

Article I. GENERAL

Section 1.01 Scope

- (a) This specification shall govern the implementation, performance, material and fabrication pertaining to the Sub-surface Stormwater Storage System. The sub-surface stormwater storage system shall be manufactured by Brentwood Industries, Inc. 610 Morgantown Road, Reading, PA 19603 (610-374-5109), distributed by XXXXX, and shall adhere to the following specification at the required storage capacities.
- (b) All work is to be completed per the design requirements of the Engineer of Record and to meet or exceed the Manufacturer's Design and Installation Requirements.

Section 1.02 Reference Standards

- (a) The following apply to work in this section:
 - (i) ASTM: Specifications of the American Society for Testing and Materials latest editions.
 - (ii) AASHTO: American Association of State Highway and Transportation Officials, current published standards.

Section 1.03 Submittals

- (a) At least 10 days prior to bid, submit to Engineer the following to be considered for pre-qualification to bid:
 - (i) A list of materials to be provided for work under this Article, including the name and address of the materials producer and the location from which the materials are to be obtained
 - (ii) Three (3) hard copies of the following:
 - 1) Aggregate: sieve analysis
 - 2) Non-woven geotextile: product manufacturer specification sheets
 - 3) Impermeable liner (if required): product manufacturer specification sheets
 - 4) Modular stormwater storage units: Brentwood Industries shop drawings, specification sheets, installation instructions and maintenance guidelines

- (iii) Sub-surface Stormwater Storage System Component Samples for review:
 - 1) Aggregate: loose material in a sealed bag labeled with name of material and manufacturer to be submitted prior to placement for analysis
 - 2) Sub-surface Stormwater Storage System Modules; provide a single 36" long by 18" wide, height as specified, unit of the product for review.
 - a) Sample to be retained by Owner
 - b) Manufacturers named as acceptable herein are not required to submit samples

Section 1.04 Quality Assurance

(a) Materials

- (i) All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM and AASHTO Standards, unless otherwise specified.
- (ii) The quality of material and the finished components shall be subject to inspection by the Engineer. Such inspection may be made on-site upon delivery or at any point thereafter. The components shall be subject to rejection at any time if material fails to meet any of the specification requirements, even though sample components may have been accepted as satisfactory. Components rejected after delivery to the site shall be marked for identification and shall be removed from the site at once.

(b) Inspection

- (i) All components shall be inspected for general appearance, dimensions, soundness, etc.
- (ii) Upon completion of relevant excavation work, and prior to placement of geotextile and aggregate, the sub-base soil shall be inspected by Specifying Engineer or authorized representative and be signed off on by the Engineer of Record as acceptable and meeting manufacturer's recommendations.
- (iii) Upon completion of the placement of the sub-surface stormwater storage system (as specified) and geotextile, and prior to backfilling, the structure shall be inspected by Specifying Engineer or authorized representative and signed off on by the Engineer of Record as acceptable and meeting manufacturer's recommendations.

(c) Defects

- (i) Products with structural defects shall be immediately removed and replaced with acceptable parts. The Specifying Engineer, before final acceptance, shall carefully inspect repairs/replacements.



Section 1.05 Division of Responsibility

- (a) Sub-Surface Stormwater Storage System Distributor/Manufacturer
 - (i) The Distributor/Manufacturer shall be responsible for delivering the sub-surface stormwater storage system to the site. The system includes all components necessary for the assembly of the sub-surface stormwater storage system modules required per the Drawings.
- (b) Contractor
 - (i) The Contractor shall be responsible for preparing the site for the system installation including, but not limited to, temporary shoring, excavation, cutting and removing pipe, new pipe, compaction, sealing all connections, backfilling and furnishing all labor, tools and materials needed.

Section 1.06 Delivery, Storage, and Handling

- (a) Components shall be unloaded, handled and stored in an area protected from traffic and in a manner to prevent damage. All plastic wrapping from the side panel packaging should be removed and the columns shall be stored under a tarp or roof.
- (b) Stored components should be checked at least once a week. A check of the stored area should be done to make any minor repairs to the cover or to restack any components that could have fallen.

Article II. Materials

Section 2.01 Aggregate

- (a) Course aggregates shall meet the following requirements:
 - (i) Maximum Wash Loss: 1% (ASTM C117)
 - (ii) Minimum Durability Index: 35 (ASTM D3744)
 - (iii) Maximum Abrasion of 10% for 100 revolutions and maximum of 50% for 500 revolutions
 - (iv) All aggregate shall be clean and thoroughly washed.
 - (v) Aggregate shall be 100% crushed material.
- (b) Unless otherwise approved by Specifying Engineer, coarse aggregate for the sub-surface stormwater storage system shall be uniformly graded as defined below:
 - (i) ¾" angular clean stone (AASHTO #56, 57, 6, 67, 68)
- (c) Sand shall not be an acceptable substitute for coarse aggregate.



Section 2.02 Geotextiles

(a) Non-woven geotextile (drainage filter fabric) shall be Mirafi® 160N or approved equal.

(i) Mirafi 160N

Mechanical Properties	Test Method	Units	Min. Avg. Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs. (N)	160 (712)	160 (712)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs. (N)	60 (267)	60 (267)
CBR Puncture Strength	ASTM D6241	lbs. (N)	410 (1825)	
Apparent Opening Size (AOS) ¹	ASTM D4751	U.S. Sieve (mm)	70 (0.212)	
Permittivity	ASTM D4491	sec ¹	1.5	
Flow Rate	ASTM D4491	gal/min/ft ² (l/min/m ²)	110 (4481)	
UV Resistance (at 500 hrs.)	ASTM D4355	% strengthretained	70	

¹ ASTM D4751: AOS is a Maximum Opening Diameter Value

(b) Impermeable liner shall be as specified below or equal.

(i) 40 mil thick high density polyethylene geomembrane designed specifically for flexible geomembrane applications.

Property	Results
Minimum Average Thickness	40 mil (mm) (ASTM D5199)
Density	0.94 g/cm ³ (ASTM 1505)
Strength at Yield (width)	84 lb./in (14,711 N/m)
Elongation at Yield	12%
Tear Resistance	28 lb.(125 N) (ASTM D1004)
Puncture Resistance	72 lb.(320 N) (ASTM D4833)

(ii) 30 mil thick PVC geomembrane designed specifically for flexible geomembrane applications.

Property	Results
Minimum Average Thickness	30 mil (mm) (ASTM D5199)
Density	1.20 g/cm ³ (ASTM D792)
Tensile Strength	73 lb./in (12,784 N) (ASTM D882)
Elongation at Break	380% (ASTM D882)
Tear Strength	8lb. (36 N) (ASTM D1004)



Section 2.03 Sub-surface Stormwater Storage System Modules

- (a) The Sub-surface Stormwater Storage System shall be made from polypropylene and 100% recycled PVC to meet the following requirements:
 - (i) High Impact Polypropylene Copolymer Material
 - 1) Injection molded, polypropylene, top/bottom platens and side panels formed to a dimension of 36" (914 mm) long x 18" (457 mm) wide [NOMINAL].
 - (ii) 100% Recycled PVC Material
 - 1) PVC Conforming to ASTM D-1784 Cell Classification 12344 b-12454 B
 - 2) Extruded, rigid, and 100% recycled PVC columns sized for applicable loads as defined by AASHTO HS-25 Loading and manufactured to the required length per engineer approve drawings.
 - (iii) Platens and columns are assembled on-site to create modules, which can be uniformly stacked, up to two modules high, in vertical structures of variable height (custom for each project).
 - (iv) Modular stormwater storage units must have a 95% void space and be continuously open in both length and width, with no walls or partitions.
- (b) Rejection
 - (i) The Sub-surface Stormwater Storage System may be rejected for failure to meet any of the requirements of this specification.

Article III. EXECUTION

Section 3.01 General Conditions

- (a) Coordinate the installation with the product distributor, as specified in Section 1.01, to have the distributor on-site during product installation.
- (b) Review manufacturer's installation procedures and coordinate Sub-surface Stormwater Storage System installation with other work affected, such as grading, excavation, utilities, construction access, erosion control, etc.
- (c) Cold weather installation or assembly of modules should not be undertaken when temperatures are below 40° F (4.44° C).
- (d) Assembled modules may be walked on, but vehicular traffic is prohibited until properly backfilled and covered per Manufacturer's recommendations. Protect personnel and the installation against damage with highly visible construction tape, fencing, or other means until construction is complete.



Section 3.02 Excavation Below Grade

- (a) Excavation required for the installation of all pipes and structures shall be made to the depths and widths indicated on the Drawings (a minimum of 12" (305 mm) beyond all sides of the Sub-surface Stormwater Storage System for proper backfill). The Contractor shall render the bottom of the excavations firm and dry and in all respects acceptable to Engineer of Record.
- (b) All objectionable material encountered within the limits indicated shall be removed and disposed of by the Contractor.
- (c) In excavation faces, all loose or protruding rocks shall be barred loose or otherwise removed to finished grade. All cut slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings or as directed by Specifying Engineer or authorized representative.
- (d) Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc.) as required by Federal, State and Local Laws, Ordinances, Regulations and Safety Requirements. Support the sides of excavation, to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement or other damage.

Section 3.03 Sub-base Preparation and Grading

- (a) Sub-base shall be unfrozen, level (plus or minus 1%), and free of lumps or debris with no standing water, mud or muck. Do not use frozen materials or materials mixed or coated with ice or frost. Sub-base shall be compacted to at least 95% Proctor Density, or as specified by the Engineer of Record.
- (b) If Contractor fails to maintain the sub-base properly, the Contractor shall remove the unsuitable material. If the bottom of any portion of the excavation is removed below the limits shown on the Drawings, it shall be restored per the Engineer of Record to the elevation shown in the Drawings. Compacted native earthen fill is not acceptable.
- (c) If in the opinion of Specifying Engineer or authorized representative the sub-base, at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for construction; it shall be removed to such depth and width as the Specifying Engineer may direct and be replaced with suitable material as directed by the Engineer of Record and Specifying Engineer.

Section 3.04 Installation of Sub-surface Stormwater Storage

- (a) Installation procedure, as follows, shall be followed by the Contractor. The Contractor shall also reference the Manufacturer's Installation Guidelines, and where any discrepancy exists the Specifying Engineer reserves the right to contact the Manufacturer's Representative prior to continuation. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.



- (i) Place geotextile fabric that will wrap around the bottom and sides with a minimum of 24" (610 mm) beyond the edge of the excavation and 12" (305 mm) seam overlaps. Geotextile fabric shall be placed such that seaming shall be minimized. Additional material to be utilized for wrapping above the structure shall be protected from damage until use.
- (ii) Install leveling bed, 6" (102 mm) of ¾" (19 mm) angular crushed stone, across the footprint of the structure. Stone shall be rolled or plate tamped to provide a level surface; free from lumps and debris or any other sharp materials.
- (iii) Place geotextile fabric and impermeable liner (if applicable) on the leveling bed with extra geotextile to wrap the bottom and sides with a minimum 24" (610 mm) overlap on the top of the modules and 12" (305 mm) seam overlaps. Geotextile fabric shall be placed such that seaming shall be minimized. Additional material to be utilized for wrapping above the structure shall be protected from damage until use.
- (iv) Utilize a soluble paint, chalk or string to outline the footprint of the Modules to be placed. Care should be taken to note any connections, ports or other irregular units to be placed. Ensure squareness prior to module placement.
- (v) Install the Sub-surface Stormwater Storage System Modules by placing side by side. Place the Modules against one another to allow no more than a ¼" (6.35 mm) separation. Use caution to avoid debris or soil intrusion to the system components.
- (vi) Identify locations of inlet, outlet, inspection ports, and any other penetrations of the liner, securing pipe into side panels and sealing the geotextile fabric. NO pipe penetrations shall be in the top/bottom panels of the Sub-surface Stormwater Storage System unless required by the Engineer of Record. Support pipe in trenches and during backfill operations to prevent damage to liner or pipe.
- (vii) Upon completion of module installation, wrap the Modules in geotextile fabric and/or liner from the sides around the top to prevent material migration into the Sub-surface Stormwater Storage System Modules. Take great care to avoid damage to fabric/liner material during placement. If damage occurs, cover that portion of repair per manufacturer specifications.
- (viii) Adjust the stone/soil interface geotextile material along the side slope of the native soil to verify it is taugth to the native soil.
- (ix) Place Side Backfill utilizing ¾" (19 mm) angular clean stone. This material shall be brought up evenly on all sides in 12" (305 mm) lifts, a minimum of 12" (305 mm) wide around the entire perimeter of the installation. Additional care should be taken to avoid damage to fabric/liner.
- (x) Place Top Backfill in 12" (305 mm) lifts and compact with vibrating plates or walk-behind non-vibrating rollers (do not use drivable rolling compactors). Take care to place backfill on top of structure and avoid damage to structure or liner, using low-pressure tire or track vehicles. All other construction vehicles or traffic of any kind is prohibited until a full 24" (610 mm) base has been placed as cover.



- (xi) Upon completion of Side and Top Backfill, wrap the system in geotextile fabric from the sides around the top to prevent material migration. Take great care to avoid damage to fabric/liner material during placement. If damage occurs, cover that portion of repair per manufacturer specifications.
- (xii) Install metallic tape around the perimeter of the system to mark the area for future utility detection.
- (xiii) Install the remaining cover to a minimum finished cover depth of 24" (610 mm) and a maximum burial depth (invert of the modules to finished grade) of 11ft.

Section 3.05 Cleaning

- (a) Perform cleaning during the installation of work and upon completion of the work.
- (b) Remove from site all excess materials, debris, and equipment. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

END OF SECTION

