

## F.2 Biofiltration Soil Media Composition, Testing, and Installation

### **803-1 GENERAL.**

Biofiltration Soil Media (BSM) is intended to filter storm water and support plant growth while minimizing the leaching of potential pollutants. This specification includes requirements that apply to BSM used in stormwater treatment BMPs, including bioretention and biofiltration. Biofiltration Soil Media is also referred to as Engineered Soil Media and Bioretention Soil Media.

### **803-2 BLENDED BSM CRITERIA AND TESTING REQUIREMENTS**

**803-2.1 General.** Blended BSM shall consist of 60% to 80% by volume sand, up to 20% by volume topsoil, and up to 20% by volume compost. Sand, Topsoil, and Compost used in BSM shall conform to requirements listed in Sections 803-3, 803-4, and 803-5, respectively. For bioretention/biofiltration with outlet-controlled designs, it is likely that topsoil will need to be omitted or reduced to achieve permeability targets.

Alternative mix components and proportions may be utilized, provided that the whole blended mix conforms to whole BSM criteria, detailed in Section 803-2.3 through 803-2.5. Alternative mix designs may include alternative proportions and/or alternative organic amendments. Alternative mixes are subject to approval by the County. Alternative mixes that use an alternative organic component (rather than compost) may be necessary when BMPs are installed in areas with nitrogen or phosphorus impaired receiving waters in order to meet more stringent BSM quality requirements as detailed in Section 803-2.5.

**803-2.2 Testing and Submittals.** At least 30 days prior to ordering materials, the Contractor shall submit the following to the County reviewer (upon request): source/supplier of BSM, location of source/supplier, a physical sample of the BSM, whole BSM test results from a third-party independent laboratory, test results for individual component materials as required, and description of proposed methods and schedule for mixing, delivery, and placement of BSM. The test results shall be no older than 120 days and shall accurately represent the materials and feed stocks that are currently available from the supplier.

Test results shall demonstrate conformance to agronomic suitability and hydraulic suitability criteria

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listed in Sections 803-2.3 and 803-2.4, respectively. BSM for use in BMPs in areas with water quality impairments in receiving waters shall also comply with applicable Chemical Suitability criteria in Section 803-2.5. No delivery, placement, or planting of BSM shall begin until test results confirm the suitability of the BSM. The Contractor shall submit a written request for approval which shall be accompanied by written analysis results from a written report of a testing agency. The testing agency must be registered by the State for agronomic soil evaluation laboratory test fees shall be paid for by the Contractor.

**803-2.3 Agronomic Suitability.** The BSM shall conform to the requirements herein to support plant growth. BSM which requires amending to comply with the below specifications shall be uniformly blended and tested in its blended state prior to testing and delivery.

- a) pH range shall be between 6.0-8.5.
- b) Salinity shall be between 0.5 and 3.0 millimho/cm (as measure by electrical conductivity)
- c) Sodium absorption ratio (SAR) shall be less than 5.0
- d) Chloride shall be less than 800 ppm.
- e) Cation exchange capacity shall be greater than 10 meq/100 g.
- f) Organic matter shall be between 2 and 5%.
- g) Carbon:Nitrogen ratio shall be between 12 and 40 (15 to 40 preferred).

Textural class fraction shall adhere to limits in Table 803-2.1, as determined by ASTM Method D422 or an approved alternative method:

**TABLE 803-2.3**

| Textural Class (ASTM D422) | Size Range            | Mass Fraction (percent)       |
|----------------------------|-----------------------|-------------------------------|
| Gravel                     | Larger than 2 mm      | 0 to 25 of total sample       |
| Clay                       | Smaller than 0.005 mm | 0 to 5 of non-gravel fraction |

Test results shall show the following information:

- a) Date of testing
- b) Project name, contractor name, and source of materials and supplier name

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- c) Copies of all testing reports including, at a minimum, analytical results sufficient to confirm compliance with all requirements listed in this section.

**803-2.4 Hydraulic Suitability.** BSM shall meet the have appropriate hydraulic properties for filtering stormwater. The BSM shall conform to the requirements herein to support plant growth. BSM which requires amending, shall be uniformly blended and tested in its blended state prior to testing and delivery.

**803-2.4.1 Testing.** The saturated hydraulic conductivity of the whole BSM shall be measured according to the method detailed in the measurement of hydraulic conductivity (USDA Handbook 60, method 34b), commonly available as part of standard agronomic soil evaluation, or ASTM D24234 Permeability of Granular Soils (at approximately 85% relative compaction Standard Proctor, ASTM D698). BSM shall conform to hydraulic criteria associated with the BMP design configuration that best applies to the facility where the BSM will be installed (Section 803-2.4.2 or 803-2.4.3).

**803-2.4.2 Systems with Unrestricted Underdrain System (i.e., media control).** For systems with underdrains that are not restricted, the BSM shall meet the minimum and maximum measured hydraulic conductivity found in Table 803-2.4 to ensure adequate flow rate through the BMP and longevity of the system but reduce excessive velocities through the media. In all cases, an upturned elbow system on the underdrain, measuring 9 to 12 inches above the invert of the underdrain, should be used to control velocities in the underdrain pipe and reduce potential for solid migration through the system.

**803-2.4.3 Systems with Restricted Underdrain System (i.e., outlet control).** For systems in which the flow rate of water through the media is controlled via an outlet control device (e.g., orifice or valve) affixed to the outlet of the underdrain system, the hydraulic conductivity of the media should meet the requirements in Table 803-2.4 and the outlet control device should control the flow rate to between 5 and 12 inches per hour. This configuration reduces the sensitivity of system performance to the hydraulic conductivity, compaction, and clogging of the material, reduces the likelihood of preferential flow through media, and allows more precise design and control of system flow rates. For these reasons, outlet control should be considered the preferred design option over unrestricted underdrain systems.

**803-2.4.4 Systems without Underdrains.** For systems without underdrains, the BSM shall have a hydraulic conductivity of at least 5 inches per hour, or at least 2 times higher than the design infiltration rate of the underlying soil, whichever is greater.

Table 803-2.4.

| Underdrain System                                       | Hydraulic Conductivity Requirements |                 |
|---|-------------------------------------|-----------------|
|   | Minimum (in/hr)                     | Maximum (in/hr) |
| Unrestricted (media control)                            | 8                                   | 24              |
| Restricted (outlet control)<br>Preferred Design Option. | 20                                  | 80              |

**803-2.5 Chemical Suitability for Areas Draining to Impaired Receiving Waters.**

**803-2.5.1 General.** The chemical suitability criteria listed in this section do not apply to systems without underdrains, unless groundwater is impaired or susceptible to nutrient contamination. Limits for a given parameter only apply if that parameter is associated with a water quality impairment, priority water quality condition, and/or TMDL in the receiving water. Limits may be waived at the discretion of the County if it is determined that it is unreasonable to meet the specification using locally-available materials (available within 100 miles).

**803-2.5.2 Testing.** Potential for pollutant leaching shall be assessed using either the Saturated Media Extract Method (aka, Saturation Extract) that is commonly performed by agronomic laboratories or the Synthetic Precipitation Leaching Procedure (SPLP) (EPA SW-846, Method 1312). If the saturation extract method is used, samples may be rinsed with up to five pore volumes before collecting extract for analysis.

**803-2.5.3 BSM Limits in Areas Draining to Impaired Receiving Waters.** The limits in this section are in terms of the concentration of a parameter in water that has been contacted with the BSM.

Table 803-2.5.3

| Applicable Pollutant(s) | Saturation Extract or SPLP Criteria |
|-------------------------|-------------------------------------|
| Phosphorus*             | < 1 mg/L                            |
| Zinc                    | < 1 mg/L                            |
| Copper                  | < 0.04 mg/L                         |
| Lead                    | < 0.025 mg/L                        |
| Arsenic                 | < 0.02 mg/L                         |
| Cadmium                 | < 0.01 mg/L                         |
| Mercury                 | < 0.01 mg/L                         |
| Selenium                | < 0.01 mg/L                         |

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**803-2.5.4 Alternative BSM for Reduced Phosphorus Leaching.** In areas with impaired receiving waters, alternative BSM should be considered, especially if receiving waters are phosphorus impaired. BSM with 20% compost may result in phosphorus leaching and soluble phosphorus test results in excess of the 1 mg/L limit presented in Table 803-2.5.3 Alternative organic amendments, such as coco coir pith and/or composted wood products, in place of compost should be considered in these areas. Sand and soil components with higher levels of iron and aluminum should also be considered to limit the solubility of phosphorus.

**803-5.5.5. Nitrogen Impaired Receiving Waters.** In areas with a downstream water quality impairment or TMDL for nitrogen, a combination of BSM composition and BMP design shall be used to reduce the potential for nitrate leaching from BMPs.

- BSM: The C:N ratio of BSM shall be between 15 and 40 to reduce the potential for nitrate leaching.
- BMP design: BMPs shall be designed to either enhance infiltration into underlying soils or with internal water storage to promote reduction of nitrogen:
  - If a BMP is installed with a liner, the BMP must include an internal saturated zone, consisting of at least an 18-inch thick layer of gravel, to enhance denitrification.
  - If a BMP does not include a liner, it must be installed with a retention zone below the underdrain discharge elevation, consisting of at least an 18-inch thick layer of gravel, to enhance infiltration into underlying soils.

### 803-3 SAND FOR BSM.

**803-3.1 General.** Sand used in BSM should preferably be washed prior to delivery. If sand is not washed it must still meet sieve analysis requirements in Table 1.

**803-3.2 Gradation Limits.** A sieve analysis shall be performed in accordance with California Test 202, ASTM D 422, or approved equivalent method to demonstrate compliance with the gradation limits shown in Table 803-3.2. Fines passing the No. 200 sieve shall be non-plastic.

TABLE 803-3.2

| Sieve Size (ASTM D422) | Percentage Passing Sieve (by weight) |         |
|------------------------|--------------------------------------|---------|
|                        | Minimum                              | Maximum |
| 3/8 inch               | 100                                  | 100     |
| #4                     | 90                                   | 100     |
| #8                     | 70                                   | 100     |
| #16                    | 40                                   | 95      |
| #30                    | 15                                   | 70      |
| #40                    | 5                                    | 55      |
| #100                   | 0                                    | 15      |
| #200                   | 0                                    | 5       |

**803-4 TOPSOIL FOR BSM.**

**803-4.1 General.** Topsoil shall be free of hazardous materials and shall be consistent with a common definition of topsoil. Decomposed granite and derivatives of decomposed granite are not considered to be topsoil for the purpose of this specification.

**803-4.2 Textural Class.** Topsoil shall be classified as a sandy loam or a loamy sand according to the US Department of Agriculture soil classification system. In addition, a textural class analysis shall be performed in accordance with ASTM D422, or an approved alternative method to demonstrate compliance with the gradation limits in Table 803-4.2.

Table 803-4.2

| Textural Class (ASTM D422) | Size Range            | Mass Fraction (percent)        |
|----------------------------|-----------------------|--------------------------------|
| Gravel                     | Larger than 2 mm      | 0 to 25 of total sample        |
| Clay                       | Smaller than 0.005 mm | 0 to 15 of non-gravel fraction |

**803-5 COMPOST FOR BSM.**

**803-5.1 General.** Compost shall be produced at a facility inspected and regulated by the local enforcement agency for CalRecycle. Compost should also preferably be certified by the U.S. Composting Council’s Seal of Testing Assurance Program (USCC STA) or an approved equivalent program. Compost shall not be produced from biosolids feedstock.

**803-5.1.1 Gradation Limits.** A sieve analysis shall be performed in accordance with ASTM D 422 or approved equivalent method to demonstrate compliance with the gradation limits show in Table

803-5.1.1.

Table 803-5.1.1

| Sieve Size (ASTM D422) | Percent Passing Sieve (by weight) |
|------------------------|-----------------------------------|
| 1/2"                   | 97 to 100                         |
| 2 mm                   | 40 to 90                          |

**803-5.1.2 Material Content.** Organic Material Content shall be 35% to 100% by dry weight and moisture shall be 25% to 60% wet weight basis. Physical contaminants (manmade inert materials) shall not exceed 1% by dry weight.

**803-5.2 Compost Testing.** Compost shall meet the following requirements as demonstrated through standard agronomic testing methods:

- a) **Carbon to nitrogen (C:N) ratio.** C:N shall be between 15:1 and 40:1, preferably above 20:1 to reduce the potential for nitrogen leaching/washout.
- b) **pH.** pH shall be between 6.0 and 8.5.
- c) **Soluble Salt Concentration.** Soluble Salt Concentration shall be less than 10 dS/m. (Method TMECC 4.10-A, USDA and U.S. Composting Council).
- d) **Stability.** Carbon Dioxide evolution rate shall be less than 3.0 mg CO<sub>2</sub>-C per g compost organic matter (OM) per day or less than 6 mg CO<sub>2</sub>-C per g compost carbon per day, whichever unit is reported. (Method TMECC 5.08-B, USDA and U.S. Composting Council). Alternatively, a Solvita rating of 5.5 or higher is acceptable.

**803-5.2.1 Pathogens and Pollutant Limits.** Select pathogens shall pass US EPA Class A standard, 40 CFR Section 503.32(a). Trace Metals shall pass US EPA Class A standard, 40 CFR Section 503.13, Table 1 for Ceiling Concentrations.

**803-6 DELIVERY, STORAGE, HANDLING, AND PAYMENT**

**803-6.1 General.** BSM shall be thoroughly mixed prior to delivery using mechanical mixing methods such as a drum mixer. The Contractor shall protect soils and mixes from absorbing excess water and from erosion at all times.

**803-6.1.1 Delivery.** The Contractor shall not deliver or place soils in wet or muddy conditions.

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**803-6.1.2 Storage.** The Contractor shall not store materials unprotected during large rainfall events (>0.25 inches). If water is introduced into the material while it is stockpiled, the Contractor shall allow the material to drain to the acceptance of the County before placement.

**803-6.1.3 Handling and Placement.** BSM shall be lightly compacted and placed in loose lifts approximately 12 inches (300 mm) to ensure reasonable settlement without excessive compaction. Compaction within the BSM area should not exceed 75 to 85% standard proctor within the BSM. Machinery shall not be used in the bioretention facility to place the BSM. A conveyor or spray system shall be used for media placement in large facilities. Low ground pressure equipment may be authorized for large facilities at the discretion of the County. Placement methods and BSM quantities shall account for approximately 10% loss of volume due to settling. Planting methods and timing shall account for settling of media without exposing plant root systems.

**803-6.1.4 Hydraulic Suitability.** The County may request up to three double ring infiltrometer tests (ASTM D3385) or approved alternative tests to confirm that the placed material meets applicable hydraulic suitability criteria. In the event that the infiltration rate of placed material does not meet applicable criteria, the County may require replacement and/or de-compaction of materials.

### 803-6.2 Quality Control and Acceptance

**803-6.2.1 General.** Close adherence to the material quality controls herein are necessary in order to support healthy vegetation, minimize pollutant leaching, and assure sufficient permeability to infiltrate/filter runoff during the life of the facility. Amendments may be included to adjust agronomic properties. Acceptance of the material will be based on test results certified to be representative. Test results shall be conducted no more than 120 days prior to delivery of the blended BSM to the project site. For projects installing more than 100 cubic yards of BSM, batch-specific tests of the blended mix shall be provided to the County for every 100 cubic yards of BSM along with a site plan showing the placement locations of each BSM batch within the facility.

**803-6.5 Measurement and Payment.** Quantities of mixed BSM will be measured as shown in the Bid. The volumetric quantity of mixed BSM to be paid for shall be the volume of BSM placed within the limits of the dimensions shown on the Plans.

## 803-7 AGGREGATE MATERIALS FOR BIORETENTION AND BIOFILTRATION DRAINAGE LAYERS

**803-7.1 General.** This section provides material specifications for drainage layers below BSM in bioretention BMPs. This consists of a two-layer filter course placed below the BSM and above an open-graded aggregate stone reservoir.



## 803-7.2 Rock and Sand Materials for Drainage Layers

**803-7.2.1 General.** All sand and stone products used in BSM drainage layers shall be clean and thoroughly washed.

**803-7.2.2 Filter Course.** Graded aggregate choker material is installed as a filter course to separate BSM from the drainage rock reservoir layer. The purpose of this layer is to limit migration of sand or other fines from the BSM. The filter course consists of two layers of choking material increasing in particle size. The top layer (closest to the BSM) of the filter course shall be constructed of thoroughly washed ASTM C33 Choker Sand as detailed in Table 200-1.5.5. The bottom layer of the filter course shall be constructed of thoroughly washed ASTM No. 8 aggregate material conforming to gradation limits contained in Table 200-1.2.1.

**803-7.2.3 Open-Graded Aggregate Stone.** Open-graded aggregate material is installed below filter course layers to provide additional storm water storage capacity and contain the underdrain pipe(s). This layer shall be constructed of thoroughly washed AASHTO No. 57 open graded aggregate material conforming to gradation limits contained in Table 200-1.2.1.

## 803-7.3 Layer Thicknesses and Construction.

**803-7.3.1 General.** Aggregate shall be deposited on underlying layers at a uniform quantity per linear foot (meter), which quantity will provide the required compacted thickness within the tolerances specified herein without resorting to spotting, picking up, or otherwise shifting the aggregate material.

**803-7.3.2 Filter Course Layers.** Each of the two filter course layers (top layer of ASTM C33 Choker Sand and bottom layer of ASTM No. 8) shall be installed to a thickness of 3 inches (75 mm). Both layers shall be spread in single layers. Marker stakes should be used to ensure uniform lift thickness.

**803-7.3.3 Aggregate Drainage and Storage Layer.** The thickness of the aggregate drainage and storage layer (AASHTO No. 57) will depend on site specific design and shall be detailed in contract documents.

**803-7.3.4 Spreading.** Drainage layers shall be as delivered as uniform mixtures and each layer shall be spread in one operation. Segregation within each aggregate layer shall be avoided and the layers shall be free from pockets of coarse or fine material.

**803-7.3.5 Compacting.** Filter course material and aggregate storage material shall be lightly compacted to approximately 80% standard proctor without the use of vibratory compaction.

**803-7.4 Measurement and Payment.** Quantities of graded aggregate choker material and open-

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graded aggregate storage material will be measured as shown in the Bid. The volumetric quantities of graded aggregate choker stone material and open-graded storage material shall be those placed within the limits of the dimensions shown on the Plans. The weight of material to be paid for will be determined by deducting (from the weight of material delivered to the Work) the weight of water in the material (at the time of weighing) in excess of 1% more than the optimum moisture content. No payment will be made for the weight of water deducted as provided in this subsection.

### 803-8 SUMMARY

Summary of BSM specification requirements for the City of San Diego and County of San Diego included in Table 803-8.

**Table 803-8**

| Component                          | Requirement   |
|------------------------------------|---|
| BSM Material Composition           | Sand: 60-80% by volume<br>Topsoil: 0-20% by volume<br>Compost: 20% by volume  |
| Alternative Blends Acceptable?     | Yes, but they must meet performance-based specifications.   |
| Sand Type                          | Washed sand conforming to particle size distribution  |
| Topsoil Type                       | Sandy loam or loamy sand with clay < 15% and gravel < 25%   |
| Compost Type                       | From a CalRecycle permitted facility. Biosolids derived materials are not acceptable  |
| BSM Permeability                   | 8-24 inches/hour for BMPs without outlet control;<br>15-80 inches/hour for BMPs with outlet control;<br>testing is required to demonstrate. |
| Agronomic Suitability Requirements | Limits for salts and potential toxins. C:N ratio between 12 and 40.   |
| Water Quality Related Limits?      | Requirements related to specific pollutants when water quality of receiving waters is impaired for those pollutants.                        |