials.

Following these practices will minimize the amount of run-off entering the right-of-ways from individual lots and when used within the right-of-way will increase the ability of the stormwater management facilities to retain water and bind pollutants.

e. The compost portion shall be reasonably free (<1 percent by dry weight) of man-made
foreign matter.
f. The compost portion shall not resemble the raw material from which it was derived.
g. A sample shall be submitted to the Engineer/landscape architect for approval prior to being used and must comply with

place.
7. Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement", will be paid for at the unit price bid for "Filter Berm Mulch" or "Filter Berm Compost". This price shall be full compensation for furnishing all material; placement and grading; and for all tools, equipment, labor and incidentals necessary for the construction and maintenance of the filter berm mulch or filter berm compost. When the Engineer directs that the filter berm mulch or filter berm compost installation (or portions thereof) be replaced, payment will be made at the unit price bid for "Filter Berm Mulch (Remove and Replace)" or "Filter Berm Compost (Remove and Replace)". This price shall be full compensation for the removal and replacement of the filter berm mulch or filter berm compost, and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work. The removal of accumulated sediment deposits, as described under Article 4, "Maintenance", will be measured and paid for under the pertinent bid items of the Special Specification, "Earthwork for Erosion Control". The work performed in the final removal of the filter berm mulch or filter berm compost installation as described under Article 4, "Maintenance" and measured as provided above will be paid for at the unit price bid for "Filter Berm Mulch (Remove)" or "Filter Berm Compost (Remove)". This price shall be full compensation for removing the material from the existing location and properly disposing of it and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

FURNISHING AND PLACING COMPOST

Description. Furnish and place compost as shown on the plans or as directed.

Materials. The type of compost or compost mixture required, based on the intended use, is shown on the plans and consists of one or more of the following:

- Compost Manufactured Topsoil (CMT) consisting of 75% topsoil soil blended with 25% compost measured by volume. CMT will be Blended On-Site (BOS) or Pre-Blended (PB) as specified on the plans.
- Erosion Control Compost (ECC) consisting of 50% wood chips blended with 50% compost measured by volume. Use fresh or partially composted wood chips less than or equal to 3 in. in length with 100% passing a 2 in. screen and less than 10% passing a 1 in. screen.
- General Use Compost (GUC) consisting of 100% compost.

Furnish compost that has been produced by aerobic (biological) decomposition of organic matter. Compost feedstock may include, but is not limited to, leaves and yard trimmings, biosolids, food scraps, food processing residuals, manure or other agricultural residuals, forest residues, bark, and paper. Compost must not contain any visible refuse or other physical contaminants, material toxic to plant growth, or over 5% sand, silt, clay or rock material. Mixed municipal solid waste compost and Class B biosolids, as defined in the United States Environmental Protection Agency Code of Federal Regulations (USEPA, CFR), Title 40, Part 503 are unacceptable. Compost must meet all applicable USEPA, CFR, Title 40, Part 503 Standards for Class A biosolids and TNRCC health and safety regulations as defined in the Texas Administrative Code (TAC), Chapter 332. Compost must have been processed to meet the time and temperature standards in TAC Chapter 332 Subchapter B Part 23 (for control of noxious weeds, and pathogen and vector attraction),

and the requirements shown in Table 1, “Physical Requirements for Compost.” All physical requirements are in accordance with the United States Department of Agriculture and the United States Composting Council, “Test Methods for the Examination of Composting and Compost” (TMECC).

Physical Requirements for Compost

Organic Matter Content: 30-65% (dry mass) in accordance with TMECC 05.07-A, “Loss on Ignition Organic Matter Method”
Particle Size: 100% passing 5/8 in., 70% greater than 3/8 in. in accordance with TMECC 02.02-B, “Sample Sieving for Aggregate Size Classification”

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- Blended On-site (BOS). Apply in a uniform layer and incorporate into existing topsoil to the depth shown on the plans. When rolling is specified, use a light corrugated drum roller.
- Pre-Blended (PB). Furnish CMT and apply in a uniform layer to the depths shown on the plans. When rolling is specified, use a light corrugated drum roller.
- Erosion Control Compost (ECC). Use only on slopes 3:1 or flatter. Apply a 2" uniform layer unless otherwise shown on the plans or as directed. When rolling is specified, use a light corrugated drum roller.
- General Use Compost (GUC). Apply in a uniform layer as a top dressing on established vegetation to the depth shown on the plans. Do not bury existing vegetation. If GUC is used as a backfill ingredient, in a planting soil mixture, for planting bed preparation, or as a mulch, apply as shown on the plans.
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Measurement. This item will be measured by the following class as shown on the plans:

Class 1. By the 100 foot-station along the baseline of each roadbed.

Class 2. By the square yard complete in place.

Class 3. By the cubic yard in vehicles at the point of delivery.

Payment. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Compost Manufactured Topsoil (BOS)," "Compost Manufactured Topsoil (PB)," "Erosion Control Compost" and "General Use Compost" for the class and depth specified. This price is full compensation for securing any necessary source and for furnishing materials; for excavation, loading, hauling, stockpiling, and placing; furnishing and operating equipment; and labor, fuel, material, tools, and incidentals. "Sprinkling", "Rolling" and "Vegetative Watering" will not be paid for directly, but will be subsidiary to this Item.