



**Hillsborough County  
Southeast County Landfill Sinkhole Remediation  
Stage 5 – Isolation of Impacted Clay Liner  
C.I.P. No. 54061**

**Construction Specifications**


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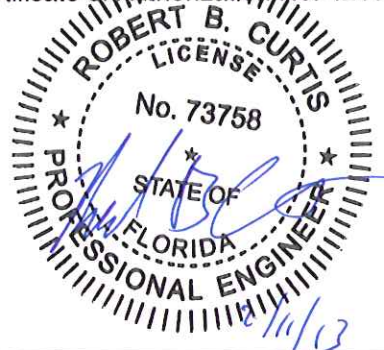


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## **SECTION 02130**

### **VERTICAL EXTRACTION WELLS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope of Work: The Contractor shall provide all labor, equipment, materials, and appurtenances necessary to drill, install and make ready landfill gas (LFG) extraction wells and wellheads as specified herein and as indicated on the Contract Drawings.
- B. The slotted pipe, bentonite seals, filter pack (tire chips), geotextile and soil backfill packs shall be set at depths shown on the Contract Drawings or as designated in the field by the Engineer. It is expected that combustible, asphyxiant, and hazardous gases will be venting from boreholes drilled to install LFG extraction wells. The Contractor's bid price shall include provision for all equipment and procedures necessary to safely install wells under this condition. All work shall be performed by qualified workers in accordance with the best standards and practices available.
- C. Upon completion of each extraction well, Contractor is responsible for the physical hauling and drop-off of all construction and drilling waste materials as directed by the Owner, at the landfill working face during normal operating hours.
- D. Related Sections include but are not necessarily limited to:
  - 1. Section 15060 – Pipe and Pipe Fittings: Basic Requirements
  - 2. Section 15075 – Pipe: Polyvinyl Chloride (PVC)

##### **1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ASTM International (ASTM):
    - a. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates
    - b. C702, Standard Practice for Reducing Field Samples of Aggregate to Testing Size
    - c. D1693 - Test Method for Environmental Stress Cracking of Ethylene Plastics.
    - d. D1784, Rigid Vinyl Compounds.
    - e. D1785, PVC Plastic Pipe, Schedule 80.
    - f. D2467, PVC Plastic Fittings, Schedule 80.
    - g. D2487, Standard Test Method for Classification of Soils for Engineering Purposes
    - h. D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
    - i. D2513, Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.

- j. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter - Controlled Polyethylene Pipe and Tubing.
- k. D2922, Standard Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
- l. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- m. D3350 - Specification for Polyethylene Plastic Pipe and Fittings Material.
- n. D421, Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
- o. D422, Standard Test Method for Particle-Size Analysis of Soils.
- p. D4220, Standard Practices for Preserving and Transporting Soil Samples.
- q. D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- r. F480, Standard Specification for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratio (SDR).
- s. F1248 - Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
- t. F1668, Standard Guide for Construction Procedures for Buried Plastic Pipe.

**B. Qualifications:**

- 1. The driller and installer of the landfill gas extraction wells shall have completed at least one hundred successful vertical landfill gas extraction wells of similar type and depth within the last 2 years.
- 2. All LFG collection wells shall be installed under the direction of a Civil Engineer, Engineering Geologist, or Geologist if so required by local or state jurisdictions. All final LFG collection well drilling logs and construction diagrams shall be signed by a registered professional or person of responsible charge. Field supervision of drilling, logging and installation activities shall be performed by trained, experienced technical personnel.

**C. Miscellaneous:**

- 1. Contractor's personnel Health and Safety Plan (HASP) shall be available for informational purposes.
- 2. Contractor shall retain a professional experienced in installation of LFG wells to be responsible for observing and documenting information related to all installation activities.
- 3. Well materials shall be inspected for cleanliness, deformations, and imperfections, and to ensure conformance with specifications prior to use.

### **1.3 SUBMITTALS**

- A. The Contractor shall prepare and submit to the Engineer, for review and approval, Certificates of Compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished.

- B. The Contractor shall submit a HASP to the Engineer for information purposes only (not review) before any construction starts.
- C. The Contractor shall prepare and submit to the Engineer for review and approval Shop Drawings showing dimensions, materials, and manufacturer's information for backfill materials, pipe, pipe perforations, fittings, bentonite, and wellhead components.
- D. One week prior to well drilling, Contractor shall submit an example well boring log and construction log. The example log shall be completed with all of the required descriptions and pertinent information required under Part 3.3 of this Section.
- E. At the end of each day, Contractor shall provide the Engineer copies of the handwritten well boring and completion logs for each well drilled on that day. Information to be included on the well logs is listed in Part 3.3 of this Section.
- F. Final boring logs, based on field information shall be typewritten and submitted with the Record Documents.
- G. As-Built drawings shall be submitted to the Engineer including, northing, easting and elevation data for all required points of the gas collection system in the state plane coordinate system. Top of casing and ground surface elevation shall be surveyed for all well points.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following Manufacturers of PVC casing, PVC screen, and accessories are acceptable:
  - 1. U.S. Plastic Corp.
  - 2. Harvel Piping.
  - 3. Charlotte Pipe and Foundry Company.
  - 4. North American Pipe Corp.
  - 5. JM Eagle.
  - 6. Or approved equal.

### **2.2 MATERIALS**

- A. PVC Casing as specified in Section 15075:
  - 1. 6 inch nominal diameter schedule 80 for PVC well casing.
  - 2. Casing shall be connected to PVC screen with solvent cement and secured with lag screws.
- B. PVC Well Screen (Slotted pipe) as specified in Section 15075:
  - 1. 6 inch nominal diameter schedule 80.
  - 2. Perforation pattern(s) as shown on Contract Drawings.
  - 3. Slots to be factory installed. No slots to be installed in the field.

4. 20 foot lengths or as needed. Field cutting will be allowed as long as cuts are clean, perpendicular to the pipe, and do not affect the integrity of the well screen.
- C. PVC Jointing:
1. All joints and bottom cap of screen shall be with solvent cement and secured with lag screws.
- D. Filter Pack:
1. Excavate, transport, and install tire chips from tire chip stockpile, located at the site's Waste Tire Processing Facility, for use as filter pack as locations and depths shown on the drawings.
  2. Tire chips shall be free of foreign materials and be 4 inches nominal size. Tire Chips to be supplied by County.
- E. Bentonite Seal:
1. Pellet or chip form of sodium bentonite that shall consist of clay greater than 85% sodium montmorillonite, without additives.
  2. Bentonite shall be hydrated per manufacturer's instructions prior to backfilling with soil. Bentonite shall be hydrated in 6-inch lifts as per Paragraph 3.2.C.15 of this Section.
  3. Under no circumstances will the use of granular bentonite be permitted.
- F. Backfill Material:
1. Soil backfill material taken from the on-site borrow area shall be granular material free of clay, sticks, roots or other organic material.
- G. Top and Bottom Cap:
1. Bottom end cap shall be SCH 80 PVC connected with solvent cement and secured with lag screws.
  2. Contractor shall supply temporary SCH 40 PVC cap on the top secured with at least three (3) set screws and silicone sealant as per Contract Drawings and Specifications until installation of wellhead is completed.
- H. Wellhead materials
1. Wellheads shall be 2-inch diameter Forrer wellheads by Forrer Supply.
  2. Vertical wellhead models shall be used for all wells.
  3. Wellheads to be provided with 0.25", 0.50", 0.75", 1.0", 1.25", and 1.5" thick orifice plates.
- I. Monitoring ports
1. Monitoring ports shall be 1/4" inch NPT polypropylene male barb monitoring port, Parker P4MCB4 Tubing barb, with McMaster Carr 9753K38 vinyl cap or equivalent.
- J. Well Identification
1. Upon completion of well drilling, Contractor shall promptly label the well identification number on the well casing to match existing gas wells, using pre-printed, adhesive backed labels.



K. LFG Collection Wells:

1. The Contractor shall install the landfill gas collection wells at the locations noted on the Contract Drawings and/or where staked in the field, or as approved by the Owner or Engineer.
2. The LFG well boring will be as noted in the Contract Drawings. The drilled boring shall be specified by the Engineer or Owner, and shall extend to no more than 15 feet of the landfill base liner system elevations. In no instance will well bores be advanced and/or completed into the native soils beneath the landfill. Wells shall be constructed in accordance with the details shown on the Contract Drawings and as noted in the Specifications.

L. Geotextile:

1. 6 oz non-woven geotextile.

M. Well Boot:

1. 40-mil HDPE well boot shall be installed on all riser pipes for the vertical wells.
2. Well boots shall be fastened to piping via stainless steel band clamps.
3. A ¼" thick by 3" wide neoprene pad shall be placed between the pipe and geomembrane well boot and between the clamp and geomembrane well boot.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. All materials necessary to complete the installation of the gas extraction wells shall be on-site prior to drilling start-up.
- B. Contractor shall follow his Health and Safety Plan at all times.
- C. Survey of 60-mil HDPE geomembrane must be conducted at each vertical well location prior to backfilling with protective cover. The location and elevation of the 60-mil geomembrane will be utilized in the placement of the bentonite plug for each vertical well.
- D. The Contractor shall survey and stake the well locations prior to drilling. Well layout surveying shall be done by a Florida Licensed Professional Surveyor. Contractor shall notify the Engineer of any discrepancies between the elevations shown on the Contract Drawings and actual field measurement elevations, and any other conflicts that may be evident.
- E. Contractor shall supply surveyed ground elevations to Engineer electronically in AutoCAD format so that the design depths may be confirmed at least one week prior to drilling.
- F. Well locations must be approved and may be adjusted by the Engineer prior to beginning drilling. Final well schedule to be used for construction of the vertical wells will be provided by the Engineer after reviewing the pre-construction survey and the 60-mil HDPE geomembrane locations provided by the Contractor.

## 3.2 INSTALLATION

### A. General:

1. All wells will be installed in the general locations shown in the Contract Drawings. The well schedule shows the estimated design depths of the wells along with the associated screen lengths. All field changes regarding the locations, depth, or dimensions specified in the Contract Drawings shall be approved by the Engineer and documented in the record drawings by the Contractor.
2. The Contractor shall provide a thoroughly experienced, competent driller during all operations at the drill site at all times.
3. The Contractor must use dry drilling equipment.

### B. Well Hole Construction:

1. Drill wells using a minimum 36 in. OD core-grab bucket auger. Alternate drilling methods must be pre-approved by the Engineer.
2. If a layer of sand or the liner is encountered while boring, drilling shall immediately cease and the Engineer shall be contacted immediately.
3. All gas extraction well borings shall extend to the depth indicated in the Contract Drawings. Under no circumstances are the drilling depths from the well schedule on the Contract Drawings to be exceeded unless approved by the Engineer in advance.
  - a. Wet Borings:
    - 1) The Engineer shall be notified of wet boring conditions.
    - 2) If water is encountered in a boring, the Contractor may be directed by the Engineer to drill beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated at the direction of the Engineer, (after driller has attempted to advance boring for 3 hours) and the length of perforated pipe adjusted by the Engineer. If wet conditions cease (e.g. due to perched water layer), then drilling will continue to the design depth.
    - 3) If water is encountered in a boring at a shallow depth, the Engineer may decrease the well depth and length of perforated pipe, or relocate the well.
  - b. Abandoned Borings:
    - 1) If, in the opinion of the Engineer, the borehole has not reached a sufficient depth to function as an effective extraction well, the Contractor shall abandon this borehole by backfilling it with cuttings removed during drilling. Soil shall be backfilled and compacted to ground surface. Contractor shall supply additional soil backfill to refill any settlement within the abandoned borehole, as approved by the Owner and Engineer.
    - 2) If cuttings are unsuitable as backfill (for example, box springs, tires, etc.) the Contractor shall use soil backfill material.
    - 3) Compensation for abandoned borings shall be at the unit price for well abandonment.

- c. As soon as drilling is completed, a safety screen shall be placed over the top of the bore. This screen shall stay in place until backfilling is within 1 foot of the surface. Safety screen size should be large enough to accommodate all backfill materials and any tools used during backfill yet not be large enough for any human to accidentally fall through.
- d. All bore holes that are not completed at the end of the day are to be covered with a metal well cover capable of preventing any persons from falling into the hole. The hole must then be covered with a piece of plywood to substantially cover the entire hole. Soil must be placed on top of the plywood to completely cover the plywood to further prevent gas emissions. Substitute safety measure may be used if approved by the Engineer.

C. Well Installation:

- 1. Contractor shall fabricate the PVC well casing and PVC well screen in accordance with Contract Drawings and Specifications. The PVC well screen shall be slotted in accordance with the Details and Specifications. Well screen shall be capped or blind-flanged at the surface connection prior to installation to prevent gas from escaping and to prevent backfill material from entering the pipe.
- 2. No pressure tests are required for the collection well screens.
- 3. Measure depth of boring. The bore for the well shall be straight and the well pipe shall be installed in the center of the borehole.
- 4. Connect the well screen of sufficient length including bottom cap.
- 5. Place 12 inches of filter pack (tire chips) in the bottom of the boring prior to installing well screen.
- 6. Lower well screen into the borehole. In no instance, drive or force into position. The Contractor shall take all necessary precautions to maintain the well pipe vertically plumb during the entire backfill operation of the borehole to the satisfaction of the Engineer.
- 7. If the pipe is installed out of plumb, as determined by the Engineer, the Contractor, at his own expense shall correct the alignment.
- 8. Join additional well screen sections for a single interval by securing with lag screws and solvent cement.
- 9. Install PVC casing and join additional sections for a single interval using solvent cement and lag screws
- 10. Extend PVC well screen and PVC casing to no more than 4 feet above existing grade elevation. The well shall be raised using additional pipe segments during final backfilling operations, including pipe HDPE/LLDPE pipe boots as required.
- 11. At the end of each day, Contractor shall cap the ends of all joined pipes longer than 20 feet to prevent entry by animals and debris.
- 12. Continue placement of filter pack (tire chips) into the annulus between the PVC casing and the borehole wall until the filter pack is 3 feet below existing surface (initial grading for installation of sheet piles). Filter pack must be placed between the PVC casing and PVC well screen until the filter pack is 2

feet below existing surface. All filter pack materials shall be placed by methods approved by Engineer.

13. Take periodic depth soundings to monitor the level of the filter pack and detect any bridging. Soundings shall be taken at no more than 5-foot intervals.
14. Place 6 ounce non-woven geotextile or approved equal on top of the filter pack between the PVC casing and borehole wall.
15. After ensuring that the PVC casing and PVC well screens are centered in the borehole, place 4 foot minimum bentonite seal on top of the geotextile between the PVC casing and borehole wall in maximum 6-inch lifts.
  - a. Hydrate bentonite chips/pellet in the bore hole per supplier's recommendations for a minimum 1 hour after placement and prior to installing clean backfill. The bentonite must be thoroughly hydrated.
  - b. Measure depth of bentonite seal after tamping each lift.
16. Repeat steps 12 through 14 for second filter pack above 60-mil HDPE geomembrane, if applicable.
17. Fill the remainder of the bore hole between the PVC casing and borehole wall to grade with clean backfill by means pre-approved by the Engineer in maximum 18-inch lifts.
  - a. Soil backfill shall be rodded in the boring to provide even distribution and compaction.
18. The grate over the borehole that is used to keep the well casing plumb shall not be removed until the borehole is backfilled to within 1 foot of ground surface and sufficiently compacted.
19. Collect and clean up drilling debris, cuttings around the work areas. Dispose in active landfill.
20. Mound shall be installed around the well riser to drain stormwater away from the well.
21. Contractor shall be responsible for any grading, leveling, towing and/or restoration that may be necessary for movement of the drill rig on the landfill property.

D. Refuse Disposal:

1. Contractor shall dispose of cuttings (refuse/waste) within the bermed Waste Stockpile and Relocation Area as shown on the drawings. Excavated refuse must be removed immediately during any rain event to prevent stormwater from contacting the refuse.
2. Contractor is responsible for weighing cuttings at landfill scale in highway legal trucks and paying tipping fees. Contractor shall be responsible for all other costs.

E. Temporary Cap:

1. The Contractor shall temporarily cap the riser pipe of the vertical extraction well immediately after well pipe installation to prevent venting of LFG into the atmosphere. The Contractor shall remove this cap during the installation of the wellheads. Lag screws may be necessary to secure the cap due to the internal gas pressure within the well.

F. Wellhead Installation:

1. Wellheads shall be installed in accordance with manufacturer's recommendations. Pipe sections of the wellhead shall be air-tight. Any leaks shall be repaired by Contractor at no additional cost to the Owner.
2. Install flexible hose so that hose has no sags, as show on the Contract Drawings. However, flexible hose shall not be taut. Provide enough slack to accommodate minor pipe settlement, as approved by the Engineer.
3. Wellhead to lateral connection shall be made with a 2 inch flexible hose fastened with stainless steel pipe clamps (or equal).

G. Asbestos Handling:

1. If asbestos is encountered during drilling operations, the following waste handling procedures must be implemented:
  - a. If any waste appearing to possibly contain asbestos is uncovered, all asbestos handling procedures will be immediately placed into effect.
  - b. All persons within 25 feet of the drilling operations will be required to wear the appropriate respirators.
  - c. The use of Tyvek suits will be optional. However, if Tyvek suits are not worn, all employee uniforms must be laundered and the launderers notified of possible contamination with asbestos. All Tyvek suits will be considered to be contaminated with asbestos and will be disposed of accordingly.
  - d. A water truck equipped with the appropriate spraying equipment to keep the drill cuttings wet will be required at all times.
  - e. An area of appropriate size will be prepared to contain the cuttings by one of the following methods.
    - 1) A waste container lined with 6 mil polyethylene will be placed as close as reasonably possible to the well being drilled. A small area next to the drill rig where drill cuttings will be handled will also be lined with 6 mil polyethylene and covered with clean soil to protect the polyethylene. A small earthen berm will be made to help contain the cuttings and facilitate loading into the container. The polyethylene and soil cover will be considered to be part of the waste.
    - 2) An area next to the drill rig that is appropriately sized to accommodate all of the drill cuttings will be surrounded by a small soil berm approximately 30-inches high. This area will then be lined with a 6-mil polyethylene tarp and covered with clean soil to protect the polyethylene. This area will be positioned in a way such that all handling of cuttings will be in the protected area. The polyethylene and soil will be considered to be part of the waste.
  - f. All cuttings that are not already damp upon removal from the well bore will be immediately wetted.
  - g. After wetting, all cuttings will be immediately placed into the container or moved to a different part of the storage area (if needed).
  - h. All cuttings will be kept damp and covered.

- i. After the container is filled, the well is completed, or at the end of the workday, a representative sample will be taken of the waste. The waste sample will be tested by a certified testing laboratory for asbestos using the polarizing light microscopy method. While waiting for the test results, all waste will be kept damp and covered.
- j. If test results indicate greater than one (1) percent asbestos, the waste will be handled and disposed as asbestos waste. This will include keeping the waste wetted and covered as it is transported to another portion of the landfill. If asbestos waste is handled, all equipment that contacted the waste must be decontaminated in an acceptable manner prior to leaving the landfill site.
- k. If test results indicate less than one (1) percent asbestos, the waste will be handled as normal waste and disposed within the Waste Stockpile and Relocation Area as shown on the drawings.
- l. An alternative to sampling and testing the waste will be to assume that the waste contains asbestos and to handle and dispose of accordingly.
- m. The cost of all laboratory testing will be the responsibility of the Contractor. The exact drilling procedure that will be followed must be included in the Contractor's Health and Safety Plan. Additionally, both the selected testing laboratory and testing protocol (should asbestos be encountered during drilling) must be submitted by the Contractor in writing and approved by the Owner prior to beginning any well drilling activities.
- n. Contractor shall be responsible for safely transporting asbestos in highway legal trucks to landfill scales for weighing prior to disposal at active face. Contractor is responsible for paying all associated tipping fees.

#### H. Settlement

- 1. Any settlement around the completed wells, or over abandoned boreholes, shall be backfilled within 3 weeks after placement of backfill from the level of the subsidence to 6 inches above existing grade with the appropriate cover materials.

#### I. Obstruction

- 1. If there is a drilling obstruction encountered in the landfill that, despite the best reasonable efforts of the Contractor, cannot be penetrated, the Contractor shall request relief from the Owner or Engineer from completion of the well. The Owner or Engineer shall be the sole authority for deciding on one of the following:
  - a. Additional drilling efforts are needed at no additional compensation.
  - b. The hole shall be abandoned. The Contractor shall backfill the well to the predrilled condition or to the satisfaction of the Owner or Engineer. The Contractor shall be compensated for the drilling and backfilling of the well, but not its completion.
  - c. The well shall be accepted at the obstructed depth. The well shall be completed at this new depth. Compensation shall be for the modified footage of the well.

### 3.3 FIELD QUALITY CONTROL

- A. Submit the following to the Engineer after each day's work.
- B. Project Record Documents:
  - 1. Daily driller's report: During the drilling of the well, maintain daily driller's report that includes:
    - a. Date
    - b. Location
    - c. Boring Identification Number
    - d. Weather Conditions
    - e. Daily Activities
    - f. Equipment Used
    - g. Materials Used
    - h. Well construction (materials used, type, quantity, etc.)
    - i. Number of feet drilled.
    - j. Number of hours on the job (rig time, down time, stand-by, etc.).
    - k. Names of contract personnel on the job.
    - l. Feet of casing set.
    - m. Other pertinent data as may be requested by the Engineer.
  - 2. Driller's log: During the drilling of the well, prepare and maintain a complete log that includes:
    - a. Logger's Name
    - b. Date
    - c. Location
    - d. Boring Identification Number
    - e. Equipment Used
    - f. Drill Crew
    - g. Time
    - h. Reference point for all depth measurements.
    - i. Depth at which each soil to refuse change occurs.
    - j. Thickness of each soil or refuse stratum.
    - k. Depth at which leachate is encountered, if applicable.
    - l. Depth to refuse and depth of undisturbed soil.
    - m. Visual description of refuse at 5-foot intervals:
      - 1) Type of waste encountered including the estimated percentage of the following components (by volume) on visual inspection:
        - a) Plastic/Cardboard
        - b) Plastic
        - c) Yard waste
        - d) Construction debris
        - e) Textiles
        - f) Tires
        - g) Sludge
        - h) Dirt
      - 2) Temperature of excavated refuse.

- n. Depth of location of any lost drilling material, tools, or any other unusual occurrences.
  - o. Total depth of completed extraction well.
  - p. Total depth of boring.
  - q. Well screen interval.
  - r. PVC casing interval.
  - s. Length of above ground riser stick-up pipe.
  - t. Filter pack (stone or tire chip) depth interval.
  - u. Bentonite seal depth interval.
3. Typed final copies of the well logs shall be submitted with the Record Drawings. Handwritten logs will not be acceptable for submittal with the Record Drawings.

**END OF SECTION**



## **SECTION 02200**

### **EARTHWORK: LANDFILLS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

**A. Section Includes:**

1. Work under this Section includes excavation, backfilling, and compaction for soils and excavated waste materials for the sheet pile cut-off wall isolation system.
2. The terms “cover soils”, “protective cover”, “intermediate cover”, and “backfill soils” all refer to the definitions for “Cover”.
3. The vegetative support layer refers to “Cover” soils that meet the topsoil definition in Section 02260.
4. The terms “Excavated Waste Backfill” materials, “waste”, and “mixed waste soils” all refer to the definition of “Excavated Waste Backfill.”

**B. Related Sections include but are not necessarily limited to:**

1. Section 02221 – Trenching, Backfilling, and Compacting for LFG Piping and Structures
2. Section 02260 – Topsoiling and Finished Grading
3. Section 02485 - Sodding
4. Southeast County Landfill Sinkhole Stage 5 - Isolation of Impacted Clay Liner, Construction Quality Assurance Plan.

##### **1.2 QUALITY ASSURANCE**

**A. Referenced Standards:**

1. ASTM International (ASTM):
  - a. D422, Method for Particle Size Analysis of Soil.
  - b. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>).
  - c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
  - d. D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.
  - e. D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  - f. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - g. D2922, Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
  - h. D2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

- i. D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- j. D4253, Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
- k. D4254, Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.
- l. D6938, Standard Test Method for in-place Density and Water Content of Soil and Soil- Aggregate by Nuclear Methods.
- 2. Florida Erosion and Sediment Control Planning and Design Manual, current edition.
- 3. Florida Department of Transportation Standard Specification for Road and Bridge Construction, current edition.
- 4. Construction Quality Assurance (CQA) Plan.

### **1.3 SUBMITTALS**

#### **A. Shop Drawings:**

- 1. Product technical data including:
  - a. Acknowledgement that products submitted meet requirements of standards referenced.
  - b. Manufacturer's installation instructions.
- 2. Certifications.
- 3. Test reports:
  - a. Soils inspection and testing results.

#### **B. Samples:**

- 1. Submit samples and source of all soil materials proposed for use.
- 2. Submit soil samples directly to CQA and CQC Laboratories with coordination and notification to the Engineer.

### **1.4 SOILS/GEOTECHNICAL**

- A. The Owner will provide for the on-site services of a CQA Inspector to selectively test materials and monitor compliance with the requirements of these Specifications.
- B. The Contractor will afford these representatives access to the job site for the performance of their duties as described in the Contract Documents.
- C. General Duties and Responsibilities of the Owner's CQA Inspector. Under the direction of a qualified registered engineer or geologist:
  - 1. Perform stockpile and in-place testing of all soil material used in the work in conformance with these Specifications and the CQA Plan.
  - 2. Inspect existing intermediate cover and excavations and evaluate/determine suitability of materials encountered. Determine extent of any over excavation required to remove unsuitable materials under areas of construction.
  - 3. Document placement of fill materials and perform testing to confirm compliance with these Specifications.

4. Measure quantity of unsuitable materials under contract provisions for authorized over excavation and backfill.
  5. Review construction operations and monitor for compliance with Contract Documents.
- D. Additional or supplementary soil borings and/or test pits may be made by the Contractor at no additional cost to the Owner. The Contractor shall provide the Owner with a copy of any data obtained/developed during such work. Such additional work shall be performed in a timely manner in accordance with and not impacting or changing the project schedule set forth in the Contract Documents.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. All "Cover" soils: Should be free of deleterious material (sticks, roots, waste, etc.) and rock fragments, boulders, or cobbles greater than 1/2 inches in size. Soils shall be obtained from the excavation of clean soils from the excavation or from the designated on-site borrow area. "Cover" soils shall be classified as SP, SW, SM, SC, SP-SM, or SP-SC materials in accordance with ASTM D2487. Fines content of installed soil shall be a maximum of 50% (passing #200 sieve).
- B. All "Excavated Waste Backfill" materials: Excavated waste, and/or mixed waste materials and soils, can be used as backfill material, with approval of the Engineer; however, in no case shall the excavated waste, and/or mixed waste and soils, be placed within the 12-inch thick cover soil layer or within 24-inch thick compacted cover soil layer.
- C. #57 Stone: Shall meet the requirements for FDOT #57 Stone.
- D. The Contractor shall conduct his own quantity and quality investigations and testing to determine availability and suitability of all borrow materials, as allowed by the Owner.
- E. All earth materials proposed for use in the Work shall be adequately characterized by the Contractor prior to the Work and testing to be completed by the CQA Inspector. Any soil samples submitted by the Contractor are assumed to be tested and approved for use by the Contractor.
- F. The Contractor shall submit source test data for all borrow soils to the Engineer for approval a minimum of 48 hours prior to its intended use.

## **PART 3 - EXECUTION**

### **3.1 PROTECTION**

- A. Protect existing surface and subsurface features on-site and adjacent to site as follows:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
  2. Protect and maintain bench marks, monitoring wells, existing structures, monuments or other established reference points and property corners.
    - a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
  3. Verify location of utilities.
    - a. Omission or inclusion of utility items does not constitute non-existence or definite location.
    - b. Secure and examine local utility records for location data.
    - c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
    - d. Repair damages to utility items at Contractor's expense.
    - e. In case of damage, notify Engineer at once so required protective measures may be taken.
  4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
    - a. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
    - b. All repairs to be made and paid for by Contractor and no additional cost to the Owner.
    - c. All paved roads shall be protected from damage due to equipment, trucks, and off-road vehicles. Any damage to existing paved roads due to the Contractor's work activities such as hauling, earthwork, or material transport shall be repaired to pre-construction conditions by the Contractor at no additional cost to the Owner.
  5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
  6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
  7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.
  8. Conduct operation with minimum interference, as identified by the Owner, with the daily landfill operations.
- B. Construct erosion and sedimentation controls prior to beginning earthwork.
- C. Salvageable Items: Carefully remove items to be salvaged or re-used as part of the Work, specifically drainage pipe and LFG system components, and store on Owner's premises unless otherwise directed. No salvaging will be permitted of items from the excavated waste materials per State regulations.
- D. Stockpiling of waste materials.
1. Waste materials excavated by the Contractor during the performance of the Work will be taken to the Waste Stockpile and Relocation Area for use as "backfill materials" during the filling of the excavation to the waste grades designated. Excess excavated waste materials that cannot be used as part of

the “fill” operations of the Work will be graded as shown on the drawings, covered with intermediate cover soils, and sodded. A soil containment berm shall be constructed by the Contractor around the Waste Stockpile and Relocation Area to contain stormwater that has come in contact with the stockpiled waste. The waste stockpile shall be no greater than 10 feet in height. The lateral limits of the Waste Stockpile and Relocation Area as shown on the drawings is approximate and is subject to change based on the amount of waste excavated during the Work.

2. Burning, as a means of waste disposal, is not permitted.
  3. Construction waste materials or construction materials generated by the Contractor during the performance of the Work will be properly disposed of at the Hillsborough County Southeast County Landfill Facility or another permitted facility and will not be placed into the excavated waste used to backfill the excavation.
  4. Contractor is responsible for the excavation, hauling, transportation and unloading of the excavated waste and construction generated materials.
  5. The Contractor will be responsible for setting up and maintaining a disposal account for the disposal of excavated waste and construction materials, The Contractor will provide payment for the disposal of all waste materials generated as part of the Work that are generated by the Contractor.
- E. The Contractor will be charged a processing fee of \$61.81 per ton for disposal of the waste at the Hillsborough County Southeast County Landfill.
- F. No additional payment shall be made to the Contractor for any over-excavation not approved by Engineer.
- G. Contractor shall be responsible for complete repair of any damage to any and all components of existing gas collection system caused by Contractor’s actions during construction of the project at no expense to the Owner. Modification, relocations (horizontally and vertically), or other work to the existing gas collection system required, needed, or resulting from grade changes or other designed construction resulting from the final cover system shall be brought to the attention of the Engineer. Contractor shall notify Engineer of any modifications to the gas collection system required for the performance of work sufficiently ahead of time to allow the modifications to take place without impacting the construction schedule.
- H. The final cover system is placed directly over the geocomposite, thus extreme caution shall be exercised by the Contractor to prevent damage to the installed geosynthetics. The final cover system will be placed after construction of the landfill gas header, laterals, and horizontal collector pipes are completed and approved.
- I. Placement of the protective cover material of the final cover system shall be conducted only when the Engineer or his representative is informed in advance of the intent to perform this work and is present at the site to observe the placement.

- J. During placement of the final cover system, no construction equipment shall be allowed directly on the geomembrane or geocomposite, except low ground pressure rubber-tired equipment necessary for the deployment and installation of geomembrane liner. Any damage to these components shall be repaired immediately in accordance with the respective specifications. A 4-foot thick traffic surface consisting of protective cover material shall be constructed to support haul trucks traveling over the liner.
- K. Stockpiles of materials for final cover system (including topsoil) shall be deposited in the closure area without vehicles traveling on the drainage composite. Soil shall then be pushed over the uncovered areas of the disposal unit with bulldozers. Advancement of soils over the liner system shall be achieved by pushing a minimum 12-inch thick loose lift ahead of the dozer blade.
- L. Only low ground pressure dozers shall be used for spreading and grading of the final cover system (including topsoil) in accordance with the appropriate geosynthetic manufacturer's recommendations.
- M. The final cover material shall be placed on slopes starting at the toe of the slope and spreading toward the top of the slope.
- N. Final cover material shall only be spread when the liner is laying evenly over the intermediate cover of the landfill. Material shall not be spread over "standing waves" in the liner that form during periods of high temperature and direct sunlight. A standing wave is defined as a ripple in the liner in which the height of the ripple (as measured from the intermediate cover surface) exceeds the width of the ripple. If standing waves are occurring during peak temperature hours, the spreading operation shall be limited to mornings (before 10:00 am) and evenings (after 6:00 pm) or hours agreed upon by the Engineer and Contractor.
- O. Any excavation in the final cover system will be performed with a backhoe bucket equipped with a protective sleeve over the bucket teeth or by another method approved by the Engineer. The Contractor shall exercise extreme care not to disturb or damage the drainage composite or liner. Any liner or drainage composite damaged shall be immediately repaired at no cost to the Owner and as directed by the Engineer.

### **3.2 SITE EXCAVATION, STOCKPILING, BACKFILLING, COMPACTION, AND GRADING**

- A. The Work includes all operations in connection with excavation, borrow, backfilling, construction of cover soil layers, intermediate cover, final cover system (including vegetative cover layer), rough grading, and disposal of excess materials in connection with the preparation of the site(s) for construction of the work.

- B. Excavation and Grading: Perform as required by the Contract Drawings.
1. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
    - a. Stake all units, structures, piping, roads, and establish their elevations.
    - b. Perform other layout work required.
    - c. Replace permanent survey markers to original location if disturbed or destroyed.
  2. Preparation of ground surface for cover soil layer:
    - a. Installation of the landfill gas header, well, laterals, and horizontal collector pipes must be completed and approved before the geosynthetics are placed.
    - b. Before cover soil layer is placed, remove vegetation and unsuitable soils and scarify existing intermediate cover to a minimum depth of 6 inches in all proposed temporary final cover and final cover areas.
    - c. Existing vegetation and clean soil stripped from the existing intermediate cover will be stockpiled for backfill. If the sod/soil contains Class I waste or appears to contain leachate, the material must be handled as excavated waste material and taken to the Waste Stockpile and Relocation Area for future re-use as waste backfill materials.
    - d. Stockpiled clean sod/soil may be tested and if it is approved by the Engineer and meets the requirements for final cover soil, the material may be used by the Contractor for final cover.
    - e. Caution must be taken to avoid any damages to the existing landfill gas system. Any damages must be repaired at Contractor's own expense.
    - f. Perform depth verifications on a minimum 50 feet x 50 feet minimum grid pattern to determine depth of existing intermediate cover and additional thickness required to achieve design depth or grades. If necessary, identify areas where waste excavation will be required to achieve minimum intermediate cover thickness without exceeding design grades.
  3. Protection of finish grade:
    - a. During construction, shape and drain intermediate cover and protective cover layers of the final cover system, berms and excavations.
    - b. Maintain ditches and drains to provide drainage at all times.
    - c. Protect graded areas against action of elements prior to acceptance of work.
    - d. Reestablish grade where settlement or erosion occurs.
- C. Borrow:
1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
  2. Include cost of excavation and transportation of all borrow material in original Bid.
  3. Fill material to be approved by Engineer prior to placement.

4. Obtain borrow soil only from the on-site borrow area designated by the Owner. Do not excavate beyond permitted grades of borrow area. Contractor is responsible for maintaining drainage within the portions of the borrow area he is working in.

D. Excavation of Waste and Waste Stockpile and Relocation Area:

1. The Contractor shall strip the existing vegetative layer and cover soils. Clean cover soils will be identified by the Contractor and the Engineer during excavation and stockpiled for re-use as cover soils, provided the soils meet cover soils specifications.
2. Excavated waste, and/or mixed soil and waste materials, will be hauled to and stockpiled at the Waste Stockpile and Relocation Area.
3. The Waste Stockpile and Relocation Area is designated at the top of the Phase VI disposal area. If the Contractor elects to use a different area it shall first be approved by the Engineer.
4. The excavated waste backfill and/or mixed waste and soil materials will be placed in one continuous stockpile mound and compacted using a) a CAT 826H or Engineer approved equal, if the waste is placed in one-foot thick lifts, or b) a CAT 836H or Engineer approved equal, if the waste is placed in two-foot thick lifts. All waste lifts will then be compacted using a minimum of five passes of each lift and complete coverage of the lift.
5. A continuous, compacted, soil berm will be constructed by the Contractor around the entire Waste Stockpile and Relocation Area that contains excavated waste backfill and/or mixed soils and waste materials. The dimensions of the berm are as designated on the plans and may be subject to change based on the stockpile configuration as placed by the Contractor.
6. Stormwater, or any water, that comes in contact with the excavated waste backfill, and/or mixed soil and waste materials is considered leachate and must be contained, collected, and properly disposed of by the Contractor. Stormwater and leachate management are the responsibility of the Contractor during the execution of the work.
7. Clean cover soils can be stockpiled within the Waste Stockpile and Relocation Area or other Contractor designated, and Engineer approved, stockpile areas and do not require a containment berm surrounding these materials. However, a silt fence (at a minimum) will be required around the stockpiled clean cover soils as part of the Contractor's erosion and sedimentation control plan.
8. The Waste Stockpile and Relocation Area will be constructed and maintained by the Contractor during execution of the work. Upon completion of the work, all berms associated with the Waste Stockpile and Relocation Area will be removed and all excess excavated waste stockpiled during execution of the work will receive intermediate cover soil and sod.



- E. Placement and compaction of excavated waste backfill and/or mixed soil and waste materials:
1. The Contractor shall re-use, place, and compact the excavated backfill waste, and/or mixed soils and waste materials, as part of the execution of the work.
  2. The excavated waste, and/or mixed soil and waste materials, will be placed and spread across the work area using heavy tracked dozer equipment, equivalent in weight and ground contact pressure as a CAT D6T WH or Engineer approved equal.
  3. Once the excavated waste, and/or mixed soil and waste materials have been placed the materials will be compacted using a) a CAT 826H or Engineer approved equal, if the waste is placed in one-foot thick lifts, or b) a CAT 836H or Engineer approved equal, if the waste is placed in two-foot thick lifts. All waste lifts will then be compacted using a minimum of five passes of each lift and complete coverage of the lift.
  4. The compacted excavated waste, and/or mixed soil and waste, will be placed as described in the summary of work in this Section. The Contractor will use maximum efforts to re-use the excavated waste materials, and/or mixed soil and waste, as the fill materials as part of the execution of the work.
  5. Excess excavated waste, and/or mixed soil and waste that cannot be placed and compacted as excavated backfill materials will be stockpiled within the Waste Stockpile and Relocation Area.
- F. Construct intermediate cover and final cover system as required by the Contract Drawings:
1. Construct intermediate cover and final cover system to minimum thicknesses shown on the Contract Drawings measured perpendicular to the slope. Grade to smooth true lines approved by Engineer with no soft spots or uncompacted areas. Top of final cover elevations shall not exceed the design elevations shown on the Contract Drawings.
  2. Provide approved fill material:
    - a. Ensure that stones larger than 1/2 inches are not placed in upper 6 inches of intermediate cover or final cover system.
    - b. Do not place material in layers greater than a 12-inch loose thickness.
    - c. Place layers horizontally to geosynthetic surfaces and compact each layer prior to placing additional fill.
    - d. Lift thickness shall be at the discretion of the Engineer.
  3. Compact by sheepsfoot, dozer, pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
    - a. Control moisture for each layer necessary to meet requirements of compaction.
    - b. Only use dozers to compact soil layers placed over geosynthetics.
- G. Upon reaching the required compacted thickness of intermediate cover layer or the final cover system, proof roll intermediate cover layer and obtain the Engineer's review/recommendation and approval. Do not proof roll cover soil

layers placed over geosynthetics. If unsuitable materials are encountered, repair as directed and approved by the Engineer to remove unsuitable materials.

- H. Proof rolling shall be conducted with a 10-ton drum roller approved by the Engineer. An alternate approved by the Engineer may be used in constricted areas.
- I. Where intermediate cover and /or cover soil layer materials are determined to be unsuitable, such materials shall be removed to the lengths, widths, and depths directed by the Engineer, and backfilled with suitable material unless further excavation or earthwork is required. Additional payment will be made for excavation and replacement of intermediate cover and/or cover soil layer in accordance with the Contract Documents except for material previously placed by Contractor that did not meet project specifications. The areas to receive additional intermediate cover shall be free of all vegetation, sticks, roots, rocks, and debris greater than 1/2 inches in size.
- J. Dewatering (as required): Provide and maintain dewatering of all surface water and/or groundwater as required for excavation. Where groundwater is expected to be encountered during borrow area excavation, install a dewatering system to prevent softening and disturbance of excavation, allow borrow material to be excavated dry, and maintain a stable excavation. Soils and hydrogeologic information may be reviewed before beginning excavation to determine where groundwater is likely to be encountered during excavation. Employ a dewatering specialist for selecting/designing, monitoring, and operating the dewatering system as needed. Keep dewatering system in operation until borrow activities are completed. Discharge groundwater to an area which will not interfere with construction operations or damage existing construction as approved by the Engineer. Install groundwater monitoring points as necessary. Shut off dewatering system at such a rate so as to prevent a quick upsurge of water that might weaken the subgrade. Installation, start-up, monitoring maintenance, and shut-off of the dewatering system shall be at no additional cost to the Owner. Any dewatering from the Stage 5 Plan disposal footprint (within the limits of liner/waste) will be considered leachate and cannot be discharged to the stormwater system, but must be disposed appropriately as directed by the Engineer.
- K. Do not place fill when the underlying material is frozen, wet, loose, or soft.
- L. Moisture control:
  - 1. Moisture content of materials prior to, and during compaction, shall be uniform throughout each layer of material.
  - 2. Granular materials shall be thoroughly wetted during or immediately prior to compaction.
  - 3. Supplementary water shall be added as required to materials by sprinkling and mixing uniformly throughout layer.
  - 4. Materials too wet for placing shall be temporarily spread or aerated until moisture content is acceptable. If these materials cannot be processed in time to use, the Contractor shall find alternatives acceptable to the Engineer.

### **3.3 ROCK EXCAVATION – NOT APPLICABLE**

### **3.4 USE OF EXPLOSIVES**

- A. Blasting with any type of explosive is prohibited.

### **3.5 FIELD QUALITY CONTROL**

- A. Moisture density relations, to be established by the Contractor are required for all materials to be compacted.
- B. Extent of compaction testing will be as necessary to assure compliance with Specifications.
- C. Give minimum of 24-hour advance notice to Engineer when ready for compaction or subgrade testing and inspection.
- D. Should any compaction density test, subgrade inspection, or other QA/QC problem be identified, the affected area shall be delineated and reworked by Contractor as necessary to achieve passing criteria.
- E. Contractor shall pay for all costs associated with corrective work and retesting resulting from failed tests.
- F. Proofroll intermediate cover soil layer of the final cover system after reaching specified thicknesses and/or grades prior to geomembrane deployment by making 2 passes parallel to the slope or as directed by Engineer. The proof-rolling shall be performed under the observation of the Engineer. Intermediate and protective cover shall be compacted in accordance with Section 3.6.

### **3.6 COMPACTION DENSITY REQUIREMENTS**

- A. Obtain approval from Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.
- B. Provide dewatering system necessary to successfully complete compaction and construction requirements.
- C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Engineer.
- D. Stabilize subgrade with approved materials as directed by Engineer.
- E. Intermediate and final cover system shall be compacted to a minimum 90% standard proctor maximum dry density. The soils shall be wetted or dried as necessary so that the moisture content during compaction is near the optimum moisture content to consistently achieve target compaction, or as otherwise determined by Engineer.

F. Perform testing at a minimum frequency as shown below:

TEST DESCRIPTION	TEST FREQUENCY
1. Intermediate Cover and Final Cover	
Density, Nuclear Method	1 per 1,000 yd <sup>3</sup> , ASTM D2922
Moisture Content, Nuclear Method	1 per 1,000 yd <sup>3</sup> , ASTM D3017
Sand Cone or Drive Cylinder Method	1 per 2 nuclear tests, ASTM D2937
Oven Moisture Content Verification	1 per 2 nuclear tests, ASTM D2216
Moisture Density Relations	1 per 2,000 yd <sup>3</sup> , ASTM D698*
Sieve Analysis	1 per 2,000 yd <sup>3</sup> , ASTM D422*

\*Increase frequency as needed to ensure each soil type is tested.

### 3.7 FINISH GRADING

- A. Grade all areas disturbed by construction operations.
- B. Grade to smooth, uniformly sloping surfaces to existing elevations or to finish grades shown on the Contract Drawings or as approved by Engineer.
- C. Grading shall maintain minimum required protective cover and topsoil thicknesses of the final cover system but not exceed the maximum top of final cover elevation of the final cover system as shown on the Contract Drawings.
- D. Ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
- E. Ensure rutting or raveling is not caused by installation equipment or weather.

### 3.8 SPECIAL REQUIREMENTS

- A. Erosion Control:
  1. Conduct work to minimize erosion of site.
  2. Remove eroded material washed off site.
  3. Clean streets daily of any spillage of dirt, rocks or debris from equipment entering or leaving site.
- B. Provide as built survey of top of intermediate cover prior to geomembrane installation to verify the required thickness of intermediate cover is installed. Depth thickness determinations shall be obtained on a maximum 50 feet x 50 feet grid pattern. Depth verifications may be made by test pits, temporary depth markers, or probes. Additional intermediate cover shall be placed in areas where insufficient depth is determined prior to geomembrane deployment in that area. Temporary depth markers, if used, shall be removed prior to installing geomembrane. Survey shall be sealed by a professional land surveyor.
- C. Provide as built survey of top of final cover (i.e. top of topsoil layer) prior to sodding to verify the required thickness of protective cover and topsoil combined is installed. Depth thickness determinations shall be obtained on a maximum 50 feet x 50 feet grid pattern. Depth verifications may be made by test pits, or temporary depth markers with careful attention to avoid damage to the underlying geosynthetics. Additional protective cover and/or topsoil, as

appropriate, shall be placed in areas where insufficient depth is determined prior to laying sod in that area. Temporary depth markers, if used, shall be removed prior to installing sod. Survey shall be signed and sealed by a Professional Land Surveyor.

### **3.9 REPAIRS AND RETESTING**

- A. At locations where the field testing indicates densities below the requirements of the project specifications, the failing area shall be reworked. Failed areas shall be scarified, moisture-conditioned, and recompact.
- B. The Contractor shall correct the deficiency to the satisfaction of the Engineer. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Engineer will develop solutions.
- C. All retests recommended by the Engineer must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency.
- D. The Engineer will also verify that installation requirements are met and that submittals are provided.

### **END OF SECTION**

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## **SECTION 02221**

### **TRENCHING, BACKFILLING, AND COMPACTING FOR LFG PIPING**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Scope of Work: Contractor shall provide all labor, materials, soils, equipment and incidentals to excavate and trench designated areas, install pipe and appurtenances, install bedding and backfill material, compact backfill, regrade, and re-vegetate disturbed areas as shown on the Contract Drawings and described in this Section.
- B. The work specified in this Section includes the trenching and trench backfilling activities associated with installation of the landfill gas (LFG) header and lateral piping, air supply and dewatering discharge line; and any other Work requiring excavation, trenching, trench backfilling, grading, re-grading, or re-vegetating disturbed areas as shown on the Contract Drawings and described in this Section.
- C. Work under this Section includes trenching and grading activities inside of the limits of municipal solid waste (MSW).
- D. No classification of type of excavated materials will be made for piping excavation and trenching except for excavation of waste for which there is a separate bid item. Soil excavation includes all soil regardless of type, character, composition, moisture, or condition thereof.
- E. Related Sections include but are not necessarily limited to:
  - 1. Hillsborough County Government Bidding Requirements and Contract Documents.
  - 2. Section 02200 – Earthwork: Landfills
  - 3. Section 02260 - Topsoiling and Finished Grading.
  - 4. Section 02485 - Sodding.

##### **1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. American Association of State Highway & Transportation Officials (AASHTO):
    - a. T99, The Moisture-Density Relations of Soils Using a 5.5 LB Rammer and a 12 IN Drop.
    - b. T180, Moisture-Density Relations of Soils Using a 10 LB Rammer and an 18 IN Drop.
  - 2. ASTM International (ASTM):
    - a. C33, Standard Specification for Concrete Aggregates.
    - b. D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>).

- c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m)).
  - d. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - e. D4253, Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
  - f. D4254, Minimum Index Density of Soils and Calculation of Relative Density.
- 3. Florida Erosion and Sediment Control Planning and Design Manual, current edition.
  - 4. Florida Department of Transportation Standard Specification for Road and Bridge Construction, current edition.

B. Safety:

- 1. All work shall be performed in strict accordance with all local, state, U.S. Occupational Safety and Health Administration (OSHA) and other applicable Federal regulations regarding trenching operations and trench safety.
- 2. All Work shall be performed in strict accordance with the Health and Safety requirements set forth in the General Conditions of the Contract Documents.
- 3. Excavation may be made without sheeting and bracing within the limitations and requirements of the governmental agencies having jurisdiction. Failure of the Engineer to order the use of bracing or sheeting and shoring or direct changes to systems in place, shall not in any way or to any extent relieve the Contractor of any responsibility concerning the condition of excavations or of his obligations under the Contract. The Contractor shall be responsible for the condition of all excavations. All slides and caves shall be removed without extra compensation, at whatever time and under whatever circumstances that they may occur.
- 4. All excavations shall comply with the applicable requirements as stated in the following:
  - a. OSHA excavation safety standards 29 CFR, 1926-650, subpart P.
  - b. Trench safety guidelines as specified by the Landfill Gas Division of the Solid Waste Association of North America (SWANA).
- 5. Contractor shall monitor the ambient air concentrations within and around excavations and take appropriate safety measures as needed.
- 6. Tests will be conducted and recorded by the Engineer in accordance with this Section.
- 7. Use adequate numbers of skilled workers who are trained and experienced in the necessary crafts and who are familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- 8. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.
- 9. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the directions of the Owner and Engineer.



### **1.3 DEFINITIONS**

- A. Excavation:
  - 1. All piping excavation and trenching will be defined as unclassified except for excavation of waste for which there is a separate bid item.

### **1.4 SUBMITTALS**

- A. Product technical data including:
  - 1. Acknowledgement that products submitted meet requirements of standards referenced.
  - 2. Manufacturer's installation instructions.
- B. Trench Safety Plan and/or trench shoring drawings including current certification of trench shields (trench boxes) if required by OSHA regulations.
- C. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
- D. Pipe slope calculations and survey notes for pre-construction layout.
- E. Pipe survey notes for installed pipe pursuant to Part 3.11 of this Section and proposed stationing and pipeline identification procedures. Prior to the start of any pipe installation, Contractor shall supply an example layout drawing showing how the header, horizontal collectors, and laterals will be marked with stations for the conformance surveys. The example layout and stations must be consistent with the requirements of Section 15060.
- F. Contractor daily logs detailing length of trench excavated and backfilled, with reference to pipe stationing and details sufficient to properly describe the work completed to date.
- G. Submit sieve analysis reports on all granular materials (one per source or pit run).
- H. Submit test reports and fully document each with specific location or stationing information, date, and other pertinent information.
- I. Submit Contractor's site-specific Health and Safety Plan for information purposes only and not for review.

### **1.5 PROJECT CONDITIONS**

- A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
  - 1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- B. Provide full access to facility as designated by Owner to prevent serious interruption of travel.
- C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

- D. Verify location of existing underground utilities.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

#### **A. Backfill Material:**

1. As approved by Engineer.
2. Material shall be in accordance with Section 02200, Earthwork: Landfills, and as approved by Engineer.
3. Backfill at least 6 inches above the top of the installed pipe.
4. Backfill and bedding material shall be free of rock cobbles, roots, sod or other organic matter, frozen material, and stones larger than 1 inch in any dimension.
5. The Contractor shall obtain pipe bedding and soil backfill material from the Owner's borrow area as designated in the Contract Drawings.

#### **B. Bedding Materials:**

1. As approved by Engineer.
2. Material shall be in accordance with Section 02200, Earthwork: Landfills, and as approved by Engineer.
3. Pipe bedding material shall be appropriate for spreading with hand tools and compaction with a bucket to provide a level and stable surface for pipe placement.
4. Granular bedding materials:
  - a. Clean dry coarse-grained sand shall be used for pipe bedding and backfill to midway to the top of the installed pipe.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Remove and dispose of unsuitable materials, as directed by Engineer, at the active face of the landfill or at locations as provided by Owner.

### **3.2 PREPARATION**

- A. Work shall be performed so as to not block or hinder site access, except as authorized by the Owner.
- B. Identify required lines, levels, contours, and datum locations.
- C. Locate, identify, and protect utilities from damage.
- D. Protect benchmarks, survey control points, monitoring wells, geomembrane (where present), existing structures and fences from excavating equipment and vehicular traffic.

- E. Prior to trenching and pipe installation, Contractor shall stake out the entire proposed trench alignment within the limits of waste. The proposed alignment must be approved by the Engineer prior to the Contractor beginning excavation activities. This pipeline route staking need not be completed by a licensed surveyor, but the routes for header, lateral pipes, and horizontal collectors must meet the minimum pipe slopes listed in this Section and on the Contract Drawings.
- F. Survey notes with proposed pipe slope calculations shall be submitted to the Engineer for approval prior to pipe installation. Notes of pre-construction survey shall identify conflicts between the proposed Work and existing features.
- G. Contractor shall use appropriate survey/level instrumentation during excavation to ensure proper trench slope. Verification of installed pipe slope shall be as specified in Part 3.11.

### **3.3 PROCEDURES**

- A. Protection of Existing Utilities:
  - 1. Unless shown to be abandoned or removed, protect utility lines and other pipes shown on the Contract Drawings or otherwise made known to the Contractor prior to excavating. Contractor is required to perform all utility clearances, including interviewing on-site personnel to inquire about existing utilities in areas of proposed excavations. If a utility is damaged by the Contractor, the utility shall be repaired or replaced at no additional cost to the Owner.
  - 2. If utility lines are encountered that are not shown on the Contract Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
  - 3. If service is interrupted as a result of work under this Section, Engineer shall be notified, and Contractor shall immediately restore service by repairing the damaged utility at no additional cost to the Owner.
  - 4. If existing utilities are found to interfere with the facilities being constructed under this Section, immediately notify the Engineer and request instructions. Maintain a minimum 12-inch horizontal and vertical separation from existing utilities and the LFG transmission pipe.
  - 5. Do not proceed with permanent relocation of the work until written instructions are received from the Engineer.
  - 6. Exposed utilities shall be properly supported at all times if undermined.
- B. Protection of Persons and Property:
  - 1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
  - 2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
  - 3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

- C. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors and to other work being performed on or near the site.
- D. Maintain access to adjacent areas at all times.

### **3.4 EXCAVATION**

- A. Contractor should not excavate more trench daily within the landfill waste limits than can be completely backfilled after installation of the pipe the same day. The maximum allowable length of open trench that can be left overnight is 100 feet. In no case shall waste be exposed overnight in an excavation or trench.
- B. Contractor shall dispose of excavated waste within the Waste Stockpile and Relocation Area as shown on the drawings. Excavated waste shall be direct-loaded and placed within the Waste Stockpile and Relocation Area for re-use in backfilling.
- C. Excavation for Appurtenances:
  - 1. 12 inches (minimum) clear distance between outer surface and embankment.
  - 2. Excavate as shown on the Contract Drawings and details.
  - 3. Trench width as shown on details.
  - 4. Provide gas monitoring in trench as required by Health and Safety Plan.
  - 5. Dispose of excavated refuse at landfill active face.
- D. Trench Excavation:
  - 1. Excavate trenches by open cut method to depth shown on Contract Drawings and necessary to accommodate work.
    - a. Support existing utility lines where proposed work crosses at a lower elevation.
      - 1) Stabilize excavation to prevent undermining of existing utility.
  - 2. Excavate as shown on the Contract Drawings and details.
  - 3. Trench width as shown on details.
  - 4. Provide gas monitoring in trench as required by Health and Safety Plan and 1.2.B.5 of this section.
  - 5. Satisfactory excavated materials shall be transported to, and placed in stockpiles or fill areas within the limits of the Work designated by the Owner and Engineer.
  - 6. If unsatisfactory materials are encountered above or at the design depth of the excavation, excavate the unsatisfactory materials as directed by the Owner and Engineer, and replace with satisfactory materials. Excavate and backfill in a manner and sequence that will provide proper drainage at all times.
  - 7. Dispose of unsatisfactory excavated material, and surplus satisfactory excavated material, away from the work area as directed by the Engineer.
  - 8. Obtain material required for fill in excess of that produced within the grading limits of the Work from Owner borrow area at locations shown on the Contract Drawings.

9. Unauthorized Excavation:
  - a. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific instruction from the Engineer.
  - b. Backfill and compact unauthorized excavations as specified for authorized excavations, unless otherwise directed by the Engineer.
10. Stability of Excavations:
  - a. Slope sides of excavations shall be cut back to 1.5H:1V or flatter, in accordance with 29 CFR 1926.
  - b. Shore and brace excavations where slope cut backs are not practical because of space restrictions or stability of the materials being excavated.
  - c. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
11. Shoring and Bracing:
  - a. Provide all labor and materials for shoring and bracing as may be necessary for safety of personnel, protection of work, and compliance with requirements of governmental agencies having jurisdiction.
  - b. Maintain shoring and bracing in excavations regardless of the time period excavations will be open.
  - c. Remove shoring and bracing as excavation progresses.

E. Asbestos Handling:

1. If asbestos is encountered during excavation operations, the following waste handling procedures must be implemented:
  - a. If any waste appearing to possibly contain asbestos is uncovered, all asbestos handling procedures will be immediately placed into effect.
  - b. All persons within 25 feet of the excavation operations will be required to wear the appropriate respirators.
  - c. The use of Tyvek suits will be optional. However, if Tyvek suits are not worn, all employee uniforms must be laundered and the launderers notified of possible contamination with asbestos. All Tyvek suits will be considered to be contaminated with asbestos and will be disposed of accordingly.
  - d. A water truck equipped with the appropriate spraying equipment to keep the excavation cuttings wet will be required at all times.
  - e. An area of appropriate size will be prepared to contain the cuttings by one of the following methods.
    - 1) A waste container lined with 6 mil polyethylene will be placed as close as reasonably possible to the excavation activities. A small area next to the excavation activities where excavated materials will be handled will also be lined with 6 mil polyethylene and covered with clean soil to protect the polyethylene. A small earthen berm will be made to help contain the materials and facilitate loading into the container. The polyethylene and soil cover will be considered to be part of the waste.

- 2) An area next to the excavation activities that is appropriately sized to accommodate all of the excavated materials will be surrounded by a small soil berm approximately 30 inches high. This area will then be lined with 6 mil polyethylene and covered with clean soil to protect the polyethylene. This area will be positioned in a way such that all handling of cuttings will be in the protected area. The polyethylene and soil will be considered to be part of the waste.

### **3.5 PREPARATION OF FOUNDATION FOR PIPE LAYING**

- A. Over-Excavation:
  1. Backfill and compact to maximum attainable density.
  2. Backfill with granular bedding material as option.
- B. Subgrade Stabilization:
  1. Stabilize the subgrade when directed by the Owner.
  2. Observe the following requirements when unstable trench bottom materials are encountered.
    - a. Notify Owner when unstable materials are encountered.
      - 1) Define by drawing station locations and limits.
    - b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.
      - 1) Replace with subgrade stabilization with no additional compensation.
- C. In-Place Intermediate Cover Soils:
  1. Backfill and compact to maximum attainable density.

### **3.6 BACKFILLING METHODS**

- A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.
- B. Contractor shall notify the Engineer prior to beginning backfilling. The Engineer shall inspect all pipe, fittings, connections, and slopes prior to approving backfilling. If Contractor backfills pipe without inspection of the pipe while pipe is installed in the open trench, Contractor shall uncover all uninspected buried pipe so that it may be properly inspected. This shall be done at no additional cost to the Owner.
- C. Place bedding material in trench to the lines and grades shown on the Contract Drawings.
- D. Backfilling procedures shall be modified as necessary as approved by the Engineer in order to not displace (either horizontally or vertically) piping installed in the trench during backfill or bedding placement.
- E. Contractor shall re-grade and return to their original condition, as determined by the Owner and the Engineer, all areas disturbed by Contractor's work. This includes, but is not limited to ruts caused by construction equipment, soil stockpile areas, and landfill benches and terraces used for access.

- F. Common backfill-trenches, utilities, appurtenances:
  - 1. Perform in accordance with the following:
    - a. The bedding shall be poured into place, not pushed, and shall be raked by hand and then compacted, using a mechanical compaction device such as walk-behind vibratory compactor, in a loose lift not to exceed 6 inches (loose thickness) above the top of the pipe.
    - b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
    - c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
- G. Water flushing for consolidation is not permitted.
- H. For all gas collection pipe trenches, a clean backfill shall be used or a material otherwise approved by the Engineer or the Owner.
- I. Warning tape to be installed as shown on the Contract Drawings.

### **3.7 COMPACTION**

- A. General:
  - 1. Place and assure bedding, backfill, and fill materials achieve an equal or "higher" degree of compaction than undisturbed materials adjacent to the work.
  - 2. In no case shall degree of compaction below "Minimum Compaction" specified be accepted.
- B. Compaction Requirements: Unless noted otherwise on the Contract Drawings or more stringently by other sections of these Specifications, comply with following compaction criteria:
  - 1. Header, Laterals, and Horizontal Collector Pipes:
    - a. None required for pipe bedding material.
    - b. Tamp waste with track hoe bucket to consolidate waste to Engineer's satisfaction.
  - 2. Gas Extraction System Appurtenances:
    - a. Tamp waste with track hoe bucket to consolidate to Engineer's satisfaction.
    - b. Compact to maximum attainable density if pipe rests on intermediate cover material.
    - c. None required for granular materials.

### **3.8 FINISH GRADING**

- A. Grade all areas disturbed by construction operations.
- B. Grade to smooth, uniformly sloping surfaces to existing elevations or to finish elevations shown on the Contract Drawings.
- C. Grading shall be to a tolerance of plus or minus 0.1 feet
- D. Evenly slope finished grade away from structures as shown on the Contract Drawings to provide drainage.

- E. Ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
- F. Ensure rutting or raveling is not caused by installation equipment or weather.

### **3.9 DEWATERING**

- A. Water that enters excavations in refuse shall be considered landfill leachate and shall not be discharged to the ground or other means that are typical for stormwater. Water in trench excavations that comes in contact with refuse shall be pumped into sealed tanks, hauled to the leachate collection system, and discharged appropriately as directed by the Owner.
- B. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove water entering excavations. Contractor shall keep such excavations dry so as to obtain a satisfactory foundation condition for all work.
- C. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottom, and soil changes detrimental to stability of subgrades and foundations. Subgrade soils which become soft, loose, “quick,” or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed and replaced by crushed stone or gravel as required by the Engineer at the Contractor’s expense. The bottom of excavations shall be firm and without standing water before placing structures or pipes. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
- D. For excavations not in refuse, establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
- E. Disposal of Water Removed by Dewatering System:
  - 1. Water conveyed away from excavations which has not contacted refuse materials shall be discharged to areas approved by the Engineer.
  - 2. Dispose of water by procedures approved by the Engineer in such a manner as to cause no inconvenience to the Owner, the Engineer, or others involved in work about the site.
  - 3. Water conveyed away from excavations which has contacted refuse materials shall be pumped into spill-proof containers and discharged at the on-site Leachate Treatment and Reclamation Facility.
- F. If the pipe trench becomes watered-in after placement of pipe, but before backfilling, Contractor shall dewater the trench, demonstrate that the pipe bedding and pipe slope remain satisfactory, and upon approval by the Engineer, backfill the pipe with clean dry soil in accordance with Part 2.1 of this Section.

### **3.10 ROAD CROSSING**

- A. Contractor shall schedule and coordinate all road crossings, if required, with the Owner to minimize disruption of waste disposal operations.



### 3.11 FIELD QUALITY CONTROL

#### A. Pipe Survey:

1. Contractor shall verify that pipe slope meets the requirements specified in this Section and on the Contract Drawings at 50-foot intervals along LFG laterals, header, and horizontal collectors and record such information in the project notes. Station numbering shall be used and marked on the pipe, as approved by the Engineer.
  - a. Contractor shall measure each length of installed pipe and mark the 50-foot stations. Stationing of laterals shall begin with 0+00 at the well, ending at the tee at the tie-in to the header.
  - b. Stationing of the header and horizontal collectors shall begin with 0+00 at a location approved by the Engineer. Station numbering for pipe installed each day shall be consecutive with pipe installed on previous days. The Contractor shall not restart station numbering at 0+00 for any header segment without advance approval from the Engineer.
  - c. The surveyed elevations and calculated change in elevation and slope for each 50-foot section shall be recorded in the Contractor's project notes.
  - d. A trench laser will not be considered acceptable survey equipment for the purpose of verifying pipe slope.
2. The project notes detailing the required pipe slope confirmation shall be provided daily to the Engineer and shall be checked by the Engineer prior to proceeding with backfilling.
3. A conformance survey shall be conducted on all installed pipe prior to backfilling the trench.
  - a. Contractor may utilize survey tubes if backfilling the LFG piping before a conformance survey is performed. If conformance survey after LFG piping is buried demonstrates that LFG piping slopes do not meet specified requirements, the Contractor shall uncover buried pipe so that it may be properly installed at the required slopes. This shall be done at no additional cost to the Owner.
  - b. Survey tubes shall be used to measure the change in relative elevation between each 50-foot station. Contractor shall be responsible for minimizing landfill gas emissions from survey tubes (e.g. seal top of survey tubes).
  - c. The survey shall document the horizontal and vertical location of the top of the landfill gas header, horizontal collectors, laterals, air supply lines, and condensate discharge line, at minimum 50-foot intervals and at each change in pipe direction, grade break, change in pipe grade, fitting, connection, pipe crossover, and tie-in along the entire pipeline routes.
  - d. If a run of pipe is 100 feet or less in length, Contractor shall provide survey shots at a 20-foot interval or less. For a run of pipe of 50 feet or less, at least three survey shots of the top of the pipe must be used to document the pipe as-built conditions.
  - e. The survey shall also document the type of pipe, location (horizontal and vertical coordinate) of structures and appurtenances such as, but not limited to, valves, pipe crossing, and tie-ins.

- f. This conformance surveying shall be signed and sealed by a licensed Florida Professional Land Surveyor as described in Section 01050, Survey.

B. Subgrade shall be compacted in accordance with Section 3.7.

### **3.12 MAINTENANCE**

- A. Protection of Newly Graded Areas:
  - 1. Protect newly graded areas from traffic and erosion, and keep free from trash and weeds.
  - 2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.
- B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

### **3.13 SEEDING AND SODDING**

- A. Provide temporary seeding and mulching in disturbed areas where further construction activities will not take place within 30 days.
- B. Install sod within disturbed areas after installation of protective cover soils in accordance with Section 02485 – Sodding.

### **3.14 SPECIAL REQUIREMENTS**

- A. Erosion Control: Conduct work to minimize erosion of site. Construct stilling areas to settle and detain eroded material. Remove eroded material washed offsite. Clean streets daily of any spillage of dirt, rocks, or debris from equipment entering or leaving site.

**END OF SECTION**

**SECTION 02260**  
**TOPSOILING AND FINISHED GRADING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Topsoiling and finished grading.
- B. Related Sections include but are not necessarily limited to:
  - 1. Section 02200 – Earthwork: Landfill.
  - 2. Section 02270 - Soil Erosion and Sediment Control.
  - 3. Section 02485 - Sodding.
- C. Location of Work: All areas within limits of grading unless otherwise shown on the Contract Drawings and all vegetated areas outside limits of grading which are disturbed in the course of the work and require the reestablishment of vegetation.

**1.2 PROJECT CONDITIONS**

- A. Verify amount of topsoil available in designated stockpiles and borrow area and determine amount of additional topsoil, if necessary, to complete work.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Topsoil:
  - 1. Original surface soil typical of the area.
  - 2. Capable of supporting native plant growth.

**2.2 TOLERANCES**

- A. Provide minimum of 6 inches (compacted) of topsoil. Final topsoil elevations shall not exceed final buildout elevations on Contract Drawings.

**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Correct, adjust and/or repair rough graded areas.
  - 1. Cut off mounds and ridges.
  - 2. Fill gullies and depressions.
  - 3. Perform other necessary repairs.

4. Ensure underlying intermediate cover and protective cover minimum thicknesses are achieved and that all underlying materials have been tested and meet Specifications.
- B. Loosen surface to depth of 2 inches, minimum.
- C. Remove all stones and debris over a 1/2 inch in any dimension.

### **3.2 PLACING TOPSOIL**

- A. Do not place when subgrade is wet or frozen enough to cause clodding.
- B. Spread to compacted depth of 6 inches for all areas where required
- C. Do not over compact topsoil. Compaction of topsoil shall only be performed with dozer tracks. Rollers and compactors will not be allowed.
- D. The Contractor shall excavate, load, haul, and place the topsoil to the work area. The Contractor shall use soil from the on-site borrow area that meets the requirements for topsoil.
- E. Provide finished surface free of stones, sticks, or other material 1/2-inch or more in any dimension and suitable for the installation of sod.
- F. Provide finished surface smooth and true to required grades.
- G. Restore stockpile area and borrow area to condition of rest of finished work.

### **3.3 ACCEPTANCE**

- A. Upon completion of topsoiling, perform depth survey as required in Section 02200, Earthwork; Landfills.
- B. Make test holes where directed to verify proper placement and thickness of topsoil.

## **END OF SECTION**

**SECTION 02270**  
**SOIL EROSION AND SEDIMENT CONTROL**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Soil erosion and sediment control.
- B. Related Sections include but are not necessarily limited to:
  - 1. Section 02200, Earthwork: Landfills.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. Florida Erosion and Sediment Control Planning Handbook, or current edition.
  - 2. Florida Department of Transportation Standard Specifications for Roads and Structures Construction, latest edition.

**1.3 SITE CONDITIONS**

- A. The Owner has installed sediment control features for their current operations.
  - 1. The Contractor may use these existing features with the Owner's prior approval, provided the Contractor maintains said features.
- B. The Contractor shall prevent damage to properties outside the construction limits from siltation due to construction of the project and assume all responsibilities to the affected property owners for correction of damages which may occur. Erosion-control measures shall be performed conforming to the requirements of and in accordance with plans approved by the applicable state and local agencies and as specified by the erosion-control portion shown on the Contract Drawings and as required by the Specifications. The Contractor shall not allow mud and debris to accumulate in the streets or enter drainage ditches, canals, or waterways.

**1.4 SUBMITTALS**

- A. Shop Drawings:
  - 1. Stone: Manufacturer's certification that materials supplied meet project requirements.
  - 2. Silt Fence: Product information demonstrating materials supplied meet project requirements including installation instructions.
  - 3. Erosion and Sediment Control Plan.

**1.5 PRACTICES**

- A. The Contractor shall adhere to the following:
  - 1. Avoid dumping soil or sediment into any stream bed, pond, ditch, or watercourse.

2. Maintain an undisturbed vegetative buffer where possible between a natural watercourse and trenching and grading operations.
3. Avoid equipment crossing of streams, creeks, and ditches where practicable.

## **1.6 EROSION AND SEDIMENT-CONTROL DEVICES AND FEATURES**

- A. The Contractor shall construct all devices (silt fences, retention areas, etc.) for sediment control at the locations required to protect federal, state, and local water bodies and water courses and drainage systems before beginning to excavate the site. All devices shall be properly maintained in place until a structure or paving makes the device unnecessary or until directed to permanently remove the device.
- B. The Contractor shall use mulch to temporarily stabilize areas subject to excessive erosion and to protect seed beds after planting where applicable.
- C. Filter fabric, hay bales, or other approved methods shall be placed and secured over grates of each existing inlet, grating, or storm pipe opening near the area of excavation to prevent silt and debris from entering the storm systems.
- D. The Contractor shall use silt fences or hay bales, as shown on the Contract Drawings or as directed by the Engineer to restrict movement of sediment from the site.
- E. The Contractor shall establish vegetative cover on all unpaved areas disturbed by the work.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Stone for temporary ditch blocks and construction entrances constructed as per the Contract Drawings.
- B. Sod shall be in accordance with Section 02485, Sodding.
- C. Fertilizer shall conform to FDOT Section 982.
  1. Fertilizer shall be granulated so that 80 percent is held on a 16-mesh screen, uniform in composition, dry, and free flowing. The Contractor shall test screen one bag of fertilizer per source and per shipment.
- D. Silt fence shall consist of non-biodegradable filter fabric (Trevira, Mirafi, etc.), in accordance with FDOT Section 985, wired to galvanized wire mesh fencing and supported by wood or metal posts.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Prior to Disturbance:
  1. Install silt fence, ditches, channels, ditch blocks, and temporary construction entrances.
  2. Refer to the Contract Drawings for further detail.

### **3.2 DURING CONSTRUCTION PERIOD**

- A. Maintain silt fence, ditches, channels, ditch blocks, and temporary construction entrances:
  - 1. Inspect regularly especially after rainstorms.
  - 2. Repair or replace damaged or missing items within 24 hours of discovery or notification by the Engineer.
- B. After rough grading, sow temporary grass cover and mulch over all exposed earth areas not draining into sediment basin or trap.
- C. Provide necessary swales, dikes and temporary culverts to control erosion. Contractor shall provide all erosion protection measures at no additional cost to the Owner to prevent off-site sediment/erosion. Although there are stormwater ponds on-site, the Contractor shall take all reasonable precautions to reduce sediment transport to the ponds.
- D. Do not disturb existing vegetation (grass and trees) to the extent possible.
- E. Excavate sediment out of basins and traps when capacity has been reduced by 40 percent.
  - 1. Remove sediment from silt fence to prevent overtopping.
- F. Topsoil and Fine Grade Slopes and Swales, etc.:
  - 1. Seed and mulch or sod as soon as areas become ready.
- G. The erosion control features shown on the Contract Drawings are performance based. If the feature does not adequately control erosion and sediment control to the satisfaction of the Engineer, the Contractor will be required to install additional erosion and sediment control features. The Engineer will work with the Contractor to determine the extent of the additional measures.
- H. After fine grading, sod all areas receiving final cover.
- I. Remove accumulated mud and soil from roadways on a daily basis.

### **3.3 NEAR COMPLETION OF CONSTRUCTION**

- A. Remove accumulated sediment from erosion and sediment control devices.
- B. Remove silt fence, ditches, channels, ditch blocks, and temporary construction entrances.
- C. Grade to finished or existing grades.
- D. Fine grade all remaining earth areas, then seed and mulch or sod in accordance with the Contract Drawings.
- E. Erosion and sediment control devices are to remain in place until sod is established.

### **END OF SECTION**

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**SECTION 02362**  
**DRIVEN VINYL SHEET PILING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Vinyl sheet piling, sheet piling fittings including corners, angles, joint sealant, pre-punch mandrel, and vinyl sheet pile mandrel.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
  - 2. Division 1 - General Requirements.
  - 3. Section 02200 - Earthwork: Landfills.
- C. Unit Prices:
  - 1. Measurement:
    - a. Measurement will be for linear foot of pre-punch mandrel driven to 2 ft above the tip elevation of the vinyl sheet piling.
    - b. Measurement will be in square feet of vinyl sheet pile installed measured from tip to cut-off elevation and to the horizontal limits shown on the Drawings.
    - c. Vinyl sheet pile lengths extending above cut-off elevation will be considered as waste.
  - 2. Payment:
    - a. No payment will be made for damaged or rejected sheet pile.
    - b. Contractor will not be paid for sheet piles that are withdrawn or discontinued due to hitting obstructions.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ASTM International (ASTM):
    - a. A36, Standard Specification for Carbon Structural Steel.
    - b. A328, Standard Specification for Steel Sheet Piling.
    - c. D4216 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Related PVC and Chlorinated Poly(Vinyl Chloride) (CPVC) Building Products Compounds
- B. Qualifications:
  - 1. Sheeting installer must have, as a minimum, three (3) successful past installations of vinyl sheet pile installation of comparable overall heights and sections and comparable penetration.

### **1.3 DEFINITIONS**

- A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
  2. Installer and applicator are synonymous.

### **1.4 SUBMITTALS**

- A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
  2. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Manufacturers' installation instructions.
    - c. Complete list and description of materials for all construction components.
  3. Documentation of qualifications required for sheeting installer.
  4. Information on the type of driving equipment to be used; including manufacturer of equipment, model number and driving energy to be used.
  5. Sheet pile driveability analysis to confirm pre-punch mandrel, equipment and vinyl sheet pile (with steel mandrel) can be driven to the elevation shown on the Drawings and based on the referenced geotechnical information provided in these documents, without damage to the vinyl sheet pile. Submittal shall be signed and sealed by a professional engineer licensed in the State of Florida.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Vinyl Sheet Piling:
1. All sheet piling shall be manufactured entirely from a rigid, high impact, ultraviolet- (UV) inhibited, weatherable vinyl compound. All exposed surfaces of the sheet piling shall be UV resistant, and comprised of virgin material with a minimum ASTM D4216 Cell Classification of 1-42443-33. If mono-extrusion technology is used, the entire sheet pile must be comprised of virgin material with a minimum ASTM D4216 Cell Classification of 1-42443-33. Vinyl sheet pile shall be Model Number SG-625 as manufactured by Shoreguard, or equal.
  2. Piling sections shall be continuously interlocking. Interlocks shall be capable of resisting the full strength of the sheet pile section.
  3. Vinyl material shall be capable of resisting chemical attack from landfill leachate.
  4. Vinyl sheet piling shall have the following minimum section properties:
    - a. The section modulus of the sheet piling shall be no less than 24.4 in<sup>3</sup> per linear foot of wall.

- b. The moment of inertia of the sheet piling shall be no less than  $122 \text{ in}^4$  per linear foot of wall.
  - c. The sheet piling shall have a minimum thickness of 0.385 inches.
  - d. The sheet pile section shall have the dimensions as shown on the Drawings.
- B. Corners and Angles:
  - 1. Meets the material requirements for vinyl sheet piling.
- C. Joint Sealant
  - 1. Joint sealant shall be continuously applied to all sheet pile joints.
  - 2. Material shall swell upon contact with water (hydrophilic).
  - 3. Material swell shall be sufficient to completely seal interlock.
  - 4. Material swell shall occur after installation of sheet piling
  - 5. Joint sealant shall be capable of resisting chemical attack from landfill leachate.
  - 6. Joint sealant shall be applied in accordance with the manufacturers instructions.
- D. Pre-Punch Steel Sheet Pile Mandrel
  - 1. ASTM A328, Standard Specification for Steel Sheet Piling
  - 2. Steel section shall have the same profile as the vinyl sheet pile section shown on the Drawings and a minimum thickness of 3/8 in.
  - 3. Section shall have a steel driving tip that is 3/4 in wider than the vinyl sheet pile cross-section (3/8 in each side) and extends 3 in. below the steel sheet pile. The driving tip cross-section shall include the shape of the interlock.
- E. Steel Mandrel for Installation of Vinyl Sheet Pile
  - 1. ASTM A328, Standard Specification for Steel Sheet Piling
  - 2. Section shall conform to the shape of the vinyl sheet pile. Steel mandrel shall provide complete coverage of the vinyl sheet over its complete width and length.
  - 3. Steel mandrel shall incorporate articulated toe clips that protect a minimum of 25% of the sheet pile section during installation.
  - 4. Steel mandrel shall include a system to adequately secure the top of the vinyl sheet during installation.
  - 5. Steel mandrel shall include a system to provide a lubricant between the mandrel and vinyl sheet pile to allow removal of the mandrel without altering the position of the vinyl sheet pile.
  - 6. The steel mandrel for installation of the vinyl sheet pile shall be a PileClaw as manufactured by Crane Materials International, or equal.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Do not begin sheet pile installation until the earthwork in the area where sheet piles are to be driven has been completed as indicated on the Drawings.

- B. Furnish lines and levels as required to install pre-punch mandrel and vinyl sheet piles at their indicated locations.

### **3.2 INSTALLATION**

#### **A. General**

1. Install pre-punch mandrel and vinyl sheet piles straight and plumb and to the dimensions shown on the Drawings.
2. Drive mandrel and vinyl sheet piles vertical at locations shown on the Drawings.
3. Adequately support and hold pre-punch mandrel and vinyl sheet piles in correct vertical position during driving by means of adequate driving equipment.

#### **B. Pre-Punch Steel Mandrel**

1. Drive pre-punch steel mandrel at exact location of vinyl sheet pile.
2. Drive mandrel to 2 ft above vinyl sheet pile tip elevation as shown on the Drawings.
3. Pre-punch mandrel shall be driven for only one vinyl sheet pile section at a time.
4. Drive pre-punch mandrel with equipment capable of achieving required final depth without damaging mandrel.

#### **C. Vinyl Sheet Piles**

1. Vinyl sheet pile shall be installed within one hour of pre-punch steel mandrel withdrawal.
2. Apply joint sealant to complete length of interlock joint.
3. Fit steel sheet pile mandrel to vinyl sheet pile with toe clips and top restraint before engaging interlock of previously placed sheet pile.
4. Sheet piles shall be installed as one (1) continuous member.
5. Block or prepare rigging for previously installed adjacent vinyl sheet pile to prohibit movement during the installation of the active vinyl sheet pile installation.
6. Provide suitable driving head to apply driving energy to steel sheet pile mandrel and not to vinyl sheet pile.
7. Drive vinyl sheet piles to the elevation shown on the Drawings.
8. Sheet pile mandrel shall disengage from vinyl sheet pile and be removed without altering the position of the vinyl sheet pile.
9. Should any vinyl sheet pile be damaged or otherwise not conform to this Specification Section as determined by the Engineer, withdraw sheet pile, re-drive pre-punch mandrel, and drive another vinyl sheet pile in its place.
  - a. Additional sheet piles shall be at Contractor's expense.

### **3.3 FIELD QUALITY CONTROL**

#### **A. Inspection:**

1. Allow each pre-punch mandrel installation and vinyl sheet pile installation to be witnessed by the Engineer who will determine that the installation is in accordance with the Contract Documents.

**END OF SECTION**

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## **SECTION 02485**

### **SODDING**

#### **PART 1 - GENERAL**

##### **1.1 WORK INCLUDED**

- A. This section covers the necessary details provided within the Work of sodding.

##### **1.2 REFERENCES**

- A. The latest edition of the Florida Department of Transportation (DOT) Standard Specifications for Road Bridge Construction (Standard Specifications) shall be referred to for both specific and general standards for materials, construction, workmanship, and quality control as specified herein with exceptions, as noted herein.
- B. The latest edition of FDOT Roadway and Traffic Design Standards.

##### **1.3 SUBMITTALS**

- A. Certificates: Fertilizer and sod shall be accompanied by certificate from vendors certifying items meet the requirements of this Specification.

#### **PART 2 - PRODUCTS**

##### **2.1 FERTILIZER**

- A. Fertilizer for grassing shall conform to Section 982 of the FDOT Standard Specifications.
- B. Fertilizer shall be granulated so that 80 percent is held on a 16-mesh screen, uniform in composition, dry, and free flowing. The Contractor shall test screen one bag of fertilizer per source and per shipment.

##### **2.2 SODDING**

- A. The following sections of the FDOT Standard Specifications shall apply:
  - 1. Section 575-1, Description
  - 2. Section 981-2 and 981-4, Materials
- B. The Contractor shall provide strongly rooted sod, not less than 2 years old, and free of weeds and undesirable native grasses. Sod shall be provided in rectangles a minimum of 12-inches x 24-inches or in rolls at least 12-inches in width and length consistent with equipment used to handle the rolls.
  - 1. Argentine Bahia (Palletized Sod)
  - 2. Common Bermuda (Rolled Sod)

## **2.3 WATER**

- A. Water for sodding shall conform to Section 983 of the FDOT Standard Specifications.

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. All areas within the limits of work and all areas disturbed by the Contractor's operations shall be sodded unless otherwise indicated on the Contract Drawings.
- B. The period of sod establishment shall begin immediately after the completion of sodding in an area and shall continue for a period of one year after the completion of sodding on the entire project unless the desired sod cover is established in a shorter period of time and shortening of the sod-establishment period is authorized by the Engineer.
- C. Areas to be sodded shall be graded to remove construction debris, litter, low-lying areas, undulations, and irregularities in the surface before sodding and in accordance with the Contract Drawings. Grading activities shall be conducted such that the minimum required thickness of topsoil is maintained.
- D. Moisten prepared areas to be sodded before planting if the soil is dry. Water thoroughly and allow the surface to dry off before sodding. Do not create a muddy soil condition.

### **3.2 SODDING**

- A. Sod that has been cut for more than 72 hours may be used if authorized by Engineer. Contractor to provide certification as to when the sod was cut.
- B. Sodding shall be placed within disturbed areas unless shown otherwise on the Contract Drawings.
- C. The following sections of the Standard Specifications shall apply:
  - 1. Section 575-3, Construction Methods
- D. Exceptions:
  - 1. Section 575-3.3, replace phrase "a suitable length of roadway" with "an area."
  - 2. Section 575-3.3, Placing Sod; do not plant dormant sod or if ground is frozen. Rolled sod shall be placed parallel to contours. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. The offsets of individual staggered strips shall not exceed 6 inches. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass. On areas where sod may slide due to the slope gradient, may be displaced by flowing water or may otherwise move, the sod must be pegged using suitable wooden pegs and netting or other approved means.



The pegs should be driven through the sod strips into firm earth, at suitable intervals. Contractor will apply at least 1.00 inch of water to new sod within 24 hours of sod placement and as frequently thereafter in order to maintain a healthy and uniform stand of grass. Water sod thoroughly with a fine spray. Roll sod within 24 hours of placement to ensure contact between sod and subgrade.

3. Section 575-3.4, watering shall conform to requirements previously specified herein. Replace the word "Department" with the word "County" in the last sentence. The cost of resodding shall be borne exclusively by the Contractor.
  4. Section 575-3.5, Maintenance shall be performed as specified herein.
- E. Sod installed within drainage swales, terraces, and near drainage inlets shall be adequately anchored using pegs, netting, or other means to ensure that the sod is not displaced by the flow of water.

### **3.3 CLEANUP**

- A. All excess sod materials, stones, and other waste shall be removed from the site weekly and shall not be allowed to accumulate.

### **3.4 MAINTENANCE**

- A. Maintenance shall begin immediately following the last operation of sodding and continue until conclusion of the sod-establishment period specified herein. Maintenance shall include watering, mowing every two weeks (or as needed) during construction and until final acceptance of the project, resodding, repair of erosion, fertilizing, and all other work necessary to produce a uniform stand of grass.
- B. Sod will be considered for final acceptance when the sod roots are firmly anchored to underlying soil and the permanent grass is healthy and growing on 97 percent of the area with no bare areas wider than 12 inches, as determined by the Engineer.
- C. The Contractor shall maintain the sodded areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary. If the planted areas must be resodded, reshaped, or otherwise repaired, regardless of cause, the Contractor shall perform such work at the Contractor's expense. The Engineer, at any time, may require replanting of any areas in which the establishment of the grass stand does not appear to be developing satisfactorily at no additional cost to Owner.
- D. The period of sod establishment for areas that are resodded shall extend to one year after the completion of resodding unless otherwise authorized by Engineer.

## **END OF SECTION**

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**SECTION 02775**  
**LLDPE GEOMEMBRANE LINER SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Furnishing, installation, quality control, and testing of a LLDPE geomembrane liner with texture on both sides. LLDPE geomembrane liner will be used as part of the final cover system.
- B. Related Sections include but are not necessarily limited to:
1. Section 02200 – Earthwork: Landfill.
  2. Southeast County Landfill Sinkhole Stage 5 - Isolation of Impacted Clay Liner, Construction Quality Assurance Plan.

**1.2 QUALITY STANDARDS**

- A. Referenced Standards:
1. ASTM International (ASTM).
    - a. D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
    - b. D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
    - c. D1505 Standard Test Method for the Density of Plastics by the Density-Gradient Technique. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
    - d. D1603 Standard Test Method for Carbon Black in Olefin Plastics.
    - e. D3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
    - f. D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
    - g. D4437 Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
    - h. D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    - i. D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
    - j. D5321, Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
    - k. D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
    - l. D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

- m. D5820, Standard Practice for Pressured Air Channel Evaluation of Dual Seamed Geomembrane.
- n. D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes.
- o. D6365 Non-Destructive Testing of Geomembrane Seams Using the Spark Test
- p. D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- q. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexibly Polypropylene Geomembranes.
- 2. The Geosynthetic Research Institute (GRI).
  - a. GM12, Asperity Measurement of Textured Geomembranes Using a Depth Gage.
  - b. GM17 Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.
  - c. GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

**B. Qualifications:**

- 1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience with a minimum of 10,000,000 square feet of LLDPE geomembranes.
- 2. Installer:
  - a. Demonstrate 5 years continuous experience with a minimum 10,000,000 square feet of LLDPE geomembranes.
  - b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
  - c. Geomembrane Installer Personnel Qualifications:
    - 1) Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
    - 2) The master welder shall have completed a minimum of 5,000,000 square feet of LLDPE geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
    - 3) Other welders shall have seamed a minimum of 1,000,000 square feet of LLDPE geomembrane.
- 3. CQC Testing Laboratory shall demonstrate 3 years of continuous experience in similar geosynthetic materials testing.
- 4. Installer shall attend pre-installation conference.

C. Quality Assurance / Control:

1. The Engineer will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
2. Unless specifically superseded by these contract documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
  - a. This specifically includes:
    - 1) Material Composition.
    - 2) Manufacturing.
    - 3) Handling and Packaging.
    - 4) Shipment.
    - 5) Storage (Manufacturer and Site).
    - 6) Placement:
      - a) Seaming and Joining.
      - b) Destructive and Non Destructive Testing.
      - c) Protection, Backfilling and Covering.
    - 7) Conformance Testing.
    - 8) Anchoring and Anchor Trenches.
    - 9) Access Roads/Ramps.
3. Installer shall attend pre-installation conference.

D. CQA Plan Implementation: Construction Quality Control will be performed in accordance with the CQA Plan prepared for this project. The Contractor and Geomembrane Installer should familiarize themselves with the CQA Plan.

E. Certifications:

1. Certifications are required for various aspects of the project related to the LLDPE geomembrane liner system construction.
  - a. Utilize certification forms approved for use on this project by the Engineer.

F. Installer's construction quality control programs to include, but not be limited to, product acceptance testing, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.

G. Geomembrane Installer's installation manual to include:

- 1) Ambient temperature at which the seams are made.
- 2) Control of panel lift up by wind.
- 3) Acceptable condition of the subsurface beneath the geomembrane.
- 4) Quality and consistency of the welding material.
- 5) Proper preparation of the liner surfaces to be joined.
- 6) Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present).

- 7) Proposed details for connecting the LLDPE liner to appurtenances, i.e. penetrations of the containment facilities.
- 8) A complete description of seaming by extrusion welding and hot-wedge welding.
- 9) Requirements of the Manufacturer's Installation Manual unless exceptions are noted and approved by the Engineer.

### **1.3 DEFINITIONS AND RESPONSIBILITIES**

- A. Geomembrane Manufacturer: Manufacturer of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:
1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.
  2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
  3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
  4. Shipping of the geomembrane sheet to installer designated facilities.
  5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.
  6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.
- B. Geomembrane Installer. Installer of geomembranes are responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:
1. Acceptance (in writing) of the geomembrane from the manufacturer.
  2. Acceptance (in writing) of the surface which will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
  3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane Installer's Installation Procedures Manual.
  4. Performance of QC testing and record keeping as required by the approved Geomembrane Installer's Field Installation Procedures Manual.
  5. Repair or replacement of defects in the geomembrane as required by the Installer's CQC Consultant or the Engineer.

C. CQA Inspector:

1. Inspectors of LLDPE geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the Manufacturer, Installer, CQA Engineer, and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.

D. CQA Testing Laboratory shall:

1. Perform destructive testing of the LLDPE geomembrane.
2. Perform conformance testing of LLDPE geomembrane.

E. Installer's CQC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the Contractor with verbal and written documentation of the compliance of the installation with these Specifications.

F. CQA Engineer: Responsible for implementing CQA Plan including overseeing material conformance testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide Owner with verbal and written documentation of the compliance of the installation with these Specifications. The CQA Engineer will use the written results of the CQC program and the CQA program in the preparation of the facility Certification Document. The CQA Engineer reports to the Owner and is not part of this contract.

G. Refer to the accompanying CQA Plan for additional definitions.

## 1.4 SUBMITTALS

A. Shop Drawings:

1. Submit for Engineer's approval Shop Drawings, including:
  - a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
    - 1) Original certificates are required.
  - b. Manufacturer/Fabricator/Installer quality control requirements.
  - c. Qualifications and experience of key personnel per 1.2 B of this section.
  - d. Manufacturer's written acceptance of Geomembrane Installer's qualifications for installation of the LLDPE geomembrane.
  - e. LLDPE Geomembrane layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
    - 1) Proposed details for connecting the geosynthetic materials to appurtenances.
    - 2) Proposed methods of welding, seaming or jointing geosynthetic materials.
    - 3) Proposed method and sequencing for placement of drainage layer on top of the LLDPE geomembrane liner.

- 4) Proposed method of testing LLDPE geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
- 5) Location and configuration of haul roads and access points.
- 6) Proposed details for anchor trench if different than included in Contract Documents.

B. Miscellaneous:

1. Test results:
  - a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
    - 1) Results shall include or bracket the rolls delivered for use in the Work.
  - b. Daily test seam results.
  - c. Daily results of production seam testing.
2. Warranties as described below.
3. Submit written certifications that:
  - a. Utilize certification forms approved for use on this project by the Engineer. Make appropriate number of copies, as required.
  - b. The LLDPE geomembrane material delivered to site meets the requirements of this Specification.
  - c. The LLDPE geomembrane was received and accepted in undamaged condition from shipper.
  - d. The LLDPE geomembrane liner was installed in accordance with this Specification and with approved Shop Drawings.
  - e. The LLDPE geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.
    - 1) All test and inspection data shall be incorporated into this certification.
  - f. The drainage composite and protective cover soil on top of the LLDPE geomembrane liner was placed properly and carefully.
4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.
5. Record Drawings: Submit reproducible drawings of record showing changes from the approved Contract Drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

- C. Provide all pre-installation shop drawing submittals in a single coordinated transmittal. Partial submittals will not be accepted. All submittals except for seam test results, certifications, and record drawings must be submitted prior to the Geomembrane Preconstruction Meeting and a minimum of four weeks prior to installation.



## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Unused or stockpiled LLDPE geomembrane shall be stored in accordance with the manufacturer's recommendations.
- B. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).
  - 1. LLDPE geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
  - 2. LLDPE geomembrane shall not be exposed to temperatures in excess of 60 Deg C (140 Deg F) or less if recommended by the Manufacturer.
- C. No hooks, tongs or other sharp instruments shall be used for handling the LLDPE geomembrane.
  - 1. Rolls shall not be lifted by use of cables or chains in contact with the LLDPE geomembrane.
  - 2. LLDPE geomembrane shall not be dragged along the ground.

## **1.6 PROJECT CONDITIONS**

- A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the Owner until the weather conditions are satisfactory.
- B. The contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.
- C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.
- D. All materials shall be placed and spread with low ground pressure equipment (10 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the geosynthetics. The geosynthetics surface shall be off limits to construction traffic. Hard turning of tracked equipment on the protective cover and stone must be avoided.
  - 1. At least 12 inches of separation between the geosynthetics and all low ground pressure equipment shall be maintained.
  - 2. Stockpiling of materials within the limits of the Stage 5 construction area shall be subject to advanced approval by the CQA Inspector. Any hauling equipment (dump trucks, etc.) operating within the Stage 5 limits (and including access ramps), shall have a minimum of 4 feet of separation between the vehicle wheels and the geosynthetics.
  - 3. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.

4. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
5. Suspect areas may be identified by Owner or Engineer.

## **1.7 WARRANTIES**

- A. Written warranties addressing LLDPE geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.
- B. Submit material samples and warranties prior to shipment.
- C. Suitability of geosynthetic liner system shall be subject to Owner's approval of warranty.
  1. The Manufacturer's warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultra- violet, and other exposure to the elements, for a period of 5 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.
  2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and joined and will not fail within two years of the date of final acceptance of the Work by the Owner.
    - a. Warranty shall not be prorated.
- D. Warranties shall provide for complete repair/replacement excluding installation costs at no additional cost to the Owner for the warranty period.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
  1. LLDPE Geomembrane liners manufacturers:
    - a. Agru/America, Inc.
    - b. GSE, Inc.
    - c. Poly-Flex Inc.
  2. LLDPE Geomembrane Liner Installers:
    - a. Authorized installers of approved manufacturers.
    - b. Other installers may qualify by providing references for a minimum of 10,000,000 square feet of liner installations.

### **2.2 MATERIALS**

- A. LLDPE Geomembrane Liner:
  1. Consist of unreinforced polyethylene.
    - a. Thickness: 40 mils.
    - b. Manufactured from virgin, first quality resin designed and formulated specifically for liquid containment in hydraulic structures.

- c. Reclaimed polymer shall not be added to the resin; except use of polymer recycled during the manufacturing process shall be allowed provided that recycled polymer shall be clean and shall not exceed 10 percent by weight.
- d. No additives or fillers may be added to the resin prior to or during manufacture of the LLDPE geomembrane.
2. Manufactured to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
  - a. Any such defects shall be cause for rejection of the material.
  - b. Minor defects may be repaired in accordance with Manufacturer's recommendations if approved by the Engineer.
3. Manufactured as seamless rolls.
  - a. Minimum width: 22 feet as delivered to the site.
4. Prior to shipment, the geomembrane manufacturer will provide the CQA Engineer and the Installer's CQC Consultant with a quality control certificate for each roll of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the geomembrane manufacturer and will include:
  - a. Roll numbers and identification; and
  - b. The results of quality control tests performed under the MQC program.
5. The Installer's CQC Consultant and the CQA Inspector will verify that a control certificate has been received for each roll and that the certified roll properties meet the requirements of these Specifications.
6. LLDPE sheet with **texture** on both sides shall be used for the closure area as part of the Stage 5 construction.
7. The geomembrane liner material shall consist of **40 MIL NOMINAL LLDPE** and meet or exceed GRI GM17 and the following requirements:

PROPERTY	TEST METHOD	TEST VALUE TEXTURED LLDPE
a. Sheet Thickness, Mils <ul style="list-style-type: none"> <li>• Minimum Average</li> <li>• Lowest Individual 8 of 10</li> <li>• Lowest Individual 10 of 10</li> </ul>	ASTM D5994 (textured)	nominal $\pm$ 5% nominal $\pm$ 10% nominal $\pm$ 15%
b. Sheet Density (min. avg.)	ASTM D1505	$\geq$ 0.92 g/cc
c. Melt Flow Index (g/10 min.)	ASTM D1238 Condition 190/2.16	$\leq$ 1.00
d. Minimum Tensile Properties (each direction) <ul style="list-style-type: none"> <li>• Break Stress</li> </ul>	ASTM D6693 Type IV Dumb- bell 2 ipm	60 ppi

PROPERTY	TEST METHOD	TEST VALUE TEXTURED LLDPE
• Elongation at Break	G.L. = 2.0 in (51 mm)	250%
e. Min. Tear Resistance Initiation	ASTM D1004	22 lbs
f. Carbon Black Content	ASTM D1603 or ASTM D4218	2.0-3.0%
g. Carbon Black Dispersion	ASTM D5596	Category
• Minimum 9 of 10		1 or 2
• All 10 of 10		1, 2, or 3
h. Puncture Resistance, Minimum Average	ASTM D4833	44 lbs
i. Oxidative Induction Time, Minimum Average	ASTM D3895 200°, O <sub>2</sub> , 1 atm	>100 min.
j. Asperity Height, Minimum Average	GRI GM12	
• Minimum Average		10 mil
• Lowest Individual 8 of 10		7 mil
• Lowest Individual 10 of 10		5 mil

8. Rolls may be rejected if they appear damaged upon delivery or if they have been rejected or returned from another project.

B. Geomembrane Manufacturing Quality Assurance (QA): The geomembrane liner shall be manufactured in accordance with a written quality assurance/quality control program (QC). This QA/QC program shall be submitted to the Engineer, together with shop drawings showing the layout of geomembrane liner in the containment facility. After this QA/QC program has been approved by the Engineer, the Manufacturer shall not deviate from the program without written approval of the Engineer. All testing shall be performed by the manufacturer and results shall be submitted to CQA Inspector for review. The QA/QC program shall include:

1. Routine testing of incoming resin prior to manufacture of geomembranes. This testing shall include tests for density, melt index, and oxidative induction time, at a frequency of not less than one per 200,000 pounds.
2. Routine testing of the manufactured sheet for physical parameters. This testing shall include tests for carbon black, tensile strength, and elongation properties, at a frequency of not less than one per 20,000 pounds of manufactured geomembrane; tear and puncture resistance and carbon black

dispersion at a frequency of not less than one per 45,000 pounds of manufactured geomembrane. Thickness shall be monitored continuously through the manufacturing process, or measured physically at a frequency of not less than one per roll of manufactured geomembrane. For textured sheet only, asperity height shall be measured every other roll.

3. Extrusion rod shall be manufactured from identical resin to that used in geomembrane manufacture. Manufactured extrusion rod shall be tested for carbon black, specific gravity and melt index at a frequency of not less than one test per batch.
  4. The Manufacturer shall reject resin shipments which do not conform with the density and melt index requirements of the approved QA/QC program. The Manufacturer shall reject manufactured geomembrane which does not conform to the sheet physical requirements of the approved QA/QC program
  5. The LLDPE textured geomembrane shall conform to the requirements prescribed in GRI Test Method GM17.
- C. Manufacturing QC data shall accompany the geomembrane shipment.
- D. Independent testing of geomembrane shall be conducted in accordance with the CQA Plan.

## 2.3 INTERFACE FRICTION TESTS

- A. Laboratory friction tests shall be conducted, on behalf of the Owner by the CQA Laboratory, with representative samples of the materials selected by the Contractor for use in the Work. The CQA Inspector is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the Owner. If any interface doesn't meet the requirements, or if the Contractor changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the Contractor. Testing will include the interfaces between the following adjacent materials.

<u>Material</u>	<u>Specification Section</u>
Intermediate/Cover Soil	02200
40 mil Textured LLDPE Geomembrane	02775
Drainage Composite: Final Cover	02777
Protective Cover	02200

- B. The testing shall be performed in accordance with ASTM D5321.
1. The materials shall be tested at normal stresses of 250, 500, and 1,000 psf. Displacement rates shall be in accordance with ASTM D5321 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear. All geosynthetic interfaces shall be tested in a wet

condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA Inspector prior to performing the tests.

- C. A minimum friction angle of 26 degrees is required for each interface in the system defined in Paragraph A.
- D. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.

## **2.4 EQUIPMENT AND ACCESSORIES**

- A. Welding and Seaming Equipment:
  - 1. Equipped with gages showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder).
  - 2. Maintained in adequate numbers to avoid delaying work.
  - 3. Supplied by a power source capable of providing constant voltage under a combined-line load.
  - 4. Electric generator shall not be placed on the LLDPE geomembrane.
- B. Field Tensiometer:
  - 1. Provide a tensiometer for on-site shear and peel testing of LLDPE geomembrane seams.
    - a. Tensiometer shall be in good working order.
    - b. Built to ASTM specifications.
    - c. Accompanied by evidence of calibration of equipment and gages within the past six months.
  - 2. Tension meter:
    - a. Motor driven.
    - b. Jaws capable of traveling a measure rate of 2 inches per minute.
    - c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
    - d. Digital readout.
- C. Punch Press:
  - 1. Provide a punch press for the onsite preparation of specimens for testing.
  - 2. Capable of cutting specimens in accordance with ASTM D4437.
- D. Vacuum Box:
  - 1. Provide a vacuum box for onsite testing of LLDPE geomembrane seams in accordance with ASTM D5641.
- E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.
- F. Gages:
  - 1. Calibrated within past six months.
  - 2. Specified test values reading near mid-range of the gage scale.
- G. Equipment necessary to perform "Non-Destructive Testing of Geomembrane Seams Using The Spark Test" in accordance with ASTM D6365.

## **2.5 FABRICATION**

- A. The Manufacturer is responsible for producing geomembrane sheet that complies with this Specification. These responsibilities include but are not limited to:
1. Resin and additive quality control:
    - a. Acceptance of the resin and additives from chemical formulators.
    - b. Testing of the raw resin and additives to ensure compliance with the Manufacturer's specifications and with this Specification.
  2. Formulation of the resin and additives into sheeting using mixing and extrusion equipment.
  3. Testing of the sheet material to ensure compliance with Manufacturer's specifications and this Specification.
  4. Shipping of the sheet material to Installer.
  5. Certification of the raw materials and finished sheet to comply with this Specification.
  6. Certification of Installer's training (unless Installer is certified by other acceptable manufacturer list herein), experience and methods for welding, seaming, joining and inspecting geosynthetic materials installations in compliance with Manufacturer's standards and with Quality Assurance requirements of this Specification Part 1.2.

## **PART 3 - EXECUTION**

### **3.1 GEOSYNTHETIC LINER SYSTEM**

- A. Geomembrane Subgrade:
1. Protect subgrade at all times from damage until such time as the placement of LLDPE geomembrane liner and other components of the geosynthetic liner system are complete.
  2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of LLDPE Geomembrane.
    - a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the LLDPE Geomembrane or other synthetic liner materials.
    - b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
    - c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
    - d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.
- B. Anchor Trenches:
1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
  2. Excavation, backfill and compaction shall be in accordance with Section 02200.

C. LLDPE Geomembrane:

1. General:

- a. Installer of LLDPE geomembranes is responsible for handling, fitting, welding, seaming, joining and testing of geosynthetic materials sheets or blankets in the field in accordance with the Construction Quality Assurance (CQA) Plan.
- b. These responsibilities include but are not limited to:
  - 1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
  - 2) Acceptance (in writing) of the surface which will serve as a base for the LLDPE geomembrane.
    - a) Shall precede installation of the LLDPE geomembrane.
    - b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of LLDPE geomembrane liners.
    - c) Shall explicitly state any and all exceptions to acceptance.
  - 3) Handling, welding, seaming, joining, testing and repair of LLDPE geomembrane liners and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.
    - a) Manual shall be submitted to the Engineer together with shop drawings showing the layout of LLDPE geomembrane within the facility.
      - (1) Do not deviate from the procedures included in the manual.
    - b) LLDPE Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.
    - c) LLDPE Geomembrane liner materials shall be laid out according to plans previously approved by the Engineer.
    - d) Adjacent rolls of LLDPE geomembrane shall overlap a minimum of 3 inches.
  - 4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.
  - 5) Installer and Manufacturer may be the same firm.

2. Panel deployment:

- a. Subgrade Preparation:
  - 1) Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of LLDPE geomembrane liner.
  - 2) Properly compact the subgrade so as not to settle and cause excessive strains in the LLDPE geomembrane liner.
  - 3) Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.



- 4) Subgrade soils proof-rolled as required per specification Section 02200 or as directed by CQA Inspector. The subbase shall be compacted and proof-rolled under observation of the CQA Inspector to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02200 for project specific compaction requirement.
- 5) Ensure rutting or raveling is not caused by installation equipment or weather.
- 6) Ensure that lines and grades have been verified by the Contractor and a subgrade acceptance form has been submitted.
- b. Construct and backfill anchor trenches.
- c. Deploy LLDPE geomembrane liner in a manner to ensure it is not damaged.
- d. On slopes, anchor the LLDPE geomembrane liner securely and deploy it down the slope in a controlled manner.
- e. Weight the LLDPE geomembrane liner with sandbags or equivalent in the presence of wind.
- f. Minimize cutting the LLDPE geomembrane liner. Whenever possible, overlap instead of cutting material. If cutting is required, cut LLDPE geomembrane liner with a cutter or other approved device. Seal all cut edges, as recommended by Manufacturer.
- g. Only those panel/sheets that can be seamed in 1 day shall be deployed.
- h. Place panels with minimal handling.
  - 1) No horizontal seams on side slopes.
  - 2) Protect panels from tear, puncture or abrasion.
- i. Equipment used to deploy the geomembrane shall not damage the LLDPE geomembrane.
- j. Minimize foot traffic.
  - 1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.
  - 2) Do not allow footwear that may damage the geomembrane.
- k. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer based on local climatic conditions.
  - 1) Remove and replace all wind damaged panels at no additional cost to Owner.
  - 2) If wind causes panels to be displaced, displaced panel may not be reused.
- l. Install LLDPE geomembrane in stress free, tension free and relaxed condition.
  - 1) Account for temperature and weather-related impacts when deploying and covering.
  - 2) Stretching to fit and folding are not permitted.

- m. Do not allow LLDPE geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
  - 1) Except as noted on Contract Drawings no folds in LLDPE geomembrane will be allowed.
- n. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
- o. Field seaming:
  - 1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer, referenced EPA documents, and this specification.
  - 2) Each piece of seaming equipment and each operator shall perform trial seams at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
  - 3) Trial seams shall use the same seaming materials and methods to be used in the actual construction.
  - 4) Surfaces to be seamed shall be clean and dry at the time of seaming.
    - a) Precipitation and ponding of water on the LLDPE geomembrane shall cause termination of seaming operations.
    - b) LLDPE geomembrane shall not be seamed when ambient temperatures are below 41 Deg F or above 104 Deg F, without written consent of LLDPE geomembrane Manufacturer and Engineer.
  - 5) LLDPE geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
    - a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
    - b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
    - c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
  - 6) All LLDPE geomembranes shall be seamed by thermal fusion methods as recommended by the LLDPE geomembrane Manufacturer.
    - a) LLDPE geomembrane seaming shall be either extrusion or double wedge welded as approved by the Engineer.
  - 7) Manufacturer's seaming instructions shall specifically address seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
  - 8) A copy of Manufacturer's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.

- 9) All panels/sheets should be overlapped a minimum of 3 inches.
  - a) No horizontal seams will be permitted on the side slopes.
- 10) Seaming shall not be conducted in the presence of standing water.
  - a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
- 11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
- 12) Tack welds shall conform with manufacturers seaming techniques and shall not damage underlying membrane.
- p. Patching:
  - 1) Defects in and damage to LLDPE geomembrane sheets shall be repaired by seaming a patch over the defect.
    - a) The patch material shall consist of an undamaged piece of LLDPE geomembrane cut to provide a minimum of 6 inches of overlap in all directions from the defect.
    - b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.
    - c) Torn or permanently twisted LLDPE geomembrane shall be replaced at no expense to the Owner.
  - 2) Test all patch seams non-destructively using a vacuum box test
    - a) Test patch seams destructively if the seam is greater than 100 feet in contiguous length (i.e. a single seam greater than 100 feet).
    - b) Perform a destructive test for every 200 total feet of contiguous seam. For example if a patch seam is 340 feet, 2 destructive tests would be required for the seam.
- q. Smoking is not permitted while on the geomembrane.
- r. No vehicles are allowed on the geomembrane.
- s. Field Panel Identification: The Installer's CQC Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.

### **3.2 FIELD QUALITY CONTROL**

- A. The CQA Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Manufacturer and Installer.
  - 1. The CQA Inspector's responsibilities include, but are not limited to:
    - a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.
    - b. All exceptions to material or installation shall be documented and furnished to the CQA firm in writing within 48 hours of discovery.
    - c. Inspection and Certification of LLDPE geomembrane integrity until completion of placement of protective soil cover.

B. Trial Seam Testing:

1. Trial seams shall be at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
  - a. The location of trial seam shall be in an area proposed for the day's production seaming.
  - b. Equipment, methods and personnel shall be the same as proposed for the day's seaming.
2. Test four replicates (1 inch wide specimens) cut from trial seam.
  - a. To be acceptable, four of four replicate test specimens must meet specified seam strength requirements and all failures shall be Film Tear Bond.
  - b. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 inches per minute.
  - c. If the field trial seam tests fail to meet these requirements, the entire operation shall be repeated.
  - d. If the additional test seams fail, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected and two consecutive successful test seams are achieved.

C. Non-Destructive Seam Testing:

1. All field seams shall be non-destructively tested over their full length.
  - a. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.
  - b. All testing shall be documented. Any seams which fail shall be repaired and documented.
2. Non-destructively test all field seams continuously using one of the following nondestructive seam tests:
  - a. Vacuum box (ASTM D5641). Test at 5psi for 10 seconds. Any loss in vacuum, as indicated by bubbling of soap solution, is a failing test.
  - b. Spark tests (ASTM D6365). Test at uniform rate between 6 and 9 meters per minute. A spark indicates a failing test.
  - c. Pressurized air channel test (ASTM D5820). For 40 mil geomembrane, test at between 24 and 30 psi for at least 5 minutes. A pressure drop of more than 3 psi is a failing test.
3. All tests should be conducted in accordance with their corresponding ASTM method.

D. Destructive Seam Testing:

1. A minimum of one destructive test per 500 linear feet of seam, and as many other samples as CQA firm determines appropriate, shall be obtained at locations specified by the CQA firm.
  - a. Sample locations shall not be identified prior to seaming.
  - b. The samples shall be a minimum of 12 inches wide by 48 inches long with the seam centered lengthwise.

- c. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to a CQA Testing Laboratory, and the remaining piece given to the CQA Engineer for quality assurance testing and/or permanent record.
- d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:
  - 1) Panel/sheet number.
  - 2) Seam number.
  - 3) Top sheet.
  - 4) Date and time cut.
  - 5) Ambient temperature.
  - 6) Seaming unit designation.
  - 7) Name of seamer.
  - 8) Seaming apparatus temperature and pressures (where applicable).
2. A minimum of four 1 inch wide replicate specimens shall be cut from the Installer's sample.
  - a. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 inches per minute.
  - b. To be acceptable, all field test specimens must meet the specified seam strength requirements and all must fail as Film Tear Bond.
  - c. If all field tests pass, 5 specimens shall be tested at the CQA Testing Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D6392.
  - d. To be acceptable, 4 out of 5 replicate test specimens must meet the specified seam strength requirements and fifth sample must meet 80% required strength and fail at Film Tear Bond.
  - e. Shear elongation and Peel separation shall not exceed values given in GRI GM19.
3. The minimum required seam strengths for 40 mil LLDPE are:

<u>Description</u>	<u>Test Method</u>	<u>Seam Type</u>	<u>Required Value (lbs/in width)</u>
LLDPE Peel	ASTM D6392	Extrusion	48
LLDPE Peel	ASTM D6392	Fusion	50
LLDPE Shear	ASTM D6392	All	60

4. For destructive samples which have failed the passing criterion, the Contractor will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the Contractor may patch or cap strip the seam between the passed samples. If either fails, the Contractor will remove and replace the entire seam. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the CQA Engineer will be final.

- a. In addition, all destructive seam sample holes shall be repaired the same day as cut.
  - b. Certified test results on all field seams shall be submitted to and approved by the CQA Engineer prior to acceptance of the seam.
- 5. All repaired areas shall be non-destructively tested and destructively tested as described in Part 3.2 of this specification.
- 6. Destructive testing shall be performed by a CQA Testing Laboratory not employed by the Installer.
- 7. A map showing the locations, number and type of all patches shall be prepared and provided to the Owner.
- 8. Documentation: The following documentation must be maintained at the project site for review by the CQA Engineer or Inspector.
  - a. Geomembrane Installer's Documentation:
    - 1) Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
    - 2) Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
    - 3) Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane Installer.
    - 4) Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
    - 5) Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane Installer's QC program.
    - 6) Seam/Panel Repair Log: provides a complete record of all repairs and vacuum box testing of repairs made to defective seams or panels.
    - 7) As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

### **3.3 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE**

- A. Contractor shall retain all ownership and responsibility for the geosynthetic liner system until final acceptance by the Owner.
  - 1. Owner will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the Contractor, Manufacturer, Inspector and Installer has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

### **END OF SECTION**

## **SECTION 02776**

### **HDPE GEOMEMBRANE LINER SYSTEM**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

**A. Section Includes:**

1. Furnishing, installation, quality control, and testing of a HDPE geomembrane liner with texture on both sides. HDPE geomembrane liner will be used as part of the barrier layer over and within the limits of the vinyl pile installation.

**B. Related Sections include but are not necessarily limited to:**

1. Section 02200 – Earthwork: Landfills.
2. Southeast County Landfill Sinkhole Remediation Stage 5 - Isolation of Impacted Clay Liner, Construction Quality Assurance Plan.

##### **1.2 QUALITY STANDARDS**

**A. Referenced Standards:**

1. ASTM International (ASTM).
  - a. D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
  - b. D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
  - c. D1505 Standard Test Method for the Density of Plastics by the Density-Gradient Technique.
  - d. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
  - e. D1603 Standard Test Method for Carbon Black in Olefin Plastics.
  - f. D3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
  - g. D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
  - h. D4437 Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
  - i. D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  - j. D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
  - k. D5321 Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
  - l. D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

- m. D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
- n. D5820, Standard Practice for Pressured Air Channel Evaluation of Dual Seamed Geomembrane.
- o. D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes.
- p. D6365 Non-Destructive Testing of Geomembrane Seams Using the Spark Test
- q. D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
- r. D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- 2. The Geosynthetic Research Institute (GRI).
  - a. GM12 Asperity Measurement of Textured Geomembranes Using a Depth Gage.
  - b. GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
  - c. GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

**B. Qualifications:**

- 1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience with a minimum of 10,000,000 square feet of HDPE geomembranes.
- 2. Installer:
  - a. Demonstrate 5 years continuous experience with a minimum 10,000,000 square feet of HDPE geomembranes.
  - b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
  - c. Geomembrane Installer Personnel Qualifications:
    - 1) Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
    - 2) The master welder shall have completed a minimum of 5,000,000 square feet of HDPE geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
    - 3) Other welders shall have seamed a minimum of 1,000,000 square feet of HDPE geomembrane.
- 3. CQC Testing Laboratory shall demonstrate 3 years of continuous experience in similar geosynthetic materials testing.
- 4. Installer shall attend pre-installation conference.



C. Quality Assurance / Control:

1. The Engineer will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
2. Unless specifically superseded by these contract documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
  - a. This specifically includes:
    - 1) Material Composition.
    - 2) Manufacturing.
    - 3) Handling and Packaging.
    - 4) Shipment.
    - 5) Storage (Manufacturer and Site).
    - 6) Placement:
      - a) Seaming and Joining.
      - b) Destructive and Non Destructive Testing.
      - c) Protection, Backfilling and Covering.
    - 7) Conformance Testing.
    - 8) Anchoring and Anchor Trenches.
    - 9) Access Roads/Ramps.
3. Installer shall attend pre-installation conference.

D. CQA Plan Implementation: Construction Quality Control will be performed in accordance with the CQA Plan prepared for this project. The Contractor and Geomembrane Installer should familiarize themselves with the CQA Plan.

E. Certifications:

1. Certifications are required for various aspects of the project related to the HDPE geomembrane liner system construction.
  - a. Utilize certification forms approved for use on this project by the Engineer.

F. Installer's construction quality control programs to include, but not be limited to, product acceptance testing, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.

G. Geomembrane Installer's installation manual to include:

- 1) Ambient temperature at which the seams are made.
- 2) Control of panel lift up by wind.
- 3) Acceptable condition of the subsurface beneath the geomembrane.
- 4) Quality and consistency of the welding material.
- 5) Proper preparation of the liner surfaces to be joined.
- 6) Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present).

- 7) Proposed details for connecting the HDPE liner to appurtenances, i.e. penetrations of the containment facilities.
- 8) A complete description of seaming by extrusion welding and hot-wedge welding.
- 9) Requirements of the Manufacturer's Installation Manual unless exceptions are noted and approved by the Engineer.

### **1.3 DEFINITIONS AND RESPONSIBILITIES**

- A. Geomembrane Manufacturer: Manufacturer of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:
1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.
  2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
  3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
  4. Shipping of the geomembrane sheet to installer designated facilities.
  5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.
  6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.
- B. Geomembrane Installer. Installer of geomembranes are responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:
1. Acceptance (in writing) of the geomembrane from the manufacturer.
  2. Acceptance (in writing) of the surface which will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
  3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane Installer's Installation Procedures Manual.
  4. Performance of QC testing and record keeping as required by the approved Geomembrane Installer's Field Installation Procedures Manual.
  5. Repair or replacement of defects in the geomembrane as required by the Installer's CQC Consultant or the Engineer.
- C. CQA Inspector:
1. Inspectors of HDPE geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the

Manufacturer, Installer, CQA Engineer, and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.

- D. CQA Testing Laboratory shall:
  - 1. Perform destructive testing of the HDPE geomembrane.
  - 2. Perform conformance testing of HDPE geomembrane.
- E. Installer's CQC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the Contractor with verbal and written documentation of the compliance of the installation with these Specifications.
- F. CQA Engineer: Responsible for implementing CQA Plan including overseeing material conformance testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide Owner with verbal and written documentation of the compliance of the installation with these Specifications. The CQA Engineer will use the written results of the CQC program and the CQA program in the preparation of the facility Certification Document. The CQA Engineer reports to the Owner and is not part of this contract.
- G. Refer to the accompanying CQA Plan for additional definitions.

#### **1.4 SUBMITTALS**

- A. Shop Drawings:
  - 1. Submit for Engineer's approval Shop Drawings, including:
    - a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
      - 1) Original certificates are required.
    - b. Manufacturer/Fabricator/Installer quality control requirements.
    - c. Qualifications and experience of key personnel per 1.2 B of this section.
    - d. Manufacturer's written acceptance of Geomembrane Installer's qualifications for installation of the HDPE geomembrane.
    - e. HDPE Geomembrane layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
      - 1) Proposed details for connecting the geosynthetic materials to appurtenances.
      - 2) Proposed methods of welding, seaming or jointing geosynthetic materials.
      - 3) Proposed method and sequencing for placement of cushion geotextile and drainage layer on top of the HDPE geomembrane liner.
      - 4) Proposed method of testing HDPE geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
      - 5) Location and configuration of haul roads and access points.

- 6) Proposed details for anchor trench if different than included in Contract Documents.

**B. Miscellaneous:**

1. Test results:
  - a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
    - 1) Results shall include or bracket the rolls delivered for use in the Work.
  - b. Daily test seam results.
  - c. Daily results of production seam testing.
2. Warranties as described below.
3. Submit written certifications that:
  - a. Utilize certification forms approved for use on this project by the Engineer. Make appropriate number of copies, as required.
  - b. The HDPE geomembrane material delivered to site meets the requirements of this Specification.
  - c. The HDPE geomembrane was received and accepted in undamaged condition from shipper.
  - d. The HDPE geomembrane liner was installed in accordance with this Specification and with approved Shop Drawings.
  - e. The HDPE geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.
    - 1) All test and inspection data shall be incorporated into this certification.
  - f. The drainage composite and protective cover soil on top of the HDPE geomembrane liner was placed properly and carefully.
4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.
5. Record Drawings: Submit reproducible drawings of record showing changes from the approved Contract Drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

- C. Provide all pre-installation shop drawing submittals in a single coordinated transmittal. Partial submittals will not be accepted. All submittals except for seam test results, certifications, and record drawings must be submitted prior to the Geomembrane Preconstruction Meeting and a minimum of four weeks prior to installation.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Unused or stockpiled HDPE geomembrane shall be stored in accordance with the manufacturer's recommendations.

- B. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).
  - 1. HDPE geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
  - 2. HDPE geomembrane shall not be exposed to temperatures in excess of 60 Deg C (140 Deg F) or less if recommended by the Manufacturer.
- C. No hooks, tongs or other sharp instruments shall be used for handling the HDPE geomembrane.
  - 1. Rolls shall not be lifted by use of cables or chains in contact with the HDPE geomembrane.
  - 2. HDPE geomembrane shall not be dragged along the ground.

## **1.6 PROJECT CONDITIONS**

- A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the Owner until the weather conditions are satisfactory.
- B. The contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.
- C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.
- D. All materials shall be placed and spread with low ground pressure equipment (10 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the geosynthetics. The geosynthetics surface shall be off limits to construction traffic. Hard turning of tracked equipment on the protective cover and stone must be avoided.
  - 1. At least 12 inches of separation between the geosynthetics and all low ground pressure equipment shall be maintained.
  - 2. Stockpiling of materials within the limits of the Stage 5 construction area shall be subject to advanced approval by the CQA Inspector. Any hauling equipment (dump trucks, etc.) operating within the Stage 5 limits (and including access ramps), shall have a minimum of 4 feet of separation between the vehicle wheels and the geosynthetics.
  - 3. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
  - 4. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
  - 5. Suspect areas may be identified by Owner or Engineer.

## **1.7 WARRANTIES**

- A. Written warranties addressing HDPE geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.
- B. Submit material samples and warranties prior to shipment.
- C. Suitability of geosynthetic liner system shall be subject to Owner's approval of warranty.
  - 1. The Manufacturer's warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultra- violet, and other exposure to the elements, for a period of 5 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.
  - 2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and joined and will not fail within two years of the date of final acceptance of the Work by the Owner.
    - a. Warranty shall not be prorated.
- D. Warranties shall provide for complete repair/replacement excluding installation costs at no additional cost to the Owner for the warranty period.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
  - 1. HDPE Geomembrane liners manufacturers:
    - a. Agru/America, Inc.
    - b. GSE, Inc.
    - c. Poly-Flex Inc.
  - 2. HDPE Geomembrane Liner Installers:
    - a. Authorized installers of approved manufacturers.
    - b. Other installers may qualify by providing references for a minimum of 10,000,000 square feet of liner installations.

### **2.2 MATERIALS**

- A. HDPE Geomembrane Liner:
  - 1. Consist of unreinforced polyethylene.
    - a. Thickness: 60 mils.
    - b. Manufactured from virgin, first quality resin designed and formulated specifically for liquid containment in hydraulic structures.
    - c. Reclaimed polymer shall not be added to the resin; except use of polymer recycled during the manufacturing process shall be allowed

- provided that recycled polymer shall be clean and shall not exceed 10 percent by weight.
- d. No additives or fillers may be added to the resin prior to or during manufacture of the HDPE geomembrane.
  2. Manufactured to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
    - a. Any such defects shall be cause for rejection of the material.
    - b. Minor defects may be repaired in accordance with Manufacturer's recommendations if approved by the Engineer.
  3. Manufactured as seamless rolls.
    - a. Minimum width: 22 feet as delivered to the site.
  4. Prior to shipment, the geomembrane manufacturer will provide the CQA Engineer and the Installer's CQC Consultant with a quality control certificate for each roll of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the geomembrane manufacturer and will include:
    - a. Roll numbers and identification; and
    - b. The results of quality control tests performed under the MQC program.
  5. The Installer's CQC Consultant and the CQA Inspector will verify that a control certificate has been received for each roll and that the certified roll properties meet the requirements of these Specifications.
  6. HDPE sheet with **texture** on both sides shall be used for the closure area as part of the Stage 5 construction.
  7. The geomembrane liner material shall consist of **60 MIL NOMINAL HDPE** and meet or exceed GRI GM13 and the following requirements:

PROPERTY	TEST METHOD	TEST VALUE TEXTURED HDPE
a. Sheet Thickness, Mils	ASTM D5994	
• Minimum Average	(textured)	nominal $\pm$ 5%
• Lowest Individual 8 of 10		nominal $\pm$ 10%
• Lowest Individual 10 of 10		nominal $\pm$ 15%
b. Sheet Density (min. avg.)	ASTM D1505	$\geq$ 0.94 g/cc
c. Melt Flow Index (g/10 min.)	ASTM D1238 Condition 190/2.16	$\leq$ 1.00
d. Minimum Tensile Properties (each direction)	ASTM D6693 Type IV Dumb-	
• Break Stress	bell 2 ipm	90 ppi
• Elongation at Break	G.L. = 2.0 in (51 mm)	100%

PROPERTY	TEST METHOD	TEST VALUE TEXTURED HDPE
e. Min. Tear Resistance Initiation	ASTM D1004	42 lbs
f. Carbon Black Content	ASTM D1603 or ASTM D4218	2.0-3.0%
g. Carbon Black Dispersion	ASTM D5596	Category
• Minimum 9 of 10		1 or 2
• All 10 of 10		1, 2, or 3
h. Puncture Resistance, Minimum Average	ASTM D4833	90 lbs
i. Oxidative Induction Time, Minimum Average	ASTM D3895 200°, O <sub>2</sub> , 1 atm	>100 min.
j. Asperity Height, Minimum Average	GRI GM12	
• Minimum Average		10 mil
• Lowest Individual 8 of 10		7 mil
• Lowest Individual 10 of 10		5 mil

8. Rolls may be rejected if they appear damaged upon delivery or if they have been rejected or returned from another project.

- B. Geomembrane Manufacturing Quality Assurance (QA): The geomembrane liner shall be manufactured in accordance with a written quality assurance/quality control program (QC). This QA/QC program shall be submitted to the Engineer, together with shop drawings showing the panel layout of the geomembrane liner. After this QA/QC program has been approved by the Engineer, the Manufacturer shall not deviate from the program without written approval of the Engineer. All testing shall be performed by the manufacturer and results shall be submitted to CQA Inspector for review. The QA/QC program shall include:
1. Routine testing of incoming resin prior to manufacture of geomembranes. This testing shall include tests for density, melt index, and oxidative induction time, at a frequency of not less than one per 200,000 pounds.
  2. Routine testing of the manufactured sheet for physical parameters. This testing shall include tests for carbon black, tensile strength, and elongation properties, at a frequency of not less than one per 20,000 pounds of manufactured geomembrane; tear and puncture resistance and carbon black dispersion at a frequency of not less than one per 45,000 pounds of manufactured geomembrane. Thickness shall be monitored continuously through the manufacturing process, or measured physically at a frequency of



not less than one per roll of manufactured geomembrane. For textured sheet only, asperity height shall be measured every other roll.

3. Extrusion rod shall be manufactured from identical resin to that used in geomembrane manufacture. Manufactured extrusion rod shall be tested for carbon black, specific gravity and melt index at a frequency of not less than one test per batch.
4. The Manufacturer shall reject resin shipments which do not conform with the density and melt index requirements of the approved QA/QC program. The Manufacturer shall reject manufactured geomembrane which does not conform to the sheet physical requirements of the approved QA/QC program
5. The HDPE textured geomembrane shall conform to the requirements prescribed in GRI Test Method GM13.

C. Manufacturing QC data shall accompany the geomembrane shipment.

D. Independent testing of geomembrane shall be conducted in accordance with the CQA Plan.

## **2.3 INTERFACE FRICTION TESTS**

A. Laboratory friction tests shall not be required for the HDPE geomembrane.

## **2.4 EQUIPMENT AND ACCESSORIES**

A. Welding and Seaming Equipment:

1. Equipped with gages showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder).
2. Maintained in adequate numbers to avoid delaying work.
3. Supplied by a power source capable of providing constant voltage under a combined-line load.
4. Electric generator shall not be placed on the HDPE geomembrane.

B. Field Tensiometer:

1. Provide a tensiometer for on-site shear and peel testing of HDPE geomembrane seams.
  - a. Tensiometer shall be in good working order.
  - b. Built to ASTM specifications.
  - c. Accompanied by evidence of calibration of equipment and gages within the past six months.
2. Tension meter:
  - a. Motor driven.
  - b. Jaws capable of traveling a measure rate of 2 inches per minute.
  - c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
  - d. Digital readout.

C. Punch Press:

1. Provide a punch press for the onsite preparation of specimens for testing.
2. Capable of cutting specimens in accordance with ASTM D4437.

- D. Vacuum Box:
  - 1. Provide a vacuum box for onsite testing of HDPE geomembrane seams in accordance with ASTM D5641.
- E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.
- F. Gages:
  - 1. Calibrated within past six months.
  - 2. Specified test values reading near mid-range of the gage scale.
- G. Equipment necessary to perform "Non-Destructive Testing of Geomembrane Seams Using the Spark Test" in accordance with ASTM D6365.

## **2.5 FABRICATION**

- A. The Manufacturer is responsible for producing geomembrane sheet that complies with this Specification. These responsibilities include but are not limited to:
  - 1. Resin and additive quality control:
    - a. Acceptance of the resin and additives from chemical formulators.
    - b. Testing of the raw resin and additives to ensure compliance with the Manufacturer's specifications and with this Specification.
  - 2. Formulation of the resin and additives into sheeting using mixing and extrusion equipment.
  - 3. Testing of the sheet material to ensure compliance with Manufacturer's specifications and this Specification.
  - 4. Shipping of the sheet material to Installer.
  - 5. Certification of the raw materials and finished sheet to comply with this Specification.
  - 6. Certification of Installer's training (unless Installer is certified by other acceptable manufacturer list herein), experience and methods for welding, seaming, joining and inspecting geosynthetic materials installations in compliance with Manufacturer's standards and with Quality Assurance requirements of this Specification Part 1.2.

## **PART 3 - EXECUTION**

### **3.1 GEOSYNTHETIC LINER SYSTEM**

- A. Geomembrane Subgrade:
  - 1. Protect subgrade at all times from damage until such time as the placement of HDPE geomembrane liner and other components of the geosynthetic liner system are complete.
  - 2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of HDPE Geomembrane.
    - a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the HDPE Geomembrane or other synthetic liner materials.

- b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
- c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
- d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.

**B. Anchor Trenches:**

- 1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
- 2. Excavation, backfill and compaction shall be in accordance with Section 02200.

**C. HDPE Geomembrane:**

**1. General:**

- a. Installer of HDPE geomembranes is responsible for handling, fitting, welding, seaming, joining and testing of geosynthetic materials sheets or blankets in the field in accordance with the Construction Quality Assurance (CQA) Plan.
- b. These responsibilities include but are not limited to:
  - 1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
  - 2) Acceptance (in writing) of the surface which will serve as a base for the HDPE geomembrane.
    - a) Shall precede installation of the HDPE geomembrane.
    - b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of HDPE geomembrane liners.
    - c) Shall explicitly state any and all exceptions to acceptance.
  - 3) Handling, welding, seaming, joining, testing and repair of HDPE geomembrane liners and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.
    - a) Manual shall be submitted to the Engineer together with shop drawings showing the layout of HDPE geomembrane within the facility.
      - (1) Do not deviate from the procedures included in the manual.
    - b) HDPE Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.
    - c) HDPE Geomembrane liner materials shall be laid out according to plans previously approved by the Engineer.
    - d) Adjacent rolls of HDPE geomembrane shall overlap a minimum of 3 inches.
  - 4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.

- 5) Installer and Manufacturer may be the same firm.
2. Panel deployment:
  - a. Subgrade Preparation:
    - 1) Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of HDPE geomembrane liner.
    - 2) Properly compact the subgrade so as not to settle and cause excessive strains in the HDPE geomembrane liner.
    - 3) Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
    - 4) Subgrade soils proof-rolled as required per specification Section 02200 or as directed by CQA Inspector. The subbase shall be compacted and proof-rolled under observation of the CQA Inspector to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02200 for project specific compaction requirement.
    - 5) Ensure rutting or raveling is not caused by installation equipment or weather.
    - 6) Ensure that lines and grades have been verified by the Contractor and a subgrade acceptance form has been submitted.
  - b. Construct and backfill anchor trenches.
  - c. Deploy HDPE geomembrane liner in a manner to ensure it is not damaged.
  - d. On slopes, anchor the HDPE geomembrane liner securely and deploy it down the slope in a controlled manner.
  - e. Weight the HDPE geomembrane liner with sandbags or equivalent in the presence of wind.
  - f. Minimize cutting the HDPE geomembrane liner. Whenever possible, overlap instead of cutting material. If cutting is required, cut HDPE geomembrane liner with a cutter or other approved device. Seal all cut edges, as recommended by Manufacturer.
  - g. Only those panel/sheets that can be seamed in 1 day shall be deployed.
  - h. Place panels with minimal handling.
    - 1) No horizontal seams on side slopes.
    - 2) Protect panels from tear, puncture or abrasion.
  - i. Equipment used to deploy the geomembrane shall not damage the HDPE geomembrane.
  - j. Minimize foot traffic.
    - 1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.
    - 2) Do not allow footwear that may damage the geomembrane.
  - k. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer based on local climatic conditions.
    - 1) Remove and replace all wind damaged panels at no additional cost to Owner.

- 2) If wind causes panels to be displaced, displaced panel may not be reused.
- l. Install HDPE geomembrane in stress free, tension free and relaxed condition.
  - 1) Account for temperature and weather-related impacts when deploying and covering.
  - 2) Stretching to fit and folding are not permitted.
- m. Do not allow HDPE geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
  - 1) Except as noted on Contract Drawings no folds in HDPE geomembrane will be allowed.
- n. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
- o. Field seaming:
  - 1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer, referenced EPA documents, and this specification.
  - 2) Each piece of seaming equipment and each operator shall perform trial seams at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
  - 3) Trial seams shall use the same seaming materials and methods to be used in the actual construction.
  - 4) Surfaces to be seamed shall be clean and dry at the time of seaming.
    - a) Precipitation and ponding of water on the HDPE geomembrane shall cause termination of seaming operations.
    - b) HDPE geomembrane shall not be seamed when ambient temperatures are below 41 Deg F or above 104 Deg F, without written consent of HDPE geomembrane Manufacturer and Engineer.
  - 5) HDPE geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
    - a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
    - b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
    - c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
  - 6) All HDPE geomembranes shall be seamed by thermal fusion methods as recommended by the HDPE geomembrane Manufacturer.
    - a) HDPE geomembrane seaming shall be either extrusion or double wedge welded as approved by the Engineer.

- 7) Manufacturer's seaming instructions shall specifically address seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
  - 8) A copy of Manufacturer's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.
  - 9) All panels/sheets should be overlapped a minimum of 3 inches.
    - a) No horizontal seams will be permitted on the side slopes.
  - 10) Seaming shall not be conducted in the presence of standing water.
    - a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
  - 11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
  - 12) Tack welds shall conform with manufacturers seaming techniques and shall not damage underlying membrane.
- p. Patching:
- 1) Defects in and damage to HDPE geomembrane sheets shall be repaired by seaming a patch over the defect.
    - a) The patch material shall consist of an undamaged piece of HDPE geomembrane cut to provide a minimum of 6 inches of overlap in all directions from the defect.
    - b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.
    - c) Torn or permanently twisted HDPE geomembrane shall be replaced at no expense to the Owner.
  - 2) Test all patch seams non-destructively using a vacuum box test
    - a) Test patch seams destructively if the seam is greater than 100 feet in contiguous length (i.e. a single seam greater than 100 feet).
    - b) Perform a destructive test for every 200 total feet of contiguous seam. For example if a patch seam is 340 feet, 2 destructive tests would be required for the seam.
- q. Smoking is not permitted while on the geomembrane.
- r. No vehicles which may damage the material are allowed on the geomembrane.
- s. Field Panel Identification: The Installer's CQC Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.

### **3.2 FIELD QUALITY CONTROL**

- A. The CQA Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Manufacturer and Installer.

1. The CQA Inspector's responsibilities include, but are not limited to:
  - a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.
  - b. All exceptions to material or installation shall be documented and furnished to the CQA firm in writing within 48 hours of discovery.
  - c. Inspection and Certification of HDPE geomembrane integrity until completion of placement of protective soil cover.
- B. Trial Seam Testing:
  1. Trial seams shall be at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
    - a. The location of trial seam shall be in an area proposed for the day's production seaming.
    - b. Equipment, methods and personnel shall be the same as proposed for the day's seaming.
  2. Test four replicates (1 inch wide specimens) cut from trial seam.
    - a. To be acceptable, four of four replicate test specimens must meet specified seam strength requirements and all failures shall be Film Tear Bond.
    - b. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 inches per minute.
    - c. If the field trial seam tests fail to meet these requirements, the entire operation shall be repeated.
    - d. If the additional test seams fail, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected and two consecutive successful test seams are achieved.
- C. Non-Destructive Seam Testing:
  1. All field seams shall be non-destructively tested over their full length.
    - a. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.
    - b. All testing shall be documented. Any seams which fail shall be repaired and documented.
  2. Non-destructively test all field seams continuously using one of the following nondestructive seam tests:
    - a. Vacuum box (ASTM D5641). Test at 5psi for 10 seconds. Any loss in vacuum, as indicated by bubbling of soap solution, is a failing test.
    - b. Spark tests (ASTM D6365). Test at uniform rate between 6 and 9 meters per minute. A spark indicates a failing test.
    - c. Pressurized air channel test (ASTM D5820). For 60 mil geomembrane, test at between 24 and 30 psi for at least 5 minutes. A pressure drop of more than 3 psi is a failing test.
  3. All tests should be conducted in accordance with their corresponding ASTM method.

D. Destructive Seam Testing:

1. A minimum of one destructive test per 500 linear feet of seam, and as many other samples as CQA firm determines appropriate, shall be obtained at locations specified by the CQA firm.
  - a. Sample locations shall not be identified prior to seaming.
  - b. The samples shall be a minimum of 12 inches wide by 48 inches long with the seam centered lengthwise.
  - c. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to a CQA Testing Laboratory, and the remaining piece given to the CQA Engineer for quality assurance testing and/or permanent record.
  - d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:
    - 1) Panel/sheet number.
    - 2) Seam number.
    - 3) Top sheet.
    - 4) Date and time cut.
    - 5) Ambient temperature.
    - 6) Seaming unit designation.
    - 7) Name of seamer.
    - 8) Seaming apparatus temperature and pressures (where applicable).
2. A minimum of four 1 inch wide replicate specimens shall be cut from the Installer's sample.
  - a. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 inches per minute.
  - b. To be acceptable, all field test specimens must meet the specified seam strength requirements and all must fail as Film Tear Bond.
  - c. If all field tests pass, 5 specimens shall be tested at the CQA Testing Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D6392.
  - d. To be acceptable, 4 out of 5 replicate test specimens must meet the specified seam strength requirements and fifth sample must meet 80% required strength and fail at Film Tear Bond.
  - e. Shear elongation and Peel separation shall not exceed values given in GRI GM19.
3. The minimum required seam strengths for **60 mil HDPE** are:

<u>Description</u>	<u>Test Method</u>	<u>Seam Type</u>	Required Value
			<u>(lbs/in width)</u>
HDPE Peel	ASTM D4437	Extrusion	78
HDPE Peel	ASTM D4437	Fusion	91
HDPE Shear	ASTM D4437	All	120

4. For destructive samples which have failed the passing criterion, the Contractor will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides



of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the Contractor may patch or cap strip the seam between the passed samples. If either fails, the Contractor will remove and replace the entire seam. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the CQA Engineer will be final.

- a. In addition, all destructive seam sample holes shall be repaired the same day as cut.
- b. Certified test results on all field seams shall be submitted to and approved by the CQA Engineer prior to acceptance of the seam.
5. All repaired areas shall be non-destructively tested and destructively tested as described in Part 3.2 of this specification.
6. Destructive testing shall be performed by a CQA Testing Laboratory not employed by the Installer.
7. A map showing the locations, number and type of all patches shall be prepared and provided to the Owner.
8. Documentation: The following documentation must be maintained at the project site for review by the CQA Engineer or Inspector.
  - a. Geomembrane Installer's Documentation:
    - 1) Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
    - 2) Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
    - 3) Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane Installer.
    - 4) Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
    - 5) Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane Installer's QC program.
    - 6) Seam/Panel Repair Log: provides a complete record of all repairs and vacuum box testing of repairs made to defective seams or panels.
    - 7) As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

### **3.3 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE**

- A. Contractor shall retain all ownership and responsibility for the geosynthetic liner system until final acceptance by the Owner.
  1. Owner will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the Contractor, Manufacturer, Inspector and Installer has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

### **END OF SECTION**

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**SECTION 02777**  
**DRAINAGE COMPOSITE - FINAL COVER**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes the bonded geotextile-geonet drainage composite used as part of the final cover system.
- B. Related sections include but are not necessarily limited to:
  - 1. Southeast County Landfill Sinkhole Remediation Stage 5 - Isolation of Impacted Clay Liner, Construction Quality Assurance Plan.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ASTM International (ASTM):
    - a. D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
    - b. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
    - c. D1603, Standard Test Method for Carbon Black in Olefin Plastics.
    - d. D1987 Test Method for Biological Clogging of Geotextile or Soil/Geotextile Filters.
    - e. D4355, Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
    - f. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
    - g. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
    - h. D4716, Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
    - i. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
    - j. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    - k. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
    - l. D5035, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (strip method).
    - m. D5199, Standard Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
    - n. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
    - o. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

- p. D7005, Determining the Bond Strength (Ply Adhesion) of Geocomposites.
- q. D7238, Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Apparatus.
- 2. Geosynthetic Research Institute (GRI).
  - a. GRI GC8 – Determination of the Allowable Flow Rate of a Drainage Geocomposite.

**B. Qualifications:**

- 1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 5,000,000 square feet of drainage composite production in the past 3 years.
- 2. Installer shall attend pre-installation conference.

### **1.3 DEFINITIONS**

- A. Manufacturer: Manufacturer producing drainage composites from geonet cores and geotextiles.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

### **1.4 SUBMITTALS**

**A. Shop Drawings:**

- 1. Manufacturer's documentation that raw materials and roll materials comply with required drainage composite physical properties.
- 2. Manufacturer and Installer quality control manuals.
- 3. Original test results for resins and roll material at frequency specified in respective quality control manuals.
  - a. Include or bracket the rolls delivered for use in the Work.
- 4. Proposed details of anchor trench if different than included in Contract Documents.

**B. Miscellaneous Submittals:**

- 1. Qualification documentation specified in Part 1.2.B.
- 2. Transmissivity test.
- 3. Interface friction test.

### **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Label, handle, and store drainage composites in accordance with ASTM D4873 and as specified herein.
- B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
  - 1. Do not remove the plastic wrapping until deployment.
- C. Label each roll with the manufacturer's name, drainage composite type, lot number, roll number, and roll dimensions (length, width, gross weight).

- D. Repair or replace, as directed by the Engineer, drainage composite or plastic wrapping damaged as a result of storage or handling.
- E. Do not expose drainage composite to temperatures in excess of 71 DegC (160 DegF) or below 0 DegC (32 DegF) unless recommended by the Manufacturer.
- F. Do not use hooks, tongs or other sharp instruments for handling the drainage composite.
- G. Do not lift rolls by use of cables or chains in contact with the drainage composite.
- H. Do not drag drainage composite along the ground or across textured geomembranes.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - 1. CETCO
  - 2. GSE Lining Technology.
  - 3. Polyflex Inc.
  - 4. Skaps Industries.
  - 5. Tenax Corp.

### **2.2 MATERIALS AND MANUFACTURE**

- A. Geonet Core:
  - 1. Use nonthermally degraded polyethylene polymer which is clean and free of any foreign contaminants.
  - 2. Manufactured geonet to conform to the property requirements listed in Table 1 and be free of defects including tears, nodules or other manufacturing defects which may affect its serviceability.

**TABLE 1 - GEONET PROPERTIES**

PROPERTY	TEST METHOD	REQUIRED VALUE	MIN. MQC TEST FREQUENCY
Specific Gravity/ Density (g/cm <sup>3</sup> ) (min)	ASTM D1505	>0.94 g/cc	1 per 50,000 ft <sup>2</sup> and every resin lot
Thickness (mil)	ASTM D5199	300 mil (min)	1 per 50,000 ft <sup>2</sup> and every resin lot
Carbon Black Content	ASTM D1603	2 percent	1 per 50,000 ft <sup>2</sup> and every resin lot
Tensile Strength	ASTM D5035	75 lbs/in MD	1 per 50,000 ft <sup>2</sup> and every resin lot

B. Geotextile:

1. Non-woven pervious sheet of polymeric material.
2. Geotextile fibers:
  - a. Long-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.
  - b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
  - c. Do not add reclaimed or recycled fibers or polymer to the formulation.
3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
  - a. Values shown are for the weaker principal direction unless both values are shown.
  - b. Acceptance of geotextile shall be in accordance with ASTM D4759.
5. Non-woven Drainage Geotextile: Used in the geocomposite for drainage as shown on Drawings.

TABLE 2 - GEOTEXTILE PROPERTIES

PROPERTY <sup>(1)</sup>	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Mass per Unit Area, (oz/sy)	ASTM D5261	6	1 per 50,000 ft <sup>2</sup>
Grab Tensile Strength (lbs)	ASTM D4632	170	1 per 50,000 ft <sup>2</sup>
Puncture Strength (lbs)	ASTM D4833	90	1 per 50,000 ft <sup>2</sup>
AOS, US sieve (mm)	ASTM D4751	70	1 per 100,000 ft <sup>2</sup>
Permittivity, (sec <sup>-1</sup> )	ASTM D4491	1.5	1 per 100,000 ft <sup>2</sup>
Flow Rate, gpm/ft <sup>2</sup>	ASTM D4491	110	1 per 100,000 ft <sup>2</sup>
UV Resistance <sup>(2)</sup>	ASTM D7238	70	1 per formulation

Notes: (1) All values are MARV except UV resistance which is a minimum value.

(2) Evaluation to be on 2.0 inch strip tensile specimens after 500 light hours exposure.

6. Cover geonet core on both sides, as shown on the Contract Drawings, with a geotextile complying with requirements specified in Section 02778: Geotextiles.

C. Drainage Composite:

1. Create a composite by heat bonding geotextiles to the geonet.
2. Transmissivity =  $1.3 \times 10^{-3}$  m<sup>2</sup>/sec @ 100 hrs and 1,000 psf by ASTM D4716 (see Paragraph 2.3 A).
3. Ply adhesion ASTM D7005 MARV of 1 lb/in.

D. Independent conformance testing shall be performed in accordance with CQA Plan.

## 2.3 SOURCE QUALITY CONTROL

### A. Transmissivity Testing:

1. Measure transmissivity using water at 68 DegF with a normal compressive load of 1,000 psf and a hydraulic gradient of 0.33
2. Attach geotextiles to the geonet in the same configuration as will be used in the field.
3. Boundary conditions are soil interface on the upper geotextile and textured 40 mil LLDPE geomembrane against the lower geotextile.
4. Maximum design normal load testing shall be conducted for a minimum period of 100 hours unless data equivalent to the 100-hour period is provided in which case the test shall be conducted for a minimum period of one hour.
5. Testing frequency: 1 test for every 50,000 square feet of installed product

### B. Interface Friction Tests.

1. Laboratory friction tests shall be conducted, on behalf of the Owner by the CQA Laboratory, with representative samples of the materials selected by the Contractor for use in the Work. The Contractor is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the Owner. If any interface doesn't meet the requirements, or if the Contractor changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the Contractor. Testing will include the interfaces between the following adjacent materials.

<u>Material</u>	<u>Specification Section</u>
Protective Cover	02200
Drainage Composite – Final Cover	02777
40 mil Textured LLDPE Geomembrane	02775
Intermediate Cover	02200

2. The testing shall be performed in accordance with ASTM D5321.
3. The materials shall be tested at normal stresses of 250, 500, and 1,000 psf. Displacement rates shall be in accordance with ASTM D5321 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear. All geosynthetic interfaces shall be tested in a wet condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA Inspector prior to performing the tests.

4. A minimum friction angle of 26 degrees is required for each interface in the system defined in Paragraph B.1.
5. Interface shear strength of the actual components which will be used in the liner system shall be tested with method ASTM D5321 or an equivalent test method.
6. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.
7. Interface friction tests will be conducted by the CQA Testing Laboratory.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Prior to placement of the drainage composite, clean the substrate of all soil, rock, and other materials which could damage the composite.
- B. The geocomposite drainage media shall be placed only on geomembrane that has been approved by the Geomembrane Installer and accepted by the CQA Inspector.

### **3.2 INSTALLATION**

- A. Install geocomposite drain in accordance with manufacturer's written recommendations.
- B. Deploy the drainage composite ensuring that the drainage composite and underlying materials are not damaged.
  1. Replace or repair faulty or damaged drainage composite as directed by Engineer.
- C. Unroll drainage composite downslope keeping in slight tension to minimize wrinkles and folds.
- D. Maintain free of dirt, mud, or any other foreign materials at all times during construction.
  1. Clean or replace rolls which are contaminated.
- E. Place adequate ballast to prevent uplift by wind.
- F. Overlap adjacent rolls a minimum of 6 inches.
  1. Overlap new drainage composite over existing as shown on the Contract Drawings.
  2. Shingle all edges of geocomposite downslope.
- G. Use manufacturer's fasteners to join adjacent rolls.
  1. Metallic fasteners will not be allowed.
  2. Space fasteners a maximum of 5 feet along downslope roll overlaps and a maximum of 1 foot along cross slope roll overlaps.
  3. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection.
  4. Do not weld drainage composite to geomembranes.



5. Install geotextile cap strip wherever ends of geocomposite are exposed to soil intrusion.
- H. See Section 02778, Geotextiles, for information on seaming the upper geotextile to the upper geotextile of the adjacent rolls.
- I. Repairs holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 feet beyond the edges of the hole or tear.
  1. Use approved fasteners, spaced every 6 inches around the patch, to fasten the patch to the original roll.

### **3.3 FIELD QUALITY CONTROL**

- A. Prior to installation of the drainage composite, the Installer's CQC Consultant shall provide the Engineer quality control certificates signed by the manufacturer's quality assurance manager for every 50,000 square feet of geocomposite drainage media to be installed illustrating satisfactory transmissivity tests among other attributes.

**END OF SECTION**

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## **SECTION 02778**

### **GEOTEXTILES**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

**A. Section Includes:**

1. Non-woven geotextile material for use as a cushion layer over HDPE geomembrane barrier layer within the limits of the vinyl sheet pile installation as shown on the Contract Drawings.

**B. Related Sections:**

1. Section 02200, Earthwork: Landfills.
2. Section 02776, HDPE Geomembrane Liner System.
3. Southeast County Landfill Sinkhole Remediation Stage 5 - Isolation of Impacted Clay Liner, Construction Quality Assurance Plan.

##### **1.2 QUALITY ASSURANCE**

**A. Referenced Standards:**

1. American Association of State Highway Transportation Officials (AASHTO):
  - a. M288, Standard Specification for Geotextile Specification for Highway Application.
2. ASTM International (ASTM):
  - a. D1987, Biological Clogging of Geotextile or Soil/Geotextile Filters.
  - b. D3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
  - c. D4354, Sampling of Geosynthetics for Testing.
  - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
  - e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  - f. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
  - g. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  - h. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
  - i. D4884, Strength of Sewn or Thermally Bonded Seams of Geotextiles.
  - j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
  - k. D6193, Standard Practice for Stitches and Seams.

1. D7238, Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Apparatus.

**B. Qualifications:**

1. Each manufacturing, fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 10,000,000 square feet of geotextile installation in the past 3 years.
2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 square feet of geotextile.
3. Installer shall attend pre-installation conference.

### **1.3 DEFINITIONS**

- A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.
- C. MARV: Minimum Average Roll Value

### **1.4 SUBMITTALS**

**A. Shop Drawings:**

1. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
2. Manufacturer and Installer quality control manuals.
3. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
  - a. Results shall include or bracket the rolls delivered for use in the Work.
4. Proposed details of anchoring and overlapping if different than included in Contract Documents.

**B. Miscellaneous Submittals:**

1. For needle punched geotextiles, the Manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
2. Qualification documentation specified in Part 1.2.B

### **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.
- B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
  1. Do not remove the plastic wrapping until deployment.
- C. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

- D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.
- E. Do not expose geotextile to temperatures in excess of 71 Deg C (160 Deg F) or less than 0 Deg C (32 Deg F) unless recommended by the manufacturer.
- F. Do not use hooks, tongs or other sharp instruments for handling geotextile.
  - 1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
  - 2. Do not drag geotextile along the ground.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
  - 1. GSE Lining Technology.
  - 2. Mirafi (TenCate Geosynthetics).
  - 3. Propex.
  - 4. SKAPS Industries.
  - 5. Tenax Corp.
  - 6. Or approved equal.

### **2.2 MATERIALS AND MANUFACTURE**

- A. Geotextile:
  - 1. Non-woven and woven pervious sheet of polymeric material.
  - 2. Geotextile fibers:
    - a. Long-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.
    - b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
    - c. Do not add reclaimed or recycled fibers or polymer to the formulation.
  - 3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
  - 4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
    - a. Values shown are for the weaker principal direction unless both values are shown.
    - b. Acceptance of geotextile shall be in accordance with ASTM D4759.
  - 5. Non-woven Drainage Geotextile: Used as a cushion layer under and over HDPE geomembrane barrier layer as shown on Drawings.

TABLE 1 – NON-WOVEN GEOTEXTILE

PROPERTY <sup>(1)</sup>	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Mass per Unit Area, (oz/sy)	ASTM D5261	16	1 per 50,000 ft <sup>2</sup>
Grab Tensile Strength (lbs)	ASTM D4632	370	1 per 50,000 ft <sup>2</sup>
Grab Tensile Elongation (%)	ASTM D4632	50	1 per 50,000 ft <sup>2</sup>
Trapexoidal Tear Strength (lbs)	ASTM D4533	145	1 per 50,000 ft <sup>2</sup>
Puncture Strength (lbs)	ASTM D4833	170	1 per 50,000 ft <sup>2</sup>
UV Resistance <sup>(2)</sup>	ASTM D7238	70	1 per formulation

Notes: (1) All values are MARV except UV resistance which is a minimum value.

(2) Evaluation to be on 2.0 inch strip tensile specimens after 500 light hours exposure.

6. Woven Geotextile: Used as a reinforcement layer beneath the stabilization stone as shown on Drawings.

TABLE 2 – WOVEN GEOTEXTILE

PROPERTY <sup>(1)</sup>	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Tensile Strength, Ultimate (lbs/ft)	ASTM D4595	2700	1 per 50,000 ft <sup>2</sup>
Tensile Strength, 2% Strain (lbs/ft)	ASTM D4595	540	1 per 50,000 ft <sup>2</sup>
Factory Seam Strength (lbs/ft)	ASTM D4884	1688	1 per 50,000 ft <sup>2</sup>
Flow Rate (gal/min/ft)	ASTM D4491	40	1 per 50,000 ft <sup>2</sup>
Permeability (cm/sec)	ASTM D4491	.05	1 per 50,000 ft <sup>2</sup>
Permittivity (sec <sup>-1</sup> )	ASTM D4491	0.52	1 per 50,000 ft <sup>2</sup>
AOS (US sieve)	ASTM D4751	30	1 per 50,000 ft <sup>2</sup>
UV Resistance (% at 500 hrs)	ASTM D4355	80	1 per formulation

B. Thread:

1. High-strength polyester, nylon, or other approved thread type.
2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
3. Contrasting color with the geotextile.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

### 3.2 INSTALLATION

- A. Install geotextiles in accordance with manufacturer's written recommendations except as follows.
- B. Handling shall be in accordance with ASTM D4873.
  1. No equipment will be permitted to traffic in direct contact with the geotextile.

- C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.
- D. Seam Construction:
  - 1. Sew all geotextile seams except for geotextile used to wrap drainage stone or used for erosion control purposes. Adjacent panels may be overlapped without sewing as long as the seams do not come apart when material is placed over them.
  - 2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
  - 3. Sew seams continuously using an SSA flat seam with 1 row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
  - 4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 inches unless otherwise recommended by the manufacturer.
  - 5. Tie off thread at the end of each seam to prevent unraveling.
  - 6. Construct seams on the top side of the geotextile to allow inspection.
  - 7. Sew skipped stitches or discontinuities with an extra line of stitching with 18 inches of overlap.
  - 8. Overlap adjacent panels a minimum of 6 inches.
- E. Protect geotextiles from clogging, tears, and other damage during installation.
- F. Geotextile Repair:
  - 1. Place a patch of the same type of geotextile which extends a minimum of 24 inches beyond the edge of the damage or defect.
  - 2. Fasten patches continuously using a sewn seam or other approved method.
  - 3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
  - 4. Replace geotextile which cannot be repaired.
- G. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.
- H. Do not use staples or pins to hold the geotextile in place.
- I. Geotextile left uncovered for more than 14 days shall be removed and replaced at the Contractor's expense.
- J. Damaged rolls may be rejected. If rejected, verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls that do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.
- K. The CQA Inspector shall observe that the equipment used to install the geotextile does not damage it during deployment.
- L. Crews working on the geotextile shall not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.

### **3.3 FIELD QUALITY CONTROL**

- A. The CQA Consultant shall confirm that the identification, storage, and handling of geotextiles are in accordance with ASTM D4873. Any deviation from this requirement will be reported to the Engineer.
- B. The CQA Consultant will examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed these specifications. Any deviations will be reported to the Engineer.
- C. The CQA Consultant will observe placement of the geotextiles to confirm that the panel overlaps and seams are in accordance with these specifications. Any deviations will be reported to the Engineer.

**END OF SECTION**



## **SECTION 02780**

### **GEOSYNTHETIC RAIN COVER**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Furnish all labor, materials, tools, and equipment, and perform all work and services necessary for or incidental to the furnishing and installation, complete, of an impermeable, geosynthetic rain cover as shown on Drawings and specified in accordance with provisions of the Contract Documents.
- B. Related Sections include but are not necessarily limited to:
  - 1. Section 02200 – Earthwork: Landfills.

##### **1.2 QUALITY ASSURANCE**

- A. Refer to the following standard references or specifications as applicable to this section of technical specifications:
  - 1. American Society for Testing and Materials (ASTM).
    - a. ASTM D751 - Standard Test Method for Coated Fabrics.

##### **1.3 SUBMITTALS**

- A. The Contractor must provide installation instructions.
- B. The Contractor must certify that the rain cover resin is first use; top grade quality only.

#### **PART 2 - PRODUCTS**

##### **2.1 MATERIALS**

- A. 12-mil Polyethylene Rain Cover
  - 1. The 12-mil polyethylene rain cover shall be made of high density polyethylene taps, coated on two sides with low density polyethylene. The coatings shall contain UV stabilizers.
  - 2. Contractor must supply (in the Bid price) a high strength adhesive tape or equal for waterproofing and sealing the field seams and for performing repair work to the rain cover. Contractor shall minimize field seams.
  - 3. The rain cover must meet the following specifications or approved equal, as determined by the Engineer.

<u>PROPERTY</u>	<u>TEST METHOD</u>	<u>TEST VALUE</u>
a. Thickness, nominal	ASTM D5199	12 mil
b. Weight	ASTM D3776	6 oz/yd <sup>2</sup>
c. Mullen Burst Strength	ASTM D751	321 psi
d. Grab Tensile Strength	ASTM D751	208 lbf
e. Hydrostatic Resistance	ASTM D751	100.1 psi
f. Perm Rating	ASTM D4491	<1.8 U.S.Perms

**B. General Requirements**

1. The rain cover must perform as specified for at least 1 year and a manufacturer's warranty must be supplied for at least 1 year.
2. The material must be able to be moved by site personnel as needed. The material must be resilient to damage when moved and/or relocated by site personnel. If necessary, the material may be cut for removal/relocation; however, in this case, must be able to be easily resealed by site personnel.
3. Factory seams must utilize methods that will eliminate excess overlap.
4. The rain cover must be impermeable, capable of repelling water with no absorption.
5. The material must be anchored, when installed, through a system so as to preclude wind damage, traffic damage, and weather.

## **PART 3 - EXECUTION**

### **3.1 METHODS**

- A. The Contractor shall deploy the rain cover in a manner consistent with the manufacturer's specifications.
- B. Anchoring methods shall be as per the manufacturer's specifications or as approved otherwise by the Engineer.
- C. Any damage to the rain cover during installation will be the Contractor's responsibility to repair/replace at no cost to the Owner.
- D. Sand bags shall be placed and tied together for ballast and preventing wind uplift. The sand bags shall be placed at a minimum of 10-foot centers. Contractor shall install additional sand bags as required to prevent uplift and damage to the rain cover.
- E. Field seams shall be of the strongest available method for the approved material except as required for patches or similar limited area applications.

### **END OF SECTION**

**SECTION 15060**  
**PIPE AND PIPE FITTINGS: BASIC REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Scope of Work: The Contractor shall supply all materials, equipment, and labor needed to install complete and make ready for use all pipe and pipe fittings as specified herein and as indicated on the Contract Drawings.
- B. Related Sections include but are not necessarily limited to:
  - 1. Division 1, General Requirements.
  - 2. Section 02130, Vertical Extraction Wells.
  - 3. Section 02221, Trenching, Backfilling, and Compacting for LFG piping.
  - 4. Section 15067, Pipe: High Density Polyethylene.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
- B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Use of the most recent version is required.
  - 1. American National Standards Institute (ANSI):
    - a. B16.5, Pipe Flanges and Flanged Fittings.
    - b. B31.8, Code for Pressure Piping, Appendix N.
  - 2. ASTM International (ASTM):
    - a. D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials.
    - b. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
    - c. D2513, Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
    - d. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter- Controlled Polyethylene Pipe and Tubing.
    - e. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
    - f. D3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
    - g. D4101, Standard Specification for Propylene Plastic Injection and Extrusion Materials.
  - 3. Plastics Piping Institute (PPI):
    - a. PPI TR-31/9-79, Technical Report.
- C. Coordinate flange dimensions and drillings between piping, valves, and equipment.

### **1.3 DEFINITIONS**

- A. SDR – Standard Dimension Ratio.
- B. ESCR – Environmental Stress Crack Resistance.
- C. HDPE – High Density Polyethylene Pipe.
- D. LFG – Landfill gas.

### **1.4 SUBMITTALS**

- A. The Contractor shall prepare and submit to the Engineer, for review and approval prior to commencement of construction, certificates of compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, inspection, maintenance and repair of each type of pipe, and pipe fitting furnished.
- B. Provide manufacturing test specification data listing resin type, cell classification, stock density, melt flow, flexural modulus, tensile strength, and coloration as appropriate for each type of pipe specified. Include results of tests with shipment of materials, with two (2) additional copies of test results furnished to Engineer.
- C. The Contractor shall prepare and submit Shop Drawings to the Engineer for review and approval. The Shop Drawings shall show the following:
  - 1. Fabrication and/or layout drawings:
    - a. Piping drawings (minimum scale 1 inch equals 10 feet) with information including:
      - 1) Pipe dimensions, schedule, fittings, and supports.
      - 2) Invert or centerline elevations of piping crossings.
      - 3) Acknowledgement of bury depth and location requirements.
      - 4) Details of fittings, tapping locations, and related appurtenances.
      - 5) Line slopes.
    - b. Schedule of interconnections to existing piping and method of connection.
  - 2. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
    - c. Separate schedule sheet for each piping system scheduled in this Section showing compliance of all system components. Attach technical product data on gaskets, pipe, fittings, and other components.
- D. Test Report:
  - 1. Copies of pressure test results on all landfill gas piping systems and corrective actions taken if test failed.
  - 2. Notification of time and date of piping pressure tests.

E. As-Built Drawings:

1. As work progresses and again when work is complete, submit "As-Recorded" drawings of piping systems including project items and pre-existing items. Identify complete location, elevation, and description of piping systems. Relate piping systems to identified structures and appurtenances.

F. Operation and Maintenance Manuals.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect pipe coating during handling using methods recommended by manufacturer. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.
- B. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.
- C. Protect materials from direct exposure to rain or sunlight until installation.
- D. Pipe Storage:
1. Store or stack pipe to prevent damage from marring, crushing or puncture. Limit maximum stacking height to 6 feet or manufacturer's maximum recommended height, whichever is less.
  2. Store in accordance with manufacturer's recommendations.
- E. Pipe handling:
1. Protect pipe from excessive heat or harmful chemicals.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers of PE pipe are acceptable for landfill gas applications:
1. Driscoplex.
  2. CSR/Polypipe.
  3. ISCO.
  4. Lee Supply.
  5. Ferguson Industrial Plastics.
  6. Plexco.

### **2.2 HIGH DENSITY POLYETHYLENE (HDPE/PE 3408/3608) PIPING AND FITTINGS**

- A. General:
1. All HDPE pipe used must be in conformance with the documentation set forth in the Contract Drawings. The SDR of each specific pipe can be found on the Contract Drawings.

2. Pipe shall be extruded from a Type III, Class C, Category 5, Grade P34 compound as described in ASTM D 1248. It shall be classified as cell 345464C according to ASTM D 3350 and have the material designation of PE 3408/3608. The pipe shall be manufactured to meet the requirements of ASTM D 2513. Manufacturer's literature shall be adhered to when "manufacturer's recommendations" are specified. All pipe and fittings shall be provided by one of the manufacturers specified in Part 2.1 of this specification.

**B. HDPE Fittings:**

1. Fittings shall be manufactured from polyethylene compound having cell classification equal to or exceeding the compound used in the pipe.
2. All fittings 12 inches and smaller shall be molded (excluding gas header pipe), unless approved by the Engineer. Extrusion welds on fittings will not be allowed, except for addition of gussets. The ends of the fabricated fittings shall not be trimmed to match the pipe section to which they are going to be joined. All polyethylene fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. All landfill gas tie-ins to the header may be shop fabricated branch saddle fittings. Field fabricated branch saddle fittings will not be accepted.
3. Flanges for HDPE Pipe:
  - a. Flanges for HDPE pipe shall be convoluted ductile iron back-up rings with a minimum thickness of 1-inch.
  - b. The studs, nuts and washers for the flanges shall be 316 stainless steel hardware. Below grade flanges shall be wrapped in 5-mil polyethylene sheeting just after installation and prior to backfilling to help prevent corrosion.
  - c. Flange gaskets shall be full-face Neoprene, or approved equal.
  - d. Flanges and bolt patterns consistent with ANSI B16.5/AWWA C207/ASTM A536, as recommended by manufacturer.
4. Reducers:
  - a. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections. Connection size requirements may change from those shown on the Contract Drawings depending on equipment furnished.

**C. All pipe and fittings must be supplied by the same manufacturer.**

**D. Identify each length of pipe clearly at intervals of 5 feet or less with the following markings:**

1. Manufacturer's name and trademark.
2. Nominal size of pipe,
3. Type of plastic (e.g. PE 3408/3608)
4. Standard dimension ratio (SDR) value
5. ASTM designations (i.e., ASTM D 2513)

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Pipe may be rejected for failure to conform to Specifications, or for:
  - 1. Fractures or cracks passing through pipe wall, except single crack not exceeding two (2) inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment will be rejected if defects exist in more than 5% of shipment or delivery.
  - 2. Cracks sufficient to impair strength, durability, or serviceability of pipe.
  - 3. Defects indicating improper proportioning, mixing, and molding.
  - 4. Damaged ends, where such damage would prevent making satisfactory joints.
- B. Acceptance of fittings, stubs, or other specifically fabricated pipe sections shall be based on visual observation by the Owner or Engineer at the Project site and documentation that they conform to these Specifications.

### **3.2 HDPE PIPE INSTALLATION**

- A. Perform trenching, backfilling, and compaction in accordance with Section 02221.
- B. Install pipe as indicated on the Contract Drawings. Pipe installation shall comply with the requirements of ASTM D 2321, PPI TR31/9-79, and the manufacturer's recommendations.
- C. Remove standing water in trench before installation.
- D. Lengths of fused pipe to be handled as one segment shall not exceed 400 feet.
- E. The Owner and Engineer shall be notified prior to any pipe being installed in the trench in order to have an opportunity to inspect the following items:
  - 1. All butt and saddle fusions.
  - 2. Pipe integrity.
  - 3. Trench excavation and bedding material for rocks and foreign material.
  - 4. Proper trench slope.
  - 5. Trench contour to ensure the pipe will have uniform and continuous support.
  - 6. Proposed backfill and filter pack (chip tires) for horizontal collector wells.
- F. Any irregularities found by the Engineer during this inspection must be corrected before lowering the pipe into the trench. Pipe shall be allowed sufficient time to adjust to trench temperature prior to any testing, segment tie-ins, and/or backfilling.
- G. Pipes and fittings shall be carefully lowered into trench to limit stress to pipes, fittings, and joints.
- H. Pipe and fittings shall be installed so that there will be no deviation at the joints and so that inverts present a smooth surface. Pipe and fittings that do not fit together to form a tight fitting joint are not permitted.

- I. Tie-ins shall be made out of the trench whenever possible. When tie-ins are to be made only in the trench, a bell hole shall be excavated large enough to ensure an adequate and safe work area.
- J. The Contractor shall ensure that kinking or excessive bend diameters of the pipe do not occur during the installation process.
- K. The Contractor shall insure that the pipe installed in the trench is firmly supported. The Contractor shall follow the minimum length and type of backfill specified in the Contract Drawings.
- L. Cap pipe sections longer than single joint (usually 40 feet) on both ends during placement, except during fusing operations.
- M. The Contractor shall cap all open pipe ends at the end of the work day.
- N. HDPE pipe and fittings shall be by the same manufacturer. The minimum strength of the fittings shall not be less than that of the pipe.
- O. Changes in direction of HDPE Pipe:
  - 1. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
- P. The Contractor shall remove cuttings. Shavings shall not be left on the ground.
- Q. HDPE shall not be field threaded and such threaded joints shall not be used in gas collection systems.
- R. Except as indicated on the Contract Drawings, landfill gas pipe fittings shall be butt fusion type, meeting the requirements of ASTM D-3261 and this specification. All fittings shall be pressure rated to match the system piping to which they are fused. The side slope riser fittings shall be factory fabricated and shall have a smooth interior surface.
- S. All perforated pipes shall be perforated by the Manufacturer as shown on the Contract Drawings.
- T. Workmanship: Exterior and interior surfaces shall be smooth with no sharp projections. The surfaces shall be free of foreign inclusions and major surface defects. Polyethylene pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties. The product function shall be considered when judging external defects.
- U. All installed HDPE pipe shall be marked in 25-foot intervals corresponding to the stationing required for slope confirmation and conformance surveying. Each joint shall be marked at header and lateral joints. For main pipeline, station numbering shall be continuous and sequential. Station numbering shall be referenced in daily logs to document pipe installation progress. Survey data shall be submitted in the state plane coordinate system. Top of pipe and cover soil elevation shall be included for all points unless piping is designed to be above grade.



### **3.3 HEAT FUSION OF HDPE PIPING:**

- A. HDPE pipe shall be joined by butt-fusion methods, having a uniform and monolithic pipe interior according to the fusion joining procedures as instructed by the manufacturer, except within the structures, as shown in the Construction Drawings.
- B. Each individual performing fusion joining shall have at least one (1) year of experience in the use of the fusion procedure.
- C. Join pipe sections at ground level to a maximum length of 400 feet, or a length recommended by the manufacturer such that maximum allowable stress, when pulling the pipe into position alongside the trench, is not exceeded. Use appropriate materials and equipment, as recommended by the HDPE pipe manufacturer, when pulling butt-fused pipe sections alongside the trench to prevent pipe damage.
- D. During installations when temperature exceeds 90 Deg F, it may be necessary to provide a slightly longer length of HDPE pipe when connections are to be made between two fixed points or structures to compensate for contraction of the pipe in a cooler trench bottom. The additional pipe length requirements shall be in accordance with the HDPE pipe manufacturer's instructions.
- E. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.
- F. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
- G. Do not subject pipe to strains that will overstress or buckle pipe or impose excessive stress on joints.
- H. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment will be of the size to facilitate saddle fusion within the trench.
- I. Before butt fusing pipe, each length shall be observed for presence of dirt, sand, mud, shavings, and other debris or animals. Remove all materials from the inside of the pipe.
- J. At end of each working day, cover open ends of fused pipe. Cap to prevent entry by animals or debris.
- K. Use compatible fusion techniques when polyethylene pipes of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.

### **3.4 FLANGED CONNECTIONS**

- A. For flanged connections in virgin soil, the Contractor shall wrap and tape the flanges and bolts in 5 mil polyethylene sheeting prior to backfilling to help protect the assembly from corrosion.

- B. Flanges shall be joined with 316 stainless steel studs and nuts. Stud lengths shall accommodate the required distance between flanges including spacers, if necessary.
- C. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint. Provide tightening torque in accordance with manufacturer's recommendations. CAUTION: Do not over-torque bolts.
- D. For flanged connections within the limits of refuse, all below grade back-up rings, studs, nuts and washers shall be thoroughly coated with a rubberized emulsion undercoating spray, or approved substitute.
- E. The Contractor shall wrap and tape the flanges and bolts in 5 mil polyethylene sheeting prior to backfilling.

### **3.5 CONNECTIONS WITH EXISTING PIPING**

- A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.
- B. When Contractor is ready to connect to existing piping, Engineer will notify Owner to shut down the flare station before proceeding to connect to existing gas system.
- C. Undertake connections in a fashion which will disturb existing gas system as little as possible.
- D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to existing gas system.
- E. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

### **3.6 SEGMENT TESTING**

- A. The HDPE header, air supply, condensate/dewatering lines, and solid sections of the horizontal collector wells shall be subjected to pneumatic pressure tests as described herein to detect any leaks in the piping. Testing shall only be performed below grade (inside the trench). The Contractor shall accept the responsibility for locating, uncovering (if previously backfilled), and repairing any leaks detected during testing.
- B. Polyethylene piping shall be butt welded together into testing segments. Segments shall be connected to a testing apparatus on one end and fitted with fusion-welded caps on all openings.
- C. The segment to be tested shall be allowed time to reach constant and/or ambient temperature before initiating the test.
- D. The test must be performed during a period when the pipe segment will be out of direct sunlight; i.e., early morning, late evening, or cloudy days. This will minimize the pressure changes which will occur during temperature fluctuations.

- E. The pneumatic test pressure for LFG header pipe and laterals shall be 10 psig with a maximum of 5% loss. Failing pipe sections will be inspected for any visible leaks and re-tested. Engineer will determine protocol for any additional failures.
- F. Pressure drop during the test shall not exceed five percent of the testing gauge pressure over a period of one hour. The pressure drop shall be corrected for temperature changes before determining pass or failure. (See Part 3.7 for test failures).
- G. The Engineer shall be notified 24 hours prior to commencement of the testing procedure and shall be present during the test.
- H. All equipment for this testing procedure, including an adequately sized air compressor, fittings, caps/pipe plugs, etc. shall be furnished by the Contractor. Other necessary equipment includes a pressure gauge with a scale that spans the test pressure range with increments equal to 0.1 percent of the test pressure, an appropriate valve to facilitate an air compressor hose, and a ball valve to release pipe pressure at completion of test. Pipe reducers shall be utilized to adapt test flange to size of pipe being tested.

### **3.7 TEST FAILURE**

- A. The following steps shall be performed when a pipe segment fails the five percent/one hour test described in Part 3.6. F.
  - 1. The pipe and all fusions shall be inspected for cracks, pinholes, or perforations.
  - 2. All blocked risers and capped ends shall be inspected for leaks.
  - 3. Leaks shall be located and/or verified by applying a soapy water solution and observing soap bubble formation.
- B. All pipe and fused joint leaks shall be repaired by cutting out the leaking area and re-fusing the pipe.
- C. After all leaks are repaired, a retest shall be performed in accordance with Part 3.6.

### **3.8 TEST REPORTING**

- 1. Each test (pass or failure) shall be reported in writing on a form approved by the Engineer.
  - a. Test report to include, date, size of pipe, length, description, and stationing.
- 2. If failure occurs, Contractor shall note the following:
  - a. Location of failure segment.
  - b. Nature of leaks.
  - c. Repairs performed.
  - d. Results of test.

## **END OF SECTION**

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**SECTION 15067**  
**PIPE - HIGH DENSITY POLYETHYLENE (HDPE)**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. High density polyethylene (HDPE) pipe, fittings, and appurtenances.
- B. Related Sections include but are not necessarily limited to:
  - 1. Hillsborough County Government Bidding Requirements and Contract Documents.
  - 2. Section 15060, Pipe and Pipe Fittings: Basic Requirements.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ASTM International (ASTM):
    - a. Polyethylene (PE) materials:
      - 1) D638, Standard Test Method for Tensile Properties of Plastics.
      - 2) D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
      - 3) D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
      - 4) D2104, (PE) Plastic Pipe, Schedule 40.
      - 5) D2239, (PE) Plastic Pipe (SDR-PR).
      - 6) D2240, Standard Test Method for Rubber Property Durometer Hardness.
      - 7) D2447, (PE) Plastic Pipe, Schedule 40 and 80 Based on Outside Diameter.
      - 8) D2513, Standard Specification for Thermoplastic Gas Pressure Pipe.
      - 9) D2609, Plastic Inserts Fittings for (PE) Plastic Pipe.
      - 10) D2657 Heat Joining Polyolefin Pipe and Fittings.
      - 11) D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
      - 12) D2837 Obtaining Hydrostatic Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
      - 13) D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
      - 14) D3350 (PE) Plastic Pipe and Fittings Materials
      - 15) F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
      - 16) F1290, Standard Practice for Electrofusion joining PE and Fittings.
      - 17) F2620, Standard Practice for Heat Fusion of PE pipe and Fittings.

- b. Installation:
  - 1) D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
  - 2) D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
- 2. American Water Works Association (AWWA):
  - a. Polyethylene (PE) materials:
    - 1) C901, Polyethylene (PE) Pressure Pipe Tubing and Fittings, 1/2 through 3 IN for Water.
    - 2) C906, Polyethylene (PE) Pressure Pipe and Fittings 4 IN through 63 IN for Water Distribution and Transmission.

### **1.3 SUBMITTALS**

- A. See Section 15060.
- B. Pipe schedule identifying:
  - 1. Style, type, size.
  - 2. Quantity.
  - 3. Location to be used.
- C. Perforation pattern(s).
- D. Schedule of fittings.
- E. Pipe data.
- F. Installer certification.
- G. Field quality control documents.

### **1.4 DEFINITIONS**

- A. SDR – Standard Dimension Ratio.
- B. IPS – Iron Pipe Size.
- C. CTS – Copper Tube Size.
- D. DIPS – Ductile Iron Pipe Size.
- E. ESCR – Environmental Stress Crack Resistance.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers of PE pipe are acceptable:
  - 1. See Section 15060.

## 2.2 HIGH DENSITY POLYTHELYENE (HDPE) PIPING

### A. General:

1. Provide PE 3408/3608 piping with fittings and appurtenances to locations shown on the Contract Drawings.
2. Furnish materials in accordance with ASTM D2513 and full compliance to the following material specifications:
  - a. Material description: ASTM D1248, Type III, Class C, Category 5, Grade P34.
  - b. Cell classification: ASTM D3350, PE 345464C.
  - c. ESCR: ASTM D1693, condition C,  $F_o > 5,000$  HRS.
  - d. ESCR: ASTM D1693, condition A, B, C,  $F_o > 5,000$  HRS.
3. Modulus of elasticity: ASTM D638, 130,000 psi.
4. Hardness: ASTM D2240, 65 Shore D.
5. SDR: 9.0, 11.0, and 17.0 as specified in the Contract Drawings.
6. IPS for line size greater than 1 inch.
7. Pipe shall meet the following pressure ratings:

SDR	PRESSURE RATING (psi)
17	100
11	160
9	200

### B. Fittings:

1. ASTM D2513.
2. SDR: 9.0, 11.0, and 17.0
3. 1/2 to 3 IN: ASTM D2683.
4. 4 to 10 IN: ASTM D3261.
5. End connections:
  - a. Socket fused ends for fittings 1 inch and under.
  - b. Butt-fused ends for fitting 1-1/2 inch and greater.
6. Use IPS reducers on the service mains.
7. Use tapping tees or straight outlet service saddles to join service lines to the main.
8. Mitered or field fabricated fittings are not allowed.

### C. Installation: Install pipe and fittings in accordance with ASTM 2513 and as recommended by the manufacturer.

1. Provide for a maximum deflection of not more than 5 percent.
2. HDPE pipe shall not be field threaded and such threaded joints shall not be used in gas collection systems.

### D. Deflection:

1. See Section 15060.

## **2.3 PIPE MARKING**

- A. During extrusion production, the HDPE pipe shall be continuously marked in accordance with AWWA 906 with durable printing including the following information:
1. Nominal size.
  2. Dimension ratio.
  3. Pressure class.
  4. Manufacturer name or trademark and product series.
  5. Standard material code designation (ex: PE 3408).
  6. Plant identification.
  7. Production date.

## **2.4 PRESSURE PIPING (UNDERGROUND)**

1. Materials: Furnish materials in full compliance with following requirements:
  - a. Materials and workmanship in accordance with ASTM F714.
  - b. Pipe type and size as shown on the Contract Drawings.
  - c. Joints for polyethylene pipe shall be fusion type in accordance with AWWA C901.
  - d. Installation: Perform installation procedures, handling, connections, and other appurtenant operations in full compliance with the manufacturer's printed recommendations and in full observance of plan details when more stringent.
2. Uniformity: Ensure that all piping and fittings are integrated into components of the finished system. Utilize products of a single manufacturer.

## **2.5 PERFORATED PIPE**

- A. HDPE pipe requiring perforations shall conform to specified pattern size and spacing shown on the Contract Drawings. The Contractor may not alter hole patterns or spacing shown on the Contract Drawings.
- B. Perforations are not authorized to be performed in the field.

# **PART 3 - EXECUTION**

## **3.1 IDENTIFICATION**

- A. Identify each length of pipe clearly at intervals of 5 feet or less. Include manufacturer's name and trademark.
1. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications, and "NSF" approvals when applicable.

## **3.2 INSTALLATION**

- A. See Section 15060.



B. General:

1. Install buried pipe as indicated on the Contract Drawings.
2. The Contractor shall insure that kinking or excessive bend diameters of the pipe do not occur during the installation process.
3. The Contractor shall insure that the pipe installed in the trench is firmly supported.
4. The Contractor shall cap all open pipe ends at the end of the work day.
5. Contractor shall remove any cave-in portions of the trench prior to placing sand bagging around the pipe.
6. HDPE pipe and fittings shall be by the same manufacturer.
  - a. The minimum strength of the fittings shall not be less than that of the pipe.
7. Service taps shall be installed as shown on the Contract Drawings.
8. Changes in direction of PE Pipe:
  - a. Pipe may be cold-bent to minimum radius of 20 times the pipe diameter as it is installed.
  - b. If fittings or fusions are present in the bend, the minimum recommended cold bending radius is 125 times the outside diameter of the pipe.
9. Remove cutting and threading burrs.

C. Joining Procedures:

1. HDPE pipe joints shall be fused on the surface prior to installation into the trench.
  - a. Alternative methods of fusing shall be approved by the Engineer.
  - b. PE pipe 1 inch and under shall be socket fused.
  - c. PE pipe joints 1-1/2 inch and over shall be butt fused.
2. Fusion joiner must be qualified by type of fusion (i.e., butt fusion, socket fusion or sidewall fusion) and fuse pipe only as qualified.
3. Each joint must be visually inspected inside and outside for damage, dirt, moisture, or any other abnormalities prior to fusing.
4. All joint fusion shall be performed in strict accordance with the manufacturer's specifications.
5. All fusion equipment must be approved by the manufacturer and operated by qualified and certified operators.
  - a. Cost for testing and certifying personnel shall be borne by the Contractor.

**END OF SECTION**

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**SECTION 15075**  
**PIPE: POLYVINYL CHLORIDE (PVC)**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Polyvinyl chloride (PVC) pipe, fittings and appurtenances.
- B. Related Sections include but are not necessarily limited to:
  - 1. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ASTM International (ASTM):
    - a. D1784, Rigid Vinyl Compounds.
    - b. D1785, PVC Plastic Pipe, Schedule 80.
    - c. D2467, PVC Plastic Fittings, Schedule 80.
    - d. D2564, Solvent-Cements for PVC Pipe and Fittings.
    - e. F1668, Standard Guide for Construction Procedures for Buried Plastic Pipe.

**1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. See Section 15060.
  - 2. Fabrication and/or layout drawings:
    - a. Submit complete layout drawings showing type of fittings, and connections to be used at each location.
    - b. Submit detail of jointing methods and step-by-step procedures to be used on this Project.
  - 3. Pipe schedule identifying:
    - a. Style, type, size.
    - b. Quantity.
    - c. Location to be used.
    - d. Slot pattern(s)
    - e. Schedule of fittings.
    - f. Pipe data.
    - g. Installer certification.
    - h. Field quality control documents.
  - 4. Product technical data including:
    - a. Acknowledgement that products submitted meet requirements of standards referenced.
    - b. Manufacturer's installation instructions.
    - c. Submit certificate secured from the manufacturer acknowledging compliance to Contract Documents.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
- a. See Section 02130.

### **2.2 POLYVINYL CHLORIDE (PVC) PIPING**

- A. General:
1. Provide PVC piping with fittings and appurtenances to location shown on the Contract Drawings.
  2. Furnish materials in accordance with ASTM D1785 and full compliance to the following material specifications:
    - a. Material description: Type I, Grade I.
    - b. Cell classification: ASTM D1784, PVC 12454.
  3. SCH: 80 as specified in the Contract Drawings.
  4. IPS for line size greater than 1 inch.
  5. SCH 80 PVC pipe shall meet the following pressure ratings:

SCH	PRESSURE RATING (psi)
80	280

- B. Fittings:
1. ASTM D2467
- C. Installation: Install pipe and fittings in accordance with ASTM F1688 and as recommended by the manufacturer.
- a. PVC pipe shall not be field threaded and such threaded joints shall not be used in gas collection systems.

### **2.3 PIPE MARKING**

- A. During extrusion production, the PVC pipe shall be continuously marked in accordance with ASTM D1785 with durable printing including the following information:
1. Nominal size.
  2. Schedule
  3. Pressure class.
  4. Manufacturer name or trademark and product series.
  5. Plant identification.
  6. Production date.

## **2.4 SLOTTED PIPE**

- A. SCH 80 PVC pipe requiring slots shall conform to specified pattern size and spacing shown on the Contract Drawings. The Contractor may not alter slot pattern or spacing shown on the Contract Drawings.
- B. Slots are not authorized to be performed in the field.

## **PART 3 - EXECUTION**

### **3.1 IDENTIFICATION**

- A. Identify each length of pipe clearly at intervals of 5 FT or less. Include manufacturer's name and trademark.
  - 1. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications, and "NSF" approvals when applicable.

### **3.2 INSTALLATION**

- A. See Section 02130.
- B. General:
  - 1. Install buried pipe as indicated on the Contract Drawings.
  - 2. Contractor shall insure that kinking or excessive bend diameters of the pipe do not occur during the installation process.
  - 3. Contractor shall insure that the pipe installed in the boring is firmly supported.
  - 4. Contractor shall cap all open pipe ends at the end of the work day.
  - 5. Contractor shall remove any cave-in portions of the boring prior to placing pipe.
  - 6. PVC pipe and fittings shall be by the same manufacturer.
    - a. The minimum strength of the fittings shall not be less than that of the pipe.
- C. Joining Procedures:
  - 1. PVC pipe joints shall be connected on the surface prior to installation into the borehole.
  - 2. Connect PVC sections with solvent cement and secure with lag screws.

## **END OF SECTION**

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