

02837 BIORETENTION / BIOSWALE GREEN INFRASTRUCTURE STRATEGY

[NTS: This specification is intended to be used as part of the Milwaukee Metropolitan Sewerage District's Green Solutions Program for implementation of green infrastructure strategies into Contract Documents by local municipalities or other entities. The specification is also intended to be used in conjunction with the Green Infrastructure Sizing Calculator and the Green Infrastructure Typical Details developed for the Green Solutions Program. The specification is considered to be a technical guidance document to assist users with the design of green infrastructure strategies. It is the responsibility of the local municipality or design engineer to make revisions to the specification as needed for specific design projects. It is recommended the documents are reviewed by a licensed professional engineer before releasing for construction. Note that the specification was last updated by the District in 2016.]

A. SCOPE

This Section covers the work necessary to furnish and install bioretention / bioswale green infrastructure strategies, including the engineered soil media layer, surface mulch layer or coconut fiber mat, stormwater storage layer, underdrain piping, cleanouts, observation wells, anti-seep collar, and overflow structures.

1. GENERAL

[NTS: Update language of this Section as necessary based on applicable references to front-end specifications.]

See CONDITIONS OF THE CONTRACT, and Division 1, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

2. RELATED WORK

[NTS: The list below may not be fully inclusive depending upon the specifics of each individual project. Update language of this Section as necessary based on applicable references to other technical specification sections.]

The applicable requirements, materials and workmanship specified in the following Sections are included by reference in this Section. The list below is from the Wisconsin Department of Transportation (WisDOT) Standards and Specifications for Highway and Structure Construction, latest edition.

Section 201 Clearing and Grubbing
Section 205 Roadway and Drainage Excavation
Section 501 Concrete
Section 601 Concrete Curb and Gutter
Section 602 Concrete Sidewalks
Section 611 Catch Basins, Manholes, and Inlets
Section 612 Underdrains

Section 627 Mulching
Section 628 Erosion Control
Section 630 Seeding
Section 631 Sodding
Section 645 Geotextile Fabrics

The following specification as developed for the Milwaukee Metropolitan Sewerage District's Green Solutions Program may also include related work.

Section 02840 Exterior Plants (Native Landscaping and Stormwater Trees)

3. SUBMITTALS

a. SUBMITTALS REQUIRED PRIOR TO BID OPENING

Prebid approval of materials is not required. Suppliers and products have been identified as a means of establishing quality, but not for purposes of limiting competition.

b. SUBMITTALS DURING CONSTRUCTION

[NTS: Update language of this Section as necessary based on applicable references to front-end specifications.]

Submittals during construction shall be made in accordance with Section 01300 in Division 1, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:

1. **CONTRACTOR's Qualifications:** CONTRACTOR shall submit information showing conformance with qualification requirements listed in specifications. Submit CONTRACTOR Qualifications to OWNER for review prior Notice to Proceed.
2. **Engineered Soil Media Mixture Analysis:** CONTRACTOR shall submit soil analysis by a qualified soil-testing laboratory showing conformance with engineered soil media mixture specifications. Submit soil analysis to OWNER for review and approval prior to installation.
3. **Engineered Soil Media Infiltration Test:** CONTRACTOR shall conduct and submit results of an on-site infiltration test of the engineered soil media to ensure conformance with saturated hydraulic conductivity criteria. Using 5 cubic yards of the prepared engineered soil media, CONTRACTOR shall place the material on site at the proper location and depth, allow for proper settlement of the engineered soil media, and conduct an infiltration test using a double-ring infiltrometer in accordance with ASTM D3385. Submit

infiltration test results to OWNER for review and approval prior to installation of the remaining engineered soil media.

4. Surface Mulch: CONTRACTOR shall submit 1/2 lb. of mulch sample placed in labeled plastic bag as well as shop drawings of materials showing conformance with specifications. Submit sample and shop drawings to OWNER for review and approval prior to installation.
5. Storage Layer: CONTRACTOR shall submit sieve analysis by a qualified testing laboratory showing conformance with specifications. Submit sieve analysis to OWNER for review and approval prior to installation.
6. Underdrain Piping: CONTRACTOR shall submit shop drawings of underdrain piping showing conformance with specifications. Submit shop drawings to OWNER for review and approval prior to installation.
7. Overflow Structure: CONTRACTOR shall submit shop drawings of overflow structure showing conformance with specifications. Submit shop drawings to OWNER for review and approval prior to installation.
8. Anti-Seep Collar: CONTRACTOR shall submit soil analysis by a qualified soil-testing laboratory showing conformance with anti-seep collar specifications. Submit soil analysis to OWNER for review and approval prior to installation.
9. Geotextile Filter Fabric: CONTRACTOR shall submit shop drawings of geotextile filter fabric showing conformance with specifications. Submit shop drawings to OWNER for review and approval prior to installation.

4. DEPARTURES FROM PLANS AND SPECIFICATIONS

Submit in writing to the OWNER for review, details of any proposed departures from these Contract Documents, and the reasons therefor. Submit such requests as soon as practicable after the Notice to Proceed. Make no such departures without prior written acceptance of the OWNER.

5. SHOP DRAWINGS, MATERIAL REVIEW AND SAMPLES

- a. Engineered Soil Media Mixture Analysis
- b. Engineered Soil Media Infiltration Test

- c. Surface Mulch or Coconut Fiber Mat
- d. Storage Layer
- e. Underdrain Piping
- f. Overflow Structure
- g. Geotextile Filter Fabric

6. CONTRACTOR QUALIFICATIONS

The CONTRACTOR shall have five years' experience (minimum) and shall have completed green infrastructure work similar in material, design, and extent to that indicated for this Project. CONTRACTOR must provide five or more successful installations of green infrastructure projects.

7. TOLERANCES

Tolerances for bioretention / bioswale green infrastructure strategy construction and materials shall conform to the requirements hereinafter specified. The finished surface elevation of the bioretention / bioswale green infrastructure strategy shall be within 0.10 feet (+/-) of the finished surface elevation as specified in the drawings.

B. MATERIALS

1. GENERAL

All bioretention / bioswale green infrastructure strategies shall meet the requirements of the following specifications. The OWNER reserves the right to take samples of materials whenever deemed necessary.

2. ENGINEERED SOIL MEDIA

The engineered soil media shall conform to the following specifications:

- a. The engineered soil media mixture shall consist of a mixture of 70% to 85% sand and 15% to 30% compost. The percentages are based on volume. Special attention should be given to plant selection when the percentage of sand exceeds 75%.
- b. The sand component of the engineered soil media shall meet one of the following gradation requirements:
 - 1. USDA Coarse Sand (.02 - .04 inches).
 - 2. ASTM C33 (Fine Aggregate Concrete Sand).
 - 3. Wisconsin Standards and Specifications for Highway and Structure

Construction, Section 501.2.5.3.4. (Fine Aggregate Concrete Sand) latest edition, or an equivalent as approved by the OWNER. The sand shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No. 4	90 to 100
No. 16	45 to 85
No. 50	5 to 30
No. 100	0 to 10

The preferred sand component consists of mostly SiO₂, but sand consisting of dolomite or calcium carbonate may also be used. Manufactured sand or stone dust is not allowed. The sand shall be washed and drained to remove clay and silt particles prior to mixing.

- c. The compost component of the engineered soil media shall meet the requirements of Wisconsin Department of Natural Resources Specification S100, Compost, as follows:
 1. Particle Size – 98% of the compost shall pass through a 0.75-inch screen.
 2. Physical Contaminants – Less than 1% combined glass, metal and plastic.
 3. Organic Matter/Ash Content – At least 40% organic matter; less than 60% ash content.
 4. Carbon to Nitrogen Ratio – 10-20:1 C:N ratio.
 5. pH – Between 6 and 8.
 6. Soluble Salt – Electrical conductivity below 10 dS m⁻¹ (mmhos cm⁻¹)
 7. Moisture Content – Between 35% and 50% by weight.
 8. Maturity – The compost shall be resistant to further decomposition and free of compounds, such as ammonia and organic acids, in concentrations toxic to plant growth.
 9. Residual Seeds & Pathogens – Pathogens and noxious seeds shall be minimized.
 10. Pathogens – The compost shall meet the Class A requirements for pathogens as specified in s. NR 204.07(6)(a), Wis. Adm. Code.
 11. Other Chemical Contaminants – The compost shall meet the high quality pollutant concentrations as specified in s. NR 204.07(5)(c), Wis. Adm. Code.
- d. The engineered soil media mixture shall be free of rocks, stumps, roots, brush or other material over 1 inch in diameter. No other materials shall be mixed with the planting soil that may be harmful to plant growth or prove a hindrance to planting or maintenance.

- e. The engineered soil media mixture shall have a pH between 5.5 and 8.0.
- f. The engineered soil media mixture shall have adequate nutrient content to meet plant growth requirements.
- g. The saturated hydraulic conductivity of the engineered soil media mixture shall be 6 to 10 inches per hour tested in accordance with ASTM F1815. The total porosity shall be 35% to 55% and the moisture holding capacity shall be 15% to 25%. Conduct infiltration test to ensure soil mix meets the saturated hydraulic conductivity criteria.

3. SURFACE MULCH LAYER / COCONUT FIBER MAT

Shredded hardwood mulch or chips, aged a minimum of 12 months, or a Class II erosion control mat (blanket) made of coconut fibers shall be placed on the surface of the bioretention / bioswale area. The shredded hardwood mulch or chips shall be 2 to 3 inches in depth and the mat shall be overlapped, and anchored with hardwood stakes (6 inches or longer to hold the mat to the media). The use of an erosion control mat shall also be placed over the hardwood mulch to prevent the mulch from floating, at least until dense vegetation is established. The mulch shall be free of foreign material, including other plant material.

4. STORAGE LAYER

The storage layer below the engineered soil media is intended for temporary storage of stormwater runoff and required when the infiltration rate of the native soil is less than 3.6 inches/hour. The storage layer shall consist of either gravel or sand that shall conform to the following specifications:

- a. The gravel shall be a well-graded coarse aggregate that meets the coarse aggregate specifications of Wisconsin Standards and Specifications for Highway and Structure Construction, Section 501.2.5, latest edition, or an equivalent as approved by the OWNER. Gravel shall be double-washed. The aggregate shall be sized in accordance with AASHTO No. 4 aggregate (size number according to AASHTO M43) to meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
2-inch	100
1 1/2-inch	90 to 100
1-inch	20 to 55
3/4-inch	0 to 15
3/8-inch	0 to 5

- b. The sand shall meet the same requirements specified above in the Engineered Soil Media materials section for sand.

5. SAND/NATIVE SOIL INTERFACE LAYER

A sand/native soil interface layer is required when the design infiltration rate of the native soil is less than 3.6 inches per hour as determined using WDNR Technical Standard 1002, "Site Evaluation for Stormwater Infiltration." The sand/native soil interface layer shall conform to the following specifications:

- a. 3 inches of sand shall be placed below the storage layer, and vertically mixed with the native soil interface to a depth of 2-4 inches.
- b. The sand shall meet the same requirements specified above in the Engineered Soil Media materials section for sand.

6. UNDERDRAIN PIPING

The underdrain pipe shall conform to the following specifications:

- a. The underdrain pipe shall have a minimum diameter of 6 inches and be made of SDR-35 PVC or other material approved by the OWNER. The pipe shall be capable of withstanding expected traffic loads over portions of the pipe extending beyond the soil planting bed.
- b. The underdrain orifice shall be restricted as necessary so that the design infiltration rate plus the underdrain rate equals the design draw down rate. The restriction shall be achieved by using an adjustable restrictor plate or valve. The restriction device shall be accessible for adjustment.
- c. The total opening area of all perforation holes combined shall be sufficient to allow the underdrain pipe to discharge at full capacity, as would occur if there were no orifice restriction. The amount of perforations shall be increased to provide a margin of safety but shall not be so great as to compromise structural integrity of the pipe material. The size of the perforations shall be small enough to prevent surrounding aggregate material from traveling through the perforations. A minimum of three rows of perforations shall be used.
- d. The underdrain pipe shall be protected from clogging by use of a filter fabric or filter sock. If the storage layer is sand, a filter sock shall be used. A cover of pea gravel may also be used. The pea gravel, filter fabric, and filter sock shall conform to the following specifications:
 1. Pea gravel - If used, the pea gravel layer shall be at least 4 inches thick. Pea gravel shall be washed. Pea gravel shall be large enough to prevent its falling through the perforations of the underdrain pipe. The pea gravel shall be sized in accordance with AASHTO No. 8 aggregate (size number according to AASHTO M43) to meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

2. Filter fabric - Filter fabric shall cover the underdrain pipe and shall not extend laterally from either side of the pipe more than two feet. The fabric shall meet the specifications of Wisconsin Standards and Specifications for Highway and Structure Construction, Section 645.2.4, Schedule Test B, latest edition, or an equivalent approved by the OWNER.
3. Filter sock - A filter sock shall only be used to protect the underdrain pipe when a sand storage layer is used. A filter sock is not permitted when an aggregate storage layer is used. The openings in the fabric shall be small enough to prevent sand particles from entering the underdrain pipe. The flow rate of the fabric shall be capable of passing water at a rate equal to or greater than the flow rate capacity of the total combined perforations in the underdrain pipe. In addition, the fabric shall meet the other requirements of Wisconsin Standards and Specifications for Highway and Structure Construction, Section 612.2.8(1-3), latest edition, or an equivalent approved by the OWNER.
- e. The underdrain pipe shall have a vertical, connecting standpipe to serve as a clean-out port for the underdrain pipe. The pipe shall be rigid, non-perforated SDR-35 PVC pipe, a minimum of 6 inches in diameter and covered with a watertight cap that is 3 inches above the finished surface elevation of the bioretention device.

7. OBSERVATION WELLS

If there is no underdrain, one or more observation wells shall be installed to monitor drainage from the bioretention / bioswale green infrastructure strategy. The observation wells shall conform to the following specifications:

- a. The observation well shall be a minimum 6 inch diameter slotted SDR 35 PVC pipe from the bottom of the sand soil interface layer to the top of the storage layer and then solid wall PVC pipe from the top of the storage layer to 3 inches above the maximum ponding depth, anchored vertically to a footplate at the bottom of the bioretention device. The top of the pipe shall be high enough to prevent the entry of water ponded within the infiltration device bed.

- b. Foot plate shall be 24 inch by 24 inch by 3/8 inch thick HDPE sheet with PVC cap to match dimension of the observation well pipe and shall be anchored to the HDPE sheet with four 3/8 inch stainless steel bolts and washers to prevent movement and rotation. Observation well PVC pipe shall be connected to PVC cap in accordance with manufacturer's recommendations.
- c. The observation well shall have a secured aboveground cap.

8. OVERFLOW STRUCTURE

The overflow structure shall conform to the following specifications:

- a. The overflow structure shall be either a weir or standpipe to regulate the maximum ponding depth on the surface of the bioretention / bioswale green infrastructure strategy. The invert of the overflow structure shall be at the elevation of the maximum ponding depth of the bioretention / bioswale strategy.
- b. The overflow structure standpipe shall consist of a vertical standpipe connected to the underdrain. The pipe shall be rigid, non-perforated SDR-35 PVC pipe, a minimum of 6 inches in diameter. The maximum elevation of the top of the overflow structure standpipe shall match the maximum ponding elevation. The top opening shall be fitted with a minimum 6 inch dome grate.

9. ANTI-SEEP COLLAR

Anti-seep collar consisting of compacted clay material shall be installed at all locations where underdrain piping or storm sewer conveyance systems leave a bioretention / bioswale green infrastructure strategy to prevent groundwater from flowing through the bedding material of the underdrain piping or storm sewer conveyance system. Anti-seep collar shall extend from the bottom of the trench excavation to within 6 inches of the ground surface and 1 foot beyond the normal trench width on both sides of the trench. Material for clay bedding dike shall be classified as either CH or CL according to the Unified Soil Classification System with minimal sand content.

C. WORKMANSHIP

1. CONSTRUCTION SITE STABILIZATION

- a. CONTRACTOR shall not construct bioretention / bioswale strategies until all of the contributing drainage areas are stabilized to the satisfaction of the OWNER. Do not use the bioretention / bioswale strategies as temporary sediment control facilities during construction. It is the responsibility of the CONTRACTOR to sequence the construction of the bioretention / bioswale

strategies in a manner such to prevent sediment from entering the bioretention / bioswale strategies as a result of construction activities.

- b. Construction site runoff from disturbed areas shall not be allowed to enter the bioretention / bioswale strategies. CONTRACTOR shall use sediment control measures as necessary to prevent construction site runoff from entering the bioretention / bioswale strategies. Sediment control measures indicated on design drawings are not intended to limit the CONTRACTOR in the manner and techniques to control erosion. It is the responsibility of the CONTRACTOR to control erosion from this site during construction.
- c. Sediment that enters the bioretention / bioswale strategies during construction as a result of construction activities shall be removed by the CONTRACTOR at no cost to the OWNER. In circumstances where, in the opinion of the OWNER, sediment significantly impacts the functionality of the underdrains, backfill materials, engineered soil media, or plantings, these items shall be completely replaced by the CONTRACTOR at no cost to the OWNER.
- d. CONTRACTOR shall not store any equipment or materials within the perimeter of the bioretention / bioswale engineered soil media area.

2. SUITABLE WEATHER

- a. Construction of the bioretention / bioswale strategies shall be suspended during periods of rainfall or snowmelt. Construction shall remain suspended if ponded water is present or if residual soil moisture contributes significantly to the potential for clumping or other forms of compaction within the bioretention / bioswale strategies. CONTRACTOR shall inspect and maintain all sediment control measures protecting both the bioretention / bioswale strategies and the entire project site following periods of rainfall or snowmelt.

3. COMPACTION AVOIDANCE

- a. Compaction and smearing of the soils beneath the floor and side slopes of the bioretention / bioswale area, and compaction of the soils used for backfill in the soil planting bed, shall be minimized. During site development, the area dedicated to the bioretention / bioswale area shall be cordoned off to prevent access by heavy equipment. Acceptable equipment for constructing the bioretention / bioswale strategy includes excavation hoes, light equipment with turf type tires, marsh equipment or wide-track loaders.
- b. If compaction occurs at the base of the bioretention / bioswale strategy, the soil shall be refractured to a depth of at least 12 inches. If smearing occurs, the smeared areas of the interface shall be corrected by raking or roto-tilling.

Refracturing shall not be used by CONTRACTOR in lieu of proper compaction avoidance techniques.

4. PLACEMENT AND SETTLING OF ENGINEERED SOIL MIXTURE

a. Placement and Settling of Engineered Soil - The following apply:

1. Prior to placement in the bioretention / bioswale strategy, the engineered soil mixture shall be premixed and the moisture content shall be low enough to prevent clumping and compaction during placement. OWNER shall review the bioretention soil mixture upon completion of premixing and before delivery to the site. No onsite mixing of soils shall be allowed. Only approved tested material shall be delivered to the site.
2. The engineered soil mixture shall be placed in multiple lifts, each approximately 12 inches in depth.
3. As approved by OWNER, steps may be taken to induce mild settling of the engineered soil bed as needed to prepare a stable planting medium and to stabilize the ponding depth. Vibrating plate-style compactors shall not be used to induce settling.
4. The entire soil planting bed shall be mulched prior to planting vegetation to help prevent compaction of the planting soil during the planting process. Mulch shall be pushed aside for the placement of each plant.

5. NOTIFICATION

- a. CONTRACTOR shall notify OWNER following the excavation of bioretention / bioswale strategies, prior to installation of underdrains, backfill materials, and engineered soil media. CONTRACTOR shall only proceed with the installation of underdrains, backfill materials, and engineered soil media with approval of the OWNER.

D. PAYMENT

Except as noted otherwise hereinafter payment for the work in this Section will be based on the quantities and unit bid prices for each of the individual bid items for the bioretention / bioswale green infrastructure strategy. Payment will be made at the unit prices stated in the Bid. The unit prices shall constitute full compensation for all labor, equipment, materials, and incidentals necessary for the satisfactory completion of the work.

* * * * *