

SECTION 00350 - GEOSYNTHETIC INSTALLATION

(Follow all instructions and make all edits with "Track Changes" turned on. If there are no instructions [purple text] above a subsection, paragraph, sentence, or bullet, then include it in the Project. Delete all purple text before preparing the final document. All other modifications to this Section will require ODOT Technical Resource and State Specifications Engineer approval.)

(Use the following lead-in paragraph when geomembrane is not included in the Project.)

Comply with Section 00350 of the Standard Specifications.

(Use the following lead-in paragraph and following subsections when geomembrane is included in the Project.)

Comply with Section 00350 of the Standard Specifications modified as follows:

00350.00 Scope - Replace the paragraph that begins "This Work consists of furnishing and placing ..." with the following paragraph:

This Work consists of furnishing and placing Geosynthetics in drains, stormwater control facilities (i.e. swales, ponds, trenches), under embankments, for embankment reinforcement, under riprap, Buttresses, inlays, shear keys, over Roadbed Subgrades, and beneath Pavement overlays as shown or directed.

00350.01 Definitions - Add the following definition:

Geomembrane - An essentially impermeable geosynthetic composed of one or more synthetic sheets.

Replace the definition "**Seam Type**" with the following definition:

Seam Type - A designation of Geotextile positioning and rows of stitching in a specified sewn seam as shown (for example Type SSn-1, "J" Seam SSn-1). The designated method of joining Geomembrane sheets (for example thermal fusion welding, extrusion welding).

Add the following subsection:

00350.02 Submittals - Submit unstamped working drawings according to 00150.35. Include the geomembrane installation layout, details of field seams, treatment around penetrations and adjacent structures and anchor trench. Provide an installation layout to include geomembrane widths appropriate for the installation and to minimize field seams.

Submit equipment lists and other submittals according to 00150.37, include geomembrane handling, storage and installation procedures, equipment and personnel experience documents, and report of quality control testing.

00350.20 Field Seam Equipment - Replace this subsection, except for the subsection number and title, with the following:

Use field seaming equipment meeting the following requirements:

(a) Geotextile - Use field seam stitching Equipment that provides an acceptable lock-type stitch as recommended by the Geotextile manufacturer and approved by the Engineer.

(b) Geomembrane - Use thermal fusion welding Equipment for dual track field seaming as recommended by the Geomembrane manufacturer. Use extrusion welding equipment as recommended by the Geomembrane manufacturer at locations where thermal fusion welding is not possible, for example at patches, repairs, and short runs.

Add the following subsection:

00350.30 Personnel Qualifications - Provide installer's and seamer's that have experience from at least five installations similar to Work in the Project. For each project, include the project name, location, year of construction, type and area of geomembrane installed, seam testing performed, owner's contact name, and current phone number.

Add the following subsection:

00350.43 Geomembrane Liner Installation Requirements - Install geomembrane liner as shown or specified in the reviewed submittals, or as directed.

(a) Placement:

(1) Surface Preparation - Prepare and compact Subgrade and Soil fills with 3/4 inch maximum Aggregate as directed. Prior to installing the geomembrane, inspect the subgrade, remove all foreign matter and sharp, protruding or loose material that could penetrate or otherwise damage the geomembrane.

(2) Weather and Temperature Restrictions - Place geomembrane when the temperature is between 40 to 104 °F. Do not place geomembrane during the presence of excessive moisture or excessive winds as determined and directed by the Engineer.

(3) Inspection - During installation, visually inspect the geomembrane for imperfections, defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Mark and repair faulty or suspect areas.

(b) Seams - Overlap panels at least 2 feet and construct dual track thermal weld seam according to the manufacturer's recommendations. For slope application, align geomembrane panels and seam parallel to the line of maximum slope and minimize cross slope seams. Perform field quality control of seams according to 00350.43(f).

Furnish test samples 1.5 feet long by 1 foot wide from the overlap with the seam centered in the sample.

(c) Cuts and Penetrations - Perform all cuts, welds and penetrations according to manufacturer's specifications.

(d) Protection of Geomembrane - Protect the geomembrane at all times from ultraviolet (UV) rays, contamination by surface runoff and damage from construction equipment and activities. Use methods to unroll the panels that minimize wrinkles. Minimize direct contact by personnel, Equipment and tools with the fabric. Do not drive Equipment directly on the geomembrane. Ensure the area to be lined and the cover fill material is smooth and free of sharp material that could penetrate or otherwise damage the geomembrane. Place and spread Aggregate over the geomembrane in a manner that prevents punctures, wrinkles, or other damage to the geomembrane.

(e) Edges - Secure edges of geomembrane using anchor trenches in Soil and attach geomembrane to Structures and around penetrations as shown or directed.

(f) Field Quality Control - Visually inspect all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Ensure the membrane is clean at the time of inspection.

Nondestructively test each suspect location in seam and non-seam areas as appropriate. Mark and repair each location that fails the nondestructive testing accordingly.

(1) Prequalification Seams - Each Day, prior to geomembrane seaming, perform a minimum 3-foot long prequalification seam by each welding technician and welding machine under the same conditions as the installation to determine proper seaming operation. Use geomembrane material from the same lot as the geomembrane to be installed.

(a) Nondestructive dual seam testing - Mark the date, ambient temperature, and welding machine identification for each prequalification test seam. Perform ASTM D5820 air channel test of the geomembrane dual track seam and use a threshold value of 4 psi pressure loss. Use ASTM D5820 Figure 1 report form for test documentation.

(b) Destructive seam testing for nonreinforced geomembrane seams produced using thermo-fusion methods - Cut samples, prepare specimens, perform peel and shear tests, and report results according to ASTM D6392 for each prequalification test seam. For each seam sample, cut, prepare, condition, and destructively test 5 specimens for peel strength and 5 for seam shear strength with a field tensometer. Perform peel tests on both the inside and outside weld tracks. The evaluation criteria are shown in Table 00350-1a, Table 00350-1b, and Table 00350-1c by geomembrane polymer type and thickness. Four out of five test specimens are required to satisfy the evaluation criteria for both peel strength and shear strength, and five out of five test specimens are required to satisfy the peel separation evaluation criteria for successful prequalification. If necessary, repeat with a new prequalification seam until successful prequalification is achieved.

(2) Field Seam Non-destructive Testing - Perform non-destructive testing the full length of field seams as seaming progresses and before seams are covered. Mark each seam by number or other approved designation. Record and submit air channel pressure test for each seam; identify each seam by number, location, date, name of QC tester, and test result.

Perform ASTM D5820 air channel test on HDEP and LLDPE geomembrane dual track seams and a threshold value of 4 psi pressure loss. Use ASTM D5820 Figure 1 report form for test documentation.

Perform ASTM D7177 air channel test on PVC geomembrane dual track field seams.

(3) Field Seam Destructive Testing Location and Frequency:

(Choose one of the following options considering the specific Project details, needs and risk.)

[Option 1 – High Risk Application]

Obtain a minimum of one destructive seam test sample per every 500 linear feet of production seam. Install a permanent patch over the test sample location and vacuum test all patches. The destructive seam sample locations will be selected by the Engineer. Cut samples, prepare specimens, perform peel and shear tests, and report results according to ASTM D6392. For each seam sample, cut, prepare, condition, and destructively test five specimens for peel strength and five for seam shear strength with a field tensometer. Perform peel tests on both the inside and outside weld tracks. Acceptance is based on four of five test specimens passing the stated criteria for both peel strength and shear strength, and five out of five test specimens passing the peel separation evaluation criteria in Table 00350-1a, Table 00350-1b, or Table 00350-1c appropriate for the geomembrane polymer type and thickness.

[Option 2 – Low Risk Application]

Obtain a destructive seam test sample from the anchor trench end of each seam. Install a permanent patch over the test sample location and vacuum test all patches. Cut samples, prepare specimens, perform peel and shear tests, and report results according to ASTM D6392. For each seam sample, cut, prepare, condition, and destructively test five specimens for peel strength and five for seam shear strength with a field tensometer. Perform peel tests on both the inside and outside weld tracks. Acceptance is based on four of five test specimens passing the stated criteria for both peel strength and shear strength, and five out of five test specimens passing for peel separation in Table 00350-1a, Table 00350-1b, or Table 00350-1c appropriate for the geomembrane polymer type and thickness.

[End of Option 2]

The following procedures apply whenever a sample fails the field destructive test:

1. Cap strip the seam between the failed location and any passed test location.

2. Retrace the welding path to an intermediate location (a minimum of 10 feet from the location of the field test) and take a sample for an additional peel and shear tests as above. If four of five test specimens pass the stated criteria in Table 00350-1a, Table 00350-1b, or Table 00350-1c appropriate for the geomembrane polymer type and thickness, the sample qualifies, cap strip the seam between that location and the original failed location. If the test fails, the process is repeated.

3. Cut out the old seam over the length of seam failure, reposition the panel, and reseam or add a cap strip, as required.

Table 00350-1a Minimum HDPE Geomembrane Hot Wedge Seam Strength

Geomembrane Thickness	Nominal	30 mils	40 mils	50 mils	60 mils
Minimum Shear Strength, lb/in		57	80	100	120
Minimum Peel Strength, lb/in		45	60	76	91
Maximum Peel separation, %		25	25	25	25

Table 00350-1b Minimum LLDPE Geomembrane Hot Wedge Seam Strength

Geomembrane Thickness	Nominal	30 mils	40 mils	50 mils	60 mils
Minimum Shear Strength, lb/in		45	60	75	90
Minimum Peel Strength, lb/in		38	50	63	75
Maximum Peel separation, %		25	25	25	25

Table 00350-1c Minimum PVC Geomembrane Hot Wedge Seam Strength

Geomembrane Thickness	Nominal	30 mils	40 mils	50 mils	60 mils
Minimum Shear Strength, lb/in		58.4	77.6	92.8	109.6
Minimum Peel Strength, lb/in		18	18	18	18

(g) Repair of Geomembrane - Repair or replace all torn, punctured or contaminated geomembrane during construction at no additional cost to the Agency. Repair according to the following:

- Repair small holes by extrusion cap welding. Patch the hole if larger than 1/4 inch.
- Repair tears by patching. Round any tears located on a slope or an area of stress or with a sharp end prior to patching.
- Repair blisters, large holes, undispersed raw materials and contamination by foreign matter using patches.
- Abrade and clean no more than 15 minutes the surface of geomembrane prior to repair by patching. Remove no more than 10% of the thickness.
- Make all patches rounded or oval in shape, of the same membrane fabric, and extend a minimum of 6 inches beyond the edge of defects. Make all patches of the same compound and thickness as the membrane specified. Make all patches with

their top edge beveled using an angle grinder prior to placement on the membrane. Apply all patches using approved methods only.

- Start the welding process by grinding the existing seaming and rewelding a new seam. Begin welding where the grinding started, overlapping the previous seam by at least 2 inches. Do not reseam over an existing seam without regrinding.
- Nondestructively test each repair. Repairs passing the nondestructive test are considered adequate. Repeat and retest each repair that fails these nondestructive tests until the repair passes.

Provide daily documentation of all nondestructive and destructive. This documentation to identify all seams that initially failed the testing and include evidence these seams were repaired and successfully retested.

00350.90 Payment - Add the following Pay Item to the Pay Item list:

(g) Geomembrane LinerSquare Yard

Add the following paragraph after the paragraph that begins "Item (e) includes...":

Item (g) includes all prequalification seams and testing, and all production seam testing and patches.