TYPICAL TECHNICAL SPECIFICATIONS

FOR

GYPSUM STACK SIDE SLOPE AND
TOP GRADIENT CLOSURE CONSTRUCTION

FDEP - ITN NO. 2004070C
BACKGROUND INFORMATION
APPENDIX 10

NOTE: The typical technical specifications contained in this Appendix 10 are intended to supplement the specifications provided in Apendices 7 and 9.

TYPICAL TECHNICAL SPECIFICATIONS

SECTION 1
LIST OF SPECIFICATION SECTIONS

**GYPSUM STACK SIDE SLOPE AND
TOP GRADIENT CLOSURE CONSTRUCTION**

**FDEP - ITN NO. 2004070C
PINEY POINT STACK SYSTEM CLOSURE**

TYPICAL TECHNICAL SPECIFICATIONS

SECTION 2
40-MIL AND 60-MIL HDPE LINER MATERIALS

GYPSUM STACK SIDE SLOPE AND
TOP GRADIENT CLOSURE CONSTRUCTION

FDEP - ITN NO. 2004070C
PINEY POINT STACK SYSTEM CLOSURE

2.1 Description of Work

This Specification covers the material requirements for High Density Polyethylene (HDPE) geomembrane liner, factory inspection and testing requirements, and independent quality control testing. The Specification includes the following sections.

2.2 Referenced Standards

The following American Society for Testing and Materials (ASTM) and Federal Test Method (FTM) standards are referenced in this Specification.

D 570: Standard Test Method for Water Absorption of Plastics

D 638: Standard Test Method for Tensile Properties of Plastics

D 746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D 792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D 1004: Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting

D 1203: Standard Test Method for Volatile Loss from Plastics Using Activated Carbon Methods

D 1204: Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

D 1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D 1248: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

D 1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique

D 1603: Standard Test Method for Carbon Black in Olefin Plastics

D 1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics

D 1898: Standard Recommended Practice for Sampling of Plastics

D 2663: Standard Test Methods for Carbon Black Dispersion in Rubber

D 3015: Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds

D 3083: Specification for Flexible Poly(Vinyl Chloride) Plastic Sheeting for Pond, Canal and Reservoir Lining

D 3895: Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis

D 4833: Standard Test Method for Index Puncture Resistance of Geotextiles and Geomembranes.

D 5199: Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

D 5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

D 5397: Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Load Test; Appendix - Procedure to Perform a Single Point Notched Constant Load (Appendix SP-NCTL Test)

D 5996: Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

D 5994: Standard Test Method for Measuring Core Thickness of Textured Geomembranes

E 96: Standard Test Methods for Water Vapor Transmission of Materials

FTM 101: Puncture Resistance and Elongation Test (1/8 inch Radius Probe Method), Federal Test Method 2065

2.3 Material Requirements

Smooth and two-sided textured geomembrane liner shall consist of unreinforced high density polyethylene (HDPE), designed and manufactured specifically for the purpose of liquid containment.

Product data sheets listing the minimum and nominal liner physical properties shall be provided for each type liner prior to shipment. Product data sheets for the HDPE resin, listing the density, melt index, low temperature brittleness and environmental stress crack resistance, shall be provided for each type resin prior to shipment.

2.3.1 Base Resin

The uncolored base resin used to manufacture the liner shall be polyethylene having a minimum density of 0.932 g/cm^3. The formulated colored resin shall classify as a Type III, Category 4 or 5, Grade P34, Class C High Density Polyethylene in accordance with ASTM Standard D 1248. The resin shall contain not less than 97 percent of the base polymer, and not less than 2.0 percent carbon black. Carbon black dispersion in the liner shall be rated as: (i) $9 of 10 views as Category 1 or 2 and # 1 of 10 views as Category 3 classified using ASTM Standard D 5996; or (ii) A1, A2 or B1 classified using the ASTM Standard D 2663 dispersion classification chart on specimens prepared in accordance with ASTM Standard D 3015. The variation in carbon black content within each resin batch shall be no greater than ±5 percent from the average carbon black content. The liner material shall contain no more than 3 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders. The liner shall be manufactured from virgin resin, with no more than 3 percent regrind material. Regrind material, if used, must be of the same formulation as the virgin resin. No post consumer resin of any type may be used.

Liner sheets shall be manufactured using one of the following base resins unless otherwise approved by the Engineer:

- Mobil HDA 601
- Chevron Phillips 66 HHM TR-400 or K306
- Atofina Finacene M3302
- BP Solvay G36-10-150

Use of any of the approved base resins shall not relieve the Liner Manufacturer from complying with all other Specification criteria.

HDPE welding rods shall be manufactured from the same resin used to manufacture the liner.

2.3.2 Physical Appearance of Liner Sheets

All liner sheets shall have good appearance qualities. The surface of smooth liner shall be smooth with no visible defects. Texturing on the surface of textured sheets shall be uniform and homogeneously distributed.

All liner sheets shall be free of pinholes, holes, blisters, gels, undispersed ingredients, any signs of contamination by foreign matter, or any defect that may affect serviceability. The edges of the sheets shall be straight and free from nicks and cuts.

2.3.3 Smooth Liner Physical Properties

Smooth liner shall meet the following criteria.

Property	Test Method	Criteria	
		60-mil	40-mil
Minimum Thickness	ASTM D 5199	\$ 54 mil	\$36 mil
Average Thickness	ASTM D 5199	\$ 60 mil	\$40 mil
Density	ASTM D 792 or D 1505	> 0.940 g/cm^3†	>0.94 g/cm^3†
Melt Index	ASTM D 1238, Condition E	<1.0 g/10 min	<1.0 g/10 min
Carbon Black Content	ASTM D 1603	\$2.0% & <3.0%	\$2.0% & <3.0%
Carbon Black Dispersion	ASTM D 3015; or ASTM D 5596 (10 views)	A1, A2 or B1; or Cat. 1 or 2 (\$9 views) or Cat. 3 (#1 view)	A1, A2 or B1; or Cat. 1 or 2 (\$9 views) or Cat. 3 (#1 view)
Tensile Strength at Yield	ASTM D 638, Type IV*	>126 lb/in	>84 lb/in
Tensile Strength at Break	ASTM D 638, Type IV*	>210 lb/in	>140 lb/in
Elongation at Yield	ASTM D 638, Type IV*	>12%	>12%
Elongation at Break	ASTM D 638, Type IV*	>650%	>650%
Modulus of Elasticity	ASTM D 638, Type IV*	>80,000 lb/in^2	>80,000 lb/in^2
Tear Resistance	ASTM D 1004	>42 lb	>30 lb
Puncture Resistance	FTMS 101 (Method 2065); or ASTM D 4833	>75 lb; or >119 lb	>50 lb; or >79 lb
Water Vapor Transmission	ASTM E 96, Procedure BW	<0.03 g/m^2/24 hours	<0.03 g/m^2/24 hours
Dimensional Stability	ASTM D 1204, 100EC for 1 hr	±2% (max)	±2% (max)
Low Temperature Brittleness	ASTM D 746, Procedure B	<-94EF (<-70°C)	<-94EF (<-70EC)
Volatile Loss	ASTM D 1203, Method A	<0.1%	<0.1%
Water Absorption	ASTM D 570	<0.1%	<0.1%
Environmental Stress Crack Resistance	ASTM D 1693, Condition B	>1,500 hrs	>1,500 hrs
Constant Tensile Load Stress Crack Resistance (Single Point Test at 30% of yield stress)	ASTM D 5397 (SP-NCTL)	> 200 hrs	>200 hrs
Oxidative Induction Time	ASTM D 3895 (200°C and 14.7 psiO_2)	>140 minutes	>140 minutes

† The density of the uncolored base resin shall be greater than 0.932 g/cm^3.
* Tested at a rate of displacement of 2 inches/minute in both machine and transverse directions. Strain at yield shall be calculated using a 1.3" gauge length and strain at break shall be calculated using a 2.0" gauge length.

All individual test specimens shall meet the minimum or maximum criterion tabulated above, with the following exceptions:

- The average elongation at break and modulus of elasticity in both the machine and transverse directions, determined as the average of five test specimens in each direction, shall meet the specified values. All individual test specimen results shall display an elongation at break equaling or exceeding 520 percent, and a modulus of elasticity equaling or exceeding 64,000 lb/in^2.

- The average water vapor transmission shall meet the specified value, and all individual test specimen results shall be equal to or less than 0.05 g/m^2/24 hours.

Routine testing for modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission will not be required from the Liner Manufacturer. Certification in writing shall be provided by the Liner Manufacturer that the liner meets the Specification requirements. In support of the certification, the Liner Manufacturer shall submit at least one test result for each property on liner manufactured with each type resin supplied to the project performed within one year of the date of the certification.

2.3.4 Textured Liner Physical Properties

Textured liner shall meet the following criteria.

Property	Test Method	Criteria	
		60-mil	40-mil
Minimum Thickness	ASTM D 5994	$ 54 mil	$ 36 mil
Average Thickness	ASTM D 5994	$ 60 mil	$ 40 mil
Density	ASTM D 792 or D 1505	> 0.940 g/cm^3†	> 0.940 g/cm^3†
Melt Index	ASTM D 1238, Condition E	<1.0 g/10 min	<1.0 g/10 min
Carbon Black Content	ASTM D 1603	$2.0% & <3.0%	$2.0% & <3.0%
Carbon Black Dispersion	ASTM D 3015; or ASTM D 5596 (10 views)	A1, A2 or B1; or Cat. 1 or 2 ($9 views) or Cat. 3 (#1 view)	A1, A2 or B1; or Cat. 1 or 2 ($9 views) or Cat. 3 (#1 view)
Tensile Strength at Yield	ASTM D 638, Type IV*	>126 lb/in	>84 lb/in
Tensile Strength at Break	ASTM D 638, Type IV*	>120 lb/in	>80 lb/in
Elongation at Yield	ASTM D 638, Type IV*	>12%	>12%
Elongation at Break	ASTM D 638, Type IV*	>200%	>200%
Tear Resistance	ASTM D 1004	>42 lb	>30 lb
Puncture Resistance	FTMS 101 (Method 2065); or ASTM D 4833	>75 lb; or >119 lb	>50 lb; or >79 lb

† The density of the uncolored base resin shall be greater than 0.932 g/cm^3.
* Tested at a rate of displacement of 2 inches/minute in both machine and transverse directions. Strain at yield shall be calculated using a 1.3" gauge length and strain at break shall be calculated using a 2.0" gauge length.

All individual test specimens shall meet the minimum or maximum criterion tabulated above, with the following exceptions.

- The average tensile strength and elongation at break in both the machine and transverse directions, determined as the average of five test specimens in each direction, shall meet the criteria tabulated above. All individual test specimen results for 60-mil textured liner shall display tensile strengths at break equaling or exceeding 36 lb/in and elongations at break equaling or exceeding 60 percent. All individual test specimen results for 40-mil textured liner shall display tensile strengths at break equaling or exceeding 24 lb/in and elongations at break equaling or exceeding 60 percent.

Textured liner shall also meet the criteria specified in Section 2.3.3 for water vapor transmission; dimensional stability; low temperature brittleness; volatile loss; water absorption; environmental stress crack resistance; constant tensile load stress crack resistance; and oxidative induction time.

2.3.5 Frictional Characteristics

The surface roughness of textured liner shall be such that the peak interface friction angle is equal to or greater than 33° between the liner and phosphogypsum, and equal to or greater than 28° between the liner and soil.

For determining compliance with the specified interface friction angle, compliance tests will be performed by the Engineer using clean sand, silty fine sand and phosphogypsum from the site meeting the following gradations in accordance with ASTM Standard D 422.

Soil Type	Sand	Gypsum
Soil Classification (ASTM D 2487)	SM	ML
U.S. Standard Sieve Size	Percent Passing (Dry Weight Basis)	
No. 4	100	100
No. 10	97-100	100
No. 20	95-100	100
No. 40	85-100	100
No. 60	60-95	95-100
No. 100	20-80	85-100
No. 140	15-40	80-95
No. 200	12-20	75-90
No. 270	-	60-85
No. 400	-	40-75

The interface frictional resistance shall be determined by direct shear tests in general accordance with ASTM Standard D 5321 at normal stresses ranging from 3 to 10 lb/in^2. The SM-sand shall be compacted to a dry density equal to 95 percent of the Standard Proctor maximum dry density (ASTM D 698). The gypsum shall be compacted at a molding moisture content ranging from 2 percent dry to 3 percent wet of the Standard Proctor optimum moisture content to a dry density equal to 95 percent of the Standard Proctor maximum dry density (ASTM D 698 with drying temperature of 40EC). The interface and soil or gypsum shall be tested saturated with water. The tests shall be performed using a horizontal displacement rate of 0.3 inches per hour.

2.4 **Field Seam Strength**

All welded field seams shall meet the following criteria:

(i) When the weld is tested in shear in accordance with ASTM Standard D 6392, the specimen shall exhibit a film tear bond failure (FTB), and the strength shall be equal to or greater than 120 lb/in (ppi) for welds in 60-mil liner and equal to or greater than 80 lb/in for welds in 40-mil liner. The tests shall be performed at a rate of displacement of 2 ipm until the maximum load is achieved, and the test then continued at a rate of displacement of 20 ipm until rupture.

(ii) When the weld is tested in peel in accordance with ASTM Standard D 6392, the specimen shall exhibit a film tear bond failure (FTB) and/or the liner must fail before the weld, and the strength shall be equal to or greater than 82 lb/in (ppi) for welds in 60-mil liner and equal to or greater than 55 lb/in for welds in 40-mil liner. The peel strength criteria shall apply to both the top and bottom welds of double wedge fusion welds.

2.5 Manufacturing and Factory Inspection and Testing

The Manufacturer shall submit product data sheets and test data for each liner type to the Engineer presenting the liner minimum physical properties for each property listed in Section 2.3.3 and Section 2.3.4, and the resin types and properties. Written certification shall be provided by the Manufacturer to the Engineer confirming compliance of the resin and liner sheets with this Specification.

2.5.1 Minimum Sheet Dimensions

The HDPE liner shall be supplied in rolled sheets having a minimum width of 22 feet and minimum length of 400 feet. Variances for shorter roll lengths may be allowed at the discretion of the Engineer.

2.5.2 Marking and Packaging

The Manufacturer shall label each roll with the roll number, thickness, length, width and date manufactured.

Each roll shall be individually packaged at the factory and protected to prevent damage during shipment. If the liner is not packaged and a roll is damaged during shipment, it shall be rejected. If only the outermost surface of the roll is affected, it shall be peeled back, cut, and wasted (i.e., it shall be treated as if it were the protective packaging for the remainder of the roll). Rolled out liner stock that requires more than one repair patch per 5,000 square feet prior to installation shall be considered faulty, and shall be rejected and replaced.

2.5.3 Factory Inspection and Spark Testing

All liner sheets shall be inspected at the factory for compliance with the physical appearance requirements listed in Section 2.3.2. All liner sheets shall be continuously spark tested during manufacturing. The spark tester shall be capable of detecting defects or pinholes equal to or less than 10 mils (0.25 mm) in diameter. A complete description of the spark tester, operating protocols, factory QA/QC plan for operating the system and identifying defective liner, and methods for removing or patching liner with pinholes shall be submitted prior to shipping liner to the project. All necessary repairs to the liner shall be made by the Manufacturer at the factory before shipment.

The Manufacturer shall provide written certification to the Engineer that all liner rolls delivered to the project were continuously spark tested and do not contain pinhole defects.

2.5.4. Factory Testing

The Liner Manufacturer shall submit the factory testing QA/QC plan, and factory laboratory quality manual for all liner and resin tests required in this Specification.

2.5.4.1 HDPE Resin

Factory sampling and testing of raw materials shall be in conformance with ASTM Standard D 1898. Factory test reports for the HDPE resin shall include the proportions of HDPE resin, carbon black and other additives, melt index, specific gravity, environmental stress crack resistance, low temperature brittleness and oxidative induction time. These reports shall be submitted to the Engineer for approval before installation of any liner material. The following tests and minimum frequency of testing shall be undertaken by the Liner Manufacturer on each batch of resin:

Resin Property	Method	Minimum Frequency
Density	ASTM D 792	Once per Batch of Resin
Melt Index	ASTM D 1238, Condition E	Once per Batch of Resin
Oxidative Induction Time	ASTM D 3895	Once per Batch of Resin

The resin density and melt index shall be reported for both the unblended resin and the blended resin after adding carbon black and antioxidants. The oxidative induction time shall be reported for the blended resin. Routine testing for low temperature brittleness and environmental stress crack resistance is not required. Certification of these properties, in accordance with the requirements in Section 2.3.3, will be accepted.

2.5.4.2 Liner Rolls

Factory test reports for each roll of liner shall include test results for the following properties: tensile strength and elongation at yield and at break; tear resistance; puncture resistance; minimum and average thickness; density; carbon black content; and carbon black dispersion. These reports shall be submitted to the Engineer before installation and prior to acceptance of the liner. Failure of any of the tests shall result in rejection of the corresponding liner rolls.

At the request of the Engineer, but not more than once per day during each production run, the Manufacturer shall furnish production line samples to the Engineer who reserves the right to test these samples to evaluate compliance with this Specification. Failure of any of the tests shall result in rejection of the corresponding batch or production run of liner material.

The following tests and minimum frequencies of testing shall be undertaken by the Liner Manufacturer on liner rolls:

Liner Property	Test Method	Minimum Frequency
Thickness (Smooth Liner)	ASTM D 5199	Every Roll
Core Thickness (Textured Liner)	ASTM D 5994	Every Roll
Tensile Strength at Yield	ASTM D 638	Every Roll
Tensile Strength at Break	ASTM D 638	Every Roll
Elongation at Yield	ASTM D 638	Every Roll
Elongation at Break	ASTM D 638	Every Roll
Tear Resistance	ASTM D 1004	Every Roll
Puncture Resistance	FTMS 101 (Method 2065) or ASTM D 4833	Every Roll
Density	ASTM D 792 or D 1505	Every 5 Rolls
Carbon Black Content	ASTM D 1603	Every 5 Rolls
Carbon Black Dispersion	ASTM D 3015 or ASTM 5596	Every 5 Rolls
Notched Constant Load ESCR (Single Point at 30% of Yield Stress)	ASTM D 5397 (SP-NCTL)	Every 20 Rolls

Tensile tests (ASTM D 638) and tear resistance tests (ASTM D 1004) shall be performed in both the machine and transverse directions. Tensile properties (ASTM D 638), tear resistance (ASTM D 1004) and puncture resistance (FTMS 101 or ASTM D 4833) tests may be performed on only one test specimen from each roll of smooth liner (in each direction, where applicable) and the moving average as well as the minimum value from each five consecutive rolls reported to the Engineer.

Five test specimens shall be tested in each direction for tensile properties (ASTM D 638) from each of the first 20 rolls of textured liner manufactured for delivery to this project. Provided all test results are in compliance with Specifications, the number of test specimens may then be reduced as allowed above for smooth liner if approved by the Engineer. All factory testing shall be at the Liner Contractor or Manufacturer's expense.

Certification of the liner modulus of elasticity, dimensional stability, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission shall be provided in accordance with Section 2.3.3 of this Specification.

2.6 Independent Quality Control Testing

The Liner Contractor shall obtain and secure samples (coupons) of the liner for destructive testing by the Engineer from locations designated by the Engineer, and shall properly mark all test specimens as needed to identify the liner panel from which the specimen was obtained. Testing by the Engineer will be made for the following liner properties at the following sampling frequencies unless revised otherwise during construction.

Property	Test Method	Sampling Frequency
Thickness	ASTM D 5199 (Smooth Liner)	2 per acre
Thickness	ASTM D 5994 (Textured Liner)	2 per acre
Density	ASTM D 792 or D 1505	1 per acre*
Carbon Black Content	ASTM D 1603	1 per acre*
Tear Resistance	ASTM D 1004	2 per acre**
Tensile Strength at Yield	ASTM D 638, Type IV, 2 ipm	2 per acre**
Tensile Strength at Break	ASTM D 638, Type IV, 2 ipm	2 per acre**
Elongation at Yield	ASTM D 638, Type IV, 2 ipm	2 per acre**
Elongation at Break	ASTM D 638, Type IV, 2 ipm	2 per acre**
Frictional Characteristics	ASTM D 5321	1 per 10 acres
Other Properties	As requested by Engineer	Up to 2 samples per acre

* The sampling frequency may be reduced, at the sole discretion of the Engineer, to 1 per 10 acres once sufficient data is available to demonstrate consistent compliance with this Specification.

** Tested in machine and transverse directions. The sampling frequency may be reduced, at the sole discretion of the Engineer, to 1 per 3 acres once sufficient data is available to demonstrate consistent compliance with this Specification.

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material or installed liner section from which the sample was collected to the extent designated by the Engineer. If the Liner Contractor or Manufacturer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner, then only that portion will be rejected. The additional tests, however, shall be performed by the Engineer.

2.7 Warranty

A written warranty shall be provided to the Receiver from the Manufacturer. This document shall warrant the quality of the liner material for a period of not less than 20 years.

2.8 Submittals

The following submittals are required as part of the requirements of this Specification.

- Product data sheets and test data for each liner type listing the minimum liner physical properties, and the product data sheets for each resin type listing the resin properties.

- A written certification from the Liner Manufacturer that the resin and liner materials are in compliance with this Specification.

- Certification in writing that the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission meet the requirements for this Specification. The results of at least one test for each property for each liner type

with each resin type, performed within one year of the date of the certification, shall be provided with the certification.

- Certification in writing that the HDPE resin low temperature brittleness and environmental stress crack resistance meet the requirements of this Specification. One test result for each property from each type resin supplied to the project performed within one year of the date of the certification shall be provided with the certification.

- Description of the spark testing device, the factory QA/QC plan for operating the system, and written certification that all liner rolls have been factory spark tested and do not contain pinhole defects.

- Factory testing QA/QC plan and factory laboratory quality manual for all liner and resin tests required in this Specification.

- Factory test reports for each batch of HDPE resin used in the liner sheets including proportions of base polymer and additives, oxidative induction time, melt index and density. The resin manufacturer's certificate of analysis for each batch of resin shall also be provided.

- Factory quality control certificates for each liner roll including minimum and average thickness, tensile properties, tear resistance, puncture resistance, density, carbon black content and carbon black dispersion.

TYPICAL TECHNICAL SPECIFICATIONS

SECTION 3
PROTECTIVE SOIL COVER

GYPSUM STACK SIDE SLOPE AND TOP GRADIENT CLOSURE CONSTRUCTION

FDEP - ITN NO. 2004070C
PINEY POINT STACK SYSTEM CLOSURE

3.1 **Description of Work**

This Specification covers material requirements, placement and compaction of soils above the HDPE liner where shown on the Drawings. The Specification includes the following sections.

3.2 **Referenced Standards**

The following American Society for Testing and Materials (ASTM) standards are referenced in this Specification.

D 422: Standard Test Method for Particle-Size Analysis of Soils

D 698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D 1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve

D 1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

D 2216: Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock

D 2487: Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D 2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method

D 2974: Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

D 4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

D 4254: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

D 4944: Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method

3.3 **Source of Soil Materials**

The Contractor shall be responsible for securing a source of soil borrow materials.

3.4 **Material Requirements**

The soil shall be non-cemented and free from rocks, stones, gravel and other deleterious materials (organic material, wood, trash, debris, sharp objects, particles greater than 1/4-inch in size, etc.), and shall consist of slightly silty sand, silty sand, and/or slightly clayey sand classifying as SP-SM, SM and/or SP-SC type soils in accordance with ASTM D 2487. Slightly clayey SP-SC type soils shall have a fines content of less than 10 percent as determined in accordance with ASTM D 1140. The organic content of all soils shall be equal to or less than 1 percent as determined in accordance with ASTM D 2974.

3.5 **Placement and Compaction**

The soil cover atop the HDPE liner shall be constructed to the lines, grades and dimensions shown on the Drawings.

Placement of the cover shall be undertaken by light track-mounted or rubber-tired equipment exerting a relatively low contact stress (e.g., low ground pressure D-4 or D-5 dozer exerting less than 4.5 lb/in^2 of contact stress) and traveling on a minimum of 18 inches of soil end dumped ahead of the equipment with front-end loaders. Care should be exercised during placement to not damage the HDPE liner with the blade, bucket, tracks or tires of the equipment. Any damage to the liner shall be immediately reported to the Engineer and repaired at Contractor's expense.

The soil cover shall be placed in two lifts. The first lift above the HDPE liner shall be 18 inches in loose thickness. The surface of the first lift shall be carefully scarified prior to placement of the second lift. Each lift shall be compacted to an in-place dry density equal to or greater than 95 percent of the Standard Proctor maximum dry density (ASTM D 698).

The soil cover shall be constructed to a vertical tolerance of 0.1 feet from the grades and dimensions shown on the Drawings, while maintaining the direction of all sloping surfaces shown on the Drawings. All construction shall be completed to within a horizontal tolerance of ±1 percent from the lines and dimensions shown on the Drawings, and within a maximum horizontal tolerance of ±0.3 feet.

3.6 **Quality Control Inspection and Testing**

The Engineer will undertake observations and perform quality control tests to determine compliance of soil materials with this Specification. Quality control by the Engineer will include monitoring: (i) the suitability of the borrow soils used in construction; (ii) placement and compaction; (iii) any repair work necessitated by damage caused by the Contractor's operations; and (iv) thickness measurements to verify compliance with the geometric requirements of the Drawings and this Specification.

The Engineer will perform moisture content determinations (ASTM D 2216) and *in-situ* density tests on the compacted soils. Density tests will be performed using the drive cylinder method (ASTM D 2937) or sand cone method (ASTM D 1556). Moisture content tests made in the field using calcium carbide gas pressure moisture meters (ASTM D 4944) may be used to provide moisture content information for construction control. The Engineer will perform Standard Proctor compaction tests (ASTM D 698) and minimum and maximum density tests (ASTM D 4253 and ASTM D 4254) on representative samples of borrow materials as needed for compaction control.

The Engineer shall perform the following quality control tests on soil materials at the indicated minimum testing frequencies.

Material	Property	Test Method	Minimum Testing Frequency
Soil Atop HDPE Liner	Thickness	Survey or Measurement	4/acre
	In-Place Density	ASTM D 2937 ASTM D 1556	2/acre
	Fines Content	ASTM D 1140	2/acre
	Organic Content	ASTM D 2974	1/acre
	Standard Proctor	ASTM D 698	As needed

3.7 **Submittals**

The Contractor shall submit his proposed methods and equipment placing and compacting soil above the HDPE liner for approval by the Engineer prior to undertaking placement of any soil.

TYPICAL TECHNICAL SPECIFICATIONS

SECTION 4
AMENDMENT AND GRASSING OF GYPSUM SIDE SLOPES

**GYPSUM STACK SIDE SLOPE AND
TOP GRADIENT CLOSURE CONSTRUCTION**

**FDEP - ITN NO. 2004070C
PINEY POINT STACK SYSTEM CLOSURE**

4.1 Description of Work

This Specification section covers amendment and pH adjustment of gypsum slopes with dolomitic limestone, grassing by seeding, mulching, and rolling of the completed slopes. The Specification contains the following sections.

4.2 Referenced Standards

The following Florida Department of Transportation Standard Specifications for Road and Bridge Construction are referenced in the specification.

Section 570 – Grassing by Seeding
Section 575 – Sodding
Section 981 – Grassing and Sodding Materials

4.3 Amended Gypsum Slope Cover

The regraded slopes of the gypsum stack shall be amended with dolomitic limestone, or Engineer-approved alternative, to increase the pH of the gypsum to not less than 5.0 and to render the gypsum less deficient in magnesium and/or potassium. Results of limited testing performed in conjunction with a test plot on the west slope of the New Gypsum Stack - North (NGS-N) by the Program Manger at Piney Point in June 2004 suggested that dolomitic limestone will need to be applied at a rate in the range of 2 to 4 tons per acre where the near surface gypsum is leached, and at rates of about 8 to 10 tons per acre where the gypsum is freshly exposed or consists of gypsum fill obtained from pond interior areas in conjunction with other stack closure operations.

Field pH determinations will be made by the Engineer 24 hours after mixing operations are complete. If the measured pH is less than 5.0, the area in question will be retested after an additional reaction period of 24 hours before additional dolomitic limestone is added. Areas that

fail the second testing shall receive an additional application of dolomitic limestone, at a rate specified by the Engineer, and the area remixed using the procedures specified below. The prepared gypsum surface shall be loose and reasonably smooth upon completion.

Dolomitic limestone shall be a finely ground product, designated for agricultural use, and approved by the Engineer. The device used for spreading dolomitic limestone shall be capable of uniformly distributing the material at the specified rate. Immediately after the dolomitic limestone is spread, it shall be thoroughly mixed into the gypsum surface, to a depth of 6 inches. The mixing may be accomplished with an agricultural disk, roto-tiller or combination of the two. Disking or tilling shall be along the contour and shall be adequate to thoroughly pulverize the gypsum and uniformly mix the amendments with the pulverized gypsum. Water shall be added as needed to maintain the completed mixture in a moist condition.

4.4 Grassing by Seeding

The following materials and methods to establish vegetation on the gypsum stack side slopes shall be used as general guidelines and shall be subject to revisions at the sole discretion of the Engineer.

4.4.1 Materials

The Contractor shall provide necessary documents/certifications to the Engineer confirming that all materials ultimately supplied (e.g., seeds, fertilizer and dolomitic limestone) meet the requirements of these specifications and, if applicable, revisions to these specifications.

4.4.1.1 General

The separate types of seed used shall be thoroughly dry-mixed on-site immediately before sowing. All seed shall meet the requirements of Florida State Department of Agriculture and Consumer Services and all applicable State laws, and shall be approved by the Engineer before being sown. The seed shall have been harvested from the previous year's crop.

4.4.1.2 Grass Seed

Each of the species or varieties of seed shall be furnished and delivered to the site in separate labeled bags. During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents and other causes.

All permanent and temporary grass seed shall have been tested within a period of 6 months of the date of planting.

All permanent and temporary grass seed shall have a minimum percent of purity and germination as follows:

- Bermuda grass seed shall be of common variety with a minimum pure seed content of 95 percent with a minimum total germination of 85 percent.

- Annual quick growing Rye grass seed (for plantings between September 1 and March 15) shall have a minimum pure seed content of 95 percent with a minimum total germination of 90 percent.

- Quick growing Millet seed (for plantings between March 16 and August 31) shall be of the Brown Top variety with a minimum pure seed content of 90 percent with a minimum total germination of 85 percent.

4.4.1.3 Commercial Fertilizers

Commercial fertilizers shall comply with the State fertilizer laws.

4.4.2 Seeding by Broadcasting

4.4.2.1 Equipment

- **Tilling:** The device for tilling the gypsum stack slope surface shall be capable of contour tilling weathered gypsum to a depth of 6 inches.

- **Fertilizer Spreader**: The device for spreading fertilizer and dolomitic limestone shall be capable of uniformly distributing the material at the specified rate.

- **Seed Spreader**: The seed spreader shall be an approved mechanical type of spreader.

- **Equipment for Cutting Mulch into Soil**: The mulching equipment shall be of a type capable of cutting the specified materials uniformly into the amended gypsum and to the required depth.

- **Rollers**: A cultipacker, or other suitable equipment will be required for rolling the grassed areas.

4.4.2.2 Construction Methods

Fertilizing, seeding, and mulching operations will not be permitted when wind velocities exceed 15 miles per hour. Seed shall be sown only when the amended gypsum is moist and in proper condition to induce growth. No seeding shall be done when the amended gypsum is unduly wet or otherwise not in a tillable condition.

4.4.2.2.1 Sequence of Operations

The operations involved in the work shall proceed in the following sequence: seeding, cutting-in mulch, and light rolling.

4.4.2.2.2 Seeding and Fertilizing

While the amended gypsum surface is still loose, the seed and fertilizer shall be uniformly distributed over the grassing area and immediately mixed into the seed bed to a depth of one-half inch. Seed and fertilizer shall be sown only when the amended gypsum is moist, but not unduly wet and in proper condition to induce growth. The Contractor shall water the surface, if needed, prior to seeding, with potable water obtained from the plant and transported in a water tanker or piping system equipped to spray irrigate.

Permanent type grass shall be at least 30 pounds of common hulled bermuda seed per acre, or as otherwise specified by the Engineer. Quick-growing type grass shall be a species which will

provide an early ground cover during the particular season when planting is done. The rate of sowing of quick-growing grass seed shall be 50 pounds per acre. The separate types of seed used shall be thoroughly dry-mixed immediately before sowing. Seed which has become wet shall not be used.

The fertilizer shall be applied at a minimum initial application as follows: 100 lb/acre N, 50 lb/acre K_2O, and 25 lb/acre Mg. Unless otherwise directed, a subsequent application containing 50 lb/acre N, 25 lb/acre K_2O, and 12.5 lb/acre Mg shall be applied without mixing into the soil approximately 6 months after the initial application.

4.4.2.2.3 Mulching

Dry bahia grass hay mulch material shall then be applied uniformly over the seeded area at an application rate of 4,500 pounds per acre, and the mulch material cut into the soil with the equipment specified. Care shall be exercised that the materials are not cut too deeply into the soil. Only undeteriorated mulch which can be readily cut into the soil shall be used.

All mulch shall be in accordance with Section 981 of the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction.

4.4.2.2.4 Rolling

Immediately after completion of the seeding, the entire grassed and mulched area shall be rolled thoroughly with the equipment specified. At least two trips over the entire area will be required. The mulch shall be anchored to the ground as needed to minimize loss by wind and rain, by a V-type wheel land packer or similar equipment, and in accordance with the requirement of Section 570 of the FDOT Standard Specifications for Road and Bridge Construction.

4.4.2.2.5 Watering

Newly seeded areas shall be watered as required to prevent grass from drying out, and to maintain the necessary moisture. The moistened condition shall extend to at least the full depth of the rooting zone.

4.4.3 Seeding By Hydroseeding-Hydromulching

Hydroseeding-hydromulching may be used as an alternative to conventional seeding and mulching techniques for grassing the amended gypsum slopes, if approved by the Engineer.

4.4.3.1 Equipment

- **Tilling:** The device for tilling the gypsum stack slope surface shall be capable of contour tilling weathered gypsum to a depth of 6 inches.

- **Hydroseeding-Hydromulching**: The device for hydroseeding-hydromulching shall be capable of uniformly distributing the specified materials on to the gypsum stack slope surface.

4.4.3.2 Construction Methods

Hydroseeding-hydromulching will not be permitted when wind velocities exceed 15 miles per hour. Seed shall be sown only when the amended gypsum is moist and in proper condition to induce growth. No hydroseeding-hydromulching shall be done when the amended gypsum is unduly wet or otherwise not in a tillable condition.

4.4.3.2.1 Sequence of Operations

The operations involved in the work shall proceed in the following sequence: seeding, cutting-in mulch, and light rolling.

4.4.3.2.2 Hydroseeding-Hydromulching

While the amended gypsum surface is still loose, the hydroseeding-hydromulching slurry shall be uniformly distributed over the grassing area. Slurry shall be applied only when the amended gypsum is in proper condition to induce growth.

On a per acre basis, the hydroseeding-hydromulching slurry shall include 6500 gallons of water, 2000 lb. dry paper fiber, 45 lb. of common bermuda seed, 90 lb. of quick-growing type seed, 70 lb. N, 17.5 lb. P_2O_5, 35 lb. K_2O, and 8.75 lb. Mg. Quick-growing type grass shall be a species which will provide an early ground cover during the particular season when planting is done.

4.4.3.2.3 Watering

Newly hydroseeded and hydromulched areas shall be watered as required to prevent grass from drying out, and to maintain the necessary moisture. The moistened condition shall extend to at least the full depth of the rooting zone.

4.4.3.2.4 Fertilizing

Broadcast supplemental fertilizer at the rate of 25 lb. N, 12.5 lb. K_2O, and 3.3 lb. Mg per acre 90 days after hydroseeding-hydromulching and at the rate of 50 lb. N, 25 lb. K_2O, and 15.5 lb. Mg per acre approximately 6 months after hydroseeding-hydromulching.

4.4.4 Maintenance

The Contractor shall maintain the planted areas in a satisfactory condition. The Engineer, at any time, may require replanting of any seeded areas in which the establishment of the grass stand does not appear to be developing satisfactorily.

The temporary grass cover, if Millet, should be mowed to a height of 4 inches when the plant reaches 6 inches and before seed heads appear. Mow all grass at regular intervals to a height of 4 inches when the grass reaches a height of 6 to 8 inches.

4.5 **Submittals**

The following submittals are required as part of the requirements of this Specification.

- A complete description and product data sheets for the dolomitic limestone and fertilizer products shall be submitted to the Engineer for approval at least two weeks prior to application.

- Certification of the type and quality of seed provided by the Contractor shall be provided to the Engineer for approval prior to seeding.

- The Contractor's proposed equipment and methods of construction shall be submitted to the Engineer for approval at least two weeks prior to the start of grassing operations.