4.0 COMPOST SPECIFICATION FOR SOIL INCORPORATION

Research efforts performed during this project demonstrated that State DOT compost specifications have become more detailed in nature, both in specific application instructions and in the numerical product standards themselves. The compost characteristics most frequently included in State DOT specifications are outlined in Figure 3. Identifying these compost characteristics was necessary for the development of a 'Model DOT Compost Specification'. It is the goal of this project that this model specification be used by many states as a template for their own compost specifications. In this way, compost specifications used throughout the country can become more uniform in nature, and so may the test methods used in their analysis. It is also understood that State DOTs may need to modify the model specifications to meet the specific requirements of their state.

Figure 3 - Most Common Compost Parameters Specified

Parameter	Frequency
pH	23
Particle size	19
Soluble salts	16
Organic Matter	14
Moisture content	13
Stability/Maturity	9/6
Pathogens	9
Heavy Metals	9
Inerts	7

The development of a Model DOT Compost Specification is necessary to allow more extensive usage of the product, in both 'public' and 'private' sector projects, and in order to allow organizations to specify and purchase compost with more confidence. Movement towards a national compost specification (standard) will not only help to develop more continuity among existing state and regional specifications, but also improve interstate commerce. To provide the necessary data and context, the model specification includes both 'boiler plate' compost usage instructions and suggested numerical standards. Access to the appropriate analytical test methodologies necessary to evaluate compost are also provided (Appendix A). The suggested numerical compost standards outline both the specific parameters (characteristics) to consider, as well as the specific numerical standards related to each characteristic.

Historically, developing numerical standards for compost has proven to be difficult because high quality compost products can be produced using a variety of feedstocks (e.g., yard trimmings, biosolids, manure, etc.), because soil characteristics and plant requirements vary with location and type, and because compost can be used for a variety of applications. For these reasons, any suggested compost standard must allow for adjustment by the project engineer, designer, or equivalent, in order to allow them to meet the requirements of a specific project (e.g., specific application, soil conditions, plant requirements, available compost products, application rates). The development of a 'feedstock independent' numerical standard for compost is more useful, if it is done so compost applications that require a product which requires similar characteristics, and if it considers standard compost application rates.

The following model compost specification was developed for composts used as a 'soil incorporant' (incorporated into the soil) on typical landscape applications. These landscape applications include garden/planting bed establishment/renovation, tree/shrub planting backfill mixes, and turf establishment/renovation.

4.1 MODEL COMPOST SPECIFICATION – PRODUCT AND APPLICATION

Figure 4 Model Compost Specificationfor General Landscape Applications (soil amending)

Parameters[1,6]	Reported as (units of measure)	General Range
pH[2]	pH units	5.0 - 8.5
Soluble Salt Concentration[2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	30 – 60
Organic Matter Content	%, dry weight basis	30 – 65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability[3] Carbon Dioxide Evolution Rate	 mg CO_2-C per g OM per day	 < 8
Maturity[3] (Bioassay) Seed Emergence and Seedling Vigor	 %, relative to positive control %, relative to positive control	 Minimum 80% Minimum 80%
Physical Contaminants (inerts)	%, dry weight basis	< 1
Chemical Contaminants[4]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants[5] Select Pathogens Fecal Coliform Bacteria, or Salmonella	 MPN per gram per dry weight MPN per 4 grams per dry weight	 Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

1 Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, The US Composting Council)

2 It should be noted that the pH and soluble salt content of the amended soil mix is more relevant to the establishment and growth of a particular plant, than is the pH or soluble salt content of a specific compost (soil conditioner) used to amend the soil. Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. Most ornamental plants and turf species can tolerate a soil/media soluble salt level of 2.5 dS/m and 4 dS/m, respectively. Seeds, young seedlings and salt sensitive species often prefer soluble salt levels at half the afore mentioned levels. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to existing soil conditions.

3 Stability/Maturity rating is an area of compost science that is still evolving, and as such, other various test methods could be considered. Also, never base compost quality conclusions on the result of a single stability/maturity test.

4 US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.

5 US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.

6 Landscape architects and project (field) engineers may modify the allowable compost specification ranges based on specific field conditions and plant requirements.

Using the Model Compost Specification

In order to properly use the Model Compost Specification, several issues must be considered and points made clear.

1. The Model Compost Specification assumes that specific application rates (outlined in the following application specifications) are used, that the appropriate plant species for indigenous soil and climatic conditions are used, and that the compost is applied just before planting.

- *It should be understood that compost products that fall outside the general specification range are not necessarily poor quality products or unusable, they may simply require different application specifications.* A good example is an animal manure compost which possesses a soluble salt content outside the general range. This nutrient rich product may simply need to be applied at a lower application rate, or be thoroughly watered in order to leach some of the salts. Another example could be the use of a compost product which possesses a stability or maturity rating outside the general range. In this case, the compost product could be applied and incorporated into the soil several weeks before planting is going to occur (if project requirements allow for this).

2. Landscape architects and project engineers should be allowed to modify the numerical ranges within the Model Compost Specification based on specific field conditions, plant requirements and the expected compost application rate.

- The ability to modify both the product and application specifications are necessary to meet specific conditions. Obviously, every state and region possesses specific soil conditions (e.g., pH and soluble salt content), so in order to allow specifiers to adjust the specification to meet their specific conditions, modification must be allowed. A good example is using the specification in an area of the country (e.g., Utah) where the level of soluble salts in the soil are much greater than in most other areas of the country. In this scenario, indigenous plant species can tolerate higher salt levels, therefore a compost which possesses a greater content of soluble salts may be usable.

3. Whenever possible, before any soil preparation procedures ensue, a soil analysis should be completed by a reputable laboratory. This will assist the landscape architect or project engineer to determine if the Model Compost Specification requires modification.

4. It should be noted that the pH and soluble salt content of the amended soil mix is more relevant to the establishment and growth of a particular plant, than is the pH or soluble salt content of a specific compost (soil conditioner) used to amend the soil. Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. Most ornamental plants and turf species can tolerate a soil/media soluble salt level of 2.5 dS/m and 4 dS/m, respectively. Seeds, young seedlings and salt sensitive species often prefer soluble salt levels at half the afore mentioned levels. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to existing soil conditions.

5. Stability/Maturity rating is an area of compost science that is still evolving, and as such, other various test methods could be considered for use in compost specification and evaluation. Also, never base conclusions for compost stability/maturity on the result of a single test.

6. Recommended compost testing methodologies and sampling procedures are provided in the *Test Methods for the Examination of Composting and Compost* (TMECC) manual published by the USCC and the United States Department of Agriculture. For more information, log onto www.tmecc.org.

Model Compost Application Specifications

Section _____, Turf Establishment with Compost

Description:

This work shall consist of incorporating compost within the root zone to improve soil quality and plant growth. This specification applies to all types of turf establishment methods including seeding, sprigging, sodding, and hydroseeding.

Materials:

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the raw material from which it was derived.

Product Parameters:

Figure 4 Model Compost Specificationfor General Landscape Applications (soil amending)

Parameters[1,6]	Reported as (units of measure)	General Range
pH[2]	pH units	5.0 - 8.5
Soluble Salt Concentration[2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	30 – 60
Organic Matter Content	%, dry weight basis	30 – 65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability[3] Carbon Dioxide Evolution Rate	mg CO_2-C per g OM per day	< 8
Maturity[3] (Bioassay) Seed Emergence and Seedling Vigor	%, relative to positive control %, relative to positive control	Minimum 80% Minimum 80%
Physical Contaminants (inerts)	%, dry weight basis	< 1
Chemical Contaminants[4]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants[5] Select Pathogens Fecal Coliform Bacteria, or Salmonella	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

Construction Requirements:

Compost shall be uniformly applied over the entire area at an average depth of 1 to 2 inches* and incorporated to a depth of 5 to 7 inches (for a 20% to 30% inclusion rate) using a rotary tiller or other appropriate equipment. Pre-plant fertilizer and pH adjusting agents (e.g., lime and sulfur) may be applied before incorporation, as necessary[t]. Rake soil surface smooth prior to seeding, sprigging, sodding, or hydroseeding. The soil surface shall be reasonably free of large clods, roots, stones greater than 2 inches, and other material which will interfere with planting and subsequent site maintenance. Water thoroughly after seeding, sprigging, or sodding.

Topdress newly seeded and sprigged turf areas with a 1/4 inch layer of fine compost (3/8 inch screen, minus), then water to protect against hot, dry weather or drying winds.

Method of Measurement:

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

t The use of stable, nutrient rich composts will reduce initial fertilizer requirements by the amount of available nutrients in the compost.

Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the turf species to be established.

Section _____, Planting Bed Establishment with Compost

Description:

This work shall consist of incorporating compost within the root zone in order to improve soil quality and plant growth. This specification applies to all types of plantings, including trees, shrubs, vines, ground covers, and herbaceous plants.

Materials:

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, only use a compost that has not received the addition of liming agents or ash by-products.

Product Parameters:

Figure 4 Model Compost Specificationfor General Landscape Applications (soil amending)

Parameters[1,6]	Reported as (units of measure)	General Range
pH[2]	pH units	5.0 - 8.5
Soluble Salt Concentration[2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	30 – 60
Organic Matter Content	%, dry weight basis	30 – 65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability[3] Carbon Dioxide Evolution Rate	mg CO_2-C per g OM per day	< 8
Maturity[3] (Bioassay) Seed Emergence and Seedling Vigor	%, relative to positive control %, relative to positive control	Minimum 80% Minimum 80%
Physical Contaminants (inerts)	%, dry weight basis	< 1
Chemical Contaminants[4]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants[5] Select Pathogens Fecal Coliform Bacteria, or Salmonella	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

Construction Requirements:

Compost shall be uniformly applied over the planting area at an average depth of 1 to 2 inches*. Incorporate uniformly to a depth of 6 to 8 inches using a rotary tiller or other appropriate equipment. Lower compost application rates may be necessary for salt sensitive crops or where composts with higher salt levels are used. Pre-plant fertilizer and pH adjusting agents (e.g., lime and sulfur) may be applied in conjunction with compost incorporation, as necessary[t]. Rake soil surface smooth prior to planting. The soil surface shall be reasonably free of large clods, roots, stones greater than 2 inches, and other material which will interfere with planting and subsequent site maintenance. Water thoroughly after planting.

Method of Measurement:

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

t The use of stable, nutrient rich composts will reduce initial fertilizer requirements by the amount of available nutrients in the compost.

Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for all plant species to be established.

Section _____, Compost as a Landscape Backfill Mix Component

Description:

This work shall consist of excavating a planting hole and blending compost with the excavated soil to improve soil quality and plant growth. This specification applies to all types of bare root, containerized, and balled and burlapped plant material.

Materials:

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, provide only compost that has not received the addition of liming agents or ash by-products. Composts containing available nutrients, primarily nitrogen, are preferred, while the use of unstable or immature compost is not approved. Care should be given when using composts possessing a basic pH (>7) near acid loving plants.

Product Parameters:

Figure 4 Model Compost Specificationfor General Landscape Applications (soil amending)

Parameters[1,6]	Reported as (units of measure)	General Range
pH[2]	pH units	5.0 - 8.5
Soluble Salt Concentration[2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	30 – 60
Organic Matter Content	%, dry weight basis	30 – 65
Particle Size	% passing a selected mesh size, dry weight basis	98% pass through 3/4" screen or smaller
Stability[3] Carbon Dioxide Evolution Rate	 mg CO_2-C per g OM per day	 < 8
Maturity[3] (Bioassay) Seed Emergence and Seedling Vigor	 %, relative to positive control %, relative to positive control	 Minimum 80% Minimum 80%
Physical Contaminants (inerts)	%, dry weight basis	< 1
Chemical Contaminants[4]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants[5] Select Pathogens Fecal Coliform Bacteria, or Salmonella	 MPN per gram per dry weight MPN per 4 grams per dry weight	 Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

Construction Requirements:

Excavate a planting hole slightly shallower and 2 to 3 times the width of the rootball or container. Set the rootball on firm soil so that the top of the rootball will sit slightly higher than the final grade. Uniformly blend compost and excavated soil at a 1 compost : 2 soil ratio*. Backfill and firm the soil blend around the rootball within the planting hole. Water thoroughly during and after planting.

Method of Measurement:

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be amended to a range suitable for the plant species to be established.

4.2 COMPOST CHARACTERISTICS AND THEIR IMPORTANCE

Described in this section are the compost characteristics that are often considered the most important in compost quality evaluation, and are therefore included in the model compost specification. These characteristics represent the basic chemical, physical, and biological data needed to assure successful compost use and overall satisfaction. Considering these characteristics will also assist you in determining which compost products possess the characteristics needed for your specific application. Since growing conditions and plant requirements differ, we can benefit greatly from accurate characterization data pertaining to the compost products we use. This data will allow you and your contractors to use compost in a way that best meets your particular requirement, or specific situation. By obtaining accurate characterization data, you can more easily obtain compost that is appropriate for a specific application, as well as use it in a way that best meets your particular requirements. To assist compost end users and specifiers in this effort, the USCC has developed the *Test Methods for the Evaluation of Composting and Compost (TMECC)* manual and the Seal of Testing Assurance Program (STA).

In its current form, the STA program is a compost testing and information disclosure program which uses uniform testing and sampling protocols. The STA program allows compost buyers to more easily purchase the products they desire, or require for a particular project. It also allows them to more systematically compare compost products, since all products will use a uniform program label. All participants will make test results available to inquiring customers using the "Compost Technical Data Sheet", a uniform product label. The STA program not only approves laboratories involved in the STA Program, but also requires them to use standard test methods and sampling procedures outlined in the USCC's TMECC manual. The TMECC manual is a technical manual of standardized test methods developed for analytical labs. For more information, log onto **www.compostingcouncil.org** or www.tmecc.org.

Compost Characteristics

pH – pH is the measure of soil/media acidity or alkalinity. The pH scale ranges from 0 to 14, with a pH of 7 indicating neutrality. A pH change of 1 unit means a 10-fold increase or decrease in pH. Most composts have a pH of between 5 and 8.5. Each specific plant species requires a specific pH range. Based on the amount of compost applied, as well as it's pH, its addition can affect the pH of the soil or growing media. Therefore, to estimate the effect, which in turn will affect maintenance practices or system management, pH is a necessary parameter of which to be aware. Soil pH is often adjusted through the utilization of materials such as lime (to raise pH) and sulfur (to lower pH). When liming agents are used in the production of the compost product you use, or are present in the source materials of the compost, it may be more or less appropriate for your specific application, because it will be more difficult to buffer.

Soluble Salts (Conductivity) – Soluble salts refers to the amount of soluble ions in a solution of compost and water. The concentration of soluble ions is typically estimated by determining the solution's ability to carry an electrical current, i.e., electrical conductivity. The units of measure for soluble salts are either mmhos/cm or dS/m (they are 1:1 equivalent). Plant essential nutrients are actually supplied to plants in a salt form. While some specific soluble salts, (e.g., sodium, chloride), may be more detrimental to plants, most composts do not contain sufficient levels of these salts to be a concern in landscape applications. Plant species have a salinity tolerance rating and maximum tolerable quantities are known. Excess soluble salts can cause phytotoxicity to plants. Compost may contribute to, or dilute, the cumulative soluble salts content of a growing media or soil. Reduction in soluble salts content can be achieved through thorough watering at the time of planting. Most composts have a soluble salt conductivity of 1.0 to 10.0 dS/m, whereas typical conductivity values in soil range from 0 to 1.5 in most areas of the country.

Nutrient Content – Nitrogen (N), Phosphorus (P, usually expressed as P2O5), and Potassium (K, usually expressed as K20) are the three nutrients utilized by plants in the greatest quantities, and therefore, are the nutrients most often contained in commercial and retail fertilizers. When purchased in bags of fertilizer, these three nutrients are measured and expressed on a dry weight basis, in the form of a percentage (%). In compost, nutrient content may be expressed on a dry, or wet weight (as received) basis. Knowing the content of these nutrients will help you make correct decisions regarding the addition of supplemental fertilization. Although concentrations of nutrients found in compost are typically not high, in comparison to most fertilizer products, compost is usually applied at much greater rates, and therefore, can represent a significant cumulative quantity. The nutrient content of compost products vary widely; however, biosolids and animal manure based composts typically contain more total nutrition. The use of certain composts may reduce or eliminate the necessity to fertilize certain plants during the first 6 –12 months following its application. In general, nutrients found in compost are in an 'organic' form thus released slowly as the compost decomposes.

Organic Matter – Organic matter content is the measure of carbon-based materials in compost. Organic matter content is typically expressed as a percentage of dry weight. Organic matter in an important ingredient in all soils and plays an important role in soil structure, nutrient availability, and water holding capacity. Being aware of a product's organic matter content is useful for estimating the age and physical properties of the compost. It may also be necessary for determining compost application rates on certain applications, such as turf establishment and agricultural crop production. In these applications, standard agricultural soil test kits are often used to determine recommended application rates of

organic matter. However, these application rates are specified as the quantity of organic matter needed on a per acre basis. Therefore, the organic matter content of the compost must be known in order to convert the suggested application rate into a usable form (tons/acre). There is no ideal organic matter content for compost, and it may vary widely, ranging from 25 to 70%.

Moisture Content – Moisture content is the measure of the quantity of water present in a compost product; expressed as a percentage of total weight. The moisture content of compost affects its bulk density (weight per unit volume) and, therefore, affects handling and transportation. Overly dry compost (below 35%) can be dusty and irritating to work with, while very wet compost (60% and above) can become heavy and clumpy, making its application more difficult and delivery more expensive. A preferred moisture percent for finished compost is often considered to be 40 -50%.

Particle Size – The way in which compost particle size is measured, and expressed, is typically based on the product's end use. For most applications, merely specifying the product's maximum particle size, or the screen size through which it passes, is sufficient. A compost product's particle size may also determine its usability in specific applications. For example, a compost product with a maximum particle size of 1/2 inch or greater may not be acceptable as a turf top-dressing, whereas a product with a maximum particle size of 1/4 to 3/8 inch or less could be acceptable. Most composts that are used as soil amendments are screened through a 3/8 or 1/2 inch screen.

Maturity (bioassay) – Maturity is the degree or level of completeness of composting. Maturity is not described by a single property and therefore, maturity is best assessed by measuring two or more compost characteristics. Some immature composts may contain high amounts of free ammonia, certain organic acids or other water-soluble compounds which can limit seed germination and root development, or cause odor. All uses of compost require a mature product free of these potentially phytotoxic components.

Stability (respirometry) – Stability refers to a specific stage of organic matter decomposition during the composting process, which is related to the type of organic compounds remaining and the resultant biological activity in the material. The stability of a given compost is important in determining the potential impact of the material on nitrogen availability in soil or growing media, as well as maintaining consistent volume and porosity in container growing media. Most soil amending type compost applications require a stable to very stable product that will prevent nutrient tie up and maintain or enhance oxygen availability in soil.

Inerts (physical contaminants) – Man-made inerts consist of materials created by humans and may be a part of the waste stream. These include: textiles, glass, plastic, and metal objects. When put into the composting process, these materials are not decomposed but may be degraded to some extent in physical characteristics, primarily through size reduction. These materials can decrease the value of the finished compost product because they offer no benefit to the compost and, in many cases, are aesthetically offensive. A common means of controlling man-made inerts is to minimize their entry into the waste stream being composted. Control is also accomplished through separation at the source during feedstock recovery at the composting facility, or during product refinement, (e.g., screening, ballistic separation). Other 'non' man-made inerts, such as stones, rocks, twigs, may also be found in compost and are considered to be aesthetically offensive. Only minimal levels of inert materials are considered o be acceptable.

Trace Metals (chemical contaminants) – Trace metals are elements whose concentrations are regulated due to the potential for toxicity to humans, animals, or plants. Regulations governing the trace metal content of composts derived from certain feedstocks have been promulgated on both the state and federal levels. Similar limits have even been developed for fertilizers and certain other horticultural and agricultural products. Specific trace elements, often referred to as heavy metals include arsenic, cadmium, chromium, copper, lead, mercury, molybdenum nickel, selenium, and zinc. The quantity of these elements are measured on a dry weight basis and expressed as mg/kg (milligram per kilogram) or ppm (parts per million). Many of these elements are actually needed by plants for normal growth, although in limited quantities. Therefore, measuring the concentration of these elements, as well as other plant nutrients, can provide valuable management data relevant to the fertilizer requirements of plants and subsequent fertilizer application rates. Certain heavy metals and trace elements are also known to cause phytotoxic effects in plants (when available in very high quantities), and specific plant species are known to be more sensitive than others. These elements include boron, manganese, molybdenum, nickel, and selenium. However, these elements are not typically found in compost in detrimental quantities. All composts that contain regulated feedstocks must meet state and/or federal safety standards in order to be marketed.

Weed Seeds* and Pathogens (biological contaminants) – Pathogens are disease causing organisms that may be present in raw wastes or by-products. Both plant and human pathogens are found in living organisms and are present at some background levels in the environment. Therefore, the composting process must eliminate or reduce pathogens to a level that is below the threshold where the danger of transmitting diseases will occur. Both pathogens and weed seeds are inactivated or destroyed by elevated temperatures, which occur over a period of time, within the composting process. The time-temperature relationship that is used as the *'Process to Further Reduce Pathogens'* (an US EPA defined process) effectively destroys both weed seeds and pathogens in compost. Therefore, by monitoring the time-temperature relationship, we can ensure plant and human pathogen destruction in compost, as well as weed free destruction.

**It should be noted that composts which contain viable noxious weed seeds should not be utilized. This specific product parameter can be required within the text of any specification, however it is a difficult parameter for which to actually test.*

4.3 EXAMPLES OF STATE DOT COMPOST SPECIFICATIONS

Several state DOTs have recently developed compost specifications, based on their field experience and research, as well as new scientific data and test methods. The following two examples provide both a compost 'product' specification, as well as an 'application' specification (instructions for specific end uses). The USCC's Model Compost Specification follows this same logical format.

Texas Department of Transportation – Item 161
FURNISHING AND PLACING COMPOST

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

161.2. 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. Use topsoil in accordance with Article 160.2, "Materials."

- 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).

Table 1, "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"
Soluble Salts: 5.0 max.* dS/m in accordance with TMECC 04.10-A, "Electrical Conductivity for Compost"
Fecal Coliform: Pass in accordance with TMECC 07.01-B, "Fecal Coliforms"
pH: 5.5 – 8.5 in accordance with TMECC 04.11-A, "Electrometric pH Determinations for Compost"
Stability: 8 or below in accordance with TMECC 05.08-B, "Respirometry"
Maturity: greater than 80% in accordance with TMECC 05.05-A, "Biological Assays"
Heavy Metals: Pass in accordance with TMECC 04.06, "Heavy Metals and Hazardous Elements" and TMECC 04.13-B, "Atomic Absorption Spectrophotometry"

* A soluble salt content up to 10.0 dS/m for compost used in Compost Manufactured Topsoil will be acceptable.

Before delivery of the compost, provide a notarized document that includes the following:

- the feedstock by percentage in the final compost product,
- a statement that the compost meets federal and state health and safety regulations,
- a statement that the composting process has met time and temperature requirements,
- a copy of the lab analysis, less than four months old, preformed by a Seal of Testing Assurance certified lab verifying that the compost meets the physical requirements as described in

The compost is subject to testing by the Engineer at the composting facility or at the project site.

161.3. Construction.

A. Compost Manufactured Topsoil (CMT). Remove and dispose of any trash, wood, brush, stumps or any other objectionable material from the topsoil before blending.

1. **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.
2. **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.

B. Erosion Control Compost (ECC). Use only on slopes 3:1 or flatter. Apply in a uniform layer as shown on the plans or as directed. When rolling is specified, use a light corrugated drum roller.

C. 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.

161.4 Measurement. This item will be measured by the following class asshown on the plans:

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

B. Class 2. By the square yard complete in place.

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

D. Class 4. By the cubic yard in the stockpile as computed by the method of average end areas.

E. Class 5. By the cubic yard in its original position as computed by the method of average end areas.

161.5 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 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" and "Rolling" will not be paid for directly, but will be subsidiary to this Item.

SECTION 751
LOAM BORROW AND TOPSOIL REHANDLED AND SPREAD

DESCRIPTION

751.20 General.

The work under this item consists of furnishing and placing loam and related items on an approved area in accordance with these specifications and in close conformity with the lines and grades shown on the plans or established by the Engineer. The work includes the placing, spreading and grading of loam borrow for seeded and planted areas, preparation of soil for plant material, amendment of loam as required to produce planting soil mix, and provision of soil additives required to adjust for pH requirements of specific plants.

MATERIALS

751.40 General.

Material shall meet the requirements specified in the following Subsections of Division III, Materials:

Loam Borrow	M1.05.0
Topsoil and Plantable Soil Borrow	M1.07.0
Organic Soil Additives	M1.06.0
Inorganic Amendments	M6.01.0

Samples and Submittals

At least 30 days prior to ordering, the Contractor shall submit to the Engineer representative samples, certifications, and certified test results for materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and approved by the Engineer. Delivered materials shall closely match the approved samples. Approval of test results does not constitute final acceptance. The Engineer reserves the right to reject on or after delivery any material which does not meet the Specifications.

Soil Additives for Loam

- Additives shall be used to counteract soil deficiencies as recommended by the soil analysis.
- Organic matter used as an amendment to soil shall be manufactured compost.
- Lime or sulfur shall be used to bring soil to acceptable pH levels, per soil test reports.
- For silty soils, those with more than 20 percent passing the 75 mm, and poorly drained soils in general, mix in gypsum at a rate of 5kg/m3 .
- Incorporate soil amendments thoroughly into loam, per recommendations of test reports, to meet the specified requirements for loam prior to delivering the material on site.

CONSTRUCTION METHODS

751.60 Preparation of Areas on Which Loam or Topsoil are to be Placed.

All areas to receive loam shall be free of construction debris, refuse, compressible or decayable materials and standing water. The area upon which the above materials are to be placed shall be raked, harrowed or dragged to form a smooth surface. All stones larger than 50 millimeters undesirable growth over 50 millimeters and debris shall be removed from the area and disposed of by the Contractor outside the location.

When directed by the Engineer, additional suitable material available from excavation or furnished under Item 150, Ordinary Borrow, shall be spread as required to repair gullies or depressions. The labor, equipment and materials necessary to place, compact and grade the additional material shall be paid for under the respective item from which the material is obtained.

751.61 Placing Loam or Topsoil.

The Contractor shall notify the Engineer when areas to receive loam are ready for inspection and approval. Placement of loam fill material shall not begin until the Engineer has approved the subgrade.

Loam shall not be handled or placed when subgrade or loam are frozen or saturated, i.e. when squeezed sample shows any sign of free moisture.

The Engineer shall reject the use of the Contractor's equipment or procedures if they are unsuitable for or are likely to damage or over-compact underlying structure or materials.

Loam shall be placed in lifts not to exceed 100 mm. After each lift, the soil shall be well-mixed into the soil layer beneath it. Compaction of each lift shall be minimal, sufficient only to achieve the required grades. Over-compaction of existing soils or fills that would be detrimental to planting objectives shall be corrected by tilling or other means at no additional cost.

Grade stakes shall be set to check finished grades. Deviation from lines and grades that are greater than 25 mm shall not be permitted.

Contractor shall supply additional loam as necessary so that following finish the grading and compaction operations, the placed loam shall conform to the depth required.

Finish grades shall exhibit no abrupt changes, and shall blend evenly with the undisturbed finish grade.

During hauling operations, the roadway surfaces shall be kept clean and any loam or other dirt which may be brought upon the surface shall be removed promptly and thoroughly before it becomes compacted by traffic. If necessary, the wheels of all vehicles used for hauling shall be cleaned frequently and kept clean to avoid bringing any dirt upon the surface. The Contractor shall take all reasonable precautions to avoid injury to existing or planted growth.

751.62 Topsoil Rehandled and Spread.

Topsoil which is obtained on the site from piles of topsoil previously excavated and stacked in accordance with the relevant provisions of Section 120 and designated as topsoil to be rehandled and spread shall be used as required, and as directed by the Engineer, on areas to be seeded or planted.

The topsoil must meet the requirements of M1.05.0 and be approved before it is spread. The Contractor will be required, without additional compensation, to take corrective action as directed, in order to make the topsoil suitable for its intended use.

The Contractor is required under the item of seeding to adjust the acidity by the addition of limestone as determined by testing as required under Subsection 765.61 and to apply the fertilizer as required under Subsection 765.62.

COMPENSATION

751.80 Method of Measurement.

The quantity of Loam Borrow, or Topsoil Rehandled and Spread shall be determined by measurement in place after compaction to the depth specified on the plans or as directed, and to the volume so ascertained there shall be added 20% to compensate for such loss as may be due to settlement, shrinkage and penetration into the underlying material.

The volume of Topsoil Rehandled and Spread including added percentage for settlement shall not exceed the total volume of Item 125, Topsoil Excavated and Stacked, less any waste.

751.81 Basis of Payment.

Loam Borrow and Topsoil Rehandled and Spread will be paid for at the contract unit price per cubic meter, complete in place, which prices shall also include the grading of areas where stockpiles of topsoil are removed.

751.82 Payment Items.

751.	Loam Borrow	Cubic Meter
752.	Topsoil Rehandled and Spread	Cubic Meter

M1.05.0 Loam Borrow.

Loam borrow shall be free of debris and other extraneous matter Loam borrow shall be fertile, friable soil obtained from naturally well-drained areas or shall be the product of a commercial sand and gravel processing facility. It shall be uncontaminated by salt water, foreign matter, or substances harmful to plant growth. Loam shall not contain rocks, clods, or any material greater than 50 mm.

Loam borrow shall have the following mechanical analysis:

Sieve Size	Percent Passing
2.00mm	85-100
425mm	35-85
75 mm	10-35
<20 mm	<5

Testing shall be on material that has passed the 2.0 mm sieve. Loam borrow shall contain 4-10 percent organic matter as determined by the loss on ignition of oven-dried samples. Lawn areas shall have an organic content of at least 4 percent. For woody planting, organic content shall be 7-10 percent. Salinity (electrical conductivity) shall be less

than 1.0 mmho/cm as determined by a 1:2 (by volume) soil-to-water mix. Salt test samples shall not be oven dried. The acidity range of the Loam borrow shall be pH 5.5 to 7.0.

Contractor shall provide testing submittals as follows:

- One 10 kg representative sample per source of loam
- For sources providing >1000 cubic meters, one additional 10 kg representative sample for each 1000 cubic meter unit of soil

In addition, five random representative 10 kg samples of on-site stockpiles of delivered loam, as directed by the Engineer, shall be collected and packaged in the presence of the Engineer.

Contractor shall deliver samples to testing laboratories and shall have the testing report sent directly to the Engineer.

Testing and analysis will be at the Contractor's expense. Soil samples shall be dry. Tests for particle gradation, organic content, and pH shall be performed by an Agricultural Experiment Station testing laboratory or other testing laboratory approved by the Engineer. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies, and for additives necessary to accomplish particular planting objectives noted. University of Massachusetts Agricultural Extension Service methods for soil and soil additive analysis shall be used.

No Loam borrow shall be delivered to the site until the review and approval of loam test results by the Engineer.

M1.06.0 Organic Soil Additives.

The Contractor shall submit for approval a written list of all vendors of manufactured compost, including location of compost facility and feedstock materials. All vendors shall submit certified results of regular periodic testing by an approved testing facility. Certification shall be per Massachusetts Highway Department approved compost certification programs.

In addition, the contractor shall provide representative 3 liter samples from each proposed source for testing and analysis at the Contractor's own expense. Contractor shall deliver samples to testing laboratories and shall have the testing report sent directly to the Engineer. Tests for levels of toxic elements and compounds shall be performed by a private testing laboratory approved by the Engineer. Tests for soil chemistry and pH may be performed by an Agricultural Experiment Station testing laboratory or other testing laboratory approved by the Engineer.

Compost shall be a well-decomposed humus material derived from the aerobic decomposition of biodegradable matter, free of viable weed seeds and other plant propagules (except airborne weed species), foreign debris such as glass, plastic, etcetera and substances toxic to plants. Compost shall be suitable for use as a soil amendment and shall support the growth of ornamental nursery stock and turf establishment. It shall be in a shredded or granular form and free from hard lumps. Food and agriculture residues, animal manure, or other biosolids that meet the above requirements and are approved by the Massachusetts Department of Environmental Protection are acceptable as source materials.

The level of toxic elements and compounds in organic matter shall be below the Massachusetts Department of Environmental Protection Type I standards for sludge and the United States Environmental Protection Agency standards for Class A "Exceptional Quality Sludge", whichever is more stringent. Levels of pathogens shall be below both federal and state thresholds.

Composted material with an unpleasant odor, such as that of ammonia or fecal material shall be rejected by the Engineer.

Compost shall have the following properties:

- maximum particle size of 25 mm
- stability =<10 mg CO2 - C/g BVS day, or
  =<10 degrees C above ambient temp (deWar self-heating test), or
  => 6 using Solvita test kit
- moisture content between 35-55 %
- pH range between 5.5 and 7.5
- minimum organic matter content of 40% (min. dry weight)
- maximum electrical conductivity of 4 mmhos/cm (dS/m)
- maximum of 1 percent foreign matter
- C:N ratio range of 11-25:1

If used, the Solvita test kit shall be procured by the Contractor, and the compost samples shall be tested on site by the Contractor, in the presence of the Engineer. Cost of testing shall be incidental to the pay item.

An extended list of commercial sources of compost material is available from the Division of Consumer Programs, Bureau of Waste Products, Massachusetts Department of Environmental Protection.

M1.07.0 Topsoil.

Topsoil and Plantable Soil Borrow shall consist of fertile, friable, natural topsoil, reasonably free of stumps, roots, stiff clay, stones larger than 25 millimeter diameter, noxious weeds, sticks, brush or other litter.

Prior to stripping the topsoil from the construction project, it shall have demonstrated by the occurrence upon it of healthy crops, grass or other vegetative growth, that it is reasonably well drained and capable of supporting plant growth. Material classified as Topsoil can only be obtained within the project limits.

SECTION M6
ROADSIDE DEVELOPMENT MATERIALS

M6.00.0 General.

This section shall contain materials used for soil conditioning, seeding, general planting, and care of plants.

M6.01.0 Inorganic Amendments.

Limestone shall consist of pulverized limestone obtained by grinding either calcareous or dolomitic limestone so that 95% of the material will pass a 850 micrometer sieve and at least 50% will pass a

150 micrometer sieve. The limestone shall have a neutralizing value satisfactory to the Engineer, and shall be only such as will have been marketed in accordance with those provisions of General Laws, as amended, which relate to commercial fertilizers.

Sulfur for adjustment of loam pH shall be commercial or flour sulfur, unadulterated, and shall be delivered in containers with the name of the manufacturer, material analysis, and net weight appearing on each container.

Gypsum for soil structure amendment and de-icing salt mitigation shall be agricultural grade, 80 percent calcium sulphate (CaSO4 ? 2H2O), in granular or slurry form, with 100 percent passing a 2 mm screen, and 90% passing through 150 mm screen. Gypsum may be derived from natural sources or from recycled wallboard.

M6.02.0 Fertilizer.

Fertilizer shall be furnished in containers plainly marked with the chemical analysis of the product.
Fertilizer for grass seeding shall have the following composition by mass.

	10-20-10
Nitrogen (N)	10% Minimum
Available Phosphoric Acid (P_2O_5)	20% Minimum
Water Soluble Potash (K2O)	10% Minimum

Fertilizer for general planting shall be commercial grade 10-10-10.

No fertilizer shall be used which has not been marketed in accordance with the provisions of General Laws, as amended, relating to fertilizers.

M6.02.1 Bone Meal.

Bone meal shall be fine-ground, steam-cooked, packing house bones with a minimum analysis of 23% phosphoric acid and 1.0% of nitrogen by mass.

5.0 EXPANDING COMPOST USAGE

Excellent opportunity exists to expand the usage of compost on roadside applications. It is likely that in years to come, greater volumes of compost will be used not only in landscape applications, but also in erosion/sediment control and other 'environmental' applications. Figure 5 illustrates the potential expansion for compost use by State DOTs, based on typical acreage that is 'planted' annually by State DOTs and typical compost application rates. The majority of compost is currently being used by State DOTs in construction related projects (not maintenance), and it is likely that this trend will continue. However, compost could certainly be used by State DOT maintenance departments for turf topdressing and mulching of planting beds. Another method for State DOTs to obtain greater success in vegetation/planting establishment and survival is for them to require minimum organic matter content standards in the soils used on their projects. Several State already have these standards in place, and several allow for a substandard soil (low in organic matter content) to be used if upgraded to the proper organic matter content through the addition of compost. In effect, this type of creative specification allows State DOTs to obtain superior quality soils, while their contractors can avoid the expense and difficulty of locating and securing a source of high quality topsoil.

Figure 5 Estimated and Potential Compost Use

State DOT	Compost Use Specification	Estimated Current Useage - cu. yds.a	Estimated Annual Potential Usage - acresb	1"-134 yds./acre Application Rate - total cubic yards	1.5"-201 yds./acre Application Rate - total cubic yards	2.0"-269 yds./acre Application Rate - total cubic yards
ALASKA	yes	250	200	26,800	40,200	53,800
ALABAMA	no	0	1,000	134,000	201,000	269,000
ARIZONAd	no	0	0	-	-	-
ARKANSAS	no	0	1,000	134,000	201,000	269,000
CALIFORNIA	yes	225,000	25,000	3,350,000	5,025,000	6,725,000
COLORADO	yes	n/a	200	26,800	40,200	53,800
CONNECTICUTf	yes	n/a	n/a	n/a	n/a	n/a
DELAWAREc	yes	n/a	$50,000/yr.- 3 years	n/a	n/a	n/a
FLORIDA	yes	n/a	2,000	268,000	402,000	538,000
GEORGIAe	yes	10,000	2,000	268,000	402,000	538,000
HAWAII	no	0	0	-	-	-
IDAHO	yes	10,000	150	20,100	30,150	40,350
ILLINOISg	yes	n/a	n/a	n/a	n/a	n/a
INDIANA	no	0	200	26,800	40,200	53,800
IOWA	yes	12,000	2,000	268,000	402,000	538,000
KANSASf	yes	n/a	n/a	n/a	n/a	n/a
KENTUCKY	no	0	300	40,200	60,300	80,700
LOUISIANA	no	0	2,500	335,000	502,500	672,500
MAINEb	yes	17,000	n/a	n/a	n/a	n/a
MARYLAND	yes	75	n/a	n/a	n/a	n/a
MASSACHUSETTS	yes	n/a	n/a	n/a	n/a	n/a
MICHIGAN	yes	n/a	n/a	n/a	n/a	n/a
MINNESOTA	yes	10,000	3,000	402,000	603,000	807,000
MISSISSIPPI	no	0	1,500	201,000	301,500	403,500
MISSOURI	no	0	4,000	536,000	804,000	1,076,000
MONTANA	yes	600	1,000	134,000	201,000	269,000
NEBRASKAd	no	0	150	20,100	30,150	40,350
NEVADA	no	0	n/a	n/a	n/a	n/a
NEW HAMPSHIRE	yes	3,500	10	1,340	2,010	2,690
NEW JERSEY	yes	50	100	13,400	20,100	26,900
NEW MEXICO	no	0	2,000	268,000	402,000	538,000
NEW YORK	yes	n/a	400	53,600	80,400	107,600
NORTH CAROLINA	yes	0	250	33,500	50,250	67,250
NORTH DAKOTA	no	0	300	40,200	60,300	80,700
OHIO	yes	75	n/a	n/a	n/a	n/a
OKLAHOMA	no	0	2,000	268,000	402,000	538,000
OREGON	yes	3,600	60	8,040	12,060	16,140
PENNSYLVANIA	yes	n/a	1,000	134,000	201,000	269,000
RHODE ISLAND	no	0	1,000	134,000	201,000	269,000
SOUTH CAROLINA	yes	100	n/a	n/a	n/a	n/a
SOUTH DAKOTA	no	0	250	33,500	50,250	67,250
TEXAS	yes	100,000	80,000	10,720,000	16,080,000	21,520,000
UTAH	yes	8,000	400	53,600	80,400	107,600
VERMONT	no	n/a	n/a	n/a	n/a	n/a
VIRGINIAf	yes	n/a	30	4,020	6,030	8,070
WASHINGTON	yes	80,000	400	53,600	80,400	107,600
WEST VIRGINIA	no	0	10	1,340	2,010	2,690
WISCONSIN	yes	100	750	100,500	150,750	201,750
WYOMING	yes	n/a	4,000	536,000	804,000	1,076,000
TOTAL		**480,350 yd3**	**139,160 Acres**	**18,647,440**	**27,971,160**	**37,294,880**

The USCC expects that the proper use of the Model Compost Specification (Section 4) will not only assist in the expanded utilization of compost by State DOTs, but also help to assure successful use of compost 'in the field'. The USCC believes that the further use of the Seal of Testing Assurance Program within State DOT product approval and evaluation processes will also assist them in becoming more comfortable with specifying compost (information on the STA Program is attached). Some State DOTs have already suggested that any compost products they specify will be required to be enrolled in an ongoing product testing program, such as the Seal of Testing Assurance Program, while others have stated that they will allow USCC certified composts which possess adequate testing records to forgo certain product testing requirements they employ.

The concept of creating more sustainable roadside environments fits in well with the use of compost. Further, the role of 'healthy' soils, those rich in stable organic matter and microbial life, in the survival of vegetation and erosion/sediment control can be correlated to the long-term integrity of roads and lower life cycle construction/management costs.

For additional information, contact the USCC at 717-238-9759 or at www.compostingcouncil.org.