SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 05 20

GEOSYNTHETIC DRAINAGE LAYER

08/08

PART 1  GENERAL

1.1 MEASUREMENT AND PAYMENT
1.2 REFERENCES
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.5 DELIVERY, STORAGE, AND HANDLING

PART 2  PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE LAYER
2.2 SAMPLING AND TESTING
  2.2.1 Manufacturing Quality Control Testing
  2.2.2 Construction Quality Control Testing

PART 3  EXECUTION

3.1 INSTALLATION
  3.1.1 Surface Preparation
  3.1.2 Placement
  3.1.3 Seams and Overlaps
    3.1.3.1 Geonet Side Seams
    3.1.3.2 Geonet End Seams
    3.1.3.3 Geonet Fasteners
    3.1.3.4 Geotextile Seams
    3.1.3.5 Geotextile Cap Strips
  3.1.4 Stacked Geosynthetic Drainage Layers
  3.1.5 Corners
  3.1.6 Penetrations

3.2 REPAIRS
  3.2.1 Geonet Damage
  3.2.2 Geotextile Damage

3.3 PROTECTION AND BACKFILLING

-- End of Section Table of Contents --
PART 1   GENERAL

1.1   MEASUREMENT AND PAYMENT

NOTE: Delete this paragraph when lump sum bidding is used.

Measure the total surface area in square meters covered by geosynthetic drainage layer. Base final quantities on as-built conditions. Allowance will be made for geosynthetic drainage layer in anchor and/or drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. Geosynthetic drainage layer accepted by the Contracting Officer will be paid for at the respective contract unit price in the bidding schedule.
The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)


ASTM D1603 (2020) Carbon Black Content in Olefin Plastics

ASTM D4218 (2020) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

ASTM D4355/D4355M (2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus


ASTM D4632/D4632M (2015a) Grab Breaking Load and Elongation of Geotextiles

ASTM D4716/D4716M (2008; R 2013) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

1.3 SUBMITTALS

**************************************************************************

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Locate the "S" submittal under the SD number that best describes the submittal item.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed
Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data
   Sampling and Testing
   Penetrations
   Construction Quality Control (QC) Laboratory

SD-04 Samples
   Geosynthetic Drainage Layer
   Seams and Overlaps

SD-06 Test Reports
   Sampling and Testing
   Geosynthetic Drainage Layer

1.4 QUALITY ASSURANCE

Provide a construction quality control (QC) laboratory that has also performed quality assurance (QA) testing, if required, of geosynthetic drainage layers for at least five completed projects, having a total minimum area of [186,000] [_____] square meters [2] [_____] million square feet. Submit qualifications of laboratory which shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests it will be required to perform.

1.5 DELIVERY, STORAGE, AND HANDLING

The QC inspector shall be present during delivery and unloading of the geosynthetic drainage layer. Ensure the drainage layer material has not been damaged during shipping, storage, or handling. Any drainage layer material found to be damaged shall be repaired or replaced. Accept delivery of material only after the required submittals have been approved. Each roll shall be labeled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls that have attached geotextiles shall be individually wrapped in plastic. Store the rolls in a level and dry area.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE LAYER

NOTE: The flow capacity required for the geosynthetic drainage layer should be determined using a procedure such as the one described in GRI
Report Number 19 - The Design of Drainage Systems Over Geosynthetically Lined Slopes. Appropriate global safety factors and reduction factors should be applied to transmissivity values reported by manufacturers. A global factor of safety of 2 is typically used. Guidance on reduction factors for intrusion, creep, chemical clogging, and biological clogging are provided in Designing with Geosynthetics by Dr. Robert Koerner and GRI Standard-GC8 Determination of the Allowable Flow Rate of a Drainage Geocomposite.

If high long term normal stresses are anticipated (e.g. 192 kPa 4000 psf or greater), requirements for maximum allowable creep strain should be included in Table 1. Creep strain requirements for geosynthetic drainage layers are determined using test method GRI GS 4 - Time Dependent (Creep) Deformation Under Normal Pressure. Typically, a normal stress of 2 to 3 times the design stress for a period of at least 10000 hours is used for creep strain testing.

Delete paragraphs and sentences which describe geotextile material and construction requirements if geotextiles will not be attached to the geonet.

**************************************************************************

The polymer used to manufacture the geonet component of the geosynthetic drainage layer shall be polyethylene which is clean and free of any foreign contaminants. Submit one properly identified 610 by 610 mm 24 by 24 inch minimum size geosynthetic drainage layer sample; fasteners proposed for use; and the method of seaming and overlapping. Submit manufacturer's quality control test results. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. Conform the geosynthetic drainage layer to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. The geonet shall be covered on [one] [both] sides with nonwoven geotextile. Create geocomposite by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 150 mm 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

**TABLE 1 - GEOSYNTHETIC DRAINAGE LAYER PROPERTIES**

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TEST VALUE</th>
<th>MINIMUM MQC TESTING FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEONET COMPONENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness, minimum avg, Note 1</td>
<td>ASTM D5199</td>
<td>5 mm 200 mil</td>
<td>9300 sq m 100,000 sq ft</td>
</tr>
<tr>
<td>Polymer Density, minimum avg</td>
<td>ASTM D1505</td>
<td>0.940 g/cc</td>
<td>9300 sq m 100,000 sq ft</td>
</tr>
<tr>
<td>PROPERTY</td>
<td>TEST METHOD</td>
<td>TEST VALUE</td>
<td>MINIMUM MQC TESTING FREQUENCY</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>ASTM D1603</td>
<td>1-3 percent</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td></td>
<td>ASTM D4218</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Strength, minimum avg, Note 2</td>
<td>ASTM D5035</td>
<td>7884 N/m45 lbs/inch</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>GEOTEXTILE COMPONENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass/Unit Area, MARV</td>
<td>ASTM D5261</td>
<td>0.2 kg/sq m6.0 oz/SY</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>Grab Strength, MARV</td>
<td>ASTM D4632/D4632M</td>
<td>698 N157 lbs</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>Grab Elongation, MARV</td>
<td>ASTM D4632/D4632M</td>
<td>50 percent</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>Tear Strength, MARV</td>
<td>ASTM D4533/D4533M</td>
<td>245 N55 lbs</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>Puncture Strength, MARV</td>
<td>ASTM D4833/D4833M</td>
<td>245 N55 lbs</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
<tr>
<td>Permittivity, MARV</td>
<td>ASTM D4491/D4491M</td>
<td>.2/sec</td>
<td>46,500 sq m500,000 SF</td>
</tr>
<tr>
<td>AOS(O95), MaxARV</td>
<td>ASTM D4751</td>
<td>.25 mm</td>
<td>46,500 sq m500,000 SF</td>
</tr>
<tr>
<td>UV Stability, percent retained (500 hours)</td>
<td>ASTM D4355/D4355M</td>
<td>50 percent</td>
<td>Note 3</td>
</tr>
<tr>
<td>GEOCOMPOSITE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmissivity, min, including attached geotextiles, Note 4</td>
<td>ASTM D4716/D4716M</td>
<td>(_____) gal/min-foot</td>
<td>18,600 sq m200,000 sq ft</td>
</tr>
<tr>
<td>Geonet/Geotextile Adhesion, minimum avg, Note 5</td>
<td>ASTM D7005</td>
<td>0.5 lbs/inch</td>
<td>9300 sq m100,000 sq ft</td>
</tr>
</tbody>
</table>

Note 1: The diameter of the presser foot shall be 56 mm 2.22 inches and the pressure shall be 20 kPa 2.9 psi. For other thickness options, see manufacturer's literature.

Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: Manufacturing quality control transmissivity tests shall be measured using a gradient of \([0.1] [_____]\) under a normal pressure of \([10] [100] [_____]\) kPa \([1.45] [14.9] [_____]\) psi. Use a minimum seating period of 15 minutes. Perform the test between rigid end platens.

Note 5: Average of five tests across the roll width. Discounting the outer 305 mm 1 foot of each side of the roll, collect samples at the 10, 30, 50, 70, and 90 percent positions across the roll width. Test both sides for double sided geocomposites.
2.2 SAMPLING AND TESTING

2.2.1 Manufacturing Quality Control Testing

Manufacturing quality control test methods and frequencies shall be in accordance with Table 1 unless otherwise approved. Submit manufacturer's quality control manual and construction quality control test results.

2.2.2 Construction Quality Control Testing

**************************************************************************

NOTE: One or more additional performance type transmissivity tests are often required to be performed by the Contractor's quality control laboratory. These tests should be performed at gradients and normal stresses that model site conditions. The type of material in contact with the geosynthetic drainage layer affects the flow properties of the drainage layer. Performance tests should use site specific soils and geosynthetics when such materials are known.

Typically, normal loads for CQC transmissivity tests are seated on the geosynthetic drainage layer for 100 hours prior to testing to account for long-term intrusion and creep. A reduction factor for intrusion should be used if a seating period of less than 100 hours is used.

The transmissivity requirement for the construction quality control transmissivity tests will generally be lower than the value shown in Table 1 for the manufacturing quality control tests.

**************************************************************************

Perform a minimum of [one] construction quality control transmissivity test in accordance with the requirements of this paragraph. Measure transmissivity using a gradient of [_____] under a normal pressure of [_____] kPa psf. Attach geotextile to the geonet in the same configuration as will be used in the field. The drainage layer shall be sandwiched between [_____] on the bottom and [_____] on the top. Use a minimum seating period of [100][_____] hours. The construction quality control test results shall achieve a minimum transmissivity of [____:].

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geosynthetic drainage layer, the subgrade shall be smooth and free of all materials which could damage the drainage layer.

3.1.2 Placement

The geosynthetic drainage layer shall not be damaged during placement. Unroll the drainage layer in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The
drainage layer shall not be dragged across textured geomembrane if a
geotextile is attached to the surface facing the geomembrane. Place
adequate ballast (e.g. sandbags) to prevent uplift by wind prior to
covering.

3.1.3 Seams and Overlaps

3.1.3.1 Geonet Side Seams

Overlap geonet side seams a minimum of 100 mm 4 inches. Side seam
fastener spacing shall be a maximum of 1.5 m 5 feet. In anchor trenches,
fastener spacing shall be a maximum of 305 mm 1 foot.

3.1.3.2 Geonet End Seams

NOTE: Flow capacity of the geosynthetic drainage
layer must be adequate to ensure all flow remains in
the drainage layer and head does not build up in the
cover soils above the drainage layer. For this
reason, consideration must be given to flow capacity
of end seams on slopes. If end seam flow capacity
is a concern, end seams can be prohibited on side
slopes or they can be configured such that water can
flow from one geonet to another without passing
through any geotextile layers.

Overlap geonet end seams a minimum of 305 mm 1 foot. End seam fastener
spacing shall be a maximum of 305 mm 1 foot. The overlaps shall be in the
direction of flow.

3.1.3.3 Geonet Fasteners

Tie geonet rolls together with plastic fasteners. The fasteners shall be
a contrasting color from the geonet and attached geotextiles. Metallic
fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The geotextile component of the geocomposite shall be [overlapped in the
direction of flow] [thermally bonded using approved methods] [sewn using
approved methods].

3.1.3.5 Geotextile Cap Strips

Place geotextile cap strips over any exposed edges of geocomposite. Cap
strips shall be a minimum of 610 mm 2 feet in width and shall be thermally
bonded to the geotextile component of the geocomposite.

3.1.4 Stacked Geosynthetic Drainage Layers

When geosynthetic drainage layers are to be stacked, stagger roll ends and
edges so that joints do not lie above one another.

3.1.5 Corners

In the corners of landfill liner side slopes, install an extra layer of
drainage layer material from the top to the bottom of the slope.
3.1.6 **Penetrations**

Submit penetration details. Mechanically attach a geotextile apron to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 610 mm 2 feet. The apron geotextile shall be thermally bonded to the geotextile [component of the geocomposite][overlying the geonet].

3.2 **REPAIRS**

3.2.1 **Geonet Damage**

Make repairs by placing a patch of the geosynthetic drainage layer over the damaged area. Extend the patch a minimum of 610 mm 2 feet beyond the edge of the damage. Use approved fasteners, spaced every 150 mm 6 inches around the patch, to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 **Geotextile Damage**

Repair damaged geotextile by placing a patch of geotextile over the damaged area with a minimum of 305 mm 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place.

3.3 **PROTECTION AND BACKFILLING**

Cover the geosynthetic drainage layer with the specified materials within [14] [_____] days of acceptance. Place cover soil from the bottom of the slope upward and shall not be dropped directly onto the drainage layer from a height greater than 915 mm 3 feet. The cover soil shall be pushed out over the geosynthetic drainage layer in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. No equipment shall be operated on the top surface of the geosynthetic drainage layer without permission from the Contracting Officer. The initial loose soil lift thickness shall be 305 mm 12 inches. Use equipment with ground pressures no greater than 50 kPa 7 psi to place the first lift of soil. A minimum of [460] [610] [915] [_____] mm [18] [24] [36] [_____] inches of soil shall be maintained between construction equipment with a ground pressure greater than 50 kPa 7 psi and the drainage layer. Cover soil compaction and testing requirements are described in Section 31 00 00 EARTHWORK.

--- End of Section ---