

The following is an excerpt from the 2014 Edition of the City of Seattle's Standard Specifications for Road, Bridge and Municipal Construction. This document in its entirety can be found here: http://www.seattle.gov/util/Engineering/Standard_Plans_&_Specs/index.htm

SECTION 7-21 BIORETENTION

7-21.1 DESCRIPTION

Section 7-21 describes work consisting of the installation of bioretention soil in bioretention cells intended to receive surface water runoff for infiltration.

7-21.2 MATERIALS

Materials shall meet the requirements of the following sections:

Bioretention Soil	9-14.1(3)
Mineral Aggregate	9-03
Geotextile	9-37
Arborist Wood Chip Mulch	9-14.4(5)
Compost	9-14.4(8)

Unless otherwise specified, geotextile shall be Construction Geotextile for Separation, Nonwoven.

Unless otherwise specified or shown on the Drawings, aggregates for the discharge subbase gravel shall meet the requirements of Mineral Aggregate Type 26.

7-21.3 CONSTRUCTION REQUIREMENTS

7-21.3(1) GENERAL

1. **Exclude Runoff From Cells Until Completion.** Runoff shall not be allowed to enter the bioretention cell in accordance with Sections 1-07.15 and 8-01, until authorization is given by the Engineer.
2. **Protect Mix From Water.** Bioretention Soil shall be protected from rainfall, surface runoff and other sources of added moisture at the Supplier's site, in covered conveyance, and at the Project Site until incorporated into the Work.
3. **Exclude Heavy Equipment from Cells and Berms.** No heavy equipment shall operate within the cell or earth berm perimeter once bioretention cell excavation has begun, including during excavation, backfilling, tree pit preparation, mulching, or planting.
4. **Exclude Foreign Materials.** No Materials or substances other than the Bioretention Soil shall be mixed or dumped within the cell or earth berm area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.
5. **Water Meter Adjustments.** Relocation and/or adjustments of water meters shall be coordinated per Section 7-15 Water Service Connection Transfers.
6. **Approved Testing Labs.** When the Contract specifies testing by a Contractor provided testing laboratory, the laboratory shall be a Seal of Testing Assurance (STA), AASHTO, ASTM or other standards organization, as designated in the Contract, accredited laboratory with current and maintained certification. The testing laboratory shall be capable of performing all tests to the standards specified, and shall provide test results with an accompanying Manufacturer's Certificate of Compliance.

7-21.3(1)A SUBMITTALS FOR BIORETENTION SOIL MIX DESIGN

At least 10 Working Days prior to placement of Bioretention Soil, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3:

1. **Aggregate Analysis.** Grain size analysis results of the Mineral Aggregate for Bioretention Soil (Section 9-03.2(2)) performed by an independent laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils;
2. **Compost Analysis.** Quality analysis results for the compost for Bioretention Soil performed in accordance with STA standards, as specified in Section 9-14.4(8);
3. **Mix Analysis.** Organic content test results of the Bioretention Soil mix. Organic content test shall be performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method";
4. **Mix Samples.** Two five (5) gallon samples of the Bioretention Soil mix, along with the following information:
 - a. The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 from the Supplier of the Bioretention Soil mix, and (if different) the Suppliers of the mineral aggregate and compost components, including their name(s) and address(es);
 - b. A description of the equipment and methods to mix the mineral aggregate and compost to produce Bioretention Soil;
5. **Laboratory Information.** Include the following information about the testing laboratories:
 - a. name of laboratory(ies) including contact person(s),
 - b. address(es),

- c. phone contact(s),
- d. e-mail address(es);
- e. qualifications of laboratory and personnel including date of current certification by STA, ASTM, AASHTO, or approved equal.

7-21.3(2) BIORETENTION CELLS AND EARTH BERMS CONSTRUCTION

Location and dimensions. Bioretention cells and earth berms shall be constructed as shown on the Drawings.

7-21.3(2)A GRADING AND PLACEMENT FOR BIORETENTION CELLS

7-21.3(2)A1 GENERAL

1. **Authorization to Proceed.** The Contractor shall not start bioretention cell grading or placement until all areas of the Project Site draining to the bioretention area have been stabilized and authorization is given by Engineer.
2. **Protection of Existing Trees.** Grading within Zone B of trees to be retained shall be in accordance with the Tree, Vegetation, and Soil Protection Plan (TVSPP) per Sections 1-07.16(2) and 8-01. The Contractor shall notify the Engineer of conflicts with tree protection standards and/or other site conditions prior to proceeding with the Work.
3. **Locate New Trees.** Locations and grading requirements to support new trees as a component of the bioretention system shall be field marked by the Engineer when identified as "field locate by the Engineer" on the Drawings. A minimum advance notice is required for Engineer to locate plantings per Section 8-02.3(5).

7-21.3(2)A2 EXCAVATION

1. **Depth.** At the locations shown on the Drawings, bioretention cells shall be excavated to the depth necessary to accommodate the placement of Bioretention Soil and, if applicable, Mineral Aggregate Type 26 for discharge subbase gravel as shown on the Drawings.
2. **Conditions.** Excavation within 6-inches of final native soil grade shall not be permitted if the Project Site soil is frozen, has standing water, or has been subjected to more than ½ inch of precipitation within 48 hours.
3. **Geotextile.** Where shown on the Drawings, the Contractor shall place Construction Geotextile for Separation in accordance with Section 2-15.
4. **Inspection Prior to Soil Placement.** The Contractor shall provide the Engineer the opportunity to inspect the excavation at least 1 Working day prior to placement of any Materials or subgrade soil scarification.
5. **Protection from Sediment.** After excavation to subgrade, if any sediment laden runoff has entered the cell prior to placement of Bioretention Soil, the sediment deposition shall be removed by overexcavating the cell by a 3-inch minimum and an additional 3-inches of Bioretention Soil shall be placed at the Contractor's expense.

7-21.3(2)A3 SUBGRADE

1. **Scarification.** The Contractor shall scarify the surface of the subgrade to a minimum depth of 3 inches prior to placement of Bioretention Soil or Mineral Aggregate for discharge subbase gravel, if applicable.
2. **Discharge Drainage Course.** Where shown on the Drawings, the Contractor shall place Mineral Aggregate for discharge subbase gravel in loose lifts and hand rake Mineral Aggregate to final grade.
3. **Protection from Sediment.** If applicable, after placement of Mineral Aggregate for discharge subbase gravel, if any sediment laden runoff has entered the cell prior to placement of Bioretention Soil, the sediment deposition shall be removed by excavating Mineral Aggregate in the cell by a 3-inch minimum and replacing it with clean Mineral Aggregate at the Contractor's expense.

7-21.3(2)A4 PLACEMENT OF BIORETENTION SOIL

1. **Acceptance of Mix Prior to Placement.** The Contractor shall not place Bioretention Soil until the Engineer has reviewed and confirmed the following:
 - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of Bioretention Soil matches the product type, volume and manufacturer named in the submittals.
 - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted 5-gallon sample, to verify that it matches the submitted sample. The Engineer may inspect any loads of Bioretention Soil on delivery and stop placement if the soil does not appear to match the submittals; and require sampling and testing of the delivered soil to determine that organic matter content is within the 4-8% target, and approximately equal to that of the approved submittal, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.
2. **Mix Moisture.** Bioretention Soil placement and consolidation shall not occur when the Bioretention Soil is excessively wet, as determined by the Engineer. There should be no visible free water in the material.
3. **Conditions.** Placing Bioretention Soil shall not be allowed if the area receiving Bioretention Soil is frozen, excessively wet or saturated, or has been subjected to more than ½-inch of precipitation within 48-hours prior to placement. The Engineer will have final authority to determine if wet or saturated conditions exist.
4. **Placement.** The Contractor shall place Bioretention Soil loosely with a conveyor belt, unless otherwise approved by the Engineer, upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer.
5. **Rake soil to final grade.**
6. **Consolidation.** Final soil depth shall be measured and verified only after the soil has been water consolidated, which requires filling the cell with water in a controlled manner, without creating any scour or erosion, to at least 1 inch of

ponding. Allowing uncontrolled runoff from adjacent impervious areas to enter cell is not an acceptable method for consolidation. Repeat until final depth is achieved.

7. **Placement and Consolidation In Grass Areas.** Place Bioretention Soil specified for grass areas in loose lifts. Compact Bioretention Soil to a relative compaction of 85- 90 percent of modified maximum dry density (ASTM D 1557), where slopes allow, as determined by the Engineer. Where Bioretention Soil is placed in the 2-foot road shoulder, compact to a minimum relative compaction of 90 percent of modified maximum dry density (ASTM D 1557). Final soil depth shall be measured and verified only after the soil has been compacted.
8. **Inspection Prior to Planting.** After placement of Bioretention Soil, and before planting or mulching, the Contractor shall notify the Engineer at least 1 Working day in advance. The Engineer will perform compaction testing.

Compaction Requirements

Bioretention Area	Relative Compaction
Bottom and side slopes planted	Water consolidation
Bottom and side slopes grassed	85-90 percent of modified dry density (ASTM D 1557), using roller or sprinkler.
2-foot road shoulder	90 percent of modified dry density (ASTM D 1557), using roller or late compaction.
7-foot radius around power poles	No requirement, existing soil untouched
Around water meters and over other utilities	Same as listed for areas above

7-21.3(2)A5 FINAL MULCHING AND PLANTING

1. **The cell shall be planted and mulched as shown on the Drawings.**
2. **Inspection.** At least 1 Working Day prior to placement of compost or arborist wood chip mulch in each cell, as specified in the Drawing, the Contractor shall notify the Engineer to inspect the bioretention cell. If any sediment laden runoff has entered the cell, the Contractor shall remove the top 3 inches of Bioretention Soil and replace with Bioretention Soil per design, at the Contractor's expense.
3. **Finished Grade.** The finished elevation shall be one (1) inch below walks, curbs, pavements and driveways, unless adjacent to a bermed area. Upon completion of finish grading Work, all excess Material shall be removed from the Project Site and disposed of accordingly.

7-21.3(2)B GRADING FOR EARTH BERM

1. **Location.** At the locations shown on the Drawings, the Contractor shall construct earth berms in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer.
2. **Soil Placement.** Place Bioretention Soil specified for berm areas in loose lifts.
3. **Compaction.** Compact Bioretention Soil to a maximum relative compaction of 85 percent of modified maximum dry density (ASTM D 1557).
4. **Inspection Prior to Mulching.** Prior to the placement of arborist wood chip mulch, the Contractor shall notify the Engineer at least 1 Working Day in advance for approval of finished grading.

7-21.4 MEASUREMENT

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs here in this Section.

Measurement for "Bioretention Soil" will be by the ton or cubic yard

Measurement for "Mineral Aggregate (type)" for discharge subbase gravel will be by the ton or cubic yard.

Measurement for grading will not be made.

7-21.5 PAYMENT

Compensation for the cost necessary to complete the Work described in Section 7-21 will be made at the Bid item prices Bid only for the Bid items listed or referenced as follows:

1. **"Bioretention Soil "**, per ton or cubic yard.

The Bid item price for "Bioretention Soil " shall include all costs for the work necessary to furnish, place, compact, grade, shape, and mix Bioretention Soil.

2. **"Common Excavation"** per ton or cubic yard per Section 2-04.

3. “**Mineral Aggregate (type)**” per ton or cubic yard per Section 4-01.
4. “**Construction Geotextile for Separation**”, per square yard per Section 2-15.

No separate payment will be made for finish grading work required to hand grade Bioretention Cells and Earth Berms to final shape as specified.

9-03.2 AGGREGATE FOR BIORETENTION SOIL

9-03.2(1) GENERAL

In general, soil aggregate shall be free of wood, waste, coating, or any other deleterious material, and all aggregate passing the No. 200 sieve size shall be non-plastic.

9-03.2(2) MINERAL AGGREGATE FOR BIORETENTION SOIL

Sieve Analysis. Mineral Aggregate for Bioretention Soils shall be analyzed by an accredited lab using the sieve sizes noted below, and shall meet the following gradation:

Sieve Size	Percent Passing
3/8" Square	100
U.S. No. 4	60 - 100
U.S. No.10	40 - 100
U.S. No. 40	15 - 50
U.S. No. 200	2 - 5

9-14.1 SOILS

The following soils and soil mixes are specified on Drawings or by the Engineer, according to project needs, and are all subject to the General Testing and Submittal Requirements of 9-14.1(A):

1. **Topsoil Type A - Imported.** A general purpose mix of Sandy Loam and compost as needed to meet minimum organic matter content requirements. Similar to Washington State Department of Transportation’s Topsoil Type A specification.
2. **Reused Amended Site Soil.** Soil from the Project Site that is either amended in place or moved/stockpiled during grading operations and then amended with compost as needed to meet minimum organic matter content requirements.
3. **Bioretention Soil.** An imported mix made of Mineral Aggregate and compost specified to meet the infiltration and filtration requirements of stormwater management structures. For Project Sites located within the City limits of Seattle; Bioretention Soil shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
4. **Planting Soil.** An imported soil mix for planting beds, planted medians and planting strips.
5. **General Turf Area Soil.** An imported soil mix for passive-recreation turf areas.
6. **High Performance Turf Mixes.** An imported soil mix for intensive-use turf areas, including three different mixes of sand and compost to optimize drainage and fertility in different sites and uses.

9-14.1A GENERAL TESTING AND SUBMITTAL REQUIREMENTS

At least 10 Working Days prior to placement of any soils specified in Section 9-14, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3. All test results shall be from samples sampled and tested less than 90 days prior to date of submittal.

1. **Aggregate and Loam Analysis.** Grain size analysis results of the Mineral Aggregate or Sandy Loam portion of each soil mix, performed by an accredited laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
2. **Compost Analysis.** Quality analysis results for the compost portion of each soil mix performed in accordance with STA standards, as specified in Section 9-14.4(8).

3. **Mix Analysis.** Test results from an accredited soil laboratory, including the following parameters:
 - a. Total Nitrogen and Soluble Nitrogen (NO₃ + NH₃)
 - b. Phosphorous
 - c. Potassium
 - d. pH
 - e. Organic Matter % (Loss on Ignition method)
 - f. Conductivity
 - g. Calcium
 - h. Sulfur
 - i. Boron
 - j. Weed seed (for General Turf Area Soil and High Performance Turf Mixes)
4. **Recommendations.** Fertilizer and amendment recommendations for the specified plant type (turf, shrubs/groundcovers, or annuals: with special provisions for Bioretention applications) and soil application depth; from the accredited laboratory, an accredited Soil Scientist or Agronomist.
5. **Mix Samples.** Two one (1) gallon samples of each soil mix (two five (5) gallon samples for Bioretention and High Quality Turf Mixes).
6. **Manufacturer.** The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 from the Supplier of the soil mix, and (if different) the Suppliers of the compost, including their name(s) and address(es).
7. **Laboratory Information.** Include the following information about the testing laboratories:
 - i. name of laboratory(ies) including contact person(s),
 - ii. address(es),
 - iii. phone contact(s),
 - iv. e-mail address(es),
 - v. qualifications of laboratory and personnel including date of current certification by STA, ASTM, AASHTO, or approved equal.
8. **Acceptance of Soils Prior to Placement.** The Contractor shall not place any soils or soil mixes specified in Section 9-14 until the Engineer has reviewed and confirmed the following:
 - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of soil matches the product type, volume and Manufacturer named in the submittals.
 - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted sample, to verify that it matches the submitted sample.

The Engineer may inspect any loads of soil on delivery and stop placement if it is determined that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.

9-14.1(3) BIORETENTION SOIL

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure bioretention soil Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Mix Components.** Bioretention Soil shall be a well-blended mixture of Mineral Aggregate and compost measured on a volume basis. Bioretention Soil shall consist of approximately two parts fine compost (approximately 35 to 40 percent) by volume meeting the requirements of Section 9-14.4(8) and three parts Mineral Aggregate (approximately 60 to 65 percent), by volume meeting the requirements of Section 9-03.2(2). The mixture shall be well blended to produce a homogeneous mix, and have an organic matter content of 4% to 8% determined using the Loss on Ignition Method.

9-14.4(4) ARBORIST WOOD CHIP MULCH

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure arborist wood chip mulch Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Quality.** Arborist Wood Chip Mulch (AWCM) shall be coarse ground wood chips (approximately 1/2" to 6" along the longest dimension) derived from the mechanical grinding or shredding of the above-ground portions of trees. It may contain wood, wood fiber, bark, branches, and leaves; but may not contain visible amounts of soil. It shall be free of weeds and weed seeds including but not limited to plants on the King County Noxious Weed list available at: www.kingcounty.gov/weeds, and shall be free of invasive plant portions capable of resprouting, including but not limited to horsetail, ivy, clematis, knotweed, etc. It may not contain more than 1/2% by weight of manufactured inert material (plastic, concrete, ceramics, metal, etc.).

3. **Gradation.** Arborist Wood Chip Mulch, when tested, shall meet the following loose volume gradation:

Percent Sieve Size	Passing	
	Minimum	Maximum
2" 95		100
1" 70		100
5/8 0		50
1/4" 0		40

No particles may be longer than eight inches.

4. **Submittals.** At the Engineer's request, prior to delivery the Contractor shall provide the following:
- The source of the product and species of trees included in it;
 - A sieve analysis verifying the product meets the above size gradation requirement;
 - A 5 gallon sample of the product, for the Engineer's approval.

9-14.4(8) COMPOST

- Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure compost Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
- Quality.** Compost production and quality shall comply with Chapter 173-350 WAC, and meet the criteria below:
- Regulatory Standards.** Compost products shall be the result of the biological degradation and transformation of feedstocks as specified below, under controlled conditions designed to promote aerobic decomposition, per WAC 173-350-220, which is available at <http://apps.leg.wa.gov/wac/default.aspx?cite=173-350-220>
- Submittals.** The Contractor shall submit the following information to the Engineer for approval:
 - A copy of the Solid Waste Handling Permit issued to the supplier by the Jurisdictional Health Department as per WAC 173-350 (Minimum Functional Standards for Solid Waste Handling).
 - The Supplier shall verify in writing, and provide lab analyses that the Materials comply with the processes, testing, and standards specified in WAC 173-350 and these Specifications. An independent STA Program certified laboratory shall perform the analysis.
 - A list of the feedstock by percentage present in the final compost product.
 - A copy of the producer's current STA certification as issued by the U.S. Composting Council.
 - Acceptance shall be based upon a satisfactory Test Report from an independent STA program certified laboratory and the sample(s) submitted to the Engineer.
- Testing Requirements.** The compost Supplier shall test all compost products within 90 Calendar Days prior to application, at the Suppliers expense. Samples shall be collected using the Seal of Testing Assurance (STA) sample collection protocol, available from the U.S. Composting Council, Phone: 631-737-4931, www.compostingcouncil.org. The sample shall be tested by an independent STA Program certified laboratory. A copy of the approved independent STA Program laboratory test report shall be submitted to the Engineer prior to initial application of the compost.
- Gradation.** Compost shall meet the following size gradations when tested in accordance with the U.S. Composting Council "Testing Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B, "Sample Sieving for Aggregate Size Classification":

- a. **Fine Compost.** Fine Compost, typically used for soil amendment, shall meet the following gradation by dry weight:

Min.		Max.
Percent passing 2"	100%	
Percent passing 1"	99%	100%
Percent passing 5/8"	90%	100%
Percent passing 1/4"	75%	100%

- b. **Coarse Compost.** Coarse Compost, typically used for erosion control or surface mulching, shall meet the following gradation by dry weight:

Min.		Max.
Percent passing 3"	100%	
Percent passing 1"	90%	100%
Percent passing 3/4"	70%	100%
Percent passing 1/4"	40%	60%

- pH.** The pH shall be between 6.0 and 8.5 when tested in accordance with TMECC 04.11-A; "1:5 Slurry pH".
- Physical Contaminants.** Manufactured inert material (concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight as determined by TMECC 03.08-A "percent dry weight basis". Film plastics shall be 0.1% or less, by dry weight.

9. **Organic Content.** Minimum organic matter content shall be 40 percent by dry weight basis as determined by TMECC 05.07A; "Loss-On-Ignition Organic Matter Method".
10. **Salinity.** Soluble salt contents shall be less than 5.0 mmhos/cm tested in accordance with TMECC 04.10-A; "1:5 Slurry Method, Mass Basis".
11. **Maturity.** Maturity shall be greater than 80% in accordance with TMECC 05.05-A; "Germination and Vigor". The Engineer may also evaluate compost for maturity using the Solvita Compost Maturity Test at time of delivery. Fine Compost shall score a number 6 or above on the Solvita Compost Maturity Test. Coarse Compost shall score a 5 or above on the Solvita Compost Maturity Test.
12. **Stability.** Stability shall be 7 or below in accordance with TMECC 05.08-B; "Carbon Dioxide Evolution Rate".
13. **Feedstocks.** The compost product shall contain a minimum of 65 percent by volume from recycled plant waste as defined in WAC 173-350-100 as "Yard waste", "Crop residues", and "bulking agents". A maximum of 35 percent by volume of "post-consumer food waste" as defined in WAC 173-350-100 may be substituted for recycled plant waste. A minimum of 10% food waste in compost is required. The Engineer may approve compost products containing up to 35% biosolids or manure feedstocks for specific projects or soil blends, but these feedstocks are not allowed unless specified, and not allowed in compost used for Bioretention Soils.
14. **C:N.** Fine Compost shall have a carbon to nitrogen ratio of less than 25:1 as determined using TMECC 04.01 "Total Carbon" and TMECC 04.02D; "Total Kjeldhal Nitrogen". The Engineer may specify a C:N ratio up to 35:1 for projects where the plants selected are entirely Puget Sound native species. Compost may be mixed with fir or hemlock bark meeting requirements of 9-14.4(3) to raise the C:N ratio above 25:1. Coarse Compost shall have a carbon to nitrogen ratio between 20:1 and 45:1.