Appendix C. Soil Compost Amendment

C.1 Description

Soil restoration is a practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce runoff from compacted urban landscapes and also may be used to enhance the runoff reduction performance of areas that receive runoff, such as downspout disconnections, grass channels, and filter strips (Table C.3-1).

Figure C.1-1. Soil with compost amendment (Photo: Center for Watershed Protection)

C.2 Physical Feasibility and Design Applications

Compost amended soils are suitable for any pervious area where soils have been or are proposed to be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be connected hydraulically to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading: the removal and stockpiling of existing topsoil (the A horizon) and replacing over top of the newly graded landscape.

Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The bedrock or at any time of the year the water table is located within 2 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- Application would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

Compost amendments can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction practices. Some common design applications include:

- ✧ Reduce runoff from compacted landscapes (while also enhancing the long term viability of the turf and other plant materials included in the amended area).
- ✧ Increase runoff reduction credit of impervious cover disconnections on poor soils.
- ✧ Increase runoff reduction credit within a grass channel.
- ✧ Increase runoff reduction credit within a vegetated filter strip.
- ✧ Reduced runoff from a tree cluster or reforested area of the site.

Considerations in the Coastal Plain. Designers should evaluate drainage and water table elevations to ensure the entire depth of soil amendment will not become saturated (i.e., a minimum separation depth of 2 feet from groundwater) at its highest point during the year. Compost amendments are most cost effective when used to boost the runoff reduction capability of grass vegetated filter strips, grass channels, and rooftop disconnections.

C.3 Design Criteria

Performance When Used in Conjunction with Other Practices. Soil compost amendments can be used to enhance the runoff reduction capabilities of allied practices. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- ✧ Impervious Surface Disconnection – see Section 4.7.
- ✧ Grass Channels – see Section 4.8.

Soil Testing. Soil chemical and physical tests are required to be conducted by a reputable laboratory during two stages of the compost amendment process. The first testing is done to ascertain preconstruction soil properties at proposed amendment areas. This initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, saturated hydraulic conductivity, organic matter content, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet, and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least one week after the compost has been incorporated into the soils. This soil analysis should be conducted to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. It should be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

Determining Depth of Compost Incorporation. The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. Table C.3-1 presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the incorporation depth for compost. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998), and others.

Table C.3-1. Short-Cut Method to Determine Compost and Incorporation Depths				
	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:
[1] IC = contributing impervious cover (ft^2) and SA = surface area of compost amendment (ft^2)
[2] For amendment of compacted lawns that do not receive off-site runoff
[3] In general, IC/SA ratios greater than 1 should be avoided, unless applied to simple rooftop disconnection
[4] Average depth of compost added
[5] Lower end for B soils, higher end for C/D soils

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by The Composting Council (TCC, 1997):

$$C = A \times D \times 0.0031$$

where:

C = compost needed (yd^3)

A = area of soil amended (ft^2)

D = depth of compost added (in)

Compost Specifications

- ✧ Compost shall be derived from plant material and meet the general criteria set forth by the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.
- ✧ The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost should have a moisture content that results in no visible free water or dust produced when handling the material. It should meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
  - 100% of the material should pass through a half inch screen.
  - The pH of the material should be between 5.5 and 8.5.
  - Manufactured inert material (plastic, concrete, ceramics, metal, etc.) should be less than 1.0% by weight.
  - The organic matter content should be >35%.

- Soluble salt content should be less than 6.0 mmhos/cm.
- Should be mature and stable per the appropriate test(s) as specified by STA.
- Carbon/nitrogen ratio should be less than 25:1.
- Must meet the Standards for the Use or Disposal of Sewage Sludge (2014) levels for heavy metals.
- The compost should have an optimum dry bulk density ranging from 40 to 50 lbs/ ft^3. However, certain fully mature coarse textured composts may be lower.

In general, fresh manure should not be used for compost because of high bacteria and nutrient levels. If manure is used, it should be aged (composed) and meet the criteria listed above.

C.4 Construction

Construction Sequence. The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas (where IC/SA < 0.5, Table C.3-1), a typical construction sequence is as follows:

Step 1. After the area has been cleared of construction activity, the area should be deep tilled to a depth of 2 to 3 feet using a tractor and sub-soiler with two deep shanks (curved metal bars) to create rips perpendicular to the direction of flow. This establishes a vertical pathway for the compost to influence microbial activity into the adjacent soil. (This step may be omitted when compost is used for narrower filter strips.)

Step 2. Spread the specified compost depth in accordance with Table C.3-1 across the surface and incorporate into the soil using a rototiller, tiller, or subsoiler as specified. It is important to have dry conditions at the site prior to incorporating compost.

Step 3. The site should be leveled and seed or sod used to establish a vigorous grass cover. Other amendments such as lime or gypsum and/or irrigation may initially be needed to help the grass grow quickly.

Step 4. Areas of compost amendments exceeding 2,500 square feet should employ simple erosion control measures, such as silt fence, to reduce the potential for erosion and trap sediment. See the South Carolina DHEC's Storm Water Management BMP Handbook (https://www.scdhec.gov/environment/water/swater/docs/BMP-handbook.pdf) for examples of erosion and sediment control.

Construction Inspection. Construction inspection involves digging a test pit to verify the depth of amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at one location per 10,000 square feet.

C.5 Maintenance During Establishment

First Year Maintenance Operations. In order to ensure the success of soil compost amendments, the following tasks are necessary in the first year following soil restoration:

- ***Initial Inspections.*** For the first six months following the incorporation of soil amendments, the site should be inspected for erosion at least once after each storm event

that exceeds ½-inch of rainfall.

- ***Spot Reseeding.*** Inspections should note bare or eroding areas in the contributing drainage area or around the soil restoration area and ensure that they are immediately stabilized with grass cover.
- ***Fertilization.*** Depending on the findings of a soils test of the amended area, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor. Fertilization rates and fertilizer source should follow soil test recommendations for the appropriate plant cover.
- ***Watering.*** Water once every three days for the first month (or more often, if signs of drought stress appear), and then weekly during the first year (March-November), accounting for effective rainfall.

C.6 Ongoing Maintenance

There are no major on-going maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. Example maintenance inspection checklists for various BMPs can be found in *Appendix F*.

C.7 Soil Compost Amendment References and Additional Resources

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3. City of Portland. 2008. "Soil Specification for Vegetated Stormwater Facilities." *Portland Stormwater Management Manual*. Portland, Oregon.
4. Composting Council (TCC). 1997. *Development of a Landscape Architect Specification for Compost Utilization*. Alexandria, VA. http://www.cwc.org/organics/org972rpt.pdf
5. Holman-Dodds, L. 2004. *Chapter 6. Assessing Infiltration-Based Stormwater Practices*. PhD Dissertation. Department of Hydroscience and Engineering. University of Iowa. Iowa City, IA.
6. Lenhart, J. 2007. "Compost as a Soil Amendment for Water Quality Treatment Facilities." *Proceedings: 2007 LID Conference*. Wilmington, NC.
7. Low Impact Development Center. *Guideline for Soil Amendments*. Available online at: http://www.lowimpactdevelopment.org/epa03/soilamend.htm
8. Roa-Espinosa. 2006. *An Introduction to Soil Compaction and the Subsoiling Practice. Technical Note.* Dane County Land Conservation Department. Madison, Wisconsin.
9. Soils for Salmon. 2003. *Soil Restoration and Compost Amendments*. Available online at: http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf
10. Standards for the Use or Disposal of Sewage Sludge. Title 40 *Code of Federal Regulations*, **§503.13**. 2014. Available online at: http://www.ecfr.gov/cgi-bin/text-idx?SID=b65d61df344d5dcbf0b5976ed7d5def1&node=40:31.0.1.2.42.2.13.4&rgn=div8