### **SECTION 02776**

#### LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE

### PART 1 – GENERAL

#### 1.01 **DESCRIPTION**

- A. Scope of Work: The work shall include furnishing and installing all materials, manufacturer's quality control and quality assurance, installer's quality control, warranties, transportation and storage, supervision, geomembrane accessories and installation equipment necessary for the installation of a geomembrane landfill cap, as herein specified. The supply and installation of these materials shall be in strict accordance with the Engineer's and be subject to the terms and conditions therein.
- B. The installation of the geomembrane shall be preformed in conjunction with other work, including but not limited to, placement of geocomposite drainage net and cover soils.
- C. Applicable Standards: All geomembrane material supplied as part of this Work shall be tasked as described in GRI-GM17 and GRI-GM19, and in the applicable American Standards and Test Methods (ASTM).

#### **1.02 DEFINITIONS AND RESPONSIBILITY**

- A. Geomembrane shall be strictly defined to be linear low density polyethylene (LLDPE) in this specification section.
- B. Manufacturer Qualifications:
  - 1. Qualified Manufacturer shall be a company, corporation, or firm regularly engaged in the development and manufacture of geomembrane liners with a history of successful production of geomembrane for a minimum period of five (5) years. The geomembrane rolls shall be manufactured by a single Manufacturer. The Manufacturer shall submit written information as follows:
    - a) Information on plant size (square feet of geomembrane produced daily), number of shifts, and capacity of each shift.
    - b) Daily production quantity shall be sufficient to meet the demands of the project schedule for this project.
    - c) Quality Control procedures (manual) for production. The manual shall define sampling procedures, test frequencies and methods. The Manufacturer shall, at a minimum, comply with the quality control specification for this project.
    - d) Statement from the Manufacturer stating the manufacturing quality control measures specified for this project will be followed and the manufactured geomembrane products will meet or exceed the product specifications for this project.
  - 2. The Manufacturer shall have successfully supplied geomembrane liner for a minimum of six (6) projects, during the last five (5) years, of similar size and scope totaling to a minimum of ten (10) million square feet of installed geomembrane. Projects shall be considered similar only if the Manufacturer had total manufacturing responsibility for geomembrane production and the installed geomembrane has successfully fulfilled its primary function for a minimum of two (2) years. The Manufacturer shall submit written information as follows;

- a) Name and location of project and date of installation.
- b) Contact name and phone number for each project.
- c) Geomembrane thickness and surface area geomembrane installed.
- C. Installer Qualifications:
  - 1. Qualified Installer shall be a company, Corporation, or firm regularly engaged in the deployment and installation of geomembrane liners with a successful history of a minimum of three (3) years. The geomembrane shall be installed by a single installer. The Installer shall submit written information as follows:
    - a) Copy of installer's letter of approval by the manufacturer and/or fabricator, or license.
    - b) Corporate background and information.
    - c) Information on equipment and personnel.
    - d) Average daily production anticipated. Daily installation quantity shall be sufficient to meet the demands of the project schedule for this project.
    - e) Quality Control procedures (manual) for field installation. The Installer shall, at a minimum, comply with the specifications for this project.

Quality Assurance/Quality Control Field Program: The QA/QC program shall provide for recording all inspection and testing of all work items to ensure conformance to applicable specifications and drawings with respect to materials, workmanship, construction, functional performance and identification. This program shall be subject to acceptance by the Engineer.

- 2. The Installer shall have successfully installed geomembrane products for at least six (6) projects, during the last five (5) years, of similar size and function totaling a minimum of ten (10) million square feet of installed geomembrane. Projects shall be considered similar only if the Installer had total installation responsibility for geomembrane installation and the installed geomembrane has successfully fulfilled its primary function for a minimum of two (2) years. The Installer shall submit written information as follows:
  - a) Name and purpose of facility, location of project, and date of installation.
  - b) Name of owner, project manager, designer, manufacturer, and name of contact at the facility who can discuss the project.
  - c) Name and qualifications of the supervisor(s) of the installer's crew(s).
  - d) Geomembrane thickness and surface area geomembrane installed.
  - e) Duration of installation.
- 3. Duration of the installation, the General Contractor shall be responsible for the timely submission of:
  - The installer's quality control documentation.
  - The installer's subgrade acceptance certificates for each area to be covered by the lining system, signed by the installer.
- 4. Resume of the qualifications of the "master seamer" to be assigned to this project. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 1,000,000 linear feet of liner seams using the same type of seaming apparatus to be used for this project. No seaming shall be carried out without the presence of the "master seamer."

## 1.03 SUBMITTALS

- A. SHOP DRAWINGS: The Contractor shall submit to the Engineer, for approval, information on the following;
  - 1. Twenty-one (21) contract days prior to the geomembrane installation;
    - a) Manufacturer's Qualifications
    - b) Installer's Qualifications
    - c) Special Guaranties
    - d) Geomembrane Resin Information & Quality Control Certificates
    - e) Geomembrane Manufacturer Material Information & Quality Control Certificates
    - f) Geomembrane Accessories
    - g) Resumes of Installation Personnel
    - h) Panel layout and details
    - i) Certificate from the geomembrane manufacturer that the installer is qualified to install their product
    - j) Certification that the geomembrane produced for this project is chemically compatible with leachate and landfill gas from a typical sanitary landfill.
  - 2. Contract Closeout Submittals:
    - a) Geomembrane installer's certification of subsurface acceptability (attached)
    - b) Geomembrane installer's Certificate of Proper Installation (attached)
    - c) Record Documents: Include panel and sheet numbers, seaming equipment and operator identification, temperature and speed setting of equipment, date seamed, identity and location of each repair, cap strip, penetration, boot and sample taken from installed geomembrane testing
    - d) Special guarantee(s).
- B. Detailed informational requirements for the shop drawing submittals are described within this specification section. The Contractor shall be required to submit and receive approval from the Engineer for all submittals described within this specification section.

### 1.04 WARRANTY

- A. The Contractor shall guarantee the materials of all products supplied, on a prorated basis, as part of this work for a minimum period of five (5) years following final acceptance of the geomembrane installation by the County.
- B. Warranty conditions, for the materials and workmanship, proposed by the Manufacturer/Fabricator concerning limits of liability shall be evaluated upon receipt by the County and must be acceptable to the County prior to installation of the geomembrane. Proposed Warranty conditions shall be submitted to the Engineer within twenty-one (21) contract days after award of contract for review and approval.

#### 1.05 RELATED WORK

Section 02220 - Excavation, Backfilling, and Compaction Section 02560 – Composite Drainage Net (CDN)

### PART 2 – PRODUCTS

#### 2.01 GEOMEMBRANE RESIN RAW MATERIALS

- A. The geomembrane shall be manufactured from virgin, first-quality polyethylene resin that shall meet the standard specification GRI GM17.
- B. At the Engineer's discretion, additional conformance sampling may be conducted. If the results of the Manufacturer and Engineer differ, the testing shall be repeated by the Engineer and the Manufacturer shall be allowed to monitor the testing. The latter of the tests will prevail, provided that the applicable test methods have been followed. The additional tests shall be at no cost to the County or Engineer if it is determined that the specifications have not been complied with.
- C. The Manufacturer shall submit written documentation on the geomembrane raw materials and resin batches;
  - 1. Resin supplier's name, plant location or identification, and production date(s) of resin.
  - 2. Copies of Quality Control Certificates, issued on company letterhead and shall be signed by responsible parties, employed by the manufacturer, supplier, or independent laboratory (such as the production manager), with test results conducted by the manufacturer or resin production plant.
  - 3. The manufacturer shall submit written documentation that no reclaimed or reworked polymer was added to the resin during the geomembrane manufacturing process to be used for this project.
  - 4. The manufacturer shall submit written documentation correlating each individual geomembrane roll delivered to the project to the respective resin batches.

### 2.02 GEOMEMBRANE MANUFACTURING

- A. The geomembrane for this project shall consist of a 40-mil LLDPE sheet and shall meet the standard specification GRI GM17, at a minimum. In addition, the geomembrane shall:
  - 1. Contain no more than one (1) percent, by weight, additives, fillers, or extenders. (Note Carbon Black not included in this limitation)
  - 2. Be free of striations, folds, crimps, roughness, pinholes, or bubbles on the surface.
  - 3. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign or contamination by foreign materials.
  - 4. Be manufactured in a single layer, i.e., thinner layers shall not be welded together to produce the final required thickness.
  - 5. Have any factory seams whose shear strengths during testing are in conformance with the seam strengths specified in method GRI GM19.
  - 6. Be subjected to continuous spark testing by the manufacturer at the factory with no defects found.
- B. Geomembrane Manufacturing Quality Control;
  - 1. The carbon black shall be added to the pure polyethylene resin as part of the roll manufacturing process.

- 2. Rolls manufactured with inclusions, bubbles, or not complying with the specifications shall be rejected and not delivered to the project. Geomembrane thickness shall be monitored continuously during manufacturing. No geomembrane shall be accepted which fails to meet minimum specified thickness.
- 3. Samples shall be taken across the entire width of the rolls and shall not include the first 3 feet. The averaged test results of the geomembrane samples shall meet or exceed the specifications. Certifications of the test results obtained shall be provided to the Engineer and recorded on the Quality Control Certificates.
- 4. The Manufacturer shall submit the Quality Control Certificates, on company letterhead, and shall be signed by responsible parties, employed by the manufacturer or independent laboratory (such as the production manager). The Quality Control Certificates shall include;
  - a) Geomembrane Roll Number and resin batch identification
  - b) Results of Quality Control tests, including description of test methods used.

# 2.03 ACCESSORY MATERIALS

- A. Accessory materials used for seaming sheets, sealing around pipes and geomembrane penetrations and other installation-related applications shall be submitted to the Engineer for approval.
- B. Metal batten strips, clamps, bands shall be a grade of 316 stainless steel. Fastening hardware, i.e., nuts, bolts, washers, screws, etc., shall also be a grade 316 stainless steel. The batten strip shall be 2 inches wide by 1/4 inch thick.
- C. Two (2) inch wide by 1/4 inch thick closed-cell, neoprene sponge shall be used around the geomembrane penetration.
- D. All geomembrane penetrations shall be sealed in such a manner, approved by the Engineer, as to provide a leak-proof seal around the penetrations.

# PART 3 – TRANSPORTATION, HANDLING, STORAGE, EQUIPMENT

### 3.01 DESCRIPTION

- A. The Contractor shall provide transportation, labor, and handling for delivery of the geomembrane to the project location. Special transportation or handling requirements required for the geomembrane shall be provided by the Contractor. The geomembrane shall be unloaded in the presence of the installer and/or representative of the County.
- B. The equipment for transportation, handling, loading and unloading the geomembrane shall be of sufficient size and capacity to safely and efficiently handle to geomembrane materials. The type, size, and capacity shall be according to Manufacturer/ Installer requirements.
- C. The Contractor shall provide all equipment and labor necessary for the loading, unloading, and handling of the geomembrane. The Contractor shall inspect the delivered materials for damage. Repairs, if approved by the Engineer, to damaged materials caused by transportation or handling of the geomembrane shall be at no additional cost to the County. Excessively damaged materials shall be rejected and replaced by the Contractor at no additional cost to the County.

- D. The materials shall be unloaded by the Contractor in areas designated by the County. If the County has not specified a storage area, the Contractor shall determine an area for storage of the materials to meet the project schedule requirements. In any case the materials shall not be stored or unloaded in areas which will impair the operations of the landfill facility or be deleterious to the materials.
- E. Storage and protection requirements of the materials shall be provided by the Contractor. Storage requirements for the materials shall be specified by the Manufacturer/Fabricator/ Installer. Protection shall be provided from puncture, cutting, ultraviolet radiation, precipitation, dirt or other damaging or deleterious conditions.
- F. The Contractor shall provide equipment and labor necessary for installation of geomembrane.

## PART 4 – GEOMEMBRANE MATERIAL ACCEPTABILITY

### 4.01 ON-SITE INSPECTION AND CONFORMANCE TESTING

- A. Upon delivery to the project site, the geomembrane material shall be inspected by the Contractor, Installer, and Engineer or County's Representative to confirm that proper labeling, transportation, handling, and storage procedures are followed. Damaged materials will be identified and repaired or rejected at the discretion of the Engineer or County's Representative. Materials to be repaired will be repaired following the repair specifications established for this project. Repairs will be at no additional cost to the County. Rejected materials will be identified and removed from the project site at no additional cost to the County. No material shall be off-loaded without the supervision of the Engineer or County's Representative.
- B. Upon delivery to the project site, the geomembrane shall be randomly sampled, by the Engineer or County's Representative, every 100,000 square feet of material to be installed. The on-site conformance sampling shall insure compliance with the specifications established for this project. This initial on-site conformance testing shall be at the County's expense.
- C. Samples shall be taken across the entire width of the rolls and shall not include the first 3-feet. The averaged test results of the geomembrane samples shall meet or exceed the contract specifications.
- D. Samples which do not satisfy the contract specifications shall be cause to reject applicable rolls. If a geomembrane sample fails to meet specifications, subsequent tests shall be performed at random on additional geomembrane samples produced from the same resin batch to determine whether all rolls produced from the same batch shall be regarded as unsatisfactory and therefore rejected. This additional testing, at no additional cost to the County, may be performed to more closely identify the rolls which do not comply with the specifications. Rejected rolls will not be installed and shall be removed from the project site at no additional cost to the County.

### 4.02 GEOMEMBRANE MATERIAL ACCEPTABILITY

Geomembrane materials shall be accepted, by the Engineer, for installation only upon receipt and approval of the following:

1. Information received and approved, by the Engineer, regarding resin quality control for delivered materials.

- 2. Information received and approved, by the Engineer, regarding geomembrane manufacturing quality control for delivered materials.
- 3. Approved repair methods established for damaged materials.
- 4. Interface shear strength of the actual components shall pass the design requirements after tested with method ASTM D5321 or an equivalent test method. (Interface friction angle (secant angle) of 26 degrees at loads 125 psf, 250 psf and 375 psf.)

## PART 5 – GEOMEMBRANE INSTALLATION

### 5.01 ENGINEER'S FULL TIME CONSTRUCTION QUALITY ASSURANCE MONITOR

- A. The Engineer's full time Construction Quality Assurance (CQA) Monitor shall observe a maximum of two (2) geomembrane seaming crews. If the Contractor and/or subcontractors chose to utilize more than two (2) seaming crews simultaneously, then additional full time CQA Monitor(s) will be required. Compensation for additional CQA Monitors shall be at \$75.00/hour and deducted from the Contract as part of the final change order. One (1) seaming crew is defined as follows:
  - (2) two personnel operating fusion welding machines;
  - (1) one personnel operating an extrusion welding machine;
  - (1) one personnel performing air test on seams;
  - (1) one personnel vacuum box testing
- B. The additional full time Resident Inspector(s) are in addition to the two required technicians.

## 5.02 EXECUTION

- A. The Installer shall submit information, prior to installation, on the following;
  - 1. All personnel performing supervisory and seaming operations shall be qualified by experience or certification. The Installer shall submit written information as follows:
    - a) Resumes of personnel performing the installation shall be submitted to the Engineer for approval. At least one seamer shall have experience seaming a minimum of 1,000,000 lineal feet of seam using the same type of seaming apparatus to be use on this project. The most experienced seamer shall provide direct supervision, as required, over the less experienced seamers. No field seaming shall take place without the Installer's site supervisor or foreman being present.
    - b) Resume(s) of supervisory personnel supervising the installation shall be submitted to the Engineer for approval. At least one supervisor shall have installation experience of a minimum of three (3) million square feet of similar geomembrane and experience using the same type of seaming apparatus to be use on this project.
  - 2. The Installer shall submit a Panel Layout and related installation details:
    - a) The panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison. The panel layout shall be on the installer's letterhead.
    - b) The panel layout shall indicate panel configuration, numbering, and dimensions, geomembrane penetrations, access roads, and berms. Factory seams shall be differentiated from field seams (if any). The layout drawing(s) shall indicate individual panel dimensions, estimated waste quantities, estimated installed square footage.

- c) The Installer shall submit drawings, using applicable drafting standards, detailing geomembrane details and cross sections showing seam overlaps for extrusion and fusion welds, geomembrane penetrations, booting details, geomembrane connection details and be sufficient in detail for construction.
- 3. Documentation shall be submitted, from the Installer, that the extrudate rods are from similar resin materials as the geomembrane resin specified for this project.
- B. Earthwork
  - 1. Geomembrane Subgrade Preparation: The Contractor shall be responsible for preparation the low permeability soil. Foreign objects such as rocks, sticks, glass, sharp objects, stones larger than 1/4-inch in diameter and any other harmful materials shall be removed from the surface of the geomembrane subgrade. Soil at the surface of the subgrade shall be graded to a smooth, even surface to ensure that the area is free of irregularities, loose earth and abrupt changes in grade. Perimeter anchor trenches shall be excavated to the lines and width shown on the plans prior to geosynthetic placement. All visible vegetation shall be removed. The Installer shall be responsible for inspection of the subgrade surface suitability in writing to the Contractor and Engineer prior to beginning geomembrane installation. This certification of acceptance shall be given to the Engineer, by the Contractor, prior to commencing geomembrane installation in the area being considered. Special care should be taken to maintain the prepared soil surface. Any damage to the subgrade caused by installation activities shall be repaired at the Contractor's expense.
  - 2. All required survey information and geotechnical testing shall be collected, reviewed, and accepted by the Engineer prior geomembrane deployment.
  - 3. The subgrade shall also be inspected by the Installer and Engineer or County's Representative prior to geomembrane deployment. The Installer and Engineer or County's Representative shall certify the acceptability of the geomembrane's subgrade. Rejected and unacceptable areas of the geomembrane's subgrade shall be repaired and reinspected before any geomembrane is deployed over this area.
  - 4. Anchor Trench: The anchor trench shall be excavated prior to geomembrane installation to the lines and grades shown on the drawings. The trench shall have the configuration as shown on the drawings. No loose soil shall be allowed beneath the geomembrane. The anchor trench shall be backfilled and compacted. Care shall be taken to prevent any damage to the geomembrane when backfilling the trenches. Slightly rounded corners shall be provided in the trench where the geomembrane turns down into the trench so as to avoid sharp bends in the geomembrane. The geomembrane shall be welded the entire length of the panel including through the entire dimensions of the trench.
- C. Geomembrane Deployment
  - 1. Layout Drawings: The Installer shall have received a set of layout and detail drawing submittal approved by the Engineer. If the Installer changes the configuration of the geomembrane or details, as shown on the approved submittals, due to field conditions, the Installer shall request prior approval by the Engineer. The layout drawings, as modified and/or approved by the Engineer shall become part of these specifications.
  - 2. Limits of Geosynthetic Deployment: The limits of geosynthetic deployment shall have the configuration as shown on the Drawings. The limits shall be surveyed and clearly identified, i.e stacked, to the Installer. Any deviations from the limits defined in the Drawings shall be approved by the Engineer and recorded on the Record (As-Built) panel layout.

- 3. Panel Identification for Field deployment: Each panel shall be given an "identification code" (number or letter-number) consistent with the layout plan. The panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.
- 4. Field Panel Placement:
  - a) Location: Field panels shall be installed as approved or modified at the location and positions indicated in the layout drawings. Instructions on the boxes or wrapping containing the geomembrane materials shall be followed to assure that the rolls and/or factory panels are unrolled and/or unfolded in the proper direction for seaming.
  - b) Installation Schedule: Field panels may be installed using any one of the following schedules:
    - 1) All field panels shall be placed prior to field seaming (in order to protect the subgrade from erosion by rain).
    - 2) Field panels shall be placed one at a time and each field panel shall be seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind).
    - 3) Any combination of the above.
  - c) Weather Conditions: Geomembrane placement shall not proceed at an ambient temperature below 40°F, unless otherwise authorized in writing by the Engineer. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of pond water, or in the presence of excessive winds.
  - d) Method of Placement: The Contractor shall ensure that:
    - 1) No equipment used shall damage the geomembrane by handling, trafficking, leakage of hydrocarbons or other means;
    - 2) No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
    - 3) The method used to unroll the panels shall not cause scratches, wrinkles, or crimps in the geomembrane and shall not damage the supporting soil;
    - 4) The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance, and must remain acceptable up to the time of geomembrane placement;
    - 5) Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels);
    - 6) Geomembrane panels shall be positioned in a slackened condition so that they will conform to subgrade irregularities without being stretched taut when covered with fill. Geomembrane panels shall be positioned such that excessive wrinkling does not occur at the overlaps where field seaming is to be completed; and
    - 7) Direct contact with the geomembrane shall be minimized; i.e., the geomembrane in excessively high pedestrian traffic areas shall be protected by geotextiles, extra geomembrane, or other suitable materials.

- e) Damage: Any field panel or portion thereof which becomes seriously damaged (torn, twisted or crimped) shall be replaced by the Contractor at no cost to the County. Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area.
- D. Field Seaming:
  - 1. Seam Layout: In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seams, (oriented parallel to the toe of slope) shall be permitted on sideslopes greater than 5(H):1(V) unless approved by the Engineer. No seams shall be located in the areas of potential stress concentrations.
  - 2. Geomembrane will have field seams whose shear strengths during testing are in conformance with the seam strengths specified in method GRI GM19.
  - 3. Requirements of Personnel: All personnel performing seaming operations shall be qualified as previously indicated.
  - 4. Overlapping and Temporary Bonding:
    - a) The panels of geomembrane shall be overlapped by a minimum of 3inches for extrusion welding, 5-inches for fusion welding, and 5inches for double wedge fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
    - b) The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of the air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.
    - c) No solvent or adhesive shall be used unless the product is approved in writing by the Engineer (samples shall be submitted to the Engineer for testing and evaluation).
  - 5. Seam Preparation:
    - a) Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
    - b) If seam overlap grinding is required, the process shall be completed according to the geomembrane Installer's instructions within one hour of the seaming operation and in a way that does not damage the geomembrane. The roughness of the grinding paper shall not exceed 80 grit.
    - c) Seams shall be aligned with the fewest possible number of wrinkles and no "fishmouths".
  - 6. Seaming Equipment and Products: Approved processes for field seaming are extrusion welding and fusion welding (hot air excluded). Only apparatus which have been specifically approved by make and model shall be used. Proposed alternate processes shall be documented and submitted for approval prior to any seaming being performed. Seam welding equipment shall be equipped with adequate temperature gauges to assure that proper seaming temperatures are maintained. Temperature gauges will be monitored, and readings recorded every four hours by the geomembrane Installer.

- Extrusion Process: The Installer shall provide documentation, for a) approval to the Engineer, on the welding apparatus planned to be used at the site prior to any geomembrane seaming work. The Installer shall provide documentation regarding the extrudate to the Engineer and shall certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resins as the geomembrane sheeting. The geomembrane Installer shall maintain at least one spare operable seaming apparatus on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be especially protected from damage in areas of heavy pedestrian or other traffic. The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat degraded extrudate. The electric generator shall be placed on a protective base such that no damage occurs to the geomembrane. Similarly, a protective insulation plate or fabric shall be placed beneath the hot welding apparatus after usage.
- b)
- Fusion Process: The Installer shall provide documentation, or approval to the Engineer, on the welding apparatus planned to be used at the site prior to any geomembrane seaming work. The fusion-welding apparatus must be automated vehicular-mounted devices. The fusion-welding apparatus shall be equipped with gauges giving the applicable temperatures and pressures. The geomembrane Installer shall maintain at least one spare operable seaming apparatus on site. Equipment used for seaming shall not damage the geomembrane, and the geomembrane shall be protected from damage in heavily trafficked areas. For cross seams associated with fusion welding, the edge of the cross seams shall be ground to a smooth incline (top and bottom) prior to welding. The electric generator shall be placed on a protective base such that no damage occurs to the geomembrane. Similarly, a protective insulating plate or fabric shall be placed beneath the hot welding apparatus after usage. A movable protective layer may be used directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets. The double wedge fusion welding apparatus must be a self-propelled unit containing a high-temperature split wedge used to melt the plastic along the weld lines on the overlapped panels. The geomembrane panels are then squeezed together by pressure rollers so that the two sheets fuse together. The temperature, pressure and welding speed are independently adjustable so that consistently high quality seams are produced. The split wedge system produces two fusion weld lines separated by an unwelded channel.
- 7. Weather Conditions for Seaming:
  - a) Unless authorized in writing by the Engineer, no seaming shall be attempted at ambient temperatures below 40°F or above 104°F. At ambient temperatures between 40°F and 50°F, seaming shall be allowed if the geomembrane is preheated by either sun or hot air device, and if there is no excessive cooling resulting from wind. At ambient temperatures above 50°F, no preheating shall be required. In all cases, the geomembrane shall be dry, clean and protected from wind damage.

- b) If the geomembrane Installer wishes to use methods which may allow seaming at ambient temperatures below 40°F or above 104°F, he shall demonstrate by seaming and testing trial seams under actual field conditions and he shall certify in writing that the seam so produced under these conditions is equivalent to those produced under normally approved conditions, and that the overall geomembrane's physical and chemical properties will not fall below the material and seam specifications for this project. In addition, an addendum to the contract between the County and the Contractor is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short- or long-term damage to the geomembrane.
- c) All seaming operations shall cease upon the presence of any precipitation (i.e., drizzle, sprinkle, etc.)
- 8. Trial Seams:
  - a) Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each four hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 3 feet long by 1-foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as previously indicated.

- b) Two adjoining specimens, each 1-inch wide, shall be cut from the trial seam sample by the geomembrane Installer. The specimens shall be tested respectively in shear and peel using a field tensiometer, and shall not fail the seam specifications established for this project. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved.
- c) After completion of the above described tests, the remaining portion of the trial seam sample can be discarded. Alternatively, the remaining portion of the trial seam can be subjected to destructive testing. If a trial seam sample fails a test, then a destructive test seam sample shall be taken from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Engineer and, if they fail the tests, the procedure indicated in Section 5.03 (D) 11 shall apply. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam(s).
- 9. General Seaming Procedures: The general seaming procedure used by the geomembrane Installer shall be as follows:
  - a) For fusion welding, a movable protective layer of plastic may be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.
  - b) Seaming shall extend the entire length of the panels, including seams within the anchor trench.

- c) If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
- d) If seaming operations are carried out at night, written approval, by the Engineer, shall be required 24 hours in advance of the intended night operation. Adequate illumination shall be provided. If during the course of the night operations, the Engineer or County's Representative decide the illumination is inadequate, proper illumination shall be provided or night operations shall be ceased. Contract specifications for placing and seaming the geomembrane shall apply to the night operations.
- e) Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.
- f) The seam bond strength shall be greater than or equal to the sheet.
- g) A width of 1-foot along the edge, and between the surfaces to be welded, of the liner hall be cleaned to remove all extraneous materials (i.e., sand, silt, oily films, water, etc.) which could be detrimental to the seaming process. The extraneous materials shall be wiped, brushed, or blown from the area to be welded.
- 10. Non-Destructive Seam Continuity Testing:
  - a) Concept: The geomembrane Installer shall non-destructively test all repairs and field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), or other approved method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Any required repairs shall be completed by the installer in accordance with Section 5.03 (D) 13. Test results shall be forwarded to the Engineer. The following procedures shall apply to locations where seams cannot be non-destructively tested:
    - 1) All such seams shall be cap-stripped with the same geomembrane.
    - 2) If the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.
    - 3) If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the Engineer for uniformity and completeness.
  - b) Vacuum Testing:
    - 1) The equipment shall be comprised of the following:
      - (a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
      - (b) A steel or aluminum vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

- (c) A rubber pressure/vacuum hose with fittings and connections.
- (d) A bucket, water and wide paint brush or mop.
- (e) A soapy solution.
- 2) The following procedures shall be followed:
  - (a) Energize the vacuum pump and reduce the tank pressure to approximately 10 inches of mercury, i.e., 5 psi gauge. All gauges shall read zero (0) psi when the vacuum pump is not turned on. Gauges not reading zero (0) psi shall be replaced.
  - (b) Wet a strip of geomembrane approximately 4 inches by 24 inches with the soapy solution.
  - (c) Place the box over the wetted area.
  - (d) Close the bleed valve and open the vacuum valve.
  - (e) Ensure that a leak tight seal is created.
  - (f) For a period of not less than 15 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles, which would indicate defects in the geomembrane.
  - (g) If no bubble appears after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.
  - (h) All areas where soap bubbles appear shall be marked and repaired in accordance with Section 5.03 (D) 13.
- c) Air Pressure Testing (For Double Fusion Seam Only): The following procedures are applicable to those processes which produce a double seam with an enclosed space.
  - 1) The equipment shall be comprised of the following:
    - (a) An air pump (manual or motor driven) equipped with a pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane. All gauges shall read zero (0) psi when the air pump is not turned on. Gauges not reading zero (0) psi shall be replaced.
    - (b) A rubber hose with fittings and connections.
    - (c) A sharp hollow needle, or other approved pressure feed device.
  - 2) The following procedures shall be followed:
    - (a) Seal both ends of the seam to be tested.
    - (b) Insert needle or other approved pressure feed device into the tunnel created by the fusion weld.
    - (c) Insert a protective cushion between the air pump and the geomembrane.
    - (d) Energize the air pump to a pressure between 25 and 30 psi, close valve, and sustain pressure for approximately 5 minutes.
    - (e) If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair in accordance with Section 5.03 (D) 13.

- (f) After a seam has passed a pressure test, release pressure at the end of seam that is opposite the air pump and pressure gauge assembly so as to ensure that the seam is continuous and has been completely tested.
- (g) Remove needle or other approved pressure feed device and repair in accordance with Section 5.03 (D) 13.
- d) All field fabricated geomembrane penetration boots shall be nondestructively tested before the boot is installed. The boot and boot seams shall be non-destructively tested, in addition to visual inspection, using one of the following methods - hydraulically, airpressure, or smoke. The Installer shall submit procedures for nondestructively testing field fabricated geomembrane penetration boots, for the Engineer's approval, prior to any geomembrane installation.
- 11. Destructive Testing:
  - a) Concept: Destructive seam tests shall be performed at selected locations by the Engineer. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.
  - b) Location and Frequency: Destructive test samples shall be collected initially at a minimum average frequency of one test location per 500 feet of seam length. The sampling frequency will be adjusted based on GRI-GM14 Standard Guide "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes". The Engineer reserves the right to increase the testing frequency should test results or seam conditions warrant. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding. The Engineer shall choose the locations. The geomembrane Installer will not be informed in advance of the locations where the seam samples will be taken.
  - c) Sampling Procedure: Samples shall be cut by the geomembrane Installer at locations designated by the Engineer as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. Each sample shall be numbered and the sample number and location identified on the Record (As-Built) panel layout drawing. A report completed by the installer's CQA personnel shall accompany each test strip listing the welder's number, date, time of day, welding machine's welding temperature, sheet temperature, sample location, and nominal thickness. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately repaired in accordance with the repair procedures described in Section 5.03 (D) 13. The continuity of the new seams in the repaired area shall be tested according to Section 5.03 (D) 10.
  - d) Size of Samples: The samples shall be 12 inches wide by 44 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the sample and these shall be tested in the field by the Installer. The remaining sample shall be cut into three parts and distributed as follows:
    - One portion to the Contractor for laboratory testing, 12 inches x 12 inches; and

- 2) One portion for the Engineer for laboratory testing, 12 inches x 18 inches; and
- 3) One portion to the Engineer for archive storage, 12 inches x 12 inches.
- e) Field Testing: The two 1-inch wide strips shall be tested, by the Installer, in the field, by hand or tensiometer, for peel and shear respectively and shall not fail to meet the specifications established for this project. If any field test sample fails to pass, then the procedures outlined in 5.03 (D) 13 shall be followed.
- Laboratory Testing: Testing by the Engineer will include "Seam f) Strength" and "Peel Adhesion". The minimum acceptable values to be obtained in these tests are those indicated in GRI-GM19. A total of five (5) specimens will be tested, from each sample, for each test method. Four (4) out of the five (5) specimens must pass for each test in order for the seam to pass destructive test. The results will not be averaged. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear). The Engineer will provide test results to the Contractor no more than 24 hours after the samples are received at the laboratory. The only exception shall be weekends or official holidays. On weekends and holidays the laboratories are closed. Arrangements to schedule testing of destructive samples on weekends and holidays shall be approved by the Engineer 24 hours in advance. Additional costs for lab work on holidays or weekends shall be at no additional expense to the County.
- g) Procedures for Destructive Test Failure: The following procedures shall apply whenever a sample fails the destructive test, whether the test is conducted by the Engineer's specified laboratory, the geomembrane Installer's laboratory, or by field tensiometer. The geomembrane Installer shall have two options, the cost of which shall be at no additional expense to the County:
  - 1) The geomembrane Installer can reconstruct the seam between any two passed test locations.
  - 2) The geomembrane Installer can trace the welding path to an intermediate location (at 10 feet) minimum from the location of the failed test in each direction) and take a specimen for an additional field test at each location. If these additional specimens pass the tests, then full laboratory destructive samples shall be taken. These additional tests shall be at the expense of the Contractor. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 130 feet of reconstructed seam, a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and/or welding apparatus or welded during the same time shift. Such additional testing shall be at the Contractor's expense.

- 12. Pipes Penetrating Geomembrane: All penetrations of leachate collection and stormwater piping shall be constructed according to the shop drawings approved by the Engineer before any installation.
- 13. Defects and Repairs:
  - a) Identification: All seams and non-seam areas of the geomembrane will be examined for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be broomed or washed by the Contractor if the amount of dust or mud inhibits examination. The Contractor shall ensure that this examination of the geomembrane precedes any seaming of that section.
  - b) Evaluation: Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 5.03 (D) 10, as appropriate. Each location which fails the nondestructive testing shall be marked by the CQA monitor and repaired by the geomembrane Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available, nondestructive testing passed and the repair has been documented by the Engineer or County's Representative.
  - c) Repair Procedures:

1)

- Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the geomembrane Installer. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Engineer and the Installer. The procedures available include:
  - (a) Patching: used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
  - (b) Grinding and rewelding: used to repair small sections of extruded seams.
  - (c) Spot welding or seaming: used to repair small tears, pinholes, or other minor, localized flaws.
  - (d) Capping: used to repair portions of failed seams, less than 5 feet in length. An extruded weld or fusion weld shall be permitted.
  - (e) Topping: used to repair inadequate seams areas, which have an exposed edge, for lengths of seams under 5 feet in length. An extruded weld will be permitted along the outside edge.
  - (f) Removing the bad seam and replacing with a strip of new material welded into place. Used with large lengths of fusion seams (greater than 5 feet in length). The strip shall be additional geomembrane material which is fusion welded over the failed seam. The cap strip shall be air-tested and vacuum tested.

- 2) In addition, the following provisions shall be satisfied:
  - (a) Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair.
  - (b) All surfaces must be clean and dry at the time of repair.
  - (c) All seaming equipment used in repairing procedures must be approved.
  - (d) The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Engineer and Installer.
  - (e) Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.
  - (f) The geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.
- d) Verification of Repairs: Each repair shall be identified, tested and logged. Each repair shall be nondestructively tested using the methods described in Section 5.03 (D) 10, as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the Engineer. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Contractor shall not cover any portion of the geomembrane until the Installer and Engineer have completed the documentation of the repair.
- e) Large Wrinkles: When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the Engineer shall identify all excessive geomembrane wrinkles. The geomembrane Installer shall cut and reseam all wrinkles so identified. The seam, thus produced, shall be tested like any other seam.
- f) Bridging or Induced Tension: Bridging is defined as areas where the geomembrane is not in contact with the subgrade due to a void in the subgrade or the sheet is pulled in tension so as to span over depressions in the subgrade. Areas likely to promote bridging, i.e., trenches, toe of slopes, etc., shall be loaded with sandbags after deployment and after seaming. Induced tension is stress introduced into the geomembrane during installation or covering. These areas will likely result in bridging. Areas bridging excessively shall be identified and repaired by either of the following methods:
  - 1) The geomembrane shall be cut, by the Installer, so the tension is relieved and the geomembrane conforms to the subgrade contours. The cut geomembrane shall be repaired and tested according to the specifications regarding repairs and testing.
  - 2) The geomembrane shall be cut, by the Installer, and subgrade material shall be added and placed, in accordance with the contract specifications, so as bring the geomembrane in contact with the subgrade. The cut geomembrane shall be repaired and tested according to the specifications regarding repairs and testing.

- g) Repairs, test sample locations, and defects in the geomembrane shall be replaced at no additional cost to the County until final acceptance of the geomembrane lining system. Repairs shall only be made by qualified members of the Installer's organization or authorized personnel.
- h) Wrinkles, gas bubbles, bridging, and inducing tension in the geomembrane system shall be avoided by the Contractor or subcontractors. Areas in the geomembrane which exhibit wrinkles, gas bubbles, bridging, and tension shall be repaired and documentation before any cover material is placed. These repairs will be at no additional cost to the County.

## PART 6 – MATERIALS IN CONTACT WITH THE GEOMEMBRANE

#### 6.01 GENERAL

- A. General: The following provisions require the Contractor to take all necessary precautions so that the installation of materials does not damage the geomembrane. Installation on rough surfaces, such as concrete, shall be carefully performed to minimize damage. If approved, additional loosely placed geotextile or geomembrane sections, may be used by the Contractor as protection for the geomembrane.
- B. Granular Materials: Placement of granular materials on the CDN shall not proceed at an ambient temperature below 40°F (5°C) or above 104°F (40 degrees C), unless otherwise approved by the Engineer. Equipment used for placing granular material shall not be driven directly on the exposed geomembrane. A minimum thickness of 1-foot of granular material is specified between a light dozer (such as a wide pad caterpillar D-4 or lighter) and the geomembrane. The dozer movement shall be forward and backward, no turning will be allowed until a minimum of 2 feet of cover is placed above the geomembrane. All turning of equipment will be off the area underlain by geomembrane. A minimum thickness of 3 feet of granular material is specified between rubber-tired vehicles and the geomembrane. In areas of heavy traffic such as access ramps, granular material thickness should be at least 3 feet. In any case, the following table shall be complied with:

Equipment Ground Pressure	Minimum Lift Thickness
psi	inches
<u> </u>	12
4-8	18
8-16	24
<u>≥</u> 16	36

C. Concrete: Geotextile or excess geomembrane layers shall be used between concrete and the geomembrane as required. Construction methods used shall not damage the geomembrane.

#### PART 7 – FINAL ACCEPTANCE

#### 7.01 GEOMEMBRANE ACCEPTANCE

The Contractor shall retain all ownership and responsibility for the geomembrane in the lining system until acceptance by the County. Full compensation for the geomembrane installation shall not occur until the geomembrane lining system is accepted by the County. The County will accept the geomembrane system when:

- 1. The entire geomembrane installation is completed.
- 2. All documentation of installation is completed, reviewed, and accepted by the County.
- 3. Verification of the adequacy of all field seams and repairs, including associated testing, is complete. This verification shall include field seams to existing geomembrane.
- 4. Written certification documents have been received and approved by the Engineer. Certifications documents include:
  - a) Final approval of all required submittals by the Engineer.
  - b) Record (As-Built) Drawings.
- 5. Upon completion of the covering operation, the Contractor shall certify the following to the County:
  - a) The geomembrane has been constructed in accordance with the approved project plans and specifications.
  - b) The cover material meets all requirements of the approved project plans and specifications. The geomembrane has not been damaged during the covering operation or construction.
  - c) Receipt of the special guaranties.

## 7.02 RECORD (AS-BUILT) DRAWINGS

- A. The Contractor shall submit a Record Panel Layout and related installation details of the actual geomembrane lining system:
  - 1. The record panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison. The record panel layout shall be on the installer's letterhead.
  - 2. The record panel layout shall indicate installed field panel and seam numbering, configuration and dimensions, geomembrane penetrations, access roads, and berms. Factory seams shall be differentiated from field seams (if any). The record panel layout drawing(s) shall indicate individual panel dimensions and estimated installed square footage.
  - 3. The locations of destructive samples with the correct corresponding sample number shall be located on the record panel layout.
  - 4. The record panel layout shall have surveyed locations of the limits of geomembrane deployment.
  - 5. The Installer shall submit detail drawings, using applicable drafting standards, of record (as-built) geomembrane penetrations details, booting details, and connection details, etc.
- B. The Contractor shall submit a Record Survey of spot elevations (grade shots) of the geomembrane elevations of the installed lining system:
  - 1. The record panel layout shall be drawn, using applicable drafting standards, to the same scale indicated on the Engineer's Drawings for easy comparison.
  - 2. The surveyor shall sign and seal the spot elevation survey.
  - 3. The spot elevations (grade shots) shall be taken at every 200 foot grid increment marker. The drawing shall indicate the design elevation prior to installation and the installed elevation at each survey point.
  - 4. The elevations (grade shots) of the terrace cross-section shall also be taken at every 100 foot increments.

### **END OF SECTION**

H:\S2Li Projects\Lake County\22-966 Astatula Phase III Closure Design\Addendum #2\Attachment 3-3 02776 - LLDPE - revised 9-1-22.doc

#### MANUFACTURER'S CERTIFICATION OF SUBSURFACE ACCEPTABILITY

Project:			Contract No:	
Date:				
Partial:	Final:			
Geomembrane Manufac Lake County Phase III A of geomembrane, unders areas shown on Attachm	turer	y certify that s ected condition llows:	upporting surfaces are acceptable 1 of constructed surfaces. This ce	for for installation rtification is for
Condition of supporting geomembrane and relate cover.	g surfaces in defined area n ed products including, but not	neets or exce limited to, co	reds minimum requirements for mposite drainage nets, GCL, and	installation of protective soil
Acceptance No.:	Area Accepted:	S.F. 7	Fotal Area Accepted to Date:	S.F.
Geomembrane Repres	entative			
Signed:				
Position		_		
Date:				
General Contractor's S	Superintendent			
Signed:				
Subgrade surface noted accordance with project	above was observed and has requirements.	s been tested	for compaction, as needed, and	found to be in
On-site Engineer's Fiel	d Representative			
Signed:		Date	:	
On-site County Reside	nt Project Representative			
Signed:		Date	:	_

#### MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

Contract Name:	Lake County Phase III Ash/MSW Cell Closure
County:	Lake County Solid Waste Division
Contractor:	
Engineer:	S2L, Incorporated
Material:	Linear Low Density Polyethylene (LLDPE) Geomembrane
Specification Section No:	02776

I, the undersigned Manufacturer's Representative, hereby certify that I am:

- 1) A duly authorized representative of the Manufacturer.
- 2) Empowered by the Manufacturer to inspect and approve the installation and repair of the material(s) identified above.
- 3) Authorized to make recommendations required to assure that the installation and/or repair of the material(s) furnished by the Manufacturer are complete and functional, except as may be otherwise indicated herein.

I further certify that:

- 1) The above referenced material(s) was installed in accordance with the (i) County's plans and specification, (ii) Manufacturer's and Installer's Quality Assurance Programs, and (iii) Manufacturer's Pro-Rata Limited Installation Warranty.
- 2) All repairs to the above referenced material(s) performed by the Manufacturer and/or Installer prior to the Final Completion date of \_\_\_\_\_\_ were performed in accordance with the (i) County's plans and specification, (ii) Manufacturer's and Installer's Quality Assurance Programs, and (iii) Manufacturer's Special Guarantees and warranties.
- 3) All information contained herein is true and accurate.

Date:\_\_\_\_\_

Manufacturer: \_\_\_\_\_

Manufacturer's Authorized Representative:

(Authorized Signature)

(Print Name)

H:\S2Li Projects\Lake County\22-966 Astatula Phase III Closure Design\Addendum #2\Attachment 3-3 02776 - LLDPE - revised 9-1-22.doc