

## Section 645 Geosynthetics

### 645.1 Description

- (1) This section describes providing geotextiles for subgrade separation and stabilization, drainage filtration, subgrade reinforcement, and under culverts and riprap.
- (2) This section also describes providing geogrid for subgrade, marsh, and slope stability reinforcement.

### 645.2 Materials

#### 645.2.1 General

- (1) Furnish material that is insect, rodent, mildew, and rot resistant in a wrapping that protects the it from ultraviolet radiation and from abrasion due to shipping and hauling. Keep material dry until installed. Clearly mark rolls to show the material type.
- (2) The engineer may obtain material samples for testing from the job site as specified here in 645.2 for individual materials, or as the engineer directs.
- (3) If no minimum values are specified here in 645.2, use those specified in the special provisions.

#### 645.2.2 Geotextile

##### 645.2.2.1 General

- (1) Furnish geotextiles of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. Fabric shall have the minimum strength values in the weakest primary direction. The contractor may use nonwoven fabric that is one or a combination of the following: needle punched, heat bonded, or resin bonded.
- (2) If using sewn seams, furnish a field sewn seam sample produced from the geotextile and thread and with the equipment proposing to use on the project, before incorporating into the work.

##### 645.2.2.2 Geotextile, Type SAS (Subgrade Aggregate Separation)

*Replace 645.2.2.2(1), 645.2.2.4(1), 645.2.2.6(1), 645.2.2.7(1), and 645.2.2.8(1) to switch from ASTM D4833 to ASTM D6241 for puncture testing. This change was implemented in ASP 6 effective with the December 2017 letting*

- (1) Furnish fabric conforming to the following physical properties:

TEST	METHOD	VALUE <sup>[1]</sup>
Minimum grab tensile strength	<a href="#">ASTM D4632</a>	170 lb
<b>Minimum puncture strength</b>	<a href="#">ASTM D6241</a>	<b>350 lb</b>
Maximum apparent opening size	<a href="#">ASTM D4751</a>	No. 70
Minimum permittivity	<a href="#">ASTM D4491</a>	0.35 s <sup>-1</sup>

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) For quantities over 20,000 square yards, furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile delivered conforms to the above requirements. Mark the delivered geotextile to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 20,000 square yards or lesser portion used in the work.

##### 645.2.2.3 Geotextile, Type MS (Marsh Stabilization)

- (1) Furnish fabric conforming to the physical properties the special provisions specify.
- (2) Deliver to the engineer a sample of the geotextile material at least 15 days before incorporating into the work. At the same time, furnish a sewn seam sample using the same geotextile, thread, seam spacing, and number, and overlap distance as are intended or required for use.
- (3) Furnish to the engineer, at least 15 days before use in the work, a manufacturer's certified report of test or analysis that shows that the geotextile delivered conforms to the above requirements. Mark the delivered geotextile to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yards or lesser portion used on the contract.

##### 645.2.2.4 Geotextile, Type DF (Drainage Filtration)

- (1) Furnish fabric conforming with the physical requirements of either schedule A, schedule B, or schedule C as the contract specifies.

SCHEDULE A TEST	METHOD	VALUE <sup>[1]</sup>
Minimum grab tensile strength	<a href="#">ASTM D4632</a>	110 lb
<b>Minimum puncture strength</b>	<a href="#">ASTM D6241</a>	<b>200 lb</b>
Minimum apparent breaking elongation	<a href="#">ASTM D4632</a>	30%

Maximum apparent opening size	<a href="#">ASTM D4751</a>	300 µm
Minimum permittivity	<a href="#">ASTM D4491</a>	0.70 s <sup>-1</sup>
<b>SCHEDULE B TEST</b>		
	<b>METHOD</b>	<b>VALUE<sup>[1]</sup></b>
Minimum grab tensile strength	<a href="#">ASTM D4632</a>	180 lb
<b>Minimum puncture strength</b>	<a href="#">ASTM D6241</a>	<b>350 lb</b>
Minimum apparent breaking elongation	<a href="#">ASTM D4632</a>	30%
Maximum apparent opening size	<a href="#">ASTM D4751</a>	300 µm
Minimum permittivity	<a href="#">ASTM D4491</a>	1.35 s <sup>-1</sup>
<b>SCHEDULE C TEST</b>		
	<b>METHOD</b>	<b>VALUE<sup>[1]</sup></b>
Minimum grab tensile strength	<a href="#">ASTM D4632</a>	180 lb
<b>Minimum puncture strength</b>	<a href="#">ASTM D6241</a>	<b>350 lb</b>
Minimum apparent breaking elongation	<a href="#">ASTM D4632</a>	15%
Maximum apparent opening size	<a href="#">ASTM D4751</a>	600 µm
Minimum permittivity	<a href="#">ASTM D4491</a>	1.00 s <sup>-1</sup>

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) Do not use slit film woven fabric for this work.
- (3) For quantities over 2000 square yards, furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile delivered conforms to the above requirements. Mark the delivered geotextile to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 2000 square yards or lesser portion used in the work.

#### **645.2.2.5 Geotextile, Type SR (Subgrade Reinforcement)**

- (1) Furnish fabric conforming to the physical properties the special provisions specify.
- (2) For quantities over 10,000 square yards, furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile delivered conforms to the above requirements. Mark the delivered geotextile to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yards or lesser portion thereof used on this contract.

#### **645.2.2.6 Geotextile, Type R (Riprap)**

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE <sup>[1]</sup>
Minimum grab tensile strength	<a href="#">ASTM D4632</a>	205 lb
<b>Minimum puncture strength</b>	<a href="#">ASTM D6241</a>	<b>400 lb</b>
Minimum apparent breaking elongation	<a href="#">ASTM D4632</a>	15%
Maximum apparent opening size	<a href="#">ASTM D4751</a>	No. 30
Minimum permittivity	<a href="#">ASTM D4491</a>	0.12 s <sup>-1</sup>

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

#### **645.2.2.7 Geotextile, Type HR (Heavy Riprap)**

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE <sup>[1]</sup>
Minimum grab tensile strength, lb	<a href="#">ASTM D4632</a>	305 lb
<b>Minimum puncture strength, lb</b>	<a href="#">ASTM D6241</a>	<b>500 lb</b>
Minimum apparent breaking elongation, %	<a href="#">ASTM D4632</a>	15%
Maximum apparent opening size	<a href="#">ASTM D4751</a>	No. 30
Minimum permittivity	<a href="#">ASTM D4491</a>	0.40, s <sup>-1</sup>

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

#### **645.2.2.8 Geotextile, Type C (Modified SAS)**

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE <sup>[1]</sup>
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Grab tensile strength, lb	<a href="#">ASTM D4632</a>	205 lb
Puncture strength, lb	<a href="#">ASTM D6241</a>	350 lb
Maximum apparent opening size	<a href="#">ASTM D4751</a>	No. 50
Minimum permittivity	<a href="#">ASTM D4491</a>	0.12 s <sup>-1</sup>

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

### 645.2.2.9 Geotextile, Type ES (Embankment Stabilization)

- (1) Furnish fabric conforming to the physical properties the special provisions specify.
- (2) Deliver to the engineer a sample of the geotextile material at least 15 days before incorporating it into the work. At the same time, furnish a sewn seam sample using the same geotextile, thread, seam spacing and number, and overlap distance as are intended or required for use in the work.
- (3) Furnish to the engineer, at least 15 days before use in the work, a manufacturer's certified report of test or analysis that shows that the geotextile delivered conforms to the above requirements. Mark the delivered geotextile to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yard or lesser portion used on the contract.

### 645.2.3 Geogrid

#### 645.2.3.1 General

- (1) Furnish geogrid that consists of either single or joined multiple layers of a uniform square or rectangular grid of bonded, formed, or fused polymer tensile strands. Furnish polyester, polypropylene, polyamide, or polyethylene material that maintains dimensional stability during handling, placing, and installation. Use geogrid that is at least 6.0 feet wide.
- (2) Deliver a sample of the geogrid material to the engineer at least 10 business days before incorporating into the work. Submit a manufacturer's Certified Report of Test or Analysis that verifies that the geogrid delivered meets the requirements of this specification. The engineer will obtain samples of geogrid for testing from the job site for each 10,000 square yards, or portion thereof, incorporated into the work.

#### 645.2.3.2 Geogrid, Type SR (Subgrade Reinforcement)

- (1) Provide geogrid for subgrade reinforcement that complies with the following physical properties:

TEST	METHOD	VALUE <sup>[1]</sup>
Tensile Strength at 5% Strain (both principal directions in lb/ft)	<a href="#">ASTM D4595</a> <sup>[2]</sup>	450 min
Flexural Rigidity (both principal directions in mg/cm)	<a href="#">ASTM D1388</a> <sup>[3]</sup>	150,000 min.
Aperture Area (in <sup>2</sup> )	Inside Measurement <sup>[4]</sup>	5.0 max
Aperture Dimension (in)	Inside Measurement <sup>[4]</sup>	0.5 min

<sup>[1]</sup> All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

<sup>[2]</sup> The tensile strength (T) of a joined multi-layered geogrid shall be computed using the following equation:

$$T = n \times t \times f$$

Where:

- n** = the number of individual layers in the joined multi-layered geogrid
- t** = the tensile strength of a single layer of geogrid as determined using testing method [ASTM D4595](#)
- f** = reduction factor based on the number of layers comprising the multi-layered system and determined by the equation  $f = 1.00 - [0.04(n - 1)]$

<sup>[3]</sup> Values determined by option "A" cantilever test of testing method [ASTM D1388](#) using test specimens that are 36 inches ±0.04 inch long. Test specimen widths for differing geogrids are variable and equal to one element plus 1/2 the aperture width on both sides of that element. An element is defined as the minimum number of parallel strands that form a distinguishable repeating pattern.

<sup>[4]</sup> Aperture area and aperture dimension for joined multi-layer geogrids are determined based on measurement of a single layer of the geogrid.

#### 645.2.3.3 Geogrid, Type MR (Marsh Reinforcement)

- (1) Provide geogrid for marsh reinforcement that complies with the physical properties specified in the contract special provisions.

#### **645.2.3.4 Geogrid, Type SSR (Slope Stability Reinforcement)**

- (1) Provide geogrid for slope stability reinforcement that complies with the physical properties specified in the contract special provisions.

### **645.3 Construction**

#### **645.3.1 Geotextiles**

##### **645.3.1.1 General**

- (1) For geotextiles that require sewing, sew factory and field seams with a thread having the same or greater durability as the fabric material. Use a 401 stitch conforming to Federal Standard No. 751a for seams. Ensure that seams develop a tensile strength equal to or greater than 60 percent of the specified grab tensile strength of the fabric, unless specified otherwise.

##### **645.3.1.2 Geotextile, Type SAS**

- (1) Before placing the geotextile, smooth, shape, and compact the subgrade to the required grade, section, and density. After placing the fabric on the subgrade area, the engineer will not allow traffic or construction equipment to travel directly on the fabric.
- (2) Roll the fabric out on the roadway and pull taut manually to remove wrinkles. Join separate pieces of fabric by overlapping or sewing. Place the fabric in the overlapped joints so it overlaps at least 18 inches.
- (3) The engineer may require the use of weights or pins to prevent the wind from lifting the fabric.
- (4) After placing, do not expose the fabric longer than 48 hours before covering.
- (5) Place the base material over the fabric by back dumping with trucks and leveling with a crawler dozer. The contractor shall not use construction equipment that causes ruts deeper than 3 inches. Fill ruts with additional material. The engineer will not allow the contractor to smooth ruts without adding additional material. Cover damaged areas with a patch of fabric using a 3-foot overlap in all directions.

##### **645.3.1.3 Geotextile, Type MS**

- (1) Complete clearing operations before placing the fabric. Within the area being covered by fabric, cut stumps and sharp objects level with the ground surface. Do not remove sod, grass, and roots that extend beneath the ground surface. Carefully place the geotextile on the ground using hand methods to avoid disturbing the existing root mat and vegetation. Roll the fabric out as smoothly as possible and pull taut manually to remove wrinkles. The engineer may require the use of weights or pins to prevent the wind from lifting the fabric. After placement, do not expose the fabric longer than 48 hours before covering. If visible defects exist, replace the defective section of fabric with a new defect-free section of fabric.
- (2) Place the geotextile with the machine direction perpendicular to the roadway alignment. Sew seams with 2 parallel stitch lines according to plan details. Space the parallel stitching no more than one inch apart. Place seams perpendicular to the roadway alignment and facing upward. Ensure that seams develop at least 80 percent of the specified cross direction tensile strength of the fabric, as determined by the same testing methods. Do not make butt splices between individual roll ends. One stitch line may not cross another stitch line. Repair breaks or faults in any seam as the engineer directs.
- (3) Place the initial fill layer over the fabric to a depth not less than one-foot but not more than 2 feet by carefully end dumping and pushing on to the fabric. The contractor shall not use construction equipment that causes ruts deeper than 3 inches and does not excessively deform the marsh surface. The contractor shall not drive vehicles on the fabric. Complete the initial lift and install instrumentation before placing any additional material. After placing the initial lift, place subsequent lifts no deeper than one foot. Do not begin any lift until completing the preceding lift and obtaining the engineer's approval. Conduct spreading operations so that no damage occurs to the fabric. Unless the engineer directs otherwise, place and spread lifts by expanding outward from the centerline of the fill. If fill placement damages the fabric, remove the fill material around the damaged area and the engineer will examine the damaged area to determine if the material requires replacement.

##### **645.3.1.4 Geotextile, Type DF**

- (1) Before placing the geotextile in trench drains, construct the trench to the grades and dimensions the plans show or as the engineer directs. Remove protruding stones and other matter that might damage the geotextile from the trench walls and base before placing the fabric. Place the geotextile in the trench so it conforms to the trench walls and remains in proper position during drain construction and backfilling. The contractor may join separate pieces of fabric by overlapping or sewing. If overlapping, place the fabric in overlap joints of at least 18 inches in the direction of drain flow. Correct misaligned

fabric as the engineer directs. The engineer will direct treatment of damaged fabric areas by one of the following methods:

1. Place an additional section of fabric extending at least 24 inches beyond any point of the damaged area and position between the trench walls and the damaged fabric.
  2. Remove the section of fabric containing the damaged area and replace it with a new section of fabric.
- (2) After placing, do not expose the fabric longer than 48 hours before covering.
  - (3) For applications other than trench drains, construct the surface on which placing the fabric to the grades and dimensions the plans show. Prepare the surface by removing or covering objects that might damage the fabric. Carefully place the fabric to prevent damage and secure in position. Conduct backfilling or covering operations so that no damage or misalignment occurs to the fabric. Treat fabric damage or misalignment as specified in the previous paragraph. After placement, do not expose the fabric longer than 48 hours before covering or backfilling.

#### **645.3.1.5 Geotextile, Type SR**

- (1) Before placing the fabric, smooth and shape the roadway to the required grade and section, and if the engineer requires, compact to the specified density. After placing the fabric on the earth grade, the contractor shall not allow traffic or construction equipment to travel on the fabric.
- (2) Roll out the fabric on the roadway and pull taut manually to remove wrinkles. Join parallel strips of fabric by overlapping or sewing. Sew seams as specified in [645.3.1.1](#), except ensure a tensile strength equal to or greater than 60 percent of the specified directional tensile strength of the fabric develops. Overlap the fabric in joints at least 24 inches. Overlap butt splices between fabric rolls at least 36 inches. The engineer may require the use of weights or pins to prevent the wind from lifting the fabric.
- (3) Cover tears, holes, or rips in the fabric with a patch of fabric overlapping the defect 36 inches in directions.
- (4) Cover fabric within 72 hours of placement.
- (5) Place the backfill material in an initial lift of 12 inches. Do not place subsequent lifts, in layers exceeding 12 inches thick. Spread each lift with a crawler type tractor and compact with suitable compaction equipment. The contractor shall not use construction equipment that causes ruts deeper than 4 inches. The engineer will not allow turning movements for any hauling or spreading equipment on the fabric until at least 2 lifts of backfill, at least 18 inches deep, are placed and compacted. Do not begin subsequent lifts until spreading and compacting a distance of at least 1000 feet of the previous lift. Maintain a 1000-foot interval between subsequent lifts until completing each lift. If ruts greater than 4 inches develop during construction operations, the engineer may require the contractor to use lighter equipment, equipment with lower contact pressure, or smaller loads on existing equipment.
- (6) Fill ruts in the surface of each lift of backfill with additional material. Do not smooth ruts without adding additional backfill.

#### **645.3.1.6 Geotextile, Type R**

- (1) Before placing the fabric, grade the area smooth and remove stones, roots, sticks, or other matter that might prevent the fabric from completely contacting the soil.
- (2) Place the fabric loosely and lay it parallel to the direction of water movement. The engineer may require pinning or stapling to hold the geotextile in place. Join separate pieces of fabric by overlapping or sewing. Overlap the fabric in the joints at least 24 inches in the direction of flow. After placing, do not expose the fabric longer than 48 hours before covering.
- (3) Cover damaged areas with a patch of fabric that overlaps 3 feet in all directions.
- (4) Place riprap from the base of the slope upward. The engineer will determine the freefall height of riprap, but in no case should this height exceed one foot.

#### **645.3.1.7 Geotextile, Type HR**

- (1) Place as specified in [645.3.1.6](#), except that the freefall height of riprap must not exceed 6 inches.

#### **645.3.1.8 Geotextile, Type C**

- (1) Before placing geotextile, construct and shape the grade to the required grade and section. After placing the fabric, the engineer will not allow traffic or construction equipment to travel on the fabric.
- (2) Roll out the fabric on the excavation and pull taut manually to remove wrinkles. Join separate pieces of fabric by overlapping or sewing. Overlap the fabric in joints at least 18 inches. The engineer may require the use of weights or pins to prevent the wind lifting the fabric.
- (3) After placing, do not expose the fabric longer than 48 hours before covering.

- (4) Then place the specified backfill material over the fabric. The contractor shall not use construction equipment that causes ruts over 3 inches deep. Fill ruts with additional material and level to required grade. Do not smooth ruts without adding additional material.

#### **645.3.1.9 Geotextile, Type ES**

- (1) Before placing the geotextile, construct the embankment to the required elevation and make the surface smooth and level. Place the fabric on the prepared surface to the limits the plans show with the machine direction of the fabric oriented in the direction the plans show. Roll out the fabric as smoothly as possible and pull taut manually to remove wrinkles. The engineer may require the use of weights or pins to prevent the wind lifting the fabric. After placing, do not expose the fabric longer than 48 hours before covering. If visible defects or damage to the fabric exists, remove the section containing the defect or damage and replace with a new section of defect-free fabric.
- (2) Sew seams between fabric strips with 2 parallel stitch lines spaced no more than one inch apart according to the details the plans show. Orient seams parallel to the roadway alignment and face upward. Sew seams with a thread having the same or greater durability as the fabric material. Use a 401 stitch conforming to Federal Standard No. 751a for all seams. Ensure that all seams develop a tensile strength equal to or greater than 50 percent of the specified cross direction tensile strength of the fabric. Repair sewing defects in any seam as the engineer directs. Do not use butt splices between individual roll ends.
- (3) Place the initial fill layer over any fabric layer to a depth not less than 8 inches or more than one foot. Carefully end dump and push this lift on to the fabric. Perform spreading operations and use equipment in a way that does not displace or damage the fabric. Do not make sharp turning movements while placing the initial lift over any individual fabric layer. The contractor shall not drive vehicles on the fabric. Complete the preceding lift before beginning the next lift. Place and compact additional lifts as specified in [207](#).
- (4) Unless specified otherwise, use the granular fill material, specified in the plans and special provisions, from at least 8 inches below to at least 8 inches above any single or multiple layer geotextile installation.

#### **645.3.2 Geogrid**

##### **645.3.2.1 General**

- (1) Place geogrid as the plans show or engineer directs. Pull flat and secure using pins, staples, or other devices to prevent movement or displacement. Lap butt joints between roll ends at least 12 inches unless the plans or special provisions specify otherwise. Secure lapped sections together using engineer-approved ties, straps, clips, or other devices. Do not operate vehicles or construction equipment directly on geogrid.
- (2) Cover small rips, tears, or defects in the geogrid with an additional section of geogrid secured in place overlapping the damaged area by at least 3 feet in all directions. Remove and replace geogrid sections with large rips, tears, defects, or other damage as the engineer directs before backfilling.
- (3) After placement, backfill the geogrid to the depth and with the type of material the plans or special provisions specify. Place, spread, and compact backfill conforming to the standard spec or special provision requirements for that backfill material, except ensure that the initial lift over the geogrid is at least 4 inches deep.
- (4) Do not displace or damage the geogrid during backfill operations. The engineer may direct the contractor to repair or replace damaged, displaced, or otherwise defective geogrid and may require equipment and operations changes to prevent further damage or displacement.

##### **645.3.2.2 Geogrid, Type SR**

- (1) Before placing geogrid, establish the placement surface to the required lines, grades, and dimensions the plans show or as the engineer directs. Smooth and shape the surface to eliminate rocks, clods, roots, or other debris that may damage the geogrid during placement or backfilling.
- (2) Overlap parallel strips at least 6 inches.

##### **645.3.2.3 Geogrid, Type MR**

###### **645.3.2.3.1 General**

- (1) Complete clearing operations before placing geogrid. Cut stumps and sharp objects level with the ground surface where placing geogrid. Do not remove sod, grass, or roots that extend beneath the ground surface unless the engineer directs. Avoid disturbing the existing root mat and vegetation during geogrid placement. Unroll the geogrid and pull tight manually to remove wrinkles. If the geogrid

has different strengths in the machine and cross directions, orientate as the plans or special provisions specify.

- (2) Overlap parallel strips at least 12 inches unless the plans or special provisions specify otherwise.

**645.3.2.4 Geogrid, Type SSR**

**645.3.2.4.1 General**

- (1) Before placing the geogrid, smooth and shape the roadway to the required lines, grades and dimensions the plans show or as the engineer directs. Smooth and shape the surface to eliminate rocks, clods, roots, or other debris that may damage the geogrid during placement or backfilling.
- (2) Overlap parallel strips at least 12 inches unless the plans or special provisions specify otherwise.

**645.4 Measurement**

- (1) The department will measure the Geotextile and Geogrid bid items by the square yard acceptably completed.

**645.5 Payment**

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
645.0100 - 0199	Geotextile (type)	SY
645.0200 - 0299	Geogrid (type)	SY

- (2) Payment for the Geotextile bid items is full compensation for providing geotextile. Payment for the Geotextile Type MS, Type ES, Type R, Type HR, and Type C bid items also includes preparing the marsh area or foundation before installation.
- (3) Payment for the Geogrid bid items is full compensation for providing geogrid. Payment for Geogrid Type MR also includes preparing the marsh area before installation.