

**Appendix C**  
**LINEAR LOW DENSITY POLYETHYLENE GEOMEMBRANE SPECIFICATION**

Linear Low Density Polyethylene (LLDPE) Geomembranes serve as liners and covers to contain water, leachate or other liquids. As a liner they can contain the liquid to prevent leakage or environmental impact and as a cover to minimize evaporation or contamination. It is of great importance that the LLDPE Geomembrane be free from defects and installed without damage.

**A. DESCRIPTION**

1. General:

The purpose of this specification is to provide details of Manufacturing Quality Control (MQC), Manufacturing Quality Assurance (MQA), Construction Quality Control (CQC), and Construction Quality Assurance (CQA) for the manufacture and pre-assembly of geomembrane products. The Contractor shall furnish all labor, material, and equipment to install the LLDPE Geomembrane including all necessary and incidental items as detailed or required to complete the installation in accordance with the Contract Drawing and these Specifications

2. Related Work:

Related Contract Work is described in the following section of the specification as approved by the CQA Engineer.

3. Reference Standards:

Geosynthetic Research Institute Test Method GM17 *Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.*

ASTM D5199 *Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.*

ASTM D1505 *Standard Test Method for Density of Plastics by the Density-Gradient Technique.*

ASTM D1004 *Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.*

ASTM D1603 *Standard Test Method for Carbon Black Content in Olefin Plastics.*

ASTM D4833 *Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.*

*ASTM D6392 Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods*

*ASTM D6693 Standard Test Method for Determining Tensile Properties of Non-reinforced Polyethylene*

4. Quality Assurance:

Quality Assurance during installation of LLDPE Geomembrane will be provided by the Owner as described in the accompanying Project CQA Manual.

5. Manufacturers Qualifications:

- a. The Manufacturer shall have previously demonstrated his ability to produce the required LLDPE Geomembrane by having successfully manufactured a minimum of 10,000,000 ft<sup>2</sup> of LLDPE Geomembrane.
- b. Manufacturer must be ISO 9001 certified

6. Installer Qualifications:

The LLDPE Geomembrane Installer shall have installed a minimum of 500,000 ft<sup>2</sup> of LLDPE Geomembrane (or similar material).

7. Warranties:

The manufacturer of the LLDPE Geomembrane will warrant the material to the installer on a pro rata basis for up to 20 years after the final acceptance of the work, based on thickness, the application and location of the installation. This warranty shall include but not be limited to defects related to workmanship and manufacturing.

**B. MATERIALS**

1. General:

The materials supplied under these Specifications shall consist of first-quality 100% virgin products designed and manufactured specifically for the purpose of this work, which shall have been satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes.

2. LLDPE Geomembrane Materials:

- a. LLDPE Geomembrane shall be manufactured to meet the following requirements:
  - (1) Provide finished product free from holes, pin holes, bubbles, blisters, excessive gels, undispersed resins and/or carbon black, or contamination by foreign matter.
  - (2) LLDPE Geomembrane shall be a very flexible Linear Low Density Polyethylene Geomembrane containing carbon black for UV stability and contain no plasticizers.
- b. Approved LLDPE Geomembrane:
  - (1) HydraFlex™ Ultra HU20B  
HydraFlex™ Ultra HU30B  
HydraFlex™ Ultra HU40B  
  
As manufactured by Raven Industries of Sioux Falls, SD.
  - (2) Equal material, as approved by the Engineer.

**C. FACTORY FABRICATION**

1. The LLDPE Geomembrane shall be supplied in panels which shall be of maximum size to provide the largest manageable sheet for the fewest seams.
2. Factory seams are produced by thermal sealing methods and shall have a minimum seam width of 1 ½ inch.
3. Factory seams are 100% visually inspected and destructive testing is done to verify quality compliance.
4. Labels on the panels shall identify the thickness, length, width, lot and panel numbers, and name of Manufacturer.
5. Factory pre-assembled panels are accordion folded and rolled on a cardboard core. Rolled panels are wrapped in a protective layer for shipment.

**D. SUBMITTALS**

The Contractor shall submit the following to the CQA Engineer:

1. Pre-Installation Requirements:

Prior to LLDPE Geomembrane installation the Contractor shall submit the following:

- a. Certificate of Conformance and Sample: Prior to shipping to the site, the Contractor shall submit a certificate or affidavit signed by a legally authorized official of the Manufacturer for the LLDPE Geomembrane attesting that the LLDPE Geomembrane meets the physical and manufacturing requirements stated in these Specifications. The Contractor shall also submit a sample of the LLDPE Geomembrane to be used (sample may be of different color). The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.
- b. Shipping, Handling, and Storage Instructions: The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.
- c. Installation Procedures:  
  
Submit installation procedures for carrying out the work. Installation procedures to be addressed shall include but not be limited to material installation, repair, and protection to be provided in the event of rain or strong winds. With regard to protection, the Contractor shall provide a plan of anchoring the LLDPE Geomembrane sufficient to satisfy the Contractor's Performance Warranty. This plan shall be approved by the Engineer prior to construction.
- d. Furnish copies of the delivery tickets or other approved receipts as evidence for materials received that will be incorporated into the construction.

2. Post-Installation Requirements:

Upon completion of the LLDPE Geomembrane installation, the Contractor shall submit the following:

- a. Completed material performance warranty.

**E. SITE PREPERATION AND INSTALLATION**

- 1. Installation shall be in done in accordance with the manufactures Geomembrane Installation Guidelines.

**TABLE 1:  
REQUIRED LLDPE GEOMEMBRANE PROPERTIES 20 MIL.**

PROPERTY	TEST METHOD	UNITS	MIMUMUM ROLL	TYPICAL ROLL
----------	-------------	-------	--------------	--------------

			<b>AVERAGES</b>	<b>AVERAGES</b>
Thickness	ASTM D5199	Mils	20	21
Density	ASTM D1505	g/cm <sup>3</sup>	0.939 max	0.939 max
1" strip tensile	ASTM D6693	Lbf./in	136	151
Tensile Elongation	ASTM D6693	%	800	950
Puncture Resistance	ASTM D4833	Lbf.	49	53
Tear Resistance	ASTM D1004	Lbf.	13	15
Carbon Black	ASTM D1603	%	2-3	2-3
Bonded Seam Strength	ASTM D6392	Lbf/inch width	45	57
Seam Peel Adhesion	ASTM D6392	Lbf/inch width	30	35

Seam testing performed at 12" per minute

**TABLE 2:  
REQUIRED LLDPE GEOMEMBRANE PROPERTIES 30 MIL.**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>MIMUMUM ROLL AVERAGES</b>	<b>TYPICAL ROLL AVERAGES</b>
Thickness	ASTM D5199	Mils	30	31
Density	ASTM D1505	g/cm <sup>3</sup>	0.939 max	0.939 max
1" strip tensile	ASTM D6693	Lbf./in	170	189
Tensile Elongation	ASTM D6693	%	800	1000
Puncture Resistance	ASTM D4833	Lbf.	62	66
Tear Resistance	ASTM D1004	Lbf.	18	19
Carbon Black	ASTM D1603	%	2-3	2-3
Bonded Seam Strength	ASTM D6392	Lbf/inch width	65	81
Seam Peel Adhesion	ASTM D6392	Lbf/inch width	45	50

Seam testing performed at 12" per minute

**TABLE 3:  
REQUIRED LLDPE GEOMEMBRANE PROPERTIES 40 MIL.**

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>MIMIMUM ROLL AVERAGES</b>	<b>TYPICAL ROLL AVERAGES</b>
Thickness	ASTM D5199	Mils	40	41
Density	ASTM D1505	g/cm <sup>3</sup>	0.939 max	0.939 max
1" strip tensile	ASTM D6693	Lbf./in	208	242
Tensile Elongation	ASTM D6693	%	800	1000
Puncture Resistance	ASTM D4833	Lbf.	77	85
Tear Resistance	ASTM D1004	Lbf.	22	24
Carbon Black	ASTM D1603	%	2-3	2-3
Bonded Seam Strength	ASTM D6392	Lbf/inch width	99	101
Seam Peel Adhesion	ASTM D6392	Lbf/inch width	60	69

Seam testing performed at 12" per minute

Notes:

1. The Engineer may allow alternates to these requirements.