PERFORMANCE SPECIFICATION

SPECIFICATION 02530

GEOSYNTHETICS INSTALLATION

FOR

Axia Energy, LLC

Completion Pit - Bulldog #5-31H-790
012-1222

PART 1 GENERAL

This specification establishes the quality of materials and workmanship and defines how quality is measured for geosynthetic materials to be manufactured and installed for the Taylor Compressor Station.

The word “Owner”, as used here, shall mean Axia Energy, LLC.

Measurement shall be made of the total surface area in square feet covered by the geosynthetic. Final quantities will be based on as-built conditions. Allowance will be made for geosynthetic in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

2.1 ABBREVIATIONS

ASTM.....	American Society for Testing Materials
HDPE	High Density Polyethylene
LLDPE	Linear Low Density Polyethylene
GCL.....	Geosynthetic Clay Layer
GDL	Geosynthetic Drainage Layer
LDS	Leak Detection System

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2.2 CODES AND STANDARDS

ASTM D 1004 (2007)	Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1203 (1994; R 2003)	Volatile Loss from Plastics Using Activated Carbon Methods
ASTM D 1204 (2007)	Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 1505 (2003)	Density of Plastics by the Density-Gradient Technique
ASTM D 1603 (2006)	Carbon Black Content in Olefin Plastics
ASTM D 1790 (2002)	Brittleness Temperature of Plastic Sheeting by Impact
ASTM D 3895 (2007)	Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D 4218 (1996; R 2001)	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4354 (1999; R 2004)	Sampling of Geosynthetics for Testing
ASTM D 4355 (2007)	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491 (1999a; R 2004e1)	Water Permeability of Geotextiles by Permittivity
ASTM D 4533 (2004)	Trapezoid Tearing Strength of Geotextiles
ASTM D 4595 (2005)	Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632 (1991; R 2003)	Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716 (2004)	Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751 (2004)	Determining Apparent Opening Size of a Geotextile
ASTM D 4759 (2002)	Determining the Specification Conformance of Geosynthetics
ASTM D 4833 (2000e1)	Index Puncture Resistance of Geotextiles,

	Geomembranes, and Related Products
ASTM D 4873 (2002)	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D 5035 (2006)	Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199 (2001; R 2006)	Measuring Nominal Thickness of Geosynthetics
ASTM D 5261 (1992; R 2003)	Measuring Mass Per Unit Area of Geotextiles
ASTM D 5262 (2007)	Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
ASTM D 5321 (2002)	Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 5397 (2007)	Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D 5596 (2003)	Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D 5721 (1995; R 2002)	Air-Oven Aging of Polyolefin Geomembranes
ASTM D 5885 (2006)	Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D 5887 (2004)	Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D 5888 (2006)	Storage and Handling of Geosynthetic Clay Liners
ASTM D 5889 (1997; R 2003)	Quality Control of Geosynthetic Clay Liners
ASTM D 5890 (2006)	Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D 5891 (2002)	Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D 5993 (1999; R 2004)	Measuring Mass Per Unit of Geosynthetic Clay Liners

ASTM D 5994 (1998; R 2003)	Measuring Core Thickness of Textured Geomembrane
ASTM D 638 (2003)	Standard Test Method for Tensile Properties of Plastics
ASTM D 6072 (1996; R 2002)	Obtaining Samples of Geosynthetic Clay Liners
ASTM D 6243 (2006)	Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D 6392 (1999; R 2006)	Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D 6496 (2004a)	Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D 6497 (2002)	Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D 6768 (2004)	Tensile Strength of Geosynthetic Clay Liners
ASTM D 751 (2006)	Coated Fabrics
ASTM D 792 (2000)	Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 814 (1995; R 2005)	Rubber Property – Vapor Transmission of Volatile Liquids
ASTM D 882 (2002)	Tensile Properties of Thin Plastic Sheeting
GSI GRI GC7 (1997)	Determination of Adhesion and Bond Strength of Geocomposites
GSI GRI GG1 (1987; R 1988)	Geogrid Rib Tensile Strength
GSI GRI GG4a (1991)	Determination of the Long-Term Design Strength of Stiff Geogrids
GSI GRI GG4b (1991)	Determination of the Long-Term Design Strength of Flexible Geogrids
GSI GRI GG5 (1991)	Test Method for Geogrid Pullout
GSI GRI GG6 (1996)	Grip Types for Use in Wide Width Testing of

	Geotextiles and Geogrids
GSI GRI GM7 (1995)	Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM9 (1995)	Cold Weather Seaming of Geomembranes
GSI GRI GM11 (1997)	Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device
GSI GRI GM12 (1998)	Asperity Measurement of Textured Geomembranes Using a Depth Gauge

2.3 SUBMITTALS

A. Shop Drawings

1. Geomembrane panel layout and penetration detail drawings, a minimum of 7 days prior to geomembrane placement.

B. As-Built Drawings

1. Final as-built drawings of geomembrane installation

C. Product Data

1. Tests, Inspections, and Verifications – Manufacturer's and fabricator's QC manuals, a minimum of 7 days prior to geomembrane shipment.

2. Field Seaming – Installer's QC manual, a minimum of 7 days prior to geomembrane placement.

3. Qualifications

a. Manufacturer's, and fabricator's qualification statements, including resumes of key personnel involved in the project.

b. Installer's, QC inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in the project a minimum of 7 days prior to geomembrane placement.

c. The submittal from the QC laboratory shall include verification that the laboratory is accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

4. Samples – Geomembrane QA and QC samples.

5. Test Reports

   a. Materials – Manufacturer's certified raw and sheet material test reports and a copy of the QC certificates.

   b. Surface Preparation – Certification from the QC inspector and installer of the acceptability of the surface on which the geomembrane is to be placed, immediately prior to geomembrane placement.

   c. Non-Destructive Field Seam Continuity Testing – QC inspector certified test results on all field seams.

   d. Destructive Field Seam Testing – Installer and certified QC laboratory test results on all destructively tested field seams.

   e. Destructive Seam Test Repairs – QC inspector certified test results on all repaired seams.

   f. Interface Friction Testing - Certified laboratory interface friction test results including description of equipment and test method.

   g. Tests – Certified QC test results.

2.4 QUALIFICATIONS

A. Manufacturer – Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects and having a total minimum area of 10 million square feet.

B. Fabricator – The fabricator is responsible for seaming geomembrane sheets into panels. Fabricator shall have fabricated the proposed geomembrane panels for at least 5 completed projects having a total minimum area of 2 million square feet.

C. Installer – The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.

D. QC Inspector – The QC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.

E. QC Laboratory – The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet.

The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

PART 2 MATERIALS

2.1 Geosynthetic Clay Layer (GCL)

A. Acceptable GCL products are Bentomat® DN, as manufactured by CETCO, 2870 Forbs Avenue, Hoffman Estates, Illinois 60192 USA (800-527-9948), or an engineer-approved equal.

B. GCL Manufacturer's Quality Control

1. The GCL shall consist of a layer of granular sodium bentonite clay needlepunched between two geotextiles and shall comply with all of the criteria listed in this Section.

2. Bentonite shall be a high-swelling sodium bentonite, with a minimum swell index of 24 mL/2g and a maximum fluid loss of 18 mL. Bentonite shall be CG-50 granular bentonite, mined and processed by American Colloid Company.

3. Bentonite shall have a granular consistency (1 percent max. passing a No. 200 sieve [75 µm]), to ensure uniform distribution throughout the GCL and minimal edge loss during handling and installation.

4. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. Contractor must also provide evidence of successful use of the proposed alternate material on past similar projects. This evidence can include past direct shear results against similar materials under similar site conditions, and/or past permeability/compatibility test results with a similar leachate or waste stream. The Contractor also must obtain prior approval of the alternative GCL by the Project Engineer.

C. Geosynthetic Clay Liner Material Properties

The Geosynthetic Clay Liner shall conform to the following material properties:

Table 1: GCL Material Properties:

Material Property	**Test Method**	**Test Frequency** (ft^2/m^2)	**Required Values**
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 ml/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 ml max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2)

Table 1: GCL Material Properties:

Material Property	**Test Method**	**Test Frequency** (ft^2/m^2)	**Required Values**
			min
GCL Tensile Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	50 lbs/in (88 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1 x 10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5 x 10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5322 ASTM D 6243	Periodic	500 psf (24 kPa) typ @200 psf

Notes
1. Bentonite property tests performed at a bentonite processing facility before shipment to GCL production facilities.
2. Bentonite mass/area reported at 0 percent moisture content.
3. All tensile strength testing is performed in the machine direction using ASTM D 6768.
4. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
5. Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa)
6. cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
7. Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

2.2 Geomembranes (30 mil RPET)

A. Geosynthetics Manufacturer's Quality Control

1. The 30 mil RPET shall be manufactured by Colorado Lining or approved equal. The geomembrane liner shall be a four layer reinforced laminate containing no adhesives. The product shall be textured on one side at a minimum. The textured side on both layers shall face downward.

2. The outer layers of the RPET shall consist of a high strength polyethylene film and shall be resistant to ultraviolet rays in exposed applications.

3. The manufacturer of the liner shall take random samples of the liner material from each fabricated roll during manufacturing. Samples shall be tested by methods specified within this Section, or applicable ASTM standards, for thickness, strength, tear resistance, low temperature impact density and dimensional stability. Each roll of material shall be clearly identified and correlated to the test results provided.

4. The geomembrane manufacturer shall confirm in writing, that the geosynthetics to be furnished will be free of defects in materials and workmanship at the time of sale, and against deterioration due to the effects of ozone, ultraviolet or other normal weathering on a pro-rata basis. The geomembrane manufacturer shall furnish a sample warranty during the submittal process for review and approval prior to shipment. In addition, the manufacturer shall provide a minimum warranty against material failure of 20 years.

B. RPET Material Properties

The material provided as Reinforced Polyethylene (RPET) textured liner shall conform to the following standards or approved equivalent:

Properties	Test Method	30 mil		36 mil		45 mil	
		Min. Roll Avg.	Typical Roll Avg.	Min. Roll Avg.	Typical Roll Avg.	Min. Roll Avg.	Typical Roll Avg.
Appearance		Black/Black		Black/Black		Black/Black	
Thickness	ASTM D 5199	27 mil	30 mil	32 mil	36 mil	40 mil	45 mil
Weight Lbs Per MSF (oz/yd^2)	ASTM D 5261	126 lbs (18.14)	140 lbs (20.16)	151 lbs (21.74)	168 lbs (24.19)	189 lbs (27.21)	210 lbs (30.24)
Construction		**Extrusion laminated with encapsulated tri-directional scrim reinforcement					
Ply Adhesions	ASTM D 413	16 lbs	20 lbs	19 lbs	24 lbs	25 lbs	31 lbs
1" Tensile Strength	ASTM D 7003	88 lbf MD 63 lbf DD	110 lbf MD 79 lbf DD	90 lbf MD 70 lbf DD	113 lbf MD 87 lbf DD	110 lbf MD 84 lbf DD	138 lbf MD 105 lbf DD
1" Tensile Elongation @ Break % (Film Break)	ASTM D 7003	550 lbf MD 550 lbf DD	750 lbf MD 750 lbf DD	550 lbf MD 550 lbf DD	750 lbf MD 750 lbf DD	550 lbf MD 550 lbf DD	750 lbf MD 750 lbf DD
1" Tensile Elongation Peak % (Scrim Break)	ASTM D 7003	20 lbf MD 20 lbf DD	33 lbf MD 33 lbf DD	20 lbf MD 20 lbf DD	30 lbf MD 31 lbf DD	20 lbf MD 20 lbf DD	36 lbf MD 36 lbf DD
Tongue Tear Strength	ASTM D 5884	75 lbf MD 75 lbf DD	97 lbf MD 90 lbf DD	75 lbf MD 75 lbf DD	104 lbf MD 92 lbf DD	100 lbf MD 100 lbf DD	117 lbf MD 118 lbf DD
Grab Tensile	ASTM D 7004	180 lbf MD 180 lbf DD	218 lbf MD 210 lbf DD	180 lbf MD 180 lbf DD	222 lbf MD 223 lbf DD	220 lbf MD 220 lbf DD	257 lbf MD 258 lbf DD
* Dimensional Stability	ASTM D 1204	<1	<0.5	<1	<0.5	<1	<0.5
Puncture Resistance	ASTM D 4833	50 lbf	64 lbf	65 lbf	83 lbf	80 lbf	99 lbf
Maximum Use Temperature		180 °F	180 °F	180 °F	180 °F	180 °F	180 °F
Minimum Use Temperature		-70 °F	-70 °F	-70 °F	-70 °F	-70 °F	-70 °F

NOTES:

Minimum Roll Averages are set to take into account product variability in addition to testing variability between laboratories.
MD stands for machine Direction and DD for Diagonal Direction.
*Dimensional stability maximum value
**30 mil, 36 mil, & 45 mil are a four layer reinforced laminate containing no adhesives. The outer layers consist of a high strength polyethylene film manufactured using virgin grade resins and stabilizers for UV resistance in exposed applications. 30 mil, 36 mil, & 45 mil are reinforced with a 1300 denier (minimum) tri-directional scrim reinforcement.

2.3 Geosynthetic Drainage Layer (GDL) (Geocomposite)

A. Geocomposite Manufacturer's Quality Control

1. The geocomposite shall be manufactured by GSE Lining Technologies or approved equal. The geocomposite shall consist of minimum 8 oz geotextile adhere to both sides of a geonet.

2. The polymer used to manufacture the Geonet core of the Geocomposite shall be polyethylene, which is clean and free of any foreign contaminants. Regrind material, which consists of edge trimmings and other scraps, may be used to manufacture the geocomposite; however, post consumer recycled material shall not be used.

3. The drainage core of the geocomposite shall be manufactured by extruding three sets of polyethylene strands to form a triaxial void maintaining structure consisting of a thick vertical rib with diagonally placed top and bottom ribs.

B. Geocomposite Material Properties.

The geocomposite shall conform to the following material properties:

TESTED PROPERTY **Geocomposite**	**TEST METHOD**	**FREQUENCY**	**MINIMUM AVERAGE VALUE[1]** **8 oz/yd^2**
Transmissivity[2], gal/min/ft (m^2/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft^2	0.48 (1 x 1 0^{-4}) 4.83 (1 x 1 0^{-3})
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft^2	1.0 (178)
Transmissivity[2], gal/min/ft (m^2/sec)	ASTM D 4716		9.66 (2 x 10^{-3})
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035/7179	1/50,000 ft^2	45 (7.9)
Carbon Black Content, %	ASTM D 1603*/4218	1/50,000 ft^2	2.0
Mass per Unit Area, oz/yd^2(g/m^2)	ASTM D 5261	1/90,000 ft^2	8 (270)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft^2	220 (975)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft^2	120 (525)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft^2	80 (0.180)
Permittivity, (sec^{-2})	ASTM D 4491	1/540,000 ft^2	1.3
Flow Rate, gpm/ft^2 (lpm/m^2)	ASTM D 4491	1/540,000 ft^2	95 (3,865)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70
Geonet Core Thickness, mil (mm)	ASTM D 5199	1/50,000 ft^2	200(5)
Roll Width[5], ft (m)			14.5 (4.4)
Roll Length[5], ft (m)	Double-Sided Composite Single-Sided Composite		260 (79.2) 310 (94.5)
Roll Area, ft^2 (m^2)	Double-Sided Composite Single-Sided Composite		3,770 (350) 4,495 (418)

NOTES:

- [1]AOS in mm is a maximum value.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes.
- [3]Component properties prior to lamination.
- [4]Refer to geotextile product data sheet for additional specifications.
- [5]Roll widths and lengths have a tolerance of ±1%.
- *Modified.

PART 3 EXECUTION

3.1 Geosynthetic Clay Layer (GCL)

A. GCL rolls should be taken to the work area of the site in their original packaging. The orientation of the GCL (i.e., which side faces up) is not a critical factor with Bentomat® DN. If an equivalent product is selected seek direction from the Engineer on orientation. The roll should be allowed to unwind from the bottom rather than pulling from the top. The arrow sticker on the plastic sleeve indicates the direction the GCL will naturally unroll when placed on the ground. Prior to deployment, the packaging should be carefully removed without damaging the GCL.

B. Equipment which could damage the GCL, should not be allowed to travel directly on it. Acceptable installation, therefore, may be accomplished such that the GCL is unrolled in front of backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

C. If sufficient access is available, GCL may be deployed by suspending the roll at the top of the slope with a group of laborers pulling the material off of the roll and down the slope.

D. GCL rolls should not be released on the slope and allowed to unroll freely by gravity.

E. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering, commonly known as a slip sheet or rub sheet, may be used to reduce friction damage during placement.

F. Place GCL on a pre-moistened subgrade and cover the material each day with the overlying geomembrane.

3.2 Geomembrane (30 mil RPET)

A. Prior to deployment of geomembrane, the Geosynthetics Contractor shall inspect, certify and accept, all surfaces on which the liner is to be placed to ensure conformance with the specifications. Surfaces not in compliance with the specifications shall be rectified by the contractor.

B. The amount of geomembrane liner deployed without final quality control and final repairs being completed shall not exceed 100,000 square feet. In addition, no seams shall be left unwelded and no openings in the liner shall be left at the end of a shift unless approved by the field engineer.

C. The liner shall be placed over the prepared surface using methods and procedures that ensure a minimum of handling. The Geosynthetics Contractor shall provide adequate temporary anchoring devices to prevent damage due to wind.

D. Handling and storage of liner material shall be in accordance with the manufacturer's printed instructions. All persons walking or working on the geomembrane shall wear soft-sole shoes.

E. The liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. All necessary precautions, including provisions for installing extra material, shall be taken to avoid trampolining of liner which will remain exposed (i.e.,pad, pond corners and solution channels).

F. Horizontal field seams on slopes should be kept to a minimum. Seams shall be made by lapping the uphill material over the downhill material with sufficient overlap. A minimum of five feet is to be allowed from the toe of the slope to any horizontal seam on flat areas.

G. Installation shall be performed under the direction of a Superintendent who has installed a minimum of 10,000,000 square feet of HDPE or LLDPE flexible lining material. The Superintendent shall be provided by the Geosynthetics Contractor and shall be in charge of the installation.

H. Extreme care shall be taken by the Geosynthetics Contractor in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to approved procedures, and all sheeting shall be welded together by thermal methods.

3.3 Geosynthetic Drainage Layer (Geocomposite)

A. The geocomposite shall be handled in such a manner as to ensure that it is not damaged in any way. On slopes, the material shall be anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the material under tension.

B. In the presence of wind, the leading edge of the material shall be weighted with sandbags or ballasts until the final cover is placed.

C. Care shall be taken to assure that any underlying layers are not damaged during placement. Low ground pressure machines such as ATVs are recommended to facilitate deployment over the geosynthetic layers. Low ground pressure machines shall be used when carrying a driver weighing approximately 150 lbs.

D. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.

E. Due to the steep slopes of this project, special care should be taken so that only full length rolls are used at the top of the slope.

F. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

G. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting

equipment shall not come into direct contact with the geocomposite.

3.4 Field Seam Inspection And Testing

A. Geosynthetic Clay Layer (GCL)

1. Proper field seaming is vital for the liner to function to its maximum abilities. There are three elements of CQA for this task:

   a. Verification of the minimum acceptable overlap.

   b. Verification of the continuity of the accessory bentonite (Bentomat only).

   c. Verification that there is no dirt in the overlap zone or on the bottom geotextile of the overlying GCL panel.

2. These elements for field seam CQA are straightforward and require only visual inspection by the CQA engineer.

3. The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Bentonite-enhanced seams are required for installation of membrane-laminated GCLs.

4. The minimum dimension of the longitudinal overlap for Bentomat® DN should be 12 inches (300 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 24 inches (600 mm).

5. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

6. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied within the zone defined by the edge of the underlying panel and the 12-inch (300 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

B. Geomembrane (RPET)

1. A maximum effort shall be made to install a perfect liner. This means that all seams completed in the field patches, and extrusions shall be inspected, tested, and recorded.

2. The welding equipment used shall be capable of continuously monitoring

and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material, to ensure changes in weather conditions will not affect the integrity of the weld

3. No “fish mouth” shall be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, overlapped, and extrusion welded. Welds on completion of the Work shall be tightly bonded. Any membrane area showing distress due to excessive scuffing or puncture from any cause shall be replaced or repaired.

4. The Geosynthetics Contractor shall take into account that rapid weather changes are very possible, resulting in delays in construction of field seams. Joining of panels and repairs will only be permitted under weather conditions allowing such work within the warranty limits imposed by the manufacturer.

5. A quality-control technician shall inspect each seam, marking his initials and the date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with approved repair procedures.

6. The field installation testing program shall consist of periodic visual observations, continuity, and strength tests. These inspections and tests are to be made routinely and are automatic regardless of other types of testing required. The program shall include:

    a. Visual Observations

        - To perform visual check field seams for squeeze out, footprint, melt and overlap.

        - Machines to be checked for cleanliness.

        - Any area of the seam or panel showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

    b. Non Destructive Testing

    A 48 inch (1.2 m) sample should be taken from each factory seam welding unit used in this work at the beginning of every work shift an every four hours of production thereafter. Samples shall be nondestructive, not requiring patching of fabricated panels. Test specimens shall be cut at quarter points from each 48 inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 modified method and peel adhesion will be tested in accordance with ASTM D413, Machine Method, Type A. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of

these specifications may be cause for rejection of the RPET material and/or seams as appropriate. The fabricator shall provide the test results to the owner or engineer upon request. The results of the leak test shall be marked at the location and shall be recorded by the geosynthetics contractor. If the test fails, the location of the leak shall be found and repaired or the entire seam shall be repaired and retested.

c. Strength Testing

For trial welds, the following procedure is to be used:

- Trial welds shall be completed under the same conditions and using the same materials, pre-seaming, and seaming techniques as used to fabricate field seams. The trial weld samples shall be a minimum of 3 feet long by 1 foot wide, marked with the date, technician's name, ambient temperature, and welding machine number and temperature. Coupons from the test weld shall be tested for peel and bonded seam strength using a calibrated tensiometer, as well as thickness, in accordance either the applicable ASTM or NSF 54 standards as appropriate. If failing results occur, the welding machine shall be repaired or replaced and retested.

- The minimum frequency for obtaining trial weld samples from each of the welding machines in operation is the following:

    - Prior to the beginning of seaming operations.
    - After every four hours of seaming operations.
    - After repairs have been made to seaming equipment.
    - By each technician using the seaming equipment.
    - As required by the Owner.

d. Destructive Testing

For destructive testing of field seams the following procedure is to be used:

- Destructive samples may be obtained from field seams or repaired areas by cutting perpendicular to the seams. The sample should be approximately 2 feet long by 1 foot wide. This sample shall be cut into two samples of 12 inches by 12 inches and labeled with the welder's identification, date, and location. One of the samples will be retained by the Owner and one of the samples will be tested by the Geosynthetics Contractor, using a calibrated tensiometer, in accordance with the applicable ASTM or NSF 54 standards as appropriate.

- The frequency for obtaining destructive test samples shall not be less than one sample per 30 feet of field seam. Coupons from the

destructive sample shall be tested for peel and bonded strength as well as thickness, in accordance with the applicable ASTM standards. If one or more of the coupons fails, the sample will be considered a failure.

- In the event of a failing test result, additional samples, on either side of the failure, shall be tested to isolate the portion of the seam which needs to be repaired, and the failed portion of the weld shall be "capped". Alternatively, the entire seam can be rewelded and retested.

C. Geosynthetic Drainage Layer (GDL)

1. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

2. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.

3. The geonet portion should be tied every 6 inches in the anchor trench or as specified by the ENGINEER.

4. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with this section.

END OF SECTION 02530